THE AMERITECH ISDN WIRING GUIDE FOR ISDN DIRECT IN RESIDENCES AND SMALL BUSINESSES

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How to Use These Guidelines

This document contains wiring and powering guidelines for ISDN Direct in residential and small business environments. This preface is intended to provide information describing the structure of this document and to guide the reader through the remaining sections of this document. It is recommended that the reader review the Important Safety Information before beginning any wiring or powering installation or modification.

Section 1 of this document contains an introduction to POTS terminology, such as:

- Plain Old Telephone Service (POTS), The 12 Inch Rule, Demarcation Point.

- Star wiring, Daisy Chain wiring, Distribution Devices, Outlets, Jacks.

Section 2 is an introduction to Integrated Services Digital Network (ISDN) concepts, which include:

- ISDN Connectors, ISDN Cable and Outlets, U interface.

- Network Termination 1 (NT1), NT1 Timing, S/T interface.

- Terminal Equipment, Extension phones.

Section 3 is an introduction to powering considerations for ISDN in a residence or small business.

Section 4 will assist the reader in wiring ISDN to a single target room using existing wiring if:

- There is a POTS line in place and ISDN will be added to an unused pair.

- There are at least two POTS lines in place and one will be converted to ISDN.

Section 5 will assist a reader in wiring and powering ISDN lines, using new wiring, to a single target room in the residence or small business.

Section 6 will assist a reader in wiring and powering ISDN lines, using new wiring, to multiple target rooms in the residence or small business.

Appendix A provides guidelines describing the 12 Inch Rule.

Appendix B provides notes on the optioning of some NT1 devices.

Foreword

Ameritech is one of the most aggressive regions in the deployment of ISDN Basic Rate (ISDN Direct) Service. In order to support this aggressive deployment strategy, the Network Services Unit has been very active with marketing groups within Ameritech and in a National Forum to develop wiring and powering guidelines for the installation of ISDN Direct in residential, small and large businesses. In order to provide Ameritech's installation forces with the most up to date information possible, this Training Manual was produced.

The Wiring and Powering Adhoc Group of the North American ISDN User's Forum (NIUF) is continuing to develop guidelines for the installation of ISDN Direct. Currently, these guidelines are out for industry review and describe the installation of ISDN Direct to Single and Multiple Target rooms utilizing existing and new wiring. Additionally, specific information needed by Ameritech Installation forces (e.g., ordering codes for new wire, NT1 options, etc.) has been integrated into this version of the document.

Not all issues have been resolved at the time of this document's printing. For example, extension phone capabilities and large business wiring scenarios are still being ironed out within the NIUF. This document will be re-issued when new information becomes available.

The first two issues of the ISDN Wiring Guide were written by a very talented engineer and writer: William A. Grabowski. This release (issue 3) reflects the updated Ameritech view of the network interface, as well as other items that are specific to Ameritech. In addition, a new section (section three) on ISDN powering is included. Revisions to this document should be sent to:

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1. Introduction

Integrated Services Digital Network (ISDN) is a digital communications technology with a great potential for the transport of all kinds of information. ISDN, as described in both domestic and international standards, is gaining widespread acceptance in commercial and industrial environments. The purpose of this document is to extend the use of ISDN to the single family home and small (store front) business by providing detailed guidelines for wiring and powering residential ISDN. The information is presented at a level of detail suitable for the electrician, wiring installer, or interested homeowner. This document recognizes that adherence to wiring standards will make the wiring more flexible for multiple applications and consequently promotes

standard wiring practices. It is intended that this document will be used as a practical tool to plan and prepare the home or small business for ISDN service.

2. Scope

This document describes wiring and powering practices for ISDN in residential and small business environments. It addresses these practices. The document includes guidelines for components, methods of installation, configuring, and powering of Basic Rate ISDN circuits.

This document does not address all cases of existing wiring, especially those that do not conform to standard wiring practices. The document avoids the theory of ISDN and the variety of application possible or the different types of vendor specific equipment that can be attached to ISDN in the home or small business. The user is referred to additional documents for such information.

3. Reason for Re-Issue

Issue 1 of this document is based, in part, to N/UF document number NIU/ICSW/BRI/022 dated June 21, 1994.

Issue 2 of this document is based, in part, to NIUF document number NIU/ICSW/BRI/XXX dated October 6, 1994. At the time of this document's printing, the NIUF document was out for industry commend and review.

Issue 3 of this document is based on the group-stable document (dated October 6, 1994) shown above. Changes update the document with current Ameritech policies and add a section on ISDN powering (Section 3)

Important Safety Information

- DO NOT WORK ON YOUR TELEPHONE WIRING AT ALL IF YOU WEAR A PACEMAKER. Telephone lines carry electrical current. To avoid contact with electrical current:

- Never install telephone wiring during a lightning storm.

- Never install telephone jacks in wet locations unless the jack is specifically designated for wet locations.

- Use caution when installing or modifying telephone lines.

- Use a screwdriver and other tools with insulated handles.

- You and those around you should wear safety glasses or goggles.

- Be sure that your inside wire is not connected to the access line while you are working on your telephone wiring. If you cannot do this, take the handset of one of your telephones off the hook. This will keep the phone from ringing and reduce, but not eliminate, the possibility of your contacting electricity.

- Do not place telephone wiring or connections in any conduit, or outlet junction box containing electrical wiring.

- Installation or inside wire may bring you close to electrical wire, conduit, terminals and other electrical facilities. EXTREME CAUTION must be used to avoid electrical shock from such facilities. You must avoid contact with all such facilities.

- Telephone wire must be at least 6 inches from base power wiring or lightning rods and associated wires, and at least 6 inches from other wire (antenna wires, doorbell wires, wires from transformers to neon signs), stream or hot water pipes, and heating ducts.

- Before working with existing inside wiring, check all electrical outlets for a square telephone dial light transformer and unplug it from the electrical outlet. Failure to unplug all telephone transformers can cause electrical shock.

- Do not place a jack where it would allow a person to use the telephone while in a Bathtub, shower, swimming pool, or similar hazardous location.

- Protectors and grounding wire placed by the service provider must not be connected to, removed, or modified by the customer.

1. AN INTRODUCTION TO WIRING AND POWERING CONSIDERATIONS FOR PLAIN OLD TELEPHONE SERVICE (POTS)

1.1. General

This section addresses the wiring and powering practices used to provide your current (pre-ISDN) phone service that is also called Plain Old Telephone Service **(POTS)**. For simplicity the words 'house', 'home' and 'residence' are used to refer to both a single family residence and a small business. As stated in the document introduction, "The information is presented at a level of detail suitable for the electrician, wiring installer, or interested homeowner."

The discussions in this section are limited to single line and dual line service installations. It answers questions such as: "How are the wires run within the house?" "Where does my POTS phone get the electrical power to operate from?" "How can I find the location where the Telephone Company's wire stops and the internal house wire starts?" and "What types of cables am I likely to find in my house?" In addition, a number of terms common to both POTS and ISDN are introduced.

Why are POTS considerations being addresses in a document, whose stated scope is limited to "... wiring and powering practices for ISDN in residential and small business environments...?" The authors believe that a basic background in POTS concepts is invaluable to understanding the remainder for this document and will aid in the understanding of in-house ISDN requirements.

If you are familiar with the following terms and their associated concepts you can skip to Section 2:

Bridging and Bridged Taps Category 3 UTP Cable

Daisy Chain Wiring configuration Network Interface

Dual Line Service Earth ground connection

EIA/TIA wiring standards Modular Jacks and Plugs

POTS Quad Cable (JK wire & FT4 station wire)

Ring wiring configuration Single Line Service

Star wiring configuration Terminal Equipment

Twisted Pair Unshielded Twisted Pair (UTP)

1.1.1. Terminology

This section introduces terminology that is commonly used when discussing both POTS and ISDN. New terms that are defined the first time they are used and a glossary at the end of the document provide definitions for frequently used terms. Terms that are in the glossary in bold type the first time they are used.

1.2. POTS Components

Figure 1.1 shows the typical components that are used to distribute POTS throughout the residence. This figure, one of many possible wiring arrangements, is intended to introduce useful terms and wiring components. A more detailed discussion of POTS wiring arrangements is provided in Section 1.3. The components and concepts discussed here are:

- Network Interface (NI)

- Premises Wiring

- Star, Daisy Chain And Home-run Wiring

- Phone Outlets (Jacks) and Mating Plugs

- Distribution Devices

- Extension Bridge

- Extension Cords and Line Cords

- FCC Inside Wire Docket 88-57 — also called the 12" Rule

- Jack Adapters

- POTS Terminal Equipment

Not all of the components described here are readily available in consumer outlets and you may have to order from product catalogs.

1.2.1. The Demarcation Point (Demarc)

The single line service, such as that shown in Figure 1.1, is delivered to the house, from the Telephone Company's building (Central Office) on two wires. By law, the Telephone Company's responsibility ends at the location where these wires are delivered to the residence. This location where the homeowner's responsibility starts is called the demarcation point (demarc). In

other words, the demarc is the dividing line between the Telephone Company's wire and the homeowner's in-house wire. The physical device that provides the means to connect the Telephone Company's wire to the in-house wire is called a Network Interface (NI). In order to reduce complexity, the term Network Interface (NI) will not be used in these guidelines, instead we will refer to both the legal separation point and the physical connection device as the NI. If you have a two line service there will be one connection point, or NI. The NI may be located inside or outside your house.
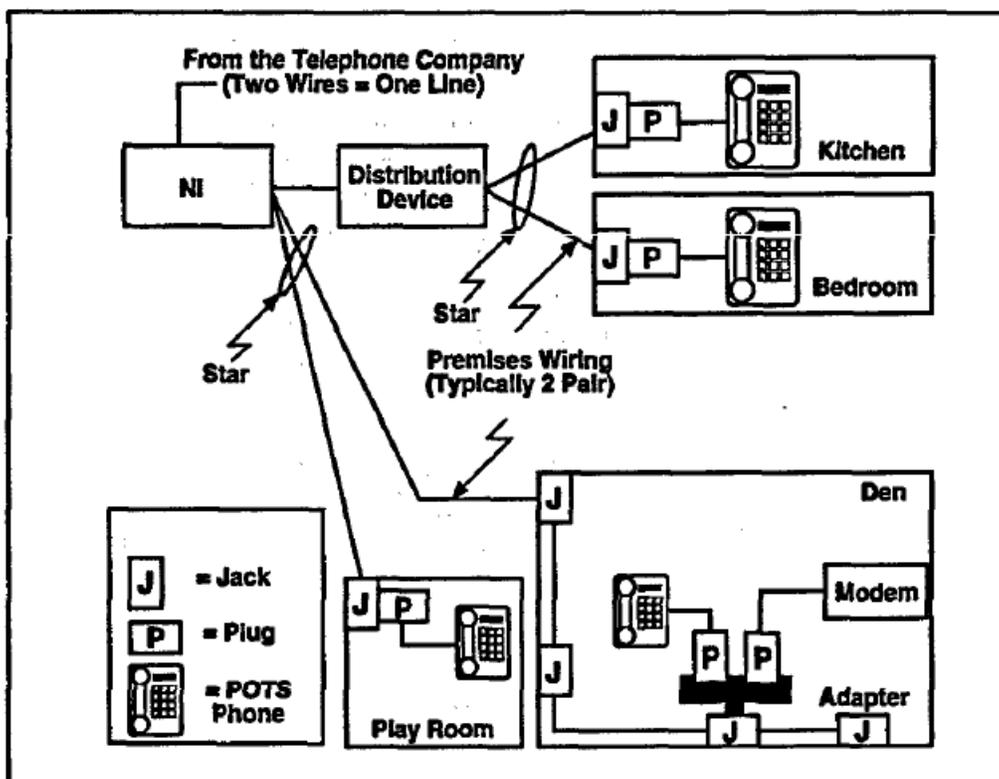
Figure 1.1
Typical POTS Components

While there are differences between NI devices, there are only two general types. In these guidelines these are referred to as "Older Type of NI" and "Newer Type of NI". If your premises wiring has been in place for a long time, you may not have a NI, in which case your cables will be connected directly to a device called a **Protector Block**. The older type of NI and protector blocks are discussed in Section 1.2.1.1 and the newer type of NI is discussed in Section 1.2.1.2. The NI and/or protector blocks that are installed in our house may look different from those shown in these guidelines since there are many physical variations of these devices.

1.2.1.1.   The Protector Block and the Older Type of NI

The protector block, shown in Figure 1.2 (a) and in Figures 1.2 (b) and 1.2 (c), is the telephone line termination device that you are most likely to find in your house. This block may be directly connected to the in-house cables as shown in Figure 1.2 (a) or it may be connected to a NI device such as the service outlet of Figure 1.2 (c).
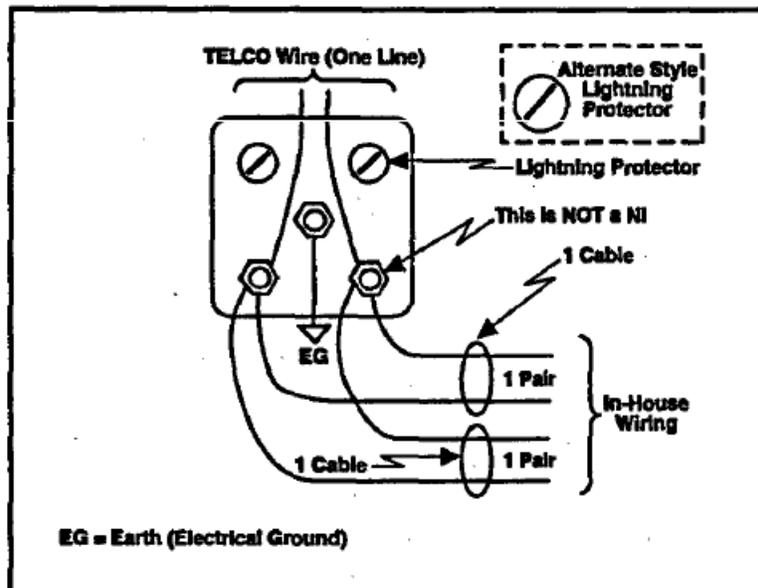
Figure 1.2 (a)
Typical Protector Block
with In-House Wire Connections

A protector block consists of a plastic block with three threaded posts, each with washers and mating nuts, used as wire connection points and devices that look like two bolt heads (hex or slotted). Not shown is the hardware used to physically attach the block to the house.

Caution: The devices that look like bolts are not bolts, they are LIGHTNING PROTEC- TORS.

It is usually easy to determine which are the in-house wire connection points since the lightning protection devices will not have wires connected, but if you are unsure get professional help.

Warning: NEVER unscrew the Lightning PROTECTION devices and NEVER work on your in-house wiring during a thunder storm.

The center threaded post of the protector block, is used for a connection to earth ground as part of the block's lightning protection circuit. While this wire is connected to ground point, usu-

ally a nearby water pipe, by the Telephone company **(TELCO)** at installation, it is always a good idea to check that there is a solid connection.

Warning: NEVER disconnect the earth ground! If you find it disconnected you should contact your local telephone company.

The other two threaded posts on the protector block are used to connect your in-house wire with the Telephone Company's line, either directly as shown in Figure 1.2 (a) or indirectly as in Figure 1.2 (b). There will be a separate protector block for each telephone line coming into your house.

If your in-house cables go directly to the protector block's threaded posts as shown in Figure 1.2 (a), there may be a number of different pairs attached to these posts. In the figure, two pairs (4 wires) in two separate cables are used for the in-house wiring and one pair for the Telephone Company's wire. It is important to understand that, in this case, there is no legal demarcation point. Before making any changes to your in-house wiring you will have to understand the restrictions associated with, what is commonly called, the 12" Rule. Section 1.2.1.1.1 provides a short introduction to the 12" Rule and Appendix A provides more detailed information as well as outlining the procedures associated with creating a legal demarcation point.
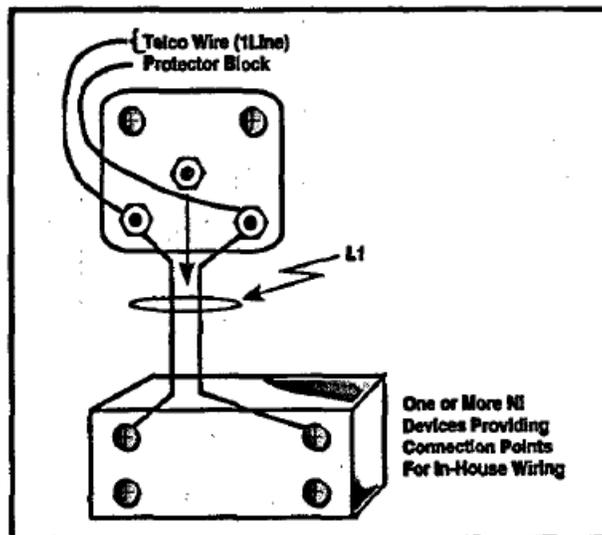
Figure 1.2 (b)
Older Type NI

Warning: If your configuration is like that of Figure 1.2 (a), it is important to understand the restrictions related to the 12 inch Rule, described below and in Appendix A.

In some homes the Protector Block may be wired directly to one or more intermediate devices as shown in Figure 1.2 (b) and the example of Figure 1.2 (c). In this case there are usually only two pairs of wires connected to a protector block, one for the wire from the Telephone Company and one pair, labeled L1 in Figures 1.2 (b) and (c), connecting the phone line to the device that provides the legal demarcation point. **Typically the device that the L1 pair terminates on provides the type of legal demarc referred to as the "Older Type of NI" in these guidelines.** It should be understood that while this type of NI is referred to as the "older type," it is still being installed in many parts of the country for both POTS and ISDN.

Figure 1.2 (c) provides a specific example of how an older type of NI might be wired.
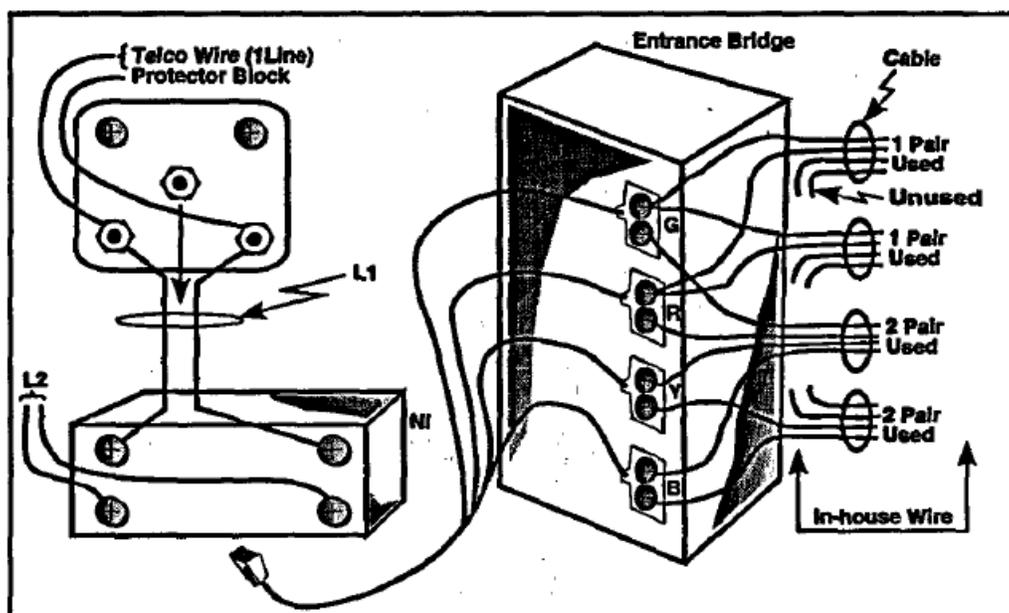
Figure 1.2 (c)
Older Type NI with Entrance Bridge

Three components are shown in Figure 1.2 (c), a protector block, and NI and a device called the Entrance Bridge. The Service outlet, or similar device, provides the demarcation connection point via a modular jack (see Section 1.2.5). The protector block is connected to the service outlet via a single pair of wires which are labeled L1 in the figure. L1 is connected to the red/green termination points on the service outlet which correspond to pins 3 &4 of the modular jack and plug (see Section 1.2.5.2). A second phone line, like L2 in the figure, can also be connected to the NI at the yellow/black termination points (pins 2 & 5). The final component shown in Figure 1.2 (c) is an entrance bridge which is a type of distribution device (see Section 1.2.4). An entrance bridge has a modular plug and cord on one side and a set of terminals for con-

necting cables on the other side. In the example of Figure 1.2 (c), four premises wiring pairs are shown connected to the entrance bridge:

- The first two cables are connected to L1 via the red/green terminals of the entrance bridge and each cable has a spare pair.

- The third cable is connected in a typical dual-line fashion to both L1 and L2.

- The last cable is connected to L2 and has a spare pair. Because the entrance bridge is on the customer's side of the NI, this device is often an option that must be requested when phone service is ordered.

The actual older type of NI that may be found in your house may vary from the configuration shown in Figure 1.2 (c). The other possibilities are:

- The protector block and the NI are combined in one unit. An external extension bridge may or may not be present.

- The entrance bridge and the NI are combined in one unit. Access to the NI is preserved by a built in plug and jack like the one shown for the newer type of NI.

In addition to the configuration described above, newer installations often utilize a single unit, combining the components shown in Figure 1.2 (c), which is called a "New Type of NI" in these guidelines. The newer type of NI shown in Figure 1.2 (d) and described Section 1.2.1.2.

1.2.1.1.1 FCC Docket 88-57

In FCC Docket 88-57, the FCC places an inside wiring restriction, commonly called the 12 Inch Rule, on both the Telco and the customer. If your in-house wiring terminates directly on a Protector Block, like the wiring shown in Figure 1.2 (a), you need to have Ameritech install a NI device before proceeding with any wiring modifications. The 12" Rule as applied to a single unit building, such as those buildings that are the subject of these Guidelines, can be summarized as follows:

- *The NI must be located within 12" of the protector block.*

- *If there is no protector block, the NI must be within 12" of where the Telco's line enters the single unit premises.*

- *The customer may not wire directly to a Protector Block.*

Caution: **You should not attempt to modify a configuration like the one in Figure 1.2 (a) without first reading Appendix A which describes how to comply with the 12" Rule while providing your own in-house wiring.**

1.2.1.2.   Newer Type of NI

Figure 1.2 (d) shows the newer type of NI. The unit shown supports two phone lines and is really two demarcs combines in one box. Network interface units are available that support almost any number of phone lines but, most likely you will find the one in your house supports one or two NI's. These units have two sides, one for the Telephone Company's wire (TELCO side) and one for the in-house wire (customers side).
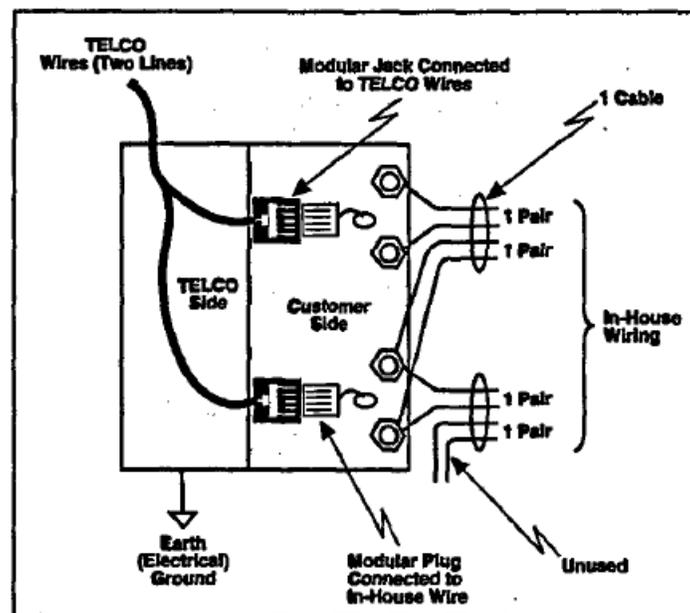
Figure 1.2 (d)
Typical "New Type NI"

The TELCO's wire connection point(s), the lightning protectors and the earth ground connection point are not accessible to the user. They are hidden behind a locked door or panel on TELCO side of the unit. However, a wire does come out of the TELCO side for connection to earth ground. The discussion, in 1.2.1.1, on the importance of a proper connection to earth ground still holds. While this wire will have been properly grounded by the TELCO at installation, it is always a good idea to check for a solid connection.

On the customer's side, the connection points are threaded posts with mating nuts, as described in 1.2.1.1, but there is no ground post. In addition, the customer's side has an

arrangement for disconnecting the in-house wire from the Telephone Company wire. This arrangement consists of a module jack which is connected to the Telephone Company's wires and a short wire with a modular plug that is connected to the in-house wire connection posts. (Please refer to Section 1.2.5 for the definitions of modular jacks and plugs.) The ability to isolate the Telephone Company side of the NI from the premises wiring is extremely useful when problems need to be isolated.

1.2.2.   In-House Telephone Cable(s)

Referring back to Figure 1.1, the wires coming out of the demarc are labeled "in-house telephone cables." These cables carry the wire pairs that are connected to the NI. Each cable can have one or more pairs (of wires). Your house is probably wired for telephone service with a type of cable commonly called Quad Cable. A "Quad Cable" is shown in Figure 1.3 (b), it has 2 pair of wires (4 wires) enclosed in an outer plastic jacket or sheath.

