

LocalNet 20™

**Reference Manual
and
Installation Guide**



LocalNet 20

REFERENCE MANUAL AND INSTALLATION GUIDE

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This document describes the architecture, principal features, operating characteristics, equipment, and interfaces of the LocalNet packet communications system. Installation and troubleshooting information is provided.

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The LocalNet 20 Reference Manual and Installation Guide contains *six* chapters and *seven* appendices. The *first* chapter introduces LocalNet and two of its fundamental features:

- broadband CATV data distribution and
- *the intelligent network* — LocalNet's approach of incorporating required communications protocols and processing in each LocalNet packet communication unit (PCU).

The *second* chapter provides a general description of the LocalNet system and introduces the basic concepts embodied in all LocalNet products. The *third* chapter describes the particular capabilities and features of the LocalNet 20 PCU. The *fourth* chapter describes each command provided by the PCU to its

attached user devices. A description of each command, including its function, arguments, and possible error conditions, is provided. Commands are listed alphabetically.

The *fifth* chapter is directed toward the installer of the LocalNet and, in particular, the LocalNet 20 PCU. This chapter starts with the unpacking of the PCU; the connection of the terminal, PCU, cable, and power; and the initial power-up. Initial testing is also discussed here; part of these tests can be used if troubleshooting becomes necessary.

The *sixth* chapter discusses troubleshooting, and offers some ways to analyze what may be wrong if the terminal and PCU do not seem to be working properly.

The manual concludes with seven appendices.

A QUICK GUIDE TO USING THE REFERENCE MANUAL AND INSTALLATION GUIDE

The following is a quick guide to the *Reference Manual and Installation Guide* for the LocalNet 20 packet communication units, the 20/100 and the 20/200. Because of the long title, *Reference Manual and Installation Guide*, it is referred to simply as "the manual." The information presented in the manual is directed toward a wide range of readers and uses. The quick guide points out sections related to specific applications of the manual and the packet communication units (PCUs). We hope that you will find the other sections of general interest and use.

All readers need to be aware of the differences between *command mode* and *data transfer mode*, and how to get out of command mode. For this information, see Chapter 3.

Appendix A describes the messages generated by the LocalNet 20 PCU. This section is useful for all readers.

For keyboard data entry, Chapter 4 will help you set up and end a connection, list the commands, check the status of your connection to the LocalNet, and switch between connections to other devices attached to the LocalNet. You may also find the glossary of LocalNet and data communication terms useful (Appendix B: Glossary).

For system management, Chapter 2 provides an overview of LocalNet's architecture and communication protocols. Chapter 3 provides detailed data on how the LocalNet 20 PCU works. PCU commands are discussed in Chapter 4, and Appendix F shows how to read a PCU's label to determine which options are implemented in that PCU.

For system maintenance, read Chapter 2 for background on LocalNet's architecture and communication protocols, Chapter 4 for commands, and Chapter 6 for troubleshooting. Appendices C, D, E, and F provide detailed technical information on the pins, specifications, flow control, and PCU labels.

For installing a LocalNet, or adding PCUs to an existing LocalNet, Chapter 5 offers a step by step guide to checking out a newly received LocalNet 20 PCU, and attaching it to the LocalNet and to a user device. It also shows how to set the attributes described in detail in Chapter 3. This includes the attributes that are common to all user devices and their sessions, the ones which are specific to one of the PCU's ports, and the ones which control the port's data-handling characteristics. Chapter 4 lists all the commands which can assist in matching the PCU to its user device. Commands controlling *autobaud*, *status*, *location*, and *unit* will be of special interest.

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This manual is designed to help you make the best use of Sytek's LocalNet* data communication network. This chapter presents the background for LocalNet; subsequent chapters define the features and use of the LocalNet 20 packet communication unit (PCU).

LOCALNET: A BROADBAND LOCAL AREA DATA COMMUNICATION NETWORK

LocalNet is an integrated, local area data communication network serving not only future intelligent workstations, but also the substantial installed base of interactive terminals, timeshared computer systems, and minicomputers which comprise today's data networks. Integrating the technologies of wideband broadcast local networks, packet switching, and cable television (CATV), LocalNet provides services inexpensively enough for today's needs but with the flexibility required for future applications. The generality of the LocalNet system enables it to serve efficiently a wide range of user applications, among them timesharing networks, management information systems, and integrated office communication systems. The particular advantages of the broadband communication system further extend its usage to industrial control and monitoring systems, as well as inter-campus and intra-city data distribution systems. Broadband CATV is unique in its capacity to integrate a wide variety of data communication applications, as well as other services, onto a single medium.

This manual describes the LocalNet 20 packet communication unit (PCU) that connects one or more terminals or (local) devices to the broadband network, and through the network to other (remote) devices, also attached to the network through PCUs. A compact unit, an individual PCU is connected to coaxial cable routed within the walls of a building. The coaxial cable carries data within a building, between the separate buildings of a large organization, and even over longer distances. The PCU, connected between the

local terminal and the coaxial cable network, allows data communication over the LocalNet system with many other remote terminals, printers, and computers. As a result, the local device can choose any network member as a correspondent device. The local device can also communicate with members of other LocalNets if the network has bridges and/or gateways to those networks.

TECHNOLOGICAL BACKGROUND

Broadband coaxial cable (CATV) systems provide superior bandwidth characteristics, excellent noise immunity, and offer straightforward user connection by inserting isolating taps on a single line or drop. The broadband system looks like a common bus to users at any physical access point. Standard frequency modulation methods are used on radio frequency (RF) carriers throughout the LocalNet portion of the RF spectrum, creating many independent LocalNet digital information channels through frequency division multiplexing (FDM). These LocalNet channels coexist with other, non-LocalNet, services of the broadband network. Examples of such services might include point-to-point broadband modems, broadcast and conference video, and specialized data services, such as energy management and physical security.

LocalNet time division multiplexes (TDM) these digital channels among a large number of user devices through the use of digital packet switching. Packet switching offers several advantages over other network architectures. Most significant are higher channel utilization and optimized throughput provided by demand assignment of channel capacity to network users. Packet switching supports substantially greater numbers of data communications network users than can be handled by the more inefficient circuit-switching techniques. Packet switching protocols provide efficient methods for user-to-user flow and error control, while providing the flexibility for user and equipment relocation and upgrade. LocalNet uses packet switching to provide time division multiplexed access to each FDM channel by many PCUs.

* "LocalNet" is a registered trademark of Sytek.

INTRODUCTION

THE INTELLIGENT NETWORK

LocalNet provides data communications intelligence in each PCU. This intelligence performs packet assembly, disassembly, buffering, error and flow control. These services allow the construction of packet-switched connections between correspondent PCUs, and sessions between their attached user devices. This intelligence can also economically provide the value-added services of protocol and code conversion, speed matching, data security and more. The LocalNet network assumes responsibility for most data communications functions, from high-level, application-dependent requirements through complete transmission management, including network monitoring and other services. LocalNet's intelligent network is illustrated in Figure 1-1.

Because network intelligence is contained within each LocalNet packet communication unit, control and reliability problems are minimized. Moving the network

intelligence required for data communication protocols and functions into the network has the following advantages. This movement:

- decreases network development and installation time by reducing the need to develop new user device software or hardware;
- substantially increases throughput by using the LocalNet packet communication unit to send user data through the network;
- increases the processing capacity of devices by offloading substantial portions of network communication processing to the PCU; and
- simplifies network growth by removing network dependent functions from user devices.

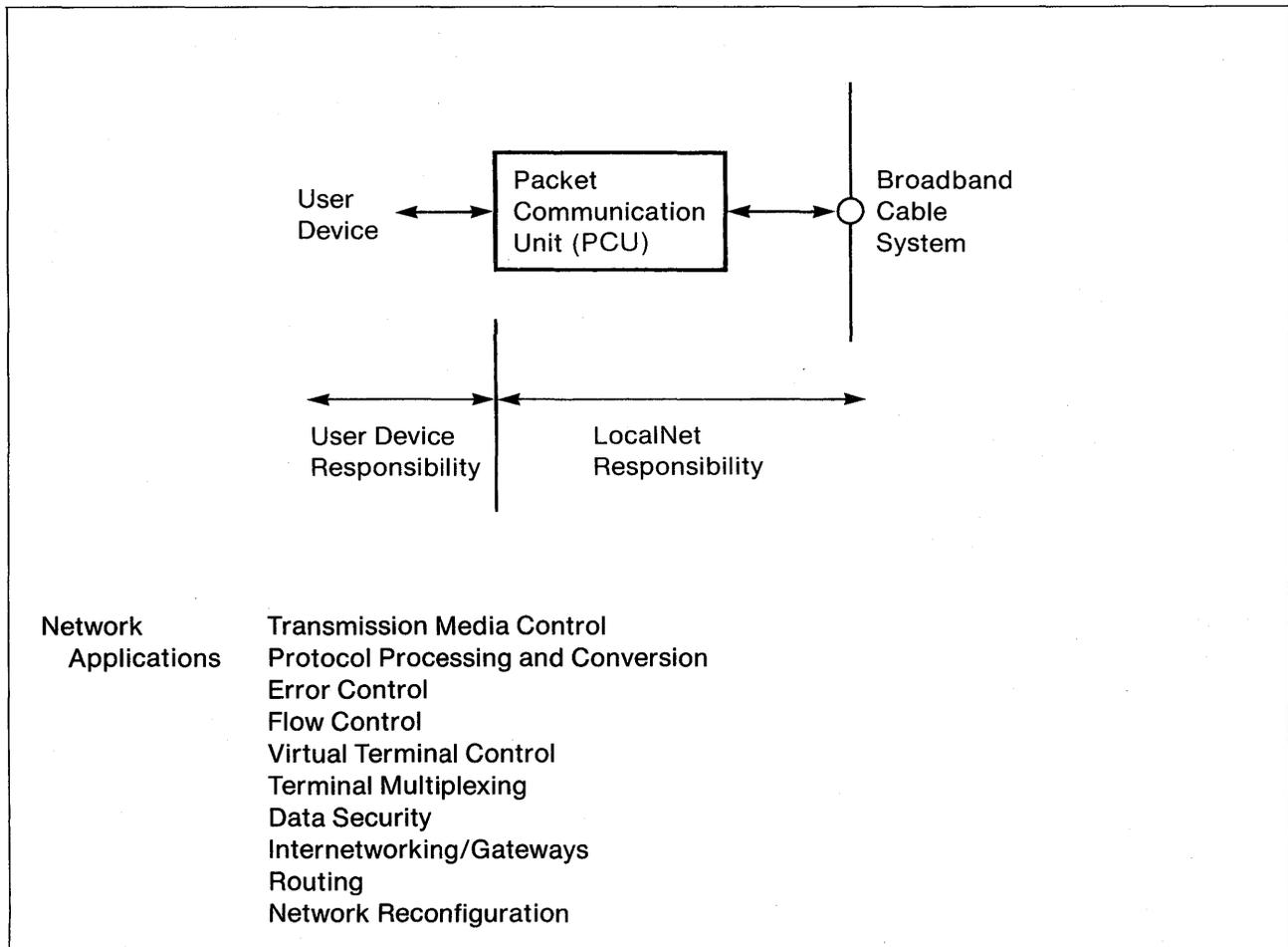


Figure 1-1. The Intelligent Network

This chapter outlines the basics of the LocalNet internal architecture, reviewing the essentials of:

- LocalNet's overall architecture,
- communication services provided by LocalNet packet communication units,
- broadband coaxial cable data distribution,
- LocalNet internal communication protocols,
- network interconnection: bridges and gateways, and
- network management.

NETWORK ARCHITECTURE

LocalNet is a packet switched local area data communication network providing communication functions via a broadband CATV data distribution system. The properties of broadband CATV permit LocalNet to construct many independent subnetworks—termed channels—on one or more CATV coaxial cable systems. Each of these subnetworks provides data communication for hundreds of user devices.

User devices are attached to the network via an intelligent interface device called a packet communication unit (PCU). Special network services, particularly support for network management, are provided by LocalNet server nodes. LocalNet subnetworks (and associated PCUs, servers and user devices) can be connected through the use of packet-switched bridges and gateways.

A typical LocalNet system is composed of a series of components:

- packet communication units,
- bridges and gateways for channel and network interconnection, and
- network management and control devices.

COMMUNICATION SERVICES

A LocalNet 20 PCU provides a variable number of full duplex sessions based on switched virtual transport connections to other PCUs in the LocalNet. Sessions can be formed to another port on the same PCU, between PCUs on the same LocalNet channel, or between PCUs on different channels and cable systems via one or more interchannel bridges or gateways. Flow control is maintained between PCUs in order to match the speeds of user devices participating in a session—pacing each transmitter to the speed of the receiver, compensating for heterogeneous bandwidth, delay, and error properties of the network, including statistical internal network congestion.

There are two user device addressing forms: a fully qualified address specifying a particular device port on a particular PCU, and a partially qualified rotary address specifying any available port on a particular PCU or group of PCUs.

The user device interface to the PCU (and thus to the LocalNet) is controllable either locally by the user device or remotely by the network manager. This supports overall LocalNet network control, permitting remote monitoring and control of a PCU from a network control center by the network manager.

BROADBAND COAXIAL CABLE

LocalNet utilizes broadband coaxial cable as its physical communication medium. In wide use in many commercial CATV applications, this medium provides the high bandwidth (300 to 400 MHz), proven reliability and multidrop capability required for growing data communications requirements. Broadband cable provides high noise immunity, with each user branch electrically isolated from the main signal. This isolation also reduces the possibility of system failure from accidental or malicious causes. Analog video or voice applications can share the same cable using dedicated frequency channels.

LOCALNET SYSTEM OVERVIEW

Broadband CATV is a directional broadcast transmission system based on a single inverted tree physical topology. Each user device can broadcast its transmission in one direction, up the tree towards the CATV head-end. The head-end contains an analog frequency broadband translator (LocalNet 50/50) that, like a satellite transponder, rebroadcasts the transmission from the headend of the tree, forward to all attached user devices.

LocalNet exploits the directional aspect of the CATV transmission system to achieve full connectivity, and provides products that are compatible with each of the major cable system architectures: mid-split, sub-split and dual-cable. Bidirectional transmission on a midsplit LocalNet is illustrated in Figure 2-1.

For LocalNet usage, the 300 MHz cable bandwidth is divided into multiple logical channels through the use of Frequency Division Multiplexing (FDM). Frequency shift keying (FSK) is used to modulate individual RF carriers at a 300 KHz spacing to create LocalNet 20 data channels, with each channel accessed by multiple PCUs spread over the geographic radius supported by the broadband transmission system—up to 50 kilometers.

DATA CHANNELS

LocalNet currently implements two classes of FDM data channels. LocalNet 20 supports one hundred and twenty channels with data rates of 128K bits per second (bps), and provides packet-switched data communications service to thousands of low duty cycle devices, such as terminals. LocalNet 40 supports five 2M bps channels and provides similar services to high duty cycle (greater than 1M bps PCU throughput) users over a smaller geographic area on the same broadband cable as LocalNet 20. LocalNet also provides for the interconnection of LocalNet 20 and LocalNet 40 through interchannel bridges, to provide a single, integrated communication network.

A simple type F coaxial cable fitting in each area to be served provides access to the underlying analog broadband network, and hence to LocalNet 20 and 40 service. The independence of the transmission system from the types of services offered makes connecting, disconnecting, and moving the PCU from room to room a simple process, with no wiring changes required. Functional upgrades or the addition of new services, such as voice and video teleconferencing, may be made without addition or change to the analog CATV transmission system.

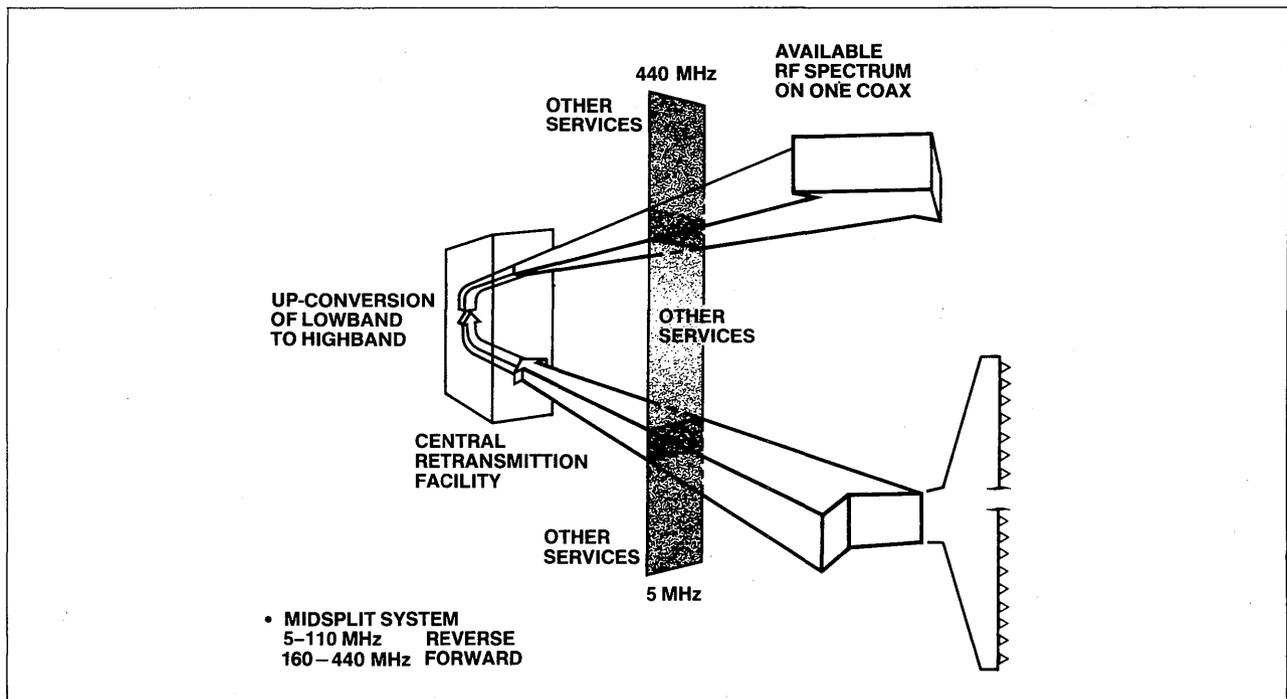


Figure 2-1. Bidirectional Midsplit Broadband Channel Organization

COMMUNICATION PROTOCOLS

Transmission bandwidth on a channel is allocated in a distributed manner using a carrier-sense multiple-access with collision detection (CSMA/CD) access method. This technique permits each packet communication unit to contend independently for transmission access with other PCUs on the same channel. The minimization of centralized network control provides for high system reliability, low transmission delay, and channel utilization in excess of 95%. The LocalNet protocol architecture is illustrated in Figure 2-2.

