AVAYA communication

MERLIN LEGEND™ Communications System

Release 1.4i

Installation and Maintenance

555-612-241
Issue 1
1988

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Avaya Inc. formed as a result of Lucent's planned restructuring, designs builds and delivers voice, converged voice and data, customer relationship management, messaging, multi-service networking and structured cabling products and services. Avaya Labs is the research and development arm for the company.

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Important Safety Instructions

AT&T 555-612-241
Issue 1
April 1996

Notice

Every effort was made to ensure that the information in this book was complete and accurate at the time of printing. However, information is subject to change.

IMPORTANT SAFETY INSTRUCTIONS

When installing telephone equipment, basic safety precautions should always be followed to reduce the risk of fire, electric shock, and injury to persons, including:

- Read and understand all instructions.
- Follow all warnings and instructions marked on or packed with the product.
- Never install telephone wiring during a lightning storm.
- Never install telephone jacks in a wet location unless the jack is specifically designed for wet locations.
- Never touch uninsulated telephone wires or terminals unless the telephone wiring has been disconnected at the network interface.
- Use caution when installing or modifying telephone lines.
- Use only AT&T manufactured MERLIN LEGEND[1] circuit modules, carrier assemblies, and power units in the MERLIN LEGEND control unit.
- Use only AT&T-recommended/approved MERLIN LEGEND accessories.

1. MERLIN and MERLIN LEGEND are trademarks of AT&T.

- If equipment connected to the loop-start station modules or to the MLX telephone module is to be used for in-range out-of-building (IROB) applications, IROB protectors are required.
- Do not install this product near water, for example, in a wet basement location.
- Do not overload wall outlets as this can result in the risk of fire or electric shock.
- The MERLIN LEGEND system requires a supplementary ground.
- Do not attach the power supply cord to building surfaces. Do not allow anything to rest on the power cord. Do not locate this product where the cord will be abused by persons walking on it.
- Slots and openings in the module housings are provided for ventilation. To protect this equipment from overheating, do not block these openings.
- Never push objects of any kind into this product through module openings or expansion slots, as they may touch dangerous voltage points or short out parts, which could result in a risk of fire or electric shock. Never spill liquid of any kind on this product.
- Unplug this product from the wall outlet before cleaning. Do not use liquid or aerosol cleaners on this product. Use a damp cloth for cleaning.

Customer Support Information

Contact Information

If you need assistance installing, programming, or using your system, contact your regional AT&T Center of Excellence (COE) location:

Asia Pacific
Telephone 65-840-3080
FAX 65-840-6677

Eastern and Central Europe
Telephone 36-1-267-1980
FAX 36-1-267-1972

Latin America
Telephone 305-662-6338
FAX 305-662-6224

Western Europe
Telephone 44-252-39-1656
FAX 44-252-37-6966

The AT&T International Technical Assistance Center (ITAC) provides Tier III support to distributors via the COE. Distributors are encouraged to contact their COE first. The ITAC is located in:

Denver, Colorado
United States of America
Telephone 303-538-4666
FAX 303-538-1855 (1856)

Federal Communications Commission (FCC) Electromagnetic Interference Information

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense.

Security

As a customer of new telecommunications equipment, you should be aware of the significant and growing problem of theft of long distance services by third parties, known commonly as "toll fraud." It is particularly important that you understand and take appropriate steps to deal with this crime because under applicable tariffs, you will be responsible for payment of associated toll charges. AT&T can not be responsible for such charges and will not make any allowance or give any credit resulting from toll fraud.

Toll fraud can occur despite the preventive efforts of network providers and equipment manufacturers. Toll fraud is a potential risk for every customer with telecommunications equipment having one or more of the following features: (1) remote access, (2) automated attendant, (3) voice mail, (4) remote administration and maintenance, and (5) call forwarding (remote). This is not a product or design defect, but a risk associated with equipment having one or more of the features described above. If your new telecommunications equipment possesses any of these features, please consult the relative portion of your documentation for further details and specific procedures to reduce the risk of toll fraud or contact your AT&T representative for further details.

The Remote Access feature must be properly administered to help reduce the risk of unauthorized use. It is your responsibility to take the appropriate steps to implement the feature properly, evaluate and administer the various restriction levels, and protect and carefully distribute access codes.

To reduce the risk of unauthorized access to your MERLIN LEGEND Communications System, you should observe the following procedures:

- Use a nonpublished Remote Access telephone number.
- Assign passwords, barrier or access codes randomly to users on a need-to-know basis, keeping a log of ALL authorized users and assigning one code to one person.
- Ensure that Remote Access users are aware of their responsibility to keep the telephone number and any access codes secure.
- Use random sequence access codes. These are less easily broken.
- Deactivate all unassigned access codes promptly.
- When possible, restrict the off-network capability of callers via use of Call Restrictions and Disallowed Lists.
- When possible, block off-hours calling.
- Frequently monitor system call detail reports for quicker detection of any unauthorized or abnormal calling patterns.

Physical Security, Social Engineering, and General Security Measures

Criminals called *hackers* may attempt to gain unauthorized access to your communications system and voice messaging system in order to use the system features. Hackers often attempt to trick employees into providing them with access to a network facility (line/trunk) or a network operator. This is referred to as social engineering. Hackers may pose as telephone company employees and employees of AT&T or your authorized dealer. Hackers will go through a company's trash to find directories, dialing instructions, and other information that will enable them to break into the system. The more knowledgeable they appear to be about the employee names, departments, telephone numbers, and the internal procedures of your company, the more likely it is that they will be able to trick an employee into helping them.

Preventive Measures. Take the following preventive measures to limit the risk of unauthorized access by hackers:

- Provide good physical security for the room containing the communications equipment and the room with administrative tools, records, and system manager information. These areas should be locked when not attended.
- Provide a secure trash disposal for all sensitive information, including telephone directories, call accounting records, or anything that may supply information about your communications system. This trash should be shredded.
- Educate employees that hackers may try to trick them into providing them with dial tone or dialing a number for them. All reports of trouble, requests for moving extensions, or any other administrative details associated with the MERLIN LEGEND Communications System should be handled by one person (the system manager) or within a specified department. Anyone claiming to be a telephone company representative should be referred to this person or department.
- No one outside of AT&T needs to use the MERLIN LEGEND Communications System to test facilities (lines/trunks). If a caller identifies themselves as an AT&T employee, the system manager should ask for a telephone number where the caller can be reached. The system manager should be able to recognize the number as an AT&T telephone number. *Before connecting the caller to the administrative port of the MERLIN LEGEND Communications System, the system manager should feel comfortable that a good reason to do so exists.* In any event, it is not advisable to give anyone access to network facilities or operators, or to dial a number at the request of the caller.

Limited Warranty and Limitation of Liability

Limited Warranty

AT&T AND ITS AFFILIATES MAKE NO WARRANTIES, EXPRESS OR IMPLIED, ABOUT OR RELATING TO YOUR MERLIN LEGEND COMMUNICATIONS SYSTEM AND SPECIFICALLY DISCLAIM ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. You should check with the reseller from whom you purchased your system to determine if it offers a limited warranty.

LIMITATION OF LIABILITY

EXCEPT FOR PERSONAL INJURY, DIRECT DAMAGES TO TANGIBLE PERSONAL PROPERTY PROXIMATELY CAUSED BY AT&T, AND LIABILITY OTHERWISE EXPRESSLY ASSUMED IN A WRITTEN AGREEMENT SIGNED BY AN AUTHORIZED REPRESENTATIVE OF AT&T, THE LIABILITY OF AT&T, ITS AFFILIATES, SUPPLIERS AND AUTHORIZED RESELLERS FOR ANY CLAIMS, LOSSES, DAMAGES OR EXPENSES FROM ANY CAUSE WHATSOEVER (INCLUDING ACTS OR OMISSIONS OF THIRD PARTIES) REGARDLESS OF THE FORM OF ACTION, WHETHER IN CONTRACT, TORT OR OTHERWISE, SHALL NOT EXCEED AN AMOUNT EQUAL TO THE LESSER OF THE DIRECT DAMAGES PROVEN OR THE PURCHASE PRICE OF THE SYSTEM. IN NO EVENT SHALL AT&T OR ITS AFFILIATES, SUPPLIERS OR AUTHORIZED RESELLERS BE LIABLE FOR INCIDENTAL, RELIANCE, CONSEQUENTIAL, OR ANY OTHER INDIRECT LOSS OR DAMAGE (INCLUDING, BUT NOT LIMITED TO, LOST PROFITS OR REVENUES AND LOSSES ARISING OUT OF UNAUTHORIZED USE (OR CHARGES FOR SUCH USE) OF COMMON CARRIER TELECOMMUNICATIONS SERVICES OR FACILITIES ACCESSED THROUGH OR CONNECTED TO THE MERLIN LEGEND COMMUNICATIONS SYSTEM) INCURRED IN CONNECTION WITH YOUR SYSTEM. THIS LIMITATION OF LIABILITY SHALL SURVIVE FAILURE OF AN EXCLUSIVE REMEDY.

About This Book

This book provides technical information about the MERLIN LEGEND Communications System. It is intended for persons who install and maintain the system.

Ordering Information

If you wish to order copies of manuals, replacement parts, accessories, or other equipment that is compatible with the system, contact your AT&T representative.

Appendix A in this manual provides product ordering numbers for the manuals and equipment available for the MERLIN LEGEND Communications System.

Product Safety Labels

Throughout this book, hazardous situations are indicated by an exclamation point inside a triangle, along with the word caution or warning.

⚠ WARNING:
Warning indicates the presence of a hazard that could cause death or severe personal injury if the hazard is not avoided.

⚠ CAUTION:
Caution indicates the presence of a hazard that will or can cause minor personal injury, property damage, or loss of data if the hazard is not avoided.

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Illustrations					
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- ❑ Add more step-by-step procedures
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System Description

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System Description

1

The MERLIN LEGEND* Communications System is an advanced digital switching system that integrates voice and data communications features. Voice features combine traditional telephone features, such as Transfer and Hold, with advanced features, such as Group Coverage and Park. Data features provide switched data connections that enable the transmission of voice and data over the same system wiring.

*. MERLIN LEGEND is a trademark of AT&T.

Modes of Operation

The system is designed for customers in the 10- to 200-station range. It can be configured to operate in one of three modes:

- Hybrid/PBX
- Key
- Behind Switch

Hybrid/PBX Mode

The Hybrid/PBX mode handles a large volume of calls and users and provides the most flexibility of the three modes. Outside facilities consist of loop-start trunks, direct inward dialing (DID) trunks, direct inward/outward dialing (DIOD) trunks, tie trunks, Digital Signal 1 (DS1) facilities, and E1 facilities. The trunks can either be grouped in pools for shared use, or can be assigned to line buttons on multiline telephones for users who need a personal line.

Users access inside lines and outside trunks via system access buttons. To make an outside call, the user enters a dial-out code (usually a 9), and the system automatically selects an available trunk. The Automatic Route Selection feature determines which trunk should be used for each type of outgoing call. Incoming calls can be handled by a direct-line console (DLC) or a queued call console (QCC), or by a combination of both console types.

Key Mode

In the Key mode, each outside line appears on a button on one or more multiline telephones. The line buttons allow users to see activity on other telephones, join conversations, place calls, or receive calls. Separate intercom buttons are used to make and receive internal calls.

A Key system automatically assigns the first eight outside lines to all telephones. This arrangement can be customized through system programming by assigning lines to individual telephones or to selected groups of telephones.

Behind Switch Mode

In the Behind Switch mode, the system is connected to a Hybrid/PBX or Centrex system. This other system (called the host) provides the interface to outside lines and some features. In a Behind Switch system, one line (called a prime line) is assigned to each telephone. Outside lines to telephones or groups of telephones are assigned through system programming. In the Behind Switch mode, people can use the special features of both the MERLIN LEGEND Communications System and the host system.

System Components

The system consists of required and optional components:

- required components
  - — control unit
  - — telephones
- optional components
  - — adjuncts
  - — adapters
  - — applications

These components are described in the following pages.

Control Unit

The control unit connects Central Office (CO) lines with telephones and adjuncts such as answering machines and fax machines. The control unit consists of the following components:

- control unit housing
- carrier(s)
- power supply module (one per carrier)
- processor module
- line/trunk and station modules

Control Unit Housing

The control unit is housed in a plastic cabinet for protection. The size of the housing increases as expansion carriers are added to the control unit. See Figures 3-9, 3-10, and 3-11 in Chapter 3.

Carriers

The basic and expansion carriers each have seven slots to hold modules:

- The basic carrier contains a power supply module, the processor module (slot 00), and line/trunk and station modules (slots 01 through 05).
- Up to two expansion carriers can be added to the right side of the basic carrier to increase the capacity of the system. Like the basic carrier, the leftmost and widest slot of the expansion carrier holds a power supply module; the remaining six slots hold line/trunk and station modules.

In addition to the module slots, both basic and expansion carriers have a backplane with an input/output (I/O) bus that provides the interfaces with the modules.

Power Supply Modules

The power supply module provides power to the carrier, to each telephone, and to adjuncts — except for adjuncts such as answering machines and fax machines that have their own power supplies. Each carrier requires its own power supply module, which goes into the first slot on the carrier.

Two types of power supply modules are available:

- model 391A1, 391A2, or 391A3 (for 117 VAC)
- model 391B1 or 391B2 (for 220 VAC)

Both versions convert 117 VAC (or 220 VAC) line voltage to these outputs: +5 VDC, -5 VDC, and -48 VDC. All modules use +5 VDC and -5 VDC for logic and analog transmission circuits. Most line/trunk and station modules use -48 VDC for power to the stations. The direct inward dialing (DID) and off-premises telephone (OPT) line/trunk and station modules also provide -48 VDC on the tip/ring (T/R) interface to the CO or OPT station. The 012 basic telephone module provides 21 VDC, and the 016 basic telephone module provides 40 VDC, to single-line telephones and equipment.

When single-line telephones are connected to an 012 or 008 OPT module that *does not* indicate "with RING GEN." on the module label, a 129B Frequency Generator (ring generator) must be installed in the 391A1, 391A2, or 391A3 power supply module of each carrier that houses one or more of these modules. For the 391B1 or 391B2 power supply modules (220 VAC), use a 129C Frequency Generator instead of the 129B.

NOTE:
For 016 modules and the 012 and 008 OPT modules that indicate "with RING GEN." on the module label, you do not need to install a ring generator in the power supply module. If, however, any carrier has at least one 012 or 008 OPT module without a ring generator, that carrier requires the 129B (117 VAC) or 129C (220 VAC) frequency generator.

A green light on the power supply module remains on as long as the module is receiving power. The power supply module also has an on/off switch and a modular telephone jack for connecting an auxiliary power unit to 391A1 or 391A2 power supply modules (117 VAC).

Auxiliary power units cannot be connected to the 391A3 (117 VAC), and the 391B1 and 391B2 (220 VAC) power supply modules. However, the 391A3 and 391B2 power supplies have a higher unit load capacity than the older power supplies, therefore it is recommended that new installations and upgraded systems use the 391A3 or 391B2 power supply (as applicable). Refer to the "Unit Loads" section of Chapter 2 for more information.

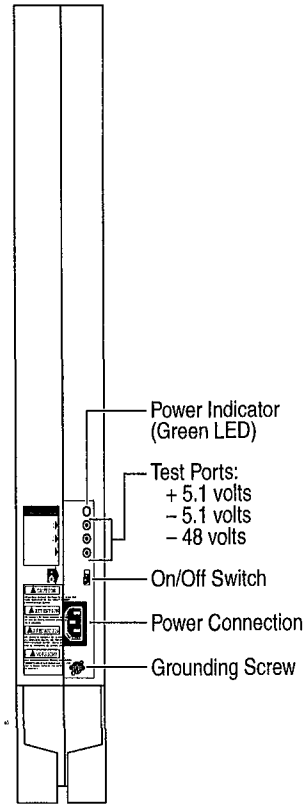


Figure 1-1. Power Supply Module

Processor Module

Placed in slot 00 of the basic carrier, the processor module controls system features and programming via the processor and memory boards and the feature module. The processor module supports up to 80 CO or tie lines/trunks and 200 stations.

The main board contains the 68000 microprocessor, a built-in 1200-baud data modem, built-in diagnostics, RAM, a real-time clock, interrupt circuitry, and interfaces to the other modules through the I/O bus on the carrier backplane.

The processor module has two modular RS-232 jacks: one for Station Message Detail Recording (SMDR) and the other for system programming and maintenance via a personal computer (see Figure 1-2).

The processor module contains either a NiCad battery or super capacitor to provide backup power for the real-time clock and nonvolatile RAM in case of power failure or system shutdown. The NiCad battery provides RAM data retention for 12 to 30 days (the capacitor provides at least five days). The trickle-charge circuit can recharge the NiCad battery to 50 percent of capacity from a discharged state in 48 hours. (The capacitor can be recharged to 63 percent in 1.5 hours and 100 percent in 7.5 hours.) The minimum NiCad battery life is five years. (The minimum capacitor life exceeds five years.)

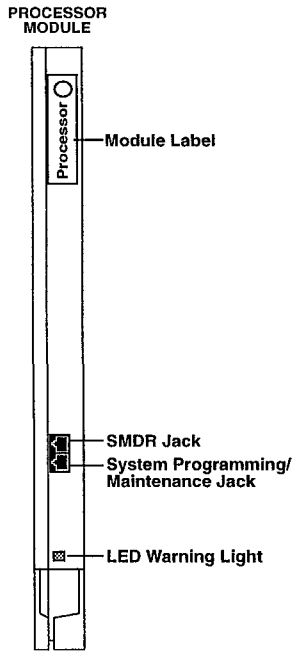


Figure 1-2. Processor Module

Line/Trunk and Station Modules

The line/trunk and station modules have jacks for connecting the CO lines/trunks and the station lines to the control unit. The station lines connect to telephones and adjuncts.

Depending on the mode of operation chosen, the outside lines that extend from the CO are called either trunks or lines. "Trunks" is used for the Hybrid/PBX mode and in the phrase "tie trunks." "Lines" is used for Key or Behind Switch modes.

There are different types of lines/trunks for the different functions of each mode. A Key or Behind Switch system can use

- loop-start (LS) lines
- tie trunks
- a DS1 facility programmed for T1 operation or emulation of LS or tie
- an E1 facility programmed for tie or loop-start (LS) operation

A Hybrid/PBX system can use

- loop-start trunks
- tie trunks
- direct inward dialing (DID) trunks
- a DS1 facility programmed for T1 operation
- an E1 facility programmed for tie, LS, DID, or DIOD operation

The names of modules consist of a number identifying the number of lines/trunks and/or stations that can be connected to the module, followed by the types of lines and/or telephones it supports.

See Figure 1-3 for the types of line/trunk and station modules that the system supports. See Table 1-1 for the module specifications.

See Appendix C for wiring diagrams.

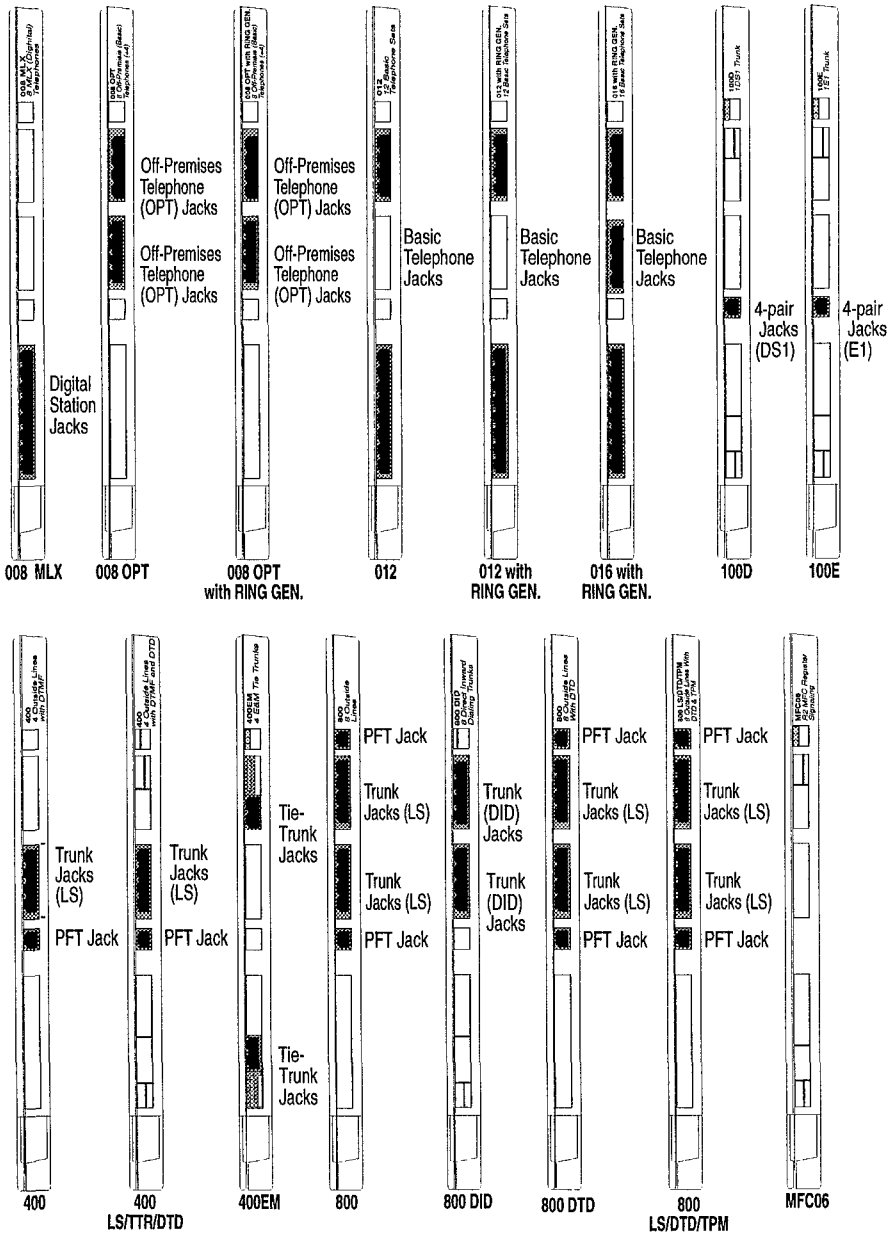


Figure 1-3. Supported Line/Trunk and Station Modules

Table 1-1. Line/Trunk and Station Modules

Module	Line/ Trunk Type	Station Type	Specifications
008 MLX	N/A	MLX telephones ISDN Terminal Adapter (such as the ExpressRoute 1000 or ISDN 7500B Data Module)	**Capacity:** 8 digital stations, each with 1 or 2 endpoints (each endpoint is assigned an individual extension number), including the following station types: ■ digital voice only ■ digital voice with Voice Announce to Busy feature ■ digital voice and digital data (via ISDN Terminal Adapter) ■ digital voice and MFM ■ digital data only (ISDN Terminal Adapter) **Signaling:** ISDN-BRI "S" protocol (two 64-kbps B channels, one 16-kbps D channel) on a passive bus **Power:** 48 VDC phantom power to telephone; 48 VDC over a separate pair (7-8) to a system operator DSS console **Loop range:** 305 meters (1000 feet), in-building and in-range out-of-building (with MLX IROB protectors) only service
008 OPT (with ring generator)	N/A	Single-line telephones or adjuncts	**Capacity:** 8 T/R stations* on two-way voice transmission path with support for telephones with message-waiting LEDs, 2 TTRs **Ringing current:** 105-Vrms, 30-Hz sinusoidal ringing superimposed on -48 VDC **REN:** >5.0 per port **Disconnect signal:** 900 ms (T/R short for answering machines, G3 fax, etc.) **Switchhook flash detection:** 100 to 1200 ms **Loop Resistance:** 1300 ohms, including stations **Loop range:** 4570 meters (15000 feet) estimated, may vary depending on gauge wire used, in-building and in-range out-of-building service only **CAUTION:** *Does not provide primary protection.*
012 (with ring generator)	N/A	Single-line telephone AT&T Attendant MERLIN MAIL Voice Messaging System T/R adjunct (such as an answering or a fax machine) Analog data device (such as a modem)	**Capacity:** 12 T/R stations on 2-way voice transmission path with support for telephones with message-waiting LEDs, 2 TTRs, built-in ring generator **Power:** 21 VDC, 600-ohm battery source **Ringing current:** 105-Vrms, 30-Hz sinusoidal ringing superimposed on -48 VDC. **REN:** ≤4 0 per port **Disconnect signal:** 900 ms (T/R short for answering machines, G3 fax, etc.) **Switchhook flash detection:** 100 to 1200 ms **Loop range:** 305 meters (1000 feet), in-building service only

Module	Line/ Trunk Type	Station Type	Specifications
016 (with ring generator)	N/A	Single-line telephone AT&T Attendant MERLIN MAIL Voice Messaging System T/R adjunct (such as an answering or a fax machine) Analog data device (such as a modem)	**Capacity:** 16 T/R stations on 2-way voice transmission path with support for telephones with message-waiting LEDs, 4 TTRs, built-in ring generator **Power:** 40 VDC, 600-ohm battery source **Ringing current:** 75-Vrms, 20- or 25-Hz sinusoidal ringing superimposed on -48 VDC **REN:** ≥4.0 per port **Disconnect signal:** 900 ms (T/R short for answering machines, G3 fax, etc.) **Switchhook flash detection:** 100 to 1200 ms **Loop range:** 305 meters (1000 feet), in-building service only
400	LS	PFT telephone	**Capacity:** 4 lines/trunks, 4 TTRs, 1 PFT telephone **Signaling:** loop-start
400EM	Tie trunk		**Capacity:** 4 tie trunks **Method of Completion:** automatic or dial-repeating start, immediate-start, wink-start, or delay-dial-start **Signaling:** E&M type 1S, type 1C, type 5
400 LS/TTR/DTD	LS	PFT telephone	**Capacity:** 4 lines/trunks, 4 TTRs, 1 dial tone detector, 1 PFT telephone **Signaling:** loop-start
800	LS	PFT telephone	**Capacity:** 8 lines/trunks, 2 PFT telephones **Signaling:** loop-start
800 LS/DTD	LS	PFT telephone	**Capacity:** 8 lines/trunks, 2 dial tone detectors, 2 PFT telephones **Signaling:** loop-start
800 LS/DTD/TPM	LS	PFT telephone	**Capacity:** 8 lines/trunks, 2 dial tone detectors, 8 TPM pulse detectors, 2 PFT telephones **Signaling:** loop-start
800 DID	DID		**Capacity:** 8 lines/trunks, 2 TTRs **Protocol:** incoming calls only; 2-way (one-pair) fixed impedance to DID trunks; no outgoing calls **Signaling:** loop-reverse battery; wink-start or immediate-start; accepts touch-tone dialing
100D	T1 LS Tie	N/A	**Capacity:** 24 lines/trunks for voice and analog data or 23 lines/trunks for voice and analog data with 1 channel used for signaling **Mode:** multiplexes 23 or 24 lines/trunks into 1 facility and demultiplexes one facility into 23 or 24 lines/trunks **Speed:** up to 64 kbps **Signaling:** DS1 over 4-wire; T1 uses RBS or CCS

Module	Line/ Trunk Type	Station Type	Specifications
100E	E1 LS Tie DID DIOD	N/A	**Capacity:** 30 lines/trunks for voice and analog data with 2 channels used for signaling **Mode:** multiplexes 30 lines/trunks into 1 facility and demultiplexes one facility into 30 lines/trunks **Speed:** up to 64 kbps per trunk **Signaling:** DTMF or R2/CaS signaling is optional with an MFC06 module **Termination Impedance:** 75 ohm or 120 ohm
MFC06	N/A	N/A	**Capacity:** 6 MFC dialers each with a generator and a detector **Signaling:** R2 MFC

*. The system software recognizes the OPT module as a 012 module. Even though the OPT module only has eight jacks, it uses 12 ports of software capacity, thereby decreasing overall station capacity by four stations for every OPT module and impacting traffic efficiency when the switch is in Key mode.

Loop-Start Lines/Trunks

Loop-start (LS) lines/trunks are the standard for home and small business Key systems. LS lines/trunks can be emulated using 100D or 100E modules.

The following options can be programmed for loop-start lines via system programming:

- **Dial Mode**
  - — Rotary
  - — Touch-tone
  - — MFC (with MFC06 module)
- **Hold Disconnect** specifies the duration of the disconnect signal (interval of open loop) used by the CO:
  - — Short interval (50 ms)
  - — Long interval (450 ms)

  Problems with calls on hold may arise if the Hold Disconnect Interval of the system does not match that of the CO.

- **Reliable Disconnect** specifies the reliability of the disconnect signal (interval of open loop) sent by the CO:
  - — Yes
  - — No

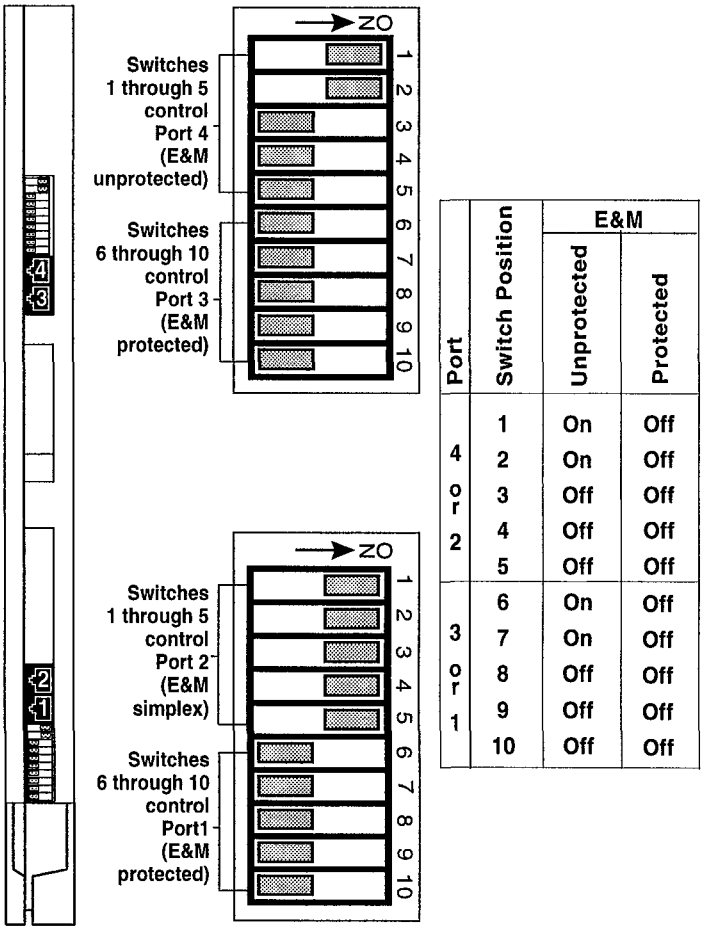
  Certain features such as Remote Call Forwarding, Remote Access, and Trunk-to-Trunk Transfer may be blocked if the reliable disconnect parameter is not set to "Yes" for at least one of the trunks on the call.
- **Glare Guard** specifies an interval at the end of a call during which incoming calls are given preference over outgoing calls. This reduces the probability of a trunk being simultaneously seized for both an incoming and an outgoing call:
  - — 1500 ms (factory setting)
  - — 1500 to 25500 ms (increments of 100 ms)

Tie Trunks

Tie trunks provide private communication between two systems. Tie trunks "tie" the two systems together, making it seem that all the telephones are on the same system. (See "Networking Capabilities" in this chapter for more information on how tie trunks connect to other systems.)

Tie trunks provide efficient communication between systems at different locations. These locations can be different floors of the same building, different buildings in the same campus, or different cities or states.

Tie trunks can be added to the system via the 400EM module. The 400EM module has four ports that must be programmed individually by selecting trunk options and setting the DIP (dual in-line package) switches, located on the front of the module, for different signaling modes and types (see Figure 1-4).



Port	Switch Position	E&M Unprotected	E&M Protected
4 or 2	1	On	Off
	2	On	Off
	3	Off	Off
	4	Off	Off
	5	Off	Off
3 or 1	6	On	Off
	7	On	Off
	8	Off	Off
	9	Off	Off
	10	Off	Off

Figure 1-4. 400EM Module DIP Switches

Tie lines/trunks can be emulated using 100D or 100E modules.

The following tie-trunk options need to be programmed:

- **Direction**
  - — Two-way (factory setting). Calls can be made in either direction.
  - — Outgoing only. Calls can be dialed but not received (no ringing).
  - — Incoming only. Calls can be received but not dialed (no dialing).

- **Signaling Type** can be any of the following types, programmed via the 400EM module. The type of signal can be set separately for incoming and outgoing calls; for example, a tie trunk can be wink-start for incoming calls and delay-dial-start for outgoing calls.
  - — Wink-start (factory setting). The originating end of the tie trunk transmits an off-hook signal and waits for the remote end to return a signal (a wink) indicating it is ready to receive dialing information.
  - — Immediate-start. No start signal is necessary, and dialing can begin immediately after the tie trunk is seized.
  - — Delay-dial-start. The originating end of the tie trunk transmits an off-hook signal and waits for the remote end to send an off-hook signal followed by an on-hook signal.
  - — Automatic-start. Incoming calls are routed directly to another station without a start signal. In other words, when you pick up the handset, the signal rings immediately at the other end. This is also called an automatic-ringdown tie trunk.
  - — Wink-start, immediate-start, and delay-dial-start are also called dial-repeating tie trunks.
- **E&M Signal** (applies only to 400EM tie trunks)
  - — Type 1 standard (factory setting)
  - — Type 1 compatible
  - — Type 5
- **Dial Mode** determines the incoming and outgoing dial modes:
  - — rotary (factory setting)
  - — touch-tone
  - — MFC (default setting for E1-emulated tie trunks using R2 signaling)

NOTE:
If the 400EM module is administered for touch-tone dialing, at least one module with touch-tone receivers (TTRs) must be installed (either the 008 OPT, 012, 016, 400, or the 800 DID module). If none of these modules is installed, install one (preferably one of the 016 or 400 modules, since they have four TTRs each, and the others have only two TTRs each).

- **Dial Tone** determines whether the system returns a dial tone to the remote end of the line:
  - — yes (factory setting) — a dial tone is sent to the remote end
  - — no — a dial tone is not sent to the remote end

- **Answer Supervision Time** sets a time limit in milliseconds (ms) for the remote station to signal the calling station:
  - — 300 ms (factory setting)
  - — 20 to 4800 ms (increments of 20 ms)
- **Disconnect Time** sets a time limit in milliseconds for the release of the E or M lead:
  - — 300 ms (factory setting)
  - — 140 to 2400 ms (increments of 10 ms)

Direct Inward Dial Trunks
Direct Inward/Outward Dial Trunks

Direct Inward Dialing (DID) and Direct Inward/Outward Dialing (DIOD) trunks allow incoming calls to reach specific individuals or facilities in the system without the assistance of a system operator. DIOD trunks also allow outgoing calls to be placed. DID/DIOD trunks are available only in the Hybrid/PBX modes. They are connected to the system on an 800 DID module, or a 100E module with facilities programmed as DID or DIOD.

With DID/DIOD service, the customer reserves blocks of DID numbers from the local telephone company. The DID numbers should correspond to the extension number for an individual, a calling group, or a Remote Access or pool dial-out code.

⚠ CAUTION:
DID numbers that correspond to pool dial-out codes (or facility access codes) can be used to evade toll restriction, leading to toll abuse and/or fraud. (See "Customer Support Information" in the front of this book for more information on security.)

The system can receive 1- to 4-digit extension numbers over the DID/DIOD trunks. The number of digits received on a specific DID/DIOD trunk is always the same for that trunk or for the trunks in a particular DID/DIOD trunk block; however, different DID/DIOD trunks (or trunk blocks) can receive different numbers of digits.

Because DID/DIOD trunks allow calls to come directly to a telephone extension, they cannot be pooled. The CO passes the necessary digits to the system, which delivers the call directly to the dialed extension.

If the extension numbers used in the system are fewer than four digits but the CO sends four, the system can be programmed to ignore the leading digit(s). For example, if the DID number sent by the CO is 2157, the extension numbers the system can access are 57, 157, or 2157. System programming determines the proper extension number to connect.

NOTE:
Work with your CO to get blocks of DID numbers that are compatible with the MERLIN LEGEND system numbering plan. Numbers with leading zeros will force you to renumber the entire numbering plan.

The system also can be programmed to match more digits than are received from the CO. For example, if the system is set up to match three digits and the CO sends the number 24, the system might insert a 9 in front of the 24 (resulting in the number 924) to complete the match and connect the call.

No routing of calls is made until the designated number of digits is received.

Incoming DID/DIOD numbers that don't match a valid extension are either directed to a predesignated extension, such as the system console, or the system sends back a reorder tone.

Options are assigned to blocks of DID/DIOD trunks. A maximum of four blocks of DID/DIOD trunks is allowed. Each block can be configured to match the system numbering plan. For example, the system could have both 3- and 4-digit extension numbers. Trunk block 1 contains the options needed to reach the 3-digit numbers and trunk block 2 contains the options needed to reach the 4-digit numbers.

The options for each trunk group are as follows:

- **Type of DID/DIOD Trunk**
  - — Wink-start (factory setting) — The preferred setting if the local telephone company can support it. It allows a greater probability of call completion during heavy calling periods.
  - — Immediate-start — The setting used when the local telephone company can support only immediate-start.

  This setting is for non-E1 trunks only as E1 trunks will be automatically assigned to R2/CaS signaling. Selection of Wink or Immediate will have no effect on E1 trunks.

- **Signaling** sent from/to the local telephone company.
  - — Rotary (factory setting)
  - — Touch-tone
  - — MFC (with MFC06 module)

  Signaling must be administered for both incoming and outgoing directions if the current block contains DIOD trunks.
- **Expected Digits** sent by the local telephone company.
  - — 3 (factory setting)
  - — 1 to 4
- **Delete Digits.** The number of leading digits that must be deleted from the digits sent by the local telephone company when the number of digits sent is more than in the chosen system numbering plan.
  - — 0 (factory setting) — Used when the number of digits sent by the telephone company matches the number of digits in the chosen system numbering plan.
  - — 0 to 4
- **Add Digits.** The specific leading digits that must be added to the digits sent by the local telephone company when the number of digits sent is fewer than the number of digits in the chosen system numbering plan.
  - — 0 (factory setting) — Used when the number of digits sent by the telephone company matches the number of digits in the chosen system numbering plan.
  - — 1- to 4-digit number (1 to 9999)
- **Invalid Destination**
  - — Backup position (factory setting)
  - — Number Unobtainable Tone

100D Module

The 100D module is the interface that connects a DS1 facility to the system. It can be configured for T1 service and can also emulate loop-start and tie trunks (see "DS1 Capabilities" later in this chapter).

100E Module

The 100E module is the interface that connects an E1 facility to the system. It can be configured for loop-start, tie, DID, or DIOD operation (see "E1 Capabilities" later in this chapter).

Touch-Tone Receivers

The 800 DID, 008 OPT, and 012 modules each provide two TTRs. Normally, these TTRs are sufficient to handle calls originated on 012 and 008 OPT modules, and calls received on the 800 DID module. However, additional TTRs may be needed to support the following services:

- tie trunks and DS1 emulated tie trunks set for Dual-Tone Multifrequency (DTMF) signaling
- Remote Access
- Account Code Entry

If more TTRs are needed to support these services, 016, 400 LS/TTR/DTD or 400 modules can be added (each module provides four TTRs). Table 1-2 shows the estimated number of TTRs needed in the system, depending on the call volume and the types of services.

Table 1-2. Touch-Tone Receiver Requirements

Calls/hr	Total Number of TTRs Required*		
	No Account Codes or Applications	Account Codes or AA (or equiv)	Account Codes and AA (or equiv)
110	2	4	6
180	4	6	8
350	4	8	10
420	6	8	10
610	6	10	12
710	8	10	14

*. System is assumed to already have basic phones, Remote Access, and tie trunks.

MFC Receiver/Generators

MFC06 modules are required to support MFC Register Signaling. This module supports six receiver/generators, each capable of detecting and generating multifrequency tones and acting as an incoming MFC register or an outgoing MFC register.

A carrier may contain a maximum of two MFC06 modules (or one MFC06 and one 100E module) if other modules are present in the same carrier. A maximum of four MFC06 modules (or combination of MFC06 and 100E modules) may be placed in a carrier that contains no other modules. These constraints are due to power supply current limitations.

Telephones and Consoles

Several different analog multiline and single-line telephones work with the system; however, the only digital telephones that work with the system are the digital (MLX) telephones.

⚠ WARNING:
An analog multiline or digital multiline telephone located in a different building but within 305 m (1000 feet) of the control unit requires an IROB (in-range out-of-building) protector at each building entrance.

See Appendix A for ordering information on these telephones.

MLX Telephones

There are four telephones in the MLX telephone line, each available with English, French, or Spanish button labels:

- MLX-20L** telephone
- MLX-28D** telephone
- MLX-10D** telephone
- MLX-10** telephone

There also special sets that meet European transmission requirements.

Some features are common to all MLX telephones:

- programmable line and feature buttons with two associated lights (red and green)
- dedicated feature buttons (four have a red or green light)
- red message-waiting light
- built-in speakerphone
- volume control for speakerphone, handset, and ringer
- user reference card tray with feature and programming codes and directory lists

**. MLX-10, MLX-10D, MLX-20L, and MLX-28D are trademarks of AT&T.

- optional internal Multi-Function Module (MFM) to connect to tip/ring (T/R) equipment and alerting devices (described in Chapter 3)

NOTE:
An MLX-20L telephone used as a QCC cannot have an MFM installed.

- two-position adjustable desk stand
- four-pair modular line cord

MLX telephones with display have two additional features:

- LCD display
- display-associated keys

A list of features specific to each telephone model in the MLX telephone family follows.

MLX-20L Telephone (see Figure 1-5)

- can be used for system programming and as a DLC or a QCC operator console
- 20 line and feature buttons
- display (7 lines x 24 characters)
- 14 display-associated buttons
- accommodates one or two Direct Station Selectors (DSSs)

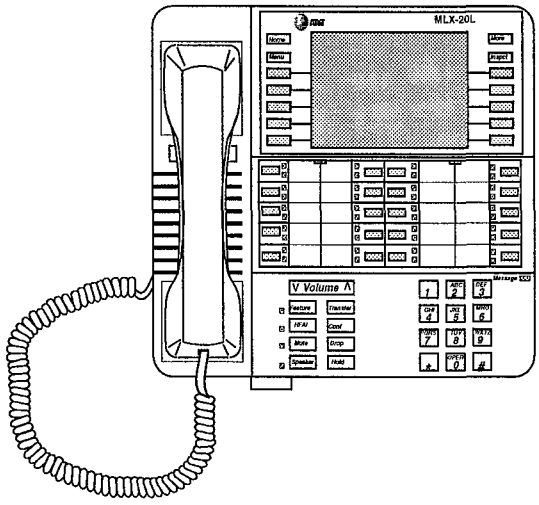


Figure 1-5. MLX-20L Telephone

MLX-28D Telephone (see Figure 1-6)

- can be used as a DLC operator console
- 28 line and feature buttons
- display (2 lines x 24 characters)
- 8 display-associated buttons
- accommodates one or two Direct Station Selectors (DSSs)

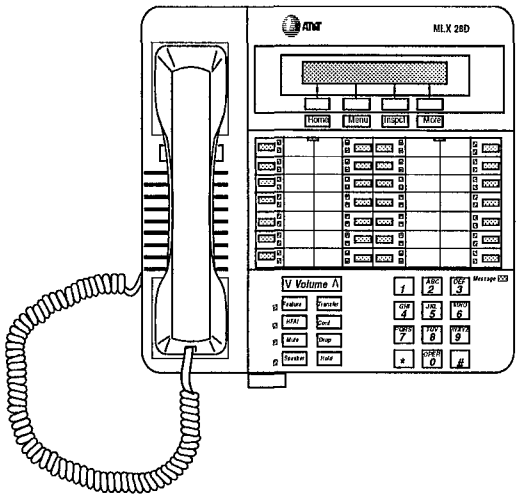


Figure 1-6. MLX-28D Telephone

MLX-10D Telephone (see Figure 1-7)

- 10 line and feature buttons
- desktop or wall-mount
- display (2 lines x 24 characters)
- 8 display-associated buttons

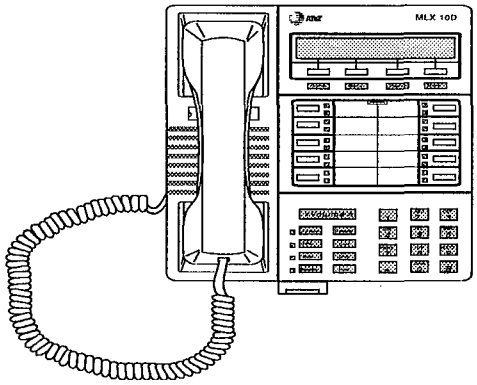


Figure 1-7. MLX-10D Telephone

MLX-10 Telephone (see Figure 1-8)

- 10 line and feature buttons
- desktop or wall-mount

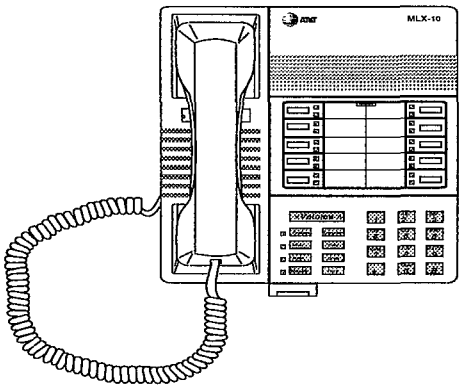


Figure 1-8. MLX-10 Telephone

Single-Line Telephones

Most U.S.A.-standard single-line telephones will work with the system. The system supports the approved AT&T single-line analog telephones listed in the following table:

NOTE:
Single-line telephones are required for use on power failure transfer (PFT) jacks. Neon message-waiting lights on single-line telephones do not work.

Table 1-3. Approved AT&T Single-Line Telephones

Model	Description
500MM 554BMPA (wall-phone) 500SM (speakerphone)	Basic telephones with rotary dials, which prohibits the use of any system features requiring * or #.
700 Series	Basic desk or wall telephone with flash buttons, mute button, redial button, 3-position receive volume control, low-medium-high ringer control, and selectable tone/pulse.
7102A	Basic desk telephone with message-waiting light and Recall button. No adjuncts are supported. Can be used for PFT stations.
8101	Analog voice terminal with data/fax jack, desk/wall-mountable, flash button, hold button, message-waiting light/LED and neon, redial button, selectable positive disconnect, and selectable tone/pulse.
2500SM	Basic desk telephone used with 4A speakerphone
2500MMGB	Basic desk telephone
2500MMGJ	Basic desk telephone
2500MMGK	Basic desk telephone with the following limitation: Timed Recall button action (similar to a switchhook flash) will invoke the Hold and Transfer feature.
2500MMGL	Basic desk telephone with selectable positive disconnect and selectable tone/pulse.
2500YMGK	Basic desk telephone with message-waiting light and Recall button. Recall button is used instead of the switchhook for features that require a switchhook flash, such as Transfer and Hold.
2500YMGL	Basic desk telephone with selectable positive disconnect, selectable tone/pulse, flash button, hold button, message-waiting light/-LED and neon, mute, and redial.
2514BMW	Basic desk telephone with built-in headset jack
2526BMG	Outdoor telephone used with weatherproof enclosure
2554MMGJ	Basic wall telephone

Telephones and Adjuncts Not Supported

⚠ CAUTION:
The following telephones and adjuncts cannot be used with the system. Connecting them can damage the telephones, adjuncts, and system.

Table 1-4. Telephones and Adjuncts Not Supported

Model	Notes
510D Personal Terminal	Uses Digital Communications Protocol (DCP)
DCP telephones	7400 telephones and adjuncts (asynchronous data units and multiple asynchronous data units) that use DCP and that are supported on the MERLIN II Communications System
MET telephones	Multibutton electronic telephones (MET) and adjuncts that are used with the Dimension* PBX and Horizon* systems
Single-line telephones with neon Message lamp	Incompatible with neon Message lamp
Analog telephone adjuncts	Basic telephone modem interface (BTMI and BTMI-2); Off-premises extension (OPX) unit; System 25* Direct Extension Selector (DXS); DSS attached to a 34-button deluxe membrane

*. DIMENSION, HORIZON, and System 25 are trademarks of AT&T.

System Operator Consoles

System operator consoles are telephones that are programmed for call handling and other operator duties.

An operator console can be configured as a Direct-Line Console (DLC) or a Queued Call Console (QCC).

DLCs

In a DLC configuration, lines/trunks are assigned to individual buttons and the console can have several calls ringing at the same time.

The following telephones can function as DLCs and must be connected to digital station jacks on an 008 MLX module:

- MLX-20L telephone
- MLX-28D telephone

NOTE:
One or two DSS adjuncts can be added to each MLX DLC to provide 50 or 100 additional extension buttons:

If your system was upgraded from a MERLIN II Communications System and still includes an 008 or 408 analog multiline telephone module, the following telephones can also function as DLCs:

- MERLIN II system display console with BIS
- BIS-22D telephone
- BIS-34 telephone
- BIS-34D telephone

CAUTION:
These analog multiline DLCs must be connected to analog station jacks on an 008 or 408 analog multiline telephone module. They cannot be connected to an MLX module. Connecting them to an MLX module will cause damage to the MLX module and/or the telephone.

QCCs

In a QCC configuration, only one call rings at a time. Additional incoming calls are held in queue, and each call in turn is directed to a QCC as it becomes available.

NOTE:
In a Hybrid/PBX system, only the MLX-20L telephone can function as a QCC.

The QCC system operator console must be connected to the first jack on the first 008 MLX module. Additional QCCs can be connected, and they must be connected to an 008 MLX module as well. See *System Programming* for specifications.

Adjuncts

Adjuncts are pieces of equipment that connect directly to the control unit or to a telephone through an adapter (see "Adapters" below). Answering machines, credit card verification terminals, and external alerts are examples of adjuncts. For more information on adjuncts, see Appendix B.

Adapters

Adapters enable a proper connection of equipment or, in the case of the channel service unit (CSU), of a DS1 facility to the CSU. Some adapters connect directly to the control unit (system adapters) while others connect to telephones (telephone adapters). See Chapters 3 and 5 for the installation procedures for these adapters:

- system adapters
  - — ESF T1 CSU
  - — 551 T1 L1 CSU
  - — PagePal
  - — E1 cable

NOTE:
The E1 cable has a modular jack on one end and a BNC connector on the other. If the BNC connector is not appropriate for the network interface provided by the CO, cut the BNC connector end of the cable and set up a twisted pair connection, using the transmit-and-receive pairs.

On the modular jack, the transmit pair is associated with pins 4 and 5 (the green and red wires). The receive pair is associated with pins 1 and 2 (the grey and brown wires).

- telephone adapters
  - — Multi-Function Module (MFM) for digital telephones
  - — General Purpose Adapter (GPA) for analog telephones
  - — ISDN Terminal Adapter (such as the ExpressRoute 1000 or ISDN 7500B Data Module) for connecting digital data equipment either directly to the control unit or to an MLX telephone (for simultaneous voice and data transmission)
  - — modem for connecting digital equipment, such as a personal computer (PC), to a tip/ring (T/R) interface
  - — Supplemental Alert Adapter (SAA) for connecting alerts (such as horns or strobes) to an analog multiline telephone

System Capacities

The system supports up to 80 outside lines/trunks and 200 stations, such as telephones and fax machines. The system has a total capacity of 280 ports (80 outside lines/trunks plus 200 stations); however, each MLX module station jack supports two logical endpoints (station devices that can operate simultaneously and independently). For example, an MLX telephone with a Multi-Function Module (MFM) plugs into only one station jack, but the jack supports the telephone and the equipment connected to the MFM (such as a fax machine or an answering machine). Both are counted as station endpoints with the MLX telephone counted as a station and the MFM counted as an adjunct.

In a similar way, although the 100D module has only one jack, it can serve up to 24 endpoints (emulated lines/trunks). The 100E module, also with only one jack, can serve up to 30 endpoints.

Thus, the entire system can be configured to connect up to 80 lines/trunks and 255 station endpoints, a total of 335 endpoints.

NOTE:
The system has a time-slot capacity of 216. If more than 216 endpoints are in use at the same time, blocking can occur.

The following table lists the hardware, software, and feature capacities of the system.

Table 1-5. Hardware, Software, and Feature Capacities

Item	Capacity	Constraining Factor
Allowed Lists ■ Number of lists ■ Entries per list ■ Digits per entry	 8 10 7	
Automatic Route Selection (ARS) ■ Number of ARS patterns ■ Subpatterns per pattern ■ Routes per subpattern ■ Number of fully programmable ARS tables ■ Entries per table ■ Entries across all tables ■ Default tables	 18 2 6 16 100 1600 4	ARS is written for the North American Dial Plan (NADP) and may have limited use outside the NADP area.
Callback ■ Number of calls in queue	 64	

Item	Capacity	Constraining Factor
Calling groups ■ Number of groups ■ Members per group ■ Groups per member ■ Delay announcements per system ■ Delay announcements per group ■ Groups per delay announcement ■ External alerts per group ■ Coverage groups per group	 32 20 1 32 1 32 1 1	QCCs cannot be members.
Carriers ■ Line/trunk and station module slots per basic carrier ■ Line/trunk and station module slots per expansion carrier ■ Maximum slots available for line/trunk and station modules	3 5 6 17	First slot of basic carrier used for processor module
Coverage groups ■ Number of groups ■ Senders per group ■ Groups per sender ■ Receiver buttons per group ■ Groups per QCC receiver	 30 255 1 8 30	QCCs cannot be senders.
Data hunt groups ■ Number of groups ■ Members per group ■ Groups per member	 32 20 1	
Direct Inward Dialing (DID) ■ Number of blocks ■ Number of trunks	 4 80	
Directories ■ System Directory —Number of directories —Listings per directory ■ Extension Directory —Number of directories —Listings per directory ■ Personal Directory —Number of directories —Listings per directory	 1 130 1 200 48 50	
Disallowed Lists ■ Number of lists ■ Entries per list ■ Digits per entry	 8 10 11	The system has 7 Disallowed Lists if the Other Numbering Plan is used.
100D and/or 100E modules	3	Maximum 2 per carrier if other modules are present, 3 per carrier if no other modules are installed in that carrier.

Item	Capacity	Constraining Factor
Endpoints (devices)	255	
Fax machines with message-waiting	16*	
Lines/Trunks	80	Software real-time limit
MFC06 modules		
■ Per carrier	4	
■ Per system	6	
Night Service		
■ Groups	8	
■ Members per group	255	
■ Groups per member	8	
■ Emergency Allowed List entries	10	
System operator consoles		
■ DLCs:		
—MLX-20L or MLX-28D	8	2 per MLX module
—BIS-22D, BIS-34, BIS-34D, or MERLIN II System Display Console	8	
■ QCCs	4	2 per analog module
■ DSSs	16	2 per MLX module 2 per MLX module (built into MERLIN II System Display Console)
■ Combination of DLCs and QCCs	8	Maximum of 4 QCCs
■ Number of consoles per module	2	
Park codes		
■ Number of codes	8	
Personal lines	64	
Pickup		
■ Number of groups	30	
■ Members per group	15	
■ Groups per member	1	
Pools (trunk groups)		
■ Maximum number of pools	11	
■ Maximum number of trunks in a pool	80	
Pool buttons	64	
Ports (not achievable simultaneously)		
■ Total	280¶	200 stations and 80 trunks
■ Voice and data (physical ports)	200	Software real-time limit
■ Voice Announce to Busy stations	127	RAM limit
■ Voice-mail interface	20†	RAM limit
■ Digital data via ISDN Terminal Adapter	127	Software real-time limits;
■ Paging	3	loop-start only
■ Delay announcements	32	Software real-time limits
Remote Access		
■ Number of barrier codes	16	
■ Digits per code	4	

Item	Capacity	Constraining Factor
Shared System Access (SSA) buttons		
■ SSA buttons per Single-line telephone	0	
■ SSA buttons any other telephone	10	
■ Number of telephones that can point to a specific extension	16	
Speed Dial		
■ Personal Speed Dial		Single-line and 5- or 10-button telephones only
—Entries per telephone	24	
—Entries per system	1200	
—Digits per entry	28	
■ System Speed Dial		
—Entries per system	130	
—Digits per entry	40	
Stations		
■ Total physical jacks		
—ATL and T/R	200	
—Entries per system	127	
■ Total endpoints	255	
System programming equipment		
■ MLX-20L	1	Remote access overrides on-site programming except during backup or restore
■ RS-232 jack (for connection of PC with SPM)	1	
■ Modem	1	
Telephones (not achievable simultaneously)		
■ Single-line	200	RAM limit
■ MLX-20L	48‡	RAM limit
■ Total MLX telephones (with or without an ISDN Terminal Adapter or MFM)	127	RAM limit
■ Power failure transfer	20	1 per 4 LS trunk jacks
Two-party conversations	108	216 time slots
Voice-mail systems	1	

*. The system can support more than 16 fax machines, but those in excess of 16 cannot use the fax message waiting indication.

†. Although the system software supports up to 24 voice-mail interface (VMI) ports, a capacity of 20 ports is listed since it is recommended that all VMI ports be in the same calling group, and the maximum number of stations in a calling group is 20.

¶. The system is said to have a total capacity of 280 (80 CO trunks plus 200 extensions). However, these are physical jacks. Each MLX station jack represents 2 logical endpoints. For example, an MLX telephone with a Multi-Function Module (MFM) plugs into only 1 station jack, but the jack supports the telephone and the adjunct connected to the MFM (fax machine, answering machine, etc). The 1 station jack is supporting 2 endpoints. Similarly, although each has only 1 100D and 100E module jack, each 100D module can serve up to 24 endpoints and each 100E module can serve up to 30 endpoints. Therefore, the entire system can be configured to connect up to 80 trunks and 255 station endpoints, a total of 335 endpoints. This total of 335 endpoints exceeds the system's capacity of 216 time slots. If more than 216 endpoints are in use at the same time, blocking can occur.

‡. Total includes the MLX-20L telephone used for system programming.

Data Capabilities

The system can provide data connections between two digital ISDN terminal adapters (such as the ExpressRoute 1000 or ISDN 7500B Data Module), between two analog modems, or between an analog modem and a digital ISDN Terminal Adapter. The system provides access to an in-house host computer or to a data station on a network.

Data facilities include the following:

- digital data endpoints — RS-232 interfaces via ISDN Terminal Adapters
- analog data endpoints — tip/ring modem interfaces
- local host computer and workstation on local area network (LAN) access (only via an RS-232 interface)
- DS1 facility interface (analog data via T1)
- E1 facility interface (analog data via E1)

Networking Capabilities

Control Unit to Control Unit

This system's control unit can connect to another system's control unit in the following ways:

- from an off-premises telephone (OPT) line to an LS line/trunk (or vice versa) via analog facilities
- via an analog tie trunk (400EM module)
- via a digital tie trunk using emulated E&M in the T1 mode on a 100D module. A back-to-back connection from one DS1 facility to the other can be used when the total cable distance is less than 400 m (1310 feet).
- via a digital tie trunk using emulated E&M or R2/CaS signaling in the E1 mode on a 100E module. A back-to-back connection from one E1 facility to the other can be used when the total cable distance is less than 200 m (655 feet).

OPT/LS Connection

An 008 OPT module on system A's control unit can be connected to an LS port on system B's control unit. This enables the user on system B to access all the stations and facilities on system A. If system B has Remote Access, the user on system A can directly access stations and facilities on system B without operator intervention. Conversely, an LS port on system A can be connected to an OPT port on system B.

NOTE:
If the systems are on the same premises, the connection can be made to any T/R port.

With the OPT/LS connection, glare is more frequent as the volume of calls increases. (Glare occurs when a user tries to make an outside call on a line/trunk at the same time an incoming call is being received on that line/trunk.) In addition, if system B (the LS interface) does not have Remote Access, only the station(s) assigned to the LS facility on system B can be accessed by system A.

Analog Tie-Trunk Connection

In an analog tie-trunk connection, the system A's 400EM module is connected to system B's control unit. On premises, this module can be connected directly to system B if system B has similar tie-trunk facilities.

For off-premises connection, the 400EM module can be connected via the telephone company's facilities to system B.

The analog tie-trunk connection can be programmed for two-way traffic or for one-way traffic (incoming or outgoing). The one-way mode prevents blocked calls caused by glare.

Digital Tie-Trunk Connection

The digital tie-trunk connection joins the DS1 interface (the 100D module), or E1 interface (the 100E module), on the MERLIN LEGEND system to another system's DS1 or E1 interface respectively. If the other system is on the same premises, the connection is back-to-back. To reach a remote system, the DS1 facility connects via a channel service unit (CSU) to the telephone company's facilities.

The E1 facility also connects to the telephone company's facilities to reach a remote system.

Tie-Trunk Network Connections

Tie-trunk networks can be set up using nontandem, tandem, or intertandem connections. See Figure 1-9 for examples of each type of tie-trunk network.

NOTE:
For tandem and intertandem connections, the MERLIN LEGEND system does not support uniform dial plan or 10-digit call routing, and requires extra access codes to be dialed at each tandem point. The transmission loss plan does not support the MERLIN LEGEND system in tandem or intertandem networks.

Nontandem

Nontandem tie-trunk network connectivity connects two systems (A and B) via one tie trunk and is used primarily to connect station lines from one system to another. In a nontandem tie-trunk connection, both systems are endpoints; they do not have additional tie-trunk connections, and there is no midpoint.

Tandem

Tandem tie-trunk network connectivity connects three systems (A, B, and C) via two independent tie-trunk groups. Systems A and C are endpoints, and System B is the midpoint. A tandem connection also can be used to connect the system to an external facility (maintaining a maximum of three systems total), but the grade of service will be fair to poor if one or both tie trunks are analog.

NOTE:
Special codes must be dialed and there may be a pause before the dial tone is heard.

Intertandem

Intertandem tie-trunk network connectivity connects four or more systems (for example, A, B, C, and D), using an independent tie-trunk group for each system-to-system connection. In this example, systems A and D are endpoints; Systems B and C are midpoints. Intertandem network connectivity always involves two or more intermediary systems. Intertandem connectivity is not recommended for analog tie trunks, due to complex dialing, complex pauses, and loss in transmission levels.

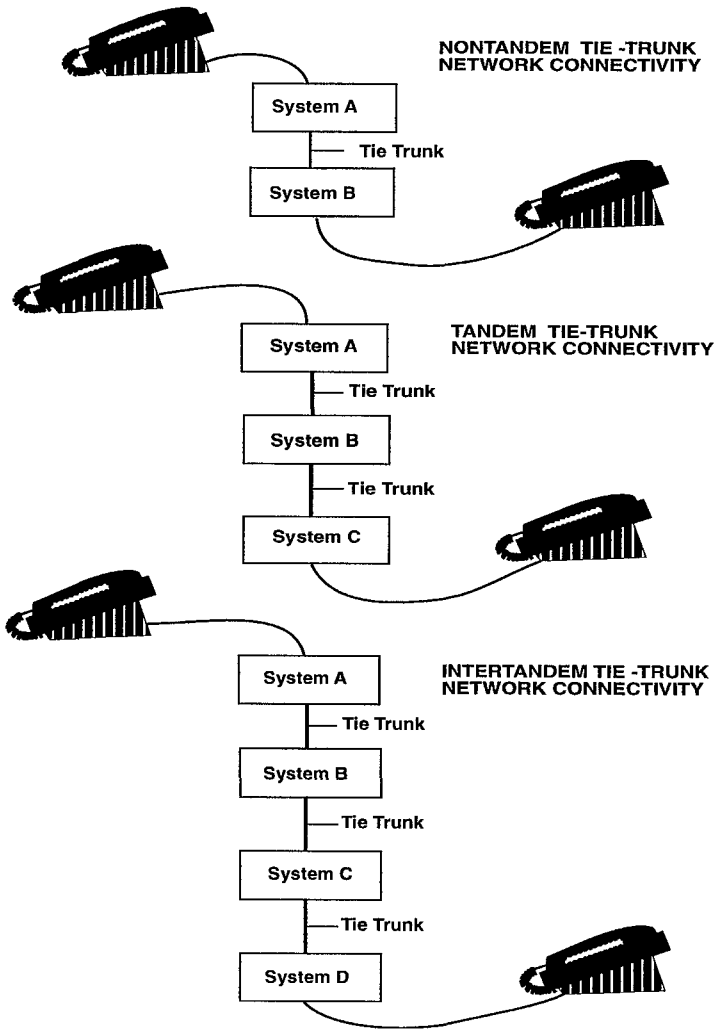


Figure 1-9. Nontandem, Tandem, and Intertandem Connectivity

Functional Units

The functional units are the processor module, which controls the operation of the system and its features; the line/trunk and station modules, which connect the CO lines/trunks to the stations; the power supply module, which supplies power to the control unit; and the carrier with its backplane assembly, which contains the input/output (I/O) bus and the time-division multiplex (TDM) bus. All the modules are electrically connected to the backplane, which provides common circuitry for the I/O bus, the TDM bus, and power distribution. (See Figure 1-10 for a functional block diagram of the system architecture.)

The processor module is connected to intelligent ports on the line/trunk and station modules, through the I/O bus, by the digital switch element (DSE) on each line/trunk and station module. The TDM bus also is connected to the DSE of each line/trunk and station module. The two busses are described below:

- **Input/Output Bus.** The I/O bus contains a 16-bit address bus and an 8-bit data bus. The address bus selects the module that receives instructions from the 68000 microprocessor in the processor module. The microprocessor provides instructions to the port processors and DSEs through the 8-bit data bus.
- **Time-Division Multiplex Bus.** The TDM bus connects the DSEs to allow voice or data to flow in and out of the system. The TDM bus is parallel, 8 bits wide, and runs at 2.048 MHz (256 time slots x 8 kHz = 2.048 MHz). Each TDM cycle has 256 time slots for voice, data, tones, and clocks. The frame repetition rate is 8 kHz, providing a 64-kbps channel on each time slot (8-bit bus x 8 kHz = 64 kbps).

The built-in data modem connects to the TDM bus; this permits access from a local or remote PC or workstation equipped with a 1200-bps modem. The TDM bus connects with the built-in diagnostics that enable the processor to read and write to dedicated TDM test slots.

Voice signals on the TDM bus are encoded in Mu-Law 255 pulse code modulation (PCM) format for use in U.S.A.-type networks. The system provides a circuit-switched connection for transmission of digital data signals up to 64 kbps. See "Signal Processing" on the next page.

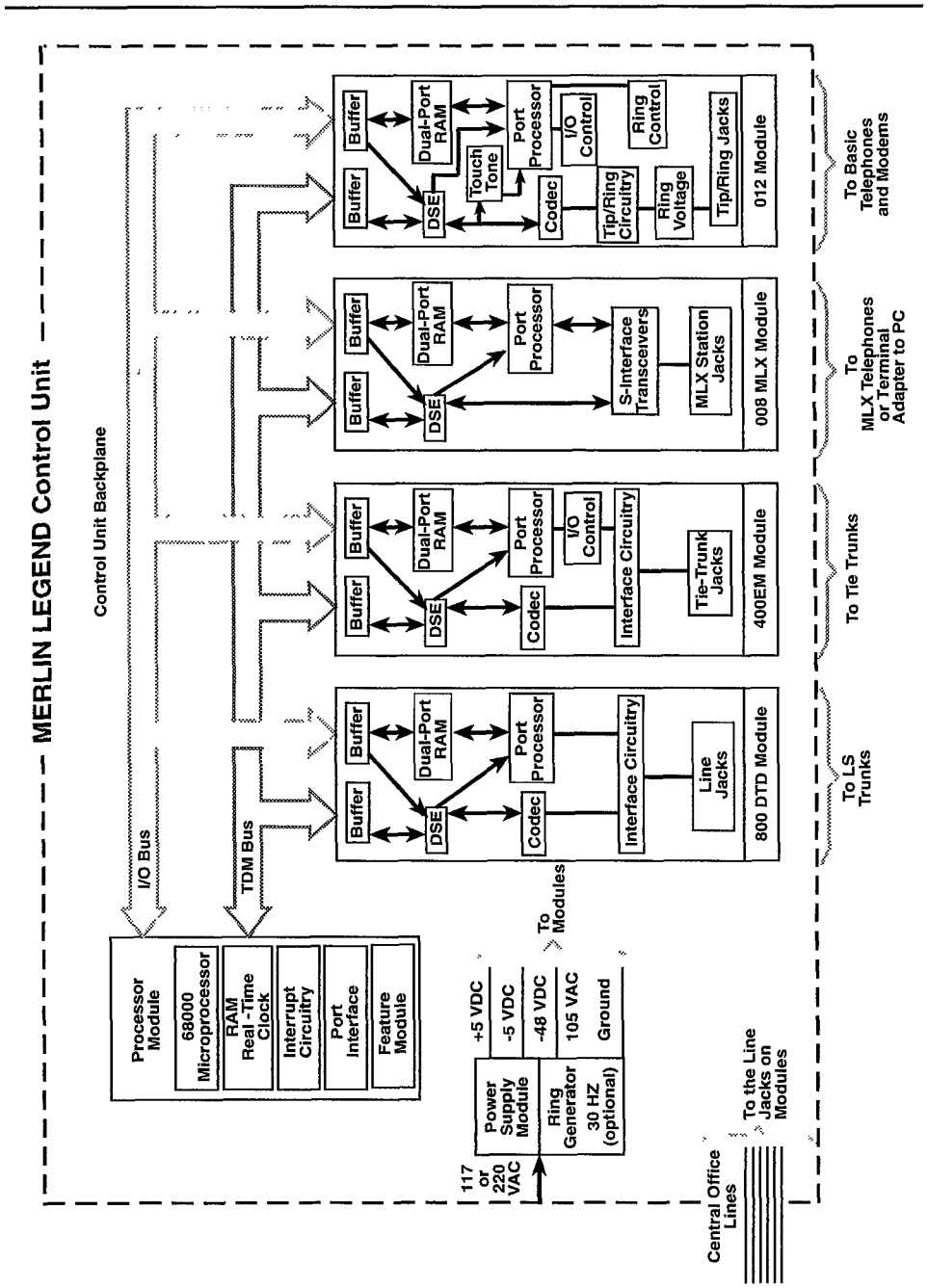


Figure 1-10. System Architecture

Signal Processing

Because the system is internally a digital system that must interact with both analog and digital devices, it must accurately translate analog signals. Doing this involves signal conversion, quantizing, companding, and switching.

Signal Conversion

The first step in analog-to-digital (A/D) conversion is to sample the analog signal and convert the signal into a series of amplitude steps. This is called pulse amplitude modulation (PAM).

PAM samples the height of the analog waveform 8000 times per second, or more than twice the frequency of the input signal bandwidth (for analog voice the bandwidth is 3300 Hz). Because the analog signal is sampled at more than twice its bandwidth, both the amplitude and frequency content of the original analog signal are preserved. The amplitude of each PAM sample is then digitally encoded and transmitted by using a process called pulse code modulation (PCM).

PCM uses PAM as its starting point but goes further by digitizing the PAM signal for transmission via the digital switch. PCM converts the height of each PAM pulse to an 8-bit digital signal for transmission.

PCM digitizes the PAM information by comparing each PAM sample to a point on a chart. Each point has a distinct 8-digit binary code. Therefore, it is the binary code (digital), not the amplitude pulse (analog), that is transmitted in PCM. At the destination, the PAM signal is reconstructed from the PCM signal via a digital-to-analog (D/A) converter. The D/A converter also completes the reconstruction of the analog signal from the stream of PAM signals.

The digitally encoded signals are routed from one interface port to another interface port by assigning source and destination to specific time slots on the TDM bus. In this way, signals can be transmitted to one or several destinations and reconstructed at the original amplitude. The result is no signal loss during switching and transmission from one point to another.

Quantizing

The process of converting PAM samples into discrete PCM values is called quantizing. In the case of voice-grade signals, eight bits are commonly used to encode one PAM sample. Quantizing with eight bits allows 256 unique values to represent the range of amplitudes in the analog signal being sampled.

Quantizing causes distortion due in part to the "rounding off" of PAM samples into discrete PCM values. This distortion can be minimized by increasing the number of bits used to encode each PAM sample or by increasing the sampling rate. Using 8-bit coded samples taken at an 8-kHz rate results in toll-grade transmission quality.

Companding

Distortion also occurs in quantizing because equal consideration is given to all amplitude levels. Linear quantizing divides the amplitude range into equal segments, which results in unnecessary quality at levels where voice signals are unlikely to occur and not enough quality where they do occur. Companding eliminates this distortion by using a nonlinear scale that has smaller divisions and more accuracy in areas of the scale where voice signals are most likely to occur.

Mu-Law 255

Mu-Law 255 is a companding scheme that uses a compression ratio compatible with modern channel bank equipment. The scale is divided into 16 intervals, with each interval having 16 levels. Therefore, the scale has 256 discrete values. But since Mu-Law 255 has a negative and a positive zero, it really has only 255 discrete values. This companding scheme is used in the United States and Japan.

A-Law 100

The companding scheme used in Europe is A-Law 100. It follows the same basic theory as Mu-Law 255; however, its scale is different. The scale tends to be more linear than Mu-Law 255. Because the intervals tend to be equal, A-Law 100 does not concentrate its accuracy in areas of the scale where voice signals occur the most.

Digital Switching

The TDM bus allows many users to communicate over a common electrical connection because it is physically distributed across the backplane of the control unit and connects all line/trunk and station modules.

The TDM bus has specific time slots for various functions. For example, during a conversation between station A and station B, a time slot is reserved for station A to transmit on and for station B to receive on. An analog station can transmit on time slot 150 and receive on time slot 160. Because the TDM bus cycles 8000 times per second, the conversation is continuous.

The TDM bus carries tones and control signals to stations via time slots 0 to 39. Unlike other bus configurations, the stations on the TDM bus receive all transmissions. If a station is not assigned to any of the time slots, the station ignores the data.

The digital switch element (DSE) is a digital switch for voice and data. It also performs the operations for companding schemes such as Mu-Law and A-Law. Each module has a DSE to interface codecs or digital transceivers to the TDM bus. The actual digital switching occurs when the DSE is programmed by the system I/O bus to transmit data on or receive data from the TDM bus in specific time slots. For example, the digital station can send data on time slot 200 and receive data on time slot 220.