The type of telephone cable used in your house is dependent upon when your house was built and what modifications were put in place since then. Some, but not all, of the possibilities are listed below.

- Prior to the early 1950's your Telephone Company installed wire without an outer jacket. This type of unjacketed cable was available in 2 wire (1 pair), 3 wire and 4 wire (2 pair) versions. In order to hold the wires together in a cable the wires were twisted together. All of the wires had the same color insulation, usually white, and color coding was done with a fabric inside of each wire's insulation. The color coding was the same as that used in Quad Cable. Red/Green for the first pair and Yellow/Black for the second.

- In the early 1950's phones with lighted dials were introduced and the Telephone Companies started to install Quad cable. This wire, shown in Figure 1.3 (b), is still being installed by some Telephone Companies and independent installers.

- In the early 1980's customers were given the right to select an independent contractor for in-house telephone wiring. The majority of these dependent contractors continued to use Quad Cable as did the Telephone Companies. However, variations in the characteristics of Quad Cable have increased in recent years and some of this cable is inferior to that used by the Telephone companies. There are a growing number of new homes being wired with this lower quality Quad Cable as well as other types of inexpensive cable that are not suitable for 2 line POTS installation or ISDN. As a result of the lack the availability of clear guidelines for cable selection, many POTS customers are experiencing noise problems. Another common problem that is directly related to the installation of low quality cable is

interference between lines (crosstalk) in 2-line POTS installations. In-house cable that is not suitable for POTS will not provide a quality ISDN connection.
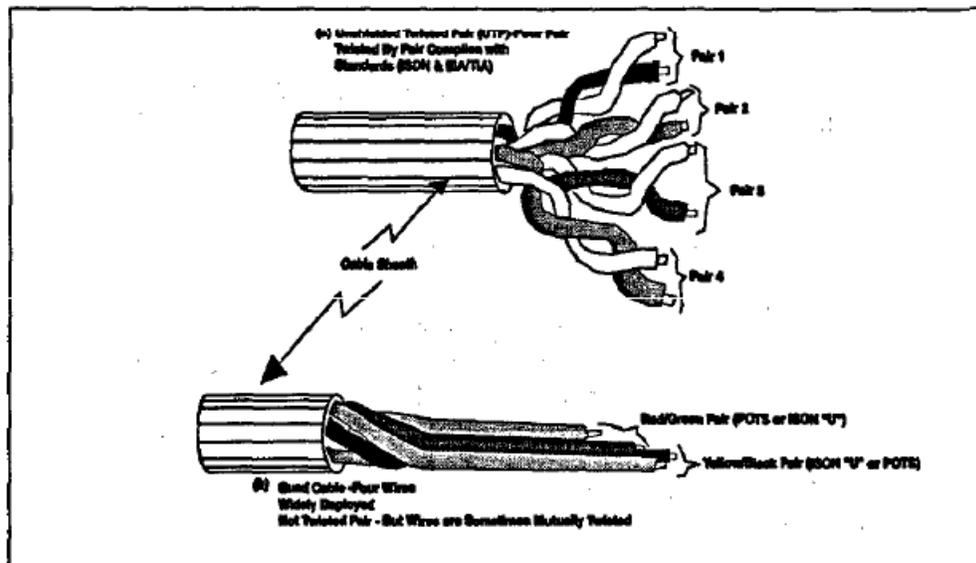
Figure 1.3
Quad and Unshielded Twisted Pair Cables

- There are also many instances of homeowners running their own wire in order to add or move phones. Often the wire used in these cases has been determined by what has been readily available. It is safe to say that almost every conceivable type of wire is in use someplace.

- In the early 1990s National standards (**EIA/TIA** wiring standards) were adapted for communications wiring practices including POTS and ISDN. A discussion of these standards is beyond the scope of this document but it is important to know that they recommend that all new homes be wired with **unshielded twisted pair (UTP)** cable.

- A Twisted Pair consists of two wires (a pair) twisted together. An unshielded twisted pair (UTP) cable contains two or more twisted pairs enclosed in a jacket or sheath. An unshielded twisted pair cable with 4 twisted pairs (8 wires) is shown in Figure 1.3 (a). The designation "unshielded" refers to the fact that the sheath does not include an electrical shield.

  Caution: **Cables with shields are often used to eliminate unwanted electrical interference, but they should never be used for POTS or ISDN.**

- The EIA/TIA Standards classify types of UTP cables as **Category 3, Category 4 and Category 5** in accordance with their electrical properties. The minimum requirement, specified by the standards, for a new residential wiring is Category 3 UTP but there has been little or no compliance. Quad Cable is not EIA/TIA standards compliant.

1.2.3. Star, Daisy Chain and Home-run Wiring

In Figure 1.1 three cables are shown leaving the NI in a configuration known as a **Star Configuration**. The configuration is called a star because a common connection point supports wiring to more than one location. In the following discussion it is assumed that the house is wired with Quad Cable which has two Pairs. Since this is a single line service, only one pair from each cable is connected to the common point at the NI. At each service outlet (jack), however, all four wires should be connected. The cable running to the Play Room goes directly to a single jack and this is called a **home-run**. Star wiring is also often referred to as "home-run wiring".

The cable going to the Den is connected to four outlets in a configuration known as a **Daisy Chain**. In a Daisy Chain the cable is terminated at the first outlet (jack) where a second length of cable is also connected in order to continue the run to the next outlet. In this case, the outlet is serving a dual purpose of a phone jack and a distribution device (see 1.2.4). This wiring continues until the last outlet is wired in the Daisy Chain. In Figure 1.1 the Daisy Chain is shown as confined to a single room, but this is not always the case and your house may be wired as one large daisy chain.

Additional information on POTS wiring configurations is included in Section 4.

1.2.4. Distribution Devices

In Figure 1.1, the cables running to the Kitchen and the Bedroom are connected to a Distribution device where they are joined to a single cable from the NI. While there are many different types of Distribution Devices, they are all used to connect a single cable input to multiple cable outputs.

An important characteristic of a Distribution Device is the ability to provide reliable connections, using mechanical connection schemes (no solder), that resist corrosion. Another function of a Distribution Device is to provide an easy way to move and/or add cables. It is a poor practice to connect cables by twisting the wires together and/or using solder.

Figures 1.4 (a-e) shows five different types of distribution devices: a Junction Box, an Entrance Bridge, a Bridging Block, a 66 Block and a Patch Panel. The Junction Box shown in Figure 1.4 (a) is similar to the surface mount outlet box with screw-down terminals described below in Section 1.2.5, however, it has no jack, typically each connection point consists of a screw with

two washers. Because good practice dictates that a washer be used to separate each wire, this device should only be used for one two-pair cable input and two two-pair cable outputs. Remember both pairs in the cable should always be connected through to the final destination, even for single line service.
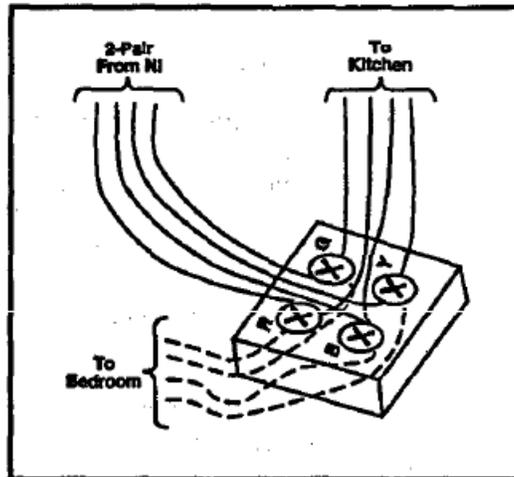
Figure 1.4 (a)
Junction Box

The entrance Bridge of Figure 1.4 (b) was described in Section 1.2.1 as a device that is often used for connecting to an older type of NI. It should also be mentioned that the newer type of NI includes a built in entrance bridge and thus also provides the functionality of a distribution device. The entrance bridge shown in the figure provides reliable connections for twice the number of wires that can be connected to a junction box but other styles have provisions for additional connections. Both the junction box and the entrance bridge, including the built-in entrance bridge that is part of a new type NI, limit the number of cable connections and lack the flexibility needed in some applications. In such cases, the entrance bridge or junction box can be connected to one or more additional distribution devices of a different or like kind.

An example of the use of multiple distribution devices is shown in Figure 1.1. In this configuration a distribution device, built into the NI, provides connections for three cables in a star configuration where one leg of the star is connected to a second distribution device. Cascading co-located distribution devices is a technique that can be used to provide low cost flexibility.

However, caution is advised when installing cascaded distribution devices because increasing the number of connection points reduces the overall reliability of the in-house wiring.
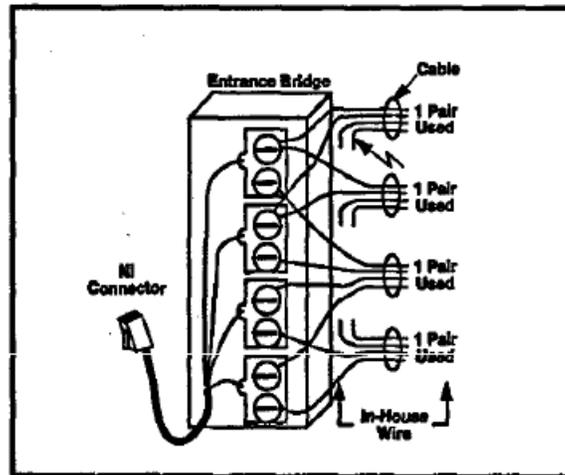
Figure 1.4 (b)
Entrance Bridge

NOTE: Cascaded distribution devices are not recommended for ISDN installations.

The Bridging Block of Figure 1.4 (c) has a number of threaded post-pairs embedded in a plastic block. These posts with their associated washers and mating nuts are like those found on some newer type demarcs. The block shown is wired for use in the configuration of Figure 1.1. Each pair in the cable from the NI terminates on one pair of posts which in turn is connected to other post pairs, by jumpers. All wires are separated by washers. In the figure, the service is continued to the Kitchen and Bedroom using separate post-pairs, but multiple pairs can share a

single post-pair provided that the wires are separated by washers. It is good practice to connect all pairs in a cable through to the final destination (jack).
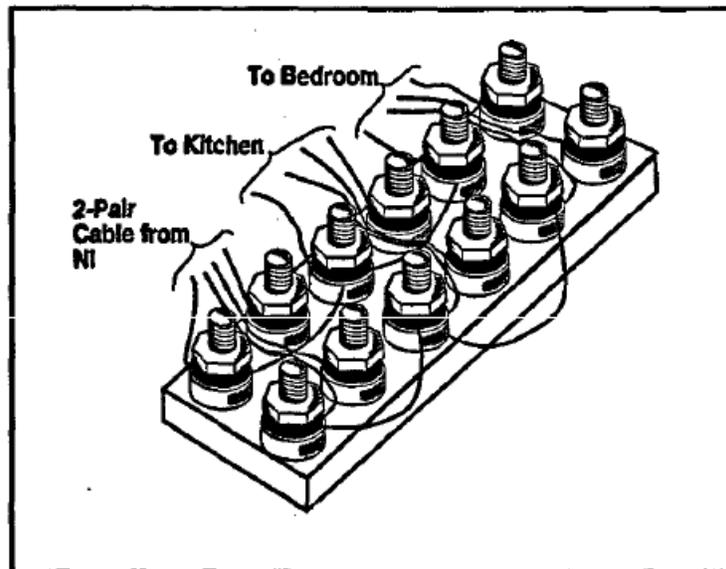
Figure 1.4 (c)
Bridging Block

Figure 1.4 (d) shows a Distribution Device commonly known as a 66-block. These devices are usually found only in large building installations but occasionally they are used in residential and/or small business installations. Because they provide more flexibility than bridging blocks, entrance bridges and junction boxes, their use in residential and small business installations is likely to increase. The device shown is only one of a number of styles with the size of the block and the number of connection points being the major difference between styles. A variation on the 66-block provides modular jack outputs (see Section 1.2.5 for a description of a modular jack). The use of these devices for wire distribution is beyond the scope of this section as they are seldom found in residential installations, they require a special tool and practice is needed to make good connections. This discussion of 66-blocks has been included for completeness and to introduce a connection scheme that is similar to connection method used in some newer

phone outlets (see Section 1.2.5). If you run across a 66-block in your house it is best to seek the advice of a skilled installer.
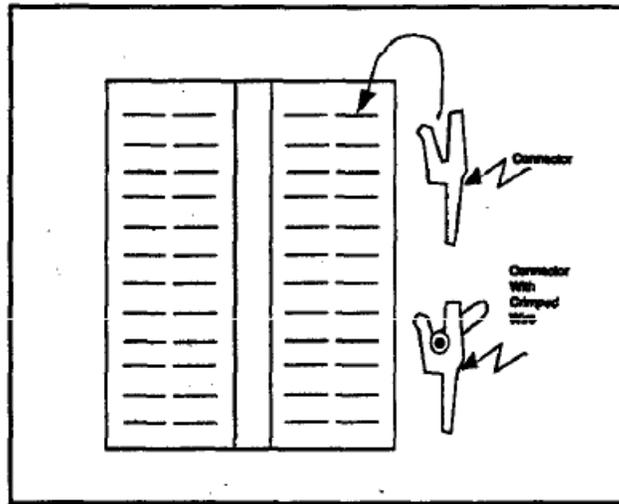
Figure 1.4 (d)
66 Block

The method used to make wire connections on a 66-block is called insulation displacement. A typical insulation displacement connector has a V shaped groove as shown in the figure. Also shown is the connector after a wire has been installed. An excellent connection is formed by forcing the wire, insulation intact, into the groove with the special tool. The groove is designed to remove the insulation without breading the wire while compressing the copper conductor. The result is a metal-to-metal connection, called a gas-tight connection, between the wire and the displacement connector. This connection is safe from the corrosive effects of the atmosphere.

The Patch Panel shown in Figure 1.4 (e) is a Distribution Device used, primarily in large installations, where rearranging the wiring is an important attribute. Patch Panels are not presently being used in small business and residential installations but because of the flexibility they provide they are worth consideration for new installations and may become common in the future.

This discussion of patch panels has been included because their flexibility is attractive for new installations.
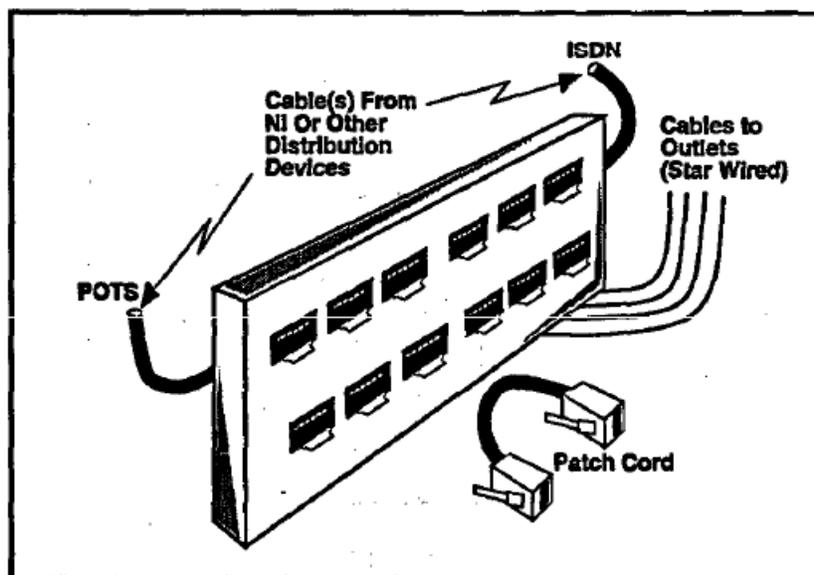
Figure 1.4 (e)
Patch Panel

The patch panel shown is just one of many configurations and they can be used to provide connections for all home wiring applications. In this case two cables are shown as inputs, one for ISDN and one for POTS. The input cables are wired to the top row of modular jacks at the back of the panel. The POTS cable is connected to jacks 1, 2 & 3 and the ISDN input cable is connected to jacks 4, 5 & 6. Cables to service outlets are wired to the bottom row of jacks, one cable for each position. The desired service is directed to any specific service outlet by connecting patch cords between the upper and lower rows. Patch panels that comply with the EIA/TIA wiring standards are expensive in comparison to the cost of other distributions devices but the flexibility they provide may justify their use in the home of the future.

While we have described some common Distribution Devices we have not tried to provide an exhaustive list and you may find other types installed in your house. It is not uncommon, for example, to find a phone outlet (see Section 1.2.5) used as a distribution device with or without a phone attached.

1.2.5.   Phone Outlets, Jacks and Mating Plugs

If your phone installation is old, you may find that there is no phone outlet. In the older installations a wall phone was hard wired directly to the NI and a desk phone was wired to Junction Box (Figure 1.4 (b)).

Phone outlets were introduced by the TELCOs to allow the phone to be moved between rooms as well as to provide a way to quickly connect the phone for service. The early type of phone outlet shown in Figure 1.5 (a) has four cylindrical female (jack) contacts located on a surface mount block (wall or base board mounting). The mating plug is also shown in this figure, if has four pins (male connectors) arranged to match the Jacks's pattern. Also shown in Figure 1.5 (a) is an adapter plug that provides conversion to the newer type of plug called a modular plug.
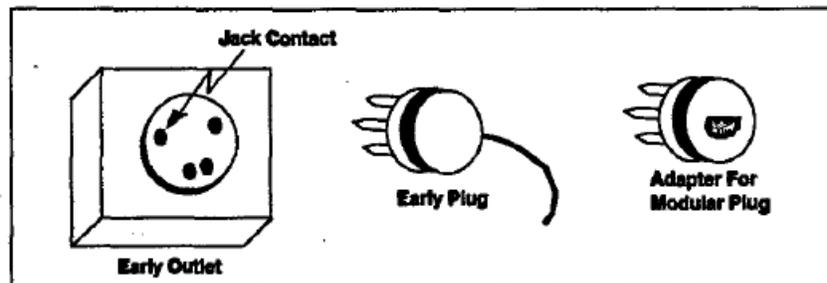
Figure 1.5 (a)
Early Outlet and Plugs

The type of outlet that you are most likely to be familiar with is shown in Figure 1.5 (b). It is a surface mount unit with a jack, called a modular jack, on the side. The mating modular plug is also shown.
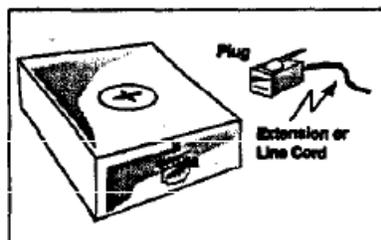
Figure 1.A.5 (b)
Surface Mount Outlet
Modular Jack and Plug

The newest type of service outlet is the Flush Mount type, shown in Figure 1.5 (c). This type of service outlet is mounted in the same way that electrical wall outlets are mounted. The service

outlet shown in the figure has two Modular Jacks, but other variations are available. Flush Mount service outlets are commonly used in new construction.
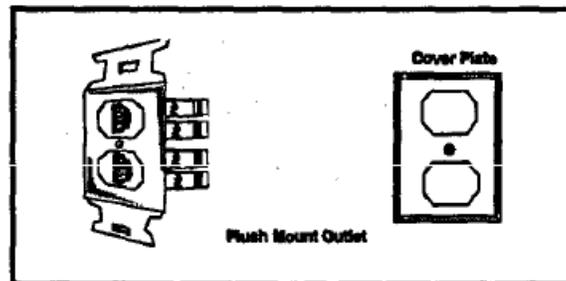
Figure 1.5 (c)
Flush Mount Outlet
with Modular Jacks

While the terms "RJ11 Jack" and "RJ11 Plug" are commonly used to describe these modular components, these designations are not always correct and the terms 6-position modular jack and 6-position modular plug are used in these guidelines.

Note that the term 6-Position Modular Jack (Plug) does not always imply that all 6 metallic conductors are present. The variations as shown in Figure 1.6 use the same modular jack (plug) housings but all conductors (pins) are not always present. The 6x4 jack, shown in the center of Figure 1.6, is the variation that you are most likely to find in your house. The notation 6x4 indicates that the jack is 6 positions wide with only the 4 center positions installed. The line cord connecting the phone to the Jack will most likely have a 6x4 or 6x2 plug.
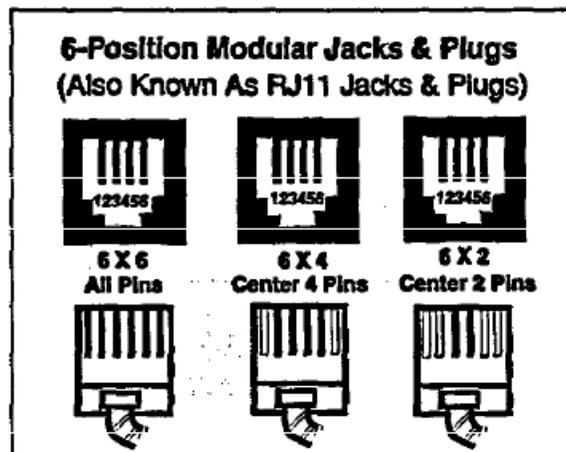
Figure 1.6

As you will see later, ISDN installations sometimes use the 6-Position Modular Jack but more typically use an 8-Position Modular Jack which only has one configuration (8x8). The 8-Position

Modular Jack and Plug are shown in Figure 1.7. A 6-position modular plug will mate with the 8-position modular jack and some caution will be required to ensure proper use in an ISDN installation.
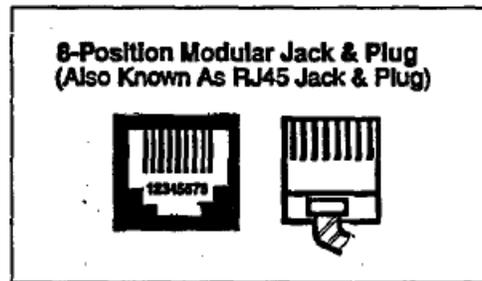
Figure 1.7
Eight Position Modular Jack and Plug

Note that for all renovations and new installations, jacks and plugs that conform to the EIA/TIA standards's Category 3 or better (Category 4 or 5) are recommended.

1.2.5.1.   Making Connections to Phone Outlets

There are two types of wire connection methods used to terminate wires on the jacks used in phone service outlets. If you have a service outlet like the one in Figure 1.5 (a) then there will be screw type termination points. These will have markings labeled R, G, Y & B to indicate the wire color code. The Red (R) and Green (G) pair is always the primary (first) phone line and the Yellow (Y) Black (B) pair the second phone line. Homes with this type of outlet usually have only one phone line present at the Jack even if there are two lines coming into the residence. If you are installing ISDN service at this Jack you will have to replace it with a Modular Jack.

The service outlets shown in Figure 1.5 (b) and 1.5 (c) may have screw-down terminals or punch-down terminals. The screw-down terminals are similar to those described for the older outlet of Figure 1.5 (a) but the Jacks are commonly used for both two line and one line service. The punch-down terminals are the insulation displacement type described in Section 1.2.4 for the 66-block. However, in this case, the tool is built into the Jack housing and no special skill is required. Just follow the directions.

1.2.5.2.   Jack Wiring

If the outlet supports one single line phone then the Red and Green pair is connected to jack pins 3 &4 as shown in Figure 1.8 (a). While this figure shows only the pair required to support one phone the Yellow/Black pair will also usually be wired to the jack as shown in Figure 1.8

(b). If the jack supports a single line phone for a second line then the Yellow/Black pair is used, as shown in parenthesis in Figure 1.8 (a).
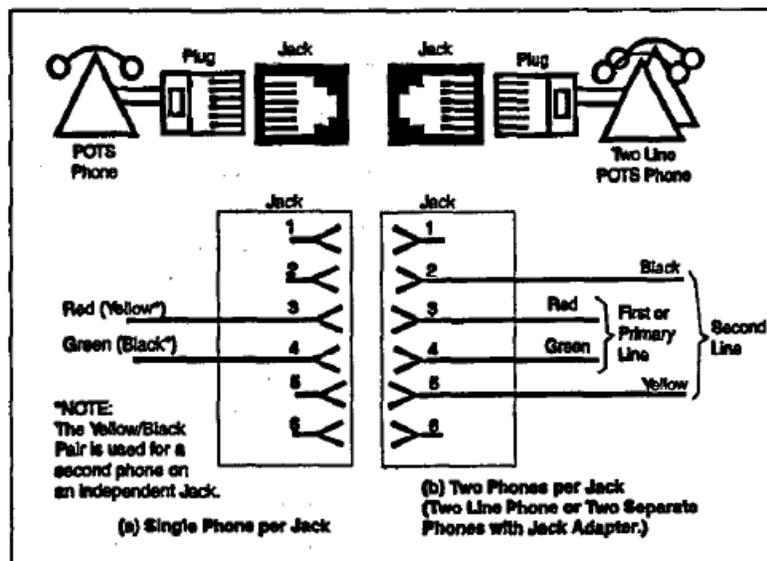
Figure 1.A.8
Jack Wiring Assignments for POTS

When a dual line phone is connected to a single jack the wiring is always as shown in Figure 1.8 (b). Note that two separate single line phones can also be connected to this jack if an adapter is used. See Section 1.2.7 for more information on adapters.

