GA33-0002-3
TP-09

Systems

IBM 3874 Modem User's Guide

IBM

Fourth Edition (February, 1976)

This major revision obsoletes GA33-0002-1 and Technical Newsletter GN33-0008 (dated 28 February, 1975) and reprint GA33-0002-2. Changes have been made to reflect the following:

1. The operation of 'receiver signal element timing' modified.
2. Customer responsibilities added in respect of the connection of the 3874 to a communication channel.
3. Information on programming considerations for back-up operation on switched network added.

To include the information indicated in 2 and 3, the section on the communications channel in Part 3 has been expanded and includes information given previously in Appendix B. A new Appendix B has been added, and Appendix C removed. These sections should, therefore, be read in their entirety. Elsewhere, changes to the text and/or illustrations are indicated by a vertical line to the left of the change.

Changes are periodically made to the information herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

A form for reader's comments is provided at the back of this publication. If the form has been removed, comments may be addressed to: IBM France, Centre d'Etudes et Recherches, Product Publications, Dept. 0762, 06610 La Gaude, France. Comments become the property of IBM.

This manual has been prepared with the IBM 72 Magnetic Tape Composer.

Preface

This publication is written for operators, system engineers, and installation planning engineers who are using or intend to use the IBM 3874 Modem in a teleprocessing system. The manual is divided into four parts:

- *Part 1. General Information*
- *Part 2. Operator's Information*
- *Part 3. Technical Description*
- *Part 4. Appendixes.*

No previous teleprocessing experience is required to understand the information given in Parts 1 and 2.

Part 1

The purpose of a modem is briefly given, followed by a short description of the 3874 Modem, together with a list of its highlights and possible configurations.

Part 2

Is intended primarily for operators. It first describes the purpose of each control and indicator on the front panel of the 3874, then gives direct operating and test procedures.

Part 3

Contains the technical information required by system and installation planning engineers. Describes in detail the IBM 3874 Modem: modulation technique, modes of operation, equalization, synchronization, interface specifications, installation specifications, communications channel details, some suggested ways of using a Fan Out feature, and how to select strapping options to tailor the 3874 for a particular mode of operation.

Part 4

Provides reference information in the form of an abbreviations list and glossary that explains terms used in the manual. Differences, as a result of national requirements, between 3874 modems are summarized. Describes equipment and programming considerations for back-up operation on the public switched network.

Additional Publications

The following communication channel publications are referenced in this manual:

- *International Telephone and Telegraph Consultative Committee (CCITT) Recommendations V24/V28 (CCITT Recommendations, White Book, Volume 8b)* available from:
  International Telegraph Union (ITU)
  Geneva, Switzerland.
  or
  United Nations Bookstore
  United Nations Plaza
  New York, New York 10017, U.S.A.
- *Electronic Industries Association (EIA) Standards RS232C, RS334, and RS366* available from:
  EIA Standards Engineering Department
  EIA Standards
  2001 "I" Street, N.W.
  Washington, D.C. 20106, U.S.A.
- *Bell System Data Communications Technical References:*
  - *PUB 41004, Data Communications Using Voice Band Private Line Channels* (October 1973)
  - *PUB 41005, Data Communications Using the Switched Telecommunications Network* (May 1971)
  - *PUB 41801, Data Access Arrangement CDT for Manual Originating and Answering Terminals* (May 1971)
  - *PUB 41802, Data Coupler CBS and CBT for Automatic Terminals* (August 1970)

  available from:
  American Telephone and Telegraph Co.
  Supervisor-Information Distribution Center
  195 Broadway, Room 208
  New York, N.Y. 10007, U.S.A.

In addition a list of appropriate publications for access methods used in teleprocessing systems is given in Appendix B.

Contents

Part 1. General Information

Part 2. Operator's Information

Part 3. Technical Description

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Illustrations

Note: The illustrations in this manual have a code number to the right of the caption. This is a publishing control number and is unrelated to the subject matter.

Note: All the controls shown cannot be present at the same time on a given 3874, as some of the features are mutually exclusive.

Frontispiece. IBM 3874 Modem [18818]

Part 1. General Information

This part of the manual introduces the IBM 3874 Modem, its highlights, and its possible configurations; a more technical description is given in Part 3.

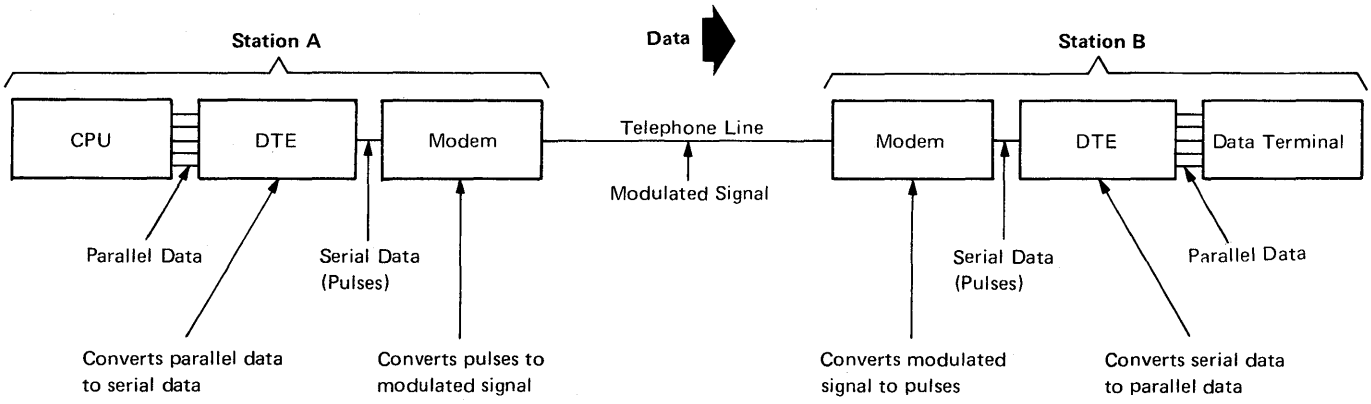
Purpose of a Modem

The modem is an essential part of a teleprocessing system (Figure 1), because it controls and converts data pulses from the data terminal equipment (DTE) into a suitable form for transmission over telephone lines. This conversion is called *modulation.* The modulated signal has to be converted back into data pulses at the receiving end. This conversion is called *demodulation.*

Two modems are, therefore, required to control the data transfer over a telephone line: one to transmit and the other to receive, each modem having a modulator and a demodulator. (The word modem is a contraction of the expression modulator-demodulator.)

For example, when station A (see Figure 1) sends data to station B, modem A modulates the data and sends the modulated signal over the telephone line. Modem B receives the modulated signal from the telephone line and converts it back into the original data.

When station B sends data to station A, modem B modulates and modem A demodulates. The modem, therefore, modulates or demodulates, dependent upon whether it is transmitting or receiving.



Note: Data transfer is shown from station A to station B. When data transfer direction is reversed, roles of modems and DTEs are interchanged.

The IBM 3874 Modem

The IBM 3874 Modem:

- Is intended to operate at a speed of 4800 or 2400 bits per second (bps) on:
  Non-switched telephone lines in point-to-point or centralized multipoint configurations.
  Public switched network (U.S.A. and Canada only), either exclusively or in back-up operation to non-switched line. Connection is made via a Data Access Arrangement (DAA) type CBS* or type CDT*.
- Uses coherent-phase-shift keying, with digital echo modulation.
- Incorporates a clock, which makes it unnecessary for the DTE to provide clocking pulses for the transmission or reception of data.
- Includes an automatic receive equalizer, thereby assuring satisfactory operation on voice-grade non-switched lines or on the public switched network.
- Accepts a Fan Out feature, which enables connection to up to three DTEs.
- Allows an operator or the using system to detect faults rapidly and to identify their origin (3874, using system, or line).
- In switched network operation, provides the possibility of using an Automatic Call Originate feature (with DAA type CBS).

In non-switched line operation, an Alternate Voice feature allows conversation directly between operators, via handsets plugged into the interconnected modems. In switched network operation, however, conversation takes place via the associated telephone handset.

To determine the IBM machines to which the 3874 can be attached, consult your IBM representative.

HIGHLIGHTS

The 3874 offers the following basic advantages:

- Reduced error rate
- High reliability
- Operation on economical non-switched lines
  U.S.A. and Canada: "C1" conditioning.
  Other countries: telephone line meeting characteristics defined under "Communications Channel Specifications" in Part 3.
- Operation on a switched network (in U.S.A. and Canada only).
- Possibility of manual or DTE-controlled switching from 4800 bps to 2400 bps if a non-switched line becomes degraded.
- Possibility of switching from a non-switched line to a switched network if non-switched line operation becomes impractical, and to operate at 4800 bps on the switched network (in U.S.A. and Canada only).
- Automatic equalization, which provides a practical means for efficiently equalizing each connection when it has been established.
- Turn around time can be reduced by use of four-wire duplex facilities (instead of four-wire half-duplex).
- Use of the fan out feature to reduce the number of modems required by allowing up to three DTEs at the same location to be connected to the same modem.
- Ability to operate in duplex data mode.
- Built-in test facilities to enable the operator to determine the location of a system fault (teleprocessing transmission path).

All these advantages increase the efficiency, availability, and flexibility of teleprocessing systems.

VARIATIONS

The 3874 is adapted for a specific application (for example, point-to-point) by the addition of special circuitry, called *features*, and by the selection of suitable strapping options. *Note:* Strapping options are jumpers installed by the IBM customer engineer during the installation of the 3874.

Features available are as follows (allowable configurations are shown in Figure 2):

1. Point-to-Point
2. Multipoint Tributary
3. Multipoint Control
4. Switched Network**
5. Switched Network Back-Up** (for use with DAA-CBS [with auto-answer] or with DAA-CDT [without auto-answer])
6. Alternate Voice
7. Fan Out
8. Automatic Call Originate**
9. Direct Line Attachment.

Required Features

Note: The "required features" are mutually exclusive, but each of them can have one or more optional features (see Figure 2).

Point-to-Point

The Point-to-Point feature allows data communication between two stations via a four-wire non-switched line.

Multipoint Tributary

The Multipoint Tributary feature is similar to the point-to-point feature, but allows connection to a 3874 with the Multipoint Control feature. A maximum of six tributary stations may be used with one control modem.

* Manufactured by American Telephone and Telegraph Company

** Available in U.S.A. and Canada only

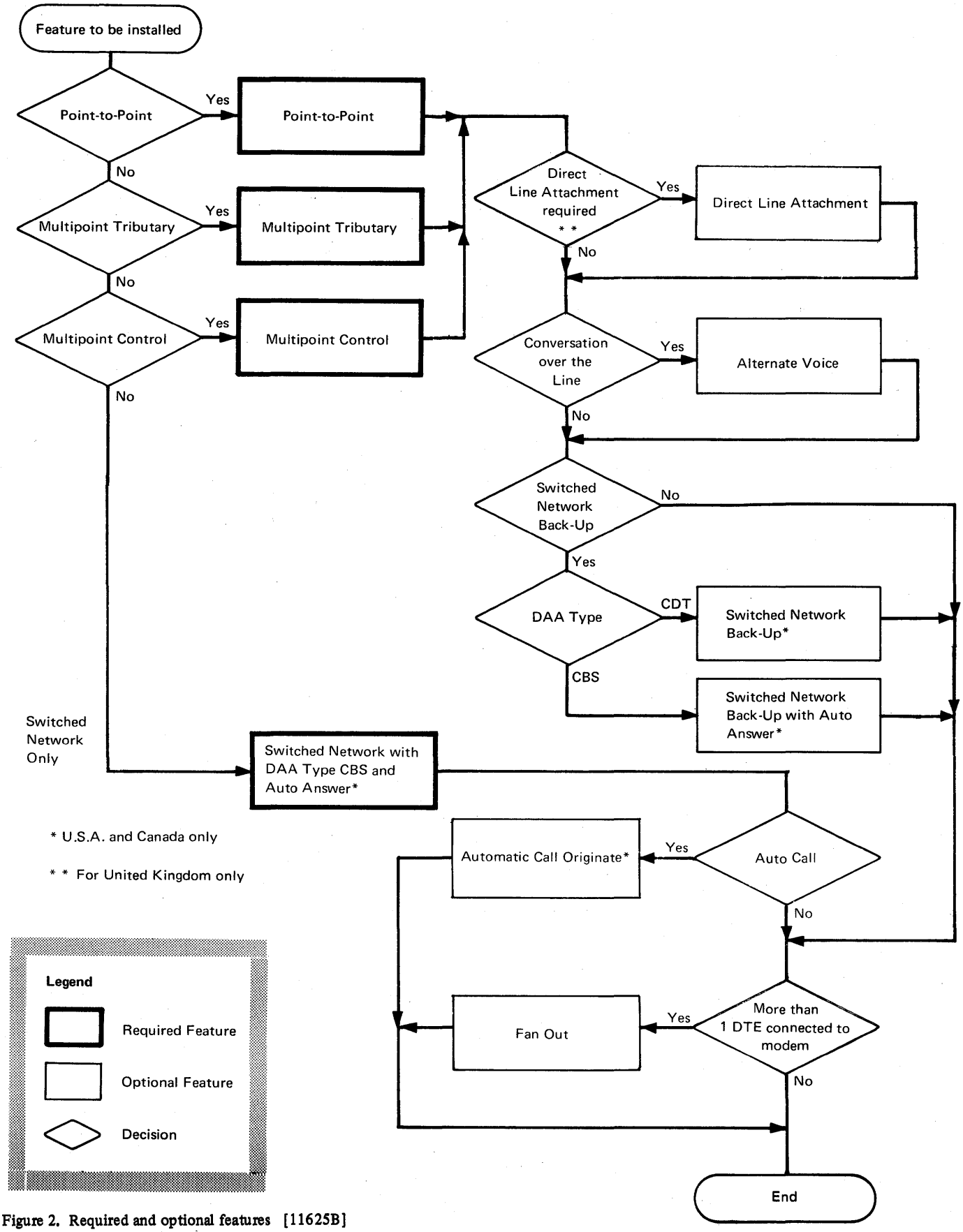


Figure 2. Required and optional features [11625B]

Multipoint Control

In addition to the basic functions, the Multipoint Control feature allows the storage of the different settings of equalization relative to each tributary station. It also adds equalization indicators on the operator panel.

Switched Network

The Switched Network feature provides for operation exclusively on the public switched network. Connection to the switched network is through a Data Access Arrangement type CBS. Calls must be initiated manually (unless the Automatic Call Originate feature is installed), but can be answered either manually or automatically. When a call is answered automatically, a 2100-Hz tone is emitted to enable an operator or an automatic call originate feature at the remote station to recognize that the call has been answered.

Optional Features

Switched Network Back-Up

The 3874 that is normally used on a non-switched line can be connected manually to the public switched network by a Switched Network Back-Up (SNBU) feature. Connection to the switched network is through one of the following:

1. DAA-CBS, if auto-answer is required. (Manual answering is, however, still possible.)
2. DAA-CDT, if manual answering and/or manual calling only is required.

As either a DAA-CBS or a DAA-CDT can be the interface between the 3874 and the switched network, and because the characteristics of each DAA are different, two appropriately matching back-up features are available.

Connection is possible with a DAA-CBS at one end and a DAA-CDT at the other.

The SNBU features are installed with the point-to-point, the multipoint tributary, or the multipoint control feature so that:

1. Additional positions (4800 SW and 2400 SW) are available on a speed/mode-select switch to allow the operator (or DTE, if this switch is set to EXTERNAL) to select the switched network.
2. DTE interface is modified.
3. Additional telephone line interfaces are provided for connection to the DAA-CBS or DAA-CDT.
   (For details see "Data Access Arrangement/3874 Interfaces" in Part 3.)

Selecting switched network back-up converts the modem to two-wire operation. (The transmit level is automatically adjusted for the change from "non-switched" to "switched".)

Alternate Voice Feature

The Alternate Voice feature allows the 3874 to be used with a suitable user-provided handset (see "Physical Installation" in Part 3 for characteristics) for conversation between operators over non-switched lines. The feature includes a telephone jack socket (labeled VOICE), for the handset, and a call switch, both located on the operator panel. One handset, therefore, may be used for several closely-positioned modems. The feature cannot be used when switched network back-up mode is selected.

Fan Out Feature

The Fan Out feature enables the 3874 to be shared by two additional DTEs. Appropriate line control techniques must be provided by the DTEs, so that only one DTE at a time transmits to the 3874.

If the fan out feature is installed with either the switched network or the switched network back-up feature, it requires special programming support (made by the customer).

Automatic Call Originate

The Automatic Call Originate (ACO) feature, on a switched network, makes possible programmed, automatic calling of other stations over the switched network. Making a call is then under DTE control. This feature is only usable with the Switched Network feature, and when DAA-CBSs are present at both ends of the line.

Direct Line Attachment

The Direct Line Attachment feature is required for use on non-switched lines in the United Kingdom to provide mains current isolation from Post Office facilities.

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This part of the manual is intended for operators using the IBM 3874 Modem.

Operator Controls

Figure 3 depicts a 3874 that has the maximum number of controls, with the following:

1. Multipoint control feature (six automatic receive equalization indicators and a selective equalization switch).
2. Switched network back-up feature (4800 SW and 2400 SW positions and TALK/DATA switch).
3. Alternate voice feature (telephone jack [VOICE] and call switch).
4. Automatic call originate feature (the controls on the left-hand half of the operator panel).

The purpose of each of these controls and indicators is summarized in Figure 4. More detailed information for the following switches is given under their related headings on this page and page 10:

- Operate/test
- Reset
- Talk/Data
- Call.

OPERATE/TEST SWITCH

The eight-position operate/test rotary switch is set to OPERATE for normal operation of the 3874 and to VOICE for conversation over non-switched line, when the alternate voice feature is installed. The following test positions of the switch can be used by the operator as described under "Tests by Operator" in "Modem Tests".

Operator Test Positions

Local	*Remote*	*Functions*
T1A		Modem internal wrap test, including receive equalizers. (Does not test the DTE interface, automatic call origination, and automatic answering)
T2	–	Modem/DTE wrap test (must be initiated and controlled by the DTE)
T3	T3	End-to-end non-switched line test
T3	T4	Remote wrap test (non-switched line)
T3	T4	End-to-end switched network test
T4	T3	

Note: The T1B position is for IBM customer engineer use

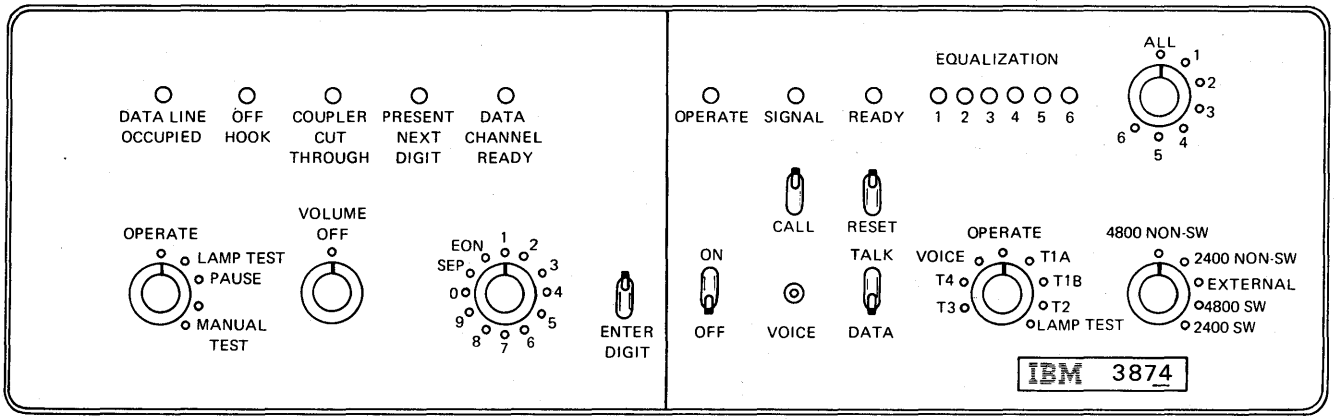


Figure 3. Operator panel (maximum number of controls) [11626B]

Automatic Call Originate

Indicators

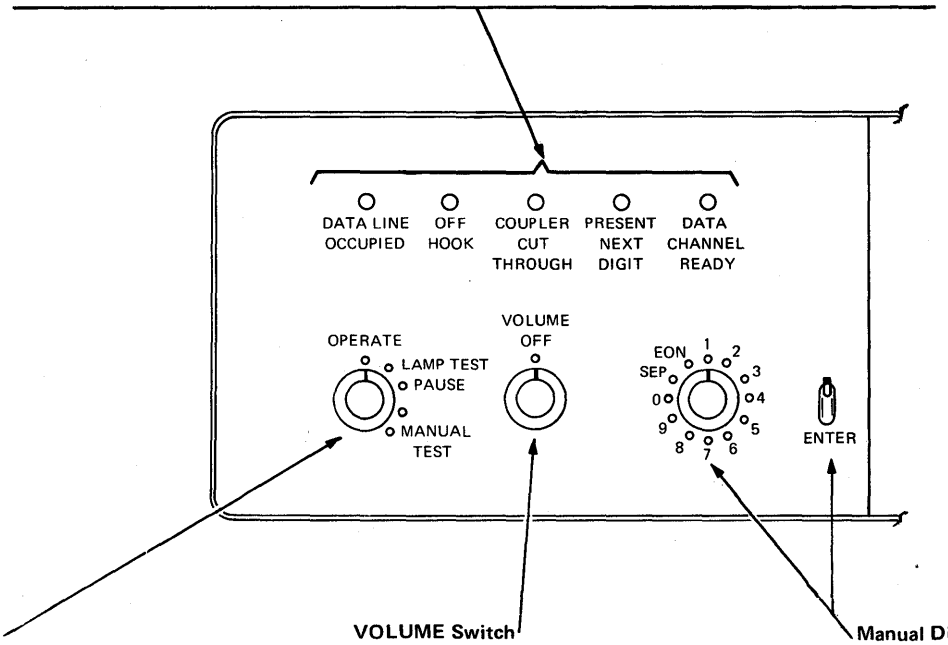
DATA LINE OCCUPIED turns on to indicate that the communication channel is busy (in use).

OFF HOOK turns on with the 'off hook' line in the interface to the DAA-CBS.

COUPLER CUT THROUGH turns on when the modem has been given use of the line for signaling by the DAA-CBS (channel is available for dialing).

PRESENT NEXT DIGIT turns on with the 'present next digit' interface line.

DATA CHANNEL READY turns on when a call has been completed by the ACO circuitry the data channel is established, and the equalization has been performed. Data exchange can proceed.



Function Switch

When this switch is set to OPERATE, the ACO is controlled only by the DTE interface lines.
When set to LAMP TEST, this switch resets the ACO and causes the five ACO indicators to turn on.
When set to PAUSE, this switch resets the ACO. All indicators should be off within six seconds.
When set to MANUAL TEST, this switch conditions the ACO to accept manual dialing inputs.

VOLUME Switch

This continuous control turns on the call progress monitor speaker and adjusts speaker volume. Dial tone, dial pulsing, ringing, and answer tone can be monitored as the call progresses.

Manual Dialing Switches

When the function switch is set at MANUAL TEST, these switches may be used to select and enter the digits of a telephone number.

Figure 4. Switches and indicators (Part 1 of 2) [11627B]

Point-to-Point, Switched Network, Multipoint Tributary, Switched Network Backup, and Alternate Voice

OPERATE Indicator
Shows that power is on. When the operate/test switch is set on OPERATE, the indicator is on for a received "mark" signal and off for a received "space" signal. As a result, when data is being received, the indicator dims. When the operate/test switch is set to one of the test (T) positions, the indicator turns off for 150 ms when an error is detected.

SIGNAL Indicator
Shows that an analog signal is being received ('received line signal detector' interface line). The energy is received either from the remote modem or from the local modem itself when it is in loop test (T1A, T1B or T2).

READY Indicator
Shows that:
- The modem is powered on
- The OPERATE/TEST switch is set to OPERATE.

Must be off in any test position. When the Alternate Voice feature is present, Ready indicator is off, but flashes when a call is initiated or detected.

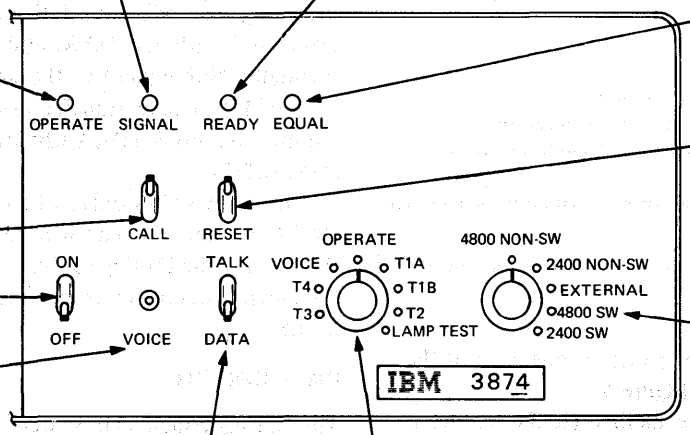
EQUALIZATION Indicator
Informs the operator that the equalization has been successfully completed.
Point-to-Point: turns on when local equalization is successful
Multipoint Tributary: turns on when local equalization is successful
Sw. Netw. Calling Station: turns on when local and remote equalization are successful
Sw. Netw. Called Station: turns on when local equalization is successful
Note: Multipoint Control: see detail below.

