

DTIC FILE COPY

①

NCS TIB 87-5



NATIONAL COMMUNICATIONS SYSTEM

AD-A224 194

TECHNICAL INFORMATION BULLETIN 87-5

PROTOCOL FOR THE RS 232 INTERFACE FOR GROUP 3 FACSIMILE EQUIPMENT

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited



JUNE 1987

June 1987

Final

Protocol for the RS 232 Interface for Group 3 Facsimile
Equipment

C-DCA100-83-C-0047

Delta Information Systems, Inc.
Horsham Business Center, Bldg. 3
300 Welsh Road
Horsham, PA 19044

National Communications System
Office of Technology & Standards
Washington, DC 20305-2010

NCS TIB 87-5

Approved for Public Release; Distribution is unlimited.

This report determines the feasibility of the development of a RS-232-C digital protocol for Group 3 facsimile apparatus. Group 3 facsimile equipment, meeting the requirements established in CCITT Recommendation T.4 & T.30 is now used extensively throughout the world, and in particular, throughout the U.S. Government. The Group 3 standard fully defines the transmission of binary documents over the public switched telephone network (PSTN).

Facsimile Group 3
Public Switched Telephone Network (PSTN)

152

Unclassified

Unclassified

Unclassified

CL

NCS TECHNICAL INFORMATION BULLETIN 87-5

PROTOCOL FOR THE RS 232 INTERFACE
FOR GROUP 3 FACSIMILE EQUIPMENT

June, 1987

PROJECT OFFICER

DENNIS BODSON
Senior Electronics Engineer
Office of NCS Technology
and Standards

APPROVED FOR PUBLICATION:

Dennis Bodson
DENNIS BODSON
Assistant Manager
Office of NCS Technology
and Standards

FOREWORD

Among the responsibilities assigned to the Office of the Manager, National Communications System, is the management of the Federal Telecommunication Standards Program. Under this program, the NCS, with the assistance of the Federal Telecommunication Standards Committee identifies, develops, and coordinates proposed Federal Standards which either contribute to the interoperability of functionally similar Federal telecommunication systems or to the achievement of a compatible and efficient interface between computer and telecommunication systems. In developing and coordinating these standards, a considerable amount of effort is expended in initiating and pursuing joint standards development efforts with appropriate technical committees of the Electronic Industries Association, the American National Standards Institute, the International Organization for Standardization, and the International Telegraph and Telephone Consultative Committee of the International Telecommunication Union. This Technical Information Bulletin presents an overview of an effort which is contributing to the development of compatible Federal, national, and international standards in the area of facsimile standards. It has been prepared to inform interested Federal activities of the progress of these efforts. Any comments, inputs or statements of requirements which could assist in the advancement of this work are welcome and should be addressed to:

Office of the Manager
National Communications System
ATTN: NCS-TS
Washington, DC 20305
(202) 692-2124

STANDARDIZATION OF A DIGITAL COMMUNICATION
INTERFACE FOR GROUP 3 FACSIMILE

June, 1987

Final Report

Submitted to:

NATIONAL COMMUNICATIONS SYSTEM
Office of Technology and Standards
Washington, DC 20305

Contracting Agency:

DEFENSE COMMUNICATIONS AGENCY
Contract Number - DCA100-83-C-0047
Modification Number - P00004

DELTA INFORMATION SYSTEMS, INC.
Horsham Business Center, Bldg. 3
300 Welsh Road
Horsham PA 19044

Table of Contents

1.0 Introduction	1 - 1
1.1 Synopsis	1 - 3
2.0 The RS-232-C Physical Interface.	2 - 1
2.1 Control Signals.	2 - 2
2.2 Parameter Settings	2 - 5
3.0 Digital Group 3 Capabilities	3 - 1
3.1 Physical Configurations.	3 - 1
3.2 Operational Functions.	3 - 8
4.0 Analysis of Protocol Alternatives.	4 - 1
4.1 Types of Protocols	4 - 1
4.2 Comparison of the Alternatives	4 - 4
5.0 Conclusions and Recommendations.	5 - 1
5.1 Conclusions.	5 - 1
5.2 Recommendations.	5 - 2

Appendix A - Panafax RS-232-C Protocol

Appendix B - 3M RS-232-C Protocol

Appendix C - Xerox RS-232-C Protocol



Accession For	
NTIS GRA&I	☒
DTIC TAB	☐
Unannounced	☐
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

1.0 INTRODUCTION

This document summarizes work performed by Delta Information Systems, Inc., for the Office of Technology and Standards of the National Communications System, an organization of the U. S. Government, headed by National Communications System Assistant Manager for Technology and Standards, Dennis Bodson. Mr. Bodson is responsible for the management of the Federal Telecommunications Standards Program, which develops telecommunications standards, the use of which is mandatory for all Federal agencies. The purpose of this study, performed under modification number P00004 of contract number DCA100-83-C-0047, is to determine the feasibility of the development of an RS-232-C digital protocol for Group 3 facsimile apparatus.

Group 3 facsimile equipment, meeting the requirements established in CCITT Recommendations T.4 and T.30 (and in Federal Standards 1062 and 1063), is now used extensively throughout the world and, in particular, throughout the U. S. Government. The Group 3 standard fully defines the transmission of binary documents over the public switched telephone network (PSTN). However, many facsimile equipment vendors now offer a digital (RS-232-C) port as an option on their Group 3 machines; the digital interface has many applications, including

- security by encryption (as per Federal Standard 1028);
- computer interfacing;
- connection to a digital network (e.g. local area network,

packet-switched data network, circuit-switched data network).

At the present time, there are no CCITT Recommendations that provide for the communication of Group 3 facsimile equipments through a digital interface. In order to ensure the interoperability of Group 3 equipments between themselves and with a wide variety of digital equipments, a standard protocol for the RS-232-C interface must be established. This report contains a summary of the requirements of such a protocol as well as a detailed comparative analysis of several available alternatives.

This document is comprised of five sections. Section 1.0 provides an introduction to the objectives of the study and a brief synopsis of the results obtained and conclusions drawn. Section 2.0 includes a discussion of the RS-232-C interface standard (The EIA has released an RS-232-D update of this standard; however, the new version is not yet in widespread use and thus was not evaluated in this report). Section 3.0 describes the various digital-facsimile configurations afforded by the addition of an RS-232-C port to Group 3 equipments and the applications in which these configurations can and will be employed. A comparison and analysis of several presently available digital protocol formats is presented in Section 4.0. Section 5.0 contains the conclusions drawn based on the analysis presented in Section 4.0 and the recommendations made based on these conclusions.

1.1 Synopsis

In this study, the applications, capabilities, and characteristics of RS-232-C equipped facsimile machines were examined in order to determine whether the specification of a digital protocol for Group 3 facsimile apparatus was feasible. The work performed included an evaluation of the EIA RS-232-C specification, an analysis of the present and potential uses of a digital port in facsimile communications, and an appraisal of three currently available digital protocols for facsimile machines.

The evaluation of the RS-232-C standard was performed in order to determine the most commonly used interface parameters for digital devices to which it is desirable to connect facsimile machines; this evaluation resulted in a set of recommended parameters, which is presented in Table 2.4 in Section 2.0). The analysis of the uses of a digital port in facsimile communications was performed in order to illustrate the expanded capabilities the digital port affords the facsimile machine. The appraisal of three currently available digital protocols for facsimile machines was performed in order to establish the requirements of the Group 3 digital protocol and to determine whether there was a currently existing protocol which met these requirements.

The analyses performed in this study indicate that an RS-232-C digital protocol for Group 3 facsimile is feasible;

several digital protocols for Group 3 facsimile machines currently exist, but none fully define the specifications required for all of the functions of a digital facsimile port. All of the functional capabilities of a facsimile machine equipped with an RS-232-C interface fall basically into two categories, those functions in which the digital port is used as a simple interface to replace the Group 3 modem, and those functions in which the digital port supplements the Group 3 modem to form a complex interface between facsimile equipments and digital devices.

The ideal specification for a digital protocol for Group 3 facsimile would be a Type 4 protocol (discussed in Section 4.0), in which the RS-232-C equipped facsimile machine would process a signal received through the digital port as follows: when the signal is received, the protocol would first determine whether the signal emanated from a computer, from a non-controlling digital device (i.e. an encryption device), or from another facsimile device; if the calling device is a computer, a computer control (Type 3) protocol would be initiated; if the calling device is a facsimile machine or a non-controlling digital device, a modified Group 3 (Type 2) protocol would be initiated. A protocol of this type would accommodate virtually all of the facsimile equipments equipped with digital interfaces (both autonomous and computer controlled).

2.0 THE RS-232-C STANDARD

The determination of the feasibility of an RS-232-C digital protocol for Group 3 facsimile equipment began with an evaluation of the RS-232-C standard itself. The RS-232-C standard is a publication of the Electronic Industries Association (EIA); the EIA is an industry group that proposes and publishes recommendations for the electronics industry. Because there is no enforcement of the EIA recommendations, they are not actually standards; however, the RS-232-C "standard" is in widespread use throughout the electronics industry and is generally regarded as such.

The RS-232-C standard defines the electrical signals and signal levels that can be used to connect various data communications equipments to various data terminal equipments. It also describes a selected set of data transmission configurations for these signals. It does not, however, define what form the data should take for transmission or how it should be interpreted. In addition to an evaluation of the signals and data transmission configurations described in the standard, the formation and interpretation of the data signals will be addressed in this section.

2.1 Control Signals

The RS-232-C standard specifies thirteen specific interface configurations for fifteen defined data transmissions applications (see Table 2.1). For each configuration, the RS-232-C standard indicates which control signals are to be used (see Table 2.2). The majority of serially interfaced equipments to which it is desirable to connect Group 3 equipments (e.g. computers, terminals) employ the half or full duplex configurations (D and E). Within these two configurations, the data transmissions may occur in either a synchronous or asynchronous fashion.

Because synchronous transmissions are generally not compatible with asynchronous transmissions, it may be necessary to decide which is preferred. Dual synchronous/asynchronous capability could be employed, but would increase both the cost and the complexity of the serial interface. There are various applications, both present and future, in which serially interfaced equipments are (or will be) connected to an RS-232-C equipped facsimile machine; these equipments are predominantly computers and computer related devices, which typically use the RS-232-C interface in an asynchronous fashion. Therefore it is recommended that the RS-232-C equipped facsimile machine use the signals associated with the full or half duplex configurations in an asynchronous fashion in accordance with the EIA RS-232-C standard.

Data Transmission Configuration	Interface Type
Transmit Only	A
Transmit Only*	B
Receive Only	C
Half Duplex	D
Duplex*	D
Duplex	E
Primary Channel Transmit Only * / Secondary Channel Receive Only	F
Primary Channel Transmit Only / Secondary Channel Receive Only	H
Primary Channel Receive Only / Secondary Channel Transmit Only*	G
Primary Channel Receive Only / Secondary Channel Transmit Only	I
Primary Channel Transmit Only* / Half Duplex Secondary Channel	J
Primary Channel Receive Only / Half Duplex Secondary Channel	K
Half Duplex Primary Channel / Half Duplex Secondary Channel	L
Duplex Primary Channel* / Duplex Secondary Channel*	L
Duplex Primary Channel / Duplex Secondary Channel	M
Special (Circuits specified by Supplier)	Z

Note: Data Transmission Configurations identified with an asterisk (*) indicate the inclusion of Circuit CA (Request to Send) in a One Way Only (Transmit) or Duplex Configuration where it might ordinarily not be expected, but where it might be used to indicate a non-transmit mode to the data communication equipment to permit it to remove a line signal or to send synchronizing or training signals as required.

TABLE 2.1

Interface Types for Data Transmission Configurations

Interchange Circuit		Interface Type													
		A	B	C	D	E	F	G	H	I	J	K	L	M	Z
AA AB	Protective Ground Signal Ground	- x	- x	- x	- x	- x	- x	- x	- x	- x	- x	- x	- x	- x	- x
BA BB	Transmitted Data Received Data	x	x	x	x	x	x	x	x	x	x	x	x	x	o o
CA CB CC CD	Request to Send Clear to Send Data Set Ready Data Terminal Ready	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	x x x s	o o o o
CE CF CG CH/CI	Ring Indicator Received Line Signal Detector Signal Quality Detector Data Signalling Rate Selector (DTE) (DCE)	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	s s s s	o o o o
DA/DB DD	Transmitter Sig. Element Timing (DTE) (DCE) Receiver Signal Element Timing (DCE)	t t	t t	t t	t t	t t	t t	t t	t t	t t	t t	t t	t t	t t	o o
SBA SBB	Secondary Transmitted Data Secondary Received Data						x	x	x	x	x	x	x	x	o o
SCA SCB SCF	Secondary Request to Send Secondary Clear to Send Secondary Received Line Signal Detector							x	x	x	x	x	x	x	o o o

Legend: ° - To be specified by the supplier

-- optional

s - Additional Interchange Circuits required for Switched Service

t - Additional Interchange Circuits required for Synchronous Channel

x - Basic Interchange Circuits, All Systems

TABLE 2.2

Standard Interfaces For
Selected Communication Systems Configurations

2.2 Parameter Settings

The RS-232-C standard does not define the allowable bit rates or format of the transmitted data. The majority of devices which employ an RS-232-C interface conform to ANSI standards; if it is desirable to communicate with these devices, the RS-232-C equipped facsimile machine should also conform. ANSI standard X3.16 defines the character structure and character parity sense for serial data communications. For synchronous transmissions, a character is defined with eight bits, one of which may be used either as a simple data bit or as a parity bit for error control purposes. A character is defined with ten bits in asynchronous transmissions: one start bit, eight data bits (one of which may be used for parity), and one stop bit. The start and stop bits employed in asynchronous transmissions are required in order to alert the receiving unit as to the beginning and end of each character; they are not required in synchronous transmissions because the receiving unit, due to the synchronization, "knows" where the start and end of each character is.

The preferred bit rates for transmissions over the RS-232-C interface are 50, 75, 110, 150, 300, 600, 1200, 1800, 2400, 3600, 4800, 7200, 9600 and 19200 bits per second (bps). Because of the large amount compressed (or uncompressed) data which would be transferred over the RS-232-C interface, it may be desirable to limit the bit rates to the higher speeds for Group 3 facsimile applications. Table 2.3 shows the transmission time in seconds

BIT RATE (BITS/SEC)	UNCOMPRESSED		COMPRESSED (10:1)	
	SYNCHRONOUS (MINUTES)	ASYNCHRONOUS (MINUTES)	SYNCHRONOUS (MINUTES)	ASYNCHRONOUS (MINUTES)
50	1267.2	1584	126.72	158.4
75	844.8	1056	84.48	105.6
110	576	720	57.6	72
150	422.4	528	42.24	52.8
300	211.2	264	21.12	26.4
600	105.6	132	10.56	13.2
1200	52.8	66	5.28	6.6
1800	35.2	44	3.52	4.4
2400	26.4	33	2.64	3.3
3600	17.6	22	1.76	2.2
4800	13.2	16.5	1.32	1.65
9600	6.6	8.25	.66	.825
19200	3.3	4.125	.33	.4125

TABLE 2.3 TRANSMISSION TIMES FOR A TYPICAL PAGE

for a typical facsimile page scanned at 200 pels per inch (1728 x 2200 pels per page). Note that the transmission time becomes prohibitive below 2400 bps for the compressed page, and transmission times for an uncompressed page are not very good in any case.

Therefore, we recommend that, for asynchronous communications, the compressed/uncompressed data be sent at 2400 bps or higher using a ten bit character. The ten bit character, as stated earlier, consists of one start bit, one stop bit, and eight data bits. Whenever possible, eight data bits should be employed as opposed to seven data bits and one parity bit to decrease transmission time; the integrity of the transmission channel can be used to determine whether or not parity checking is necessary. When seven bit ASCII data is sent over the RS-232-C interface, the eighth data bit may be used for parity or can be arbitrarily set to ONE or ZERO. Because ASCII data files are generally much smaller than facsimile files, the seven bit ASCII data may be sent at any bit rate. Table 2.4 contains the recommended RS-232-C interface parameters resulting from the evaluation of the EIA RS-232-C standard.

- o HALF/FULL DUPLEX
- o ASYNCHRONOUS
- o ONE START BIT
- o ONE STOP BIT
- o EIGHT BIT DATA
 - All 8 bits used for compressed/uncompressed data
 - Eighth bit for 7 bit ASCII used for parity or set to one or zero
- o 7 BIT ASCII DATA RATES
 - 1200, 1800, 2400, 3600, 4800, 7200, 9600, 19200
- o COMPRESSED/UNCOMPRESSED DATA RATES
 - 2400, 3600, 4800, 7200, 9600, 19200

Table 2.4 - Recommended Parameters

3.0 DIGITAL GROUP 3 CAPABILITIES

The addition of an RS-232-C port to a facsimile machine expands its functions and capabilities. This section will examine some of the environments in which an RS-232-C equipped facsimile machine might find itself and the additional capabilities afforded by the RS-232-C port.

3.1 Physical Configurations

The addition of an RS-232-C port to a facsimile machine permits the facsimile machine to be used in situations different from the typical configuration. The typical Group 3 facsimile machine can scan, print, and transmit and receive over the Public Switched Telephone Network (PSTN), as illustrated in Figure 3.1 and summarized in Table 3.1. The RS-232-C port greatly expands these capabilities; it permits facsimile machines to communicate with each other without using the PSTN by communicating instead over digital data links (e.g. PSDN, CSDN, LAN), as shown in Figure 3.2; it allows computers or other devices to have access to compressed or uncompressed facsimile data (see Figure 3.3); it allows computers or other devices to transmit or receive facsimile data over the PSTN (see Figure 3.4); and it allows for the encryption of facsimile messages (see Figure 3.5).

These are just a few of the possible configurations that are being employed on certain facsimile equipments already offering

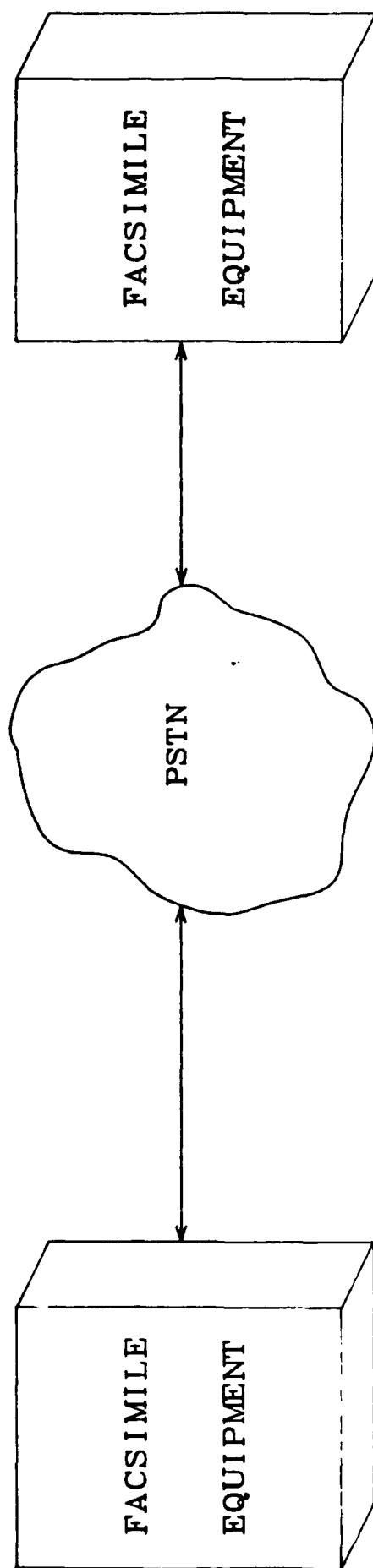


Figure 3.1 - The Typical Facsimile Machine Environment

FUNCTION	SOURCE	DESTINATION	INPUT	OUTPUT
FAX TRANSMIT	SCANNER	MODEM	IMAGE	MH/MR
FAX RECEIVE	MODEM	PLOTTER	MH/MR	IMAGE
COPY	SCANNER	PLOTTER	IMAGE	IMAGE