1.2.6.   Extension Cords and Line Cords

These two types of cords are similar, they are both used to connect the phone to the service outlet. A line cord shown in Figure 1.9 (a) is a flexible cord with plugs on both ends. It is used to directly connect from the service outlet jack to the jack on the phone. Extension cords have a plug on one end and a jack on the other end, they are used to extend the reach (distance) of a line cord as shown in Figure 1.9 (b). There is almost no limit on the length of either a line cord or an extension cord used for POTS, but this is not true in ISDN implementations.

Another important characteristics of these cords is that, for historical reasons, the pins on each pair from one end to the other are reversed. A two pair reversed cord, sometimes called a crossed cord, is shown in Figure 1.9 (c). By contrast a two pair cord with straight-through con-

nections is shown in Figure 1.9 (d). Straight-through cords are required for certain types of ISDN connections.
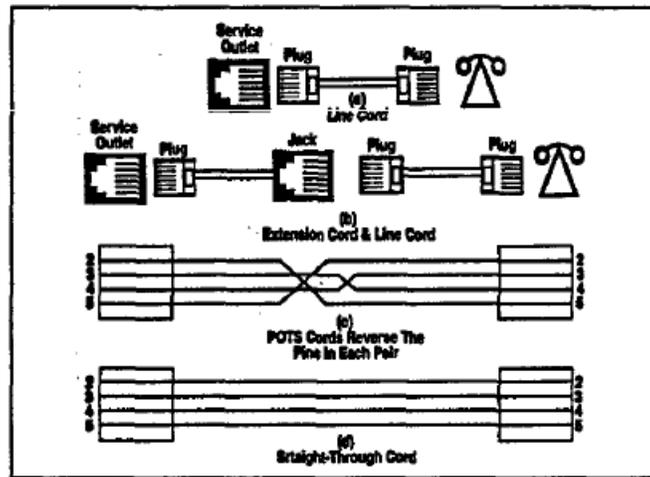
Figure 1.9
Extension Cords and Line Cords

Warning: **Many cords that look alike have wires that are connected to different modular pins than those shown in the above examples. Always check the suitability of cords for the intended ISDN or POTS use.**

1.2.7.   Jack Adapters

Adapters are used to convert the wiring at a service outlet jack into another wiring configuration. They are also used to provide fan-out connections (one to many) and convert from 6(8)

position modular to 8(6) position modular configurations. Figure 1.10 (a-d) shows four common types of adapters but many others are available.
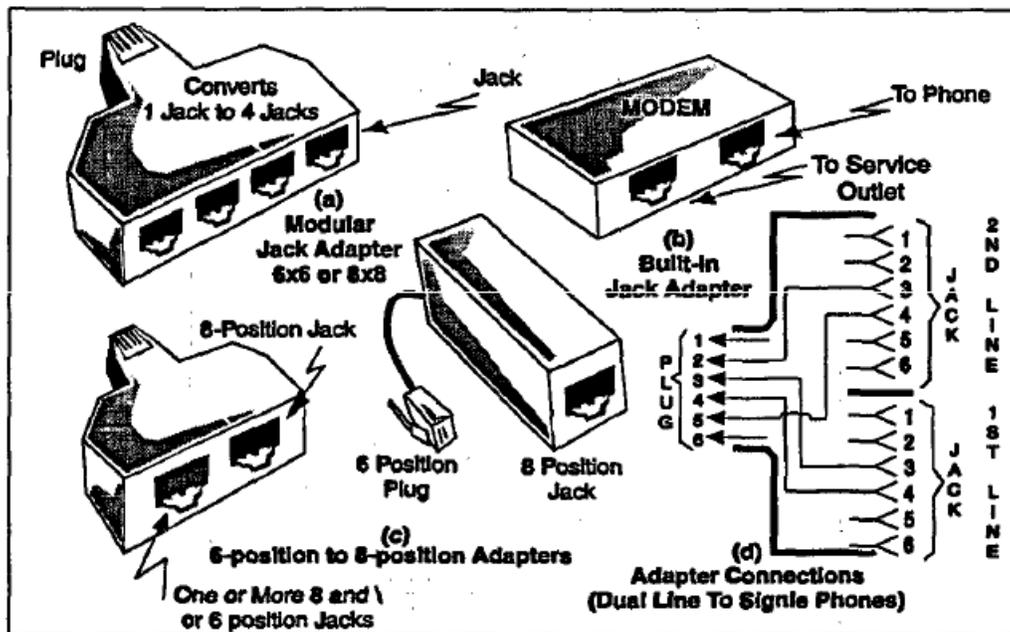
Figure 1.A.10
Jack Adapters

Figure 1.10 (a) shows an adapter that converts one jack into four jacks. This type of adapter usually provides a direct pin mapping (pin 1 or Pin 1, etc.) and is used to provide parallel connections allowing a single jack to fan-out to multiple devices. The combination of this type of jack and a service outlet like the one shown on Figure 1.5 (b) performs the same function, within the confines of a single room, as the distribution devices shown in Figure 1.4.

Warning: **It is not good practice to run cords long distances; they are not designed for this sort of use. This is especially true for ISDN service. You should always use cables for wiring between the NI and the service outlets.**

In Figure 1.1 an adapter like the one in Figure 1.10 (a) is shown supporting a phone and a modem in the Den. Often devices like modems have built in adapters, as shown on Figure 1.10 (b) eliminating the need for an external adapter. Figure 1.10 (c) shows two variations of an adapter that converts a 6-position modular jack to an 8-position modular jack. This type of an adapter is often useful for converting existing POTS jacks to ISDN jacks.

Another type of adapter, that looks like those shown in Figures 1.10 (a) and 1.10 (c) is used to convert a service outlet wires for dual line service (see Figure 1.8 (b)), into two jacks that are

wired for single line service like the jack shown in Figure 1.8 (a). The internal wiring of such an adapter is shown in Figure 1.10 (d).

The adapter described here are only a sample of what is available. Most are only available from parts distributor's catalogs.

Warning: Many adapters look alike but provide different pin translations (in-to-out).

1.2.8.   POTS Terminal Equipment — Also Called Customer Premises Equipment (CPE)

In the above descriptions we have used the term telephone (phone) in a very loose fashion to mean any device that is connected to a POTS line. However, there are a number of other devices that are used for voice and data communications over a POTS line. These are: facsimile machines, answering machines, alarm systems, calling number identification boxs and modems. There are two general terms commonly used to describe phones and these other communications devices. They are: **Terminal Equipment (TE)** and **Customer Premises Equipment (CPE).** In these guidelines you will find both of these terms used frequently.

1.2.8.1.   Powering Terminal Equipment

Your POTS telephone gets the power required to operate from the Telephone Company. This power is delivered to your house over the same pair of wires that carry your voice. However, it you are a user of any other POTS Terminal Equipment, for example a cordless phone, it probably needs to be plugged into an AC outlet. Even some new phones, those with fancy features, will not operate properly unless a small power supply is plugged into the house AC power.

A basic POTS phone is a very simple device. It requires no power when not in use (on-hook) and very little when it is operating (off-hook). In contrast, other Terminal Equipment requires considerable power to operate even in stand-by mode (on-hook). The power system that feeds your phone over the telephone line was designed for the POTS phone and is not capable of driving many types of modern Terminal Equipment.

1.3.   POTS Wiring Configurations

Two basic types of wiring configurations were introduced in Section 1.2, the Star and the Daisy Chain. In this section we introduce a third configuration and expand on the information previously provided.

Figure 1.11 presents three residences, each wired to support a single or dual line service. To simplify the discussion, each house is wired using only one wiring configuration and no intermediate distribution devices are used. In each of these cases, the demarc is shown on the outside of the house but you may find that yours is inside. A separate Distribution Device is

also shown in these configurations but often the distribution device and the demarc are the
same physical device.
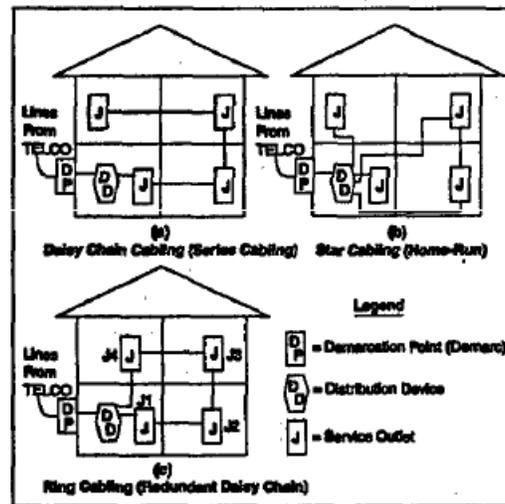
Figure 1.11
Basic POTS Wiring Configuration

Figure 1.11 (a) shows a residence completely wired in the Daisy Chain Configuration and Fig-
ure 1.11 (b) shows how the same residence would be wired using only the Star Configuration.
In Figure 1.11 (c) a new configuration, the Ring Configuration, is introduced.

The Ring configuration is an extension of the Daisy Chain configuration with the wiring from the
last outlet returned to the Distribution Device. This wiring scheme provides redundant connec-
tions so that the Terminal Equipment at all the service outlets will survive a single cable break.
As an example, if there is a cable break between the points labeled J2 and J3 all of the service
outlets will remain alive. J1 and J4 will then be connected in a star to the Distribution Device
while J2 is connected in a Daisy Chain via J1 and J3 is connected in a Daisy Chain via J4.
While this is a good configuration for POTS wiring, it cannot be used for some ISDN or other
modern communications services.

The new National Wiring standard (EIA/TIA-570 Standard), mentioned previously in Section
1.2.2, recommends the use of the Star Configuration of 20 (b) in all new Residential construc-
tion and renovations to all existing residential wiring. Because these standards are new, the
level of compliance is still low.

What you will find in your home may not look like any of the configurations presented in this section. Instead, the wiring most likely will be a composite of the configurations shown. Figures 1.1 and 1.12 are examples of composite configurations.
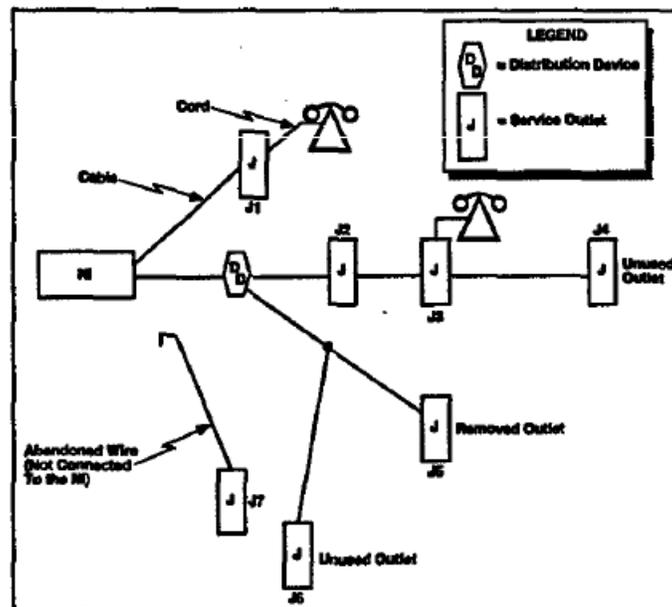
Figure 1.12
Bridged Taps

When you investigate how your house is wired, you may find some practices that we have not described in these guidelines as well as some of the following conditions. You may find some hidden, unused jacks under counter tops, in closets and other unlikely places. There may be abandoned wire where the Jack has been removed but the wiring is still connected to the NI like shown at J5 in Figure 1.12. Another type of abandoned wire is shown in J7 of Figure 1.12, where the jack is still in place but the NI side of the cable is disconnected. Abandoned wiring and wiring to unused jacks (like J6 in Figure 1.12) are called Bridged Taps. A Bridged Tap is a wire run that is not terminated by the presence of Terminal Equipment or other device. In Figure 1.12, outlets J4, J5 and J6 are at the end points of Bridged Taps. Since the wire from outlet J2 is terminated by the phone at the outlet J3 it is not the terminating point of a Bridged Tap even though it is unused. Bridged Taps are not a problem in a POTS environment but they may be in some ISDN configurations.

Also shown in Figure 1.12 is a junction made without the use of a Distribution Device. The homeowner may have created this connection by simply twisting wires together mechanically and/or soldering them together. This type of connection is bad practice in a POTS environment and must be eliminated in an ISDN installation.

Other things that you may find in your home wiring include:

- Only one pair continued from outlet-to-outlet in a Daisy Chain.

- The wrong wires used as a pair (pairs must be Red/Green and Yellow/Black).

- Wires run parallel to the AC power cables.

- Types of wire not described in this section. For example, an extension phone out-let wired with electrical cord, audio speaker wire, thermostat cable or other "odd ball" cable.

- Flat cable used to connect a wire run under a rug.

2.   AN INTRODUCTION TO ISDN WIRING CONSIDERATIONS

2.1.   General

Section 1 provided general information about wiring and powering considerations for **POTS** in a residence or small business. This section provides similar information about ISDN wiring considerations for a residence or small business. It assumes that the reader may be purchasing and/or installing ISDN wiring and equipment. Understanding how the ISDN components work together prior to starting the purchasing and installing process should help the process go smoothly. The objective is to introduce and provide simple explanations for a variety of topics related to ISDN wiring issues. Subsequent sections contain more detailed coverage of some of these topics. The following topics are included in this section:

ISDN Connectors

ISDN Outlets

ISDN Cords

ISDN Cable

Demarcation point (Network interface)

U interface

Network Termination 1 (NT1)

Terminating resistors

NT1 timing

S/T interface

Terminal equipment

Extension phones and the R interface

2.1.1.   Terminology

As with any subject, one thing that must be understood is the terminology used. Some has already been covered in the review of POTS in the preceding section. New terms are described the first time they are used, and there is a glossary at the end of the document that describes some of the frequently used terms. The first appearance of words or phrases that appear in the glossary will be bolded.

2.1.2.   ISDN Wiring Requirements

Wiring considerations for ISDN are different from those for POTS. Wiring for POTS is usually simple and straightforward. For example, it is normally possible to add an extension telephone in a home simply by adding another **jack** and plugging in the telephone. The wiring for the new jack may have been spliced into existing wiring, or perhaps extended from an existing jack in order to accommodate the new jack. Whatever the situation, if one follows the color code and exercises reasonable caution, it is likely that things will work fine. Similarly, it doesn't make much difference if there are unused jacks around the house.

However, there are some new factors to consider with ISDN. The ISDN electrical signals that must be transported in the home are different from those for POTS. **The existing wiring used for POTS may or may not be suitable for ISDN.** The characteristics of the cable, the manner in which it is installed, and the placement of components along the cable can affect the quality of the service. One also need to understand whether, in certain cases, existing wiring (see Section 4) might be usable for ISDN or new wiring (see Section 5) will be required.

In addition to how the equipment functions and how the house is wired, there are also differences between POTS and ISDN with respect to how the equipment (e.g., a telephone) is powered. ISDN powering arrangements and issues are covered in Section 3.

2.2.   ISDN Components

2.2.1.   Connectors

One of these basic connectors is the so-called modular connector (i.e., modular plugs and modular jacks) that have been used in recent years by the telephone industry. There are two that are of particular interest — the modular 6-position jack/plug and the modular 8-position

jack/plug shown in Figure 2.1 (see also Section 1.2.5). The modular 6-position jack/plug is often referred to as an RJ-11 jack/plug, and the modular 8-position jack/plug is often referred to as an RJ-45 jack/plug. While the RJ-11 and RJ-45 designations are commonly used, there are situations when they might cause some confusion so we will use the more generic 6-position and 8-position terminology here.

The connector normally used for ISDN service/equipment is the modular 8-position jack/plug mentioned above. Although not typically used for POTS in a residence, modular 8-position connectors are often used for data services. Unlike the modular 6-position plug/jack where some of the pins are often not present (see Section 1.2.5), the 8-position plug/jack typically has all eight positions equipped with pins.
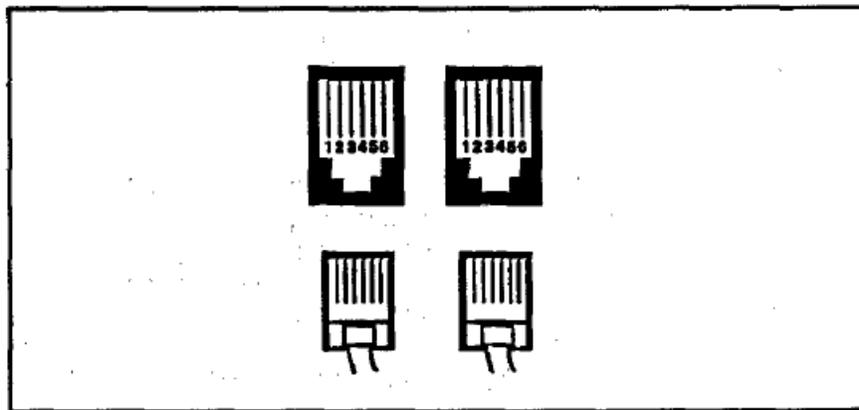
Figure 2.1
6-Position Jack

We have briefly mentioned the standard connectors (modular 6- and 8-position plugs and jacks) and several of the wire types that one might have to deal with in doing wiring for ISDN. A modular 8-position plug/jack with only the center two pins wired is referred to as an SJA-11 (see Figure 2.2(a)). Similarly a modular 8-position plug/jack with all eight pins wired is referred to as a T568A connector if the wiring is as shown in Figure 2.2(b). However, a modular 8-position plug/jack might also be a T568B connector; similar to a T568A except with pairs 2 and 3 swapped (see Figure 2.2(c)). The applicable color coding for wiring an ISDN connector using the recommended 4 pair twisted wire is as shown in Table 2.1.

It is worth noting that, despite the difference in width, a modular 6-position plug can be inserted into a modular 8-position jack. The construction of the 6- and 8-position connectors is such that the pins in the 6-position plug will align with the pins in the six center positions of the 8-position plug. For example, if the center four pins are present in a 6-position plug they will align properly with the center four pins in an 8-position jack. While the use of a 6-position plug in an 8-

position jack is not recommended or encouraged, it can be used without fear of mismatching between the plug and jack pins.
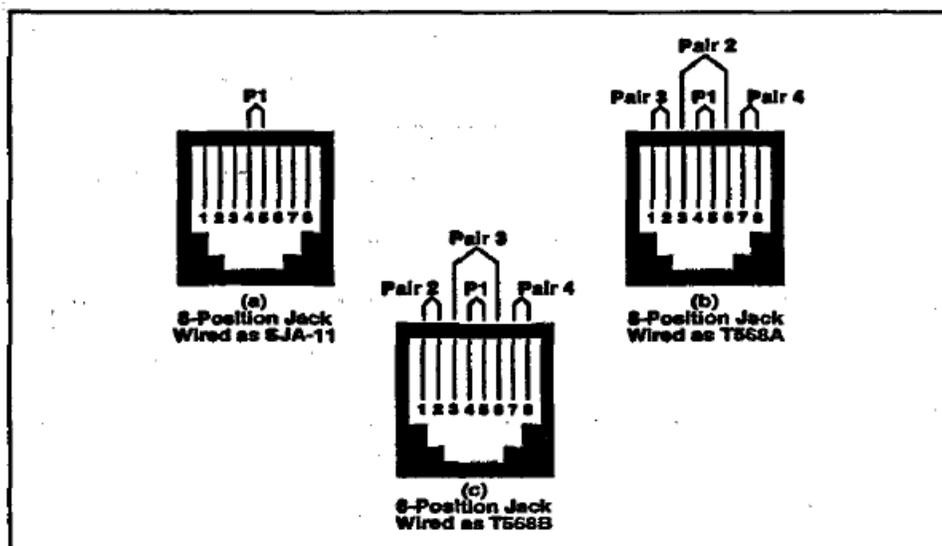
Figure 2.2
Some Typical Connector Wiring Configurations

2.2.2.   Outlets

The recommended jack/wall **outlet** for ISDN service is the modular 8-position jack referenced earlier. If that type of jack is used, there should not be any connector compatibility problems since that jack can receive either an 8-position or a 6-position modular plug. **It may be possible to use existing 6-position jacks/wall outlets but there is a high likelihood of encountering compatibility problems (e.g., your ISDN components will likely have 8-position plugs).** While it is possible to buy or make **adapters** (see Section 1.2.7) to deal with almost any incompatibility problem, it seems a more realistic approach to simply use the proper jacks to start with.

2.2.3.   Cords

There are two types of **cords** commonly used with **terminal equipment**: one is a **line cord** and the other is an **extension cord**. Both types are described in Section 1.2.6. Although cords are relatively simple, the reader should be aware that there is a difference between POTS cords and ISDN cords. A pair reversal arrangement is usually built into a POTS cord, but such a reversal is not acceptable for ISDN cords — they must be wired on a "straight through" basis as shown in Figure 1.9. A pair reversal is not a problem on the U-interface (see Section 2.2.6.1) portion of the layout — if, for example, a reversal type cord was used between a

U-interface wall jack and an **NT1** (see Section 2.2.6.2) there would not be a problem. The reversal problem arises in connection with the **S/T interface** (see Section 2.2.6.2)

| Conductors | EIA/TIA Standards | | |
| | Twisted Pair | 8-Position Pin Number | |
		T568A	T568B
Pair 1	White-Blue*	5	5
	Blue**	4	4
Pair 2	White-Orange*	6	1
	Orange*	3	2
Pair 3	White-Green*	1	3
	Green**	2	6
Pair 4	White-Brown*	7	7
	Brown**	8	8

*   The wire insulation is white with a colored marking (typically a stripe) added for identification.
** A white marking (typically a stripe) is optional.

Conductors	Twisted Pair	6-Position Pin Number
Pair 1	White-Blue*	4
	Blue**	3
Pair 2	White-Orange*	2
	Orange**	5
Pair 3	White-Green*	1
	Green**	1

Premises Wiring Color Code Table 1.
*   The wire insulation is white with a colored marking (typically a stripe) added for identification
** A white marking (typically a stripe) is optional.

if multiple terminals are connected to it. The polarity of any individual terminal is not critical, but it is critical that all terminals on the same S/T interface be wired using the same polarity. The simplest way to avoid cord-related problems is to avoid the use of reversal-type cords for ISDN. Some straight-through and reversal types of cords are shown in Figure 2.3. It should also be noted that ISDN technical specs call for limiting the length of ISDN line cords to 33 feet or less.

2.2.4. Cable

In addition to cords and connectors, another basic ingredient for providing ISDN service in a home or business is the cable itself. Until the early 1980's, the telephone company was responsible for telephone wiring in homes and businesses. Subsequently, **premises wiring** has been the responsibility of the home/building owner. Even when the telephone company was responsible for wiring, multiple cable types were used everywhere for residence wiring. Since that time there has not been any standard type of cable used in wiring a home.

A wide variety of telephone cabling already exists in homes. Even **quad cable** (see Section 1.2.2) which has been widely used by the telephone industry has no single standard. Thus, it your ISDN installation plans include the possibility of using existing wiring caution is recommended. There is no simple way to evaluate existing cabling — it may or may not be satisfactory. Probably the best way to determine whether existing wiring is satisfactory for ISDN use is to try it. If there is any doubt, use new wiring as specified in the next paragraph.

If new cabling is to be installed, in either home or a new home, it is strongly recommended that the standards set forth by the Electronic Industries Association (EIA) and the Telecommunications Industry Association (TIA) be followed. The EIA/TIA recommended minimum wiring is 8-conductor (4-pairs) **unshielded twisted pair** (UTP), **category 3** or higher, 24 gauge. Category 4 or 5 cable is satisfactory for ISDN service although it exceeds the requirements necessary for ISDN and is somewhat more expensive than category 3 cable. See Section 5 for the specific cable that must be used.

2.2.5. The Demarcation Point

ISDN is "delivered" to a home or business in a manner that appears identical to existing POTS (see Section 1.2.1) — a pair of wires that comes to the house and connects to a **junction box** or **terminal block** of some sort. Typically that occurs just before or after the wire enters the building. Whether it be a junction box on the outside or terminal block on the inside, the point at which the wire from the telephone company is connected to the wire the runs through the house is usually called the demarcation or "**demarc**" point. This point is also sometimes known as the **network interface** (NI) since it is where the responsibility of the network service provider (Ameritech) meets or "interfaces" with the responsibility of the home or building owner. In other words, the ISDN demarc point is the same as the POTS demarc point. In this docu-

ment the term demarcation (demarc) point is replaced by Network Interface. The NI can take many forms — several examples are shown in Figure 1.2.
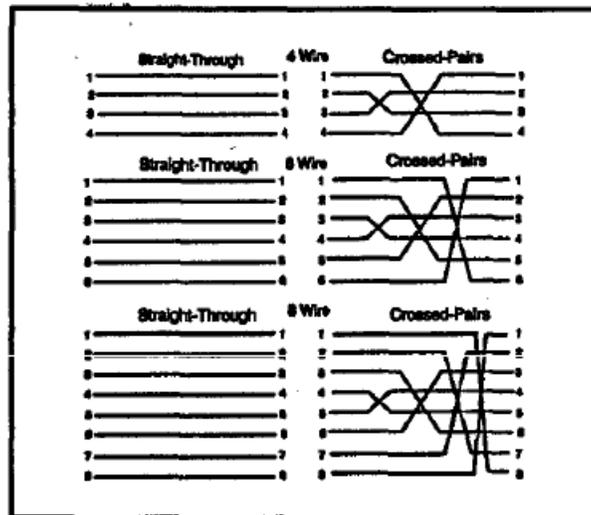
Figure 2.3
Straight Through and Crossed Pair Cords

2.2.6.   ISDN Equipment and Interfaces

With normal telephone service (POTS), nothing really changes between the NI and the terminal equipment (i.e., the telephone set) - the same electrical signals that arrive at the NI from the telephone company central office continue on to the telephone set over two wires. However, with ISDN, an additional component is required between the NI and the ISDN terminal equipment (see Section 2.2.6.5). That additional component is called a **Network Termination 1** (NT1). The NT1 is described in more detail in Section 2.2.6.2. Figure 2.4 shows a simplified layout of the items mentioned below. For simplicity, no power arrangements are shown in this section - they are covered in Section 3.