This architecture allows user devices to communicate primarily through *sessions*. User initiated sessions provide the communication services to each port. Many sessions can be attached to (and controlled from) each port, and many ports can be attached to (and controlled from) each user device. In general, each transaction between host and PCU is labeled, either directly or indirectly, with the port and session numbers to which it applies.

LocalNet employs a layered architecture conforming to the Reference Model for Open Systems Interconnection (OSI), developed by the International Standards Organization (ISO). This model specifies a

seven layer architecture that facilitates communication among open, or standardized, systems. The seven layers are described below:

Physical Layer — The physical layer within LocalNet is the broadband coaxial cable information distribution system.

Link Layer — LocalNet uses several link layer protocols. The most important of these provides for channel level addressing, packet framing, and cyclic redundancy check (CRC) generation and checking, as well as channel bandwidth allocation using distributed CSMA/CD control. Other link protocols are used, as required, in bridges and gateways.

Network Layer — LocalNet implements a datagram network layer that provides datagram-based addressing and routing of packets.

Transport Layer — LocalNet provides several transport layer services, the most important of which is flow- and error-controlled connections between PCUs.

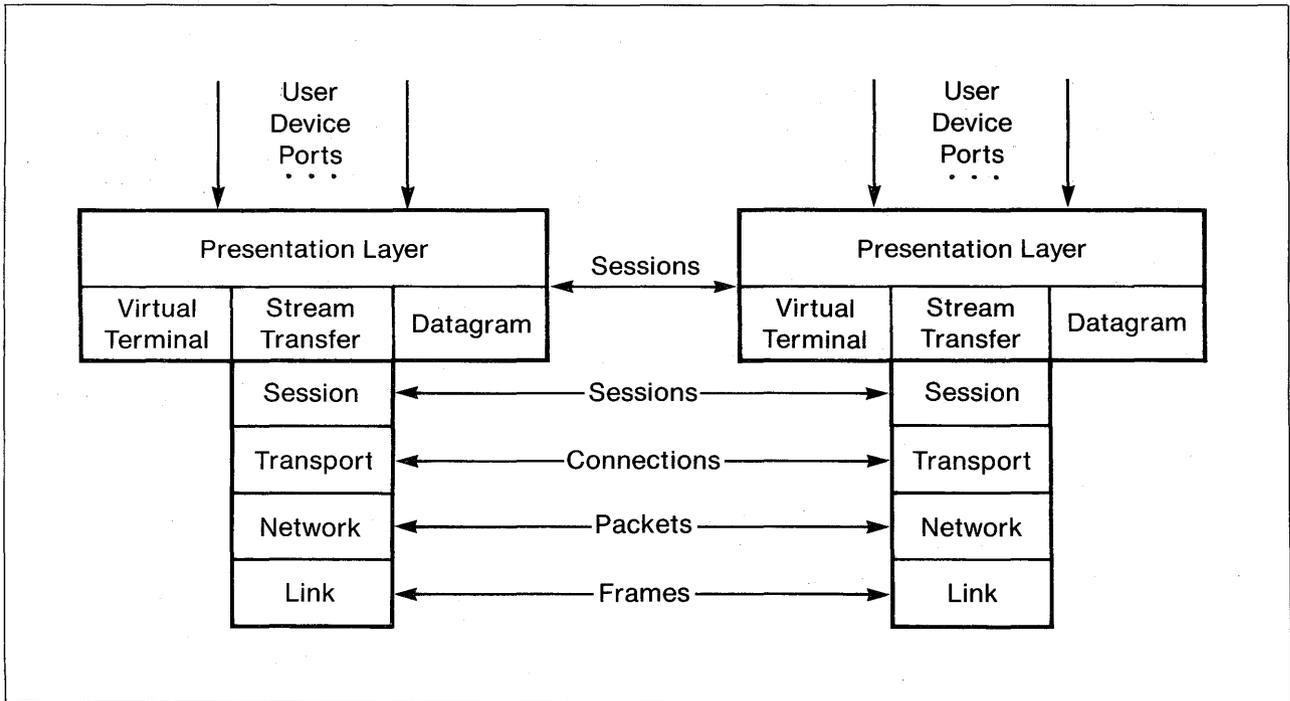


Figure 2-2. LocalNet Protocol Architecture

LOCALNET SYSTEM OVERVIEW

Session Layer — LocalNet PCUs implement session layer services that provide access control, service accounting, name directory, and extended addressing services.

Presentation Layer — The presentation layer provides data formatting and conversion functions. LocalNet PCUs support presentation layer functions.

Application Layer — The application layer provides application-specific services to user devices. Generally, implementation of functions in this layer is left to the user.

The Physical Layer

Broadband coaxial cable is the physical foundation of LocalNet. LocalNet divides the available bandwidth of the coaxial cable into a number of frequency division multiplexed channels which are allocated for low speed (LocalNet 20) and high speed (LocalNet 40) applications, as required. LocalNet PCUs transmit on the cable via radio frequency (RF) modems that convert the digital data stream to an FSK modulated analog signal. As illustrated in Figure 2-3, LocalNet modems are an integral part of each PCU.

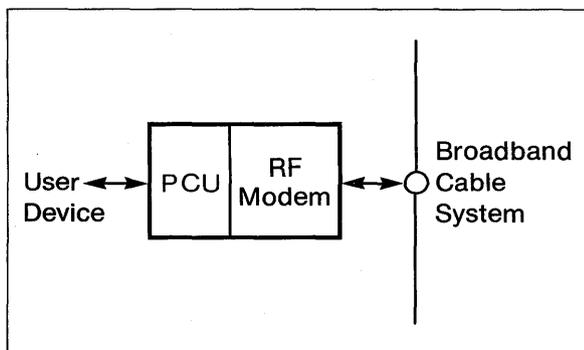


Figure 2-3. User Device Attachment

The cable system is passive and does not impose a specific digital protocol on user devices and PCUs. The modems are packaged with the PCU, making the broadband cable system independent of the application, capable of supporting simplified service upgrades and extensions without cable system changes.

The connection of a LocalNet device to the coaxial cable and to the cable facilities is passive; connection or disconnection of the LocalNet device, or of a user device, does not affect the operation of either LocalNet

or the cable system. LocalNet transmissions are contained in two frequency bands: an inbound band (low frequency) and an outbound band (high frequency). The inbound and outbound directions are usually referred to as the reverse and forward directions, respectively. Each modem transmits at a selected low frequency and receives at a correspondingly higher frequency. An analog frequency translator, the LocalNet 50/50, joins corresponding low and high frequencies to construct logical LocalNet digital channels.

Channels are allocated in groups of 20, and correspond to standard 6 MHz commercial video channel bandwidths. Transmission and channel allocation methods are RF analog.

The Data Link Layer

The data link layer transfers user data and commands between network nodes by way of the coaxial cable medium. The unit of information exchanged at this layer is referred to as a frame; frames are encoded in a High Level Data Link Control (HDLC) format, which has been modified to better support the local networking environment. HDLC allows for variable data record lengths through the use of flag characters to delimit the frame. Data integrity is assured through the use of a frame check sequence (FCS) algorithm which provides error detection and enables error correction through retransmission by the transport layer protocol. Automatic zero insertion and deletion allows for the transparent transmission of user data.

The use of an HDLC-derived data link protocol, coupled with the CSMA/CD cable-access technique, provides for the fair and equitable allocation of channel bandwidth to all LocalNet users, without requiring a centralized control mechanism.

The Network Layer

The network layer provides an unacknowledged packet transfer service between packet communication units on the same channel, on differing channels, or on differing LocalNet cable systems. Internal routing of packets between LocalNet elements is the fundamental function of the network layer protocol.

The Transport Layer

The transport layer provides end-to-end data transport via a reliable stream protocol (RSP) that is optimized for high throughput, providing reliable, flow-controlled transfer of user data via a virtual

connection. Up to four simultaneous virtual connections can be supported by a LocalNet 20/100 PCU. The LocalNet 20/200 PCU supports up to sixteen simultaneous virtual connections. One or more virtual connections can be associated with each user port. High data integrity, as well as the in-sequence delivery of user data, is obtained by the use of sequence numbers, end-to-end positive acknowledgments, and packet retransmission. Control over the flow of data across the virtual connection and to user devices is provided by a windowing algorithm.

The Session Layer

The session layer provides the network and session management functions to LocalNet packet communication units. Session layer protocols are responsible for resource protection, data security, network authentication, and symbolic name translation.

The Presentation Layer

The presentation layer provides data communication through the virtual terminal service. The virtual terminal service consists of a single transport layer virtual connection constructed from network layer datagram packets.

The virtual terminal service is oriented towards the support of many low-speed devices transmitting essentially character-at-a-time traffic. It provides a host interface that maximizes host terminal buffer utilization and provides tools for controlling the format of data presented to and received from remote terminals attached to LocalNet 20 PCUs.

The Applications Layer

LocalNet packet communication units provide a common, high performance, high function computer network that minimizes the effort needed by users to implement sophisticated applications. Standard LocalNet packet communication units leave the implementation of applications to the user's devices.

NETWORK MANAGEMENT FUNCTIONS

The OSI Reference Model provides for the implementation of network management protocols and services. These services allow for the configuration, test,

control, and management of an operational network. The following network management services are implemented in LocalNet 20:

- Diagnostic and maintenance facilities
- Network startup and shutdown
- Performance monitoring
- Reconfiguration
- Network security

PACKET COMMUNICATION UNITS

LocalNet provides communication intelligence at each user interface point implementing applicable protocols from the LocalNet protocol suite. Services typically provided include: packet assembly and disassembly, buffering, session management, error and flow control, protocol and code conversion, speed matching, and data security.

NETWORK INTERCONNECTION

LocalNet provides three methods by which packet communication units (and their associated user devices) can communicate. First, for users connected to PCUs configured on the same LocalNet channel, the basic protocol provides complete one-hop connectivity. Second, for users attached to different channels on the same cable, an optional store-and-forward packet mode *bridge* routes packets between LocalNet channels. Third, for users attached to different cable systems, each supporting LocalNet, the *gateway*, a variant of the bridge, provides for interconnection of these distinct LocalNet systems into one common network through use of one or more transit networks: AT&T's Digital Data Service (DDS), a public packet-switched value added network (VAN), or other data communication system.

LocalNet gateways provide data communication between LocalNet installations and external networks, including X.25 packet networks. These gateway products both extend the size and geographical coverage of LocalNets, as well as supporting their interconnection with other types of networks.



This chapter introduces the basic concept of operation of the LocalNet 20 packet communication unit (PCU), and defines each of the PCU's features and attributes. Chapter 4 defines the individual commands recognized by the PCU and controlling its operation. This chapter concludes with a basic overview of the internal and external construction of the LocalNet 20 PCU.

CONCEPT OF OPERATIONS

The LocalNet 20 PCU is designed as a network interface for serial interface devices, such as asynchronous terminals and computer systems. The LocalNet 20 PCU uses a common packet-switched backbone network, permitting communication with other devices interfaced to the network through LocalNet products.

The essential service provided to user devices by LocalNet 20 PCUs is the full-duplex transport of data bytes between correspondent user devices over packet-switched *sessions*. A LocalNet 20 PCU interfaces its user devices via *ports* that provide access points to a virtual terminal service provided by each PCU. Sessions provide the communication medium between ports. A total of four sessions can be supported concurrently by each LocalNet 20/100 PCU, apportioned in any manner to the two device ports.

A LocalNet 20/200 PCU can interface as many as eight user devices. A total of sixteen sessions can be supported concurrently by each 20/200 PCU, and these sessions can be apportioned in any manner to the eight 20/200 user device ports.

The PCU provides the means for user devices to initiate sessions to other devices attached to the same or a different PCU. The requesting user device need not be aware of the physical or logical location of its correspondent, as the LocalNet system provides all the necessary routing services. A source PCU, once a session has been initiated, takes data provided by a transmitting user device, formats that data into packets and uses the LocalNet internal data communication protocols to route that packet to the destination PCU. The destination PCU removes the data from received packets and transmits the data to the receiving

user device. Data transmission is full duplex so that both correspondent user devices can be simultaneously transmitting and receiving. The manner in which data is presented to the PCU, and by the PCU to its attached devices, is under the control of the device.

LocalNet 20 channels are organized into six frequency groups. Each PCU contains a frequency-agile RF modem capable of directly tuning to the twenty LocalNet 20 channels in its frequency group. PCUs with modems belonging to the same frequency group can communicate by selecting the same channel. PCUs with modems belonging to differing frequency groups, or prohibited from changing their modem channel, can communicate only through an intermediary, LocalNet's interchannel packet mode store-and-forward *bridge*.

COMMUNICATION SERVICES

Each LocalNet 20 PCU provides a range of communication services to its attached devices. These services include:

- PCU management — overall management of the PCU, including specifying its identity, location, and protection attributes
- session management — management of individual sessions, including session initiation, termination, and control
- data handling — handling and processing of user data through sessions, including flow-and-error control
- signaling — out-of-band signaling across session boundaries
- maintenance — facilities provided for network diagnostics and maintenance, particularly local PCU diagnostics.

The PCU features described above are controlled by a set of attributes set via PCU commands from the device. Attributes are divided into two categories: those maintained for the entire PCU, and those maintained for each PCU port. Sessions can individually control their per-port attributes.

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Capacity

The 20/100 PCU supports a maximum of four simultaneous sessions and two user device ports. The 20/200 PCU supports a maximum of sixteen simultaneous sessions and eight user device ports.

Performance

The throughput of a LocalNet 20 PCU depends on the characteristics of traffic between it and its user device. Sending single characters at low speeds requires more processing overhead than sending files at higher speeds. The aggregate throughput is on the order of 20 bps. Some settings of the PCU data handling attributes can increase delay in processing a packet while also increasing throughput; see the discussion on the intercharacter idle timer.

USER DEVICE CHARACTERISTICS

LocalNet 20/100 and 20/200 PCUs interface asynchronous interactive terminals to the LocalNet. These devices can range in data rate from 300 to 19.2K bps, and may use any parity and number of stop bits. The hardware interface is EIA RS-232C compatible. For user devices such as host computers and block mode terminals, where the aggregate input data rate to the PCU is greater than 2400 bps, flow control is recommended in order to prevent loss of data.

PCU/DEVICE INTERFACE

A PCU has three device interface modes: command, autobaud, and data transfer.

Command Mode

In command mode, a user device may input commands to either the local PCU or a remote PCU. When the PCU is reset, initially powered up, or has a terminal initially attached, the user interface is in command mode—indicated by the # prompt.

If there are no sessions on a port, and the port is not in autobaud mode, it is in command mode. While in

command mode, the PCU responds to flow control requests from the user device. However, the PCU does not request flow control of input from the user device.

Autobaud Mode

A PCU enters autobaud mode after the rear-panel reset button has been pushed twice within a few seconds. In autobaud mode, the PCU ascertains and matches the baud rate of devices attached to all its ports. The PCU searches the incoming data stream, beginning at a rate of 19.2K bps. The device must supply ASCII carriage returns until the PCU has matched data rates with its attached devices.

In addition, each PCU accepts an interface signal (see Appendix C) that causes the port to autobaud. This autobaud can be accomplished at any time while Data Terminal Ready (DTR) is asserted.

Each device is placed in command mode after this reset. Receipt of the PCU command mode prompt announces a successful reset.

NOTE:

If the port has *quiet* enabled, the PCU does not display the command mode prompt #, nor command mode echo, nor does it display error messages when the PCU is in data transfer mode (see below). Having *quiet* on disables the display of a PCU's responses to all but two local commands: the PCU's response to the *status* and *help* commands is still displayed at the attached device.

Data Transfer Mode

Once a session has been established, by use of the *call* or *pcall* command, (see Chapter 4) the user device enters data transfer mode from command mode automatically. At this point the user can log in to a remote device and begin sending and receiving data.

NOTE:

A new user may accidentally enter command mode. Simply entering one or two carriage returns, or a space and a carriage return, restores data transfer mode.

Transparent Mode

Devices often require the use of a connection on which all eight bits of each byte may be transmitted transparently, without interpretation by either the source or destination PCU. For this purpose, transparent mode is defined in the following way:

- *none* or *break* is specified as the command mode entry string
- *none* is specified for the end of message delimiter (EOM)
- *none* or *EIA* is specified for source and destination local flow control
- *none* is specified for parity.

When the specified attributes are set as shown, the PCU does not interpret characters in an attempt to derive command mode invocation, message delimiters, or flow control characters. In addition, the PCU does not interpret or modify the eighth bit of each byte as parity. For more information, see the *command*, *flow*, *eom*, and *parity* commands in Chapter 4.

Abbreviated Commands

The LocalNet 20 PCU permits the user to enter just enough characters to distinguish a command from all other available commands. For instance, *help* is the only command that begins with an *h*, so *h* is the only letter needed to request a display of currently enabled commands. However, in order to distinguish between *status*, *stops*, and *switch*, the command strings *sta*, *sto*, or *sw*, respectively, are entered.

The PCU supplies the remaining characters of the command if a space or carriage return is entered after the minimum character string.

GLOBAL PCU MANAGEMENT

PCU management attributes are of two types: those global to the PCU and all its ports and sessions simultaneously, and those specific to a particular port and its sessions.

Global attributes include: *unitId*, *location* (*linkAddress*, *channelNo*), *group*, *privilege*, and *enabled* commands. The value of these attributes is the same for all ports on a given PCU.

Global attributes control the *identity* of the PCU on the LocalNet, its *location* on the LocalNet, and its protection state.

Addressing

To support information routing, each PCU possesses a set of address attributes, including

- the PCU's unique *unitId*, used for PCU-to-PCU routing in the network layer and for session initiation
- the modem group for which the PCU is configured
- the modem *channelNo* to which the PCU modem has been tuned
- the link access protocol *linkAddress*, used for on-channel link layer routing.

Generally, a remote PCU port is identified only by the PCU *unitId*, as well as required *portIds*. The *unitId* is specified for each PCU at its initial configuration time. It is a sixteen bit value—represented as four hexadecimal digits—and permits over 65,000 PCUs to be configured onto a single LocalNet.

The modem group specifies which of six groups of twenty LocalNet 20 channels the PCU's modem can directly tune. The modem group is determined by the hardware installed in each PCU and is specified at the factory. The modem group is indicated by an alphabetic value between A through F, and L through N, inclusively.

A PCU's location is specified by its *channelNo* and *linkAddress*. The *channelNo*, specified in the range of 0—119, identifies which of the 120 LocalNet 20 channels is to be used by the PCU for its communications with other PCUs. Each PCU has the ability to make limited changes to its location by tuning its modem to one of the twenty *channelNos* addressable within its modem frequency group. The modem frequency group of a PCU is indicated by its option label (see Appendix G).