NOTE: MH IS MODIFIED HUFFMAN COMPRESSED DATA
MR IS MODIFIED READ COMPRESSED DATA

TABLE 3.1 : TYPICAL FACSIMILE MACHINE FUNCTIONS

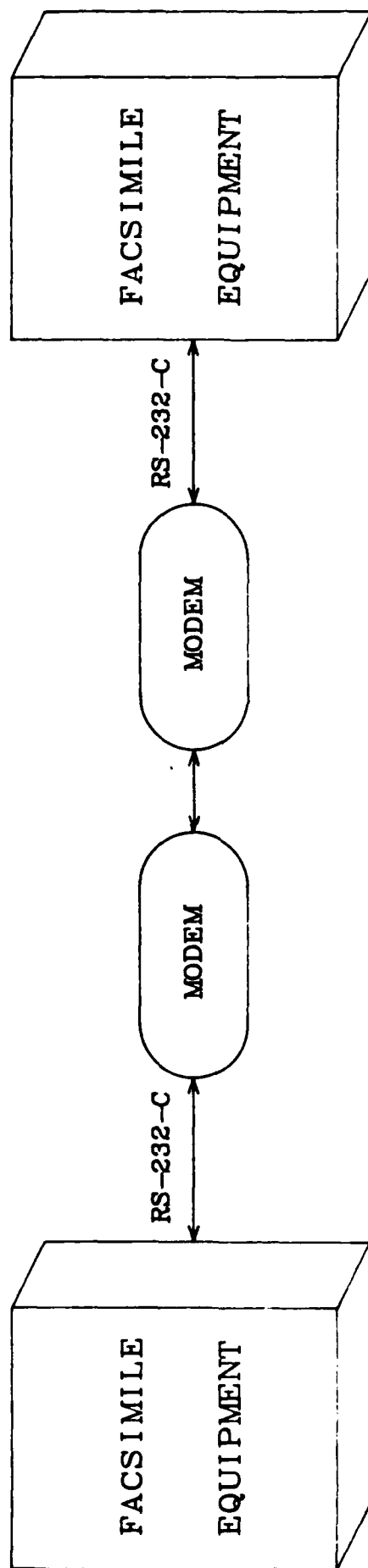


Figure 3.2 - Facsimile Machines Bypassing the PSTN

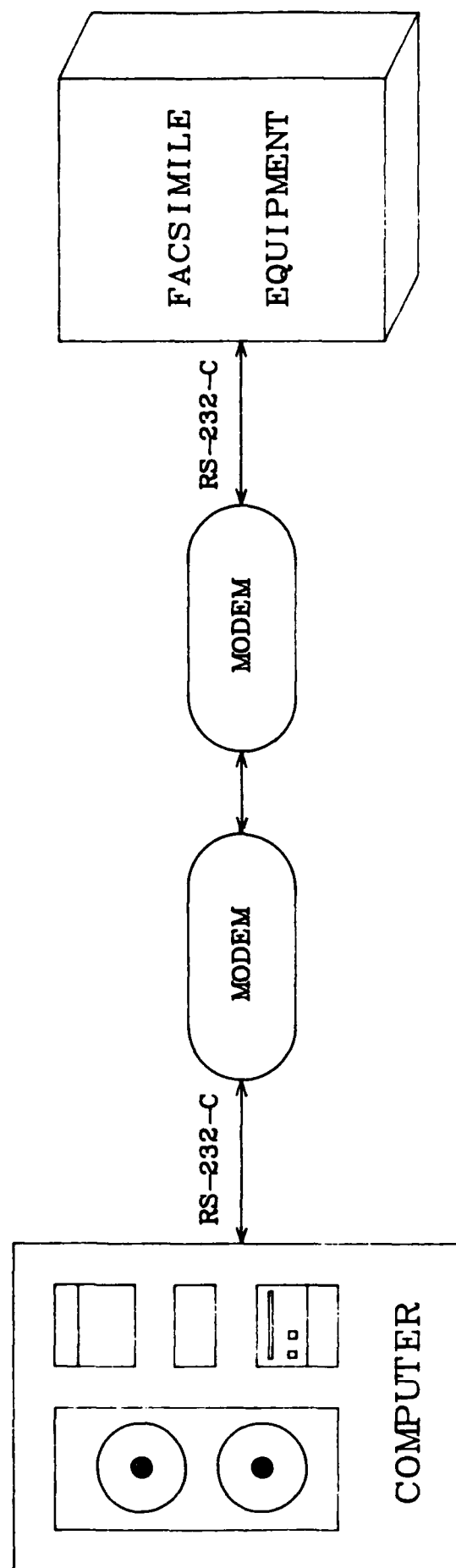


Figure 3.3 - Computer Access to Facsimile Data

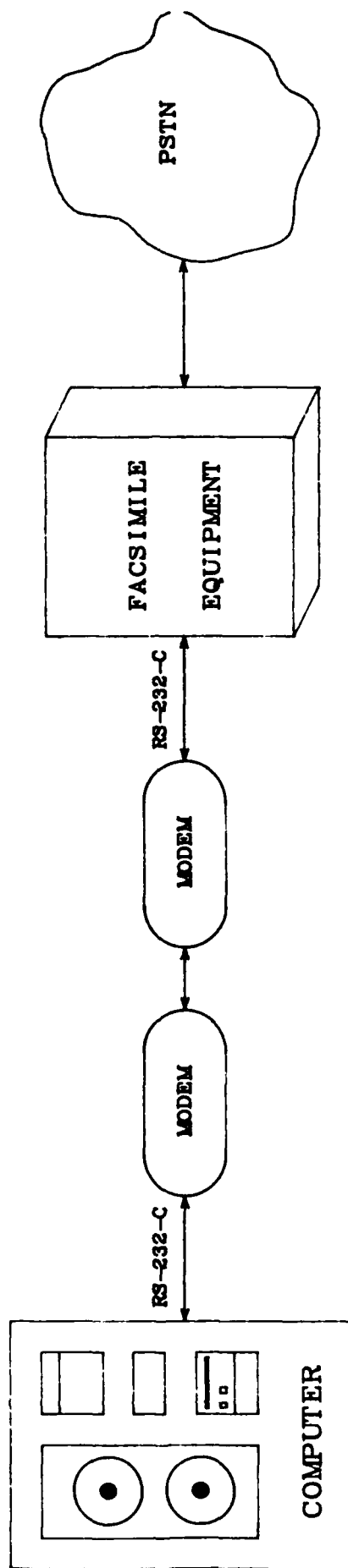


Figure 3.4 - Computer Transmitting/Receiving Facsimile Data From PSTN

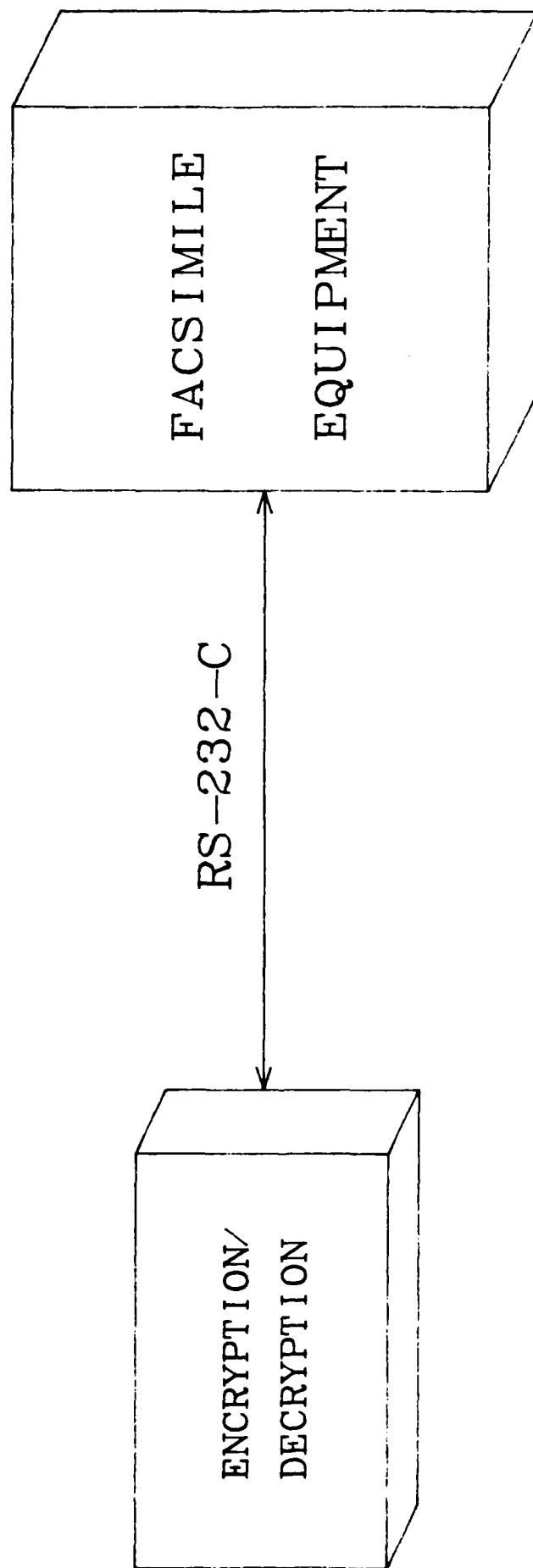


Figure 3.5 - Encryption of Facsimile Data

RS-232-C interfaces. Obviously, the RS-232-C interface allows the facsimile machine to be connected to an infinite variety of serially-interfaced devices; to which devices the facsimile machine will be connected will be determined by future applications.

3.2 Operational Functions

The addition of an RS-232-C interface to a facsimile machine changes the functional capabilities of the machine; the extent to which its capabilities are changed depends on how the digital port is used. The RS-232-C port may be used to replace the Group 3 modem, in which case the functional capabilities of the facsimile machine would change only slightly (see Figure 3.6 and Table 3.1). The RS-232-C may also be used in addition to the Group 3 modem; the capabilities of the facsimile machine would then be greatly enhanced (see Figure 3.7 and Table 3.2).

When a facsimile machine's Group 3 modem is **replaced** by a digital port, the machine still functions autonomously, as if the digital port were a simple interface like the Group 3 modem. The digital port allows external communications equipment, such as a modem (for digital transmissions over long distances) or an encryption device (for secure transmissions), but this equipment is virtually transparent as far as the facsimile machine is concerned because the intent is still to communicate with distant facsimile stations over switched networks. The two facsimile

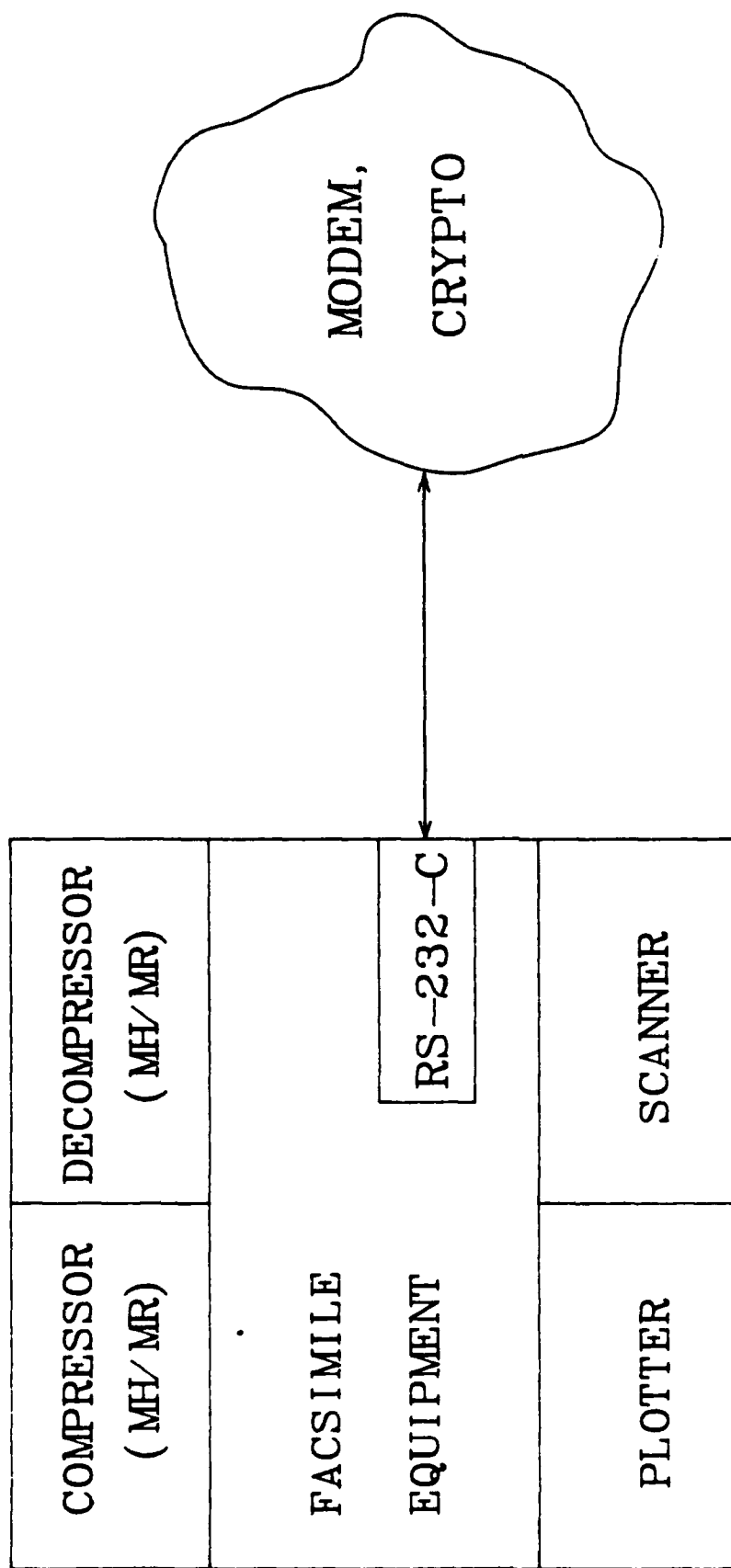


Figure 3.6 - Simple RS-232-C Interface

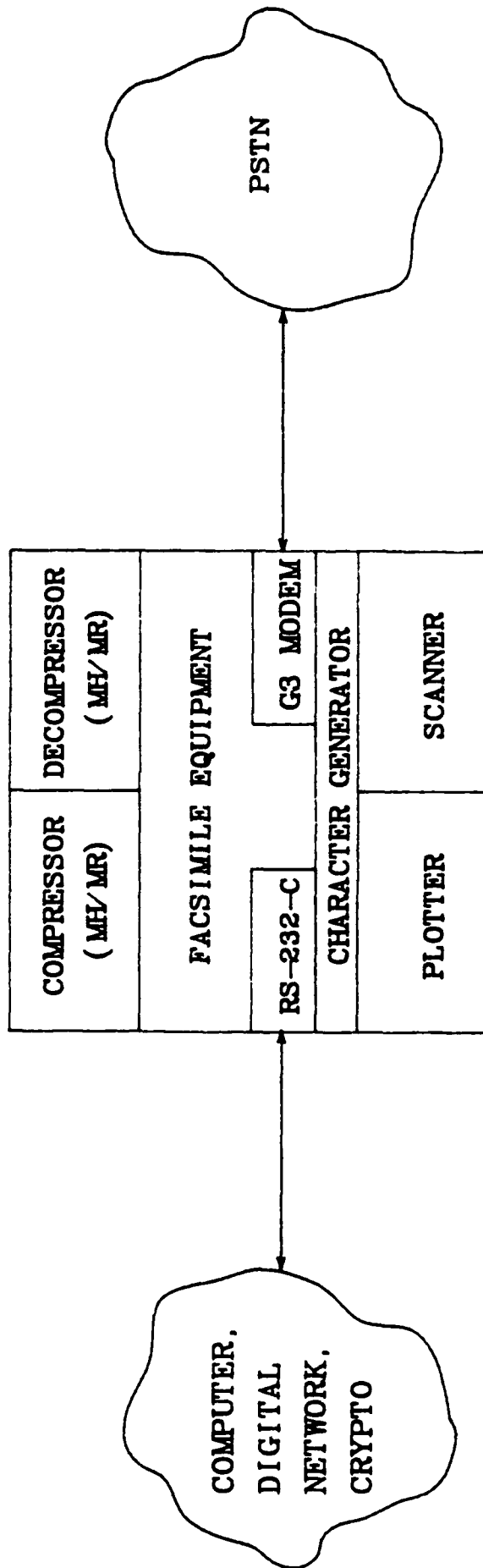


Figure 3.7 - Complex RS-232-C Interface

FUNCTION	SOURCE	DESTINATION	INPUT	OUTPUT
FAX TRANSMIT	SCANNER	MODEM	IMAGE	MH/MR
FAX RECEIVE	MODEM	PLOTTER	MH/MR	IMAGE
COPY	SCANNER	PLOTTER	IMAGE	IMAGE
PLOT	RS-232-C	PLOTTER	MH/MR/IMAGE	IMAGE
SCAN	SCANNER	RS-232-C	IMAGE	MH/MR/IMAGE
TRANSMIT	RS-232-C	MODEM	MH/MR/IMAGE	MH/MR
RECEIVE	MODEM	RS-232-C	MH/MR	MH/MR/IMAGE
COMPRESS	RS-232-C	RS-232-C	IMAGE	MH/MR
DECOMPRESS	RS-232-C	RS-232-C	MH/MR	IMAGE
PRINT*	RS-232-C	PLOTTER	ASCII	IMAGE
REMOTE PRINT*	RS-232-C	MODEM	ASCII	MH/MR
CREATE IMAGE*	RS-232-C	RS-232-C	ASCII	MH/MR/IMAGE

* REQUIRES CHARACTER GENERATOR

TABLE 3.2 : FUNCTIONS OF FACSIMILE MACHINE WITH RS-232-C

machines must still exchange information concerning their respective capabilities, as they do when communicating with Group 3 modems over the PSTN using the Group 3 protocol. Therefore it would seem reasonable to use the same Group 3 protocol, but modified slightly for use through the digital port.

When the digital port **supplements** the facsimile machine's Group 3 modem, the functional capabilities of the facsimile machine are greatly expanded. The facsimile machine equipped with both a digital port and a Group 3 modem essentially becomes a complex interface between virtually all RS-232 equipped devices and all Group 3 compatible facsimile stations. The RS-232-C port would allow compressed or uncompressed images to be sent to or received from a computer. These images could be scanned or printed locally by a facsimile machine or remotely via the PSTN. The facsimile machine could also be automatically controlled as a peripheral device by a host computer via the RS-232-C interface. In this configuration, the computer and facsimile machine would constitute a facsimile station. The facsimile machine acts as the interface to remote facsimile machines for the computer. An appropriate protocol for the digital port in this case would permit the computer to control the various functions of the facsimile machine in non-standard ways. The Group 3 protocol does not allow this, as it was established for station-to-station transmissions and does not support all the possible computer-to-facsimile machine functions.

Although the environments in which an RS-232-C equipped facsimile machine may find itself vary greatly, the functions the digital port afford the machine fall into one of two basic categories: those functions in which the port operates as a simple interface, replacing the Group 3 modem, and those in which the digital port supplements the Group 3 modem, effectively transforming the facsimile machine into a complex interface between RS-232 equipped devices and Group 3 compatible equipments. Because the specifications required to standardize these two functional categories are quite different, and yet both are desirable, a dual protocol in which both the simple and complex interface operations of the digital port are outlined is required.

4.0 ANALYSIS OF PROTOCOL ALTERNATIVES

As stated earlier, there are two basic categories into which the various capabilities of a facsimile machine equipped with a digital port can fall. The first category includes those functions in which the digital port is used to bypass the PSTN by replacing the Group 3 modem, which requires a protocol for the RS-232-C interface that is similar to that used for the Group 3 modem. The second category includes those functions in which the digital port is used to connect a facsimile machine to a computer to form a more powerful facsimile station. In this section, the various types of protocols to be considered for the Group 3 protocol will be discussed, and an analysis of several of the currently available alternatives be presented.

4.1 Types of Protocols

There are four identifiable types of protocols which are applicable to the Group 3 RS-232-C interface specification (henceforth designated the Type 1, Type 2, Type 3, and Type 4 protocols). The Type 1 protocol does not initiate a transmission over the RS-232-C interface without an operator. If a facsimile machine is going to receive a document, the operator must manually configure the facsimile machine to receive from the digital port and then verbally direct the operator at the sending station to transmit the document, as outlined in Figure 4.1. The

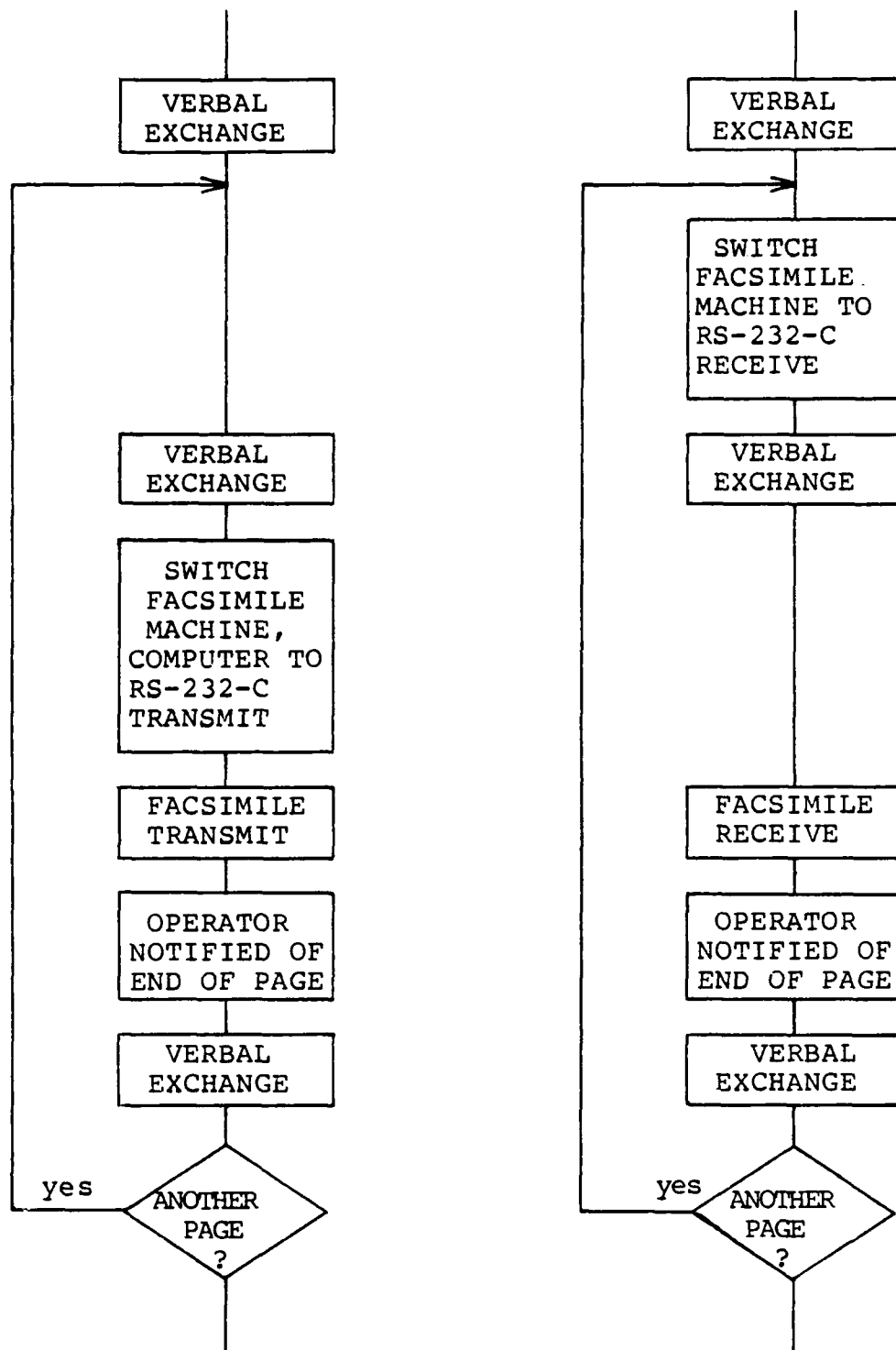


FIGURE 4.1: TYPE 1 PROTOCOL

Type 1 protocol makes the transmission of multipage documents difficult and does not permit the automatic reception and/or transmission of a document (See Figure 4.1). It does, however, permit all the extended facsimile capabilities (See Table 3.2) afforded by a digital port.