2.2.6.1.   U Interface

As shown in Figure 2.4(a) or 2.4(b), the U interface is simply any point along the pair of wires from the telephone office after they have passed through the NI and before they get to the NT1. Thus, the term U interface does not refer to a specific connection point like the NI, but rather represents certain electrical characteristics, defined by the ISDN technical standards, that occur on a 2-wire transmission path.

2.2.6.2.   Network Termination 1 (NT1) and S/T Interface

As mentioned above, one of the new pieces of ISDN CPE is known as the NT1 (Network Ter-
mination 1). One side of the NT1 connects to the U-interface. The NT1 converts the signal
arriving on the 2-wire U interface to a 4-wire electrical signal known as the S/T interface. The
NT1 may be almost adjacent to, or a considerable distance from, the NI. There are several sig-
nificant points worth noting:

- The NT1 may be a standalone piece of equipment (Figure 2.4(a)) or it may be built
  into an item of terminal equipment such as an ISDN telephone (Figure 2.4(b)). An
  ISDN terminal with a built-in NT1 is sometimes called a U interface terminal.

- There can be only one NT1 connected to a U interface. Thus, if multiple terminals
  are to be serviced by one ISDN line, they must be served by a single NT1 as
  shown in Figure 2.4(a) (but see note below). **Multiple U interface terminals (i.e.,
  with built-in NT1s) are not acceptable (Figure 2.4(c)).**

NOTE: There are ISDN terminals that have a built-in NT1 and a jack that allows adding an-
other terminal that does not have a built-in NT1. Thus, a standalone NT1 as shown in
Figure 2.4(a) is not the only possible option when multiple terminals are involved.

For purposes of this discussion, the basic function of the NT1 is to convert the ISDN electrical
signals that travel from the telephone office to the NT1 over the equivalent of one pair of wires
(i.e., 2 signal leads) into an electrical configuration that uses 2 pairs of wires (i.e., 4 signal
leads) as required by the ISDN customer terminal equipment. The wiring that runs between the
NT1 and the terminal equipment is called the S/T interface as shown in Figure 2.4. Just as with
the U interface, the term S/T interface does not refer to a specific connection point but rather
represents specific electrical characteristics. Also, recall that in some applications the NT1 may
be included in the terminal equipment (TE) so there is no exposed S/T interface. Unlike with
the U interface, multiple terminal equipment devices can be connected to the S/T interface.

As mentioned earlier, the ISDN electrical signals that pass from the NT1 to the TE require two
pairs of wires (i.e., the S/T interface uses 4-wire transmission). However, the S/T interface is
defined as an 8-wire interface - 4 wires for signal transmission and 4 wires for optional power

arrangements. Depending upon the powering arrangements used, the S/T interface for a given installation may require only 4 or 6 of the 8 wires are specified.
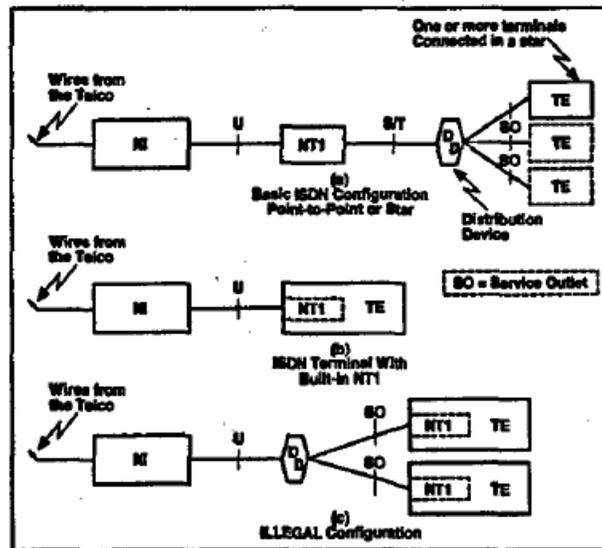
Figure 2.4
Examples of ISDN Equipment Configurations

2.2.6.3.   Terminating Resistors

In order to ensure the proper electrical characteristics of the signals passing over the S/T interface, the ISDN technical specifications require the use of terminating resistors. Improper placement of terminating resistors will result in unsatisfactory operation of the equipment. A detailed discussions of terminating resistors is beyond the scope of this section, but this subject is covered in later sections. The manufacturer's literature should also provide information on this subject. Figure 2.5 provides some examples of the various configurations you may encounter.

2.2.6.4.   NT1 Timing

Many NT1's allow the selection of one of two timing modes - fixed or adaptive. A discussion of NT1 timing is beyond the scope of this section, but the manufacturer's literature should provide

helpful information when needed (Also see Section 2.2.81). In general, for the types of configurations covered in this document the use of adaptive timing will always be satisfactory.
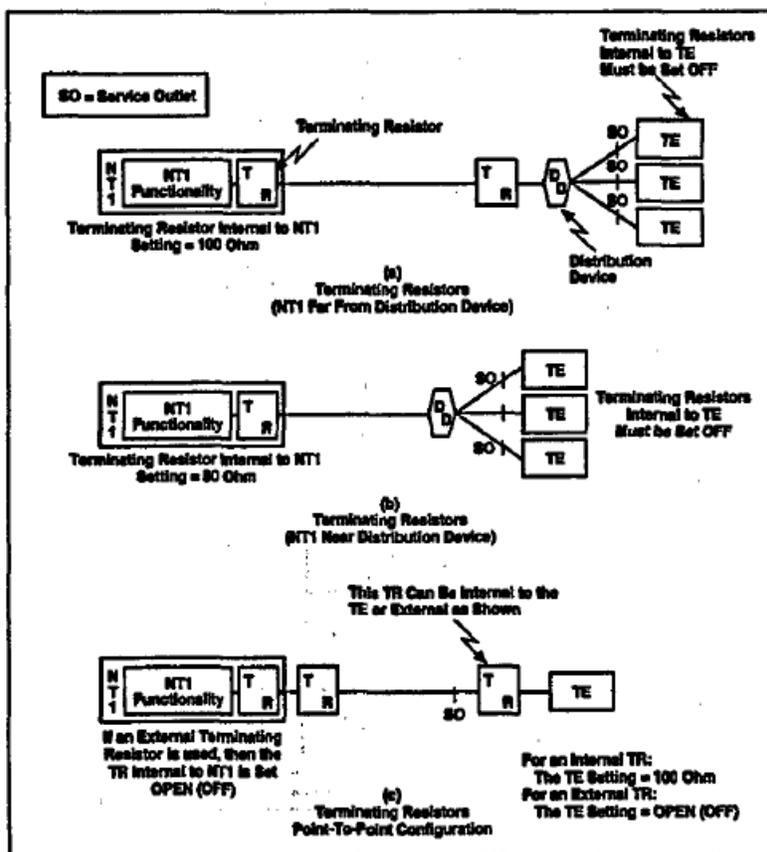
Figure 2.5
Examples of Resistor Termination Usage

2.2.6.5.   Terminal Equipment (TE)

From the customer's perspective, the terminal equipment is where the action is. Terminal equipment is the communication device, or devices, that the customer actually uses. In the POTS case, the terminal equipment is usually a telephone, but it could be a facsimile machine, a modem/computer, or whatever the customer had connected to the line to handle the desired communication. With ISDN, the concept is the same but the equipment is a bit different - it could be an ISDN telephone, a personal computer with a special plug-in board to provide an ISDN interface, an ISDN fax machine, etc. Figure 2.6(a) shows what a typical ISDN telephone might look like. It is shown connected to a separate NT1, but some ISDN telephones might have an NT1 built-in and thus connect directly to the U interface. Figure 1.6(b) shows a PC as the terminal equipment. As the reader might imagine, there are many possible terminal equipment arrangements.

In addition to the normal ISDN terminal equipment discussed above, there is a somewhat special situation that is worthy of a brief mention here. The ISDN technical literature defines a device or function known as a terminal adapter. A terminal adapter converts the ISDN signal into a form usable by non-ISDN terminal equipment. Terminal adapters are intended for both data and voice applications. A terminal adapter could be a stand-alone item as shown in Figure 2.6(c) or it could be built into a piece of non-ISDN terminal equipment. The arrangement shown in Figure 2.6(d) assumes the existence of a terminal adapter in the form of a PC plug-in card. The signal between the terminal adapter and the non-ISDN terminal equipment is defined in ISDN technical specifications as the R interface.
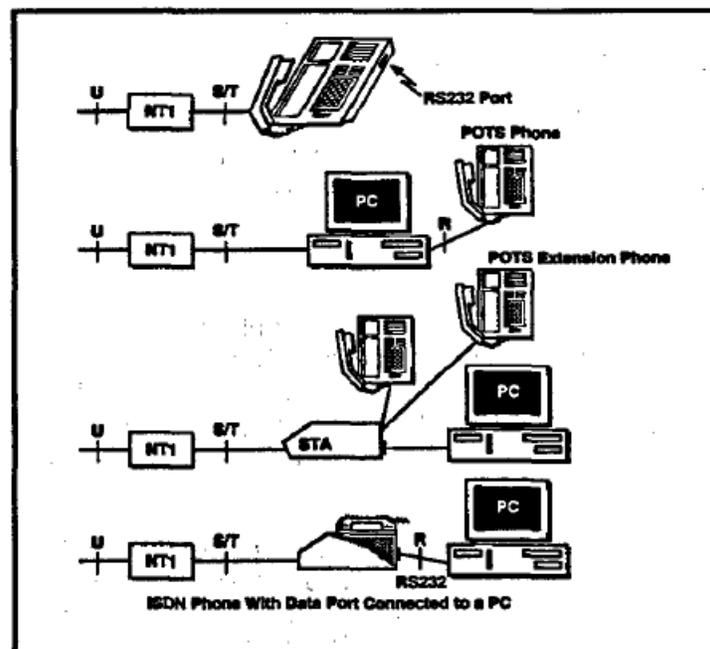
Figure 2.6
Examples of Terminal Equipment Arrangements

2.2.6.6.   Extension Phones and the R interface

One of the differences between POTS and ISDN is that ISDN does not include the same concept of extension phones as we know in POTS. We cannot just lift the handset of any **ISDN phone** in the house and join in a conversation. A way of providing POTS-like extension capability in an ISDN installation is by using the R interface mentioned in the preceding paragraph and described in more detail in Section 7 (To be provided in next version of this document). Unfortunately, the R interface is not as well defined as it might be. Characteristics such as the number of POTS extension phones supported by an R interface, the number of ringer equivalencies, and the allowable cabling distances, are left somewhat to the vendor's discretion.

Thus, if you need to make use of the R interface and have specific requirements it would be well to check them out with the equipment vendor ahead of time.

2.3.   Working out a Wiring Plan

For POTS, one can normally add a new extension phone by simply tapping into the existing telephone line somewhere, running the new cable to wherever the new phone should be, and installing a jack to plug the phone into. Other than following the appropriate color code to make the proper connections, the process is quite straightforward. In addition, yet another extension could be added by again tapping into the wiring almost anywhere an repeating the process. Another type of arrangement often used for wiring new homes is to run the wire so that is passes sequentially through each jack location. This is often referred to as a series or **daisy chain** configuration - an example is shown in Figure 1.11(a).

While the series, or daisy chain, wiring arrangements described above are acceptable for POTS, they are not consistent with the ISDN technical standards. In some cases, a series type arrangement will work while in others it will not. The wiring arrangement recommended by the EIA/TIA wiring standards is a **star**, or home run, configuration where the wiring to any individual piece of terminal equipment comes from a central or home point and goes only to that terminal equipment location. An example of the star or home run configuration is shown in Figure 1.11(b).

2.3.1.   New or Existing Wiring?

When considering the various wiring issues, one of the main questions is whether to use existing wiring, If your situation permits, or install new wiring. You will need to weight the value of time and materials for new wiring against the value of time to figure out the existing wiring plus any risk that the existing wiring might not do the job. If the decision is close, or it there is any significant uncertainty about the suitability of the existing wiring, new wiring is recommended.

If you will be installing new wiring from the NI, it is reasonably simple and straightforward to figure out what you need to do and then do it. New wiring will insure that there are no unwanted connections along the path of the wiring and, assuming you use cabling of the recommended quality, that the cabling will perform as desired. Thus, the wiring already in place in the house is not a factor. In that case you can ignore the rest of this subsection that talks about how to deal with the existing wiring. Section 5 of this document provides useful information regarding new wiring.

2.3.2.   Existing Wiring

If you are considering using existing wiring for ISDN, there are some additional factors to be considered. **Bridged taps** or unused jacks can cause trouble in some cases. If you are working with your own home you may have a good understanding of the existing wiring, but if you

are working with someone else's home things are likely to be more of a mystery. If you are lucky enough to be working in a house where the wiring is reasonably exposed (e.g., a ranch house with a full basement where the telephone wires are visible in the basement except where it goes up through the floor and wall to a phone), much of the problem is solved. Unfortunately, if much of your wiring is hidden from view the issue gets more complex.

First, find out what wiring exists today and where it goes. Obviously, if you will be wiring a house that you are not familiar with, one of the first things to determine is how many POTS lines (e.g., main line, teen line) enter the house. Each separate line would have a different telephone number, and it is important to keep track of the different lines. If quad wire is used to feed any given jack you should determine whether that particular wiring/jack serves more than one line or not. Even if you know that a specific segment of quad wire carries only one telephone line, there is always a possibility that the additional wires might carry power for an older style lighted dial phone, serve a burglar alarm or intercom system, carry an audio signal for a hi-fi set, etc.

After you have determined what services are being carried by the telephone wiring, try to draw a diagram similar to Figure 1.1 or 1.12 that shows all existing telephone wiring in the house. That may range anywhere from a simple to a fairly complex effort. Ideally, you need to know where all the jacks (or equivalent junction boxes if you still have some phones that don't have jacks) are and how the existing wiring gets to them. The actual path that it takes is not critical, the important issue is trying to determine whether or not there is anything unknown (e.g., a jack, a bridged tap) along the way. It is the hidden things that might cause trouble. An unused jack wired in the path probably won't cause any trouble unless someone inadvertently plugs a telephone or some other piece of equipment into it. Similarly, an unknown bridged tap may or may not be a problem depending upon the circumstances. Knowing about those types of things ahead of time let's you deal with them, instead of being surprised by them.

3.   An Introduction to ISDN Powering Considerations

3.1.   Introduction

This section describes powering considerations for ISDN equipment. Power requirements are dependent upon the installed equipment and a number of personal preferences. Subsequent sections will contain specific powering details.

3.2.   Powering Requirements

ISDN equipment has different powering requirements than traditional POTS equipment. With POTS, the Telco provides limited power to the customer's equipment. With ISDN, the Telco does not provide the supporting power. However, powering for ISDN equipment is similar to some types of POTS equipment.

POTS equipment can be divided into two categories: basic telephone and specialized equipment. The basic POTS telephone requires no power when in stand-by-mode (on-hook), and very little power when in normal operation (off-hook).

Specialized POTS equipment requires more power than the Telco can provide. Examples of this category of equipment include cordless telephones, fax machines, computer modems, feature phones, speaker phones, and answering machines. This equipment is typically powered from an electrical outlet.

Warning: Loss of commercial power will require the use of backup power to maintain ISDN service.

A typical ISDN Component System is shown in Figure 3.1. The service from the Telco is a 1-pair wire line which enters the customer location through the Demarc. The Demarc is then connected to the NT1. Here it is transformed into a 4-wire pair (2 signals, 1-power and 1-spare). There can be as many as eight pieces of terminal equipment connected to the NT1.

3.3.   Powering Options Specifications

ISDN powering standards define three different powering options on the S/T interface. These are called PS1, PS2 and PS3. Consult the manufacturer's equipment manual for the powering option being used. It is recommended that 4-pair (8 wire) UTP cable, Category 3 or better be used for all new ISDN installations.

3.3.1.   PS1

For PS1 cable wire assignments see Figure 3.2. PS1 provides terminal power over the ISDN signaling pairs (4&5, 3&6). To use this option, make sure that all ISDN TE will operate from PS1, the NT1 supports PS1, and the NT1 power supply (see Section 3.3.4) provides enough capacity for all ISDN equipment. The PS1 option is sometimes referred to as phantom powering.

3.3.2.   PS2

For PS2 cable wire assignments see Figure 3.3. The PS2 option for powering ISDN is the most widely used. PS2 is considered the primary power source to ISDN TE. Under this configuration, power is applied to a separate pair of wires. PS2 powering uses pins 7 and 8 of the S/T interface. The signaling pairs use pins 3, 4, 5 and 6. Pins 1 and 2 are not used. The unused wires should be reserved as spares.

3.3.3. PS3

For PS3 cable wire assignments see Figure 3.4. PS3 is specified to power the ISDN TE through pis 1 and 2 of the S/T interface. The PS3 option is not presently used by the majority of CPE vendors, however, pins 1 and 2 should be connected at both the TE and NT1. Pins 7 and 8 are not used. The unused wires should be reserved as spares.

3.3.4. Powering the NT1 (external)

The standards permit that power to the NT1 can be supplied on pins 7 and 8 of the "U" interface connector. There may be additional powering options available. The NT1 may pass power to the ISDN terminals using PS1 and PS2, as discussed above.

3.4.   Powering Equipment Location

3.4.1.   Local, Remote and Distributed Power

Local power is defined as a power supply co-located with the equipment utilizing that supply. In this type of powering arrangement, the NT1 and TE will be co-located in the same room or possibly integrated in the same unit. The power supply will be sized to power the NT1 and TE (see Figure 3.5).

Remote Central Bulk Power is defined as a power supply which is found in some location other than where the equipment is located (see Figure 3.6).

Distributed power is any combination of local and remote power sources. In Figure 3.7, distributed power is provided by one remote supply and two local supplies.

3.5.   Factors Affecting Power Equipment Sizing

3.5.1.   Distribution Devices

The location and type of distribution devices will vary with the installation and age of installation. The most important issue regarding power is not the type of distribution device, but the number of wires it supports. If the device can not handle 8-wires, then a new distribution device should be installed. See Section 1.2.4 for information on types of distribution devices.

3.5.2.   Power Supply Cable Length Considerations

Provided that the wire used is 24 gauge, all of the wiring configurations recommended in this document are compatible with power options described in this section

3.5.3.   Location and Environment

Choose a location which is easily accessible and has sufficient room for all of the equipment. The area should be cool, dry, and well ventilated. Consult the vendor's manual for recommended operational ranges and local codes for safety issues.

3.6.   Powering and Wiring Variations

3.6.1.   Powering of Terminal Equipment Using Existing Quad Wiring

With existing quad wiring, local powering must be used. Bulk powering and distributed powering options require more wires than are currently available. Local powering is defined in Section 3.4.1.

3.6.2.   New Wiring to a Single Target Room

Wiring to a single target room can use either local or bulk power. There are no special considerations for powering, as wire installed for ISDN phone systems will provide an adequate power source.

3.6.3.   New Wiring to Multiple Target Rooms

Wiring to multiple target rooms could consist of local power in each room, bulk power at one central location, or distributive power at different locations.

3.6.4.   Terminal Equipment with Internal NT1 Functionality

Some equipment have NT1s embedded inside. Equipment of this type provide a "U" interface jack and may also supply an S/T interface jack.

3.6.5.   Backup Powering Alternatives

3.6.5.1.   Remote NT1 Powering

Figure 3.8 shows a situation where the NT1 and the power supply with backup power source (UPS or battery) are located in different parts of the house. In this case it is necessary to back feed power from the TE location (Den) to the NT1 and the other ISDN sets, to achieve emergency power operation.

Power is supplied to pins 7 and 8 of the S/T interface in the den, using a 2:1 adapter, to power the NT1 located near the Demarc. For this application to work the NT1 must support PS2 and be able to accept power input on pins 7 and 8 of its S/T interface; check with your vendor.

3.6.5.2.   Selectively Powering Phones

In Figure 3.9, only the ISDN set in the den is required to have backup power. The other sets are locally powered. The considerations are identical to those described in Section 3.6.5.1 with the exception that pins 7 and 8 going to the kitchen and bedroom are disconnected at the distribution device. Using the distribution device, you can selectively apply power to any desired destination, and all combinations of local and remote powering are possible.

3.7.   Power Supply Alternatives

3.7.1.   Equipment Description

There are three types of equipment which may be used for powering ISDN equipment. The first type of equipment is a power supply without battery backup. The second is a power supply with battery backup. The third type is an Uninterruptible Power Supply (UPS).

3.7.1.1.   Power Supply without Battery Backup

A power supply is defined as a unit which will take commercial power and provide DC power out to run ISDN equipment.

3.7.1.2.   Power Supply with Battery Backup

Battery backup may be added to a power supply to maintain equipment operation in the event of commercial power failure.

3.7.1.3.   UPS

A UPS is a powering system that takes in 115 VAC and outputs 115 VAC. When the original input power is disrupted and is no longer being provided by the local utility, the UPS will continue to provide 115 VAC to the load. Typically, internal batteries power an inverter to provide the 115 VAC, uninterrupted power source.

3.8.   How to Select the Power Source

3.8.1.   Determining Power Source Type

Each user must choose power to fit the system needs.

Three options are available.

- A DC power supply only. This provides no backup. The ISDN equipment will not work during a commercial power outage unless the NT1 and the TE contain internal reserve power (battery).

- A DC power supply with backup power. Backup may be in the DC power supply or added by an optional external battery. You need to size the power supply and the battery.

- A DC power supply and a UPS. The UPS provides backup AC power to the DC power supply. You may have a UPS for your computer. The UPS may have extra capacity to power the DC power supply.

In all cases, you need a DC power supply.

3.8.2.   Sizing the DC Power Source

The sizing of the power supply needs to be known so that the appropriate power supply can be purchased. This is found by determining the powering requirements of all the equipment (ISDN phone, NT1) used in the system. These powering requirements can be found by consulting the individual owner's manuals of the ISDN phone and NT1. The DC power source may have an optional battery backup; see Section 3.8.3.

3.8.3.   Backup Power Source

3.8.3.1.   Battery Selection for DC Power Source

The following variables will affect the real performances of the battery. Batteries are not linear with time vs. current draw, and are affected by ambient temperature and usage. The amount of reserve capacity is also dependent upon time since last power outage. For battery selection consult the DC power source's manual.

3.8.3.2.   UPS Power Source

There are other possible powering configuration that can be explored. In some installations, a UPS system may be on site for the purpose of providing backup power for computer systems which are connected to ISDN communication lines and/or other systems. If this is the case, the UPS should be checked for proper rating and load prior to connecting the ISDN communications equipment.

The use of a UPS will not change the ISDN powering specification mentioned above. PS1, PS2, or PS3 powering options would still power the communications equipment. The UPS would maintain the AC power to the communications equipment power supplies.