A local user, if permitted, can alter his or her PCU *channelNo* within the range of the PCU modem group. However, most installations will choose to disallow this movement, because unrestricted changing of the *channelNo* can overload the channel if many users select the same channel at the same time. The *linkAddress* provides an internal hardware address that is

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used to minimize internal processing overhead. Alterations to the *linkAddress* are made by the network manager.

A PCU's location, both *channelNo* and *linkAddress*, can be changed independently of its *unitId* while the PCU retains its membership in its LocalNet. PCU location changes in a large LocalNet are tracked by inter-channel bridges and the network control center.

Access Control: Command Protection and Privilege

LocalNet 20 PCUs provide tools to control access to the system facilities. This control is based on two facilities: enabled commands and privilege.

The network manager's guide supplied with each system explains these tools.

PCU global attributes are summarized in Figure 3-1.

Each attribute is retained in the non-volatile attribute memory; these attributes are also retained across power failures and normal PCU resets.

Attribute Name	Possible Values
<i>unitId</i>	0000-FFFF (hexadecimal)
<i>linkAddress</i>	0-254 (decimal)
<i>channelNo</i>	0-119 (decimal)
enabled commands	all commands
privilege	on or off
group	A-F (mid-split) L-N (sub-split)

Figure 3-1. PCU Attribute Summary

Global PCU Management Commands

The PCU attributes are controlled by the following commands:

disable — disables named commands from non-privileged invocation

enable — enables named commands for non-privileged invocation

group — specifies to the PCU its modem frequency group. Normally the group is set at the factory and the command is not further used

location — specifies, to the PCU, the LocalNet 20 *channelNo* to which it is to tune its modem, and the *linkAddress* to be used on that channel

privilege — enables/disables the privilege state of the PCU

unit — specifies the *unitId* of the PCU

These commands control the availability of commands for each PCU, its location and group numbers, and the ability of the PCU to control other PCUs remotely. For more information on these commands, refer to their alphabetical listing in Chapter 4.

SESSION MANAGEMENT

A *session* is a data communication connection between a local user device and a remote user device through the respective PCUs. Each session has its own set of attributes controlled by PCU commands. A session can be initiated or terminated from the local device, and the device can be switched among two or more sessions attached to its port. In addition, sessions can be controlled remotely from correspondent and third party PCUs.

Addressing

A user-level address has two parts: *unitId* and *portId*. The *unitId* uniquely identifies the selected PCU on its LocalNet, and the *portId* identifies the requested access point at which a user device is attached to the PCU.

The address used to establish a session with a remote device can have one of the two following forms:

unitId,portId — a fully qualified address

unitId — a partially qualified (rotary) address

A session initiation request that is fully qualified specifies the LocalNet access point (*portId*) to which the session request is directed. If the requested port is unavailable, the request is denied. If the partially qualified address is used, the *portId* is omitted, and the PCU places a *rotary* call.

ROTARY

Using a partially qualified address permits any of a group of equivalent points, called a rotary group, to serve as the destination of the session. This group consists of ports

- 1 which are on PCUs with *unitlds* within the range of the rotary
- 2 where the number of current sessions is less than the specified maximum number of sessions
- 3 which, if Data Terminal Ready (DTR) is not set to *off*, have the EIA pin DTR asserted by the destination device (e.g. computer port)
- 4 that have *listen* set to *on*.

A rotary call is made to the first free port found within the PCU rotary group. The first unassigned *unitld* terminates the rotary. For example, the *unitld* sequence:

```

1234    1235    1236
1238    1239
1241
1243
    
```

contains four rotary groups: 1234 through 1236, 1238 through 1239, 1241, and 1243. A rotary call to a group will result in a session with the first available port within that group. If no free port is found within the group, the session initiation attempt fails. The PCUs within a rotary are not confined to the same LocalNet channel if a bridge is used, nor do they have to serve the same user device.

Session Management Commands

The following commands provide session control, as well as set the values of session management attributes:

- call* — The *call* command initiates fully qualified and rotary sessions.
- done* — The *done* command terminates either current or non-current sessions. (See the section on Multiple Sessions, below).
- help* — The *help* command displays a list of commands enabled for the requesting port.

listen — The *listen* command enables/disables the port to respond to incoming session requests.

maxsession — The *maxsession* command specifies the maximum number of sessions that can be attached to a given port.

status — The *status* command supplies a summary of all global PCU and port-specific attributes, as well as a list of established sessions for the port.

suspend — The *suspend* command places a session into a flow controlled state.

switch — The *switch* command changes the current session, re-activates it if it was suspended, and places the port in data mode.

Session Initiation

A PCU responds to both local and remote requests to initiate sessions. A local session initiation request takes the form of a *call* command from a user device attached to the local PCU. The session can be established either to another port on the same PCU, or to a port on a remote PCU. A remote PCU can request the establishment of a session between two other PCUs.

Sessions also can be established using the permanent session mechanism (*pcall*) to call a pre-selected PCU (*punit*). Attempts to establish a permanent session can be initiated either automatically or by the occurrence of an external event. In automatic mode, a call is automatically initiated whenever the local port has no current session. In the *on* mode, the external event which triggers *pcall* can be either a carriage return entered by the user device when there are no sessions, or the raising of DTR by the device (if DTR control is not set to *off*).

Fully or Partially Qualified Addresses

The session request can use an address which is either fully or partially qualified. If the address is fully qualified, the request is for a specific port. If the port has a free session available, the request is granted and the session is established. If the address is partially qualified, the request is for a rotary and the local PCU responds by establishing a session to the first free port enabled for incoming sessions. If no such port is so enabled, the request is denied. Each session is labeled with a port specific *sessionNo* identifying the session. The *sessionNo* is assigned sequentially from 1 when multiple connections are established.

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Session Establishment

A remote PCU can not accept a request for a session if the DTR control parameter is set to *on* and the DTR line of its EIA interface is not asserted, or if a DTR timeout is specified and DTR is not raised within the specified time. If a PCU has been enabled to receive incoming sessions and has not yet received DTR from the user device, ring indicator (RI) is raised when an incoming session request is detected. RI is lowered when DTR is received from the user device.

If DCD control is set to *on*, the PCU asserts Data Carrier Detect (DCD) for each port having an active session. If all sessions on that port are terminated, DCD is dropped.

Session Termination

The PCU supports termination of sessions through the use of the *done* command. A local user device can terminate both the current session and any non-current sessions. The remote PCU may also terminate a session.

Sessions may be terminated if a timeout value has been specified for the local or remote PCU and if no character has been sent or received during the specified period. Also, if *DTR* control is set either to *on* or to a timeout value, and DTR is dropped by the user device, all outstanding sessions for that port are automatically terminated.

Multiple Sessions

The 20/100 PCU supports up to four simultaneous sessions which may be allocated to a single port or distributed to both ports. The 20/200 PCU supports up to sixteen simultaneous sessions which may be allocated to a single port, or distributed among the eight user device ports.

The number of simultaneous sessions allowed for a particular port is determined by its *maxsession* parameter. For instance, on a 20/200 PCU, port 0 might have a *maxsession* limit of 8, while ports 1, 2, and 3 have limits of 5, and ports 4 through 7 have limits of 4 each. If ports 2, 5, and 6 have all sessions connected, 13 of the 20/200 PCU's sessions are in use. Port 0 can now have no more than 3 sessions, (making the 20/200 PCU's total of 16), even though the *maxsession* limit for port 0 is 8.

On a port, one active session is marked as the current session, and all input from the user device is directed to this session for transmission. On a status display, the current session is indicated by an asterisk after the unit and port numbers of the remote PCU. Sessions that are not current may remain active, or be *suspended*. An active session continues to receive and to deliver output data to the local device. To prevent data from another active session from being mixed at the user device with data and commands from the current session, a session may be suspended, thus flow controlling its connection, preventing subsequent data transport until reactivated. See the *suspend* command, Chapter 4.

Session Switching and Suspension

A device can request its PCU to switch between sessions. The switched-from session remains active until explicitly suspended. If the switched-to session had been suspended, it is reactivated as a side effect of the switch.

If a device issues a new session request while any session is open, the completion of the new session request automatically switches the device port to the newly opened session. If a session is initiated to a remote port which already has a session, and the remote port is in command mode, the remote port is switched to the new current session. However, if the remote port is in data mode, it does not switch to the new session.

Remote Command Execution

Any enabled PCU command can be invoked either by the local device or by a remote PCU via an outstanding session. The status of remotely executed commands is routed back to the originating PCU port through the current session. Disabled commands are unavailable, except to a privileged PCU. Flow controlling a session inhibits receipt of remote commands.

DATA HANDLING

The user device may specify several attributes that control the manner in which its PCU port presents and processes data over the sessions attached to that port.

Flow Control

LocalNet 20 PCUs support the capability to control the flow of data to and from attached devices. Flow control provides for:

- speed matching between devices of differing transmission speeds,
- compensation for links of differing bandwidth, delay, and error rate, between linked LocalNets, and
- reliable data delivery in the event of network or PCU congestion.

Each LocalNet 20 PCU responds to flow control signals both from its attached devices and from the remote PCUs with which each of these devices is communicating. Each session's underlying transport virtual connection propagates flow control information between correspondent PCUs.

LocalNet 20 supports two local flow control modes: EIA and xon/xoff. A device may select one of these modes to apply to its PCU port. The type of local flow control may differ between correspondent PCUs. More information on PCU flow control is contained in Appendix D.

Packet Construction and Transmission

The PCU makes packets of the characters sent by a device for transmission to a remote PCU, and separates received data packets into characters for subsequent transmission to the local device. A device can define the conditions under which packets are transmitted to a remote PCU. Four conditions result in transmission:

- 1 PCU input buffer full,
- 2 intercharacter idle timer timeout,
- 3 logical end-of-message, or
- 4 an EOM count.

BUFFER FULL

When the internal PCU input buffer is full, the contents of the buffer become the data portion of a packet and are transmitted. Packets are always transmitted when the buffer is full.

INTERCHARACTER IDLE TIMER

The PCU maintains an idle timer to measure the time elapsed between input characters. The timer clock is restarted after each character is received.

To insure prompt delivery of single characters when using a full-duplex terminal, the buffer is closed and its contents are queued for packet transmission, if no subsequent character is input before the designated time expires.

The user can specify the value of the idle timer in units of 10 milliseconds.

END OF MESSAGE

LocalNet 20 PCUs support the definition of logical messages as sequences of characters within a session. A message is delimited by an End Of Message (EOM) event that can be selected from several supported by the PCU. When the sending PCU has detected a local End Of Message condition, the current buffer is closed and transmitted. A buffer can contain both data and an EOM signal, but the EOM signal is the last that can be placed in the buffer. The EOM signal takes precedence over the two other conditions: buffer full and expiration of the idle timer. Several buffers or packets may constitute a logical message. Message length can be specified by the device and is not limited by buffer size.

The user can specify one of a series of EOM events, or a message length, to be recognized:

none — If *none* is the EOM parameter selected, an End Of Message event is not sensed.

newline — Each newline character received from the device signals an EOM. The newline character can be defined by the device. When the device transmits the newline character to the PCU, the PCU places the newline character in the current buffer, closes the buffer and transmits it as a packet labeled EOM.

control character — When the device transmits any ASCII control character, the PCU places that character in the current buffer, closes the buffer and transmits it as an EOM packet. This condition ensures prompt delivery of ASCII control characters.

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message length — When the count of characters received from the device reaches a specified number, the internal buffer is closed and transmitted as an EOM packet.

Newline Expansion

The device can request the local expansion of input newline characters in order to provide for automatic line feed. If newline expansion mode is enabled, when a newline character is received from the device, the specified expansion will be echoed to the attached device regardless of the setting of the echo command. Only the newline character is sent to the remote PCU.

The device can specify whether this feature is enabled, and what character is used for the expansion.

Command Mode

COMMAND MODE ENTRY

The PCU enters command mode after the user device issues a command delimiter. The delimiter can take one of the following forms:

- a string of two ASCII characters, or
- the *break* signal.

The user must specify which form to use, using the *command* command. The default is the *escape* character (hexadecimal 1B), followed by the *delete* character (hexadecimal 7F). To determine what a PCU port's command entry sequence is, type the *status* command and note the hexadecimal values which appear next to the *command* listing. (See Appendix G for the ASCII equivalents of those codes.)

COMMAND MODE RESPONSE DISABLE

The PCU normally echoes command characters locally and supplies prompts and status information. The device can disable this output, if desired. When command echo is disabled by issuing the *quiet* command with the parameter *on*, no command characters or command prompts are issued by the PCU, except for information returned in response to *help* and *status* commands. The *quiet* command is most useful for interfacing PCUs to computer communication ports so

that PCU-issued prompts and messages are not received by the host, and so the host software does not have to be modified to interpret the prompts and messages.

Ports that have *quiet* enabled may appear inoperative. For this reason, the *help* and *status* commands always cause a display, regardless of the *quiet* mode setting.

Baud Rate

The device can select a baud rate from the range between 19.2K and 75 bps. As a result of this command, the PCU port begins sending data to the device at the selected baud rate, and expects data to arrive at that rate from the device.

Parity Rate

The attached device uses the *parity* command to specify the parity applied to characters output to the device. If parity is *none*, 8-bit data is passed to the device as it was received. If parity is *odd* or *even*, parity is generated for 7-bit data. Incoming parity is never checked by the PCU.

Stop Bits

The device uses the *stops* command to specify the number of stop bits used on the EIA interface. The number can be 1, 1.5, or 2 bits.

Timeout

Using the *timeout* command with a parameter between 1 and 30 minutes disconnects the port if no input or output to the device has occurred during the specified interval. Entering a parameter of 0 disables the automatic disconnect feature.

Punit

The *punit* command identifies the unit, and optionally the port, to which a permanent session is to be made. Parameters are the same as those for *call*. Using *unitld* and *portld* provides a fully qualified address; the *unitld* alone provides a rotary address.

Pcall

The *pcall* command determines if permanent sessions are to be established, and under what conditions.

Calls are made to the unit and port specified by the *punit* command. Depending on the mode selected, sessions can be established automatically or when prompted. Pcall can be set to *on*, *off*, or *auto*.

Local Echo

The *echo* command controls whether the PCU port echoes to the attached device the data presented to the PCU for transfer to a remote device. Echo can be set to *on* or *off*.

Autobaud Pin Enable

The *autobaud* command enables and disables the functioning of the autobaud (AB) pin on the port's RS-232 connector. Autobaud can be set to *on* or *off*.

Port-Specific Data Handling Attributes

Figure 3-2 summarizes the PCU attributes specific to each port and all sessions attached to the port.

Port Specific Data Handling Commands

The following commands control the data handling attributes of each port on a PCU.

autobaud — The *autobaud* command enables or disables the autobaud (AB) pin on the port's RS-232 connector. A double reset using the button on the PCU's rear panel will still cause all ports of the PCU to autobaud, regardless of the setting of this command.

baud — The *baud* command specifies the baud rate to be used on the port.

command — The *command* command specifies the command mode entry string.

echo — The *echo* command enables/disables local character echoing only when the PCU is in data transfer mode. The *quiet* command controls echo in command mode.

eom — The *eom* command specifies the type of end-of-message processing to be done by the session.

Attribute Name	Possible Values	Default
Local flow control mode	none, EIA, xon/xoff	xon/xoff
Xon Character	Any ASCII	DC1
Xoff Character	Any ASCII	DC3
Character idle timer	10 to 2550 msec	50 msec
Command mode delimiter	none, break, sequence	sequence
Command mode characters	Any ASCII	ESC,DEL (1B, 7F)
Command mode response disable	on or off	off
Baud rate	75, . . . , 19200	19200
Parity	none, odd, even	none
Stop bits	1, 1.5, 2	1
Message length	0 to 255	0
Newline character	Any ASCII	ASCII CR
Newline expansion character	Any ASCII, or none	none
Local echo enable	on or off	off
Message delimiter	none, newline, control, length	none
Autobaud (pin enable)	on or off	off
Pcall	off, on, auto	off
Timeout	0—30 min.	0 (disabled)
Punit	any unit and port, or rotary	0000

Figure 3-2. Port Specific Data Handling Attributes

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expand — The *expand* command both enables/disables newline expansion and specifies the character to be used for expansion.

flow — The *flow* command specifies the method of local flow control to be used at the port.

idle — The *idle* command specifies the value of the intercharacter idle timer.

newline — The *newline* command specifies the character to be used for newline recognition.

parity — The *parity* command specifies the parity to be added to each byte delivered to the user device.

pcall — The *pcall* command specifies whether a permanent session is to be established automatically, or in response to an external event.

punit — The *punit* command specifies the unit and port or rotary group to which a permanent session is to be established.

stops — The *stops* command specifies the number of stop bits to added to each byte delivered to the user device.

timeout — The *timeout* command provides for automatic session termination if no data has been sent or received within a specified interval.

xoff — The *xoff* command specifies the character to be used to stop data transmission to (and from) the user device.

xon — The *xon* command specifies the character to be used to start data transmission to (and from) the user device.

For more information on these commands, see their alphabetical listing in Chapter 4.

SIGNALING

The PCU can generate an out-of-band signal to a remote PCU and device. This signal is termed an *interrupt* control signal and is communicated across the session. Data packets buffered either in the source or destination PCU are not affected and the interrupt signal is not delivered in sequence with any buffered

data. The signal is delivered to the destination port as a *break* — a 250 millisecond space on the RS-232C Receive Data (RD) pin.

The *interrupt* can be generated either by explicit command at the source PCU port or by the input of *break* on the source RS-232C TD pin. The latter is enabled if the command mode entry string has not been specified as *break*.

DIAGNOSTIC AND MAINTENANCE SERVICES

Each PCU contains a set of software self-test routines for first level diagnosis of hardware problems. These diagnostics:

- verify the condition of major LSI components;
- checksum the ROM memory;
- checksum the RAM memory;
- test the buffer RAM memory;
- echo test the modem.

LOCALNET 20 PCU CONSTRUCTION

External Description

The LocalNet 20 PCU is packaged in a stand-alone cabinet containing all required digital, analog, interface and power electronics to connect two (20/100) or as many as eight (20/200) asynchronous terminals or computer ports to the LocalNet. Physically resembling a conventional point-to-point modem, the PCU is a small enough unit to sit near the terminal which it attaches to the network.