The Type 2 protocol basically uses the Group 3 protocol with certain modifications to account for the differences between the Group 3 modem and the RS-232-C interface. This protocol type allows existing Group 3 facsimile equipment to easily add RS-232-C capability because it essentially replaces the PSTN with the digital port. However, for a computer to communicate with the facsimile equipment, the computer must emulate a facsimile machine; while this is possible, it may place an undesirable burden on the computer.

The Type 3 protocol does not use the Group 3 protocol and is designed specifically for computer to facsimile equipment communications. This protocol type permits computer control of the facsimile equipment without operator intervention in addition to the typical and extended capabilities. Major modifications, however, would be required to add an RS-232-C interface employing the Type 3 protocol to an existing Group 3 facsimile machine, and communications between facsimile equipments would be difficult, because one facsimile machine would have to control the other.

The Type 4 protocol is a mixture of Types 2 and 3. The Type 2 portion of the Type 4 protocol is used to determine whether a facsimile machine or a computer is calling the facsimile machine

with extended capabilities. If it is established that a typical facsimile machine is calling, the modified Group 3 protocol (as described in the Type 2 protocol discussion) is used. If it is a computer calling, then the computer control protocol (as described in the Type 3 protocol discussion) is used. Of the four types of protocols discussed, the Type 4 protocol is the most versatile and the most applicable to the Group 3 facsimile application.

4.2 Comparison of the Alternatives

There are several vendors in the facsimile field which currently offer RS-232-C interface-equipped facsimile machines and, thus, have developed protocols to control the flow of information across the interface. Three of these protocols have been evaluated in this study, those developed by Panafax, 3M, and Xerox; Appendices A, B, and C, respectively, contain the specifications for these protocols. In terms of compliance with the Group 3 standard, all three protocols support CCITT Recommendation T.4, and two of the three, those developed by Panafax and 3M, support CCITT Recommendation T.30 (with modifications).

The modifications required by the Panafax and 3M protocols in order to replace the Group 3 modem with a digital port were minor. Both Panafax and 3M introduced a flag pattern transmitted from the calling station to the called station to "wakeup" the

called station. In addition, Panafax eliminated the training check (TCF) signals. With these exceptions, and the recognition that tonal messages are not supported by the RS-2232-C standard, both the Panafax and the 3M protocols conform to the CCITT Recommendation T.30. The 3M protocol also has a second option in which the facsimile machine can be connected to a computer through the digital port to serve as an ASCII printing device; the protocol permits ASCII to be received and printed by the facsimile machine by switching manually to a type one protocol when it is receiving ASCII data.

The Xerox protocol is not based on the CCITT Recommendation T.30; Xerox employs the digital port to control Group 3 facsimile machines from a host computer. This protocol permits the transfer of compressed, uncompressed, and ASCII data between a host computer and a facsimile machine. Because the digital port is supplemental to the Group 3 modem in this instance, the Xerox protocol allows the host computer to access data from remote facsimile machines that are not equipped with digital ports.

Both the Panafax and 3M protocols are Type 2 protocols, as defined herein, while the Xerox protocol is a Type 3 protocol. The Panafax and 3M protocols use the digital port as a simple interface, which allows for its connection to some RS-232-C equipped devices (e.g. modems, encryption devices) but does not allow computer access to the facsimile data. The 3M protocol does allow limited computer connectivity, as it permits the

facsimile machine to receive and print ASCII data from a computer. The Xerox protocol is more powerful than either the Panafax or the 3M protocols in that it permits computer control of the facsimile machine as well as computer access to the facsimile data. One drawback to the Xerox protocol, however, is that it requires significant modifications to be built into the facsimile equipments, while the Panafax and 3M protocols would require only modest modifications.

5.0 CONCLUSIONS AND RECOMMENDATIONS

In performing the analysis of the available information concerning the potential addition of a digital port to Group 3 facsimile machines (see Sections 2.0, 3.0, and 4.0), several conclusions were drawn concerning the feasibility of an RS-232-C protocol for Group 3 facsimile communications. These conclusions, in turn, led to the formulation of a number of recommendations as to which direction future work in this area should be directed.

5.1 Conclusions

1. The selection of an RS-232-C digital protocol for Group 3 facsimile will be dependent upon the applications in which the interface will be employed; these applications generally fall into two basic categories, (1) those applications in which the digital port is used as a simple interface to replace the Group 3 modem, and (2) those applications in which the digital port supplements the Group 3 modem to form a complex interface between digital equipments and facsimile equipments.
2. A Type 2 protocol (as described in Section 4.0), in which a modified version of the Group 3 protocol is

employed to control facsimile-to-facsimile communications over the digital port, is required for RS-232-C equipped facsimile machines in which the digital port is used to replace the Group 3 modem. This type of protocol has the advantage of a high degree of compatibility with existing facsimile machines, but makes difficult advanced applications such as computer access to facsimile data.

3. A Type 3 protocol, in which computer control of a facsimile machine without operator intervention is specified, is required for RS-232-C equipped machines in which the digital port is used to supplement the Group 3 modem. This type of protocol greatly expands the functional capabilities of the facsimile machine; under computer control, the facsimile machine and computer basically form a facsimile station with capabilities such as computer access of facsimile data and computer-to-computer communications over the PSTN. However, the Type 3 protocol does not provide for direct communications between facsimile equipments.
4. A Type 4 protocol, which employs a combination of Types 2 and 3 to implement both computer control of a facsimile machine and facsimile-to-facsimile communications over the digital data link, appears to

be the type of protocol required for the Group 3 application. Basically, a Type 4 protocol would employ an extension of the Type 2 protocol to determine whether a computer or another facsimile machine was attempting to establish contact; once is determined, the appropriate portion of the Type 4 protocol (the Type 2 part for facsimile-to-facsimile communications and the Type 3 part for computer-to-facsimile communications) would be initiated.

5. None of the three digital protocols evaluated in Section 4.0 (those by Panafax, 3M, and Xerox) provide full Type 4 protocol capability. The Panafax and 3M offerings are Type 2 protocols, with the 3M protocol affording limited computer connectivity in the form of an ASCII printer mode of operation; the Xerox protocol is a Type 3 protocol that specifies computer control of a facsimile machine; while this protocol greatly expands the capabilities of the facsimile machine, it does not conform to Recommendation T.30 and thus does not provide for facsimile-to-facsimile communications through the digital port.

5.2 Recommendations for Further Study

1. Now that the feasibility of an RS-232-C digital protocol for Group 3 facsimile has been established, all present and future applications of the digital interface should be examined in detail in order to establish the requirements of such a protocol.
2. All presently available protocols for digital interfaces to facsimile machines should be studied, and from this analysis a single, unifying digital protocol for Group 3 facsimile should be established.

A P P E N D I X A
PANAFAX RS-232-C PROTOCOL

Panafax SERVICE BULLETIN

PSB NO. 029

Date: October 19, 1982

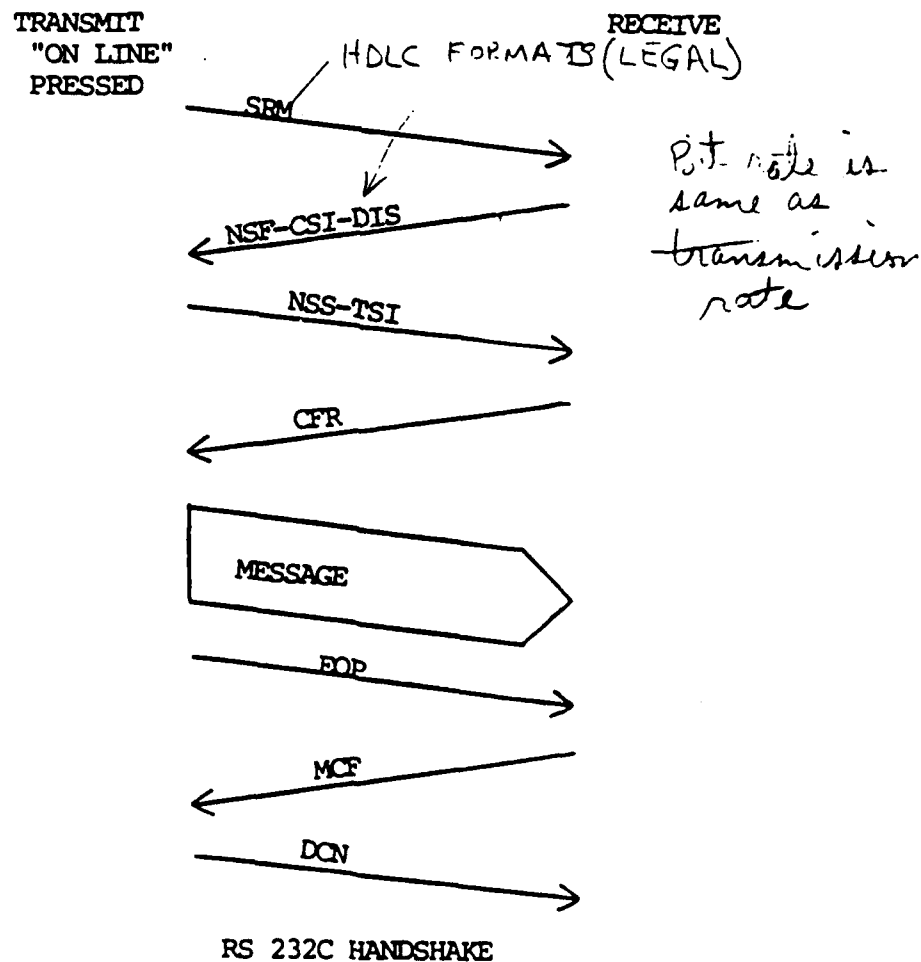
8. Communication Protocol in RS 232C Mode

There are two major differences between RS 232C protocol and the Group three protocol used on the DDD.

1. A new command "SRM" (Set up Receiver Mode) is defined and is used for the receiver wake up signal.
2. The handshaking signals and message signals have the same data rate, so no training or training check frame (TCF) signals are used.

Note 1. Prior to the handshaking between machines, the modems also go through a handshaking routine to confirm the condition of the circuit.

Note 2. The MV-3000 is not compatible with the UF-520 in the RS 232C mode. The handshaking protocol is different.



Panafax SERVICE BULLETIN

PSB NO. 029

Date: October 19, 1982

7. PIN ASSIGNMENT OF RS-232C CABLES

<u>PIN</u>	<u>NAME</u>	<u>DIRECTION</u> <u>FAX - DCE</u>	<u>FUNCTION</u>	<u>USED IN</u> <u>MV-3000</u>
1.	FG (AA)		Frame Ground	Yes
2.	TD (BA)	→	Transmitted DATA	Yes
3.	RD (BB)	←	Received DATA	Yes
4.	RTS (CA)	→	Request to Send	Yes
5.	CTS (CB)	←	Clear to Send	Yes
6.	DSR (CC)	←	Data set ready	No
7.	SG (AB)		Signal Ground	Yes
8.	DCD (CF)	←	Data carrier detect	Yes
9.				No
10.				No
11.				No
12.	(S) DCD (SCF)	←	Secondary Data carrier detect	No
13.	(S) CTS (SCB)	←	Secondary Clear to send	No
14.	(S) TD (SBA)	→	Secondary Transmitted Data	No
15.	TC (DB)	←	Transmitter Clock	Yes
16.	(S) RD (SBB)	←	Secondary Received Data	No
17.	RC (DD)	←	Receiver Clock	Yes
18.				No
19.	(S) RTS (SCA)	→	Secondary Request to Send	No
20.	DTR (CD)	→	Data Terminal Ready	Yes
21.	SQ (CG)	←	Signal Quality Detect	No
22.	RI (CE)	←	Ring Indicator	No
23.	(CH/CI)	→	Data Rate Select	No
24.	TC (DA)	→	External Transmitter Clock	No
25.				No

JOB	MV 3000	SYNCHRONOUS PROTOCOL	DRAWN	Ishii	PAGE	1/14
CUSTOMER			CHECKED		DATE	82.6.28
SYSTEM			REVISION			

1. Setting of Dip SW

To ensure proper operation of MV3000 RS-232C Protocol described in the following, Dip SW must be set as follows.

TxF P.C.B DSW1 PiN 7. ON (OFF=NSF)
SPB P.C.B DiP(1) PiN 5,6,7 Set ^{for} clock rate

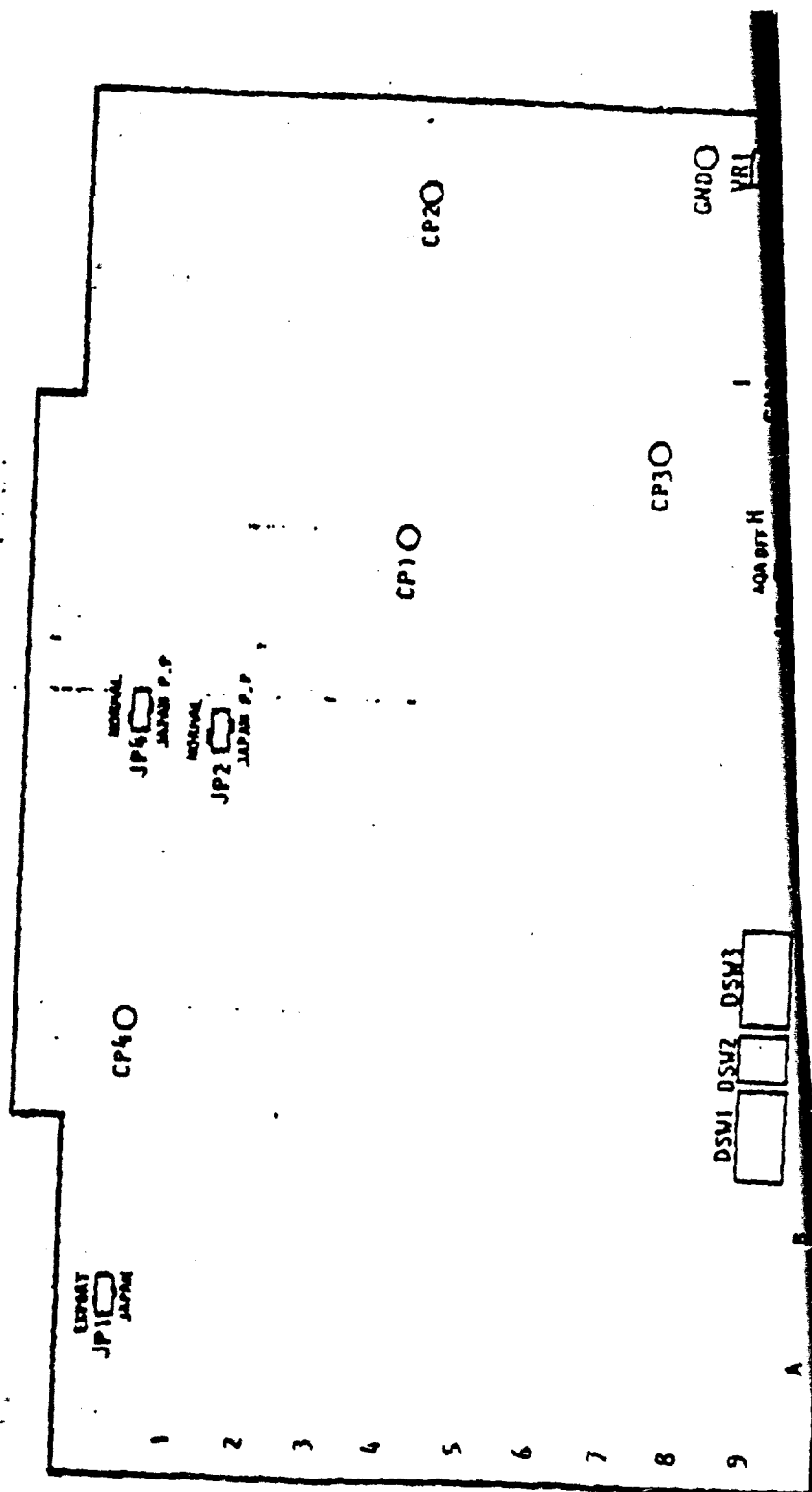
7	6	5	Clock Rate
0	0	0	50 bps
0	0	1	300
0	1	0	600
0	1	1	1200
1	0	0	2400
1	0	1	4800
1	1	0	7200
1	1	1	9600

(0 ; OFF , 1 ; ON)

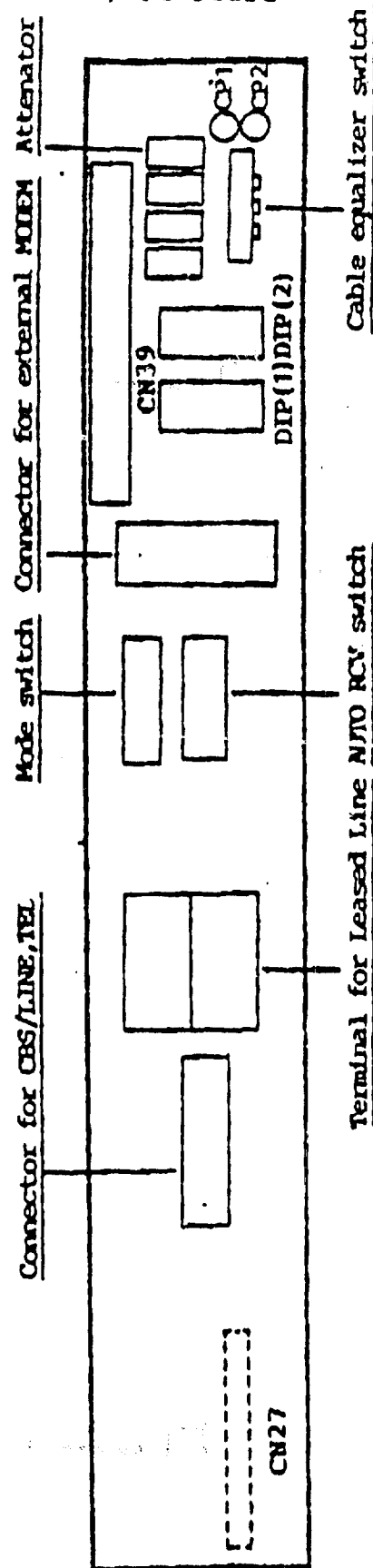
SPB P.C.B DiP(2) PiN 5 ON

Other Dip SW is set at the factory.

This Page
Reproduced From
Best Available Copy



3.7 SPB2 (C-P0076) PC Board



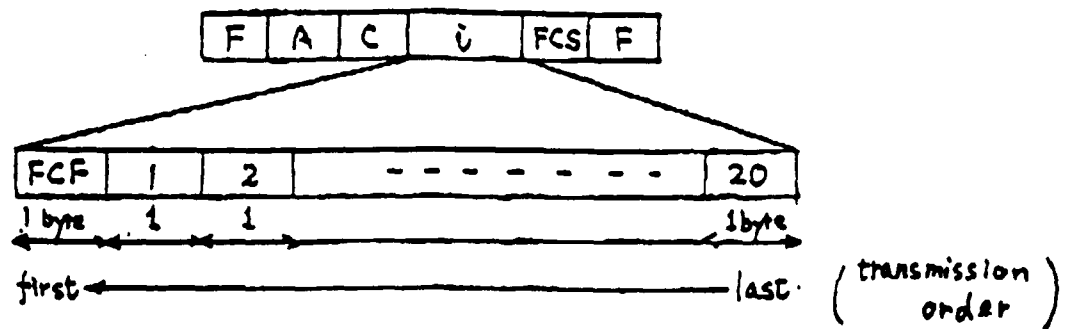
3. I-field Bit Pattern

(table 1) FCF bit pattern

FCF Name	bit pattern								i-field Byte Number
	8	7	6	5	4	3	2	1	
SRM	0	0	0	0	1	1	1	1	1 (FCF only)
CS0	0	1	0	0	0	0	0	0	21
DIS	1	0	0	0	0	0	0	0	5
TS0	0	1	0	0	0	0	1	1	21
PCS	1	0	0	0	0	0	1	1	5
CFR	1	0	0	0	0	1	0	0	1 (FCF only)
MPS	0	1	0	0	1	1	1	1	1 (FCF only)
EOP	0	0	1	0	1	1	1	1	1 (FCF only)
MCF	1	0	0	0	1	1	0	0	1 (FCF only)
RTN	0	1	0	0	1	1	0	0	1 (FCF only)
DCN	1	1	1	1	1	0	1	1	1 (FCF only)

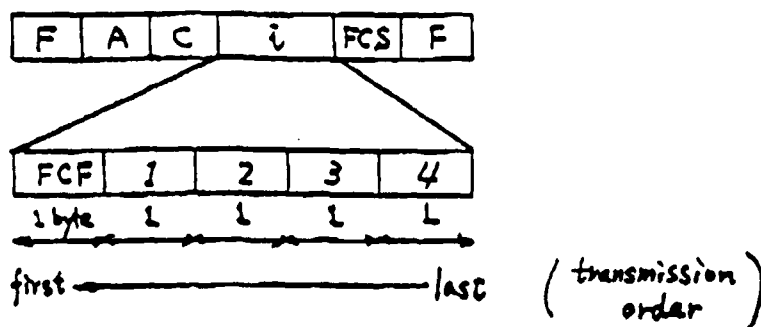
(Note 1) Transmission order bit 1 first
 bit 8 last

(Information Field of CSi, TSi)



FCF ;	bit 8 7 6 5 4 3 2 1 CSi ⓧ 1 ⓧ ⓧ ⓧ ⓧ ⓧ ⓧ TSi ⓧ 1 ⓧ ⓧ ⓧ ⓧ 1 1 last —————> first (transmission order)
1~20 ;	1~20 indicates iD, so bit pattern is not determined uniquely.