Examples
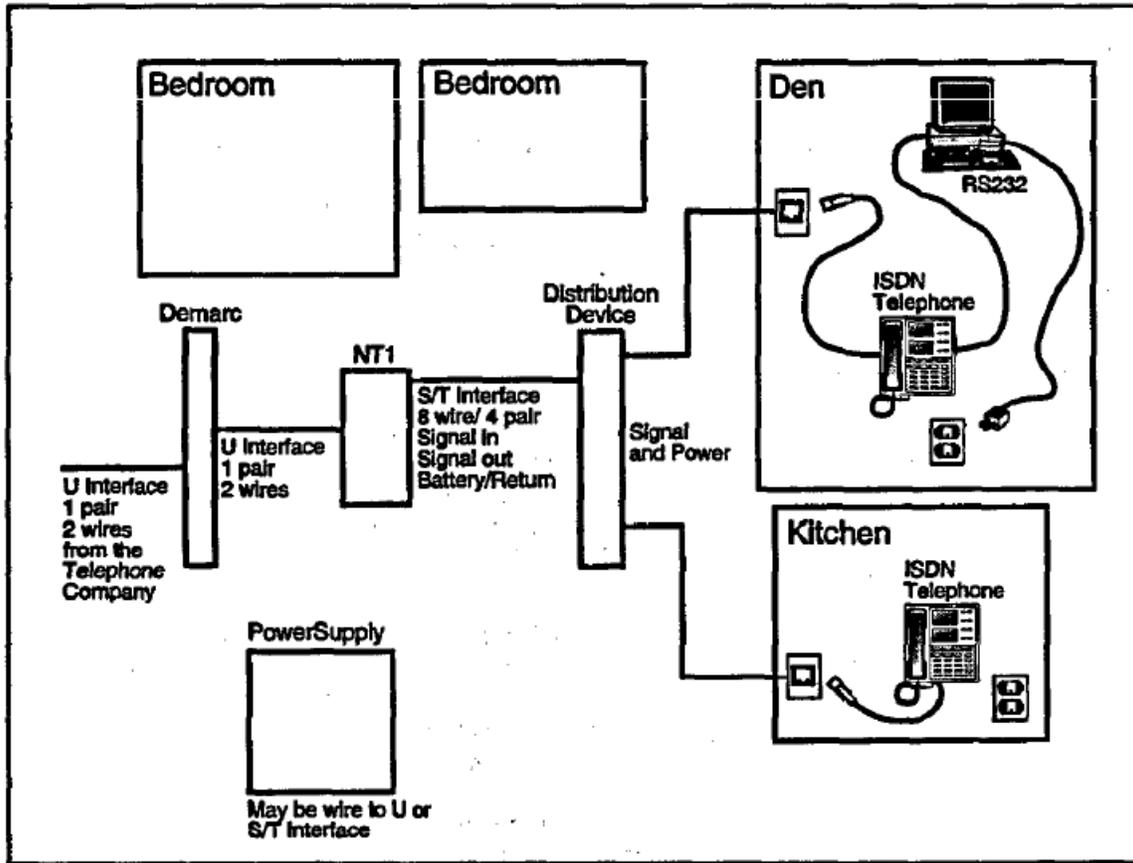
Figure 3.1
ISDN Service
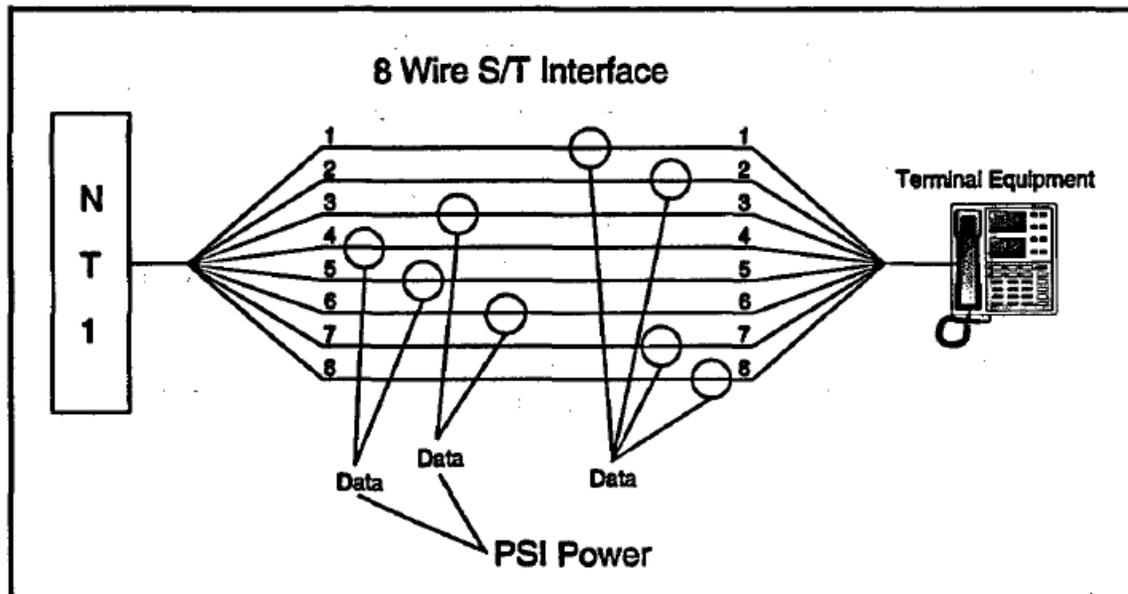
Figure 3.2
PS1 Power

Figure 3.3
PS2 Power

Figure 3.4
PS3 Power

This is the U interface wire pair. This wire pair carries digital data only. No power.

Figure 3.5
Local Power

Figure 3.6
Central/Bulk Power
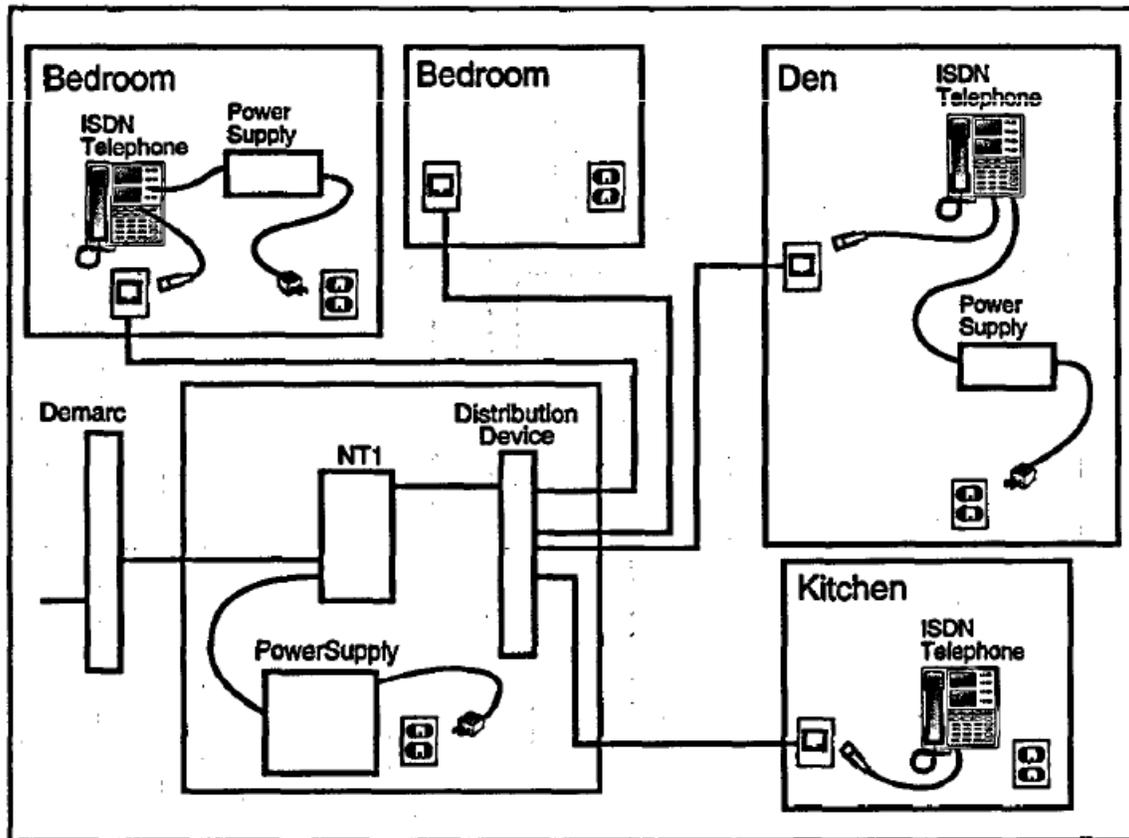
Figure 3.7
Distributive Power
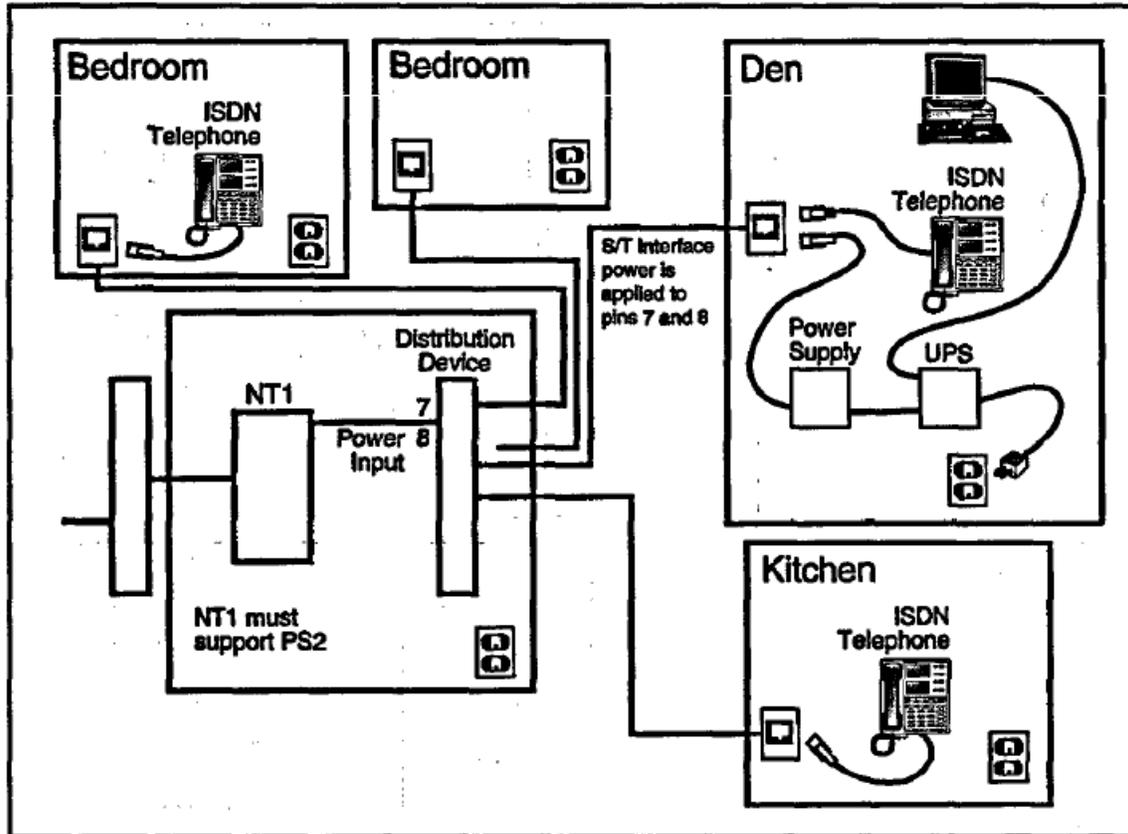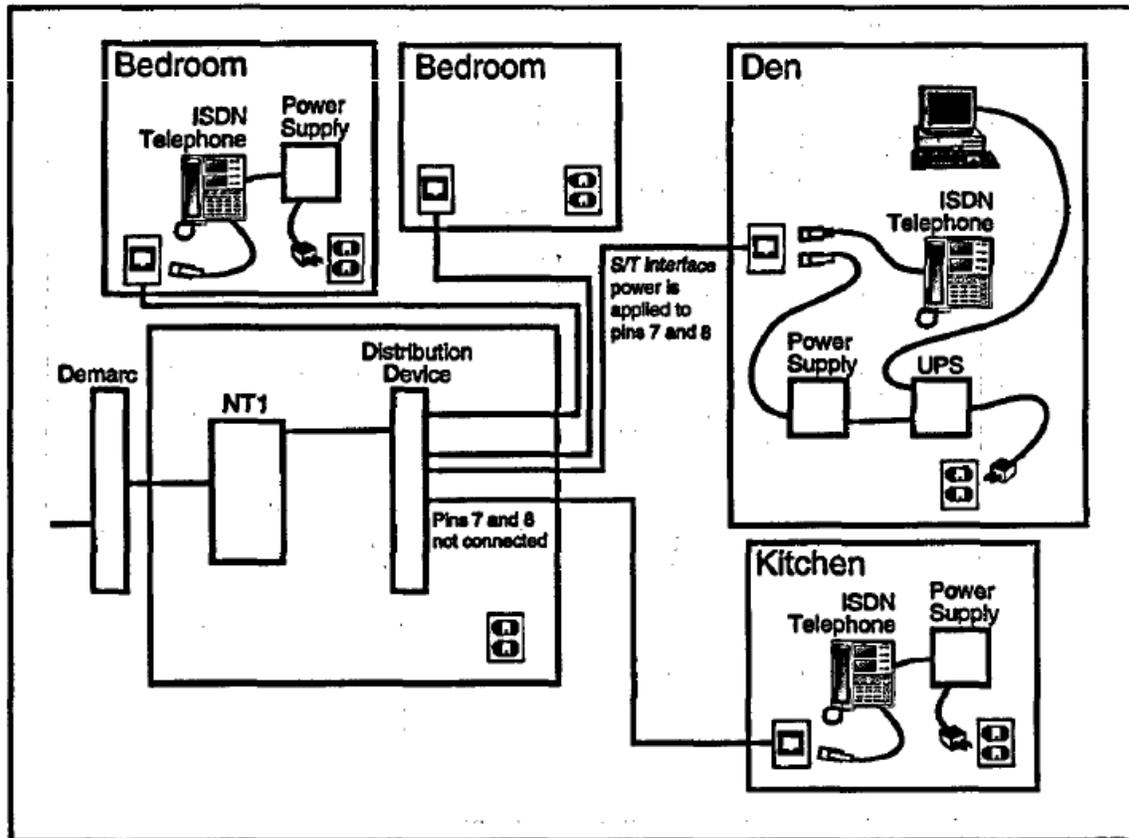
Figure 3.8
Powering

Figure 3.9

4. ISDN to a Single Target Room (Using Existing Wiring)

4.1. General

Use this section to help guide your ISDN wiring activities if:

- You already have at least one POTS line and will be adding ISDN to an unused pair.

- You have two or more POTS lines and you will be converting one of the existing POTS lines to ISDN service.

- You want to have "U" interface access to a service outlet.

The goal is to use the existing wiring to serve the new ISDN line. In most cases, these procedures will provide satisfactory service because your premises are currently wired with quad or UTP wire. Due to the wide diversity of wire that is installed in North America today, the proce-

dures described herein may not result in a successful installation. If it is determined the existing wiring cannot serve the new ISDN line, then you will be directed to consult Section 5, which will explain how to run new wiring for ISDN.

The section is written assuming the following:

- The building is a single-family home or small business (ground-level business)

- The existing service to the building is POTS

- The ISDN line is only going to one room in the building

- There is already a telephone outlet in the room where ISDN is desired.

- The existing premises wiring is either quad cable or UTP as shown in Figure 4.5.

As the name of this section, ISDN To a Single Target Room (Using Existing Wiring) suggests, the target configuration for this section would be that of residence or ground-level business that provides accommodations for office functionality. In addition to this home-office, basic services provided by POTS are assumed to be well spread through out the residence (see Figure 4.1).

NOTE: Please read the Cautionary Notes in the Introduction before performing any TASK.
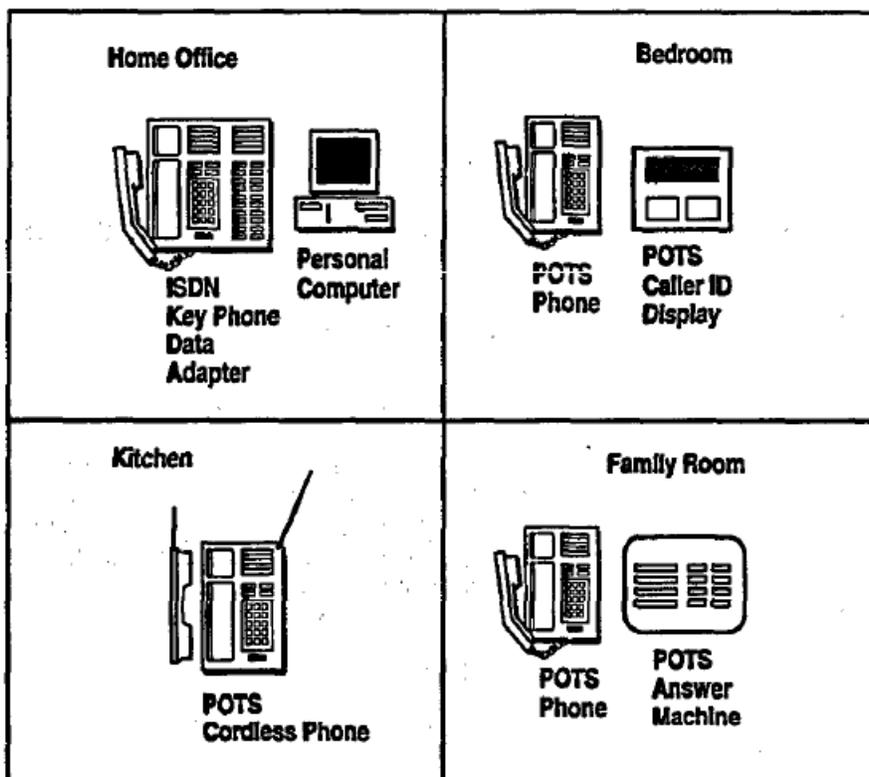
Figure 4.1
Typical Configuration

4.2. Installation Procedures

This section will step you through the tasks involved in adding an ISDN line to your residence when you intend to retain your POTS service and you have a spare pair in your premises wiring to support the new ISDN service. The tasks for adding ISDN to a residence with multiple POTS lines when one spare pair already exists or one POTS line will be changed to ISDN service, are similar and are further explained in Section 4.3. You may encounter slightly different situations then the tasks describe. It would be impractical to describe all the variations you might en-counter.

4.2.1. TASK — Locate the Demarcation (Demarc) Device

To have the ISDN U-interface wired in a specific room in the building using the existing premises wiring, it is necessary to survey the pairs of the customer premises wiring to find a spare pair of wires. First of all, you will need to identify an electrically isolated pair that has continuity from

the NI to the target room. Therefore, you will need to find the demarc (additional information may be found in Section 1.2.1). There should be one NI for each line going into your building. It can be found either inside or just outside the walls of the building. Generally, there are two types of NI you might find. The earlier version is depicted in Figure 4-2(a). As stated in Section 1.2.1.1, **only** Ameritech personnel may make changes to this type of NI directly. It is important to understand that, in the case of this older type of NI device, there is no legal point of demarcation between the network and the inside wiring. In order to modify the wiring that is connected to this type of NI, a legal point of demarcation must be created. This can be done by using an additional service outlet or entrance bridge to connect inside wiring to. These configurations are depicted in Figures 4-2 (b) and 4-2 (c). The conversion process to add either a service outlet or entrance bridge to a legal demarcation point can be found in Appendix A, located in Section 1.

WARNING: Lightning Arrestors-
(Do Not alter or tamper with
these terminals.)

Threaded Posts for Wiring
Connectors (check these
terminals for your color code)

GROUND Terminal
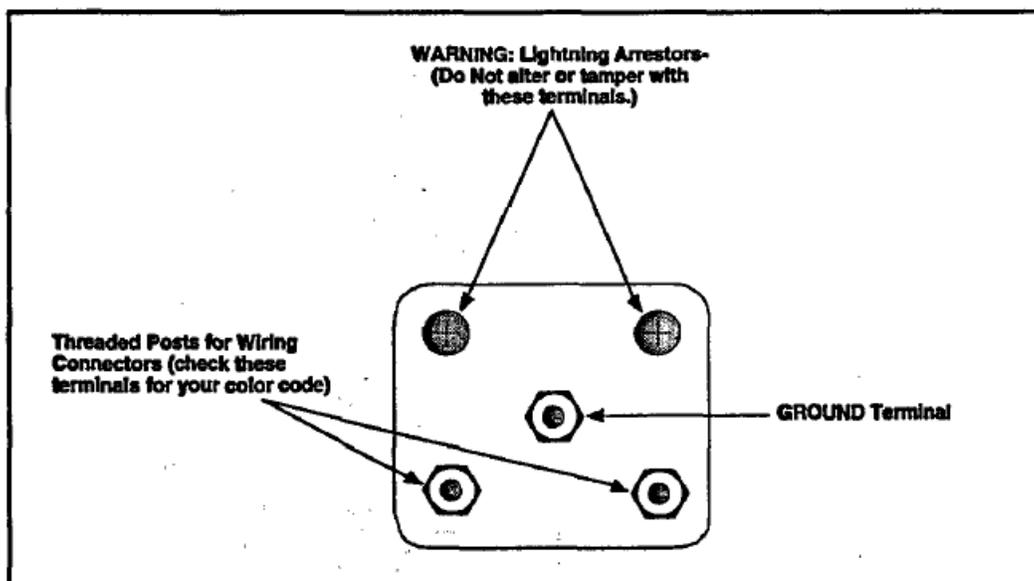
Figure 4.2 (a)
Typical Protector Block (See Fig. 1.2(a))
Early Version – Cannot be wired directly by anyone
except Telco personnel

NOTE: As you can see, there are screws and bolts on this demarc that can be adjusted. As stated in Section 1.2.1.1.1, only telephone company personnel may make any changes to the Protector Block.
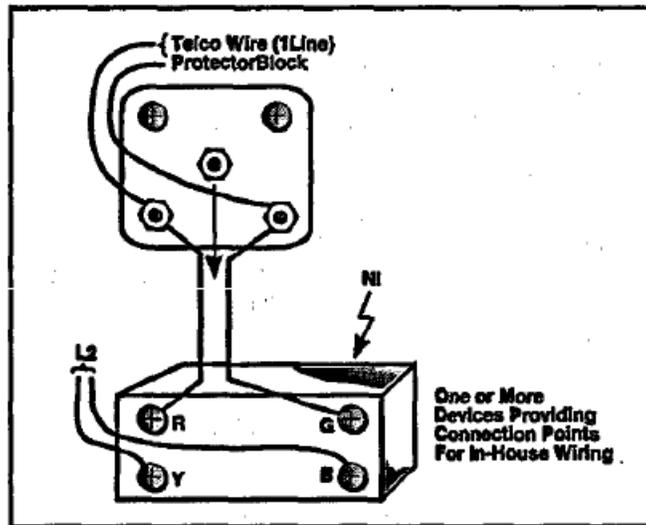
Figure 4.2 (b)
Older Type NI
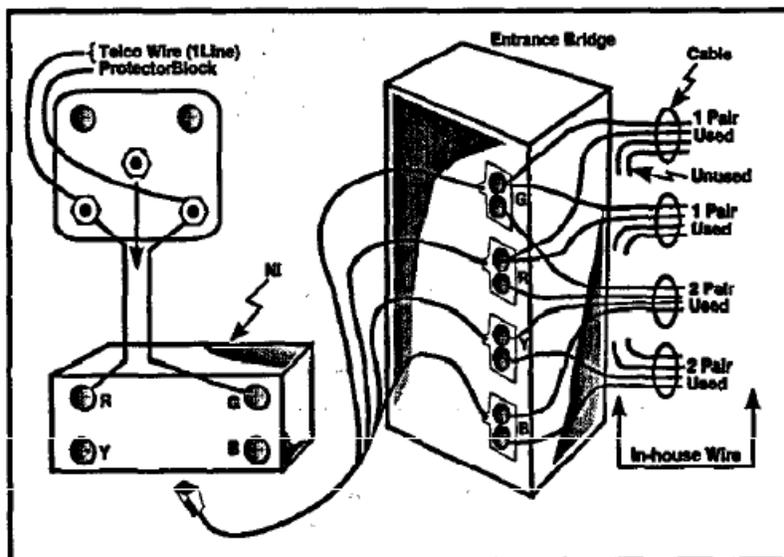
Figure 4.2 (c)
Older Type NI with Entrance Bridge

Otherwise, the NI could resemble the one depicted in Figure 4-3.
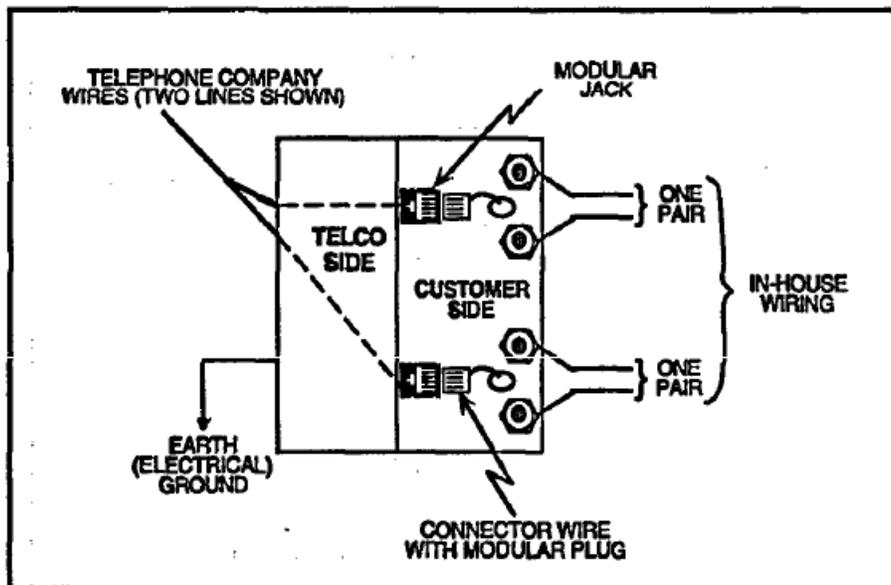
Figure 4.3
Typical Modular NI Device
New Version

As you can see, the device is made with a short, modular "pigtail" so that the customer can plug in a telephone or TE to isolate any problem that might be found in the line. After looking closely at the NI's depicted in Figures 4-2(b), 4-2(c) or 4-3, you will notice that each of them have screw down/bolt down terminals as connector points. This is where the customer premises wiring begins.