The front panel of the 20/100 PCU contains two multi-color light-emitting diodes (LEDs) used to display summary status information concerning the PCU and its activities. The front panel of a 20/200 PCU contains an additional eight LEDs, one for each user device port. A port LED is green when a session exists on that port, and unlit when no session exists. The port LED is red if no session exists and if the port will not accept an incoming call for one of the following three reasons:

- *DTR* control is *on* and the DTR signal is not asserted
- *Listen* is *off*
- *Maxsession* is 0

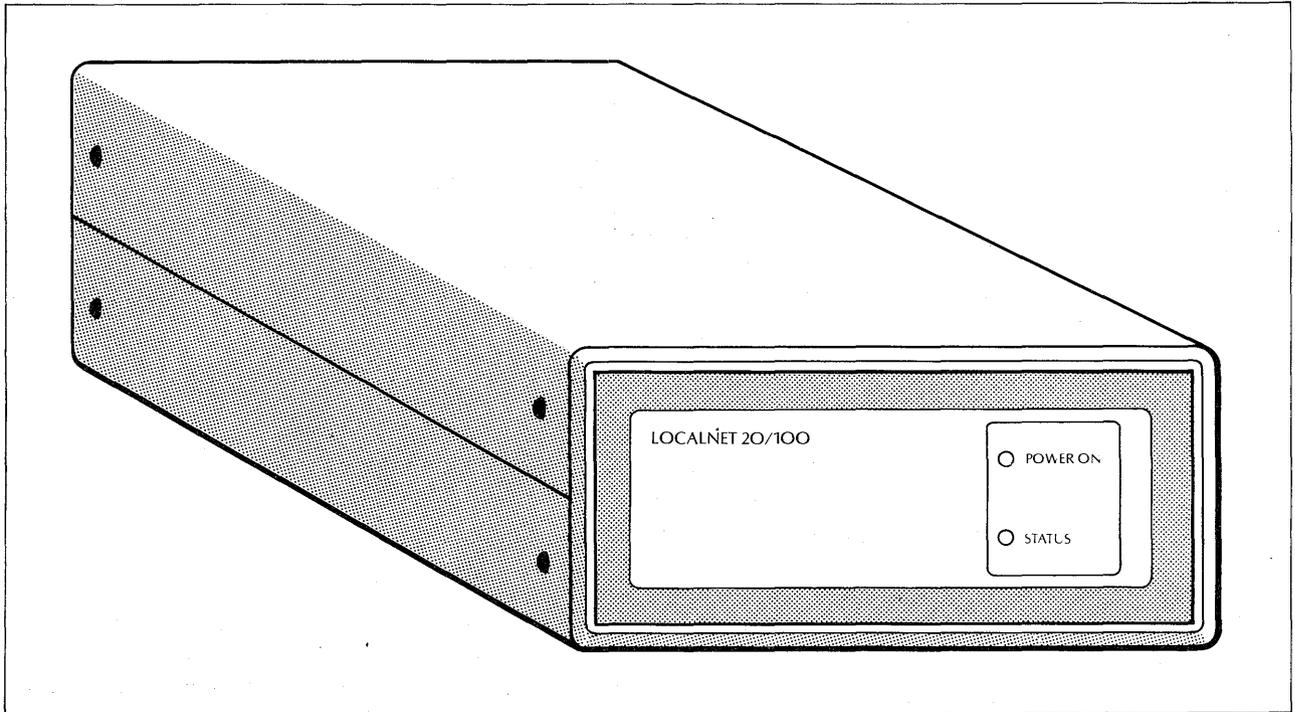


Figure 3-3. LocalNet 20/100 PCU Front Panel

For more information on the LEDs, see Chapter 5, PCU Check Out. Figures 3-3 and 3-4 present the front panels.

The rear panel of the PCU contains connectors for

- power,
- DB-25 connectors for user devices (two on a 20/100),

- reset momentary push button, and
- a type F coax CATV fitting for attachment to the broadband cable system.

In addition, the rear panel of the 20/200 contains eight DB-25 connectors for devices. The rear panels are shown in Figures 3-5 and 3-6.

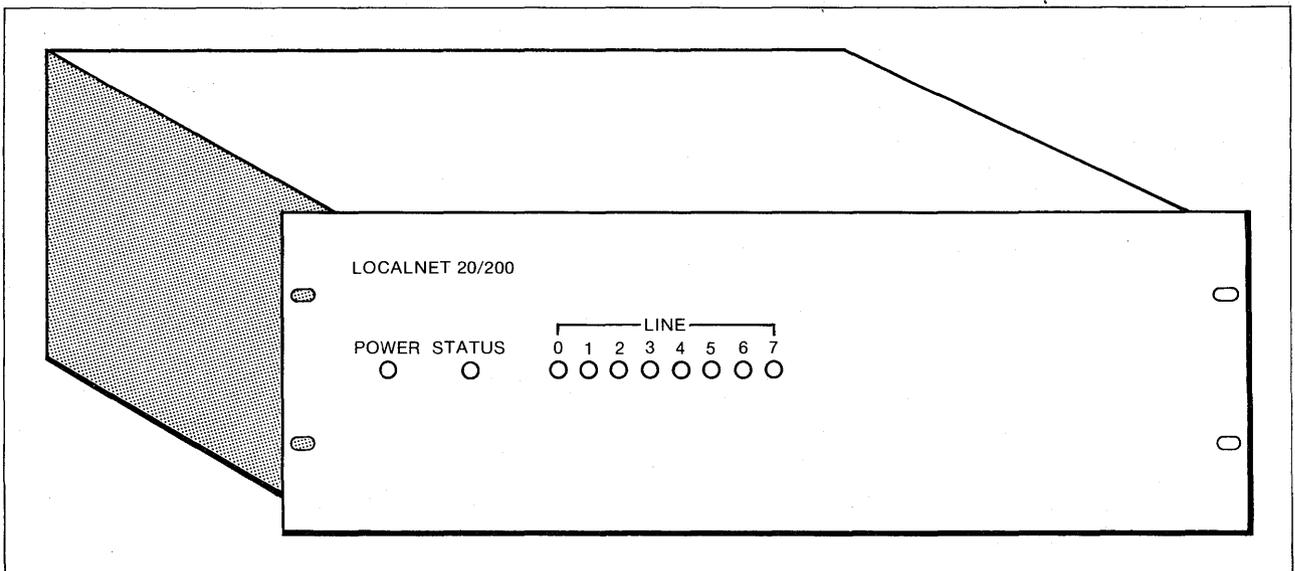


Figure 3-4. LocalNet 20/200 PCU Front Panel

SERVICES AND OPERATION

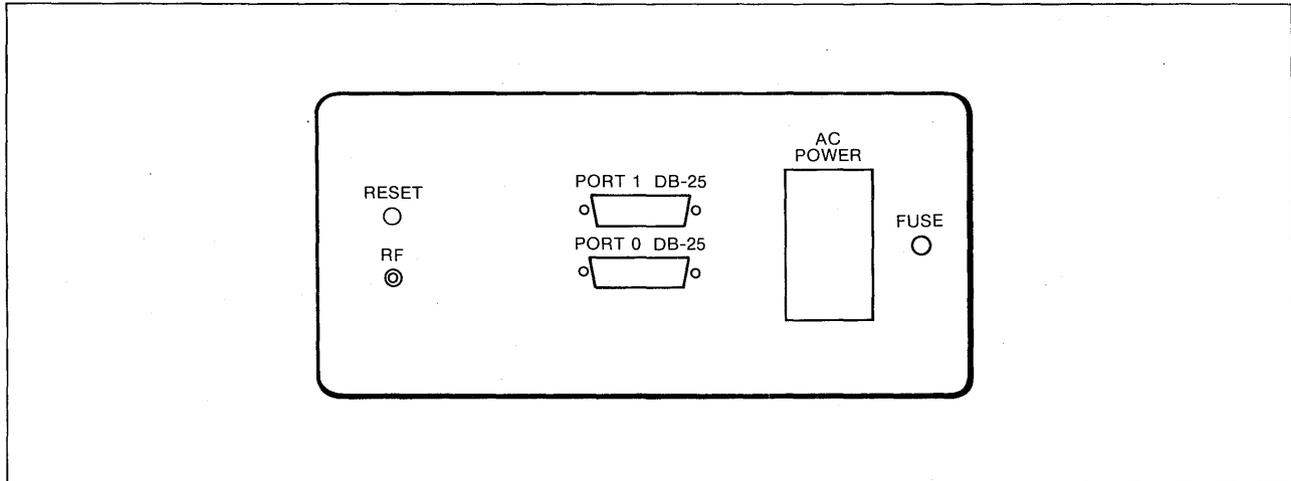


Figure 3-5. LocalNet 20/100 PCU Rear Panel

The *lower* DB-25 connector for a 20/100 is user device port 0 and the upper is user device port 1.

The PCUs contain static and dynamic random access memory (RAM), and use static CMOS RAM, with a battery back-up, for storage of internal configuration and PCU and port attribute information.

Figure 3-6 represents the rear panel of a 20/200 PCU.

The *left-most* connector on a 20/200 rear panel is user device port 0; the connector at the far right is user device port 7.

Internal Software Architecture

The LocalNet PCU software is constructed as a set of cooperating sequential processes, scheduled by a central event processor in response to communication events. In general, the software is organized to reflect the LocalNet protocol architecture, with two processes for each protocol layer. As outlined in Figure 3-8, data bytes (either received from the network or from user devices) pass through a sequence of protocol interpreting processes before delivery to the user device or the network, respectively.

Hardware Description

Internally, a LocalNet PCU is constructed from two printed circuit boards: a digital processing board and the analog broadband modem board. An overall functional block diagram is presented in Figure 3-7.

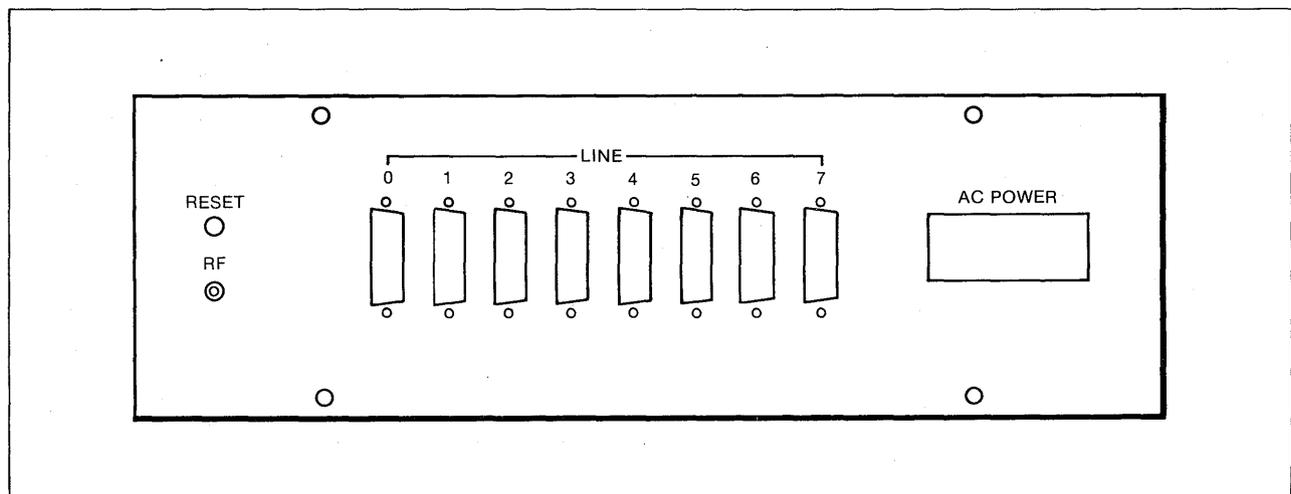


Figure 3-6. LocalNet 20/200 PCU Rear Panel

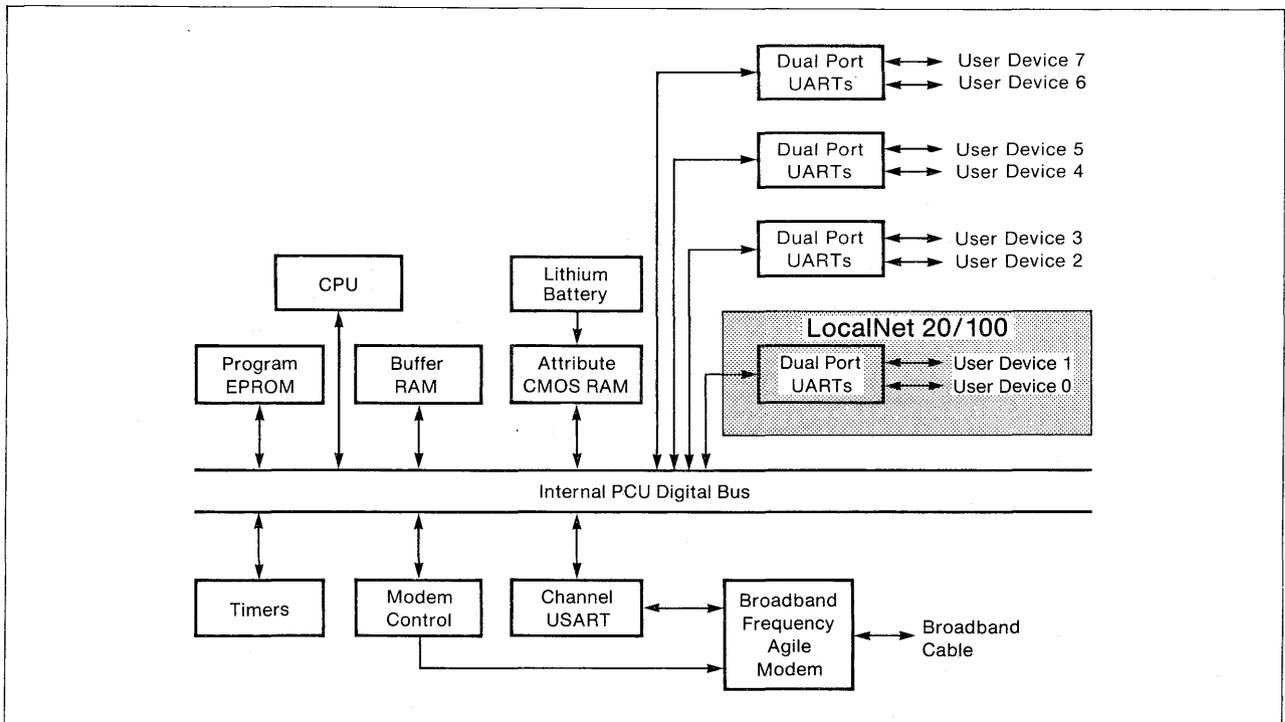


Figure 3-7. LocalNet 20 PCU Hardware Block Diagram

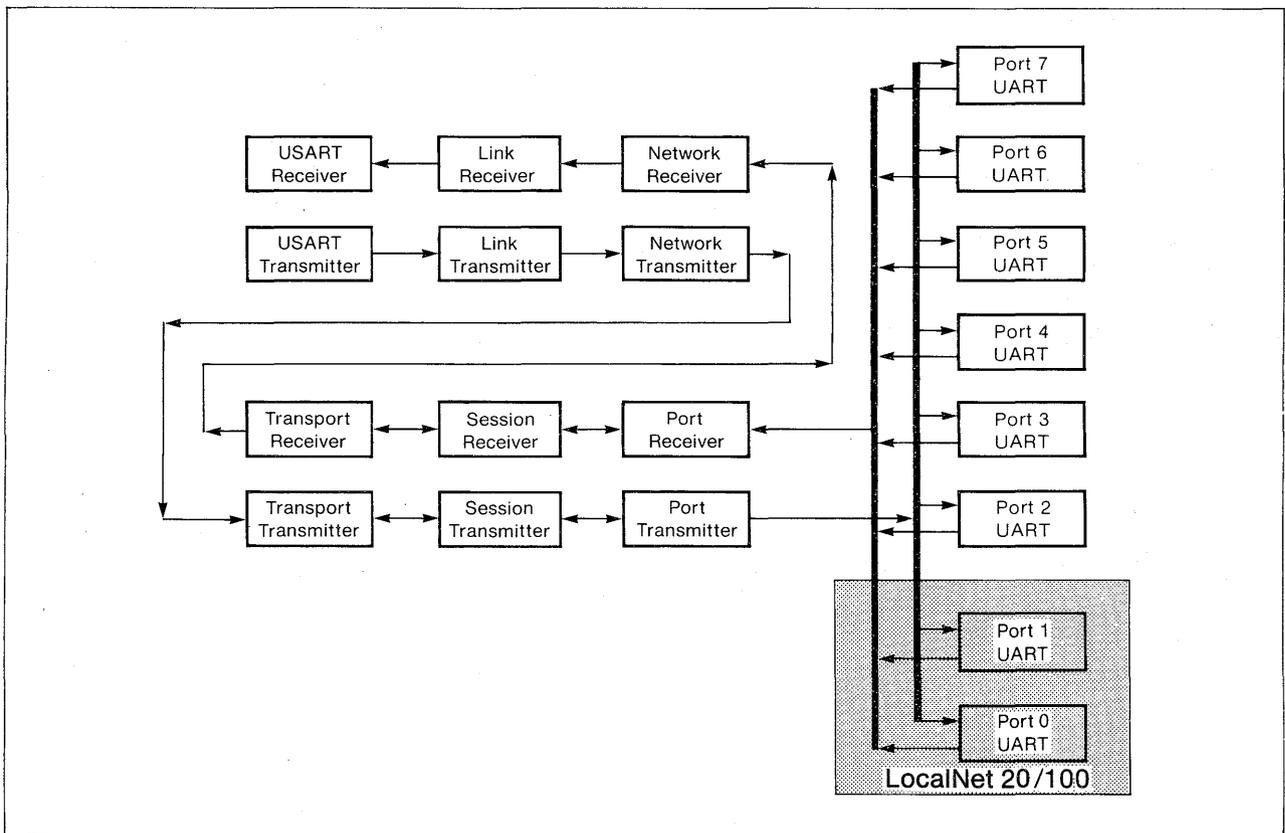


Figure 3-8. LocalNet 20 PCU Software Architecture



COMMAND SYNTAX

LocalNet 20 PCU commands have the form

```
command-name <parameter><CR>
```

Parameters must be specified for most commands. A space separates the command and any parameter. A carriage return serves as the final command delimiter.

For instance,

```
#call 1234,1<CR>
```

```
#disable flow<CR>
```

```
#autobaud on<CR>
```

In the second command above, *flow* is the parameter indicating which command to disable.

The PCU command-line interpreter provides command completion. Therefore, only letters uniquely distinguishing a command need be typed before typing a space or a carriage return. The user may choose to type the complete command or parameter, or any substring beyond the minimal recognition string. For example, type

```
sta<space>    or    sta<carriage return>
```

The interpreter completes the command and

```
staTUS
```

is printed on the screen, followed immediately by the *status* display.