(Information Field of DIS/DCS)



FCF ;	bit 8 7 6 5 4 3 2 1 DIS 1 0 0 0 0 0 0 0 DCS 1 0 0 0 0 0 1 1 last → first (transmission order)
1 ~ 4 ;	See table 2 bit is transmitted first

(Table 1.3) FIF Table of DIS, DTC, DCS (1/2)

Bit NO.	DIS	PCS	DIS	DCS
1	Transmitter - T.2		0	0
2	Receiver - T.2	Receive - T.2	0	0
3	T.2 iOC = 176		0	0
4	Transmitter - T.3		0	0
5	Receiver - T.3		0	0
6	Reserved for future T.3	Receive - T.3	0	0
7			0	0
8			0	0
9	Transmitter - T.4		0	0
10	Receiver - T.4	Receive - T.4	1	1
11	Data Signalling Rate (table 1)	Data Signalling Rate (table 2)	Set By Rec stand Rate Dip SW	Set By DIS FcF and TX stand Rate Dip SW
12	Reserved for new modulation		0	0
13	"		0	0
14			1	1
15	Vertical Resolution (970/line)	Vertical Resolution (970/line)	Set by resolution SW	
16	Top Dimensional Coding	Top Dimensional Coding	1	1

(table 2)

Bit NO.	DCS
11 12	
0 0	2400 bps / V27ter
0 1	4800 bps / V27ter
1 0	9600 bps / V29
1 1	19200 bps / V29

(table 1)

Bit NO.	DIS/DTC
11 12	
0 0	V27ter Fall-back
0 1	V27ter
1 0	V29
1 1	V29, V27ter

FiF Table of DiS. DCS (2/2)

Bit NO.	DiS	DCS	DiS	DCS
17	Maximum Width of Paper (table 1)	Maximum Width of Paper (table 1)	0	Smaller size of RxFIF and Tx Dec.
18	Maximum Length of Paper (table 2)	Maximum Length of Paper (table 2)	0	0
19	Minimum Scan Time at receiver (table 3)	Minimum Scan Line Time at receiver (table 3)	1	1
20	Extend Field	Extend Field	0	0
21	2400 BPS handshaking	2400 BPS handshaking	0	0
22	Uncompressed Mode	Uncompressed Mode	0	0
23	Unassigned		0	0
24	"		0	0
25	"		0	0
26	"		0	0
27	"		0	0
28	Extend Field	Extend Field	0	0
29			0	0
30			0	0
31			0	0
32			0	0

Bit NO.	DiS	DCS	DiS	DCS
20ms (at 3.850/4.25)	0	0	0	0
40ms (")	0	0	0	0
10ms (")	0	0	0	0
5ms (")	0	0	0	0
10ms (")	0	0	0	0
20ms (")	0	0	0	0
40ms (")	0	0	0	0
0ms (")	0	0	0	0

Bit NO.	DiS	DCS	DiS	DCS
20ms (at 3.850/4.25)	0	0	0	0
40ms (")	0	0	0	0
10ms (")	0	0	0	0
5ms (")	0	0	0	0
10ms (")	0	0	0	0
20ms (")	0	0	0	0
40ms (")	0	0	0	0
0ms (")	0	0	0	0

(table 3) bit 21 22 23

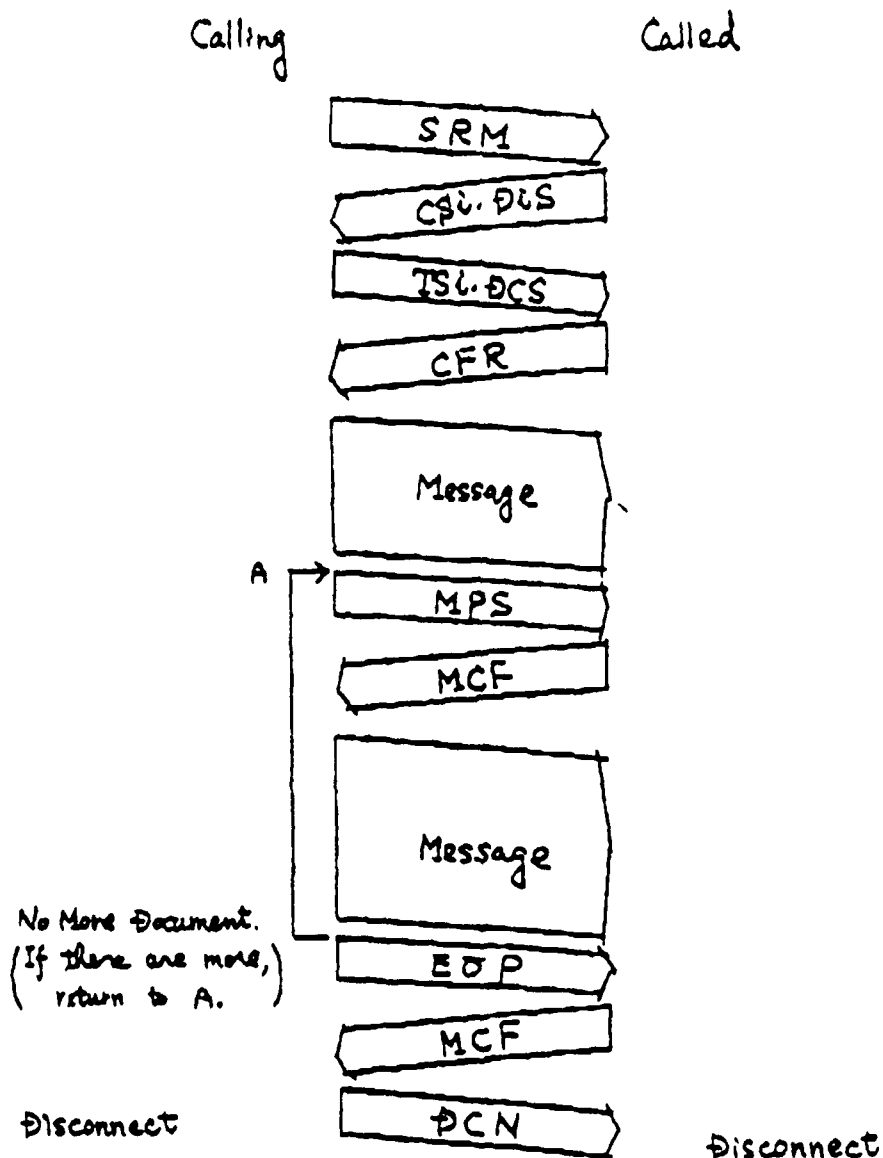
(table 2)

Bit NO.	Paper Length
19 20	0 0
0 1	A 4
1 0	No Limit
1 1	B 4

(table 1)

Bit NO.	Paper Width
17 18	0 0
0 1	A 4
1 0	A 3
1 1	B 4

4. Signal Sequence

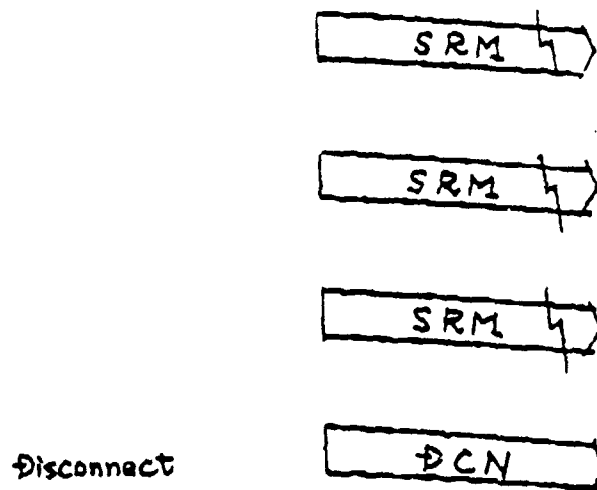


(Note) TLF P.C.B Dip SW 1 Pin 1 OFF

(Fig 1) Signal Sequence 1.

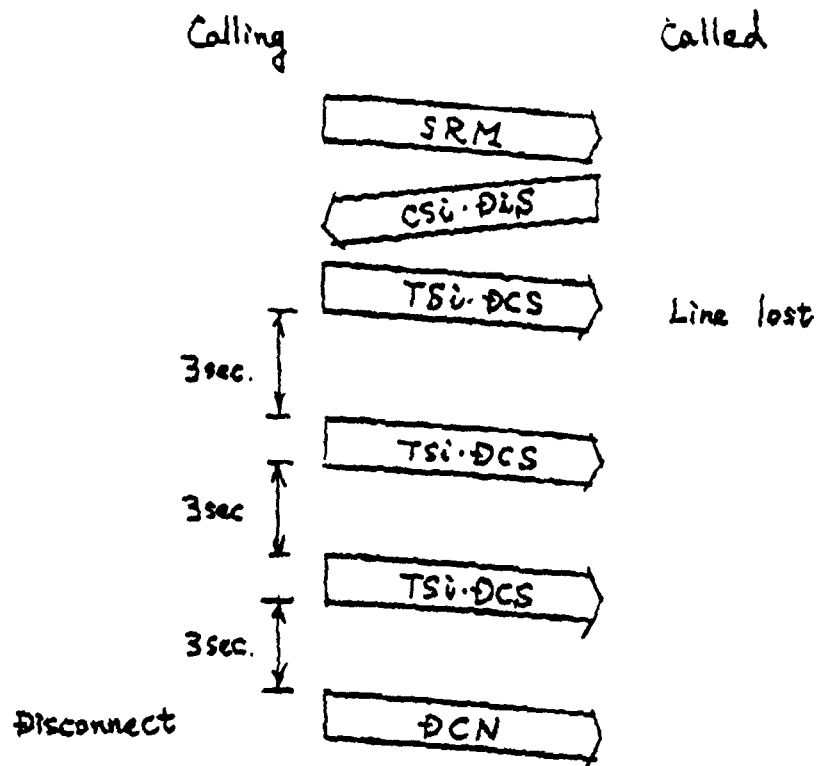
Calling

Called



(Note) h means error.

(Fig 4) Signal Sequence 4.



(Fig 5) Signal Sequence 5

Calling

Called

SRM

SRM

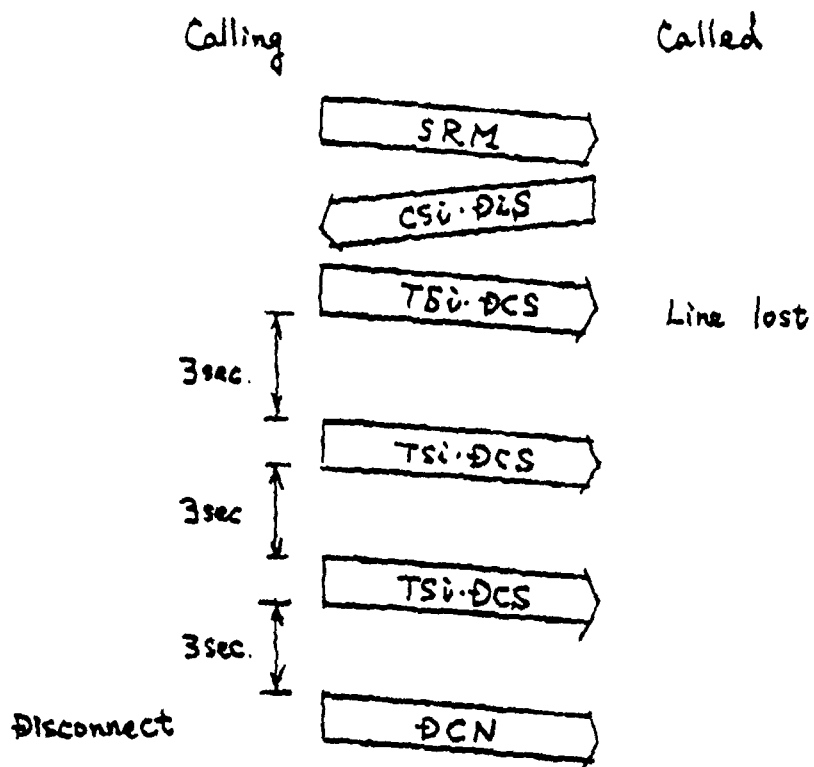
SRM

Disconnect

DCN

(Note) $\hookrightarrow$ means error.

(Fig 4) Signal Sequence 4.



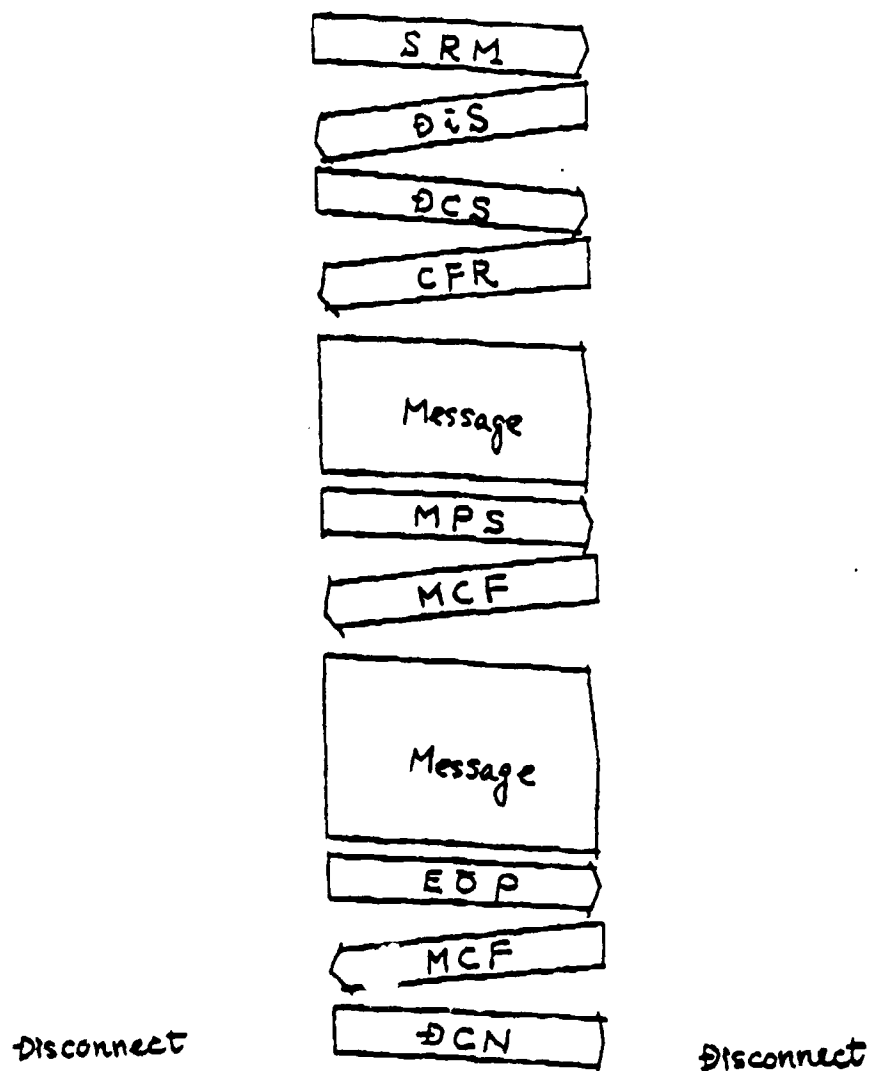
(Fig 5) Signal Sequence 5

CUSTOMER	
SYSTEM	

CHECKED		14
REVISION		DATE '82.6.28

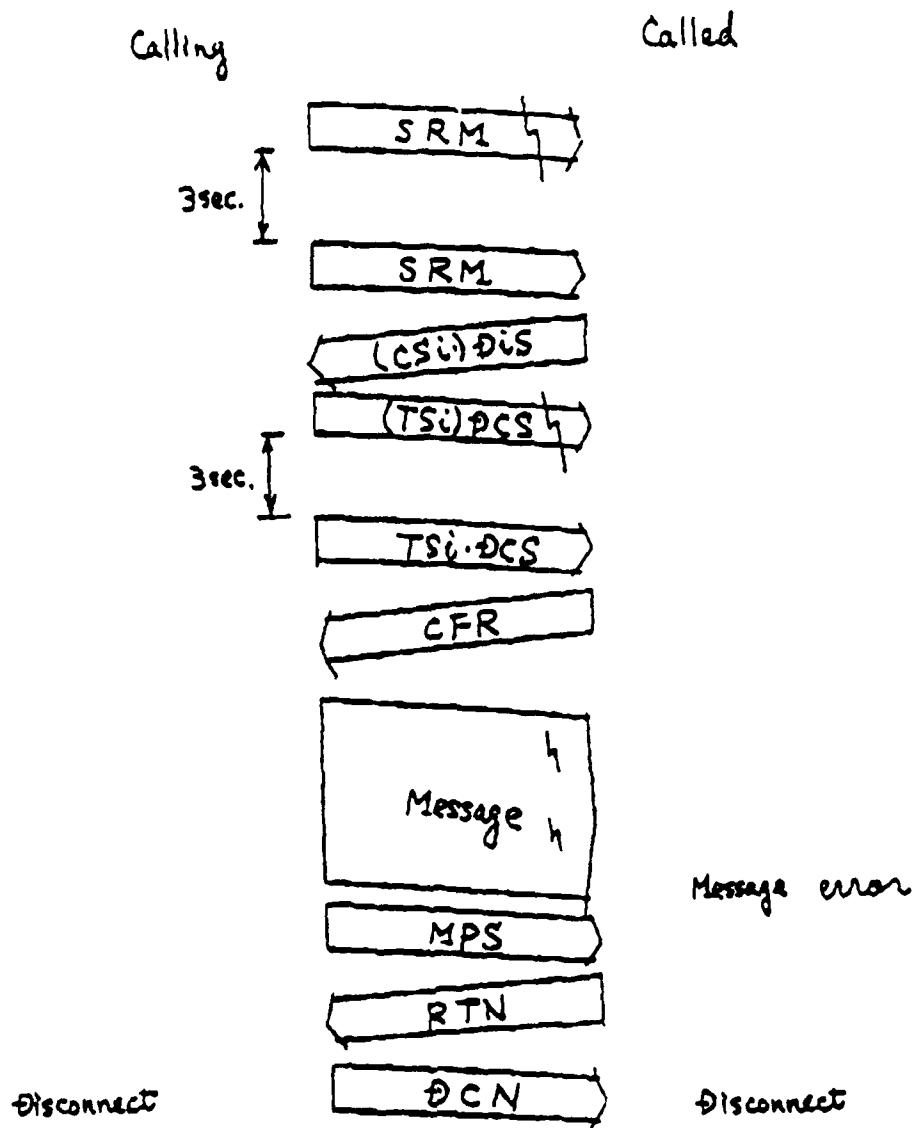
Calling

Called



(Note) TxF P.C.B Dip SW1 Pin1 ON

(Fig 2) Signal Sequence 2



(Note 1) CSi and TSi is deleted if (NO iD) Dip Sw is ON.

(No iD) ; TxF P.C.B Dip Sw 1 Pin 1.

(Note 2) If message is not correctly received at receiver,
transmit RTN instead of MCF.

(Note 3) h means error.

(Fig 3) Signal Sequence 3.

A P P E N D I X B
3M RS-232-C PROTOCOL

International Telegraph and Telephone
Consultative Committee
(CCITT)
Period 1985-1988

COM VIII No. _____

Original: English
Date: 9 Nov. 1984

Source: 3M

Title: RS-232-C Interface for Group 3 Apparatus

1. Introduction

During the last study period, Working Party VIII/2 discussed several issues relating to Group 3 apparatus such as reproducible area and error correction. Reproducible area has been completed, while work still progresses on error correction techniques. An area equally important is the standardization of a digital interface for Group 3 apparatus.

A large number of Group 3 facsimile apparatus are presently being used in a wide variety of applications. In addition to working over the PSTN, these terminals are interfaced to multiplexers, external modems, personal computers, and PBX's just to name a few. When interfacing Group 3 facsimile to the above mentioned devices, the user is faced with finding a terminal that supports a digital interface and is not assured that the interface on the facsimile terminal from Vendor A is identical to that supplied by Vendor B.

supports a digital interface and is not assured that the interface on the facsimile terminal from Vendor A is identical to that supplied by Vendor B.

The purpose of this contribution is to propose a digital interface that would allow vendors to meet a wide variety of user requirements.

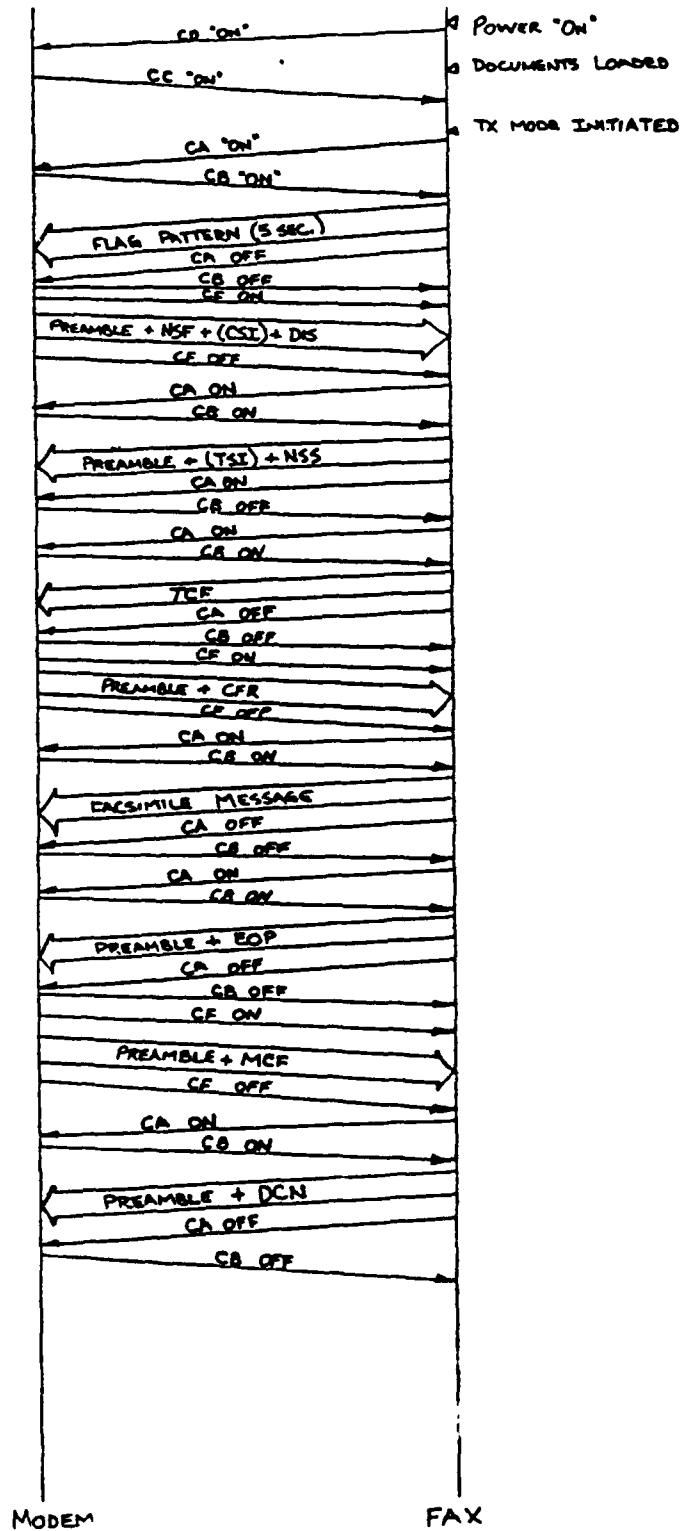
2. Proposal

Group 3 apparatus on the market today supports not only CCITT Recommendations T.4 and T.30, but Group 2 and North America 6 minute FM. When using the interface as proposed, the terminal will not be allowed to communicate in CCITT Group 2 and N.A. 6 minute modes. The protocol (T.30) will be set at the data rate set internally by use of a switch. The signal flow for various modes of operation are shown in the attached figures.