This process also involves time slot interchanging so that an available slot in the TDM cycle can be filled with a transmit or receive slot. The DSE allows up to 16 time slots to be conferenced and sent out to a single station port.

Tie-Trunk Signaling

Tie trunks transmit via three different signaling formats, each made up of a specific mode and a specific type.

The DIP switches on the 400EM module select the signaling modes needed for tie-trunk transmission (see Figure 1-4); the signaling type is selected during system programming.

Signaling Modes

There are two signaling modes:

- **Simplex mode**. Two signaling leads superimposed onto the analog transmission leads provide a 2-pair wire interface for connecting two local systems at minimal cost.
- **E&M mode**. This is a standard interface. The E&M signaling leads are isolated from the transmission leads, requiring a 3-pair wire interface.

In the simplex mode, protective resistance is always included in the circuit. The E&M mode can be either protected or unprotected from high-voltage transients or fluctuations. In the protected mode, a resistance is added to the leads to reduce current peaks. The protected mode is used when there is no network interface to protect the circuit from outside interference.

The unprotected mode must be used for an E&M type 1 standard interface (see below) to meet the specified voltage-drop criteria. This mode is used when there is a network interface.

⚠ CAUTION:
The protected mode must be used whenever the E&M leads extend out-of-building and are not connected to the network interface.

Signaling Types

Three different signaling types combine with the signaling modes. Together these create the proper signaling format for each system.

- **Type 1 standard.** This is the factory-set type, which is used to connect two systems through two intermediate COs. The switches must be set for E&M mode.
- **Type 1 compatible.** This type is used to connect directly without intermediate COs. One system is set to type 1 standard, the other to type 1 compatible. The switches must be set for E&M mode.
- **Type 5 simplex.** This type is used to connect similar systems or systems with compatible signaling that are located in the same building or on the same business campus.

The choice of a tie-trunk signaling format depends on the particular application and the two systems being connected, including whether or not the tie-trunk signals pass through CO lines or over customer-owned cable. Table 1-7 shows how to determine tie-trunk compatibility between the MERLIN LEGEND Communications System and other systems.

Table 1-6. Tie-Trunk Compatibility

Installation Situation		Preferred Signaling Format			
From MERLIN LEGEND Communications System		MERLIN LEGEND Communications System		Far End	
To	Location	Signaling Mode and Type	Protected or Unprotected	Signaling Mode and Type	Protected or Unprotected
MERLIN LEGEND, MERLIN II, System 25, System 75*, System 85*, or DEFINITY*	Same site or inter-building	Simplex; type 5	N/A	Simplex; type 5	N/A
Dimension PBX	Same site	E&M; type 1; compatible	Unprotected	E&M; type 1; standard	Unprotected
Dimension PBX	Inter-building	E&M; type 1; compatible	Protected	E&M; type 1; standard	Protected
Other	Same site	E&M; type 1; compatible	Unprotected	E&M; type 1; standard	Unprotected
Other	Inter-building	E&M; type 1; compatible	Protected	E&M; type 1; standard	Requires a protection unit
Network Interface	N/A	E&M; type 1; standard	Unprotected	N/A	N/A

* DEFINITY, System 75, and System 85 are trademarks of AT&T.

DS1 Capabilities

A Digital Signal One (DS1) facility is a transmission system that transports digital signals in the DS1 format. The interface that allows the connection of DS1 facilities to the system is the 100D module. Through this module voice and data calls can be placed on or received by a DS1 facility. Twenty-four Digital Signal Zero (DS0) channels, each operating at 64 kbps, plus framing bits, are multiplexed, forming a DS1 signal of 1.544 Mbps. Each DS0 channel within the DS1 signal corresponds to a logical endpoint. Even though there is only one physical jack, the 100D module supports up to 24 logical endpoints or ports (one for each channel).

In DS1 format, calls to other digital PBXs or COs remain digital, and signals do not need to be converted to analog for acceptance by the connecting trunk.

To connect the 100D module to an outside DS1 facility, a channel service unit (CSU) is used. The CSU regulates the transmission into and out of the 100D module so that the module matches the transmission of the outside facility. Both ends of the DS1 facility must be able to communicate using the same protocol. To ensure this, the following options are set during system programming to match the transmission of the outside DS1 facility:

- type of service
- framing format
- line coding
- line compensation
- clock synchronization
- signaling mode

The appropriate setting for each option is determined by the transmission facility to which the module is connected. See the *Programming Guide* for any programming information you may need.

The cable provided with the 100D module is designed for connection to a data terminal equipment (DTE) interface. It cannot be used to connect the module either to a multiplexer or a D4 channel bank, both of which are data communications equipment (DCE). To connect a 100D module to a DCE interface, an adapter, wired as follows, is required:

Pin (cable side)		**Pin (DCE side)**
3	-->	1
11	-->	9
1	-->	3
9	-->	11

E1 Capabilities

An E1 facility is a digital transmission system that transports voice and analog data signals in the E1 format. The interface that allows the connection of E1 facilities to the system is the 100E module. Through this module voice and analog data calls can be placed on or received by an E1 facility.

Thirty channels, each operating at 64 kbps, plus framing bits, are multiplexed, forming an E1 signal of 2.048 Mbps. Each channel within the E1 signal corresponds to a logical endpoint. Even though there is only one physical jack, the 100E module supports up to 30 logical endpoints or ports (one for each channel).

In E1 format, calls to other digital PBXs or COs remain digital, and signals do not need to be converted to analog for acceptance by the connecting trunk.

To connect the 100E module to an outside E1 facility, use the E1 cable with the modular jack at one end and the BNC connector at the other. If the BNC connector is not appropriate for the network interface provided by the CO, see "Adapters" earlier in this chapter.

Both ends of the E1 facility must be able to communicate using the same protocol (for example, R2/CaS or E&M tie emulation). To ensure this, the following options are set during system programming to match the transmission of the outside E1 facility:

- type of service (loop-start, tie, DID, or DIOD)
- line coding (changing the line coding busies-out the entire system)
- clock synchronization
- signaling mode

The appropriate setting for each option is determined by the transmission facility to which the module is connected. See the *Programming Guide* for any programming information you may need.

DTMF Signaling

If DTMF signaling is used over E1-emulated DID, DIOD, or tie trunks, and the protocol is R2/CaS line signaling, incoming calls may not route due to lost digits.

NOTE:
When the Country Code is set to a value other than 5, do not use DTMF signaling over E1 facilities when using R2/CaS line signaling protocols.

For systems that have a Country Code setting of 5, the network's R2/CaS signaling protocol must allow the system at least 1000 ms to acknowledge an incoming seizure. If, however, the following restrictions are met, the system can acknowledge an incoming seizure within 500 ms:

- The system is in PBX mode.
- The system is programmed in such a way that prohibits a broadcasting to more than 32 stations. For example, no single trunk can be programmed as a DFT for more than 32 stations. Also, no more than 32 stations can be assigned to one pool, and each pool must consist of only one or two trunks.

If the above restrictions cannot be met for E1-emulated tie trunks using R2 line signaling (R2 Dial), use non-R2 tie emulation (wink, delay, or immediate).

Preparation

2

Contents

Preparation

2

Certain hardware placement and connection requirements must be met before installation. This chapter tells you how to meet these requirements to ensure proper operation.

To verify that the requirements have been met, you must have the following information about the system:

- location of the control unit, wiring fields, network interface, and power for the system
- type and number of Central Office (CO) facilities provided by the local telephone company
- hardware requirements for the control unit, wiring fields, telephones, data equipment, and optional equipment
- location of the telephones, data equipment, and optional equipment
- types and placement of control unit modules
- jack assignments for lines, trunks, and stations
- requirements for voice and data features

Planning Forms

For maximum efficiency, it is strongly recommended that a floor plan and the following planning forms be completed prior to installing the system.

Table 2-1. Recommended Planning Forms

Form No.	Description
Form 1	System Planning
Form 2a	System Numbering — Station Jacks
Form 2b	System Numbering — MLX Station Adjuncts
Form 2c	System Numbering — Trunk Jacks
Form 2d	System Numbering — Special Renumbers
Form 3b	Outside Trunks — Pools
Form 4a	Analog Multiline Telephone
Form 4b	MLX Telephone
Form 4c	Tip/Ring Equipment
Form 5a	Direct-Line Console (DLC) — Analog Telephone
Form 5b	Direct-Line Console (DLC) — MLX Telephone
Form 5c	Queued Call Console (QCC)
Form 5d	MFM Adjunct

Table 2-2. Recommended Planning Forms for 100D, 100E, MFC06, 400EM, or 800 DID Modules

Form No.	Description
Form 3a	Outside Trunks — Remote Access
Form 3c	Outside Trunks — DS1 Facility (100D Module)
Form 3d	Tie Trunks
Form 3e	DID/DIOD Trunks
Form 3f	Outside Trunks — E1 Facility (100E Module)

Table 2-3. Optional Planning Forms

Form No.	Description
Form 6a	Optional Operator Features
Form 6b	Call Pickup Groups
Form 6c	Group Paging
Form 6d	Group Coverage
Form 6e	Group Calling
Form 6f	System Features
Form 6g	Allowed Lists
Form 6h	Disallowed Lists
Form 6i	Special Numbers Table
Form 6j	Call Restriction Assignment Lists
Form 6k	Toll Criteria List Table
Form 6l	Authorization Codes
Form 7a	Night Service — Group Assignment
Form 7b	Night Service — Outward Restriction
Form 7c	Night Service — Time Set
Form 8a	Label Form — Trunks
Form 8b	Label Form — Stations and Calling Groups
Form 8c	Label Form — Posted Message
Form 8d	System Speed Dial and System Directory
Form 9a	Automatic Route Selection Worksheet
Form 9b	Automatic Route Selection Tables
Form 9c	Automatic Route Selection Default and Special Numbers Tables
Form 10a	Programmable Inter-digit Timers
Form 10b	Call Progress Tones
Form 10c	Flash Detection Duration (012, 016 and 008 OPT Modules) Ringing Frequency (016 T/R Modules)
Form 11a	Dial Tone Detection (DTD) — Analog Trunks
Form 11b	Tariff Pulse Metering (TPM) — Analog Trunks

Environment

The control unit requires the following environmental conditions.

Table 2-4. Environmental Requirements

Operating Temperatures	4°C — 40°C (40°F — 104°F) Optimum temperature 16° C (60°F)
Relative Humidity	20% — 80%
Airborne Contamination	Do not expose the control unit to moisture, corrosive gases, dust, chemicals, spray paint, or similar material.
Ventilation	■ Allow at least 2.54 cm (1inch) on the right and left sides of the control unit and 30.48 cm (12 inches) above and below the control unit to prevent overheating. ■ Do not place the control unit near extreme heat (furnaces, heaters, attics, or direct sunlight).
Electrical Fields	Do not expose the control unit to devices that generate electrical currents that cause interference (such as arc welders or motors).
Heat Dissipation	■ Basic carrier 500 Btu/hr ■ Basic carrier with one expansion carrier 1000 Btu/hr ■ Basic carrier with two expansion carriers 1500 Btu/hr

⚠ WARNING:
Do not install the control unit outdoors.

Space and Location

The customer must provide a backboard on which to mount the control unit. The backboard should be wide enough to accommodate additional carriers if system growth is anticipated. Attach the backboard to the wall, allowing enough room on either side of the control unit for necessary wiring fields and for future expansion if installing fewer than three carriers.

Backboard Requirements

- Approximate dimensions (must be large enough to support the current size of the control unit and have room for any future system expansion):
  - 18.3 m W x 91.4 cm H x 2 cm D (6 feet W x 3 feet H x 3/4 inch D)
- Material (must be sturdy enough to mount the control unit with screws):
  - Approximately 2-cm (3/4-inch) plywood

NOTE:
Be sure to comply with all local building codes, including the use of fire-retardant material.

- Mounting Hardware:
  - For a wood mounting surface, use woodscrews.
  - For a brick, cinder block, or concrete mounting surface, use masonry anchors.
  - For a plaster or plasterboard mounting surface, use toggle bolts.
  - For a sheet-metal mounting surface, use sheet-metal screws and attach them to structural members.

NOTE:
The combined pullout force of the backboard should be at least 293 Kg (650 pounds).

Control Unit Requirements

- Dimensions
  - Basic carrier — 29.2 cm W x 58.42 cm H x 30.48 cm (11.5 inches W x 23 inches H x 12 inches D)
  - Basic carrier and one expansion carrier — 59.7 cm W x 58.4 cm H x 30.48 cm (23.5 inches W x 23 inches H x 12 inches D)
  - Basic carrier and two expansion carriers — 90.2 cm W x 58.4 cm H x 30.48 cm (35.5 inches W x 23 inches H x 12 inches D)

- Location
  - — Within 1.52 m (5 feet) of AC power outlet that is not switch controlled
  - — Within 8 m (25 feet) of the network interface
  - — Within 305 m (1000 cable feet) of telephones

NOTE:
The basic carrier weighs 20.41 Kg (45 pounds).

Power and Grounding

Proper power and grounding are essential for correct and safe functioning of the system.

Power Requirements

A load center of the appropriate current rating, equipped with 117 VAC or 220 VAC, 15-amp circuit breaker(s) is required. Each breaker must protect one dedicated quad AC outlet or two dedicated duplex AC outlets.

One outlet must have an attached ground bar connected by a #6 AWG (4.1 mm or next larger size) copper wire to an approved ground. This ground bar is the system's single-point ground (see Figure 2-1).

Tables 2-5 and 2-6 contain the AC power requirements and specifications for the control unit.

Table 2-5. AC Power Requirements (391A1, 391A2, and 391B1)

Parameter	Value (for the 117 VAC 391A1 or 391A2 power supply module)	Value (for the 220 VAC 391B1 power supply module)	Unit
Nominal voltage	117	220	VAC
Voltage range	99 — 129	220 — 240	VAC
Frequency	60 ±5%	50 or 60 (47 — 63)	Hz
Maximum current	3 per power supply	2 per power supply	amps
Power consumption	225 per power supply	225 per power supply	watts

Table 2-6. AC Power Requirements (391A3 and 391B2)

Parameter	Value (for the 117 VAC 391A3 power supply module)	Value (for the 220 VAC 391B2 power supply module)	Unit
Nominal voltage	117	220	VAC
Voltage range	99 — 129	220 — 240	VAC
Frequency	60 (-15% to +10%)	50 (-20% to +10%)	Hz
Maximum current	5.4 per power supply	3.1 per power supply	amps
Power consumption	225 per power supply	225 per power supply	watts

NOTE:
The system will bridge a 40-ms AC power supply outage without DC voltages being affected. In case of an AC power drop of 60 ms or less, the system re-establishes call states. If line AC power drops for 60 ms and then stays up for 1.2 seconds, the system functions normally. *However, if power drops again for 6 ms or more during that 1.2-second time period, the system will initiate a* ***cold start.***

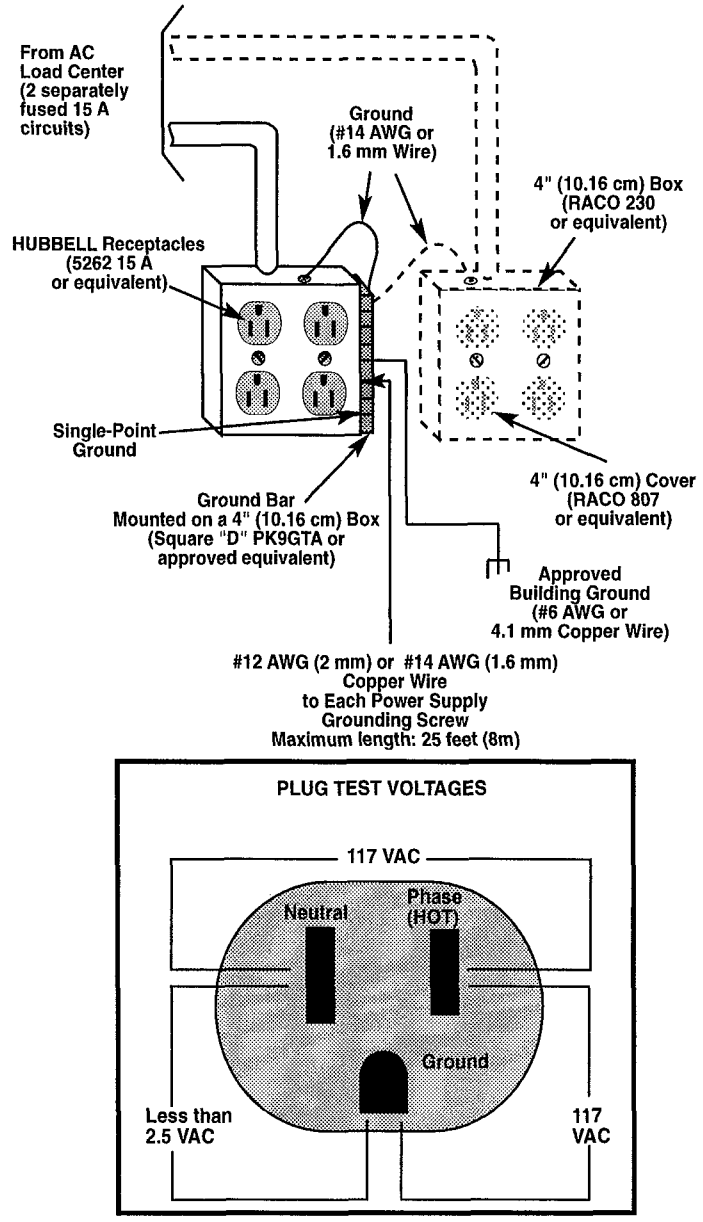


Figure 2-1. Typical AC Grounding (U.S.A. Example)

Each carrier requires one outlet receptacle. Additional AC outlets may be required for auxiliary equipment. All AC outlets must be connected to the same load center and must have the ground wire connected to the single-point ground bar on the first AC outlet (see Figure 2-1).

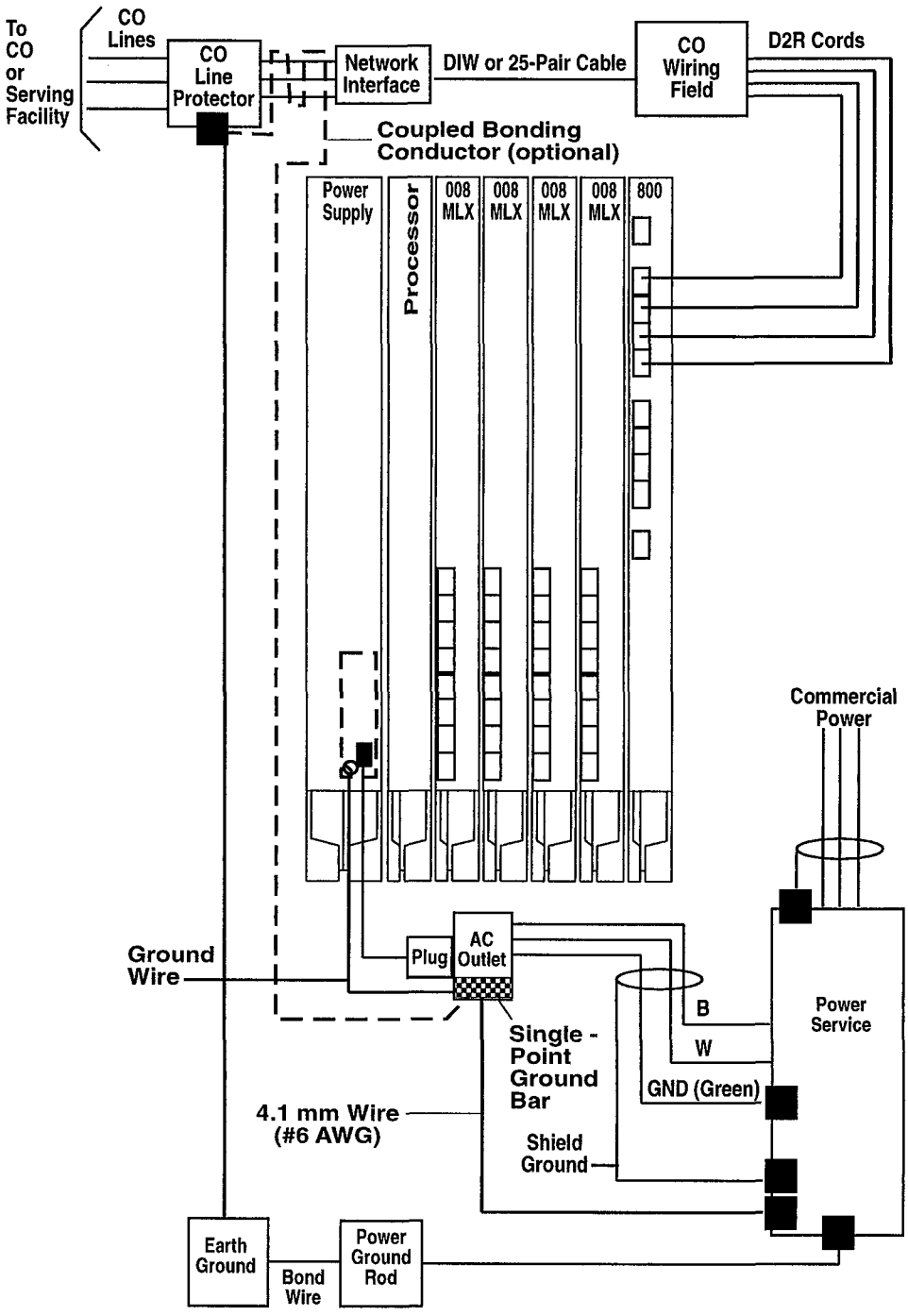


Figure 2-2. Grounding Requirements

If a printer or a PC is installed with the system, it must be plugged into the same AC branch as the power supply module of the basic carrier. If the printer or the PC is 15.24 m (50 feet) or more from the control unit, asynchronous data units (ADUs) must be installed. (See Chapter 3, "Installation," for procedures for Station Message Detail Recording (SMDR) printer and PC installations.)

⚠ CAUTION:
The AC outlet for the Control Unit should not be switch controlled. Plugging the Control Unit into an outlet that can be turned on and off by a switch invites accidental disconnection of the system. The AC outlet must be properly grounded (see "Grounding Requirements" below).

Grounding Requirements

Proper grounding (see Figure 2-2) of the installation site safeguards system functioning by protecting the system from the following:

- lightning
- power surges
- power crosses on CO lines/trunks
- electrostatic discharge (ESD)

If the telephone company has not provided primary protection of the CO lines/trunks, you are required to do so. The system's built-in electrical protection works properly only when primary protection of the CO lines/trunks is provided. If this protection is not provided, electrical protection may not be adequate, which may void your warranty. See your warranty conditions to be certain. The protection should consist of the following:

- carbon blocks or gas discharge tubes connected to an approved ground
- adequate bonding of the CO line/trunk protector ground and the power company ground

The control unit, the CO line protector, and the AC power service panel should be as close to each other as possible. Because equipment can be located throughout a building, the ground point for the CO line protector must be bonded to the AC power ground. The AC outlet and the single-point ground bar must be properly grounded.

Each power supply module in the control unit must be connected to the single-point ground bar by a #12 AWG (2 mm or next larger size) or a #14 AWG (1.6 mm or next larger size) solid copper wire. The wire run should not exceed 8 m (25 feet). (See "Provide Proper Grounding" in Chapter 3, "Installation.")

⚠ WARNING:
Improper ground can cause equipment failures, service outages, and electrical shock. Verify that the AC power uses an approved ground for its primary ground, that all voltage-limiting devices are grounded to an approved ground, and that the ground is one of the approved grounds below.

Approved grounds (listed from most to least preferred) are:

- building steel
- acceptable water pipe — must be a metal, underground water pipe at least 1.3 cm (1/2 inch) in diameter, in direct contact with the earth for at least 3.05 m (10 feet). It must be electrically continuous (or made electrically continuous by bonding around insulated joints, plastic pipe, or plastic water meters) to the point where the protector ground is connected. A metallic underground water pipe must be supplemented by the metal frame of the building, a concrete encased ground, or a ground ring. If these grounds are not available, the water pipe ground can be supplemented by one of the following types of grounds:
  - metal underground gas piping system — an electrically continuous metal underground gas piping system that is uninterrupted with insulating sections or joints, and without an outer nonconductive coating
  - other local metal underground systems or structures — local underground structures such as tanks and piping systems
  - rod and pipe electrodes — a 1.6-cm (5/8-inch) (solid rod) or 2-cm (3/4-inch) (conduit or pipe) electrode driven to a minimum depth of 2.44 m (8 feet)
  - plate electrode — a minimum of 61 square cm (2 square feet) of metallic surface exposed to the exterior soil
- concrete encased ground — must be an electrode, consisting of at least 6.1 m (20 feet) of one or more steel reinforcing rods at least 1.3 cm (1/2-inch) in diameter, or 6.1 m (20 feet) of bare copper conductor not smaller than #4 AWG (5.2 mm or next larger size) encased in 5.1 cm (2 inches) of concrete. This electrode must be located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth.
- ground ring — consists of at least 6.1 m (20 feet) of bare copper conductor not smaller than #2 AWG (6.5 mm or next larger size) encircling the building. The ground ring must be in direct contact with the earth and buried at least 80 cm (2.5 feet) below the earth's surface.

Power Surge and Lightning Protection

For most surges, the following standard grounding requirements provide adequate lightning and power surge protection:

- properly wired/grounded/bonded CO line protectors
- properly wired/grounded AC outlet
- properly grounded single-point ground bar
- properly wired connection between single-point ground and power supply modules

Additional Protection

The power supply module (391A1, 391A2, 391A3, 391B1, or 391B2) and the line/trunk and station modules have built-in AC line protection. This built-in protection handles almost all situations.

Occasionally, additional protection may be needed if the customer is located in a heavy lightning area. A 147A protector can be connected to the system to limit surges from the AC lines and CO lines. One 147A protector provides protection for four CO lines. Up to three 146A protectors can be added to the 147A to provide protection for a maximum of sixteen CO lines. For more than sixteen lines, additional 147A protectors are required. (See Figure 2-3 for a typical 147A protector installation.)

NOTE:
The 147A protector is usually **not** needed with the 391A1, 391A2, 391A3, 391B1, or 391B2 power supply module. It may be needed with the older 391A power supply module in heavy lightning areas.

For complete installation instructions, see the booklet provided with the protectors. See Appendix A for ordering information.

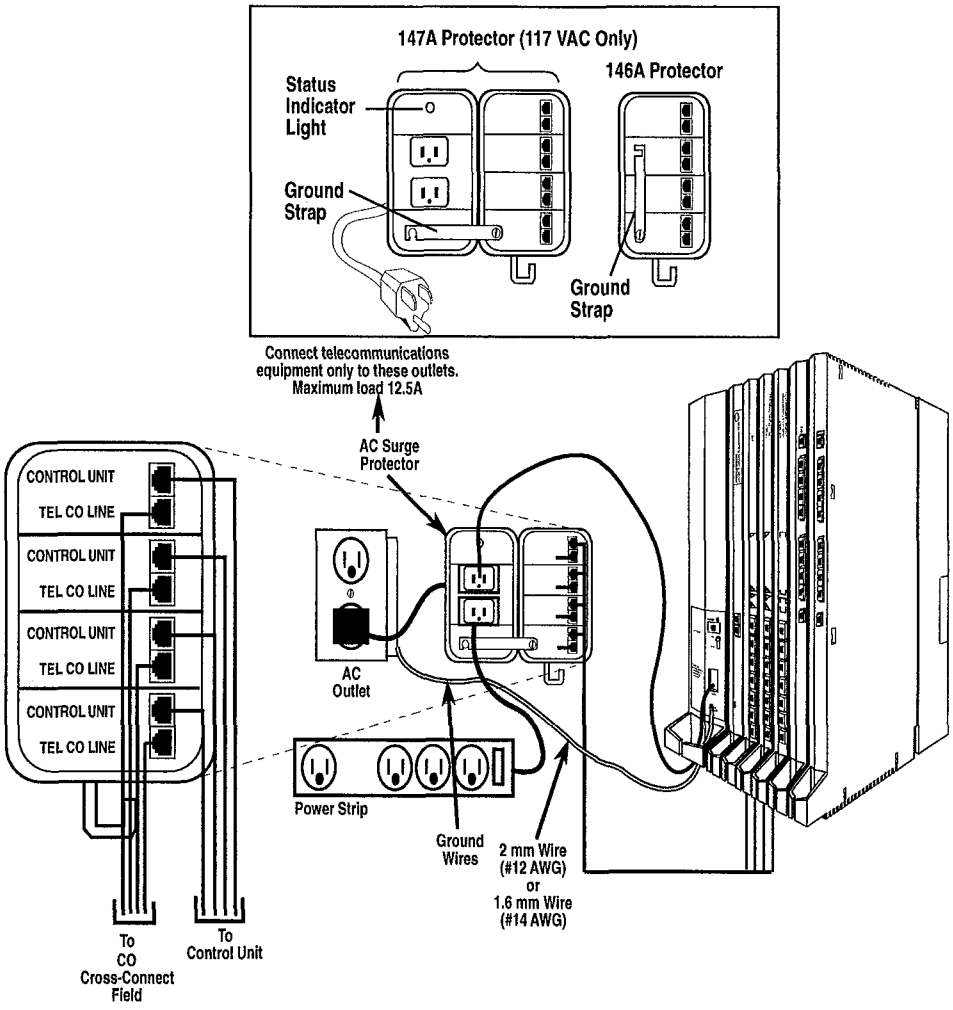


Figure 2-3. Installing a 147A Protector (117 VAC Only)

Unit Loads

A unit load is a measure of power used to determine the electrical load on the power supply module caused by telephones, adjuncts, and DID modules. One unit load equals 1.9 watts.

Before installation, unit load and power requirements for a new system are computed by AT&T service personnel or an authorized dealer and any necessary power equipment must be ordered. However, in the event of maintenance or equipment changes, unit loads must be calculated to ensure proper operation under all conditions (see Appendix D for a unit load work sheet with specific unit load values).

The 391A3 (117 VAC) and 391B2 (220 VAC) power supplies provide 75 unit loads to each carrier and do not support the connection of an auxiliary power unit. The older 391A1 and 391A2 (117 VAC) and 391B1 (220 VAC) power supply modules provide 54 unit loads to each carrier and support the connection of an auxiliary power unit to increase the unit load capacity an additional 27 unit loads.

If the unit load requirement for a carrier exceeds the rated capacity, do one of the following, depending on which power supply module is installed:

- For control units powered by 391A1 or 391A2 power supply modules (117 VAC), upgrade the power supply to the 391A3 to increase the unit load capacity to 75, or add an auxiliary power unit to allow that carrier to support an additional 27 unit loads.
- For control units powered by 391B1 power supply modules (220 VAC), upgrade the power supply to the 391B2 to increase the unit load capacity to 75, otherwise the system must be reconfigured; the 391B1 cannot use an auxiliary power unit.
- For control units powered by 391A3 (117 VAC) or 391B2 (220 VAC) power supply modules, the system must be reconfigured; the 391A3 and 391B2 power supplies cannot use an auxiliary power unit.

NOTE:
Running the system with more than the rated number of unit loads per carrier may not appear to do harm. However, this can cause the system to malfunction, creating "no trouble found" situations.

An auxiliary power unit redirects the power requirements from the last two slots on the carrier. Any station connected to the modules in the last two slots receives power from the auxiliary power unit instead of the power supply module.

Besides DID trunks, only telephones and adjuncts that connect to analog and digital ports on the control unit require unit load calculations. Any equipment with its own power supply (for example, an answering machine) does not have to be included in the unit load calculation.

Unit Loads for the Hybrid/PBX Mode

The 391A1 or 391A2 (117 VAC) and 391B1 (220 VAC) power supply modules generally support six modules of any type in a Hybrid/PBX system. However, the unit loads on a carrier can exceed 54 if both of the following exist:

- all six carrier slots have only MLX telephone or analog multiline telephone modules installed
- the carrier has a total of more than 45 MLX-20L or 34-button analog multiline telephone stations installed

The 391A3 (117 VAC) and 391B2 (220 VAC) power supply modules support 75 unit loads without an auxiliary power unit. The above conditions need not be considered when the carrier is powered by a 391A3 or 391B2 power supply.

Unit Loads for the Key or Behind Switch Mode

In a Key or Behind Switch system with four or fewer modules, no calculation is needed. The 391A1, 391A2, 391A3, 391B1, and 391B2 power supply modules generally support four modules of any type in Key or Behind Switch mode.

Calculating Unit Loads

Calculate the unit loads of each carrier by completing the steps on the worksheet in Appendix D.

Installation

3

Contents

Installation

3

Installation of the MERLIN LEGEND Communications System involves these equipment areas:

- control unit
- system wiring
- telephones and consoles

Depending on the system's configuration, other equipment, such as an ISDN Terminal Adapter or a Station Message Detail Recording (SMDR) printer, can also be connected to the control unit.

This chapter tells you how to install the system. Follow the recommended sequence whenever possible.

NOTE:
We recommend that you record each station jack connection and each station change on the "System Technician's Run Sheet" (see Appendix E).

The Control Unit

Use these instructions to install a basic system control unit. Instructions for installing other equipment, such as an SMDR printer or an ISDN Terminal Adapter, are also given in this chapter. All connections to the control unit must be made with the control unit housing removed.

⚠ CAUTION:
The system contains components that can be damaged by electrostatic discharge (ESD). To prevent ESD:

- *Properly ground yourself when working on the control unit.*
- *Have the customer maintain relative humidity between 20 and 80 percent.*

Install the Basic Carrier

Place the backboard and the basic carrier by using the instructions in Chapter 2 under "Space and Location." Mount the basic carrier onto the plywood as far left as possible to leave space for system expansion (up to a total of three carriers). Also refer to the ventilation requirements provided in Chapter 2.

Follow these steps to install the basic carrier (see Figure 3-1):

1. Mark the screw hole locations on the backboard by using the basic carrier as a guide. Make sure the carrier is level before marking the holes.
2. Lay the carrier to the side.
3. Drill a pilot hole in the center of each of the four marked mounting-hole locations.
4. Anchor the screws approximately halfway into the backboard.
5. Position the carrier on the screws and slide the carrier to the left.
6. Check to see that the carrier is level. Tighten the screws.

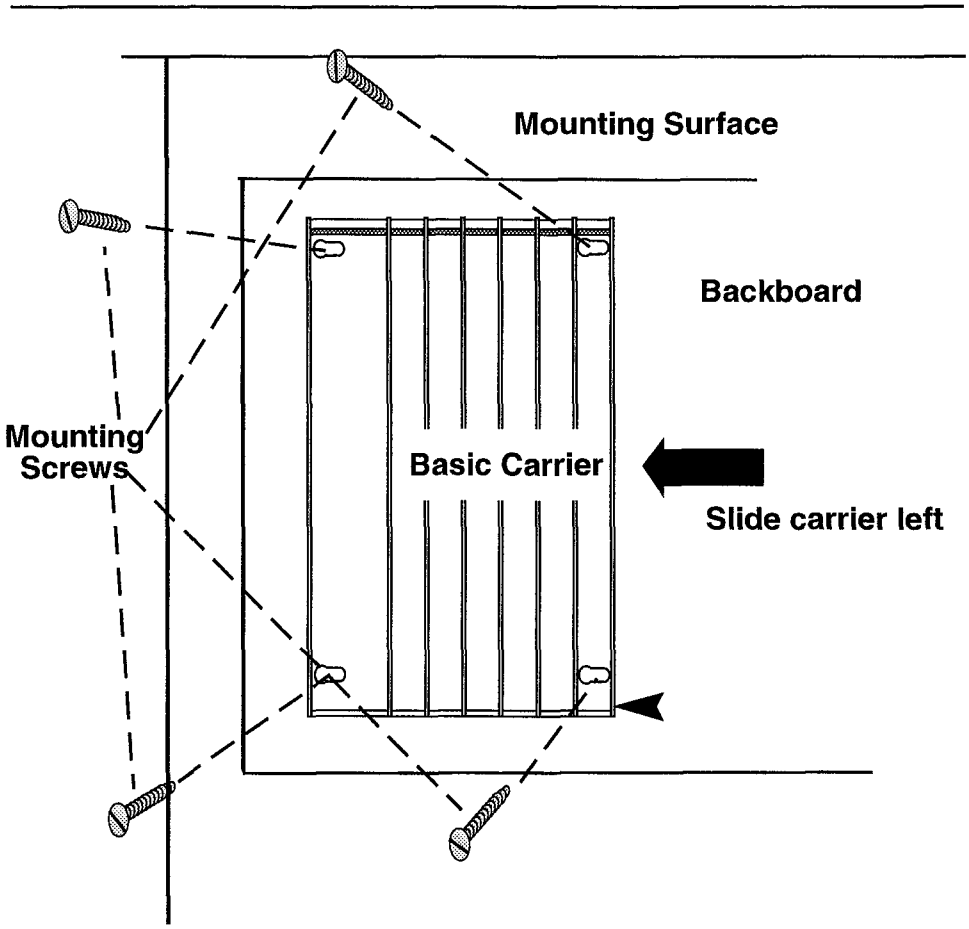


Figure 3-1. Installing the Basic Carrier (Steps 3, 4, and 5)

Install the Expansion Carrier

Follow these steps to mount the expansion carrier to the backboard and connect it to the basic carrier or to an existing expansion carrier (see Figure 3-2).

1. Locate the breakaway plastic tab on the right side of the already mounted carrier. Using a flat-blade screwdriver, gently pry the tab open to expose the card extenders and connectors on the carriers.
2. Align the connector of the expansion carrier with the card extender on the already mounted carrier and slide the connector onto the extender.
3. Mark the screw hole locations on the backboard by using the expansion carrier as a guide. Make sure the carrier is level before marking the holes.
4. Disconnect the connector on the expansion carrier from the card extender on the already mounted carrier and lay the expansion carrier to the side.
5. Drill a pilot hole in the center of each of the four marked mounting-hole locations.
6. Anchor the screws approximately halfway into the backboard.
7. Position the expansion carrier on the screws and slide it to the left, reconnecting the card extender on the expansion carrier to the connector on the already mounted carrier. Make sure the connection is secure.
8. Check to see that the carrier is level. Tighten the screws.

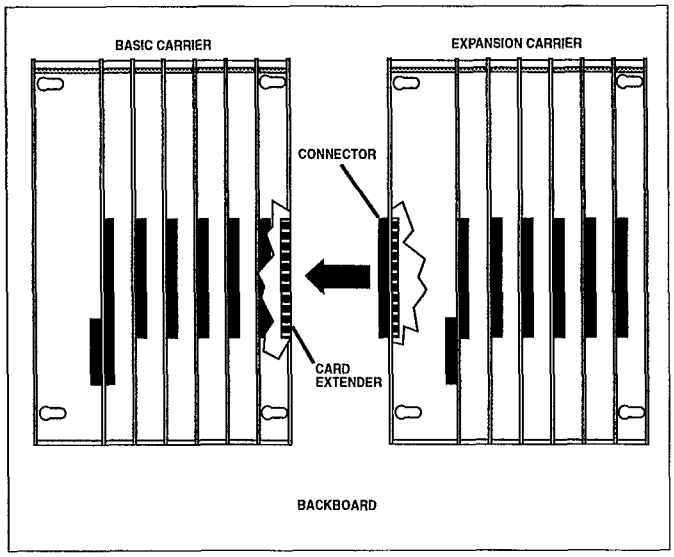


Figure 3-2. Installing the Expansion Carrier

Install the Power Supply Modules

⚠ WARNING:
*Do **not** fasten any cables or power cords to the power supply module until it is installed in the carrier. Do not apply power to the control unit until all the modules and power equipment are installed. Once they are installed, follow the procedures under "Turn the Power On" in this chapter. Failure to comply can result in shock hazard or damage to the equipment.*

If a ring generator is needed, install it in the power supply module before the power supply module is installed in the carrier (see "Install a Ring Generator in the Power Supply Module" in this chapter).

⚠ CAUTION:
Prevent damage from electrostatic discharge (ESD): do not touch leads, connectors, pins, or other components. Use a properly grounded wrist strap.

Remove the protective cover from each module's gold-finger connector before installing the module into the carrier.

Follow these steps to install the power supply modules:

1. Make sure all power to the control unit is turned off.
2. Set the power switch on the power supply modules to OFF.
3. If the power supply will be powering a carrier that includes an 012 or 008 OPT module that *does not* specify "with RING GEN." on the module label, install a ring generator in the power supply module. (See "Install a Ring Generator in the Power Supply Module" in this chapter.)
4. Add a copper-foil shield to any 391A1, 391A2, or 391B1 power supply module that is to be installed in an expansion carrier. (See "Add a Foil Shield to the Power Supply Module" in this chapter.) The 391A3 and 391B2 power supply modules do not require copper shielding.
5. Install a power supply module in the leftmost slot of each carrier:
   a. Lower the module hook onto the rod.
   b. Be sure the connector on the module mates properly with the connector on the carrier.
   c. Push the module into the carrier until it locks into place.
6. Connect one end of the AC power cord to the connector marked AC INPUT on the power supply module.

⚠ CAUTION:
Do not plug the power cord into the outlet now.

Install a Ring Generator in the Power Supply Module

A ring generator provides the ringing capability for basic telephones and T/R devices. Figure 3-3 shows the proper placement of the ring generator in the power supply module.

NOTE:

If a carrier has at least one 012 or 008 OPT module that *does not* indicate "with RING GEN." on the module label, install a ring generator in the power supply module. If the system contains more than one of these modules, place them in the same carrier whenever possible. For the 012, 016, and 008 OPT modules that indicate "with RING GEN." on the module label, a ring generator in the power supply module is not required.

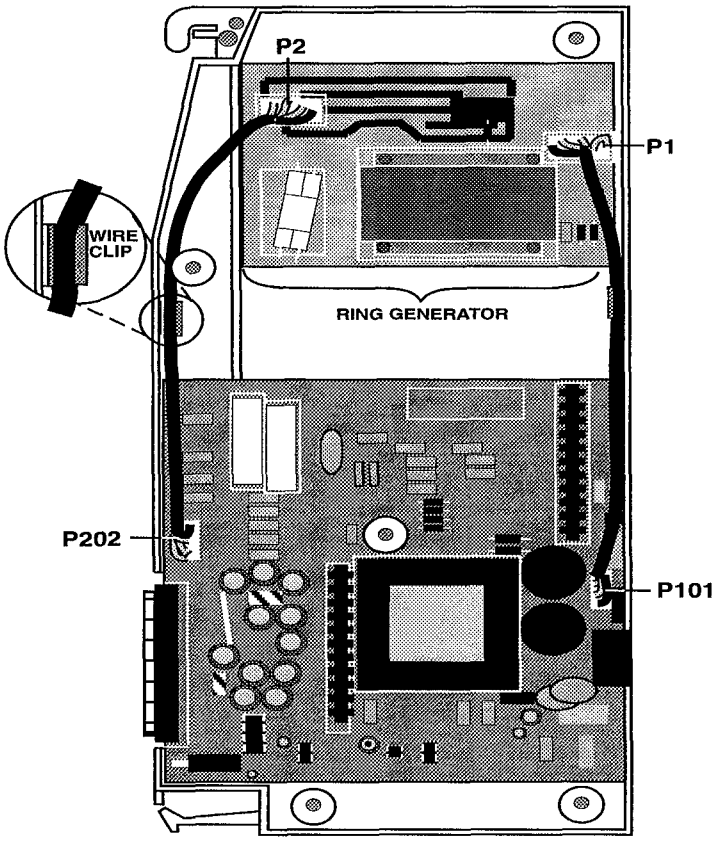


Figure 3-3. Installing a Ring Generator in the Power Supply Module

⚠ WARNING:
Hazardous electrical voltages may be present if the following steps are not performed correctly.

Follow these steps to install a ring generator:

1. Turn off the power switch at the power supply module.
2. If there is an auxiliary power unit, unplug it from the AC outlet and then unplug it from the front of the power supply module.
3. Unplug the power supply module's power cord first from the AC outlet (or from the auxiliary power unit) and then from the front of the power supply module itself.
4. Remove the power supply module from the carrier.

⇒ NOTE:
At this point there should be no cords connected to the front of the power supply module.

5. Place the power supply module on its left side and remove the five screws.
6. Carefully turn the module over on its right side and remove the left half of the power supply module.
7. Position the 129B or 129C Frequency Generator (ring generator) so that its screw holes are aligned with the screw posts on the power supply module and the transformer is next to the main board.
8. Attach the ring generator to the power supply module with four screws.
9. Connect one end of the cable with the 3-pin connectors to the header labeled P101 on the power supply circuit board. Connect the other end of the cable to the header labeled P1 on the ring generator (see Figure 3-3).
10. Connect one end of the 4-pin cable to the header labeled P202 on the power supply circuit board. Connect the other end of the cable to the header labeled P2 on the ring generator (see Figure 3-3).
11. Use the clips provided with the ring generator to attach the cables to the inside edge of the plastic housing (see Figure 3-3). Make sure the cables do not lie across the circuit boards.
12. Replace the left half of the module housing.
13. Carefully turn the module over and replace the five screws.
14. Stick the modification label "Equipped with 129B Freq. Gen." or "Equipped with 129C Freq. Gen." to the wire manager on the front end of the power supply module.
15. Place the power supply module back in the carrier.

Add a Foil Shield to the Power Supply Module

NOTE:
The instructions for adding a foil shield to a power supply module apply only to the 391A1, 391A2, and 391B1 power supply modules. The 391A3 and 391B2 power supply modules do not require copper shielding.

For each expansion carrier, you must install another power supply module for the additional line and station modules. The added power supply module can cause excessive noise on the module immediately to its right.

To eliminate the noise, apply copper-foil shields to the power supply module housing. These shields and their labels are packaged in the power unit shielding kit included with the expansion carrier.

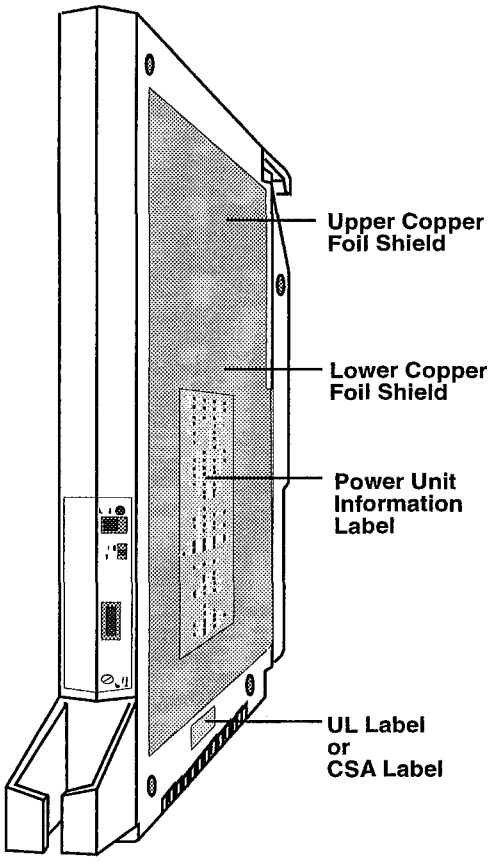


Figure 3-4. Adding a Foil Shield to the Power Supply Module

Follow these steps to install a copper-foil shield on a 391A1, 391A2, or 391B1 power supply module (see Figure 3-4):

1. Lay the power supply module on a flat surface with the right side up (as viewed from the front edge).
2. Wipe the module free of any dust or dirt.
3. Peel the backing paper from the smaller copper-foil shield to expose the adhesive.

   NOTE:
   Check the position of the foil shield before sticking it to the side of the module. Once in place, the foil is difficult to remove.

4. Position the foil on the upper part of the module. Work out any air bubbles as you press the foil firmly in place.
5. Peel the backing paper from the larger copper-foil shield to expose its adhesive.
6. Position the foil on the lower part of the module (the shields should meet and not overlap or leave space between). Tuck the foil shield tightly along the ledge (or crease) of the housing. Work out any air bubbles as you press the foil firmly in place.
7. With the copper-foil shield in place, put the power unit information label on the lower piece of foil.
8. Attach the UL or CSA label on the power supply module below the copper-foil shield, if applicable.

Install the Processor Module

There are three steps to installing the processor module:

1. If necessary, modify the processor module for Key-only operation.
2. Install the feature module in the processor module (the feature module must be replaced when upgrading the system).
3. Insert the processor module into the carrier.
4. Perform a system erase.

⚠ CAUTION:
Prevent damage from electrostatic discharge (ESD): do not touch the leads, connectors, pins, or other components when handling the circuit board. Use a properly grounded wrist strap.

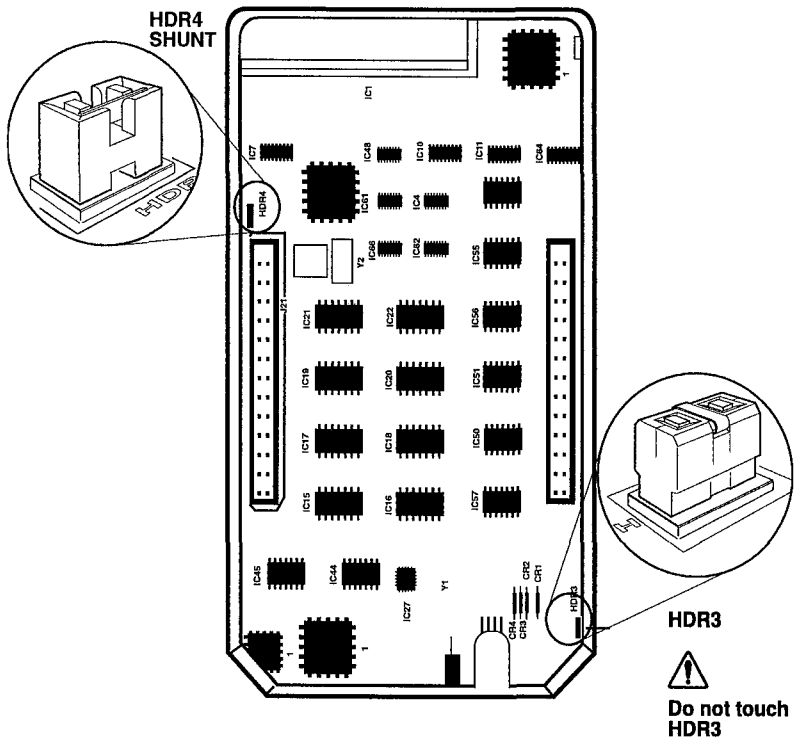


Figure 3-5. Modifying the Processor Module for Key-Only Operation

Modify the Processor Module for Key-Only Operation

Follow these steps to modify the processor module for Key-only operation (see Figure 3-5):

1. Remove the processor module from its package. Do not open the module case.

⚠ CAUTION:
Removing the HDR3 header will undo all system programming, thereby returning the system to default settings. Do not touch the HDR3 header unless this is your intention.

2. Locate the header marked HDR4 on the module's circuit board.
3. Locate the shunt attached to one of the pins of the HDR4 header.
4. Remove the shunt from the single header pin; then reinsert it so that it covers both pins on the header.

Install the Feature Module in the Processor Module

Before you install the processor module in the carrier, you must install the feature module in the processor module.

NOTE:
If upgrading, you must replace the feature module as described in the next section.

Follow these steps to install the feature module (see Figure 3-6):

1. Unpack the feature module.
2. Stick the round feature module label to the front of the processor module housing.
3. Lay the processor module on its left side.
4. Align the connectors on the feature module with the connectors in the processor module.
5. Firmly press the feature module into the processor module.

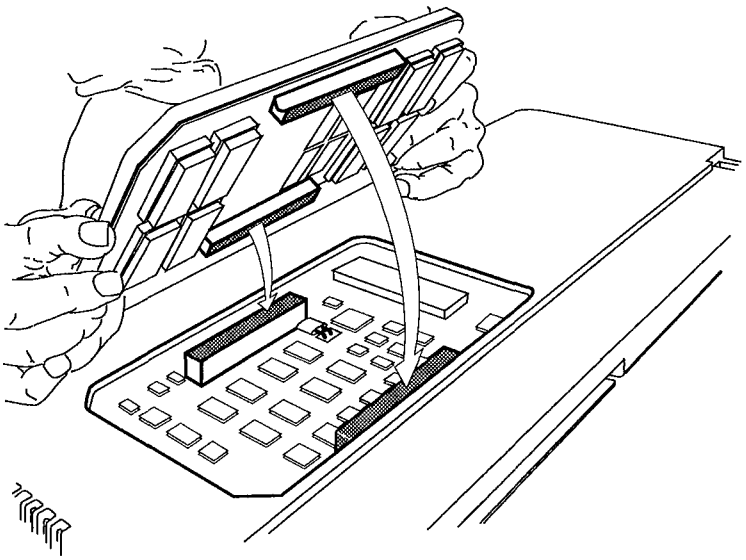


Figure 3-6. Installing the Feature Module in the Processor Module

Replace the Feature Module

⚠ CAUTION:
Make sure that you have all the necessary records to reprogram the system before you replace the feature module. When the feature module is replaced, all system memory is lost and the system must be reprogrammed (or restored, as described earlier in this chapter, under "Upgrade the System").

It may become necessary at some point to replace the feature module because of upgrades or malfunctions. Follow these steps to replace the feature module in a fully installed system:

1. Turn off the system (see "Shut the Power Off" later in this chapter). Make sure the ON/OFF switch on the power supply module is set to the OFF position.
2. Remove the processor module from the carrier.
    a. Press up on the tab on the bottom of the module.
    b. Pull the bottom of the module away from the carrier.
    c. Lift upward to disengage the module from the rod on the top of the carrier.

3. Lay the processor module on its left side.
4. Grasp the metal rings on the outside of the feature module and pull up.
5. Check the HDR4 header on the processor module circuit board for proper mode operation (see "Modify the Processor Module for Key-Only Operation" earlier in this chapter).
6. Align the connectors on the new feature module with the connectors in the processor module.
7. Firmly press the new feature module into the processor module.
8. Insert the processor module back into the carrier (see "Insert the Processor Module" earlier in this chapter).
9. Perform a system erase.

Insert the Processor Module

⚠ CAUTION:
Remove the protective cover from the processor module's gold-finger connector before installing the module into the carrier.

Follow these steps to insert the processor module (see Figure 3-7):

1. Lower the processor module onto the rod on the carrier in slot 00.
2. Be sure that the connector on the module fits properly with the connector on the carrier.
3. Swing the processor module into the slot.
4. Push firmly until the processor module snaps into place. The processor module should be securely attached to the rear of the carrier and held in place by the tab on the bottom toward the back of the processor module.

⚠ CAUTION:
To avoid damage, do not force the module. If the module does not insert easily, push in on the rear locking tab, remove the module, check for any obstruction, and reinsert the module.

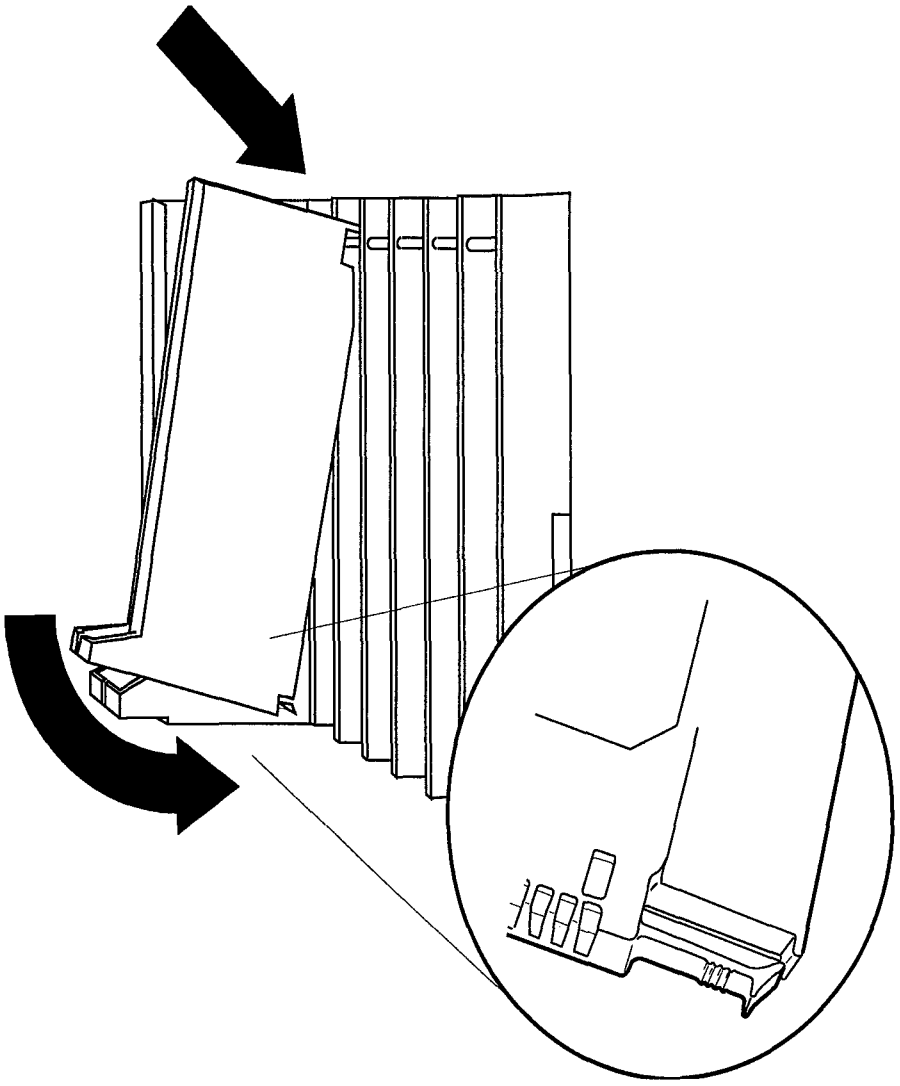


Figure 3-7. Inserting the Processor Module into the Carrier

Install the Auxiliary Power Unit (391A1 or 391A2 Only)

If a system using 391A1 or 391A2 (117 VAC) power supply must support more than 54 unit loads, install the Auxiliary Power Unit 9024. This cannot be done for systems using the 391A3, 391B1 or 391B2 power supply module. For any additional information on unit loads, see "Unit Loads" in Chapter 2.

NOTE:
A previously installed 335A auxiliary power unit can continue to be used if no new telephones or modules are added to the system.

Follow these steps to install an auxiliary power unit in a 391A1 or 391A2 power supply module (see Figure 3-8):

1. Make sure that the ON/OFF switch on the power supply module is set to the OFF position.
2. Mount the auxiliary power unit on a surface within 61 cm (2 feet) of the control unit (probably the backboard on which the control unit is mounted).
3. Insert one end of the modular line cord that comes with the auxiliary power unit into the jack labeled AUX POWER INPUT on the power supply module. Insert the other end of the modular line cord into the jack labeled AUX POWER on the auxiliary power unit.

CAUTION:
Do not plug the power supply module or the auxiliary power unit into the AC outlet until you are ready to turn on the system. See "Turn the Power On" later in this chapter.

CAUTION:
Do not fasten the power cord(s) to any building surfaces.

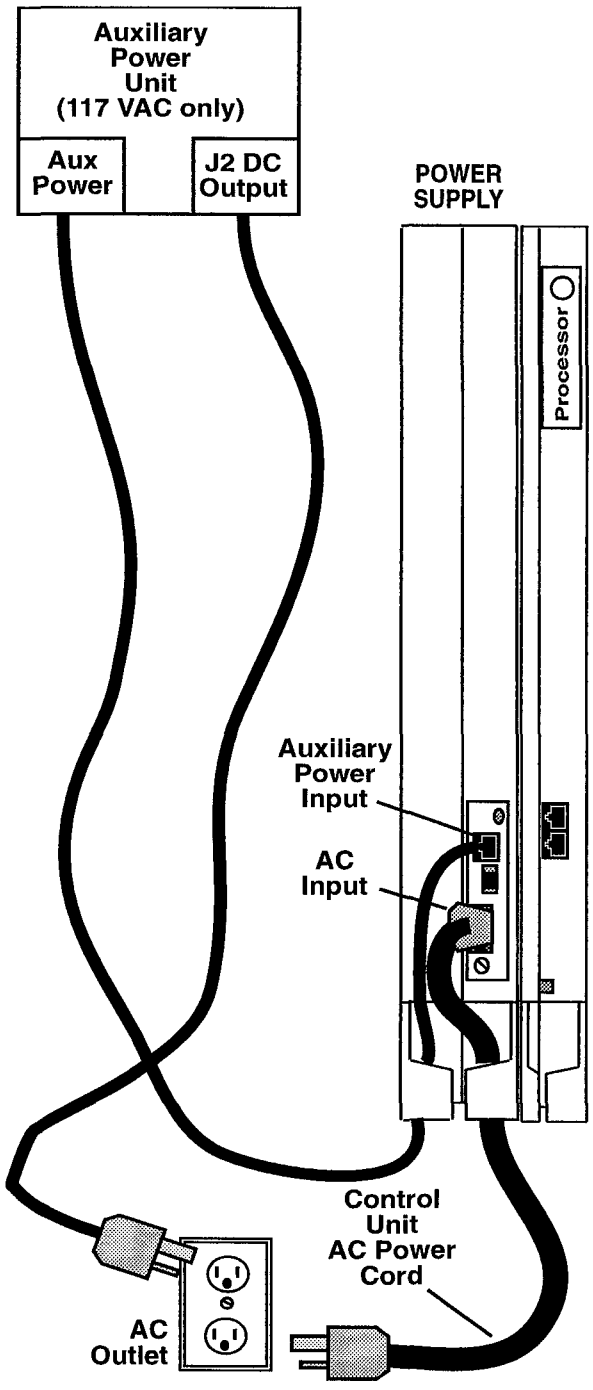


Figure 3-8. Installing the Auxiliary Power Unit (391A1 or 391A2 Only)

Install the Line/Trunk and Station Modules

Use caution when installing the line/trunk and station modules to prevent damage to the connectors. See Appendix C for specific wiring applications.

⚠ CAUTION:
To prevent damage from electrostatic discharge (ESD), avoid touching leads, connectors, pins, and other components. Use a properly grounded wrist strap.

Remove the protective cover from each module's gold-finger connector before installing the module into the carrier.

NOTE:
Do not leave any empty slots between modules. If you must leave slots empty, they must be the last slots in the system. The system will ignore modules installed beyond an empty slot.

Whenever possible, place all of the 012 and 008 OPT modules that *do not* indicate "with RING GEN." in the same carrier so that the same ring generator can support them.

Follow these steps to install line/trunk and station modules (see Figure 3-7):

1. Review the appropriate system planning forms to verify slot placement on the carrier for each module. Following the planning forms, install line/trunk and station modules in slots 01 through 05 on the basic carrier, slots 06 through 11 on the first expansion carrier, and slots 12 through 17 on the second expansion carrier.
2. Lower the module onto the rod on the carrier in the appropriate slot.
3. Be sure that the connector on the module mates properly with the connector on the carrier.
4. Swing the module into the slot and firmly push the module into the carrier until it locks into place.

NOTE:
If you have difficulty installing a module, check the module for alignment problems. Inspect the carrier for damage. If no damage is present, the modules should snap into place. If the carrier is damaged, you must replace it.

5. After all modules have been installed, label all jacks with the numbered labels provided with the feature module.

   The labels for *lines/trunks* have a cream-colored background and *green* numbers.

   The labels for *stations* have a cream-colored background and *blue* numbers.

   a. Label each line/trunk jack on the modules sequentially, from 01 up to 80. Begin with the module in slot 01, numbering from bottom to top on each module and working from left to right across the carrier.

   b. Label each station jack on the modules sequentially, from 01 up to 200. Begin with the module in slot 01, numbering from bottom to top on each module and working from left to right across the carrier.

NOTE:
For each 400EM module, set the dual in-line package (DIP) switches on the module for the desired tie-trunk options (see "Tie-Trunk Signaling" in Chapter 1 and Figure 1-3).

Follow these steps to remove a module:

1. Press up on the tab on the bottom of the module.
2. Pull the bottom of the module away from the carrier.
3. Lift upward to disengage the module from the rod on the top of the carrier.

Provide Proper Grounding

Proper grounding of the system protects it from

- lightning
- power surges
- power crosses on CO lines/trunks
- electrostatic discharge (ESD)

WARNING:
Grounding circuit continuity is vital for safe operation. There is a risk of electric shock if the system is not properly grounded.

Follow these steps to properly ground the control unit power supply modules (see Figures 2-1 and 2-2):

1. Attach a AWG #12 (2 mm or next larger size) or AWG #14 (1.6 mm or next larger size) ground wire to the grounding screw on each power supply module.
2. Connect the other end of each ground wire to the terminals of the single-point ground bar on the AC outlet box.

Connect the Control Unit to an AC Outlet

⚠ CAUTION:
Be sure the AC outlet is properly grounded (see "Grounding Requirements" in Chapter 2). For control units powered by 391A1, 391A2, or 391A3 power supply modules (117 VAC), the outlet should be 117 VAC, 60 Hz, 3-wire grounded. For control units powered by 391B1 or 391B2 power supply modules (220 VAC), the outlet should be 220 VAC, 50 or 60 Hz, 3-wire grounded.

⚠ CAUTION:
To prevent someone from accidentally shutting off the power, do not connect the control unit to a switch-controlled outlet. The AC outlet should be within 1.52 m (5 feet) of the control unit.

Follow these steps to connect the control unit to an AC outlet:

1. Turn the switch on the power supply module in the basic carrier to the OFF position.
2. Turn off the power switches on the expansion carrier power supply modules.
3. Unplug any auxiliary power units.
4. Plug one end of the power cord into the AC INPUT connector just below the power switch on the front of the power supply module. Do this for each carrier.
5. Plug the other end of the power cord into the AC outlet. Allow at least 30.5 cm (1 foot) of slack in the cord. Do this for each carrier.

⚠ CAUTION:
*Do **not** fasten the power cord(s) to any building surfaces.*

Turn the Power On

⚠ CAUTION:
Follow the steps in exact sequence.

When the system is completely installed, follow the steps in the sequence below to turn on the power to the power supply module:

1. For each power supply module and auxiliary power unit (see "Install the Auxiliary Power Unit" earlier in this chapter), plug the AC line cord into the AC outlet.
2. Set the power switch on the power supply modules to ON for all **expansion** carriers.

   The green power lights on the expansion carriers' power supply modules go on.
3. Set the power switch on the **basic** carrier's power supply module to ON.

   The green light on the power supply module goes on. The red light on the processor module goes on for 15 to 45 seconds and then goes off.

If the system is operating properly, you will see the following indicators:

- The green power lights on all the power supply modules remain on.
- The red warning light on the processor module goes on for 15 to 45 seconds during power-up and then goes off.
- All indicators on the 100D, 100E, and 400EM modules (if present) go on and then off. They remain off when the modules are idle.

If any of these conditions are not present, see Chapter 4, "Maintenance and Troubleshooting."

Shut the Power Off

During installation, you may need to shut the power off for troubleshooting or because you need to add something to the carrier.

⚠ CAUTION:
Follow the steps in exact sequence.

1. Turn off the power at the power supply module in the **basic** carrier.
2. Turn off the power at the power supply modules in the **expansion** carriers.
3. Unplug any auxiliary power units. Because the power supply modules are already off, the sequence for removing auxiliary power cords is not important.

Install the Control Unit Housing

After wiring and testing the system, install the front and top cover on the control unit. See Figure 3-9.

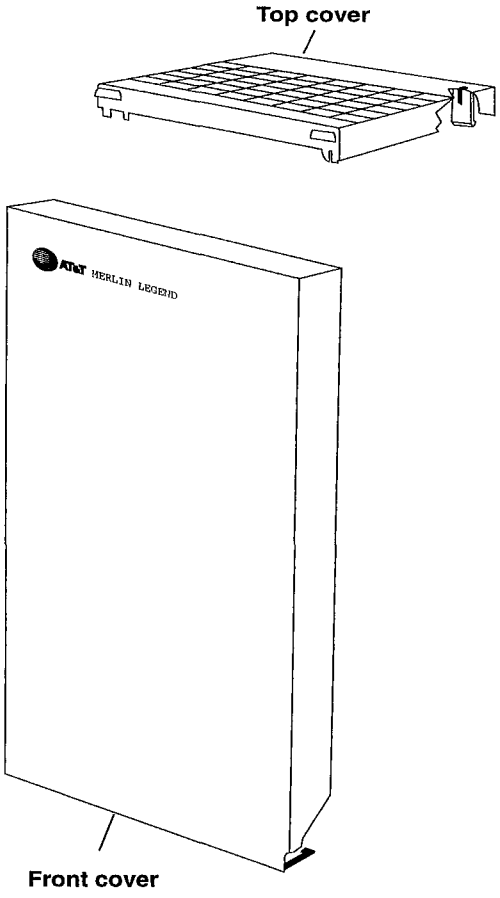


Figure 3-9. Control Unit Covers

A set of covers should be installed on both the basic carrier and any expansion carriers. Make sure that there is a module in the rightmost slot of each carrier so that the covers are properly supported. If no functional module occupies the rightmost slot of a carrier, install the empty module that came with the system. See Figures 3-10 and 3-11 as a guide when attaching the covers to the control unit.

Installing the Top Cover

To install the top cover, see Figure 3-10 and follow these steps:

1. Be sure the cords have been pressed through the wire managers at the base of the modules.
2. Install the empty module that came with the system in the rightmost slot of the carrier if it is lacking a functional module in this slot. This empty module helps to support the top cover.
3. Hold the top cover with the hooks facing you.
4. Engage the tabs at the rear of the top cover with the carrier.
5. Lower the top cover so the legs lock into the vents on the modules.

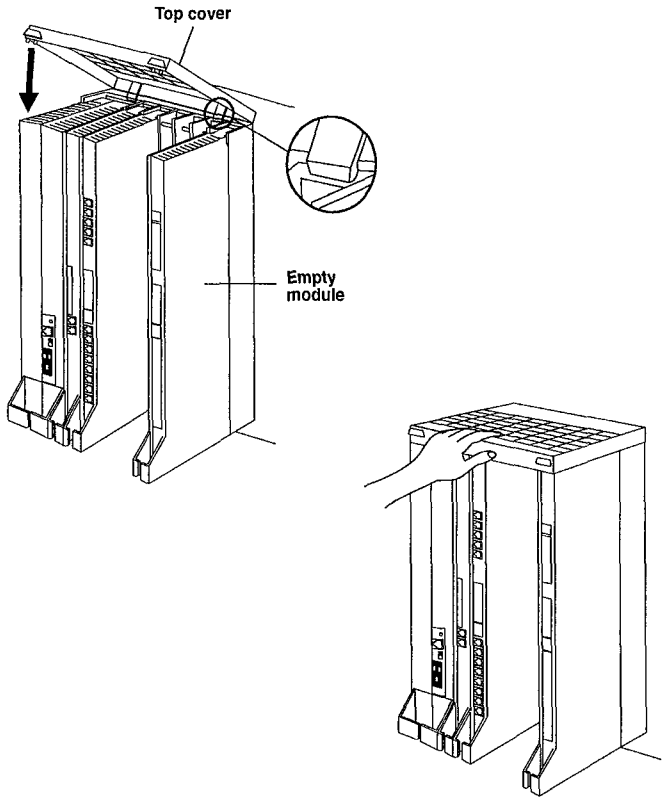


Figure 3-10. Installing the Control Unit Top Cover

Installing the Front Cover

To install the front cover, see Figure 3-11 and follow these steps:

1. Hook the top of the front cover onto the top cover that was just installed.
2. Push down on the bottom of the front cover until it locks securely onto the base of the module wire managers.
3. If the installation is an upgrade (from a MERLIN II Communications System), locate the D-kit containing the "MERLIN LEGEND" labels. For each MERLIN II label that is on the front cover, do the following:
   a. Ensure that the MERLIN II label is dry and free of grease or dust.
   b. Remove the backing on the MERLIN LEGEND label and place it over the existing MERLIN II label.

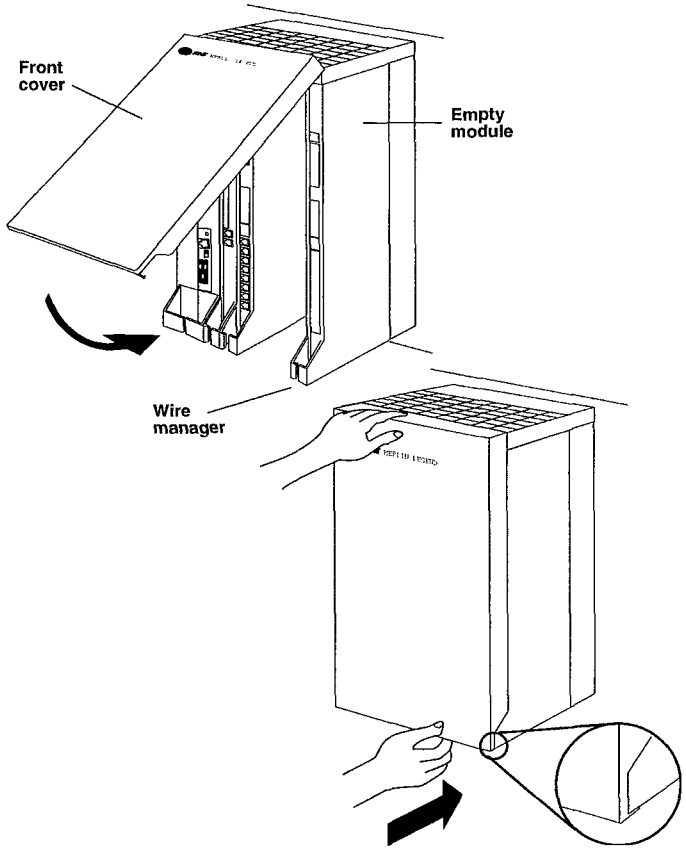


Figure 3-11. Installing the Control Unit Front Cover

Upgrade the System

If you are upgrading the system, do the following:

1. Using the *System Programming* guide for detailed instructions, perform the following:
   a. Upgrade SPM to the current version.
   b. Make two distinct system backups (each with a different file name). Store one of the backup files in a safe place in case you must restore the system to it's old configuration.

      See the following table to determine whether one of the backups should be run through the SPM conversion utility.

