330 Dataplexer
System Description

Technical Manual 76-820330FP7-1

Revision A, April 1986

Manual Organization

INTRODUCTION

This manual is one of a set of three Tellabs technical manuals that describes the 330 Dataplexer. This Dataplexer **System Description** covers the features, functions, and applications of the 330 Dataplexer.

The Dataplexer **Physical Installation** manual describes Dataplexer enclosure mounting, module optioning, cabling, and system startup and troubleshooting techniques.

The Dataplexer **Network Manager's Guide** describes configuration of Dataplexer systems via the administrative control facility.

Reference to all three manuals is required for a comprehensive understanding of the system.

SCOPE

This manual describes the features, functions, and applications of Tellabs 330 Dataplexers equipped with the **330FP6** and **330FP7** firmware packages. Dataplexers equipped with earlier firmware releases are covered in an earlier System Description.

MANUAL ORGANIZATION

This manual is divided into 8 sections:

General Description	a general overview of the Tellabs 330 Dataplexer
Physical	a description of Dataplexer mounting enclosures
Application	how Dataplexers are used in local and network applications
System Capacity	calculating Dataplexer hardware capacity and traffic engineering
Data Channel States	a description of asynchronous and synchronous channel states and modem control signaling
Administrative Control Facility	an overview of the Dataplexer's menu-driven programming system
Specifications	product and performance specifications
Warranty	warranty information

FCC WARNING STATEMENT

Federal Communications Commission (FCC) Rules require that you be notified of the following:

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

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NOTICE OF COPYRIGHT

System Description

330 Dataplexer

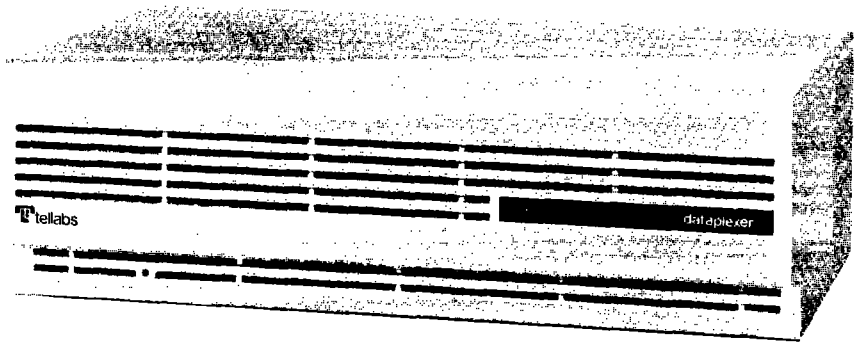
Section 1. General Description

INTRODUCTION

The 330 Dataplexer (figure 1-1) is a high-performance statistical multiplexer that provides error-free transmission for up to 32 independent data channels (both asynchronous and synchronous) over one or two composite data links.

An interactive programming system allows complete configuration, diagnostic, statistics, and system message capabilities to be accessed from a data terminal connected to any authorized asynchronous data channel.

Figure 1-1. 330 Dataplexer



FEATURES

The 330 offers the following significant features:

- An aggregate input rate of 307,200bps allows the Dataplexer to serve up to thirty-two 9600bps channels.
- Individually selectable combinations of asynchronous channel speeds and character codes for each channel.
- Support of composite-link speeds up to 76,800bps over broadband coaxial cable, fiber optic, microwave, satellite, and metallic transmission facilities.
- An automatic repeat request (ARQ) protocol (a subset of the CCITT X.25 standard) protects composite link(s) from transmission errors.
- The capability of selecting local echoplex individually for each channel. The Dataplexer also provides excellent response-time characteristics in many applications where remote (host) echoplex is required.

APPLICATION

In point-to-point applications, a single Dataplexer combines input from up to 32 independent communication lines and transmits the combined data over one or two composite links to a remote 330, which recreates the independent data channels at the remote end.

SYSTEM OVERVIEW

All Dataplexers consist of one of four available communication processor modules (with firmware), and from one to four data-channel interface modules. The 330E and 330F Dataplexers are equipped with integral V.29 modem modules.

Six models of the 330 are available. Each model is distinguished by its composite-link interface and described by a model number, as follows:

330A — single RS-232-C, CCITT V.24/V.28 interface

330B — Plexerlink interface, single RS-232-C/V.24/V.28 interface

330C — CCITT V.35 wideband modem interface, single RS-232-C/V.24/V.28 interface

330D — dual (load-sharing) RS-232-C/V.24/V.28 interfaces

330E — single RS-232-C/V.24/V.28 interface equipped with integral V.29 modem

330F — dual (load-sharing) RS-232-C/V.24/V.28 interfaces equipped with integral V.29 modems

Firmware

Two firmware feature packages are available for use with the 330 Dataplexer:

- 330FP6, an extended package that provides all of the earlier firmware package features as well as updated link and data-channel configuration parameters such as X.21 support, X.29 support, slow packetizing, delayed resync, ENQ/ACK pacing, and a convenient "channel profile" configuration method.
- 330FP7, a load-sharing firmware package that provides all of the extended FP6 package features for use in dual-link Dataplexers.

Processor Modules

Dataplexer communication processor modules each contain a central processor, a program memory, a random access memory (RAM) buffer, and at least one data-link interface.

More than 25,000 bytes of RAM are available to buffer data queued for transmission to a data link or channel. A nonvolatile electrically alterable read-only memory (EAROM) protects configuration data from power outages. A data-link controller with direct memory access (DMA) provides maximum efficiency and throughput.

Table 1-1 lists the features and functions of the communication processor modules provided with the various Dataplexers.

Table 1-1. Available communication modules and functions

Dataplexer	communication processor	firmware version	interface
330A	3001A	FP6	RS-232-C/V.24/V.28
330B	3001B	FP6	Plexerlink*
330C	3001C	FP6	CCITT V.35 wideband*
330D	3002	FP7	dual (load-sharing) RS-232-C/V.24/V.28
330E	3001A	FP6	RS-232-C/V.24/V.28**
330F	3002	FP7	dual (load-sharing) RS-232-C/V.24/V.28**

* Also contains an RS-232-C/V.24/V.28 interface that can be used alternatively.
** Equipped with integral V.29 modem(s) (3003 module).

Dataplexer Clock

The internal Dataplexer clock provides data-link rates from 1200 to 76,800bps.

When used with the Plexerlink interface, this clock provides a fixed 64,000bps rate. When used with the V.35 wideband-modem interface, data-link rates are selected via the external Data Service Unit (DSU).

The integral modem clock used with the 330E Dataplexer and 330F Dataplexer accommodates data-link rates of 2400, 4800, 7200, or 9600bps.

With a modem-supplied clock, as with the internal clock, data-link rates up to 76,800bps are accommodated.

Available clock sources and data-link rates are summarized in table 1-2.

Table 1-2. Available data-link rates

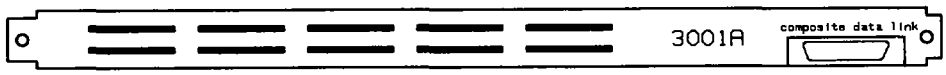
clock source	available data-link rates
internal clock	1200 through 76,800bps*
Plexerlink clock	64,000bps, fixed
CCITT V.35 wide-band modem interface	operates at DSU-supplied clock rate; statistics calculated at fixed 56,000bps rate
integral modem clock	2400, 4800, 7200, or 9600bps
modem-supplied clock	1200 through 76,800bps*

* Available in increments of 400: i.e., 1200, 1600, 2000, 2400, 2800, 3200, etc.

3001A Processor

The 3001A Processor Module (figure 1-2) is used in the 330A and 330E Dataplexers. This module provides a single RS-232-C/V.24/V.28 data-link interface suitable for use with synchronous private-line modems and compatible with high-speed modems designed for use with coaxial cable, fiber-optic, microwave, or satellite transmission facilities.

Figure 1-2. 3001A Processor Module

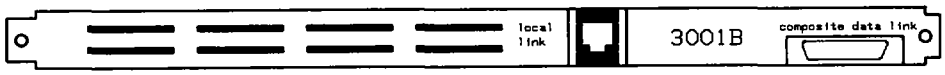


3001B Processor

The 3001B Processor Module (figure 1-3) is used in the 330B Dataplexer. This module derives a local digital line driver/receiver interface (Plexerlink).

This module also contains an alternate single RS-232-C interface identical to that provided on the 3001A module. The two interfaces cannot be used simultaneously.

Figure 1-3. 3001B Processor Module



The Plexerlink interface operates without modems over typical four-conductor (two-pair) telephone cable, commonly called housewire, for distances of 1 mile or greater at a fixed 64,000bps rate.

With this interface, the maximum distance between Dataplexers is determined by the signal loss of the housewire. The Plexerlink can tolerate maximum signal loss of 12.25dB at 62,500Hz.