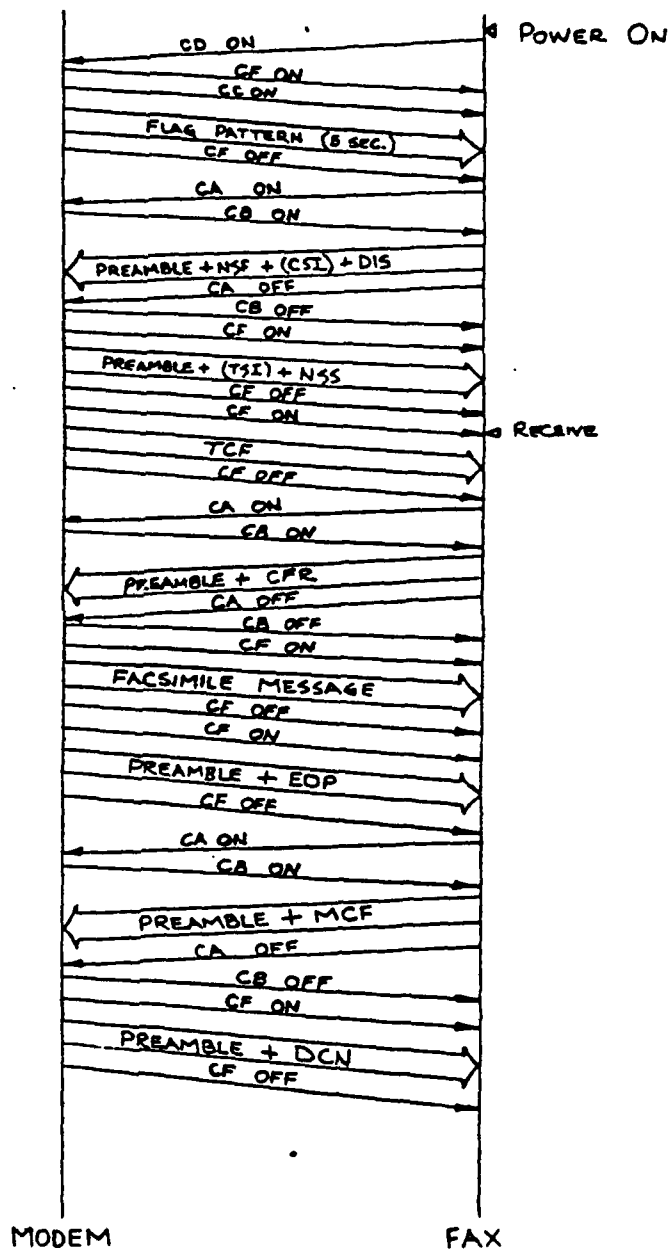
The interface signals are listed below:

Connection	Description	Abbreviation
1	Protective Ground	AA
2	Transmitted Data	BA
3	Received Data	BB
4	Request to SEND	CA
5	Clear to SEND	CB
7	Signal Ground (Common Return)	AB
8	Received Line Signal Detector	CF
15	Transmitter Signal Element Timing (DCE Source)	DB
17	Receiver Signal Element Timing (DCE Source)	DD
6	DSR (Date Set Ready)	CC
20	DTR (Data Terminal Ready)	CD
22	Ring Indicator	CE

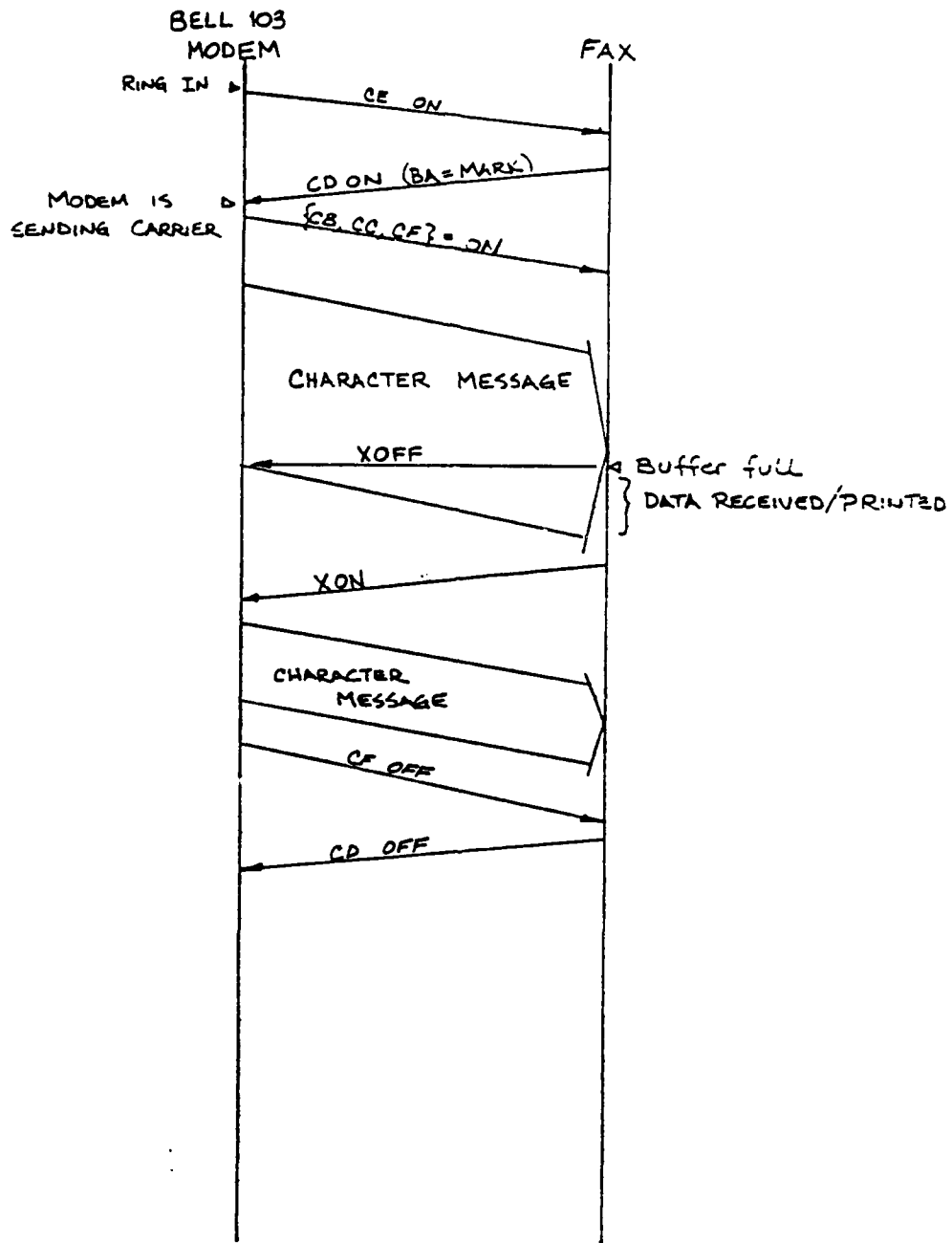
TX MODE



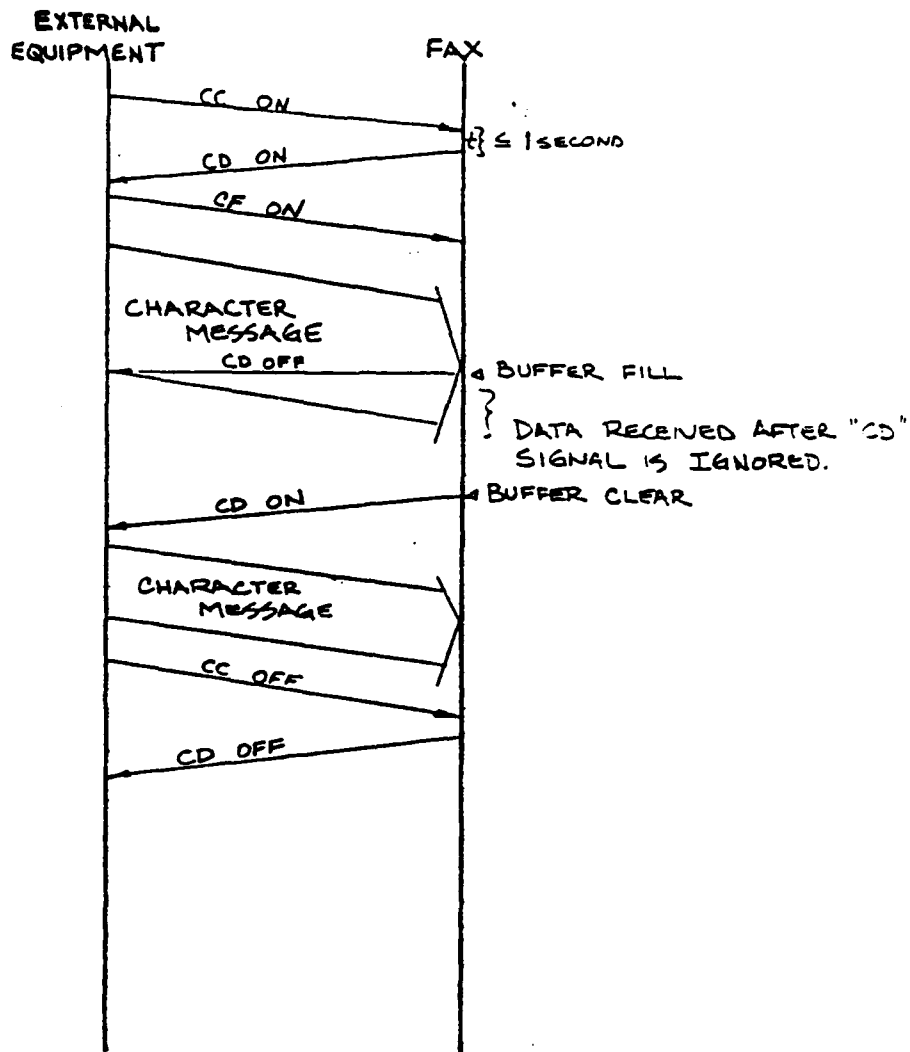
AUTO RECEIVE



RCV ASCII DATA



LOCAL PRINTER



3 M

1.0 RS-232C Ports

1.1 General Information

The RS-232C Port works in one of four configurations:

1. As an Encryption interface.
2. With an External Modem.
3. As an Output Port for Scan Dump.
4. As an Input Port for ASCII Printing. The machine carries on normal facsimile functions when the RS-232C Port is inactive.

- Changing between the modes is achieved manually.

Interface

Physical: Two 25 Pin D 232 Connectors
Electrical: EIA RS-232C Optional TTL Level
Modem: Uses "EMT" 9165 internal modem
Type of
Encryption Unit: Transparent to 9165

1.3 External Modem

The RS-232C Port may be used to connect an external modem to the M711 for access to other types of communication systems. The M711 will work in one mode or the other but not simultaneously.

Specifications:

Encryption Mode (User-Supplied External Encryption Device)

Input/Output

Data type: Synchronous Serial
Image Data
Format: Modified Huffman or Modified Read.
Compressed
Data Rate: 9600, 7200, 4800 or 2400 bps

Specifications:

External Modem Mode (User Supplied Modem)

Input/Output

Communication

Method: Synchronous Serial
Protocol: CCITT T 30 with High-Speed Hand-shaking

Image Data

Format: Modified Huffman or Modified Read.
Compressed
Data Rate: 9600, 7200, 4800 or 2400 bps (one selected at installation)

Machine Interface

Physical: One 25 Pin D 232-Connector
Electrical: EIA RS-232C Optional TTL Level

Section 3. Additional Information

Subsection B. Options

External Modem

Type: The external modem should conform to either CCITT recommendation V29 or CCITT recommendation V27 bis/ter. If the external modem has a multiplexer option with carrier detect by channel, the multiplexer may be used. This would normally be a private line type of operation. If the external modem can generate a Ring Indicator signal, it can also be used for Auto Answer with the M-711B _____. This would normally be a dial-up network type of operation.

Signalling: The external modem must have an interface conforming to CCITT recommendations V24 and V28 (RS-232C). Clock signal of 9.6K, 7.2K, 4.8K or 2.4K BPS. Data flow control by clock ON/OFF. Maximum OFF for TX is 60 minutes. Maximum OFF for RX is 6 seconds.

Print Width: B4, A4, 8½ inches.

Resolution: 100 x 200, 200 x 200, 400 x 200.

1.4 Dump Mode

The M711 is capable of transmitting or receiving compressed Modified Huffman Code. Normal facsimile functions are not effected by the M711 cannot perform Dump Mode and normal facsimile transactions simultaneously.

Specifications:

Digital Data Input/Output Mode (Dump)

Input/Output

Communication

Method: Synchronous Serial

Protocol: None

Image Data

Format: Modified Huffman, Compressed

Data Rate: 9600, 7200, 4800 or 2400 bps

Scan Width: Maximum, B4 (automatically reduced), 8½ inch width or less, no reduction.

Print Width: Maximum, 8½ inches

Resolution: Standard or fine selected at the transmitter. Fixed at standard or fine at receiver of installation.

Flow Control: External clock

Local Station ID: The 20 digit Terminal ID (TSI/CSI)

Remote Station: The number registered in Location 01 of Auto Dial

Interface

Physical: One 25 Pin D RS-232 Connector
Electrical: EIA RS-232C Optional TTL Level

1.5 ASCII Print

The M711 RS-232C Port can be an input port for ASCII Data. The M711 cannot transmit ASCII Data. Three types of ASCII Data can be processed.

1. Received through an external modem, Bell-103 Type.
2. ASCII Data which uses X-ON/X-OFF flow control.
3. ASCII Data which uses DTR flow Control.

Normal facsimile transactions are not affected, but simultaneous operation is not possible.

Specifications:

ASCII Printer Mode

Input

Data Type: Asynchronous ASCII

Protocol: TTY

Data Format: One start bit, seven character bits, even parity bit, one or two stop bits

Line Length: 2 characters minimum, 80 characters maximum

Parity Check: None

Section 3. Additional Information

Subsection B. Options

Data Rate: Connection through Bell 103. Modem—300 Baud. Direct Connection—4800, 2400, 1200 or 300 Baud (one rate selected at installation, maximum receive rate 240 characters per second)

Flow Control: Direct Connection only—X-On/X-Off or DTR (selected at installation)

Control Code Processing

Page Control: Not functional

Control Codes: The following control codes are the only ones recognized:

ENQ (05)—Response is CR, LF. (20 digits) CR, LF

Xon (11)—Recognized only when in the Bell 103 or Serial Printer Xon-Xoff modes

Xoff(13)

LF(0A)—Recognized as CR + LF. Multiple LFs ignored

CR(0D)—Recognized as CR + LF

Print Character Format

Resolution: 7.7 lines per/mm (8 dots/mm)

Data Matrix: 7 x 9

Printing Matrix: 14 dots x 18 lines

Space Between Characters: 2 dots

Space Between Lines: 8 white lines

Character Size: 2mm x 3.37 mm

Number of Printing Lines: A4—88 lines, letter—83 lines

Maximum Characters Per Line: 80 characters

Character Set: 92 characters

Interface*

Physical: One 25 Pin D RS-232 Connector

Electrical: EIA RS-232C Optional TTL

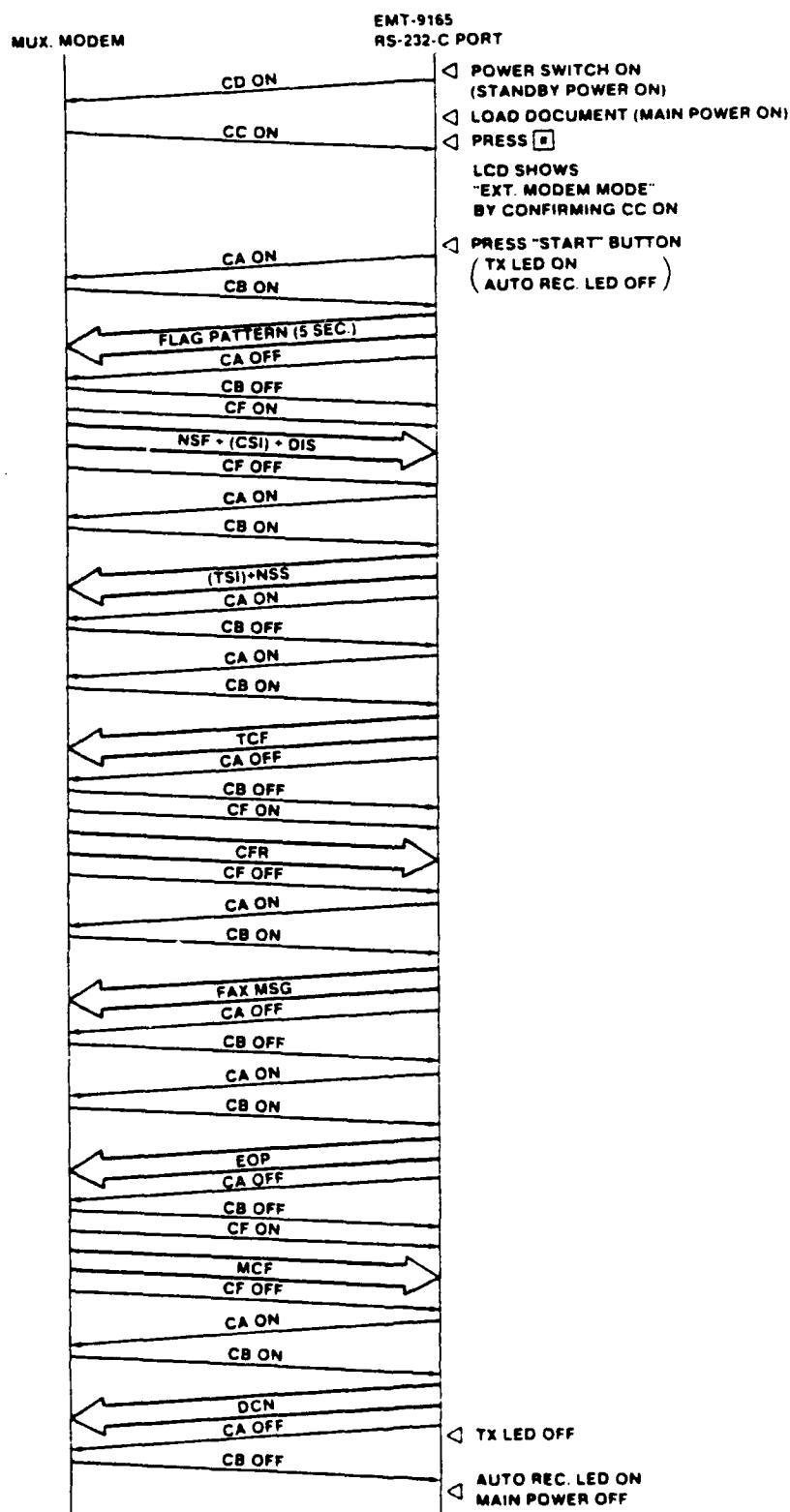
Section 3. Additional Information

Subsection B. Options

3 M

2.0 Interface Signals

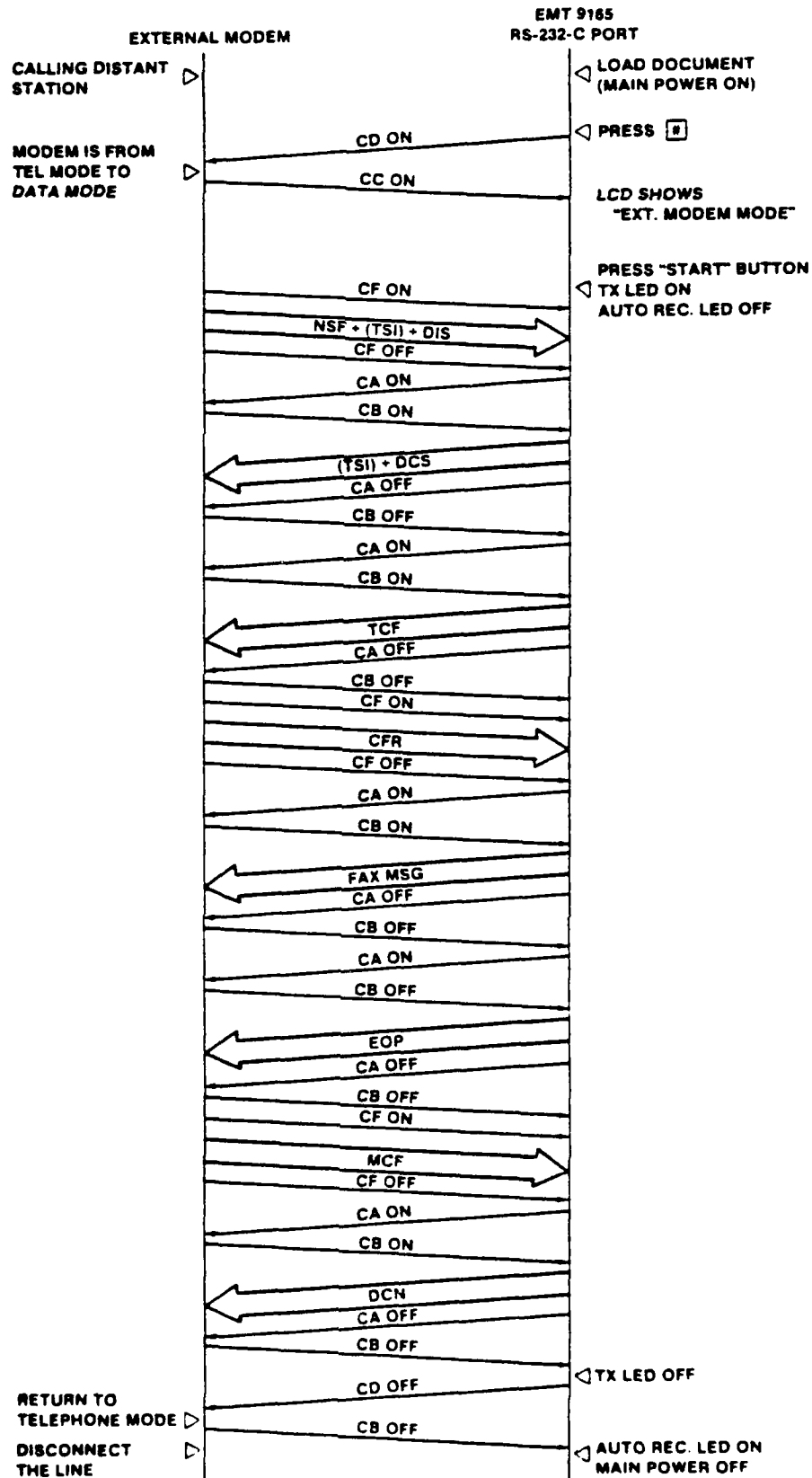
2.1 External Modem, Manual TX - CF Control