4.2.2.   TASK — Identify Unused Wire Pairs at the Demarc

Once the POTS NI has been located, you should be able to find the customer premises wiring. Typically, the sheath of the customer premises wiring is gray, white, or beige and the sheath contains several colored conductors. Sketch and label the pairs that are connected to the NI. **For safety, disconnect all of the pairs in the customer premises wiring that lead to the NI while you are working on the wiring.** For a modular NI, disconnect the modular pigtail to sep-

arate the customer premises wiring from the network. For the older type NI, disconnect all of the wires connected to the customer premises wiring side of the NI (see Figures 4-2(b) or 4-2(c)).
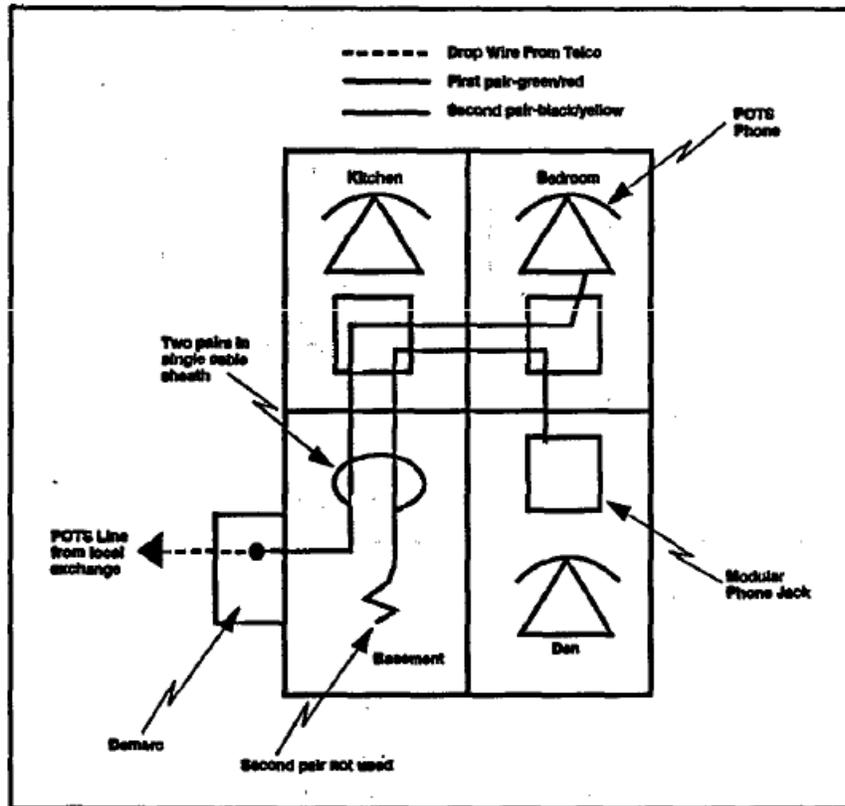
Figure 4.4
Daisy Chain Configuration
Residence with "Spare Pair"

Most homes have customer premises wiring that is composed of quad cable which has two pairs within it (see Figure 4-5). Newer installations could be using UTP cable which has many pairs within in (see Figure 4-5). If there is only one pair found in the customer premises wiring, then there are no spare pairs; in order to install the ISDN U-interface, proceed to Section 5, which will explain how to install new wiring for ISDN. Figure 4-5 shows some examples of different types of wires that could be found in the building.

Daisy chain wiring is depicted in this figure, but other wiring topologies such as star, ring, etc. maybe found in your residence.
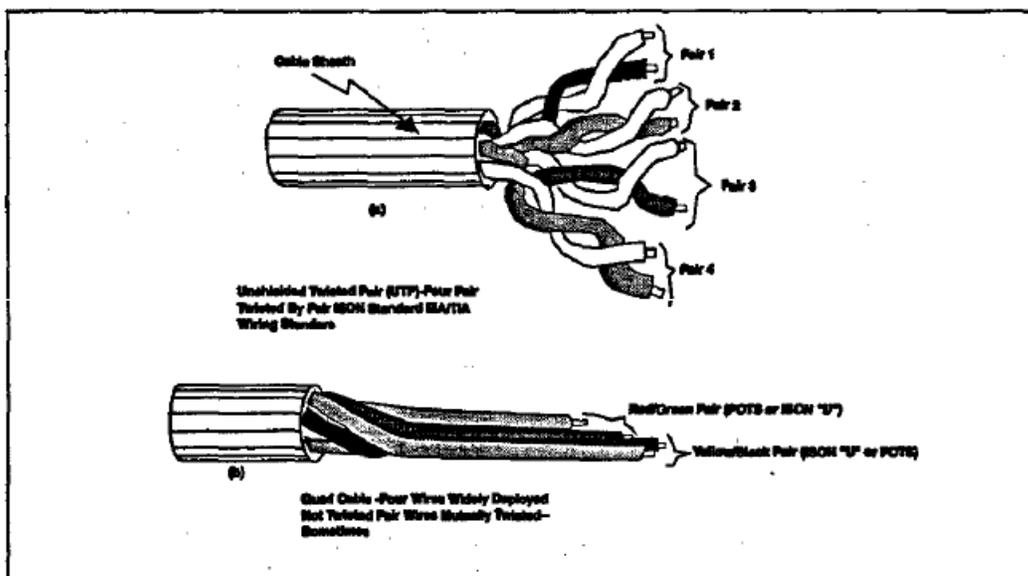
Figure 4.5
Types of Customer Premises Wire

The conductors in telephone wiring are color coded. They may be a solid color, or striped. The following table depicts color combinations identifying cable pairs:

	TABLE 2.1	
Pair Numbering	Quad Cable Color Coding	T568A Color Coding
Pair 1	Green & Red	White/Blue & Blue
Pair 2	Black & Yellow	White/Orange & Orange
Pair 3	White & Blue	White/Green & Green
Pair 4		White/Brown & Brown

NOTE: For T568B Color Coding, Pairs 2 and 3 are swapped (see Section 2).

Caution: **As you connect ISDN, or any telephone service, it is important to maintain the pairing of the wires. Do not "cross match" wires from different color combinations. For example, green and yellow wires are never used together as a "pair".**

Identify which pairs of wires are "in use" at the NI. If the NI is modular, plug a POTS telephone set into each modular jack on the NI (see Figure 4-6). If you can hear dial tone when con-

nected to a jack on the NI, it indicates an active POTS line. If the NI is the older type and you have multiple NI (located within the same or different physical housings), then construct an adapter (see Figure 4-7) using a surface mount outlet and verify live POTS service at all NI's. Any wire pairs connected to the live jack should be considered "in-use". Any pairs which are not connected to the live jack should be considered potential "spare pairs" Also, any pairs connected to a NI which is not active (does not have dial tone) should be considered potential spare pairs. (Pairs which are connected to a NI that have no dial tone should be disconnected.)
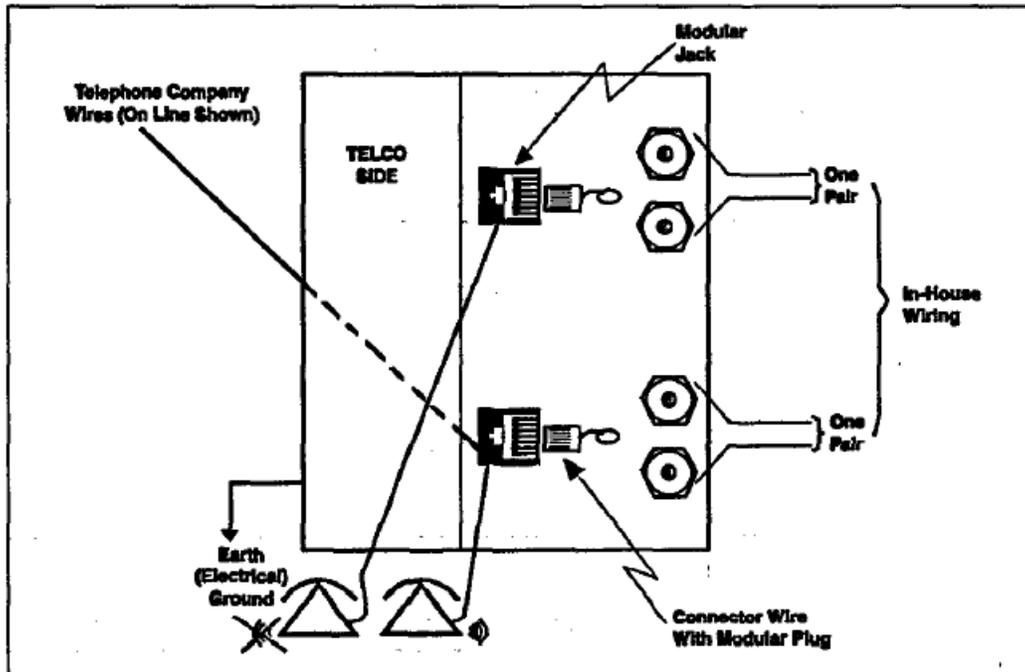
Figure 4.6
Checking for Spare Pairs at Modular NI's

For the spare pairs identified at the demarc, make note of the colors of the conductors.
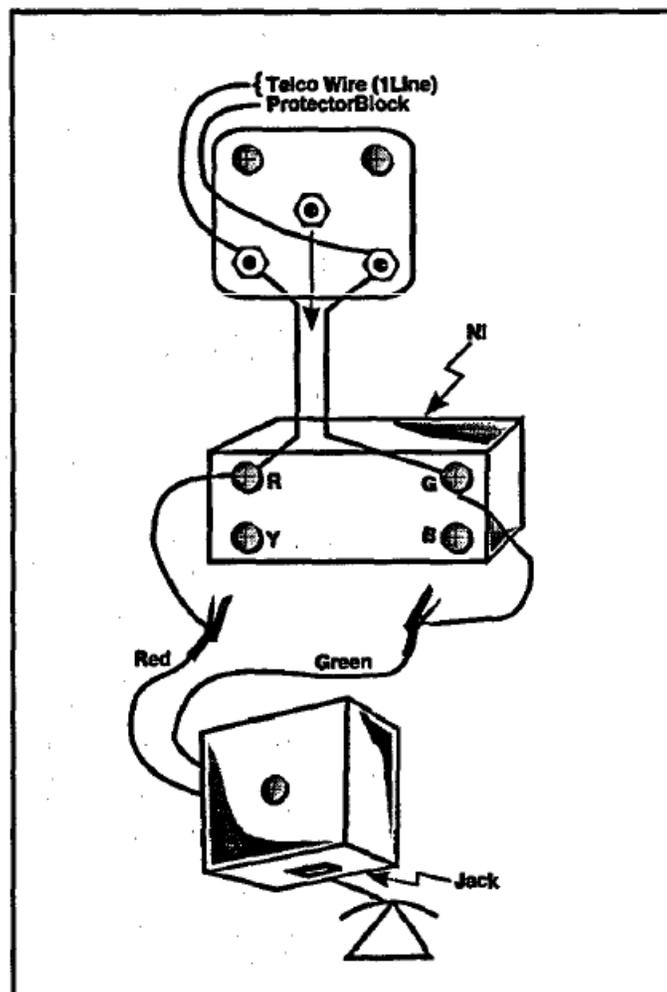
Figure 4.7
Test Adapter for Verifying Live POTS Service on Old Style NI's

Caution: **Some of the pairs which appear "spare" at the NI may be in use for other purposes in the residence. You may need to check with the residents to learn if they have any knowledge of the customer premises wire being used for intercoms, stereo speakers, home alarms, local area network for computers, or similar applications within the residence. If they know of such uses of the communications wiring, they may be able to show you where it is used. Otherwise, you may wish to quickly survey the residence to determine if it appears that any other equipment is connected to the customer premises wire.**

If there are such uses of the wiring, you should determine the colors of the pairs used, and eliminate these pairs from your list of potential "spare" pairs.

4.2.3.   TASK — Wiring the U-interface Service Outlet in the Desired Room

Locate the existing telephone service outlet in the room where ISDN is desired. Open the service outlet, and determine if any of the pairs you have identified as "spare" appear to be present.

If the spare pair is not present at this service outlet, you will need to run new wiring to serve the ISDN service outlet (see Section 5). If there is no existing service outlet in the room, you will also need to run new wiring.

Once a pair of unused conductors is found at both the NI and the room where ISDN is to be placed, you may want to perform a continuity test on the spare pair that has just been identified at the service outlet. This can be accomplished by twisting the conductors together at the NI location and measuring the resistance of the pair at the service outlet with an ohm meter. If the continuity test fails, you may need to troubleshoot this problem further. For example, the premises may have been wired in a daisy chain configuration and the spare pair may not have been wired to each service outlet in the chain. **Significant troubleshooting may be required to identify the specific service outlet in the chain and then to verify that the spare is wired to each service outlet in the chain. The installer may want to review Section 5 (new wiring), before attempting this troubleshooting process since installing new wire may be easier and less time consuming than attempting to correct this wiring deficiency.**

If the continuity test is positive, a new service outlet for the ISDN access should be installed. Service outlets for POTS provide either 4 or 6 conductors, and actually use the center two pins for service. To wire the ISDN access, a 6-position modular service outlet (sometimes referred to as an RJ-11 style service outlet) may be used or an 8-position modular service outlet (sometimes referred to as an RJ-45 style service outlet) can be used. An 8-position modular service outlet is preferred. There are many types of service outlets and service outlet adapters that can be used to wire additional outlets (see Figure 1.10) instead of replacing or adding an additional service outlet. The following will assume that the service outlet used for the ISDN access is placed directly next to the service outlet currently used for the first POTS line (see Figure 4-8).

Mount the service outlet that will be used for ISDN access directly next to the existing service outlet. Be sure to make note for which service outlet is used for POTS and which service outlet will be used for ISDN. Remove the cover of both service outlets. Find the spare pair of conductors that you have decided to use for ISDN in the service outlet for POTS. Connect these two conductors to the two center pins of the new ISDN service outlet. When you make the connection of the spare pair to the ISDN service outlet you can either; remove the spare pair from the POTS service outlet completely or you can wire between the two service outlets (see Figure 4-5, alternate wiring configuration). (Note: the actual method of connecting the wires maybe

different for each service outlet, so be sure to read the manufacturer's instructions carefully.) The service outlet's terminals may be color coded as described in Table 4-1.

After the ISDN service outlets been wired, reattach the cover for both the POTS and ISDN service outlets. Label the ISDN service outlet "ISDN" with a marker, or by some other means. Also label the spare pair you have selected at the NI.
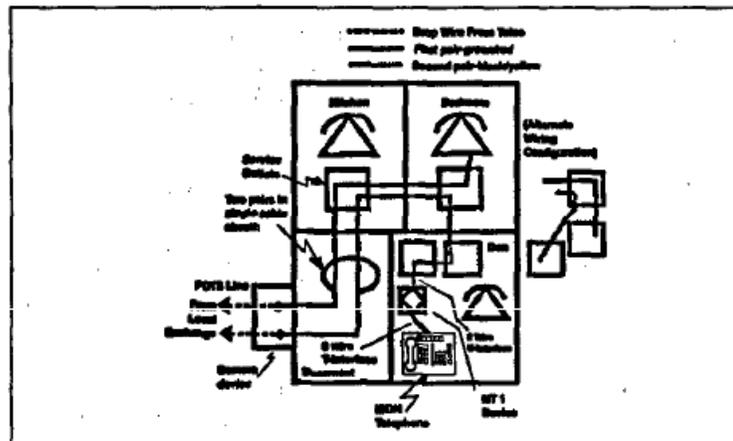
Figure 4.8
Spare Pair Connected between NI and New ISDN jack

4.2.4.   TASK — Verify Continuity at the ISDN Service Outlet

Before the ISDN service is connected, you may wish to verify the continuity between the spare pair you identified at the NI and the pair you connected to the new ISDN service outlet. If your ISDN service is not working, you can use this procedure to troubleshoot the wiring between the service outlet and the NI.

NOTE: This task requires you to disconnect and possibly add several connections to your NI's. Before starting this process, you may wish to draw yourself a sketch of the current wiring that is in place at the NI's. After this task and task 4.2.5, you will be instructed to reconnect your wiring in exactly the same way that you depicted in your sketch.

Disconnect any ISDN equipment from the ISDN service outlet. At the NI, connect the pair you selected for ISDN to the pair currently used to run POTS to other service outlets in your premises. This can be done in a number of ways depending on the type of NI you have. Figure 4-9 illustrates a method that can be used if your premises contains multiple NI's of the older variety. If you followed the instructions in task 4.2.2, you have already disconnected the wires attached to the customer premises side of the POTS Network Interface (if you have not performed this function, do it now). Obtain a pair of alligator clip leads and connect the customer

side of the POTS NI to the customer side of the ISDN NI. (If you have a modular NI that supports multiple pairs, the procedure should be as easy as unplugging each of the pig tails from the POTS and ISDN modular jacks and leave the POTS pigtail disconnected and plug the ISDN pigtail into the POTS modular plug. Or, if the pigtails are not long enough, the alligator clip leads can be connected between the terminal lugs of the respective pairs. Now, plug a POTS telephone into the ISDN NI. If you do not hear dial tone, there is a problem in the wiring, and you will need to select a different spare pair between the protector and the ISDN NI. If no more spare pairs exist, you will need to run new wiring, see Section 5.)

NOTE: Proceed with the following task before disconnecting your jumper wires.

4.2.5.   TASK — Block Other Jacks Using Same Conductor

You may wish to test the customer premises wiring to determine if any other jacks in the residence are connected to the ISDN pair, in addition to the ISDN jack you installed. If other jacks are connected to the ISDN pair, you may wish to "plug" those phone jacks with dummy plugs, and label the jacks, to prevent equipment from being connected to those jacks. You should not disconnect any jacks you find connected to the ISDN pair because this could break the continuity to the ISDN jack, and your ISDN service would not work.

With the jumpered connections left in place from the previous task, perform the following: Take a POTS telephone set to every other telephone jack in the residence, and plug it in and listen for dial tone. Any jack at which you can hear dial tone is also connected to the ISDN pair, and should be "plugged" and labeled.

Once you have tested all the jacks in the residence make sure you have disconnected the POTS phone you were using for your testing. Return to the NI, and re-connect the POTS and ISDN NI as they are depicted in the sketch you made in task 4.2.4.
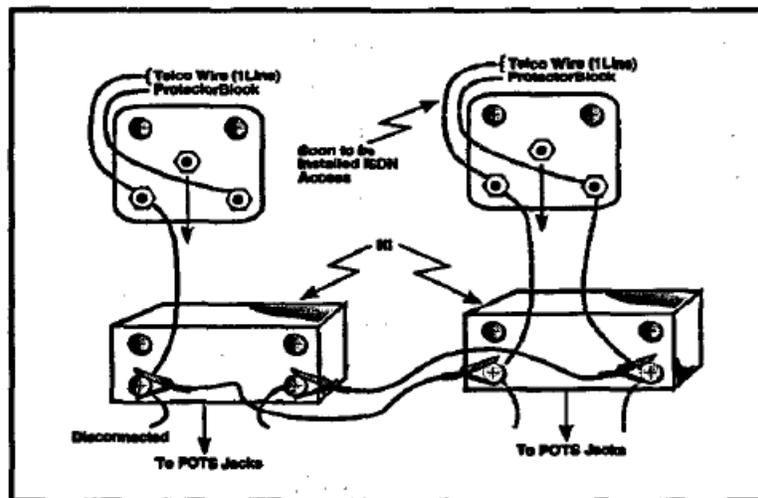
**Figure 4.9
Setup for Verification of Continuity of
Spare Pair used for ISDN Jack Wiring**

4.2.6. TASK — Verify That POTS is OK

You now need to check to see that the POTS access was not indirectly affected. Reconnect the pigtail you identified for POTS at the NI (or reconnect the wires to the bolt down terminals if you have an old type NI), that you disconnected as part of task 4.2.2 and return to the room where the new line has been installed. Connect a standard telephone to the POTS jack and pick up the handset. Dial tone should be hard, possibly after a few minutes delay. If it is not heard, recheck the connections in the POTS jack and at the NI. Now that the POTS line has been re-connected at the NI, all other telephone equipment connected to the original POTS line should also be working again. If it is not, you will need to troubleshoot the problem.

4.2.7. TASK — ISDN Service Connection

Verify that the service provider has connected and activated your ISDN service. You may now connect the pair of wires you selected for ISDN service in the customer premises wiring to the appropriate ISDN access at the NI. The service provider may have identified the connection points for ISDN on the demarc device. The identification will often be a notation of the phone number assigned to your ISDN line NI to one of the NI connecting points. Connect the ISDN

pair you selected and tested to the terminals of the NI identified for your ISDN service. Be sure the pigtail (if one exists) for the ISDN NI is plugged in.

4.2.8.   TASK — Connecting Your ISDN Equipment

Connect your ISDN equipment at the ISDN jack you installed. A typical arrangement includes a power supply, an NT1 device, and an ISDN telephone (see Figure 4-10). Another configuration includes the use of multiple pieces of terminal equipment and the wiring topology that should be utilized in wiring multiple terminals on the S/T bus is the star wiring configuration. This configuration is depicted in Figure 2.4(a).

4.2.8.1.   TASK — Connecting Your ISDN NT1 Equipment

Proper selection of NT1 timing and terminating resistors are very important for satisfactory ISDN service. In most cases, where all of the ISDN TEs are located within the same room (less than 250 feet per leg of the star), the NT1 should be configures so that it provides a 50 ohm resistance termination. This 50 ohm termination can be provided in many ways depending upon the design of the NT1; some vendors provide a 50 ohm terminating resistor, others may provide a combination of resistive terminators that achieves a 50 ohm termination. See the manufacturer's instructions for proper optioning of your specific piece of equipment.

If your NT1 has an option for fixed or adaptive timing, choose the default timing option equipped in your NT1. See the manufacturer's instructions for additional optioning information of your specific piece of equipment.

Plug the NT1 power supply into a wall outlet and follow the instructions provided to you from the manufacturer. You may need another cord with modular connectors to connect the power supply to the NT1 device. Again, consult the power supply and NT1 device instructions of the type of cable and where it should be connected on each device. Once the NT1 is connected to the power supply, you may notice indicators lighting to show the NT1 and ISDN line status (see Section 4.2.9).

4.2.8.2.   TASK — Connecting Your ISDN TE Equipment

The user should connect the ISDN terminal equipment directly to the NT1 which supports the star wiring configuration depicted in Figure 2-4(a). Adapters such as those depicted in Figure 1.10 (a) maybe required for connection of multiple terminals in a star configuration. The instructions for your ISDN TE will provide you with information regarding cables, power supplies, and (possible) terminating resistor options. In the wiring configuration discussed here, the proper option for terminating resistors in ISDN TE is "off or none". Your TE may provide you with a straight through 8 conductor cord suitable for ISDN with 8 pin modular plugs at both ends to connect the NT1 to the ISDN TE (if not, see Section 1.2.6). Plug the cable into the NT1 and

ISDN TE as directed in the instructions that came with the NT1 and the TE. Many ISDN TEs need to be programmed to set the operating parameters. If your TE needs to be programmed, follow the instructions that came with the TE. If your ISDN service includes voice capabilities, you should not be able to make a voice call from your ISDN TE. If everything is operational, the installation is completed.

4.2.9.   TASK — Troubleshooting

If you ISDN service is not working as you expect, you may need to troubleshoot your configuration:

- Is everything plugged in as it is supposed to be?

- Do status indicators on the NT1 and/or ISDN telephone appear OK (based on instructions that came with the equipment?)

- Is your ISDN telephone programmed with the correct parameters?

- Are the terminating resistors optioned correctly in the NT1 (50 ohms) and the ISDN TE (off or none)?

You may use the procedure in the section titled "TASK — Verify continuity for the New ISDN Jack" to determine if there is a wiring problem to the ISDN jack. To verify that your ISDN service from your provider is working correctly, you may connect the ISDN equipment directly to the test jack at the NI by disconnecting the pigtail and wiring the NT1, ISDN telephone and necessary power supplies to the NI and then attempt to access ISDN service.
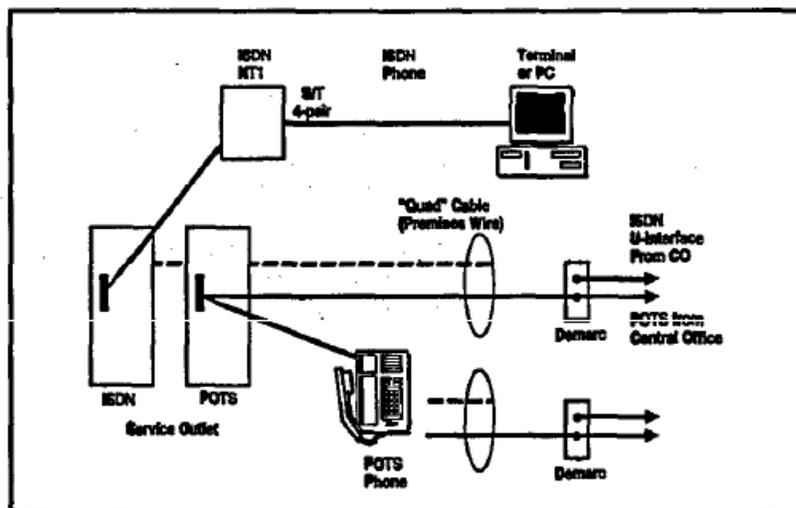
Figure 4.10
ISDN Equipment Connected to Wall Jack

4.2.9.1.   Presence of a Distribution Device

Some residences might include a distribution device. This is a connecting block that can be used to "fan out" the customer premises wiring from the NI to the rest of the residence (see Figure 1.4 (d)).