CALL Switch*
When the local operate/test switch is set to VOICE:
- Sounds a buzzer and flashes the ready indicator in the remote station.
- Sounds a buzzer in the local station.

RESET Switch*
Starts an automatic equalization procedure, depending on the setting of the operate/test switch.

ON/OFF Switch **
Controls ac power input to the modem.

VOICE
Socket for connecting a telephone handset to enable an operator to talk over non-switched line.



TALK/DATA Switch*
Normally set on DATA for all operations. It is set to TALK when operating on switched network, to manually answer or make a call.

OPERATE/TEST Switch
Normally set to OPERATE, is set to one of the test (T) positions for problem determination, or to VOICE for voice communication over non-switched line when the alternate voice feature is installed.
When set to LAMP TEST causes all the indicators to light

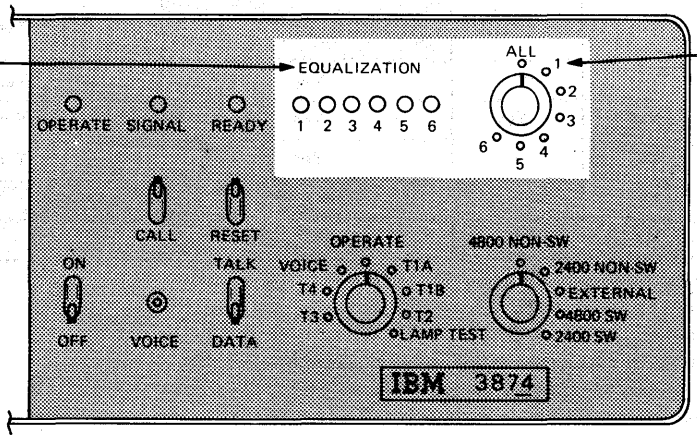
Speed/Mode-Select Switch
Must be set the same as other modems on the same line.
4800 NON-SW setting is for 4800 bps dedicated channel.
2400 NON-SW setting is for 2400 bps dedicated channel.
EXTERNAL setting is for system control of transmitting and receiving rate by way of the 'data signal rate selector' interface line (if the DTE is capable of activating this interface lead).
4800 SW setting is for 4800 bps operation on switched network.
2400 SW setting is for 2400 bps operation on switched network.
Changing from 4800 NON-SW to 2400 NON-SW, and vice versa, starts a new equalization

* Further details are given on following page

** Whenever switching from power-on to power-off, wait at least 10s before switching from *off* to *on*

Multipoint Control

EQUALIZATION Indicators
Turn on when the local equalization related to one tributary modem has been successfully performed.



Selective Equalization Switch
- When set to ALL, allows the equalization process for all tributary stations installed.
- When set to 1 through 6, allows the equalization process only for the tributary station selected.

This switch must be positioned prior to operating the reset switch to initiate an equalization procedure. After a selective equalization, this switch must be set back to ALL.

Figure 4. Switches and indicators (Part 2 of 2) [11628B]

Operate/Test Switch	Indicators on			
	Operate	Signal	Ready	Equal
Operate	Yes[2]	Yes[4]	Yes	Yes[1]
T1A	Yes[3]	Yes	No	Yes[1]
T1B*	Yes[3]	Yes	No	Yes[1]
T2	No	Yes[4]	No	Yes[1]
T3 Non-Sw	Yes[3]	Yes	No	Yes[1]
T3 Sw-Net	No	No	No	Yes[1]
T4	Yes[3]	Yes	No	Yes[1]
LAMP TEST	Yes	Yes	Yes	Yes

* For IBM customer engineer use only

Notes:

1. After equalization is successfully performed.
2. After equalization, when data "mark" is being received.
3. After equalization is successfully performed and if no error is detected.
4. During equalization and after equalization, if data is being received.

Figure 5. Indicator status with operate/test switch position [17909C]

The status of the indicators at the various positions of the operate/test switch are shown in Figure 5.

When using the alternate voice facility (if the feature is installed), the operate/test switch must be set to VOICE before the call switch is operated and while conversation takes place via the telephone handset. The operate/test switch must not be left on VOICE when the handset is not used.

Note: When the modem is in switched network mode, the voice position of the operate/test switch must not be used.

RESET SWITCH

The reset switch allows an operator to initiate automatic equalization, depending upon the type of station and the setting of the operate/test switch (Figure 6).

TALK/DATA SWITCH

The talk/data switch is provided as part of the switched network or SNBU feature (U.S.A. and Canada only) for use with the DAA-CBS or DAA-CDT.

The talk/data switch is set to TALK to call manually and is switched to DATA before a subsequent data transfer.

When the talk/data switch is initially set to TALK, an incoming call will sound the ringer of the telephone set associated with the DAA, and the call must be answered manually. Subsequently, the switch must be set to DATA to establish a data transfer prior to placing the telephone handset on hook (DAA-CBS) or pulling up the data key (DAA-CDT).

With a DAA-CBS only, when the switch is initially set to DATA an incoming call will be answered automatically by the 3874 if the DTE is ready.

Manual disconnect is performed by switching back to TALK.

CALL SWITCH

The spring-loaded call switch is provided as part of the alternate voice feature. It is used when the operate/test switch is set to VOICE, to contact another operator by sounding a buzzer in the remote modem and by flashing the ready indicator; the remote buzzer sounds and the indicator flashes for as long as the switch is held depressed.

The local buzzer is also sounded to allow the calling operator to send, for example, prearranged coded-calls.

	Operate/ Test Switch	Non-Switched Line			Switched Network or Switched Network Back-Up with CBS	Switched Network Back-Up with CDT
		Point-to-Point	Multipoint Control	Multipoint Tributary		
Normal Operation	OPERATE	Yes	Yes	*	–	Yes
Test Operation	T1A/T1B	Yes	Yes	Yes	Yes	Yes
	T2	Yes	Yes	Yes	Yes	Yes
	T3	Yes	Yes	*	Yes	Yes
	T4	–	Yes	–	–	–
	VOICE	–	–	–	–	–

Yes : Reset switch starts an automatic equalization.
- For local station in T1A/T1B and T2
- For local and remote stations in OPERATE and T3

For multipoint configurations, the tributary station to be equalized is selected by the selective-equalization switch at the control station (ALL, or 1 through 6).

* : Reset switch starts an automatic equalization locally only.

– : Automatic equalization not possible.

Figure 6. Equalization started by the reset switch [11629B]

Equalization

Equalization corrects the amplitude and phase distortion of the telephone line. No manual *adjustment* is required, as it is automatically performed by the 3874 itself.

The equalization takes place on different occasions (Figure 7) depending on:

- The modem status (normal operation or test operation)
- The type of line (non-switched or switched)
- The configuration (point-to-point, multipoint control, or multipoint tributary).

Equalization is *initiated*:

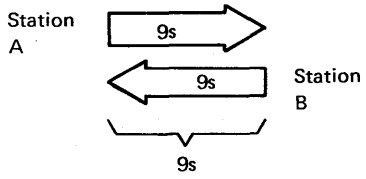
- Automatically when power is switched on at the 3874.
- By program or by the operator, if the telephone line becomes degraded (too many transmission errors).

EQUALIZATION DURATION

Because one automatic equalizer is located in each receiver (see Figure 17), it is necessary to equalize the line between two modems in both directions.

Approximately 9 seconds are needed by an equalizer to perform an equalization. The total equalization time, therefore, depends on the line configuration.

- *In non-switched line point-to-point:* about 9s, because the four-wire connection allows both equalizations to occur at the same time:



	Operate/test Switch	Operator/DTE Action	Point-to-Point	Control	Tributary	Switched Network without ACO or SNBU	Switched Network with ACO
Normal Operation	OPERATE	Power On	Yes	Yes	*	—	—
		Reset switch	Yes	Yes	*	***	—
		Cradle handset (with DAA-CBS only)	—	—	—	***	—
		Back to OPERATE	Yes	Yes	*	—	—
		Speed change (non-sw only)	Yes	Yes	*	—	—
		Speed/mode-select switch going to a non-switched position	Yes	Yes	*	—	—
		"Select standby" line back to OFF. Speed/mode-select switch to EXTERNAL	Yes	Yes	*	—	—
		"Distant station connected" line going on	—	—	—	—	Yes
		"Test" line back to off	Yes	Yes	*	—	—
Test Operation	OPERATE	"Test" line going on	Yes	Yes	Yes	Yes	Yes
	T1A/T1B/T2	Reset	Yes	Yes	Yes	Yes	Yes
	T3	Reset	Yes	Yes	**	Yes	Yes
	T4	Reset	—	Yes	—	—	—
	VOICE	Reset	—	—	—	—	—

Yes: The involved station initiates an equalization procedure.
- For local station in T1A/T1B and T2
- For local and remote station in OPERATE or T3.

* If previously equalized under control station supervision, the involved station can equalize itself as soon as it receives any pattern (for example, data transmission between control station and another tributary station), but cannot initiate an equalization procedure.

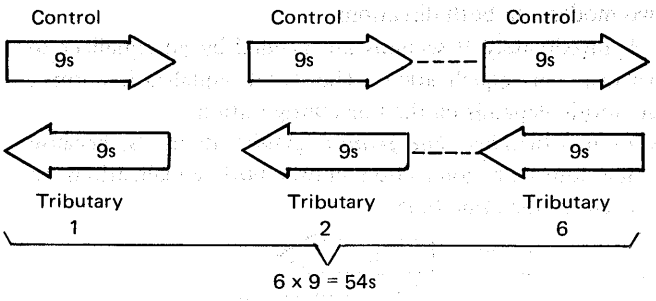
** Yes, but only locally.

*** Yes only at calling station.

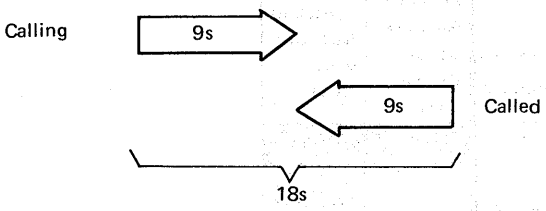
— Automatic equalization not possible.

Figure 7. Occurrence of equalization [11630A]

- *In non-switched line centralized multipoint:* up to 54s, if six tributary stations are installed (9s per tributary station).



- *In switched network:* about 18s, because the two-wire connection only allows one equalization to occur at a time:



EQUALIZATION PROCEDURES

In normal operation, equalization of the 3874 to the line occurs automatically whenever:

- The operate/test switch is set to OPERATE.
- The speed/mode-select switch is set to 4800 NON-SW, 2400 NON-SW, or EXTERNAL.
- Power is switched on.

Note: For switched network applications, see the specific operator procedures 3 through 7 .

Operator responsibility is, therefore, basically limited to using the reset switch to start another equalization, when necessary. The following Figures summarize the equalization procedures for each type of configuration, give the status of indicators as a procedure progresses, and identify operator intervention, if required:

Configuration	*Figure*
Non-Switched Line	
Point-to-Point	8
Centralized Multipoint	9
Switched Network	10

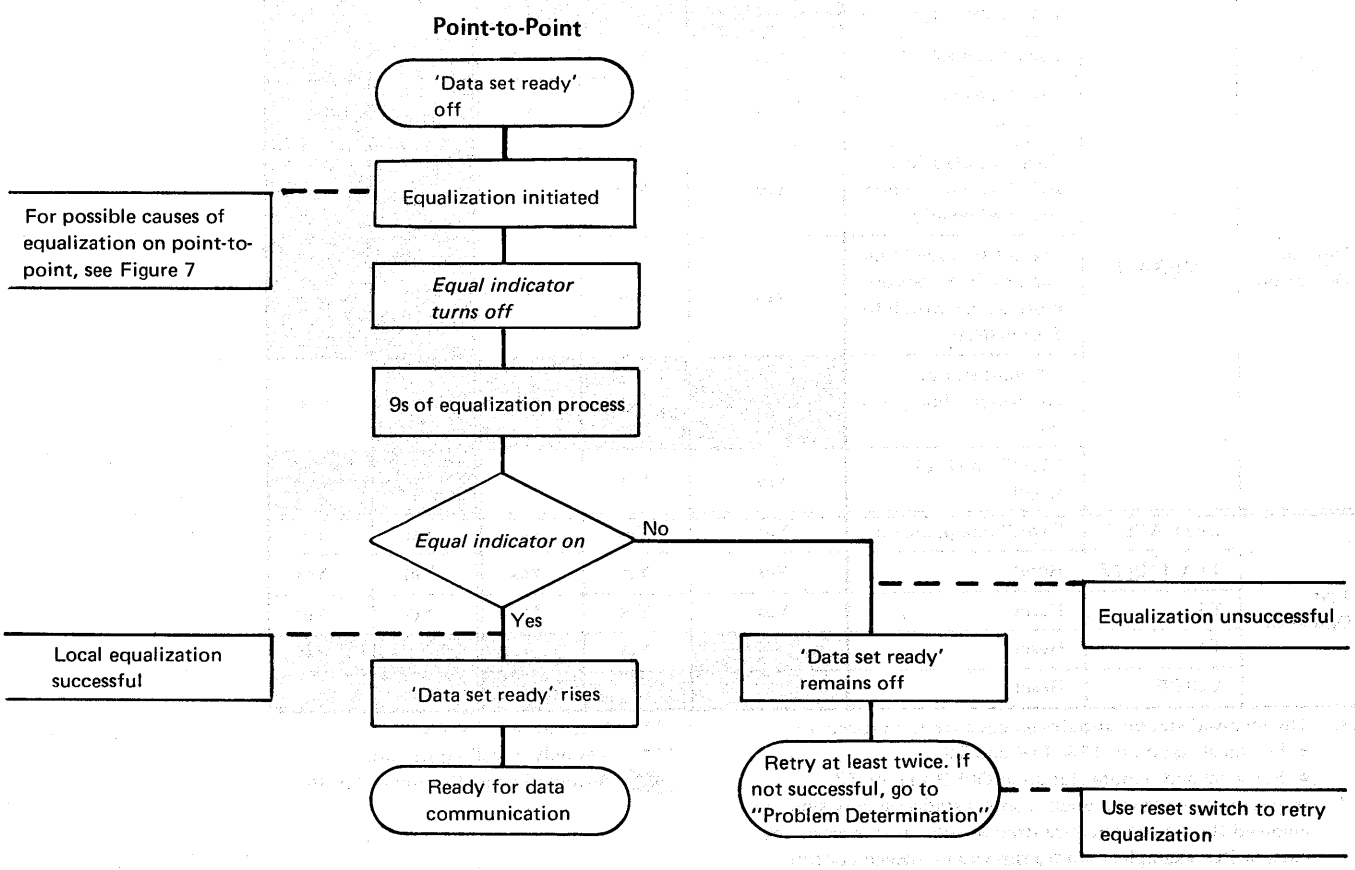


Figure 8. Equalization in non-switched line: point-to-point [11634A]

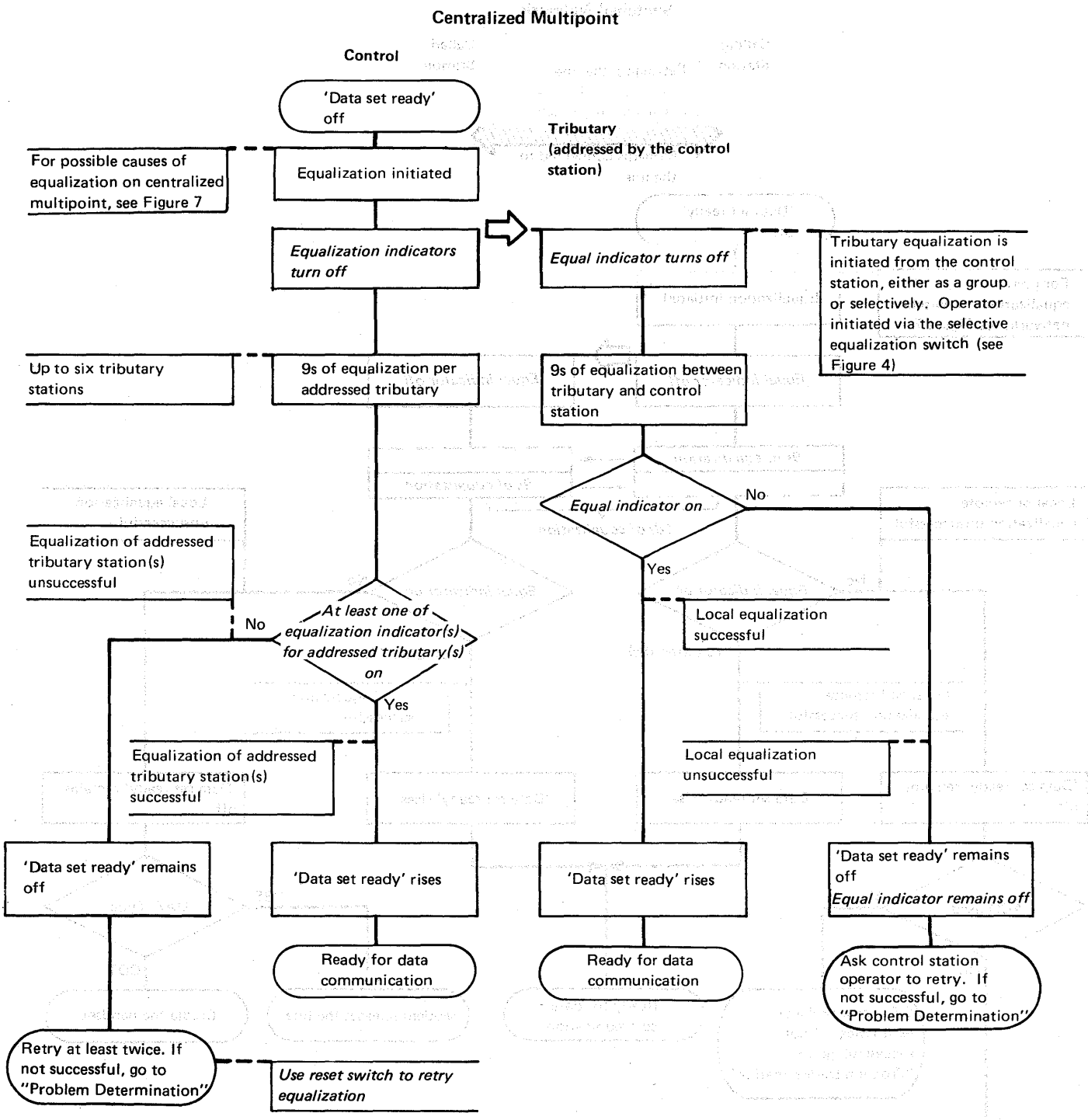


Figure 9. Equalization in non-switched line: centralized multipoint [11635A]

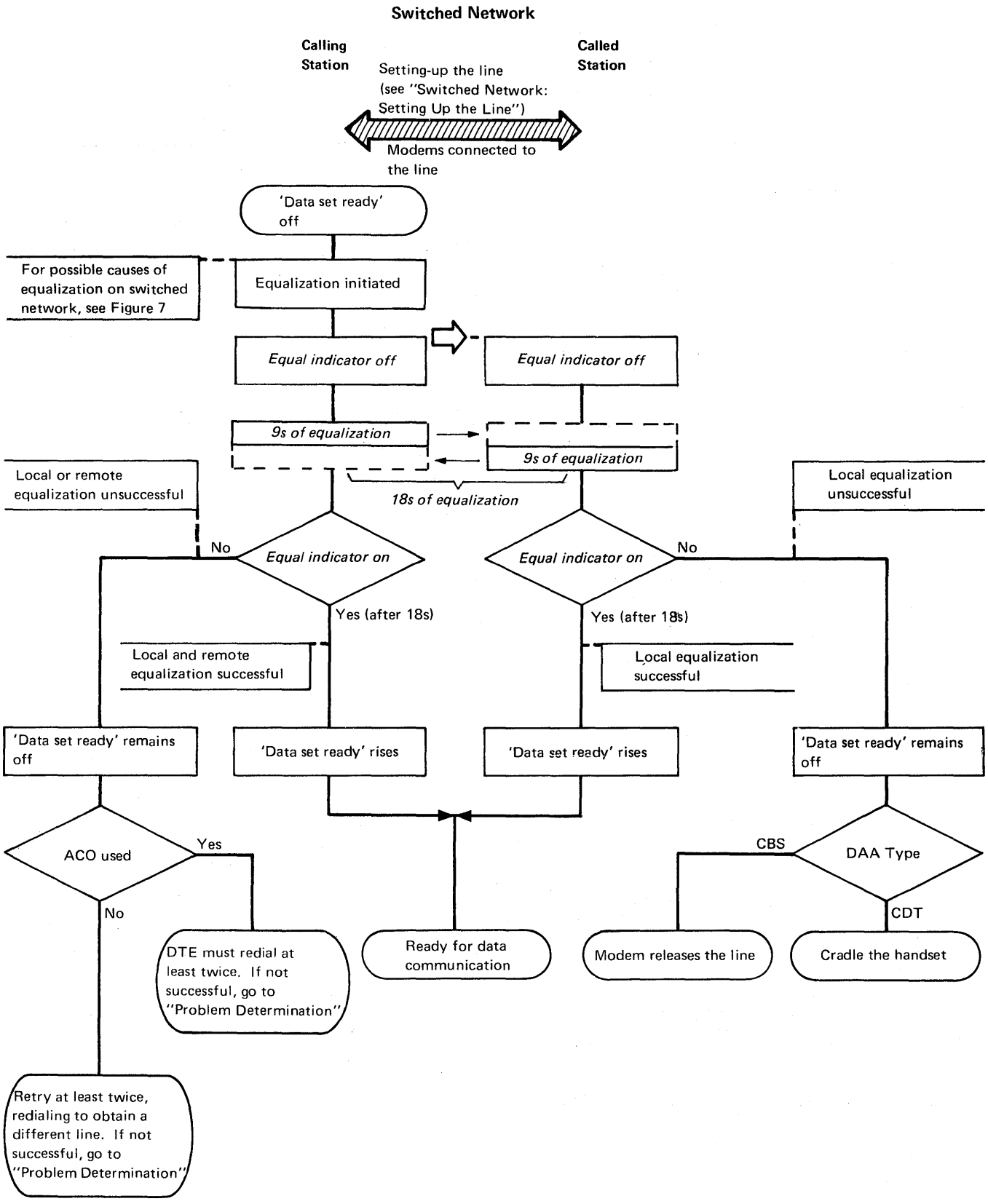


Figure 10. Equalization in switched network [11636A]

Operating Procedures

The operating procedures for the different types of lines and configurations shown in this section refer only to the controls and indicators on the 3874; additional procedures may be required to operate other equipment with which the modem is used.

The procedures referenced as "automatic" are fully automatic after the speed/mode-select switch settings have been made the same at each end of the line, and power has been switched on (READY indicator on, when OPERATE/TEST switch at OPERATE).

The procedures referenced by a number (1 through 13 in Figure 11), however, require manual intervention. In these instances, first select the overall procedure (for example, 'Automatic Call Originate (ACO)" under "Calling"), then carry out the detailed procedure identified by the same number (in this example, "3").

Note: In all cases, data transmission can take place only after a proper equalization between modems, i.e. equal (or equalization) indicator(s) on for each modem of the link. If an extra equalization is needed*, it can be made manually as follows:

At a Point-to-Point Station

1. Press the reset switch at any end of the line. (Equalization of both stations.)

At a Multipoint Control Station

1. Set the selective equalization switch to the desired position (ALL or "1" through "6").
2. Press the reset switch. (Equalization of the control and selected tributary station(s).)

At a Multipoint Tributary Station

1. Press the reset switch. (Equalization of the tributary station provided that it has been previously equalized by the control station and that the control station is actually transmitting.)

At a Switched Network Station

1. Re-dial to establish a new connection, as described in procedures 3 through 7.

Indication of successful equalization is given by the equal or equalization indicator(s) turning on.

* For example, if the line suddenly becomes degraded, or in a multipoint configuration, if a tributary station is not powered-on at the general equalization. These situations are signaled to the operator by error messages.

Non-Switched Line	Switched Network
Voice Communication If the Alternate Voice feature is installed: 1 Making a call. 2 Answering a call.	*Voice Communication*
Setting-Up the Line Automatic	*Setting-Up the Line* **Calling** 3 Automatic Call Originate (ACO) (CBS/CBS). 4 Manual calling with CBSs at both ends. 5 Manual calling with CDT, but with CBS at the other end. 6 Manual calling with CDTs at both ends. 7 Manual calling with CBS, but with CDT at the other end. **Answering** 8 Auto-answering (CBS only). 9 Manual answering with CBSs at both ends. 10 Manual answering with CBS, but with CDT at the other end. 11 Manual answering with CDTs at both ends. 12 Manual answering with CDT, but with CBS at the other end. **Testing** 13 Manual dialing from the ACO panel (3874).
Data Transfer Under DTE control.	*Data Transfer* Under DTE control.

gure 11. Key to operating procedures [11637A]

NON-SWITCHED LINE: VOICE COMMUNICATION

If the alternate voice feature is installed at both stations, conversation may take place between operators over a non-switched line as follows, for instance to ensure that the controls on each 3874 are correctly set.