Section 3. Additional Information

Subsection B. Options

2.2 External Modem, Manual TX - CE Control

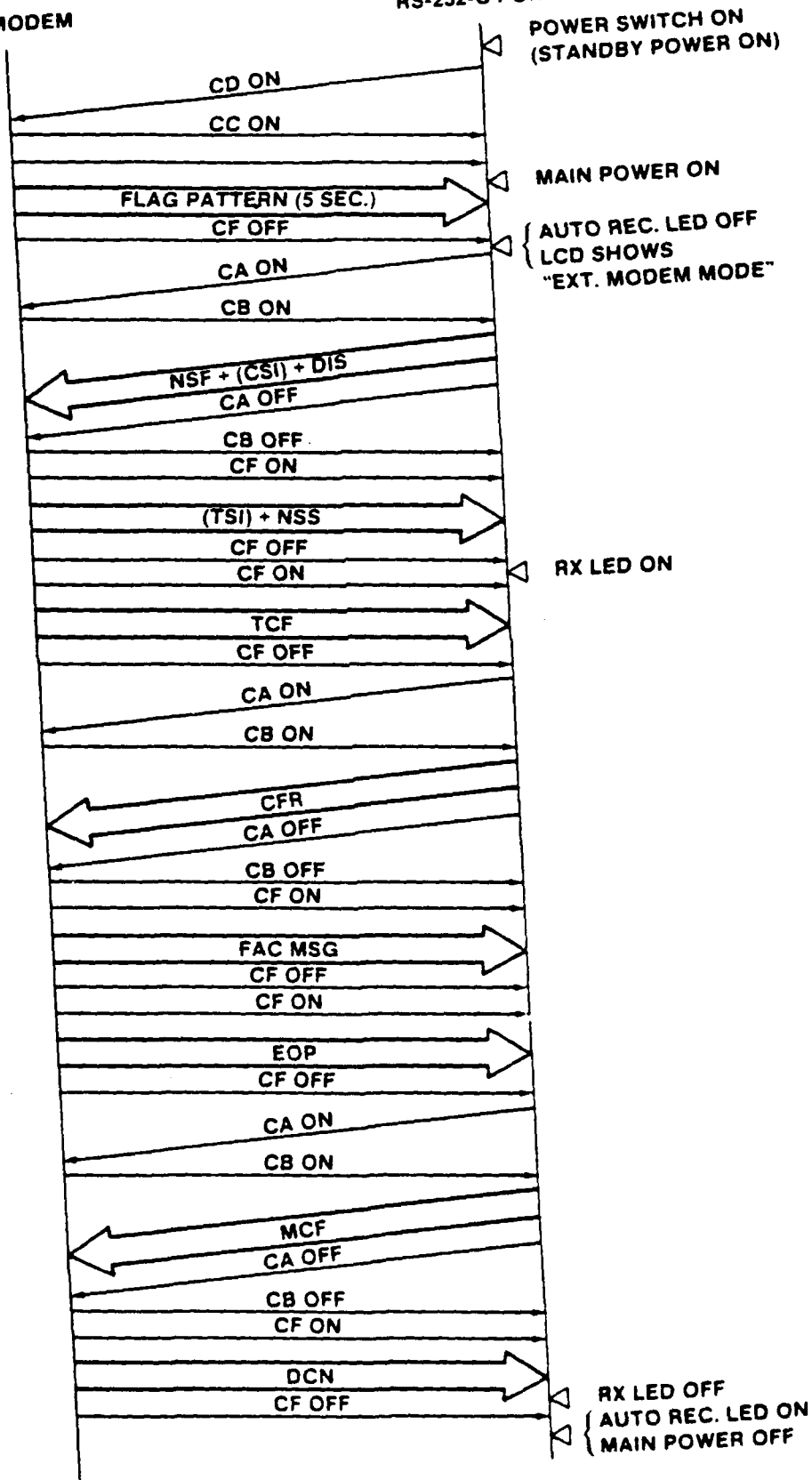


Section 3. Additional Information Subsection B. Options

2.3 External Modem. Auto Receive - CF Control

MUX MODEM

EMT 9165
RS-232-C PORT

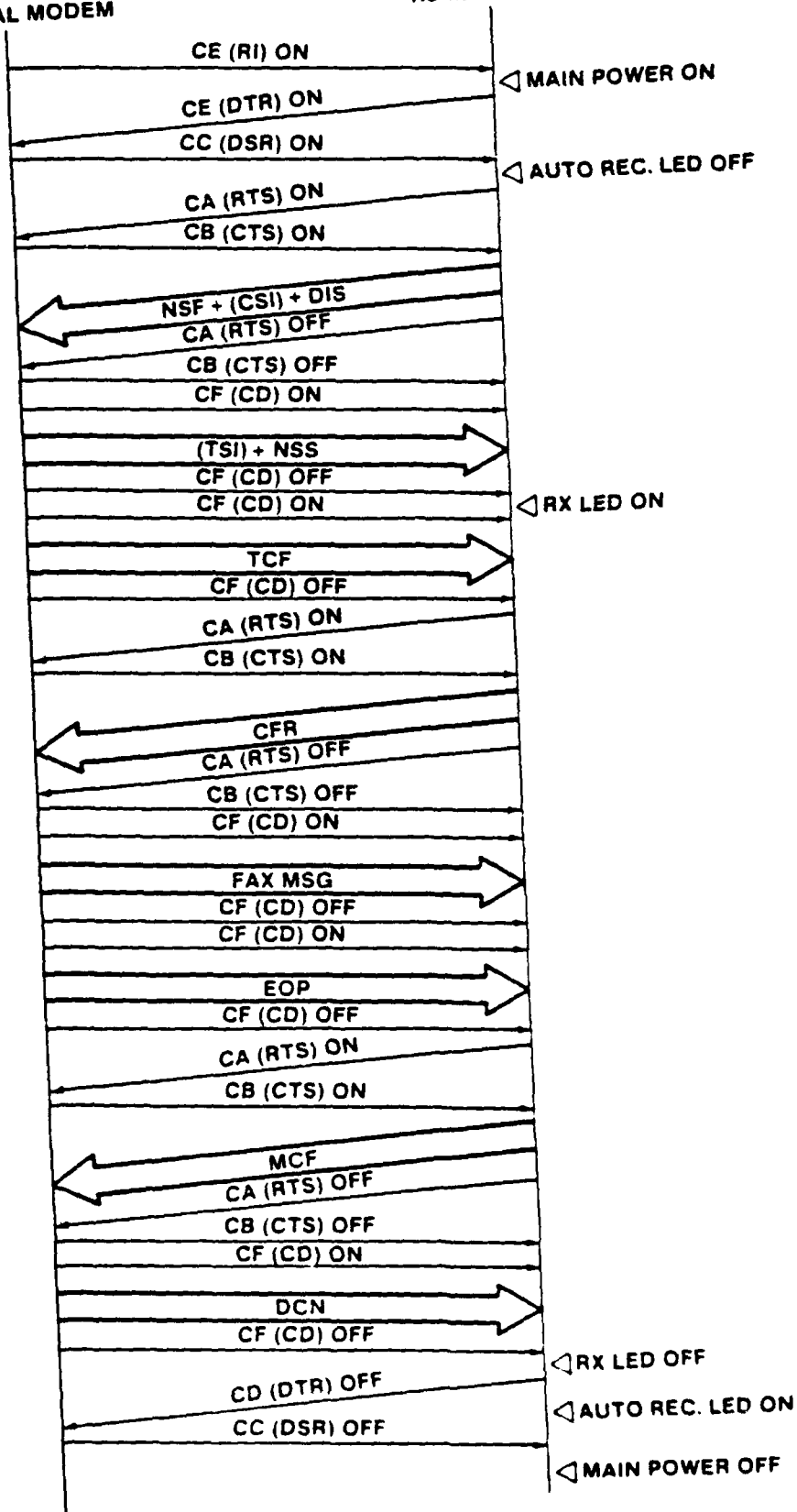


Section 3. Additional Information Subsection B. Options

2.4 External Modem. Auto Receive - CE Control

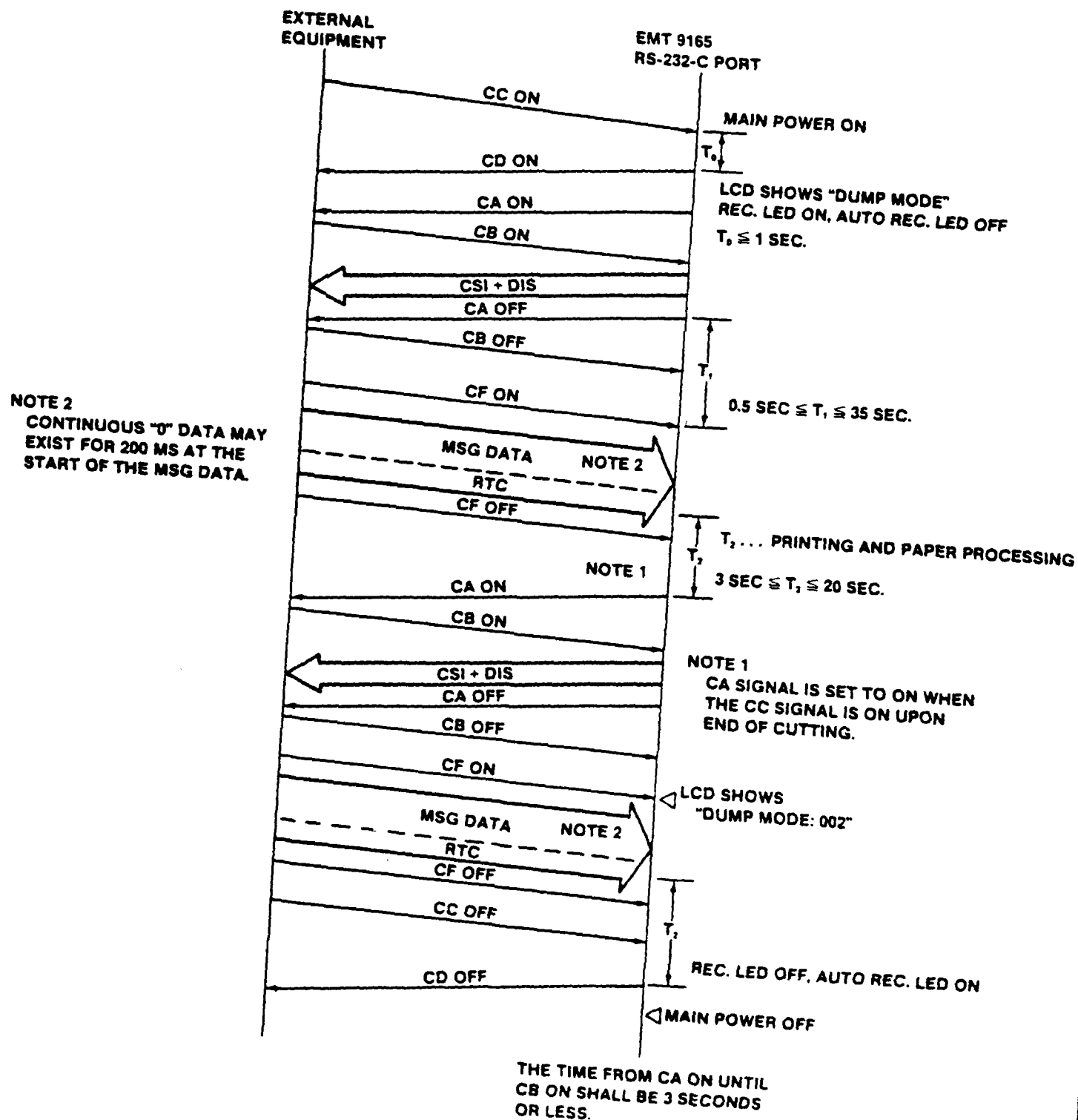
EXTERNAL MODEM

EMT 9165
RS-232-C PORT



Section 3. Additional Information Subsection B. Options

2.5 External Modem. Print Mode



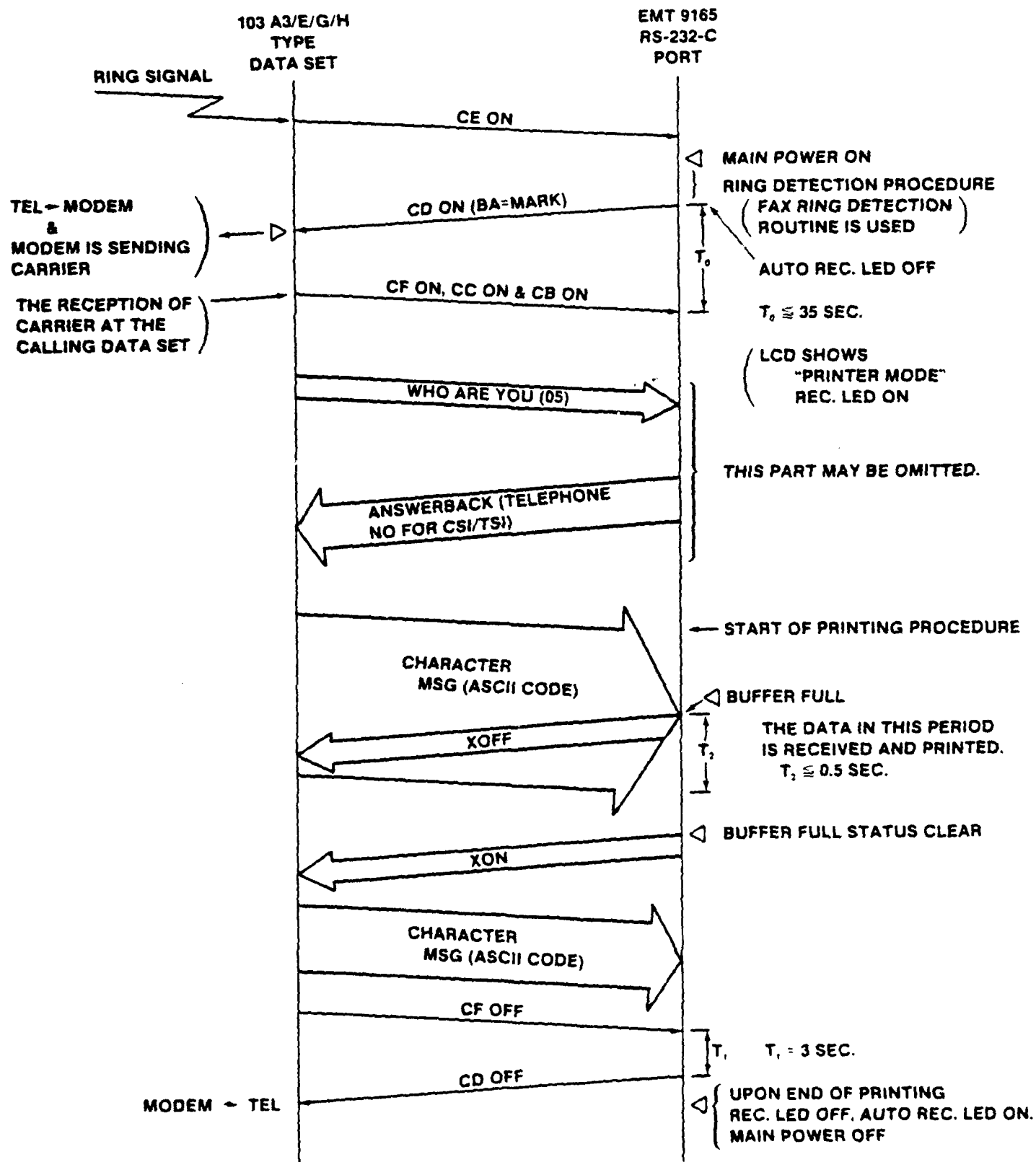
2.6 Dump Mode. Scan



Section 3. Additional Information

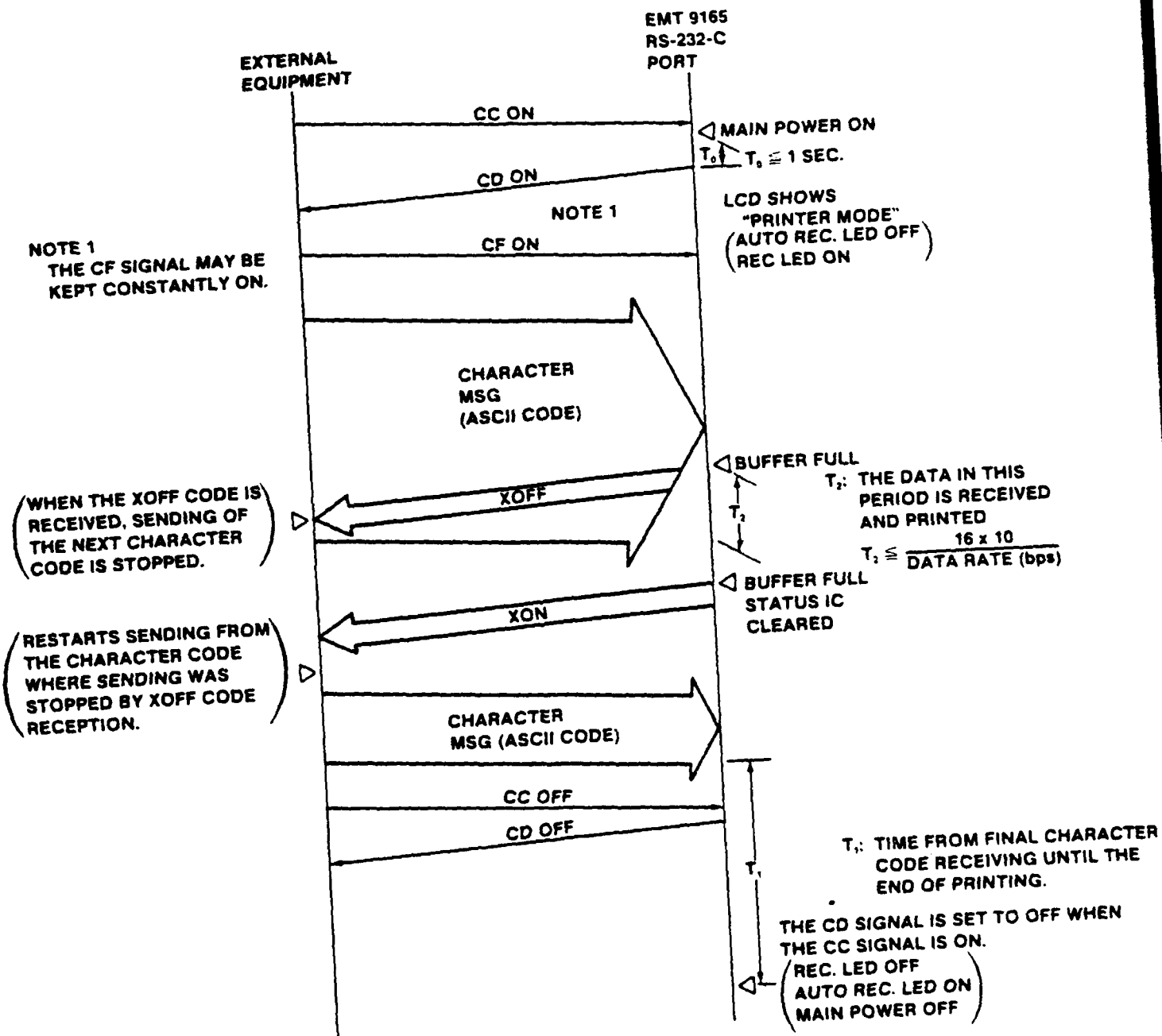
Subsection B. Options

2.7 ASCII Printer, 103 Modem



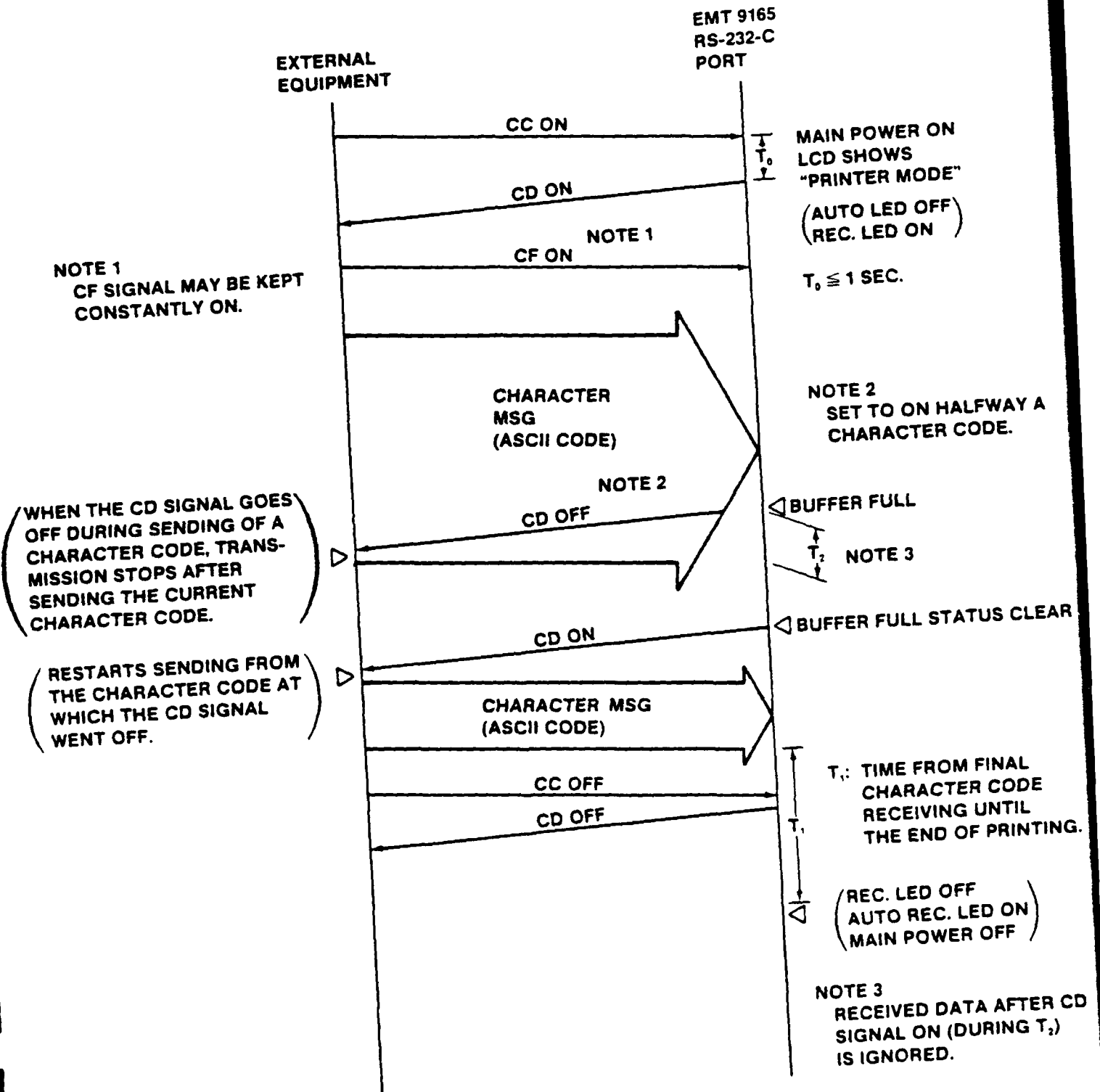
Section 3. Additional Information Subsection B. Options

2.8 ASCII Printer, X on - X off



Section 3. Additional Information
Subsection B. Options

2.9 ASCII Printer. DTR



A P P E N D I X C
XEROX RS-232-C PROTOCOL

SECTION ONE

INTRODUCTION

1.0 GENERAL DESCRIPTION OF THE RS-232-C COMMUNICATION OPTION.

The RS-232-C Communication Option is an interface available for the Xerox Telecopier 495-I Terminal (referred to as TC495-I hereafter in this document) which provides the unit with enhanced communications capabilities. The TC495-I Terminal retains all facsimile capabilities originally provided by the TC495, while adding the ability to interface with a computer. The RS-232-C Communication Option supplies an alternate input/output to the TC495-I.

The TC495-I, with the RS-232-C Communication Option, supports a wide variety of potential applications, including halftone transmission. More detailed information regarding utilization of the TC495-I may be found in Xerox applications publications. Some of these applications require the use of the Group 1/2 Compatibility and/or Automatic Dialer options.

In addition to the online facsimile capabilities of the TC495-I, the following capabilities are available with the addition of the RS-232-C Communication Option:

- Local Printing - converts ASCII data received from a host and prints it. Also prints facsimile data received from a host.
- Remote Printing - transmits converted ASCII data or facsimile data to a remote facsimile terminal where it may be printed.
- Local Scanning - scans documents and transmits encoded facsimile data to a host computer through the RS-232-C port.
- Remote Scanning - receives encoded facsimile data from a remote source and forwards it to a host computer through the RS-232-C port in compressed or uncompressed format.
- Data Conversion - converts Modified Huffman or Modified Read data formats to Image Data format.
- Touch-tone Decoding - decodes touch-tone (DTMF) frequencies received from a remote source and passes the information, as ASCII digits, to a host for use as operational codes.
- Mark-sense card reading and decoding - reads and decodes mark-sense cards for setting various operational parameters and/or for subsequent processing by an attached host.

1.1 SCOPE OF THIS SPECIFICATION.

This Specification provides the detailed information needed to interface a host computer to the TC495-I.

Section 1 presents a description of the TC495-I, including the RS-232-C Communication Option, and host computer requirements.

Section 2 provides information on the physical interface and protocol required for both directly connected and modem linked TC495-I to host communications.

Section 3 explains how to control TC495-I printing formats.

Section 4 describes the formats of the command/response messages between the host and TC495-I.

Section 5 presents example flow charts of program command/response sequences that may be used to accomplish various TC495-I functions.

Section 6 lists TC495-I operational and fault codes, and fault recovery procedures.

Appendix A illustrates the functional data paths possible with the RS-232-C Communication Option.

1.2 DEFINITIONS.

The following definitions are provided to assist the user in interpreting information contained in this specification.

CCITT - The International Telephony and Telegraphy Consultative Committee: An international standardization organization which sets worldwide communications standards (including facsimile communications.)

Document - one or more pages of characters, marks, drawings, etc. which are transmitted by facsimile equipment.

Facsimile - the process, or the result of the process, by which fixed graphic material is scanned and the information converted into signals which are used locally or remotely to produce, in record form, a likeness (facsimile) of the subject copy.

Group 1 - apparatus which uses frequency modulation without any special measures to compress the bandwidth of the transmitted signal. This equipment is suitable for the transmission of an ISO A4 size document in about six minutes via a telephone-type circuit.

Group 2 - apparatus which exploits bandwidth compression techniques in order to achieve transmission of an ISO A4 size document in about three minutes via a telephone-type circuit. Vestigial sideband amplitude modulation is used.

Group 3 - apparatus which incorporates means for reducing the redundant information in the document signal prior to the modulation process and which can achieve a transmission time of about 30 seconds for a typical typescript document of ISO A4 size via a telephone-type circuit. Quadrature amplitude modulation is used for the digital data.

Group 4 - CCITT has not completed the standards for this class of equipment at this time, however it is expected to be apparatus which incorporates means for reducing redundant information in the document signal prior to transmission mainly via Public Data Networks (PDN). The apparatus will utilize procedures applicable to the PDN and will assure error-free reception of the document. The apparatus may also be used on the general telephone network where an appropriate modulation process will be utilized.

1.3 APPLICABLE REFERENCES.

The following references provide detailed specifications pertinent to the TC495-I and/or the RS-232-C Communication Option:

1. "Interface between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange, EIA Standard RS-232-C," Engineering Department, Electronic Industries Association, Washington, D.C., August, 1969.
2. "Application Notes for EIA Standard RS-232-C," Engineering Department, Electronic Industries Association, Washington, D.C., May 1971.
3. "Standardization of Group 1 Facsimile Apparatus for Document Transmission" CCITT Recommendation T.2