Old MERLIN LEGEND Version	New MERLIN LEGEND Version	Run SPM Conversion Utility	SPM Version Required for Conversion
1.0	1.1	No	NA
1.1	1.2i	Yes	2.16 or higher
1.1	1.3i	Yes	3.18 or higher
1.2i	1.3i	No	NA
1.2i/1.3i	1.4i	Yes	4.15 or higher

2. Turn off the system (turning off the main carrier first) using the instructions provided earlier in this chapter.
3. Replace the feature module as described earlier in this chapter, under "Replace the Feature Module."
4. Turn on the system (turning on the main carrier last) using the instructions provided earlier in this chapter.
5. Using the *System Programming* guide for detailed instructions, perform the following:
   a. If required, convert one of the backup files created in Step 1 above.
   b. Perform a system erase (frigid start).
   c. Restore system programming from the converted file.

⚠ CAUTION:
An unsuccessful restore procedure or an aborted restore causes a frigid start. (A frigid start drops all calls and erases the system configuration; this requires restoring and rebooting the system.) If the restore is being done remotely, the system drops the connection immediately. All system programming is lost, and the system returns to the factory settings. ***You must reconnect to the switch and do another restore immediately.***

6. Program new features as desired. Table 3-1 shows the parameters that are assigned default values, and whether that parameter may need additional administration if upgrading from a MERLIN LEGEND Release 1.2i or Release 1.3i system. This table only lists the features that may need administration. For the actual programming procedures, refer to the *System Programming* manual, 555-612-211.

NOTE:
Additional programming of these features is required only if the default values are not appropriate for your system.

Table 3-1. Release 1.4i Features Requiring Additional Programming

Release 1.4i Feature	Programming May be Required if Upgrading From:	
	1.2i	1.3i
System Password	yes*	yes*
Ring Frequency (016 module)	yes*	yes*
Glare Guard	yes*	no†
Ring Disconnect Timer	yes*	no†
Flash Detection Duration	yes*	no†
R2/CaS Signaling	yes*	no†
R2/CaS Signaling MFC Dialing	yes*	no†
Analog Tariff Pulse Metering	yes*	no†
E1 MFC Capability	yes*	no†
Call Progress Tones	yes*	no†
SMDR Option and Authorization Codes	yes*	no†
DID/DIOD Trunk Settings	yes*	no†
Line/Trunk Dialtone Detection Settings	yes*	no†

* Default value is the factory setting.

† Default value is the system value at the time of conversion.

Channel Service Unit

The channel service unit (CSU) provides the interface between the 100D module and the DS1 facilities. Two models are described in this chapter: the ESF T1 CSU and the 551 T1 L1 CSU.

NOTE:
If you are using a different CSU, see the documentation packaged with your CSU to implement the instructions in this chapter, which are specifically written for the ESF T1 CSU and the 551 T1 L1 CSU.

ESF T1 CSU

The ESF T1 CSU can connect to the DS1 network by using the D4 or extended superframe format (hence the ESF). Also, it is the only CSU to provide the B8ZS line coding needed to transmit a 64-kbps clear channel.

Mount the ESF T1 CSU in a relay rack or on a shelf as a standalone unit. Plug the CSU into a 117 VAC or 220 VAC outlet.

NOTE:
Before the CSU can be installed, the local telephone company must be contacted for information such as services available, equipment options, and -48 VDC power on the line.

To install the ESF T1 CSU, set the switch options, mount the CSU (as needed), and connect the wires from the 100D module and the DS1 network. Follow the procedures below to install an ESF T1 CSU.

Set the DIP Switches on the Rear Panel

The seven 8-position dual in-line package (DIP) switches on the rear panel are set for operating features and for diagnostic tests:

- SW1 sets the CSU address, which must be confirmed with the local telephone company (see Table 3-2).
- SW2 sets the bit-error rate (BER) alarm threshold (see Table 3-3).
- SW3 is not used.
- SW4 sets the Errored Seconds threshold; positions 7 and 8 can be changed to match diagnostic equipment (see Table 3-4).
- SW5 sets signal processing parameters according to the services required by the customer and provided by the telephone company (see Table 3-5).
- SW6 sets signal processing parameters according to the services required by the customer and provided by the telephone company (see Table 3-6).
- SW7 sets the distance from the 100D module to the CSU (see Table 3-7).

NOTE:
Setting SW7 or administering line compensation for the 100D module can provide for cable distances up to 200 m (655 feet). If the SW7 is set and the 100D module is administered, the maximum cable distance between the 100D module and the CSU can be up to 400 m (1310 feet).

In the following tables, "up" is the physical position of the setting and represents "off" or "open." "Down" is the physical position of the setting and represents "on" or "closed." To effect option changes, you must power down the CSU and then power up.

Table 3-2. SW1 Default Settings

Position	Status
1	up
2	down
3	down
4	down
5	down
6	down
7	down
8	down

Table 3-3. SW2 Default Settings

Position	Status	Effect
1	up	BER threshold is 10^{-6}
2	down	BER threshold is 10^{-6}
3	up	BER threshold is 10^{-6}
4	up	BER threshold is 10^{-6}
5	up	not used
6	up	not used
7	up	not used
8	up	Alarm LED/relay operation is momentary.

Table 3-4. SW4 Default Settings

Position	Status	Effect
1	down	not used
2	down	not used
3	down	not used
4	down	not used
5	down	not used
6	down	not used
7	up	disable auto dial modem
8	down	TABS protocol enabled

Table 3-5. SW5 Default Settings

Position	Status	Effect
1	down	DTE is D4 framed.
2	down	Network is AMI.
3	down	DTE is AMI.
4	up	generate CRC-6 to DTE
5	up	generate CRC-6 to network
6	up	Part 68 Density enforcement
7	up	does not poll far-end CSU for alarms
8	up	not used

Table 3-6. SW6 Default Settings

Position	Status	Effect
1	down	send received signal to DTE or network during loopback operation
2	up	DTE B8ZS is not decoded.
3	up	Network B8ZS is not decoded.
4	down	network ESF
5	down	default to DIP switch configuration upon power-up
6	up	not used
7	up	not used
8	down	loop network signal back (ESS loopback) to network during keep-alive

Table 3-7. SW7 Settings

Position	Status		
	0 to 45.72 m (0 to 150 ft)	45.72 to 137.16 m (150 to 450 ft)	137.16 to 199.64 m (450 to 655 ft)
1	down	up	up
2	up	down	up
3	up	up	up
4	up	down	up
5	up	up	down
6	up	down	up
7	up	up	down
8	up	up	up

Bit-Error Rate Threshold Option

DIP switch SW2 can be set to alarm at bit-error rate (BER) threshold levels between 10-4 and 10-9 or can be disabled. Table 3-8 shows the settings for SW2 for the various thresholds.

Table 3-8. SW2 BER Options

Position	Threshold Option						
	10-4	10-5	10-6	10-7	10-8	10-9	Disable
1	up	down	up	down	up	down	down
2	up	up	down	down	up	up	up
3	up	up	up	up	down	down	up
4	up	up	up	up	up	up	down
5	not used (up)						
6	not used (up)						
7	not used (up)						
8	up = non-latching mode; down = latching mode						

Switch Settings for Framing in Hybrid/PBX Mode

The framing format for the network and for data terminal equipment can be either D4 or extended superframe (ESF). DIP switches SW5 and SW6 must be set according to the following tables to match the framing format for the network and the equipment. This applies to Hybrid/PBX mode only.

Table 3-9. Switch Settings in Hybrid/PBX Mode: Network and Equipment are ESF Framed

Switch	Position							
	1	2	3	4	5	6	7	8
5	up	down	down	down	down	down	*	up
6	up	up	up	down	down	up	up	up

*. When this switch position is set to down, the near-end CSU polls the far-end CSU for alarm status. If the network is set to D4 framing, the polling option at this switch position must be off (up).

Table 3-10. Switch Settings in Hybrid/PBX Mode: Network and Equipment are D4 Framed

Switch	Position							
	1	2	3	4	5	6	7	8
5	down	down	down	up	up	down	up	up
6	up	up	up	up	down	up	up	up

Table 3-11. Switch Settings in Hybrid/PBX Mode: Network is ESF Framed and Equipment is D4 Framed

Switch	Position							
	1	2	3	4	5	6	7	8
5	down	down	down	down	up	down	*	up
6	up	up	up	down	down	up	up	up

*. When this switch position is set to down, the near-end CSU polls the far-end CSU for alarm status. If the network is set to D4 framing, the polling option at this switch position must be off (up).

Table 3-12. Switch Settings in Hybrid/PBX Mode: Network is D4 Framed and Equipment is ESF Framed

Switch	Position							
	1	2	3	4	5	6	7	8
5	up	down	down	up	up	down	up	up
6	up	up	up	up	down	up	up	up

Set the Power Option Switch

At the power option switch, accessed through the top panel of the ESF T1 CSU, select the appropriate power source:

- span power (SP)
- local power-dry loop (DL)
- local power-wet loop (WL)

CAUTION:
Connecting an ESF T1 CSU provisioned for local power-wet loop to digital microwave, digital multiplexers, or fiber optics can damage the equipment. Connecting an ESF T1 CSU provisioned for local power-wet loop with span-line power present can damage the CSU. Therefore, the local power-wet loop option can be used only in private networks with user-owned facilities.

Local power is required for total unit operation no matter which method of power is selected.

NOTE:
Select local power-dry loop in almost all cases. If span-line power is provided and the telephone company agrees, you can option the CSU for SP. However, most telephone companies do not provide span-line power for new installations.

Set the Artificial Transmit Line Option

Depending on the distance from the CSU to the first line repeater, set the Line Build-Out (LBO) switch to the proper option (see Table 3-13). The LBO switch is accessed through the top panel of the CSU.

NOTE:
The required setting for the LBO switch is usually specified by the telephone company.

The receive path contains a fixed 7.5 dB artificial line and an automatic line build-out (ALBO) circuit, which automatically compensate for signal levels in the range of 0 to -27.7 dB.

Table 3-13. Artificial Transmit Line Options

Position	Option	Distance
1	0.0 dB	0 —305 m (0 — 1000 ft)
2	7.5 dB	305 — 610 m (1000 — 2000 ft)
3	15.0 dB	610 — 915 m (2000 — 3000 ft)

Connect the ESF T1 CSU

Follow these steps to connect the ESF T1 CSU to the 100D module and the DS1 network (see Figure 3-12):

1. Connect the D8W cord from the 100D module (see Table 3-14) to the rear panel of the CSU in one of the following ways:
   - directly to the wire-wrap connector (see Table 3-15)
   - with a special cable adapter to the 15-pin DTE female connector (see Table 3-16)
2. Connect the network cord to the CSU in one of the following ways:
   - directly to the wire-wrap connector (see Table 3-15)
   - with a special cable adapter to the NET 15-pin male connector (see Table 3-17)

Table 3-14. 100D Module Pin Assignments

Pin No.	Designation	Signal
1	T1	RCV (tip)
2	R1	RCV (ring)
4	RX	MT (ring)
5	TX	MT (tip)

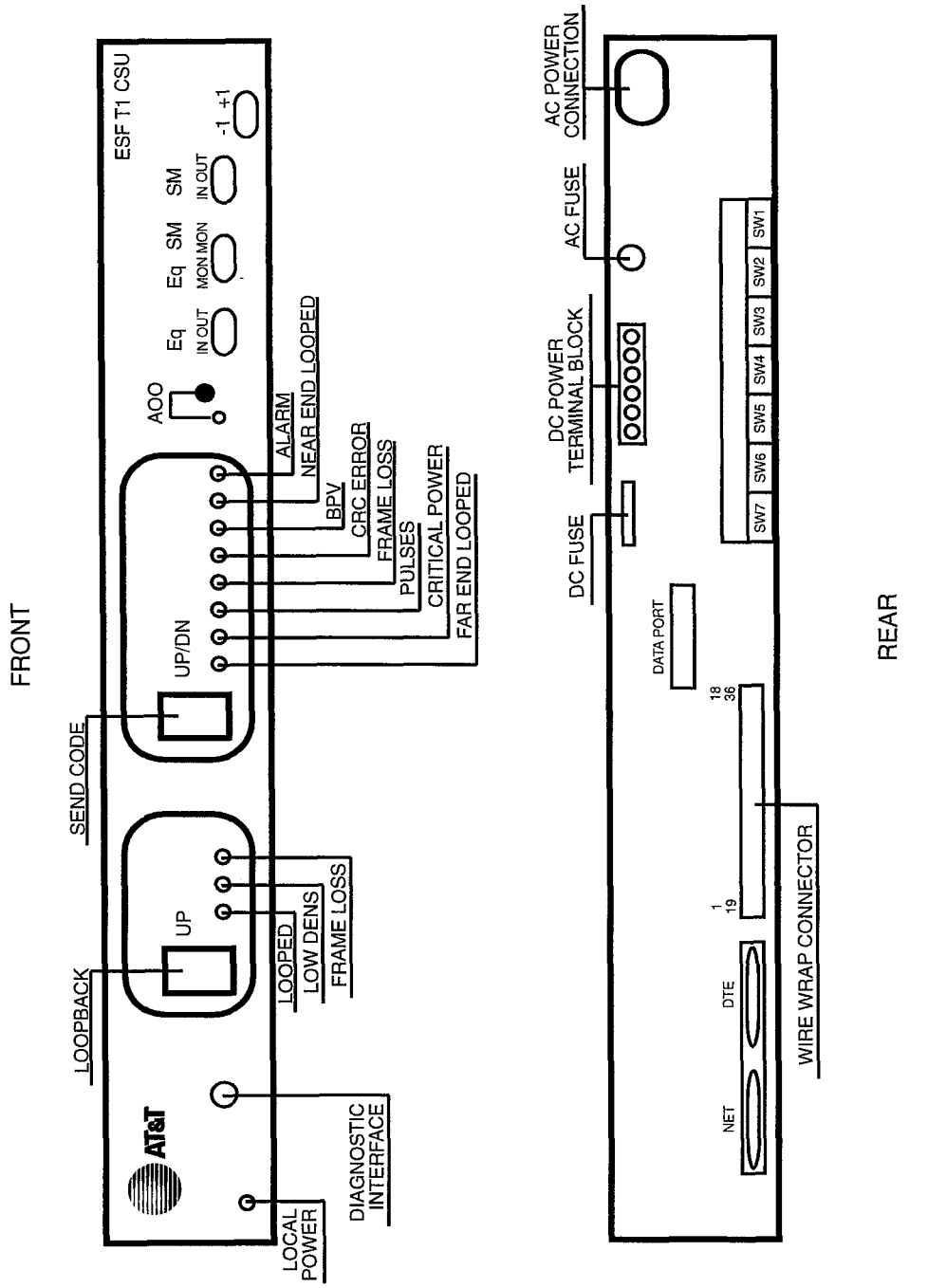


Figure 3-12. Channel Service Unit (Front and Back Panels on the ESF T1 CSU)

Table 3-15. Wire-Wrap Connector Pin Assignments

Pin No.	Signal
1	shield ground
2	shield ground
3	transmit data to the DTE (ring)
5	receive data from the DTE (tip)
8	receive data from the network (tip)
10	transmit data to the network (ring)
19	shield ground
20	shield ground
21	transmit data to the DTE (tip)
23	receive data from the DTE (ring)
26	receive data from the network (ring)
28	transmit data to the network (tip)
30	external ACO input
31	audible com
32	audible N/C (with ACO)
33	audible N/O (with ACO)
34	visual com
35	visual N/C (no ACO)
36	visual N/O (no ACO)

Table 3-16. DTE 15-Pin Connector Pin Assignments

Pin No.	Signal
1	receive data from the DTE (tip)
2 or 8	shield ground
3	transmit data to the DTE (tip)
4 or 15	shield ground
9	receive data from the DTE (ring)
11	transmit data to the DTE (ring)

Table 3-17. Network 15-Pin Connector Pin Assignments

Pin No.	Signal
1	transmit data to the network (tip)
3	receive data from the network (tip)
8	shield ground
9	transmit data to the network (ring)
11	receive data from the network (ring)
15	shield ground

Front Panel

The ESF T1 CSU's front panel consists of LEDs, controls, and test jacks (see Figure 3-12). Table 3-18, Table 3-19, and Table 3-20 show the functions of these items.

Table 3-18. CSU Front Panel LEDs

LED	Color	When Lit Indicates
LOCAL POWER	Yellow	Local 117 VAC or -48 VDC is ON
Network Side		
FAR END LOOPED	Red	Far-end CSU looped if initiated by near-end CSU
CRITICAL PWR	Yellow	Power is on to critical circuits
PULSES	Green	Normal incoming signal from network
FRAME LOSS	Red	Loss of signal, loss of frame synch, improper frame sequence, or unframed signal
CRC ERROR	Red	CRC error detected
BPV	Red	Non-B8ZS violation detected when set for B8ZS; other bipolar violations detected
NEAR END LOOPED	Yellow	Loopback is activated
ALARM	Red	BER threshold exceeded (associated contacts for an audible alarm are also activated)
System Side		
LOOPED	Yellow	Loopback activated on system side
FRAME LOSS	Red	Loss of signal, loss of frame synch, improper frame sequence, or unframed signal
LOW DENS	Red	Avg. ones density below threshold or consecutive zeroes threshold
ACO	Yellow	Lights when ACO button is pressed when ALARM LED is lit

Table 3-19. CSU Front-Panel Controls

Control	Function
LOOPBACK	Loops the incoming signal from the system to the system
SENDCODE	Sends "loop up" or "loop down" code to far-end CSU
ACO	Functions only when the ALARM LED is lit; turns on ACO LED and deactivates audible alarm; clears alarm if the alarm condition has been cleared

Table 3-20. CSU Front-Panel Test Jacks

Jack	Provides
DIAGNOSTIC	Access via 310 jack to the 4-kbps data link
EQ IN	Break-in access to transmit line to system
EQ OUT	Break-in access to receive line from system
SM IN	Break-in access in transmit path to network
SM OUT	Break-in access in receive path from network
EQ MON	Monitor access to received signal from system
SM MON	Monitor access to received signal from network
+1, -1	Test points for measuring simplex current from network to critical circuits (if provided)

551 T1 L1 CSU

The 551 T1 L1 CSU (see Figure 3-13) performs many of the same functions as the ESF T1 CSU, but it does not support B8ZS and therefore does not support the 64-kbps clear channel. Also, it does not support extended superframe (ESF) format; if a network requires this format, the ESF T1 CSU must be used.

Mount the 551 T1 L1 CSU in a relay rack, in various types of cabinets, or as a standalone unit. This CSU consists of the following components:

- chassis with top and rear cover
- Signal Monitor Unit (plug-in)
- Office Repeater (plug-in)
- Fault Location Filter (a factory-installed option)

NOTE:
Before the CSU can be installed, the serving telephone company must be contacted to obtain all necessary information, such as services available, equipment options, and power on the line. Also a completed "Request for 1.544 Mbps End Section Characteristics" form must be submitted to the telephone company.

Follow these procedures to install the components of the 551 T1 L1 CSU.

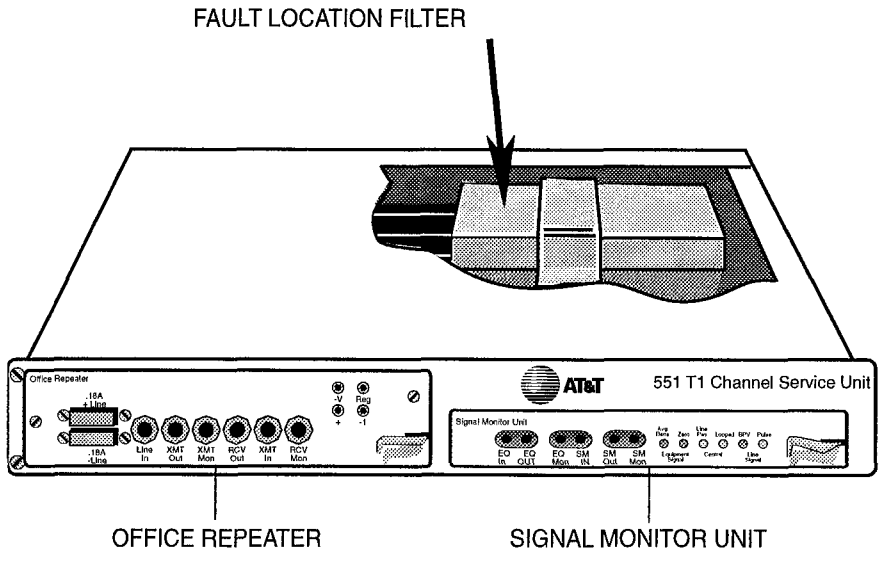


Figure 3-13. Channel Service Unit (551 T1 L1 CSU)

Set the Switch Options on the Signal Monitor Unit and the Office Repeater

Set the switches before placing the Signal Monitor Unit (SMU) and the Office Repeater (OR) in the CSU chassis.

The default settings accommodate most installations. However, some options depend upon local line conditions, for example, availability of line power and the type of service requested by the customer.

Also, proper settings for some options must be obtained from AT&T, its authorized representative, or the local telephone company. The local telephone company representative must be informed of the options selected.

Signal Monitor Unit Switch Settings

There are four option switches in the SMU (see Figure 3-14). These switches govern the operation of the following options:

- ONES causes the unit to transmit an "ALL ONES" keep-alive signal to the CO when the customer signal drops below the minimum average ones-density.
- ESS (electronic switching system) causes the CSU to loop back its receive line to its transmit line (instead of generating "ALL ONES") when the customer signal fails. The loopback framing pattern prevents false alarms at an ESS or a data acquisition control system (DACS).
- ZEROES selects either 16 or 50 consecutive zeroes to be the criteria for lighting the Zeroes LED.
- ACTIVE FAULT LOCATE causes the remote loopback path to preserve bipolar violations to allow single-ended fault locating when active fault filters are used.

Table 3-21 shows the switch settings for the different options.

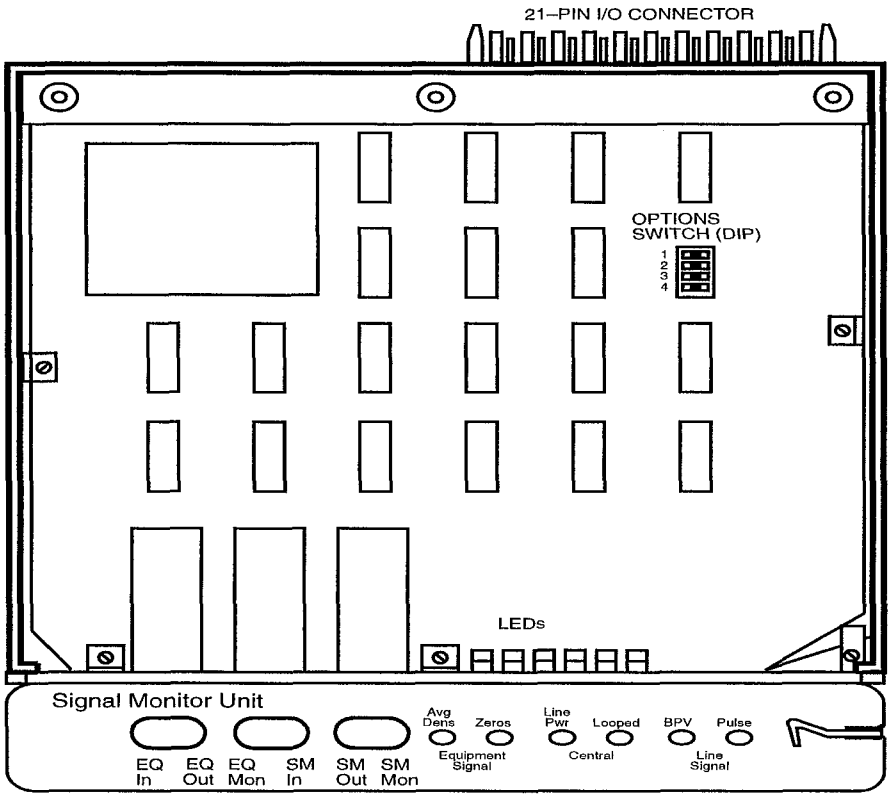


Figure 3-14. Signal Monitor Switch Settings

Table 3-21. SMU Switch Settings

Option	Switch Setting
ONES	#1 — closed #2 — open
ESS	#1 — open #2 — closed
ZEROES	#3 — closed for 16-zero limit
ACTIVE FAULT LOCATE	#4 — closed

Office Repeater Switch Settings

Table 3-22 and Table 3-23 show the power mode and artificial line-option settings for the OR (see Figure 3-15).

Table 3-22. OR Power Mode Option Settings

Power Mode	Screw Options*	S2	S3	S4	S5
Line power	C, E, K	n/a	n/a	AB	B
-48 V with sealing current	C, E, K	Y	OUT	AA	B
-48 V without sealing current	C, G, J	Y	OUT	AA	B

*. Letters indicate those screws that are closed.

Table 3-23. OR Artificial Line Options

Line Loss	S1	S5
0 dB	C	n/a
7.5 dB	A	A
15 dB	B	B

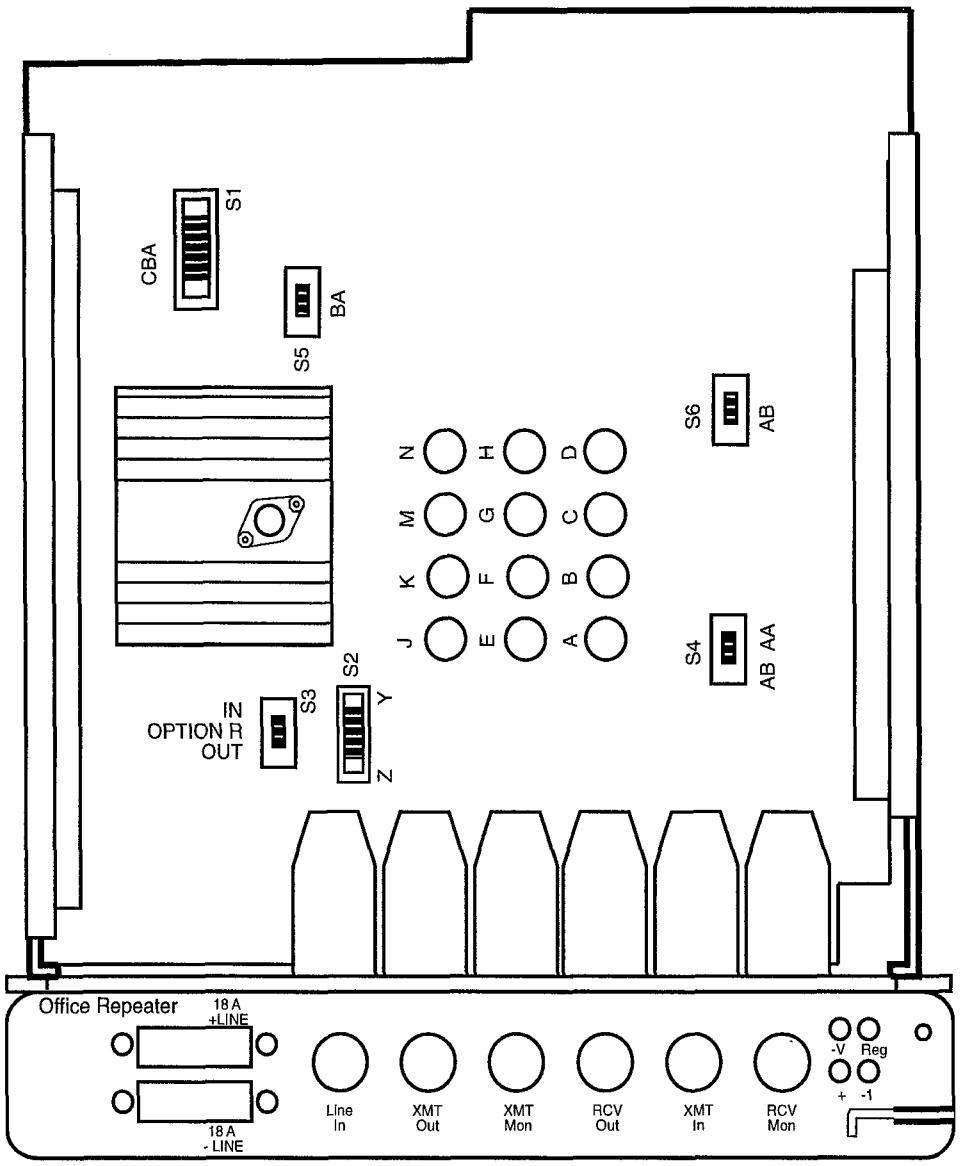


Figure 3-15. Office Repeater Switch Settings

Mount the CSU Chassis

After the options have been set on the SMU and the OR, mount the CSU shelf assembly into a rack or other enclosure.

Connect Lines to the Terminal Block (TB1)

The terminal block (TB1) on the back of the chassis is the connecting point for T1 service lines and for fault and loopback wires. Also, if a local power supply is used, the TB1 is the termination spot for the power supply wires.

⚠ WARNING:
Voltages as high as 260 V can occur between the transmit and receive pairs of the T1 line.

Follow these steps to connect the lines to TB1 on the back of the CSU chassis (see Figure 3-16):

1. Connect the T1 service lines to terminals 1 through 5.
2. Connect the fault pair (if provided by the local telephone company) to terminals 8 and 9.
3. Connect the DC loopback pair (if provided by the local telephone company) to terminals 11 and 12.
4. If the CSU is to be locally powered, connect the power supply leads to terminals 14 and 15.

Insert the Signal Monitor Unit

After setting the option switches, plug the SMU into the right side of the 551 T1 L1 CSU chassis.

The SMU has six LEDs and six bantam jacks (see Figure 3-14). Table 3-24 and Table 3-25 show the functions of the LEDs and the test jacks on the front panel.

Table 3-24. SMU Front-Panel LEDs

Label	Color	When Lit Indicates
Avg. Dens	Red	Low average ones density
Zeroes	Red	> 50 consecutive zeroes (needed for encryption) or > 16 consecutive zeroes (option switch S4 closed)
Line Pwr	Yellow	Presence of simplex current
Looped	Yellow	Loopback function activated
BPV	Red	Bipolar violations received
Pulse	Green	Normal 1.544-Mbps pulses present

Table 3-25. SMU Front-Panel Test Jacks

Jack	Provides
EQ (IN-OUT-MON)	Access to transmit input and receive output of the 100D module
SM (IN-OUT-MON)	Access to CSU transmit input and receive output

Insert the Office Repeater

Plug the OR into the left slot of the 551 T1 L1 CSU chassis (see Figure 3-15). The front panel has

- six 310 jacks for in-line access and monitoring of the span line and the SMU card
- two GMT fuses for protection of the local powering circuitry
- four test points

NOTE:
The transmit path in the OR has an adjustable artificial line; this allows the transmit level to be adjusted to 0, 7.5, or 15 dB to meet the required -15 or -22.5 dB section loss. The receive path contains a fixed 7.5 dB artificial line and an Automatic Line Build-Out (ALBO) circuit, which automatically compensate for signal levels in the range of 0 to -27.7 dB.

Connect the 551 T1 L1 CSU to the 100D Module

Connect the 100D module to the CSU's rear panel (see Figure 3-16):

1. Place an adapter on the end of the D8W cord from the 100D module.
2. Plug the adapter into the 15-pin subminiature connector.

NOTE:
The maximum length of cable from the 100D module to the CSU for line compensation is 200 m (655 feet).

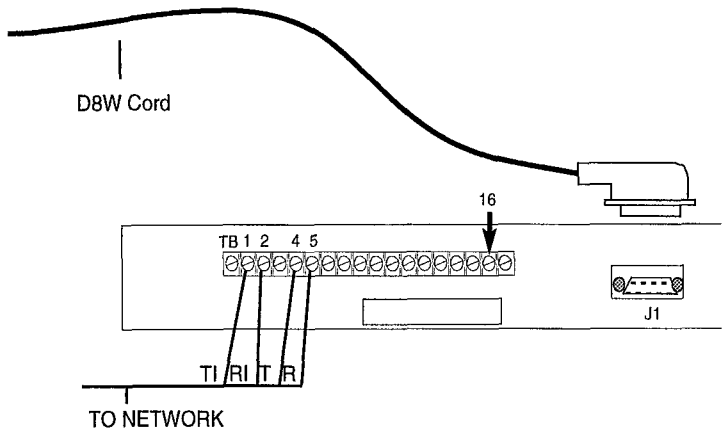


Figure 3-16. Connecting the 551 T1 L1 CSU to the 100DModule

Table 3-26 shows the pin assignments for the rear panel connections.

Table 3-26. CSU Rear-Panel Pin Assignments

100D Module			551 T1 L1 CSU		
PIN #	DESIG	SIGNAL	D-CONN	DESIG	SIGNAL
1	T1	RCV (tip)	3	T	XMT (tip)
2	R1	RCV (ring)	11	R	XMT (ring)
4	R	XMT (ring)	9	R1	RCV (ring)
5	T	XMT (tip)	1	T1	RCV (tip)

DC Power Options

Depending on the type of line provided by the local telephone company, the CSU can be supplied with -48 VDC power on the T1 wire pair from the network. If the CSU is not powered from the network, a WP-92464,L3 power supply is required. Connect the power supply to the rear panel at TB1 as follows:

- positive lead to terminal 15
- -48 VDC lead to terminal 14

The SMDR Printer and the System Programming PC

Both an SMDR printer and a personal computer (PC) used for system programming can be connected to the processor module.

Connect a Printer to the Control Unit

A serial printer can be connected to the control unit through the SMDR port on the processor module. There are two procedures for installing a printer, depending on whether the printer is within 15.24 m (50 feet) of the control unit or not.

CAUTION:
Prevent damage from electrostatic discharge (ESD): do not touch leads, connectors, pins, and other components. Use a properly grounded wrist strap.

NOTE:
Before connecting a printer, make sure that all modules have been installed on the control unit.

The printer must be plugged into the same AC outlet as the control unit.

Connect a Printer Within 15.24 m (50 Feet) of the Control Unit

Use the following hardware and procedure to connect a printer to the control unit when the printer is within 15.24 m (50 feet) of the control unit and is powered from the same electrical circuit and ground as the control unit.

Hardware

- Z200A EMI filter
- adapter for the connector on the interface cable
  - — 355A for a male connector
  - — 355AF for a female connector

Procedure (see Figure 3-17)

1. Take the Z200A EMI filter and cord, and plug the end of the cord closest to the filter into the SMDR port (the top one) on the processor module.
2. Plug the other end of the EMI filter cord into the adapter (355AF or 355A).
3. Connect the female connector on the adapter to the 25-pin male connector on the printer's interface cable.

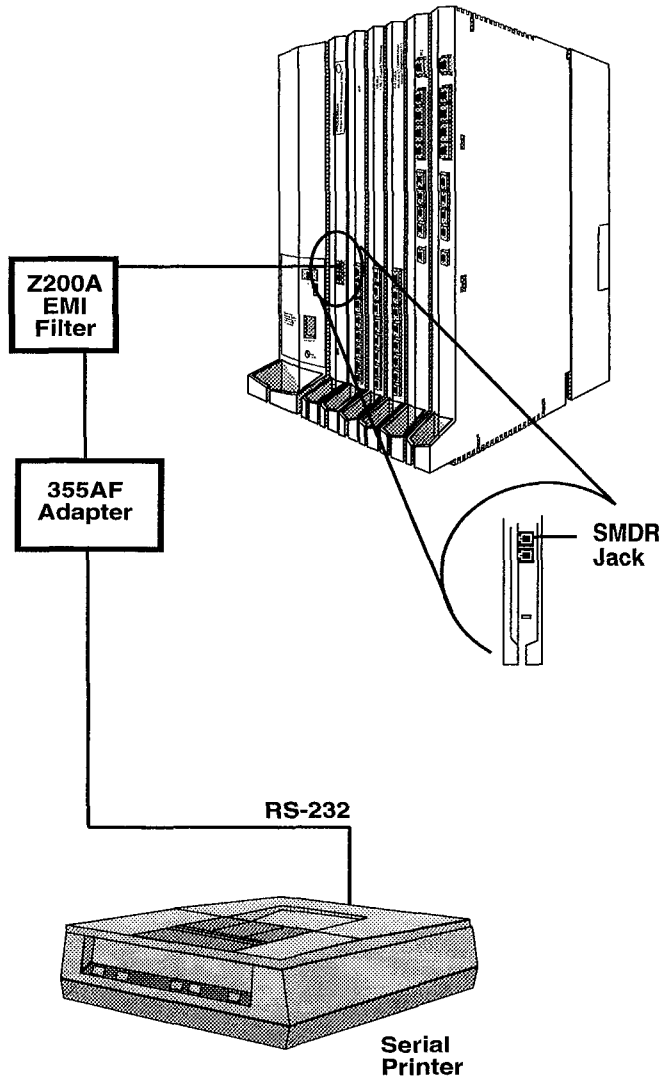


Figure 3-17. Connecting a Printer to the Control Unit within 15.24 m (50 Feet)

4. Set the printer options for use with the SMDR feature.

NOTE:
The following table provides options that allow most serial printers to work with the SMDR port on the control unit. Printers vary, so you may need to adjust your printer accordingly.

Table 3-27. Printer Options

Function	Status	Function	Status
FORM LENGTH	28 cm (11")	CHAR. SET (G0,GL)	USA
LP1	6	CHAR. SET (G1,GR)	UK
CPI	10	CHAR. SET (G2)	GE
LQ or NLQ	LQ	CHAR. SET (G3)	"LINE" DRAWING
BUZZER	ON	OFF-"LINE" STATE	ALL RECEIVE
FONT	BUILT-"IN"	DSR	OFF
RESOLUTION	144	RTS TIMING	RTS
BUFFER	ON-"LINE"	CD	OFF
PW ON MODE	ON-"LINE"	CTS	OFF
DIRECTION	BI-DIR.1	OVER RUN	256
BUFFER FULL	LF + CR	DATA BIT	8
P.E.	acTIVE	PROTOCOL	XON/XOFF*
AUTO CR	CR + LF	STOP BIT	2
ZERO	0	PARITY	NON
AUTO LF	CR ONLY	BPS	1200
2.54 cm (1") SKIP	OFF		

*. This is the default status, but the system cannot read the character sent by the printer.

Connect a Printer 15.24 m (50 Feet) or More from the Control Unit

Use the following hardware and procedure to connect a printer to the control unit that is:

- 15.24 m (50 feet) or more from the control unit
- not grounded to the same AC outlet as the control unit
- not grounded to an outlet that is on the same electrical circuit or ground as the control unit and that is 15.24 m (50 feet) or less from the control unit

Hardware

- Z200A EMI filter
- adapter for the interface cable connector
  - — 355A for the male connector
  - — 355AF for the female connector
- 400B2 power adapter
- Z3A2 ADU (asynchronous data unit)
- BR1A-4P adapter, 102 connecting block, or 103 connecting block
- EIA crossover cable
- ADU crossover cable
- 2012D transformer (117 VAC only) or WP-92464,L3 (117 VAC or 220 VAC)
- 248B adapter
- D8W cords
- D6AP power cord
- RS-232 cable

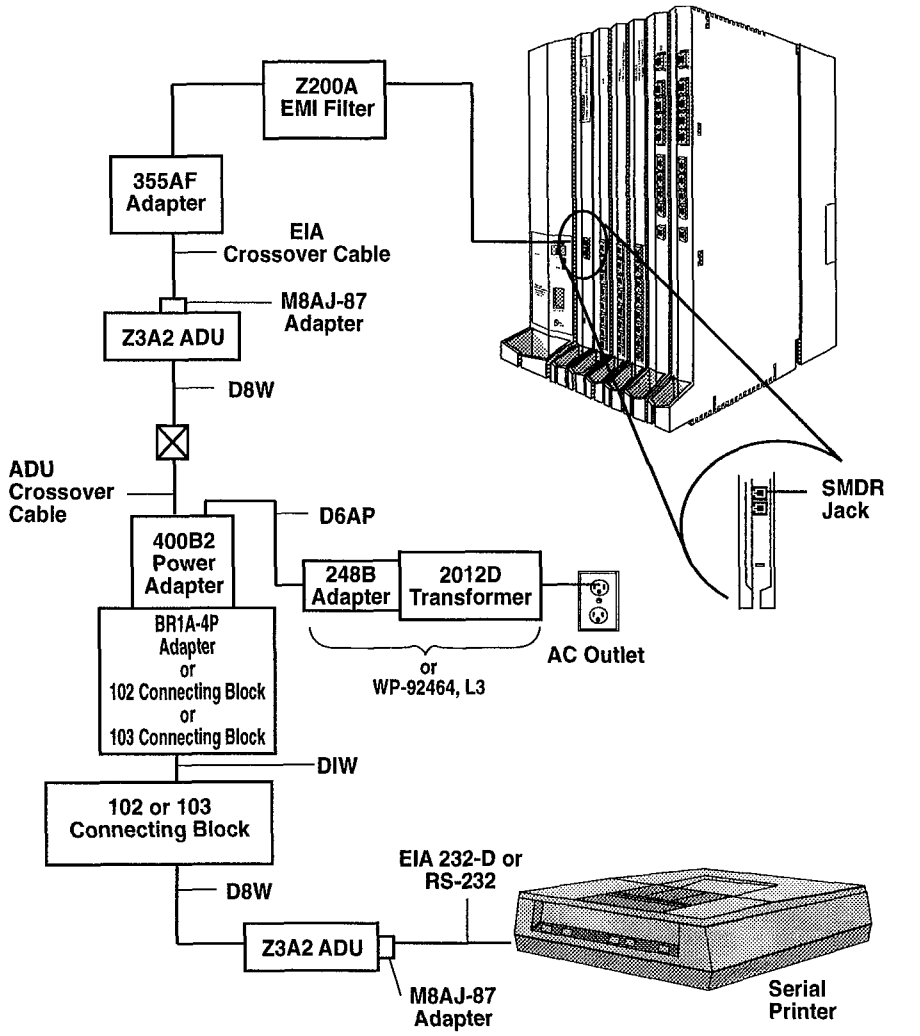


Figure 3-18. Connecting a Printer 15.24 m (50 Feet) or More from Control Unit

Procedure (see Figure 3-18)

1. Take the end of the Z200A EMI filter cord that is closest to the filter and plug it into the SMDR jack (the top one) on the processor module.
2. Plug the other end of the EMI filter cord into a 355AF adapter.
3. Connect the female connector on the 355AF adapter to one end of the EIA crossover cable. Connect the other end of the EIA cable to the 25-pin male connector of a Z3A2 ADU, using an M8AJ-87 adapter.

CAUTION:
If the printer is in a building outside the main building (control unit location), an ADU and an additional protector must be installed in each building. The ADUs and protectors provide both the control unit and the printer additional protection against exposure to lightning, inadvertent contact with power lines, and power currents induced by nearby power lines. See the installation notes packed with the ADU for more information.

4. Plug one end of a D8W cord into the Z3A2 ADU and the other end into an ADU crossover cable.
5. Plug the other end of the ADU crossover cable into one of the jacks on a 400B2 power adapter.
6. Plug one end of a D6AP cord into the other jack of the 400B2 adapter. Plug the other end of the D6AP cord into one of the following:
   - 117 VAC: plug the D6AP cord into the jack on a 248B adapter, and then connect the spade-tip wires on the 248B adapter to the screws on a 2012D transformer (117 VAC only). See Figure 3-19.
   - 220 VAC: plug the D6AP cord into the jack on the WP-92464,L3 power unit (117 VAC or 220 VAC).

   NOTE:
   If the WP-92464,L3 is packaged with a cord that is different from the D6AP cord, use that cord instead of the D6AP (to connect the WP-92464,L3 to the 400B2 adapter).
7. Plug the 400B2 adapter into a BR1A-4P adapter, 102 connecting block, or 103 connecting block.
8. Place a plug onto the end of the inside wiring (DIW) on the control unit side and plug the DIW cord into the BR1A-4P adapter, 102 connecting block, or 103 connecting block.
9. On the printer side of the inside wiring, punch down the DIW cord onto a 102 or 103 connecting block.
10. Plug one end of a D8W cord into the 102 or 103 connecting block and the other end into a Z3A2 ADU.
11. Connect an RS-232 cable to the Z3A2 ADU, using an M8AJ-87 adapter.
12. Plug the other end of the RS-232 cable into the printer.
13. Do one of the following:
    - Plug the 2012D transformer into a 117 VAC wall outlet.
    - Plug the WP-92464,L3 into a 117 VAC or 220 VAC wall outlet.
14. Set the printer options for use with the SMDR port (see Table 3-27).

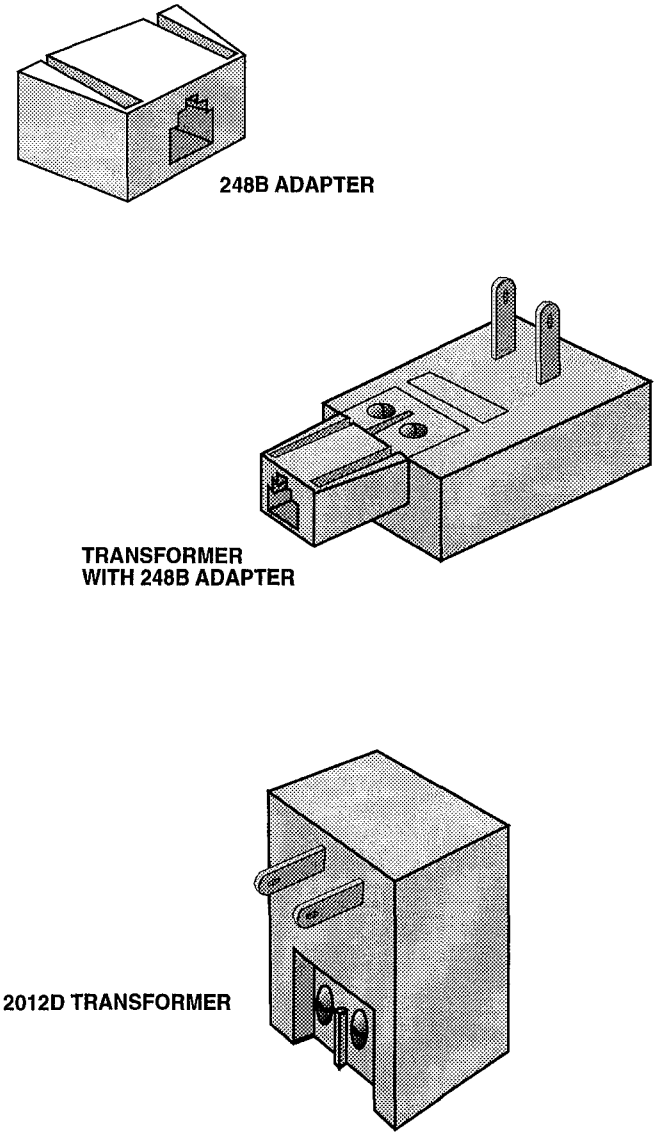


Figure 3-19. 2012D Transformer (117 VAC Only) with the 248B Adapter

Connect a PC to the Control Unit

A PC with MS-DOS[1] 3.3 or higher can be used for programming and maintenance of the system. The connection of the PC to the control unit depends upon whether or not the distance between the two is less than 15.24 m (50 feet).

⚠ CAUTION:
To prevent damage from electrostatic discharge (ESD), avoid touching leads, connectors, pins, and other components. Use a properly grounded wrist strap.

Connect a PC Within 15.24 m (50 Feet) of the Control Unit

Use the following hardware and procedure to connect a PC to the control unit when the distance from the PC to the control unit is less than 15.24 m (50 feet).

Hardware

- 355AF adapter
- D8W cord
- RS-232 cable

1. MS-DOS is a trademark of Microsoft Corporation.

Procedure (see Figure 3-20)

1. Plug one end of a D8W cord into the system programming/maintenance jack (the lower jack) on the processor module. Plug the other end of the D8W cord into a 355AF adapter.
2. Connect one end of an RS-232 cable to the 355AF adapter and the other end to the COM1 port on the PC.

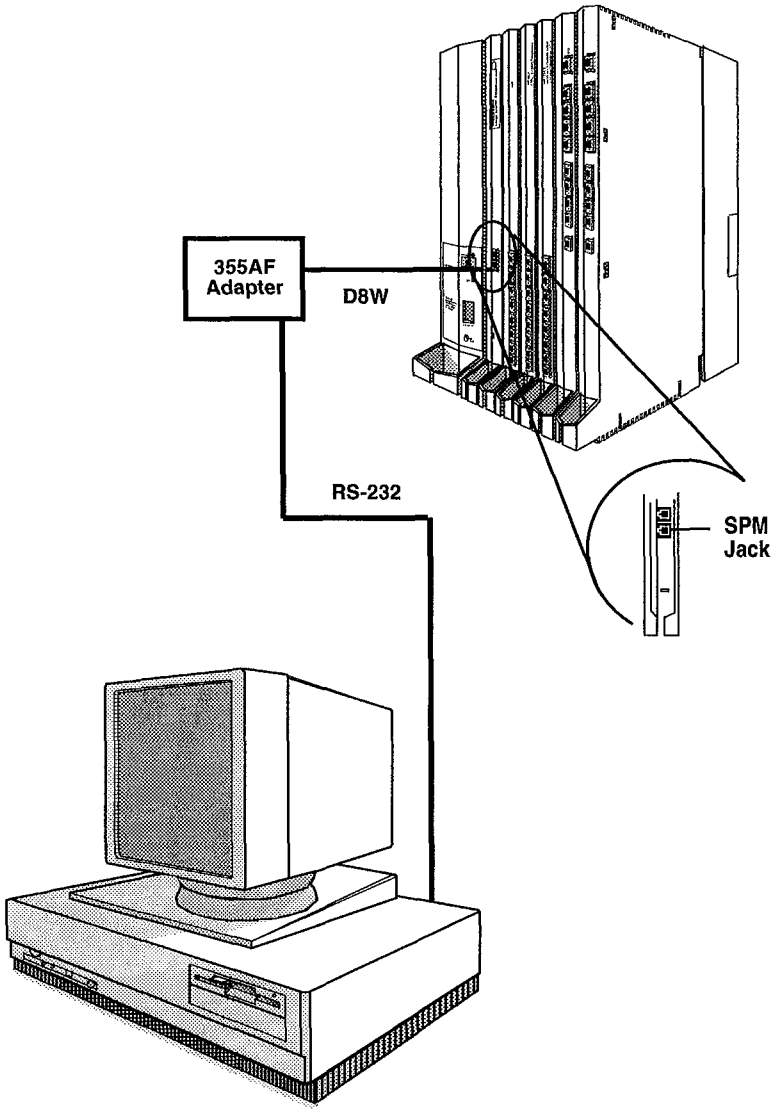


Figure 3-20. Connecting a PC within 15.24 m (50 Feet) of the Control Unit

Connect a PC 15.24 m (50 Feet) or More from the Control Unit

Use the following hardware and procedure to connect a PC to the control unit when the distance from the PC to the control unit is 15.24 m (50 feet) or more.

Hardware

- 355AF adapter
- 400B2 power adapter
- BR1A-4P adapter, 102 connecting block, or 103 connecting block
- Z3A2 ADU (asynchronous data unit)
- EIA crossover cable
- ADU crossover cable
- 2012D transformer (117 VAC only) or WP-92464,L3 (117 VAC or 220 VAC)
- 248B adapter
- 102 or 103 connecting block
- DIW cable
- D8W cords
- D6AP power cord
- RS-232 cable

Procedure (see Figure 3-21)

1. Plug one end of a D8W cord into the system programming/maintenance (SPM) jack (the lower jack) on the processor module. Plug the other end of the D8W cord into a 355AF adapter.
2. Connect an EIA crossover cable to the 355AF adapter.
3. Connect one end of an RS-232 cable to the EIA crossover cable and the other end to a Z3A2 ADU.

⚠ CAUTION:
If the PC is in a building outside the main building (control unit location), an ADU and an additional protector must be installed in each building. The ADUs and protectors provide both the control unit and the PC additional protection against exposure to lightning, inadvertent contact with power lines, and power currents induced by nearby power lines. See the installation notes packed with the ADU for more information.

4. Plug one end of a D8W cord into the Z3A2 ADU and the other end into an ADU crossover cable.
5. Plug the other end of the ADU crossover cable into one of the jacks on a 400B2 power adapter.
6. Plug one end of a D6AP cord into the other jack of the 400B2 adapter. Plug the other end of the D6AP cord into one of the following:
   - 117 VAC: plug the D6AP cord into the jack on a 248B adapter, and then connect the spade-tip wires on the 248B adapter to the screws on a 2012D transformer (117 VAC only). See Figure 3-19.
   - 220 VAC: plug the D6AP cord into the jack on the WP-92464,L3 power unit (117 VAC or 220 VAC).

   NOTE:
   If the WP-92464,L3 is packaged with a cord that is different from the D6AP cord, use that cord instead of the D6AP (to connect the WP-92464,L3 to the 400B2 adapter).
7. Plug the 400B2 adapter into a BR1A-4P adapter, 102 connecting block, or 103 connecting block.
8. Place a plug onto the end of the inside wiring (DIW) on the control unit side and plug the DIW cord into the BR1A-4P adapter.
9. On the PC side of the inside wiring, punch down the DIW cord onto a 102 or 103 connecting block.
10. Plug one end of a D8W cord into the 102 or 103 connecting block and the other end into a Z3A2 ADU.
11. Connect one end of an RS-232 cable to the Z3A2 ADU and the other end to the COM1 port on the PC.
12. Do one of the following:
    - Plug the 2012D transformer into a 117 VAC wall outlet.
    - Plug the WP-92464,L3 into a 117 VAC or 220 VAC wall outlet.

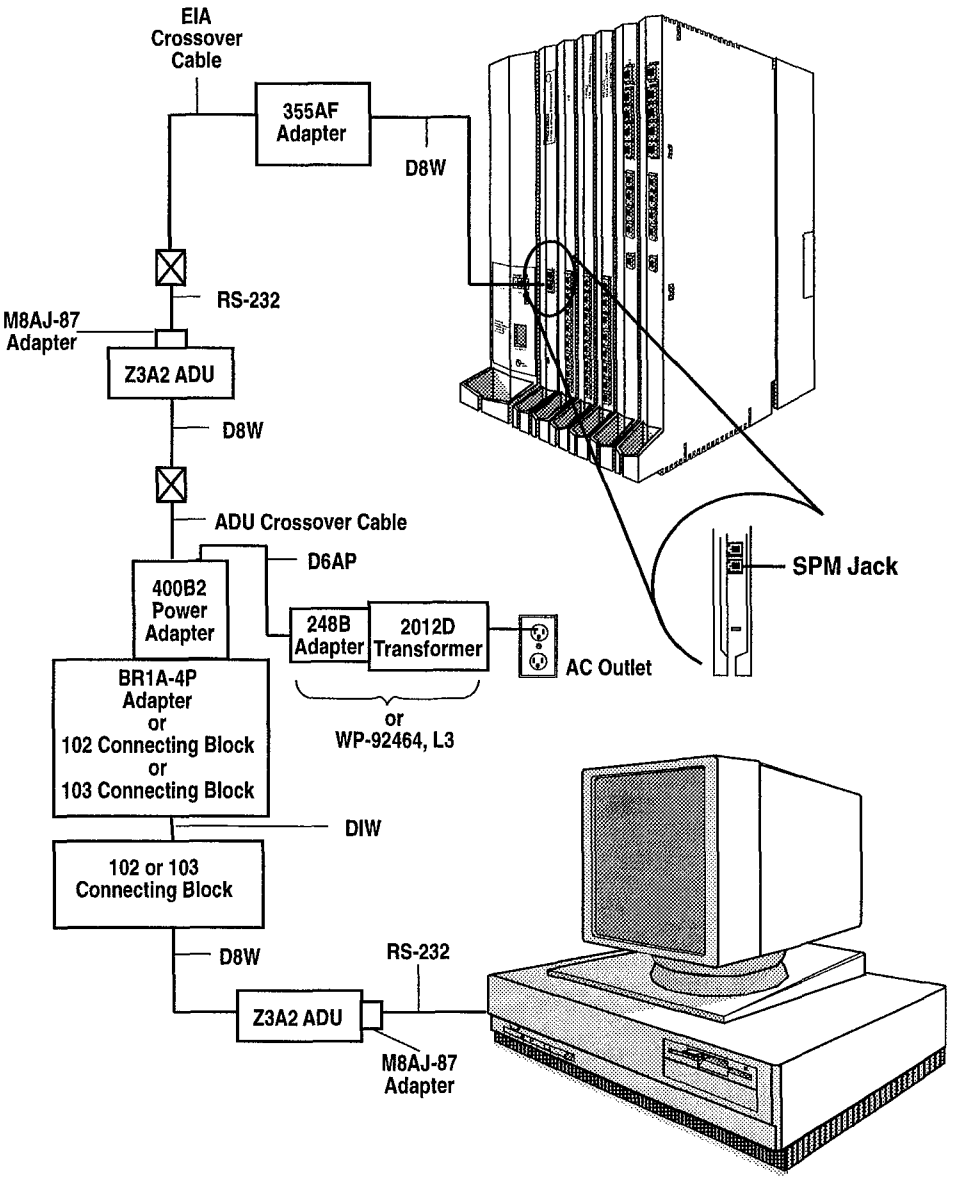


Figure 3-21. Connecting a PC 15.24 m (50 Feet) or More from Control Unit

Data Adapters

Adapters are needed to connect data equipment to the control unit. The kind of adapter used depends on whether or not the data is analog or digital. For analog data a modem or modem pool is used; for digital data an ISDN Terminal Adapter, such as the ExpressRoute 1000 or ISDN 7500B Data Module, is used.

ExpressRoute 1000

The ExpressRoute1000 is a data communications device that allows connection between RS-232 data terminal equipment (DTE) and the control unit via the 008 MLX module. The ExpressRoute 1000 can be used together with a modem in a modem pool to change digital data signals to analog signals, and vice versa, which allows transmission between digital and analog data stations.

For information on configuring your ExpressRoute 1000 and connecting it to your MERLIN LEGEND Communications System, refer to the documentation that came with your ExpressRoute 1000

ISDN 7500B Data Module

The ISDN 7500B Data Module is used to connect a digital data terminal to the system on an 008 MLX module. The data module is used at the digital data station to make and receive data calls. When a data terminal is used to make calls, the keyboard is used to dial the number. Instead of converting digital data signals to analog signals as a modem does, the 7500B maintains a digital data format that allows transmission to another digital station.

The ISDN 7500B Data Module provides an RS-232 interface for asynchronous data terminal equipment operating at speeds up to 19.2 kbps. The data module also provides an ITU-T V.35 interface for synchronous data terminal equipment operating at speeds up to 64 kbps. (Optional enhancement boards must be ordered separately.)

The 7500B can be set up to handle a variety of data communications equipment (DCE) and is the only digital adapter that can be used with the system.

The 7500B front panel has the following (see Figure 3-22):

- **POWER/TEST** LED. Lights when power is supplied to the 7500B; flashes when 7500B tests are performed.
- **DATA** LED. Flashes to indicate an incoming data call and lights when a call is in progress; flashes when 7500B tests are performed.
- **Display**. Displays status information and option settings.
- **NEXT**, **BACK**, and **ENTER** buttons. Used to operate the 7500B and to adjust the screen's contrast.

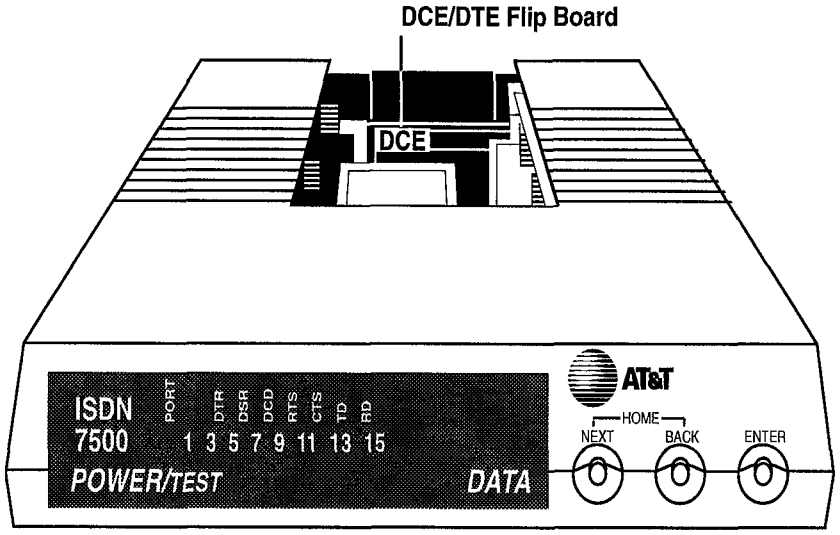


Figure 3-22. ISDN 7500B Data Module (Front Panel)

The 7500B back panel has the following (see Figure 3-23).

- **PHONE** jack. Connects a digital/ISDN (MLX) telephone to the 7500B.
- **LINE** jack. Connects the 7500B to an MLX system module.
- **POWER** connector. Connects the 7500B to the DC power supply, which connects to an AC outlet.
- **PORT 1**. Connects the 7500B to a data terminal, computer, or modem.
- **PORT 2**. When an enhancement board is installed for synchronous operation, Port 2 connects a second data terminal, an automatic calling device (with an RS-366 interface), or a data terminal with a V.35 interface.

NOTE:
A modem can provide an analog data interface from an MLX telephone that has an MFM installed.

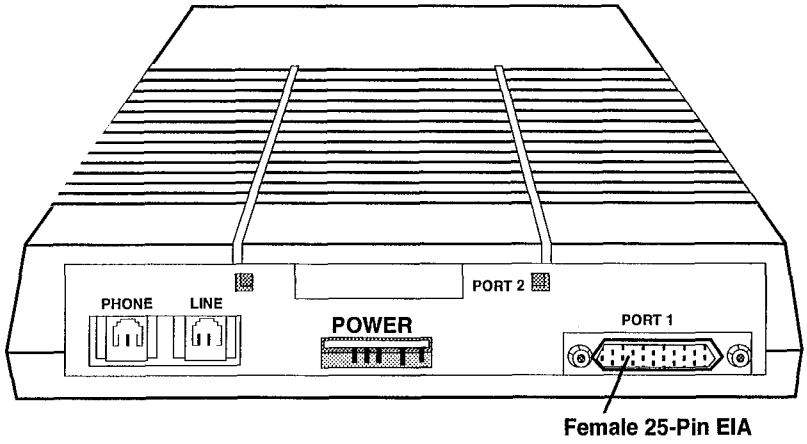


Figure 3-23. ISDN 7500B Data Module (Back Panel)

When you use the ISDN 7500B Data Module with an MLX telephone, plug one end of the D8W cord into the PHONE jack on the 7500B and the other end of the cord into the LINE jack on the MLX telephone.

The maximum cord length from the 7500B to the telephone cannot exceed 24.4 m (80 feet).

The MLX telephone cannot be used to dial data calls, and the data module cannot be used to dial voice calls. Each device operates independently, and features are assigned to each device independently.

NOTE:
Do not connect two ISDN 7500B Data Modules on one line.

The data module can be configured as a standalone by ordering a WP-90110,L1 (117 VAC) or WP-90110,L8 (220 VAC) power unit. The 7500B can also be configured in a multiple-mount arrangement by ordering a Z77A data mounting, which provides a common power supply for up to eight data modules. Both the power unit and the data mounting require a 117 VAC or 220 VAC power outlet. Neither the power unit nor the data mounting is provided with the data module, and both must be ordered separately.

The 7500B does not have the internal 100-ohm line termination that is provided with MLX telephones. Therefore, when the 7500B is used without an MLX telephone, a 100-ohm, 440A4 terminating resistor adapter must be installed on the line near the 7500B.

To provide synchronous operation at speeds up to 64 kbps, one of the following optional circuit boards must be ordered:

- **Multipurpose Enhancement Board**. Provides an RS-366 Automatic Calling Unit (ACU) interface and converts the RS-232 interface on the main circuit board from asynchronous to synchronous. A V.35 adapter cable must be ordered separately to operate at data rates of 56 and 64 kbps. Without the adapter cable, data rates are limited to 1200, 2400, 4800, 9600, and 19,200 bps.
- **High-Speed Synchronous Interface Enhancement Board**. Provides a V.35 interface at synchronous data rates of 48, 56, or 64 kbps. A V.35 adapter cable that converts the 25-pin male connector on the board to the industry-standard 34-pin V.35 interface is included.

Data Module Features

The data module offers three types of features:

- asynchronous
- synchronous with multipurpose enhancement board
- synchronous with high-speed synchronous enhancement board

Asynchronous Features

- RS-232 interface
- asynchronous full-duplex operation
- selected data rates of 300, 1200, 2400, 4800, 9600, and 19,200 bps
- data options set via the data terminal connected to the RS-232 interface
- ability to change options without dropping a data call
- autobaud (also called data metering or speed matching), or the ability to adjust the speed of transmission to match the speed of the data terminal being called
- auto-adjust, or the ability to adjust to the speed and parity of the data terminal being used
- call setup (dialing) from the keyboard of an ASCII data terminal by using the local command (CMD) mode or AT mode
- automatic or manual answering of incoming data calls

Synchronous Features with Multipurpose Enhancement Board

- RS-232 interface
- half- or full-duplex operation using the RS-232 interface at data rates of 1200, 2400, 4800, 9600, and 19,200 using data transport Mode 2
- half- or full-duplex operation at 56 kbps via the V.35 interface adapter cable
- full-duplex operation at 64 kbps via the V.35 interface adapter cable
- automatic answering of incoming data calls
- ability to place outgoing data calls manually and select user-programmable telephone numbers from the data module display on the front panel
- RS-366 interface to an Automatic Calling Unit (control unit)

Synchronous Features with High-Speed Synchronous Enhancement Board

- V.35 interface (adapter cable required)
- full-duplex operation at 48, 56, and 64 kbps
- half-duplex operation at 56 kbps only
- automatic answering of incoming data calls
- ability to place data calls manually and select user-programmable telephone numbers from the data module display on the front panel

Installation

Various configurations are used on the ISDN 7500B Data Module. Depending on the configuration, some equipment is required and some is optional.

Required Equipment

- ISDN 7500B Data Module
- WP-90110,L1 (117 VAC) or WP-90110,L8 (220 VAC) power supply (for standalone)
- D8W cord
- EIA-232D cable(s) or V.35 cable

Optional Equipment

- multipurpose enhancement board
- high-speed, synchronous enhancement board with V.35 adapter cable
- 440A4 terminating resistor adapter (needed when the 7500B is installed without an MLX telephone)

Installation Procedures

Follow one of the following procedures for the proper configuration to install the ISDN 7500B Data Module.

- Standalone, single-port, asynchronous DCE configuration
- Standalone, asynchronous DTE configuration
- Standalone, multipurpose, enhancement DCE configuration
- Standalone, high-speed, synchronous DCE configuration

Standalone, Single-Port, Asynchronous DCE Configuration.

This configuration uses the basic ISDN 7500B Data Module (see Figure 3-24).

1. Remove the 7500B from the box.
2. Plug the D8W cord into the jack labeled LINE on the back of the 7500B.
3. Plug the WP-90110,L1 (or WP-90110,L8) power supply cord into the connector labeled POWER on the 7500B.
4. Plug the male end of the EIA-232D cable into the connector labeled PORT 1.
5. Connect the other end of the EIA-232D cable to the data terminal.
6. Plug the other end of the D8W cord into a telephone wall jack or into a 440A4 terminating resistor adapter (when the 7500B is installed without an MLX telephone).

7. As necessary, plug the terminating resistor adapter into the wall jack.
8. Plug the power cords of the WP-90110,L1 (or WP-90110,L8) power supply and the data terminal into an AC power outlet that is not controlled by a wall switch.

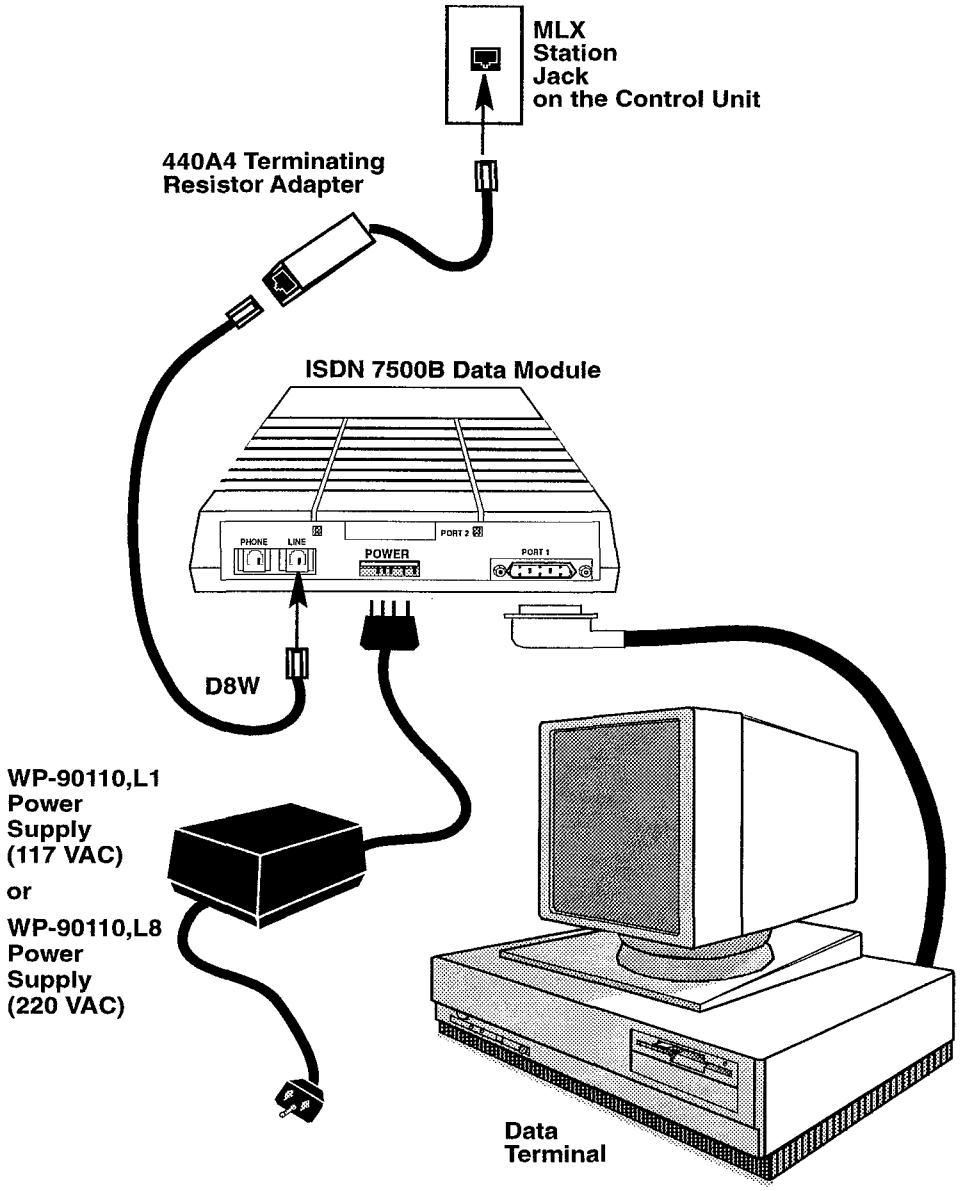


Figure 3-24. Standalone, Single-Port, Asynchronous DCE Configuration

Standalone, Asynchronous DTE Configuration. Follow the steps below to configure the ISDN 7500B Data Module to work with a modem in a modem pool:

1. Remove the 7500B from the box.
2. Open the door panel on the 7500B.
   a. Insert a pen into the small hole near the LINE label on the back panel.
   b. Push in on the tab in the hole while you pull up on that side of the door.
   c. Repeat steps a and b for the other side of the door panel by sticking your pen into the small hole near the PORT 2 label.
   d. Lift off the door and set it aside.
3. Looking straight down at the inside of the 7500B, locate the large silver arrow pointing toward the back.

   This arrow points to the DCE/DTE flip board, which is perpendicular to the plane of the arrow.
4. Look at the DCE/DTE flip board from the front of the 7500B (see Figure 3-22).

   Either DTE or DCE will be in the left-hand corner of the board.
5. Adjust the flip board as needed.
   - If DTE is in the left-hand corner of the board, the 7500B is already configured for DTE; go to step 6.
   - If DCE is in the left-hand corner of the board:

   a. Grasp the flip board firmly with both hands.
   b. Pull up gently until the board is completely free.
   c. Turn the board around 180 degrees (DTE is in the left-hand corner).
   d. Replace the board in its slot.
6. Close the door panel by hooking the hinges under the front housing and then snapping the rear tabs into place.
7. Plug the D8W cord into the jack labeled LINE.
8. Plug the power supply cord into the connector labeled POWER on the 7500B.
9. Plug the male end of the EIA-232D cable into the connector labeled PORT 1.
10. Connect the other end of the EIA-232D cable to the modem (a male-to-male cord or a male-to-female cord with a gender changer is needed).

11. Plug the power cord into an AC power outlet.
12. Plug the D8W cord into a telephone wall jack.

NOTE:
Before plugging the D8W cord into a wall jack, make sure you do not need the terminating resistor adapter. If you need it, see "Terminating Resistor Adapter Installation" later in this chapter.

Standalone, Multipurpose, Enhancement DCE Configuration. Follow the steps below to configure the 7500B for use with the multipurpose enhancement board to work with modems.

1. Remove the 7500B from its box or turn off the power on installed sets.
2. Remove the multipurpose enhancement board from its box.
3. Open the door panel on the 7500B.
    a. Insert a pen into the small hole near the LINE label on the back panel.
    b. Push in on the tab in the hole while you pull up on that side of the door.
    c. Repeat steps a and b for the other side of the door panel by sticking the pen into the small hole near the PORT 2 label.
    d. Lift off the door and set it aside.
4. Remove the protective cover from the PORT 2 slot (see Figure 3-25).
    a. Hold the cover (the marked area) for the PORT 2 slot in one hand and the rest of the rear panel in the other.
    b. Gently move the cover back and forth until the cover separates from the rear panel.
    c. Discard the cover.