The distribution device, is used, will often be located inside the residence, near the location where the wiring from the NI (on the outside of the residence) enters the structure. It will have terminals for connecting the wires leading to the NI, and for connecting the customer premises wiring leading to the rest of the residence. If a distribution device is present the task for locating a spare pair between the NI and ISDN jack will need to be performed in two steps. You will need to locate a spare pair between the NI and the distribution device, and then you will need to locate another spare between the distribution device and the ISDN jack.

Distribution devices can be used in other locations within a residence. If there are multiple telephone jacks in a room, there may be a distribution device within the room to "fan out" the wiring to multiple jacks, for example.

4.3.   Multiple POTS Line Scenario

The tasks for adding ISDN to a residence with multiple POTS lines, when one spare pair already exists or one POTS line will be changed to ISDN service, are similar to those described in Section 4.2. As was previously mentioned, the goal of Section 4 is to incorporate (when possible) the use of existing customer premises wiring to serve the new ISDN line. In scenarios where the premises has multiple POTS lines in use, a few possibilities exist.

For example, if there is a spare pair contained within the premises wiring, the installer should follow the procedures in Section 4.2.

It there is not a spare pair in the wiring, then the installer has a choice. Either the installer can add additional customer premises wiring by following the instructions in Section 5, or, the installer could use a pair of wires that a current POTS phone is using for ISDN service. If this POTS phone is an extension line to another phone on the premises, then the installer would have to trace the pair of wires used to provide the extension service and disconnect them appropriately. Then, the tasks in Section 4.2.2 can be followed. If this POTS phone is the only phone tied to a specific POTS NI, then the installer would need to call the service provider, cancel POTS service to that NI, and specify ISDN service to that NI. The installer could then follow the tasks cited in Section 4.2.7.

5.   ISDN TO A SINGLE TARGET ROOM (USING NEW WIRING)

INTRODUCTION

This section is written to further support installation of ISDN in residential and small business applications. It is not covered in the NIUF Documentation.

In this scenario, the customer would like ISDN installed to a single target room. Upon inspection of the Customer Premises Wiring, there were no spare pairs (or working spare pairs) to support the transmission of the "U" interface to the specific room where the customer wanted the ISDN service terminated. Therefore, the need for re-wiring or additional wiring is needed. An issue is important in this scenario is the other services which maybe co-located within the Customer Premises Wire.

5.1.   Wiring Standards

The reason for discussing standards is to increase awareness and promote adherence in practice. This contains a summary of the wiring standards applicable to ISDN. Refer to EIA/TIA-570 Residential and Light Commercial Telecommunication Wiring Standard for more details. This standards specifies the number of conductors and cable quality. Cables for new installations should contain four twisted pairs of solid conductors. The additional pairs will support new functions and features, such as distribution of DC power to TEs. The standard recommends 8 position modular jacks with 8 conductors. The pinout for these jacks (called T568A or T568B) can be found in table 2.1. The TSB-40 standard defines five levels or "categories" of cable characteristics. Category 3 cables satisfy the characteristics required in new installation of telephone and ISDN services. Installing a Category 4 or Category 5 cable may save money in the long run if used for future higher rate services. The standards specify Star wiring to each service outlet. Daisy chains between outlets, even in the same room, violate the standard. The length of cable from the distribution device to each service outlet shall not exceed 90 meters. Once the service enters the house and passes the NI, the wiring should continue within the building. Sometimes this makes it impractical or expensive to reach the target room. Wiring has been run outside the building along the frame. Remember that the exposed cable may degrade when exposed to the elements.

5.2.   Distribution Device

Figure 5.1 shows a distribution device providing 12 input rows with four outputs per input. For ISDN in one room (and daisy chained POTS) only one output per input is needed. The distribution device with multiple outputs allows simpler additions and rearrangement as your service needs change. The number of outputs depend on your future service needs. If you plan to move TEs between outlets, then a simple disconnect method at the distribution device for the

unused runs will help. The distribution device is not required but will ease cable management for the homeowner. Use a Category 3 cable to connect the ISDN U signal to the office.
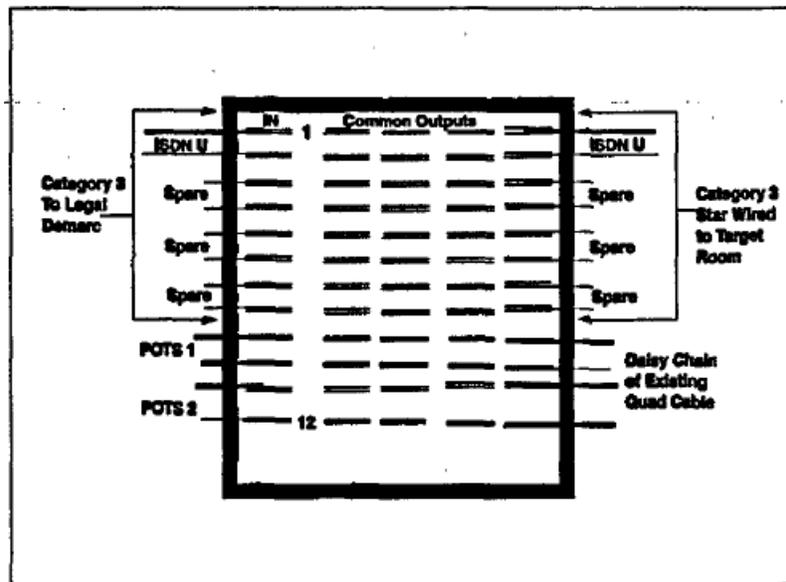
5.1 Distribution Device

5.3. Modular Jacks

When installing 4 pair cables, the modular jacks must terminate all pairs. The acceptable modular jacks conform to T568A or T568B wiring (Refer to Section 2). These jacks are 8 position modular jacks with 8 conductors. TSB categories also apply to modular jacks. The minimum requirement is Category 3 jacks when rewiring or in new installations. A Category 5 wiring system requires Category 5 jacks. Introducing 8 position modular jacks into the user environment may cause confusion. The connecting cords used in these jacks are also different than ordinary phone cords (Refer to Section 1.2.5). We suggest labeling the modular jacks and cords used for ISDN with a color coded sticker or some other means.

5.4. Wiring Summary

A summary of minimum equipment requirements for rewiring according to the standards:

- Category 3 cables and connecting cords.

- Category 3 modular jacks conforming to T568A or T568B wiring.

- Determine the route from the distribution device to the target room.

- Distribution device (optional) for simple administration

- ISDN Terminal Equipment NT1 and Power supply

The next sections will describe the tasks necessary to install the ISDN service from the NI device to the target room and then check for dial tone.

5.5.   New Wiring for Supporting ISDN to a Single Target Room

Section 4 states that for an overlay type of application, use a spare pair in existing quad cable for transporting the U interface between the NI and service outlet is supported. If, for any number of reasons, the spare pair is not available for use, new wiring will have to be installed.

The installer should inform the customer of the lack of customer premises wiring between the NI and the preferred customer location of the service outlet. Further, the installer should make the customer aware that, for a time and materials charge, the installer will install the necessary additional wire to complete the installation. The installer is required to use the following wire for the installation: AT&T 403101140/1024/004AGY/4/24. This cable is composed for four (4) individually twisted pairs of wire within a plastic sheath, 24 gauge. Also, this new cabling should not affect the way any POTS service within the residence is currently deployed (that is, the installer should not re-wire POTS service onto this cable when POTS works fine on the existing cable). In particular, unless otherwise needed to provide additional POTS services, this new cabling should not co-locate any other services beside the ISDN service for which it is being installed.

The use of this type of cable will better help prepare this residence for applications that may make use of ISDN throughout the entire residence in the future.

5.5.1.   NT1 Location

As mentioned in Section 4, in order for this type of installation to have the minimal affect upon customer premises wiring, the NT1 must be co-located with the ISDN TE after the service outlet. If, for any reason, including customer request, the NT1 is required to be positioned at or near the NI (or any location other than being co-located with the ISDN TE after the service outlet), this situation becomes the same as the one addressed by scenario 2. This occurs because of the difference between the S/T interface and the U interface. The S/T interface requires multiple pairs to provide service as opposed to the single pair needed to provide service through the U interface.

5.5.2.   Other Services Co-located within the Customer Premises Wire

As mentioned in Paragraph 5.1, Section 4 of the NIUF documentation supports the use of quad cable for delivery of both POTS and ISDN through a U interface. However, any new cable in-

stallation needed to expand the amount of spare pairs to the residence should use AT&T 403101140/1024/004AGY/4/24 and should not be used to support the transmission of any other services within this cable. The only exception to this rule will be the following:

If the customer purchases yet another POTS line, and if no other spare pairs are available in other customer premises cable (i.e., quad cable pairs), then an unused twisted pair of the AT&T 403101140/1024/004AGY/4/24 cable may be used for the purpose of providing dialtone for this additional POTS line.

5.6.   TASK — Wiring from the NI to the Target Room

Mount the distribution device in a suitable location. Connect the distribution device to the Telco service at the legal NI with Category 3 cable. Even through the Telco service uses 1 pair, connect all pairs to the distribution device. The device represented in Figure 5.1 requires a special tool, but other devices may use modular plugs or simple lugs with washers. If you are replacing an existing service, you may not have a legal Demarc point. In this case, refer to Section 1.2.1.1 and Appendix A to create a legal demarc. The twisted pairs will be color coded so you can identify the wires that make up a pair. The first wire of a pair is colored with a trace of white. The second wire is white with a trace of color matching the first wire. Connect a pair from the Category 3 cable to the distribution output, noting the color of the pair. Again, connect the unused pairs to the distribution device, similar to the input side. Run the cable to the ISDN target room. You may need to drill holes in the floors/ceilings or route the wiring along baseboards.

5.7.   TASK — Installing a Modular Jack

Once the wiring reaches the desired location, strip back the outer jacket and select the same color pair connected to the NI. This pair carries the ISDN U signal. Connect the pair to PAIR 1 of the 8 position modular jack. Connect the remaining pairs to the other PAIRS on the modular jack in the same order they as on the distribution device.

Mount the Category 3 jack to the wall or baseboard and place the cover plate on the jack.

You should now have a continuous pair from the NI to the target outlet. Label this outlet to avoid connecting the wrong equipment.

5.8.   TASK — Connecting Equipment in the Target Room

You may now begin connecting your equipment to the ISDN jack. First select the terminating resistor options for the NT1 and the phone. If the NT1 supports the 50 Ohm option, then choose it. With 50 Ohms in the NT1, no other terminating resistor is needed. If the phone has a resistor option, turn if off. See the manufacturers instructions for proper optioning of the NT1. Some NT1s do not have options, so read the instructions that explain the use of terminating resistors.

If the NT1 does not support 50 Ohms but does support 100 Ohms, then choose this option. With 100 Ohms in the NT1, then a 100 Ohm resistance is needed in the phone. If the phone has a resistor option, turn it on. If it does not, you will need a terminating resistor adapter, so see your ISDN distributor. If the NT1 has a timing option, choose the default explained in the instructions.

Connect the power supply to the modular jack and the NT1 to the power supply with Category 3 cords. Then connect the ISDN terminal to the NT1 with a Category 3 cable. Plug the power supply into an AC outlet. ISDN terminals need operating parameters programmed to initiate service. Follow the instructions that came with the TE to enter the parameters. If your ISDN service includes voice, you should now be able to make a call from your ISDN TE. If you ordered data service, then the manufacturers instructions should guide you through the installation and options needed to establish data calls.

5.9. Testing

Section 4.2.7 describes methods to be used to verify ISDN Service. This section can also be used to test for ISDN service if the topology in paragraph 5.0 is used.

6.   NEW WIRING FOR SUPPORTING ISDN TO MULTIPLE TARGET ROOMS

This scenario describes a customer who would like to have multiple service outlets wired throughout this premises.

The installer should inform the customer of the lack of appropriate the customer premises wiring needed to support ISDN between the demarc and the preferred customer location of the service outlets. Further, the installer should make the customer aware that, for a time and materials charge, the installer will install the necessary additional wire to complete the installation. The installer is required to use the following wire for the installation: AT&T 403101140/1024/ 004AGY/4/24. This cable is composed to 4 individually twisted pairs of wire within a plastic sheath, 24 gauge.

The installer should inform the customer that, if the customer would prefer to have only one ISDN service outlet wired within the residence, then most likely additional wiring would have to be installed and the current customer premises wiring could be utilized (this installation would then take on the same parameters as Scenario 1 in Section 5.5, except there would be only ISDN access).

6.1. NT1 Location

The location of the NT1 device should be placed in either of two locations, near the demarc or centrally located within the premises. Parameters affecting the NT1 location are the length of

individual runs to each service outlet and the proximity of AC line power (for powering the NT1). The length of any individual run between the service outlet and the distribution device (see below) is dependent upon the type of passive bus topology being wired (see Section 5.11, passive bus configurations). The preferred placement of the NT1 is near the demarc point (or distribution device) but should be moved if the length of individual runs is greater than those cited in Section 5.11.

6.2.   Passive Bus Configurations

Below is a description of four passive bus configurations. The installer need to decide which configuration best fits the premises wiring configuration being installed.

S/T Bus Configurations

Short passive bus – Up to eight TEs, Maximum bus length 490 ft **(Note 1)**

Extended passive bus – Up to four TEs, Maximum bus length 1900 ft. 22 AWG

(Note 1)   " " " 1310 ft. 24 AWG

" " " 1110 ft. 26 AWG

Short branched passive bus – Up to two branches, and two TEs per branch.

(Note 1)   Maximum branch length 230 ft.

Branched passive bus – Up to two branches, and two TEs per branch.

(Note 1)   Maximum branch length 165 ft.

" extension length 720 ft.

NOTE 1: Maximum NT1 associated Cable 10 ft., Maximum TE associated cable 33 ft., Maximum cable stub length 3.3 ft.

Northern Telecom has a STAR configuration that supports TWO S/T busses. Each can be configured the same or differently. One loop can be point-to-point and the other short passive bus. Use the same guide lines for the appropriate type of bus.

6.3.   NT1 Options/Switch Settings

NT1 equipment has options that must be chosen based on the wiring topology being installed. Most NT1s have switches that can be change timing, terminating resistors and passive bus options.

6.4.   Timing Options

Fixed or Adaptive Timing
Point-to-point .... Adaptive   Short passive bus .... Fixed
Extended passive bus .... Adaptive   Short branched passive bus ..... Fixed
Branched passive bus .... Adaptive

NOTE: **Setting all installations as Adaptive Timing will work but may result in a**
         Longer than normal synchronization time on some NT1s.

6.5.   Terminating Resistors Options

Short passive bus - TRs at both ends of the bus.

Extended passive bus - TRs located at the NT1 and the furthest TE.

Short branched passive bus - Both TRs located at the NT1.

Branched passive bus - TRs at the NT1 and the common branch point.

Know problems with missing or misplaced TRs:

1.   Touch tone pad emits crackling noise with DTMF tones.

2.   AT&T 7507 drops the Circuit Switched Data call after typing "end" while in the CMD mode. This causes the line to lose sync and the DSL goes out of service.

3.   Two sets on short passive bus, both go out of service at times.

4.   Passive bus with two sets, far end set removed (move order) leg left un-terminated, remaining set goes in and out of service.

5.   NT1 will not sychronize (activate).

6.6.   NI's

Section 4.1.2, ISDN Wiring Requirements, discusses the proper wiring of the ISDN NI. The section refers the installer to the proper jack and wiring guidelines that should be followed to wire ISDN NI's.

6.7.   Use of Distribution Devices

Section 1.2.4 discusses distribution devices. Such a device will be needed when wiring ISDN to multiple service outlets. Until comments from the field are received, it is advised that the use of

standard 66 connector blocks be used to bridge the 8 conductors that the installer must wire to each service outlet.

6.8. Other Services Co-located with Customer Premises Wire

When the installer wires ISDN to multiple service outlets, no other services should be co-located within that customer premises wire.

6.9. Testing

Section 4.2.7 describes methods to be used to verify ISDN Service. This section can also be used to test for ISDN service if the topology in scenario 2 is used except that an ISDN TE should be plugged into the service outlet, not an NT1 (since the NT1 is located behind the service outlet in this topology). Also, all of the service outlets should be verified for proper operation. The installer may need to follow basic continuity test to verify the wiring of the demarc, NT1, distribution device and service outlets if proper ISDN service fails to work.

7. APPENDIX A: THE 12 INCH RULE

Introduction

The Federal Communications Commission (FCC) Inside Wire FCC Docket 88-57 places a restriction, sometimes referred to as the 12" Rule, on both the customer and the service provider. The 12" Rule as applied to a single unit building, such as those buildings that are the subject of these Guidelines, can be summarized as follows:

The Demarcation Point is defined to be located within 12" (or closest practical point) of the protector, or, if there is no protector, within 12" of where wire enters the single unit premises. Additionally, the customer may not wire directly to the Protector Block.

In the case of older homes where the in-house connections go directly to the Protector Block and intermediate device will have to be installed to create a legal demarcation point. This intermediate device must be located within 12" of the Protector Block or the point of wire entry into the house. This Appendix explains the 12" rule and provides guidance on the required installation. It is assumed that the reader is familiar with the material presented in Section 1.2.1 (and sub sections) which introduces the types of NI and the protector block. A summary of Section 1.2.1 is provided below as a convenience to the reader.

Caution: **In the FCC Inside Wire FCC Docket 88-57, the Federal Communications Commission disallows user connections directly to the Protector Block. This restriction is commonly called the "12 inch rule". This Appendix describes how to comply with the 12" rule while providing your own in-house wire.**

Summary of Section 1.2.1

- In some homes, usually those with older installations, the in-house wire is directly connected to the Protector Block as shown in Figure 1.2(a). If this is the case in your home you should read this section.

- In other installations, a surface mount outlet or other device (see next bullet), usually installed by the Telephone Company, provides the NI. An installation like this is shown on the left side of Figure 1.2(c). Here the NI provides the legal demarcation point or NI.

- While the use of a surface mount outlet for the NI is common it is not the only device that has been (is being) used for the purpose. Examples of other devices that have been (or could be used) to provide a NI are:

    – A Distribution device like on of those shown in Figure 1.4(a), (b), (c) & (d).

    – A second Protector Block with the Lightning Protector removed.

    – A modified Surface Mount Outlet (SMO) that provides screw terminals in addition to a modular jack connection point. (Combined SMO and Entrance Bridge).

    – Any other device that isolates the protector block from the in-house wire.

If there is a device that provides isolation from the protector block in your home then there is no need to continue reading this appendix.

NOTE: In this appendix, the NI device used in the examples is the surface mount service outlet type. The reader is reminded that any other device providing equivalent functionality can be used. However, because you are prohibited from working at the protector block. only Ameritech can install the newer type of NI or any other device that must be wired directly to the telephone line.

Creating a Demarcation Point in Conformance with the 12" Rule

In the case where there is no physical device available for NI connections, a number of options are available to the homeowner. The intent of the following discussion is to provide the information required to convert a situation like the one in Figure 1.2(a) into a configuration like one of those shown in Figures A.2 and A.3. The most important step in this process is the addition of

a device that provides a legal demarc but the installation of a distribution device is considered an important part of the conversion process.

Caution: **The practices of individual Telephone Companies, while compliant with the 12" Rule, may differ. If the installation is not being done by Ameritech you should check with them in order to confirm compliance with their rules.**

The first step in a conversion involves understanding the 12" Rule which is illustrated in Figure A.1. The left side of the figure shows where the Protector Block is located inside the building, while the right side illustrates where the protector is outside the building or there is no protector. In both cases there are most likely one or more distribution devices, like the junction boxes of Figure 1.4 (a), located within your house. While these junction boxes can legally be used to add additional cables, this approach is not consistent with good practice and will not provide the flexibility that is required for modern communications services like ISDN.
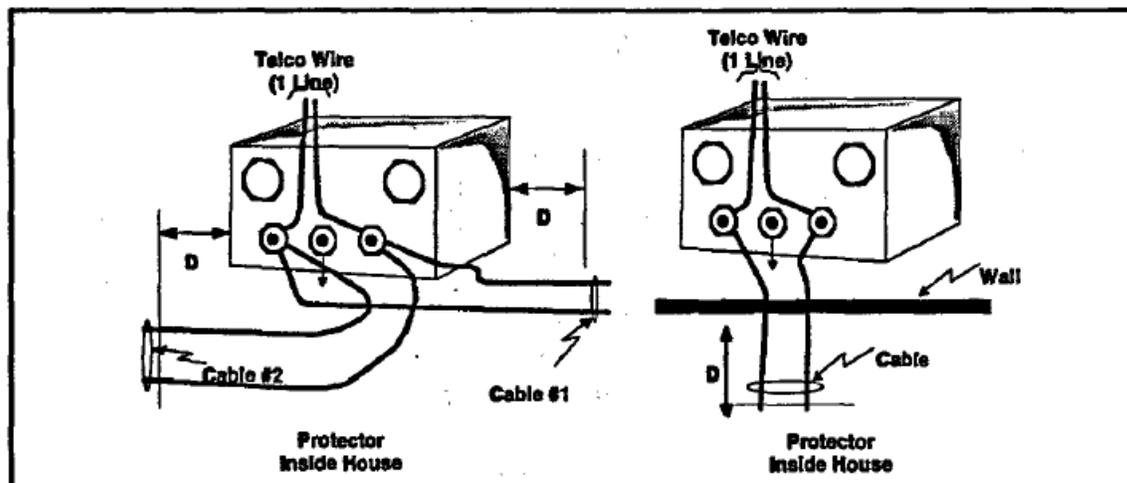
Figure A.1
The 12 Inch Rule

If the Telephone Company performs the conversion they are required, by the 12" rule, to place the NI device within 12 inches of the Protector Block or the point of wire entry into the house. This distance is shown as dimension 'D' in Figure A.1. It is important to understand that D is the distance from the Protector Block and NOT the length of the **wire**. For example, notice the difference in the length of cable 2 and the distance D on Figure A.1. A number of options are available to you when you do not have a NI device.

- You can request Ameritech to replace the existing protector block with a New Type NI like the one shown in Figure 1.2(d).

Caution: **You are prohibited by law from having this type of installation done by an independent contractor or doing the installation yourself.**

- You can request that Ameritech install a demarc device which they will place within 12" of the Protector Block. Ameritech may provide some options which could include: A Surface Mount Outlet (SMO), a SMO with an Extension Bridge, a single unit that combines a SMO and an Extension Bridge or some other kind of NI device.

- You can install your own distribution device or have an independent contractor do this installation. It is important to understand that this installation must be performed without touching the connection points on the Protector Block.

If you have chosen to do your own installation, or use a contractor other than Ameritech, you should understand Ameritech policy with respect to its physical location. The physical location of the demarc device, in a non-TELCO installation, is open to interpretation and Ameritech policies may vary.

Figures A.2 and A.3 provide illustrations of the type of NI that uses a Protector Block and a surface mount outlet (SMO). In these figures the distance D1 will be 12" or less in Ameritech installation. If you are not going to use Ameritech for your installation you should understand their policy with respect to the distance from the Protector Block to the NI device (D1). There are two possibilities, either you can place the NI device within the 12" limit or you must place it more than 12" from the Protector Block. In either case, you are prohibited from working any

place on the Protector Block including at its terminals. Thus it will be necessary to cut the cable(s) on the customer's side (in-house wires) in order to make the connection.