Table 1-3 lists the maximum operating distances for various gauges of telephone cable with the following characteristics:

1. Solid annealed copper conductors.
2. Solid polyethylene insulation (outer jacket).
3. Aluminum shield.
4. Air core.

Table 1-3. Maximum operating distances for Plexerlink with typical housewire

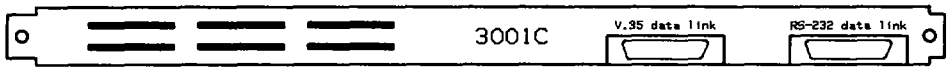
wire gauge (AWG)	maximum distance (feet)
19	14,300
22	8,400
24	5,900
26	4,050

3001C Processor

The 3001C Processor Module (figure 1-4) is used in the 330C Dataplexer. This module derives a wideband modem interface suitable for use with a Data Service Unit (DSU) or other wideband modem, and is completely compatible with the 56,000bps Dataphone Digital Service (DDS)[SM].

[SM]Service Mark of AT&T.

Figure 1-4. 3001C Processor Module



Please note that while the V.35 interface operates at the clock rate supplied by the DSU or other V.35 modem, system statistics are calculated at a fixed 56,000bps baud rate. This means that if the supplied clock rate does not operate at 56kbps, the system statistics will be inaccurate and must be recalculated according to the existing clock rate.

The 3001C module also derives a single RS-232-C interface identical to that provided on the 3001A module.

3002 Processor

The 3002 Processor Module (figure 1-5) is used in the 330D and 330F Dataplexers to derive dual interfaces that operate in a parallel, load-sharing arrangement.

In this way, the 330D and 330F Dataplexers offer not only greater traffic capacity than a single-link Dataplexer, but also add redundancy for critical applications.

If either data link fails, all traffic is routed automatically over the operative link without data loss. When the failed link is restored, traffic is again balanced over both links.

Please note that synchronous data experiences a momentary delay on initial link transfer in order to allow the link to ensure correct synchronization.

Figure 1-5. 3002 Processor Module

3003 Modem

The 3003 Multispeed 2400/9600bps V.29/V.27 Modem Module (figure 1-6) used with the 330E and 330F Dataplexers is designed for full-duplex operation over conditioned or unconditioned 3002 lines.

This modem transmits serial synchronous digital data at 9600bps. Fallback modes of 7200, 4800, and 2400bps are provided for lines with excessive noise or limited bandwidth. Modem speed options are configured via the Dataplexer's administrative control facility.

A digital adaptive equalizer automatically overcomes the effects of large variations in delay and amplitude distortion that might otherwise cause errors.

Integral self-test diagnostics automatically test the modem and the data link if the data link times out. In addition, on-demand diagnostics available via administrative control can place the modem in a variety of test states.

The 3003 modem module provides amplitude limiting, circuit isolation, and protection for the telephone network in both the transmit and receive channels. Data-carrier-detect (DCD) signal threshold levels of −16dBm, −26dBm, or −43dBm can be selected via a DIP switch located on the module's printed circuit board.

Transmit and receive impedances are fixed at 600 ohms. An electrostatically shielded output transformer provides complete circuit output protection. Varistor diode clippers protect the telephone network. Modem output is fixed at 0dBm (± 0.5dB).

The back panel of the 3003 modem module contains a **norm/loop** toggle switch, three status-indicating LEDs, and a **reset** pushbutton.

Setting the **norm/loop** toggle switch to LOOP forces the modem into a digital loopback state. (This mode can also be selected via the Dataplexer's administrative control facility. Please note, however, that selecting the digital loopback option for the 330F places **both** modems into loopback.)

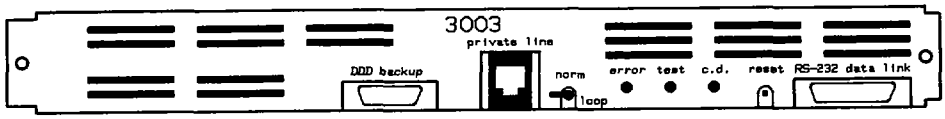
The **error** LED lights if internal modem diagnostics detect a failure condition.

The **test** LED lights when modem self-test diagnostics are performed and when the modem is placed into loopback.

The **cd** (carrier detect) LED lights when carrier tone is sensed from the remote end.

When the **reset** pushbutton is depressed, the modem executes a power-on/reset sequence.

Figure 1-6. 3003 Multispeed Modem Module



Data Channels

The 330 supports both asynchronous and synchronous data channels. Table 1-4 summarizes the available data-channel modules.

Asynchronous data channels can be equipped with Tellabs 3010 Asynchronous Line Drivers, which permit full-duplex 9600bps operation with terminals up to 2 miles from the Dataplexer via common two-pair housewire. (See table 1-5 for maximum operating distances; the 3010 operates over greater distances, but with reduced speed.)

Up to eight channels directly terminated on a fully equipped 330 can be either synchronous or asynchronous. Both bisynchronous and SDLC/HDLC protocols are supported.

Table 1-4. Available channel-interface modules

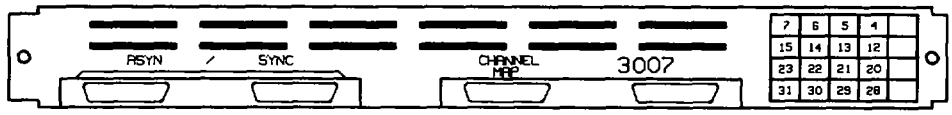
module	asynchronous channels	synchronous capability	line driver capability
3007	4	2 of 4	no
3008	8	2 of 8	no
3009	8	2 of 8	8 of 8 *

* Requires 3010 Line Driver at each terminal.

3007 Module

The 3007 Asynchronous Channel Module (figure 1-7) supports four asynchronous data channels. Of the four, two can be configured for either asynchronous or synchronous operation. Both bisync and SDLC/HDLC protocols are supported.

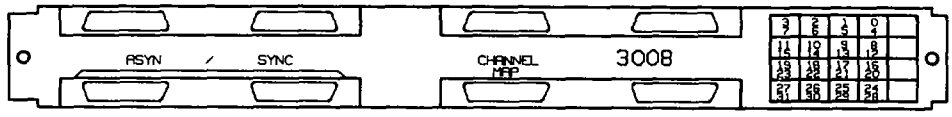
Figure 1-7. 3007 Channel Module



3008 Module

The 3008 Asynchronous Channel module (figure 1-8) provides all the features of the 3007 for eight individual channels. Like the 3007, the last two channels on the 3008 can be either asynchronous or synchronous.

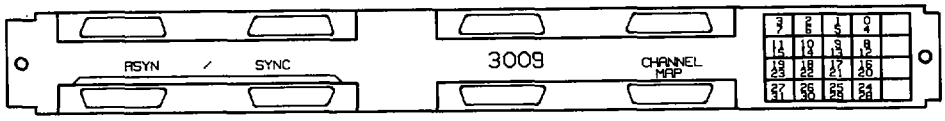
Figure 1-8. 3008 Channel Module



3009 Module

The 3009 Asynchronous Channel Module with Line Drivers (figure 1-9) offers optional individual asynchronous line drivers for eight independent data channels. These line drivers derive balanced differential transmit and receive signals to interface a 4wire metallic transmission facility.

Figure 1-9. 3009 Channel Module



The line drivers operate over any unconditioned nonloaded cable facility with dc continuity (Bell System tariff 3081) or over equivalent customer-supplied cables.

At the terminal, a stand-alone 3010 Asynchronous Line Driver accepts the balanced differential transmit and receive signals and derives an RS-232-C-compatible input to the terminal.

In this way, full-duplex 9600bps communication can be achieved with terminals located up to 2 miles from the Dataplexer. (The 3009 and 3010 can operate over greater distances but at reduced baud rates [see table 1-5].)

Table 1-5. Typical transmission range (with data rates) for 3009/3010

3009/3010 transmission range (over 24-gauge cable)
2 miles at 9600bps
3 miles at 4800bps
5 miles at 2400bps
7 miles at 1200bps
10 miles at 600bps

Control Facility

The 330 Dataplexer offers a convenient menu-driven programming system for configuration, diagnostics, statistics, and messages. Access to this administrative control facility is via any authorized ASCII asynchronous terminal.

After administrative control is accessed, a series of menus lead the network administrator through the following facilities:

Diagnostics — These menus are used to perform system and channel diagnostic tests on demand.

Configuration — These menus are used to review, select, and update all configurable system, link, and channel parameters.

Statistics — These menus are used to retrieve operating system and channel statistics.

Messages — These menus are used to obtain queued system messages on demand.