Making a Call

1

Operator Action	Indicator On	Audible Signal
CAUTION If you are making the call from a tributary station, first ensure that the OPERATE indicator is not dim (data being received).		
1. Set the power-on/off switch to ON.		
2. Plug the telephone handset into the jack socket (VOICE) on the operator panel of the 3874.		
3. Set the operate/test switch to VOICE to be able to talk to the other end (or to the control station, if you are calling from a tributary station).		
4. Press the call switch to buzz the operator at the other modem.	Ready (flashes)	Buzzer (for as long as the call switch is pressed)
5. Voice communication to arrange transmit/receive speed and operate/test switching sequence.		
6. Return to data communication:		
• *Point-to-Point*		
a. Ask the remote operator to switch back to OPERATE.		
b. Wait for at least 10 seconds.		
c. Switch back to OPERATE on your 3874.	Ready Equal (after 9 seconds)	
• *Multipoint*		
a. Tributary station(s) switch back to OPERATE.		
b. Control station switches back to OPERATE, with no delay.	Ready 'n' equalization(s) (after 'n' x 9 seconds)	

Answering a Call

2

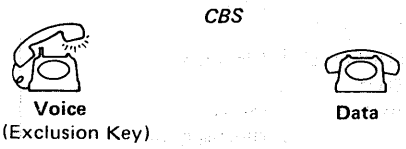
Operator Action	Indicator On	Audible Signal
1. —	Ready (flashes)	Buzzer
2. Plug the telephone handset into the jack socket on the operator panel to listen to the other end; the operate/test switch must not be set to T1A, T1B*, T2, LAMP TEST.		
3. Set the operate/test switch to VOICE to be able to listen and *talk* to the other end.		
4. Voice communication to arrange transmit/receive speed and operate/test switching sequence.		
5. Return to data communication:		
• *Point-to-Point* Switch back to OPERATE at the request of the other operator.	Ready Equal (after 20 seconds approx)	
• *Multipoint*		
a. Tributary station(s) switch back to OPERATE.		
b. Control station switches back to OPERATE, with no delay.	Ready 'n' equalization(s) (after 'n' x 9 seconds)	

SWITCHED NETWORK: SETTING UP THE LINE

The handset referred to in the following procedures is the handset of the telephone associated with the DAA.

The "exclusion key" (for DAA-CBS) and the "data key" (for DAA-CDT) is the white key on the left-hand side of the cradle of the DAA-associated telephone set:

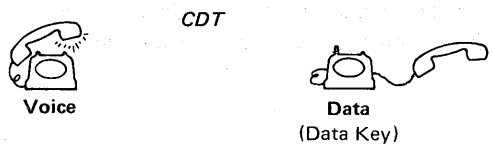
- With a DAA-CBS, the exclusion key is pulled up for dialing and voice communication.



CAUTION

When going to data mode (handset cradled), ensure that the handset is placed correctly (horizontal) on the cradle. Never depress the cradle button with the finger.

- With a DAA-CDT, the data key is pulled up for data communication, and the handset must remain out of the cradle.



Note: General information for operating the CDT and/or CBS Data Access Arrangement is given in, respectively, *Bell System Data Communications Technical References,* PUB 41801 and PUB 41802.

Automatic Call Originate (CBS only)

3 **CBS→CBS (Automatic)**

Operator Action	Indicator On	Audible Signal
1. Set the speed/mode select switch to 4800 SW, 2400 SW, or EXTERNAL, as previously arranged with the intended answering station(s).		
2. Set OPERATE/TEST switches (ACO and basic modem) to OPERATE.	Ready	
3. Set talk/data switch to DATA.		
4. Turn on the volume control and increase the volume to a suitable level.		
5. Make DTE ready.	Data Line Occupied	
	Off Hook	Click
	Coupler Cut Through	Click
6. —	Signal (during Dial tone)	Dial tone
7. —	Present Next Digit	
8. *DTE dials remote station number.*	Off Hook (blinks)	Clicks
9. *(Dialing complete).*		Ringback tone
10. —	Signal (during answer tone)	Answer Tone (2100 Hz)
11. *(Answer Tone ends)*		Equal pattern (9s)
12. —	Signal (during 9s)	Equal pattern (9s)
13. —	Equal (18s after answer tone ends)	
14. —	Data Channel Ready	
15. Ready for data communication.		

Manual Calling with CBSs at both ends

In making a call to a DAA-CBS-equipped 3874, you might be answered automatically or manually depending on whether the talk/data switch is set to data or talk respectively. Both possibilities are considered in the following table.

4 **CBS→CBS**

Operator Action	Indicator On	Audible Signal
1. Make the DTE ready.	Ready	
2. Set the talk/data switch to TALK.		
3. Remove the handset from the cradle.		
4. Pull up the exclusion key.		Dial tone
5. Dial the desired station.		Clicks
		Auto-Answer
		Answer tone (2100 Hz)
		Manual Answer
		Ringback tone
		Answer tone (after the remote operator hangs up)
7. **Auto-Answer** (talk/data switch set to DATA at answering end). Wait for the end of the answer tone; then proceed to step 8. **Manual Answer** (talk/data switch set to TALK at answering end). Voice communication to arrange transmit/receive (for example, speed). *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first. Wait for the *end* of the answer tone.		
8. Set the talk/data switch to DATA and cradle the telephone handset, within 12s.	Signal (for 9s after 9s from this step)	
9. —	Equal after 18s	
Note: If equal indicator does not turn on within 30 seconds after the handset at the called station has been cradled, the telephone is automatically disconnected.		
10. *Ready for data communication.* (When data communication is complete, disable the DTE or set the talk/data switch to TALK.)		

Manual Calling with CDT, but with CBS at the other end

In making a call to a DAA-CBS-equipped 3874, you might be answered automatically or manually. Both possibilities are considered in the following table.

5 **CDT→CBS**

Operator Action	Indicator On	Audible Signal
1. Make the DTE ready.	Ready	
2. Set the talk/data switch to TALK.		
3. Raise the handset and dial the desired station		
4. –		Dial tone **Auto-Answer** Answer tone (2100 Hz) **Manual Answer** Ringback tone Answer tone (after the operator hangs up)
5. **Auto-Answer** Wait for the *end* of answer tone. **Manual Answer** Voice communication to arrange transmit/receive (for example, speed). *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first. Wait for the end of answer tone.		
6. Raise the local data key and set the talk/data switch to DATA within 12s.		
7. Press the reset switch to equalize the 3874 to the line.	Signal (for 9s after 9s from this step (7))	
8. –	Equal (after 18s)	
9. *Ready for data communication.*		
10. Leave local handset off-hook. (When data communication is complete, calling operator: a. Cradles handset. b. Sets talk/data switch to TALK. c. Presses RESET switch.)		

Manual Calling with CDTs at both ends

6 **CDT→CDT**

Operator Action	Indicator On	Audible Signal
1. Make the DTE ready.		
2. On the 3874, set the talk/data switch to TALK.		
3. Raise the handset and dial the desired station.		
4. –		Ringback tone (remote station rings)
5. Voice communication to arrange transmit/receive. *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first.		
6. Ask the remote operator to make his DTE ready, raise the data key on his DAA-associated telephone set, and place the talk/data switch on his 3874 to DATA.		
7. Raise the local data key and set the talk/data switch to DATA.		
8. Press the reset switch to equalize the 3874 to the line.	Signal (for 9s after 9s from this step)	
9. –	Equal (after 18s)	
10. *Ready for data communication.*		
11. Leave both handsets off-hook. (When data communication is complete, calling operator: a. Cradles handset. b. Sets talk/data switch to TALK. c. Presses RESET switch.)		

Manual Calling with CBS, but with CDT at the other end

7 **CBS ⟶ CDT**

Operator Action	Indicator On	Audible Signal
1. Make the DTE ready.	Ready	
2. Set the talk/data switch to TALK.		
3. Remove the handset from the cradle.		
4. Pull up the exclusion key.		Dial tone
5. Dial the desired station.		Clicks
6. Remote station rings.		Ringback tone
7. Voice communication to arrange transmit/receive (for example, speed). *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first.		
8. Ask the remote operator to raise the data key on his DAA-associated telephone set and place the talk/data switch on his 3874 to DATA.		
9. Set the talk/data switch to DATA.		
10. Cradle the handset.	Signal (for 9s after 9s from this step)	
11. –	Equal (after 18s)	
12. *Ready for data communication.* (When data communication is complete, the operator disables the terminal or sets the 3874 to TALK.)		

Auto-Answering (CBS only)

To have incoming calls answered automatically, set the 3874 and prepare the DAA-CBS as follows:

8 **⟵ CBS** (Automatic)

Operator Action	Indicator On	Audible Signal
3874 Modem		
1. Set the power on/off switch to On.		
2. Set the operate/test switch to OPERATE.	Ready	
3. Set the talk/data switch to DATA.		
4. Set the speed/mode-select switch to 4800 SW, 2400 SW, or EXTERNAL, as previously arranged with expected calling station(s).		
5. Make DTE ready.		
DAA-CBS		
6. Ensure that the associated handset is on-hook.		
7. –	Equal	
8. *Ready for data communication.* (When data communication is complete, disable the DTE or set the talk/data switch to TALK.)		

Manual Answering with CBSs at both ends

9 CBS◄---CBS

Operator Action	Indicator On	Audible Signal
1. (Talk/data switch was previously set to TALK.)	Ready	Ring
2. Lift the telphone handset.		
3. Pull the exclusion key.		
4. Voice communication to arrange transmit/receive (for example, speed). *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first.		
5. Make the DTE ready.		
6. Turn talk/data switch to DATA.		
7. Cradle the telephone set (before the remote station).	Signal (for 9s after 9s from this step)	
8. –	Equal (after 18s)	
Note: If equal indicator does not turn on within 30 seconds after the handset has been cradled, the telephone line is automatically disconnected.		
9. *Ready for data communication.* (When data communication is complete, disable the terminal or set the 3874 to TALK.)		

Manual Answering with CBS, but with CDT at the other end

10 CDT◄---CBS

Operator Action	Indicator On	Audible Signal
1. (Talk/data switch was previously set to TALK.)	Ready	Ring
2. Lift the telephone handset.		
3. Pull the exclusion key on the telephone set.		
4. Voice communication with the calling operator to arrange transmit/receive. *Note:* In manual operating procedures, the calling station must enter data mode last and will transmit first.		
5. Make the DTE ready.		
6. Turn talk/data switch to DATA.		
7. Cradle the telephone set.	Signal (for 9s after 9s from this step)	
8. –	Equal (after 18s)	
9. *Ready for data communication.* (When data communication is complete, the operator at the: CBS station : Disables the terminal or sets the 3874 to TALK. CDT station : Cradles the handset. Sets the 3874 to TALK. Presses RESET.)		

Manual Answering with CDTs at both ends

11 CDT◄---CDT

Operator Action	Indicator On	Audible Signal
1. –	Ready	Ring
2. Set the talk/data switch to TALK.		
3. Lift the telephone handset.		
4. Voice communication with the calling operator to arrange transmit/receive. *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first.		
5. Make the DTE ready.		
6. Raise the data key.		
7. Turn the talk/data switch to DATA.	Signal (for 9s after 9s from this step)	
8. –	Equal (after 18s)	
9. *Ready for data communication.*		
10. Leave both handsets off-hook. (When data communication is complete, both operators: a. Cradle their handsets. b. Set their 3874s to TALK. c. Press RESET.)		

Manual Answering with CDT, but with CBS at the other end

12 CBS◄---CDT

Operator Action	Indicator On	Audible Signal
1. –	Ready	Ring
2. Set the talk/data switch to TALK.		
3. Lift the telephone handset.		
4. Voice communication with the calling operator to arrange transmit/receive. *Note:* In normal operating procedures, the calling station must enter data mode last and will transmit first.		
5. Make the DTE ready.		
6. Raise the data key.		
7. Turn the talk/data switch to DATA.	Signal (for 9s after 9s from this step)	
8. –	Equal (after 18s)	
9. *Ready for data communication.* (When data communication is complete, the operator at the: CBS station : Disables the terminal or sets the 3874 to TALK. CDT station : Cradles the handset. Sets the 3874 to TALK. Presses RESET.)		

Manual Dialing from the ACO panel (3874)

13

Operator Action	Indicator On	Audible Signal
1. Set talk/data switch to DATA.	Ready	
2. Set volume control to maximum.		
3. Set the ACO function switch to MANUAL TEST.	Data Line Occupied Off-Hook Coupler Cut Through Signal Present Next Digit	 Dialing tone
4. Select the dial digit on the rotary manual dialing switch within 10 seconds.		
5. Press ENTER until present-next-digit indicator goes off.		(Dialing tone ends)
6. Release ENTER.	Present Next Digit Off-hook blinks	 Dial pulsing
7. Proceed in the same way up to the last digit.	*(As for steps 4, 5, and 6)*	
8. If EON is strapped, select EON, press ENTER until present next digit indicator goes off.		
9. Release ENTER, and wait for ringback tone.		
10. Dialing complete.	Signal	Ringback tone
11. —	Signal	Answer tone (2100 Hz)
12. *Answer tone ends.*		Equal pattern (9s)
13. —	Signal	Equal pattern (9s)
14. —	Equal (after 18s)	
15. *Ready for data communication.*	Data Channel Ready	

COMPLETION OF DATA TRANSFER

DAA-CBS Used

When the DAA-CBS is used, the line is disconnected automatically when the terminal has finished transmitting. This is indicated by the equal indicator going out on the associated 3874.

DAA-CDT Used

When the DAA-CDT is used, line disconnection is under the responsibility of the operator who has to:

1. Place the handset back on the cradle of the associated telephone set.
2. Set the talk/data switch to TALK.
3. Press RESET.

Modem Tests

Sufficient controls and indicators are provided on the 3874 to enable an operator to identify a fault as occurring in the modem, in the DTE, or on the telephone line. Thus, the correct maintenance service (for example, IBM Customer Engineer (CE) or PTT*) can be requested the first time:

- An internal wrap test that fails indicates a problem in the 3874. (Call the IBM CE for the 3874.)
- A modem/DTE wrap test that fails when the internal tests are good indicates a possible problem with the DTE or its interface. This test requires a DTE program, and can be independently implemented at each station. (Call the IBM CE for the DTE.)
- An end-to-end test that fails when the internal wrap tests are good at both ends indicates a possible problem with the line. (Contact the PTT authorities.)

Overheating: An indication of possible overheating of the 3874 is given by the power switching off.

If the temperature has sufficiently decreased to a normal value, switch the 3874 to OFF then to ON to restart operations. If overheating persists, call the IBM CE for the 3874.

To avoid overheating it is recommended that a periodic check be made to ensure that all air intakes or exits are clear.

TESTS BY OPERATOR

The tests that you, as the operator, may carry out are shown in Figure 12 (identified as "A" through "E"), in which the settings of the operate/test switch are given. The test functions are also briefly described; full details are given under "Problem Determination".

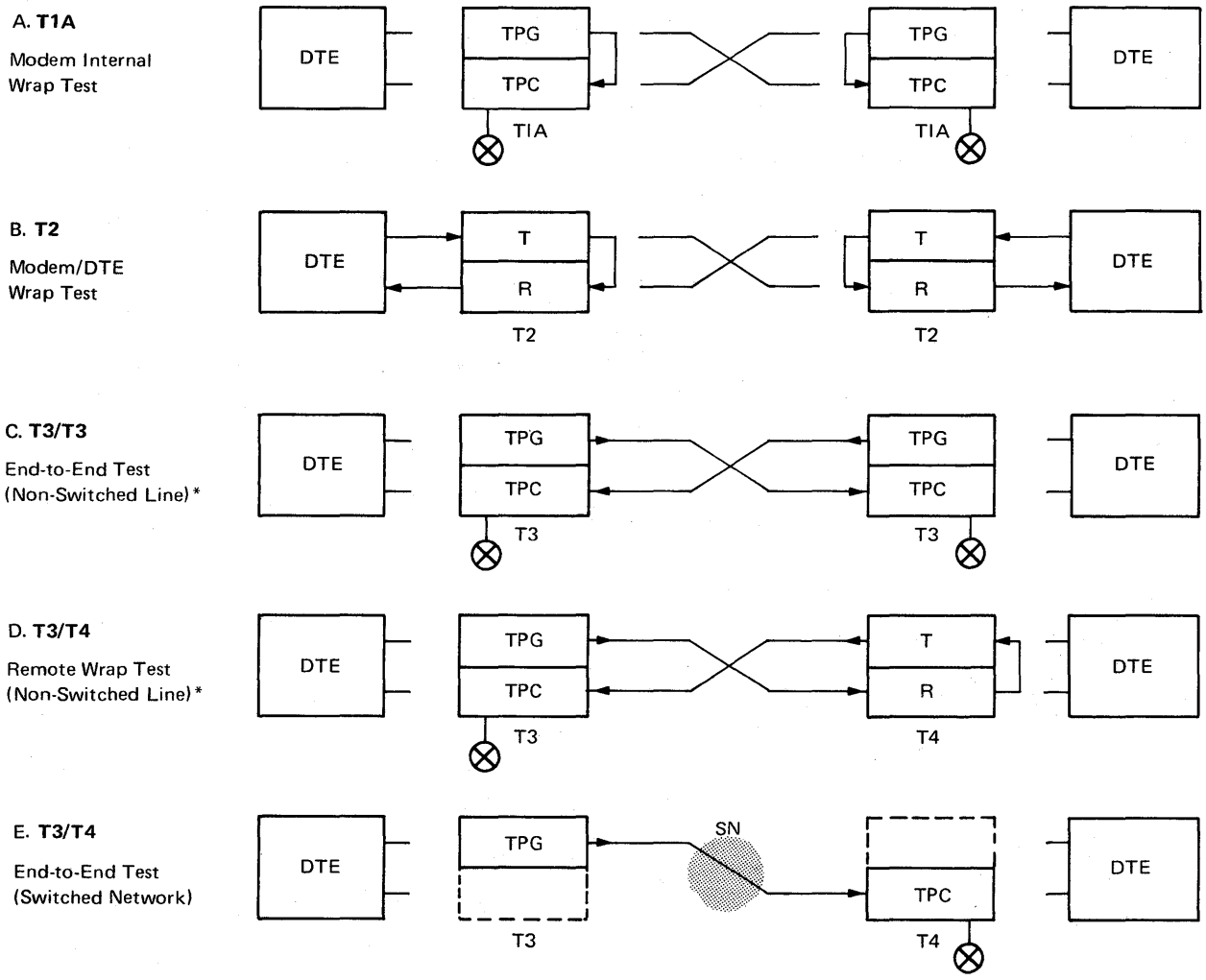
* Post-Telegraph-Telephone (used generally to denote any controlling and operating telephone authority). In the U.S.A., the Common Carrier should be called.

- Tests A, B, C, and D may be carried out for a point-to-point or a centralized multipoint configuration. In this latter configuration, end-to-end testing is always carried out between the control modem and one of the tributary modems (never between tributaries).
- Tests A, B, and E may be carried out for public switched network operation. Test B, however, requires programming support in the attached DTE and may, therefore, not be possible at all stations.
- Tests C through E require the co-operation of the other-end operator (remote or tributary); for tests C and D, conversation may take place over a separate telephone line or over the non-switched line via the handset (if the alternate voice feature is installed). Alternatively, the call switch and a previously arranged code could be used.
- When test E is being performed, the conversation must take place via the DAA-CBS or the DAA-CDT handset.
- Tests A through E exercise the auto-equalizer each time the reset switch is pressed. A restriction exists, however, for tests C through E; if a tributary station is set to T3, no equalization pattern is generated by the station when its reset switch is operated; instead, its receiver tries to equalize on the incoming messages.
- In each of the tests (with the exception of test B) a fault is indicated by the operate lamp on the receiving modem going out momentarily after the equalization period.

Note: Because a modem can be connected in several ways it is necessary to use standard terms such as *centralized multipoint, point-to-point,* and *duplex* to define a particular type of connection. Although the meanings of these terms are defined in the "Glossary", it is not necessary to understand the technical implications to carry out these tests. Your machine room manager will be able to identify which of the tests are applicable to your installation.

Test	Operate/Test Switch Setting		Function
	Local	Remote	
A. Modem Internal Wrap Test	T1A	–	Uses locally-generated test pattern to test local receiver (including automatic equalizer) and transmitter in a local loop.
B. Modem/DTE Wrap Test	T2	–	When DTE has wrap test capability, loops back the received test message sent from the DTE to the DTE for analysis. Checks the DTE, DTE interface cable, and 3874.
C. End-to-End Test (Non-Switched Line)	T3	T3	Uses the test pattern to check the local and remote 3874s simultaneously.
	T3	VOICE	Transmits test pattern to remote 3874 for checking there.
	VOICE	T3	Uses the remotely-generated test pattern to check local reception.
D. Remote Wrap Test (Non-Switched Line)	T3	T4	Generates and checks the test pattern locally after the remote 3874 has received and retransmitted it via test circuits.
E. End-to-End Test (Switched Network)	T3	T4	Transmits test pattern to remote 3874 for checking there.

Figure 12. Modem Tests (Part 1 of 2) [11651]



* In centralized multipoint configuration, the tributary stations not being tested must be set to OPERATE or VOICE.

When a tributary is set to T3 and the control station to T4, the selective equalization switch at the control station must point to the corresponding tributary station number.

Notes:

1. An equalization must be performed by pressing the reset switch when in T1A, T2, or T3.
2. With the exception of test T2, a fault is indicated by the operate indicator on the receiving 3874 going out momentarily after the equalization period (9s for tests A, C, and D; 18s for test E). A flash rate of from one to two flashes per minute should not be interpreted as a failure when running test C through E, as this is the normal rate.
3. In test B, error checking is performed in the DTE. The test results are as defined by the local procedures.
4. The T1B position of the operate/test switch is for use by the IBM customer engineer only.

Legend

DTE	Data Terminal Equipment	
T	Transmitter	
R	Receiver	
TPG	Test Pattern Generation (T)	
TPC	Test Pattern Checking (R)	
SN	Switched Network	
T1A	Test 1A	Operate/Test Switch
T2	Test 2	
T3	Test 3	
T4	Test 4	
⊗	Operate Lamp (see Note 2)	

Figure 12. Modem Tests (Part 2 of 2) [11652A]

PROBLEM DETERMINATION

The following procedures (I through V) allow the operator to:

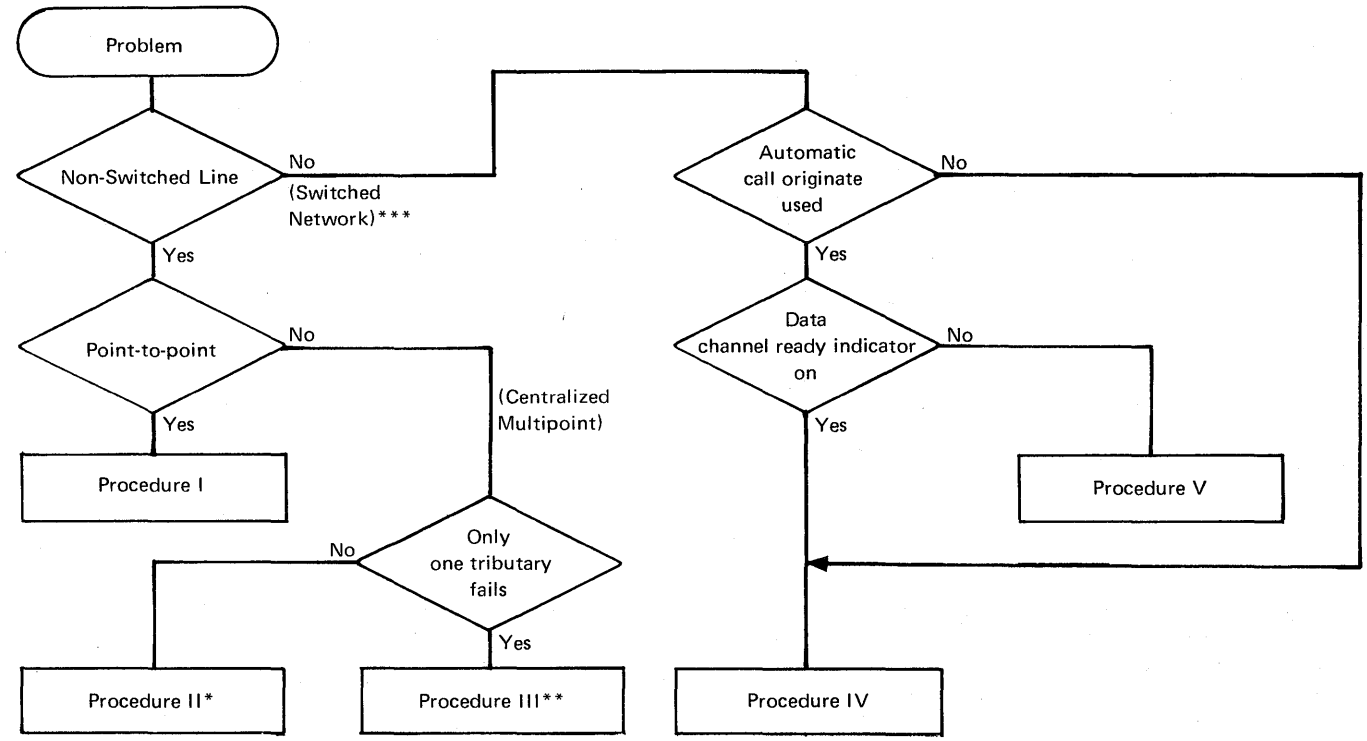
- Identify minor problems that can be quickly corrected.
- Determine which maintenance service should be called to locate and correct the problem.