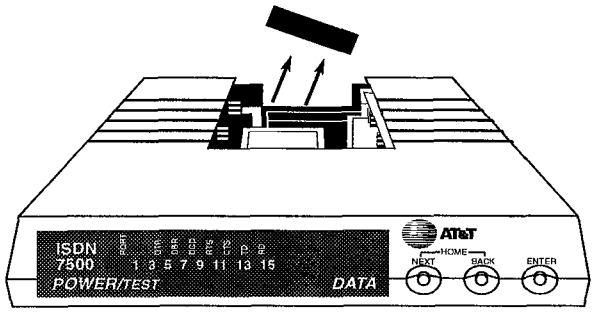


Figure 3-25. Removing the cover from PORT 2 of the Data Module

5. Install the multipurpose enhancement board (see Figure 3-26).
   a. Holding the enhancement board with the EIA-232D connector pointed toward the back of the 7500B and with the component side down, position the board over the open area of the 7500B.
   b. Attach the pigtail connector to the pin between the power connector and the screw for the EIA-232D connector.
   c. Position the board so that its cutouts correspond to the notches in the plastic housing.
   d. Gently push on the board until it is firmly in place and the edges of the board rest on the notches in the housing.

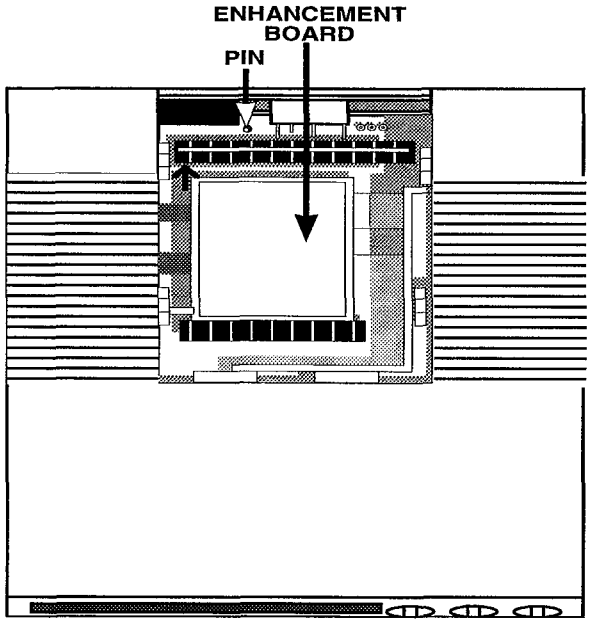


Figure 3-26. Installing the High-Speed, Synchronous, Enhancement Board

6. Close the door panel by hooking the hinges under the front housing and then snapping the rear tabs into place.
7. Peel off the label indicating the EIA-232D interface from the enhancement board package and stick it to the rear panel under the PORT 2 connector.
8. Plug the D8W cord into the jack labeled LINE.
9. Plug the power supply cord for the 7500B into the connector labeled POWER.

10. Plug the male end of the EIA-232D cable into PORT 1.
11. Connect the other end of the EIA-232D cable to the data terminal or computer port.
12. If the automatic calling unit function is to be used, connect a 25-pin EIA cable between the RS-366 interface (PORT 2) and the computer's RS-366 ACU interface.
13. Plug the power cord for the 7500B into the AC outlet.
14. Plug the D8W cord into the telephone wall jack.

NOTE:
Before plugging the D8W cord into a wall jack, make sure you do not need the terminating resistor adapter. If you need it, see "Installing the Terminating Resistor Adapter" later in this chapter.

Standalone, High-Speed, Synchronous DCE Configuration. Follow the steps below to configure the ISDN 7500B Data Module for high-speed, synchronous modem operation.

1. Remove the 7500B from its box or turn off the power if the 7500B is already installed.
2. Remove the high-speed, synchronous enhancement board from its box.
3. Open the door panel on the 7500B.
    a. Insert a pen into the small hole near the LINE label on the back panel.
    b. Push in on the tab in the hole while you pull up on that side of the door.
    c. Repeat steps a and b for the other side of the door panel by sticking the pen into the small hole near the PORT 2 label.
    d. Lift off the door and set it aside.
4. Remove the protective cover from the PORT 2 slot (see Figure 3-25).
    a. Hold the cover (the marked area) for the PORT 2 slot in one hand and the rest of the rear panel in the other.
    b. Gently move the cover back and forth until the cover separates from the rear panel.
    c. Discard the cover.

5. Install the high-speed, synchronous enhancement board (see Figure 3-26).
    a. Holding the enhancement board with the EIA-232D connector pointed toward the back of the 7500B and with the component side down, position the board over the open area of the 7500B.
    b. Attach the pigtail connector to the pin between the power connector and the screw for the EIA-232D connector.
    c. Position the board so that its cutouts correspond to the notches in the plastic housing.
    d. Gently push on the board until it is firmly in place and the edges of the board rest on the notches in the housing.
6. Close the door panel by hooking the hinges under the front housing and then snapping the rear tabs into place.
7. Plug the D8W cord into the jack labeled LINE.
8. Plug the power supply cord for the 7500B into the connector labeled POWER.
9. Connect a V.35 adapter cable (packaged with the enhancement board) to PORT 2.
10. Connect a V.35 cable between the adapter and the V.35 data terminal.
11. Plug the power cord into the AC outlet.
12. Plug the D8W cord into the telephone wall jack.

NOTE:
Before plugging the D8W cord into a wall jack, make sure you do not need the terminating resistor adapter. If you need it, see "Terminating Resistor Adapter Installation" below.

Terminating Resistor Adapter Installation

Connect a terminating resistor adapter to the D8W cord going to the wall jack if there is no MLX telephone connected to the ISDN 7500B Data Module. This adapter provides 100 ohms to terminate the line.

Modems

A modem is used at an analog data station to place and/or answer data calls. It converts the digital signals from the data terminal into analog signals for transmission over standard telephone lines. It also converts incoming analog signals to digital signals for acceptance by the data terminal.

Hardware Requirements

Most modems can be connected to the system. If a modem is used in a modem pool, an AT&T 2224G modem or its equivalent must be used (see "Modem Pool" later in this chapter).

If you use a modem with an MLX telephone, install a Multi-Function Module (MFM) in the telephone to provide a tip/ring interface for the modem. Connect the modem directly to the MFM. If the modem is used with an analog multiline telephone, a General Purpose Adapter is required to provide a tip/ring interface for the modem. (See "Install the Multi-Function Module" later in this chapter and "General Purpose Adapter" in Chapter 5 for more detailed information.)

When a modem is connected to an MLX telephone using an MFM, dial data calls using the data terminal keyboard and dial voice calls using the telephone dialpad. The MLX telephone cannot be used to dial data calls, and the data terminal cannot be used to dial voice calls. Each device operates independently, and features are assigned to each device independently.

When a modem is connected to an analog multiline telephone using a GPA, data calls and voice calls are dialed by using the telephone dialpad. The modem and telephone do not operate independently; features assigned to the telephone also apply to the analog data station (modem and associated data terminal).

Modem Features

The modem used in an analog data station (and not in a modem pool) provides the following features:

- dialing or ending asynchronous data calls from the keyboard when connected to a tip/ring station jack on an 012, 016, or 008 OPT module or when connected to an MLX telephone using an MFM
- autobaud (also called data metering or speed matching), or the ability to adjust the speed of transmission to match the speed of the data terminal being called
- automatic or manual answering of incoming data calls
- self-test and maintenance procedures
- ability to set data options for the call on the keyboard and, if necessary, change the options without dropping the call

Modem Pool

A modem pool (also called a conversion resource) is made up of one or more pairings of an ISDN Terminal Adapter and a modem. The modem pool is used to convert data signals from digital to analog or to convert data signals from analog to digital. This allows data communications between digital data stations and analog data stations.

There are two types of modem pools:

- **Analog-to-Digital** converts analog signals to digital signals. This allows analog data station users to communicate with inside digital station users. The modem is connected to the control unit by a basic station jack on an 012 or 016 module, and the ISDN Terminal Adapter is connected to the control unit by a digital station jack on an 008 MLX module. Data calls are placed to outside data stations through the control unit using system lines.
- **Digital-to-Analog** converts digital signals to analog signals. This allows digital data station users to communicate with inside analog data stations or to place data calls using the regular telephone network.

  The modem is connected to the control unit by a tip/ring jack on an 012, 016, or 008 OPT module, and the ISDN Terminal Adapter is connected to the control unit by a digital station jack on an 008 MLX module. Data calls are placed to outside data stations through the control unit using system lines (outside lines/trunks connected to a line/trunk jack on a 100D, 100E, 400, 400EM, or 800 module in the control unit).

Analog-to-digital and digital-to-analog pools can also connect dedicated outside analog data lines to digital ports (008 MLX module) on the system.

Because of interfacing problems between the RS-232 on the modem with the RS-232 on the 7500B, modem pools can operate in one direction only — analog-to-digital or digital-to-analog.

Hardware Requirements

A modem pool requires an ISDN Terminal Adapter and an AT&T 2224G modem or its equivalent. Since the ISDN Terminal Adapter operates without an MLX telephone, if the ISDN Terminal Adapter in a modem pool is an ISDN 7500B Data Module, a 100-ohm 440A4 terminating resistor adapter must be installed on the line near the 7500B. The 7500B Data Module does not provide termination. This requirement does not apply to the ExpressRoute 1000.

The ISDN Terminal Adapter can be configured as a standalone by ordering a WP-90110,L1 (117 VAC) or WP-90110,L8 (220 VAC) power unit. The ISDN Terminal Adapter can also be configured in a multiple-mount arrangement by ordering a Z77A data mounting, which provides a common power supply for up to eight ISDN Terminal Adapters. Both the power unit and the data mounting require a 117 VAC or 220 VAC power outlet. Neither is provided with the ISDN Terminal Adapter, and both must be ordered separately.

The modem used in a modem pool must have the following features:

- full-duplex operation
- 10-bit code support (start, 8 data bits, stop)
- RS-232 asynchronous interface
- any or all of the following data rates: 300, 1200, 2400, 4800, and 9600 bps
- supports DTMF dialing via the RS-232 interface
- ability to turn on or maintain the Clear-to-Send indicator when it is ready to receive ASCII dialing sequences from the data module in response to a Data-Terminal-Ready signal from the data module
- ability to keep the Data-Set-Ready lead on (and not turn it off) during transition from the interactive dialing mode to the data mode
- ability to terminate a data call or dialing sequence when the data module turns off its Data-Terminal-Ready lead
- ability to turn off the Data-Set-Ready or Receive-Line-Signal detect lead for a minimum of 50 ms when hanging up at the termination of a data call
- ability to turn on the Ring indicator lead for at least 100 ms in the presence of an incoming analog call
- supports Electronic Industries Association (EIA) signals CI and CI2 if the modem is multispeed

Option Settings Requirements

The options set on a modem and an ISDN Terminal Adapter in a modem pool differ depending on whether the modem pool is digital-to-analog or analog-to-digital.

Following are the options required for the modem and ISDN Terminal Adapter for each type of modem pool. See the user manuals provided with the modem and the ISDN Terminal Adapter for instructions on how the options are set and the meaning of each option.

Digital-to-Analog Modem Pool Option Settings

Data Module Option Settings. Use the following procedure to prepare the ISDN 7500B Data Module for operation in a digital-to-analog modem pool:

1. Use the instructions provided in the 7500B user manual to set the DCE/DTE flip board to the DTE position.
2. Use the front panel controls on the 7500B to set the options on the display (see Table 3-28). See the ISDN 7500B Data Module user's manual for detailed information on using the front panel controls and the meaning for each option.

Table 3-28. ISDN 7500B Data Module Option Settings for Digital-to-Analog Modem Pool Operation

Position No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	L	1	:	3	3	3	0	0	0	b	0	0	1	0	1	1
	L	1	·	0	1	1	1	0	0	0	3	1	0	0	0	0

Note: b = blank, L = Line #

Modem Option Settings. The following procedure is one method to prepare the AT&T model 2224G modem for operation in a digital-to-analog modem pool. The procedure is only a recommended method and may be different if you are using another type of modem.

1. Connect a data terminal such as a PC to the modem and plug both the modem and data terminal into an AC outlet.
2. Use the instructions provided with the modem to set all bit-switches to their default positions; except set the switch 1, bit 2 to the right.
3. Save all bit-switch settings by unplugging the modem from the wall outlet and then plugging it back in.
4. Set the data terminal speed to match the modem's default speed.
5. The modem is now operating in the AT&T command protocol. Set the default software options:
   - Type "od"
   - Press Enter
6. Set all bit-switches according to Table 3-29.

7. Unplug the modem from the wall outlet; then plug it back in. Set switch 1, bit 2 to the left. This stores the switch settings in the modem's memory, and the modem is now operating in the AT command protocol.

Table 3-29. Modem Option Setting for Digital-to-Analog Modem Pool Operation

Switch	Bit Number							
	1	2	3	4	5	6	7	8
1	L	R	L	R	R	R	L	L
2	L	R	L	L	L	L	L	L
3	D	D	D	D	U	U	D	D
4	D	D	D	D	D	U	D	D
5	U	D	U	U	U	D	D	D
7	on	on						

Note: L = left, R = right, U = up, D = down

8. Enter command mode, set the options, and save the options into protected memory to prevent loss of settings in case of a power failure:
   - Type "AT" and press Enter to enter the local mode.
   - Type "AT&D2" and press Enter. Option set: drop call when DTR low.
   - Type "AT&C1" and press Enter. Option set: data carrier detect follow call.
   - Type "ATS0=1" and press Enter. Option set: Auto Answer.
   - Type "ATQ0" and press Enter. Option set: enable result codes (factory setting).
   - Type "AT&W" and press Enter to write options to protected memory.

Analog-to-Digital Modem Pool Option Settings

Data Module Option Settings. Use the following procedure to prepare the ISDN 7500B Data Module for operation in an analog-to-digital modem pool:

1. Use the instructions provided in the 7500B user manual to set the DCE/DTE flip board to the DTE position.
2. Use the front panel controls on the 7500B data module to set the options on the display (see Table 3-30). See the ISDN 7500B Data Module user's manual for detailed information on using the front panel controls and the meaning for each option.

Table 3-30. ISDN 7500B Data Module Option Settings for Analog-to-Digital Modem Pool Operation

Position No.:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	L	1	:	3	3	3	0	1	0	b	0	0	1	0	1	0
	L	1	:	0	1	1	1	0	0	0	3	1	0	0	0	0

Note: b = blank, L = Line #

Modem Option Settings. The following procedure is one method to prepare the AT&T model 2224G modem for operation in an analog-to-digital modem pool. This procedure is only a recommended method and may be different if you are using another type of modem.

1. Connect a data terminal such as a PC to the modem and plug both the modem and data terminal into an AC outlet.
2. Use the instructions provided with the modem to set all bit-switches to their default positions; except set the switch 1, bit 2 to the right.
3. Save all bit-switch settings by unplugging the modem from the wall outlet then plugging it back in.
4. Set the data terminal speed to match the modem's default speed.
5. The modem is now operating in the AT&T command protocol. Set the default software options:
   - Type "od"
   - Press Enter.
6. Set all bit-switches according to Table 3-31.

Table 3-31. Modem Option Setting for Analog-to-Digital Modem Pool Operation

Switch	Bit Number							
	1	2	3	4	5	6	7	8
1	L	R	L	R	R	R	L	L
2	L	R	L	L	L	L	L	L
3	D	D	D	D	U	U	D	D
4	D	D	D	D	D	U	D	D
5	U	D	U	U	U	D	D	D
7	on	on						

Note: L = left, R = right, U = up, D = down

7. Unplug the modem from the wall outlet; then plug it back in. Set switch 1, bit 2 to the left. This stores the switch settings in the modem's memory, and the modem is now operating in the AT command protocol.
8. Enter command mode, set the options, and save the options into protected memory to prevent loss of settings in case of a power failure:
   - Type "AT" and press Enter to enter the local mode.
   - Type "AT&D2" and press Enter. Option set: drop call when DTR low.
   - Type "AT&C1" and press Enter. Option set: data carrier detect follow call.
   - Type "ATS0=1" and press Enter. Option set: Auto Answer.
   - Type "ATQ1" and press Enter. Option set: disable result codes.
   - Type "AT&W" and press Enter to write options to protected memory.

System Wiring

System wiring involves two installations:

- connecting the network interface to the control unit
- connecting the control unit to the stations

On the network interface side, the method of connection depends on the type of network interface that is installed.

On the station side, the method of connection depends on the number of stations; 24 stations and under uses direct connection, while over 24 stations requires building a cross-connect field.

The recommended options for building the wiring field on the station side are Interconnect Wire, a complete wiring kit that uses 110 jack-panel blocks, a template, wiring troughs, D-rings, and D8W cords; or SYSTIMAX, a complete wiring kit containing 110 termination blocks with modular jacks, a 110A field-termination block, a template, wiring troughs, D-rings, and patch cords.

⚠ WARNING:
Building codes may specify the type of cable required for telecommunication wiring. For example, indoor wiring (DIW) cable cannot be used inside or on top of air plenums or ducts, along hot pipes, or across walkways.

Category 3 (Level 3) components represent the minimum transmission performance acceptable for horizontal cabling systems.

⚠ CAUTION:
To avoid coupling power supply noise onto system wiring, allow at least 8 cm (3 inches) of clearance between the basic carrier's power supply and any wiring or termination hardware located left of the control unit.

⇒ NOTE:
While there are many ways to connect the network interface to the control unit and the control unit to the stations, the methods shown here are the recommended ones.

If staples are used to fasten the cords to walls or baseboards, check that the cords have not been pierced. Also, do not run CO lines from the network interface to the control unit if the distance is greater than 8 m (25 feet).

Connect the Network Interface to the Control Unit

The local telephone company installs the network interface for the CO lines. Before you install the system, verify that the network interface is the proper type and that it is located within 8 m (25 feet) of the control unit. The adapter needed to connect the CO lines to the control unit depends on the type of network interface, as shown in the following table.

⚠ CAUTION:
To avoid coupling power supply noise onto system wiring, allow at least 8 cm (3 inches) of clearance between the basic carrier's power supply and any wiring or termination hardware located left of the control unit.

Table 3-32. Network Interface

Network Interface	Description	Adapter
RJ11-type	Connects one outside loop-start (LS) or Direct Inward Dialing (DID) line/trunk to one modular jack	
RJ14-type	Connects two outside lines/trunks to one modular jack (LS and DID)	2-line adapter (267C-type)
RJ21X	50-pin connector connects 25 outside lines/trunks (LS and DID)	110AB1 jack-panel block
RJ2GX	50-pin connector for up to eight tie trunks	356A for eight tie trunks 259A for one tie trunk
RJ48C/X	Connects DS1or E1 facilities to a 4-pair jack (two active pairs)	Z601A if modular cords are used

NOTE:
The E1 cable has a modular jack at one end and a BNC connector at the other. If the BNC connector is not appropriate for the network interface provided by the CO, cut the BNC connector end of the cable and set up a twisted pair connection, using the transmit-and-receive pairs.

On the modular jack, the transmit pair is associated with pins 4 and 5 (the green and red wires). The receive pair is associated with pins 1 and 2 (the grey and brown wires).

After installing the adapter, label each jack going to the control unit with the CO line number. Use the list provided by the local telephone company or the planning form(s) for outside lines/trunks as a reference.

You may also need to know the interface codes for network facilities. These codes are shown in the following table by trunk type and adapter type.

Table 3-33. CO Network Interface Codes

Line/Trunk Type	Network Interface
LS CO line	RJ11C, RJ14C, RJ21
DID	RJ11C, RJ14C, RJ21
OPS	RJ11C
Tie trunk	RJ2GX
DS1	RJ48C/X*
E1	dual BNC

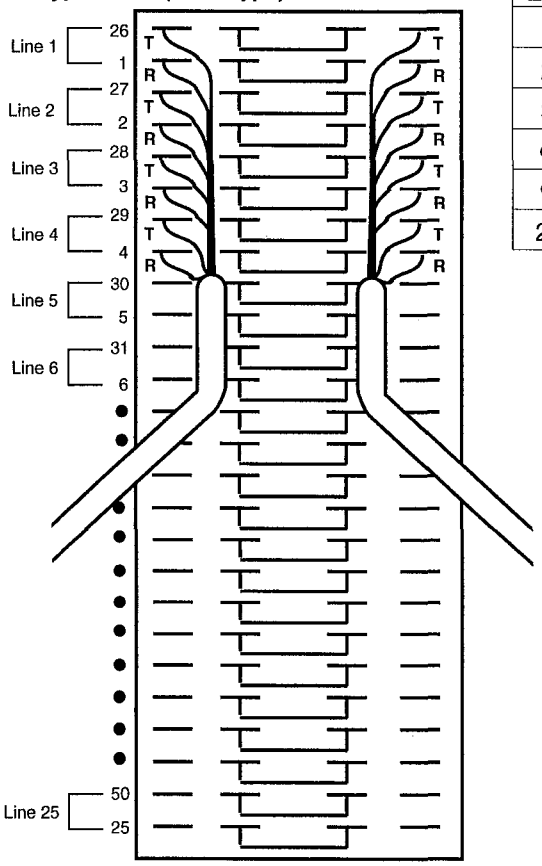
*. The preferred network interface is the RJ48X. With the RJ48X interface, if no connection is provided by the customer's equipment, the T1 facility's receive pair is looped back to the transmit pair. This simplifies troubleshooting the T1 facility.

In most installations, the network interface is connected through a cross-connect field to the control unit. However, for systems with fewer than 24 stations, the line/trunk wires can be directly connected to the control unit.

NOTE:
When constructing wiring fields between the network interface and the control unit, you must order hardware as individual parts. Do not use Interconnect Wiring or SYSTIMAX kits.

RJ21X Interface

The RJ21X interface has a female 50-pin (25-pair) amphenol connector (see Figure 3-27).



Line	Tip	Ring	Phone Number
1	26	1	555-3827
2	27	2	555-3828
3	28	3	555-3829
•	•	•	• • •
•	•	•	• • •
25	50	25	555-3851

Figure 3-27. RJ21X Interface with Female 50-Pin (25-Pair) Connector

To connect the RJ21X interface to the control unit, you must build a wiring field between the RJ21X interface and the control unit. This field, in effect, converts the female amphenol connector to 8-wire modular jacks.

Building the Wiring Field

Build the wiring field between the network interface and the control unit by using 110AB1-100JP12 terminal blocks with modular jacks and associated hardware. Use the hardware and procedure below to build this wiring field.

Hardware (see Figure 3-28)

- D-rings
- 110A1 wire troughs
- 110AB1-100JP12 termination blocks with modular jacks
- 110AB1-100FT field termination blocks
- D2R cords

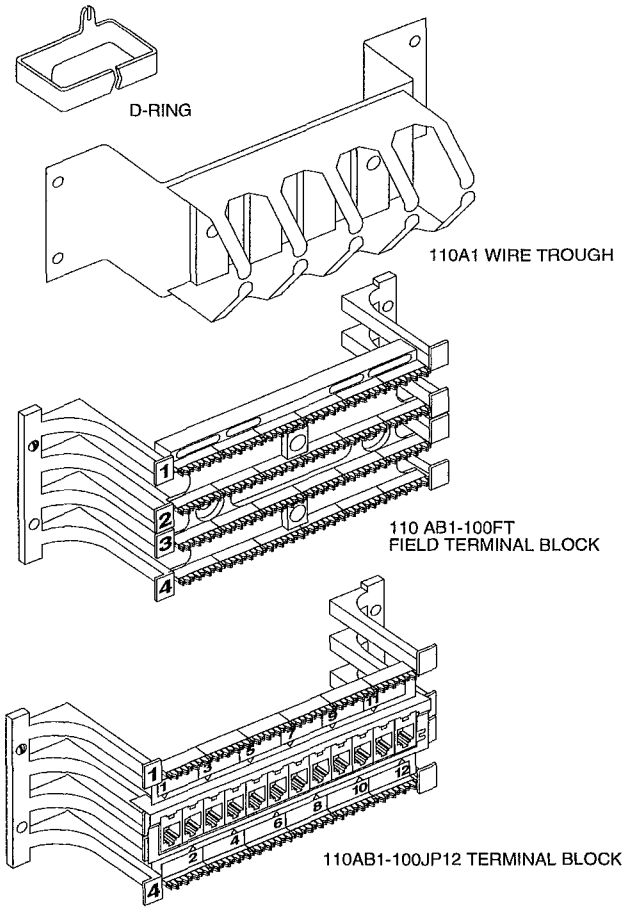


Figure 3-28. Hardware for Building the RJ21X Interface Wiring Field

Tools (see Figure 3-29)

- AT-8762 D-impact tool
- spudger
- 788 K1 retainer tool
- 110 impact tool 788J1
- modular plug pressers
- hand tools

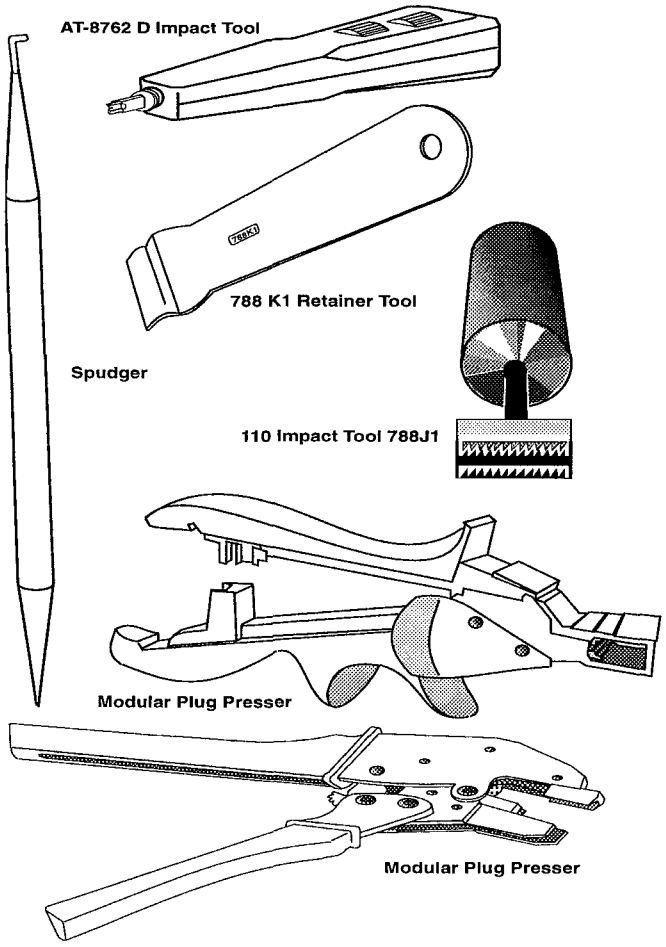


Figure 3-29. Tools for Building the RJ21X Interface Wiring Field

Procedure

Follow these steps to connect the RJ21X network interface to the control unit:

1. Drill two diagonally opposite holes in a suitable backboard (plywood is recommended) for each piece of hardware. Keep 2 mm (1/16-inch) space between each piece of hardware.
2. Mount the wire troughs and the termination blocks. There is a wire trough above and below each termination block.
3. If necessary, repeat steps 1 and 2 for a second column.
4. Run the 25-pair amphenol cable on the RJ21X interface to the termination blocks. If more length is needed, an A25D male-connector, single-ended, 25-pair, non-plenum cable can be used.
5. As needed, mount D-rings to properly dress the wires.
6. Cut off the amphenol connector on the cross-connect field side and strip the wires for each of the 25 pairs.

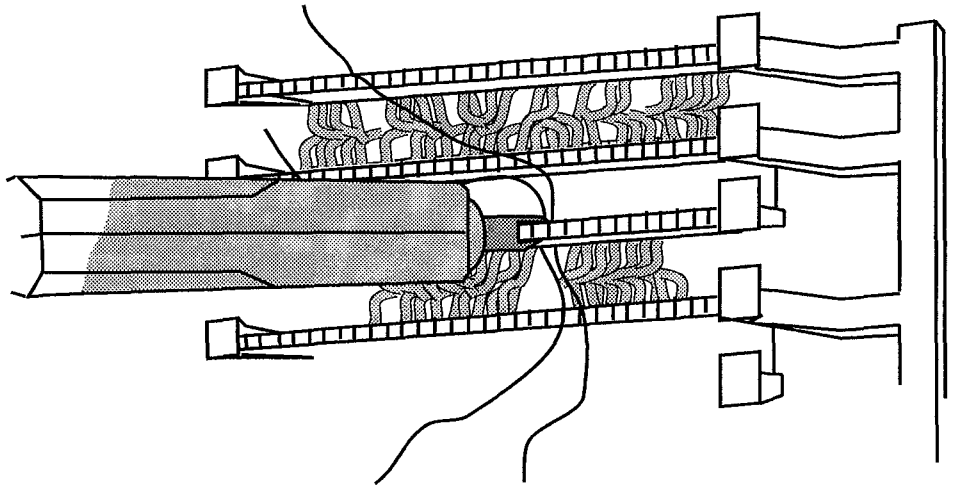


Figure 3-30. Punching Down the 25-Pair Wires

7. Punch down the 25-pair wires to the termination block:
    a. Route the wires through the fanning slots on the termination block.
    b. Insert the conductors into the designated 110 connecting blocks already on the termination block.
    c. Use the D-impact tool to seat the conductors (see Figure 3-30).
    d. Remove any insulation fragments with a spudger.

8. Test the CO lines for proper connection (see "Testing CO Lines/Trunks" in this chapter).
9. Label the network interface jacks, control unit module jacks, termination blocks, and D2R cords properly (see "Labeling CO Lines/Trunks" in this chapter).
10. For each line/trunk, plug one end of a D2R cord into the designated jack on the termination block and the other end into the line/trunk jack on the proper control unit module.

NOTE:
The modular jacks on the termination block are 8-wire jacks. The D2R cords are only 6-wire cords, but they will plug into the 8-wire jacks.

CAUTION:
Do not plug an analog multiline telephone, an MLX telephone, or anything else from the station side of the control unit into this wiring field on the CO side. Doing so will busy-out the line/trunk and/or damage the telephone or adjunct from ring current.

RJ11 and RJ14 Interfaces

The RJ11 and RJ14 interfaces are connected in nearly identical ways, but the RJ11 interface connects one CO line per jack, while the RJ14 interface connects two lines per jack. Plug a 267C-type adapter into each RJ14 jack (see Figure 3-31).

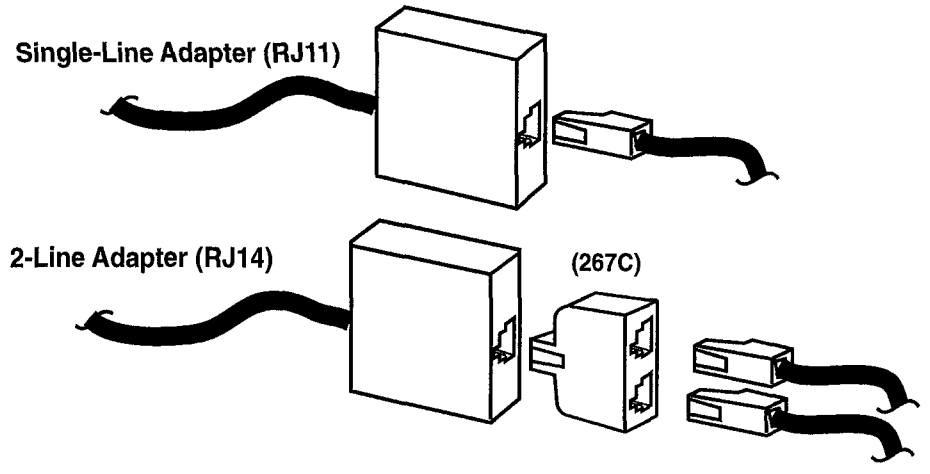


Figure 3-31. RJ11 and RJ14 Interfaces

Hardware

- D2R cords

Procedure

Follow these steps to connect the RJ11 and RJ14 network interfaces to the control unit.

1. Test the CO lines for proper connection (see "Testing CO Lines/Trunks" in this chapter).
2. Label the network interface jacks, the control unit module jacks, and the D2R cords properly (see "Labeling CO Lines/Trunks" in this chapter).
3. Plug one end of a D2R cord into the jack at the network interface and the other end into the appropriate line/trunk jack on the control unit.
4. Dress the wires properly.

RJ2GX Interface

The RJ2GX interface is a 25-pair amphenol connector that interfaces up to eight tie trunks. You construct the cross-connect field in the same way as for the RJ21X interface (see "RJ21X Interface" earlier in this chapter).

NOTE:
RJ21X and RJ2GX interfaces do not require separate termination blocks. If there is room on the termination block for the line wires, both the RJ21X and the RJ2GX can be punched down on the same 110AB1-100JP12 block. Any wires not used are left unterminated.

CAUTION:
Be careful not to connect tie trunks to LS or DID ports and vice versa. Since all the jacks on the termination block are 8-wire jacks, it is possible to accidentally interchange tie-trunk wires with LS or DID wires.

RJ48C/X Interface

The RJ48C/X interface terminates a DS1 line at the customer's premises. Both RJ48C and RJ48X interfaces have 8-wire modular jacks. However, the RJ48X interface includes shorting bars that loop the T1 facility's receive pair to the transmit pair. This helps in testing the T1 facility from the CO.

Testing CO Lines/Trunks

Before connecting the CO lines/trunks to the control unit, you must verify that a dial tone is being received and that you can dial out on every line.

NOTE:
DID trunks can be tested only through the control unit; do not test DID trunks at this time.

CAUTION:
Do not use analog multiline telephones or MLX telephones for testing. They do not work for these tests and can be damaged if you use them for this purpose.

Test Loop-Start Lines/Trunks

To perform this test, you need a single-line telephone or an installer's test telephone (craft set). (If you are installing rotary dial lines/trunks, you should perform this test with a rotary telephone.)

1. Plug the telephone or the craft set into each CO line jack (either at the network interface or at the cross-connect field) and listen for a dial tone.
2. If you find a CO line that does not have a dial tone, check for a bad adapter or loose connections.
3. If adapters and wiring are in working order but you still don't hear a dial tone, notify the customer.
4. If you hear a dial tone, dial a known telephone number to verify dialing. Also check that you have good two-way transmission after the CO completes the connection.
5. If outward dialing is not possible on any of the lines, notify the customer.

NOTE:
It is the customer's responsibility to report service outages to the local telephone company.

Labeling CO Lines/Trunks

You can have up to 80 CO line jacks on the communications system (01 to 80). Follow the procedure in this chapter to label each D2R or D8W cord, network interface jack, and control unit module jack.

Procedure

1. Review the system planning forms to determine each CO line assignment on the control unit.
2. Place a green cord label (packaged with the basic carrier) at each end of every D2R or D8W cord. The green label indicates the number of the CO line jack to which the cord is connected.
3. Label the jacks on the termination blocks.
4. Leave a copy of the CO line assignment planning form in a secure spot near the control unit.

Connect the Control Unit to the Stations

The following recommended methods of wiring the system from the control unit to the stations are divided according to the number of stations: 24 stations and under, and over 24 stations.

⚠ CAUTION:
To avoid coupling power supply noise onto system wiring, allow at least 8 cm (3 inches) of clearance between the basic carrier's power supply and any wiring or termination hardware located left of the control unit.

NOTE:
You must record each station jack connection and each station change on the "System Technician's Run Sheet" (see Appendix E).

NOTE:
If switchhook flash is generated by pressing a flash button (typically available on touch-tone telephones), the flash duration is a fixed duration determined by the manufacturer of the set. Any telephone without a fixed flash button sends a variable switchhook flash that is dependent upon the length of time the switchhook is pressed. For this reason, it is recommended that sets with a fixed flash and sets with a variable flash be configured on separate slots.

24 Stations and Fewer

For a system with up to 24 stations, direct wiring is recommended. To do this, plug in one end of a DIW cord into the station jack on the control unit module and connect the other end to the 103/104 wall jack of the station.

Hardware (see Figure 3-32)

- DIW cords
- cable ties
- Unicon plug

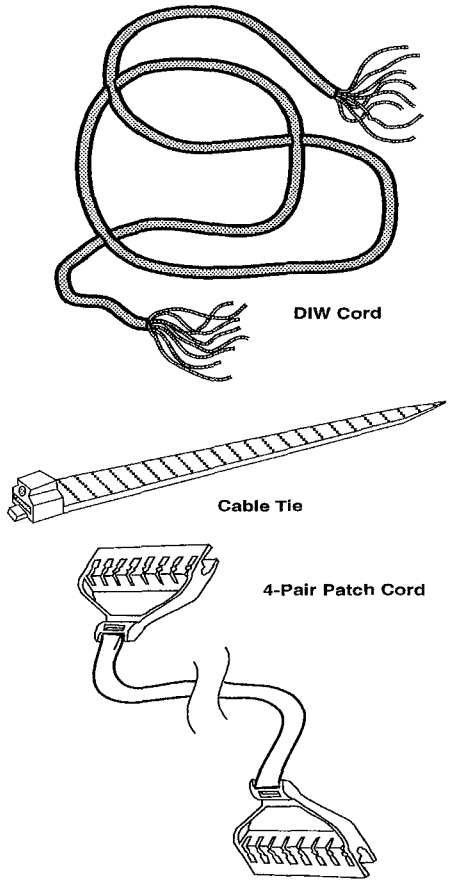


Figure 3-32. Hardware for Connecting up to 24 Stations to the Control Unit

Tools (see Figure 3-29)

- 4-pair plug presser

Procedure

1. Run the DIW cord from the control unit to the station and cut it. Allow enough slack for dressing the wire.
2. Attach a Unicon plug to the control unit end of the DIW cord by using the 4-pair plug presser.
3. Plug the DIW cord into the control unit and connect the other end to the station jack (see "Terminating Cable at a Station Outlet" in this chapter).
4. Repeat steps 1 to 3 for each station line.
5. Dress the wires properly by using cable ties. Fasten wire runs vertically to the left or right of the control unit. The final horizontal wire run to the control unit must be fastened within 30.5 cm (1 foot) of the control unit. Allow sufficient slack to reach any port on the control unit.
6. Label the control unit module jacks, station jacks, and DIW cords properly (see "Label the System Wiring" in this chapter).

More than 24 Stations

For systems with more than 24 stations, the two recommended methods are Interconnect Wiring and SYSTIMAX.

Interconnect Wiring

Interconnect Wiring is required when the system has more than 24 stations and SYSTIMAX has not been ordered. The Interconnect Wiring module provides the hardware to interconnect up to 12 stations with 110-type wiring.

For Interconnect Wiring, you must build a jack field between the control unit and the stations by using 110AB1-100JP12 termination blocks with modular jacks and 110A1 wire troughs.

Hardware

Each kit includes:

- instructions and parts sheet
- 110AB1-100JP12 termination blocks with modular jacks
- 110A1 wire troughs
- D-rings
- D8W cords

Tools (see Figure 3-29)

- D-impact tool
- spudger
- hand tools

Procedure

1. Drill two diagonally opposite holes in a suitable backboard (plywood is recommended) for each piece of hardware. Keep 2-mm (1/16-inch) space between each piece of hardware.
2. Mount the wire troughs and the termination blocks. There is a wire trough above each termination block.
3. If necessary, repeat steps 1 and 2 for a second column.
4. Mount the termination blocks and terminate the station cable. If the station cable is bottom feed, start at the top and work down. If the station cable is top feed, start at the bottom and work up.
    a. Mount a termination block to the wall with appropriate fasteners.
    b. Strip the jacket off the 4-pair DIW station wires, exposing the conductors.
    c. Punch down the station wires to the termination block:

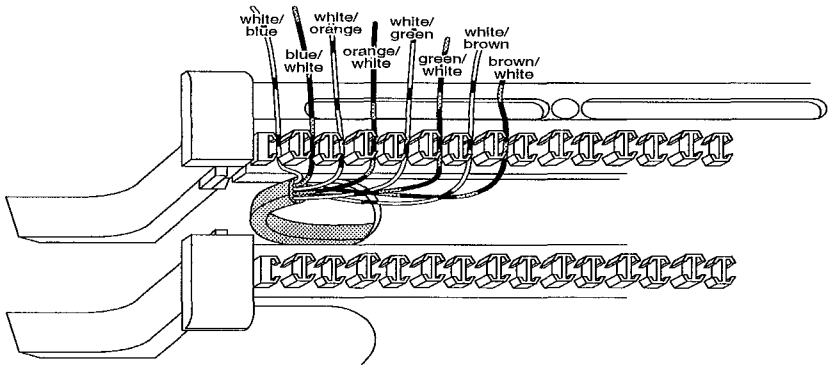


Figure 3-33. Color Sequence for Punching Down the DIW Station Wires

1. Route the station wires underneath the termination block and through the fanning slots.
2. Insert the conductors into the designated 110 connecting blocks already on the termination block. Follow the color sequence shown in Figure 3-33.

3. Use the D-impact tool to seat the conductors (see Figure 3-30).
4. Remove any insulation fragments with a spudger.

d. Repeat steps a through c above for each termination block.

5. Mount the wire troughs.
6. As needed, mount the D-rings.
7. Label the D8W cords, termination blocks, and DIW cords properly (see "Label the System Wiring" in this chapter).
8. Plug one end of a D8W cord into the station jack on the control unit module and the other end into the designated jack on the termination block. Do this for all stations.
9. Dress the wires through the wire troughs and D-rings (see Figure 3-34).

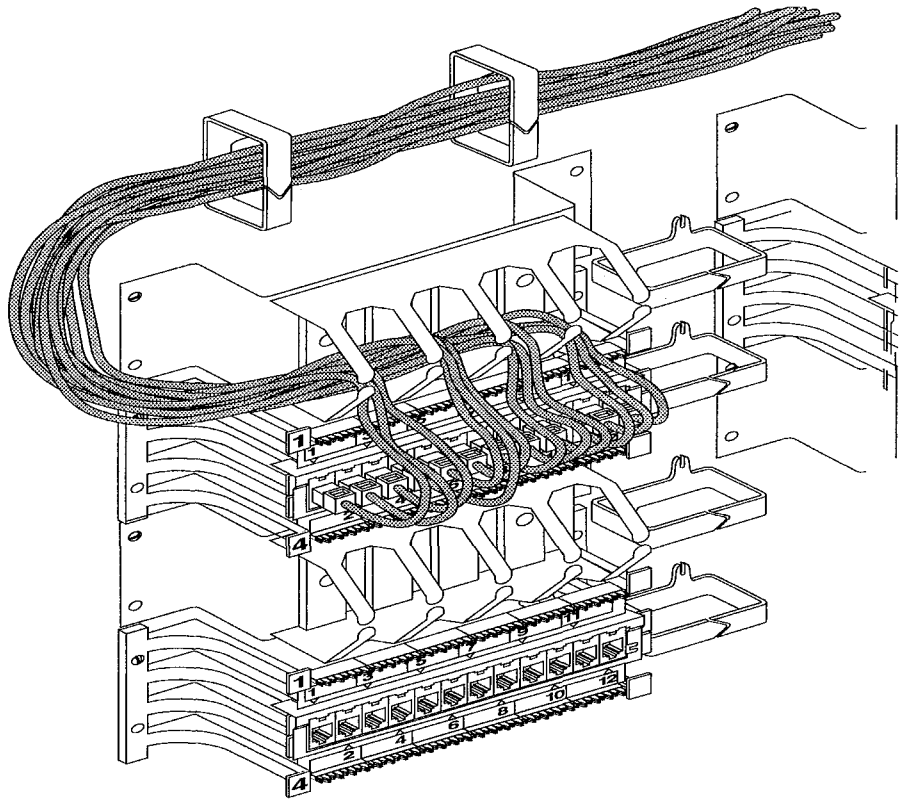


Figure 3-34. Dressing the Wires through the Troughs and D-Rings

SYSTIMAX

SYSTIMAX is a wiring method that uses kits containing all the hardware you need to build a cross-connect field between the control unit and the station jack.

⚠ CAUTION:
To avoid coupling power supply noise onto system wiring, allow at least 8 cm (3 inches) of clearance between the basic carrier's power supply and any wiring or termination hardware located left of the control unit.

With each kit you can build up to 24 jacks. The maximum number of stations on the system is 200 and would require nine kits.

Hardware (see Figures 3-28 and 3-32)

Each SYSTIMAX kit includes:

- instructions and parts sheet
- template
- two 110AB1-100JP12 termination blocks with modular jacks
- one 110AB1-100FT field-terminated block
- 110A1 wire troughs
- D-rings
- 110P8A5B patch cords
- D8W cords

Recommended Tools (see Figure 3-29)

- D-impact tool
- 788J1 impact tool
- spudger
- hand tools

NOTE:
These tools are not included in the SYSTIMAX kit; they must be obtained separately.

Procedure

1. Locate the proper wall space. The cross-connect field will usually be to the right of the control unit. Leave enough space between the control unit and the cross-connect field to allow for system growth.
2. Attach the template to the wall or backboard with a staple gun, tacks, or tape. Make sure that the upper edge of the template outline is 1.78 m (70 inches) above the floor and that the template is parallel to the floor (see Figure 3-35).

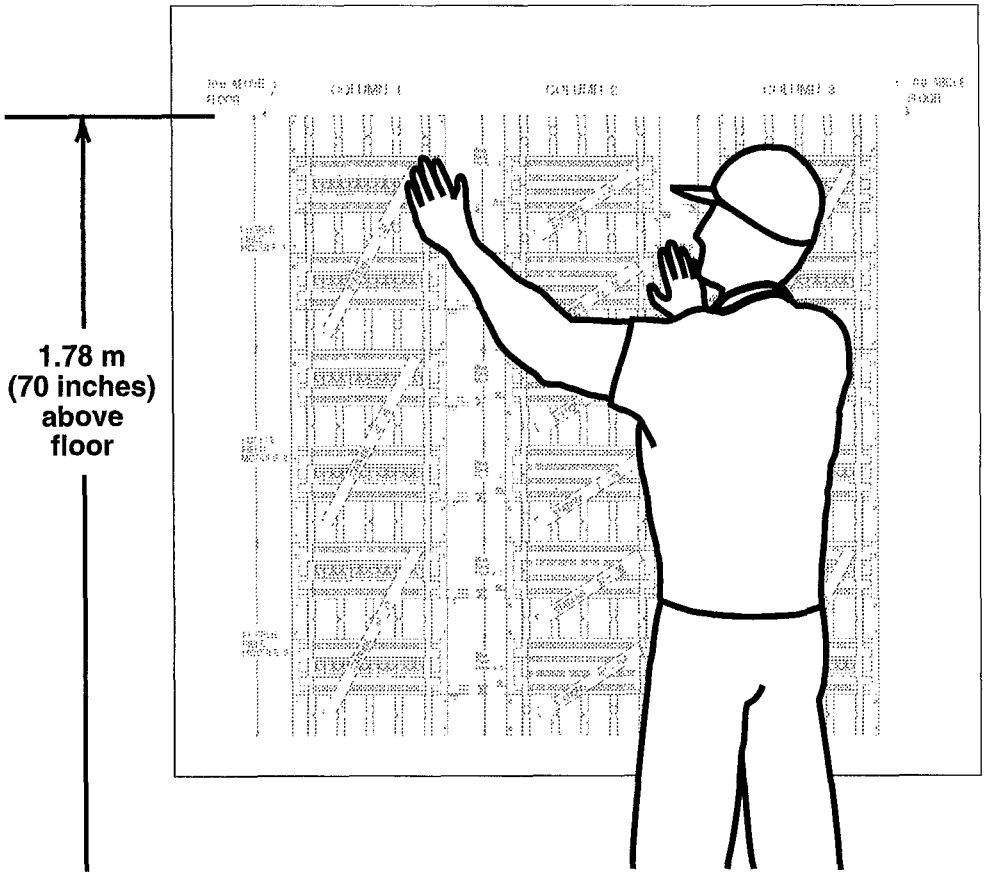


Figure 3-35. Attaching the SYSTIMAX Template to the Wall

3. Find the placement of the hardware on the template (see Figure 3-36). The first and third columns on the template show where the termination blocks go; the middle column shows the place for the field-terminated blocks.

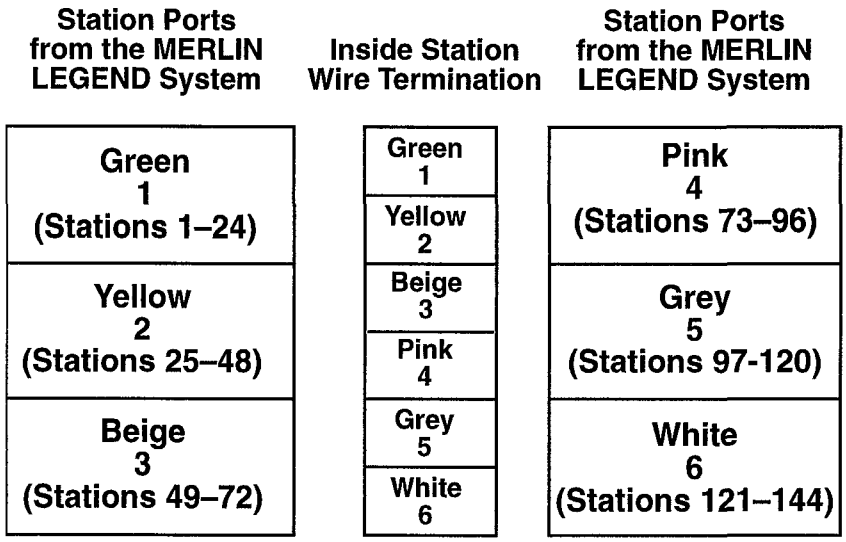


Figure 3-36. Placing the Termination Blocks and Field-Terminated Blocks Using the SYSTIMAX Kit Template Color Scheme

NOTE:
Keep the elements of each kit in the same-colored blocks. For example, the termination blocks of kit #1 go in the green section of column 1; the field-terminated block of kit #1 goes in the green section of column 2.

4. Drill two diagonally opposite holes for each piece of hardware. You can drill right through the template (see Figure 3-37). There is 2-mm (1/16-inch) space between the outline of each piece of hardware; keep this space as you mount the hardware.

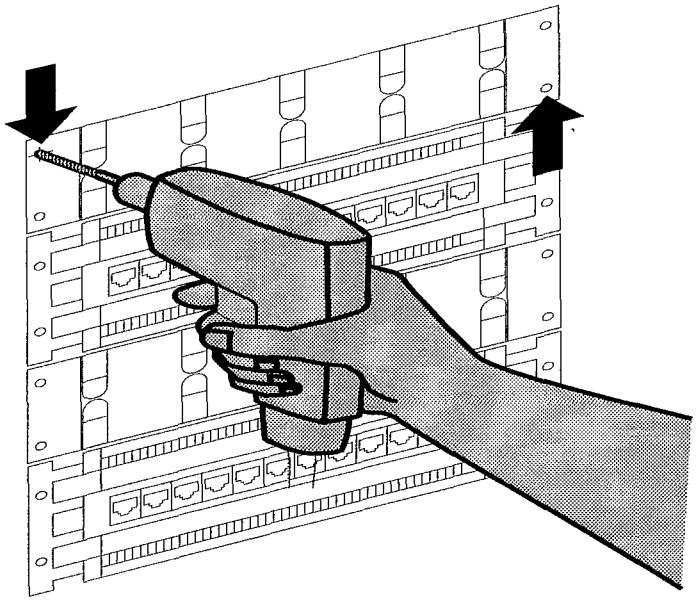


Figure 3-37. Drilling the Diagonally Opposite Holes for the Wire Troughs

5. Remove the template from the wall. Keep it in one piece so you can check it for correct placement of the hardware.
6. Mount the wire troughs and termination blocks on columns 1 and 3 as needed.
7. Mount the field-terminated blocks on column 2 and terminate the station cable. If the station cable is bottom feed, start at the top and work down. If the station cable is top feed, start at the bottom and work up. In either case, work on one field-terminated block at a time.
    a. Run the station cable underneath the field-terminated block.
    b. Strip 30.5 cm (1 foot) of jacketing off the cable, exposing the conductors.
    c. Press the conductors into the index strip on the field-terminated block according to the color sequence shown in Figure 3-33. Make sure each pair keeps its twist up to the index strip. (Each pair is split by a raised tooth on the index strip.)

d. Use the 788J1 impact tool to seat and trim the conductors (see Figure 3-38). Make sure the blade edge is positioned properly: blade up for rows 1 and 3, blade down for rows 2 and 4.

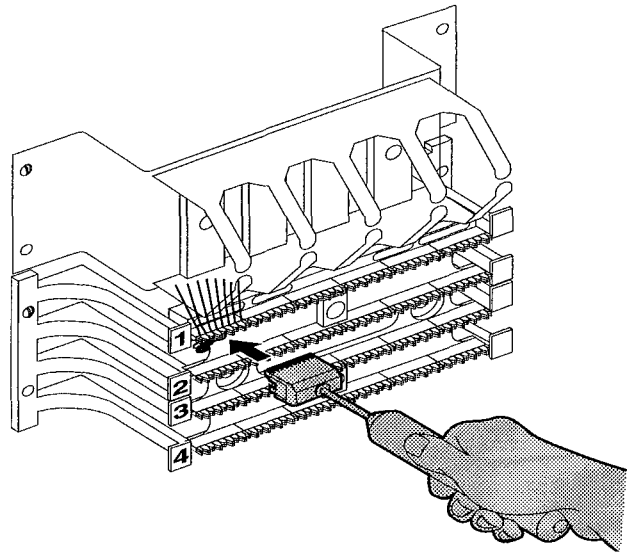


Figure 3-38. Seating and Trimming the Conductors

e. Continue seating and trimming conductors from left to right for each row.

NOTE:
The last two right-hand slots must remain vacant.

f. Reverse the blade edge on the 788J1 impact tool and use the tool to seat the connecting blocks on each index strip (see Figure 3-39). Make sure the slate strip on each connecting block is facing down.

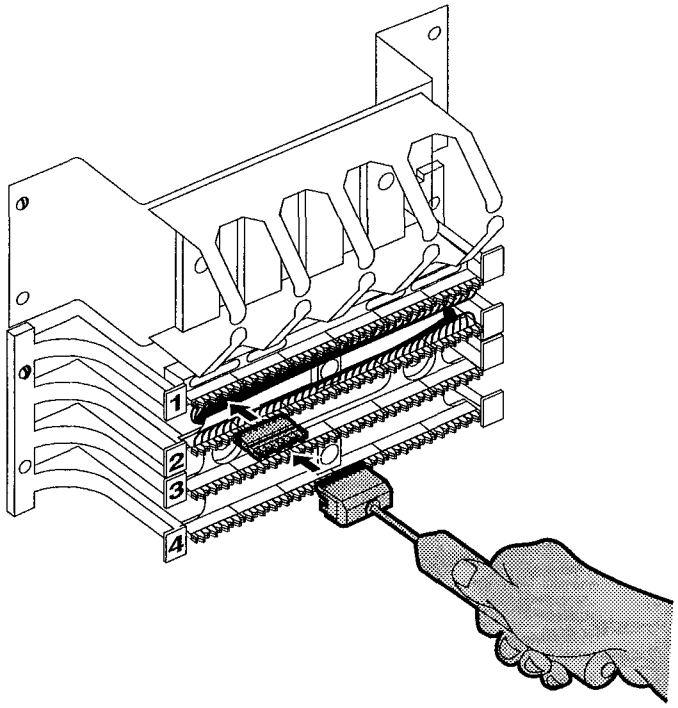


Figure 3-39. Reversing the Blade on the 788J1 Impact Tool

8. As shown on the template, mount the wire troughs on column 2 after all the field-terminated blocks have been wired.
9. Mount the D-rings between the columns as needed to dress the patch cords.
10. Plug one end of a D8W cord into the proper control unit module station jack and the other end into the corresponding jack on the termination block in column 1 or column 3. Repeat for all the D8W cords.
11. Dress the D8W cords through the wire trough above the termination block (see Figure 3-34).

NOTE:
Each kit has extra D-rings and wire troughs. Use them as needed to dress the cords.

12. Label the termination and field-terminated blocks (see "Label the System Wiring" in this chapter). Write the appropriate information (such as extension numbers and users' names) on the strip labels provided and snap the designation strips into place.
13. Use the 110P8A5B patch cords to connect termination blocks to field-terminated blocks (see Figure 3-40). Properly dress the patch cords through the wire troughs and D-rings.

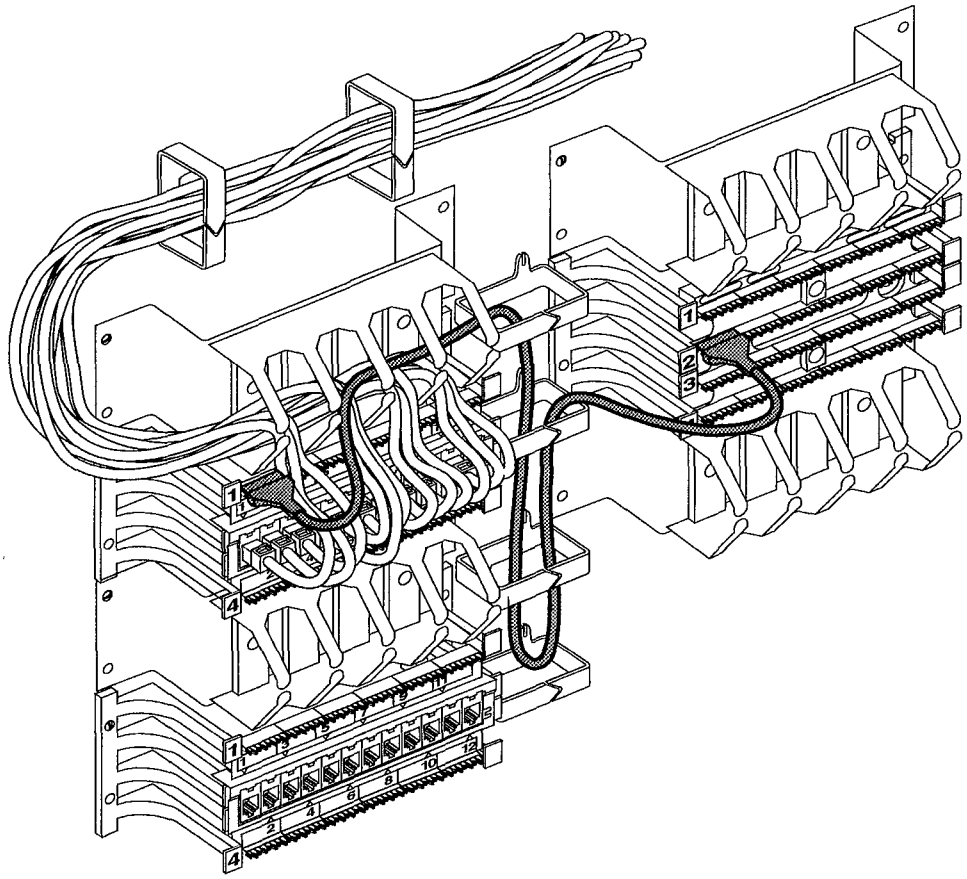


Figure 3-40. Connecting Termination Blocks to Field-Terminated Blocks

Wire a Telephone for Two Voice-Pairs

If an analog telephone requires either the Voice Announce to Busy feature or the Simultaneous Voice and Data feature, you must assign two adjacent odd/even station jacks (01 and 02, 13 and 14, etc.) on an analog station module to that telephone. The numbers of these station jacks are boxed on the planning forms.

Two voice-pairs (one pair from each jack) must be connected from the control unit to the telephone (see Figure 3-41). A bridging adapter is used to connect both voice-pairs to the telephone.

NOTE:
In Figure 3-41, the wire from station jack 7 connects to the jack labeled EVEN on the bridging adapter. The label on the bridging adapter refers to the default intercom number, which does not necessarily match the station jack number in terms of it being odd or even. Conversely, odd/even wiring refers to jack numbers, not intercom numbers.

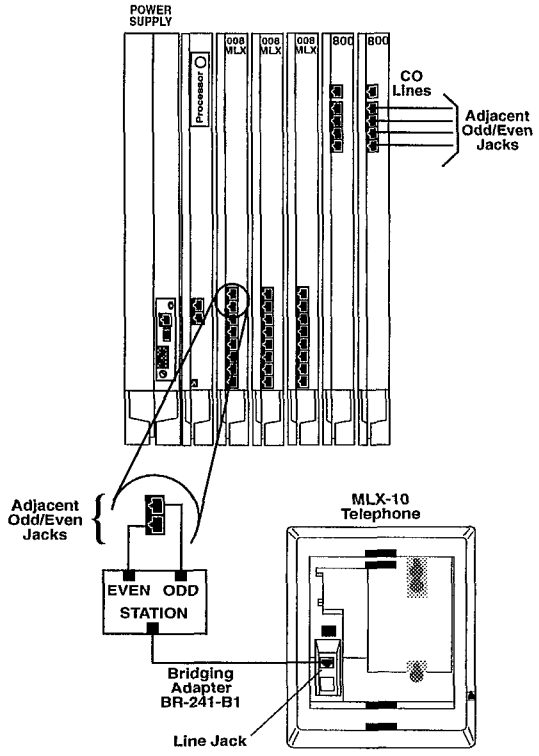


Figure 3-41. Wiring a Telephone for Two Voice-Pairs

Terminate Cable at a Station Outlet

There are many kinds of station outlets, which are fundamentally all the same. Some are wall-mounted, affixed directly onto a wall surface, and others are flush-mounted, where the jacks are located inside a wall housed in a regular electrical box. On the workstation side, a cord plugs into the jack; on the closet side, the 4-pair wire is hardwired to the outlet.

Following is one method to use when connecting 4-pair wire to a wall-mounted station outlet. You should be able to adapt the method used to join 4-pair wire to flush-mounted outlets.

NOTE:
In some cases the electrical boxes will already be mounted; in others the installer must do the job. In either case, the box should be installed before the wire is terminated on the outlet.

1. Take the outlet apart by first unscrewing the screw that holds the sections together; then pull off the termination clips.
2. Pull out approximately one meter (a few feet) of slack from the wall.
3. Use diagonal pliers to strip 8 to 10 cm (3 to 4 inches) off the end of the 4-pair wire.
4. Thread the conductors through a hole in the base of the outlet.
5. Press the wires into appropriate slots on the outlet (see Figure 3-42).
6. Use diagonal pliers to clip off the ends of the conductors.
7. Press the clips back on over the wires (see Figure 3-42).

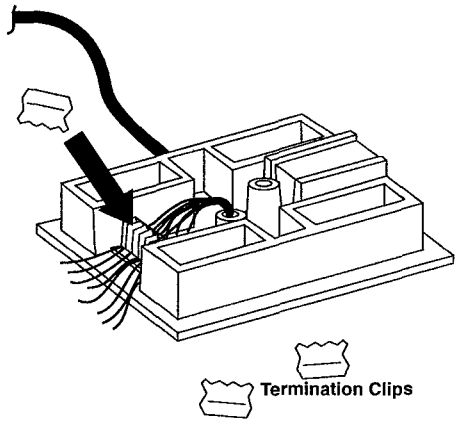


Figure 3-42. Terminating a Cable at a Station Outlet

8. Strip off the protective paper from the adhesive strips and press them onto the back of the outlet.
9. Press the outlet onto the wall.
10. As further security, also screw the outlet to the wall.
11. Screw the parts of the outlet together.

Label the System Wiring

If done correctly, labeling can provide valuable information about the location of wire or cable within the building and save hours of frustrating work.

There are five types of labels used for identification:

- **Cable labels**. Cable labels are white adhesive-backed tabs that are stuck to the cables to identify the source and the destination of the cables before they are pulled to and terminated in satellite closets and equipment rooms. The labels come in a variety of shapes and sizes to accommodate different sizes of cable. Use a pen or a felt-tip marker to write on the surface.
- **Field labels**. Field labels are adhesive-backed tabs that are applied to smooth surfaces in the equipment room and satellite closets. They identify components. Use a pen or a felt-tip marker to write on them.
- **Insert labels**. Insert labels are cardboard-like strips that slip inside the clear plastic designation strips located between the rows of a termination or field-terminated wiring block. They are color-coded to identify the origins of cables.

  Along with the color-coding scheme, alphanumeric codes on the labels help to identify the specific location of the same pair or series of pairs at the other end of the cable (see Table 3-34).
- **Jack labels**. Jack labels are small, white, rectangular-shaped stick-on tabs that are stuck to the cover plate or housing of station outlets. They identify the location of the satellite closet where the cable to that outlet is terminated and the number of the circuit.
- **Station cord labels**. The blue station cord labels are packaged with the control unit carriers and wrap around each end of the station cords leaving the control unit.

Table 3-34. Insert Labels

Color	What It Identifies	Special Features
Light blue	4-pair cable originating at station outlets in offices or other locations	The fourth pair of the 4-pair cable to MLX stations is reserved for supplying power to one DSS at an operator console.
White	Various types of riser (house) or campus cable connections	
Gray	Closet letter and circuit number	Used with 25-pair tie cables that link large riser closets and smaller satellite closets or two riser/satellite closets.
Green	CO pairs	Used only on the line/trunk or auxiliary field in the equipment room.
Purple	System-common equipment, such as a PBX or a data switch	Usually supplied with the system-common equipment.
Yellow	Auxiliary circuits arranged in 3-pair modularity	For auxiliary circuits not arranged in 3-pair modularity, use blank labels. If a system has customized labels for the auxiliary system, use them.
Orange	Connections from transmission electronics equipment, such as multiplexers or concentrators	Supplied by the equipment manufacturers.

Labeling 4-Pair Wire and Outlets

It doesn't matter whether you pull the 4-pair wire from the station to the control unit or from the control unit to the station. In either case, mark one end of the 4-pair wire with the location or destination of the other end.

NOTE:
In the following procedure, it is assumed you are pulling from the station to the control unit.

1. If you have not already received labeling instructions from the designer of your system, assign a number to each jack on the floor.
2. Put the boxes of wire near the offices (and jacks) to which they have been assigned.
3. Mark the end of each 4-pair wire with the number of the jack to which the wire has been assigned.
4. Mark the box with the letter of the closet to which the 4-pair is pulled and with the circuit number of the wire. This is the same as the number you wrote on the wire sheath. Wire 1 becomes circuit 1; wire 2 becomes circuit 2.
5. At the boxes next to the offices, pull out enough wire to reach the wall jacks. Allow plenty of slack. Cut the wire and mark the end of the 4-pair wire with the closet letter and the circuit number.
6. After you pull the wire into the office or work area and fish it through the wall opening for the wall jack, transfer the information to the faceplate of the jack itself. If you've done the job correctly, you should now have the correct closet letter and circuit number of the wire on the jack.
7. When the 4-pair wire reaches the control unit cross-connect field, punch down the pairs in the sequence they are labeled on the sheath.
8. On the blue labels designed for the 110-type field-terminated block, add any necessary information. With preprinted labels, you add only the floor number. With blank labels, you also have to write in the closet letter and the number from the wire sheath.

If no labeling exists, simply assign a different number to each 4-pair wire and write that number on both the box and the wire end. Anyone who comes after you will find both ends of the wire labeled with the same unique number and should be able to proceed accordingly.

Checking Poorly Labeled Wiring

If you don't understand the labeling system used or a label is missing or damaged, use a tone device and a telephone handset to match like wires.

Hardware

- tone device
- telephone handset
- telephone cord with an 8-pin modular plug
- 4-pair patch cord

Tools

- diagonal pliers or wire strippers

Procedure

1. Insert the 8-pin plug of the telephone cord into an outlet on the floor area.
2. Using diagonal pliers or wire strippers, cut off the end of the telephone cord to expose the pairs.
3. Choose a single pair and untwist the wires.
4. Extending from the bottom of the tone device are two clips. Attach one wire of the pair you have chosen to one of the clips and the other wire to the other clip.
5. Turn on the switch on the outside of the tone device. You will hear a high-pitched, alternating signal.
6. Take the telephone handset and a 4-pair patch cord to the cross-connect field between the control unit and the station.
7. Go to the blue field on the cross-connect field and, starting at the top left corner, push the patch cord onto the first connecting block.
8. Using the diagonal pliers or wire strippers, cut off the other end of the patch cord and expose the pairs. Do not cut off too much of the cord because you will need the length to test the top rows of the cross-connect field.
9. The handset also has two clips with "teeth" that extend from its base. Attach the clip of the handset to the exposed wires of the patch cord. Set the switch on the side of the handset to MONITOR.
10. Listen in the handset for the tone device signal.
11. If you hear the signal, you have found the correct wires. Correctly label both the cross-connect field and the outlet.
12. If you don't hear the signal, remove the patch cord from the connecting block and push the patch cord down onto the connecting block to the right of the one just tested. Keep moving the patch cord to the next connector block on the right until you find the pairs that carry the tone device signal.

Remove Damaged Connecting Blocks

In some cases, a connecting block can become damaged and must be removed.

Procedure

1. Remove the wires or the patch cord from the connecting block.
   - With interconnect wiring, remove the station wires with long-nosed pliers and tag the wires with tape to identify their position.
   - With SYSTIMAX, pull off the patch cord.
2. Place a 788K1 retainer tool against the conductor pairs beneath the connecting block to be removed.
3. Grip the connecting block in the center with pliers. Move the block gently up and down and pull it out (see Figure 3-43).

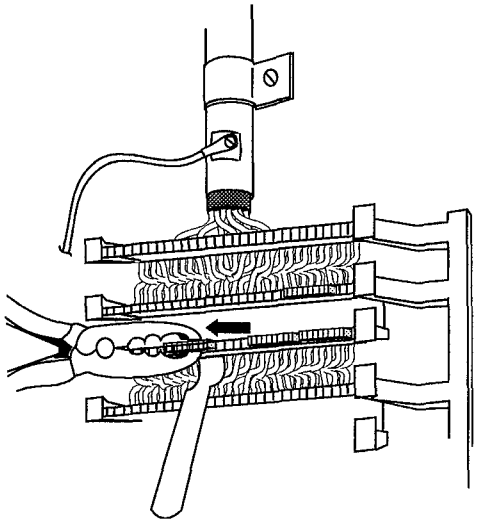


Figure 3-43. Removing Damaged Connecting Blocks

4. If a conductor wire is accidentally pulled from a block, pull it with the long-nosed pliers to get some slack. Use your fingers to lay the conductor wire back in its slot in the index strip. Reseat it with the D-impact tool.
5. Seat the new connecting block using the 788J1 impact tool (Figure 3-39).
6. Replace the station wire onto the connecting block.
   - With interconnect wiring, remove the tag from the station wires and reseat the wires using the D-impact tool.
   - With SYSTIMAX, fasten the patch cord to the connecting block.

IROB Protection

IROB (in-range out-of-building) protection units are required for any equipment that is connected to MLX station jacks (on the 008 MLX module), located in a different building from the control unit, and within 305 m (1000 cable feet) of the control unit. These IROBs protect the equipment and the control unit from lightning strikes and power surges. Two units are required for each piece of equipment — one for the control unit end of the wire run, the other for the equipment end.

⚠ WARNING:
The IROB protectors must be installed by an AT&T service technician, or an authorized representative, or a qualified installer. For installation instructions, see the booklet packaged with the IROB protector.

NOTE:
The 012 and 016 basic telephone module should not be used in out-of-building applications.

Use the AT&T Model 505A for MLX telephones and equipment (see Figure 3-44).

The 505A IROB protector contains fused primary and secondary protection for two pairs of wires. Auxiliary power cannot be fed through the 505A protector to terminal equipment.

Make sure each IROB protector is properly connected and is grounded to an approved building ground.

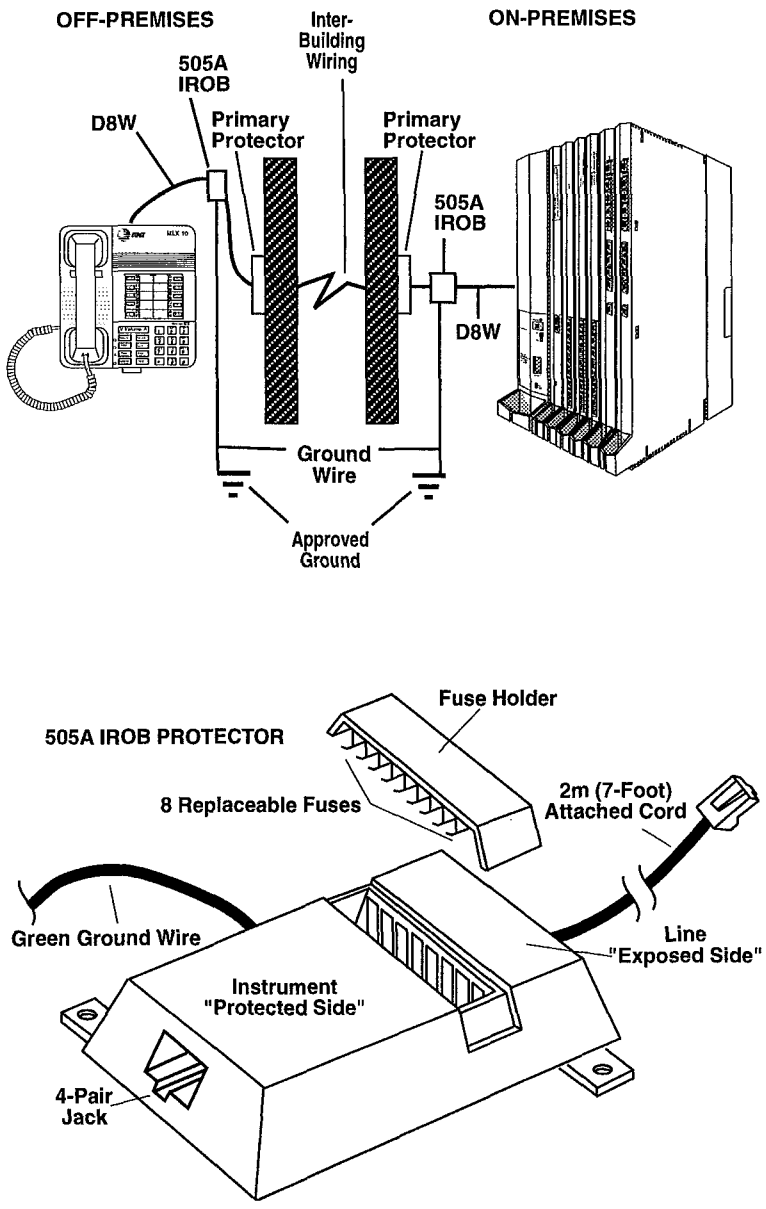


Figure 3-44. Installing the 505A IROB Protector

Telephones and Consoles

The telephone system supports the MLX-10, MLX-10D, MLX-20L, and MLX-28D telephones (see Figures 1-4 through 1-7), as well as analog multiline and single-line telephones.

The following describes how to install the MLX telephones and consoles, the Multi-Function Module, and the Direct Station Selector.