4. "Standardization of Group 2 Facsimile Apparatus for Document Transmission" CCITT Recommendation T.3
5. "Standardization of Group 3 Facsimile Apparatus for Document Transmission" CCITT Recommendation T.4
6. "Procedures for Document Facsimile Transmission in the General Switched Telephone Network," CCITT Recommendation T.30
7. Bell System Technical Reference - PUB 41106 - Data Set 103J
8. "300 bits per second Duplex Modem Standardized for use in the General Switched Telephone Network," CCITT Recommendation V.21
9. Bell System Technical Reference - PUB 41214 - Data Set 212A
10. "600/1200-baud Modem Standardized for use in the General Switched Telephone Network," CCITT Recommendation V.23

11. "International Specifications for Interface between Modems and Terminals," CCITT Interface Recommendation V.24
12. "4800/2400 bits per second Modem Standardized for use in the General Switched Telephone Network," CCITT Recommendation V.27 ter
13. "Electrical Characteristics for Single-current Interchange Circuits Controlled by Contact Closure," CCITT Interface Recommendation V.28
14. "9600 bits per second Modem Standardized for Use on Point-to-Point 4-wire Leased Telephone-type Circuits," CCITT Recommendation V.29
15. Federal Standard Glossary of Data Terms.

EIA documents may be purchased from: Electronic Industries Association
2001 Eye Street N.W.
Washington, D.C. 20006

CCITT documents may be purchased from: National Technical Information Service
P.O. Box 1553
Springfield, VA 22151

1.4 RS-232-C COMMUNICATIONS OPTION BLOCK DIAGRAM DESCRIPTIONS.

Figure 1-1 presents a block diagram of the TC495-I and RS-232-C Communication Option. The key components of the configuration are an RS-232-C controller, a Touch Tone (DTMF) detector, a character generator, a time/date/ID encoder, a compressed data (MH/MR) encoder, and a compressed data (MH/MR) decoder. The local scanner, printer, and various modem interfaces are basic to the TC495-I terminal. The individual data path utilized (see Appendix A for description) is under user software control and depends on the function enabled and the source and type of data involved.

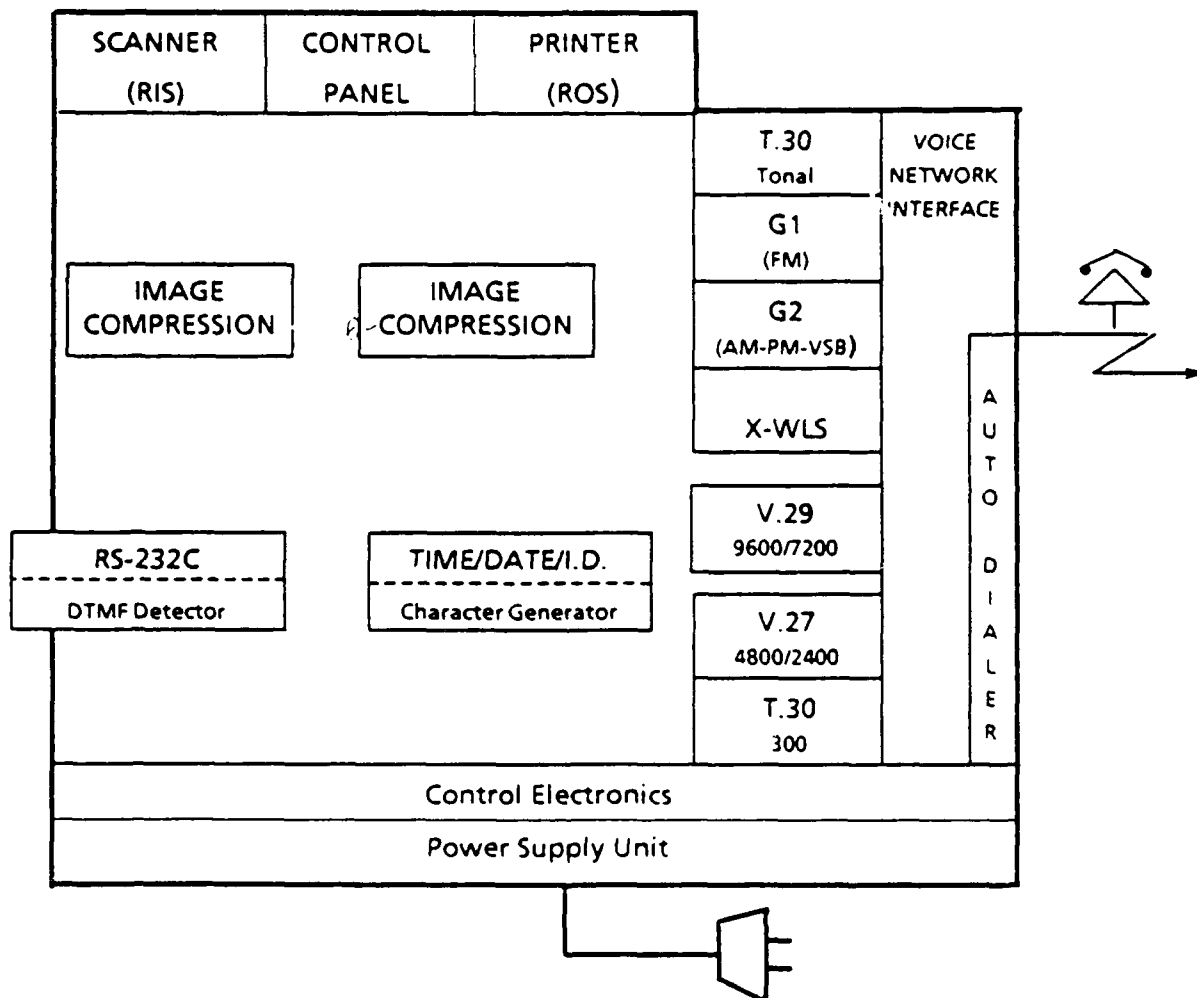


Figure 1-1. TC495-I Subsystem Block Diagram.

1.5 RS-232-C INTERFACE FUNCTIONAL DATA PATHS.

The TC495-I has the capability to receive ASCII or facsimile data (compressed or image) from a host computer through the RS-232-C interface and transmit facsimile data (compressed or image) to appropriately equipped remote facsimile terminal units. It may also print ASCII or facsimile data.

In addition, the TC495-I may receive compressed or image data from a remote facsimile terminal and transmit it to a host computer for storage. It may also scan documents and store them on a host computer as compressed or image data.

Appendix A defines all of the possible data combinations that are supported by the TC495-I and the RS-232-C interface.

1.6 HOST COMPUTER REQUIREMENTS.

The TC495-I will interface to most computers capable of supporting an RS-232-C serial input/output port. The host operating system must be capable of running a device driver with the TC495-I protocol specified herein. The bit rate at the TC495-I RS-232-C Interface may be from 110 baud up to 19.2 kilobaud. Document storage requirements vary, depending on document format. An average text page requires about 36 kbytes when stored in Modified Read format; 52 kbytes in Modified Huffman format. Image data requires up to 432 kbytes of storage, depending on the scanning resolution.

MODE/DATA TYPE	LOCAL or REMOTE	SCAN/PRINT	RS 232 C		FAX SPEED
			BIT RATE(S)	7/8 CODE	
TTY					
ASCII	LOCAL	PRINT	110 to 19.2k	7 or 8 BIT	NA
BLOCK					
ASCII	LOCAL	PRINT	110 to 19.2k	7 or 8 BIT	NA
	REMOTE-G3	PRINT	600 to 19.2k	7 or 8 BIT	9600/4800
	REMOTE-G2/G1	PRINT	600 to 19.2k	7 or 8 BIT	G2/G1
MH/MR					
	LOCAL	BOTH	110 to 19.2k	8 BIT	NA
	REMOTE-G3	BOTH	19.2k	8 BIT	≤9600
	REMOTE-G3	BOTH	9.6k	8 BIT	≤4800
	REMOTE-G2/G1	BOTH	19.2k	8 BIT	G2/G1
IMAGE					
	LOCAL	BOTH	110 to 19.2k	8 BIT	NA
	REMOTE-G2/G1	BOTH	19.2k	8 BIT	G2/G1

Table 1-1. Functional Capabilities of the RS-232-C Communication Option.

SECTION TWO

HOST/TC495-I PHYSICAL INTERFACE

2.0 GENERAL.

This section describes the physical connections required between the TC495-I and the host computer. A modem can also be used to communicate with a host computer at a remote site. The RS-232-C Communication Option does not affect normal facsimile communications provided by the TC495-I; it simply provides added capabilities as described in the following paragraphs.

2.1 RS-232-C PHYSICAL INTERFACE.

The TC495-I may be interfaced to a number of different types and models of host computers, either by direct connection to the RS-232-C interface or by remote connection through a communications link with a modem connected to the interface. The host computer may be a stand-alone general-purpose data processor or a communications processor. The communications support software must conform to the protocol described in this document.

Figure 2-1a shows the pin assignments and signals for direct connection of most types of host computers to the RS-232-C interface. Figure 2-2a shows the pin assignments and signals for connection of a Xerox 820-II Personal Computer to the RS-232-C interface. The connection at the 820-II is to the RS-232-C printer port. Figure 2-3a shows the pin assignments and signals for connection of an asynchronous modem to the RS-232-C interface.

Figures 2-1b, 2-2b, and 2-3b show the required settings of the RS-232-C crossover switch, located on the rear of the machine, for each of the associated connections. Figure 2-4a shows the layout of the crossover switch, figure 2-4b provides a block diagram of the crossover switch, and figure 2-4c is a schematic diagram of the switch. A decal, as illustrated in Figure 2-5b is affixed to the inside of the lower front cover of the unit for recording the settings of the crossover switch for your configuration.

2.1.1 Direct Connection - TC495-I/Host.

This connection differs from a standard RS-232-C interface in that both the host computer and the TC495-I function as data terminal equipment (DTE). The connection between the two units is configured as a "null modem" by the settings of the RS-232-C crossover switch as shown in figure 2-1b.

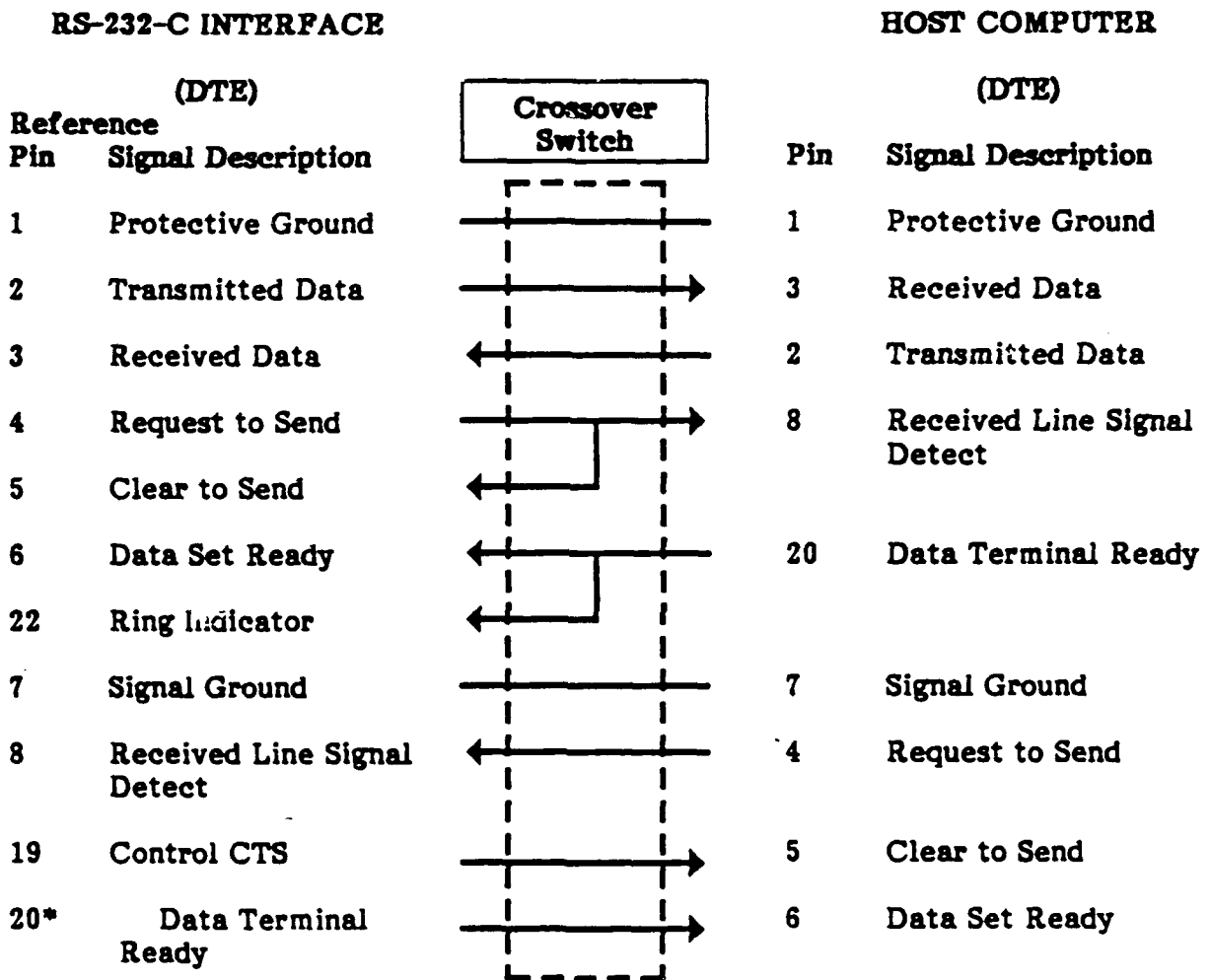
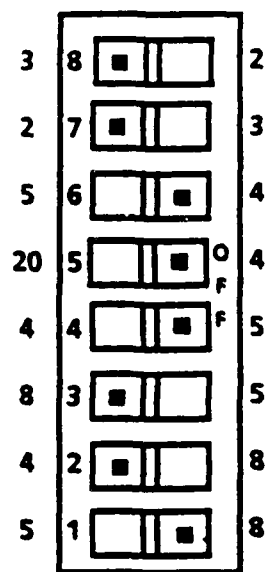


Figure 2-1a. TC495-I/Host Direct Connection

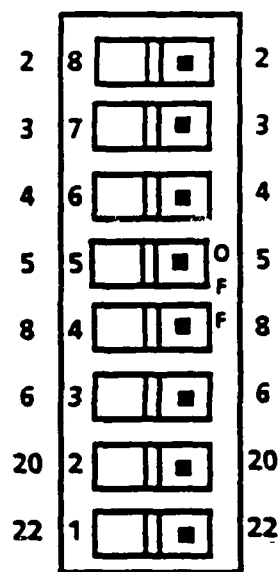
* NOTE: For some computer communications ports, pin 6 (Data Set Ready) is connected to +15VDC through a 4.7kOhm resistor. In these situations, switch 2, DTE to DTE, must be modified such that bit 5 (pin 6 to pin 20) is in the OFF position.