The operator has to:

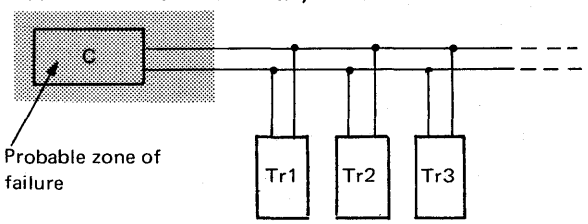
1. Select the relevant procedure from the flowchart in Figure 13.
2. Carry out that procedure.

Notes:

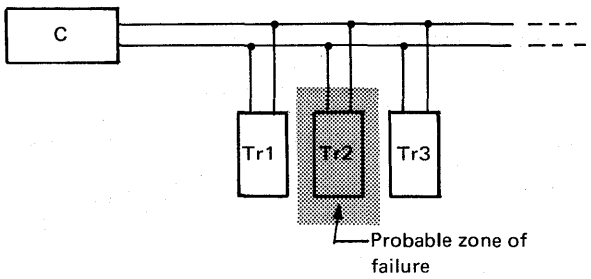
1. Text in italic is a call to maintenance personnel (IBM 3874, DTE, or PTT). Shaded areas are not operator checking or testing procedures.
2. When performing an end-to-end test (T3/T3 or T3/T4), the operate indicator goes off for 150 ms with each detected error. (An error rate of two flashes a minute can be expected on a normal line.)
3. When "equal indicator on", is given, this means 'on' after the equalization time (9s, 18s, ... 54s). See "Equalization Duration" in this Part.
4. There is a possibility that, in a few cases, the problem determination procedure cannot identify a modem malfunction. If the line is suspected, the PTT could find it within its specifications. In that case, refer to the recommendations given under "Communication Channel Specifications" in Part 3.



* All or more than one tributary fail:



** Only one tributary fails (for example Tr2):

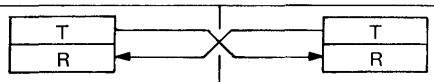
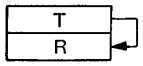
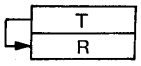
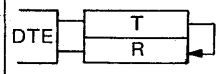
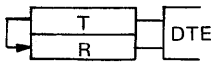


*** In the case of switched network back-up:

- If problem appears in non-switched line, proceed with Procedure I
- If problem is in switched network back-up only, proceed with Procedure IV

Figure 13. Selection of problem determination procedure [11653A]

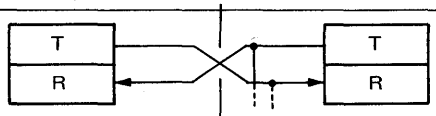
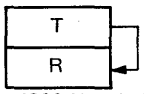
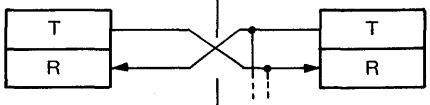
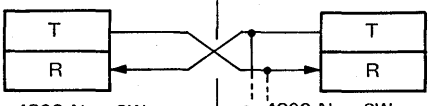
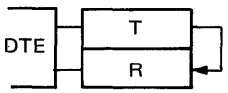
Procedure I. Point-to-Point

	Station A	Station B	Expected Result	Yes	No
1	Check switch positions on both modems		Same at both stations	Switch settings correspond. Go to 2	Switch settings do not correspond. Correct the settings and restart
2	 • 4800 Non-SW • T3 • RESET*	• 4800 Non-SW • T3	Operate, signal, and equal indicators on at both stations	1. Check program and restart 2. If problem remains go to 9	Go to 3
3	 • 4800 Non-SW • T1A • RESET		Operate, signal, and equal indicators on	Go to 4	*Call modem-A CE*
4		 • 4800 Non-SW • T1A • Reset	Operate, signal, and equal indicators on	Go to 5	*Call modem-B CE*
5	 • 2400 Non-SW • T3 • RESET*	• 2400 Non-SW • T3	Operate, signal, and equal indicators on at both stations	1. Continue traffic at 2400 bps. 2. *Contact PTT to check the line* 3. Go to 6	1. *Contact PTT to check the line* 2. Go to 6
6	 PTT checks the line		Line found good	1. PTT returns the line 2. Go to 7	1. PTT repairs the line 2. Go to 7
7	 • 2400 Non-SW • T3 • RESET*	• 2400 Non-SW • T3	Operate, signal, and equal indicators on at both stations	Go to 8	*Call one of the modem CEs* (see Note 4 on page 26)
8	 • 4800 Non-SW • T3 • RESET*	• 4800 Non-SW • T3	Operate, signal, and equal indicators on at both stations	Restart and continue traffic	1. Continue traffic at 2400 bps 2. *Call one of the modem CEs*
9**	 • T2 • RESET		Given by DTE messages (as implemented by user)	Go to 10	*Call DTE-A CE*
10**		 • T2 • RESET	Given by DTE messages (as implemented by user)	*Call one of the modem CEs*	*Call DTE-B CE*

* Can be done at either station (at least once)

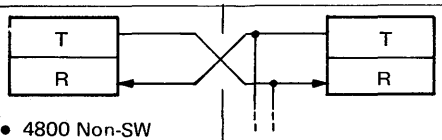
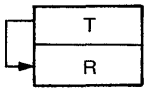
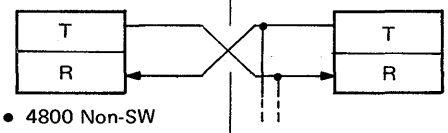
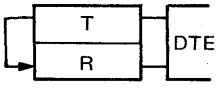
* * If DTE cannot handle modem test T2, *call one of the modem CEs*

Procedure II. Multipoint (All, or more than one, tributaries fail)

	Control	Tributaries	Expected Result	Yes	No
1	Check switch positions on control and failing tributary stations		Same at both stations	Switch settings correspond. Go to 2	Switch settings do not correspond. Correct the settings and restart
2	 • 4800 Non-SW • T3 • ALL • RESET	• 4800 Non-SW • T3	Operate, signal, and equalization indicators at control station on Operate, signal, and equal indicators at selected powered-on tributary stations on	1. Check program and restart 2. If problem remains, go to 8	Go to 3
3	 • 4800 Non-SW • T1A • RESET		Operate, signal, and equalization indicators on	Go to 4	*Call control modem CE*
4	 • 2400 Non-SW • T3 • ALL • RESET	• 2400 Non-SW • T3	Operate, signal, and equalization indicators at control station on Operate, signal, and equal indicators at selected powered-on tributary stations on	1. Continue traffic at 2400 bps. 2. *Contact PTT to check the line between control and furthest tributary station* 3. Go to 5	1. *Contact PTT to check the line between control and furthest tributary station* 2. Go to 5
5	 PTT checks the line		Line found good	1. PTT returns the line. 2. Go to 6	1. PTT repairs the line. 2. Go to 6
6	 • 2400 Non-SW • T3 • ALL • RESET	• 2400 Non-SW • T3	Operate, signal, and equalization indicators at control station on Operate, signal, and equal indicators at selected powered-on tributary stations on	Go to 7	*Call control modem CE*
7	 • 4800 Non-SW • OPERATE • ALL • RESET	• 4800 Non-SW • OPERATE	Operate, signal, and equalization indicators at control station on Operate, signal, and equal indicators at selected powered-on tributary stations on	Restart and continue traffic	1. Continue traffic at 2400 bps. 2. *Call control modem CE* (see Note 4 on page 26)
8*	 • T2 • RESET		Given by DTE messages (as implemented by user)	*Call control modem CE*	*Call control DTE CE*

* If DTE cannot handle test T2, *call control modem CE*

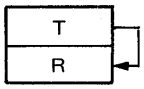
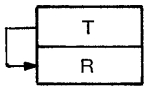
Procedure III. Multipoint (Only one tributary fails)

	Control	Tributary	Expected Result	Yes	No
1	Check switch positions on tributary station. (For control station, see "Operating Procedures" for proper equalization procedure)		Same at both stations	Switch settings correspond. Go to 2	Switch settings do not correspond. Correct the settings and restart
2	 • 4800 Non-SW • T3	• 4800 Non-Sw • T3 • RESET	Operate, signal, and equal indicators at tributary station on*	Restart and continue traffic	Go to 3
3		 • 4800 Non-SW • T1A • RESET	Operate, signal, and equal indicators on	When control station is Free (no more traffic with other tributaries), Go to 4	*Call tributary modem CE*
4	 • 4800 Non-SW • T3 • Select involved trib. • RESET	• 4800 Non-Sw • T1A	Corresponding operate, signal, and equalization indicator at control station on Operate, signal, and equal indicators at tributary on	1. Check program and restart 2. If problem remaining go to 7	*Contact PTT to check the line* Go to 5
5	 Common carrier checks the line		Line found good	1. PTT returns the line 2. Go to 6	1. PTT repairs the line 2. Go to 6
6		Restart • RESET *	Continue traffic	Continue traffic	*Contact control station operator to call control modem CE* (see Note 4 on page 26)
7**		 • T2 • RESET	Given by DTE messages (as implemented by user)	Go to 6	*Call tributary DTE CE*

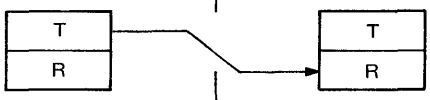
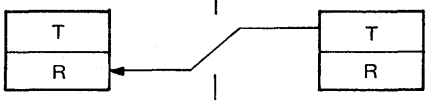
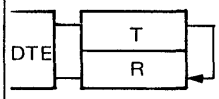
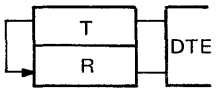
* Equal indicator may come on if control station has the continuous carrier strapping option or is transmitting data to another tributary station.

** If DTE cannot handle test T2, go to 6

Procedure IV. Switched Network (Part 1 of 2)

	Station A	Station B	Expected Result	Yes	No
1	Check switch positions on both modems		Same at both stations	Switch settings correspond Go to 2	Switch settings do not correspond, correct the settings and restart
2	Check both DAAs		Switch settings OK	Go to 3	Correct switch settings and restart
3	Disconnect and redial to re-establish the connection		Normal operation	Continue traffic	Go to 4
4	 • 4800 SW • T1A • RESET		Operate, signal, and equal indicators on	Go to 5	*Call modem-A CE*
5		 • 4800 SW • T1A • RESET	Operate, signal, and equal indicators on	Go to 6	*Call modem-B CE*

Procedure IV. Switched Network (Part 2 of 2)

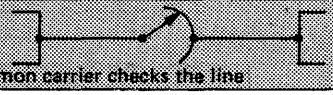
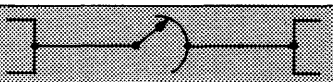
	Station A	Station B	Expected Result	Yes	No
6	– Redial  • 4800 SW • T3	• 4800 SW • T4	Operate, signal, and equal indicators at station B permanently on	Go to 7	1. *Contact common carrier to check the line.* 2. Go to 8
7	 • 4800 SW • T4	• 4800 SW • T3 • RESET	Operate, signal, and equal indicators at station A permanently on	Go to 10	1. *Contact common carrier to check the line.* 2. Go to 8
8	 Common carrier checks the line		Line found good	1. Common carrier repairs the line 2. Go to 9	1. Common carrier repairs the line 2. Go to 9
9	Restart Operation			Continue traffic	*Call one of the modem CEs* (see Note 4 on page 26)
10*	 • T2 • RESET		Given by DTE messages (as implemented by user)	Go to 11	*Call DTE-A CE*
11*		 • T2 • RESET	Given by DTE messages (as implemented by user)	Go to 9	*Call DTE-B CE*

* If DTE cannot handle test T2, go to 9

Procedure V. Switched Network with ACO (Part 1 of 2)

	Station A (ACO)	Station B (Auto-Answer)	Expected Result	Yes	No
1	Check switch positions on both modems		Same at both stations	Go to 2	Correct the settings and restart
2	Check both DAAs		Switch settings OK	Go to 3	Correct switch settings and restart
3	Disconnect and redial to re-establish the connection		Equal indicator on	Go to 4	Go to Procedure IV. step 4
4	• PAUSE		All indicators off after 2 to 3s	Go to 5	*Call modem A CE*
5	• MANUAL TEST (See "Operating Procedure 13 ")		Data line occupied, off-hook indicators on	Go to 6	*Call modem A CE*
6			Coupler cut through indicator on	Go to 7	*Contact common carrier to check the station A loop.* *Go to 11*
7			Dial tone at calling station	Go to 9	Go to 8
8			Dial tone at CBS telephone set	*Call modem A CE*	*Contact PTT to check the loop* *Go to 11*
9			Present-next-digit indicator on	Go to 10	*Call modem A CE*
10	Dial the number of a nearby telephone that can be heard to ring • MANUAL TEST • ENTER		Nearby telephone (being called) rings	Go to 12	*Contact the common carrier to check the station A loop.* *Go to 11*

Procedure V. Switched Network with ACO (Part 2 of 2)

	Station A (ACO) / Station B (Auto Answer)	Expected Result	Yes	No
11	 Common carrier checks the line	Loop and CBS OK	*Call modem A CE*	Common carrier repairs the line. Restart normal operation
12	Reset the ACO: • PAUSE • OPERATE Ensure that the remote terminal DTE is in a "ready" condition. Check to see that the remote modem talk/data switch is set to DATA, that the CBS coupler switches are off (that the indicator lights under the switches are off), and that the handset is cradled. Dial the remote terminal from the CBS associated telephone set (proceed with "Operating Procedure 4 ").	Ringback tone at station A	Go to 14	Go to 13
13		Busy tone at station A	*Contact the PTT to contact the station B loop* Go to 19	*Contact the common carrier to check the loop* *Go to 19*
14		Ringback tone stops at station A	Go to 15	*Contact common carrier to check the station B loop* *Go to 19*
15		Answer tone at station A	Go to 16	*Call modem B CE*
16		Answer tone ends at station A	Go to 17	*Call modem B CE*
17	Set local talk/data switch to DATA and cradle handset	Equal and data channel ready indicators on after 18s	Restart normal operation If problem remains, go to procedure IV, step 4	Go to 18
18		Modem B equal indicator on	*Call modem A CE*	*Call modem B CE*
19	 Common carrier checks the line	Loop and CBS OK	*Call modem B CE*	Common carrier repairs the line. Restart normal operation

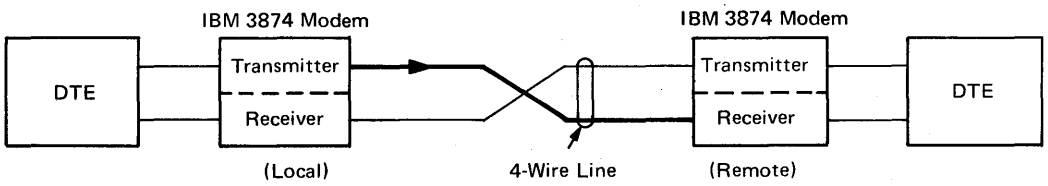
Part 3. Technical Description

This part of the manual is intended for system and installation planning engineers who require a more detailed description of the IBM 3874 Modem than that given in Part 1.

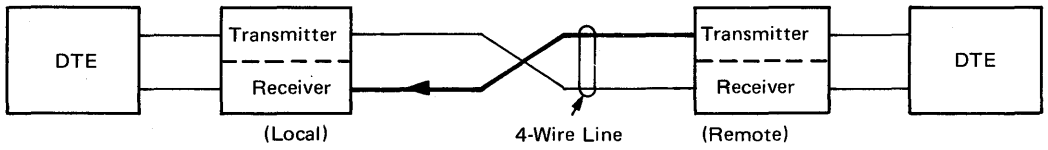
3

Point-to-Point, Half-Duplex

(Local transmitting to remote)

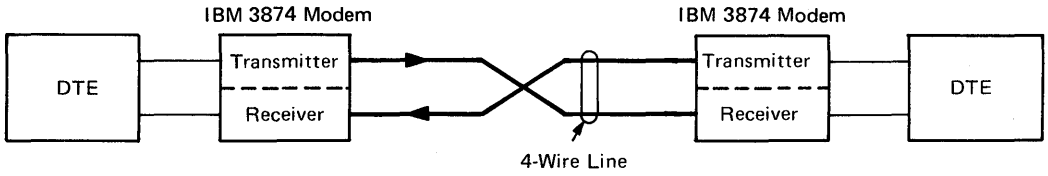


(Remote transmitting to local)



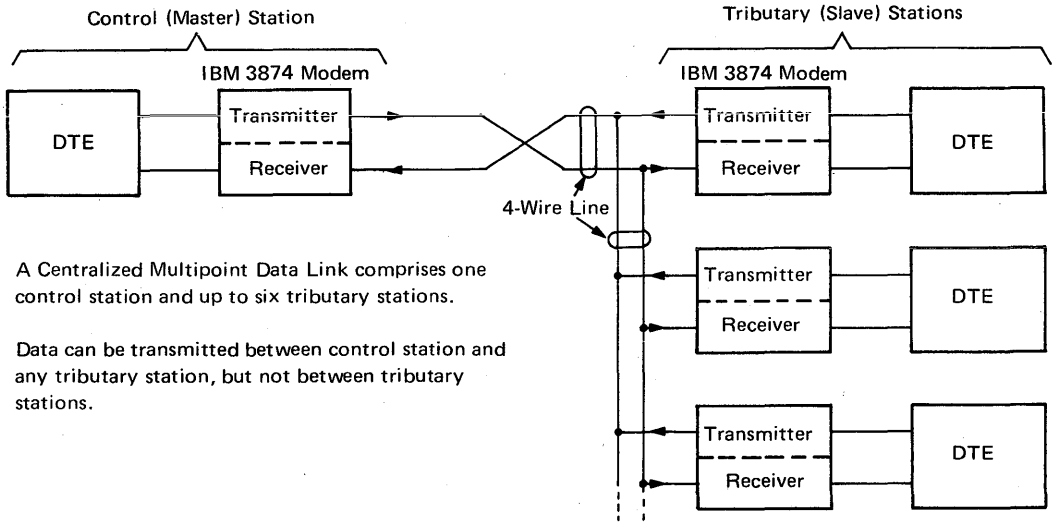
Data is transmitted alternately in each direction.
Transmitters are off between data transmissions.
Local receiver is clamped off when the local transmitter is operating, and vice versa.
Local receiver must be synchronized by the remote transmitter before reception of each message, and vice versa.

Point-to-Point, Duplex



Data may be transmitted simultaneously in both directions.
Transmitters and receivers are permanently on.
Each receiver is held continuously synchronized by the remote transmitter.
Data transmission rate is maximum in this mode.

Centralized Multipoint



A Centralized Multipoint Data Link comprises one control station and up to six tributary stations.

Data can be transmitted between control station and any tributary station, but not between tributary stations.

Figure 14. Non-switched line data link configurations [11659A]

Functional Description

MODULATION TECHNIQUE

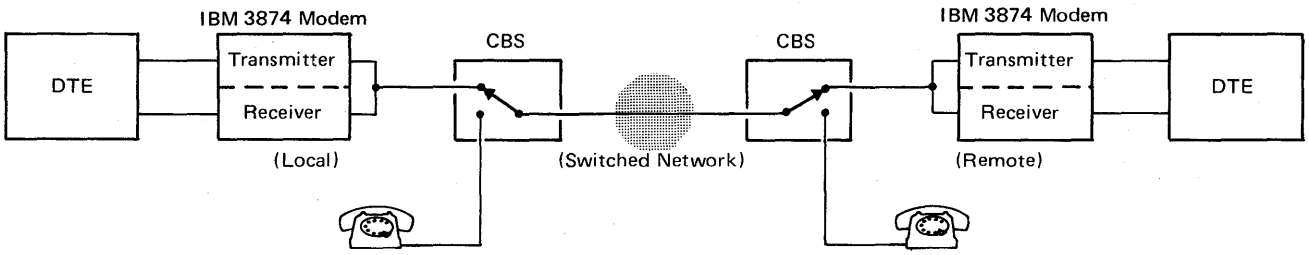
The 3874 uses 8-phase coherent-phase-shift keying at 4800 bps and 4-phase coherent-phase-shift keying at 2400 bps, with digital echo modulation, to shift and compress the frequency spectrum of a train of pulses (representing binary data) to be within the bandwidth of the telephone line. This technique minimizes telephone line impairment effects normally found in the outermost sides of the bandwidth of voice grade telephone lines.

MODES OF OPERATION

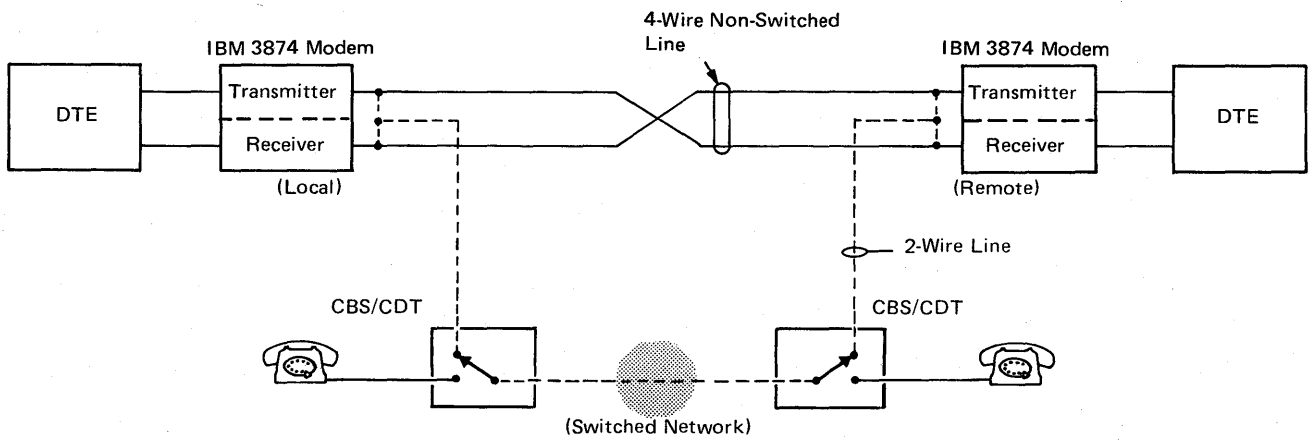
In non-switched line operation, the 3874 can operate in *point-to-point* or *centralized multipoint* teleprocessing configurations (Figure 14). Data transfer may occur in the *half-duplex* or *duplex* mode. In both instances, a four-wire telephone line is required. (The duplex mode includes continuous carrier in both directions or continuous carrier in one direction and alternate carrier in the other direction.)

In switched network operation, data is transferred in half-duplex mode over two-wire lines (Figure 15).

Switched Network



Switched-Network Back-Up



Once a switched network connection is established between two teleprocessing stations the resulting data link is point-to-point, half-duplex (two-wire).
Data is transmitted alternately in each direction.
Transmitters are off between data transmissions.
Local receiver is clamped off when the local transmitter is operating, and vice versa.
Local receiver must be synchronized by the remote transmitter before reception of each message, and vice versa.
A 160 ms delay is necessary to change the direction of the signal over the line; in addition, a delay for the signal to pass through the receiver and the transmitter must be considered; although variable, this delay cannot exceed 10 ms.

Figure 15. Switched network data link configuration [11660A]

TRANSMISSION AND RECEPTION OF DATA

The 3874 consists basically of a transmitter, a receiver, and associated control and timing circuits (Figure 16).

The transmitter accepts data from the DTE on the 'transmitted data' line as a series of positive and negative pulses and converts it, by phase modulation, into a signal the spectrum of which falls within the telephone line bandwidth.

The transmitter scrambles the data and sends it via a line transformer to the telephone line. The scrambler is incorporated in the transmitter to ensure that the transmitter output always consists of a pseudo-random bit pattern. Thus the transmitter power is constant and independent of the bit pattern of the data being transmitted.

The transmitter output on the telephone line is adjustable by the IBM CE by strapping between 0 dBm and −30 dBm in 1 dB steps to suit the requirements of the PTT. This adjustment is made during installation. When the 3874 is connected to both non-switched line and switched network, two such adjustments are made. These adjustments are independent of each other.

The receiver, using the timing from the modem timing circuits, reconstitutes the binary data from the incoming signal and sends it, as a series of positive and negative pulses, to the DTE on the 'received data' interface line. In switched network configuration, the receiver accepts without any adjustment a signal level between −12 dBm and −38 dBm. In non-switched line configuration, the appropriate receiver input level (between −10 dBm and −30 dBm) is set by the IBM CE during installation. The receiver will subsequently accept a receiver input variation of ±10 dB about this preset level. The receiver incorporates a line signal detect circuit that blocks the receive path when the signal from the telephone line is too low to be dependable (15 dBm below the preset receiver input level).

The control circuits control the transmitter and receiver operation according to signals received from the DTE and send supervisory signals to the DTE.

