



## **Hotliner Application Note**

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**TEN - SUPER TEN - HDR**

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# Introduction

These instructions are intended for telephone and power company personnel who plan to use the SNC Transformer Exciting Network (TEN), Super TEN, or Harmonic Drainage Reactor (HDR). The instructions explain how to find the proper location for these drainage devices, how to test that location to determine the proper placement, and how to install the drainage device. All testing and installation procedures are explained in detail. SNC recommends that you read the entire set of instructions before you begin field testing.

## A Message on Safety

SNC Manufacturing Co. is concerned about your safety. Read these instructions carefully. Pay strict attention to all DANGER, WARNING and CAUTION statements. When you see these statements, take heed - your personal safety, the safety of your co-workers, and the safety of your equipment may be at risk.

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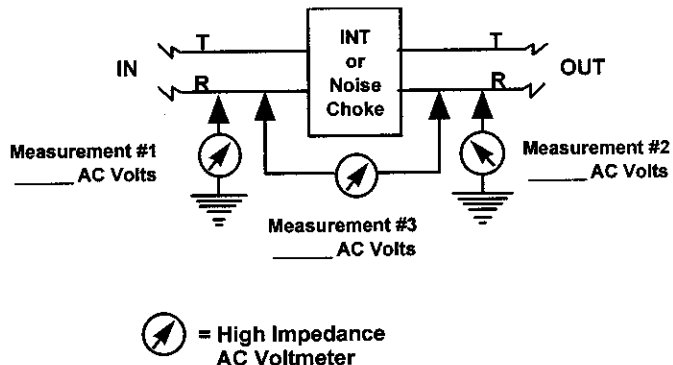
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## 1. SYMPTOMS

- No spare cable pair available to excite an Induction Neutralizing Transformer (INT).
- Excessive 50/60 Hz AC induced voltages on a single circuit.
- INT or Noise Choke fails to "self excite".
- Facility has noticeable shock voltage to the touch.
- Wire line causing noise on serving cable.
- Excessive harmonic "Power influence".



**Figure 1: AC Voltage Measurements**

## 2. PROBLEMS TREATED

- Need for a low impedance path-to-ground for induced 50/60 Hz longitudinally induced power line interference currents to flow through and produce magnetic flux, which excites or "turns-on" an INT or noise choke.
- Unshielded wire line has high electrostatic voltages.
- Need for a longitudinal drain to reduce voice-frequency harmonic noise influence.

## 3. TEST PROCEDURES

### A. Field Located INT.

**3.01** If there is no spare pair available through a field located INT for use as an "exciting pair" and the transformer does not appear to be performing as desired, make the following measurements on any selected pair at the transformer location. (INTs need exciting current "flow" to produce magnetic flux and, in turn, high mutual impedance in the primary/exciting pair. This induces counteracting voltage in the secondary pairs.) Record these measurements on the "Diagnostic Test Work Sheet" in the Appendix.

**NOTE:** A single power exposure or interference source is assumed. Multiple exposures may require a more thorough evaluation than what is included in these instructions.

- (a) Using a high impedance AC voltmeter, measure and record the AC voltage, tip (T) or ring (R) to ground, on the central office (CO) side of the transformer. See Figure 1, measurement #1.

**NOTE:** "T" and "R" are designated as "a" and "b" in some places.

- (b) Measure and record the AC voltage, T or R to ground, of the same pair on the field or remote side of the transformer. See Figure 1, Measurement #2.

- (c) Measure and record the AC voltage across the transformer, T-IN to T-OUT or R-IN to R-OUT. See Figure 1, measurement #3.

- (d) If measurement #3 approximately equals the total of measurements #1 and #2, the transformer is "excited" and working properly. If not, see step e.

- (e) If measurement #3 is less than either measurement #1 or #2, the transformer may not have enough exciting current. A Transformer Exciting Network (TEN) placed on the far end of a working single party subscriber's line will provide a low impedance path for 50/60 Hz exciting current to flow and excite the unit.

**Note:** The "far end" is the "subscriber", "remote terminal", or "station" end of a pair, while the Central Office (CO) is the "near end".

### B. CO or Station Located INT or Chokes.

**3.02** If the INT is CO or station located with no spare pair available for the transformer "exciting pair", and the transformer is not effectively limiting noise and voltage, make and record the following measurements. Chokes without any exciting current are also ineffective.

- (a) To insure measurement of AC voltage only, use a high impedance AC voltmeter. Measure and record the AC voltage, tip (T) or ring (R) to ground, on the central office (CO) side of the transformer. See Figure 1, measurement #1.