Figure A.2
Sample Implementation Using an Entrance Bridge

Figure A.3
Sample Implementation Using a Second Surface Mount Outlet
Service Outlet (SMO)

Proceed with the following steps:

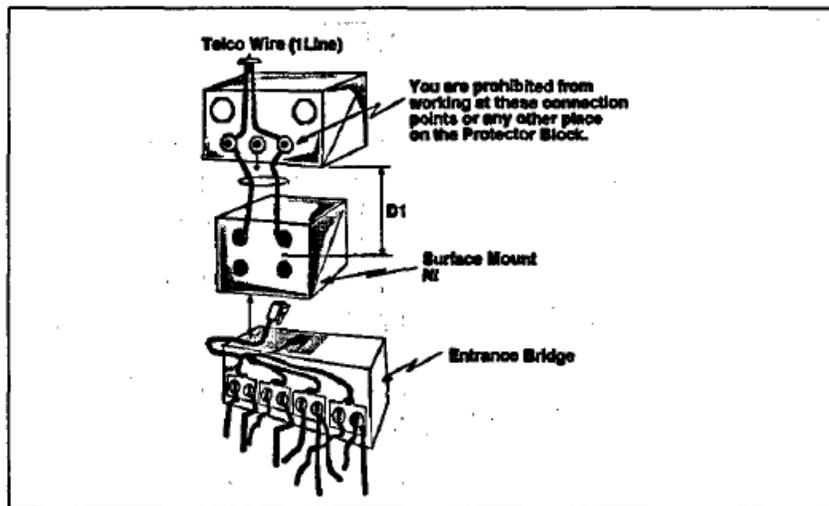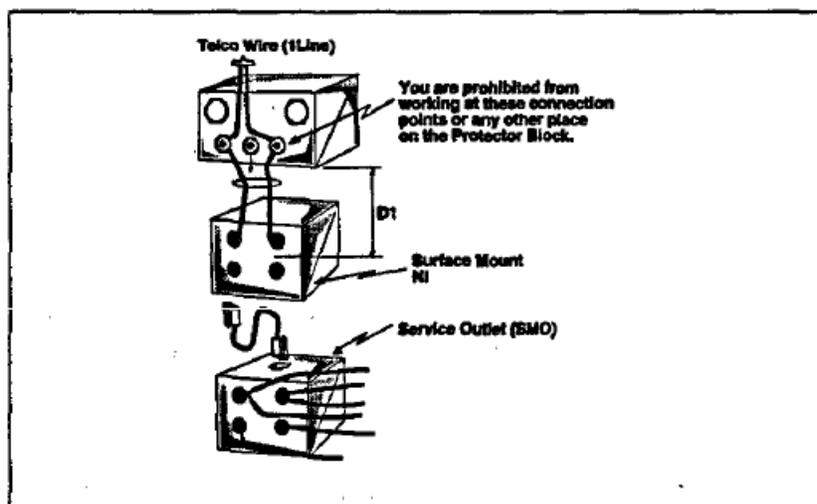1.   Review all of following installation steps before beginning any work. **Note: It is assumed that the protector block is still connected to live POTS service.** If the

service at the protector block is ISDN then the warnings about phone line voltage do not apply. While it will do no harm to connect a POTS phone to an ISDN line, the phone will not work.

2.   Select the desired location for the distribution device. Make sure that all of the cables connected to the Protector Block will reach the demarc device (for example, the Surface Mount Service Outlet in Figures A.2 & A.3).

3.   Select a single in-house cable, for example cable #2 in Figure A.1. Cut this cable to reach the NI Device but leave any other cables connected to the protector block intact. Strip wires on the end connected to the protector block. Then make the connection, between the NI device and the Protector Block, as shown in Figures A.2 & A.3.

   Warning: POTS lines are electrically hot (48 Volts). You should use insulated cutters and NOT touch water pipes or other metal objects while making this connection. Do not work on this installation during a rain storm. Additionally, if there are other cables on the protector block then you should place a phone connected to one of these cables off-hook (lift the receiver). This will reduce the voltage but you should still follow the precautions outlined above.

4.   Tests your connection by plugging a phone into the SMO's jack. If you have made connections to the proper terminals on the SMO then you will have dial tone. If you do not have dial tone you should review Section 1.A.2.5 (and sub-sections). (Note that the in-house side of the cut cable remains unconnected at this point in the conversion.)

5.   Now that you have a working NI device the next stop is to deal with any additional cables still connected to the protector block. For example, it used cable #2 of Figure A.1 in step 3 then cable #1 will still be connected to the protector block. Cut any remaining cables connected to the protector block in the same fashion that you cut the original cable in step 3.

   Warning: The warning notice in step 3 still applies. In this case you can connect a POTS phone directly at the NI jack and place it off-hook.

   NOTE: Since you can not work at the protector Block, you must cut these cables to reach the distance D1 which will leave unused cables connected to the Protector Block. The unused cable(s) remaining on the Protector Block could have internally shorted wires as a result of the cable cutting process. It is important to eliminate any such shots because they will result in loss of phone service. If there is a short then the phone connected to the NI you will no

longer have dial tone. In any case, it is a good practice to cut back the sheath from these cables, separate the individual wires, and then tape each wire.

6.   If the NI device has a built in distribution device (output screw terminals) then connect the free ends of the cables, that were connected to the protector block, to those terminals.

7.   If the NI device is a flush mount outlet type then use a standard 'Entrance Bridge' (sometimes called a Junction Box) as shown in Figure A.2. The cord on an Extension Bridge should be no longer than 12" (D2). If you have a device with a longer cord it is not a Entrance Bridge.

Additional Comments:

1.   It is not considered good practice to install a plug on an inside cable in order to connect to a Surface Mount Outlet type of NI.

2.   It is possible to create you own Entrance Bridge, using an SMO, as shown in figure A.3. This is not a recommended practice. Entrance Bridge are specifically designed to provide for multiple cable connections and provide greater flexibility and reliability. If you decide to proceed with this type of installation make sure that the cord, connecting the NI to the surface mount outlet serving as an extension bridge, is as short as possible. This cord should never exceed 12".

3.   An Entrance Bridge can service as a Distribution Device (see Section 1.2.4) and in some instances this use is appropriate. However, this practice lacks the flexibility that may be required in the future and it is recommended that a separate Distribution Device be installed.

8.   APPENDIX B: SETTING OPTIONS ON NT1 DEVICES

8.1.   NT1 Switch Settings

8.1.1.   ADTRAN NT1's

Warning: NO NOT CHANGE OPTIONS WITH POWER ON!!!

ADTRAN NT1 ACE:

- Configuration set to SHORT for short passive bus.

- Configuration set to LONG for long passive bus.

- Termination switch has a NONE, 50 and 100 position.

ADTRAN NT1 TYPE 400:

SWITCH	FUNCTION	ON	OFF
1-1	TE powering	TE power on	TE power off
1-2	Power Source Select	PS2	PS1
1-3	S/T Bus Select	Extended	Short
1-4	Installation	Rackmount	Standalone
1-5	Xmit Termination	100 ohms	None
1-6	Rcv Termination	100 ohms	None
1-7	Xmit Termination	50 ohms	None
1-8	Rcv Termination	50 ohms	None

8.1.2.   AT&T NT1s

AT&T NT1U-200: (No longer being sold but still supported)

Switch	ON	OFF
S1	TR is present on pins 4 & 5	No termination on 4 & 5
S2	TR is present on pins 3 & 6	No termination on 3 & 6
S3,S4	50 ohms termination	100 ohms termination
S5,S6,S7	NOT USED	.
S8	Fixed timing	Adaptive timing

AT&T NT1U-220: / NT1P - 200 (Rack mount version)

Switch	ON	OFF
S1	TR is present on pins 4 & 5	No termination on 4 & 5
S2	TR is present on pins 3 & 6	No termination on 3 & 6
S3,S4	50 ohms termination	100 ohms termination
S5	ON is Passive Bus	OFF is Point-to-point
.	(fixed timing)	(adaptive timing)

AT&T NT1L-230:

NO SWITCHES

50 ohm Terminating Resistor permanently installed

Fixed Timing permanently installed

8.1.3.   Northern Telecom NT1s

Northern Telecom (NTBX80AA) stand-alone:

J1	Should always be ON (left) (used for manufacturing testing)
J6 and J7	BOTH to OUT (right) to select NO termination
J6 or J7	ONE IN (left) and ONE OUT (right) to select ONE internal TR
J6 and J7	BOTH to IN (left) to select TWO internal TRs Note: J6 (TR1) factory set to OUT & J7 (TR2) factory set to IN.
J8	FIXED timing two LEFT pins, ADAPTIVE timing two RIGHT pins

Northern Telecom (NTBX84AA) rack-mount:

J2	(STAR CARD) ADAPTIVE timing TOP two pins, FIXED tiing BOTTOM two pins (B Loop in Star card ONLY)
J3	ADAPTIVE timing TOP two pins, FIXED timing BOTTOM two pins (A Loop in Basic NT1 card and Star card)
J4	BACK-UP Power for TEs ON, set jumpers on TOP two pins BACK-UP power for TEs OFF, set jumpers on BOTTOM two pins
J5	POLARITY for REVERSAL, set jumper to REV, TOP two pins POLARITY NORMAL, set jumper to NORM, BOTTOM two pins
Note:	**In a TE that doesn't support the J5 option, the reversed polarity signal can cause TE shut down on ac power loss.**
J6	TE power to HI (10 W), set jumper on the two RIGHT pins TE power to LO (2.5 W), set jumper on the two LEFT pins Note: See power section for VARIOUS TE's power comsumption.
J7	TRB for B loop (STAR) 100 ohms IN, set jumpers to UPPER row of pins. (short branched passive bus with no external TR) TRB for B loop (STAR) 100 ohms OUT, set jumper to LOWER row of pins. (other bus configurations, with external TR)

J8	TRA for A loop 100 ohms IN, (same as J7 IN) TRA for A loop 100 ohms OUT, (same as J7 OUT)
Note:	**Regardless of the jumper settings (J7 and/or J8), the NT1 always provides one internal terminating resistor on each of the A and B loops.**

8.1.4.   Siemens Stromberg-Carlson NT1s

Siemens NTBA-2B1Q (S42024-A247-A1) and (S42024-A247-A4) (Module TU):

IMPORTANT: All links are factory set and should not be altered.

Links	.	-A1	-A4	.	.	.	.	.	.
.	210-A	210-B	211-A	211-B	211-C	213-A	213-B	214-A	214-B
A1	ON	ON	OFF	ON	ON	OFF	ON	ON	OFF
A4	ON	ON	OFF	OFF	ON	ON	OFF	OFF	ON

Siemens NTBA-2B1Q (S42024-A247-A1) Module TU:

170-C	170-B	170-A	170-D	175-1	175-2	MODE
OFF	OFF	OFF	OFF	ON	ON	Factory Mode 2 (TM2) 96kHz on S/T
.	OFF	ON	OFF	.	.	Test Mode 2 (TM2) 96kHz on S/T
.	ON	OFF	OFF	.	.	Test Mode 1 (TM1) 2kHz on S/T
.	.	.	ON	.	.	Hardware RESET
OFF	OFF	OFF	OFF	.	.	Bus operation
ON	OFF	OFF	OFF	.	.	Point-to-point/extended bus
.	.	.	.	ON	ON	100 ohm termination IN
.	.	.	.	OFF	OFF	100 ohm termination OUT

Siemens NTBA-2B1Q (S42024-A247-A4) Module TU:

170-C	**170-B**	**170-A**	**170-D**	**175-1**	**175-2**	**MODE**
OFF	OFF	OFF	OFF	ON	ON	Factory default settings
OFF	.	.	ON	.	.	Hardware RESET

.	.	.	.	ON	ON	100 ohm termination IN
.	.	.	.	OFF	OFF	100 ohm termination OUT

Module MCC:

14-1	14-2	14-3	14-4	MODE
OFF	OFF	OFF	OFF	Factory default settings
ON	OFF	OFF	OFF	Point-to-point / extended bus
OFF	OFF	OFF	OFF	Bus operation
.	OFF	ON	OFF	Test mode 2 (TM2) 96kHz on S/T
.	ON	OFF	OFF	Test mode 1 (TM1) 2kHz on S/T

8.1.5.   Tone Commander NT1s

Tone Commander NT1U-220TC

Termination Switch: Off, 50 ohms, 100 ohms

Timing: No switch settings required

8.2.   NT1 Status Indicators

8.2.1.   ADTRAN NT1 Status Indicators

ADTRAN NT1 ACE has five LED indicators for status:

LED	COLOR	DESCRIPTION
Network Test	YELLOW	Network is performing a test
Network Error	RED	"U" interface to network is not ready
Network Ready	GREEN	Network is ready to place a call
Local Error	RED	"S/T" interface is not ready
Power	GREEN	Unit Power

ADTRAN NT1 Type 400 has five LED indicators for status:

LED	DESCRIPTION
Line Error "ON"	"U" interface to network is not ready
Line Test "ON"	Network is performing a test
Terminal Error "ON"	"S/T" interface is not ready
Active "ON"	Network is ready
Power "ON"	Unit has power

8.2.2.   AT&T NT1 Status Indicators

AT&T's NT1U-200 and NT1U-220 have four status indicators, below are the various states:

TERMINAL ER-ROR	ACTIVE ERROR	LINE	POWER	STATUS
ON	ON	ON	ON	Power-up self-test (1 second)
FLASHING	FLASHING	FLASHING	FLASHING	Self-test errors
N/A	N/A	N/A	FLASHING	Input power reversed or too low
OFF	OFF	ON	ON	Line error w/sealing current
OFF	OFF	FLASHING	ON	Line error w/o sealing current
ON	OFF	OFF	ON	Terminal Error
OFF	ON	OFF	ON	Normal - Line active
OFF	FLASHING	OFF	ON	Network MLT test
OFF	OFF	OFF	ON	Loss of signal w/o TE present
FLASHING	FLASHING	OFF	ON	Wrong DIP switch set-tings

AT&T's NT1L-230 has two status indicators
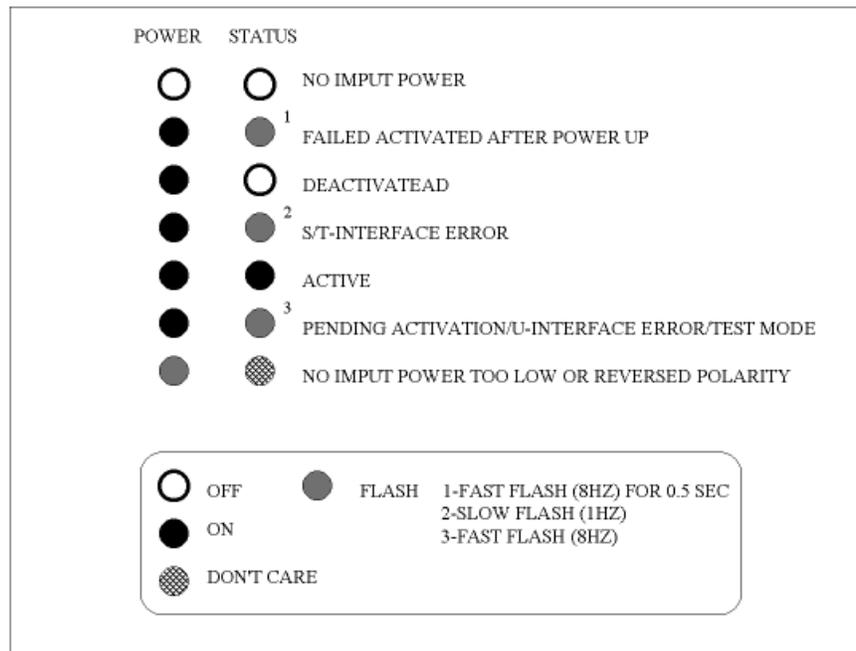
8.2.3.   Northern Telecom NT1 Status Indicators

Northern Telecom's (NTBX80AA) Stand-alone NT1 has four status indicators:

* The green power LED

* The red S/T sync LED indicates operating status as follows:

The light is OFF during normal operation

The light is ON to show loss of sync with the TEs

The light FLASHES to show excessive errors on the S/T bus

* The red U sync LED indicates the U interface operating status:

The light is OFF during normal operation

The light is ON to show loss of sync with the network

The light FLASHES to show excessive errors on the U line

* The red test LED indicates test status (network, CPE or self-test):

The light is OFF to show normal operation or self-test OK

The light is ON to indicate test in progress

The light FLASHES to indicate a failed self-test

Northern Telecom's (NTBX83AA) NT1 Module has six status LED Indicators:

NOTE: The status of the LEDs is the same as the Stand-alone with the following exceptions/
additions.

* The green power LED

The light is ON for normal operation

The light is OFF is there is no power

The light FLASHES to show Battery Back-up, Loss of AC power

* The red battery LED

The light is OFF is battery is good (or no battery module)

The light is ON if battery is bad or degraded capacity

* The red S/T power LED

The light is OFF during normal operation

The light is ON to indicate that the TEs on the S/T bus are current-limited due to an OVER-
LOAD condition

* Selection Indicators

The selection indicator corresponds to the slot number

The light FLASHES to show which NT1 is selected and its condition by the STATUS LEDs

The light is ON to indicate a STATUS ALERT (@ abnormal condition)

The light is OFF to show normal operation

* Selection and Test switches

Press the up-arrow or down-arrow to select the next NT1

Press the TEST switch TWICE within a 2-second period to start a self test on the selected NT1

8.2.4.   *Tone Commander NT1 Status Indicators*

Tone Commander's NT1U-220TC has four status indicators; below are the various states.

TERMINAL ERROR	ACTIVE	LINE ERROR	POWER	STATUS
OFF	OFF	OFF	OFF	No Input Power
ON	ON	ON	ON	Power-up self-test (1 second)
FLASHING	FLASHING	FLASHING	FLASHING	Self-test error
OFF	OFF	OFF	FLASHING	Input power reversed or loo low
OFF	OFF	ON	ON	Line error w/ sealing current
OFF	OFF	FLASHING	ON	Line error w/o sealing current
ON	OFF	OFF	ON	Terminal error/No TE Present
OFF	ON	OFF	ON	Normal - Line active
OFF	FLASHING	OFF	ON	Network MLT test
OFF	OFF	OFF	ON	Loss of signal w/o TE present
FLASHING	OFF	FLASHING	ON	Terminal Active Only (No U interface) w/o sealing current
FLASHING	OFF	ON	ON	Terminal Active Only (No U interface) with sealing current

9.   GLOSSARY

Term	Description
66 block	A common type/family of connecting blocks. Typical applications are in large buildings but occasionally they are used for smaller installations.
adapter	Converts one type of jack or plug to another, e.g., 6 pin to 8 pin.
ANSI	American National Standards Institute. Organization that develops and distributes standards for a wide range of commercial products.
analog phone	A POTS phone or one that does not use digital representations of the voice or data information being communicated on it. Residential phones are almost always analog.

analog channel	Communications channel that responds linearly to changes in the frequency and amplitude of the information transmitted and accurately represents the input signal over a specified range of parameters.
ASCII	American Standard Code for Information Interchange. An 8-bit (seven bits plus parity) code for data transfer adopted by ANSI to achieve compatibility between data devices. It is also called US ASCII. There are also other versions. Unless otherwise indicated, 1PSS assumes that international Alphabet No. 5 is used.
bandwidth	Specific frequencies available to a given application.
Basic Rate Interface (BRI)	Interface by which ISDN terminals access the local switch that provides full-duplex ISDN basic rate access. The BRI is composed of two 64-kbps clear B channels for information (voice or data) transfer in either circuit or pocket mode and one 16-kbps clear D channel for packet data information transfer and signaling communication with the Telco Switch.
B-channel	A 64-kbps channel used to cnvey user information (voice/data); the BRI has two B channels and the PRI has 23.
bridged tap	An unused segment or leg of a cable pair - often the result of equipment rearrangements.
cable	A number of insulated conductors within a protective sheath. Cables are generally fixed in place. Compare to "cords".
category 3 cable	See discussion under unshielded twisted pair UTP) cable.
category 4 cable	See discussion under unshielded twisted pair (UTP) cable.
category 5 cable	See discussion under unshielded twisted pair (UTP) cable.
coder/decoder (CODEC)	Device that turns analog signals into digital signals and vice- versa.
connecting block	An insulating base with binding posts upon which connections to phones, etc. can be made. Often, insulation-splicing clips are used instead of screw terminals. Also called terminal blocks.
cords	The term generally applied to the flexible multi-conductor cables used for connecting terminal equipment to a service outlet or a handset to the base unit. Also see line cord and extension cord.
customer premises (CPE)	Telephone sets or other terminal equipment or devices which are owned by and the responsibility of the end user (customer). equipment
daisy chain wiring configuration	A configuration of customer premises wiring where a series connection of the jacks is used, i.e., wiring from jack 1 is extended to jack 2, then perhaps to jack 3 and so on.
Data terminal equipment (DTE)	User equipment that is joined to a data communication network. It can be anything from a simple terminal to a large computer system.

distribution device	A connection device which typically has one plug directly connected to more than one jack or one terminal pair onto which more than one wire pair can be connected. A common type would be one modular plug to 2 or 3 modular jacks.
dual line service	Telephone service where 2 pairs of wires are connected to the premises. One or both could be in service.
earth ground connection	The conductor which connects directly to earth ground usually via a water pipe or possibly via a copper rod driven into the earth. This ground is different than the logic ground used in electronic circuits.
extension cord	A cord which typically has a modular jack at one end and a modular plug at the other end. It is used to extend the reach of a line cord.
Federal Communications Commission (FCC)	Principal regulatory body in the United States responsible for interstate communications and common carrier services.
High-tech Equipment	Terminla Equipment that requires more power to operate than the Telco will provide.
Integrated Services Digital Network (ISDN)	International standard for a public communication network to handle circuit-switched digital voice, circuit-switched data, and packet-switched data.
interface	Point at which independent systems or devices communicate with each other.
ISDN phone	A telephone set which is able to communicate according to the ISDN protocol, for both voice and data.
jack	A socket or receptacle into which a plug is inserted for purposes of making an electricl connection. Also see outlets and plugs.
junction box	A box in which 2 or more wires can be joined together.
line cord	The flexible, multi-conductor, cord which connects the telephone or other terminal equipment to the wall jack. Usually has modular jacks at both ends.
loop (local)	Local connection between a network switch and a subscriber's end instrument.
modern	MOdulator-DEModulator. Device that allows digital signals to be transmitted over analog facilities.
modular jack	The popular, modern, small jack which is found in most homes/businesses and into which is plugged your phone, using a line cord terminated by a modular plug. It adheres to industry standards for size, shape, etc.
modular plug	The popular, modern, small plug which is found on most cords and adheres to the industry standards for "modular" connectors.
multipoint	See Passive Bus.
Network Interface	The point where telco ownedwiring meets customer owned wiring. The actual connection device may be anything from simple bindig posts to special boxes which include lightning & power surge protection devices.

Network Termination 1 (NT1)	The NT1 is a physical device that converts the 2-wire U interface into the 4-wire S/T interface. It may be standalone item or it may be built into a piece of terminal equipment.
outlet (phone)	See service outlet.
plug	The connecting device on the end of a cord which electrically mates with a jack.
POTS	Plain Old Telephone Service, i.e., the typical residential phone service, with few "features." May also be used to describe the type of connection (loop) to a central office which is designed for the POTS type of phone.
premises wiring	Cables, jacks, etc. which are on the customer's side of the N (O PW) and are the responsibility of the customer.
protector block	A rectangular carbon block used to protect equipment from lightning. There are other types of devices which also provide lightning protection and may erroneously be referred to as protector blocks.
quad cable	A type of cable which contains 4 conductors in a plastic sheath. These 4 conductors are not 2 twisted pairs, although the 4 may have a slow twist of them.
ing wiring configuration	The same as daisy chain wiring, except the last jack is connected to jack 1, thus completing a ring.
RJ11 jack/plug	A 6 position modular jack/plug.
RJ45 jack/plug	An 8 position modular jack/plug.
RS232 (EIA)	Technical specifications set by the Electronic Industries Association (EIA) which define electrical and mechanical interfaces between terminals, modems, computers, and communication lines.
service outlet	The physical housing (e.g., cover place) and jack(s) used to provide a flush or surface outlet (typically in the wall) for POTS or ISDN.
SPID (service profile identification)	A unique number used to identify a terminal to the Telco.
shielded twisted pair	See twisted pair cable.
single line service	Telephone service where only one pair of wires is brought home or service small business.
S/T interface	The electrical characteristics for a four wire physical interface, defined by ISDN standards, that exist on the output or terminal equipment side of an NT1.
star wiring configuration	A wiring configuration in which each jack or endpoint is directly connected to a central distribution point.
station protector	Protects stations (i.e., CPE) from lightning. See protector block.
Telco	Telephone company.

terminal adapter (TA)	Device that interfaces non-ISDN devices, e.g., POTS, RS232, to ISDN interfaces.
terminal block	See connecting block.
terminal equipment	A telecommunications or input/output device which is at the end of the communications circuit. Includes such equipment as telephones, personal computers and answering machines.
twisted pair cable	A cabling configuration wherein each pair of wires within the sheath is twisted together. The twisting provides a significantly greater level of crosstalk rejection compared to cabling where the pairs are not twisted together. Twisted pair cable without metallic shielding around any of the pairs is called Unshielded Twisted Pair (UTP) cable. One or more pairs, wrapped with metallic foil or braid, designed to shield the pair(s) from electrical interference, is called Shielded Twisted Pair (STP) cable. ISDN cannot use shielded wire.
U interface	The electrical characteristics, defined by ISDN standards, that exist on a 2-wire transmission path portion of an ISDN line (i.e., on the input or line side of the NT1).
unshielded pair (UTP) cable, category 3, 4 and 5	EIA/TIA-568 defines three "levels" of 24 gauge UTP cable and twisted associated connecting hardware - category 3, 4 and 5. Category 3 is the minimum considered suitable of ISDN. Categories 4 and 5 are also suitable but are likely to be more expensive than category 3 due to higher performance characteristics. The main difference between categories 3, 4 and 5 is that they handle signal frequencies up to 16, 20 and 100 MHz, rspectively. The desired wiring for 1 ISDN is 24 gauge, 4-pair, category (minimum) UTP.