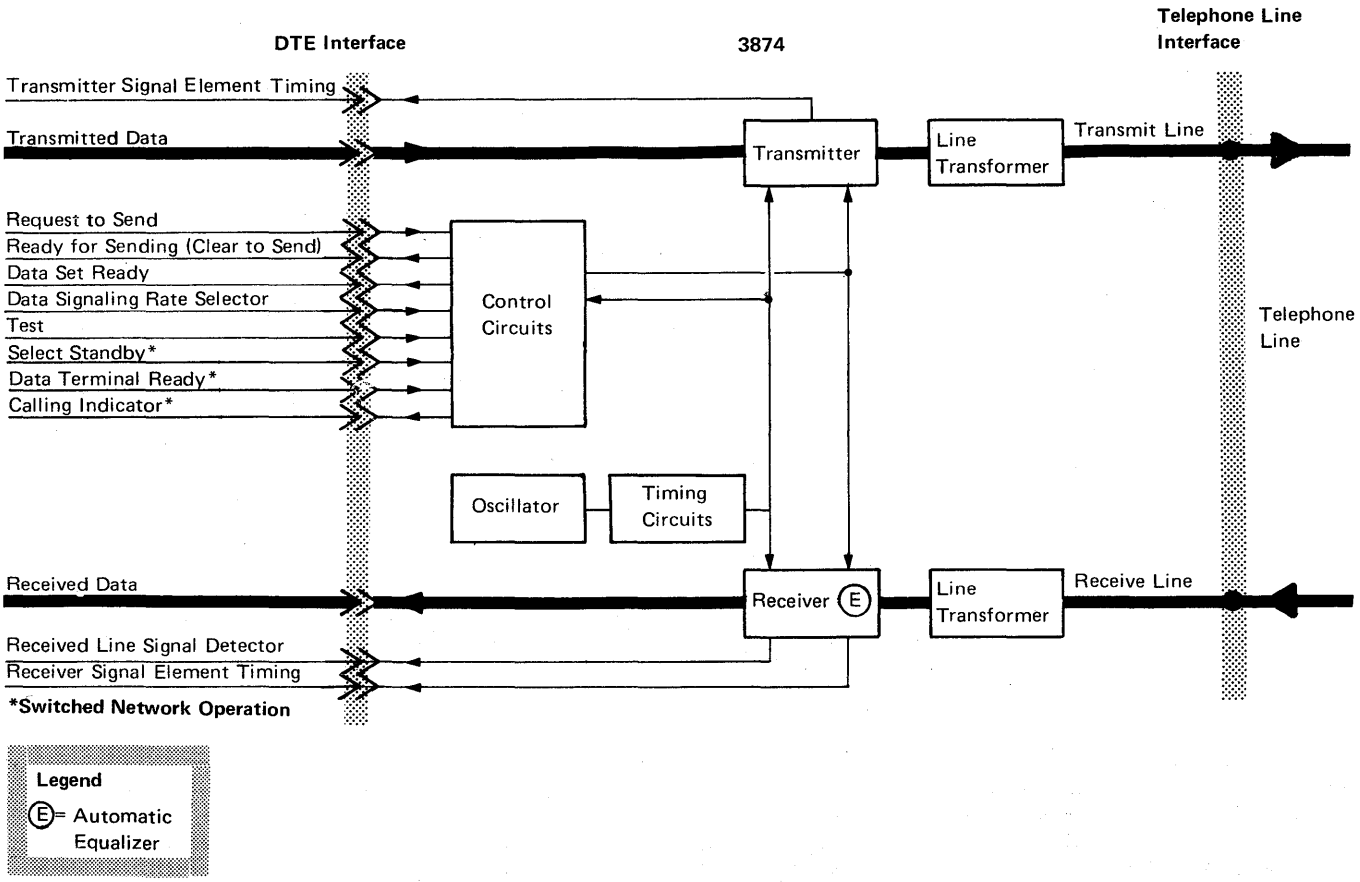


Figure 16. Block diagram of 3874 [11661A]

EQUALIZATION

Equalizers compensate for the amplitude and phase distortions of the telephone line. One automatic equalizer is located in each receiver to equalize each transmission path (Figure 17).

Equalization of the 3874 is described in Part 2. Additional information is given here about equalization in centralized multipoint configuration.

In *centralized multipoint,* the equalization is supervised by the control station. As there is only one equalizer in the control station receiver, and up to six different links between it and the tributary stations, the equalization of each link is performed one at a time and the parameters of each link are stored in a random access memory fitted in the control station.

When the control station equalizes, it addresses each tributary station one after the other, sending one specific frequency recognizable by only one tributary station. An addressed tributary might, however, be in one of the following conditions:

- *It is powered-on:* It sends back to the control station the same frequency as it receives to say it has power-on. Then the equalization process starts for 9s in both directions. If the operation has been successful, 'data set ready' rises, and the equal indicator lights at the involved tributary station. The equalization indicator corresponding to that tributary station lights at the control station, and the control station addresses the next tributary station.
- *It is powered-off:* The control station does not receive the answer of the tributary station and, after a 2.56s delay, addresses the next tributary. The corresponding equalization indicator remains off at the control station.

After equalization is performed for all the links leading to all powered-on tributary stations, 'data set ready' rises at the control station (at least one link has been successfully equalized).

Special consideration must be given to network equalization status whenever the multipoint control modem is powered-down, either as a normal routine or as an unscheduled event, such as a power failure or for maintenance. When power is removed from the control modem, memory circuits which store equalization data for each tributary station are cleared.

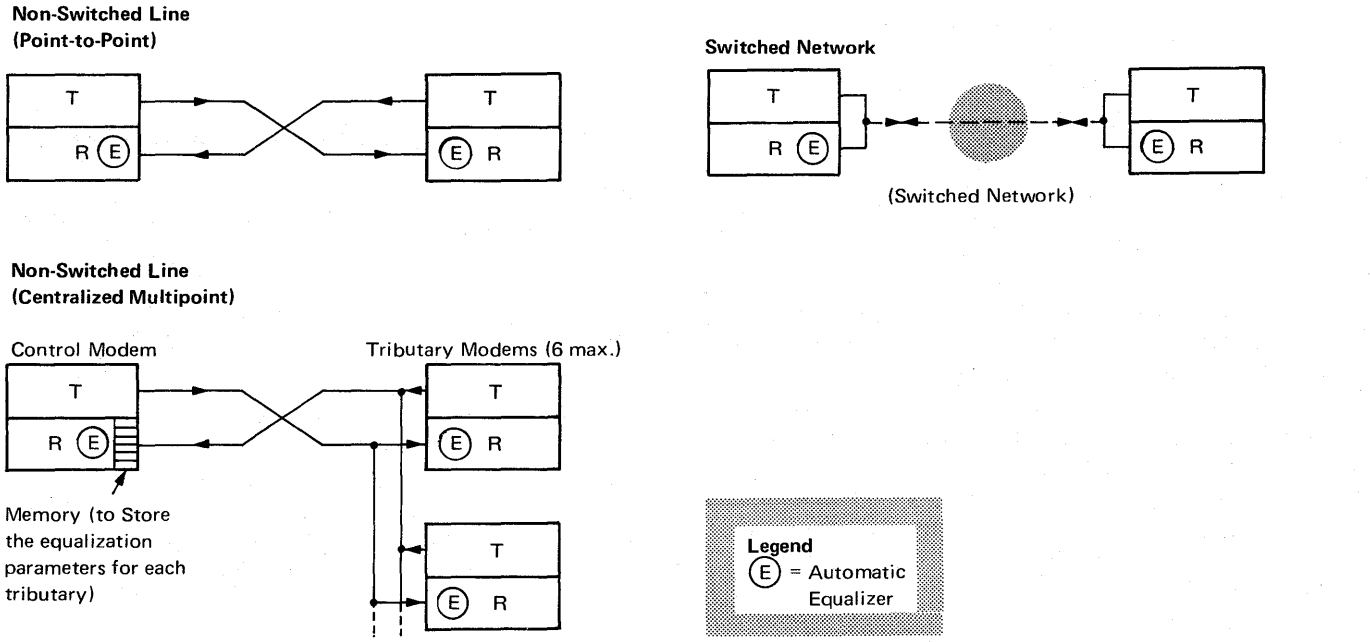


Figure 17. Automatic equalizer locations [11662A]

When the control station is powered-on, the equalization procedure is automatically initiated with each tributary station as previously described. If a tributary modem has 'power-off' at this time, equalization parameters for that tributary station will not be established. The front-panel equalization indicator for that tributary will remain off. When power is subsequently turned on at that tributary station, a 9s equalization will occur on the initial poll of that tributary.

'Ready for sending' does not drop for the *control modem,* but the modem–DTE data interface will be inactive during the equalization period. Because of the temporarily inactive data interface, time-outs in the DTE will occur, resulting in transmission retries. Usually the time required for the execution of the maximum number of retries attempted by the DTE error recovery procedure (ERP) will exceed the 9s equalization period and the interruption will not cause an 'intervention required'.

'Ready for sending' drops for a *tributary modem* at the beginning of the equalization period. On those DTEs that monitor the level of the 'ready for sending' interface lead, this will cause a signal to the DTE that the modem is unavailable for data transmission and result in an 'intervention required'.

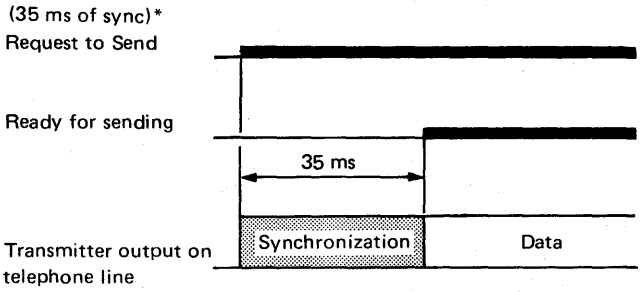
Note: A strapping option allows a *point-to-point* modem to have during equalization the characteristics of a control modem or those of a tributary modem in respect of 'ready for sending'.

SYNCHRONIZATION

Before data can be sent from one 3874 to another, the receiver of the receiving modem has to be synchronized with the transmitter of the transmitting modem. Once this synchronization is achieved, the receiver will demodulate the signal correctly until the signal stops or is excessively distorted due to telephone line impairments.

Synchronization takes place after each automatic equalization phase, and after all switching of the interface line 'request to send' from off to on, unless the 'line-signal' option is selected (see strapping options in this Part). (The option cannot be selected for a tributary station.) After receiving 'request to send' from the DTE, the 3874 sends a synchronizing signal (sync pattern). The sync pattern lasts for 35 milliseconds (ms) in non-switched line configuration (Figure 18) and lasts for 160 ms in switched network configuration (Figure 19). At the end of this sync pattern, data can be recovered correctly by the remote receiver.

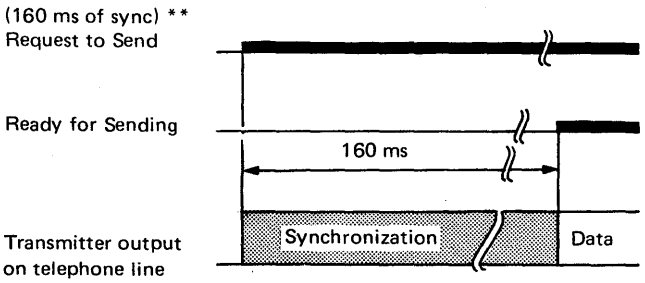
Non-Switched Line



* When the line-signal option is selected (continuous carrier), only one synchronization takes place at the beginning of transmission. 'Ready for sending' rises with 'request to send' with no delay.

Figure 18. Synchronization in non-switched line configuration [19763]

Switched Network



** This delay allows time for echo suppressors, which are located in most switched networks, to reverse.

Note: Propagation delay through the transmitter is not shown.

Figure 19. Synchronization in switched network configuration [19764]

DATA TERMINAL EQUIPMENT/3874 INTERFACE

The DTE interface conforms to CCITT* Recommendation V24 (October 1968) and EIA** Standards RS232 C and RS 334 except for 'test' lines. The sense, voltage levels, and impedances of the interface lines are defined in the relevant CCITT and EIA publications.

A physical description and the pin allocations of the DTE interface is given under "Physical Installation".

In the following descriptions the interface lines are grouped according to their main functions:

- Transmission
- Reception
- Transmission and Reception
- Testing
- Grounding

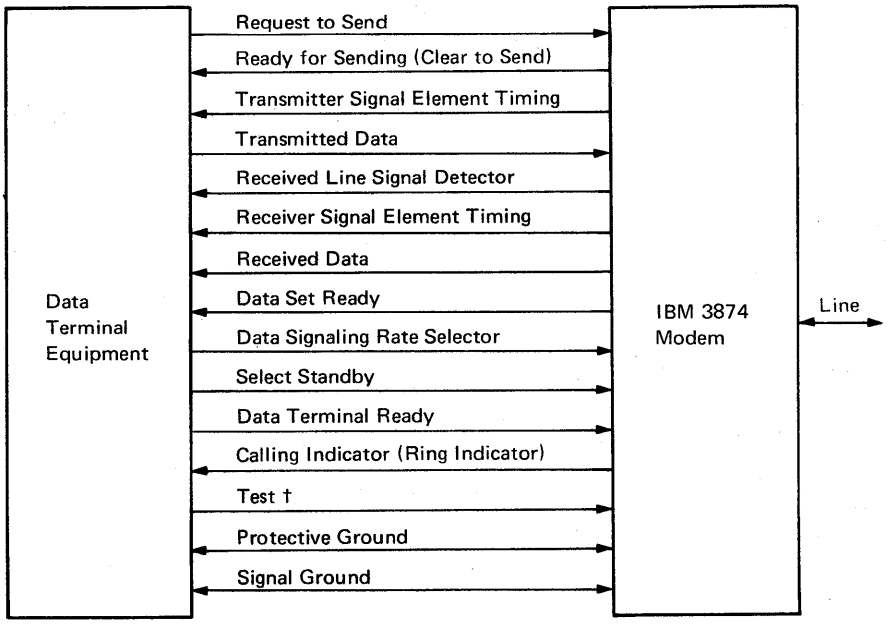
When there is a difference between the CCITT and EIA nomenclature, that of the EIA is shown in parentheses.

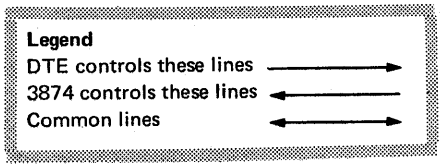
With switched network operation, changes are made to the data terminal interface by the addition of signals, and by modifying the function of 'data set ready' so that the 3874 may operate on the public switched network.

Interface Line Modified	*Interface Lines Added*
'Data set ready'	'Select standby' 'Data terminal ready' 'Calling indicator'

A complete list of the interface signals is given in Figure 20.

* International Telephone and Telegraph Consultative Committee
** Electronic Industries Association





† Test is not a CCITT standard

Note: DTE interface lines not controlled by an originating machine are interpreted by the other machine to be down or off (standard).

Figure 20. DTE/3874 interface: signal summary [11665A]

Transmission

Request to Send

Direction : from DTE
Up level : on
Down level : off

Transmission is initiated by 'request-to-send'. When 'request-to-send' switches from off to on:

- If the continuous-carrier option is not selected (see "Strapping Options"), 'request to send' causes the transmitter to send the sync pattern on the telephone line, then to raise 'ready for sending' (see Figure 19).
- If the continuous-carrier option is selected, 'request to send' causes the transmitter to:
  a. Send the sync pattern on the telephone line after the first equalization period, then to raise 'ready for sending'.
  b. Raise directly 'ready for sending' at all other times.

On switched network operation, the receiver remains clamped for an additional 125 ms delay (echo clamp delay), after 'request to send' goes off.

Ready for Sending (Clear to Send)

Direction : from modem
Up level : on
Down level : off

'Ready for sending' on informs the DTE that the modem is ready to transmit data. 'Ready for sending' turns on:

- After 35 ms each time that 'request to send' turns on for a point-to-point or a multipoint control or tributary station. If the continuous carrier option is selected for a point-to-point or control station, the 35 ms delay for 'ready for sending' applies only at the beginning of transmission; thereafter, 'ready for sending' rises with 'request to send'.
- 160 ms after 'request to send' turns on for a switched network station (see Figure 19).

'Ready for sending' turns off after 'request to send' goes off; all data remaining in the modem is, however, transmitted to the telephone line.

Note: If a *re-equalization* is initiated while 'request to send' is on, 'ready for sending':

- Remains on at a *control modem* during the equalization.
- Drops at a *tributary modem* during the equalization.
- Remains on or drops, according to the strapping option selected, at a *point-to-point* modem during the equalization.

Transmitter Signal Element Timing

Direction : from modem
Up level : on
Down level : off

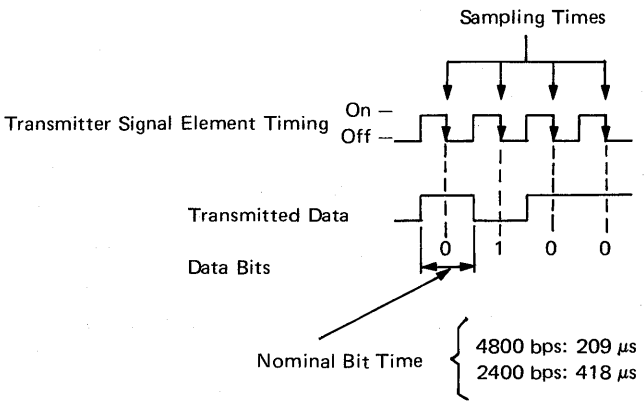
'Transmitter signal element timing' signal serves the DTE as a clock for the transmitted data. This signal, which is a square wave with a frequency of 4800 Hz or 2400 Hz (for 4800 bps or 2400 bps), is generated when the modem has power on.

Transmitted Data

Direction : from DTE
Up level : space (logical 0)
Down level : mark (logical 1)

The DTE uses the 'transmitted data' line to send data to the modem for transmission over the telephone line. The modem samples the 'transmitted data' line during the on to off transition of the 'transmitter signal element timing' (Figure 21).

The modem ignores any spurious signals that may appear on the 'transmitted data' line during the delay between 'request to send' coming on and 'ready for sending' coming on.



Notes:

1. The timing of 'transmitted data' presented to the modem must be such that the time interval between any transmitted data transition and the sampling times of 'transmitter signal element timing' is not less than 25% of the nominal bit time.
2. The frequency tolerance of 'transmitter signal element timing' is ±0.01%.
3. The maximum asymmetric jitter of 'transmitter signal element timing' is ±1%.

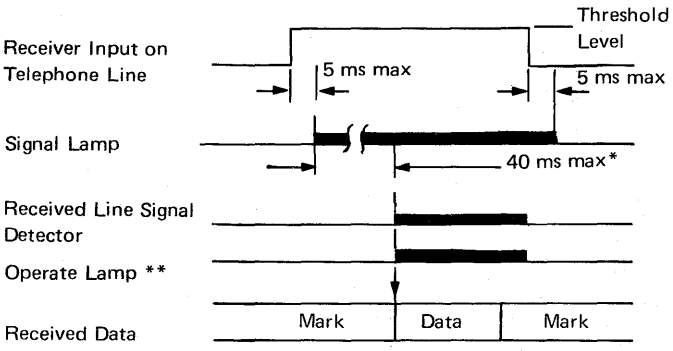
Figure 21. Transmitted data sampling [11666]

Reception

Received Line Signal Detector

Direction : from Modem
Up level : on
Down level : off

The 'received line signal detector' signal indicates to the DTE that the modem is receiving a signal above the preset threshold level (line signal detect circuit on) and that the bit synchronization has been performed (Figure 22). Data sampling does not occur until 'received line signal detector' is on.



* or 160 ms max in switched network.
** dimming

Figure 22. Received line signal detector timing [11667]

Receiver Signal Element Timing

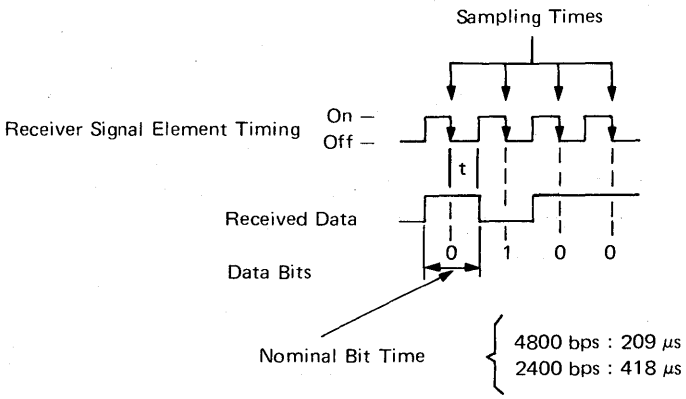
Direction : from modem
Up level : on
Down level : off

'Receiver signal element timing' serves the DTE as a clock for the received data. This signal, which is a square wave with a frequency of 4800 Hz, or 2400 Hz, is free-running and delivered permanently to the DTE.

Received Data

Direction : from modem
Up level : space (logical 0)
Down level : mark (logical 1)

Provided that 'received line signal detector' is on, the modem uses the 'received data' line to send data, received from the telephone line, to the DTE. The DTE must sample the received data at the time of the on/off transitions of the 'receive signal element timing' (Figure 23). The modem cannot use clocking signals generated by the DTE.



Notes:
1. 'Received data' must be sampled at the sampling time of 'receiver signal element timing' with a tolerance of ± 25% of the nominal bit time.
2. The frequency tolerance of 'receiver signal element timing' is ±0.01%.
3. The maximum asymmetric jitter of 'receiver signal element timing' is ±10%. Irrespective of this jitter, the sampling time always corresponds to the center of a bit on 'received data' with a tolerance of ±1% of the nominal bit time.

Figure 23. Received data sampling [11668]

Transmission and Reception

Data Set Ready

Direction : from modem
Up level : on
Down level : off

Basic 3874: 'Data set ready' indicates to the DTE that the modem has power on (with the operate/test switch at OPERATE or T2) and equalization has been performed.

Switched Network Operation: 'Data set ready' on indicates that the modem is connected to the line and equalization has been performed. (Complies with CCITT V24/EIA 232 C.)

Data Signaling Rate Selector

Direction : from DTE
Up level : prime speed (4800 bps)
Down level : half speed (2400 bps)

When the speed/mode-select switch is set to EXTERNAL (modem controlled by DTE), the 'data signaling rate selector' line controls the speed at which the modem

transmits and receives data (either full or half speed). Consequently, it determines the frequencies of the signals appearing on the 'transmitter signal element timing' and 'receiver signal element timing' lines. An up level causes full speed (4800 bps) operation, and a down level causes half speed (2400 bps) operation. In non-switched network only, a change in the level of 'data signaling rate selector' causes an equalization.

When the speed/mode-select switch is not set to EXTERNAL, the speed/mode-select switch directly controls the data signaling rate, and the modem ignores the condition of the 'data signaling rate selector' line.

Select Standby

Note: On switched network operation with DAA-CBS or DAA-CDT.

Direction : from DTE
Up level : switched network
Down level : non-switched line

When the speed/mode-select switch is set to EXTERNAL (modem controlled by DTE), 'select standby' selects:

- Non-switched line operation, when turned off
- Switched network operation, when turned on.

Note: When 'select standby' turns off, an auto-equalization takes place for a point-to-point station and a centralized multipoint control station. ('Select standby' remains off up to the end of equalization.)

Data Terminal Ready

Note: On switched network operation with DAA-CBS only.

Direction : from DTE
Up level : on
Down level : off

'Data terminal ready' is turned on by the DTE at any time to indicate that it is ready to transmit or receive data.

With switched network selected and 'data terminal ready' on, the DAA-CBS will switch the modem to the telephone line (after a delay of 4 to 7 seconds provided by the DAA-CBS) whenever 'calling indicator' comes on.

When 'data terminal ready' goes off and the modem is in *transmit mode,* the modem:

1. No longer accepts data on 'transmitted data'.
2. Continues transmission until the data received just before 'data terminal ready' going off has been transmitted.
3. Causes the DAA-CBS to go "on-hook" and to disconnect the modem from the line.
4. Drops 'data set ready'.
5. Drops 'ready for sending', if 'request to send' is still on.

When 'data terminal ready' goes off and the modem is in *receive mode,* the modem:

1. Clamps 'received line signal detector' and 'received data'.
2. Causes the DAA-CBS to go "on hook" and to disconnect the modem from the line.
3. Drops 'data set ready'. 'Data terminal ready' must not be turned on again until 'data set ready' has been turned off by the modem.

Calling Indicator (Ring Indicator)

Note: On switched network operation with DAA-CBS only (auto-answer).

Direction : from modem
Up level : on
Down level : off

When using a DAA-CBS, 'calling indicator' on informs the DTE that a calling (ringing) signal is being received by the auto-answer circuitry.

This line is always clamped to an OFF condition when a DAA-CDT is used.

Testing

Test

Note: This line is not included in the CCITT Recommendations or EIA Standards.

Direction : from DTE
Up level : on
Down level : off

When the 3874 operate/test switch is set to OPERATE 'test' on causes the output of the transmitter to be wrapped to the input of the receiver, thus setting up a modem/DTE wrap test T2 (see "Modem Tests" in Part 2).

When 'test' turns on, auto-equalization takes place ('test' remains on up to the end of equalization); the remainder of the test is controlled by the DTE. The test pattern is generated and checked by the DTE.