(b) Measure and record the AC voltage, T or R to ground of the same pair on the field or remote side of the transformer. See Figure 1, Measurement #2.

(c) Measure and record the AC voltage across the Choke or INT, T-IN to T-OUT or R-IN to R-OUT. See Figure 1, measurement #3.

(d) If the Choke or INT is functioning correctly, the measurement across the Choke or INT should equal the difference of the field side measurement minus the CO side measurement (subtract measurement #1 from measurement #2). If not, see step e.

(e) If measurements #1 and #2 are nearly equal and measurement #3 is near zero, the Choke or INT has no exciting current through it. A TEN placed on the far end of this circuit should provide the low impedance path-to-ground and enough longitudinal current flow necessary to "excite" or "turn-on" the Choke or INT.

**NOTE:** Under some circumstances, it will be advantageous to substitute a Super TEN or Harmonic Drainage Reactor (HDR) for the TEN. See "Solution Principles" for details and use of the Super TEN and HDR.

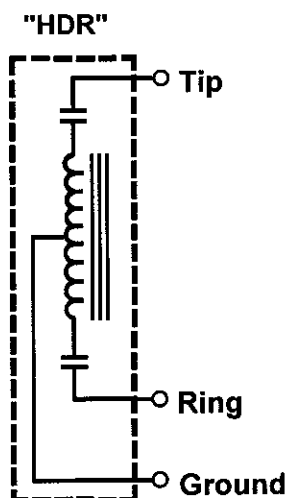
#### 4. SOLUTION PRINCIPLES

**4.01** Most CO line circuits have a low longitudinal AC impedance path-to-ground via the line relays, talk battery or other terminal equipment. The HDR, TEN and Super TEN also provide a path-to-ground for the longitudinal AC currents to flow. INTs and Noise Chokes both require a minimum amount of longitudinal current to flow through their windings to function properly. Placing an HDR, TEN or super TEN on the far end of a working subscriber's line that is equipped with an INT or Noise Choke will provide a path for the longitudinally induced interfering currents to flow.

##### A. Harmonic Drainage Reactor (HDR)

**4.02** The HDR is a broadly tuned, well balanced mutual drainage reactor. Electrically it contains two closely matched capacitors connected to the ends of a center tapped, grounded inductor. This arrangement provides a low longitudinal impedance (Z) path-to-ground while maintaining a high Z to metallic current flow. See Figure 2.

**4.03** The HDR (Fig. 2) is noted for its wide voice-frequency band current drainage capability of the longitudinally induced harmonics (power



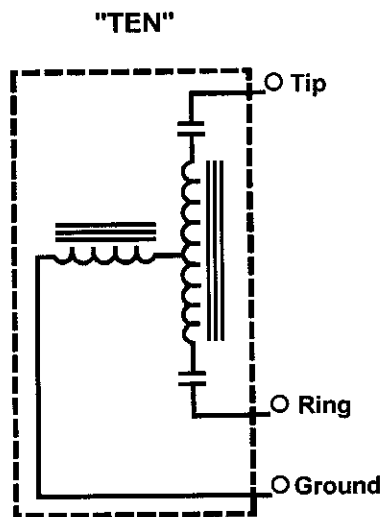
**Figure 2: Harmonic Drainage Reactor (HDR)**

influence), that cause audible noise.

##### B. Transformer Exciting Network (TEN)

**4.04** The TEN (Fig. 3) is a well balanced capacitively coupled two inductor mutual drainage reactor. Although electrically similar to the HDR, the use of the second inductor gives the TEN its lowest longitudinal Z to ground at the fundamental frequency (50/60 Hz) of the power line, while maintaining a high Z to metallic current flow.

##### C. Super TEN

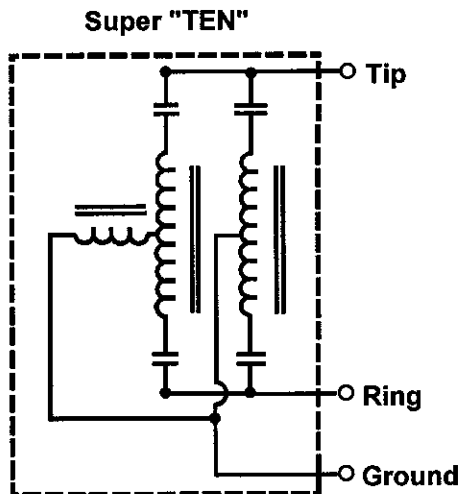


**Figure 3: Transformer Exciting Network (TEN)**

**4.05** The Super TEN (Fig. 4) is a combination HDR/TEN. The HDR and TEN are bridged together and arranged to take advantage of the unique properties of each.