Commands which are not required may be selectively disabled at a PCU, thus preventing their use by either local or remote users. Privileged PCUs may override this disablement either remotely or locally. The message UNKNOWN COMMAND is displayed in response to unknown commands or ones that have been locally or remotely disabled. Invalid parameters elicit the message PARAMETER ERROR.

NOTATION

The following notation is used in this chapter of the manual.

```
comMAND <parameter1a | parameter1b, parameter2>[,optional parameters]
```

where

comMAND — shows the full name of the command. Only the lower case letters need be entered to invoke the command; after entering these letters and a space or carriage return, the remaining letters of the command are printed by the PCU.

<...> — angle brackets enclose necessary parameters for the command.

<1a | 1b> — the vertical bar separates two or more options of a single parameter, only one of which can be selected; “select 1a or 1b”.

<1, 2> — the comma separates two distinct parameters, both of which can be selected.

[, 3] — square brackets enclose optional parameters for the command. Optional parameters follow necessary parameters where both are used, and are separated from them by a comma.

NOTE

All commands that require parameters must be terminated with a carriage return. This character is not shown in the command string, but it must be supplied at the end of each command. The only exception to this rule is the STATUS command. This command can be terminated with either a space or a carriage return.

All special key entries from the keyboard are denoted by upper case letters. For example, BREAK indicates that key on the user's keyboard.

COMMANDS

AUTOBAUD	BAUD												
<p>FUNCTION</p> <p>The <i>autobaud</i> command enables or disables the autobaud (AB) function on pin 25 of the port's RS-232 connector.</p> <p>FORMAT</p> <p>aUTOBAUD <on off></p> <p>where</p> <p>on — means autobaud pin is enabled.</p> <p>off — means autobaud pin is disabled. This is the default.</p> <p>USAGE</p> <p>When the autobaud function is enabled (on), a signal asserted on pin 25 returns the PCU to the autobaud state, just as if a hard reset had occurred.</p> <p>When the function is disabled (off), any signals on pin 25 are ignored.</p>	<p>FUNCTION</p> <p>The <i>baud</i> command resets the PCU port baud rate as specified by the parameter.</p> <p>FORMAT</p> <p>bAUD <baud rate></p> <p>where baud rate is a number selected from the list under USAGE.</p> <p>USAGE</p> <p>The <i>baud</i> command causes the PCU port to:</p> <ol style="list-style-type: none">1 use the designated baud rate to send data to the device, and2 expect data to arrive at the same rate from the device. <p>The <i>baud</i> command requires a parameter from the following list. Note that the rate of 19.2K bps should be used only for data consisting of single characters or short bursts.</p> <table data-bbox="921 1192 1103 1381"><tbody><tr><td>19200</td><td>450</td></tr><tr><td>9600</td><td>300</td></tr><tr><td>4800</td><td>150</td></tr><tr><td>2400</td><td>134</td></tr><tr><td>1200</td><td>110</td></tr><tr><td>600</td><td>75</td></tr></tbody></table> <p>See Chapter 3 for details of the autobaud function.</p> <p>ERROR MESSAGES</p> <p>Designating a baud rate not in the list elicits the message</p> <p>PARAMETER ERROR</p> <p>If the device's baud rate is different from the PCU's new value, data transmitted and received between the device and the PCU port is garbled. This incompatibility continues until the device alters its baud rate, or until a privileged PCU uses the <i>remote</i> command to reset the local PCU's baud rate to match that of its attached device.</p>	19200	450	9600	300	4800	150	2400	134	1200	110	600	75
19200	450												
9600	300												
4800	150												
2400	134												
1200	110												
600	75												

COMMANDS

CALL

FUNCTION

The *call* command initiates a session to the designated PCU port. Establishment of a session elicits the following response:

CALL COMPLETED TO <LocalNet Address>

The originating user device port is automatically switched to the new session, following successful call completion.

FORMAT

cALL <unitId>[,portId]

where

unitId,portId — is a fully qualified address

unitId — is a rotary address

USAGE

The parameter can specify either a particular user device port or any one of a class of equivalent user device ports, on one or more PCUs with consecutive *unitIds*.

NOTE

If the user does not know what the command mode entry string is before making a call, then she or he will have difficulty in returning to command mode from data mode in order to issue further commands. It may be possible to issue a *remote status* command from another terminal, at either the local or a remote PCU, in order to determine the proper command mode entry string. But if the local port can have only one current session, a new session cannot be opened in order to check the status remotely.

To avoid problems, check the command mode entry string before originating a call.

"CTRL B CTRL B" EXITS

ERROR MESSAGES

The requested call may not be completed for reasons having to do with the local PCU, the remote PCU, or the network generally.

- If the call specifies a particular port and the port cannot accept the request, or if a rotary request is made but no rotary ports are available, the calling PCU port produces the message

UNABLE TO OPEN SESSION—PORTS BUSY

- If all sessions are in use on the local (calling) port, the message is

NO SESSIONS AVAILABLE ON THIS PORT

- If all sessions are in use on the remote unit, the message is

UNABLE TO OPEN SESSION—NO REMOTE SESSIONS AVAILABLE

- If all sessions are in use on the local unit, the message is

NO SESSIONS AVAILABLE ON THIS UNIT

- If the called unit does not respond, the message is

UNABLE TO OPEN SESSION—NO RESPONSE FROM UNIT

- The call may have requested a remote unit lacking the resources to complete the call; there may be no free table entry at one of several levels of protocol. In this case, the message is

NO RESOURCES AVAILABLE ON REMOTE

- The call may have requested a remote unit lacking in "servers," that is, high-level processes for handling the call. Here the message is

NO SERVER ON REMOTE

- The local PCU may have received an unexpected acknowledgement of an *open* request, although it had not requested that a session be opened. In this case, the message is

RECEIVED UNEXPECTED OPEN ACK

- The remote PCU may have received an unknown result code in a *call* request. This produces the message

OPEN FAILURE, UNKNOWN CAUSE ON REMOTE

COMMANDS

COMMAND	DCD
<p>FUNCTION</p> <p>The <i>command</i> command specifies the event to be used to enter command mode. The user device can select either the RS-232C BREAK signal, or a two character ASCII sequence.</p> <p>FORMAT</p> <p>coMMAND <none break nn,mm></p> <p>where</p> <p>none — Enter command mode only when no sessions are active.</p> <p>break — Use BREAK.</p> <p>nn,mm — Use the two character sequence specified by the four hexadecimal characters: nn and mm.</p> <p>The designated delimiter takes effect immediately.</p> <p>USAGE</p> <p>The default command mode entry string is the <i>escape</i> character, followed by the <i>delete</i> character.</p> <p>ERROR MESSAGES</p> <p>An invalid parameter elicits the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>DCD</i> command determines whether or not the Data Carrier Detect signal is controlled by the session activity, or is continuously asserted.</p> <p>FORMAT</p> <p>DCD <off on></p> <p>where</p> <p>off — sets control OFF, DCD continuously asserted; this is the default value.</p> <p>on — sets control ON, DCD is asserted when one or more sessions exist on the port.</p> <p>ERROR MESSAGES</p> <p>A parameter unrecognized by the PCU will generate the message</p> <p>PARAMETER ERROR</p>

COMMANDS

DISABLE	DONE
<p>FUNCTION</p> <p>The <i>disable</i> command specifies those commands which will be unavailable to unprivileged PCUs. Disabled commands can be subsequently re-enabled by the <i>enable</i> command. Attempts to invoke a disabled command, either locally or remotely, (except from a privileged PCU) are rejected.</p> <p>FORMAT</p> <p>diSABLE <command-name></p> <p>where</p> <p>command-name — is the name of the command to be disabled.</p> <p>ERROR MESSAGES</p> <p>An attempt to disable an unknown command will generate the message:</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>done</i> command causes the PCU to terminate the specified session.</p> <p>FORMAT</p> <p>doNE [<i>sessionNo</i>]</p> <p><u>doNE RETURN RETURN</u></p> <p>where</p> <p><i>sessionNo</i> — specifies the session to close.</p> <p>When no value is supplied, the command must be terminated by a space and a carriage return, or by two carriage returns, instead of a single carriage return. In this case, the current session is closed.</p> <p>USAGE</p> <p>When closure is successful, the PCU generates the message</p> <p>SESSION <X> CLOSED TO <LocalNet address></p> <p>ERROR MESSAGES</p> <p>If the remote PCU fails to respond to the closure request, the message</p> <p>SESSION <X> ABORTED TO <LocalNet address></p> <p>is displayed.</p> <p>If no session is defined for the supplied <i>sessionNo</i>, or if no session exists, the PCU generates the message</p> <p>PARAMETER ERROR</p>

COMMANDS

DTR	ECHO
<p>FUNCTION</p> <p>The <i>DTR</i> command determines how the DTR input signal controls the establishment and termination of sessions.</p> <p>When DTR control is on or a DTR timeout value is specified, and the DTR signal changes from asserted to negated, all current sessions are terminated.</p> <p>When DTR control is on or a DTR timeout is specified, and the DTR signal is not asserted by the user device, no incoming session requests to this port are accepted.</p> <p>When a DTR timeout value is specified, the RI signal will be raised when an incoming call is received. A session is established when DTR is raised within the specified interval.</p> <p>When DTR control is off, sessions can be established either locally or remotely, and maintained without regard for the DTR signal. When DTR is off, and incoming sessions are enabled, and an incoming request is detected, and no DTR signal has been received from the user device, Ring Indicator (RI) is raised. RI is lowered when DTR is received from the user device.</p> <p>Outgoing calls can be placed from the port regardless of the DTR setting.</p> <p>FORMAT</p> <p><code>DTR <on off x></code></p> <p>where</p> <ul style="list-style-type: none"><code>on</code> — means listen for incoming DTR signal.<code>off</code> — means ignore the DTR signal; this is the default value.<code>x</code> — means assert the RI signal and wait <code><x></code> times 10 milliseconds for DTR to be asserted by the user device; <code>x</code> can be from 1-255. <p>ERROR MESSAGES</p> <p>Entering a parameter beyond the range recognized by the PCU elicits the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>echo</i> command causes the PCU port to echo to the user device the data which the user device has presented to the PCU for transfer.</p> <p>FORMAT</p> <p><code>echo <on off></code></p> <p>where</p> <ul style="list-style-type: none"><code>on</code> — enables local echo.<code>off</code> — disables local echo; this is the default. <p>NOTE</p> <p>Local echoing is only intended for use with input having low data rates, such as that produced by a half-duplex terminal. Use of <i>echo</i> with input having high data rates will cause some characters not to be echoed.</p>

COMMANDS

ENABLE	EOM
<p>FUNCTION</p> <p>The <i>enable</i> command enables previously disabled commands which can then be invoked either locally or remotely.</p> <p>FORMAT</p> <p>enABLE < command-name ></p> <p>where</p> <p>command-name — is the name of the command to be enabled.</p> <p>ERROR MESSAGES</p> <p>An unknown command elicits the message</p> <p>PARAMETER ERROR</p> <p>If the <i>enable</i> command has been disabled, the response is</p> <p>UNKNOWN COMMAND</p>	<p>FUNCTION</p> <p>The <i>eom</i> command specifies the conditions under which End Of Message (EOM) is signaled to the remote PCU. Detection of EOM, in addition to marking the data stream, also causes immediate forwarding of the current packet. The command does not itself elicit a display, but the message delimiters set by it are indicated in the status display.</p> <p>FORMAT</p> <p>eoM < none newline control ></p> <p>eoM < message-length ></p> <p>where</p> <p>none — specifies normal buffer forwarding; no EOM is signaled. This is the default, with a message length (called EOM COUNT on the status display) of zero.</p> <p>newline — specifies the newline character.</p> <p>control — specifies any control character.</p> <p>message-length — specifies the minimum message length, 0-255 characters.</p> <p>USAGE</p> <p>When the <i>EOM</i> indicator is either "newline" or "control", the additional "message-length" parameter can be specified in a separate <i>EOM</i> command. A packet will be terminated when either a newline or control character is encountered, or when the minimum character count is reached.</p> <p>Changing to one of these EOM options from the default value (none), should be done only by personnel familiar with the network, and only for specific reasons (for example, to guarantee a certain packet size). Otherwise, performance can be severely degraded.</p> <p>The message length parameter should be zero for almost all applications.</p> <p>When "none" is specified, the "message-length" parameter cannot be specified.</p>

COMMANDS

A message length of zero disables message length checking.

ERROR MESSAGES

Invalid parameters elicit the message

PARAMETER ERROR

NOTE

Use of a small value (less than 32) for the EOM count can result in loss of data at high data rates. The loss of data results from resources being exhausted by the large number of packets being generated.

EXPAND

FUNCTION

The *expand* command enables or disables newline expansion and specifies the expansion character. Newline expansion occurs by local echoing of the expansion character when the newline character is entered. This command also specifies the value of the expansion character. No display occurs when a PCU accepts the *expand* command, but an appropriate entry appears in the status display. The expansion character is not included in the packet going to the remote device.

FORMAT

exPAND <none | nn>

where

none — disables newline expansion; this is the default value.

nn — enables newline expansion and specifies the ASCII character represented by the hexadecimal value nn as the expansion character.

COMMANDS

FLOW

FUNCTION

The *flow* command specifies the type of local flow control applied between the PCU port and the user device. If flow control is not used, data may be lost when the load is heavy on a PCU, channel, or device. Local flow control may result in flow control on the virtual connection, which in turn may result in flow control at the remote PCU port.

FORMAT

`fLOW <none|EIA|xon>`

where

`none` — specifies that no flow control signals are recognized or generated by the PCU.

`EIA` — specifies that bidirectional flow control between a PCU port and a user device is implemented, using RS-232C pins as specified in Appendix D.

`xon` — specifies that bidirectional flow control between a PCU port and a user device is implemented using the `xon` and `xoff` characters. This is the default.

ERROR MESSAGES

Invalid parameters elicit the message

PARAMETER ERROR

GROUP

FUNCTION

The *group* command specifies the modem channel group for the PCU. It is normally issued only by the Network Manager, and the modem channel group is never changed unless the PCU is replaced.

Table 4-1. Group and Channel Designations for Midsplit and Subsplit Cable Networks

MIDSPLIT		SUBSPLIT	
Group	Channels	Group	Channels
A	0-19	L	0-19
B	20-39	M	20-39
C	40-59	N	40-59
D	60-79		
E	80-99		
F	100-119		

FORMAT

`gROUP <A|B|C|D|E|F|L|M|N>`

where

`A-F` — specifies a group of channels on a mid-split system.

`L-N` — specifies a group of channels on a sub-split system.

The parameter specifies the LocalNet 20 channel group to which the installed modem belongs.

There is no default parameter for this command. Each PCU must be initialized to the desired group before the user can reliably communicate on the network. Check the current group of a PCU with the `STATUS` command.

ERROR MESSAGES

An invalid parameter elicits the message

PARAMETER ERROR

and the command is ignored.

COMMANDS

HELP	IDLE
<p>FUNCTION</p> <p>The <i>help</i> command displays a list of enabled commands. The list does not include currently disabled commands. There is no indication of the parameters which the displayed commands may require. Placing the PCU port in <i>quiet</i> mode has no effect on the display of enabled commands. A sample display appears in Figure 4-1.</p> <p>FORMAT</p> <p>hHELP</p>	<p>FUNCTION</p> <p>The <i>idle</i> command specifies the setting of the idle timer for the port. The PCU maintains the timer after each character is received from the user device. If a subsequent character is received from the device before the timer expires, the timer is restarted. If no subsequent character is received before the timer expires, the contents of the buffer are then transmitted as a packet.</p> <p>FORMAT</p> <p>idLE <nn></p> <p>where</p> <p>nn — is a decimal number designating the idle interval in units of 10 milliseconds. Zero specifies an infinite setting, effectively disabling the timer-based packetization mechanism.</p> <p>The default value is 5 (50 msec).</p>

AUTOBAUD	BAUD	CALL	COMMAND	DCD	DISABLE
DTR	DONE	ECHO	ENABLE	EOM	EXPAND
FLOW	GROUP	HELP	IDLE	INTERRUPT	LISTEN
LOCATION	MAXSESSION	NEWLINE	PARITY	PRIVILEGE	QUIET
REMOTE	STATUS	STOPS	SUSPEND	SWITCH	UNIT
XOFF	XON				

Figure 4-1. HELP Display

COMMANDS

INTERRUPT	LOCATION
<p>FUNCTION</p> <p>The <i>interrupt</i> command causes the PCU to transmit a control signal across the current session to the remote PCU's port. No in-transit data are flushed by this operation. An interrupt control signal is delivered through the remote PCU's port to the corresponding user device as an RS-232C <i>break</i> signal on its RD line.</p> <p>FORMAT</p> <p>inTERRUPT</p> <p>ERROR MESSAGES</p> <p>If no session exists, the PCU generates the message</p> <p>NO SESSION</p> <p>LISTEN</p> <p>FUNCTION</p> <p>The <i>listen</i> command determines whether the PCU port will accept incoming requests for sessions. The system provides no visual response to the command. Check the PCU status if confirmation is needed.</p> <p>FORMAT</p> <p>liSTEN <on off></p> <p>where</p> <p>on — Incoming requests for sessions are accepted if the current number of sessions is less than that specified by <i>maxsession</i>. This is the default.</p> <p>off — Incoming requests for sessions are ignored.</p>	<p>FUNCTION</p> <p>The <i>location</i> command sets the channel number and <i>LinkAddress</i> on that channel for a PCU.</p> <p>FORMAT</p> <p>loCATION <channelNo>[,linkAddress]</p> <p>where</p> <p><i>channelNo</i> — specifies the channel on which the PCU will operate, from 0 to 119 depending on its <i>group</i>.</p> <p><i>linkAddress</i> — specifies the link address of the PCU on the network, from 0 to 254.</p> <p>USAGE</p> <p>This command is normally used only by the Network Manager to initialize a PCU to its network address. Usually, the command is disabled in all PCUs after their initial configuration by the Network Manager.</p> <p>A specific example is:</p> <p><i>location</i> 23,134</p> <p>The PCU's modem can also be retuned to a new channel by giving the <i>location</i> command with a new <i>channelNo</i> alone. This provides a new <i>channelNo</i> without changing the <i>linkAddress</i>.</p> <p>As a result of this command, the PCU's internal address variables are updated, and the modem is tuned to the specified <i>channelNo</i>. The PCU henceforth uses the specified <i>linkAddress</i> for its link level protocol address.</p> <p>If no <i>linkAddress</i> is specified, it is unchanged.</p> <p>ERROR MESSAGES</p> <p>If an address has a value outside the accepted range, the message</p> <p>PARAMETER ERROR</p> <p>is returned.</p>

COMMANDS

MAXSESSION	NEWLINE
<p>FUNCTION</p> <p>The <i>maxsession</i> command determines the maximum number of sessions that can be simultaneously attached to a single port. The system provides no visual response to the command. Check the PCU status if confirmation is needed.</p> <p>FORMAT</p> <p>mAXSESSION <nn></p> <p>where</p> <p>nn — specifies the maximum number of sessions allowed: 1-4 for LocalNet 20/100; 1-16 for LocalNet 20/200. The default value is 1 for both devices.</p> <p>ERROR MESSAGES</p> <p>Issuing the command with a parameter greater than the number of available PCU sessions elicits the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>newline</i> command specifies the value to be used for the newline character. The system provides no visual response to the command. Check the PCU status if confirmation is needed. The current "newline" character is represented in the status display by the hexadecimal value of the selected character.</p> <p>FORMAT</p> <p>nEWLINE <nn></p> <p>where</p> <p>nn — is a hexadecimal number that specifies the ASCII character used for newline. The default is the carriage return (0D hexadecimal).</p> <p>ERROR MESSAGES</p> <p>A parameter not in range elicits the message</p> <p>PARAMETER ERROR</p>

COMMANDS

PARITY	PCALL
<p>FUNCTION</p> <p>The <i>parity</i> command specifies the parity to be applied to characters output to the device. No display results, though PCU status information is updated. If parity is "none," 8-bit data is passed to the device as it was received from the sending device. If parity is "odd" or "even", parity is generated for 7-bit data and passed to the device. Note that incoming parity is never checked by the PCU.</p> <p>FORMAT</p> <p>paRITY <none odd even></p> <p>where</p> <p>none — denotes no parity. This is the default value.</p> <p>odd — denotes odd parity.</p> <p>even — denotes even parity.</p> <p>ERROR MESSAGES</p> <p>A parameter not in range elicits the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>pcall</i> command determines if permanent sessions are to be established, and under what conditions. Calls are made to the unit and port specified by the <i>punit</i> command. Depending on the mode selected, sessions can be established automatically or when prompted.</p> <ol style="list-style-type: none">1 In AUTO mode, whenever no sessions exist on the local port, an attempt is made to establish a session to the specified unit and port. This attempt is made when one of the following conditions is met.<ol style="list-style-type: none">a. DTR mode set to OFF.b. DTR mode set to ON and DTR signal asserted.c. DTR mode set to timeout and DTR signal asserted.When a session cannot be established to the remote unit, a new attempt is made approximately every 20 seconds in AUTO mode.2 In ON mode, whenever no session exists on the local port, an attempt is made to establish a session to the specified unit and port whenever a carriage return is entered as the first character of a line in command mode. This attempt is made when one of the following conditions is met.<ol style="list-style-type: none">a. DTR mode set to OFF.b. DTR mode set to ON and DTR signal asserted.c. DTR mode set to timeout and DTR signal asserted.Only one attempt is made to open a session in ON mode.