For information on connecting stations to the control unit, see "Connect the Control Unit to the Stations," earlier in this chapter.

Install the Multi-Function Module

The Multi-Function Module (MFM) is an optional adapter for connecting tip/ring (T/R) or supplemental alert devices to any MLX telephone. If you are installing an MFM, do it before you install the MLX telephone.

The MFM provides a modular jack connection for:

- T/R devices such as single-line telephones, fax machines, modems, credit card verification terminals, cordless telephones, and answering machines. The MLX telephone and the adjunct that is connected to the MFM are independent and can place and receive calls at the same time. The MFM is the only T/R adapter used with the MLX telephones.
- supplemental alerts such as bells, chimes, horns, and strobes. These alerts notify people in noisy areas of incoming calls.

The MFM is set for T/R devices or for supplemental alerts by two jumper blocks preset at the factory for T/R operation.

The MFM is packaged with the following (see Figure 3-45):

- one of the following power supplies:
  - — WP-92464,L3 (compatible with either 117 VAC or 220 VAC)

    NOTE:
    The WP-92464,L3 power supply is sufficient power for an MFM and two Direct Station Selectors (DSSs) connected to one telephone.
  - — LS-10015-ADT (117 VAC only)
  - — LS-10034-ADT1 (220 VAC only)
- 400B or 400B2 adapter
- D6AP cord (the WP-92464,L3 may be packaged with a different cord)

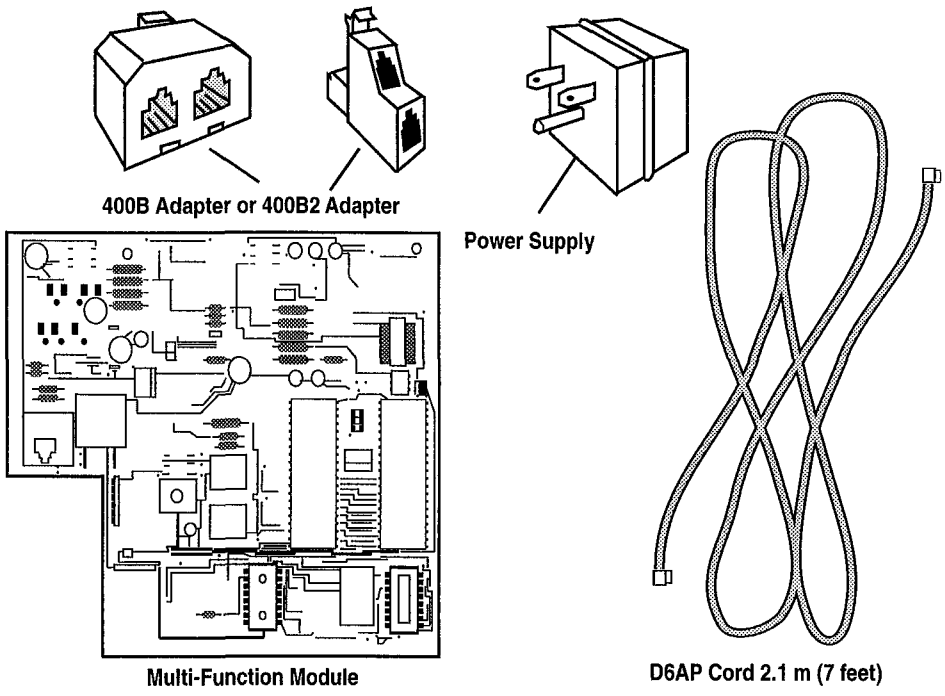


Figure 3-45. Multi-Function Module (MFM) Packaging Components

Before installing the MFM, consider the following:

- The MFM power supply must be connected to an electrical outlet that is within 15.24 m (50 feet) of cord length of the MLX telephone.
- A longer D8W telephone cord is required if the wall jack is more than 2.1 m (7 feet) from the MLX telephone.

NOTE:
The MFM uses one of the two B channels when it is active. This means that when an accessory, such as a fax machine, and the MLX telephone are in use at the same time, Voice Announce to Busy is not possible. (Voice Announce to Busy is a feature that allows users to be paged on the speakerphone even if they are on a call.)

Procedure

WARNING:
Before installing the MFM, disconnect all cords (line and/or power) attached to the MLX telephone. This is to ensure that no hazardous voltages are present during assembly. Ringing voltage from the MFM attached to the MLX telephone can cause electrical shock if adjustments are made while the cords (line and/or power) are connected.

Follow these steps to install and replace an MFM and change its pin settings.

1. Remove the user card tray from the bottom of the desk stand on the telephone.
2. Remove the desk stand and the module cover (see Figure 3-46).

NOTE:
To install or replace an MFM in a previously wall-mounted MLX-10 or MLX-10D telephone, go to step 2c.

a. Place the telephone face down on a flat surface. Press on the top rear center of the stand to release the tab.

b. Pull the stand toward you and away from the telephone.

c. Use a screwdriver to remove the screw in the lower right-hand corner of the module cover.

d. Press the center of the right side of the module cover with one hand and lift the cover to remove it.

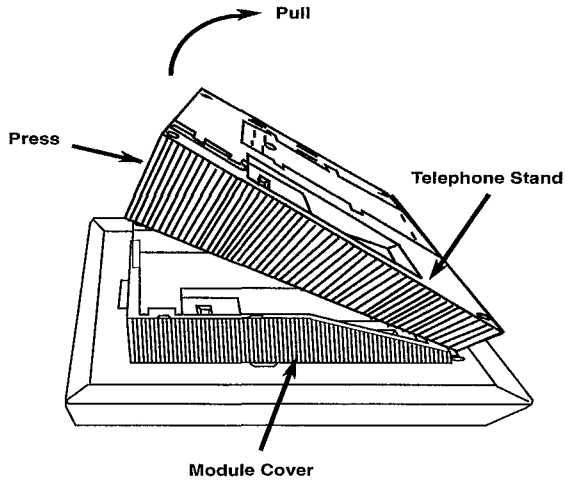


Figure 3-46. Removing the Stand and Module Cover from the MLX Telephone

3. Remove an existing MFM (see Figure 3-47).

NOTE:
If the telephone does not have an existing MFM, go to step 4. To reset the jumpers on an existing MFM, go to step 5.

a. Locate the MFM locking tabs on the top and bottom of the telephone. Spread these tabs apart to release the MFM.

b. Grasp the MFM by the edges and pull it toward you to free the connector pins. Do not touch the connector pins. Set the MFM aside on a clean surface.

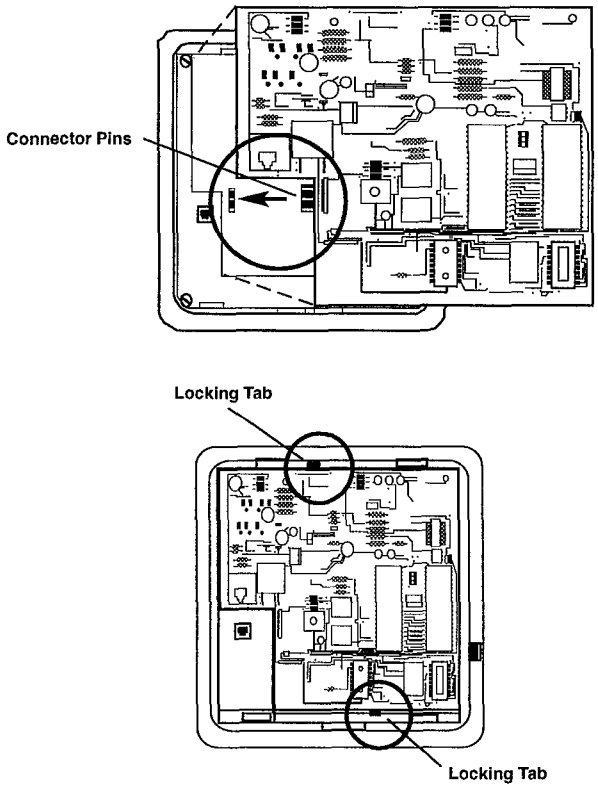


Figure 3-47. Removing an Existing MFM

4. Install a new MFM (see Figure 3-47).
    a. Hold the MFM circuit board by the edges with the long connector pins facing the underside of the telephone.
    b. Taking care not to touch the connector pins, push down on the MFM board so that the connector pins are inserted into the socket in the telephone.
    c. Press firmly to lock the tabs in place. The connector pins and tabs must be secure.
5. As needed, adjust the jumper settings for T/R operation or for a supplemental alert device (see Figure 3-48).
    a. Pull the connectors off.
    b. Push the connectors down over the appropriate pins.

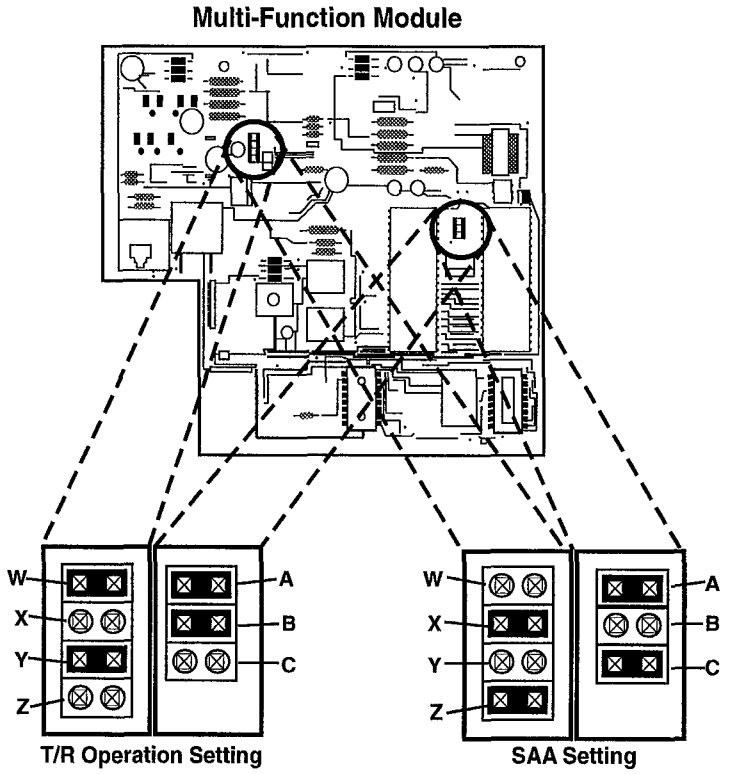


Figure 3-48. Adjusting the MFM Jumper Settings

6. Replace the module cover.

   a. If the module cover has a square jack guard that protects the TEL/OTHER jack area, grasp and twist the guard to remove it (see Figure 3-49).

> **NOTE:**
> Save the jack guard if you are wall mounting an MLX-10 or MLX-10D telephone.

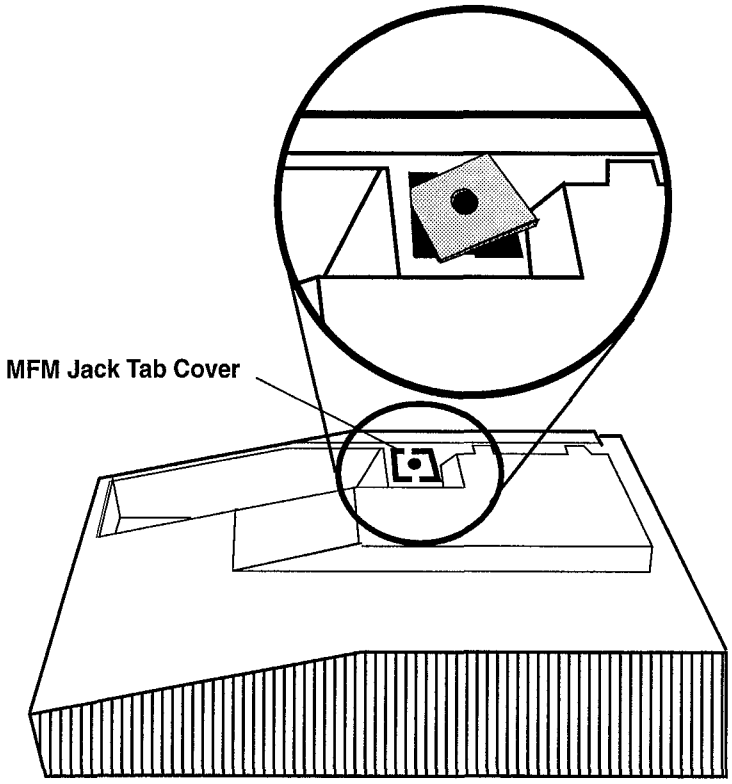


Figure 3-49. Removing the MFM Jack Guard

   b. There are locking tabs on both sides of the module cover and a screwpost on the right side of the telephone. Place the tab in the slot on the left side of the telephone.

   c. Lower the cover to the right and press firmly to lock the tabs in place. Both tabs must be secure.

   d. Replace and tighten the screw you removed earlier.

7. Replace the desk stand and the user card tray.

NOTE:
If you are wall mounting an MLX-10 or MLX-10D telephone, do not replace the desk stand. Go to step 8.

   a. The desk stand has two height adjustments. Insert the tab at the bottom of the stand in either the low or high position.

   b. Insert the tab at the top of the stand into the corresponding slot on the desk telephone. To readjust the stand, see the instructions on the bottom of the card tray.

8. Connect the telephone (see Figure 3-50).

   a. Plug the D8W cord from the telephone into the 8-conductor (large) modular jack of the 400B or 400B2 adapter.

CAUTION:
Plugging the D6AP cord into the 8-conductor (large) modular jack on the 400B or 400B2 adapter can cause electrical damage to the control unit and the telephone.

   b. Connect one end of the D6AP cord to the 2-conductor (small) modular jack on the 400B or 400B2 adapter, and plug the other end into the modular jack of the MFM power supply. The total length of the cords connecting the power supply to the MLX telephone must be less than or equal to 15.24 m (50 feet).

NOTE:
If the MFM power supply is packaged with a cord that is different from the D6AP cord, use that cord instead of the D6AP (to connect the MFM power supply to the 400B2 adapter).

   c. Plug the power supply into a 117 VAC or 220 VAC outlet not controlled by a wall switch.

   d. Insert the plug end of the 400B or 400B2 adapter into the wall jack.

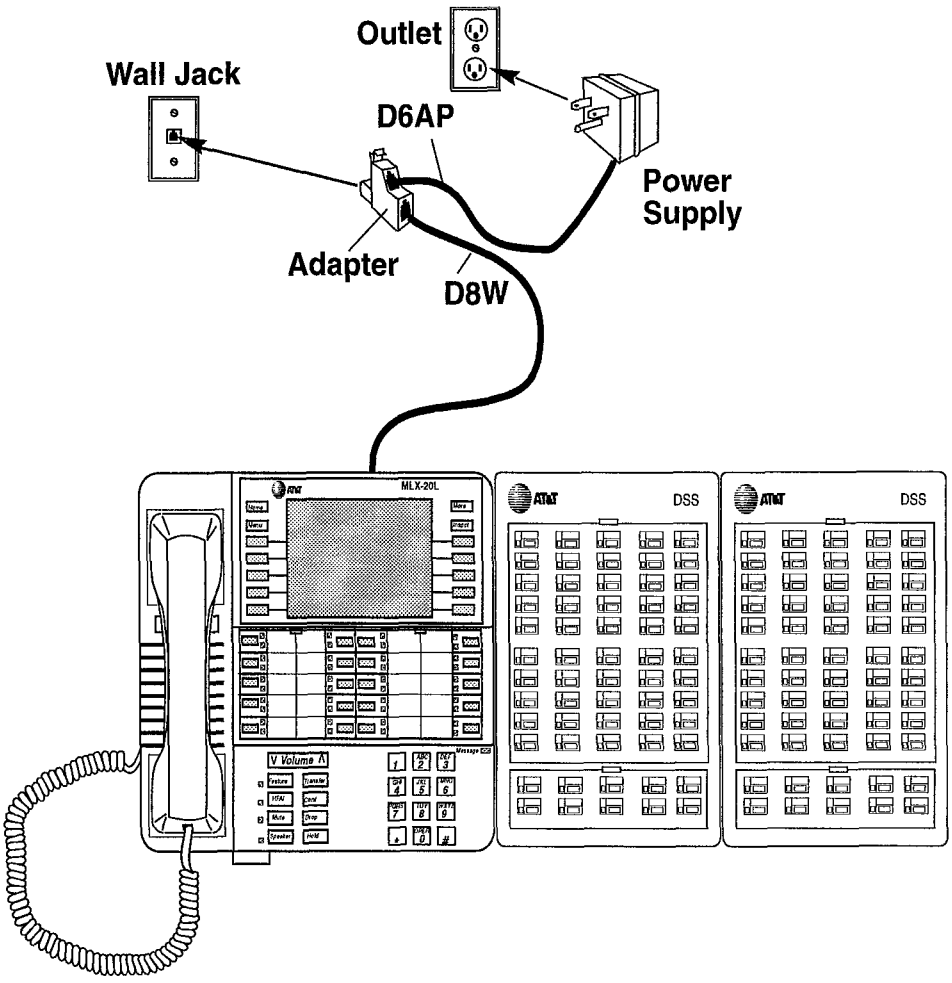


Figure 3-50. Connecting the MLX Telephone to the Wall Jack

9. Test the MFM for T/R operation by using the directions in "Test the MLX Telephones with an MFM" in this chapter.
10. Attach the adjunct (see Figure 3-51).
    a. Insert one end of the cord supplied with the adjunct into the jack labeled TEL/OTHER on the back of the telephone.
    b. Route the adjunct and D8W telephone cords through the cord channel.
    c. Test the adjunct by dialing its extension.

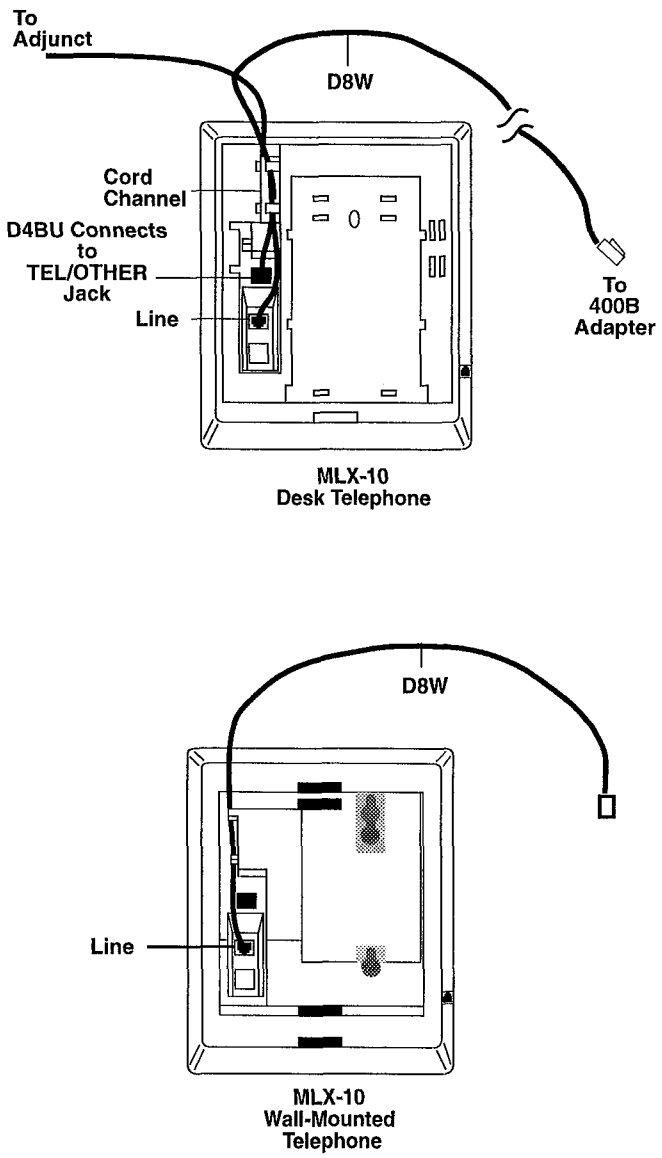


Figure 3-51. Attaching Adjuncts to the MLX Telephone

NOTE:
See Appendix B for a list of approved adjuncts.

Attach the Direct Station Selector

The Direct Station Selector (DSS) is an optional piece of telephone equipment. One or two DSSs can be connected to an MLX-28D or MLX-20L telephone.

NOTE:
Connect the DSS(s) before you install the MLX telephones.

Before installing the DSS, consider the following:

- Auxiliary power is required for the following configurations (see Appendix A for any ordering information you may need):
  - — an MLX telephone with two attachments (for example, two DSSs or an MFM and a DSS) requires an LS-10015-ADT (117 VAC) or LS-10034-ADT1 (220 VAC) power unit.
  - — an MLX telephone with three attachments (two DSSs and an MFM) requires the WP-92464,L3 power unit (117 VAC or 220 VAC).
  - — when two MLX telephones, each with a DSS, are on the same carrier, use an LS-10015-ADT (117 VAC) or LS-10034-ADT1 (220 VAC) power unit for each additional station with a DSS.
- For 117 VAC power supplies (391A1 or 391A2 only): When additional control unit carrier power is required and the system is backed up by an Uninterruptible Power Supply (UPS), the Auxiliary Power Unit 9024 should also be connected to this UPS.
- The total length of cords between the MFM power supply and the MLX telephone can be no more than 15.24 m (50 feet).
- Improper operation can result if the 61-cm (2-foot) D8AC cord (packaged with the DSS) is replaced with a longer cord.

Procedure

NOTE:
If you are connecting two DSSs to the telephone, unpack the second DSS now.

1. Adjust the angle of the DSS (see Figure 3-46).

   The DSS is packed fully assembled with the desk stand in the low position. If you prefer the low position, go to step 2. To adjust the angle of the DSS to the high position, place the DSS face down on a flat surface and follow these steps:

   a. Press on the top rear center of the stand to release the tab. Pull the stand toward you and away from the DSS.

b. To adjust the stand to the high position, insert the tab at the bottom of the stand into the other slot.

c. Lower the stand and press the tab at the top into the corresponding slot on the DSS.

2. Connect the D8AC cord to the DSS (see Figure 3-52).

a. There are two jacks on the DSS labeled IN and OUT. Plug one end of the D8AC cord into the jack labeled IN.

b. Route the D8AC cord through the cord channel on the left side of the DSS.

- If you are installing one DSS, go to step 4.
- If you are installing two DSSs, repeat steps 1 and 2 for the second DSS; then go to step 3.

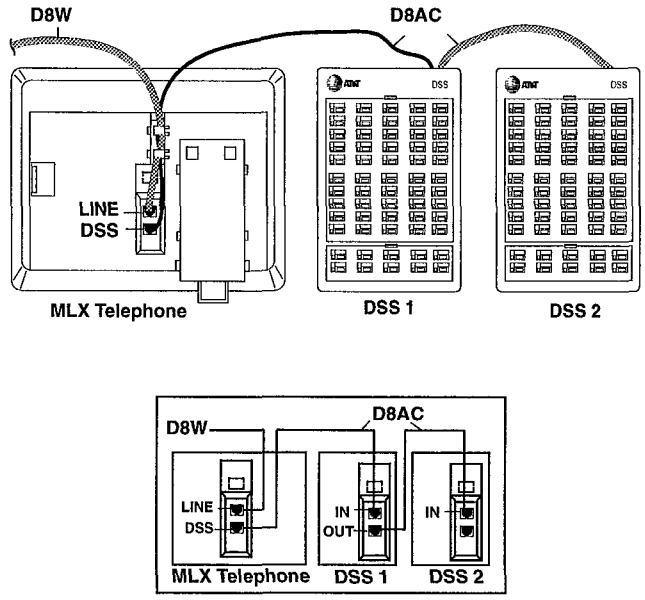


Figure 3-52. Connecting One or More DSSs to an MLX Telephone

3. Wire the two DSSs (see Figure 3-52).

a. Place the two DSSs side by side and face down.

b. Route the D8AC cord from the IN jack of the second DSS (DSS2) through the cord channel of the first DSS (DSS1).

c. Plug this D8AC cord into the jack labeled OUT on DSS1.

4. Wire the telephone to the DSS(s) (see Figure 3-52).
    a. With the handset removed from the telephone, place the telephone face down on a flat surface to the right of the upside-down DSS(s).
    b. Plug the D8AC cord from the IN jack of the DSS1 into the jack labeled DSS on the telephone, and route the cord through the cord channel.
    c. Plug the D8W line cord into the jack labeled LINE of the MLX telephone. The D8AC and D8W cords share the cord channel on the telephone.
5. Turn the telephone and the DSS(s) face up with the telephone now to the left of the DSS(s).
6. Insert one end of the coiled H4DU handset cord into the handset and the other end into the jack on the side of the telephone.

NOTE:
If auxiliary power is not required, go to step 7.
If auxiliary power is required, go to step 8.

7. Connect the telephone (auxiliary power is not required) by plugging the D8W cord into the wall jack. Go to step 9.
8. Connect the telephone (auxiliary power is required; see Figure 3-50).
    a. Plug the D8W cord from the telephone into the 8-conductor modular jack of the 400B or 400B2 adapter.

CAUTION:
Plugging the D6AP cord into the 8-conductor (large) modular jack of the 400B or 400B2 adapter can cause electrical damage to the control unit and the telephone.

NOTE:
The combined total length of the D6AP and D8W cords can be no more than 15.24 m (50 feet).

    b. Connect one end of the D6AP cord to the 2-conductor (small) modular jack of the 400B or 400B2 adapter, and plug the other end of the D6AP cord into the modular jack of the LS-10015-ADT (117 VAC), LS-10034-ADT1 (220 VAC), or WP-92464,L3 (117 VAC or 220 VAC) power supply.

NOTE:
If the power supply is packaged with a cord that is different from the D6AP cord, use that cord instead of the D6AP (to connect the MFM power supply to the 400B2 adapter).

c. Insert the plug end of the 400B or 400B2 adapter into the wall jack.

d. Plug the power supply into a 117 VAC or 220 VAC outlet.

9. Label the DSS designation cards.

a. Pull the tab at the top of the large plastic cover and rotate the cover toward you.

b. Remove the cover and the large designation card.

c. Write or type the button assignments on the card. For the DSS1, use the side of the large card that is labeled 00 through 49. For the DSS2, use the side labeled 50 through 99.

NOTE:
The button assignments on the designation card should be by extension number, not by logical ID port number.

d. Replace the card and the plastic cover. Be sure the coated side of the cover is facing up.

e. Repeat these steps to remove the small plastic cover and to label the small designation card.

NOTE:
If the MLX telephone to which the DSS is attached is unplugged from the control unit and then again plugged into the control unit, the display on the telephone may disappear. Press the Home button to bring back the display.

Assemble the MLX Telephone or Console

Before installing an MLX telephone or console, consider the following:

- A 630B Phonemount (not included) is required to mount an MLX-10 or MLX-10D telephone to the wall.
- To connect an adjunct, you must first have a Multi-Function Module (MFM). (Adjuncts include answering machines, alerts, and fax machines.) If you are installing an MFM, do it now by using the procedure in "Install the Multi-Function Module" earlier in this chapter. After the MFM is installed, go to step 1.

Procedure

1. Remove or adjust the desk stand (see Figure 3-46).

MLX telephones are packed fully assembled with the desk stand in the low position. The angle of any MLX desk telephone can be adjusted to the high position. If you are wall mounting an MLX-10 or MLX-10D telephone, you must first remove the desk stand.

To remove the desk stand or adjust its angle, place the telephone face down on a flat surface and follow these steps:

a. Press on the top rear center of the stand to release the tab(s). Pull the stand toward you and away from the telephone.

NOTE:
If you have removed the stand to wall mount an MLX-10 or MLX-10D telephone, set the stand aside and go to step 2.

b. To adjust the stand to the high position, insert the tab(s) at the bottom of the stand into the slot(s).

c. Lower the stand and press the tab(s) at the top into the corresponding slot(s) on the telephone.

NOTE:
The diagram on the bottom of the user card tray also shows the steps to adjust the stand.

2. Connect the line cords (see Figure 3-51).

   a. Plug one end of the D8W cord into the telephone jack labeled LINE on the underside of the telephone.

   b. Route the D8W cord through the cord channel on the back of the telephone.

   c. If the telephone is for desktop use, turn the desk telephone face up and plug the D8W cord into the wall jack.

3. Install the handset by inserting one end of the coiled H4DU handset cord into the handset and the other end into the jack on the side of the telephone.

4. Label the extension identification card (see Figure 3-53).

   a. Insert a straightened paper clip into the hole on the side of the plastic cover while holding your finger on the opposite edge. Use the paper clip to push and lift the cover.

   b. Type or write the assigned extension number on the card.

NOTE:
If you are mounting an MLX-10 or MLX-10D wall telephone, go to step 5.
If you are assembling a desk telephone, go to step 6.

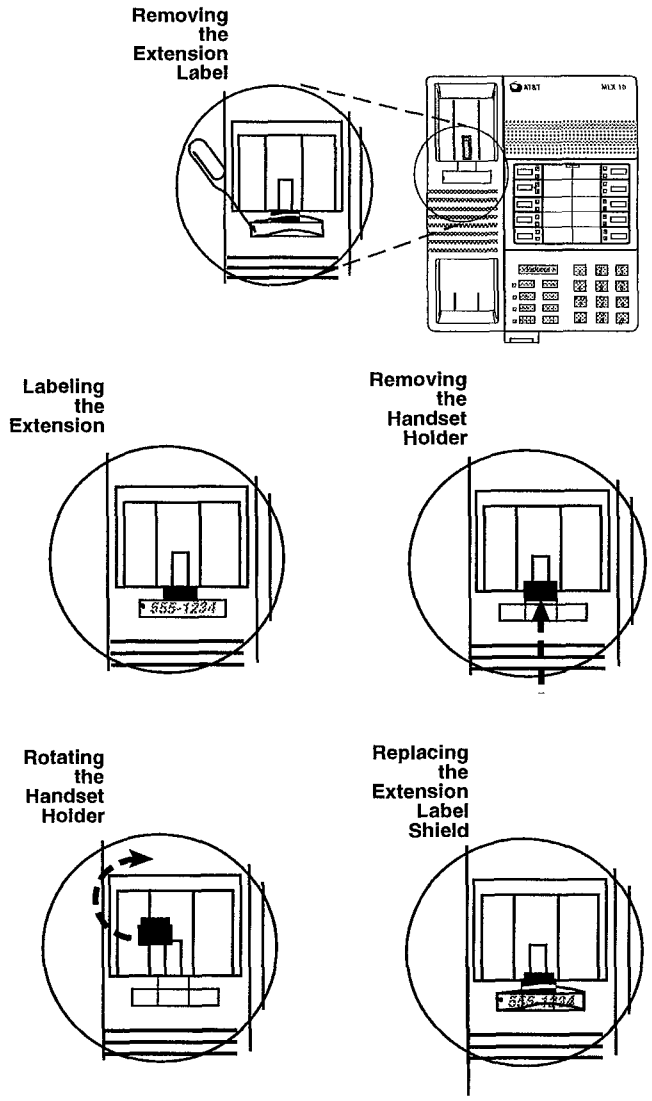


Figure 3-53. Labeling the Extension Identification Card

5. Prepare the handset holder for wall mounting (see Figure 3-53).
   a. Remove the handset holder by pushing it up and pulling it out.
   b. Rotate the handset holder 180 and replace it in its slot.
6. Replace the extension identification card and plastic cover by inserting one end into the slot and bending the cover to snap the other end into place.

NOTE:
If you are mounting an MLX-10 or MLX-10D wall telephone, go to step 7.
If you are assembling a desk telephone, go to step 8.

7. Mount an MLX-10 or MLX-10D wall telephone.
    a. Turn over the telephone and remove the jack guard from the TEL/OTHER jack area. Set the telephone aside.
    b. Unpack the 630B Phonemount and remove the modular jack from the backplate.
    c. Route the cord (D8W) through the hole in the backplate and have it exit at the top of the backplate, leaving 25.5 cm (10 inches) of cord to connect the telephone (see Figure 3-54).
    d. Attach the backplate to the wall by using the instructions provided with the 630B Phonemount.
    e. Insert the two short screws provided with the Phonemount into the mounting plate (see Figure 3-54). Be sure to thread the upper screw through the jack guard.
    f. Plug the free end of the cord into the jack labeled LINE on the back of the telephone. Route the cord through the cord channel above the jack (see Figure 3-51).
    g. Position the telephone on the mounting plate mounting studs and then slide the telephone down to lock it in place. To remove the telephone, slide it up and off (see Figure 3-54).
8. Label the button assignment card.
    a. Pull the tab at the top of the plastic cover toward you.
    b. Type or write the button assignments on the card.
    c. Replace the card and the plastic cover. Be sure the textured side of the cover is facing you.
9. Adjust the contrast on the telephone's display.
    - MLX-20L: Slide the lever on the top of the telephone.
    - MLX-10D and MLX-28D: Follow the directions in the user's guide for the appropriate MLX telephone.

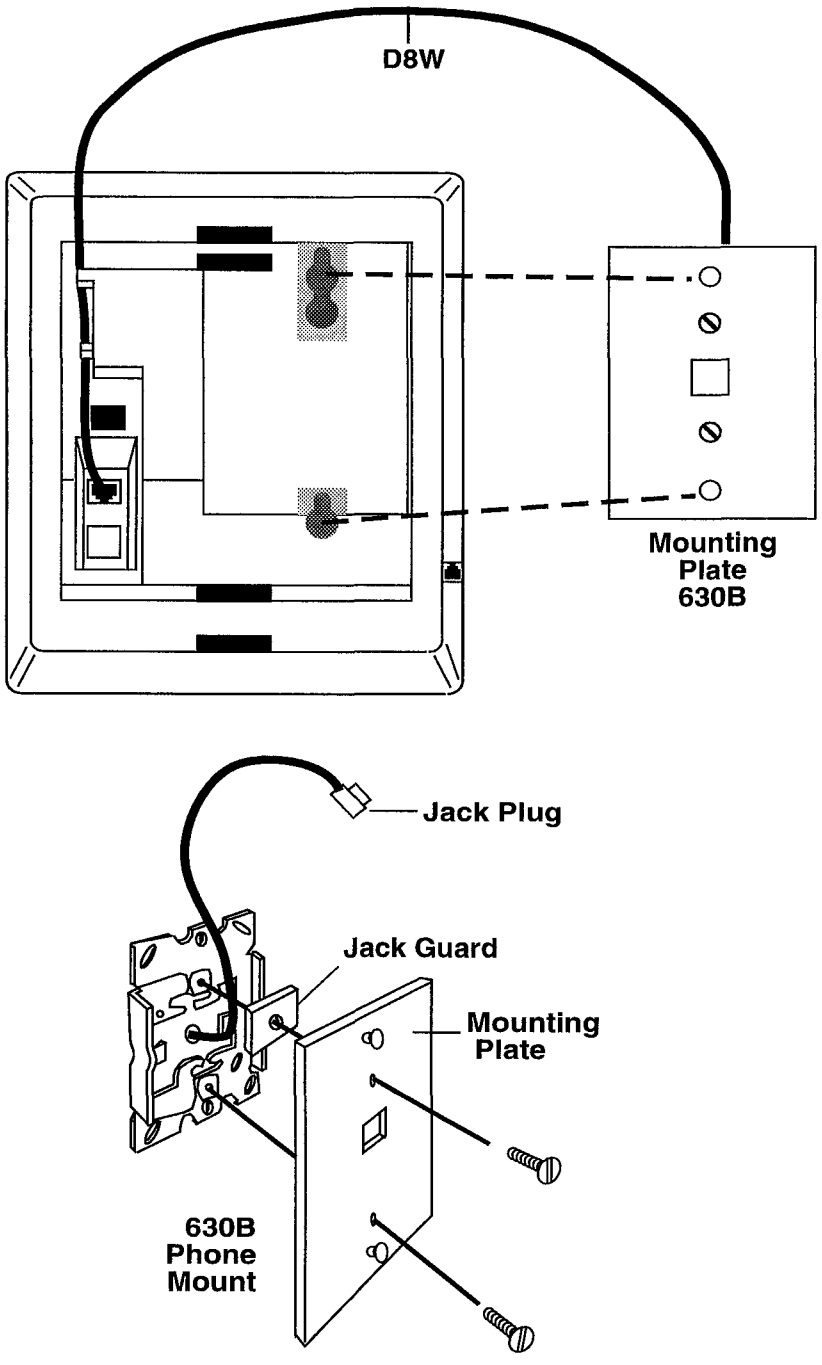


Figure 3-54. Mounting an MLX-10 or MLX-10D Telephone to the Wall

System Acceptance Test

Once the system has been installed and initialized, it is ready for acceptance testing. Test all lines/trunks, telephones, and features to ensure they are working correctly. If any equipment is not working correctly, see Chapter 4, "Maintenance and Troubleshooting."

Test the MLX Telephones

The switch-based software test described in this chapter verifies that the LEDs, ringer, buttons, switchhook, and B-channel operation on the MLX telephones are working correctly. This test cannot be run when the telephone is in program, forced-idle, or maintenance mode. When an MLX telephone is in the test mode, it is considered busy and therefore not available for use.

If you hang up during any of these procedures, you are automatically taken out of the test mode.

Follow these steps to test the basic features of an MLX telephone:

1. Pick up the handset of the telephone being tested and push an Intercom button (Key or Behind Switch mode) or a System Access button (Hybrid/PBX mode). After receiving a dial tone, dial ✱00 to activate the test mode.

   You should hear a steady test tone over the handset and a ring burst over the speaker. The telephone's red and green LEDs should be on.

2. To test the line buttons, press any line button with two LEDs.

   The diagnostic tone should stop, and the LEDs for that button should go off.

3. Press the same line button repeatedly to toggle between the green and red LEDs.

4. To test a fixed-feature button with one LED, press the button.

   The ***Feature*** *and* ***HFAI*** *LEDs should go off. The first press of the* ***Speaker*** *button should turn off the* ***Mute*** *LED. The second press of the* ***Speaker*** *button should turn off the* ***Speaker*** *LED.*

NOTE:
If the **Mute** button has been pressed before the Speaker button, the **Mute** LED cannot be turned off; it will wink.

5. Press the fixed-feature buttons repeatedly to toggle the LEDs on and off.
6. To test the red **Message** light, press either a fixed-feature button without an LED (such as **Transfer** or **Drop**) or any dialpad button.

   The ***Message*** *LED should go off.*
7. Press the fixed-feature or dialpad button repeatedly to toggle the **Message** LED on and off.
8. Hang up the handset to leave test mode.

Test the MLX Telephones with a Display

While the telephone is in the test mode, follow these steps to test the display buttons:

1. Press the labeled display buttons (**Home**, **Menu**, **Inspct**, and **More**).

   The display should spell out these button labels.
2. Press the unlabeled display buttons.

   The display should spell out `Display Button` *and the number of the button pressed (1 through 4).*

Test the MLX Telephones with an MFM

Test an MLX telephone with an MFM installed and configured for a T/R adapter. Follow these steps to check the proper channel operation and the MFM circuitry for the TTR, the ring generator, and the message LED:

1. Connect a known working 2500-type single-line telephone with a message light to the MFM adapter. The 2500 telephone must also have a mechanical ringer.
2. Pick up the handset on the 2500 telephone and dial ✱09 after receiving the dial tone.

   You should receive another dial tone.
3. Press any button to deactivate the test tone.
4. Dial the following sequence of numbers: 123456789✱0# and press the switchhook quickly.

   You should receive a confirmation tone.
5. Hang up.

   The control unit should send a ring burst, and the message LED on the 2500 telephone should go on.
6. Turn off the message LED by dialing the appropriate code number.

Test the Telephones for Intercom Dial Tone

Follow these steps to test for intercom dial tone:

1. Press the Intercom or System Access button (depending on the mode of operation).

   The red LED next to this button should go on.

2. Press the **Speaker** button.

   *The green LED next to the red LED on the Intercom or System Access button should go on, you should hear an intercom dial tone, and the green LED next to the **Speaker** button should go on.*

3. Press the **Speaker** button again to disconnect the Intercom or System Access button.

   *The red and green LEDs next to the Intercom or System Access button should go off, the green LED next to the **Speaker** button should go off, and the dial tone should stop.*

Test the Telephones for Outside Line Dial Tone

Follow these steps to test for an outside line dial tone:

1. Without lifting the handset, press a line button.

   The red LED next to this button should go on.

2. Pick up the handset or press the **Speaker** button.

   The green LED next to the red LED at the line button should go on, and you should hear a dial tone.

3. Hang up as needed and repeat steps 1 and 2 for each line button on the telephone.

Test the Analog Multiline and Single-Line Telephones

Follow these steps to test the basic functioning of analog telephones:

1. If you are at a multiline telephone, press the Intercom or System Access button.

2. Pick up the handset.

   You should hear a dial tone.

3. Dial the extension number of another working telephone.

   You should hear ringback at the calling telephone and ringing at the called telephone.

4. At the called telephone, have someone pick up the handset; verify that you have good two-way communication.
5. At both telephones, hang up.
6. If you are at a multiline telephone, press an outside line button or the System Access button.
7. Pick up the handset.

   You should hear a dial tone.
8. If you are using a System Access button, dial the dial-out code.
9. Dial one of the numbers assigned to the telephone you want to answer the call.

   You should hear ringback at the calling telephone and ringing at the answering telephone.
10. Have someone pick up the handset at the answering telephone; verify that you have good two-way communication.
11. At both telephones, hang up.
12. If the station is toll restricted, place a toll call.

    You should hear a reorder tone.

Test the Loop-Start Trunks

Follow these steps to test the LS outgoing and incoming lines/trunks at a telephone:

1. Do one of the following to make sure you hear a dial tone:
   a. For Hybrid mode, pick up the telephone handset and dial ✱03, followed by the line/trunk ID number (01 through 80).

      You should hear a dial tone for a working line/trunk, a reorder tone for a DID trunk or an invalid line/trunk number, or a busy tone if the line/trunk is in use.

      NOTE:
      Dialing ✱03 on a single-line telephone works only if the line/trunk accepts touch-tone dialing. After you dial ✱03 on a single-line telephone, you may have to wait for a "click" before dialing the line/trunk number.

b. For Key or Behind Switch mode, access the line from a DFT and then go offhook.

You should hear a dial tone for a working line/trunk, a reorder tone for a DID trunk or an invalid line/trunk number, or a busy tone if the line/trunk is in use.

2. Dial an incoming line/trunk on the system.
3. Have someone answer the call at another telephone; verify that you have good two-way communication.
4. Hang up to exit the test mode.
5. Repeat steps 1 through 4 for all incoming and outgoing lines/trunks.

Test the DID and Incoming DIOD Trunks

This testing procedure explains how to dial into the system, from the outside, to test incoming calls. Follow these steps to test the DID and incoming DIOD trunks:

1. Do one of the following to make sure you hear a dial tone:

   a. For Hybrid mode, pick up the telephone handset and dial ✱03, followed by the line/trunk ID number (01 through 80).

   You should hear a dial tone for a working line/trunk, a reorder tone for a DID trunk or an invalid line/trunk number, or a busy tone if the line/trunk is in use.

   NOTE:
   Dialing ✱03 on a single-line telephone works only if the line/trunk accepts touch-tone dialing. After you dial ✱03 on a single-line telephone, you may have to wait for a "click" before dialing the line/trunk number.

   b. For Key or Behind Switch mode, access the line from a DFT and then go offhook.

   You should hear a dial tone for a working line/trunk, a reorder tone for a DID trunk or an invalid line/trunk number, or a busy tone if the line/trunk is in use.

2. Dial an incoming DID or DIOD number on the system.
3. Have someone answer the call at another telephone; verify that you have good two-way communication.
4. Hang up to exit the test mode.
5. Repeat steps 1 through 4 for all DID/DIOD numbers on the system.

Test the Incoming Tie Trunks

NOTE:
Before performing any of the tie-trunk tests in this section, make sure that the tie trunks for the system are connected and properly configured.

Follow these steps to make sure the incoming tie trunks work:

1. At the far-end tie-trunk site, have someone pick up the handset and access a tie trunk assigned to a button on your telephone.

   Your telephone should ring, and the green LED next to the tie-trunk button should flash.

   NOTE:
   To test a dial-repeating tie trunk, have the person at the far-end tie-trunk site dial a system extension number. (No dialing is required to test an automatic incoming tie trunk.)

2. Pick up your handset and verify that you have good two-way communication.
3. At your telephone and the distant telephone, hang up.
4. Repeat steps 1 through 3 for all incoming tie trunks.

Test Outgoing and Two-Way Automatic-Start Tie Trunks

Before testing outgoing or two-way automatic-start tie trunks, have someone ready to receive your call at the receiving telephone. Follow these steps:

1. At any telephone that has access to an automatic-start tie trunk, press the first tie-trunk button.

   The red LED next to the tie-trunk button just pressed goes on.

   NOTE:
   In Hybrid/PBX systems with pooled tie trunks, press the System Access button and dial the pool dial-out code.

2. Pick up the handset.

   The green LED goes on next to the red LED at the tie-trunk button, and you hear ringing.

3. When the person answers, verify that you have good two-way communication and hang up.
4. Repeat this procedure for each automatic-start tie trunk administered.

Test the Outgoing and Two-Way Dial-Repeating Tie Trunks

Test dial-repeating tie trunks (wink-start, immediate-start, and delay-start) when you are sure that someone can receive your call at the far end. Follow these steps:

1. At any telephone that has access to a dial-repeating tie trunk, press the first tie-trunk button.

   The red LED next to the pressed tie-trunk button goes on.

   NOTE:
   In Hybrid/PBX systems with pooled tie trunks, press the System Access button and dial the pool dial-out code.

2. Pick up the handset.

   The green LED next to the red LED at the tie-trunk button goes on.

3. Dial the tie-trunk number of the station where someone is waiting for your call.

   You hear ringing.

4. When the person answers, verify that you have good two-way communication and hang up.

5. Repeat steps 1 through 4 for each tie trunk administered.

Test the Incoming and Two-Way Automatic-Start Tie Trunks

Follow these steps to test incoming and two-way automatic-start tie trunks:

1. At a preset time, have someone at the far-end tie-trunk site place a call to your telephone by dialing the proper tie-trunk number.

   You hear ringing at the telephone connected to the tie trunk, and the green LED next to the tie-trunk button flashes.

2. Pick up the handset.

   The red LED next to the tie-trunk button goes on, and the green LED becomes steady.

3. Verify that you have good two-way communication and hang up.

4. Repeat steps 1 through 3 for each tie trunk administered.

Test the Incoming and Two-Way Dial-Repeating Tie Trunks

Follow these steps to test the dial-repeating tie trunks:

1. At a preset time, have a person at the far end place a dial-repeating call to your telephone by dialing the proper tie-trunk number.

   Your telephone rings, and the green LED next to the tie-trunk button flashes.

2. Pick up the handset.

   The red LED next to the tie-trunk button goes on, and the green LED becomes steady.

3. Verify that you have good two-way communication and hang up.
4. Repeat steps 1 through 3 for each tie trunk administered.

Test the Dial Access Codes

Follow these steps to test the dial access codes:

1. Verify the proper operation of each feature requiring a dial access code:
   - Automatic Route Selection (ARS)
   - Group Calling
   - Group Page
   - Listed Directory Number (the QCC queue)
   - Park
   - Pools
   - Remote Access
2. If any feature is not working properly, check the system programming translations.

Test the System Features

You can test these system features from an MLX telephone or an analog multiline telephone:

- Automatic Route Selection (ARS)
- Coverage
- Group Calling
- Station Message Detail Recording (SMDR)
- System Speed Dial

NOTE:
You can also use a single-line telephone to test all of these features except for Coverage.

ARS and SMDR Tests

If ARS patterns have been translated, you can test the routing by placing toll calls and checking the line/trunk indicated on the SMDR printout.

Follow these steps to verify ARS patterns:

1. Determine which toll numbers to call by examining the system administrator's ARS patterns.
2. At any multiline telephone, pick up the handset, dial the ARS access code, and dial one of the toll numbers. Make sure that the call is completed before hanging up.
3. Repeat step 2 for any additional toll numbers.
4. At the SMDR printer, verify that the call was placed over the correct line/trunk group and check the number of seconds before the call is reported on the SMDR printout. If there are errors, check the translations.

Group Calling Test

Follow these steps to test the Group Calling feature:

1. At any telephone, pick up the handset, dial the CO line/trunk access code, and dial a calling group listed directory number.
2. At the ringing telephone in the calling group, have someone pick up the handset; verify that you have good two-way communication.
3. Repeat steps 1 and 2 for each calling group.
4. Make additional calls to check each member of each calling group.
5. Test the calling group delay announcement (if provided) by making the whole group busy or by logging out all members of the group.
6. At any telephone, dial the calling access code and repeat step 2.

System Speed Dial Test

Follow these steps to test System Speed Dial:

1. From the test telephone, determine which numbers have been translated for System Speed Dial. (Get the list of translated numbers from the system manager.)
2. Pick up the handset and dial a System Speed Dial code. Verify that you have good two-way communication and that the correct party was reached.

Coverage Test

Follow these steps to test Coverage:

1. Have someone call the covered telephone.
2. Count the number of rings that occur at the covered telephone before the covering telephone starts ringing. This should be the same as the programmed number of rings.
3. Pick up the handset at the covering telephone and verify that you have good two-way communication.
4. Hang up at the covering telephone.
5. Check both individual and group coverage.

Test the Operator Console

Testing the operator console, whether it is analog or digital, is the same as testing an MLX telephone, except for testing the console's unique feature buttons. Follow these steps to test the operator console:

1. Pick up the handset of the telephone being tested and push an Intercom button (Key or Behind Switch mode) or a System Access button (Hybrid/PBX mode). After receiving the intercom dial tone, dial ✱00 to activate the test mode.

   You should hear a steady test tone over the handset and a ring burst over the speaker. The telephone's red and green LEDs should be on.

2. To test the line buttons, press any line button with two LEDs.

   The diagnostic tone should stop, and the LEDs for that button should go off.

3. Press the same line button repeatedly to toggle the green and red LEDs on and off.
4. To test a fixed-feature button with one LED, press the button.

   The ***Feature*** *and HFAI LEDs should go off. The first press of the* ***Speaker*** *button should turn off the* ***Mute*** *LED. The second press of the* ***Speaker*** *button should turn off the* ***Speaker*** *LED.*

NOTE:
If the **Mute** button has been pressed before the **Speaker** button, the **Mute** LED cannot be turned off; it will wink.

5. Press the fixed-feature buttons repeatedly to toggle the LEDs on and off.
6. To test the red **Message** light, press either a fixed-feature button without an LED (such as **Transfer** or **Drop**) or any dialpad button.

   The ***Message*** *LED should go off.*
7. Press the fixed-feature or dialpad button repeatedly to toggle the **Message** LED on and off.
8. Verify that all features are working properly.
9. If any features are not working properly, verify the translations through system programming.

Test the DSS

At each Direct Station Selector (DSS), check that all lights are operational. Using the DSS, call a telephone in the system. Test that the page buttons on the DSS work properly.

Test the Night Service

Follow these steps to test the Night Service feature on the system operator console:

1. At the system operator console, press the Night Service button. If the Night Service with Outward Restriction option is programmed, enter the assigned password after pressing the Night Service button.

   The Night Service LED goes on.

   NOTE:
   Night Service on a DLC can also be activated by pressing the **Feature** button and dialing 39.
2. Pick up the handset and press a button for any outside line/trunk. Dial the CO line/trunk access code and the number of a CO line/trunk that receives Night Service coverage.
3. Verify that the telephones assigned to the Night Service group are ringing.
4. Have someone pick up the handset at a telephone in the Night Service group; verify that you have good two-way communication.
5. At both telephones, hang up.
6. Repeat steps 2 through 5 for each Night Service line/trunk.

7. Test telephones that have been programmed for Night Service with Outward Restriction.
    a. Pick up a handset on a restricted telephone and verify that outside calls are not allowed.
    b. Using the password, make an outside call.
        1. Hang up the handset.
        2. Press the Recall button and dial the password.

        NOTE:
        On an MLX telephone without a programmed Recall button, press the **Feature** button and dial 775 and the password before picking up the handset.

        3. Pick up the handset and make an outside call.
        4. Verify that you have good two-way communication and hang up.
8. At the operator console, press the Night Service button again and verify that the Night Service LED goes off.

Test the Dictation System Access

Place a call to verify that the dictation equipment can be accessed. If dictation equipment has not been installed, this feature cannot be tested.

1. At the test telephone, pick up the handset.
2. Dial the access code and the number associated with the dictation equipment.
3. Verify that the ready tone is being transmitted.
4. Test the transmission in both directions. Make a recording and play it back.
5. Hang up.

Test the Paging Interface

Follow these steps to test the paging interface:

1. Pick up the handset at the test telephone and dial the access code or extension number for a particular zone.

   You may hear a confirmation tone.

2. Make an announcement into the handset.

   You should hear the announcement from the loudspeaker(s).

3. Hang up.

4. Repeat steps 1 through 3 for all paging zones provided.

Test Music on Hold

Follow these steps to verify that music is provided to outside callers placed on hold. Inside callers do not receive Music on Hold (MOH).

1. Pick up the handset at the test telephone. Dial the CO line/trunk access code and the system's listed directory number, or if you are using the DID trunk, dial any station.

2. At the called station, answer the incoming call.

3. At the called station, press Hold.

   The line button's green LED should flash.

4. Verify that music is heard at the calling telephone.

5. Hang up.

NOTE:
If equipment that rebroadcasts music or other copyrighted materials is used, it may be a requirement to obtain a copyright license from and pay license fees to a third party. This should be verified first before any rebroadcasting is done. However, if a Magic-on-Hold system is purchased (see Appendix A, Ordering Information) from an AT&T representative, no special license is required.

Test the PFT Jacks

To test a power failure transfer (PFT) jack for proper operation, the outside line numbers to the module's line/trunk jacks must be assigned and the lines/trunks must be operational. Follow these steps to test the PFT jacks:

1. Plug a touch-tone or rotary dial telephone into a PFT jack.
2. Note the outside line number assigned to the lowest-position line/trunk jack on the module and be sure that the outside line/trunk is connected to the system.
3. Turn off power to the control unit, first at the power supply module on the basic carrier and then at the power supply module on each expansion carrier.
4. Pick up the handset on the touch-tone or rotary dial telephone.

   You should hear a dial tone.
5. Dial an outside number where you know someone will answer the call.
6. After the call is answered and you have verified that you have good two-way communication, tell the person the telephone number assigned to the outside-line jack bridged by the PFT jack to which you are connected.
7. Have that person call the number after you hang up.

   Your phone should ring after the other person completes dialing the number.
8. Answer the phone and verify that you have good two-way communication before disconnecting.

   NOTE:
   Test all PFT jacks (by repeating steps 1 through 10 for each jack) before going to step 11.
9. Turn the power back on, first at each expansion carrier and then at the basic carrier.

Test the Touch-Tone Receivers

Four touch-tone receivers (TTRs) are available on 016 modules, 400 modules, and the 800 DID module. Both 008 OPT modules and both 012 modules each provide two TTRs. Follow these steps to test TTRs:

1. At a single-line telephone connected to an 012, 016, or 008 OPT module, pick up the handset. Dial ✱04 and the 2-digit number (starting with 01) of the TTR to be tested.

   You should hear a busy tone if the receiver is in use or a reorder tone if you misdialed or addressed a receiver not in your system (for example, you dialed 07 and your system has only an 012 module and one 400 module for a total of six TTRs). Try again.

   If you hear a dial tone after one to three seconds of silence, proceed with this test.

2. Dial the digits 123456789✱0#.

   You should hear a dual-tone multifrequency (DTMF) signal as each button is pressed. After all the digits are dialed, you should hear a dial tone.

3. Repeat the test for each TTR.

Maintenance and Troubleshooting

4

Contents

Maintenance and Troubleshooting

4

Maintenance

The purpose of maintenance is to detect, report, and clear problems quickly with minimum disruption of service. To do this, the system isolates troubles to a single replaceable module whenever possible.

To isolate problems, the control unit (CU) runs automatic diagnostic, auditing, and monitoring tests. Errors found by the automatic tests go into error logs. In addition, demand tests can be run by using an MLX-20L telephone or a PC with System Programming and Maintenance (SPM) software.

Notification of trouble comes from users who report problems or from alarms generated by the system when it detects serious errors. Alarms can appear as an LED on an operator console and as a status display on the maintenance terminal.

Error records and alarms may be retired either automatically or manually. After a trouble or error has been cleared, the system retests the previously faulty area within a variable time interval. when the error is no longer detected, the error message and the alarm, if applicable, are retired. Maintenance personnel can retire error records and alarms either on-site or from a remote location (using a PC and SPM software).

NOTE:
It is recommended that you record each station jack connection and each station change on the "System Technician's Run Sheet" (see Appendix E).

Equipment

To access the maintenance program on-site, you need an MLX-20L telephone or a PC with SPM software. In addition, you should have the following tools:

- EIA breakout box
- digital voltmeter
- 110/66-type punchdown tool
- Dracon TS21 or equivalent touch-tone test telephone
- assorted flathead screwdrivers
- assorted Phillips-head screwdrivers
- long-nosed pliers
- regular pliers
- wrist grounding strap
- laptop PC with MS-DOS 3.3 or higher and SPM software
- troubleshooting guide
- any replacement parts that you may need

Remote access to the maintenance program requires a PC with SPM software.

⚠ CAUTION:
The system contains components that can be severely damaged by electrostatic discharge (ESD). To minimize the possibility of damage due to ESD, it is recommended that you properly ground yourself using the wrist grounding strap whenever you are working on the control unit.

Maintenance Elements

This section describes the following important elements of the system's maintenance:

- error logs
- alarms
- restarts
- system status displays
- automatic tests
- demand tests

Error Logs

Errors occur because of hardware malfunctions, recurring program logic inconsistencies (PLIs), or system restarts. Whenever an error occurs, it is entered into an error log.

Errors are classified as one of three types: major, minor, or warning, and are recorded in one of the following tables within the error log that is stored in battery backed-up RAM:

- **permanent system alarms** — contains a list of the major system errors. Major errors are generally steady in nature and cause a degradation of service that requires immediate action. An example of a major alarm would be a ROM checksum failure.
- **transient system errors** — contains a list of the minor system errors. Minor errors are generally intermittent in nature and cause a reduced level of service that may require action, but the system continues to process most calls normally. An example of a minor alarm would be a trunk or station out of service.
- **last 30 system errors** — contains a list of warning errors. Warning errors cause no noticeable degradation of service. Some CO trunk errors are examples of warning errors.

All errors are initially entered into the thirty most recent error table. Each error in this table includes the Error Code, Slot, Port, and date and time information. The Error Logger checks the error against a list to determine if the error needs to be recorded in the alarm table. Only errors which qualify for transient or permanent status are entered into the alarm table. Each error has a threshold count that, when exceeded, escalates an error from transient to permanent. To be automatically cleared, each type of error must be trouble-free for a set time period.

Alarms

A permanent error causes an alarm which may cause an external alarm device to be activated (if such a device is installed and administered) and/or light a red LED next to a line or feature button (on a system operator console or other designated telephone) programmed for alarm notification. The alarm device and/or LED stay on until the error is cleared.

Alarms can be cleared:

- automatically by the system when the error condition no longer exists
- manually (via the maintenance menus)
  - — by replacing a module
  - — by clearing an error log entry via the **Drop** button on an MLX-20L telephone or via ALT-P on a PC

Restarts

Depending on the severity and duration of a problem, it may be necessary to restart the system either by a warm start, cold start, or frigid start. Certain errors can cause the system to automatically restart; cold starts and frigid starts can be initiated by the maintenance technician.

- **Frigid start.** All calls are dropped, the system configuration information is erased and reset to the factory default, and the alarm tables are cleared. All system memory must be reinitialized, including customer translations. The entire system must be rebooted. When selected from the maintenance terminal, a warning will be issued stating that system translation information will be erased and an option is provided to either continue or cancel the operation.

  NOTE:
  After a frigid start, the default printer is the PC printer, not the SMDR printer. If you want printouts on-site from the SMDR printer, make sure you change the print options from SPM.

- **Cold start.** Unless the system is connected to an Uninterruptable Power Supply (UPS) a power interrupt of more than one second causes a cold start. All calls are dropped, but customer translations are retained.

  NOTE:
  A cold start does not blank out the screen on an MLX-28D telephone until the end of the cold start.

  A cold start can cause stations with the Extension Status feature to lose their toll restrictions.

- **Warm start.** Warm starts occur automatically and are not initiated by a menu selection. Loss of power for less than 250 ms causes a power transfer to the internal battery backup and causes a warm start. Stable calls are not dropped, but calls in the process of being established may be. Call processing resumes from the point where new and stable calls are handled.

  NOTE:
  Power interruptions of less than 100 ms generally are not noticed by the system.

  Warm starts can cause a telephone to ring without having an associated call. To stop the ringing, place a new call to the telephone.

Every restart causes an error log entry, and each type of restart has its own error code.

System Status Displays

The System Status screen displays simulated LEDs for all modules in the control unit, except the power supply module. The only modules in the control unit that have physical LEDs are the power supply, processor, 100D, 100E, and 400EM.

The simulated LEDs are R (red), Y (yellow), and G (green). R indicates an alarm or standby state; when a module enters a normal state, the R LED goes off. When a call is in progress on a module, the Y LED is on. The word "on" or "off" appears after the R, Y, or G.

Automatic Tests

The system automatically runs tests to:

- monitor the status of equipment
- audit operations consistency
- detect hardware malfunctions

The tests check hardware and software that are in service but do not disrupt normal service. Any errors detected are registered in the error logs. Errors are corrected automatically whenever possible. When automatic error correction is not possible, errors remain in the error logs until manually corrected.

Demand Tests

Demand diagnostic tests for the line/trunk and station modules are selected and scheduled by using the menu screens. Demand tests:

- increase the effectiveness of on-site troubleshooting and repair
- verify complaints of malfunctioning equipment

NOTE:
For some modules, the demand test does not test the shared memory.

When a demand test fails, the module being tested either was not busied-out or is faulty and may have to be replaced.

To run demand tests, the processor module, the power supply module, and the MLX-20L telephone or PC must be working.

NOTE:
You cannot run a demand test on the 008 MLX module to which the MLX-20L telephone is attached. However, you can run a demand test on this module from the PC.

To run a demand test, you must take the equipment out of service. You can choose "Busy-Out" or "Reset" to do this, but "Busy-Out" is preferred since:

- Busy-out removes lines and stations as they become idle but does not disrupt calls in progress.
- Reset drops all calls in progress and removes equipment from service.

Once the equipment is out of service, you can select demand tests. After testing is finished, choose "Restore" from the menu to cancel "Busy-Out" or "Reset."

NOTE:
A cold start or a warm start does not restore equipment that has been busied-out or reset.

On-Site Maintenance

You can do on-site maintenance with an MLX-20L telephone or a PC with SPM software. The MLX-20L plugs into whichever of the first five jacks on the first MLX module is being used as the system programming/maintenance port. (The default is the first MLX jack.) Only one jack at a time can be used for system programming or maintenance. The PC plugs into the RS-232 system programming/maintenance port.

Remote Maintenance

By using a PC with System Programming and Maintenance (SPM) software, maintenance personnel can remotely access the maintenance program. This remote access is provided by a built-in 1200-bps modem in the processor module.

NOTE:
Line noise can distort the SPM screen. When this happens, the remote administrator should hang up and redial.

Once in the maintenance program, the remote administrator can use the menu screens as the on-site technician does to check error logs, check system status, and even cause restarts.

The remote administrator can access the maintenance program by:

- dialing the listed directory number for the customer's system. Usually this rings at the system operator's console, and the operator transfers the call to the system programming/maintenance (SPM) port. The remote administrator then enters the password. (When remote SPM is in use, any local administration is blocked.)

- directly dialing the SPM port by using the Remote Access feature. The administrator enters an access barrier code and the password to connect to the SPM port.

NOTE:
The on-site system technician can also call the SPM port by using either method above. However, it is recommended that the technician connect the laptop PC directly to the RS-232 port on the processor module.

Security

Certain security measures guard against unauthorized remote access. A barrier code can be used for access to the built-in modem. In addition to the barrier code, the SPM software has password validation.

CAUTION:
Precautions should be taken to prevent unauthorized use of the system's outside lines by remote callers, also called toll fraud. See "Customer Support Information" at the front of this book for more information on security.

The following menu selections must be used with care. To eliminate any selection mishaps, you must confirm or cancel them.

- Busy-Out
- Reset
- Restore
- Poke
- System Erase

Maintenance Strategy

The goal of maintenance is to isolate the trouble to one or more replaceable units and to replace the faulty units as quickly as possible. To help isolate the fault, check equipment in the following order:

1. Telephones, adjuncts, and station wiring
2. Line/trunk and station modules
3. Processor module
4. Power supply module
5. Carrier backplane
6. CO connections (network interface)

NOTE:
Traffic problems can result from having more than 64 personal lines or pool buttons on the system. If you have traffic problems, check this first.

Use the maintenance program as follows:

1. Check the error logs.
2. If the error logs indicate trouble in the processor module, correct that problem first since it may be causing trouble in the line/trunk and station modules.
3. Run demand tests on the line/trunk and station modules to further isolate the trouble.
4. If replacing the faulty equipment does not solve the problem, use the screen menus to find the hardware vintage, the software vintage, and the ROM ID of the modules.
5. Escalate the problem.

Using the Maintenance Screens

Using the maintenance screens involves selecting items on menus. The menu selections are identical whether you are using an MLX-20L telephone or a PC. The only difference is that the function keys on the computer keyboard simulate the display buttons on the telephone.

In the following procedures, a representation of the menu screen is shown with the actions to take. To enter maintenance programming, press the button for "Menu" and then the button for "Maintenance." The following main menu appears:

```
Maintenance:
Make a selection
System
Slot
Port

Exit
```

NOTE:
On the maintenance screens, the power supply modules are not shown and the processor module is numbered "00."

System Screens

System screens are used for getting information; you cannot alter anything with system screens.

Error Logs

Error logs show you what errors have occurred in the system. Write down any errors before you leave the error logs.

Select "System" from the main menu.

```
System:
Make a selection
Status       Upgrd/Instll
Error Log
Inventory
Access Log
Exit
```

Select "Error Log."

```
System Error Log:
Make a selection
Last 30
Permanent
Transient
(most recent alarm)
Exit
```

Select the error log desired, for example, "Permanent."

NOTE: The most recent alarm message stays on the System Error Log screen until it is replaced by another one.

```
Permanent Errors:          >
aaaaaaaaaaaaaaaaaaaaaa
Slotxx Portxx    Countxxx
First  mm/dd/yy hh:mm
Last   mm/dd/yy hh:mm
Code   xxxx
Exit
```

The error information appears.

System Status

The System Status screen displays the simulated LED status for each module, except the power supply modules.

Select "System" from the main menu.

```
System:
Make a selection
Status       Upgrd/Instll
Error Log
Inventory
Access Log
Exit
```

Select "Status."

```
System Status:                >
Slot00:  Raaa
Slot01:  Raaa Yaaa Gaaa
Slot02:  Raaa Yaaa Gaaa
Slot03:  Raaa Yaaa Gaaa
Slot04:  R    Y    G
Exit
```

The screen appears with simulated LEDs for each module for red, yellow, and green. Press the "More" button to display more modules, up to 17. If a slot is empty, `R`, `Y`, and `G` will appear, but not `on` or `off`.

System Inventory

System Inventory shows the vintage of the hardware and software and the ROM ID.

Select "System" from the main menu.

```
System:
Make a selection
Status       Upgrd/Instll
Error Log
Inventory
Access Log
Exit
```

Select "Inventory."

```
System Inventory          >
Slot 00
Board Processor
Hardware Vintage: xx
LEGEND 1.4 Vx.x
D1D1D1D1
Exit
```

The processor module inventory information appears. Press the "More" button to show the inventory information for the other modules.

```
System Inventory          >
Slot xx
Board xxxxxx
Hardware Vintage: xx
Firmware Vintage: xx
Application Vintage: xx
Exit
```

The inventory information for the first line/ trunk and station module appears. Press "More" to show information for the next module.

Slot Screens

Slot screens let you check the status of the module in a particular slot and to perform maintenance activities such as demand tests and restore.

NOTE:
On the maintenance screens, the power supply modules are not represented and the processor module is numbered "00."

To get to all slot functions, select "Slot" from the main menu.

```
Slot:
Enter slot number (00-17)

xx

Backspace
Exit                Enter
```

The slot screen appears. Enter the slot number of the module you want by keying in the number, using the dialpad (MLX-20L telephone) or the keyboard (PC) and pressing "Enter."

Slot Status

Slot Status gives information about the module in a particular slot.

Enter the slot number of the module you want.

```
Slot 00:
Make a selection
Status
Demand Test

Exit
```

This is the slot menu for the processor module. Select "Status" from the Slot menu.

```
Status Slot 00:
LED:      Raaa
Errors:

Alarms:

Exit
```

This is the screen for the processor module.

```
Slot xx:
Make a selection
Status       Demand Test
Busy-Out     Reset
Restore      Upgrade

Exit
```

If you entered a slot number other than 00 and the module in that slot is not the 100D, 100E, or MFC06, this screen appears. Select "Status."

```
Status Slot xx:
LED:      Raaa Yaaa Gaaa
Errors:
Mode:
Alarms:
Maintenance Busy:
Exit          Next
```

This screen appears with information for the module in the numbered slot.

```
Slot xx:
Make a selection
Status        Demand Test
Busy-Out      Reset
Restore       Error Events
CSU-lpbk      Clock
Exit          Upgrade
```

If you entered the slot number of the 100D module, this screen appears. Select "Status."

For the 100E module, "E1-lpbk" appears in place of "CSU-lpbk."

For the MFC06 module, "MFC Tone" appears in place of "CSU-lpbk." Additionally, "Error Events" and "Clock" are not displayed.

```
Status Slot xx:
LED:      Raaa Yaaa Gaaa
Errors:
Mode:
Alarms:
Maintenance Busy:
Exit          Next
```

Depending on your selection, status information appears for the 100D, 100E, or MFC06 module.

Busy-Out and Reset

You must busy-out or reset any module before you run a demand test for it and before you replace it. "Busy-Out" is the preferred choice because it does not drop calls in progress.

In the following screens, "Busy-Out" is shown, but choosing "Reset" works the same way.

```
Status Slot xx:
Make a selection
Status       Demand Test
Busy-Out     Reset
Restore      Upgrade

Exit
```

Choose "Busy-Out" from this Slot screen.

```
Busy-Out Slot xx:
Do you want to continue?
Yes
Cancel


Exit
```

A screen appears that allows you to either confirm your selection, or cancel and return to the previous screen.

```
Busy-Out Slot xx:

Busy-Out in Progress



Exit
```

This screen appears.

```
Busy-Out Slot xx:

Busy-Out Complete



Exit
```

This screen appears when busy-out is successfully completed.

If busy-out is not successfully completed, the message displayed is as follows:

Busy-Out FAILED

Demand Tests

Demand tests let you pinpoint module problems.

NOTE:
Before running any tests on the processor module, back up the system translations by using the PC with SPM (see the *System Programming* guide for details).

After you run a demand test on a module, you must restore the module. See "Restore" later in this chapter.

Module Demand Test. Request this demand test to find out if the module is functioning properly. The screens shown apply to any module other than the processor module. In the following screens, the "BoardCntrlr" demand test is shown, but choosing "IntLoopback" works the same way.

NOTE:
A module must be busied-out before a demand test is run.

```
Slot xx:
Make a selection
Status       Demand Test
Busy-Out     Reset
Restore      Upgrade

Exit
```

Select "Demand Test" from the Slot menu.

```
Demand Test Slot xx:
Make a selection
Note:Busy out slot first
BoardCntrlr
IntLoopback

Exit
```

Select the demand test you wish to run.

```
Demand Test Slot xx:
Board aaaaaaaaaaaaaaaa
Board Controller:
Test Once
Repetitive

Exit
```

This screen is displayed if "BoardCntrlr" was selected.

Select "Test Once" to run the test once; choose "Repetitive" to repeat the test continuously.

```
Demand Test Slot xx:
Board aaaaaaaaaaaaaaaa
Board Controller Test
in Progress


Exit
```

Once you have made your selection, this screen appears.

If you selected "Repetitive," you can interrupt the test at any time by selecting "Exit."

```
Demand Test Slot xx:
Board aaaaaaaaaaaaaaaa
Board Controller Test
Successfully Completed


Exit
```

If you selected "Test Once" and the test passes, this screen appears.

```
Demand Test Slot xx:   >
Board aaaaaaaaaaaaaaaa
Board Controller Test
FAILED
xxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxx
Exit
```

If you selected either "Repetitive" or "Test Once" and the test fails, this screen appears.

The lines indicated by "xxxx" may contain error messages.

Processor Module Demand Test. If you select "Demand Test" for the processor module, you get three choices: "Peek," "Poke," and "System Erase."

CAUTION:
"Peek" and "Poke" should be done only at the direction of AT&T.

```
Demand Test Slot 00:
Make a selection
Peek
Poke
System Erase

Exit
```

With "Peek" you can examine system memory or circuit board memory but cannot change anything.

"Poke" allows you to change system or circuit board memory.

"System Erase" is a frigid start and erases all system memory.

```
Slot 00 EnterHexAddress:
aaaaaaaa
                    Enter
Backspace            Exit
A                       B
C                       D
E                       F
```

If you selected "Peek," this screen appears. Key in the memory address and press "Enter."

```
Peek Address 0xaaaaaaaa:>

0xaaaa              0xaaaa
0xaaaa              0xaaaa
0xaaaa              0xaaaa
0xaaaa              0xaaaa
Exit
```

This status screen appears. Press "More" to view the next 16 bytes of memory locations.

The first 2-byte word of data at the requested address is shown in the upper left-hand part of the screen. The next two-byte word is shown in the upper right-hand part of the screen.

```
Poke - WARNING!! SYSTEM
MEMORY WILL BE MODIFIED!
Continue
Cancel


Exit
```

If you selected "Poke," this screen appears. Choose to continue or cancel.

```
Slot 00   EnterHexAddress:
aaaaaaaa
                      Enter
Backspace              Exit
A                         B
C                         D
E                         F
```

If you selected "Continue," this screen appears. Key in the address of the desired memory address and press "Enter."

```
0xaaaaaaaa   Enter data:
aa
                      Enter
Backspace              Exit
A                         B
C                         D
E                         F
```

This screen appears and you can enter any changes you want to make. Press "Enter" when you are done.

```
Slot 00 System Erase:
System will be down ...
Do you want to continue?
Yes
No

Exit
```

If you selected "System Erase," this screen appears. Choose "Yes" or "No." Remember that "System Erase" wipes out the system's memory.

```
System Erase:
Full-default Restarting
```

If you chose to continue with "System Erase," this screen appears.