**5. INSTALLATION NOTES**

**5.01** The HDR, designed as Model AP149, has a black, weather-resistant plastic case and is provided with a 36 inch long jacketed three conductor 22 gauge wire lead. It has two mounting



**Figure 4: Super TEN**

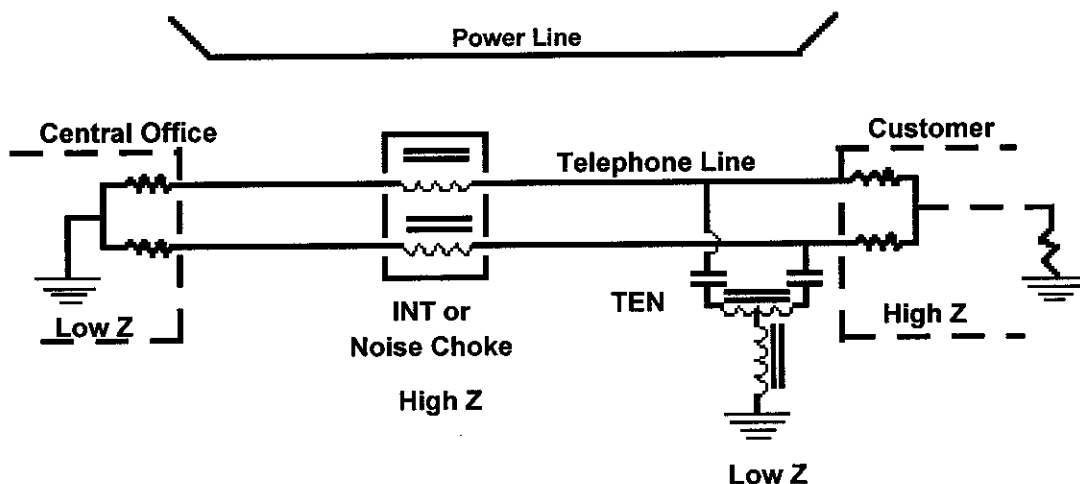
holes in the plastic case; one at the top and one at the bottom. Number 8 screws are recommended for mounting.

**5.02** The Super TEN, designated as Model AP161, and the TEN, designated as TEN-P, are packaged in a round plastic weather-resistant tube with a 36 inch long 3 conductor wire lead.

**5.03** All three products are connected to the circuit by bridging the T (Green) and R (Red) wires of the unit across the T and R of a cable or wire line facility. The ground (Yellow) wire is then connected to a good low Z earth ground, such as a power company multigrounded neutral ground.

**5.04** A TEN or Super TEN may be placed wherever an exciting pair ground is specified to excite an INT. An HDR alone may not provide a low enough longitudinal impedance to ground to adequately excite an INT at the fundamental power line frequency.

**5.05** Although not originally designed as "stand alone" devices, the HDR, TEN and Super TEN can all be used alone. They are effective in reducing electro-static induction. However the TEN and Super TEN also reduce magnetically induced voltage if placed near the high Z end of a subscriber's line. Voltage reduction results from their low Z to ground. "Stand alone" application should always be limited to high impedance



**Figure 5: Typical "TEN" Installation**

induction sources (generally electrostatic) to achieve the most effective induced voltage reductions of 90% or better.

**5.06** A standard HDR, TEN or Super TEN should only be used at a location where regular primary station protection is provided. A standard HDR or Super TEN, along with a weather proof 3 element gas tube protector, attached to an anodized aluminum support bar becomes an AP157 or an AP158, respectively. The AP157 and AP158 may be placed wherever a protected unit is required. These are typically used in "open wire" applications.