Section 2. Physical

INTRODUCTION

The 330 Dataplexer is housed in enclosures designed for desktop as well as 19, 23, or 24-inch equipment-rack installation. The Dataplexer operates from 90 to 135 Vac input power.

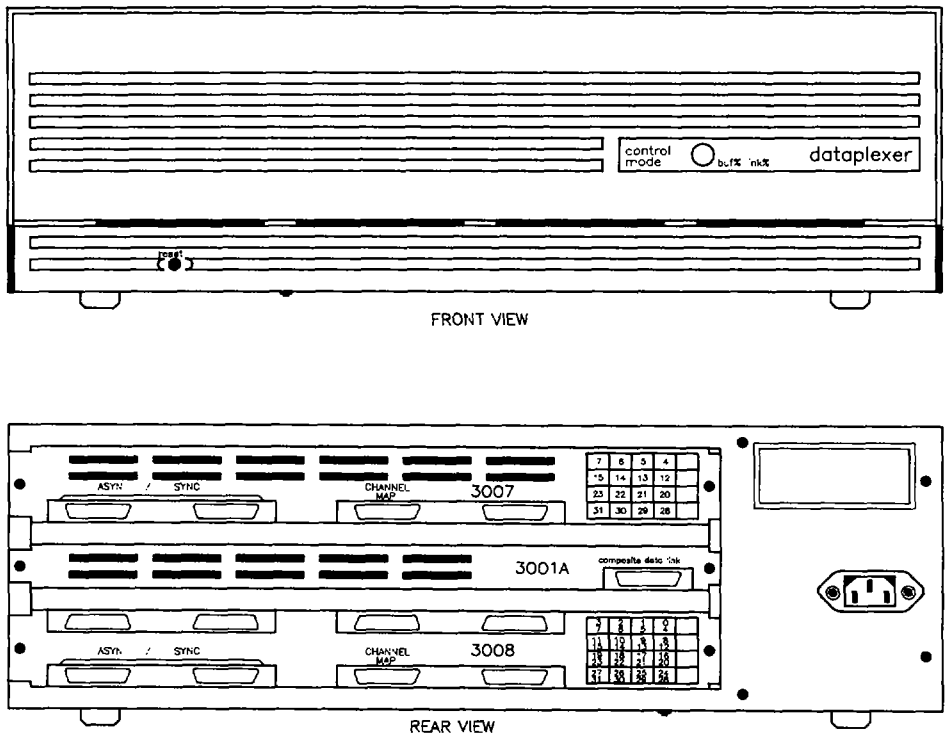
Main Enclosure

Dataplexers comprising up to three modules are housed in a single enclosure (figure 2-1).

This main enclosure, like all 330 enclosures, measures 5-1/4 inches (13.33cm) high by 17 inches (43.18cm) wide by 11 inches (27.94cm) deep.

The main enclosure houses the 330's communication processor module and up to two data-channel interface modules, or one data-channel interface module and one integral modem module, or two integral modems. Additional modules are housed in additional enclosures, as described below.

Figure 2-1. 330 main enclosure



Front Panel

The front panel of the main 330 enclosure contains two nonlocking pushbuttons and three single-character LED displays.

Depressing the **control** pushbutton places the first active in-service channel into the 330's interactive administrative control facility.

Depressing the **reset** pushbutton at the lower left of the 330's front panel initiates a power-on/reset sequence that includes self-test diagnostics.

The LED displays labeled **buf %** and **link %** provide single-digit indications of the percentage of data-buffer and data-link use, respectively.

The **buf %** LED displays 0 through 9 to indicate percentage of data-buffer use (e.g., 7 indicates 70 to 79%) and flashes if data is lost due to buffer overflow.

Likewise, the **link %** LED provides a single-digit indication of the percentage of data-link use and flashes if data-link errors exceed 1 in 100,000 bits.

The third display shows a constant **c** to indicate that a data channel has accessed the 330's administrative control facility, or a flashing **c** to indicate that an information message is pending. During normal operation, this display is blank.

A **t** followed by a two-digit code indicates that an error has been detected through execution of the 330's self-test diagnostics.

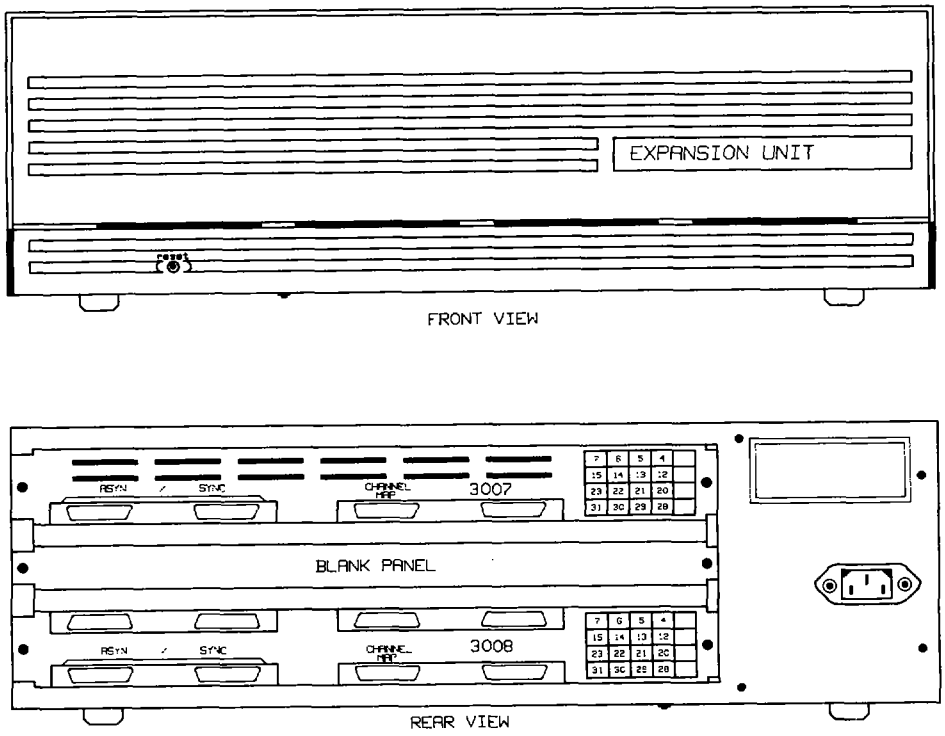
Expansion Enclosure

When more than two channel modules are used, a Dataplexer Expansion Enclosure (figure 2-2) augments the main enclosure.

This enclosure is a self-contained unit (similar to the main enclosure) with an integral power supply. A combined total of two data-channel modules and/or integral modem modules can be housed in this enclosure.

The 330 Expansion Enclosure must be located directly below the main 330 enclosure to permit their interconnection.

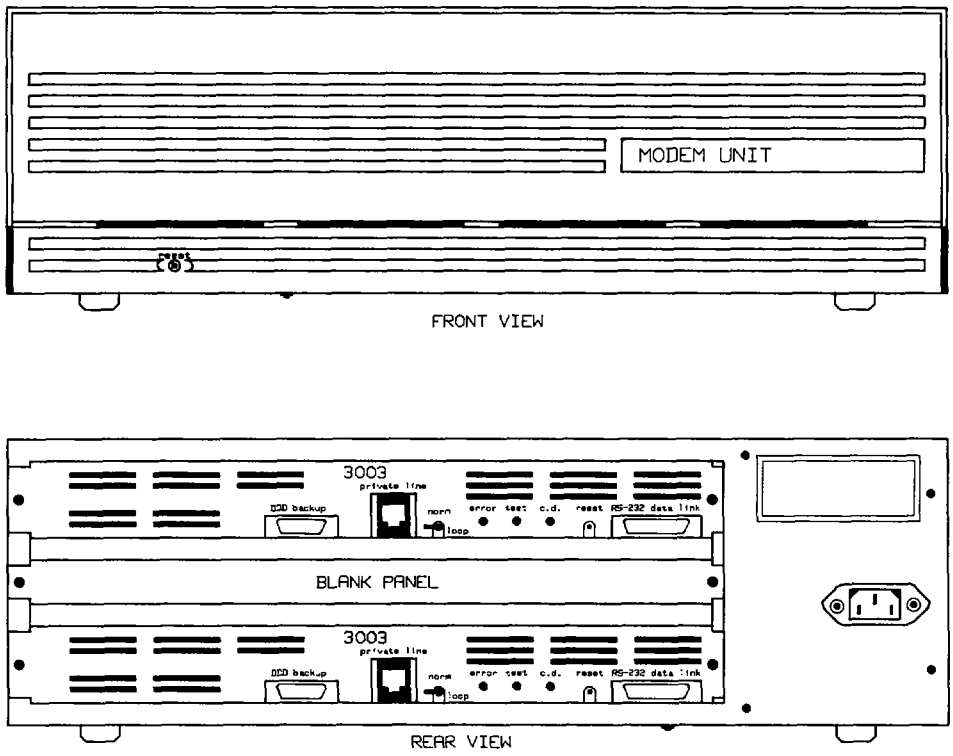
Figure 2-2. 330 expansion enclosure



Modem Enclosure

In the 330E and 330F Dataplexers, a separate 330M modem enclosure (figure 2-3) may house up to two integral modem modules. The 330M is a self-contained unit (similar to the main enclosure) with an integral power supply.