Grounding

Protective Ground

'Protective ground' is normally connected to the frame ground of the modem, but can be isolated if it is grounded in the DTE.

Signal Ground

'Signal ground', which provides the return in the modem for the interface signals and is normally isolated from the frame ground, can be connected to the frame ground if it not already connected to the frame ground in the DTE.

DATA TERMINAL EQUIPMENT/3874-ACO INTERFACE

The automatic call originate (ACO) feature performs the following functions:

- Signals 'off-hook' to the public (central) exchange.
- Recognizes dial tones.
- Receives dial digits from the DTE, and pulses them out to the telephone line (via the DAA-CBS).
- Provides timeout for abandon call procedures, if the call is unsuccessful.

In addition to the ten dialing digits (0 through 9), two control characters are available to control the dialing:

- *EON (end of numbering)*
  Causes the ACO to await an answer from the remote called station (can be inhibited by strapping: see "Strapping Options" in Part 3).
- *SEP (separate)*
  Indicates to the ACO a need for a pause between successive digits, and causes the ACO to insert the appropriate time interval (for example, to await a second dial tone).

A physical description and the pin allocations of the interface are given under "Physical Installation" in Part 3.

Power Indication

Direction: From ACO

'Power indication' on informs the DTE that the ACO has been powered on.

Call Request

Direction: From DTE

'Call request' on conditions the ACO to originate a call and to connect the modem to the line. It turns off when the DTE finishes with the ACO.

Present Next Digit

Direction: From ACO

In reply to 'call request', the ACO raises 'present next digit' to indicate to the DTE that the line is available and that a code combination can be sent on the 'digit signal' lines. 'Present next digit' comes on each time a digit can be accepted.

Data Line Occupied

Direction: From ACO

The ACO sends 'data line occupied' in reply to 'call request' if the line is occupied as indicated by:

- 'Ring indicator' on.
- DAA-CBS-associated handset "off-hook."
- ACO function switch is not set to OPERATE.

Digit Signal (four lines)

Direction: From DTE

The four lines:
"Digit signal 1"
"Digit signal 2"
"Digit signal 4"
"Digit signal 8"
carry the hexadecimal value of the digits to be dialed by the ACO and the two associated control characters (EON and SEP).

The status of the 'digit signal' lines according to the digit or the control characters dialed are shown in Figure 24.

Digit/ Control Character	Digit Signal 8	4	2	1
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	0	0	0	0
EON	1	1	0	0
SEP	1	1	0	1

Figure 24. ACO: digit/control character codes [11669]

Digit Present

Direction: From DTE

After 'present next digit' and 'digit signal' have been turned on, 'digit present' on causes the ACO to read the code combination (present on 'digit signal').

Distant Station Connected

Direction: From ACO

'Distant station connected' on indicates to the DTE that the connection has been established with the remote station.

Abandon Call

Direction: From ACO

'Abandon call' on indicates to the DTE that an interruption has occurred. The DTE has to cancel the call and retry.

'Abandon call' remains off during a normal calling procedure and after receipt of 'distant station connected'.

Protective Ground

'Protective ground' is connected to the frame ground of the modem.

Signal Ground

'Signal ground' provides the return for the interface signals.

DATA ACCESS ARRANGEMENT/3874 INTERFACES

Data Access Arrangement Type CBS

In addition to the provision of two lines to connect the modem transmission path to the DAA, the interface also comprises a number of control lines that carry digital signals. The level and sense of the digital signals is in accordance with CCITT Recommendation V24 and EIA Standard RS 232 C. The interface lines are as shown in Figure 25.

A physical description and the pin allocation of the DAA-CBS interface is given under "Physical Installation" in Part 3.

Auto-Calling

With the 3874 and the automatic call originate feature prepared for auto-call (see "Automatic Call Originate [CBS/CBS]" under "Operating Procedures" in Part 2), signals are exchanged as follows:

1. DTE sends 'call request' to the 3874 to condition it for automatic calling.
2. The 3874 signals 'off-hook' (OH) to the DAA.
3. The DAA handles the connection to the telephone line.
4. When the connection to the line is established, the DAA returns 'coupler cut through' to the ACO. As a consequence, the DTE dials, and appropriate signals are exchanged with the 3874 (see "Data Terminal Equipment/3874-ACO Interface" in this Part).

Auto-Answering

With the 3874 and the DAA-CBS prepared for auto-answering (see "Auto-Answering" [CBS only]" under "Operating Procedures" in Part 2), signals are exchanged as follows:

1. The DAA detects the ringing signal and sends 'RI' to the 3874.
2. If the DTE is ready, the 3874 signals 'off-hook' (OH) to the DAA.
3. As soon as the DAA is ready ('CCT' on), the 3874 transmits an answering tone of 2100 Hz during 3 to 4 seconds.
4. At the end of the transmission of this tone, the auto-answering circuit in the 3874 transfers line control to the DTE and the 3874.

Data Access Arrangement Type CDT

The two lines ('data tip' and 'data ring') that connect the 3874 to the DAA-CDT are used solely as a transmission and reception path and have the same functions as those for the similar lines of the DAA-CBS. No control lines are provided, the answering and making of calls being done entirely manually.

Line Name	Direction	Function
Data Tip (DT) and Data Ring (DR)	both	Transmission and reception path for modem
Data Transmission (DA)	from modem	Up permanently when modem is selected for switched network operation
Ring Indicator (RI)	from DAA	Up level informs modem that a ringing signal is being detected by the DAA
Off Hook (OH)	from modem	Up level causes off-hook relay in the DAA to operate
Coupler Cut Through (CCT)	from DAA	Up level indicates to modem that DAA is ready. Down level indicates that the DAA is inoperative
Switch Hook (SH)	from DAA	Up level indicates to modem that the associated handset is off hook and that the exclusion key has been pulled out
Signal Ground (SG)	both	Return path for control signals

Figure 25. DAA-CBS/3874 interface signal functions [11670]

Use of Fan Out Feature

The Fan Out feature enables the 3874 to be connected to two additional DTEs. Appropriate line control techniques must be used so that only one DTE transmits at a time to the 3874; the 3874, however, always sends signals indiscriminately to every DTE, with the exception of 'ready for sending', which is sent only to the DTE that issued 'request to send'.

The 3874 ignores any signals on the 'transmitted data' lines coming from DTEs that have not raised 'request to send'.

With switched network operation, only one 'data terminal ready' must be on at a time if an autodisconnect is required; manual disconnect may be effected by setting the talk/data switch on the 3874s to TALK.

Typical applications of the fan out feature are described in the following text.

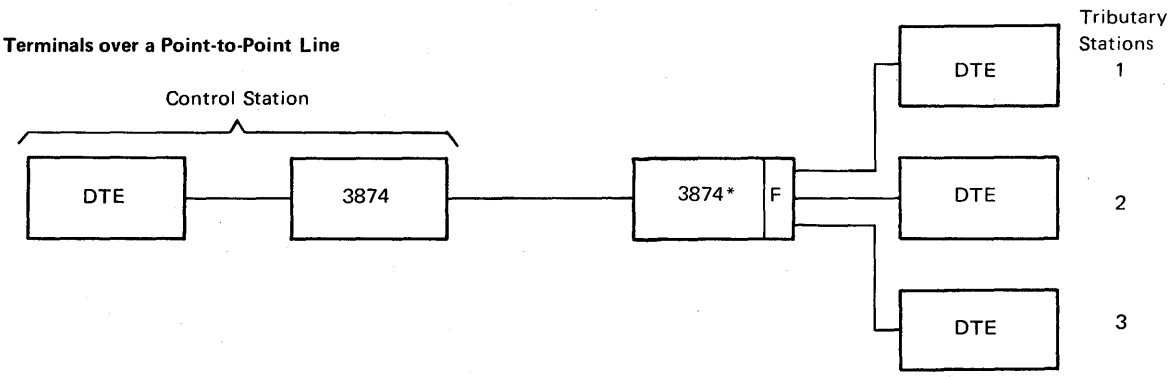
- *Multipoint Terminals over a Point-to-Point Line (Figure 26a):* The fan out feature allows up to three tributary stations to be created with the same modem. Although a four-wire point-to-point line is used, the configuration is identical to a normal multipoint as far as the programming, line control, and terminal operation are concerned.

- *Multipoint Terminals over a Multipoint Network (Figure 26b):* This configuration comprises a normal multipoint line with at least two groups of tributary stations and at least three modems. From the operational standpoint, the configuration is the same as an equivalent configuration where each tributary station has its own modem. Figure 26b does not represent a limiting case of this application.

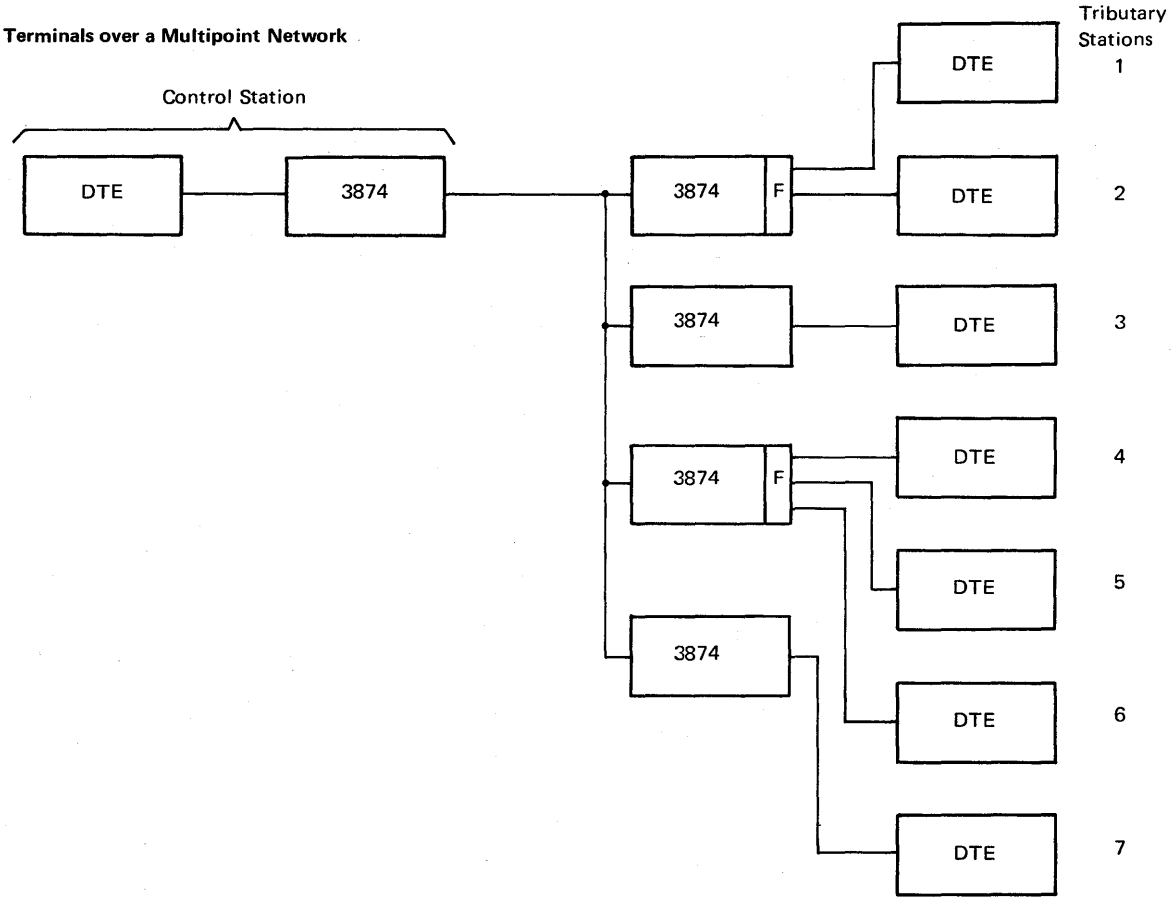
- *Fan Out Feature at Control Station (Figure 26c):* In this application, two controllers are used at the control station for back-up purposes. The rest of the configuration may be point-to-point* or multipoint, with or without other fan out features being installed at the tributary stations.

* Although a physical point-to-point configuration (equalization procedures, etc) it is a multipoint configuration from the programming support viewpoint.

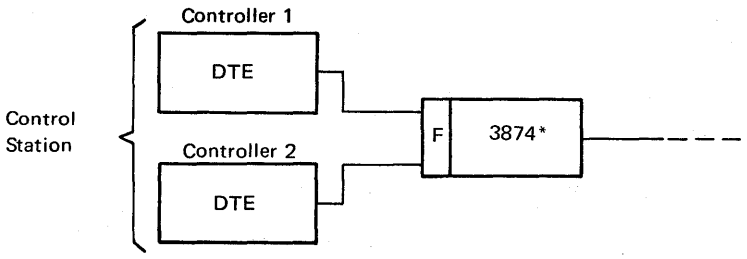
a. Multipoint Terminals over a Point-to-Point Line



b. Multipoint Terminals over a Multipoint Network



c. Fan Out Feature at Control Station



* To eliminate the synchronization delay when changing from one controller to another, 'request to send' can be strapped to be on permanently (line-signal option selected). In this condition, the modem returns 'ready for sending' as soon as it receives 'request to send' from the DTE. (DTEs must only send one 'request to read' at a time.)

Legend:
F: Fan Out Feature

Figure 26. Typical applications of the Fan Out feature [11671]

Strapping Options

The strapping options available are summarized in Figure 27. The strap settings and adjustments are carried out by IBM CEs at installation time.

Strap Name	Purpose	Remarks
Configuration	Defines the status of the station: • Point-to-point • Control • Tributary • Switched network	
Clamping Mode (non-switched line only)	Selects the appropriate four-wire mode of operation: • Duplex • Half-duplex	When in half-duplex mode, the receiver is clamped when 'request to send' is on.
Transmit Level	Obtains correct transmission level. Maximum permissible output is specified by PTT	Adjustment range: • Non-switched line: 0 dBm to −29 dBm • Switched network: 0 dBm to −17 dBm in 1 dBm steps
Continuous Carrier	Avoids the 35 ms-synchronization delay between rises of 'request to send' and 'ready for sending' by providing a continuous carrier	• Mandatory in multipoint control • Optional in point-to-point (can be used with fan out feature)
Tributary Address	*Control Station* Reduces the equalization time when less than six tributary stations are installed. *Tributary Stations* Defines the specific address frequency to be sent back as an acknowledgement to the polling of the control station	Prevents the control station from polling tributary stations not actually installed
Ready for Sending	'Ready for sending' remains on during a re-equalization if 'request to send' is also on	*Control Station* Mandatory *Tributary Station* Not available *Point-to-Point* Optional *Note:* Continuous carrier option must be selected if the ready for sending option is strapped
Echo Clamp	*Switched Network and SNBU only* Clamps the receiver entry for a certain time after RTS has dropped, to prevent the reception of possible echoes on the line	• Normal: 125 ms • Short: 15 ms
EON Inhibit	When the ACO feature is installed, allows to operate without the EON code	See "Data Terminal Equipment/3874-ACO Interface" in this Part

Figure 27. Strapping options: names and purpose [11672B]

Physical Installation

The 3874 stands on four rubber feet fitted to its base. The location must give the operator complete access to the control panel. On no account must the cooling be affected by restriction of the air flow into or out of the 3874.

For servicing purposes, access must be provided for cover removal, and to permit the 3874 to be turned on its side. Service clearances are given in Figure 28.

CAUTION
Under no circumstances must the 3874s be stacked (one on top of the other). If 3874's are placed on shelves, the customer must provide space for air circulation and space to allow for the service clearances if the modem cannot be removed for service. Cables must remain connected.

UNIT SPECIFICATIONS

Dimensions

	Width	*Depth*	*Height*
Inches	17	22	6
Centimeters	43,2	55,9	15,3

Service Clearances

Given in Figure 28.

Weight (Maximum with All Features)

lb	65
kg	29.5

Heat Dissipation

BTU/hour	600 (max)
kcal/hour	150 (max)

External Power Supplies

Voltage (rms)	100, 110, 112.5, 115, 123.5, or 200, 208, 220, 235
Voltage tolerance	±10%
Phase	Single
Frequency range	49 to 61 Hz
Maximum power consumption	0.2 kVA at the rated voltages

Environmental Requirements

Temperature	50 to 105°F (10 to 40.6°C)
Relative humidity	8 to 80%
Barometric pressure	29.9 to 23.3 in. (759,5 to 586,7 mm) of mercury; this is equivalent of from sea level to 7000 ft (2134m).

Connector and Cable Locations

The positions of the sockets and cables used to connect the 3874 to the DTE and telephone lines are shown in Figure 29.

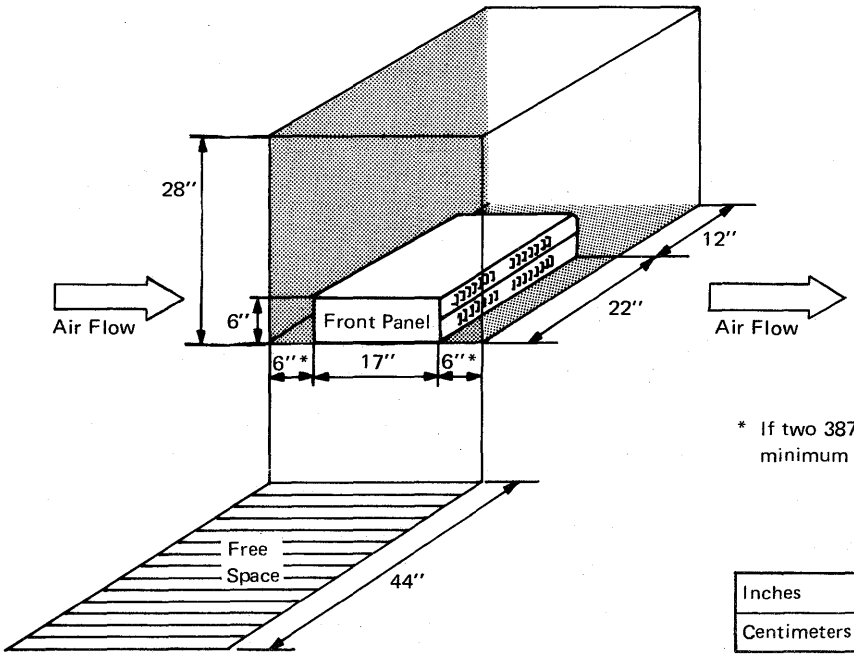


Figure 28. Service clearances [17914A]

* If two 3874s lie on the same plane next to each other, the minimum space between them both is 12in.

Service Clearances

Inches	6	12	17	22	28	44
Centimeters	15	31	43	56	71	112

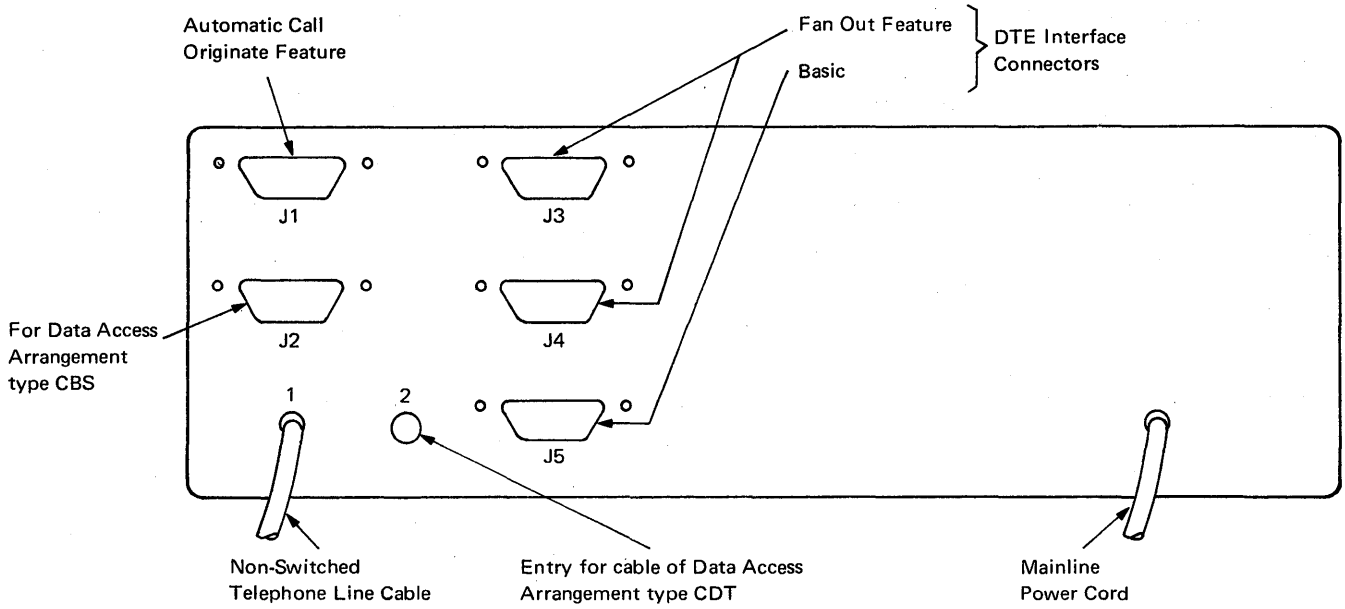


Figure 29. Back panel of 3874 [11674]

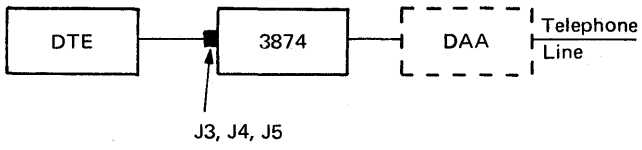
DATA TERMINAL EQUIPMENT CONNECTOR BASIC

Connection from the DTE to the 3874 is made via a 25-pin connector as shown on Figure 30:

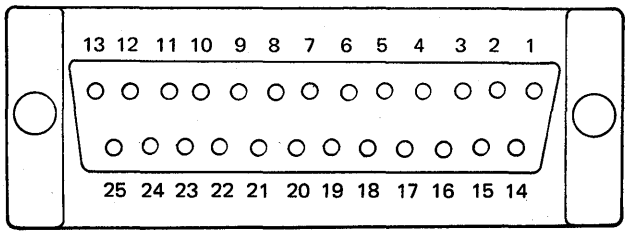
- The 3874 provides the female connector.
- The DTE provides the cable and the male connector.

When the fan out feature is installed, two additional connectors are provided (see Figure 29). Their cables and associated driving and terminating circuits must meet CCITT recommendation V24 and/or EIA standard RS 232 C.

Connector Identification



Pin Locations



Pin Assignments

Pin No.	Signal Name
	Basic Modem
1	Protective Ground
2	Transmitted Data
3	Received Data
4	Request to Send
5	Ready for Sending (Clear to Send)
6	Data Set Ready
7	Signal Ground
8	Received Line Signal Detector
15	Transmitter Signal Element Timing
17	Receiver Signal Element Timing
18	Test
23	Data Signaling Rate Selector
	Switched Network Operation
11	Select Standby
20	Data Terminal Ready
22	Calling Indicator (Ring Indicator)

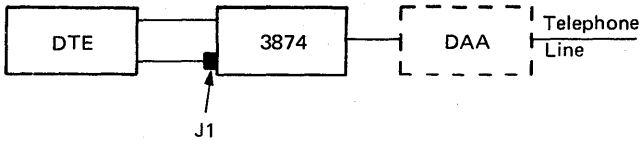
Figure 30. Data terminal equipment/3874 interface [11675]

DATA TERMINAL EQUIPMENT CONNECTOR WITH THE ACO FEATURE

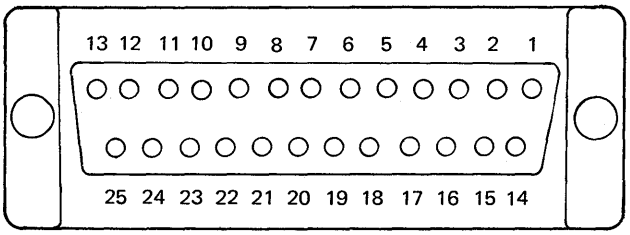
When the ACO feature is present, an additional 25-pin connector is provided to handle the connection between the ACO and the DTE (Figure 31):

- The 3874 provides the female connector.
- The DTE provides the cable and the male connector.

Connector Identification



Pin Locations



Pin Assignments

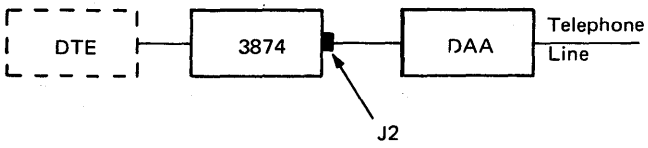
Pin No.	Signal Name
1	Protective Ground
2	Digit Present
3	Abandon Call
4	Call Request
5	Present Next Digit
6	Power Indication
7	Signal Ground
13	Distant Station Connected
14	Digit Signal 1
15	Digit Signal 2
16	Digit Signal 4
17	Digit Signal 8
22	Data Line Occupied

Figure 31. Data terminal equipment/3874-ACO interface [11676]

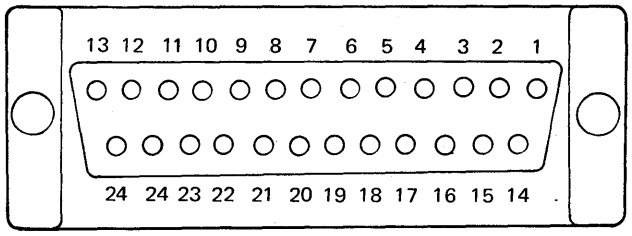
DAA-CBS CONNECTOR

Connection from the DAA-CBS to the 3874 is made via a 25-pin connector as shown in Figure 32. The 3874 provides the female connector, the cable, and the male connector.