Restore

You must restore a module after a demand test has been run and after a module has been replaced.

```
Slot xx:
Make a selection
Status       Demand Test
Busy-Out     Reset
Restore      Upgrade

Exit
```

After entering the slot number for the module, this screen appears. Choose "Restore."

```
Restore Slot xx:
Do you want to continue?
Yes
Cancel


Exit
```

This screen appears allowing you to either confirm the action, or cancel the reset and return to the previous screen.

```
Restore Slot xx:

Restore in Progress



Exit
```

If you selected "Yes," this screen appears and indicates that restore is in progress.

```
Restore Slot xx:

Restore Complete



Exit
```

When restore is successfully completed, this screen appears.

```
Restore Slot xx:

Restore FAILED
Board Mismatch


Exit
```

If the restore fails, this screen appears, indicating a board mismatch (a different module from the one replaced has been inserted in the slot).

100D and 100E Module Selections

The 100D and 100E modules have the following unique selections: "Error Events" and "Clock." Additionally, the 100D module has a "CSU-lpbk" (loopback) selection, and the 100E module has an "E1-lpbk" selection. Each of these is selected from the 100D or 100E Slot screen below.

Error Events. "Error Events" lists the errors for the current and previous hours for the 100D and 100E modules.

Enter the slot number of the 100D or 100E module.

```
Slot xx:
Make a selection
Status        Demand Test
Busy-Out      Reset
Restore       Error Events
CSU-lpbk      Clock
Exit          Upgrade
```

For the 100D module, this screen appears. Select "Error Events."

For the 100E module, "E1-lpbk" appears in place of "CSU-lpbk."

```
Status Slot xx:
Make a selection
Current hr
Previous hr


Exit
```

Choose "Current hr" or "Previous hr."

```
Current hr Slot xx:

mm/dd/yy     hh:00-hh:mm
CurAlm aaaa MaxAlm aaaa
MIS SLP ES   BS   SEC FS
xxx xxx xxx xxx xxx xxx
Exit
```

This screen appears if you selected "Current hr." The "Previous hr" screen is identical except for the title line.

Clock. Choosing "Clock" from the 100D or 100E Slot screen provides information on the clock synchronization for that module.

```
Clock Slot xx:
mm/dd/yy      hh:00-hh:mm
Admin as:
Active:
Synch source:
PPM:  xxx
Exit
```

If you selected "Clock," this screen appears.

100D Module "CSU-lpbk" Selection

Channel Service Unit (CSU) Loopback Test. Before you select "CSU-lpbk" from the 100D Slot screen, you must do the following:

1. Plug one end of a bantam-to-bantam patch cord (or a loopback fixture, if one is available) into the EQ OUT jack on the front of the CSU.

   This causes the CSU to either loop back the network signal or send the all-ones pattern, depending on the chosen CSU option.

2. Plug the other end of the patch cord into the EQ IN jack on the CSU.
3. Using the maintenance screens, busy-out the 100D module (see "Line/ Trunk or Station Busy-Out" later in this chapter).
4. Select "CSU-lpbk" from the 100D module Slot screen. (Four tests are run for each channel.) The following screen appears.

```
CSU-lpbk Slot xx:

CSU-lpbk in Progress



Exit
```

This screen indicates that the loopback test is running.

Each time a channel is selected, the green LED on the 100D module flashes.

You can interrupt the test at any time by selecting "Exit."

```
CSU-lpbk Slot xx:

CSU-lpbk Passed

                .


Exit
```

This screen appears if the loopback test is successfully completed.

```
CSU-lpbk Slot xx:
CSU-lpbk Failed
xxx xxx xxx xxx xxx xxx
xxx xxx xxx xxx xxx xxx
xxx xxx xxx xxx xxx xxx
xxx xxx xxx xxx xxx xxx
Exit
```

This screen appears if the loopback test fails. The screen shows the number of failures for each channel.

5. After the test is completed, restore the 100D module by using the maintenance screens (see "Line/Trunk or Station Restore" later in this chapter) and unplug the patch cord, first from the EQ IN jack and then from the EQ OUT jack.

100E Module "E1-lpbk" Selection

E1 Loopback Test. Before you select "E1-lpbk" from the 100E Slot screen, you must do the following:

1. Plug a loopback cable into the jack on the 100E module.

   This causes the E1 signal to loop around at the signal jack. If a loopback cable is not available, see Table C-2 in Appendix C for the connector pin information needed to make a loopback cable.

2. Using the maintenance screens, busy-out the 100E module (see "Line/Trunk or Station Busy-Out" later in this chapter).

3. Select "E1-lpbk" from the 100E module Slot screen. (Four tests are run for each channel.) The following screen appears:

```
E1-loopback Slot xx:

E1-loopback in Progress



Exit
```

This screen indicates that the loopback test is running.

Each time a channel is selected, the green LED on the 100E module flashes.

You can interrupt the test at any time by selecting "Exit."

```
E1-loopback Slot xx:

E1-loopback Passed



Exit
```

This screen appears if the loopback test is successfully completed.

```
E1-loopback Slot xx:
E1-loopback Failed
xx xx xx xx xx xx xx xx
xx xx xx xx xx xx xx xx
xx xx xx xx xx xx xx xx
xx xx xx xx xx xx xx xx
Exit
```

This screen appears if the loopback test fails. The screen shows the number of failures for each channel.

4. After the test is completed, restore the 100E module by using the maintenance screens (see "Line/Trunk or Station Restore" later in this chapter) and unplug the loopback cable from the E1 jack.

MFC06 Module "MFC Tone" Selection

MFC Tone Test. Before you select "MFC Tone" from the MFC06 Slot screen, you must do the following:

1. Using the maintenance screens, busy-out the MFC06 module (see "Line/Trunk or Station Busy-Out" later in this chapter).
2. Select "MFC Tone" from the MFC06 module Slot screen. The following screen appears:

```
MFC Tone Test Slot xx:

MFC Tone Test in Progress



Exit
```

This screen indicates that the loopback test is running.

You can interrupt the test at any time by selecting "Exit."

```
MFC Tone Test Slot xx:

MFC Tone Test Passed



Exit
```

This screen appears if the loopback test is successfully completed.

```
MFC Tone Test Slot xx:
Board
MFC Tone Test FAILED
xx xx xx xx xx xx


Exit
```

This screen appears if the loopback test fails. The screen shows the number of failures for each channel.

3. After the test is completed, restore the MFC06 module by using the maintenance screens (see "Line/Trunk or Station Restore" later in this chapter).

Port Screens

Port screens show information for individual lines/trunks and stations, as well as information for RS-232 ports, modems, and MFC channels. They also allow you to busy-out and restore these lines/trunks, stations, and MFC channels.

Select "Port" on the main menu screen.

```
Port:
Make a selection
Line/Trunk  Modem
Station     MFC-Channel
RS232 Port1
RS232 Port2
Exit
```

This screen appears. Choose the port you want.

Line/Trunk, Station, or MFC-Channel Selection

Choosing "Line/Trunk," "Station," or "MFC-Channel" gives you three options: "Status," "Busy-Out," and "Restore."

Status (for the Line/Trunk or Station Selection). Select "Line/Trunk" or "Station" to display the "Line/Trunk" or "Station" selection screen.

```
Line/Trunk
Enter line number

xxxx

Backspace

Exit          Enter
```

Enter the dial plan line number for a particular line/trunk and press "Enter."

If you selected "Station," "Station" appears in place of "Line/Trunk" throughout this procedure. (Enter the dial plan extension for a particular station and press "Enter."

```
Line/Trunk xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

Select "Status."

```
Line xxxx:

Dial Plan:  xxxx
Label:  xxxxxxxxxx
Maintenance Busy:

Exit
```

This screen appears with the current line/ trunk status information.

```
Station xxxx:

Dial Plan:  xxxx
Profile:
Maintenance Busy:

Exit
```

This is the screen for station status information.

Status (for the MFC-Channel Selection). Select "MFC-Channel" to display the "MFC-Channel" selection screen.

```
MFC-Channel:
Enter MFC-Channel (sspp,
ss=01-17, pp=01-06)
xxxx

Backspace

Exit        Enter
```

Enter the slot and port for a particular MFC-Channel and press "Enter."

```
MFC-Channel xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

Select "Status."

```
MFC-Channel xxxx:

Maintenance Busy:



Exit
```

This screen appears with the current MFC-Channel status information.

Busy-Out (for the Line/Trunk or Station Selection). This allows you to busy-out an individual line or station without affecting an entire module.

NOTE:
A telephone on a busied-out line cannot be accessed. The system provides a busy signal and, as applicable, a busy message to any incoming calls. However, when a queued call console (QCC) is busied out, calls to that QCC remain in queue until the QCC is restored or the caller disconnects.

```
Line/Trunk xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

Select "Busy-Out."

If you selected "Station," "Station" appears in place of "Line/Trunk" throughout this procedure.

```
Line/Trunk xxxx:

Busy-Out in Progress



Exit
```

This screen appears, indicating that the busy-out is in progress.

```
Busy-Out Line/Trunk xxxx:

Busy-Out Successfully
Completed


Exit
```

If the busy-out has finished successfully, this screen appears.

```
Busy-Out Line/Trunk xxxx:

Busy-Out FAILED



Exit
```

If the busy-out fails, this screen appears.

Busy-Out (for the MFC-Channel) Selection). This allows you to busy-out an individual MFC-Channel without affecting an entire module.

```
MFC-Channel xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

Select "Busy-Out."

```
MFC-Channel xxxx Busyout:

Busy-Out in Progress



Exit
```

This screen appears, indicating that the busy-out is in progress.

```
MFC-Channel xxxx Busyout

Busy-Out Successfully
Completed


Exit
```

If the busy-out has finished successfully, this screen appears.

```
MFC-Channel xxxx Busyout

Busy-Out FAILED



Exit
```

If the busy-out fails, this screen appears.

Restore (for the Line/Trunk or Station Selection). You must restore a line/trunk or station after you have used busy-out.

```
Line/Trunk xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

Select "Restore."

If you selected "Station," "Station" appears in place of "Line/Trunk" throughout this procedure.

```
Restore Line/Trunk xxxx:

Restore in Progress



Exit
```

This screen appears, indicating that the restore is in progress.

```
Restore Line/Trunk xxxx:

Restore Successfully
Completed


Exit
```

If the restore is completed successfully, this screen appears.

```
Restore Line/Trunk xxxx:

Restore FAILED



Exit
```

If the restore fails, this screen appears.

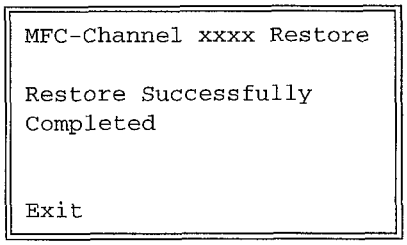
Restore (for the MFC-Channel Selection). You must restore an MFC-Channel after you have used busy-out.

```
MFC-Channel xxxx:
Make a selection
Status
Busy Out
Restore

Exit
```

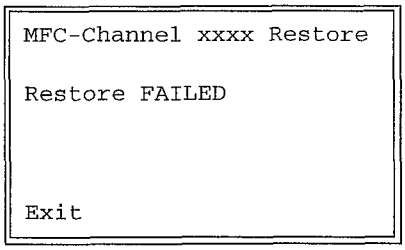
Select "Restore."