Figure 2-3. 330 modem unit



Notes:

Section 3. Application

INTRODUCTION

The 330 Dataplexer is a high-performance statistical multiplexer designed to provide error-free transmission for up to 32 data channels over one or two composite links to a remote Dataplexer, which recreates the independent channels at the distant end.

The Dataplexer exploits the statistical load characteristics of typical data traffic by assigning data-link capacity to input channels only as necessary. Because most data-terminal communication is bursty in nature, a major portion of the data-link capacity can be used by a single channel when required.

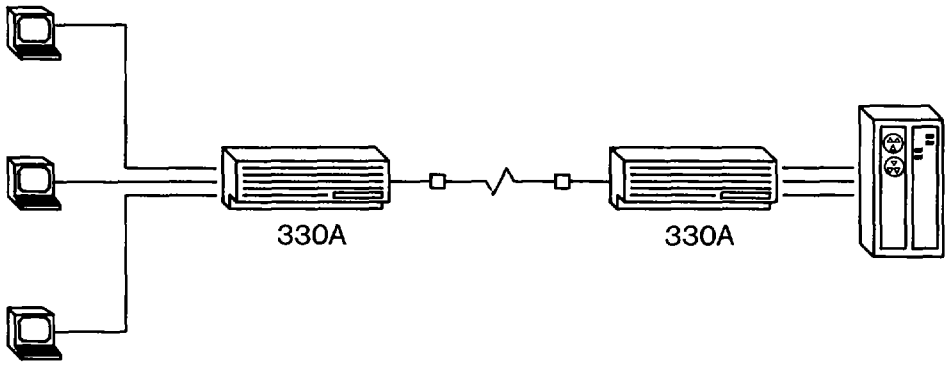
Often, the sum of the independent asynchronous channel speeds can substantially exceed the speed of the composite link, resulting in a multiplexing efficiency greater than 100 percent.

The 330 Dataplexer uses an Automatic Repeat Request (ARQ) composite-link protocol (a subset of CCITT X.25 level 2) that eliminates transmission errors between Dataplexers. By using a Cyclic Redundancy Code (CRC) at the end of each transmitted block of data, the receiving Dataplexer can detect an erroneous or missing block and request retransmission.

330A Dataplexer

This Dataplexer derives an EIA RS-232-C, CCITT V.24/V.28 interface suitable for use with synchronous private-line modems and is compatible with high-speed modems designed for voice-grade private-line facilities, coaxial cable, microwave, or fiber-optic transmission facilities. See figure 3-1.

Figure 3-1. 330A application

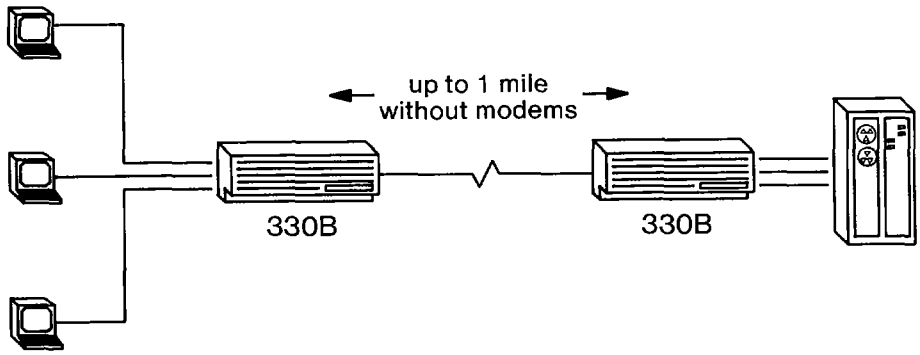


330B Dataplexer

The 330B contains an integral digital line driver/receiver interface (Plexerlink). This Dataplexer also contains an integral RS-232-C interface that can be used instead of the Plexerlink.

The Plexerlink operates without modems over twisted-pair cable (commonly called housewire) for distances up to 1 mile at a fixed 64,000bps rate. See figure 3-2. In single-premises or local-area networks where terminals are within 1 mile of the host, this Dataplexer provides responsive, cost-effective communication.

Figure 3-2. 330B application



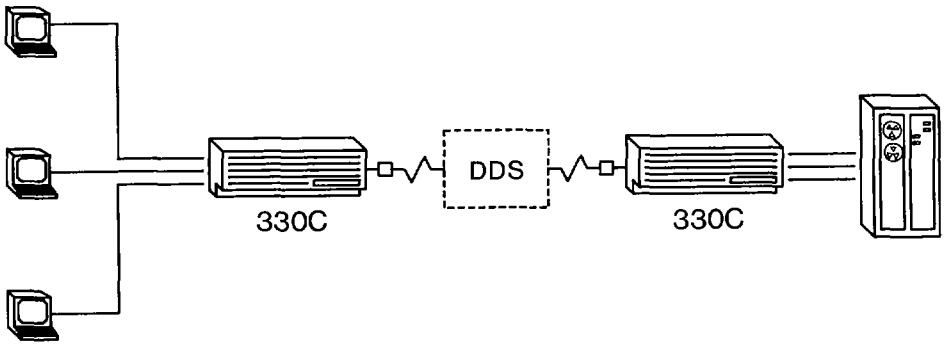
330C Dataplexer

This Dataplexer contains a wideband modem interface suitable for use with a Data Service Unit (DSU) or other wideband modems that conform to the 56,000bps Dataphone Digital Service (DDS) as well as the CCITT V.35 wideband modem standard.

The 330C Dataplexer's wideband modem interface is primarily used for high-speed long-distance communication between cities served by DDS.

As an alternative, an RS-232-C interface identical to that of the 330A is also provided. Figure 3-3 shows a DDS application.

Figure 3-3. 330C application

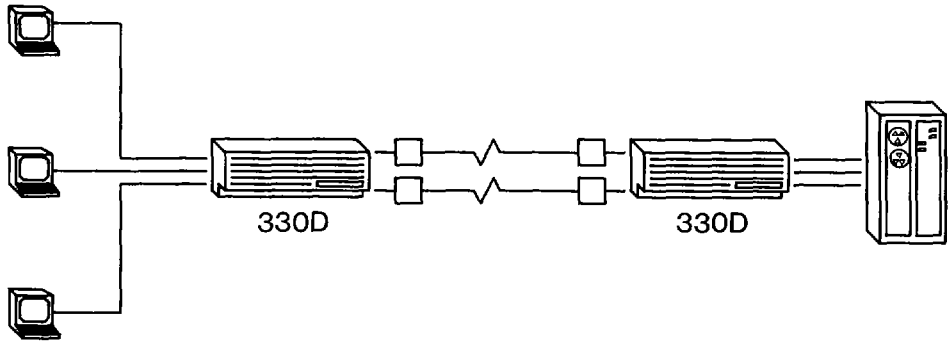


330D Dataplexer

The dual-link 330D derives two parallel RS-232-C/V.24/V.28 interfaces that operate in a load-sharing arrangement. In this way, the 330D provides not only greater traffic capacity than a single-link Dataplexer, but adds redundancy for critical applications. See figure 3-4.

If either link fails, all traffic is automatically routed over the operative link without data loss; when service on the failed link is restored, data traffic is again shared by both links.

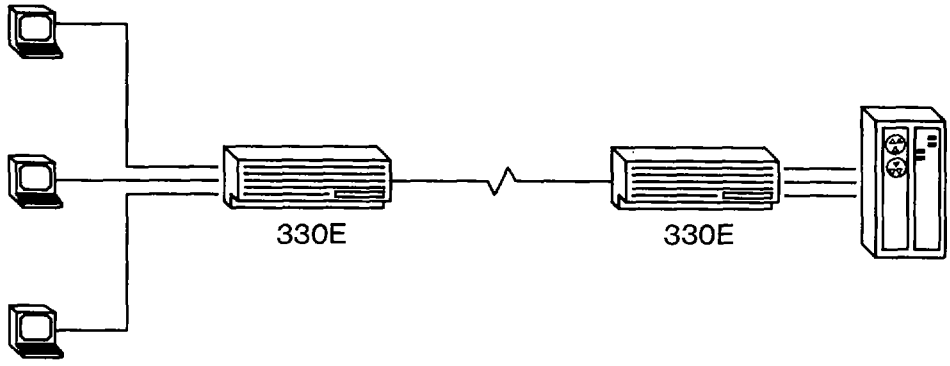
Figure 3-4. 330D application



330E Dataplexer

The 330E offers all of the features of the 330A, and in addition contains an integral CCITT V.29/V.27-compatible modem (3003 module) designed for full-duplex operation over conditioned or unconditioned 3002 lines. See figure 3-5. Modem speed options are configured via the Dataplexer's administrative control facility, which also provides sophisticated diagnostic tests.