COMMANDS

FORMAT

pcALL <off|on|auto>

where

- off — Permanent session capability is disabled. This is the default.
- on — An attempt to establish a permanent session will be made when triggered by an external event.
- auto — An attempt to form a permanent session will be made when no session already exists on the local port.

ERROR MESSAGES

[see call]

PUNIT

FUNCTION

The *punit* command identifies the *unit* and, optionally, the *port* to which a permanent session is to be made.

FORMAT

puNIT <unitld>[,portld]

where

unitld,portld — denotes a fully qualified address.

unitld — denotes a rotary address.

COMMANDS

PRIVILEGE	QUIET
<p>FUNCTION</p> <p>The <i>privilege</i> command enables or disables the PCU's privilege mode. In privilege mode, a PCU port can override both local and remote command disablement, and can execute any command on any PCU.</p> <p>FORMAT</p> <p>prIVILEGE <on off></p> <p>where</p> <p>on — enables privilege mode. This is the default.</p> <p>off — disables privilege mode.</p> <p>USAGE</p> <p>To prevent the <i>privilege</i> command from being used, the following command sequence should be executed:</p> <p>#privilege off -> Turns privilege off</p> <p>#disable privilege -> Makes privilege an unknown command</p> <p>#disable enable -> Prevents privilege from becoming known</p> <p>#disable disable -> Prevents disabling of other commands</p> <p>ERROR MESSAGES</p> <p>A parameter not in range elicits the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>quiet</i> command enables or disables the display of messages which indicate response to local and remote commands. The PCU responds to the commands, but no information about the response is returned to the user device. This command affects the following features:</p> <ul style="list-style-type: none">• command mode prompt;• command mode echo;• command mode responses;• error messages in data mode. <p>FORMAT</p> <p>qUIET <on off></p> <p>where</p> <p>on — disables command responses.</p> <p>off — enables command responses.</p> <p>USAGE</p> <p>PCUs that are attached to computer ports might use this command to prevent unusable input from being sent to the computer.</p> <p>NOTE</p> <p>A PCU port left <i>quiet</i> by a previous user may appear inoperative to subsequent users who cannot see the LEDs on the PCU. Therefore, responses to the <i>status</i> and <i>help</i> commands are not suppressed by this command, and can be used to determine the status of the port.</p>

COMMANDS

REMOTE	STATUS
<p>FUNCTION</p> <p>The <i>remote</i> command precedes each command that is to be applied to a remote PCU. It is only applicable while a session is active. PCU attributes that are altered by remote commands remain changed after the session is terminated.</p> <p>This command is useful in dealing with a PCU interfacing a computer, printer, or alarm system to the network. Commands which are disabled on the remote PCU can be invoked only by a privileged PCU.</p> <p>FORMAT</p> <p>rEMOTE <command></p> <p>where</p> <p>command — specifies the command to be executed on the remote PCU.</p> <p>USAGE</p> <p>The command takes the string following <i>remote</i> and sends it to the remote PCU for execution as if it had been entered from the RS-232 port on the remote PCU. The <i>remote</i> command to be executed need not be available on the local PCU. Note that commands are executed by the remote PCU with the privilege mode of the originating PCU.</p> <p>The results of the remote execution are returned from the remote PCU for display at the requesting PCU port.</p> <p>ERROR MESSAGES</p> <p>Attempting to perform this command when a session is not established yields the message</p> <p>NO SESSIONS</p> <p>Errors returned by the remote PCU are displayed at the user device attached to the requesting PCU. A remote <i>remote</i> command is not allowed.</p>	<p>FUNCTION</p> <p>The <i>status</i> command displays the current values of port attributes and the status of established sessions.</p> <p>FORMAT</p> <p>staTUS</p> <p>USAGE</p> <p>Figure 4-2 represents one of many possible status displays.</p> <p>The XXX on the top line of this display is replaced in an actual display with the LocalNet 20 number of the PCU: 100 or 200. The YYY is replaced with the version number of the PCU's software.</p> <p>The first four digits in the <i>unit</i> number give the <i>unitId</i> of the PCU. The next number gives the <i>portId</i> of the PCU port whose status is being reported.</p> <p>The last lines of the status display show how many sessions exist for that port. A session may be either active or suspended. The asterisk (*) indicates the current session. Any session may be suspended, even the current session.</p> <p>The entries after <i>group</i> and <i>location</i> provide information about which group of channels the PCU belongs to, and what its <i>linkAddress</i> on the channel is.</p> <p>The characters after <i>command</i> indicate, in hexadecimal, the character string used to enter command mode.</p> <p>The characters following the entries for <i>eom character</i>, <i>newline</i>, <i>expand</i>, <i>xon</i> and <i>xoff</i> indicate which characters are used to define each condition. The <i>newline</i> character's value is also given in hexadecimal.</p> <p>Entries after <i>baud</i>, <i>echo</i>, <i>flow</i>, <i>parity</i>, <i>listen</i>, <i>expand</i>, <i>privilege</i> and <i>quiet</i> indicate which options are currently enabled.</p> <p>The entry after <i>idle</i> indicates, in units of 10 msec., the period for which the idle timer is set. The entry after</p>

COMMANDS

eom count indicates the minimum character count defining the End of Message signal.

The entry after *maxsession* indicates the maximum number of sessions possible at that port.

The entry after *stops* shows the number of stop bits needed in data bytes output on the EIA interface.

STOPS

FUNCTION

The *stops* command specifies the number of stop bits used on the EIA interface to this port. The command does not itself produce any display. The status display indicates the current number of stop bits required.

FORMAT

stoPS <1|1.5|2>

where

1, 1.5, or 2 — specifies the number of stop bits.
The default is 1.

ERROR MESSAGES

A parameter not in range elicits the message

PARAMETER ERROR

LOCALNET	20/XXX	22-01	VYYY		
UNIT	0012,1	BAUD	4800	IDLE	5
GROUP	A	PARITY	NONE	EOM COUNT	0
LOCATION	08,01	STOPS	1	EOM CHARACTER	NONE
COMMAND	1B,7F	AUTOBAUD	ON	NEWLINE	0D
LISTEN	ON	DCD CONTROL	OFF	EXPAND	NONE
PRIVILEGE	OFF	DTR CONTROL	OFF	XON	11
MAXSESSION	1	ECHO	OFF	XOFF	13
PCALL	OFF	QUIET	OFF	FLOW	XON
PUNIT	0000	TIMEOUT	0		
SESSIONS					
1} 0011,1* ACTIVE					
2} 0006,2 SUSPEND					

Figure 4-2. STATUS Display

COMMANDS

SUSPEND

FUNCTION

The *suspend* command deactivates the specified session. The PCU suspends the specified session by preventing the flow of data to the user device. All sessions may be suspended, if the user chooses.

To reconnect to a suspended session, the *switch* command must be used, with a number identifying the session to be made current. The session number may range from 1 through 255.

On completion, the command causes an update of the tables used to generate the status display. If the *status* command is issued after the *suspend* command, the session suspended is marked

SUSPEND

FORMAT

suSPEND <*sessionNo*>

where

sessionNo — specifies the number of the session to be suspended.

ERROR MESSAGES

If an attempt is made to suspend a nonexistent session, the user device will receive the message

PARAMETER ERROR

SWITCH

FUNCTION

The *switch* command switches the user device to a session attached to the port. If the session was suspended, it is reactivated.

FORMAT

switch <*sessionNo*>

where

sessionNo — specifies the number of the session to switch to.

ERROR MESSAGES

If an attempt is made to switch to an undefined session, the PCU generates the message

PARAMETER ERROR

COMMANDS

TIMEOUT	UNIT
<p>FUNCTION</p> <p>The <i>timeout</i> command allows a port to be disconnected automatically if no input or output to the device has occurred during a specified interval.</p> <p>FORMAT</p> <p>timeout <0 1-30></p> <p>where</p> <p>0 — disables the timeout feature. This is the default.</p> <p>1-30 — indicates the time in minutes to wait before disconnecting.</p> <p>ERROR MESSAGES</p> <p>Entering a parameter outside the range of 0 to 30 minutes will elicit the message</p> <p>PARAMETER ERROR</p>	<p>FUNCTION</p> <p>The <i>unit</i> command specifies the <i>unitId</i> for the PCU.</p> <p>FORMAT</p> <p>uNIT <nnnn></p> <p>where</p> <p>nnnn — specifies the unitId for the PCU, a hexadecimal value between 0000-FFFF.</p> <p>ERROR MESSAGES</p> <p>An invalid parameter elicits the message</p> <p>PARAMETER ERROR</p> <p>and the command is ignored.</p> <p>NOTE</p> <p>If unit numbers are assigned consecutively, a rotary call to a lower unit number which is busy will attempt to connect to the next unoccupied higher-numbered PCU. For this reason, it is recommended that PCUs which are not intended to be part of a multi-unit rotary be given unit numbers with intervening numbers left unassigned.</p>

COMMANDS

XOFF	XON
<p>FUNCTION</p> <p>The <i>xoff</i> command specifies the hexadecimal value of the character to be used for xoff in the xon/xoff flow control protocol. The selected xoff value appears in the status display in hexadecimal.</p> <p>FORMAT</p> <p><code>xofF <nn></code></p> <p>where</p> <p><code>nn</code> — specifies the hexadecimal equivalent of the characters to be used for flow control. The default value is 13 hexadecimal, or an ASCII control-S, or DC3.</p>	<p>FUNCTION</p> <p>The <i>xon</i> command specifies the hexadecimal value of the character to be used for xon in the xon/xoff local flow control protocol. The xon character appears in the status display in hexadecimal.</p> <p>FORMAT</p> <p><code>xon <nn></code></p> <p>where</p> <p><code>nn</code> — specifies the hexadecimal equivalent of the characters to be used for flow control. The default value is 11 hexadecimal, or an ASCII control-Q, or DC1.</p>

PCU CHECK OUT

After receiving a LocalNet 20 PCU, do the following.

- 1 Remove the PCU from its shipping container and inspect for damage. If it appears damaged in any way, notify the carrier and keep all packing materials for inspection by the carrier's agent.

- 2 Plug the power cord into an outlet supplying 110 volts of alternating current (AC) power.

After the PCU is plugged in, the *power* light-emitting diode (LED) on the front panel of the PCU should immediately turn red. In several seconds the *status* LED should also turn red. Both lights should then change within several seconds as described below. If the LEDs are unlit, the PCU is not getting power; try another outlet. If the LEDs remain unlit, return the PCU for service.

When first plugged in, a PCU executes a self-test procedure to verify correct operation. When the PCU passes this self-test, the *power* LED turns green and the *status* LED is extinguished. If both LEDs stay red for more than 30 seconds, or if both remain yellow, the PCU should be returned for service.

When operating, the PCU uses the *power* and *status* LEDs to indicate its status. Figure 5-1 presents the possible combinations of these LEDs, and their significance.

In addition to the *power* and *status* LEDs, the front panel of the 20/200 also presents eight *line* LEDs, one for each user device port. In most configurations, each of these lights remains unlit until a connection is formed to the associated port. However, if *listen* is off, *maxsession* is zero, or *DTR control* is on and the DTR signal is not asserted, the *line* LED glows red, indicating that the port can not accept incoming session requests.

POWER	STATUS	INDICATION
OFF	OFF	NO POWER
RED	OFF	INITIALIZATION BEFORE SELF-TEST
RED	RED	SELF-TEST EXECUTING (> 30 sec. indicates failure)
GREEN	OFF	READY, NO CONNECTION ESTABLISHED
GREEN	GREEN	READY, ONE OR MORE CONNECTIONS ESTABLISHED
YELLOW	YELLOW	PCU PROCESSOR NOT RUNNING

NOTES:
The 'power' LED flashes green when a packet is transmitted, while the 'status' LED flashes green when a packet is received.

Figure 5-1 PCU LED Display

TERMINAL ATTACHMENT

When the LED display indicates that the PCU is working correctly, use the bottom (port 0) DB-25 connector at the back of the 20/100 PCU to attach an RS-232-C terminal to the PCU. For the 20/200 PCU, use the left-most port (port 0).

Reset

Having attached the terminal to the PCU, press the reset button on the back of the PCU once, wait two seconds, then press the reset button again while the *status* and *power* LEDs are still red. This *double reset* is called a hard system reset. It causes the PCU to run self tests for several seconds, to reset most attributes to their initial values, and to prepare to match the baud rate of the attached device, by going through the *autobaud* process.

Self Tests

The PCU runs several tests on itself. These tests check the device's memory (both ROM and Read/Write Memory), its LSI components, and the modem

PCU INSTALLATION AND SET UP

circuitry. When these tests are executing, the LEDs are red. After successful completion, the PCU moves into the autobaud mode. When a test is not successfully completed, an appropriate message indicates the cause. These messages appear only on the terminal connected to port 0 of the PCU.

CABLE JAMMED — indicates that the PCU was unable to access the network. This could be due to a problem in the modem circuitry, or a network that is extremely busy. Eliminate the latter factor by running these tests when the network is not busy.

CARRIER LOOPBK FAILURE — indicates that a carrier signal was transmitted out of the PCU, but not received properly.

DATA LOOPBK FAILURE — indicates that data was transmitted out of the PCU, but not received properly.

MEMORY ERROR AT xxxx yy — indicates a problem in the PCU memory, at location xxxx, which contained the value yy.

Autobaud

The process of autobauding allows the PCU to determine and match the baud rate of the attached device by inspecting the characters sent to the PCU from that device. When the unit is ready to begin the autobaud process, the PCU's power indicator is green and the status indicator unlit.

At this point, type a carriage return. If the PCU does not recognize the carriage return, it moves to the next lower baud rate. Enter another carriage return. The PCU repeats this process until it recognizes a carriage return. If the PCU fails to recognize the carriage return at the proper baud level, it moves down to 75 bps (the lowest baud rate), pauses briefly to see if data is being received, and then repeats the process, beginning again with 19200 bps.

When in the autobaud state, the PCU returns to a baud rate of 19200 bps anytime an interval of more than 2.5 seconds occurs since the last carriage return, providing the baud rate has not yet been matched.

When the PCU and the terminal are operating at the same rate, the PCU sends its attached device the message

```
LOCALNET—<hardware version>—<software version> (C)Sytek 1982
```

This initial message will be completely legible only if the terminal expects to receive characters without parity and with single stop bits. If the initial message is completely legible, you can proceed to attach the PCU to the cable system. If the display is not legible, the communication between the terminal and the PCU must be improved before you can proceed.

NOTE

If *quiet* is already set to *on*, the initial message will not be displayed.

The setting for *quiet*, and the success of autobauding, can be checked by entering *status*, to request a display of the PCU's current status. The *status* display appears even if *quiet* is on. If the *status* request elicits the UNKNOWN COMMAND response, insure this command is available by entering *enable status*.

Default Settings

At the end of the autobaud process, the PCU reverts to the default configuration given in Figure 5-2. Note that the settings for *unit*, *group*, *privilege*, and *quiet* are unchanged by autobaud.

When this display appears at the terminal, the first XXX in the top row will be replaced with the LocalNet 20 number of the PCU (100 or 200). The YYY will be replaced with the software version number. When the display appears, the PCU can be attached to the cable system. If the display is not legible, the communication between the terminal and the PCU must be improved before the next step.

The Help Command

With the PCU in default configuration, check the device's ability to communicate with the PCU by typing h <carriage-return>.

On receiving this short form of the help command, the PCU causes the terminal to produce a display like the one given in Figure 5-3, which lists the commands which that PCU can recognize. Any disabled commands do not appear in the *help* display.