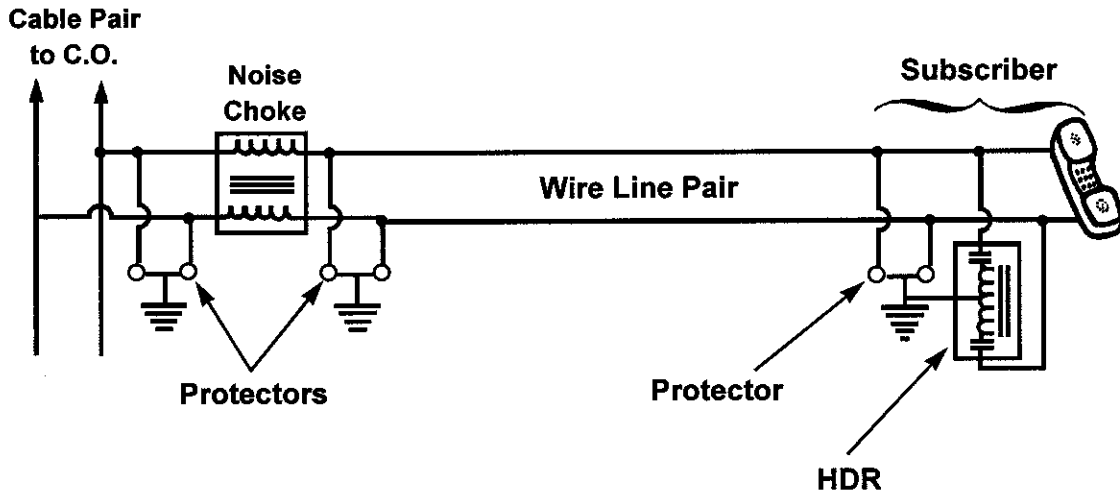
**5.07** A well balanced pair should always be selected for use with a TEN or Super TEN. Since these units provide a low impedance path for longitudinal AC influence currents to flow, their use on a resistively unbalanced pair may result in increased noise on that circuit.

## 6. ADDITIONAL INFORMATION

**6.01** Normally only one TEN or Super TEN is necessary to excite each INT. However, there have been occasions where the use of TENs or Super TENs on more than one pair was needed to adequately excite an INT.

**6.02** Keep in mind that the use of these units directly on the high frequency line of a carrier system will result in some bridging loss. This loss increases with frequency and should be considered in the system design. The TEN can have bridging losses ranging from less than 0.1 dB at 10 kHz to near 4.0 dB at 1.5 MHz. The HDR and Super TEN range up to near 7.0 dB at 1.5 MHz.

**6.03** Multi-party subscriber lines using harmonic ringing frequencies near the specified frequency of a TEN or Super TEN may be affected by their presence on the line.



**6.04** An effective application of the HDR is to help keep the longitudinal power influence of an unshielded wire line from "noising up" the other pairs in its serving cable. To help solve this problem a protected noise choke can be placed at the junction of the serving cable and the wire line. Then an AP149 or AP157, whichever is appropriate, is placed near the far end of the line. See Figure 6.

This arrangement results in a reduced voltage-to-ground at the subscribers end of the circuit. It places a high longitudinal impedance to the usually high longitudinal power line influence of the unshielded wire line at the junction of the serving cable. The interference is therefore current limited at the choke and kept out of the serving cable.

**6.05** Some of the newer electronic switching systems, such as AT&T's #5ESS, have a high longitudinal AC impedance-to-ground. An INT or noise choke, if used on the cable facilities out of this type CO, may require one of these drainage reactors at or near the CO. This would assure an adequate, low AC impedance path-to-ground at the CO end of the circuit.

It may also be desirable to place this second TEN or Super TEN at or near the CO to make sure that the exciting current path of the INT is not inadvertently interrupted due to a subscriber line (exciting pair) disconnect at the CO.

**6.06** In most cases, if the problem being resolved is basically 50/60 Hz in nature, a TEN should be used. If the problem is noise with little

fundamental power line frequency influence, an HDR may be adequate. However, if both noise and high 50/60 Hz influences are present, a Super TEN would be the appropriate choice.

**A. Single Noise Interference Xterminator (SNIX)**

**6.07** For single circuit applications at the station end, SNC has a Single Noise Interference Xterminator (SNIX) and a Super SNIX. The SNIX incorporates a noise choke, with an HDR providing the path for exciting current to flow through the noise choke to ground. The Super SNIX also has a noise choke, but it uses a Super TEN to provide the path-to-ground.

**B. Telecom Line Conditioner (TLC)**

**6.08** For multi-circuit applications at the circuit end, SNC has a Telecom Line Conditioner (TLC) that incorporates a Super TEN on the first pair of an INT. The TLC is encapsulated in a fiberglass housing with ten foot long cable tails, in and out, for connecting into the telephone network.