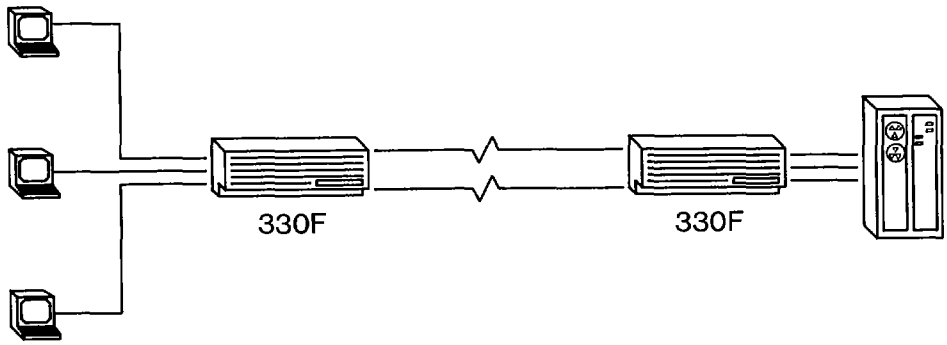
Figure 3-5. 330E application



330F Dataplexer

The 330F Dataplexer offers all of the features of the 330D. In addition, this Dataplexer provides two integral CCITT V.29/V.27 compatible modems (3003 modules) intended for operation over parallel 3002 facilities. Figure 3-6 shows a 330F application.

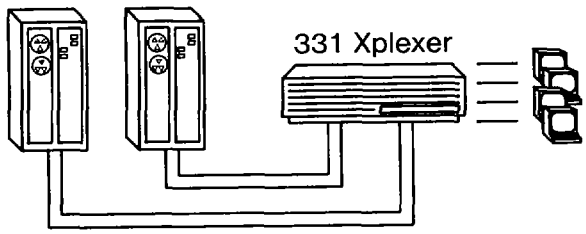
Figure 3-6. 330F application



Distributed Networks

In distributed communication networks, the 330 Dataplexer is used extensively with Tellabs' 331 Xplexer data switching system. The Xplexer, a microprocessor-controlled packet-switching system, supports a variety of network applications, functioning as a stand-alone port concentrator (see figure 3-7) or as the center of a distributed data switching network.

Figure 3-7. 331 Xplexer as simple port selector/data PBX

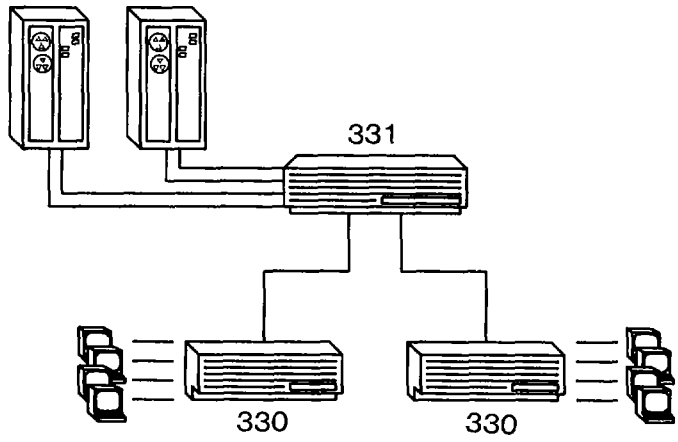


Linking Dataplexers to the Xplexer increases the capacity and range of the Xplexer. Each connected Dataplexer adds an additional 32 local channels to the Xplexer with only a single composite link connection to the Xplexer. (See figure 3-8.)

Connected Dataplexers operate as logical and physical extensions of the Xplexer; the combination appears to the user as a single, integrated data switching system. Data terminals connected to the Dataplexers can establish virtual circuit connections with any asynchronous port via the Xplexer's port and group selection features.

In this way, terminal users can access data bases or share dedicated devices such as printers. Xplexer configuration, statistics, diagnostics, and messages can also be accessed from any authorized asynchronous terminal directly connected to the Dataplexer.

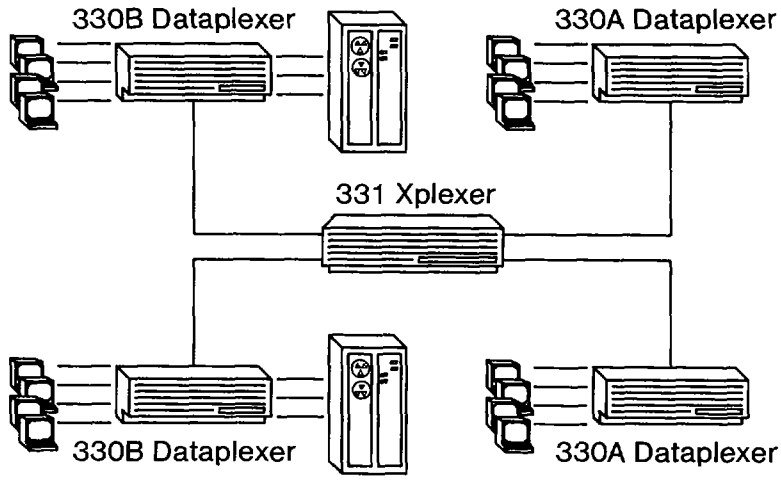
Figure 3-8. Packet switching/statistical multiplexing Xplexer



Tellabs' 330A Dataplexers can interface the Xplexer via the two RS-232-C data-link interfaces derived by the Xplexer's 3002 Communication Processor module, or via any equipped 3004A Quad RS-232-C Data Link Interface Module (figure 3-9).

A standard Tellabs Synchronous Null Modem Cable (part number 50-74XX) allows 330A Dataplexers to be connected without modems when the Dataplexer is within RS-232-C distance limits.

Figure 3-9. 331 Xplexer with directly connected 330A and 330B Dataplexers



The combination of a 331 Xplexer and a connected 330A Dataplexer is extremely powerful because of the wide range of transmission media that the 330A can interface. The RS-232-C interface of the 330 and 331 accommodates broadband coaxial cable, fiber-optic, and satellite links (via appropriate modem devices), as well as standard voice-grade private-line facilities.

Tellabs 330B Dataplexers located within 1 mile of the Xplexer are connected to the 331 via 64,000bps composite-link interfaces provided by the Xplexer's 3004B Quad Plexerlink module. Connecting 330B Dataplexers to the Xplexer is particularly advantageous in local-area networks because the Plexerlink interface affords high-speed (64,000bps) communication over common twisted-pair housewire without modems. Figure 3-9 shows a 331 Xplexer with directly connected 330A and 330B Dataplexers.

To allow RS-232-C operation with Dataplexers located farther than 50 feet from the Xplexer, outboard modems of various manufacture can be used. As an alternative, the Xplexer's RS-232-C links can be integrally equipped with Tellabs' 3003 Multispeed Modem Modules, and the 330A Dataplexers replaced by or upgraded to 330E Dataplexers.

The Tellabs 330C Dataplexer offers the same distributed network capabilities as the 330A with the addition of V.35 link capabilities. The Tellabs 330D Dataplexer offers the same distributed network capabilities as the 330A with the addition of dual-link support.

The 330E Dataplexer contains an RS-232-C interface identical to that of the 3002 and 3004A modules and incorporates a 3003 Multispeed Modem Module. In this way, complete modem compatibility is achieved, with the added benefit that all modems are under direct configuration and diagnostic control from any authorized asynchronous terminal.

The Tellabs 330F Dataplexer offers the dual-link support of the 330D with the addition of integral modems.

X.21bis Interface

Dataplexers equipped with the 331FP6/FP7 firmware support automatic call-initiation over circuit-switched Public Data Networks (PDNs) as defined in CCITT Recomendation X.21bis.

X.21 is the original CCITT comunications standard that defines a general purpose interface between DCE and DTE for synchronous operation over a PDN. X.21bis is an updated X.21 version designed for interfacing DTEs to synchronous V-series modems.

Specifically, X.21bis provides a full-duplex synchronous pathway to a PDN that is DTE transparent. X.21bis is identical to RS-232-C at a physical level and is responsible for both the physical and electrical connections, as well as for fault indications across a DCE/DTE interface.

The X.21bis interface allows users to take advantage of the features provided by PDNs without requiring precise knowledge of either the operating characteristics of remote DTEs or of the X.21bis link.