Parity and Stop Bits

If the display of PCU commands is garbled, the attached device can communicate with the PCU but

PCU INSTALLATION AND SET UP

LOCALNET	20/XXX	22-01	VYYY			
UNIT	{unchanged}	BAUD	19,200	IDLE	5	
GROUP	{unchanged}	PARITY	NONE	EOM COUNT	0	
LOCATION	--,--	STOPS	1	EOM CHARACTER	NONE	
COMMAND	1B,7F	AUTOBAUD	ON	NEWLINE	OD	
LISTEN	ON	DCD CONTROL	OFF	EXPAND	NONE	
PRIVILEGE	{unchanged}	DTR CONTROL	OFF	XON	11	
MAXSESSION	1	ECHO	OFF	XOFF	13	
PCALL	OFF	QUIET	{unchanged}	FLOW	XON	
PUNIT	{unchanged}	TIMEOUT	0			

Figure 5-2. PCU Default Status Display

cannot fully understand what the PCU sends in reply. Possible causes include:

- The device expects to receive characters with parity but is getting characters without it.
- The device expects to receive characters having one and a half or two stop bits, rather than the one stop bit provided by the default settings.
- The device word length is configured for seven bit words, instead of eight bit words.

To deal with this problem, first determine the parity and number of stop bits the user device needs on received characters. Then change the current PCU settings, using the *parity* and *stops* commands as necessary.

Questions to Ask

Use the following questions to help isolate any hardware trouble:

- 1 Is the terminal an ASCII terminal with an EIA RS-232-C interface?
- 2 Are the cable and DB-25 connectors sound?
- 3 Is the connector at one end of the cable attached firmly to the bottom DB-25 connector

on the back of the 20/100 PCU, or the left-most connector on the back of the 20/200 PCU (port 0)?

- 4 Is the connector at the other end of the cable attached firmly to the correct socket on the terminal?
- 5 Is there a reverse in some of the signal lines in the cable? (Is there a null modem along the line?)
- 6 Is *quiet* mode on?

Check the answers to the questions above, then doubly reset the PCU, and start from the very beginning to establish communication between the user device and the PCU to be installed.

When the attached device can communicate with the PCU, attach the PCU to the cable system: connect one end of a length of coaxial cable to the coaxial connector on the back of the PCU, the other end to the broadband cable system.

Once the PCU is attached to the cable system, the PCU is almost ready to be tested for ability to communicate over a LocalNet. But first you must determine the address the PCU is to use on its assigned channel. See Chapter 3 for help.

AUTOBAUD	BAUD	CALL	COMMAND	DONE	FLOW
HELP	IDLE	INTERRUPT	PARITY	QUIET	STATUS
SUSPEND	SWITCH	TIMEOUT	UNIT	XOFF	XON

Figure 5-3. HELP Display

Analysis of problems in a PCU's operation begins by repeating the sequence used to configure the equipment, and proceeds through the various command and data transfer functions. Any abnormal indications occurring during this procedure should be noted in detail.

POWER AND STATUS

Make sure the PCU and the terminal are plugged in and are receiving power. If the PCU is not receiving power, the status and power LEDs on its front panel are off. When the PCU is ready to accept commands, the power light is green, and the status light is unlit. If both lights stay red for more than 30 seconds, the PCU should be returned for service. If both lights remain yellow after power is applied, press the reset button. If the power light does not turn green, the PCU should be returned for service.

PCU Control

The PCU supports a warm restart and cold reset.

Restart

A restart disconnects all outstanding sessions and flow control conditions but retains the values of each PCU attribute for each user device port. Since the *quiet* setting is unchanged by a restart, you will need to enter *quiet off* in some cases, to see if the terminal is responding correctly.

A restart is triggered by a single push of the reset button on the back panel of the PCU, and executes a self-test of the PCU. Disablement of commands is unaffected, and parameter settings are unchanged.

Powerup

The action taken at powerup is the same as that taken for restart. Privileged mode, protected commands, *unitId*, *channelNo*, and *linkAddress* are retained during powerup and restart.

Reset

Sometimes it may be necessary to return to the default values configured into the PCU. Press the reset button on the back panel once, wait until the *power* and *status* LEDs are both red, then press the reset button again.

At the end of the reset process, the power light is green and the status light is unlit. Disablement of commands is unaffected, and *privilege* is unchanged. The PCU will be in autobaud mode until a variable number of carriage returns (the number depends on the data rate of the attached device) are entered at the attached device. At the end of the autobaud process, the PCU's data rate is set to match that of its device. During the autobaud process, if the PCU does not correctly read the entered carriage returns, it continues to decrease its data rate and looks for carriage returns until it reaches 75 bps, the slowest rate available. If the terminal does not transmit carriage returns every 2.5 seconds (approximately), the PCU returns to 19200 bps and begins to step down its data rate again, expecting another series of carriage returns in answer. This process continues until the PCU reaches the proper data rate for the attached device.

COMMAND SEQUENCE

The PCU performs several tests on its internal components once activated. A terminal must be connected to port 0 to receive the diagnostic error messages from these tests. Some of the self test processes check for failure of the RF carrier or the data loopback within the PCU.

When any of these tests fails, a message is delivered to the terminal. Consult Appendix A for details on the following messages.

CABLE JAMMED

CARRIER LOOPBK FAILURE

DATA LOOPBK FAILURE

MEMORY ERROR AT xxxx yy

TROUBLESHOOTING

After these tests have been passed, the PCU's ability to enter command mode can be verified. The default signal for entering command mode is the "escape" character, followed by the "delete" character. Enter the *help* command or the *status* command, to determine the current command mode entry string.

Any unexpected results or problems in entering command mode should be noted, including such possibilities as an inability to enter command mode, no response to commands, or erroneous command status. All abnormal LED and display conditions should also be noted. If the command sequence tests reveal no problems, proceed with the next sequence, which tests data transfer.

DATA TRANSFER SEQUENCE

Establish Connection and Transfer Data

The PCU's basic ability to make use of the RF carrier and to transfer data, in loopback mode, has been checked by the configuration self-tests, the first sequence to be run. The data transfer test analyzes the

PCU's ability to send and receive data, to and from its attached user device, and over the cable system.

Trouble-shooting is made easier by using two PCUs, each of which is attached to a terminal. The messages and responses displayed by each terminal may reveal anomalies in the PCU or the cable system. These messages should be noted. The data sent during this test should consist of a known and recognizable pattern in order to aid the operator in evaluating the PCU's performance and reliability.

If a connection cannot be established between the PCU under test and a second PCU in the network, try connecting the first PCU to a third PCU.

If a connection can be established, the transfer of data should be closely monitored for reliability. Flow control conditions should be noted; various methods of flow control should be used to determine if one particular method alters the reliable transfer of data.

Other factors which may affect reliable data transfer are the parameters which control packetization of data: character count, control characters, and idle timer. Try altering these parameters, and notice which conditions produce trouble with data transfer.

Each PCU can display messages with information about the results of commands entered locally and remotely. Some messages result from the normal and intended working of the PCU and the LocalNet, while other messages indicate that the intended command was not carried out as expected. If a PCU has been made quiet, the only messages it can display are the *help* and the *status* displays.

CALL COMPLETED TO <XXXX,YY> — In response to a *call* command, the PCU has completed a session initiation to the LocalNet PCU with an address whose numbers are represented here by <XXXX,YY>. When the call is to a member of a rotary, the address uses only the four digits designating the first member of the rotary.

CABLE JAMMED — One of the PCU self tests attempted to transmit a signal, but was unable to access the network. This could indicate an internal PCU problem, or a network that is busy. Try to connect to the network when it is not being heavily used, to eliminate one possible cause of failure.

CARRIER LOOPBK FAILURE — One of the PCU self tests transmitted a carrier signal onto the cable, but did not receive the proper response at its receiver after the signal traversed the network.

CONNECTION CLOSED BY XXXX — A connection between two PCUs was closed by the remote unit. XXXX gives the remote address.

DATA LOOPBK FAILURE — One of the PCU self tests transmitted data onto the cable, but did not receive the proper response at its receiver after the signal traversed the network.

MEMORY ERROR AT XXXX YY — One of the PCU self tests has detected an error in the PCU's memory at location XXXX, which contains YY.

NO SESSION(S) — This message appears in response to any of several commands given to the PCU when no session is active at the port. The commands are: *done*, *interrupt*, *remote*, *suspend*, *switch*.

NO REMOTE SESSIONS AVAILABLE — This message appears when no sessions are available on the remote unit.

NO RESOURCES AVAILABLE ON REMOTE — This message results when the remote PCU lacks the resources to complete the requested call.

NO SERVER ON REMOTE — This message results when the remote device lacks a server, that is, a high-level process necessary to complete the connection.

NO SESSIONS AVAILABLE ON LOCAL PORT — All available sessions on the local port are already in use.

NO SESSIONS AVAILABLE ON LOCAL UNIT — All available sessions on the local unit are already in use.

PARAMETER ERROR — The *parameter error* message can occur in connection with many different commands. These commands are listed alphabetically below. This message generally means that the PCU has been requested to do something it cannot do, or that it has met a typographical error.

Baud — The baud rate specified is not available on the PCU.

Command — The parameter used with the *command* command is not recognized by the PCU.

Done — The parameter used with the *done* command used the number of a session which is not open to this port.

End of Message — The parameter entered with the *EOM* command is not recognized by the PCU.

Flow — The parameter entered with the *flow* command is not one of those recognized by the PCU: EIA, XON, or none.

MESSAGES

Location — The parameter entered with the *location* command is out of the range accepted by the PCU.

Maxsession — The parameter entered with the *maxsession* command is greater than the number of available PCU sessions.

Newline — The parameter entered with the *newline* command is out of the range recognized by the PCU.

Parity — The *parity* value entered is not one of those recognized by the PCU—odd, even, or none.

Privilege — The parameter entered with the *privilege* command is out of the range recognized by the PCU.

Stops — The parameter entered with the *stops* command is not within the range recognized by the PCU: 1, 1.5, or 2.

Suspend — The session number entered with the *suspend* command does not belong to any current session.

Switch — The session number entered with the *switch* command does not belong to any current session.

Timeout — The parameter entered with the *timeout* command is not within the range recognized by the PCU: 0-30 minutes.

Unit — The *unitId* entered with the *unit* command is out of range for that PCU.

OPENFAILURE—CAUSEUNKNOWNONREMOTE — The local unit has received an unknown result code.

RECEIVED UNEXPECTED OPEN ACK — The remote unit acknowledged a request to *open* a session, but the request has not come from the local unit.

SESSION <XX> ABORTED TO <YYYY> — An abnormal condition caused the closure of a PCU-to-PCU connection. XX indicates the number of the aborted session; YYYY indicates the address.

SESSION <XX> CLOSED TO <YYYY> — A normal close was entered by the local or remote PCU. XX indicates the session; YYYY indicates the address.

<STATUS> — This information results from entering the *status* command. It shows the current attribute values of the PCU port and the status of established sessions connected to the port. Figure A-1 represents one of many possible status displays.

This display is discussed in greater detail in the description of the *status* command.

UNABLE TO OPEN SESSION—NO REMOTE SESSIONS AVAILABLE — No sessions are available on the remote unit; it is conducting all the sessions it can.

UNABLE TO OPEN SESSION—NO RESPONSE FROM UNIT — The called unit does not respond, perhaps because it is out of service.

UNABLE TO OPEN SESSION—REMOTE PORT(S) BUSY — The call request has specified a port which cannot accept the call. In addition, no rotary ports are available.

UNKNOWN COMMAND — One cause for this message may be that the command entered has been disabled on the PCU.

MESSAGES

```
LOCALNET 20/XXX 22-01 VYYY

UNIT      0019,1  BAUD      9600  IDLE      5
GROUP     B      PARITY     NONE   EOM COUNT 0
LOCATION    28,44  STOPS     1     EOM CHARACTER NONE
COMMAND   1B,7F  AUTOBAUD  ON     NEWLINE   0D
LISTEN    ON     DCD CONTROL ON    EXPAND    NONE
PRIVILEGE OFF    DTR CONTROL ON    XON       11
MAXSESSION 1     ECHO      OFF   XOFF      13
PCALL     ON     QUIET     OFF   FLOW      NON
PUNIT     750,0  TIMEOUT   0

SESSIONS
1} 0026,1* ACTIVE
2} 0037,2 SUSPEND
```

Figure A-1. STATUS Display



address — A LocalNet address is a two-component entity specifying a particular user device attachment point. An address consists of a *unitId* specifying the PCU and a *portId* specifying the particular port on that PCU.

bridge — A bridge is a specialized packet gateway used to route packets among LocalNet channels either on the same or different broadband cables.

broadband — A term describing the use of industry standard CATV data distribution using digital channels modulating RF carriers. A broadband network is an analog information distribution system permitting both the above digital services as well as conventional analog information services (television) to coexist on the same cable system.

CATV — Community Antenna Television. This generic term describes broadband networks used for information distribution in cities, campuses, and buildings.

channel — A LocalNet channel is a frequency division multiplexed digital multipoint channel occupying 300 KHz of analog spectrum and modulated at 128K bps. 120 such channels can be configured on each broadband cable and each channel can be shared among a number of PCUs using the CSMA/CD distributed channel arbitration mechanism. Twenty channels are in each "channel group," and each group is like a standard 6MHz commercial video channel.

channel group — LocalNet channels are grouped in units of 20 channels, each group representing 6 MHz of analog cable spectrum. Each LocalNet 20 PCU modem can directly tune the channels within the channel group for which its modem is configured at the time of order. A channel group is identified by an alphabetic character in the range A:F for midsplit systems, and L:N for sub-split.

channelNo — *ChannelNo* is a numeric value in the range 0:119 identifying one of the LocalNet

channels. A PCU's current *channelNo* (along with its channel group) specifies the LocalNet channel to which its modem is tuned.

CSMA/CD — Carrier Sense Multiple Access with Collision Detection is a technique by which many independent nodes can share a common broadcast communication channel without requiring a central transmission allocation authority.

default — The default value of a setting is the original one, which is in effect until other instructions are entered. A double reset of a PCU returns the PCU to its default values for all PCU attributes except *unitId*, *linkAddress*, and *channelNo*.

datagram — A datagram is a particular type of packet, at the Network Layer of the LocalNet protocol. No explicit acknowledgement for the packet is sent by the receiver. Instead, transmission relies on the "best effort" of the underlying protocol layers as well as on the reliability mechanism provided by higher protocol layers. LocalNet's Network Layer is a datagram system.

echo — Echo refers to the local display at a device of data entered at that device. A PCU that is set with echo on will locally transmit to the terminal every character that the terminal transmits to the PCU.

gateway — A gateway is a protocol-translating interface between a LocalNet (and its protocols) and an external network which uses a distinctly different protocol suite.

linkAddress — The *linkAddress* is an internal addressing construct used to optimize PCU micro-processor operation. It bears no special or a priori relationship either to *channelNo* or *unitId*.

location — A PCU's LocalNet location is the combination of the current *channelNo* to which its modem is tuned (hence specifying the channel on which the PCU currently transmits and receives data) and its *linkAddress*. A PCU or the LocalNet Network Control Center can change one or both components of the PCU's location.

GLOSSARY

- message — A message is a logical partition of the user device's data stream to and from the PCU. For example, a <carriage-return> can demarcate a logical message (a line of text).
- modem — A modem is an A/D and D/A conversion device interfacing the LocalNet PCU micro-processor to the analog broadband cable. LocalNet 20 PCU modems provide direct access to twenty 128K bps half-duplex digital data channels.
- NCC — Network Control Center. This LocalNet unit provides enhanced network services to users and network managers.
- packet — A packet is the unit of protocol used by the LocalNet Transport Layer. The packet contains header control information, as well as user data.
- parity — Parity is a horizontal one's complement checksum of each data byte transmitted and/or received between a LocalNet 20 PCU and a user device. Parity may be even, odd, or none.
- PCU — Packet Communication Unit. This LocalNet unit interfaces one or more user devices to the LocalNet broadband data communications network and hence to other attached user devices.
- port — A user device attachment socket on the rear of a PCU; a point of access to the LocalNet. Each LocalNet 20/100 PCU has two such ports, and each port has an identifying number. Port 0 is the lower connector, and Port 1 is the upper. Each LocalNet 20/200 PCU has eight ports, numbered from left to right.
- portld — A *portld* has a numeric value specifying the particular port *unitld* used to call a specific device attached to a PCU.
- protocol — A protocol is a procedure for ordering the exchange of formatted information packets between correspondents. Protocols are "interpreted" by hardware and software within PCUs. Protocols may be layered; that is, one protocol interpreter may use a "lower" protocol for the transport of its packets to its correspondent protocol interpreter.
- rotary address — A rotary address is the address of a group of "equivalent" user devices. These devices may be located on one or more PCUs. A rotary address ambiguously specifies these user devices by only requiring a *unitld* as an address for *call* command.
- session — A session is the data transport connection resulting from a call between two user devices attached to the LocalNet via PCUs. It is identified by a PCU port local session number ranging from 1:255. A session is the network service provided by the LocalNet Session Layer.
- unitld* — A PCU's *unitld* is a 16-bit (four hexadecimal digit) number that uniquely identifies the PCU within its LocalNet. Its specification and allocation are under the control of each LocalNet Network Manager and usually correspond to the PCU's assigned factory serial number.
- virtual connection — A virtual connection is a bounded, numbered, sequenced stream of network datagrams passing user data and control information between correspondent PCUs. A connection is established and broken by the LocalNet Transport Layer.

Each LocalNet 20 PCU exports its data communications services via a physical interface corresponding to the EIA RS-232C standard. The LocalNet 20 PCU definition of the RS-232C lines is shown in Figure C-1.

Pin	Name	Device	PCU	Function
1	FG			Frame or chassis ground
2	TD		→	Transmitted data
3	RD	←		Received data
4	RTS		→	Request to send
5	CTS	←		Clear to send
6	DSR	←		Data set ready
7	SG			Signal ground
8	DCD	←		Data carrier detect
20	DTR		→	Data terminal ready
22	RI	←		Ring indicator
25	AB		→	Autobaud request

Figure C-1. PCU RS-232C Signal Definition

Pins not defined in the above figure are currently unused. However, future PCUs may make use of any or all of the supplied 25 pins, hence these are reserved.

The following paragraphs briefly review the function performed by each interface signal.

TD Input data to the PCU port.

RD Output data from the PCU port.

RTS An input signal to the PCU used for PCU/user device flow control. When EIA flow control mode is selected, this signal should be asserted by the user device to indicate it is ready to accept data from the PCU. When EIA flow control is not selected this signal is ignored.

CTS An output signal from the PCU, used for PCU/user device flow control. When EIA flow control is selected, this signal is asserted by

the PCU to indicate it is ready to accept data from the user device. If EIA flow control is not selected this signal is held asserted by the PCU.

DSR Data Set Ready is always asserted when power is applied to the PCU.

DCD When DCD control is on, and at least one session is attached to the PCU port this signal is asserted by the PCU. If no sessions are attached to the port, this signal is dropped. If DCD control is off, this signal is always asserted by the PCU.