Connector Identification



Pin Locations



Pin Assignments

Pin No.	Signal Name
3	Coupler Cut Through (CCT)
4	Switch Hook (SH)
5	Ring Indicator (RI)
6	Data Transmission (DA)
7	Signal Ground (SG)
8	Off-Hook(OH)
24	Data Tip (DT)
25	Data Ring (DR)

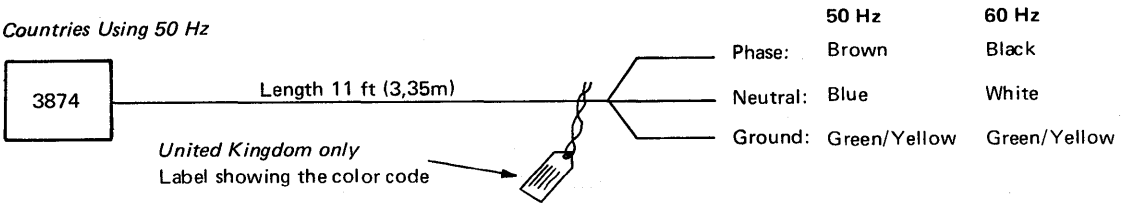
Figure 32. DAA-CBS/3874 interface [11677A]

MAINLINE POWER CORD AND TELEPHONE LINE CABLES

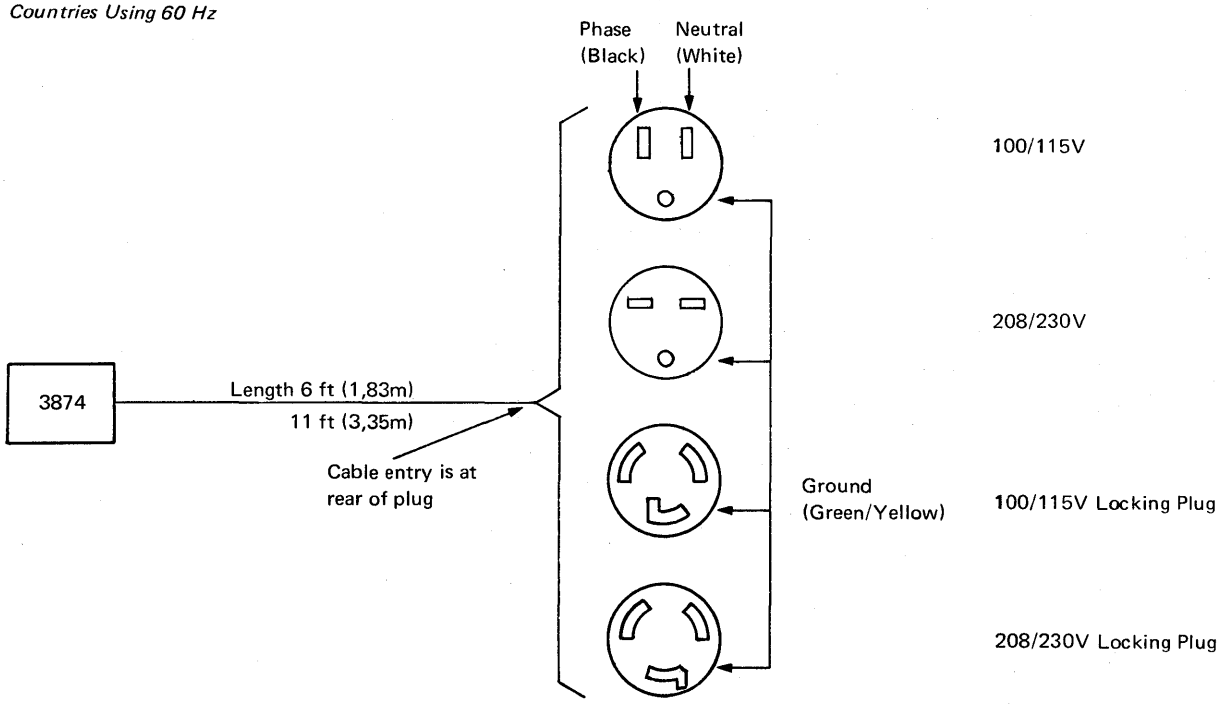
Details of the mainline power cord and the telephone line cables provided or used with the 3874 are given in Figure 33.

Mainline Power Cord

Countries Using 50 Hz



Countries Using 60 Hz



Line Cable — Non-Switched

*U.S.A. or Canada**

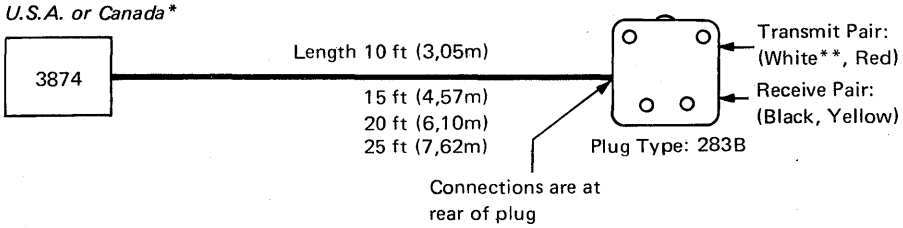
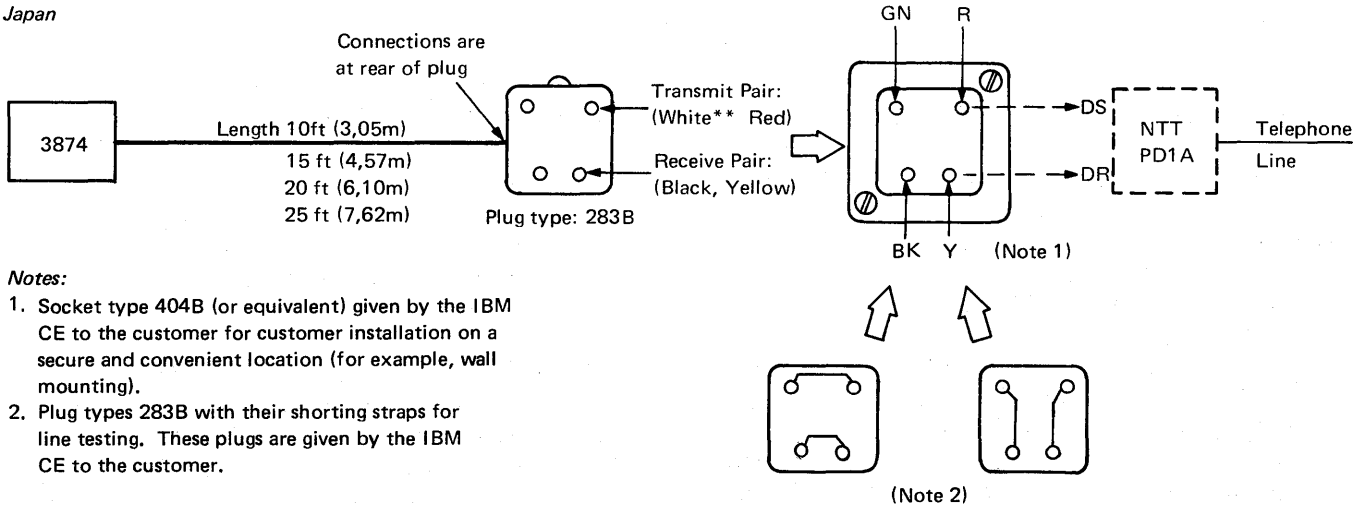


Figure 33. Connecting cables (Part 1 of 2) [17915B]

Line Cable – Non-Switched *(continued)*

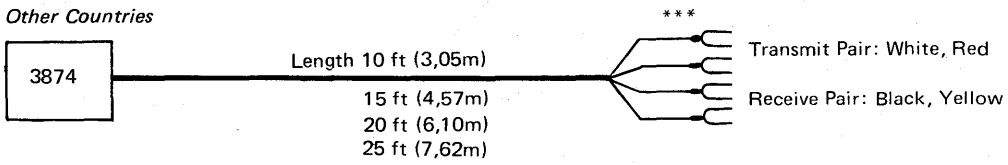
Japan



Notes:

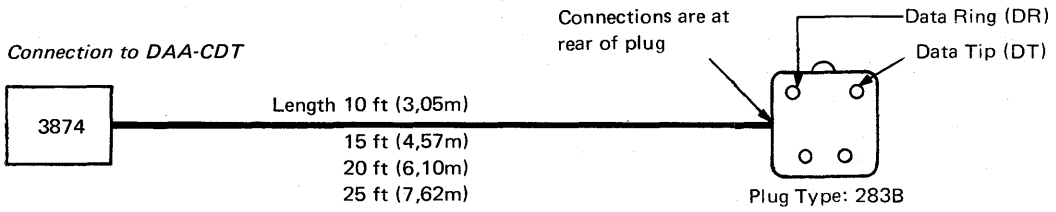
1. Socket type 404B (or equivalent) given by the IBM CE to the customer for customer installation on a secure and convenient location (for example, wall mounting).
2. Plug types 283B with their shorting straps for line testing. These plugs are given by the IBM CE to the customer.

Other Countries

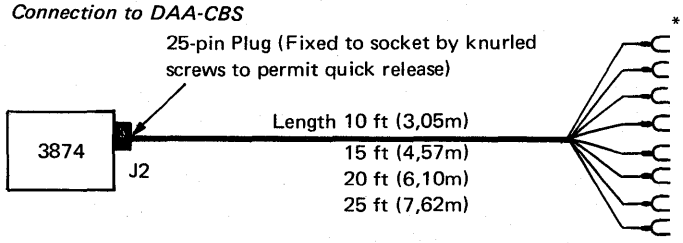


Line Cable – Switched Network (U.S.A. or Canada)

Connection to DAA-CDT



Connection to DAA-CBS



Signal	*Pin Number of 25 pin Plug at 3874 end*	*Wire Color*	*DAA-CBS Connection*
Data Tip	24	White	DT
Data Ring	25	Black	DR
Off Hook	8	Blue	OH
Data Transmission	6	Yellow	DA
Ring Indicator	5	Violet	RI
Signal Ground	7	Grey	SG
Coupler Cut Through	3	Brown	CCT
Switch Hook	4	Red	SH

Note: Cable shield is connected to pin number 1 of the 25-pin plug

* A line termination plug (part 5151251) can be used in place of plug type 283B to maintain the line termination (loaded) even when the cable is disconnected from the telephone line for modem servicing.

** This position is referenced as green inside the plug.

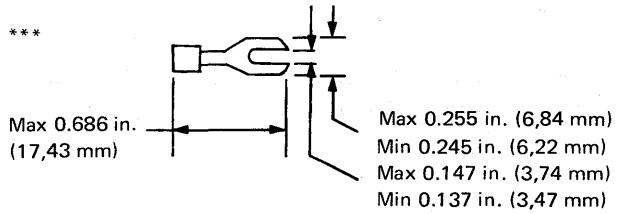


Figure 33. Connecting cables (Part 2 of 2) [11678B]

Communication Channel

Owing to the nature of the teleprocessing environment, it is possible that the throughput anticipated on the specified network configuration might not be achieved. The probability of this is slight and is more likely at the higher data transmission rates.

Some actions the user may take if the anticipated throughput is not achieved are:

- Re-dialing the connection, if operating on the public switched network.
- Adjusting, when possible, the data block size to optimize the throughput based on the error characteristics of the particular channel.
- Requesting the PTT/Common Carrier to provide alternative routing or a line improvement. This is usually possible at extra cost. The PTT/Common Carrier representatives should be contacted for further details.

It is possible, however, that, at a particular location, only operation at a lower speed is obtainable; the local IBM representative is available to assist in analyzing and planning for these alternatives.

CUSTOMER RESPONSIBILITIES

In preparing for the installation of the 3874, the customer is responsible for:

1. Ensuring the availability of the required non-switched and/or switched communications channel (see under "Specifications" for the necessary characteristics).
2. Arranging for the installation of the appropriate device (for example, socket and DAA) for the connection of the 3874 to the communications channel as described under the following paragraphs.
   Note: The wiring of the IBM-supplied connectors and cables is shown in Figure 33.

Non-Switched Connection

USA and Canada

Connection to a non-switched, voice grade channel is to be made via a Western Electric socket, type 404B, 493A, or 549A (or equivalent). The customer wires the socket as follows:

- Transmit pair to GN and R.
- Receive pair to BK and Y.

Japan

Connection to a voice band, private, non-switched D1 line is to be made via a four-pin IBM-provided socket to a PD1A protective device. The customer instals the IBM-provided socket and wires it as follows:

- Transmit pair to GN and R.
- Receive pair to BK and Y.

Other Countries

Connection to a non-switched channel is to be via a terminal block that accepts spade lugs.

Switched Network Connection (USA and Canada only)

To connect a 3874 with the switched network feature to the public switched network, the customer must:

1. Ensure that the communications channel local loop is conditioned for transmission of data at a speed faster than 300 bits per second.
2. Instal a DAA-CBS (Western Electric type 1001A series 5 or later, Western Electric type 1001F, or common carrier equivalent).
3. Connect the 3874 to the DAA-CBS.

In addition, the customer must specify the options required:

1. Appropriate telephone set with exclusion key or data key.
2. DAA control of the communication channel.
3. 'Ring indicate' to the 3874 only or to the 3874 and the telephone set.

Switched Network Back-Up Connection (USA and Canada only)

The customer responsibility for connection of a 3874 with the SNBU feature with auto-answer to the public switched network is identical to that for the connection of a 3874 with the switched network feature, as both connections are made via a DAA-CBS.

When a 3874 with the SNBU feature, but without auto-answer, is to be connected to the public switched network the requirements are different, as the connection is made via a DAA-CDT. In this instance, the customer must:

1. Ensure that the communications channel local loop is conditioned for transmission of data at a speed faster than 300 bits per second.
2. Instal a DAA-CDT (Western Electric type 1000A or common carrier equivalent).
3. Provide a Western Electric socket type 404B, 493A, or 549A (or equivalent) wired to the DAA-CDT as follows:
   - GN to DR.
   - R to DT.

SPECIFICATIONS

Non-Switched Network

USA and Canada

The 3874 requires a duplex communication channel, type 3002 channel or equivalent, with C1 conditioning.

In addition, the characteristics of the required channel include those specified in the Bell System administrative guidelines, as described in Bell System Data Communications Technical References PUB 41004, *Data Communications Using Voice Band Private Line Channels* (October 1973)*.

Other Countries (including Japan)

The 3874 requires a normal quality data communication channel, having at least the characteristics described under the following headings in Figure 34.

- "Attenuation Distortion"
- "Signal Loss Variations with Time"
- "Circuit Noise"
- "Group Delay Distortion"
- "Frequency Shift"
- "Harmonic Distortion"

If the PTT cannot provide an equivalent line, they should be asked to provide a line meeting the requirements of a special quality CCITT recommendation M102. Consult your IBM representative to obtain information on specific procedures and facilities available in your country.

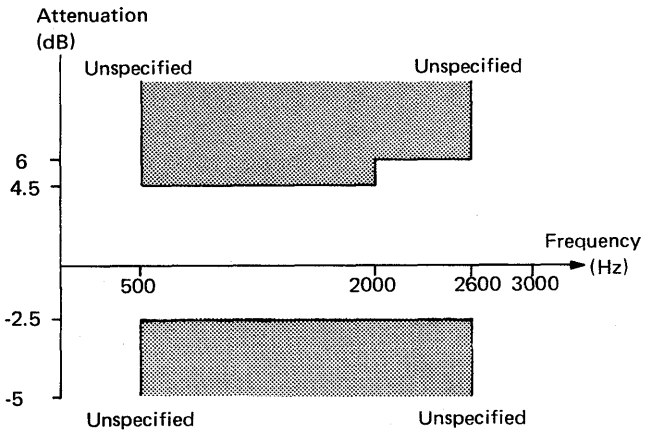
Permitted transmit power level (and signal-to-noise ratio) may vary among countries. The transmit level and receiver sensitivity threshold of the 3874 are strapped in these applications, to allow for adjustments to the specific situation (see "Strapping Options" in this Part).

Switched Network (USA and Canada only)

The characteristics of a switched network channel for the 3874 in the USA and Canada are described in Bell System Data Communications Technical Reference PUB 41005, *Data Communications Using the Switched Telecommunications Network* (May 1971)*.

* These publications may be obtained from American Telephone and Telegraph Co., Supervisor-Information Distribution Center, 195 Broadway, Room 208, New York, N.Y. 10007 (U.S.A.)

Attenuation Distortion



Note: Limits for overall circuit loss relative to that at 1000 Hz.

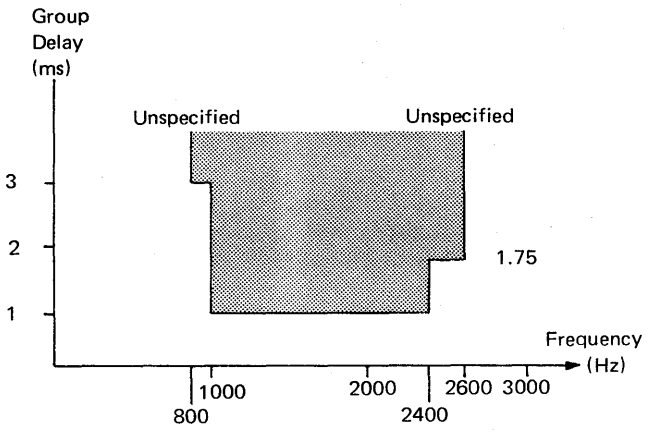
Signal Loss Variations with Time

- Short-term variations (over a period of four seconds) should not exceed ±3 dB.
- Long-term variations (over long periods: daily and seasonal variations) should not exceed ±4 dB.

Circuit Noise

- Random Noise: Must never exceed −41 dBm.
- Impulsive Noise: Should not exceed 18 pulses of −20 dBm max. in 15 minutes.

Group Delay Distortion



Note: Those limiting values over the frequency band are expressed as values relative to the minimum measured group delay.

Frequency Shift

The frequency shift introduced by the circuit must not exceed ±5 Hz.

Harmonic Distortion

When a 700-Hz test frequency of −13 dBm is injected at the transmit end of a point-to-point circuit, the level of any individual harmonic frequency at the receiving end must be at least 32 dB below the received level of the fundamental frequency.

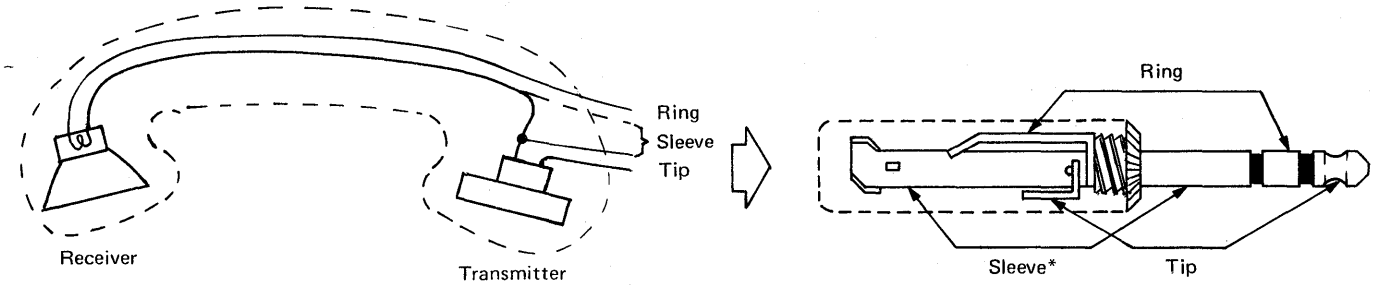
Figure 34. Non-switched line requirements (not USA or Canada) [20410]

Telephone Handset

The telephone handset for use with the alternate voice feature is not provided with the 3874. Any PTT- or Common Carrier-approved unit is suitable, provided it is of a type in current use with the following characteristics:

- Carbon microphone
- Conventional receiver (permanent magnet)
- Three-wire connection (microphone, receiver and common).

These handsets come without plugs, the correct plug being provided with the alternate voice feature. The connections to the plug are shown in Figure 35.



* In some countries (for example, the U.S.A.), two ground wires (one for 'tip' and one for 'ring') are provided for the handset. In this instance, the two wires must be connected together to form only one ground.

Because the telephone handsets can be supplied by different manufacturers, wire colors are not standardized.

Figure 35. Telephone handset connection for Alternate Voice feature [11680]

Part 4. Appendixes

4

Appendix A. Country Differences

Owing to differences in network requirements, the 3874's and features available in the U.S.A. or Canada differ slightly from those available in other countries. The differences are summarized in Figure 36, but the descriptions and purposes are given in the appropriate section of text for completeness. Figure 36 also shows the corresponding French and German wording on the right-hand side operator panel. The left-hand side operator panel (ACO controls) is only available in English, as the ACO is used only in U.S.A. or Canada.

3874 Differences

Item	U.S.A. or Canada	Other Countries	See:	Page
Mainline Power Cord	60 Hz	50 Hz or 60 Hz	"Mainline Power Cord and Telephone Line Cables" in Part 3	54
Non-Switched Line Connection	Plug fitted to cord	*Japan:* Plug fitted to cord *Others:* Spade connectors fitted to cord	"Mainline Power Cord and Telephone Line Cables" in Part 3	55
Switched Network feature and Switched Network Back-Up features	Available	Not available	1. See under "Variations" in Part 1 for descriptions. 2. See "Switched Network: Setting-Up the Line" in Part 2 for data transfer details	3 17
Non-Switched Telephone Line	FCC tarif 260 type 3002 with C1 conditioning as described in Bell Systems Data Communications Technical References PUB 41004	Normal quality line or CCITT M102 (although it far exceeds these requirements)	"Communication Channel"	56

Right-Hand Operator Panel

English	French	German
OPERATE	FONCT NORM	BETRIEB
SIGNAL	SIGNAL	SIGNAL
READY	PRET	BEREIT
EQUAL	EGAL	ENTZ
EQUALIZATION	EGALISATION	ENTZERRUNG
ALL	EGAL GENERALE	ENTZ ALLE TRAB
CALL	APPEL	RUS
RESET	CDE EGAL	GRUNDSTLG
ON/OFF	EF/HF	EIN/AUF
VOICE	VOIX	SPRECHEN
TALK/DATA	TEL/DONNEES	TELPHON/DATEN
OPERATE	FONCT NORMAL	BETRIEB
VOICE	VOIX	SPRECHEN
LAMP TEST	TEST LAMPE	LAMP PRÜF
4800 NON-SW	SPECIALISE 4800	4800 ML
2400 NON-SW	SPECIALISE 2400	2400 ML
EXTERNAL	EXTERNE	EXTERN
4800 SW	COMM 4800	4800 WN
2400 SW	COMM 2400	2400 WN

Figure 36. Country differences [11681B]

Appendix B. Switched Network Back-Up Operation

Switched network back-up operation with the 3874 provides a new level of availability for teleprocessing systems using the following access methods when non-switched line failures occur:

- BTAM under OS, DOS, OS/VS1, OS/VS2, or DOS/VS
- TCAM/EP under OS, OS/VS1, or OS/VS2
- TCAM/VTAM/NCP under OS/VS1 or OS/VS2
- VTAM/NCP under OS/VS1, OS/VS2, or DOS/VS

A non-switched line problem on such systems will cause, when so implemented in a customer's program, console printouts showing that errors on that line have become excessive.

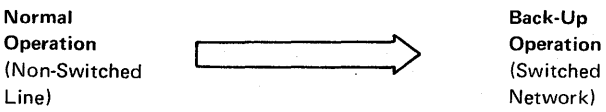
Then, several choices are available:

1. Try to re-equalize.
2. Close the non-switched line for a while, and try again later.
3. Use the non-switched line at half speed.
4. Carry out the problem determination procedures (see Part 2) with the intention of correcting the problem or calling for maintenance assistance.
5. Change to *switched network back-up* operation to re-establish a path between the two teleprocessing units. *Note:* This choice may result from the outcome of one of the other possibilities; the actual choice depends on the type of application involved when the problem occurs and the activity of the rest of the network (for example, multipoint configuration).

This appendix provides guidance for implementing and using the switched network back-up (SNBU) feature of the 3874.

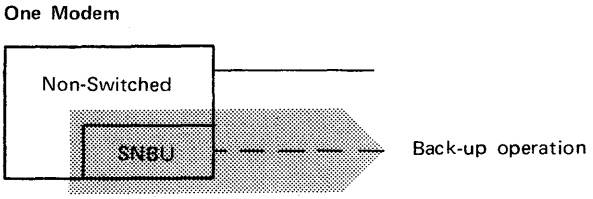
Note: All the choices listed might not necessarily be available with all access methods (see under "Equipment Selection at CPU End" for details of documentation available).