Section 4. System Capacity

INTRODUCTION

Calculating the capacity of a 330 Dataplexer link is a two-step process:

The network administrator must first consider the physical capacity of the Dataplexer hardware. Throughput and aggregate-input rate give the network administrator a guideline for how much traffic the Dataplexer can handle.

With this information as a basis, the network administrator can then perform traffic engineering, balancing the hardware capacity against composite-link speed and acceptable transmission delays.

Both of these factors, hardware capacity and traffic engineering, must be considered in the design of an efficient Dataplexer installation. The remainder of this section details the hardware capacity of the Dataplexer and traffic engineering for Dataplexer installations.

HARDWARE CAPACITY

The 330 Dataplexer can multiplex up to 32 asynchronous data channels at speeds up to 9600 bits per second (bps). Maximum Dataplexer throughput is 7500 characters per second (cps).

Additional limitations apply for synchronous channels:

1. If bisynchronous channels are used, the sum of the bisynchronous channel rates cannot exceed 38,400bps.
2. If SDLC/HDLC channels are used, the sum of **all** synchronous (bisync and SDLC/HDLC) channel rates cannot exceed 19,200bps. (At 19,200bps, errors will not exceed 1 percent.)
3. If synchronous channels (bisync or SDLC/HDLC) are used, aggregate input rate (the sum of all asynchronous **and** synchronous channel speeds) is reduced to 76,800bps.

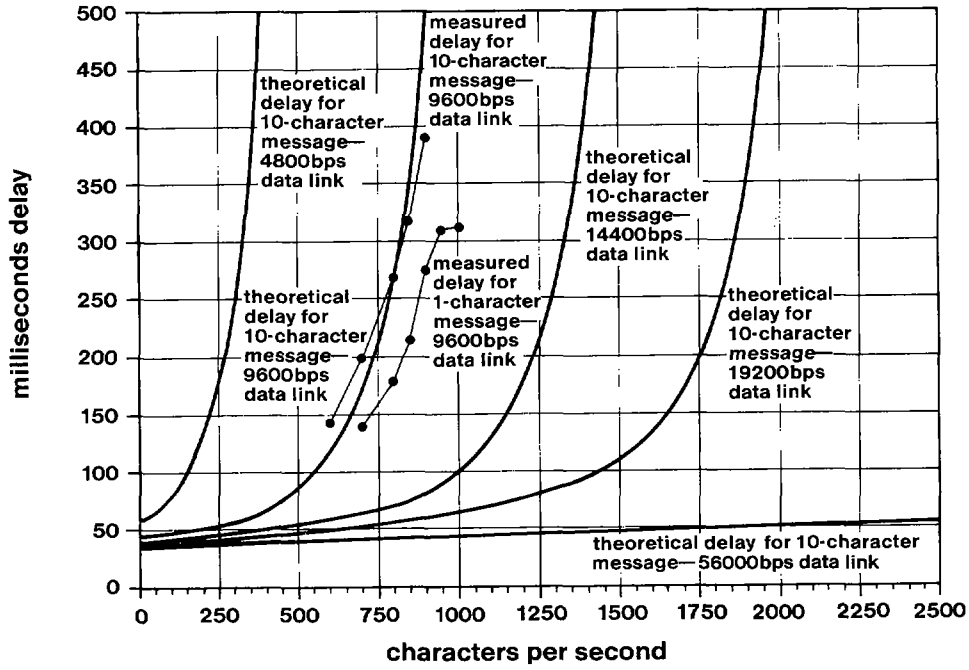
TRAFFIC ENGINEERING

System capacity of a statistical multiplexer is often determined by the bandwidth and delay characteristics of the composite link. The Dataplexer accommodates data-link speeds up to 76,800bps. Operation over satellite facilities is possible at speeds up to 56,000bps.

A composite data link of specified speed can only handle a certain amount of traffic. The advantage of a statistical multiplexer is that the available composite-link bandwidth can be allocated to whichever data channel requires transmission. When more traffic is present than the data link can carry, some data is delayed in a queue until data-link bandwidth is available. The length of time that data will be queued is dependent on the amount of traffic overload, and its distribution in time (i.e., the burstiness of the traffic).

Basic queuing theory demonstrates that the expected delay approaches infinity as the offered load approaches the capacity of the composite link. In a well-designed application, channel transmission delay is held to an acceptable level without allocation of excessive data-link bandwidth. Figure 4-1 shows the theoretical expected delay for composite data-link speeds up to 56,000bps with varying offered data traffic.

Figure 4-1. Theoretical expected message delays (4800 to 56,000bps data links)



The delay presented is the time between reception of the last character of a 10-character message at one Dataplexer and the transmission of the same character by the remote Dataplexer. This example assumes terrestrial (non-satellite) facilities.

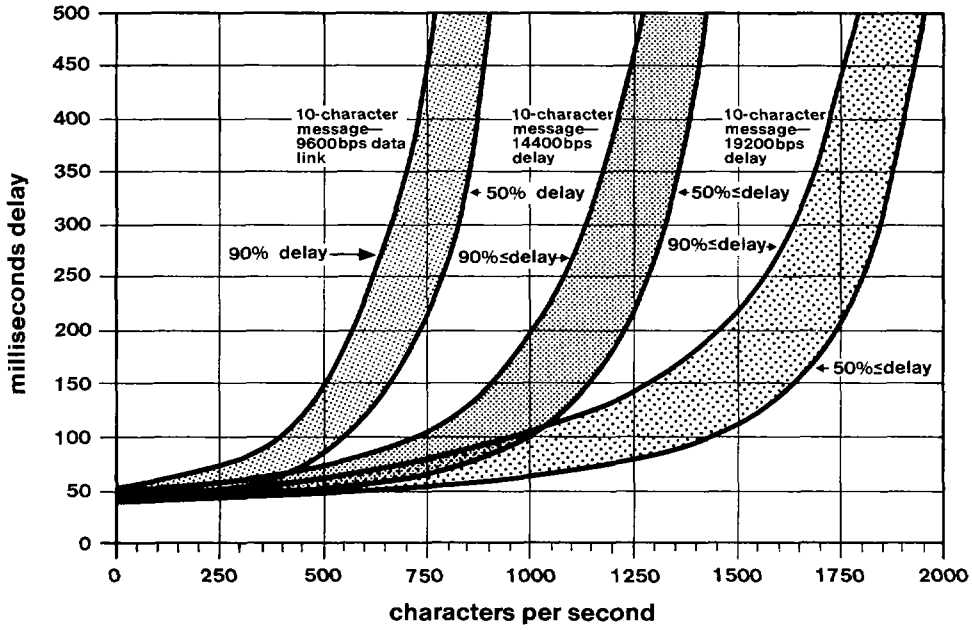
Also presented is the measured average delay for a 10-character message and a 1-character message, each at a data-link speed of 9600bps. The difference in delay is due to the Dataplexer's priority treatment of very short messages, such as single keystrokes and their echoes in host-echoplex applications.

Figure 4-2 shows the theoretical expected delay in greater detail for the common data-link speeds of 9600, 14,400, and 19,200bps.

Please note that the choice of a 10-character message in figure 4-2 is arbitrary. The curves in the figure are for data not given priority treatment. Delays for longer messages can be estimated by adding the time for the entire block to be read in to the multiplexer (dependent on the channel speed and message length; see the example later in this section) to the multiplexing delay for the last 10-character block (from figure 4-2).

An important caveat may apply for very long messages. Such messages distort the results by raising the effective offered load (e.g., the effect of a 10-character message is insignificant; that of a 250 character message is not).

Figure 4-2. Theoretical 50% and 90% message delays



The lower bound of each shaded area in figure 4-2 is the same as in figure 4-1, and represents the average expected delay. Fifty percent of all delays are expected to be less than or equal to the indicated delay for a given average total offered load.

The upper bound of each band represents the ninety-percentile delay. Ninety percent of all message delays are expected to be less than or equal to the values indicated.

To summarize: for a given data-link capacity, half the experienced message delays are less than indicated by the band and most longer delays fall within the given band. Ten percent of all message delays can be expected to exceed the indicated range.

Expected Delay

To determine the expected delay for a given application, estimate the data traffic during the busiest hour of a typical day, the number of data devices that will be used at this time, and the average total load.

For interactive terminals operating at 4800 or 9600bps (or personal computers operating as terminals), approximately 25 characters per second (cps) is a fair estimate of average load. Adjust this estimate up or down if the application is unusual in some regard.

For file transfer applications, e.g., to a printer, estimate the number of simultaneous file transfers at the expected transfer rate (usually considerably less than the operating baud rate).

Also, because printers do not exhibit the bursty load pattern typical of interactive devices, assume the printers are operating constantly and use the rated print speed as the load estimate.