DTR When DTR control is on or has a timeout value, and the DTR signal is dropped, all current sessions are terminated. When DTR is on and is not asserted by the user device, no incoming session requests to this port are accepted. When DTR has a timeout value, an incoming call will assert RI and the PCU will wait <x> times 10 milliseconds for DTR to be asserted by the user device. Regardless of DTR, outgoing calls can be placed from the port. When DTR control is off, sessions can be established and maintained without regard for this signal.

RI When the DTR signal is not asserted by the user device, this signal will be asserted by the PCU when the first incoming session is established. RI remains asserted while one or more sessions are established and DTR is low. When DTR has a timeout value, RI will be dropped either when DTR is asserted or when the timeout has expired.

AB The user device may request autobaud of its PCU port by asserting AB. When *autobaud* is enabled and the port is in command mode and has no current sessions, the user device may request autobaud of its PCU port, by a high-to-low transition of AB.



Each LocalNet 20 Packet Communication Unit implements flow control mechanisms which have the following attributes:

integrity — The PCU does not deadlock over lack of internal buffers;

fairness — No one session or user device port monopolizes internal buffers;

performance — Sufficient buffers are provided to deal with the throughput required by user devices;

efficiency — In order to minimize retransmissions caused by dropped packets, the PCU responds to the flow control actions of its correspondent PCUs.

A LocalNet PCU provides three types of local flow control mechanisms to attached user devices. These include:

None

No local flow control is selected. If the PCU cannot transmit fast enough to keep up with a transmitting user device, the device's data may be lost. Similarly, if the user device cannot receive quickly enough to keep up with data received from its local PCU, some data on the current connection may be lost.

EIA Flow Control

EIA flow control is bi-directional between the PCU and the attached local device.

The CTS (Clear To Send) signal line controls input from the local user device to the PCU port. The PCU blocks input from the user device by selectively dropping the CTS signal.

The PCU decides when to assert CTS in the following manner. If sufficient local buffer space is available, and the destination PCU is not flow controlling the session, then the local PCU asserts CTS.

If the number of local PCU buffers decreases below an internal threshold, or if the destination PCU is flow

controlling the session, the local PCU does not assert CTS until these resource limitations are removed. The limitations can be removed either when the number of local PCU buffers becomes large enough, or when the session receives additional transmission capacity from the remote PCU.

The RTS (Request To Send) signal line controls output from the PCU to the local device. If the user device drops RTS, the PCU imposes flow control on its virtual connection and ceases delivery of data to the user device port until the device again raises RTS.

Xon/xoff Flow Control

Xon/xoff flow control is applied in both directions between the PCU and its user device(s).

The PCU provides each user device the ability to specify the hexadecimal representation of ASCII characters used for xon and xoff. The default is the ASCII standard. The characters are the same for both transmission and reception. When the user device transmits the xoff character to the PCU, the PCU prevents subsequent transmissions through that port to the user device and also flow controls the port's current session.

Flow control to that session is lifted when the user device transmits the xon character to the PCU, and transmissions to the device port are resumed. Transmission of an xon character when no previous xoff is pending has no effect, and the xon will be delivered to the output port. Transmission of two xoff characters with no intervening xon has no effect.

When the PCU must prevent transmission from the user device, either because not enough local buffers are available, or because the remote PCU has imposed flow control, the PCU transmits the xoff character to the user device. The PCU ignores characters it receives, until flow control is removed. When more buffers are available or when the remote PCU has removed session flow control, the PCU transmits xon to the user device port, thus enabling subsequent transmission by the user device.

The type of flow control used at each PCU port may be specified by the *flow* command.

FLOW CONTROL

A user device may have as many as four sessions connected at the same time through a given 20/100 PCU port. A device attached to a 20/200 PCU can have as many as sixteen simultaneous sessions. The user device may switch between these sessions, directing which session is current.

In order to control which sessions (in addition to the current session), can output data to the port, the user device may direct the PCU to impose flow control on one or more of the inactive sessions. The *suspend* command is used to impose flow control on inactive sessions. When a flow-controlled inactive session is made current, the local flow control condition is automatically removed as a side effect of the *switch* command. However, the new session may have its flow controlled by the remote PCU.

Device

Type Microprocessor-based packet-mode network interface designed to provide data communications services via broadband coaxial cable networks for as many as two DTEs (20/100) or eight DTEs (20/200).

Capacity

DTEs	Two for a 20/100, eight for a 20/200 PCU
Channel	200 simultaneous active users
Medium	120 channels
System	24000 simultaneous active users
Error rate	Less than 1 in 10^{*9} bits

Network

Type	Midsplit or subsplit Broadband CATV System
Compatibility	Compatible with 6 MHz CATV channel assignments

Medium

Cable type	75 ohm coaxial cable or standard CATV cable
Cable topology	Branching tree
Medium access method	Carrier Sense Multiple Access with Collision Detection (CSMA/CD)
Line protocol	HDLC derivative, designed for local network use

Analog

Transmitter	
Transmit frequency range	a 6 MHz group
Midsplit	within 70—106 MHz range
Subsplit	within 226.25—262.25 MHz range
Transmitter output	+30 to +48 dBmv, adjustable
Output linearity	± 2 dB
Modulation technique	Frequency modulation (FM)

TECHNICAL SPECIFICATIONS

Frequency deviation	± 35 KHz., with a tolerance of ± 2 KHz
Frequency stability	$\pm 0.005\%$
Number of channels supported	120; 20 channels per PCU
Channel spacing	300 KHz
Frequency agility	20 channels from the set of 120 can be software selected—the selection of which 20 channel subset is an ordering option
Carrier on/off ratio	Greater than 50 dB
Carrier harmonic content	Greater than 50 dB below carrier level
Output impedance	75 ohms

Receiver

Receive frequency range	226.25 - 262.25 MHz
Input level	-2 dBmv \pm 6dBmv
Receiver sensitivity	Greater than 2.7 microvolts for 20 dB of quieting on all channels
Receiver stability	$\pm 0.01\%$
Input impedance	75 ohms

Digital Interface

Type	EIA RS-232C asynchronous with full modem control (RS-232C byte synchronous available as an option)
Data rate	75 bps—19.2 Kbps
Flow control	Clear-to-send (CTS), xon/xoff, or none
Number of stop characters	1, 1.5, or 2
Parity	Odd, even, or none
Number of DTE interfaces	Two (20/100) or eight (20/200)

User Interface

Type	A subset of CCITT X.3 parameters and functions is provided for interface between the DTE and the PCU. Interface to the LocalNet is provided via an X.28 subset specifically designed to support local area networks.
Protocol	Virtual connection (VC) protocol providing end-to-end data integrity
Number of concurrent virtual connections supported	Four (20/100) or 16 (20/200)

TECHNICAL SPECIFICATIONS

Physical and Mechanical

Rear panel connectors:

Digital	Cannon DB-25S or equivalent per DTE port
RF	Female type F coaxial fitting
Power	Recessed male RFI-filtered AC connector
Rear panel controls	System reset pushbutton

Front panel indicators:

Power on	Red/green LED used to indicate power on condition and packet transmission.
Status	Red/green LED used to indicate self-test status, connection established, and packet reception.
Lines (20/200)	8 Red/green LEDs used to indicate existing session, or not accepting session requests.

20/100—

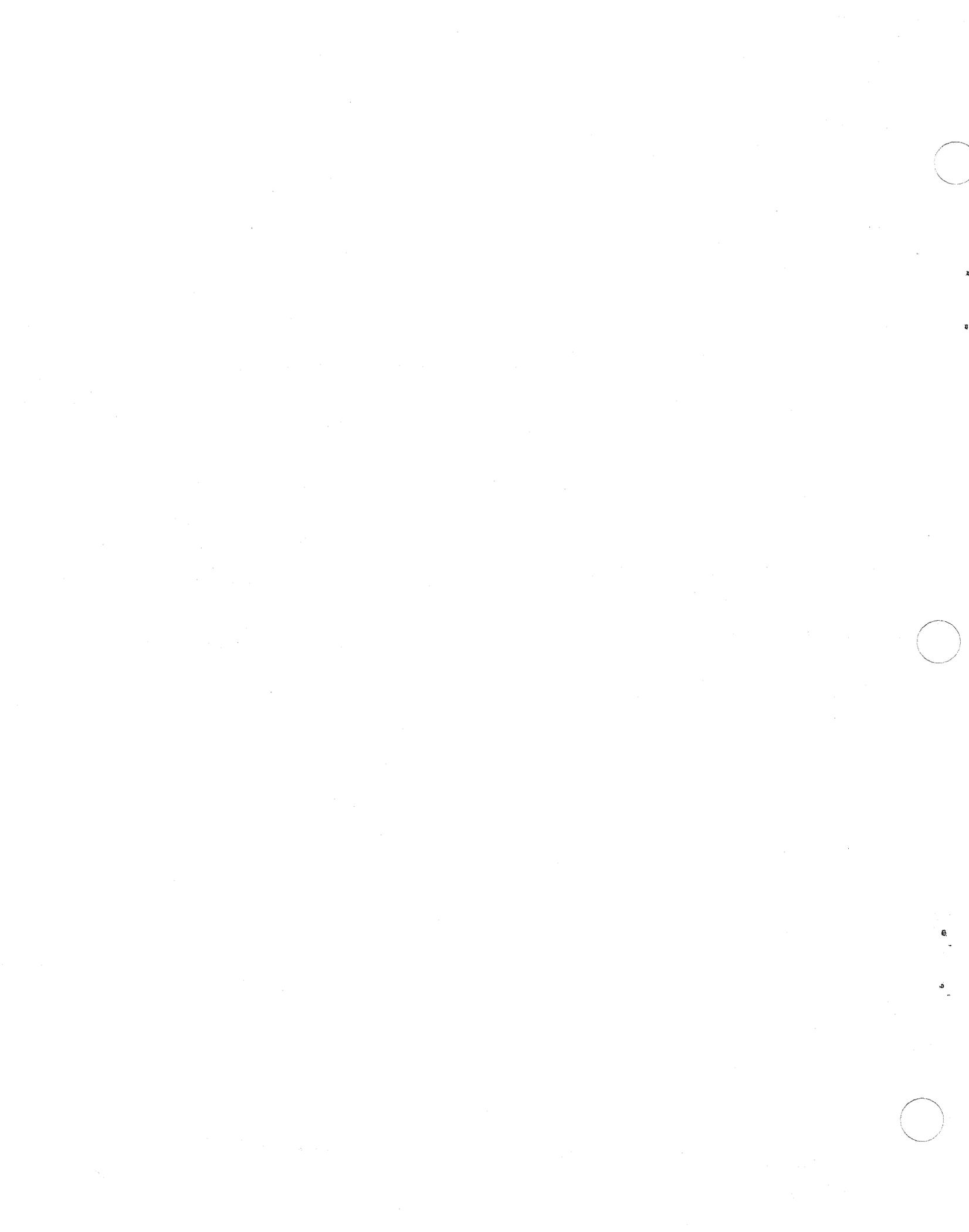
Size	3.625" high x 8.25" wide x 12.5" long
Weight	6 lbs., approximate
Power	105-125 VAC \pm 5%, 50 - 60 Hz., 25VA maximum (Optional 210-250 VAC)

20/200—

Size	5.5" high x 16.5" long
Weight	20 lbs. approximate
Power	105-125 VAC \pm 5%, 50 - 60 Hz., 25VA maximum (Optional 210-250 VAC)

Environmental

Operating temperature	0 to +40 degrees Centigrade
Relative humidity	To 95% (non-condensing)



PRODUCT OPTIONS

The following figures list the possible entries in each section of the LocalNet 20 PCU label. By comparing the option label on your PCU with the entries and their meanings given here, you will see what options are implemented on a PCU. Note that for some options, there is a default configuration. Figure F-1 lists the modem channel groups and other options currently available on the LocalNet 20 PCU.

Each PCU includes a modem, and the modem's channel group determines the PCU's *channelNo*.

The first number in the modem option section indicates the channel group.

The second number gives the modem type (0: midsplit; 1: subsplit).

The last number indicates the modem cable interface (1: single cable; 2: dual cable).

A01	Single Cable Midsplit Channel Group A
B01	Single Cable Midsplit Channel Group B
C01	Single Cable Midsplit Channel Group C
D01	Single Cable Midsplit Channel Group D
E01	Single Cable Midsplit Channel Group E
F01	Single Cable Midsplit Channel Group F
A02	Dual Cable Midsplit Channel Group A
B02	Dual Cable Midsplit Channel Group B
C02	Dual Cable Midsplit Channel Group C
D02	Dual Cable Midsplit Channel Group D
E02	Dual Cable Midsplit Channel Group E
F02	Dual Cable Midsplit Channel Group F
L11	Single Cable Subsplit Channel Group L
M11	Single Cable Subsplit Channel Group M
N11	Single Cable Subsplit Channel Group N
L12	Dual Cable Subsplit Channel Group L
M12	Dual Cable Subsplit Channel Group M
N12	Dual Cable Subsplit Channel Group N
P01	Asynchronous User Device Protocol
P02	Bisynchronous User Device Protocol
U00	RS-232C User Device Physical Interface
W00	120 VAC 50-60 Hz. AC Power
W01	240 VAC 50-60 Hz. AC Power

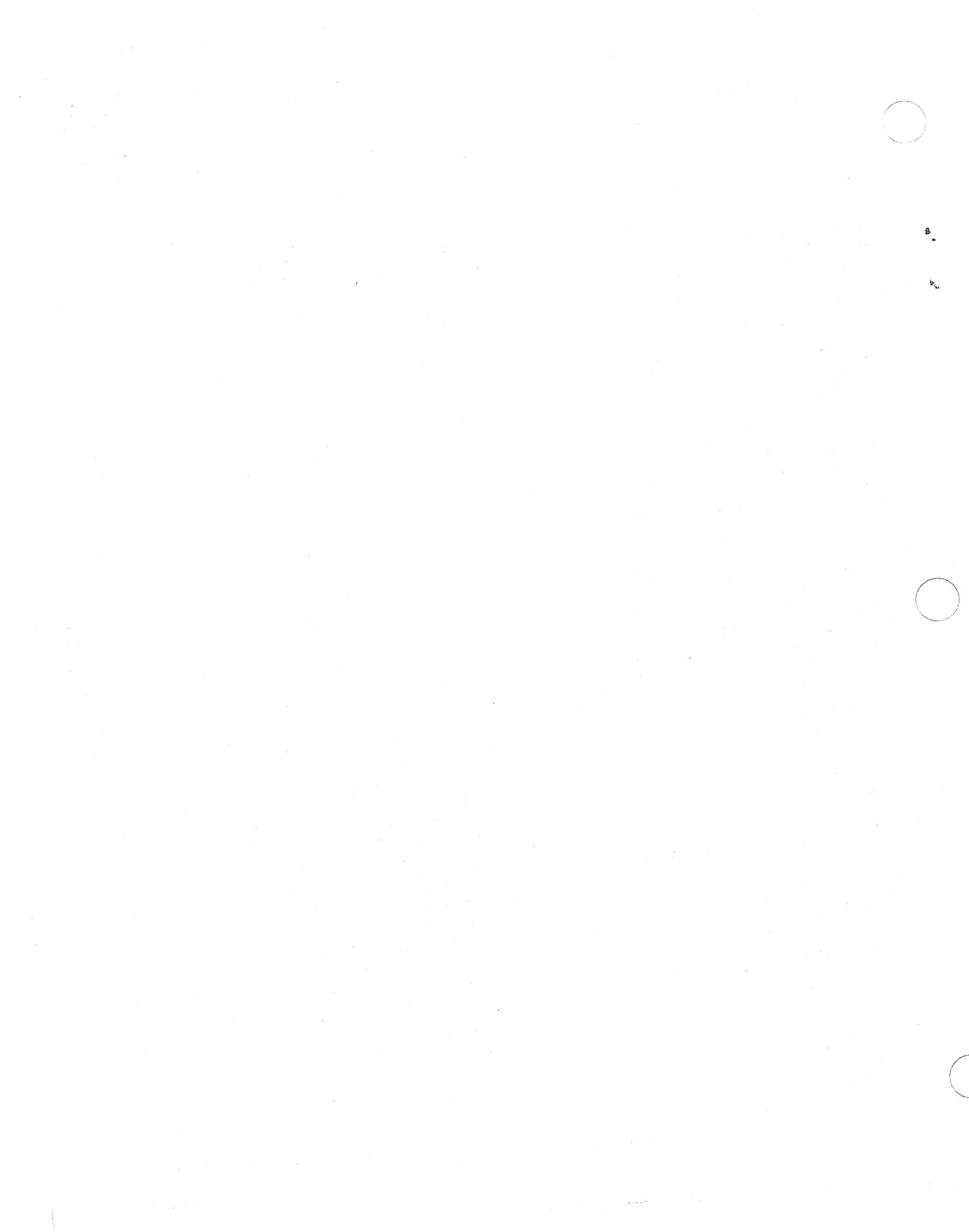
Figure F-1. Product Options



Hex	ASCII	Hex	ASCII	Hex	ASCII
00	NUL	2B	+	56	V
01	SOH	2C	,	57	W
02	STX	2D	-	58	X
03	ETX	2E	.	59	Y
04	EOT	2F	/	5A	Z
05	ENQ	30	0	5B	[
06	ACK	31	1	5C	\
07	BEL	32	2	5D]
08	BS	33	3	5E	^
09	HT	34	4	5F	_
0A	LF	35	5	60	`
0B	VT	36	6	61	a
0C	FF	37	7	62	b
0D	CR	38	8	63	c
0E	SO	39	9	64	d
0F	SI	3A	:	65	e
10	DLE	3B	;	66	f
11	DC1	3C	<	67	g
12	DC2	3D	=	68	h
13	DC3	3E	>	69	i
14	DC4	3F	?	6A	j
15	NAK	40	@	6B	k
16	SYN	41	A	6C	l
17	ETB	42	B	6D	m
18	CAN	43	C	6E	n
19	EM	44	D	6F	o
1A	SUB	45	E	70	p
1B	ESC	46	F	71	q
1C	FS	47	G	72	r
1D	GS	48	H	73	s
1E	RS	49	I	74	t
1F	US	4A	J	75	u
20	SP	4B	K	76	v
21	!	4C	L	77	w
22	"	4D	M	78	x
23	#	4E	N	79	y
24	\$	4F	O	7A	z
25	%	50	P	7B	{
26	&	51	Q	7C	
27	'	52	R	7D	}
28	(53	S	7E	~
29)	54	T	7F	DEL
2A	*	55	U		



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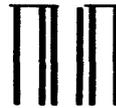
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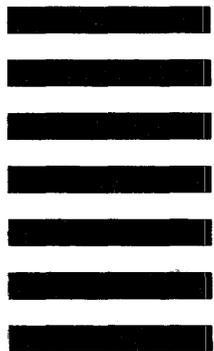
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