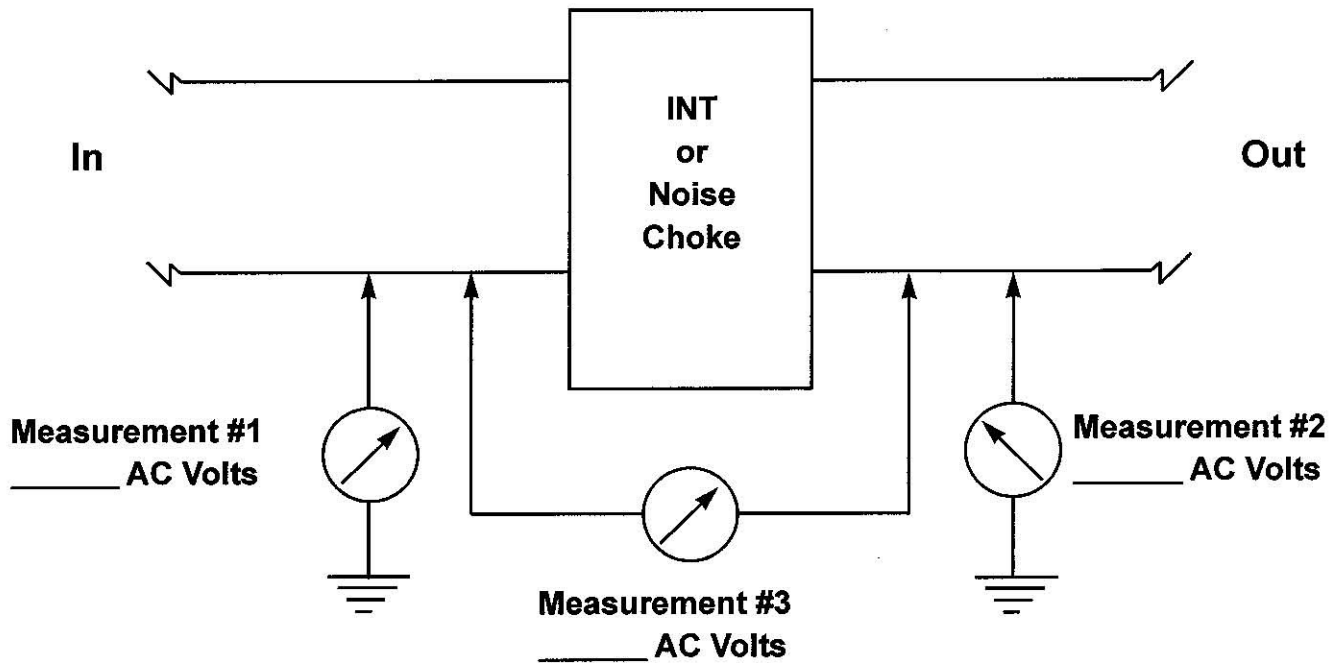
**Typical Characteristics**

Model Number	Impedance T and R to Ground ( $\Omega$ @ 50/60 Hz)	Net Weight (Pounds)	Physical Size Length X Width X Depth (Inches)
TEN	170	3.0	5.5 x 2.3 Dia.
AP161 (Super TEN)	160	3.25	6.50 x 2.3 Dia.
AP158 (Prot. AP161)	160	4.0	10.88 x 3.0 x 2.62
AP149 (HDR)	1350	1.0	3.0 x 2.0 x 1.5.
AP157 (Prot. HDR)	1350	1.5	7.25 x 3.0 x 1.62

Bridging Loss = <0.10 dB @ 1KHz (All Units)

Impedance Tip to Ring = >20 K Ohms @ 1 KHz (All Units)

# "TEN" Diagnostic Tests Work Sheet



 = High Impedance Voltmeter

Use the Measurements Above to Complete the Calculations Below.

## Field Located INT Calculations

$$\text{Measurement \#1} + \text{Measurement \#2} = \text{Measurement \#3}$$
$$(\quad) + (\quad) = (\quad)$$

## Noise Choke, Central Office or Station

### Located INT Calculations

$$\text{Measurement \#2A} - \text{Measurement \#1A} = \text{Measurement \#3A}$$
$$(\quad) - (\quad) = (\quad)$$



Contact SNC Manufacturing Co. for further  
information on these quality  
Noise Solution products:

- Induction Neutralizing Transformer (INT)
- Digital Induction Neutralizing Transformer (DINT)
- Single Noise Interference Xterminator (SNIX)
- Noise Chokes
- Transformer Exciting Network (TEN)
- Harmonic Drainage Reactor (HDR)
- Glitch Tamer
- Telecom Line Conditioner (TLC)
- Harmonic Suppression Reactor (HSR)
- HumZapper
- Li'l Zapper

For further information or for technical support call  
800-558-3325 – or visit – [www.sncmfg.com](http://www.sncmfg.com)



**SNC Manufacturing Co., Inc.**

101 West Waukau Ave., Oshkosh, WI 54902-7299  
800-558-3325 or 920-231-7370 FAX 920-231-1090

E-mail: [telecom@sncmfg.com](mailto:telecom@sncmfg.com)

Website: [www.sncmfg.com](http://www.sncmfg.com)