After determining the total average load in cps for a busy hour, obtain the expected 90 and 50-percentile delays from figure 4-2. Remember that the indicated delay is for a pair of Dataplexers using terrestrial facilities.

If satellite facilities or Tellabs 331 Xplexers are used, the expected delay should be adjusted upward (500ms for satellite, 100ms for each Xplexer node).

Application Impact

The impact of transmission delay depends on the application. For interactive asynchronous applications using remote (host) echoplex, 100 to 200ms is usually reasonable for one-way delay, because the Dataplexer affords priority to single keystrokes and their corresponding host echoes (figure 4-1). For half-duplex or local-echoplex applications, the tolerable delay may be considerably greater.

For half-duplex, block-mode protocols such as bisynchronous and IBM bitsynchronous, block delay can have significant impact on an individual channel's throughput.

For example, consider an application with an average busy hour load of 600cps using a 9600bps composite data link. With reference to figure 4-2, we find that 90 percent of the block delays are less than 230ms. This delay is reasonable for most uses, but a question exists about an IBM 3276 Bisync Cluster Controller operating at 4800bps. For a 250-character block, the total one-way transmission time (ignoring protocol overhead) can be expressed as the sum of the time required to read in the characters (determined by the channel speed) and the multiplexing delay (from figure 4-2). The time required to read in the characters is given by:

$$\text{time} = \text{no. of chars.} \times \frac{\text{bits per char.}}{\text{speed (bps)}} \times 1000 \text{ ms}$$

$$= 250 \times \frac{8}{4800} \times 1000 \text{ ms}$$

$$= 417 \text{ ms}$$

The total one-way transmission time is thus:

$$\text{time} = 417 + 230 \text{ ms}$$

$$= 647 \text{ ms}$$

Assuming light traffic in the return direction, an acknowledgment requires an additional 50ms. Thus, a 250-character block can be sent every 697ms, resulting in channel throughput of 359cps.

Assuming 250-character blocks, displaying a 500-character screen will require approximately 1.4 seconds plus host response time. If host response time is 1 second, the total screen time is 2.4 seconds, or 30 per cent longer than a direct connection at the same speed. (If the 3276 is connected directly to the host at the same speed, the screen display time is approximately 1.8 seconds, including 1-second for the host.)

If a 1.4-second transmission time (2.4-second screen delay) is unacceptable, there are three alternatives:

- Increase the 3276 channel speed to 9600bps for a 2.0-second screen delay, only 8 percent longer than a direct 4800bps connection.
- A second alternative is to increase the composite data link speed. At 14,400bps, the 90-percentile expected delay is reduced to 90ms for a screen delay of 2.1 seconds, only 15 percent longer than a direct connection.
- The third alternative is to reduce the total average load by deleting channels or channel use from 600cps to approximately 400cps for a resulting 110ms delay and a 2.1-second screen delay.

Guidelines

Table 4-1 presents basic synchronous capacity guidelines on an application (controllers, printers, and displays) basis. The table represents a reasonable indication of Dataplexer synchronous capacity based on the general assumptions described in the table.

Table 4-1. Dataplexer synchronous capacity guidelines

composite data link speed (bps)	controllers				total devices	
	bitsync		bisync		printers or displays	
	4800	9600	4800	9600	@ 300 lpm	----
9,600	4	2	8	4	2	8
14,000	4	2	8	4	4	14
19,200	4	2	8	4	6	20
56,000	4	2	8	4	8	32

The above data is based upon the following assumptions:

1. The numbers of devices presented are reasonable maximums. These numbers should not be exceeded on initial order, but could be exceeded after application experience or traffic analysis.
2. If both printers and displays are used, the total number must be prorated between device types.
3. Printers are assumed to run at 300 lpm (300cps). Faster or slower printers affect the totals proportionately.
4. No asynchronous traffic is assumed. Asynchronous printers reduce the synchronous printer total. Asynchronous displays reduce the synchronous display total.
5. Because delay and the impact of delay is application dependent, the actual number of devices a Dataplexer can support may vary.

Notes:

Section 5. Data-Channel States

INTRODUCTION

A 330 Dataplexer data channel can be in any one of several possible states, as shown in table 5-1 and summarized below. Movement through the various data-channel states is shown in figure 5-1.

Table 5-1. Data-channel states

asynchronous data-channel state	**explanation**
disconnect	DTR and RTS are inactive
auto-baud	waiting for auto-baud character
ready	DTR or RTS is active
administrative control	channel is accessing administrative control facility
out of service	channel is ignored as a result of self-test diagnostics or administrative control facility request
loopback	channel is internally looped back; all data transmitted to the channel is returned to the remote location
connect	channel is connected to remote end

Disconnect

When the data-terminal-ready (DTR) and request-to-send (RTS) modem-control signals are inactive, the local channel is in the **disconnect** mode and can neither send nor receive data or participate in a virtual circuit connection.

If the data channel is configured for modem operation, the channel will remain in the **disconnect** state until the channel's BO (modem RI) signal becomes active. If the BO (RI) signal cycles on and off (modem ringing) or remains active for more than two seconds, the channel will raise the CTS (modem DTR) signal and wait for the RTS (modem DCD) signal to become active.

Ready

When either the DTR or RTS modem-control signal becomes active (usually after power is applied to the terminal), the channel enters the **ready** mode or, if the automatic baud-rate option is selected, the **auto-baud** mode.

From the **ready** state, a channel can enter either the **control** mode (if the channel has administrative control facility access privileges) or the **connect** mode.

Auto-Baud

If the automatic baud-rate option is selected, the Dataplexer waits for the first ASCII carriage return to determine the speed of the local data channel. After the auto-baud character is entered, the channel is placed into the **ready** mode.

Control

To access **control**, enter a <BREAK> from the **ready** mode. Once in **control**, the user can select, review, and reassign system and channel parameters, execute diagnostic tests, and retrieve operating statistics and information messages.

Connect

The **connect** mode is only entered when an end-to-end connection is established, i.e., when the remote DTE is physically connected to the Dataplexer and data is transmitted. When a data channel is in the **connect** mode, data is passed transparently.

If both the DTR and RTS signals become inactive, the channel returns to the **disconnect** mode and the remote channel is placed into the **ready** mode.

A channel in the **connect** mode can return to the **ready** mode if the user enters a <BREAK> followed by a customer-specified termination sequence. (As factory-configured, the default termination sequence "QQQ" is entered to terminate virtual circuit connections.)

If information messages are allowed, they are sent to the channel upon entry into either the **ready** or the **connect** mode.

Out of Service

A channel is **out of service** if the Dataplexer's self-test or on-demand diagnostics determine that the channel is inoperative.

A data channel can also be forcibly placed **out of service** by another channel with administrative control facility access.

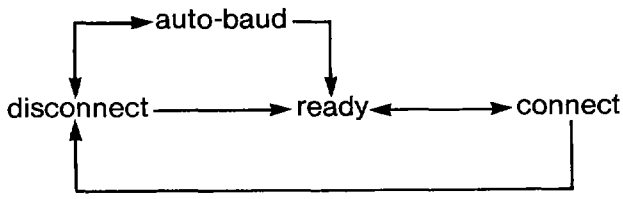
When a channel is **out of service,** all data and signals at the channel connector are ignored.

Loopback

Any in-service data channel (without echoplex and not in **control**) can be placed into a local **loopback** state by another channel with administrative control facility access.

When a channel is in **loopback,** data received by the Dataplexer for the looped-back channel is returned to the source.

Figure 5-1. Movement through data-channel states



Section 6. Administrative Control Facility

INTRODUCTION

The 330 Dataplexer provides a convenient menu-driven dialogue for configuration, messages, statistics, and diagnostics.

This administrative control facility is accessed from any asynchronous data terminal with enabled access privileges. (Access to the administrative control facility can be restricted on a per-channel basis.) Control facility communication must be in ASCII format.

Only one user can be in administrative control at any time. The network administrator accesses the administrative control facility by entering a <BREAK> from any enabled data channel in the ready mode.

When physical access to the multiplexer is convenient or required, depressing the **control** pushbutton on the front of the Dataplexer's main enclosure forces the first active in-service channel out of the ready mode and into administrative control.

Menus

After administrative control is accessed, a series of menus lead the user through the various administrative control facilities.

Menus are arranged in a tree structure, in which the initial menu is the root and each submenu is a branch of the tree. In general, movement through the tree is from menu to adjacent menu. Figure 6-1 shows the structure of the administrative control menus.

A set of control characters that allow convenient movement through the menu structure is also provided.