Planning a system that will accommodate switched network back-up operation involves the selection of suitable *configuration, programming,* and *equipment options.*

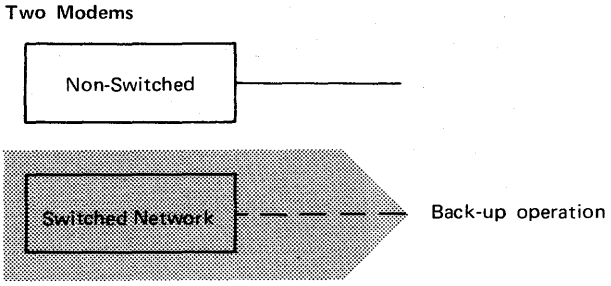


Switched network back-up operation with the 3874 can be achieved by:

- The implementation of an SNBU feature in the *same* modem (operates with DAA-CDT or DAA-CBS). The SNBU features provide for easy changeover from a non-switched line to switched network, and automatically select the corresponding strapping options made at the installation time:



- The installation of a *second* modem equipped with the switched network feature (operates with DAA-CBS only):



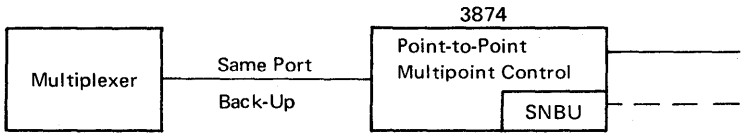
TYPICAL BACK-UP CONFIGURATIONS

Typical back-up configurations are shown in Figures 37 and 38 for the CPU side and for the terminal side, respectively.

When analyzing the possible solutions to increase the availability of teleprocessing links, some consideration should be given to the way in which the system components are to be used. For example, in "c" of Figure 37, the second multiplexer could be permanently wired to the switched network and dedicated for back-up operation or it could be a multiplexer that is used for low-priority tasks such that it could be used for back-up, when necessary.

a. One Modem/One Multiplexer

One 3874 equipped with:
Point-to-Point
or Multipoint Control } + SNBU feature

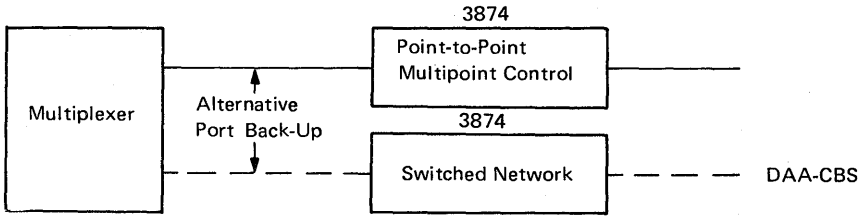


- DAA-CBS, if auto-answering required (mandatory with Network Control Program).
- DAA-CDT, if manual calling/answering is required.

b. Two Modems/One Multiplexer

One 3874 equipped with:
- Point-to-Point or Multipoint Control feature

One 3874 equipped with:
- Switched Network feature



c. Two Modems/Two Multiplexers

One 3874 equipped with:
- Point-to-Point or Multipoint Control feature

One 3874 equipped with:
- Switched Network feature

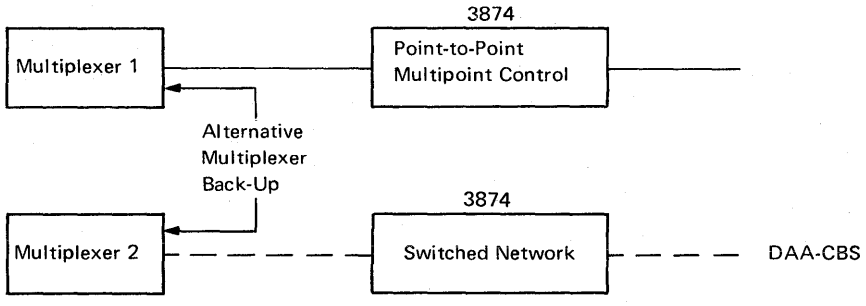
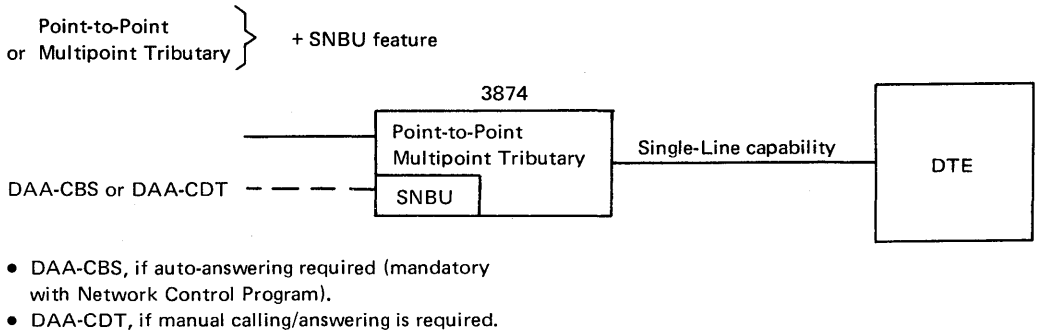


Figure 37. Possible back-up configuration: CPU side [20402]

a. One Modem/Single-Line Capability Terminal



- DAA-CBS, if auto-answering required (mandatory with Network Control Program).
- DAA-CDT, if manual calling/answering is required.

b. One Modem/Dual or Multiline Capability Terminal

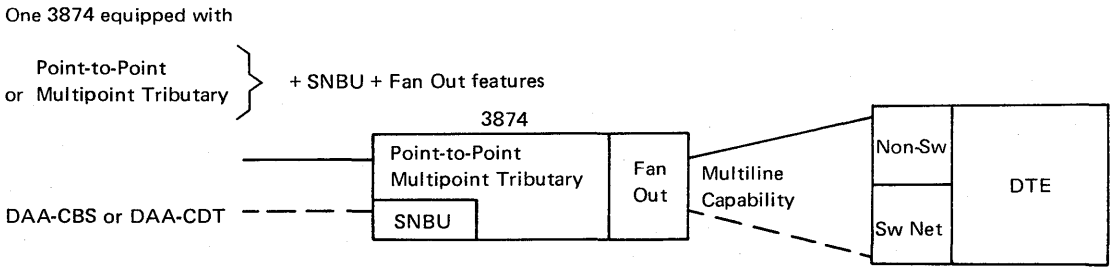


Figure 38. Possible back-up configuration: terminal side [20403]

PROGRAMMING AND EQUIPMENT OPTIONS

The DTE programming and equipment options that interface with the 3874, are affected by the plans for switched network back-up operation. Non-switched line operation is likely to be multipoint and/or duplex, but switched network operation is typically point-to-point, half-duplex (see Figure 15).

The DTE must be permanently wired for half-duplex control of the 'request to send' interface line. Where appropriate, duplex throughput is maintained by strapping the 3874 for continuous carrier on the non-switched line. On the switched network back-up facility, the DTE half-duplex control of 'request to send' and the 3874 two-wire configuration provide the necessary half-duplex operation.

Programming Option Selection

The selection of the programming environment affects the type of data transmission, as shown in Figure 39.

Component elements of a programming environment are as follows:

Operating Systems

OS, OS/VS1, OS/VS2, DOS, DOS/VS

Access Methods

BTAM : Basic Teleprocessing Access Method
TCAM : Telecommunication Access Method
VTAM : Virtual Telecommunication Access Method

Multiplexer Programs

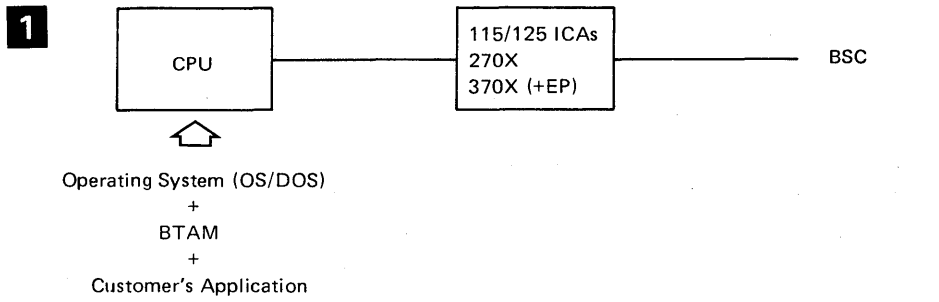
NCP : Network Control Program
EP : Emulator Program

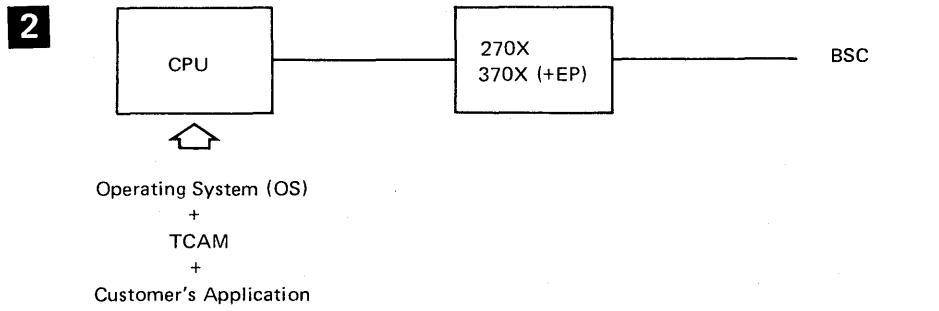
Teleprocessing Operation Concepts

BSC : Binary Synchronous Communication
SDLC : Synchronous Data Link Control.

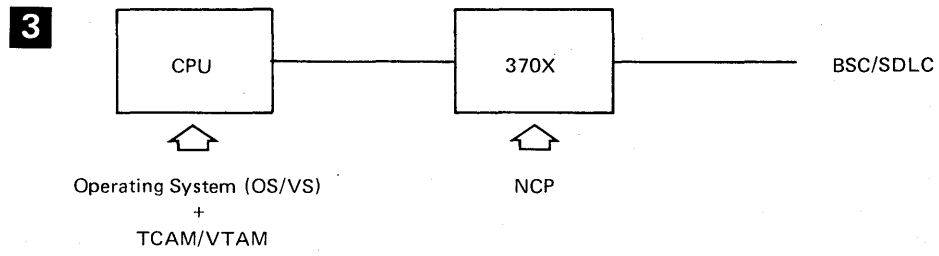
Note: Typical relationships between the access methods and operating systems are given at the beginning of this appendix.

a. **BSC Operation with Half-Duplex Data**





b. **BSC Operation with Half-Duplex Data or SDLC Operation with Duplex Data**



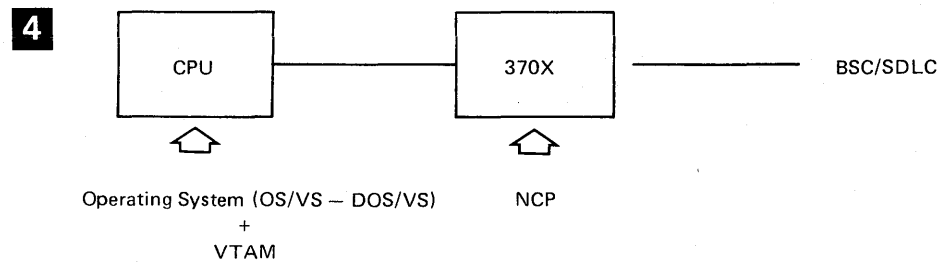


Figure 39. Programming environments [20404]

Access Method	Publication Title	Order No.
DOS/BTAM	*IBM System/360 DOS Basic Telecommunication Access Method*	GC30-5001
OS/BTAM	*IBM System/360 OS Basic Telecommunication Access Method*	GC30-2004
DOS/VS/BTAM	*DOS/VS BTAM Manual*	GC27-6978
OS/TCAM	*User's Guide*	GC30-2025
OS/VS/TCAM	*Programmer's Guide*	GC30-2044
OS/VS/TCAM	*User's Guide*	GC30-2045
OS/VS1/TCAM	*Programmer's Guide*	GC30-2054
OS/VS2/TCAM	*Programmer's Guide*	GC30-2041
VTAM	*Introduction to VTAM*	GC27-6987
VTAM	*VTAM Applications Programmer*	GC27-6995
NCP	*IBM 3704 and 3705 Communication Controllers Network Program: VS Generation and Utilities Guide and Reference Manual*	GC30-3008

Figure 40. Access methods: publications list [20405]

Access Method	Communication Controller
BTAM	2701, 2703, 3704/05 EP Mode System/370 Model 115 ICA System/370 Model 125 ICA
TCAM	2701, 2703, 3704/05 EP Mode
TCAM/NCP TCAM/VTAM/NCP VTAM/NCP	3704/05 NCP Mode

Figure 41. Access methods: communication controllers [20406]

Equipment Selection at CPU End

Planning the back-up of links in a system environment requires a careful evaluation of the possible program-supported solutions; the study of the appropriate documentation selected from the list in Figure 40 is, therefore, recommended.

Communication controllers are supported as shown in Figure 41.

The table shown in Figure 42 allows the selection of the 3874 features required for SNBU operation at the CPU end modem, depending on:

- The programming option as described in Figure 39.
- The terminal, teleprocessing operation concept (BSC or SDLC).

Note: The types of SNBU configuration available ('a', 'b', or 'c') refer to those described on Figure 37. This figure also shows the 3874 features to be installed for each configuration.

Terminal Family / Programming Options (Figure 39)	BSC		SDLC	
	All (except 3271/75 BSC)	3271/75 BSC	All (except 370X remote)	370X remote
1	a, b, c	a, b, c	–	–
2	a	a	–	–
3	a, b	a	a	a, b
4	a	a	a	a, b

Figure 42. Equipment selection: CPU side [20407]

Back-Up for Point-to-Point (or Single-Drop Multipoint)

Point-to-point (or single-drop multipoint) non-switched lines that operate in half-duplex mode require no equipment configuration change for SNBU operation, unless automatic answering is selected. Duplex channels require half-duplex control of 'request to send' for back-up operation. (Duplex operation on non-switched lines is achieved by strapping the 3874 for continuous carrier.)

The same programming can be used in non-switched and in switched network back-up operation if:

- The standby facility uses manual calling, answering, and disconnecting.
- The same port and the same modem are used at the CPU side.

Automatic calling or answering or disconnecting requires control of 'data terminal ready', and implies special support.

If multiple applications exist, both on non-switched and switched lines, and if they are not supposed to work simultaneously or if the priorities are significantly different, an economic solution would be to use the switched network ports to back-up the non-switched lines:

- With BTAM, some modifications are required to the user's program.
- With TCAM and/or VTAM, the CPU operator can make the necessary changes which consist in:
  1. Disabling the switched port from the previous application
  2. Enabling it for the application requiring switched back-up call.

If the above conditions cannot be met, the two following possibilities are offered:

1. Establish a restricted number of ports dedicated for back-up operation and shared by multiple terminals/applications. This allows the use of the auto call feature on those ports and avoids operator intervention on the modem itself (the whole procedure can be handled from the CPU console). This is the most economical solution for large systems.
   Note: with BTAM, assigning the terminal and/or the application to the SNBU operation, introduces an operator activity.
2. Use same port back-up (see Figure 37), calling and answering must be manual, and operator intervention *on the modem* is required to go to the back-up mode and return to the normal mode.

In both possibilities, if automatic disconnection is needed, the SNBU feature of the 3874 must have the auto-answering facility (DAA-CBS), at least at the CPU end.

Back-up for Multipoint

Communication via switched network back-up, with a terminal that is normally on a multipoint non-switched line, requires use of multipoint procedure programming support at the multiplexer, with a polling or addressing list of one terminal.

Note: The program must provide the terminal with a polling or selection address, but timeouts would occur if the polling list is not reduced to one terminal. Exceptions to this are terminals that can be reprogrammed (re-IPL), for a switched network configuration or have dual-line capability, and if there is appropriate support available at the host end.

Basic configurations for multipoint are:

- Same port back-up
- Alternative port back-up.

Note: Same port back-up configuration is less recommended because:

1. When switching to switched network back-up operation, the non-switched traffic between the control station and the other tributary stations is stopped. (Availability considerations favor dual or multipoint configuration at the CPU end.)
2. Alternative port back-up allows both types of traffic at the same time, with:
   a. Control to up to five tributaries on non-switched lines.
   b. Control to one tributary on switched network.
3. An alternative back-up port may:
   a. Serve multiple lines, multiple controllers or multiplexers.
   b. Use auto call, eliminating manual intervention on the modem.

Note: Multiple back-up ports may be necessary to back-up multipoint configurations where sessions have to be maintained. The procedure to assign back-up ports to the terminals is a repetition of the procedure as that used to assign one port.

Equipment Selection at Terminal End

Terminal configurations for switched network back-up operation are shown in Figure 38. Two configurations are available, depending on the terminal line capability (single or dual/multiline).

A terminal planned and installed for point-to-point, half-duplex operation on the dedicated communications channel requires no change for switched network back-up operation. Any terminal planned for switched network back-up to duplex dedicated-channel operation (including multipoint) must be wired for half-duplex at the time of installation. Duplex operation on the dedicated communications channel (if appropriate) is achieved by wiring the 3874 for continuous carrier.

A multipoint tributary terminal requires no special consideration for switched network back-up in respect to half-duplex; however, multipoint tributary terminals require a station address for selection or polling.

A terminal with a dual communications interface (for

example, an IBM 2780 Data Transmission Terminal with the Dual Communications Interface feature, an IBM 2020 Processing Unit Submodel 2 or 4 with RPQ M58081, or a 2020 Processing Unit Submodel 5 with RPQ E71851) offers the capability of having one interface equipped for dedicated channel operation and the other for switched network (half-duplex point-to-point) operation (Figure 38(b)). The cable from the appropriate interface must be manually plugged into the 3874 interface cable receptacle. Automatic answering is available for the second interface, but the call must be disconnected manually.

Full switched network capability is available for terminals not communicating to 3704/05/NCP and with reloadable program-controlled communication adapters (IBM 5406 or 5410 Processing Units, or 2020 Processing Unit, Submodels 2, 4, 5 or 6). Switched network controls, achieved through reprogramming the second interface or the same interface, make it possible to use automatic answering and disconnecting (by controlling the 'data terminal ready' interface line).

3874 FEATURES FOR BACK-UP OPERATION

In addition to the non-switched features (point-to-point, multipoint control, and multipoint tributary) for normal operation, three other features are available for switched network back-up operation:

1. SNBU for use with DAA-CDT (manual calling/answering only)
2. SNBU for use with DAA-CBS (manual calling, auto answering)
3. Switched Network (for use with DAA-CBS and/or ACO).

Figure 43 shows which feature is to be used according to the type of:

- Multiplexer, and
- Terminal.

		3874 Features		
		SNBU with DAA-CDT	**SNBU with DAA-CBS(3)**	**SN with DAA-CBS**
Multiplexer	270X, 370X EP 115, 125 ICA's	Yes (1)	Yes	Yes (2)
	370X NCP	–	Yes	Yes (2)
Terminal	BSC terminals (except 2770, 2780, 3270)	Yes	Yes	–
	2770, 2780, 3270	Yes	–	–
	SDLC terminals (except 3770)	Yes	Yes	–
	3770	Yes	–	–

Notes:

1. Not recommended for alternative port back-up or same port back-up of a multipoint line.
2. Possibility of automatic calling.
3. Mandatory when the modem at the other end has the ACO feature.

Figure 43. 3874 features for switched network back-up operation [20408]

OPERATING PROCEDURES FOR STANDBY CHANGEOVER

System planning and implementation may require certain changes in equipment and programming to prepare for switched network back-up operation. Apart from these changes, connecting and disconnecting the switched network back-up call are the main operating considerations. The possible procedures to establish and disconnect an SNBU call in the various configurations of multiplexers, controllers, and terminals are summarized in Figure 44. These procedures, which depend on the 3874 associated DAA-CDT or DAA-CBS, are detailed under "Operating Procedures" in Part 2.

Note: Any call placed through a telephone operator should be identified as a data call, to preclude intervention or unexpected disconnection. If SNBU data transfer appears to be unsatisfactory, the operator should disconnect and try again. If the transmission is still unsatisfactory, continue traffic at half-speed.

The selection of the calling versus called party must ensure that disconnection at the CPU side will release the complete link.

		with DAA-CDT	with DAA-CBS	
	Multiplexer / Terminal Family	270X 370X/EP 115, 125 ICA's	270X 370X/EP 115, 125 ICA's	370X/NCP
with DAA-CDT	BSC	❶ ❷	❸ ❺	❸ ❺
	SDLC	–	–	❸ ❺
with DAA-CBS	BSC	❹ ❷	❻ ❺	❻ ❺
	Remote 370X	–	–	❸ ❹ ❼

❶ Manual call at any end/manual answer at the other.

❷ Manual disconnect at both ends.

❸ Manual call at CPU/manual answer at terminal or remote 370X.

❹ Manual call at CPU/auto-answer at terminal or remote 370X.

❺ Auto-disconnect at CPU/manual disconnect at terminal.

❻ Manual or auto-call at CPU/auto-answer at terminal.

❼ Auto-disconnect at both ends.

Figure 44. Calling, answering, disconnecting: summary [20409]

Appendix C. Abbreviations and Glossary

ABBREVIATIONS

bps	bits per second
BSC	Binary Synchronous Communications
BTU	British Thermal Unit
CCITT	International Telephone and Telegraph Consultative Committee
CE	customer engineer
CPU	central processing unit
DAA	Data Access Arrangement
dB	decibel
dBm	decibel-milliwatt (measured on a 600-ohm resistor)
DTE	Data Terminal Equipment
EIA	Electronic Industries Association
FCC	Federal Communications Commissions
Hz	hertz (cycle per second)
ICA	Integrated Communication Adapter
kcal	kilocalorie
ms	millisecond
PTT	Post-Telegraph-Telephone *(used generally to denote* any controlling and operating telephone authority; in the U.S.A., Common Carrier operates and FCC controls and rules).
s	second
SNBU	Switched Network Back-Up
sync	synchronization

GLOSSARY

The glossary defines terms as they are used in this publication.

Centralized Multipoint: A system in non-switched line operation in which several tributary modems are connected via a common line to a control modem.

Communications Channel (Line): A single or dual transmission path, characterized by a particular frequency bandwidth.

Control: Refers to the controlling unit in a centralized multipoint configuration; the term may be applied to modem or to station. (Sometimes other publications use "master" or "central.")

Delay (group): The time of propagation between two locations of a certain point of the envelope of a wave (varies with the frequency).

Demodulation: The conversion by the receiving modem of the modulated signal sent by the transmitting modem back into the original data.

Distortion: The unwanted change in waveform that may occur between two points in a transmission system.

Duplex:* In communications, pertaining to simultaneous two-way independent transmission in both directions. Contrast with *half-duplex.*

* American National Standard Definition

Equalizer: Any combination of active and/or passive elements inserted in a transmission line or amplifier circuit to improve its frequency response or phase characteristics.

Half-Duplex:* In communications, pertaining to an alternate, one way at a time, independent transmission in both directions. Contrast with *duplex.*

Note: When the common carrier supplies four-wire duplex facilities for half-duplex mode of operation in a point-to-point system, carrier may be maintained from both stations.

Interface: A point of demarcation that divides the responsibilities of any two connected pieces of equipment.

Local: Arbitrarily refers to the modem in a point-to-point configuration from which the system is viewed at a particular instant in time.

Mark: The quiescent or binary 1 data bit condition.

Modem: A contraction of "modulator-demodulator." This term may be used when the modulator and demodulator are associated in the same signal conversion equipment.

Modulation: A process by which certain characteristics of a wave are modified in accordance with a characteristic of another wave or signal.

Noise: Any unwanted disturbance within a useful frequency band, such as undesired electric waves in a

transmission channel or device.

Non-Switched Line: A communications channel that is permanently connected between two or more data stations. Can be leased or private for dedicated use.

Off-Hook/On-Hook: Activated/deactivated, in reference to a telephone set. It may also be used in reference to a device attached to a switched network line.

Parallel Data: Multiple signal elements, usually a character or byte, transferred simultaneously.

Point-to-Point: A system in non-switched operation in which two modems are permanently interconnected; at any point in time, one modem is referred to as *local* and the other is referred to as *remote.*

Remote: Arbitrarily refers to the modem in a point-to-point configuration that is connected via the telephone line to the modem termed local.

Space: The binary 0 data bit condition.

Station: In the teleprocessing system, the input/output point, which comprises data terminal equipment and a modem (see Figure 1).

Strap, Strapping: Selectable wiring to provide optional variations in the performance of equipment.

Switched Line (Switched Network): A communication line in which the connection between the local and a remote station is established by dialing. (Switching facilities are provided by the PTT or common carrier.)

Synchronization: Bringing the receiver timing pulses into phase with the received modulated signal in order to correctly demodulate the received data.

Teleprocessing: A form of information handling in which a data processing system uses communications facilities.

Transmit Level: A power level of energy introduced onto the communications channel by the transmitter.

Tributary: Refers to the unit in a centralized multipoint configuration that is under the control of the control modem: the term may be applied to modem or to *station*. (Sometimes other publications use "slave.")

Two-Wire or Four-Wire: These terms refer to the physical connection to the communications channel. They do not determine half-duplex and duplex communications facilities.

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