```
MFC-Channel xxxx Restore

Restore in Progress



Exit
```

This screen appears, indicating that the restore is in progress.



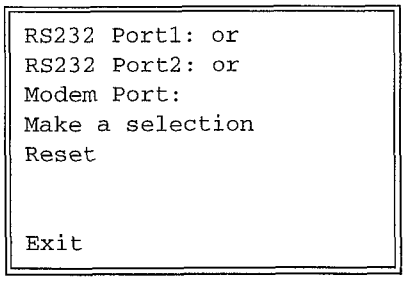
If the restore is completed successfully, this screen appears.



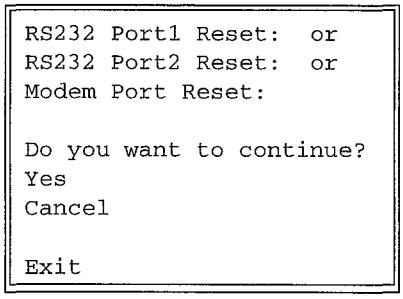
If the restore fails, this screen appears.

RS-232 or Modem Port Reset. Select the desired RS-232 port or the modem from the Port menu.

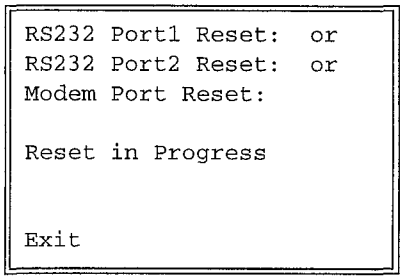
NOTE:
Port 1 is the system programming/maintenance port and Port 2 is the SMDR port.



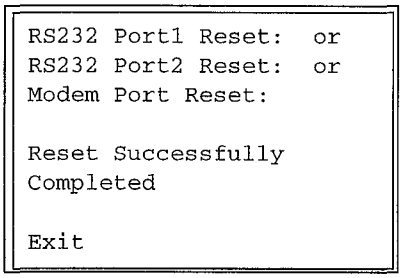
If you want to reset the RS-232 ports or the modem, select "Reset."



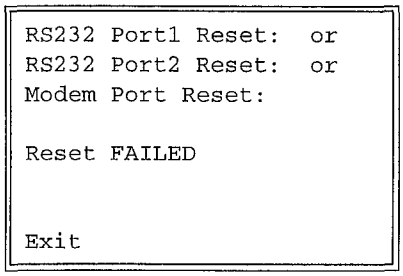
Select "Yes" to start the reset.



This screen appears, indicating that the reset is in progress.



If the reset is completed successfully, this screen appears.



If the reset fails, this screen appears.

Replacing Equipment

When an error has been isolated to one of the following pieces of equipment, you can replace the equipment:

- telephones, adjuncts, and station wiring
- line/trunk and station modules
- processor module
- power supply module
- carrier

NOTE:
We recommend that you record each station jack connection and each station change on the "System Technician's Run Sheet" (see Appendix E).

The ring generator and auxiliary power units may also be faulty and need to be replaced. (See Chapter 3, "Installation," for information on replacing this equipment.)

Replacing the Telephones and Adjuncts

Once a problem has been isolated to a telephone (or a group of telephones), various tests can be done to see if the telephone is working properly. Check the telephone wire first. Also, swap a telephone you know is good with the one you think is faulty. These practical steps isolate the problem quickly.

The following describes the telephone tests and how to fix particular problems.

MLX Telephone Tests

Follow the procedure in this section to test MLX telephones. The tests check the

- LEDs
- display screen
- ringer
- buttons
- switchhook
- B-channel operation

Follow this basic procedure for any MLX telephone test:

1. Pick up the handset.
2. At the dial tone, enter the feature access code (*00) by pressing the dialpad.

   The software should place the telephone in test mode.
3. Run the test.
4. Hang up when done.

NOTE:
Telephones cannot be tested remotely.

Basic MLX Telephone Test. This test connects a test tone to the B channel and sends a repeated ring burst to the telephone. All the LEDs turn on.

Follow these steps to test an MLX telephone:

1. Press a line/feature button with two LEDs to toggle these LEDs red and green.
2. Press a fixed-feature button with one LED to toggle the LED on and off.

   NOTE:
   Mute and **Speaker** LEDs may not toggle consistently since they are managed by both the CU and the telephone.
3. Press a fixed-feature button without an LED or press a dialpad button to toggle the **Message** LED on and off.
4. Press the fixed-feature buttons and the dialpad in the following sequence to turn on all the LEDs:
   a. **Volume** down
   b. **Volume** up
   c. **Transfer**
   d. **Conf**
   e. **Drop**
   f. **Hold**
   g. 123456789*0#

MLX Telephones with Displays Test. Activating the test blacks out the display.

Follow these steps to test an MLX telephone with a display:

1. Press any display button.

   A unique character string should appear.

2. Press each display button in turn to cause a unique character string to appear.

MLX Telephones with a DSS Test. Activating the test turns on all the LEDs. Follow the steps in "Basic MLX Telephone Test" above to get the LED response.

MLX Telephones with Multi-Function Modules (MFMs) in the T/R Mode Test. To run this test, you must connect a single-line telephone to the MFM.

Follow these steps to test a telephone with an MFM:

1. At the system access or intercom dial tone, dial the feature code ✱09 to activate the test.

   The diagnostic test tone connects to the B channel.

2. Press the sequence 123456789✱0# and then quickly press the switchhook.

   The CU should send a confirmation tone.

3. Hang up.

   The CU should send a ring burst to the MFM, turn on the ***Message*** *LED, and resume normal operations.*

Fixing Telephone Problems

When a user complaint or a system test identifies the telephone as the problem area, the trouble can be in the telephone itself, in the mounting cord, or in the wiring between the CU and the telephone. Check the wiring and the mounting cord before checking the telephone.

NOTE:
If the wiring has been crushed or severed, the -48 VDC power supply may be shorted.

General Telephone and Wiring Troubles

Symptom:

Intermittent telephone trouble

Procedure:

1. Swap a known good telephone with the suspect telephone to determine if the problem is localized to the suspect telephone. If local power is provided, check the power supply.
2. If trouble disappears, the fault is with the suspect telephone. Replace it.
3. If the known good telephone does not work properly, the fault may be in the wiring and/or the line/trunk and station module.
4. Check the other telephones connected to the same module. If they are working properly, the fault is probably in the wiring, or it may be a single-port failure on the line/trunk and station module. Swap the wiring between the jack field and the telephone to see if it is a wiring problem. Fix the wiring problem.
5. If the other telephones connected to the same line/trunk and station module are not working properly, the fault is probably in the line/trunk and station module.
6. Check the circuit module translations from the maintenance terminal. Ensure that the module has been properly translated.
7. Check the LEDs on the line/trunk and station module.
8. Check the error log for relevant messages.
9. Replace the faulty line/trunk and station module.

Analog Multiline Telephone Trouble

Symptom:

Telephone LEDs and/or ringing tones do not work properly.

Procedure:

1. Move the T/P lever on the left-hand side to the "T" (test) position.

   You should hear tone ringing. All the red and green LEDs on the terminal should flash alternately.

2. If LEDs do not light, check the CU and wiring by using a known good phone.
3. Move the T/P lever to its normal position.

   Ringing tone should stop, and the LEDs should be off.

4. If any part of the test fails, replace the telephone.

Symptom:

Time appears on the display, but the incoming call information does not.

Procedure:

Move the T/P lever on the side of the telephone to the center position.

Voice Transmission Troubles

Symptom:

Telephone does not receive tones.

Procedure:

Check the CU and wiring with a known good telephone.

Single-Line Telephone Problems

Symptom:

Many single-line telephones cannot dial correctly even though they are receiving calls.

Procedure:

Using a single-line telephone, test the touch-tone receivers (TTRs) as follows:

1. Pick up the handset and dial ✱04 and the 2-digit number of the TTR to be tested.
   - If you hear a busy tone, the receiver is in use.
   - If you hear a reorder tone, you have misdialed or have reached an invalid TTR.
   - If you hear a dial tone, continue this test.
2. Dial the digits 123456789✱0#

   You should hear a DTMF signal as each button is pressed. If the test is successful, you will hear a dial tone within one to three seconds after you enter #.
3. Repeat the test for each TTR.
4. Replace the module containing the faulty TTR if this test fails.

Symptom:

User cannot make outside calls on touch-tone telephone.

Procedure:

Check the individual line/trunk for rotary-dial programming.

Call Forward Problems

Symptom:

Users are getting other people's calls.

Procedure:

Usually this problem results from someone unknowingly activating Call Forward. Cancel the forwarding of calls to the receiving telephone as follows:

- For multiline telephones
  1. Press the **Feature** button.
  2. Dial ✱34✱.
- For single-line telephones
  1. Pick up the handset.
  2. Dial #✱34✱.
  3. Hang up.

Replacing Modules

With the exception of the power supply and processor modules, all modules can be removed and inserted without affecting normal call processing: powering down the system is not required, and all modules can be replaced at the same time.

NOTE:
This section does not pertain to the power supply module or the processor module. For those procedures, see the next two sections.

Although the system is designed for modules to be replaced without affecting call processing, partially inserting or removing a module can cause a cold start.

The module removed must be replaced with a module having the same type of circuit board, in other words, the same signature. If a module is replaced with another type of module, or if a module is added to the system without the system being powered down, a cold start occurs. If you move the first 008 MLX module from its slot, you must renumber the modules by selecting "Board Renumber" from the System Programming menu.

NOTE:
This procedure is **not** the procedure for replacing the **processor** module.

Follow these steps to replace a line/trunk and station module:

1. Busy-out or reset the module. (Busy-out is recommended.)

   The module enters standby mode.

2. Label all line/trunk and station cords (if they haven't been labeled already) and unplug them from the module.
3. Run a demand test by entering the test mode.
4. Remove the module and inspect it for visible damage.
5. Insert the new module.
6. Select "Restore" to put the module back in service.
7. Plug in the line/trunk and station cords.
8. Attach a tag identifying any visible problems or failure symptoms, and any relevant error reports to the replaced module.

Replacing the Processor Module

A failed processor module must be repaired immediately. Follow these steps to replace a failed processor module:

1. If possible, save all the translations to a floppy disk by using the backup function.

   NOTE:
   When the processor module fails, backup is usually impossible.

2. Power down the system by turning off
   a. the power supply module on the basic carrier
   b. the power supply module(s) on the expansion carrier(s)
   c. any auxiliary power unit (if present)
3. Unplug the SMDR printer and/or system programming PC cords if present.
4. Remove the processor module.
5. Inspect the processor module for any visible problems.
6. Inspect the carrier backplane.
7. Remove the feature module from the processor module and install it in the new processor module.
8. Install the new processor module.
9. Restore power by turning on
   a. any auxiliary unit (if present)
   b. the power supply module(s) on the expansion carrier(s)
   c. the power supply module on the basic carrier

   The system automatically cold starts.
10. Use the maintenance screens to select "System Erase" (frigid start).
11. Restore the system translations from the backup floppy disk.
12. Plug in the SMDR printer and/or administrative PC cords.
13. Attach a tag identifying any visible problems and any relevant error reports to the replaced processor module.

Replacing the Power Supply Module

Failure of the power supply shuts down everything connected to the carrier.

If the power supply fails, check that the interlocking post in the power supply slot of the carrier has not broken off. Without this post, the power supply will not operate and the carrier must be replaced.

Follow these steps to replace the power supply module:

1. If possible, save the translations on a floppy disk by using the backup function.

   NOTE:
   If the power supply module on the basic carrier has failed, the system cannot save the translations to a disk.

2. Power down the system by turning off
   a. the power supply module on the basic carrier
   b. the power supply module(s) on the expansion carrier(s)
   c. any auxiliary power unit (if present)
3. Unplug the system from the AC outlet.
4. Remove the power supply module and insert a new one.
5. Restore power by turning on
   a. any auxiliary unit (if present)
   b. the power supply module(s) on the expansion carrier(s)
   c. the power supply module on the basic carrier

   The system automatically cold starts.

Replacing the Carrier

Typical carrier problems include power supply failure, sudden failure of one or more line/trunk and station modules, or system problems that cannot be isolated to a specific module.

Follow these steps to check carrier problems:

1. Visually inspect the pins on the carrier. (Bent or broken pins often cause carrier problems.) To do this, you may have to remove one or more line/trunk and station modules by using Busy-Out, Reset, and Restore.
2. If you find a problem with the carrier, you must replace it (but not the line/trunk and station modules). Carriers cannot be repaired in the field.
3. Attach a tag that describes the problem to the faulty carrier.

CO Troubles

The automatic maintenance program takes the ports out of service when a line/trunk is malfunctioning. The line/trunk is periodically tested to put it back in service.

Maintenance-Busy

When a line/trunk cannot be seized for an incoming or outgoing call, the line/trunk is automatically put into a maintenance-busy state. When a line/trunk is in a maintenance-busy state, no outgoing calls can be placed on it. However, the line/trunk still receives incoming calls.

The system-wide Automatic Maintenance Busy feature (if enabled) applies to all trunks, except DID trunks, which cannot be used to make outgoing calls. In addition, there is an administrable DTD Maintenance Busy parameter that applies to any trunk with DTD enabled (including trunks in a pool). If the DTD Maintenance Busy parameter is set to "Yes" and the DTD time-out interval is exceeded four times on a trunk without an intervening dial tone being detected, the trunk will be marked as "unavailable for DTD." Trunks busied out because dial tone was not detected will remain busied out until manually restored to service.

While the line/trunk is in a maintenance-busy state, the software periodically runs tests to try to seize the line/trunk. If the seizure is unsuccessful, the line/trunk stays in a maintenance-busy state. If the seizure is successful, the line/trunk is placed back in service. If a test is running when an incoming call is received on the line/trunk, the test is dropped and the call is processed.

NOTE:
No more than 50 percent of lines/trunks in a pool can be maintenance busy at one time. The only exceptions are:

- user-imposed maintenance busy
  (for example, module replacement)
- module maintenance busy
  (for example, a loss-of-service alarm in the 100D or 100E module)
- no external release at the far end of the line

A permanent error is entered when more than 50 percent of the lines/trunks in a pool are maintenance busy. When the maintenance-busy level falls below 50 percent, the permanent error is automatically removed.

NOTE:
Make sure that no modules are in a maintenance-busy state during a backup procedure (see *System Programming* guide). Any module in a maintenance-busy state will be recorded as such on the translations disk.

Conditions Causing a Maintenance-Busy State

- **Loop-Start Line/Trunk**
  - — No loop current exists when the LS line/trunk is seized.

    A transient error is reported. After four occurrences, the port enters a maintenance-busy state and the error becomes permanent.

- **Tie Trunk**
  - — A seizure of an outgoing tie trunk fails.

    A transient error is reported. After four unsuccessful seizure attempts, the port is marked maintenance busy and the error becomes permanent.

  - — The far-end station fails to disconnect.

    A transient error is reported. After two occurrences, the port is marked maintenance-busy and the error becomes permanent.

    NOTE:
    The test is not run on auto-out tie trunks.

Maintenance-Busy Programming

You can select automatic maintenance busy as a system programming option. If you do, there is also a menu selection to include tie trunks.

Manual Correction of Line/Trunk Problems

If the system cannot seize a line/trunk even after repeated attempts, you may have to replace the module. To identify the line/trunk problem, first check for a dial tone at the CU. If you do not hear a dial tone, check the error logs and make a line/trunk test call.

It is sometimes difficult for the customer to detect line/trunk troubles. If a line/trunk is down, an error is recorded in the error log and the line/trunk is taken out of service. If an incoming-only line/trunk is down, however, the only sign of trouble is customer complaints that incoming calls are not being received.

Check the error log for line/trunk-related error messages. Also check the wiring and the system parameters (for example, touch-tone/rotary/MFC, toll restriction, and disconnect time interval).

Outgoing Line/Trunk Problems

Symptom:

Outgoing lines/trunks cannot be seized.

Procedure:

1. At the network interface, check for a dial tone from the CO. If a dial tone is not present, notify the customer.
2. Pick up the handset at a test station to get a system dial tone.
3. For a Hybrid/PBX system, dial ✱03

   NOTE:
   Dialing ✱03 on a single-line telephone works only if the line/trunk accepts touch-tone dialing. After you dial ✱03 on a single-line telephone, you may have to wait for a "click" before dialing the line/trunk number.

4. Dial the 2-digit line/trunk number of the line/trunk to be tested (01 to 80).
5. Listen for a dial tone. If a dial tone is not present, use a test set to isolate the fault to the line/trunk and station module where the line/trunk terminates or to the location in the line/trunk access equipment.
6. If a dial tone is present, dial a working outside number. Verify that the call is complete.

   If the line/trunk is busy, you hear a busy tone. You hear a reorder tone if a wrong line/trunk type (such as DID) or an invalid line/trunk number was dialed.

7. If the module continues to malfunction, replace it.

Incoming Line/Trunk Problems

Symptom:

Incoming lines/trunks do not work properly.

Procedure:

1. Place an incoming call through the troubled line/trunk.
2. For an LS line/trunk, connect a single-line telephone to the line/trunk at the network interface. Listen for ringing. Pick up the handset and check for dial tone. Dial an outside number and verify that you have good two-way transmission.
3. At the maintenance terminal, check the line/trunk translations to be sure this line/trunk has been properly translated. (See the system planning forms.)
4. If the module continues to malfunction, replace it.

Line/Trunk Error Summary

Table 4-1 shows the line/trunk errors reported when a transient or permanent error is registered by the system. These errors are also recorded for T1 ports.

NOTE:
In some cases, errors occur not because a single port fails, but because the entire E1 (or T1) link fails. If the entire E1 or T1 link fails, the periodic E1 or T1 board-level maintenance monitoring functions perform the testing and activate alarming.

Table 4-1. Line/Trunk Errors

Error	Line/Trunk
No loop current	LS lines/trunks
No external release on far-end disconnect	DID and tie lines/trunks
On-hook before ready to receive digits; trunk with delay-dial or wink-start	DID and tie trunks
On-hook before wink; trunk with delay-dial or wink-start	DID and tie trunks
Stuck ringing	LS lines/trunks
Wink too short for valid signal	Tie trunks

The 100D and 100E System Modules — E1 or T1 Maintenance

The system provides the following automatic maintenance activities on an ongoing basis:

NOTE:
E1 maintenance pertains to 100E modules, and T1 maintenance pertains to 100D modules.

- **Initialization**. The system ensures that all E1 or T1 ports are properly initialized and placed into service. It also resolves the conflicts of different service levels (for example, between the individual ports or for the initialization of the ports to support features).
- **Error detection and handling**. The system detects errors and takes the facility out of service, if appropriate. It attempts to restore the facility and put it back into service.
- **Error recording**. The system records all errors and outages in the error logs.
- **Audits and updates**. The system checks the state of the E1 or T1 facilities through audits, status checks, and error logging.
- **Maintaining the synchronization plan**. The system maintains proper synchronization to the loop clock and switches to the local clock when the loop clock is not available (for example, during a loss of signal or a blue alarm). When the loop clock source is restored, the system switches back to the loop clock.

Troubleshooting

Table 4-2 below is a quick reference for maintenance problems and possible solutions.

Table 4-2. Maintenance Problems and Solutions

Error Code	Screen Description	Possible Cause	Solution
0001	TIMEOUT COLD START	■ Software initiated ■ Power failure ■ Faulty processor module	No action is needed. If problem persists, check or replace processor module.
0002	POWER UP WARM START	■ Power failure ■ Power supply failure ■ Faulty processor module	Check for erratic AC power. Check power supply voltages and replace if necessary; otherwise no action is needed. If problem persists, check or replace processor module.
0003	SOFTWARE COLD START	■ Software initiated ■ Faulty processor module	No action is needed. If problem persists, check or replace processor module.
0004	SOFTWARE WARM START	■ Software initiated ■ Faulty processor module	No action is needed. If problem persists, check or replace processor module.
0006	INCOMPLETE COLD START	■ System was cold started while restart was in progress ■ Power supply failure ■ Faulty processor module	Check power supply voltages and replace if necessary; otherwise no action is needed. If problem persists, check or replace processor module.
0007	SANITY TIMEOUT RESET	■ Processor module sanity timer failure ■ Software failure ■ Backplane failure	Check module and replace if necessary, or check or replace processor module.
0008	MAX RESET COUNT EXCEEDED	■ System initiated cold start because of too many warm starts ■ Power supply module failure ■ Faulty processor module	Check power supply voltages and replace power supply module if necessary; otherwise no action is needed. If problem persists, check or replace processor module.
0009	FRIGID START	■ Processor module was removed while in use, and system initiated frigid start because of translation loss ■ User initiated frigid start	Restore translations if backup disk is available. If no backup is available, reprogram system by using instructions in *System Programming* guide.

Error Code	Screen Description	Possible Cause	Solution
000A	POWER UP COLD START	■ Power supply module failure ■ Faulty processor module ■ Power failure	Check power supply voltages and replace if necessary; otherwise no action is needed. If problem persists, check or replace processor module.
000B	CARD INSERTED/ REMOVED	■ Module was installed or removed	Usually no action is needed.
000C	SLOT STREAM CNT EXCEEDED	■ Excessive interrupts generated by slot	If problem persists, check or replace processor module.
000D	FMWR NOT IN STANDBY MODE	■ Module firmware is not in standby mode at cold start	If problem persists, check or replace module.
000E	COMMAND BUFFER FULL	■ Module failure ■ Faulty processor module	No action is needed. If problem persists, check or replace module.
000F	TASK RUNNING TOO LONG	■ Faulty processor module	No action is needed. If problem persists, check or replace processor module.
0010	INVALID SLOT INTERRUPT	■ System cannot determine module responsible for generating interrupt	Check modules and replace if necessary. If problem persists, check or replace processor module.
0011	STACK OVERFLOW	■ Faulty processor module	Check or replace processor module.
0012	INVALID RESET FLAG	■ Faulty processor module	Check or replace processor module.
0013	DUART STREAMING INT	■ Faulty processor module	Check or replace processor module.
0014	PROCESSOR ERR INTERRUPT	■ Faulty processor module	Check or replace processor module.
0015	MODULE MISMATCH	■ Module inserted into wrong slot, and physical and logical types do not match	Change programming to reflect proper module or install proper module.
0C01	NO I-VMS PORT IN SERV	■ All VMS ports are out of service	No action is needed.
0C02	DID INTERDIGIT TIMEOUT	■ DID Interdigit timeout	Check DID/DIOD ExpectDigit administration. Check with DID service provider if problem persists.

Error Code	Screen Description	Possible Cause	Solution
0C03	RING DISCONNECT TIMEOUT	■ System disconnected a ringing call after the administered interval expired.	No action is needed.
1C01	POOL M-BUSY EXCEEDS 50%	■ 50% or more of lines/ trunks in the pool indicated by the PORT number are maintenance busy.	Check line/trunk.
1C02	DPR TEST NOT COMPLETED	■ Module did not complete cold start test during initialization.	If problem persists, replace module.
3001	ALARM TABLE FULL	■ Error logs are full, and no more errors can be written to them.	Correct indicated errors, then remove entries from transient system error log to create space. If problem persists, cold start system before continuing with troubleshooting.
6C01	DS1 LOSS OF SIGNAL ALARM	■ Service on line is lost. ■ T1 facility failure.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C02	DS1 BLUE ALARM	■ All 1s are being received. ■ Service on link is lost. ■ Far end is out of service.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C03	DSI RED ALARM	■ Incoming signal does not contain valid framing information. ■ Service on link is lost.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persist, escalate the problem.
6C04	DS1 YELLOW ALARM	■ Far end lost frame synchronization. ■ Service on link is lost.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C05	DS1 LOSS OF MULTIFRAME	■ Service on link is lost.	Occurs only with common-channel signaling. Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.

Error Code	Screen Description	Possible Cause	Solution
6C06	DS1 REMOTE MULTIFRAME	■ Far end is experiencing loss-of-multiframe. ■ Service on link is lost.	Occurs only with common-channel signaling. Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C07	DS1 MAJOR ALARM	■ Average bit error rate is greater than 10E-3. ■ Service on link is lost.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C08	DS1 MINOR ALARM	■ Average bit error rate is greater than 10E-6.	Check T1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C09	DS1 MISFRAME ALARM	■ Misframe count reached 17.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C0A	DS1 SLIP ALARM	■ Slip count reached 88.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C0B	DSI HARDWARE INOPERATIVE	■ DSI module is down.	If problem persists, escalate the problem.
6C0C	E1 LOSS OF SIGNAL ALARM	■ Service on link is lost. ■ E1 facility failure.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C0D	E1 BLUE ALARM **NOTE:** A blue alarm is also known as an alarm indication signal (AIS).	■ All 1s are being received. ■ Service on link is lost. ■ Far end is out of service.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C0E	E1 LOSS OF FRAME ALARM	■ Incoming signal does not contain valid framing information. ■ Service on link is lost.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.

Error Code	Screen Description	Possible Cause	Solution
6C0F	E1 REMOTE LOSS OF FRAME	■ Far end lost frame synchronization. ■ Service on link is lost.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C10	E1 LOSS OF MULTIFRAME	■ Service on link is lost.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C11	E1 REMOTE MULTIFRAME	■ Far end is experiencing loss-of-multiframe. ■ Service on link is lost.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C12	E1 MAJOR ALARM	■ Average bit error rate is greater than 10E-3. ■ Service on link is lost.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C13	E1 MINOR ALARM	■ Average bit error rate is greater than 10E-6.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C14	E1 MISFRAME ALARM	■ Misframe count reached 17.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C15	E1 SLIP ALARM	■ Slip count reached 88.	Check E1 facility and report to service provider; otherwise no action is needed. If problem persists, escalate the problem.
6C16	E1 HARDWARE INOPERATIVE	■ E1 module is down.	If problem persists, escalate the problem.
7401	TRK UPLINK MESSAGE ERROR	■ Communication problems between the processor module and the line/trunk and station modules ■ Unrecognized message from the line/trunk and station modules to the processor module.	Turn power off for at least 1 second and then back on. Repeat system programming procedure. If problem persists, replace line/trunk and station module.

Error Code	Screen Description	Possible Cause	Solution
7402	LOOP CONTROL BIT NOT SET	■ No loop current	Test the line/trunk with a single-line telephone. If the problem is not in the line/trunk, swap the positions of similar line/trunk and station modules. If the problem follows the module, replace the line/trunk and station module.
7403	NO LOOP	■ No loop current	Test the line/trunk with a single-line telephone. If the problem is not in the line/trunk, swap the positions of similar line/trunk and station modules. If the problem follows the module, replace the line/trunk and station module.
7404	STUCK RINGING	■ Continuous ringing from CO ■ AC power cross	Test the line/trunk with a single-line telephone. If the problem is not in the line/trunk, swap the positions of similar line/trunk and station modules. If the problem follows the module, replace the line/trunk and station module.
7405	DTD DID NOT ID TONE	■ Dial tone not detected within expected interval.	Test the line/trunk with a single-line telephone. If problem persists, check or replace module.
7406	DTD TONE NOT VALID	■ Tone detected but is not valid.	Test the line/trunk with a single-line telephone. If problem persists, check or replace module.
7407	DTD TIMEOUT	■ Dial tone not received within expected interval.	Test the line/trunk with a single-line telephone. If problem persists, check or replace module.
7408	NON-DT ENERGY DETECTED	■ Energy other than dial tone detected.	Test the line/trunk with a single-line telephone. If problem persists, check or replace module.
7409	DTD NOT AVAILABLE	■ Trunk administered for dial tone detection, but hardware is not available.	Incorrect module installed. Replace module.
740A	NO DTD FW RESPONSE	N/A	If problem persists, replace module.
740B	TPM NOT AVAILABLE	■ TPM hardware not present.	Incorrect module installed. Replace module.

Error Code	Screen Description	Possible Cause	Solution
740C	CONTINUOUS TPM	■ TPM pulse exceeded expected duration.	If problem persists, replace module.
740D	SHORT TPM PAUSE	■ TPM pause duration fell below programmed value.	If problem persists, check administration of the Minimum Pause duration parameter, or replace module.
7801	NOT IN NORMAL OP MODE	■ During background port board check, system detected port board that was not in normal operation mode.	If problem persists, check or replace module.
7802	SANITY INT NOT GENERATED	■ Station port board failure	If problem persists, check or replace module.
7803	NO PORT BOARDS AVAILABLE	■ No port boards are present.	No action is needed. Remove entry from transient log.
7804	INVALID SANITY RESPONSE	■ Station board failure	If problem persists, check or replace module.
7805	INVALID SLOT ID FROM TA	N/A	Escalate the problem.
7806	NOT IN STANDBY MODE	■ Faulty module detected during cold start.	If problem persists, check or replace module.
7807	SELF TEST NOT COMPLETED	■ Faulty module detected during cold start or background check.	If problem persists, check or replace module.
7808	TEST RESULT REGISTER BAD	■ Faulty module detected during cold start or background check. ■ T1/PRI link not physically connected to the module.	Ensure the T1/PRI link is physically connected to the module. If problem persists, check or replace module.
7809	TEST STATUS REGISTER BAD	■ Faulty module detected during cold start or background check.	If problem persists, check or replace module.
780A	DPR TEST NOT COMPLETED	■ Faulty module detected during cold start or background check.	If problem persists, check or replace module.
780C	RAM TEST FAILURE	N/A	Escalate the problem.

Error Code	Screen Description	Possible Cause	Solution
780D	ROM TEST FAILURE-UPPER	■ Memory failed ROM test.	Replace the feature module. If problem persists, check or replace processor module.
780E	ROM TEST FAILURE-TEST	■ Memory failed ROM test.	Replace the feature module. If problem persists, check or replace processor module.
7C01	NA CALL TONE FAILURE	■ Low-level call progress tone error	Execute Store All procedure or cold-start the system.
7C02	ATD CALL TONE FAILURE	■ High-level call progress tone error	Readminister tone and execute Store All procedure or cold-start the system.
7C03	MINOR CALL TONE FAILURE	■ Call progress tone inconsistency detected.	Execute Store All procedure or cold-start the system.
8001	TA HARDWARE ERROR	N/A	Swap the positions of similar line/trunk and station modules. If the problem follows the module, replace the line/trunk and station module. If the problem stays at that position, test the line/trunk.
8402	WINK TOO SHORT	■ Wink from far end is less than minimum for an outgoing tie trunk with delay-dial or wink-start. Line is waiting for valid signal. ■ Faulty cable	Check far end for proper operation and programming. Check for faulty cable. Replace the line/trunk and station module as needed.
8403	NO EXTERNAL RELEASE	■ Far end not disconnected within 4 minutes.	Check far end for proper operation and programming. Check for faulty cable.
8404	ON HOOK BEFORE WINK	■ Far end went on-hook before handshake was completed on an outgoing tie trunk with delay-dial or wink-start, or on a DID trunk with wink-start.	If problem persists, check tie trunk configuration. Check the far end for proper working and translation. Check for faulty cable. Replace the line/trunk and station module as needed.

Error Code	Screen Description	Possible Cause	Solution
8405	ON HOOK BEFORE READY	■ Far end went on-hook before guard time elapsed on an outgoing tie trunk with delay-dial-start or wink-start, or on DID trunk with delay-dial-start or wink-start.	Check the far end for proper working and translation. Check for faulty cable. Replace the line/trunk and station module as needed.
8406	INTERDIGIT TOO SHORT	■ Noisy line	Check the far end to see if it is working and translated properly. Check for faulty cable. Replace line/trunk and station module as needed.
8407	BAD UPDATE	■ Invalid trunk parameter	Turn the power off for at least 1 second and then back on. Repeat system programming procedure. If the problem persists, replace the line/trunk and station module.
8408	ROTARY RATE > 12PPS	■ Noisy line	Check the far end to see if it is working and translated properly. Check for faulty cable. Replace line/trunk and station module as needed.
8409	ROTARY RATE < 8PPS	■ Noisy line	Check the far end to see if it is working and translated properly. Check for faulty cable. Replace line/trunk and station module as needed.
840A	BAD DOWNLINK MESSAGE	■ Unrecognized message from the processor module to the line/trunk and station module ■ Unsteady power cycle	Turn power off for at least 1 second and then back on. Repeat system programming procedure. If problem persists, replace line/trunk and station module.
840B	NO LOOP CURRENT	■ Communication problems between the line/trunk and station module and the CO ■ No loop current	Swap positions of similar line/trunk and station modules. If problem follows the module, replace line/trunk and station module. If problem stays at that position, test line/trunk.
840C	STUCK RINGING	■ Continuous ringing from CO ■ AC power cross	Swap positions of similar line/trunk and station modules. If problem follows module, replace line/trunk and station module. If problem stays at that position, test line/trunk.

Error Code	Screen Description	Possible Cause	Solution
840D	INCORRECT FIRMWARE STATE	■ Incorrect system module firmware state	Turn power off for at least 1 second and then back on. Repeat system programming procedure. If problem persists, replace line/trunk and station module.
840E	TRK UPLINK MESSAGE ERROR	■ Unrecognized message from the processor module to the line/trunk and station module	Turn power off for at least 1 second and then back on. Repeat system programming procedure. If problem persists, replace line/trunk and station module.
840F	BLOCKED	■ Trunk is blocked by the CO.	Check E1 facility and report to service provider; otherwise no action is needed.
8411	LOST IDLE MESSAGE	■ The loop-start trunk lost an idle message during glare timing.	If condition persists, reexamine traffic patterns.
8410	INTERDIGIT TIMEOUT	■ Rotary interdigit timeout.	Check facility and report to service provider it problem persists. Otherwise, no action is needed.
8C01	SLOT NOT EQUAL	■ Module installed does not match the translation.	Check installed modules.
9001	BAD DOWNLINK MESSAGE	■ Firmware received bad downlink message.	If problem persists, replace module.
9002	MFC FWD ACTIVE TIMEOUT	■ Far end failed to respond to forward signal.	Check facility and report to service provider if problem persists.
9003	MFC FWD INACTIVE TIMEOUT	■ Far end failed to turn off backward signal after the forward signal ended.	Check facility and report to service provider if problem persists.
9004	MFC BCK ACTIVE TIMEOUT	■ Far end failed to turn off forward signal after the backward signal ended.	Check facility and report to service provider if problem persists.
9005	MFC OUT INTERDIG TIMEOUT	■ Outgoing MFC interdigit timeout.	No action is needed.

Error Code	Screen Description	Possible Cause	Solution
9006	MFC IN INTERDIG TIMEOUT	■ Incoming MFC interdigit timeout.	If problem persists, report to the service provider.
9007	MFC QUEUING ERROR	■ Error in the MFC messaging queues.	If problem persists, replace module.
9401	NO MFC DIALERS	■ Not enough MFC dialers.	If problem persists, add an additional MFC06 module.

Adapters, Accessories, and Applications

5

Contents

Adapters, Accessories, and Applications

5

This chapter provides descriptions and installation instructions for the adapters that connect adjuncts and accessories to the control unit and the telephones. It also describes accessories and applications that add features to the system.

Adapters

A variety of adjuncts (see Appendix B) can be connected to analog and digital telephones and to the system by using one of the following adapters: General Purpose Adapter (GPA), ISDN Terminal Adapter (such as the ExpressRoute 1000 or ISDN 7500B Data Module), Multi-Function Module (MFM), or Supplemental Alert Adapter (SAA).

General Purpose Adapter

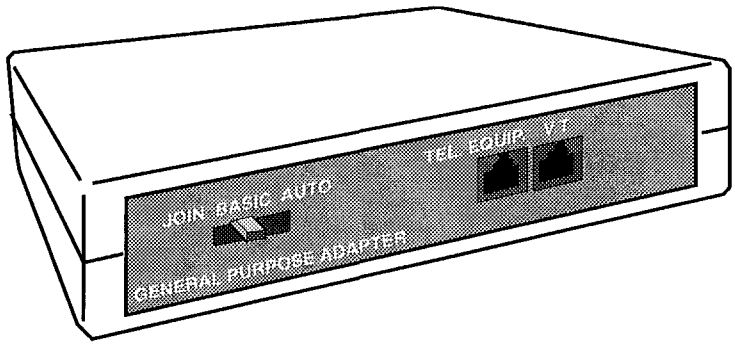
A GPA permits the attachment of a tip/ring (T/R) device such as a single-line telephone, modem, or answering machine to an analog multiline telephone. The device must be touch-tone, not rotary.

NOTE:
The GPA is intended for answer-only service. Calls must be originated (dialed) by using the associated analog multiline telephone. The GPA has no touch-tone receivers or pulse dial detectors for dialing.

Plug one end of a 4-pair cord into the VT jack on the back of the GPA and the other end into the OTHER jack on the underside of the telephone. Plug the cord from the adjunct into the TEL EQUIP jack on the GPA (see Figure 5-1).

Slide the switch on the back of the GPA to the setting that provides the GPA service required.

- **Basic.** This setting is used to dial and answer calls from an analog multiline telephone or to attach a T/R adjunct such as a single-line telephone, answering machine, or fax machine. Incoming calls ring only on the analog multiline telephone.
- **Join.** This setting is used to add a recording device or a single-line telephone to a call that is in progress on the telephone. You cannot originate or answer calls on this setting.
- **Automatic.** This setting is used in two ways:
  - — with a device, such as an answering machine or a modem, to answer calls. An Auto Answer button is needed so that calls can be answered automatically.
  - — to make and receive calls on the telephone while using a computer or modem that is attached to the GPA. This is called "simultaneous voice and data."



General Purpose Adapter

Figure 5-1. General Purpose Adapter (GPA)

ISDN Terminal Adapter

See "Data Adapters" in Chapter 3 for information on the ExpressRoute 1000 and ISDN 7500B Data Module.

Multi-Function Module

See "Install the Multi-Function Module" in Chapter 3.

Supplemental Alert Adapter

An SAA allows the connection of an extra alerting device, such as a bell or chime, to an analog multiline telephone. Alerts notify people working in noisy areas of incoming, transferred, and inside calls.

NOTE:
The MFM allows the connection of alerting devices to an MLX telephone.

Follow these steps to install an SAA (see Figure 5-2):

1. Plug the telephone cord into the jack labeled Telephone
2. Plug the cord from the external alert device into the jack labeled ALERTER.
3. Plug the cord from the station jack into the jack labeled Control Unit.

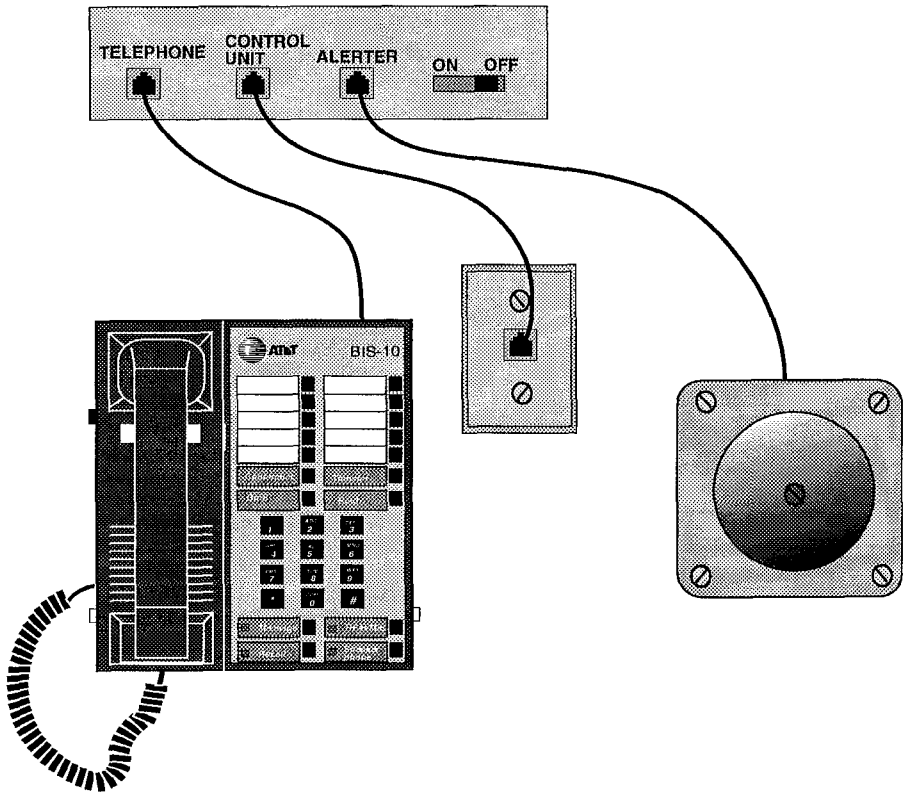


Figure 5-2. Installing a Supplemental Alert Adapter (SAA)

Unusable Adjuncts and Adapters

The following analog telephone adjuncts and adapters are not to be used with the system and, in some cases, will damage the device or the system if connected:

- Basic Telephone and Modem Interface (BTMI)
- Basic Telephone and Modem Interface-2 (BTMI-2)
- ATR Interface (ATRI)
- MTR Interface (MTRI)
- Off-Premises Extension Unit (OPX)
- System 25 Direct Extension Selector (DXS)
- Adapters, Accessories, and Applications

Accessories

Accessories can be added to the system to provide more power and added protection from power surges. Other accessories apply to specific conditions.

NOTE:
In most cases, additional power surge protection is not needed.

Power Accessories

In a power failure, battery backup units can keep the system running for up to four hours.

When adjuncts and adapters are connected to telephones, the power requirements of the telephones and the communications system increase. Adding a power accessory to an individual telephone or to the system accommodates these additional needs.

Battery Backup Power

Battery backup power for a 117 VAC system can be provided by an optional 500 VA uninterruptible power supply (UPS) and reserve UPS units. The basic UPS provides power for 15 minutes. Reserve UPS units provide power for one hour per supply.

The holdover back-up durations for normal system operation of one full carrier at a maximum system load are as follows:

15 minutes	basic 500 VA UPS
1 hour	one 500 VA reserve cabinet for each UPS
2 hours	two 500 VA reserve cabinets for each UPS
4 hours	four 500 VA reserve cabinets for each UPS

Battery backup power for a 220 VAC system can be provided by optional 1KVA, 750 VA, or 250 VA uninterruptible power supplies. The basic 1KVA UPS provides power for 30 minutes, the basic 750 VA UPS provides power for 14 minutes, and the basic 250 VA UPS provides power for 10 minutes. Reserve UPS units are not supported on the 220 VAC system.

Telephone Power Units

Connected between the telephone and the wall jack, the telephone power unit provides additional power to the telephone with an adjunct, adapter, and/or Direct Station Selector (DSS) attached. The same power unit can also be used to provide power to telephones far from the control unit. Adding local power to a few telephones can reduce the system load.

NOTE:
Telephone operation without adjuncts is guaranteed for a wiring run up to 305 m of cable (1000 cable-feet) from the control unit.

Auxiliary power is required for the following configurations (see Appendix A for any ordering information you may need):

- an MLX telephone with two attachments (for example, two DSSs or an MFM and a DSS) requires an LS-10015-ADT (117 VAC) or LS-10034-ADT1 (220 VAC) power unit.
- an MLX telephone with three attachments (two DSSs and an MFM) requires the WP-92464,L3 power unit (117 VAC or 220 VAC).
- when two MLX telephones, each with a DSS, are on the same carrier, use an LS-10015-ADT (117 VAC) or LS-10034-ADT1 (220 VAC) power unit for each additional station with a DSS.

Auxiliary Power Units (for 391A1 or 391A2 Power Supply Modules Only)

When a power demand of over 54 unit loads is placed on a 391A1 or 391A2 power supply module (117 VAC), an Auxiliary Power Unit 9024 is generally needed and increases power by 27 unit loads.

To determine the number of unit loads for each power supply module on each carrier, see "Unit Loads" in Chapter 2 and Appendix D.

NOTE:
Only one auxiliary power unit can be connected to the 391A1 or 391A2 power supply module. If additional -48 VDC power is needed, connect some telephones to WP-92464,L3 telephone power units.

Auxiliary power units cannot be connected to 391A3, 391B1, or 391B2 power supply modules.

In-Range Out-of-Building (IROB) Protector

See "IROB Protection" in Chapter 3, "Installation."

Power Failure Transfer

A power failure transfer (PFT) telephone is a single-line telephone connected to a PFT jack on a 400, 408, 800, or 800 LS/DTD/TPM module (see Figure 1-2). In the event of a power failure, the system shuts off and the PFT telephone automatically turns on so that calls can be made and received.

NOTE:

- The PFT jack does not operate unless a power outage occurs or the power supply units are turned off.
- A single-line telephone connected to an MFM cannot be used as a PFT telephone.
- If rotary lines/trunks are used, rotary telephones must be used as PFT telephones.

System Alarms

An alarm detected by the system can cause the control unit to activate contact closures at an LS port. When the contacts close, a signal is passed on to an AT&T PagePal Interface Unit and then to an external alert. Alerting devices can be a strobe, horn, bell, or chime.

A PagePal is needed because -48 VDC alerting devices require four contact closures and the LS ports have only two. The PagePal provides the additional two.

Trouble Alarms

An LS port can be programmed to activate an alarm connected to the port via an AT&T PagePal Interface Unit (see Figure 5-3). When system trouble (caused by hardware or software malfunction) is detected by the operator console, a signal is sent to that port. The port's switching contacts close and send the signal on to the PagePal, which activates an external alert.

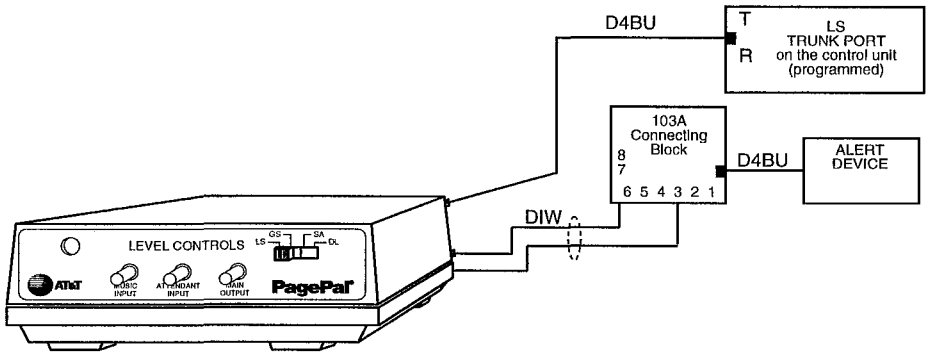


Figure 5-3. Connecting an Alarm to an LS Port via a PagePal

Power Failure Alarm

An LS PFT port can be programmed to activate an alerting device during a power failure. The device is connected to the port via an AT&T PagePal Interface Unit (see Figure 5-4). When a power failure occurs, the switching contacts on the PFT port close and send a signal to the PagePal, which activates an external alert.

NOTE:
A PFT telephone cannot be used on this port when the port is connected for a power failure alarm.

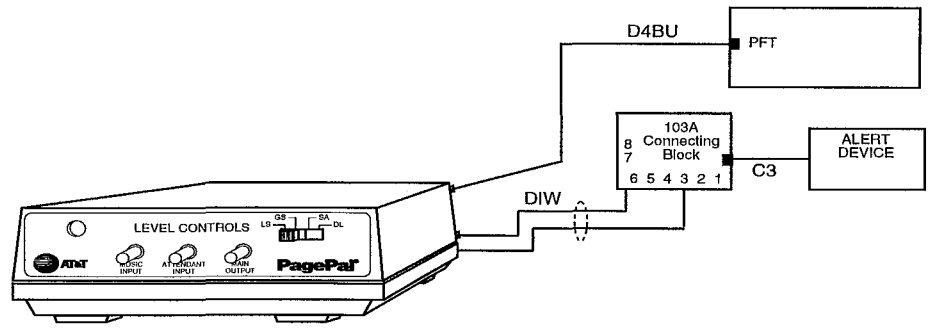


Figure 5-4. Connecting an Alarm to a PFT Port via a PagePal

Power Failure DID Busy-Out

The PFT port on an LS module can be programmed to automatically short the busy-out wire pair associated with a group of DID trunks. Usually an LS line/trunk is used as the busy-out pair. When a power failure occurs, shorting this busy-out pair signals the CO that the DID trunks are out of service (see Figure 5-5).

NOTE:
To remove the LS module containing the PFT port for the DID busy-out, you must first short the busy-out pair and then disconnect the modular cord from the PFT jack. Otherwise, a false busy-out will occur. Remove the short after the system is powered up.

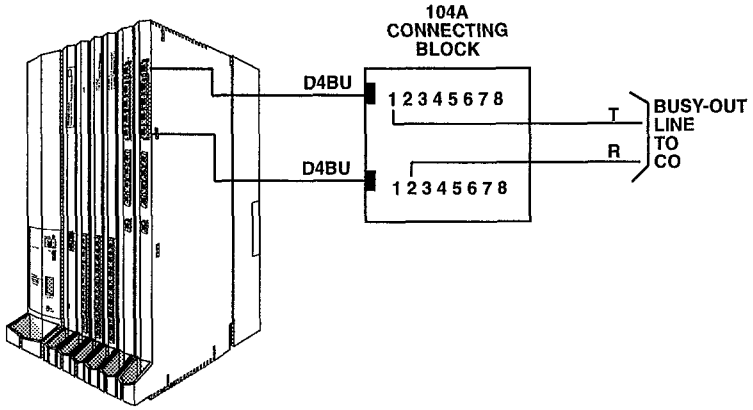


Figure 5-5. Setting Up a Power Failure DID Busy-Out

Applications

The following software and hardware applications can be installed on the system. See the documentation packaged with each application for detailed installation instructions.

- standalone products
  - — AT&T Attendant for the MERLIN LEGEND Communications System
  - — MERLIN MAIL Voice Messaging System Multi-Lingual Version for the MERLIN LEGEND Communications System
- MS-DOS* based products
  - — Call Management System (CMS) for the MERLIN LEGEND Communications System
  - — System Programming and Maintenance (SPM) for the MERLIN LEGEND Communications System — DOS

Voice Messaging Systems and Touch-Tone Receivers

The following applications are voice messaging systems (VMSs):

- MERLIN MAIL Voice Messaging System Multi-Lingual Version
- AT&T Attendant

The system provides generic and integrated voice messaging interface (VMI) ports. The MERLIN MAIL Voice Messaging System Multi-Lingual Version uses streams of touch-tone codes (called mode codes) to communicate information.

Applications that use mode codes must be connected to integrated VMI ports. Applications (such as AT&T Attendant) that do not use mode codes connect to generic VMI ports. The tip/ring ports on 012 and 016 basic telephone modules are programmed to be either "generic VMI" or "integrated VMI."

A VMS requires a certain number of touch-tone receivers (TTRs), depending on the number of VMS ports (see Table 5-1). TTRs are supplied by the following modules: 008 OPT, 012, 016, 400, and 800 DID modules. However, the VMS applications are not supported on the 008 OPT modules.

* MS-DOS is a trademark of Microsoft Corporation.

Table 5-1. TTRs Required by VMS

No. of VMS Ports	No. of TTRs Required
1	1
2	1
3	2
4	2
6	3
8	4
12	6

Call Management System

The Call Management System (CMS) for the MERLIN LEGEND Communications System is an MS-DOS software application that simulates the actions of a system operator by answering calls and distributing them to individual agent telephones. If no agents are available, CMS places calls on hold and, if programmed, plays a recorded announcement to the callers such as, "Thank you for calling the ABC Company. Please hold for the next available agent." CMS then searches its network for the appropriate agent, usually the one who's been idle the longest, and transfers the call to that person's telephone.

⚠ CAUTION:
There is a high risk of generating inaccurate reports when using the AT&T Call Management System on loop-start lines, due to lack of disconnect supervision.

CMS is appropriate for businesses with large groups of personnel who perform a common function, such as airline ticketing, filling catalog orders, and providing customer service. Agents within these groups can be divided into agent splits to handle different types of calls or customers. For example, the agents in a travel agency can be divided into three splits: one that handles personal vacations, one that handles business trips, and one that handles group charters. Another split can be designated for support when the call traffic is heavy in the other splits. Calls come into each of the splits on a group of lines designated to ring into the split.

Agents make themselves available and unavailable to take calls by logging in and out. Also, agents can enter the after-call-work (ACW) state, which allows them to complete work on their last call without being interrupted by new CMS calls.

The system can be set up so that agents are automatically in the ACW state whenever they complete a CMS call or so that agents must press a programmed button or dial a feature code to enter ACW.

Other features of CMS include

- easy-to-use management reports that analyze call volume and patterns, as well as agent activity
- Answer Delay option, which determines how long a call rings before it is designated as unanswered and is connected to the recorded announcement
- Forced Delay option, which connects calls to the recorded delay announcement regardless of whether all agents are busy when the calls come in
- designation of priority lines to ensure that calls coming in on these lines are answered first
- display of current agent activity on system status screens to allow monitoring, tracking, and analyzing of short- and long-term performance
- ability to connect Music on Hold to callers waiting for agents
- up to four external alerts to show when an exception has occurred; for example, an LED lights when the oldest call has waited longer than 30 seconds. Exception thresholds are programmed.
- summary reports from 1 to 93 days
- real-time dynamic reconfiguration, which lets the user modify the call flow on-line

Considerations

- The CMS cannot be connected to a system that is in Behind Switch mode.
- Flexible numbering cannot be used; CMS works only with the default 2-digit numbering plan.
- The CMS can handle calls for up to 28 agents on up to 28 lines, and it can answer calls on two lines at the same time with the same announcement.
- There can be up to six agent splits with 28 agents per split.
- Up to two CMSs can be installed on a system to handle a second set of lines if a business requires more than 28 lines or employs more than 28 agents.
- CMS operates on an approved AT&T PC with MS-DOS, version 3.3. The PC must be dedicated to CMS.
- The CMS supervisor's console is the MERLIN II System Display Console. CMS agents can have any MLX telephone that can be used with the system. CMS agent telephones must be connected to the first 57 telephone jacks on the control unit. (CMS allows only a two-digit method to specify an extension number; jacks 58 to 200 are designated by four digits.)
- The two CMS interface card ports on the PC must be connected to two analog multiline telephone jacks on the same analog multiline telephone module; these jacks must be operator positions. If two operator position jacks are not available on the same module, another analog multiline telephone module must be installed in the control unit to provide these jacks.
- CMS lines/trunks can be loop-start, emulated ground-start, E1, or T1.
- Up to four CMS external alerts can be used for agents and supervisors. For example, an alert sounds if the number of calls waiting to be answered nears a programmed threshold.
- MERLIN MAIL Voice Messaging System Multi-Lingual Version or AT&T Attendant can be used to direct callers to the appropriate CMS group.
- To play music for waiting callers, you must have a Music on Hold (MOH) source to the system that is compatible with an AT&T MOH coupler.

NOTE:

If equipment that rebroadcasts music or other copyrighted materials is used, it may be a requirement to obtain a copyright license from and pay license fees to a third party. This should be verified first before any rebroadcasting is done. However, if a Magic-on-Hold system is purchased (see Appendix A, Ordering Information) from an AT&T representative, no special license is required.

Hardware and Software Requirements

- CMS has been tested only on certain AT&T PCs. It should also work with most PCs meeting the following criteria: Intel-based x86-processor, minimum 640K RAM, 3.5-inch floppy disk drive, and 20-Mbyte hard disk drive. AT&T does not guarantee that CMS will run on PCs that are not AT&T.
- monochrome or color monitor
- CMS interface card with two 4.3-m (14-foot), 4-pair modular plug station cords and one 4.3-m (14-foot) DIN connector cord for connection to the AT&T Digital Announcer
- CMS software
- AT&T Digital Announcer
- parallel printer
- parallel printer cable to connect the printer to the PC
- supervisor console — DLC position
- agent telephones — any MLX telephones supported by the communications system (single-line telephones cannot be used)
- two analog multiline modules: one to connect the two PC ports to the station jacks assigned as DLCs, and one to connect the CMS supervisor console. (A maximum of two attendant positions may be assigned to any analog multiline module.)

NOTE:
For a list of optional hardware that can be used with CMS, see the documentation provided with CMS.

Installation

CMS comes with a hardware installation checklist and information on installing the CMS software, creating an agent directory, programming lines and groups, and testing and managing calls.

The system control unit permits the connection of two CMS applications, and each application can use up to two PCs.

Product References

Call Management System (CMS) for the MERLIN LEGEND Communications System Installation and System Programming Guide.

AT&T Attendant

The AT&T Attendant is a single-port standalone application that provides operator-like services through the use of prerecorded messages and electronic switching.

The Attendant automatically answers incoming calls on designated lines with a recorded greeting and transfers these calls to extensions or departments based on information provided by the caller. Since the Attendant can respond only to touch-tone telephone signals, the announcement asks callers who dial from rotary telephones to wait for the system operator.

Calls can be transferred in one of two ways, either "blind" or "supervised." A blind transfer means the Attendant dials the extension or department requested by the caller and disconnects. If the call is not answered or the phone is busy, the caller is routed to the system operator.

With a supervised transfer, the Attendant transfers the call and can retrieve it if the transfer is unsuccessful. The Attendant then directs the call to another telephone, allows the caller a second route choice, or provides a failed-transfer announcement, depending on how the application has been programmed.

Calls can be answered immediately (Primary Call Handling) or after a delay (Secondary Call Handling), for example, if the call goes unanswered by the system operator after a certain number of rings. Table 5-2 shows the number of Attendants required based on a Primary Call Handling situation.

Table 5-2. Suggested Number of Attendants

Estimated Number of Attendants	2	3	4
Incoming Lines/Trunks	1 to 6	7 to 9	10 to 12
Busy-Hour Calls	1 to 25	25 to 50	50 to 100

NOTE:
The numbers in Table 5-2 are estimates based on average call volume. Your call volume may require additional attendants.

Considerations

- The AT&T Attendant cannot be connected to a system that operates in the Behind Switch mode.
- The AT&T Attendant cannot be connected to a system that has a MERLIN MAIL Voice Messaging System Multi-Lingual Version installed.
- A maximum of four Attendants can be connected to the system (see Table 5-2).
- All VMI loop-start ports should be programmed for "reliable" far-end disconnect.

  NOTE:
  Setting reliable disconnect to "Yes" can cause trunk disconnect failures, unless you are using a forward disconnect service from the CO.

- The Attendant can answer every call that comes in or just answer calls that ring on certain lines.
- Unanswered transferred calls do not return to the Attendant; they are redirected to a designated extension, such as the system operator.
- If the extension called is busy or unanswered or if it is after business hours, calls can be directed to an answering machine to allow callers to leave messages.
- The Attendant can direct and transfer calls to fax machines.
- The system may need more touch-tone receivers if the following is true:
  - Single-line telephone users do not get dial tone.
  - Calls fail to ring or calls go to coverage prematurely.
- When the Attendant is set up for after-hours operation, the time on the Attendant's clock must match the system clock so the end of the business day is recognized.
- The Attendant provides 64 seconds for recording up to five standard messages, including the caller greeting used during and after business hours, a hold announcement for a caller who is being transferred, a connect announcement for the department or extension receiving a transferred call, and a message explaining that a call cannot be completed.

Hardware Requirements

- 012 or 016 module (008 OPT not recommended)
- AT&T Attendant unit and cords

Installation

Some AC power strips may be needed since the Attendant is powered by individual wall-mounted transformers, each outputting 10 VAC. These wall-mounted transformers are available in both 117 and 220 input voltage.

NOTE:

- Attendant can use a maximum of four ports per 012 module, as the 012 cannot ring more than four ports simultaneously. When four ports are used for Attendant, two other ports can be connected to telephones. This restriction does not apply to the 016 module.
- Powering and grounding procedures must follow those established for T/R telephones that require auxiliary power.

Product References

AT&T Attendant Installer's Guide.

MERLIN MAIL Voice Messaging System Multi-Lingual Version

The MERLIN MAIL Voice Messaging System Multi-Lingual Version (hereafter referred to as the MERLIN MAIL system) is available in English, French, and Spanish, and works with the MERLIN LEGEND Communications System to automate the call handling, call answering, and voice messaging needs of a company. To meet these needs, the MERLIN MAIL system offers three services:

- **Automated Attendant Service** provides the MERLIN MAIL system's call handling features. Automated Attendant Service can be set up to answer calls and present callers with menus of selectable options, such as transferring to specific extensions or playing pre-recorded announcements. Automated Attendant Service can also automatically route calls, accept fax calls, answer calls based on a programmed business schedule, and provide customized after-hours service.
- **Call Answer Service** provides the MERLIN MAIL system's call coverage features. Call Answer Service automatically answers calls when the subscriber (that is, the user of a MERLIN MAIL extension) is either on another call or away from the phone. Call Answer Service lets the caller leave a message or transfer to another extension.
- **Voice Mail Service** provides the MERLIN MAIL system's voice messaging features. Voice Mail Service lets subscribers send voice mail messages to other subscribers and listen to messages left in their mailboxes from subscribers and external callers.

NOTE:
Refer to the appropriate MERLIN MAIL Voice Messaging System Multi-Lingual Version manual for information regarding installing, planning, and operating the MERLIN MAIL system. The "Documentation Ordering Information" section of Appendix A provides ordering information for the MERLIN MAIL system's documentation.

All services provided by the MERLIN MAIL system can be implemented in a single language (monolingual mode) or two languages (bilingual mode). If set up for bilingual mode, the MERLIN MAIL system lets callers and subscribers select the language in which they want to hear prompts, menus, and announcements. The MERLIN MAIL system can operate in English, French, or Spanish.

NOTE:
In bilingual mode, English *must* be one of the language choices.

The number of incoming lines and subscribers programmed for Automated Attendant service and the number of busy-hour calls determine how many MERLIN MAIL ports are required for the user's system (see the table below).

Table 5-3. MERLIN MAIL Ports Required

No. of Attendants Required	2	4	6
Incoming Lines/Trunks	1 to 6	7 to 18	19 to 80
No. of Subscribers or Busy-Hour Calls	1 to 20	21 to 60	61 to 80

Application Features

The MERLIN MAIL Voice Messaging System Multi-Lingual Version features for the MERLIN LEGEND Communications System include the following:

- **Outcalling** automatically calls a designated phone number to notify a subscriber when a new message has arrived in the subscriber's mailbox. The subscriber can then log in to the MERLIN MAIL system to retrieve messages.
- **Pager Notification** like Outcalling, calls the subscriber at a designated pager number when a new message is received. However, the subscriber cannot log in to the MERLIN MAIL system.

- **Broadcast Lists** allows the system administrator to send a message to every subscriber on the MERLIN MAIL system. However, this message does not light message LEDs and does not cause outcalling.
- **Fax Transfer** directs an incoming fax call to a designated fax station. This fax station can be a single machine or a calling group with several machines.
- **Announcement Service** allows a caller to enter a code to hear information about specific subjects, such as new product information or marketing programs.
- **Guest Mailboxes** allows the system administrator to set up a guest mailbox so that users who do not have their own extension (such as temporary workers, consultants, and so on) can receive messages from subscribers and non-subscribers.

Mode Differences

The MERLIN MAIL Voice Messaging System cannot be connected to a telephone system that operates in the Behind Switch mode.

Considerations

- The MERLIN MAIL Voice Messaging System Multi-Lingual Version is available in two-port, four-port, and six-port configurations. The 2-port and 4-port models have approximately four hours of message storage capacity. The 6-port model has approximately 10 hours of message storage capacity.
- The size of a user's mailbox — that is, the number of minutes of messages that a mailbox can hold — can be matched to individual needs. Available options are 5, 10, and 15 minutes.
- When users receive voice-mail messages, the message LEDs on their telephones illuminate, provided that a mailbox has been assigned to each of those telephones.
- Callers who dial from rotary telephones cannot use the features of the MERLIN MAIL system and should be directed to the system operator during business hours.
- Automated Attendant can answer calls immediately (Primary Call Handling) or after a delay (Secondary Call Handling), for example, when a call remains unanswered by the system operator after a certain number of rings.
- The MERLIN MAIL Voice Messaging System Multi-Lingual Version does not work in conjunction with the AT&T Attendant.

- Programming of the MERLIN MAIL system is done via touch-tone interface. The MERLIN MAIL system is equipped with an RS-232 serial port and an external modem to support remote diagnostics.
- The following symptoms indicate that the system needs more touch-tone receivers.
  - Single-line telephone users do not get dial tone when trying to dial out.
  - The MERLIN MAIL system fails to transfer calls.
  - Calls fail to ring or calls go to coverage prematurely.
- Call restrictions should be assigned to the station jacks that connect the MERLIN MAIL system to the MERLIN LEGEND system to prevent toll calls from being dialed through this product.
- When in bilingual mode, English must be one of the language choices.

System Feature Interactions

Coverage

All extensions that need to be covered are assigned to a coverage group through system programming. The calling group that is made up of MERLIN MAIL Voice Messaging System ports is designated as the coverage receiver for the group.

An internal call on a VMI port that transfers to an internal extension will not go to coverage. It will continue to ring at the internal extension.

If a sender programs his or her telephone so that only outside calls are sent to coverage, calls received on Intercom or System Access buttons will not be sent to voice mail.

Group Calling

All the station jacks to which the MERLIN MAIL Voice Messaging System ports are connected are assigned to the same calling group through system programming.

Calls that overflow from one calling group to another calling group with integrated VMI ports are treated and identified as coverage calls. This occurs because the control unit sends the appropriate coverage call mode codes along with the calling group number.

Leave Word Calling

If a Leave Word Calling message is left in a mailbox in a system with heavy VMI traffic, the user may have to dial out manually for messages.

Night Service

The MERLIN MAIL Voice Messaging System Automated Attendant works with the system's Night Service feature to provide specialized after-hours service. Automated Attendant can answer calls on lines it does not handle during business hours or can direct calls to ring at a specific night extension or department, such as Building Security. A special night announcement can greet after-hours callers.

If the Automated Attendant only handles after-hours calls, a phantom station (an unused station jack) must be programmed as a member of a Night Service group associated with a system operator. In turn, this phantom station is covered by a calling group with integrated VMI ports as members. If an incoming call is not answered in the programmed number of rings, the control unit sends the call to the calling group with the VMI ports. Because of prior programming, the MERLIN MAIL Voice Messaging System recognizes the call to be from the phantom station and provides Automated Attendant service rather than the usual Call Answer service.

Privacy

Privacy must be programmed for each port designated for the MERLIN MAIL Voice Messaging System.

Ringing Options

If lines set for answering by the Automated Attendant also appear on telephones other than the system operator console or a backup station, these lines should be programmed for "no ring."

Transfer

VMI ports can transfer an incoming call to an outgoing line/trunk.

If a call received on a line/trunk is transferred to a VMI port, the direct inside access mode code is sent and the call is treated as a transferred call; the caller hears the internal greeting.

If a caller incorrectly specifies the answering VMI port as the desired transfer destination station, the VMI port can inadvertently park the call.

Any calling group, calling group member, or station can be programmed to be a VMS transfer redirect extension. If a QCC is programmed as such, the transfer redirect call is delivered to the QCC as a returning call and is not placed in the QCC queue.

If a transferred caller gets no answer and returns through voice mail to the system operator, the system operator has no indication of the originator of the call.

Hardware Requirements

- MERLIN MAIL Voice Messaging System Multi-Lingual Version unit and power cords
- Remote maintenance device (RMD) with a wall-mount transformer and cable to connect the remote maintenance device to a port on the 012 or 016 module
- RS-232 cable to connect the remote maintenance device to the serial port on the MERLIN MAIL system
- D4BU modular cords (two for a 2-port system, four for a 4-port system, or six for a 6-port system, plus one for the remote maintenance device)
- 012 or 016 basic telephone module

NOTE:
Additional touch-tone receivers (TTRs) may be needed to allow the 012 or 016 module to handle a large number of voice connections.

Figure 5-6 shows the connection of a MERLIN MAIL Voice Messaging System Multi-Lingual Version unit to the control unit.

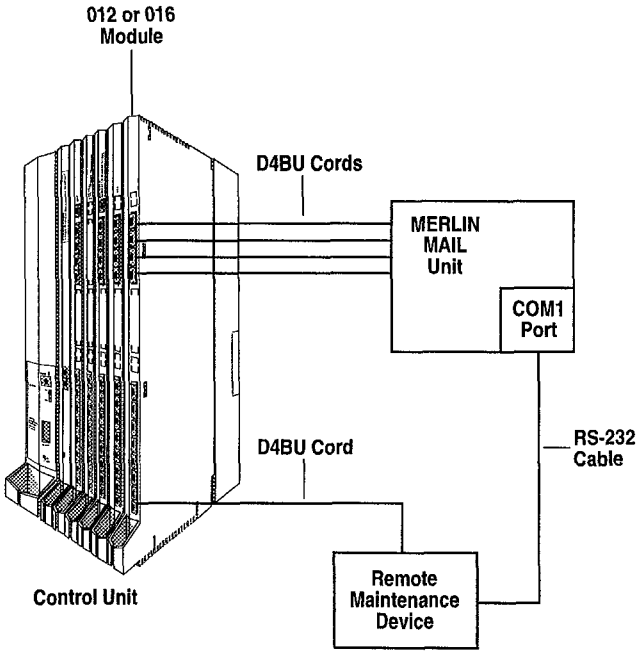


Figure 5-6. Connection of MERLIN MAIL Voice Messaging System

Installation

MERLIN MAIL Voice Messaging System Multi-lingual Version connects to two, four, or six 012 or 016 basic telephone module jacks on the system's control unit.

MERLIN MAIL Voice Messaging System Multi-lingual Version unit can be desk or wall mounted and should be placed in an area with low humidity and proper ventilation.

NOTE:
Follow the power and ground procedures for T/R telephones that require auxiliary power.

Product References

MERLIN MAIL Voice Messaging System Multi-lingual Version *for the MERLIN LEGEND Communications System Installation, System Programming, and Maintenance.*

System Programming and Maintenance

System Programming and Maintenance (SPM) for the MERLIN LEGEND Communications System is an MS-DOS software application that allows the use of a personal computer (PC) for programming and maintaining the system. SPM performs the same functions as an MLX-20L telephone used as a system programming console and has some additional features, such as the ability to back up and restore files and print reports. The PC's display shows the same button and screen layout as an MLX-20L telephone.

Either a PC with SPM can be connected directly to the system or SPM can be accessed remotely in one of the following ways:

- Using Remote Access, the system programmer dials the system directly. A password can be set up to prevent unauthorized access.
- The system programmer dials the system operator and asks to be transferred to the system's built-in modem.

Considerations

- SPM operates with MS-DOS, version 3.3 or later.
- Unless the system is being backed up or restored, a remote user takes priority over a local user. If the local user is programming when a remote user connects to the system, the system sends a message to the local user that a remote connection has been made and disconnects the local user.
- The PC with SPM connects to the RS-232 jack on the processor module of the control unit. The RS-232 baud rate is 1200/2400 bps with auto speed adjust.
- The SPM reports can be printed out or can be saved to a disk (hard or floppy).
- SPM reports should not be printed while the system is handling more than 100 calls per hour.
- A printer connected to the PC with SPM can be used to print system programming reports. Or reports can be sent to the printer that is connected to the SMDR port on the system's control unit.
- SMDR information may be lost while system programming reports are printed via the SMDR port.

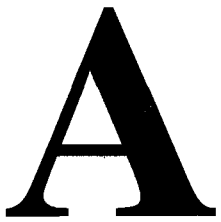
Hardware Requirements

- an MS-DOS compatible PC with the following:
  - — at least 128K of RAM
  - — a double-sided floppy diskette drive (either 5 1/4" or 3 1/2")
  - — a serial port assigned to COM1 or COM2. The serial port can use either a DB-9 or DB-25 connector. If a DB-9 connector is used, a 9-pin to 25-pin adapter is also required. The 9-pin side must be female.
- video monitor (monochrome or color)
- D8W modular cord and 355AF modular adapter if PC is within 50 feet of the control unit. Distances of greater than 50 feet require back-to-back ADUs.

Installation

See "PC with MERLIN LEGEND System Programming and Maintenance" in *MERLIN LEGEND System Programming* for installation instructions.

Ordering Information



Contents

Ordering Information

A

This chapter provides the ordering information for equipment and documentation pertaining to the MERLIN LEGEND Communications System. Every effort was made to ensure that the information in this appendix was complete and accurate at the time of printing. However, information is subject to change.

In addition, some of the AT&T equipment and products mentioned in this manual may not be available in your country. Contact your local AT&T representative for product availability.

Product Ordering Information

The following table summarizes the equipment that can be connected to the MERLIN LEGEND system and provides the corresponding ordering codes.

Component	PEC	Comcode	App Code
Control Unit			
MERLIN LEGEND Control Unit (117 VAC)	6141-INT		
Power supply module		107184848	391A3
Processor		106215155	517A27
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.4i Feature module		106875750	517B30 (28)
MERLIN LEGEND Control Unit (220 VAC)	6141-220		
Power supply module		107184855	391B2
Processor		106215155	517A27
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.4i Feature module		106875750	517B30 (28)
MERLIN LEGEND Control Unit (220 VAC - Hong Kong only)	6141-220-ctr24		
Power supply module		107184855	391B2
Processor		107221434	517A27 (16)
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.4i Feature module		106875750	517B30 (28)
MERLIN LEGEND Control Unit (220 VAC - Czech Republic only)	6141-220-ctr30		
Power supply module		107184855	391B2
Processor		107221434	517A27 (16)
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.4i Feature module		106875750	517B30 (28)
MERLIN LEGEND R1.4i Upgrade	61449		
SPM — DOS		107053415	SPM
1.4i Feature module		106875750	517B30 (28)

Component	PEC	Comcode	App Code
MERLIN LEGEND Control Unit (117 VAC)	6140-INT		
Power supply module		107184848	391A3
Processor		106215155	517A27
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.3i Feature module		106875750	517B30 (28)
MERLIN LEGEND Control Unit (220 VAC)	6140-220		
Power supply module		107184855	391B2
Processor		106215155	517A27
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.3i Feature module		106875750	517B30 (28)
MERLIN LEGEND Control Unit (220 VAC - Hong Kong only)	6140-220-ctr24		
Power supply module		107184855	391B2
Processor		107221434	517A27 (16)
Backplane (403G)		107007114	403G WALL
SPM — DOS		107053415	SPM
1.3i Feature module		106875750	517B30 (28)
MERLIN LEGEND R1.3i Upgrade	61455		
SPM — DOS		107053415	SPM
1.3i Feature module		106875750	517B30 (28)
117 VAC Specific Components			
MERLIN LEGEND Expansion Unit	61490		
Power supply module		107184848	391A3
Expansion Carrier		107007122	403H WALL
Frequency Ring Generator	61388	105213201	129B
220 VAC Specific Components			
MERLIN LEGEND Expansion Unit	61450		
Power supply module (220 VAC)		107184855	391B2
Expansion Carrier		107007122	403H WALL
Frequency Ring Generator	61498	106741788	129C
Power supply module (220 VAC)	61497	107184855	391B2

Component	PEC	Comcode	App Code
Uninterruptible Power Source Units			
Basic 500VA (117 VAC)	2403-050	105610141	UPS-005C111
Reserve Cabinet 500VA (117 VAC)	24035	105610174	PWR UNIT-0053150
Basic 250VA (220 VAC)	2403-028	406784181	9030226S01
Basic 750VA (220 VAC)	2403-078	406784231	9030726T01
Basic 1KVA (220VAC)	2403-211	406929604	CAB-E100T20200
Station and Line/Trunk Modules			
008 MLX	61486	105628010	517A21
008 OPT (with built-in ring generator)	61479	106995269	517D28
012 (with built-in ring generator)	61459	107108698	517G13 (28)
016 (with built-in ring generator)	61507	107533887	517A34
100D (DS1)	61491	105512438	517C15
100E (E1 - 75 ohm)	61454-ckt75	106825896	517C15 (28)
100E (E1 - 75 ohm Czech Republic only)	61454-ctr30	107533861	517C15 (28)
100E (E1 - 120 ohm)	61457	107100133	517D15 (28)
400EM (tie trunk)	61492	105311401	517A14
400 LS with TTRs	61379	105408892	517B12
400 LS/DTD/TTR	61452	106819238	517B12 (28)
800 DID	61488	106995251	517D20
800 LS without DTD	61384	105351100	517B4
800 LS/DTD	61451	106819220	517B4 (28)
800 LS/DTD/TPM	61458	107074726	517C4 (28)
MFC06 (R2 MFC Signaling)	61456	106825904	517C16 (28)

Component	PEC	Comcode	App Code
Telephones			
MLX Telephones			
MLX-10			
English (black)	3156-02B	107108722	7712D01D-003
English (white)	3156-02W	107108748	7712D01D-264
French (black - COL03)	3156-F2i	107108797	7712D01D(29)-003
French (white - COL04)	3156-F2i	107108798	7712D01D(29)-264
Spanish (black - COL03)	3156-S2i	107108755	7712D01D(22)-003
Spanish (white - COL04)	3156-S2i	107108771	7712D01D(22)-264
E. Europe (white - COL10)	3156-EE2	107108813	7712D01D(30)-264
E. Europe (black - COL09)	3156-EE2	107108805	7712D01D(30)-003
MLX-10D			
English (black)	3156-03B	107108870	7712D02D-003
English (white)	3156-03W	107108888	7712D02D-264
French (black - COL03)	3156-F3i	107108938	7712D02D(29)-003
French (white - COL04)	3156-F3i	107108920	7712D02D(29)-264
Spanish (black - COL03)	3156-S3i	107108904	7712D02D(22)-003
Spanish (white - COL04)	3156-S3i	107108912	7712D02D(22)-264
E. Europe (white - COL10)	3156-EE3	107108854	7712D02D(30)-264
E. Europe (black - COL09)	3156-EE3	107108847	7712D02D(30)-003
MLX-16DP			
English (black)	3156-07B	106922271	7715D01D-003
English (white)	3156-07W	106922289	7715D01D-264
MLX-20L			
English (black)	3156-05B	107108979	7713D01D-003
English (white)	3156-05W	107108987	7713D01D-264
French (black - COL03)	3156-F5i	107109027	7713D01D(29)-003
French (white - COL04)	3156-F5i	107109019	7713D01D(29)-264
Spanish (black - COL03)	3156-S5i	107108995	7713D01D(22)-003
Spanish (white - COL04)	3156-S5i	107109001	7713D01D(22)-264
E. Europe (white - COL10)	3156-EE5	107109050	7713D01D(30)-264
E. Europe (black - COL09)	3156-EE5	107109035	7713D01D(30)-003

Component	PEC	Comcode	App Code
MLX Telephones, continued			
MLX-28D			
English (black)	3156-04B	107115800	7713D02D-003
English (white)	3156-04W	107115818	7713D02D-264
French (black - COL03)	3156-F4i	107115842	7713D02D(29)-003
French (white - COL04)	3156-F4i	107115859	7713D02D(29)-264
Spanish (black - COL03)	3156-S4i	107115826	7713D02D(22)-003
Spanish (white - COL04)	3156-S4i	107115834	7713D02D(22)-264
E. Europe (white - COL10)	3156-EE4	107115875	7713D02D(30)-264
E. Europe (black - COL09)	3156-EE4	107115867	7713D02D(30)-003
Single-Line Telephones			
8110 Analog Voice Telephone	3193-001		
(Black - COL09)		106745714	8110A01C-003
(White - COL10)		106745730	8110A01C-264
8102 Analog Voice Telephone	3192-001		
(Black - COL09)		106745698	8102A01B-003
(White - COL10)		106745706	8102A01B-264
8101 Analog Voice Telephone	3192-101		
(Black - COL09)		106272289	8101A01A-003
(White - COL10)		106272297	8101A01-A264
8101M Analog Corded Voice Telephone	3192-102		
(Black - COL09)		107358889	8101A02A-003
(White - COL10)		107358897	8101A02A-264
MLX Adjuncts			
DSS			
English (black)	3156-DCB	106902463	604B1-003
English (white)	3156-DCW	106902489	604B1-264
Spanish (black - COL03)	3156-SDi	107013294	604B1(22)-003
Spanish (white - COL04)	3156-SDi	107013302	604B1(22)-264
MFM Module (117 VAC)	3156-MFM	105736474	540A1
Power Unit		406943837	LS-10015-ADT
MFM Module (220 VAC)*			
Power Unit		847007366	LS-10034-ADT1
Cord		107009565	D6BE-087 7FT

Component	PEC	Comcode	App Code
Applications			
AT&T Attendant (117 VAC power supply)	6125-ATT		
Auto Attendant Unit		406899054	
Documentation		106431265	
220 VAC Power Supply (order with 6125-ATT)	6124-010	407007772	
MERLIN MAIL Voice Messaging System Multi-Lingual Version R3 (110/220V)			
2-port	6107-400	407241926	
4-port	6107-401	407241934	
6-port	6107-402	407241942	
2-port line card (upgrade two to four or four to six)	6107-403A	407072115	
System Programming and Maintenance (SPM) — DOS	61453	107053415	SPM
System Adjuncts/Adapters			
AT&T Digital Announcer (one minute)	3119-001		
Announcer		407344365	
Recorder		406659342	RCDR-DMOH2
Cassette		406769455	CSTT-DMOH5
AT&T Digital Announcer (three minutes)	3119-003		
Announcer		407344357	
Recorder		406659342	RCDR-DMOH2
Cassette		406659359	CSTT-DMOH3
Channel service units (CSUs)			
ESF T1	2152-ESF	405616293	305010171-001
Cable (8 mod, wire wrp)	21555	406012609	513861312-50 5
Cable (8 mod, 15-pin sub)	21554	406012591	513823015-50
Standalone wall mount	21545	405970104	380-100213-001
551 T1 L1	2152-15T	403768179	305-10097-001
Power unit	21530		
Unit (117/220 VAC)		403242639	WP-92464,L3
Cord		103985660	DW4A-SE 10FT IP
Standalone wall mount	21545	405970104	380-100213-001

Component	PEC	Comcode	App Code
System Adjuncts/Adapters, continued			
Electrostatic discharge suppression kits			
D181574	n/a	105179329	D181574
D181589	n/a	105201891	D181589
D181590	n/a	105201909	D181590
D181591	n/a	105201917	D181591
D181593	n/a	105201933	D181593
EMI filter			Z200A