Configuration Facilities

These four main sections of the administrative control facility allow the network administrator to perform the following tasks:

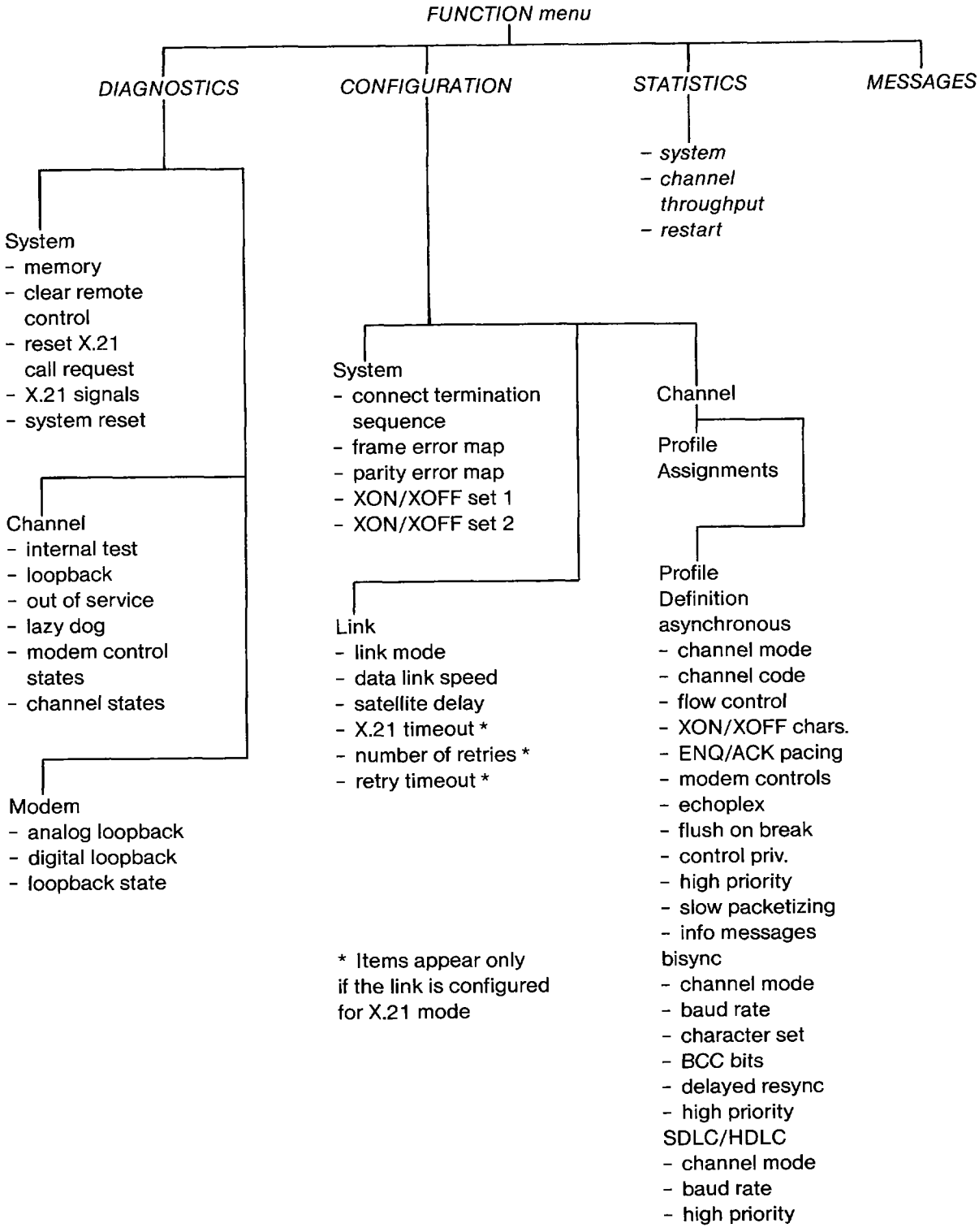
Diagnostics — These menus allow the network administrator to perform system, channel, and integral-modem diagnostic tests on demand.

Configuration — These menus allow the network administrator to review, select, and update all configurable system and channel parameters.

Statistics — These menus allow the network administrator to retrieve system and channel statistics.

Messages — These menus allow the network administrator to obtain queued system messages on demand.

Figure 6-1. Control menu tree structure (330FP6/FP7)



Section 7. Specifications

multiplexing technique	character interleaved, asynchronous time division (statistical)

Principal Channels

number	4, 8, 16, 24, or 32
channel speeds	50 to 9600bps asynchronous full-duplex; 1200 to 9600bps synchronous
aggregate input rate	307,200bps (76,800bps if synchronous channels are used)
throughput	approximately 5000 cps (4MHz); 7500 cps (6MHz)
codes	5, 6, 7, or 8 bits; 1, 1.5, or 2 stop bits asynchronous; Bisync and SDLC/HDLC synchronous
synchronous protocols	Bisync, as defined by IBM publication GA27-3004-2; Bitsync, SDLC as defined by IBM publication GA27-3092-1; HDLC as defined by CCITT X.25 level 2
interface	EIA RS-232-C, CCITT V.24, female 25-pin (DB-25-S)
interface controls	RTS, CTS, DSR, DTR, RI, DCD, DRS, BO
echoplex	none, local, or remote, individually programmed per channel profile
flow control	1) in-band (XON/XOFF) 2) out-of-band (CTS/DTR) 3) XON/XOFF to the Dataplexer 4) XON/XOFF from the Dataplexer 5) No flow control individually programmed per profile
automatic baud detection	300/1200/2400/4800bps, individually programmed per channel
options	asynchronous line driver

Composite Data Link

number	1 or 2
link speeds	1200 to 76,800bps each
transmission mode	SDLC/HDLC bitsynchronous
link protocol	subset of X.25 level 2
error detection	16-bit CRC frame check
interface	EIA RS-232-C, CCITT V.24/V.28, male 25-pin (DB-25-P) internal or external clock
options	dual RS-232-C data links; integral local digital line driver/receiver; optional V.29 multispeed data-link modem; CCITT V.35 wideband modem interface (AT&T's DDS @ 56,000bps)

Integral Modem (3003 Module)

private-line channel speed	2400, 4800, 7200 or 9600bps, CCITT V.29
private-line interface	FCC Part 68 RJ-14C jack
composite-link interface	EIA RS-232-C, CCITT V-24/V-28, male 25-pin (DB-25-P), internal or external clock
output level	0dBm (±0.5dB)
transmit and receive port impedances	600 ohms, fixed
DCD signal threshold	−16dBm, −26dBm, or −43dBm, switch-selectable

Indicators and Controls

link utilization	one-digit display indicates 0 to 99% link usage, flashes if errors exceed 1 in 100,000 bits
buffer utilization	one-digit display indicates 0 to 99% buffer usage, flashes if data is lost due to buffer overflow
administrative control facilit indicator	one-digit display indicates that a channel is in administrative control, flashes if administrative control facility message is pending
administrative control facility	nonlocking pushbutton places first in-service channel in administrative control
reset	nonlocking pushbutton forces power-on/reset sequence; three-digit display indicates error codes detected during reset sequence

Environment

input power ranges	nominal 90 to 135Vac at 47 to 440Hz or, by special order, 180 to 270Vac at 47 to 440Hz; 50 watts maximum, 35 watts typical (Dataplexer w/16 channels)
heat	175BTU maximum, 120BTU typical
operating temperature	32° to 104°F (0° to 40°C)
humidity	0 to 95% (no condensation)
dimensions (single enclosure)	5.25 inches (13.3cm) high 17 inches (43.18cm) wide 11 inches (27.94cm) deep
weight (single enclosure)	15.5 pounds (7.03 kilograms)
mounting	desktop placement or 19-inch, 23-inch, or 24-inch equipment rack mounting (via optional mounting ears)

Section 8. Warranty

Tellabs warrants the 330 Dataplexer to be free of defective components and workmanship for a period of two years from the date of manufacture, when used as outlined in our technical manuals, subject to handling and installation commensurate with industry standards for solid-state electronic equipment.

If the 330 Dataplexer does not prove to be free of defective components and workmanship under these criteria, Tellabs will replace or repair it free of charge. We strongly recommend that no internal (component-level) testing or repairs be attempted on the 330 Dataplexer. Unauthorized testing or repairs may void the Dataplexer's warranty.

For additional information on the 330 Dataplexer, please contact Tellabs Customer Service at your Tellabs Regional Office or at our Lisle, Illinois, or Mississauga, Ontario, Headquarters. Telephone numbers are as follows:

region	telephone	office (metro) location
US Atlantic	(203) 798-0506	Danbury, CT
US Capital	(703) 478-0468	Washington, D.C.
US Central	(312) 357-7400	Chicago, IL
US Southeast	(305) 834-8311	Orlando, FL
US Southwest	(214) 869-4114	Dallas, TX
US Western	(714) 850-1300	Orange County, CA
Canada (all)	(416) 624-0052	Toronto, Ontario