IROB unit — MLX†	32919	106417447	505A ASSY 0A WD
Fuse block 505A for IROB		406610337	
ExpressRoute 1000 Data Unit (Not a kit)	2164-ER1(A)	107651796	
ExpressRoute 1000 V&D KIT (1 user)	2164-DOK(A)	107651804	
NT1L-230 Network Termination Module	2164-NT1(A)	107655797	
400B Adapter	2164-400(A)		
Power Supply Unit			KS22911-L2
V.35 Cable	2164-V35(A)	107651275	
RS-449 Cable	2164-449(A)	107651283	
ISDN 7500B Data Module	2164-BDM	105657654	Z7500B-L1
Standalone power supply (117 VAC)	21625	405509852	WP-90110,L7
220 VAC power supply			WP-90110,L8
Multiple mounting	21626	105441166	Z77A
7500A upgrade kit	21627	105688501	D182208
Magic on Hold player (Digital)	3128-020	406659326	PAKG DMOH1 DIG L
Music coupler	61398	406143925	ASSY-KS23395L3
Supplemental Alerts			
MERLIN Alert Bell	61212	406293720	TB591D
MERLIN Alert Horn	61213	406207217	THET4-1
MERLIN Alert Strobe	61221	403319197	AT-WHL LK
MERLIN Alert Chime	61222	405136060	CHBT2-1
MERLIN Alert Deluxe Horn	61223		
MERLIN Alert Switch	61215		

Component	PEC	Comcode	App Code
Telephone Adapters			
General Purpose Adapter (GPA)	2301-GPA	103977997	Z1C
Multi-Function Module (MFM)	3156-MFM	105736474	540A1
Supplemental Alert Adapter (SAA)	2301-SSA	105031199	ADPTR-856A
220 VAC Power Supply	847007366		LS-10034-ADT1
Power Cord	107009565		D6BE-087 7FT
Telephone Adjuncts			
S201 Speakerphone	3152-007A	103786786	D8W-87
Black		106192651	MOD-S201AP-003
Misty cream		106192693	MOD-S201AP-215
CS201 Conference Speakerphone	3131-004A	103786786	D8W-87
Black		106270325	MOD-CS201A-003
Misty cream		106270333	MOD-CS201A-215
MLX Telephones — Miscellaneous Add-Ons/Replacement Parts			
Handsets and Cords			
Handset (black)	n/a	106050065	K2S1-003
Handset (white)	n/a	106053408	K2S1-264
Handset, amplified hearing	31052		
Black		105581896	K6S2-003
White		106248248	K6S2-264
Misty cream		105581904	K6S2-215
Handset cord (3 meters [9 feet], black)	n/a	105635429	H4DU-003 9FT
Handset cord (3 meters [9 feet], white)	n/a	105701809	H4DU-264 9FT BULK
Handset cord (4 meters [12 feet], black)	n/a	102401445	H4DU-3 12FT IP
Handset cord (4 meters [12 feet], white)	n/a	102402609	H4DU-264 12FT IP
Handset cord (8 meters [25 feet], black)	n/a	105523866	H4DU-3 25FT
DSS line cord (1 meter [2 feet])	n/a	106187545	CORD D8AC-87

Component	PEC	Comcode	App Code
Headsets			
StarSet II — StarMate-E	3122-304A	405211723	HDST-KS23080L7
Supra — StarMate-E	n/a	n/a	HDST-KS23080L8
Starset	3122-030A		
Supra Monaural	3122-040		
Supra Binaural	3122-045		
Mirage	3122-050		
Supra Monaural Noise Cancelling	3122-055		
Supra Binaural Noise Cancelling	3122-060		
Adapter	3122-020		
Desk Stands and User Trays			
Stand (large, black)	n/a	846320851	STAND-LARGE BL
Stand (large, white)	n/a	846320844	STAND-LARGE WH
Stand (small, black)	n/a	846320810	STAND-SMALL BL
Stand (small, white)	n/a	846320802	STAND-SMALL WH
User tray (black)	n/a	846320240	USER TRAY DWR B
User tray (white)	n/a	846320232	USER TRAY DWR W
Designation (Button Assignment) Cards and Covers			
Designation cards‡ — MLX-10, MLX-10D, MLX-20L, MLX-28D	n/a	847193273	CARD-DESIGN
Designation card set — DSS	n/a	106448756	KIT SET DSS
Designation card covers** — DSS (black)	n/a	106448731	KIT-D182462 PRT
Designation card covers** — DSS (white)	n/a	106448749	KIT-D182463 PRT
Designation card set†† — QCC	n/a	106561673	KIT-D182562 PRT
Designation card covers‡‡ — MLX-10, MLX-10D, MLX-20L	n/a	106448681	KIT-D182457 PRT
Designation card covers — MLX-28D	n/a	106448699	KIT-D182458 PRT

*. Ordering information not available at time of printing.

†. Any multiline off-premises telephone must have an appropriate IROB protector at the control unit location and at the off-premises location.

‡. Twelve per package

**. Includes both top and bottom cards or covers.

††. Four per package

‡‡. Eight cards per kit (four sets)

Documentation Ordering Information

The books needed for operating the communications system are not supplied with the system. Copies of these, and other books applicable to the MERLIN LEGEND system, are orderable using the numbers provided in the table below:

Book Title	Order Number
System Reference, Setup, and Modification	
System Planning	555-612-213
System Planning Forms	555-612-217
System Reference	555-612-219
System Programming	555-612-211
Installation and Maintenance	555-612-241
Telephone User Support	
MLX-10, MLX-10D, MLX-28D, and MLX-20L Telephones User's Guide	555-612-228
Single-Line Telephones User's Guide	555-612-227
Operator Guides	
MLX Direct-Line Consoles Operator's Guide	555-612-236
MLX Queued Call Console Operator's Guide	555-612-237
Miscellaneous	
Calling Group Supervisor's Guide	555-612-234
Pocket Reference	555-612-218
User Tray Cards	
MLX-10, set of 6 (R 2.0)	555-620-151
MLX-10D, set of 6 (R 2.0)	555-620-150
MLX-20L/MLX-28D, set of 5 (R 2.0)	555-620-152
Button Labels	
MLX-10/10D (100 per package)	555-610-142
MLX-20L (100 per package)	555-610-143
MLX-28D (100 per package)	555-610-144

Adjuncts

B

Contents

Adjuncts

B

Table B-1 summarizes the types and specifications of the adjuncts that can be connected to the MERLIN LEGEND Communications System, the available AT&T products and associated ordering codes (PECs), and the appropriate interfaces. A description of each equipment type follows the table.

NOTE:
Table B-1 extends from page B-2 through B-11, and each row of the table begins on the left-hand page and ends on the right-hand page. For example, the first "page" of the table extends across pages B-2 and B-3.

Adjunct Specifications

Table B-1. Adjunct Equipment Types, Specifications, AT&T Products, PECs, and Interfaces

Equipment Type	Specifications	AT&T Products	PEC
Alerts (AC)	■ Line-powered bells ■ Any audible or visual alert that operates on 20 to 30-Hz ringing signals ■ A device associated with a specific station (supplemental alert) or that works on a programmed line/trunk port (external alert)	External ringer – Loud External ringer	31016 31019
Alerts (DC)	■ Any audible or visual alert that operates on -48 VDC ringing signals ■ A device associated with a specific station (supplemental alert) or that works on a programmed line/trunk port (external alert)	MERLIN Alert bell MERLIN Alert horn MERLIN Alert strobe MERLIN Alert chime MERLIN Alert deluxe – horn MERLIN Alert switch	61212 61213 61221 61222 61223 61215
Answer/record machine	■ Industry-standard machine ■ Low-ringer equivalence (less than 0.15 or ≤1.0 total REN for T/R port) ■ Ability to recognize 600-ms disconnect signal or other means of automatic disconnect (such as voice reset disconnect timer, fixed recording time)		(1)

Interface					
LS	**T/R**	**MFM**	**GPA**	**SAA**	
Line Jacks	**012, 016, or 008 OPT Station Jack**	**MLX Station Jack**	**ATL Station Jack**	**ATL Station Jack**	**Notes**
	✔	✔	✔		Cannot be connected to a QCC
✔(1)		✔		✔	1. Requires PagePal to provide -48 VDC
	✔	✔	✔		Cannot be connected to a QCC

Equipment Type	Specifications	AT&T Products	PEC
Cordless telephone	■ Must have touch-tone dialing capability when connected via MFM; rotary or touch-tone dialing can be used on T/R port ■ Single line		
Credit card verification terminal	■ Must have touch-tone dialing capability when connected via MFM; rotary or touch-tone dialing can be used on T/R port		
Dial dictation	■ A device that requires contact closure can be used on an LS line jack only with PagePal		
Direct Station Selector	■ A maximum of two DSSs can be connected to a console ■ A WP-92464,L3 power unit must be used to power a console with an MFM and two DSSs ■ Connects to "DSS" jack on console		3156-DCB (black) 3156-DCW (white)
Fax	■ Must have touch-tone dialing capability when connected via MFM; rotary dialing can be used on T/R port ■ Industry-standard analog interface		

Interface					
LS	T/R	MFM	GPA	SAA	
Line Jacks	012, 016, or 008 OPT Station Jack	MLX Station Jack	ATL Station Jack	ATL Station Jack	Notes
	✔	✔ (1)	✔		Cannot be connected to a QCC 1. Device originates and receives calls independently of associated telephone when used with an MFM. When used with a GPA, the analog telephone dials and receives calls.
	✔	✔ (1)			Cannot be connected to a QCC 1. Device originates and receives calls independently of associated telephone.
✔ (1)	✔	✔	✔		Cannot be connected to a QCC 1. PagePal required
	✔	✔ (1)			Cannot be connected to a QCC 1. Device originates and receives fax messages independently of associated telephone when used with an MFM.

Equipment Type	Specifications	AT&T Products	PEC
Group Calling delay announcement	■ Industry-standard announcement device ■ Must provide automatic disconnect ■ Each calling group can have its own announcement (maximum 32) ■ A device can provide delay announcement for more than one group	AT&T Digital Announcer	3119-001
Hands-free unit	■ For use with analog multiline telephones ■ Connects directly to telephone	S202A	3152-008
Headset for MLX telephone		Starset II — StarMate-E	3122-304
		Supra — StarMate-E	
		Starset	3122-030A
		Supra Monaural	3122-040
		Supra Binaural	3122-045
		Mirage	3122-050
		Supra Monaural Noise Cancelling	3122-055
		Supra Binaural Noise Cancelling	3122-060
		Adapter	3122-020

Interface					
LS	T/R	MFM	GPA	SAA	
Line Jacks	012, 016, or 008 OPT Station Jack	MLX Station Jack	ATL Station Jack	ATL Station Jack	Notes
	✔	✔ (1)	✔		Cannot be connected to a QCC 1. Device originates and receives calls independently of associated telephone.
					No headset adapter required

Equipment Type	Specifications	AT&T Products	PEC
Headset adapter	■ Need to program Auto Answer All button for use with 502B, 502C ■ Connects directly to telephone OTHER jack	502C 502B	3164-HFA 62524
Loudspeaker paging	■ External paging system using DTMF signaling is connected to LS line jack ■ CPE paging systems require an interface unit; if CPE has 2-wire input, the PagePal can be used		
Message-waiting indicator	■ For single-line sets ■ Connects directly to telephone	Z34	31032
Modem	■ If the modem supports touch-tone dialing via the associated data terminal, the keyboard can be used for dialing ■ If the modem does not support touch-tone dialing, an associated basic (single-line) set can be used for dialing	Modem Model 4000 Modem Model 2224G Modem Model 4024 Modem Model 2296A Modem Model 2296	2212-MUK (1) 2224-CEO (1) 2224-CDO (1) 2296-BAR (1) 2296-BDM (1)
Music on Hold*	■ Any FCC-registered 8-ohm music source or recorded announcement device	Magic-on-Hold	3128-010 (1)

* If equipment that rebroadcasts music or other copyrighted materials is used, it may be a requirement to obtain a copyright license from and pay license fees to a third party. This should be verified first before any rebroadcasting is done. However, if a Magic-on-Hold system is purchased (see Appendix A, Ordering Information) from an AT&T representative, no special license is required.

Interface					
LS	T/R	MFM	GPA	SAA	
Line Jacks	012, 016, or 008 OPT Station Jack	MLX Station Jack	ATL Station Jack	ATL Station Jack	Notes
✔ (1)					1. Bi-directional paging is supported; only one line jack is needed for multizone paging. 2. LS adapter (53518) is required when connected to LS line jack.
✔ (2)	✔	✔	✔		1. See sales manual for requirements. 2. For modem model 2224G only.
✔ (1)					1. Music Coupler required 61398
					1. Requires 2500SM telephone

Equipment Type	Specifications	AT&T Products	PEC
Speakerphone	■ Connect directly to telephone ■ For single-line sets only	4A (1) S203A	3120-02W 3131-008
SMDR printer	■ Connects to upper RS-232 jack on processor module ■ Must be located within 50 feet of control unit or use ADU to extend distance		

Interface					
LS	**T/R**	**MFM**	**GPA**	**SAA**	
Line Jacks	**012, 016, or 008 OPT Station Jack**	**MLX Station Jack**	**ATL Station Jack**	**ATL Station Jack**	**Notes**
					1. Requires 2500SM telephone

Adjunct Descriptions

Answer/Record Machine

Connected to the system through a single-line telephone jack, an MFM port on an MLX telephone, or a GPA on an analog multiline telephone. Use any industry-standard device that recognizes a 600-ms disconnect signal and connect a 267A2 bridging adapter to the telephone. (The 267A2 bridging adapter is not needed when the telephone is built in to the answering machine.)

Answering devices, such as voice-reset disconnect timers and fixed recording timers, that disconnect automatically can also be used.

Cordless Telephone

Attached to the system through a single-line telephone jack or an MFM port on an MLX telephone. When connected through an MFM port, the cordless touch-tone telephone can place and receive calls independently of the MLX telephone. Use with a GPA is not recommended because the cordless telephone cannot dial out through the GPA.

Credit Card Verification Terminal

Connected to the system through a single-line telephone jack or an MFM port on an MLX telephone. Use with a GPA is not recommended because the credit card verification terminal cannot auto dial through the GPA. When connected through an MFM port, the transaction terminal makes and receives calls independently of the associated MLX telephone.

Group Calling Delay Announcement

Connected to the system through a single-line telephone jack, an MFM port on an MLX telephone, or a GPA on an analog multiline telephone. An industry-standard announcement device, such as an AT&T Digital Announcer, announces to a caller that calling groups are busy or provides Night Service information.

Dial Dictation

Connected to the system through a single-line telephone jack, an MFM port on an MLX telephone, or a GPA on an analog multiline telephone. Dial dictation can also be connected by using a commercially available "trunk adapter" or PagePal Interface Unit with a loop-start (LS) CO line jack and an external power supply unit. Dial dictation equipment requiring contact closure must be connected via the PagePal.

Fax Machine

Connected to the system through a single-line telephone jack or an MFM port on an MLX telephone. Use with a GPA is not recommended because the fax machine cannot auto dial through the GPA. The fax machine originates and receives fax calls independently of the associated telephone. Calls are dialed with the fax machine's dialpad or from an associated single-line telephone.

Headset

Connected to a telephone for answering calls automatically without lifting the handset. When a SPIRIT StarMate E Headset is used with a MLX telephone, the headset connects to the same jack as the telephone handset. Analog telephones operate with a 502C adapter connected to the OTHER jack on the telephone, or without an adapter by plugging the headset into the handset jack.

Loudspeaker Paging Systems

Connected to a programmable LS line/trunk port for single-zone or multizone paging. Used to page co-workers and make announcements through loudspeakers. Wiring diagrams for different configurations are included in Appendix C.

NOTE:
Since most paging equipment works with an LS port, programming the port for LS is recommended.

External paging systems that use DTMF signaling can be connected to a line jack programmed for paging operation, including bi-directional paging.

Zone paging systems require one LS jack. Any zone can be used once the paging port is activated.

A PagePal Interface Unit is used to connect the system to paging equipment that requires contact closure. It can be used on any LS port that is programmed for paging.

Modem

Connected to the system through a single-line telephone jack, an MFM port on an MLX telephone, or a GPA on an analog multiline telephone. Modems are used for converting digital signals to analog, or analog signals to digital, so that digital equipment can transmit data over telephone lines. When connected through an MFM, data calls made from the modem are independent of the associated MLX telephone. Data calls can be dialed from either the data terminal keyboard or an associated single-line telephone.

Music on Hold, Magic-on-Hold

Connected to an LS CO line/trunk port programmed for Music on Hold (MOH) (see Appendix C). The system supports one MOH connection, either Magic-on-Hold or a customer-owned music source. The external music coupler (PEC 61398) uses an 8-ohm music source and two attenuation controls for setting the MOH music level.

NOTE:

- Since most equipment works with an LS port, programming the port for LS is recommended.
- If equipment that rebroadcasts music or other copyrighted materials is used, it may be a requirement to obtain a copyright license from and pay license fees to a third party. This should be verified first before any rebroadcasting is done. However, if a Magic-on-Hold system is purchased (see Appendix A, Ordering Information) from an AT&T representative, no special license is required.

Supplemental Alerts

Connected to the system through a single-line telephone jack, an MFM port on an MLX telephone, or an SAA on an analog multiline telephone. The MFM and SAA support devices operating on -48 VDC. Alerts operating on 20Hz can be connected to either an MFM or a single-line telephone jack.

Compatible alerts include horns and bells to audibly alert workers, and strobes for use in quiet zones (hospitals and libraries) and noisy areas (factories) and for the hearing-impaired.

Wiring

C

Contents

Wiring

C

The following tables summarize the basic conductor wire connections in the MERLIN LEGEND Communications System. The diagrams that follow the tables show the main wiring schemes.

Wiring Tables

Table C-1. LS, DID, and OPT 6-Position Jacks

Control Unit Jack		D2R Cable		RJ11 Network Interface		
Desig.	Pin	Plug	Plug	Desig.	Pin	Color
T	3	3	4	T	4	Green
R	4	4	3	R	3	Red

NOTE:
If a Brand-Rex Quad cable from an E66 block is substituted for the recommended D2R cable, the tip-and-ring leads will be reversed at the line/trunk port, and the trunk will not operate correctly. To correct this problem, reverse the wiring at the E66 block.

Table C-2. E1 or DS1 8-Position Jacks

DS1/E1 Desig	Jack Pin	Pair #	E1 BNC Cable Color*	DS1 DB15 Cable Color	103A Term Stamp	DIW Cable Color
T(xmt)	5		red	green	1	white-blue
R(xmt)	4	1	green	red	2	blue
T1(rcv)	1		grey	white	3	white-orange
R1(rcv)	2	2	brown	orange	4	orange
n/c	3		yellow	black	5	white-green
n/c	6	3	black	yellow	6	green
n/c	7		orange	blue	7	white-brown
n/c	8	4	light blue	brown	8	brown

* Your cables may have different colors from those listed in Columns 4 and 5 of Table C-2, depending on the cable manufacturer. If the wires in your cables have different colors, or if you are using D8W cords, use the jack pin numbers (see Column 2) instead of using the colors indicated in Columns 4 and 5.

Table C-3. Analog Tie Trunk 8-Position Jacks

E&M Desig	Jack Pin	Pair #	D8W Cord Color	103A Term Stamp	DIW Cable Color
T	5		green	1	white-blue
R	4	1	red	2	blue
T1	1		blue	3	white-orange
R1	2	2	orange	4	orange
E	3		black	5	white-green
M	6	3	yellow	6	green
n/c	7		brown	7	white-brown
n/c	8	4	grey	8	brown

Table C-4. Tie-Trunk Jack to RJ2GX Network Interface

Pin	CU Jack	Trk 1	Trk 2	Trk 3	Trk 4	Trk 5	Trk 6	Trk 7	Trk 8
T	5	26	29	3	35	38	41	44	47
R	4	1	4	7	10	13	16	19	22
T1	1	27	30	33	36	39	42	45	48
R1	2	2	5	8	11	14	17	20	23
E	3	28	31	34	37	40	43	46	49
M	6	3	6	9	12	15	18	21	24

Table C-5. Eight-Pin RS-232 Flow Control Cable

Pin No.	Processor (DCE)	Data Term (DTE)
1		
2	DSR	CTS
3	DTR	DTR
4	GND	GND
5	RXD	
6	TXD	
7	+5	DSR
8		

Wiring Diagrams

The following illustrations are examples of different wiring applications for the MERLIN LEGEND Communications System.

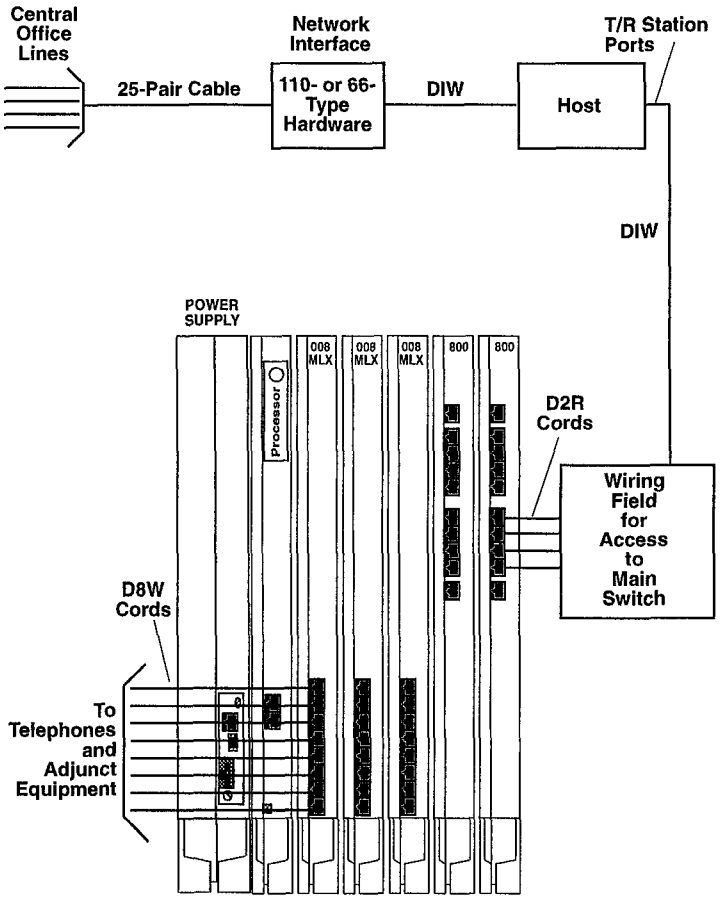


Figure C-1. Behind Switch Wiring

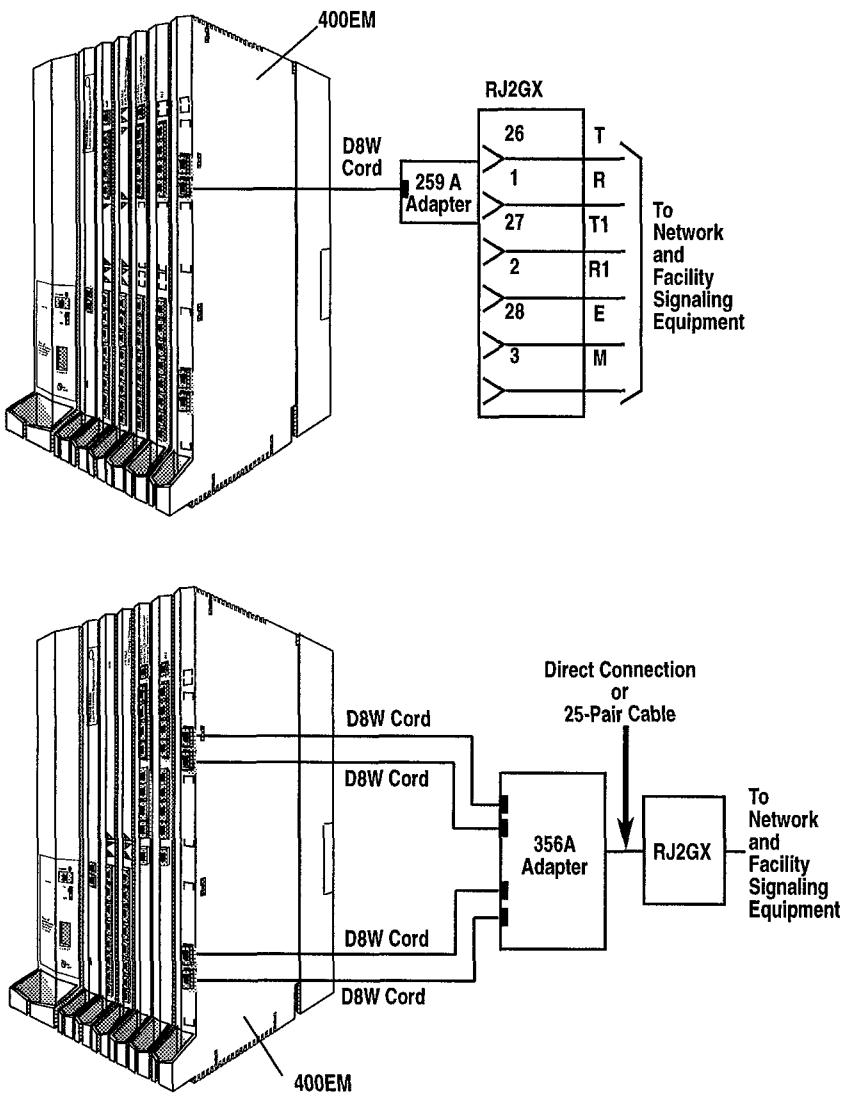


Figure C-2. Tie-Trunk Wiring

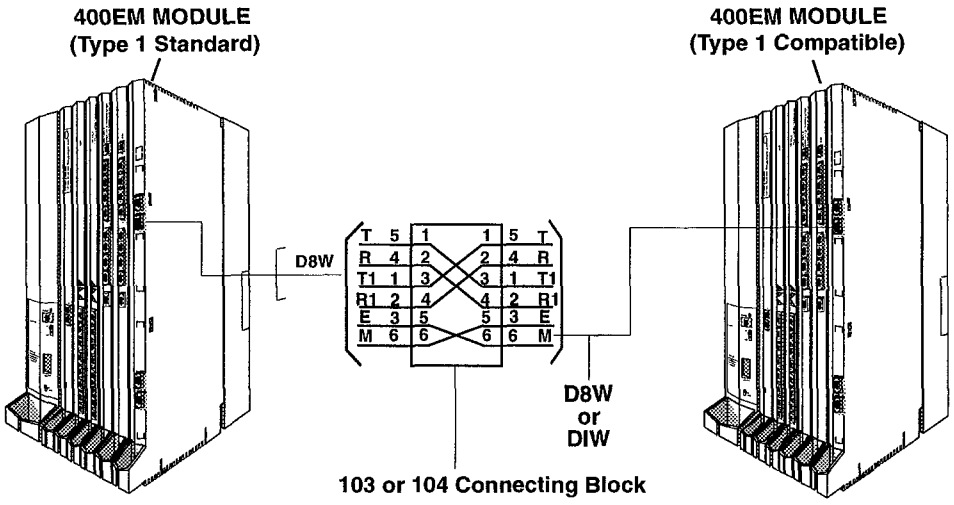


Figure C-3. Back-to-Back Tie-Trunk Wiring

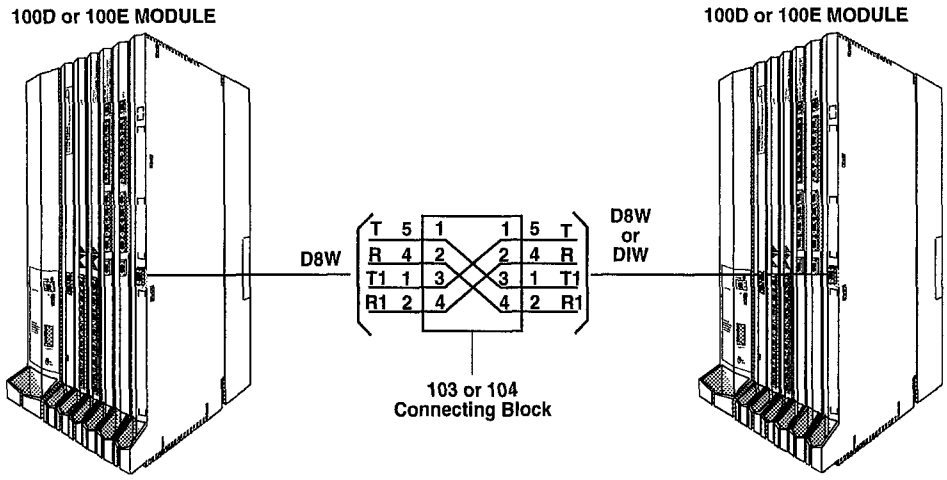


Figure C-4. Back-to-Back 100D (or 100E) Modules

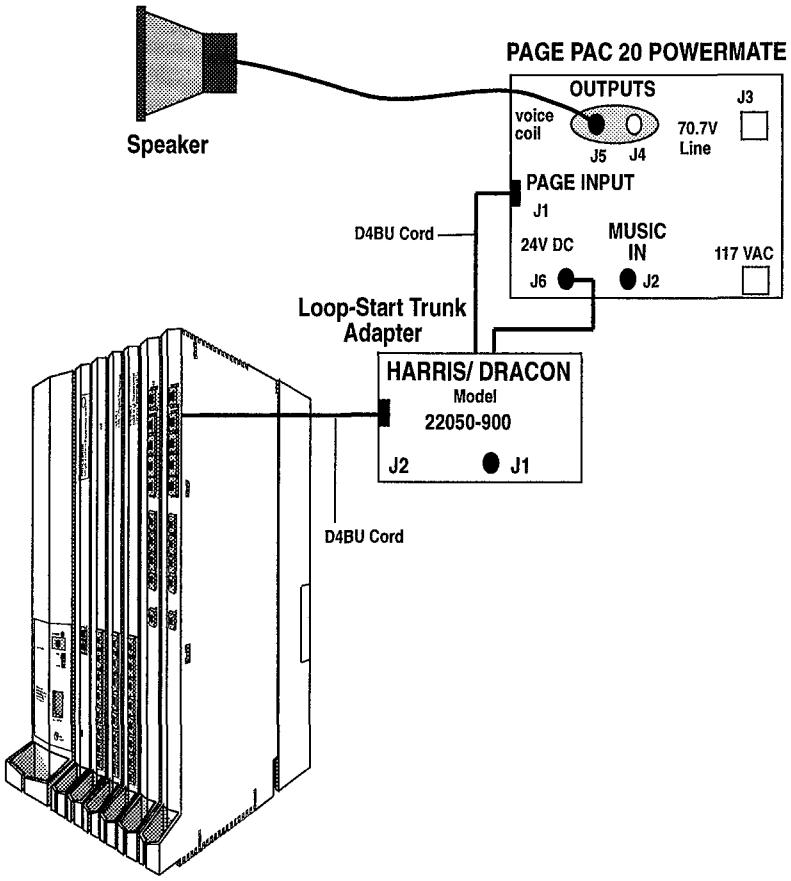


Figure C-5. Single-Zone Paging with PagePac

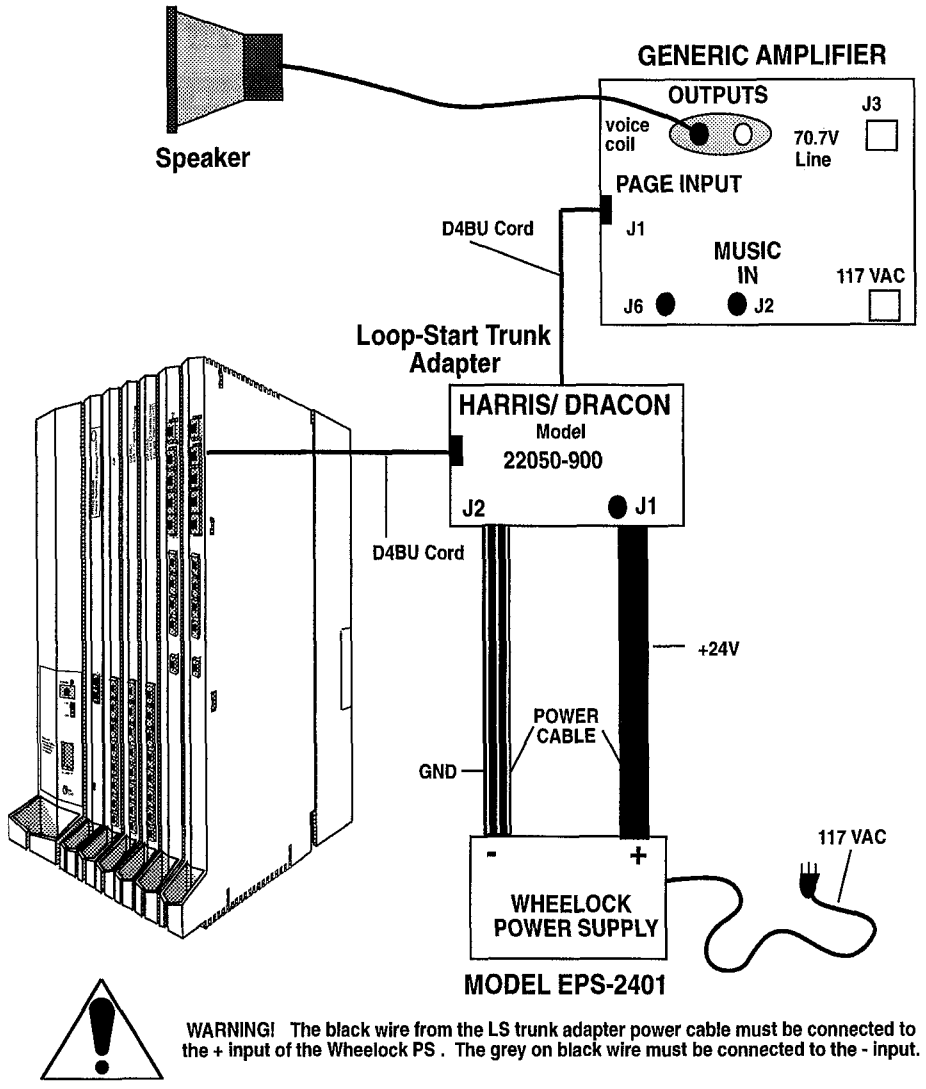


Figure C-6. Single-Zone Paging with Customer-Supplied Amplifier

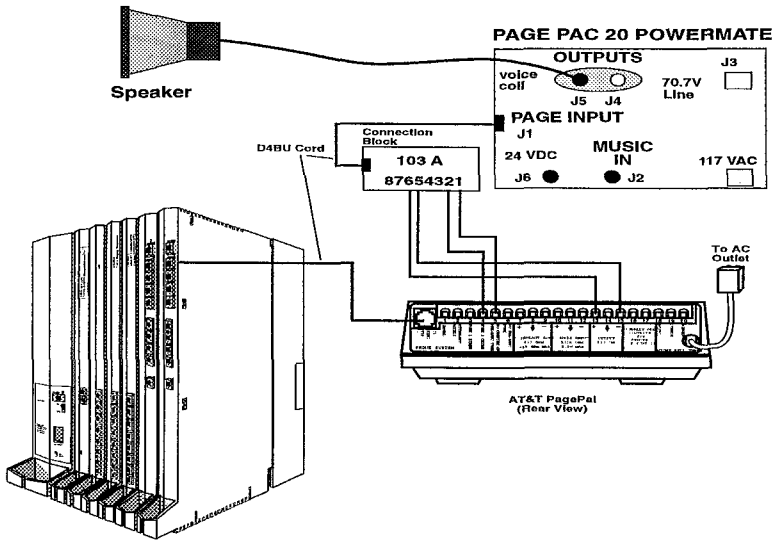


Figure C-7. Single-Zone Paging with PagePal

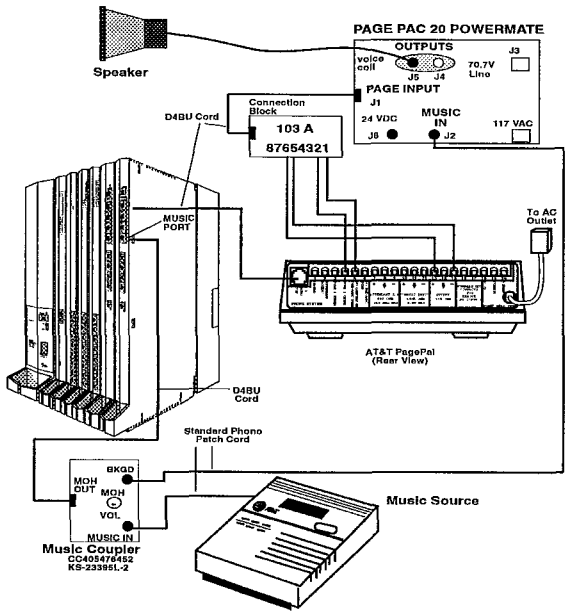


Figure C-8. Single-Zone Paging with Background Music and MOH

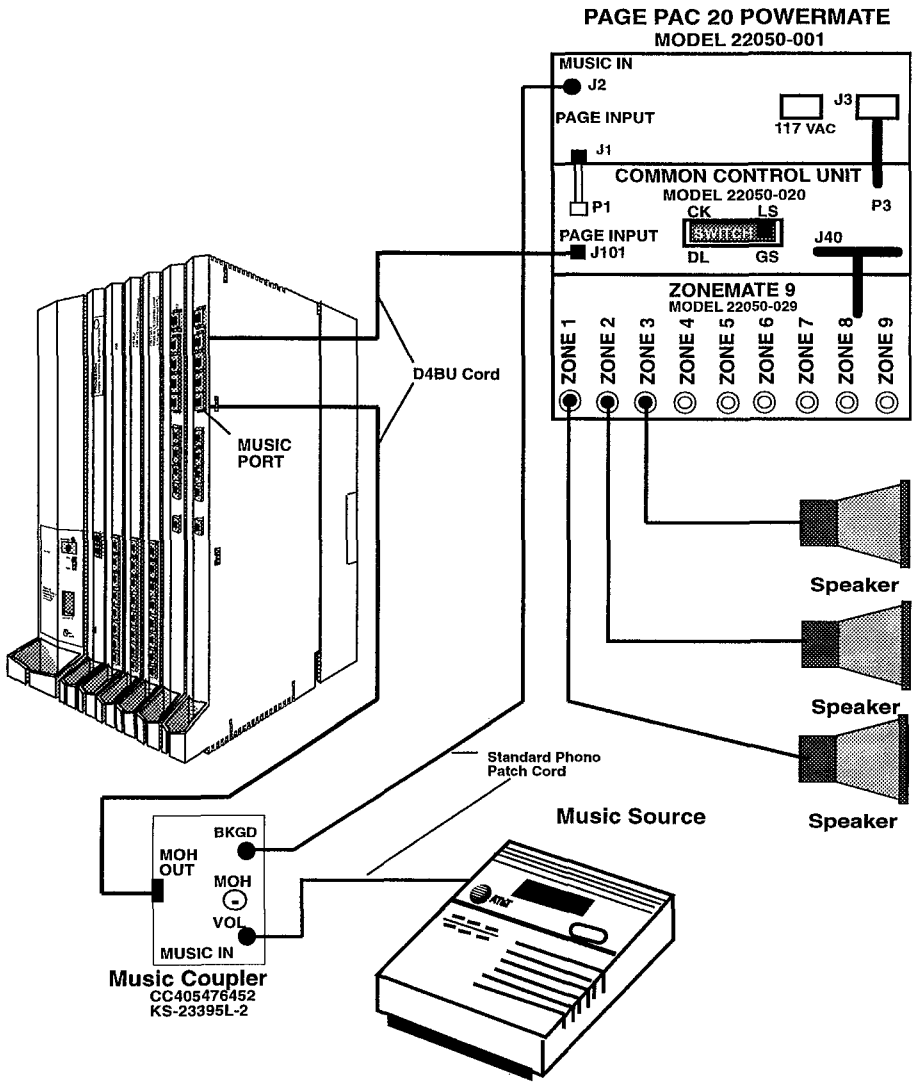


Figure C-9. Multizone Paging with Background Music, MOH, and Talk-Back

Unit Load Calculation WorkSheet

D

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Unit Load Calculation Worksheet

D

Use the instructions on the following worksheet to calculate unit load totals for each carrier. Make a copy of the worksheet for each carrier.

NOTE:
When computing the unit loads for your system, only systems using a 391A1 or 391A2 (117 VAC) power supply module can add extra power capacity through use of an auxiliary power unit if the unit load exceeds 54. However, it is recommended that the power supply module be replaced with a 391A3 (117 VAC) power supply module which increases the unit load capacity to 75 rather than add an auxiliary power unit.

For systems using a 391B1 (220 VAC) power supply module, the unit load cannot exceed 54. Auxiliary power units cannot be used with this module.

For systems using a 391A3 (117 VAC) or 391B2 (220 VAC) power supply module, the unit load cannot exceed 75. Auxiliary power units cannot be used with these modules.

Unit Load Worksheet

1. Number of modules in carrier (excluding power supply module and processor module):
   - If fewer than 5, auxiliary power is not required.
   - If 5 or 6, continue to step 2.

2. Key or Behind Switch mode only:
   Indicate configuration of lines; then go to step 5.
   - ❑ Square
   - ❑ Modified

3. Hybrid/PBX mode only:
   Do all modules in the carrier have MLX station jacks?
   - ❑ Yes
   - ❑ No
   - If no, auxiliary power is not required.
   - If yes, continue to step 4.

4. Hybrid/PBX mode only:
   Calculate the total number of MLX telephones.

   Number of MLX-20L telephones connected to modules in the carrier

   Number of MLX-28D telephones connected to modules in the carrier

   Total of MLX-20L, MLX-28D, and 34-button analog telephones

   - If total is less than 54, auxiliary power (391A1 and 391A2 117 VAC systems only) is not required.
   - If total is 54 or more (391A1, 391A2, and 391B1 systems only) or 75 or more (391A3 or 391B2 systems only), continue to step 5.

5. Calculate the estimated unit loads.

Module	Qty	x	Unit Load	=	Total
008 MLX			13.5		
008 OPT (with built-in ring generator)			8.0		
012 (with built-in ring generator)			7.2		
016 (with built-in ring generator)			12.8		
100D			0.0		
100E			0.0		
400			0.0		
400 EM			8.0		
400 LS/TTR/DTD			0.0		
800			0.0		
800 LS/DTD			0.0		
800 LS/DTD/TPM			0.0		
800 DID			8.0		
MFC06			0.0		
			Total Estimated Unit Load		

- If total is less than 54, auxiliary power (391A1 and 391A2 117 VAC systems only) is not required.
- If total is 54 or more (391A1, 391A2, and 391B1 systems only) or 75 or more (391A3 or 391B2 systems only), continue to step 6.

NOTE:
Auxiliary power is not available for 220 VAC systems or for 117 VAC systems using the 391A3 power supply. The unit load may not exceed 54 for systems using the 391B1 (220 VAC) power supply, and may not exceed 75 unit loads for systems using the 391A3 or 391B2 power supply.

6. Calculate the actual carrier unit load.

	Qty	x	Unit Load	=	Total
Equipment			**Hybrid/PBX or Modified**	**Square**	
Network Access Lines*					
DID			1.0	1.0	
DS1			0.0	0 0	
E1			0.0	0 0	
LS			0.0	0.0	
Tie			1.4	1.4	
Telephones					
MLX-10			9	1.2	
MLX-10D			.9	1.2	
MLX-28D			1 2	1 7	
MLX-20L			1.1	1.6	
MLX-10 (Eastern European)			9	1.2	
MLX-10D (Eastern European)			9	1 2	
MLX-28D (Eastern European)			1 2	1 7	
MLX-20L (Eastern European)			1 1	1.6	
10-Button Basic			0.9	1 1	
10-Button HFAI			1 0	1.2	
34-Button Basic			0.9	1.1	
34-Button DLX			1.2	1 7	
34-Button BIS			1.2	1 4	
34-Button BIS/DIS			1.2	1.4	
Single-Line Telephone			0.6	0.7	

Equipment	Qty	x Hybrid/PBX or Modified	Unit Load Square	= Total
Optional Equipment†				
Direct Station Selector‡		0 7	0.9	
General Purpose Adapter		0 8	1 0	
Hands-Free Unit		0.8	1 0	
Headset Adapter		0.8	1.0	
			Total Actual Unit Load	

*. Unit loads are computed per trunk for trunk-type network access lines.

†. The MFM has its own wall power unit located at the station and therefore is not added to the unit load calculation.

‡. Up to two DSSs (one DSS per MLX-28D or MLX-20L) can be powered from each control unit carrier. For example, a three-carrier system can have six system operator positions, each with one DSS powered from the control unit.

- If the total actual unit load is less than or equal to 54 (391A1 and 391A2 117 VAC systems only), auxiliary power is not required.
- If the total actual unit load is more than 54 (391A1, 391A2, and 391B1 systems only) or 75 or more (391A3 or 391B2 systems only), continue to step 7.

NOTE:
Auxiliary power is not available for 220 VAC systems or for 117 VAC systems using the 391A3 power supply. The unit load may not exceed 54 for systems using the 391B1 (220 VAC) power supply, and may not exceed 75 unit loads for systems using the 391A3 or 391B2 power supply.

7. Try to exchange modules between carriers to reduce the unit loads to 54 (for systems with 391A1, 391A2, and 391B1 power supplies) or 75 (for systems with 391A3 or 391B2 power supplies). (Remember that 100D, 100E, 400, 400 LS/TTR/DTD, 800, 800 LS/DTD, 800 LS/DTD/TPM, and MFC06 modules have unit loads of 0.0.) Repeat steps 1 through 6 to recalculate unit loads for the new configuration.

NOTE:
Empty slots are not permitted between modules.

- If the exchange reduces the unit load to below the maximum rating for your power supply, auxiliary power is not required (391A1 and 391A2 117 VAC systems only).
- If the exchange does not reduce the unit load to below the maximum rating for your power supply, auxiliary power is required (391A1 or 391A2 117 VAC systems only). Continue to step 8.

8. Calculate the unit load for slots 5 and 6 of the carrier.

	Qty	x	Unit Load	=	Total
Equipment			**Hybrid/PBX or Modified**	**Square**	
Network Access Lines*					
DS1			0.0	0.0	
E1			0.0	0.0	
LS			0.0	0.0	
Tie			1.4	1.4	
Telephones					
MLX-10			.9	1 2	
MLX-10D			9	1.2	
MLX-28D			1 2	1.7	
MLX-20L			1.1	1.6	
MLX-10 (Eastern European)			.9	1 2	
MLX-10D (Eastern European)			9	1 2	
MLX-28D (Eastern European)			1.2	1 7	
MLX-20L (Eastern European)			1 1	1.6	
10-Button Basic			0 0	0 0	
10-Button HFAI			1.0	1 2	
34-Button Basic			0 9	1 1	
34-Button DLX			1 2	1.7	
34-Button BIS			1.2	1.4	
34-Button BIS/DIS			1.2	1 4	
Single-Line Telephone			0.6	0 7	

	Qty	x	Unit Load	=	Total
Equipment		**Hybrid/PBX or Modified**	**Square**		
Optional Equipment†					
Direct Station Selector‡		0.7	0 9		
General Purpose Adapter		0.8	1 0		
Hands-Free Unit		0.8	1.0		
Headset Adapter		0 8	1 0		
			Total Actual Unit Load		

*. Unit loads are computed per trunk for trunk-type network access lines.

†. The MFM has its own individual wall power unit located at the station and therefore is not added to the unit load calculation.

‡. Up to two DSSs (one DSS per MLX-28D or MLX-20L) can be powered from each control unit carrier. For example, a three-carrier system can have six system operator positions, each with one DSS powered from the control unit.

- If the unit load for slots 5 and 6 is less than or equal to 27, auxiliary power is sufficient for the carrier.
- If the unit load for slots 5 and 6 is more than 27, continue to step 9.

9. Try to exchange modules between carriers to reduce the unit loads for slots 5 and 6 to 27. (Remember that the 100D, 100E, 400, 400 LS/TTR/DTD, 800, 800 LS/DTD, 800 LS/DTD/TPM, and MFC06 modules have unit loads of 0.0.) Repeat steps 1 through 8 to recalculate unit loads for the configuration.

NOTE:
Empty slots are not permitted between modules.

- If the exchange reduces the unit load for slots 5 and 6 to 27 or less, auxiliary power is sufficient.
- If the exchange does not reduce the unit load for slots 5 and 6 to 27, install wall power units for the appropriate number of telephones to reduce the unit load to 27.

System Technician's Run Sheet

E

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System Technician's Run Sheet

E

When installing a new MERLIN LEGEND Communications System or changing any existing station wiring, record information about the station wiring on copies of the System Technician's Run Sheet in this appendix.

The following explains how to complete the System Technician's Run Sheet. The number in the Logical ID column refers to the number of the station jack in the control unit.

NOTE:
Be sure to make copies of the System Technician's Run Sheet and write on the copies so that you can use this appendix as a blank master.

1. On the first line of the "Type" column, enter the type of device (such as an MLX-20L telephone) connected to the station jack. On the second line, enter any attached adjuncts (such as an answering machine).
2. In the "Wire No." column, enter the number of the wire as indicated by the label on the wire.
3. In the "Old Ext. No." column, if the wire run is being changed, enter the extension number of the old station. If you are working with a new installation, leave this space blank.
4. In the "New Ext. No." column, enter the extension number of the station. This includes new installations.
5. In the "Miscellaneous" column, enter any information particular to that station.
6. In the "Person, Location, or Function" column, enter the name of the person at, the location of, or the function of (such as fax machine) the station.

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System Technician's Run Sheet — Page 1

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						

System Technician's Run Sheet — Page 2

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
31						
32						
33						
34						
35						
36						
37						

System Technician's Run Sheet — Page 3

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
51						
52						
53						
54						
55						

System Technician's Run Sheet — Page 4

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
56						
57						
58						
59						
60						
61						
62						
63						
64						
65						
66						
67						
68						
69						
70						
71						
72						
73						

System Technician's Run Sheet — Page 5

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
91						

System Technician's Run Sheet — Page 6

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
92						
93						
94						
95						
96						
97						
98						
99						
100						
101						
102						
103						
104						
105						
106						
107						
108						
109						

System Technician's Run Sheet — Page 7

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
110						
111						
112						
113						
114						
115						
116						
117						
118						
119						
120						
121						
122						
123						
124						
125						
126						
127						

System Technician's Run Sheet — Page 8

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
128						
129						
130						
131						
132						
133						
134						
135						
136						
137						
138						
139						
140						
141						
142						
143						
144						
145						

System Technician's Run Sheet — Page 9

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
146						
147						
148						
149						
150						
151						
152						
153						
154						
155						
156						
157						
158						
159						
160						
161						
162						
163						

System Technician's Run Sheet — Page 10

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
164						
165						
166						
167						
168						
169						
170						
171						
172						
173						
174						
175						
176						
177						
178						
179						
180						
181						

System Technician's Run Sheet — Page 11

Logical ID	Type	Wire No.	Old Ext. No.	New Ext. No.	Miscellaneous	Person, Location or Function
182						
183						
184						
185						
186						
187						
188						
189						
190						
191						
192						
193						
194						
195						
196						
197						
198						
199						
200						

System Programming Console Overlay

F

Contents

System Programming Console Overlay

F

System Programming Console Overlay

The MERLIN LEGEND Communications System can be programmed from either an MLX-20L telephone used as a system programming console or from a PC with System Programming & Maintenance (SPM) software.

Using a system programming console may involve the dialpad, some of the labeled function buttons on the lower part of the console, and the 20 line and feature buttons in the center of the console. The programming functions of the line and feature buttons are on the overlay for the console, as shown in Figure F-1.

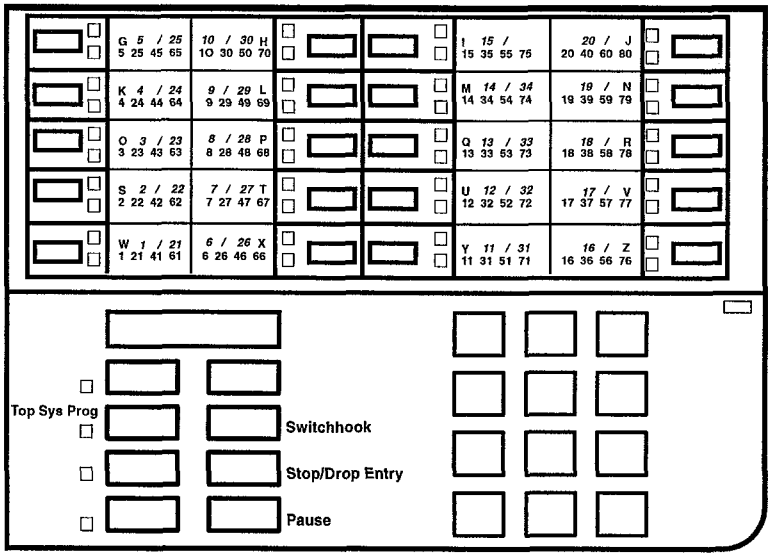

Figure F-1. Console Overlay

On a PC with SPM, the screen is arranged to represent the console, as a comparison of Figures F-2 and F-3 shows.

The window at the top of the SPM screen matches the console's display. The columns to the left and right of the window show keys that work in the same way as the buttons on either side of the console's display.

The bottom of the SPM screen simulates the 20 buttons in the center of the console and are identified on the screen as LINE 01, LINE 02, and so forth. The outside columns to the left and right of the "line buttons" show the keys that work in the same way as the line buttons. For example, pressing the Shift and F1 keys simultaneously is the same as pressing the lower left button on the console. The letters R and G simulate the red and green lights beside these buttons. For example, to simulate that a red LED is on, the letter R appears on the screen next to the line button.

The labels on the top right side of the SPM screen (**Drop**, **Transfer**, **Hold**) correspond to the buttons on the lower left side of the telephone.

See Chapter 4 "Programming Procedures" for instructions on programming from a system programming console or from a PC with SPM.

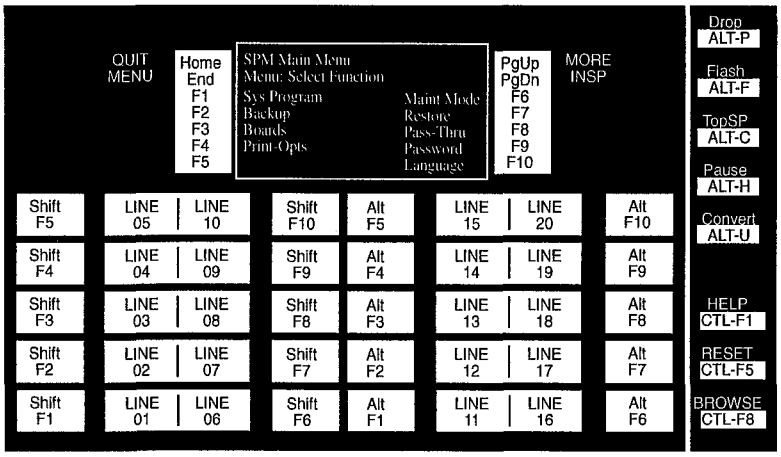

Figure F-2. SPM Screen

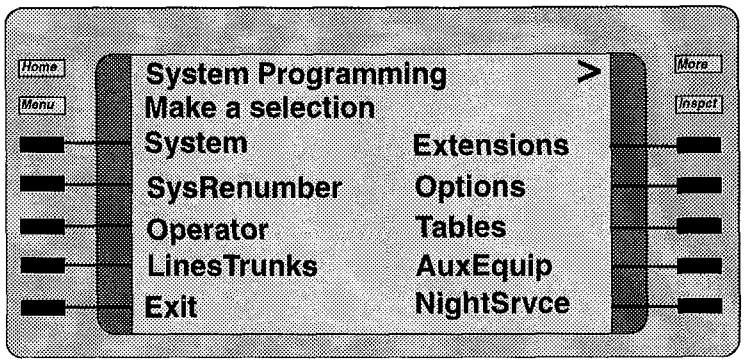

Figure F-3. System Programming Console Display

System Programming Menu Hierarchy

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System Programming Menu Hierarchy

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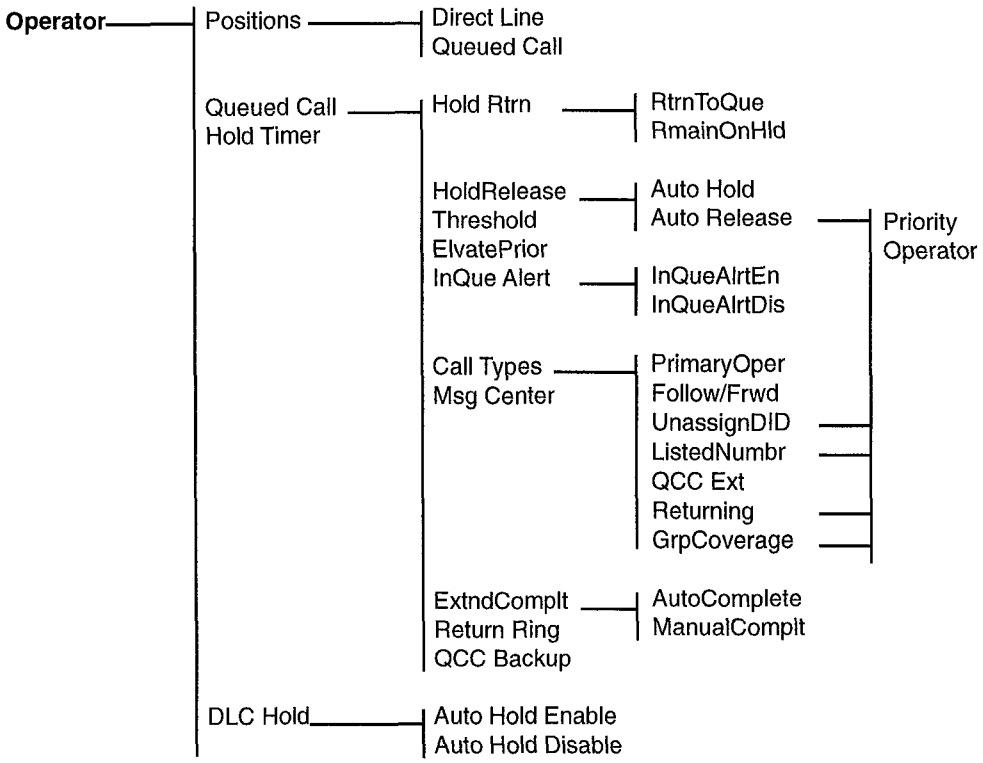
System Programming Menu Hierarchy

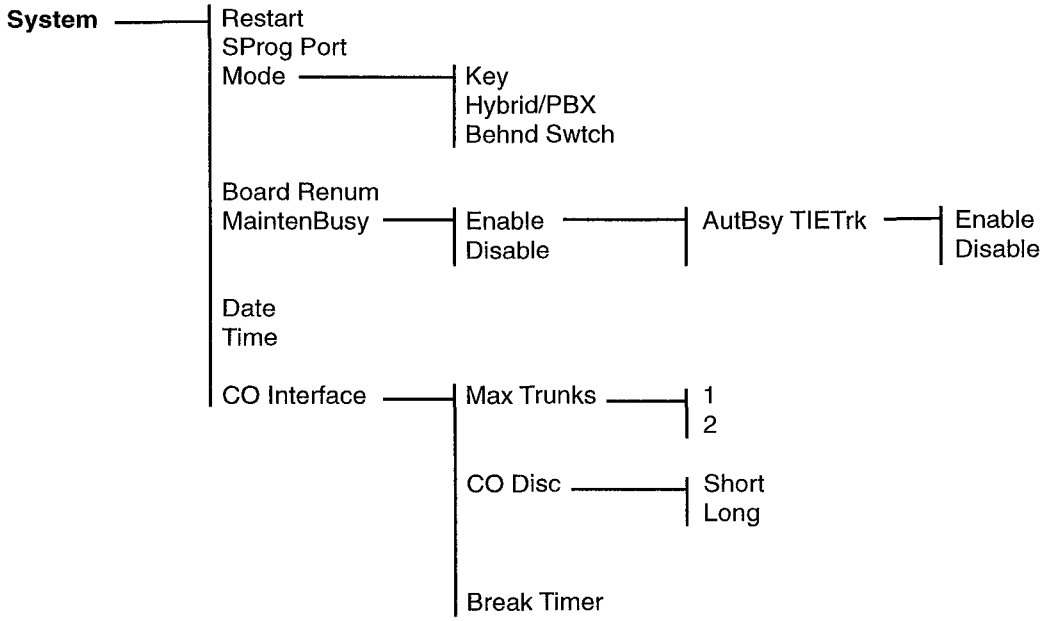
The system programming menu hierarchy is the sequence of menu screens that appear when you select the system programming options. The choice of an option on the first menu screen leads to either a second menu screen or a data-entry screen. A secondary menu screen may lead to still another menu screen, and so on up to six screens, as shown in the following pages.

You can use the Inspect feature in system programming to display the telephone or line/trunk numbers that are programmed with a specific feature. Inspect is helpful when you must assign a feature to many lines/trunks or extensions and you do not have a Direct Station Selector (DSS) attached to the system programming console, or when you are programming a PC with SPM.

Inspect can be used with the menu options which have an asterisk (*) next to them. To use Inspect in system programming, choose an eligible option, and press **Inspct** or **PgDn**.

*The Inspect feature can be used with this menu option. Press **Inspct** or **PgDn**.


Operator
Positions
Direct Line
Queued Call
Queued Call
Hold Timer
Hold Rtrn
RtrnToQue
RmainOnHld
HoldRelease
Threshold
ElvatePrior
InQue Alert
Auto Hold
Auto Release
InQueAlrtEn
InQueAlrtDis
Priority
Operator
Call Types
Msg Center
PrimaryOper
Follow/Frwd
UnassignDID
ListedNumbr
QCC Ext
Returning
GrpCoverage
ExtndComplt
Return Ring
QCC Backup
AutoComplete
ManualComplt
DLC Hold
Auto Hold Enable
Auto Hold Disable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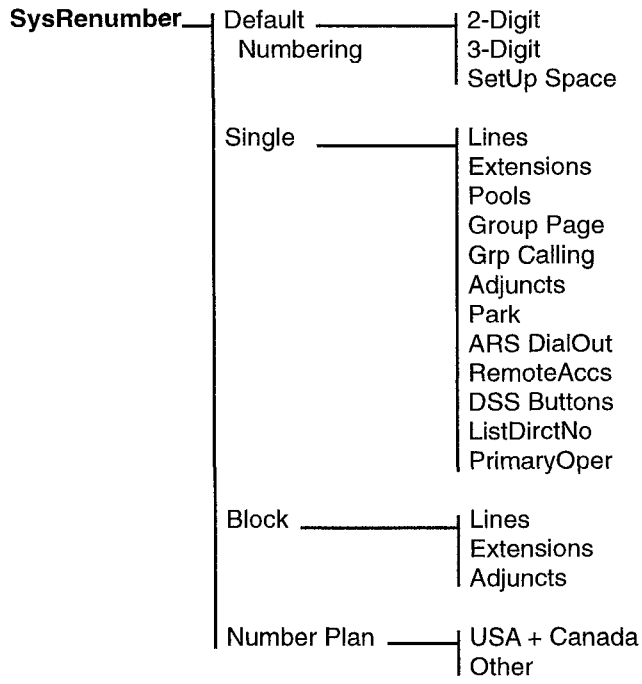
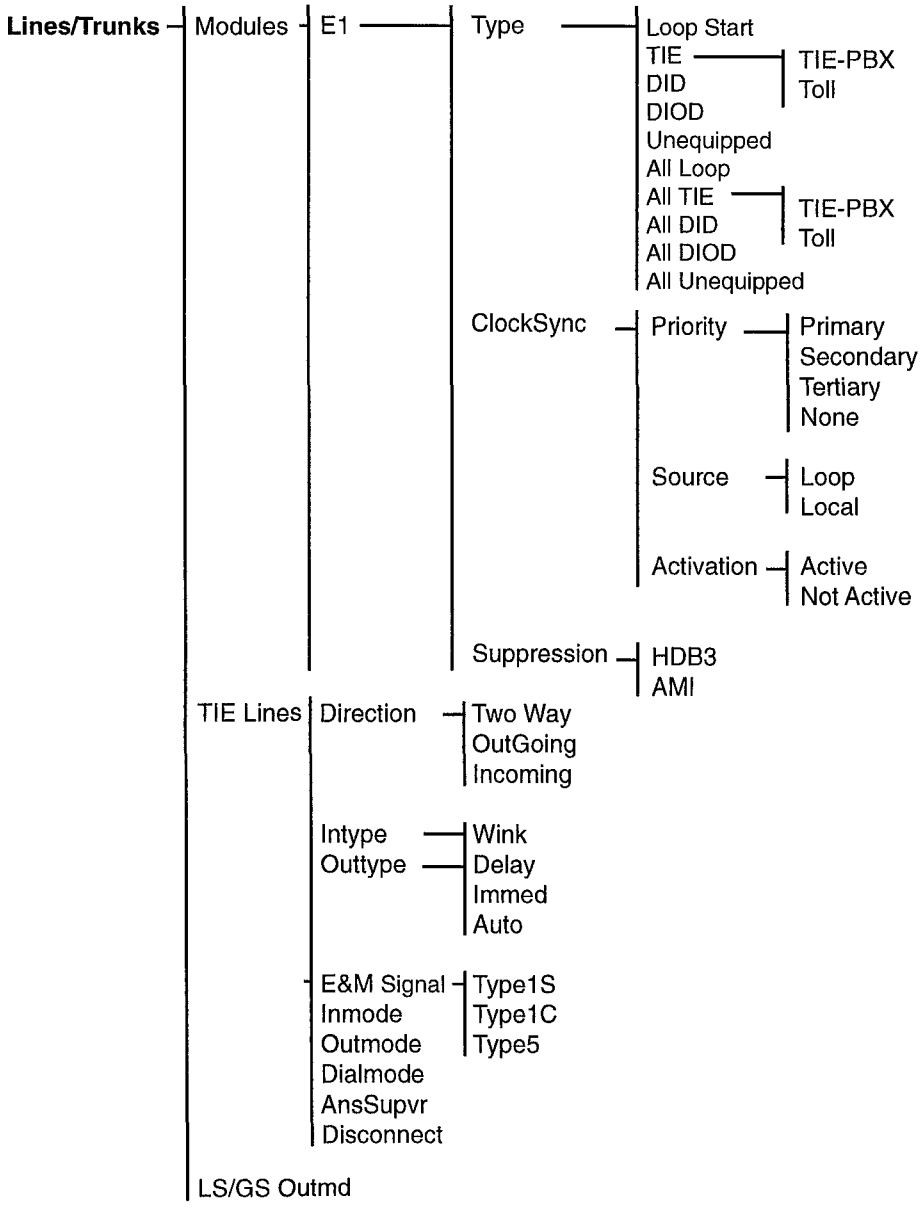
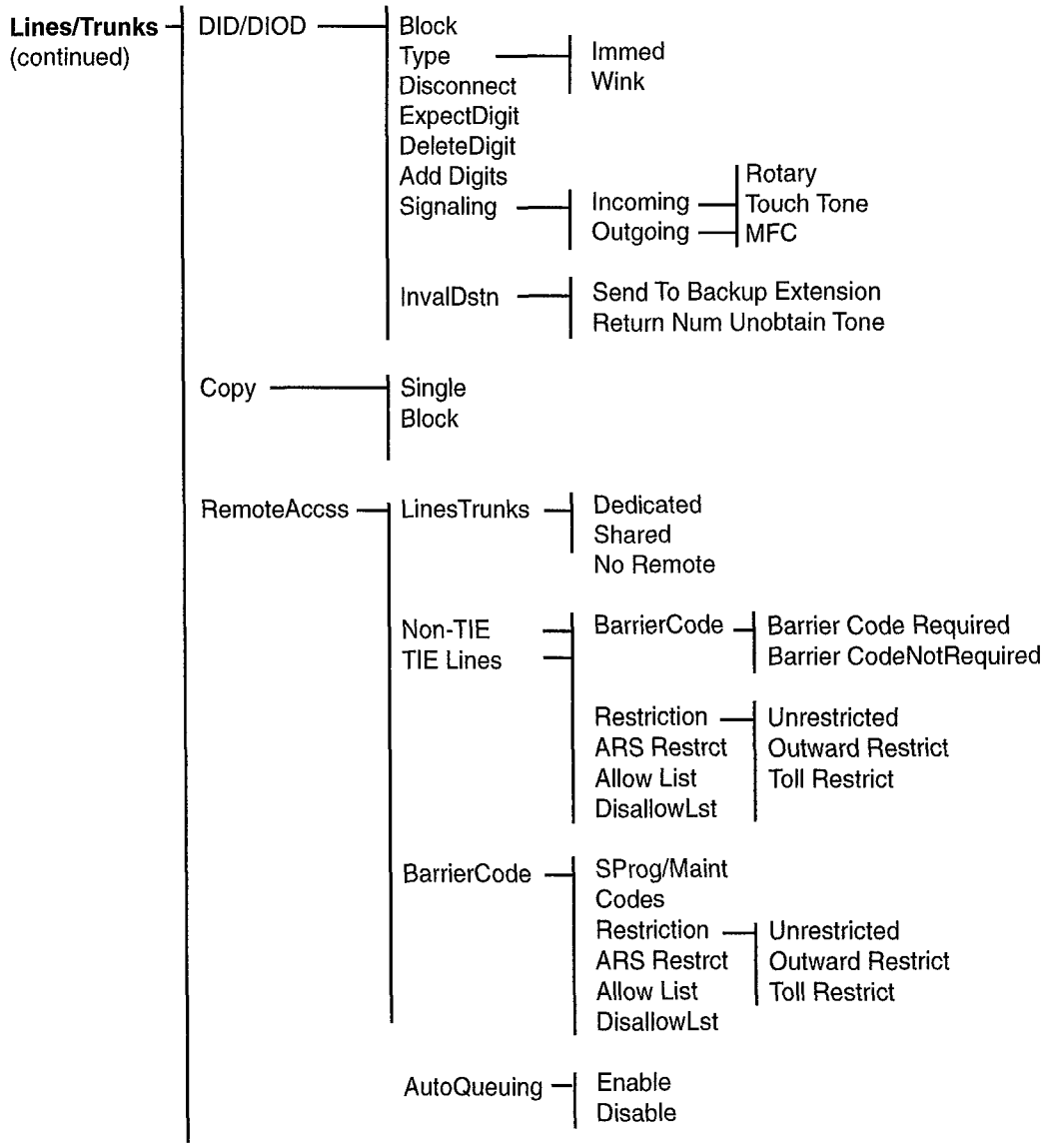
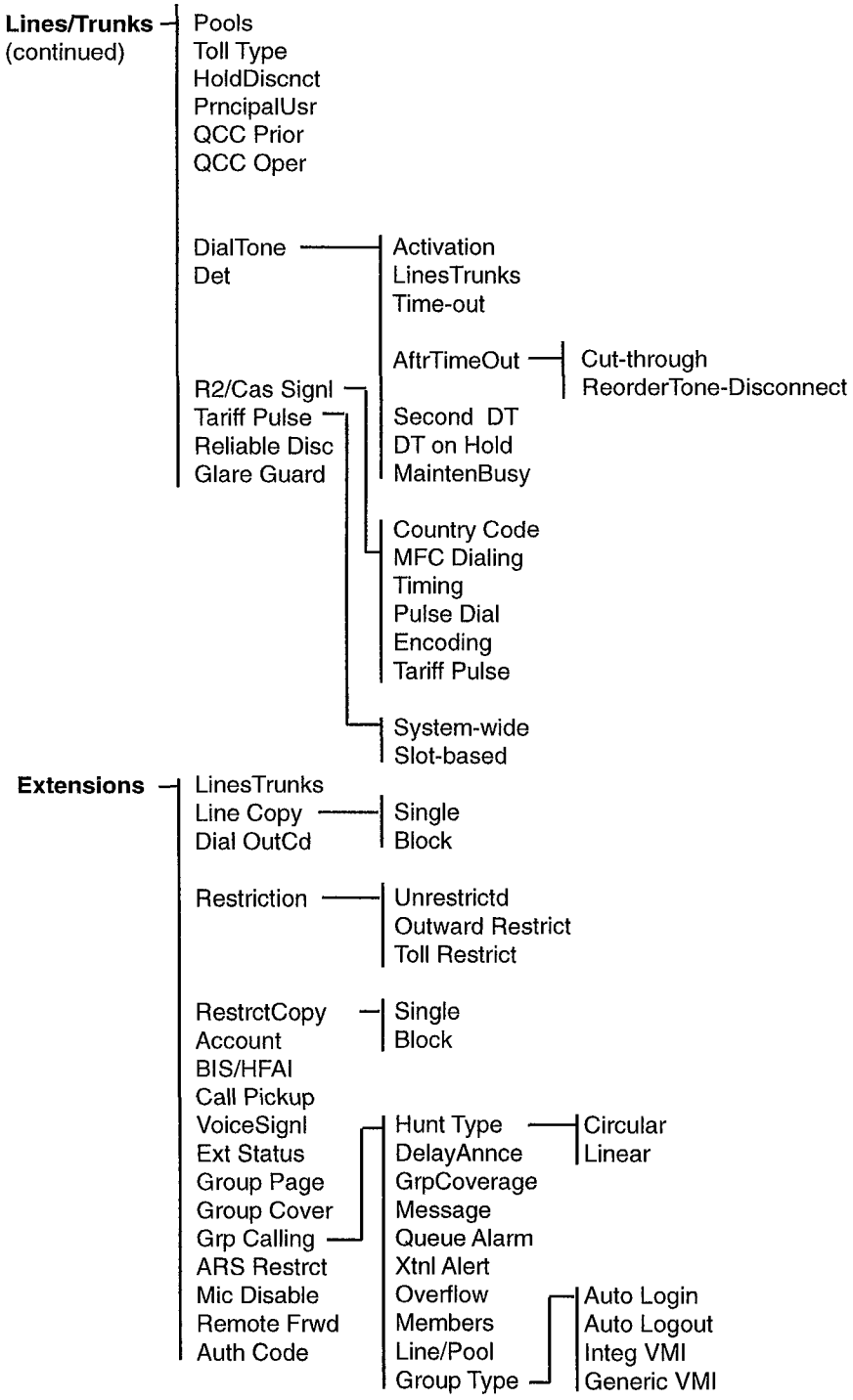
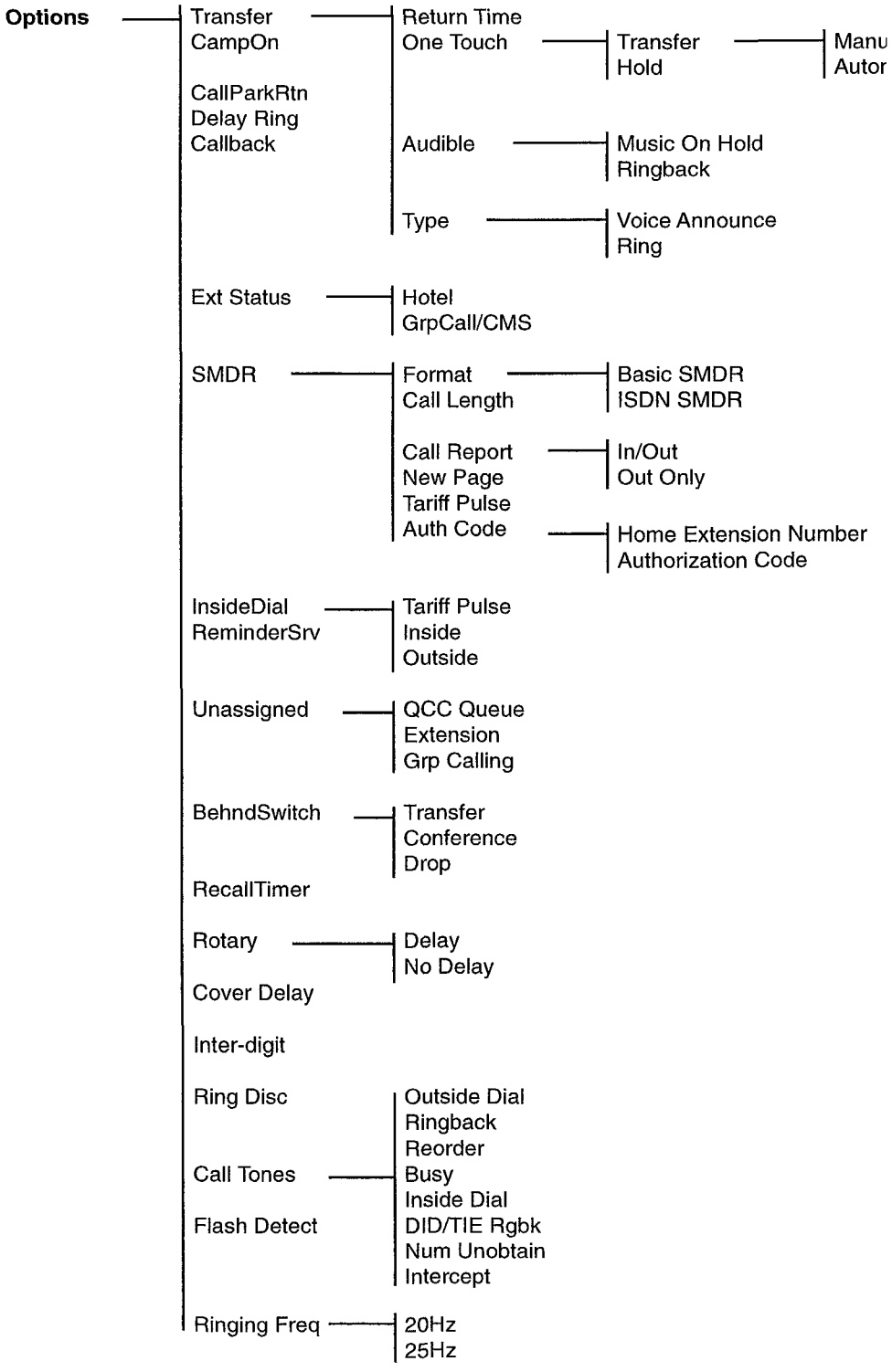
Restart
SProg Port
Mode
Key
Hybrid/PBX
Behnd Swtch
Board Renum
MaintenBusy
Enable
Disable
AutBsy TIETrk
Enable
Disable
Date
Time
CO Interface
Max Trunks
1
2
CO Disc
Short
Long
Break Timer


SysRenumber
Default Numbering
2-Digit
3-Digit
SetUp Space
Single
Lines
Extensions
Pools
Group Page
Grp Calling
Adjuncts
Park
ARS DialOut
RemoteAccs
DSS Buttons
ListDirctNo
PrimaryOper
Block
Lines
Extensions
Adjuncts
Number Plan
USA + Canada
Other


Lines/Trunks
Modules
E1
Type
Loop Start
TIE
TIE-PBX
Toll
DID
DIOD
Unequipped
All Loop
All TIE
TIE-PBX
Toll
All DID
All DIOD
All Unequipped
ClockSync
Priority
Primary
Secondary
Tertiary
None
Source
Loop
Local
Activation
Active
Not Active
Suppression
HDB3
AMI
TIE Lines
Direction
Two Way
OutGoing
Incoming
Intype
Outtype
Wink
Delay
Immed
Auto
E&M Signal
Inmode
Outmode
Dialmode
AnsSupvr
Disconnect
Type1S
Type1C
Type5
LS/GS Outmd


Lines/Trunks (continued)
DID/DIOD
Block
Type
Immed
Wink
Disconnect
ExpectDigit
DeleteDigit
Add Digits
Signaling
Incoming
Outgoing
Rotary
Touch Tone
MFC
InvalDstn
Send To Backup Extension
Return Num Unobtain Tone
Copy
Single
Block
RemoteAccss
LinesTrunks
Dedicated
Shared
No Remote
Non-TIE
TIE Lines
BarrierCode
Barrier Code Required
Barrier CodeNotRequired
Restriction
ARS Restrct
Allow List
DisallowLst
Unrestricted
Outward Restrict
Toll Restrict
BarrierCode
SProg/Maint
Codes
Restriction
ARS Restrct
Allow List
DisallowLst
Unrestricted
Outward Restrict
Toll Restrict
AutoQueuing
Enable
Disable


Lines/Trunks (continued)
Pools
Toll Type
HoldDiscnct
PrncipalUsr
QCC Prior
QCC Oper
DialTone Det
Activation
LinesTrunks
Time-out
AftrTimeOut
Cut-through
ReorderTone-Disconnect
R2/Cas Signl
Tariff Pulse
Reliable Disc
Glare Guard
Second DT
DT on Hold
MaintenBusy
Country Code
MFC Dialing
Timing
Pulse Dial
Encoding
Tariff Pulse
System-wide
Slot-based
Extensions
LinesTrunks
Line Copy
Dial OutCd
Single
Block
Restriction
Unrestrictd
Outward Restrict
Toll Restrict
RestrctCopy
Account
BIS/HFAI
Call Pickup
VoiceSignl
Ext Status
Group Page
Group Cover
Grp Calling
ARS Restrct
Mic Disable
Remote Frwd
Auth Code
Single
Block
Hunt Type
DelayAnnce
GrpCoverage
Message
Queue Alarm
Xtnl Alert
Overflow
Members
Line/Pool
Group Type
Circular
Linear
Auto Login
Auto Logout
Integ VMI
Generic VMI


Options
Transfer
CampOn
CallParkRtn
Delay Ring
Callback
Return Time
One Touch
Transfer
Hold
Manu
Autor
Audible
Music On Hold
Ringback
Type
Voice Announce
Ring
Ext Status
Hotel
GrpCall/CMS
SMDR
Format
Basic SMDR
ISDN SMDR
Call Length
Call Report
In/Out
Out Only
New Page
Tariff Pulse
Auth Code
Home Extension Number
Authorization Code
InsideDial
ReminderSrv
Tariff Pulse
Inside
Outside
Unassigned
QCC Queue
Extension
Grp Calling
BehndSwitch
Transfer
Conference
Drop
RecallTimer
Rotary
Delay
No Delay
Cover Delay
Inter-digit
Ring Disc
Call Tones
Flash Detect
Outside Dial
Ringback
Reorder
Busy
Inside Dial
DID/TIE Rgbk
Num Unobtain
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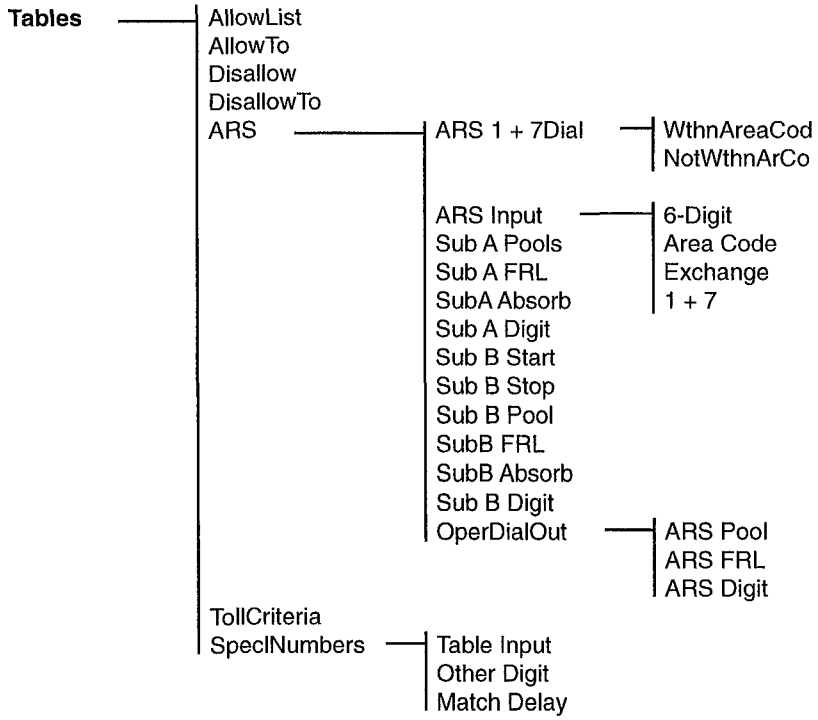
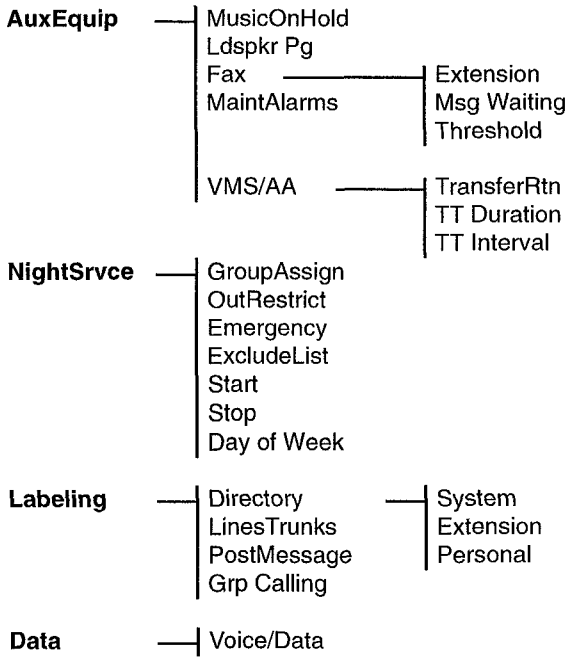
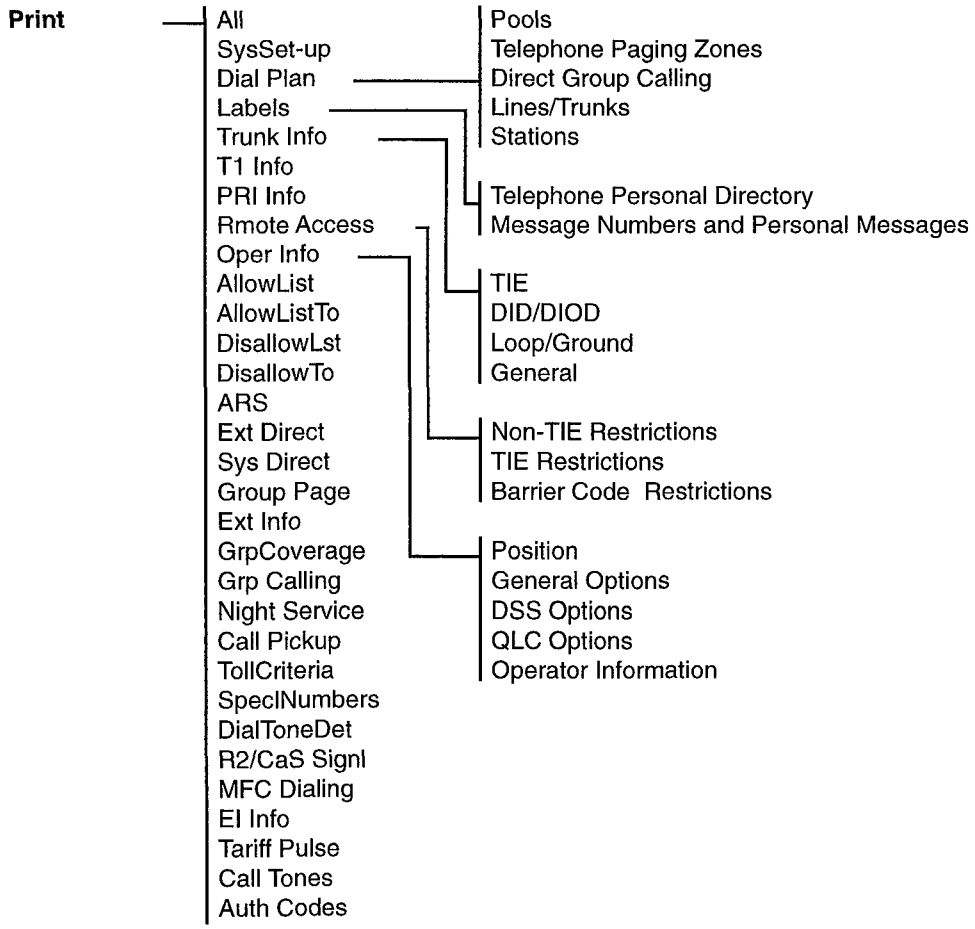
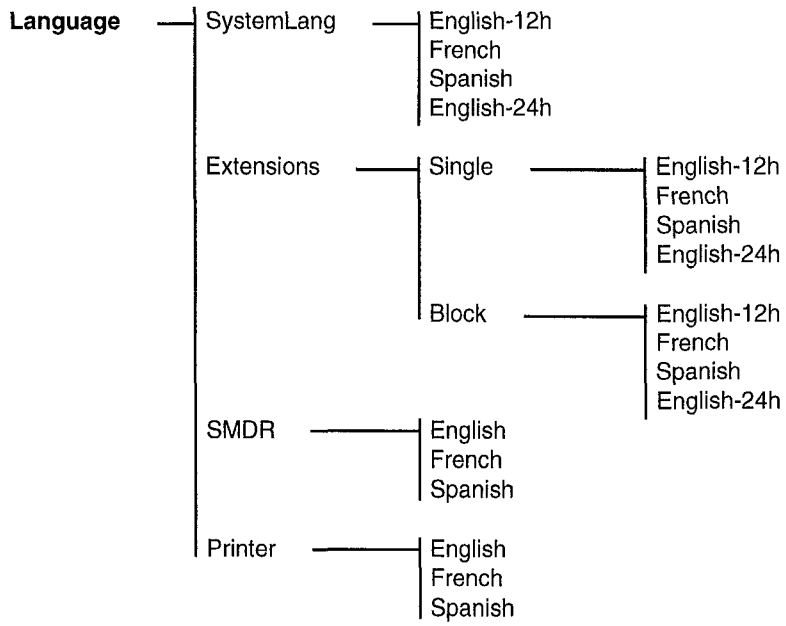

Tables
AllowList
AllowTo
Disallow
DisallowTo
ARS
ARS 1 + 7Dial
WthnAreaCod
NotWthnArCo
ARS Input
6-Digit
Area Code
Exchange
1 + 7
Sub A Pools
Sub A FRL
SubA Absorb
Sub A Digit
Sub B Start
Sub B Stop
Sub B Pool
SubB FRL
SubB Absorb
Sub B Digit
OperDialOut
ARS Pool
ARS FRL
ARS Digit
TollCriteria
SpecINumbers
Table Input
Other Digit
Match Delay


AuxEquip
MusicOnHold
Ldspkr Pg
Fax
Extension
Msg Waiting
Threshold
MaintAlarms
VMS/AA
TransferRtn
TT Duration
TT Interval
NightSrvce
GroupAssign
OutRestrict
Emergency
ExcludeList
Start
Stop
Day of Week
Labeling
Directory
System
Extension
Personal
LinesTrunks
PostMessage
Grp Calling
Data
Voice/Data


Print
All
SysSet-up
Dial Plan
Labels
Trunk Info
T1 Info
PRI Info
Rmote Access
Oper Info
AllowList
AllowListTo
DisallowLst
DisallowTo
ARS
Ext Direct
Sys Direct
Group Page
Ext Info
GrpCoverage
Grp Calling
Night Service
Call Pickup
TollCriteria
SpecINumbers
DialToneDet
R2/CaS Signl
MFC Dialing
EI Info
Tariff Pulse
Call Tones
Auth Codes
Pools
Telephone Paging Zones
Direct Group Calling
Lines/Trunks
Stations
Telephone Personal Directory
Message Numbers and Personal Messages
TIE
DID/DIOD
Loop/Ground
General
Non-TIE Restrictions
TIE Restrictions
Barrier Code Restrictions
Position
General Options
DSS Options
QLC Options
Operator Information

Cntr-Prg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Spanish
English-24h
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French
Spanish
English-24h
Block
English-12h
French
Spanish
English-24h
SMDR
English
French
Spanish
Printer
English
French
Spanish

Numbering Plans

H

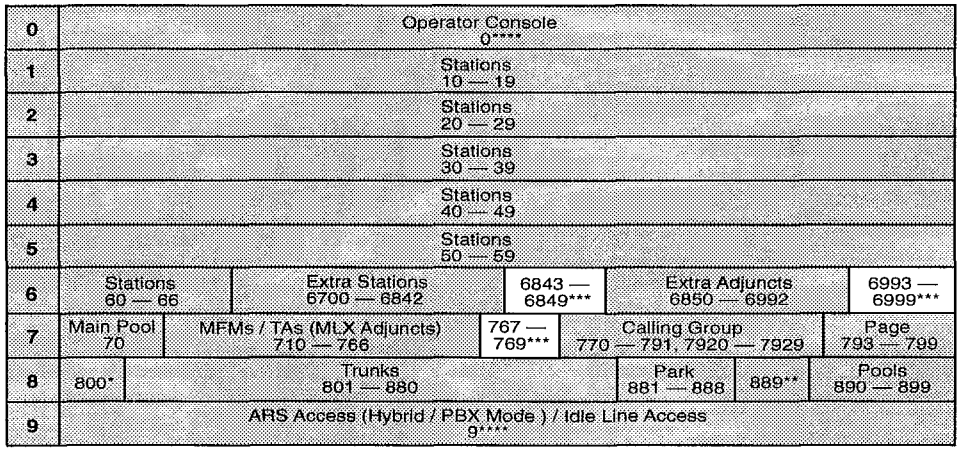
Contents

Numbering Plans

H

Two-Digit Numbering Plan

The two-digit dial plan is intended for mid-size customers. It provides 57 two-digit station numbers (10-66) with the remaining stations numbered 6700-6842. This dial plan is best suited for customers with a station capacity of 57 or less.



* Listed Directory Number (QCC Queue)
** Remote Access
*** Unused in the default Available for renumbering
**** System default Can be changed

Figure H-1. Two-Digit Numbering Plan

The numbers in the figure are arranged in blocks according to the first digit. The type of equipment, jack, or feature to which they are assigned is indicated in the block.

Each of the first 57 station jacks is assigned a two-digit extension number beginning with extension 10 and ending with extension 66. The rest of the stations (67 through 200) are assigned four-digit extension numbers 6700 through 6842. Extra adjuncts are assigned as extensions 6850 through 6992.

The extension numbers shown for MFMs/TAs (710 through 766) are reserved for digital station jacks. These numbers are automatically assigned by the system to ISDN Terminal Adapters (TAs), such as the ExpressRoute 1000 or ISDN 7500B Data Module, or to adjuncts (such as a data terminal, answering machine, or fax) connected to an MLX telephone using a Multi-Function Module (MFM).

For the first 57 digital station jacks, the actual extension number assigned to the adjunct is the extension number assigned to the MLX telephone preceded by a 7. For example, if the extension number assigned for an MLX telephone is 25, the extension number assigned for the adjunct on that telephone is 725. In this example, a call can be placed to the telephone by dialing extension 25 or to the adjunct by dialing 725.

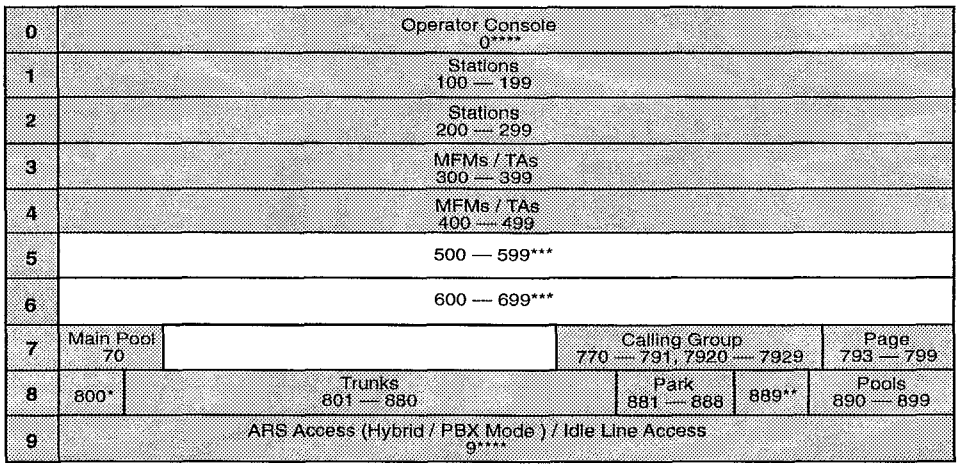
NOTE:
The extension numbers are reserved whether or not an adjunct is connected to an MLX telephone. If you reassign the extension number of the telephone, the system does not automatically change the extension of the MFM or data module.

If the system has fewer than 50 stations and you want to keep the two-digit numbering plan, determine whether any of the numbers that are automatically assigned by the system should be reassigned.

The unshaded areas of the two-digit numbering plan in Figure H-1 show the extension numbers you can reassign. This means that you can change selected extension numbers to one of the available numbers. If the available numbers do not meet your needs, the three-digit numbering plan should be considered.

Three-Digit Numbering Plan

The three-digit dial plan is intended for larger customers. All stations have three-digit station numbers (100-299). This dial plan provides a customer with a consistent set of numbers for all 200 stations in the system. This dial plan is more suitable for a customer using DID trunks as well as MLX adjuncts, as all stations and adjuncts have the same number of digits.



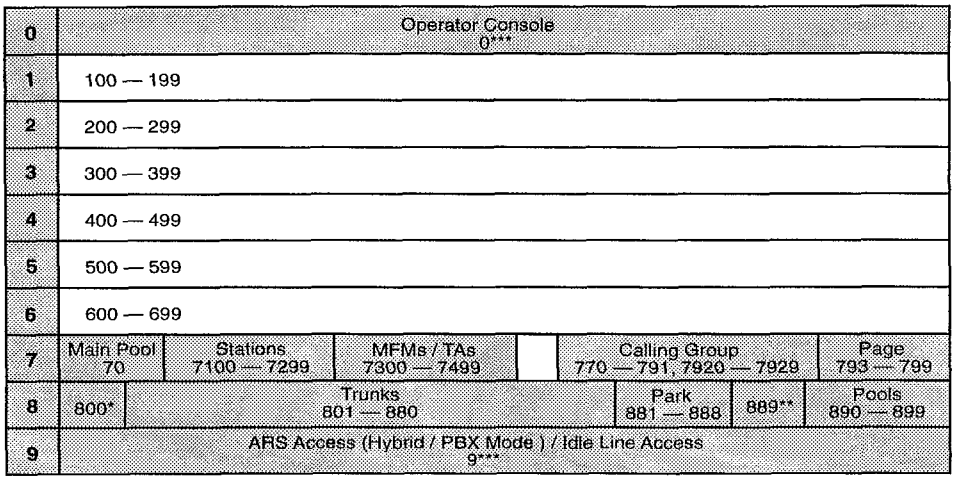
* Listed Directory Number (QCC Queue)
** Remote Access
*** Unused in the default. Available for renumbering
**** System default Can be changed

Figure H-2. Three-Digit Numbering Plan

Set Up Space Numbering Plan

The Set Up Space numbering plan is designed for businesses that want to customize their system numbering plan and assign 1- to 4-digit extension numbers that are more meaningful for the business and/or more convenient for users. As an example, hotels and motels may want to renumber extensions to match room numbers, and to renumber extensions for services (such as Housekeeping or Room Service) to more convenient 1-digit extension numbers.

Figure H-3 shows the numbers automatically assigned when the system is renumbered by using the Set Up Space numbering plan.



* Listed Directory Number (QCC Queue)
** Remote Access
*** System default. Can be changed

Figure H-3. Set Up Space Numbering Plan

The system reassigns extension numbers in the 7000 range for all stations. This makes numbers beginning with 1 through 6 available for use in reassigning extension numbers. These new extensions can be from one to four digits long.

The extension numbers shown for MFMs/TAs (7300 through 7499) are reserved for digital station jacks. These numbers are automatically assigned by the system to adjuncts (such as a data terminal, answering machine, or fax) connected to an MLX telephone using an MFM or ISDN Terminal Adapter (TA). The actual extension number assigned to the adjunct is the extension number assigned to the MLX telephone increased by 200. For example, if the extension for an MLX telephone is 7125, the extension for the adjunct on that telephone is 7325. In this example, a call can be made to the telephone by dialing 7125 or to the adjunct by dialing 7325.

Abbreviations

A	ampere
AC	alternating current
ACD	automatic call distribution
ACW	After Call Work (CMS)
AMI	alternate mark inversion
amps	amperes
ANI	automatic number identification
ARS	Automatic Route Selection
ASI	alternate space inversion
ASN	AT&T Switched Network Services
B8ZS	bipolar 8 zero substitution
BIS	Built-In Speakerphone
bps	bits per second
BTMI	basic telephone modem interface
BTU	British thermal unit
CaS	channel associated signaling
CCITT	Comitee Consultatif Internationale Telephonique et Telegraphique
CCS	common channel signaling
CIB	customer information bulletin
CMS	Call Management System
CO	central office

ComCode	component code
CRC	cyclic redundancy check
CSU	channel service unit
dB	decibel
DC	direct current
DCE	data communications equipment
DCP	Digital Communications Protocol
DFT	direct facility termination
DHG	data hunt group
DID	direct inward dialing
DIOD	direct inward/outward dialing
DIP	dual in-line package
DISA	Direct Inward System Access
DLC	direct-line console
DOS	Disk Operating System
DS0	Digital Signal 0
DS1	Digital Signal 1
DSE	digital switch element
DSS	direct station selector
DTD	dial tone detection
DTE	data terminal equipment
DTMF	dual-tone multifrequency
DXS	direct extension selector
E1	CCITT standard digital CO interface

E&M	ear and mouth (receive and transmit)
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPROM	erasable and programmable read-only memory
ES	Extension Status
ESD	electrostatic discharge
ESF	extended superframe format
ESS	electronic switching system
ETN	electronic tandem network
ETU	emergency transfer unit
F	Fahrenheit
FACE	Forced Account Code Entry
FCC	Federal Communications Commission
FRL	Facility Restriction Level
GPA	General Purpose Adapter
HDB3	High Density Bipolar of order 3
HFAI	Hands Free Answer on Intercom
HFU	hands-free unit
Hz	hertz
ICOM	Intercom
I/O	input/output
IROB	in-range out-of-building
ISDN	Integrated Services Digital Network
ITAC	International Technical Assistance Center

kbps	kilobits per second
LAN	local area network
LDN	listed directory number
LED	light-emitting diode
LS	loop-start
Mbps	megabits per second
MCT	malicious call trace
MET	multibutton electronic telephone
MFC	MultiFrequency Compelled Register Signaling
MFM	Multi-Function Module
MIS	management information system
MOH	Music-on-Hold
modem	modulator-demodulator
ms	millisecond
OPT	off-premises telephone
OPX	off-premises extension
PAM	pulse amplitude modulation
PBX	private branch exchange
PC	personal computer
PCM	pulse code modulation
PEC	price element code
PFT	power failure transfer telephone
PSTN	public switched telephone network
QCC	queued call console

RAM	random access memory
RBS	robbed-bit signaling
REN	ringer equivalency number
ROM	read-only memory
RSC	Regional Support Center
SA	System Access
SAA	Supplemental Alert Adapter
SMDR	Station Message Detail Recording
SPC	system programming console
SPM	System Programming and Maintenance
SSN	Switched Services Network
TA	ISDN terminal adapter
TDM	time-division multiplexing
TEI	terminal equipment identifier
T/R	tip and ring
TPM	Tariff Pulse Metering
TSI	time-slot interchanger
TTR	touch-tone receiver
UDM	universal data module
UPAM	Universal Paging Access Module
UPS	uninterruptible power supply
VA	volt-ampere
VAC	volts AC
VAN	value-added network

VAU	voice announcement unit
VMI	voice messaging interface
W	watts
ZCS	zero code suppression

Glossary

A

access line
A connection from the customer to the local telephone company that provides access to the public network. Also called local loop.

account code
A code used to associate incoming and outgoing calls with corresponding accounts, employees, projects, and clients.

address
A coded representation of the destination of data or of the data's originating terminal, such as the dialed extension number assigned to the data terminal. Multiple terminals on one communications line, for example, must each have a unique address.

adjunct
Optional equipment used with the communications system such as an alerting device that connects to a multiline telephone or to a station jack.

administration port reassignment
Reassignment of the system programming position to any of the first five station jacks on the first 008 MLX module in the communications system control unit.

alternate mark inversion (AMI)
A line coding format in which a binary 1 is represented by a positive or negative pulse, a binary 0 is represented by no line signal, and subsequent binary 1's must alternate in polarity or there will be a bipolar violation. AMI is used in the DS1 interface.

analog transmission
A mode of transmission in which information is represented in continuously variable physical quantities such as amplitude, frequency, phase, or resistance. See also *digital transmission.*

application
Software and/or hardware that allows users to perform specific tasks. For example, the Call Management System (CMS) is a DOS-based application that simulates the actions of a system operator by answering calls and distributing them to individual telephones.

area code
The term "area code" is used to refer to an area code for USA+Canada dial plans, and city and/or country codes for dial plans defined as "other."

asynchronous data transmission
A method of transmitting a short bit stream of data, such as printable characters represented by a 7- or 8-bit ASCII code. Each string of data bits is preceded by a start bit and followed by a stop bit, thus permitting data to be transmitted at irregular intervals. See also *synchronous transmission.*

authorization code
A character string that, when entered on a telephone, allows the user to complete a call as if the call is being made from their own extension using the restrictions that apply to their own telephone rather than the restrictions that apply to the extension from which the call is made.

automatic-ringdown tie trunk
See *automatic-start tie trunk.*

automatic-start tie trunk
A tie trunk on which incoming calls are routed to an operator or other designated destination without a start signal. Also called automatic-ringdown tie trunk or auto-in tie trunk.

auxiliary power unit
A device that provides additional power to the communications system. Available only for systems that use the 391A1 or 391A2 (117 VAC) power supply.

B

bandwidth
The difference, expressed in hertz, between the highest and lowest frequencies in a range of frequencies that determine channel capacity.

barrier code
A password used to limit access to the Remote Access feature of the communications system.

basic carrier
A piece of hardware that holds and connects the processor module; power supply module; and up to five line, trunk, or station modules in the communications system. See also *expansion carrier.*

baud
In telecommunications applications, a unit of transmission speed equal to the number of signal events per second. See also *bit rate* and *bits per second.*

Behind Switch
A mode of operation in which the communications system control unit is connected to (is "behind") another communications system.

binary code
An electrical representation of quantities or symbols expressed in the base-2 number system.

bipolar 8 zero substitution (B8ZS)
A line-coding format that encodes a string of 8 zeros in a unique binary sequence using bipolar violation. See also *bipolar signal* and *bipolar violation.*

bipolar signal
A digital signal in which pulses (1's) alternate between positive and negative. See also *alternate mark inversion, alternate space inversion, bipolar 8 zero substitution,* and *bipolar violation.*

bipolar violation
A condition that occurs when two positive or two negative pulses are received in succession. See also *alternate mark inversion, alternate space inversion, B8 zero substitution,* and *bipolar signal.*

bit (binary digit)
One unit of information in binary notation, having two possible values: zero or one.

bit rate
The speed at which bits are transmitted, usually expressed in bits per second. Also called data rate. See also *baud* and *bits per second.*

bits per second (bps)
The number of binary units of information that are transmitted or received per second. See also *baud* and *bit rate*.

blocking
A condition in which end-to-end connections cannot be made on calls because of a full load on all possible services and facilities.

broadband
A transmission path having a bandwidth greater than a voice-grade channel.

bus
A multiconductor electrical path used to transfer information over a common connection from any of several sources to any of several destinations.

button
A key on the face of a telephone or console that is used to access a line, activate a feature, or enter a code on a communications system.

byte
A sequence of bits (usually eight) processed together. "Octet" is used instead of "byte" in CCITT (International Telegraph and Telephone Consultative Committee) documentation.

C

call accounting system
A vendor-supplied DOS-based application that monitors and manages telecommunications costs.

call accounting terminal
A vendor-supplied stand-alone unit with a built-in microprocessor and data buffer that provides simple call accounting at a low cost.

Callback queue
The queue used to hold Callback callers who have requested a busy pool or extension.

calling group
A team of agents who answer the same types of calls.

Call Management System (CMS)
A DOS-based application that simulates the actions of a system operator by answering and distributing calls. CMS also produces management reports for call analysis.

call progress tone
Any of eight administrable tones (at a particular frequency and cadence) that are sent by the MERLIN LEGEND system to the central office and/or far-end/MERLIN LEGEND user (depending upon who initiated the call). The eight administrable tones are: inside dialtone, outside dialtone, ringback, DID/TIE ringback, reorder, number unobtainable, busy, and intercept.

campus cable
Cable that runs between buildings connected to the same communications system.

central office (CO)
The location of telephone switching equipment that provides local telephone service and access to toll facilities for long-distance calling.

central processor
The part of a computer that interprets and executes instructions. Also called central processing unit.

Centrex
A set of communications system features a user can subscribe to on telephone lines from the local telephone company.

channel
A telecommunications transmission path for voice and/or data.

channel associated signaling (CaS)
Channel Associated Signaling (CaS) is a form of line signaling whereby all signaling information for 30 channels is packed into a single channel, typically channel 17 for E1 modules.

channel service unit (CSU)
Equipment used at a customer's premises to provide DS1 facility terminations and signaling compatibility.

checksum
The sum of ones in a sequence of ones and zeros to detect or correct errors in data transmission.

circuit-switched data call
A data call made via a connection exclusively established and maintained between data stations for the duration of the data call.

clock synchronization
The operation of digital facilities from a common clock.

coaxial cable
A cable consisting of one conductor, usually a small copper tube or wire, within and insulated from another conductor of large diameter, usually copper tubing or copper braid.

codec (coder-decoder)
A device used to convert analog signals such as speech, music, or television to digital form for transmission over a digital medium and back to the original analog form.

CO line/trunk jack
A jack that connects an outside line/trunk to the communications system control unit.

common-channel signaling (CCS)
Signaling in which one channel of a group of channels carries signaling information for each of the remaining channels, permitting each of the remaining channels to be used to nearly full capacity. In the system's DS1 module, channel 24 can be designated as the signaling channel for channels 1-23 by selecting "common channel" for emulated service when programming the system.

communications system
The software-controlled processor complex that interprets dialing pulses, tones, and/or keyboard characters and makes the proper interconnections both inside and outside the system. The communications system itself consists of a digital computer, software, a storage device, and carriers with special hardware to perform the actual connections. A communications system provides voice and/or data communications services, including access to public and private networks, for telephones and data terminals on a customer's premises.

companding
The compression or expansion of the quantizing scale to reduce distortion. See also *quantizing.*

control unit
The housing, carriers, power supply module, processor module, and line/trunk and station modules of a communications system.

conversion resource
See *modem pool.*

cyclic redundancy check (CRC)
An error-detection code used on DS1 facilities with the extended superframe framing (ESF) format.

D

D4 framing format
A framing format consisting of a sequence of individual frames of 24 eight-bit slots and 1 signal bit (193 bits) in a 12-frame superframe. See also *extended superframe format.*

data communications equipment (DCE)
Equipment such as modems or ISDN Terminal Adapters used to establish, maintain, and terminate a connection between the communications system and data terminal equipment (DTE), such as printers, host computers, or workstations.

data hunt group (DHG)
A group of analog or digital data stations that share a common access code. Calls are connected in a round-robin fashion to the first available data station in the group.

data rate
See *bit rate.*

data terminal
An input/output (I/O) device that can be connected to the communications system control unit via an interface.

data terminal equipment (DTE)
The equipment that makes up the endpoints in a connection over a data circuit — for example, a data terminal, host computer, or printer.

dedicated feature buttons
The imprinted feature buttons on a telephone: Conf or Conference, Drop, HFAI (Hands Free Answer on Intercom), Hold, Mute or Microphone, Speaker or Speakerphone, Transfer, Message, and Recall.

delay-dial-start tie trunk
A type of tie trunk on which the originating end of the tie trunk transmits an off-hook signal to the receiving end and waits for the receiving end to send an off-hook signal followed by an on-hook signal. Also called a dial-repeating tie trunk.

dial access
See *feature code.*

dial tone detection
Dial Tone Detection (DTD) addresses the problem of slow dial tone from the exchange by assuring that dial tone is present from the exchange before outdialing digits. Slow dial tone occurs when the exchange takes longer than three seconds to provide dial tone to a caller.

dial-out code
A code (usually a 9) dialed by single-line telephone users and multiline telephone users with System Access (SA) buttons to get an outside line.

DID (direct inward dialing) trunk
An incoming trunk that receives dialed digits from the local exchange, allowing the communications system to connect directly to a station without assistance from the system operator.

DIOD (direct inward/outward dialing) trunk
Similar to a DID trunk, DIOD trunks also allow outgoing calls.

digital
The representation of information in discrete elements such as off and on or 0 and 1. See also *analog transmission*.

Digital Communications Protocol (DCP)
An AT&T proprietary protocol to transmit both digitized voice and data over the same communications link. A DCP link is made up of two 64-kbps information (I) channels and one signaling (S) channel.

digital switch element (DSE)
A device in each jack on each module in the communications system control unit that interfaces with the TDM (time-division multiplex) bus.

digital transmission
A mode of transmission in which the information to be transmitted is first converted to digital form and then transmitted as a serial stream of pulses. See also *analog transmission*.

DIP (dual in-line package) switch
A switch on a 400EM module used to select the signaling format for tie-line transmission. DIP switches are also used on other equipment for setting hardware options.

direct facility termination (DFT)
A central office (CO) line/trunk that terminates directly on one or more telephones; in PBX mode a DFT cannot be part of a trunk pool.

direct inward dialing (DID)
A service that transmits the called station number to the communications system from the central office (CO) and routes incoming calls directly to the called station, calling group, or outgoing trunk pool, bypassing the system operator.

direct inward/outward dialing (DIOD) trunk
Similar to a DID trunk, DIOD trunks also allow outgoing calls.

Direct Station Selector (DSS)
A 60-button adjunct that enhances the call-handling capabilities of an MLX-20L telephone or MLX-28D telephone when used as an operator console.

display buttons
The buttons on an MLX display telephone used to access the telephone's display.

door answering unit
A device that is connected to a basic telephone jack and used at an unattended station or front desk.

DS0 (Digital Signal 0)
A single 64-kbps voice or data channel.

DS1 (Digital Signal 1)
A bit-oriented signaling (BOS) interface that multiplexes 24 64-kbps channels into a single 1.544-Mbps stream.

dual-tone multifrequency (DTMF) signaling
Touch-tone signaling from telephones using the voice transmission path. The code for DTMF signaling provides 12 distinct signals, each composed of two voice-band frequencies.

E

E1
E1 is a CCITT standard Central Office interface operating at 2.048 Mbps and capable of supporting 30 channels per link with two additional channels for signaling. An E1 facility is a digital transmission system that transports voice and analog data signals in the E1 format.

E and M signaling
Trunk supervisory signaling, used between two communications systems, in which signaling information is transferred through two-state voltage conditions (on the E and M leads) for analog applications and through two bits for digital applications. Used in tie trunks.

EIA (Electronic Industries Association)
A trade association of the electronics industry that establishes electrical and functional standards.

electronic switching system (ESS)
A class of modern switching central office (CO) systems developed by AT&T in which the control functions are performed principally by electronic data processors operating under the direction of a stored program.

endpoint
The final destination in the path of an electrical or telecommunications signal.

expansion carrier
A carrier added to the control unit when the basic carrier cannot house all the modules needed. An expansion carrier houses a power supply module and up to six additional line/trunk and station modules.

ExpressRoute 1000
A data communications device that allows connection between RS-232 data terminal equipment (DTE) and the communications system control unit via MLX station jacks on the 008 MLX module. The ExpressRoute 1000 can be used together with a modem in a modem pool to change digital data signals to analog signals, and vice versa, which allows transmission between digital and analog data stations.

extended superframe format (ESF)
A framing format consisting of individual frames of 24 eight-bit slots and 1 signal bit (193 bits) in a 24-frame extended superframe. See also *D4 framing format.*

F

facility
The equipment constituting a telecommunications path between the communications system and the central office (CO).

factory setting
The default state of a device or feature if the user does not choose an optional setting.

fax (facsimile)
A process or the result of a process in which graphic material is scanned and the information converted into electrical signal waves to produce an exact likeness.

feature
A function or service provided by a hardware or software product.

feature code
A code entered on a dialpad to activate a feature. For example, a user might press the feature button or might dial #33.

Feature screen
A display screen on MLX display telephones that provides quick access to commonly used features.

flash detection
A feature that detects administrable lengths of switchhook flashes. This feature works best when telephones with a fixed flash and telephones with variable flash are connected to modules in separate slots.

foil shield
A copper foil sheet for power units on expansion carriers that is used to prevent excessive noise on the module immediately to the right of the power supply module in each expansion carrier.

frame
One of several segments of an analog or digital signal that has a repetitive characteristic. For example, a DS1 frame consists of a framing bit and 24 octets, which equals 193 bits.

frequency generator
A circuit pack added to the power unit module that generates a high-voltage, 20-Hz signal to ring a telephone. Also called a ring generator.

G

General Purpose Adapter (GPA)
A device that connects an analog multiline telephone to optional equipment such as an answering machine or a fax machine.

glare
The event of going off-hook to make an outgoing call and being connected to an incoming call (without any ringing/alerting to the MERLIN LEGEND user). Caused by the simultaneous access of the same trunk by the Central Office and the MERLIN LEGEND user.

glare guard
Specifies an interval at the end of a call during which incoming calls are given preference over outgoing calls. This reduces the probability of glare.

H

headset
An ultralight earpiece and microphone for hands-free telephone operation.

Home screen
The "home base" of the display screen on MLX telephones, which shows time, date, and call information, and when a feature is in use.

house cable
Cable that runs from the equipment room to a small, walk-in closet (called a satellite closet) elsewhere in the building.

Hybrid/PBX
A mode of operation in which the communications system uses trunk pools and Automatic Route Selection (ARS) in addition to personal lines — that is, direct facility terminations (DFTs) on line buttons. The Hybrid/PBX mode also provides a single interface to users for both internal and external calling.

I

immediate-start tie trunk
A tie trunk on which no start signal is necessary and dialing can begin immediately after the tie trunk is seized.

in-band signaling
See *robbed-bit signaling.*

inside dial tone
A tone the user hears when they are connected to an intercom line.

Inspect screen
A display screen on MLX telephones that allows users to preview incoming calls and see a list of the features programmed on line buttons.

interface
Hardware, software, or both that links systems, programs, or devices.

I/O (input/output) device
Equipment that can be attached to a computer internally or externally for managing a computer system's input and output of information.

IROB (in-range out-of-building) protector
A surge protection device for off-premises telephones at a location within 305 meters (1000 feet) of cable distance from the communications system control unit.

ISDN 7500B Data Module
A data communications device that allows connection between RS-232 data terminal equipment (DTE) and the communications system control unit via MLX station jacks on the 008 MLX module. The ISDN 7500B Data Module is used together with a modem in a modem pool to change digital data signals to analog signals, and vice versa, which allows transmission between digital and analog data stations.

ISDN terminal adapter
A data communications device (such as the ExpressRoute 1000 or ISDN 7500B Data Module) that allows connection between RS-232 data terminal equipment (DTE) and the communications system control unit via MLX station jacks on the 008 MLX module. The ISDN Terminal Adapter can be used together with a modem in a modem pool to change digital data signals to analog signals, and vice versa, which allows transmission between digital and analog data stations.

J

jack
A device, accessed by inserting a plug, that is used to terminate the permanent wiring of a circuit.

K

Key
A mode of operation in which the communications system uses direct facility terminations (DFTs) on line buttons with a separate path for internal calling.

L

LED (light-emitting diode)
A semiconductor device that produces light when voltage is applied. LEDs show the operational status of hardware components, the results of maintenance tests, the alarm status of circuit packs, and the activation of telephone features.

line and trunk assignment
The assignment of lines and trunks connected to the communications system control unit to specific buttons on each telephone.

line coding
The pattern data assumes as it is transmitted over a communications channel.

line compensation
An adjustment for the amount of cable loss in decibels (dBs), based on the length of cable between a DS1 module and a channel service unit (CSU) or other far-end connection point.

line/trunk and station module
A module on which the jacks for connecting central office (CO) lines/trunks and/or the jacks for connecting the stations are located.

local area network (LAN)
A networking arrangement designed for a limited geographical area.

local host computer access
A method for connecting a station jack to an on-site computer for data-only calls through a modem or ISDN Terminal Adapter.

logical ID
A numbering sequence used to identify station and line/trunk locations on the communications system control unit.

loop-start (LS) line/trunk
A line/trunk on which a closure between the tip and ring leads is used to originate or answer a call. High-voltage 20-Hz AC ringing from the central office (CO) signals an incoming call.

M

Magic-on-Hold
A customized Music on Hold (MOH) system enhancement that promotes the customer's products and services.

MERLIN LEGEND Attendant
An application with equipment that connects to one or more tip/ring station ports and automatically answers incoming calls with a recorded announcement. In response to touch-tone digits dialed by the caller, MERLIN LEGEND Attendant directs the caller to a department, an extension, or the system operator.

MERLIN MAIL Voice Messaging System Multi-Lingual Version
An application that provides automated attendant, call answering, and voice-mail services on the communications system.

MLX-10/MLX-10D telephone
A 10-button telephone offered with or without a 2-line by 24-character, menu-driven display.

MLX-20L telephone
A telephone with 20 programmable line or feature buttons and a 7-line by 24-character, menu-driven display.

MLX-28D telephone
A telephone with 28 programmable line or feature buttons and a 2-line by 24-character, menu-driven display.

modem
A device that converts digital data signals to analog signals for transmission over telephone lines. The analog signals are converted back to the original digital data signals by another modem at the other end of the line.

modem pool
A pair, or group of pairs, of modems and ISDN Terminal Adapters with interconnected RS-232 interfaces that converts digital signals to analog, or analog signals to digital, thereby allowing users with digital data stations to communicate with users who have analog stations.

MultiFrequency Compelled Register Signaling
MultiFrequency Compelled (MFC) Register Signaling is a call setup protocol commonly used over E1 facilities. MFC Register Signaling is part of the R2 Signaling System and uses multifrequency tones (created by combining two frequencies) as call setup signals to establish a call.

Multi-Function Module (MFM)
An adapter that provides a tip/ring interface for the connection of optional equipment such as answering machines, external alerts, and fax machines to a MLX telephone. The optional equipment and the MLX telephone operate simultaneously and independently. The MFM is installed inside the MLX telephone.

multiplexing
A process in which a transmission channel is divided into two or more channels, either by splitting the frequency band into a number of narrower bands or by dividing the channel into successive time slots.

Music on Hold (MOH)
Magic-on-Hold or a customer-provided music source connected to the communications system via a loop-start (LS) jack. Most MOH equipment is designed for LS operation.

N

network
A configuration of communications devices and software connected for information interchange.

network interface
Hardware, software, or both that links two systems in an interconnected group of systems, for example, between the local telephone company and a PBX.

O

off-premises telephone
A telephone located in a building other than where the control unit is located.

ones density
The requirement for channelized DSI service to the public network that eight consecutive zeros cannot be in a digital data stream.

outcalling
A feature of the MERLIN MAIL Voice Messaging System application. When outcalling is activated, the user is automatically called by the system at a programmed number when a new message is received in his or her mailbox.

out-of-band signaling
Signaling that uses the same path as voice-frequency transmission and in which the signaling is outside the band used for voice frequencies.

P

parity
The addition of a bit to a bit string so that the total number of 1's is odd or even. Parity can be used to detect and correct transmission errors.

pass through
A connection from an internal modem to a programming port on the communications system.

periodic pulse metering
See Tariff Pulse Metering.

personal line
A central office (CO) line that rings only at the user's telephone.

pool
On a Hybrid/PBX system, a grouping of outside trunks that users can choose with multiple pool buttons or by dialing access codes on an SA (System Access) button on the telephone. Pools are also used by the Automatic Route Selection (ARS) feature to choose the cheapest method to route a call.

port
A point of access into a communications system, computer, network, or other electronic device.

power supply module
A device that directs electricity to modules and telephones on the communications system. One power supply module is needed for each carrier.

prime line
An individual extension number assigned to a telephone in a Behind Switch system. Each telephone user has his or her own prime line and is automatically connected to that line when he or she lifts the handset.

processor module
The module in the second slot of the basic carrier that contains the software that runs the communications system.

protocol
A set of conventions governing the format and timing of message exchanges between devices, such as a multiline telephone and the communications system control unit.

public network
A network that is commonly accessible for local or long-distance calling. Also called public switched telephone network (PSTN).

pulse amplitude modulation (PAM)
A modulation technique in which an analog signal, such as speech, modulates a carrier signal consisting of a series of precisely timed pulses of equal amplitude. See also *pulse code modulation.*

pulse code modulation (PCM)
An extension of pulse amplitude modulation (PAM) in which each PAM pulse is quantized and encoded into a 8-bit code to represent the amplitude of each PAM pulse. See also *pulse amplitude modulation.*

Q

quantizing
The process of converting a pulse amplitude modulation (PAM) sample into a discrete number of amplitude values.

R

R2 Signaling System
The R2 Signaling System is a CCITT signaling protocol comprised of line signaling (supervisory signals) and register signaling (call setup signals) used over digital E1 facilities for incoming (DID, DIOD, Loop Start, TIE) and outgoing (DIOD, TIE, Loop Start) calls.

RAM (random access memory)
Computer memory in which an individual byte or range of bytes can be addressed and read or changed without affecting other parts of the memory.

reliable disconnect
The Reliable Disconnect option enables you to specify which trunks always receive open-loop current from the exchange. Any trunk where the exchange *always* provides open-loop current as the disconnect signal is considered "reliable."

ring disconnect timer
The Ring Disconnect Timer enables you to set a system-wide time interval for calls on trunks that do not have Reliable Disconnect.

riser cable
Cable that runs between floors in a multistory building and connects wire closets.

robbed-bit signaling (RBS)
Signaling in which the least significant bit (LSB) of every sixth frame per channel is used for signaling in that channel.

ROM (read-only memory)
Computer memory that can be read but cannot be changed.

RS-232
A physical interface, specified by the EIA (Electronics Industries Association), that transmits and receives asynchronous data at speeds of up to 19.2 kbps over cable distances of 15 meters (50 feet.)

S

signaling
The sending of control and status information between devices to set up, maintain, or take down a connection.

simplex signaling
The transmission of signals in one direction only across a telecommunications channel.

single-line telephone
An industry-standard, touch-tone or rotary telephone that only handles one line/trunk and is connected to the communications system via a jack on a basic telephone module.

SMDR printer
A printer used for Station Message Detail Recording (SMDR) that is connected to the communications system via an RS-232 jack on the processor module.

special character
A pause, stop, or end-of-dialing signal in a programmed dialing sequence such as an Auto Dial or Personal Speed Dial number.

Square Key
A way of configuring the communication system in Key mode so that all lines appear on all telephones.

station
The endpoint on the station side of the communications system. A station can be a telephone with or without an adjunct or can be a data terminal with a modem (analog) or an ISDN Terminal Adapter (digital) attached.

station jack
An analog, digital, or tip/ring (T/R) interface on the control unit module for connecting telephones and other equipment.

Supplemental Alert Adapter (SAA)
A device that permits alerting equipment to be connected to an analog multiline telephone jack so that people working in noisy or remote areas of a building can be alerted to incoming calls.

switched service network (SSN)
A network consisting of terminals, transmission lines, and at least one exchange on which a user can communicate with any other user at any time.

switchhook flash
Operation of the telephone switchhook in which the on-hook period is in the range of 100-1200ms.

synchronous
A method for transmitting a continuous digital data stream in which the transmission of each binary bit is synchronized with a master clock.

system acceptance test
A test of all trunks, telephones, data terminals, and features after installation to ensure they are working correctly.

system date
The date that appears on display telephones and Station Message Detail Recording (SMDR) reports.

System Programming & Maintenance (SPM)
A DOS-based application for programming and maintaining the communications system.

system renumbering
A process used to change the extension numbers assigned to stations, adjuncts, calling groups, paging groups, Call Park zones, and Remote Access.

system time
The time that appears on display telephones and is printed on Station Message Detail Recording (SMDR) reports.

T

T1
A digital transmission carrier path that in North America transmits at the DS1 rate of 1.544 Mbps.

tariff pulse metering
Method by which the PSTNs in some countries assess incoming and outgoing call charges. Sometimes referred to as Periodic Pulse Metering (PPM).

telephone power supply unit
Equipment that provides power to an individual telephone.

tie trunk
A private line directly connecting two communications systems together.

time-division multiplexing (TDM)
A process where the transmission channel is divided.

timer
A built-in timing device in a display telephone.

time-slot interchanger
An element of a time-division switching network that separates and switches time-division multiplexed (TDM) signals.

tip/ring (T/R)
The contacts and associated conductors of a single-line telephone plug or jack.

touch-tone gate
An operation used to determine if a call is from a touch-tone or rotary telephone.

touch-tone receiver (TTR)
A device used to decode touch-tones dialed from single-line telephones or Remote Access telephones.

translation
The information used to identify a particular user with a particular telephone.

U

uninterruptible power supply (UPS)
A device that connects to the communications system to provide backup power to the equipment when the commercial power source fails.

unit load
A measure of the power load drain of a module, telephone, or adjunct.

V

voice-band channel
A transmission channel, generally the 300frequency band.

voice-only
A station that is set up for making and receiving voice calls but not data calls.

W

wink-start tie trunk
A tie trunk on which the originating end transmits an off-hook signal and waits for the remote end to send back a signal (a wink) that it is ready for transmission.

Z

zero code suppression (ZCS)
A binary coding scheme that ensures a data stream contains at least a minimum number of information bits (1's) for receiver synchronization.

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