CABLE 495

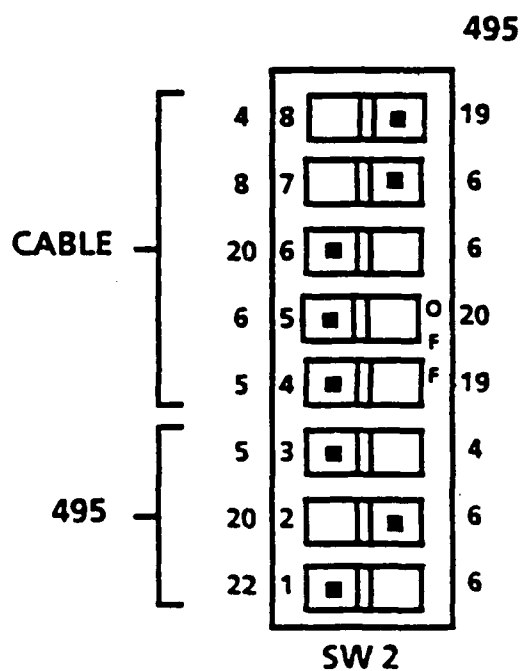


SW 3

CABLE 495



SW 1



SW 2

Figure 2-1b. Crossover Switch Settings (DTE-DTE)

2.1.2 TC495-I to Xerox 820-II.

In this configuration the RS-232-C interface is connected to the printer port of a Xerox 820-II Personal Computer. The TC495-I functions as data communications equipment (DCE), while the 820-II functions as data terminal equipment (DTE).

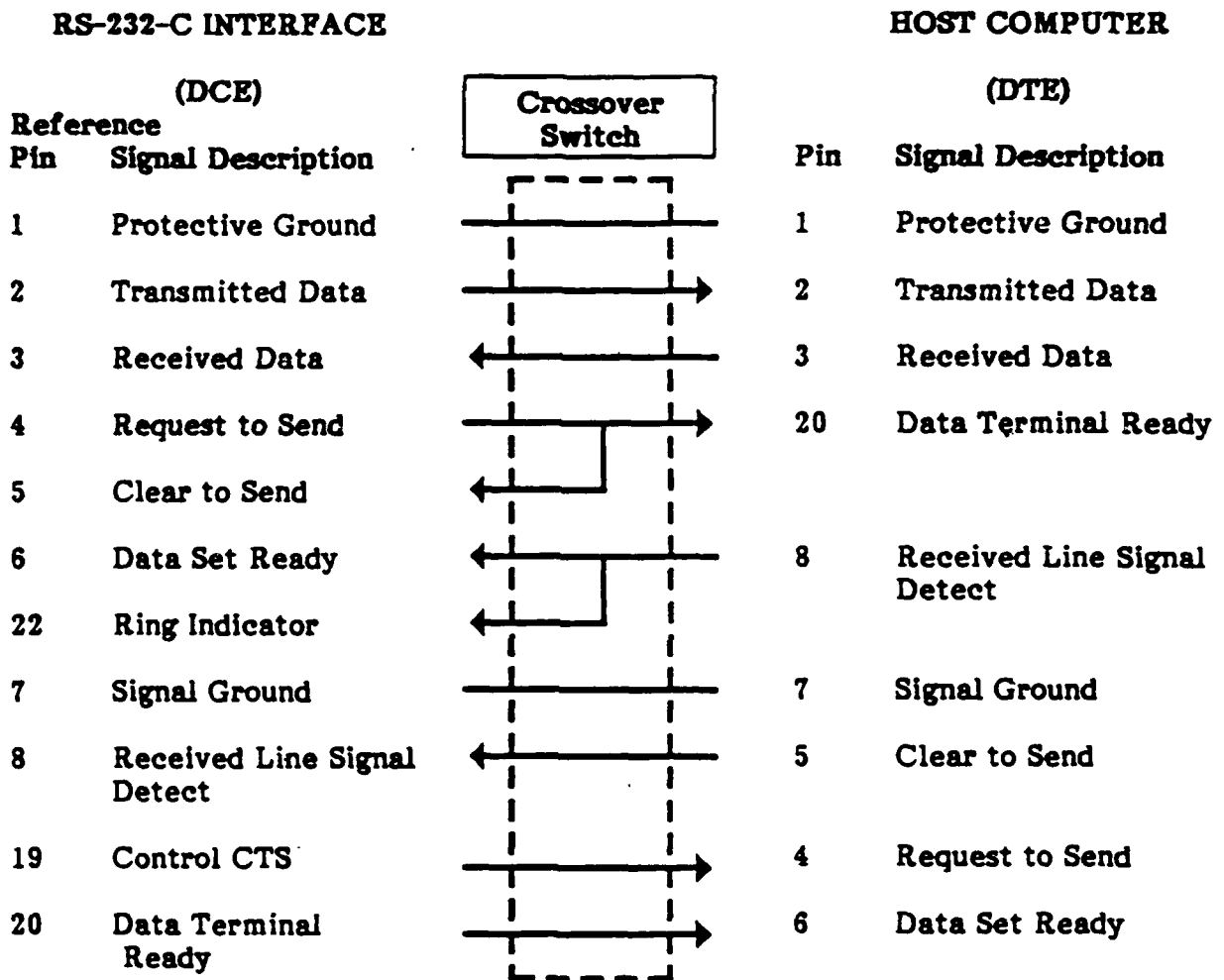
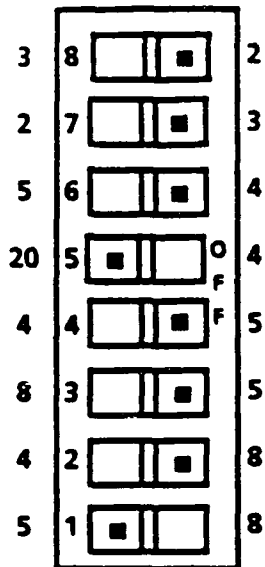


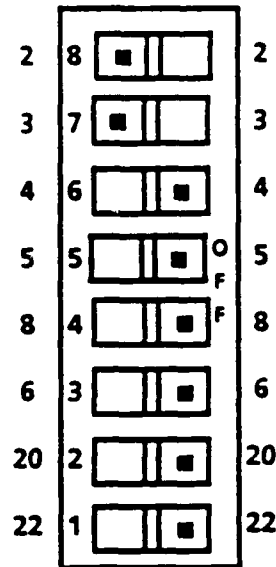
Figure 2-2a. TC495-I/820-II Printer Port Direct Connection

CABLE 495

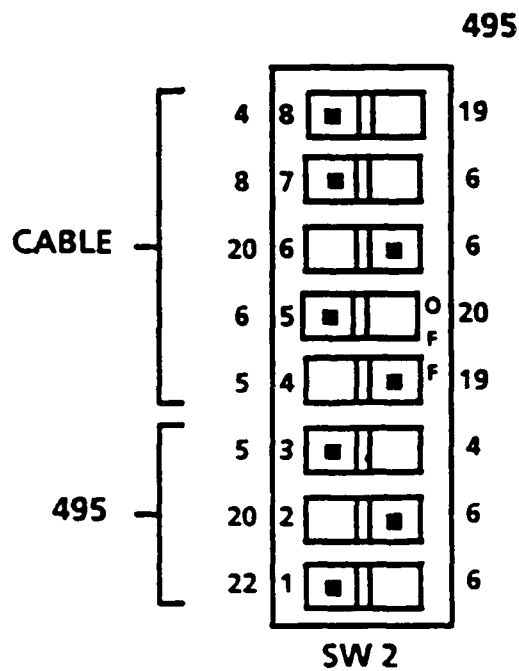


SW 3

CABLE 495



SW 1



SW 2

Figure 2-2b. Crossover Switch Settings (820-II Printer Port - TC495-I)

2.1.3 Modem Connection - TC495-I/Modem.

This connection is a standard RS-232-C interface. The TC495-I is the data terminal equipment (DTE), while the modem is the data communications equipment (DCE). The modem selected should be capable of full-duplex, 2-wire switched network operation.

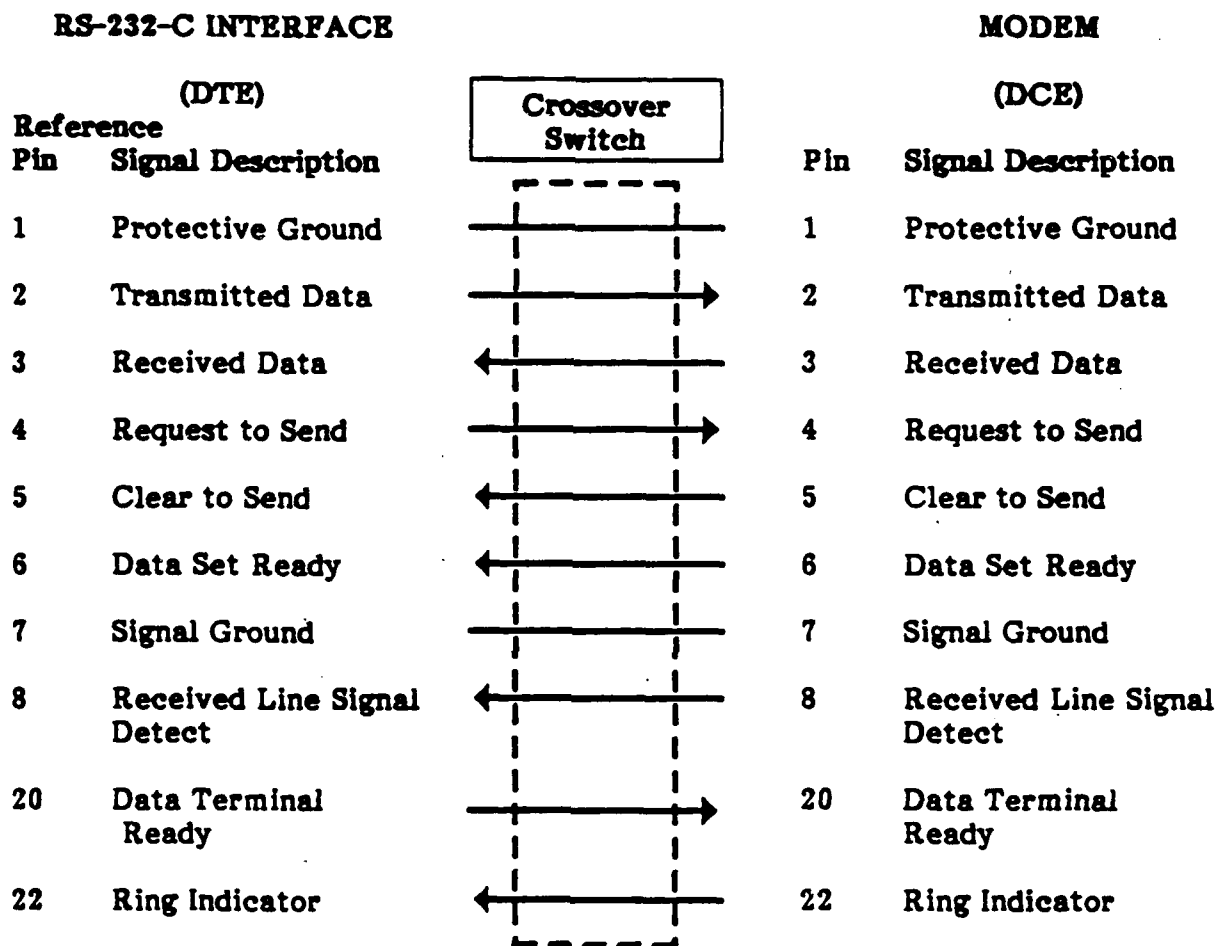
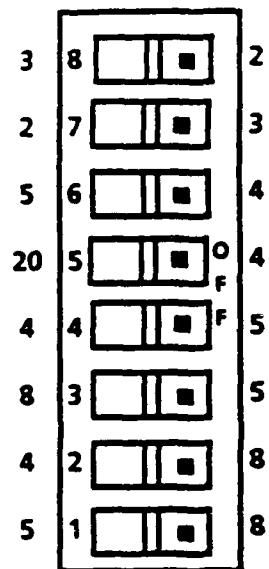


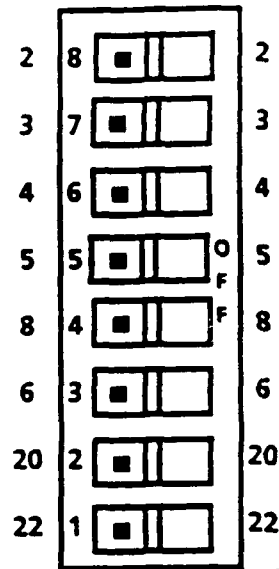
Figure 2-3a. TC495-I/Modem Connection.

CABLE 495



SW 3

CABLE 495



SW 1

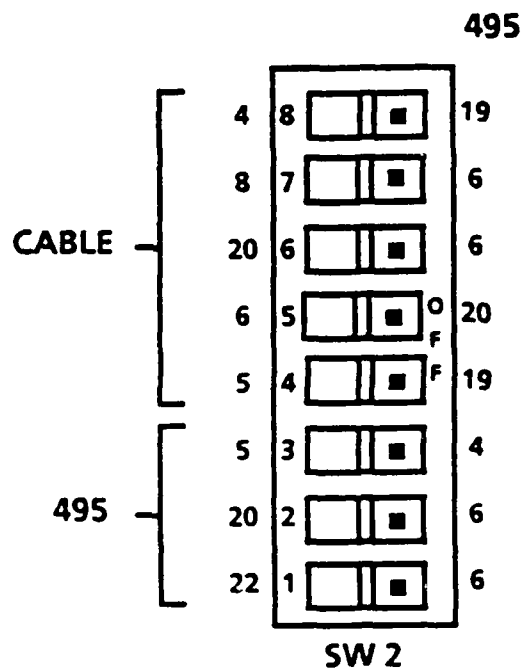


Figure 2-3b. Crossover Switch Settings (DTE-DCE)

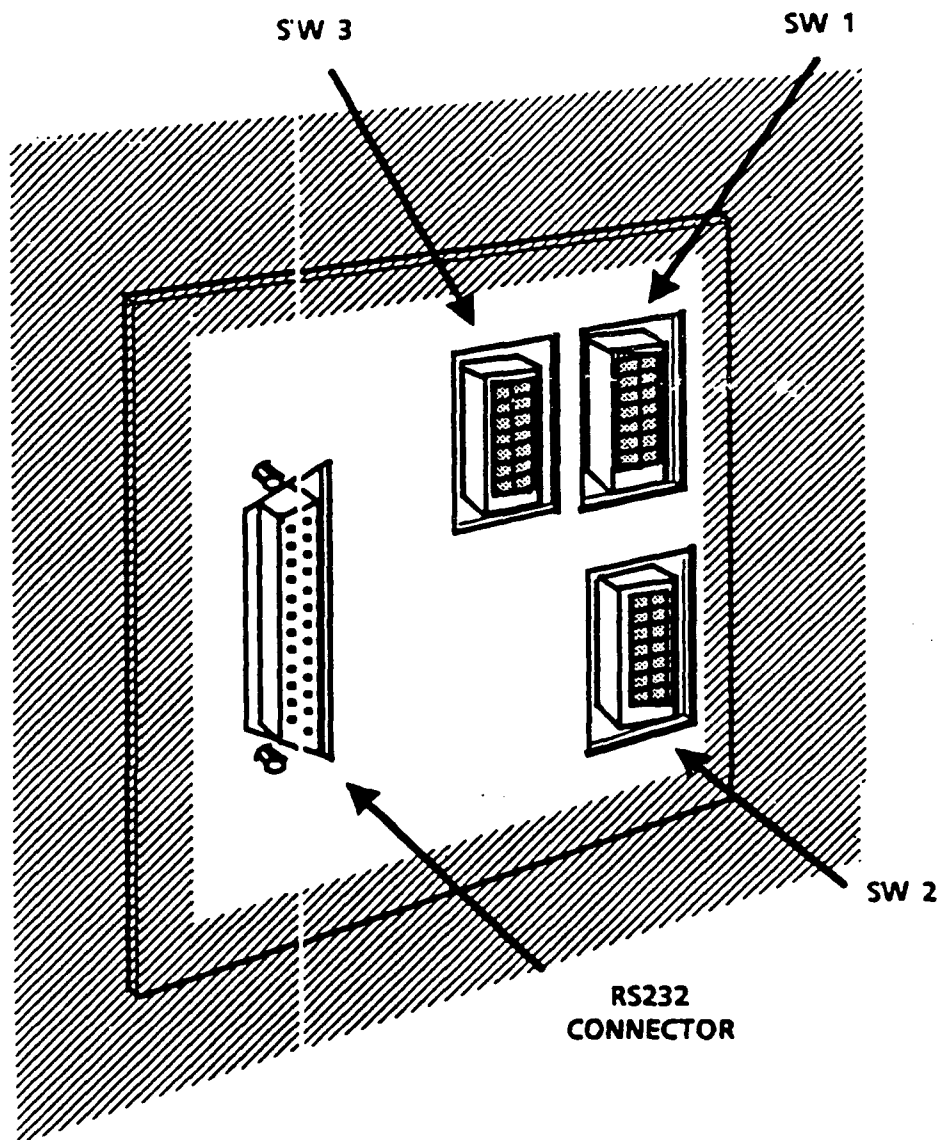


Figure 2-4a. RS-232-C Connector and Crossover Switch.

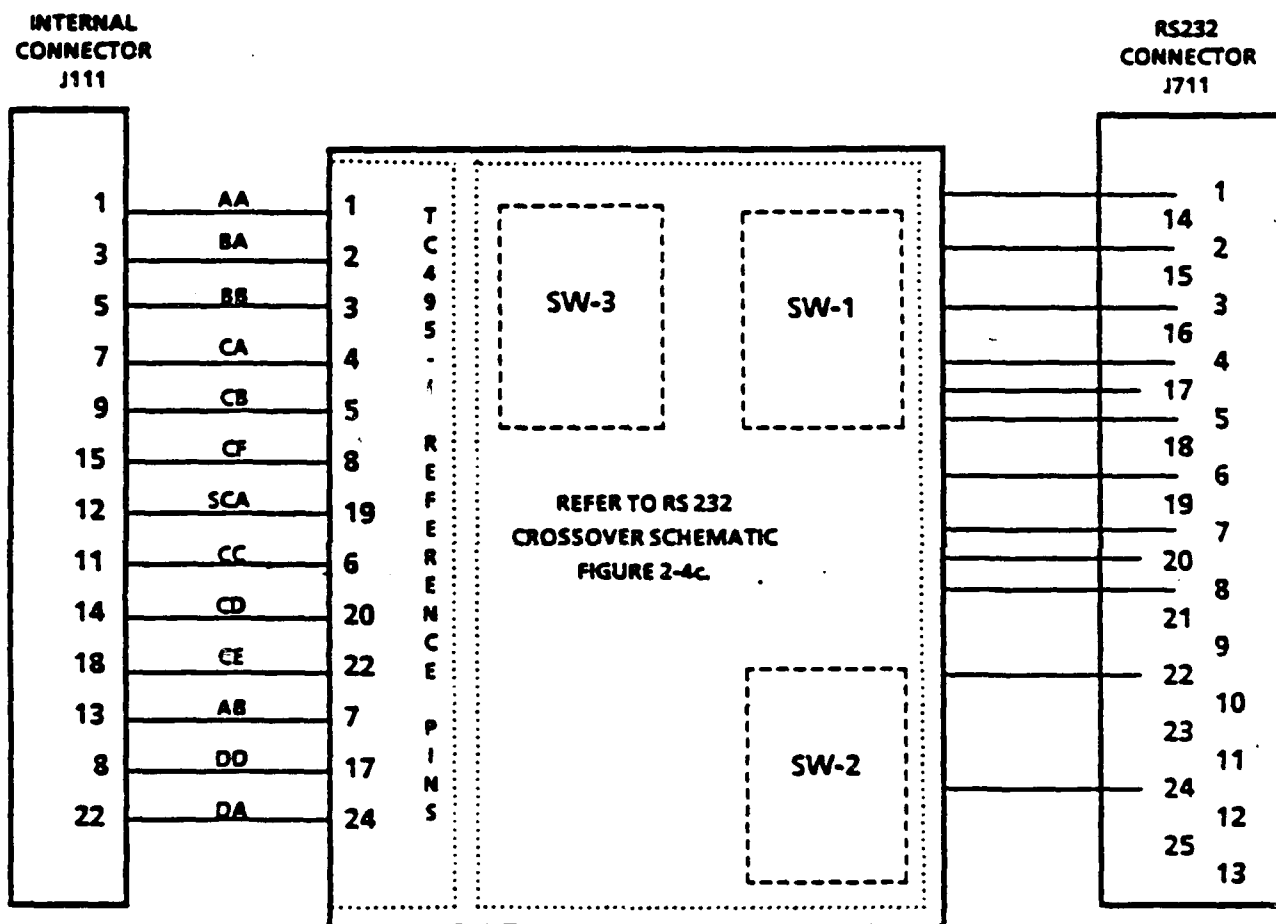


Figure 2-4b. RS-232-C Crossover Switch Block Diagram.

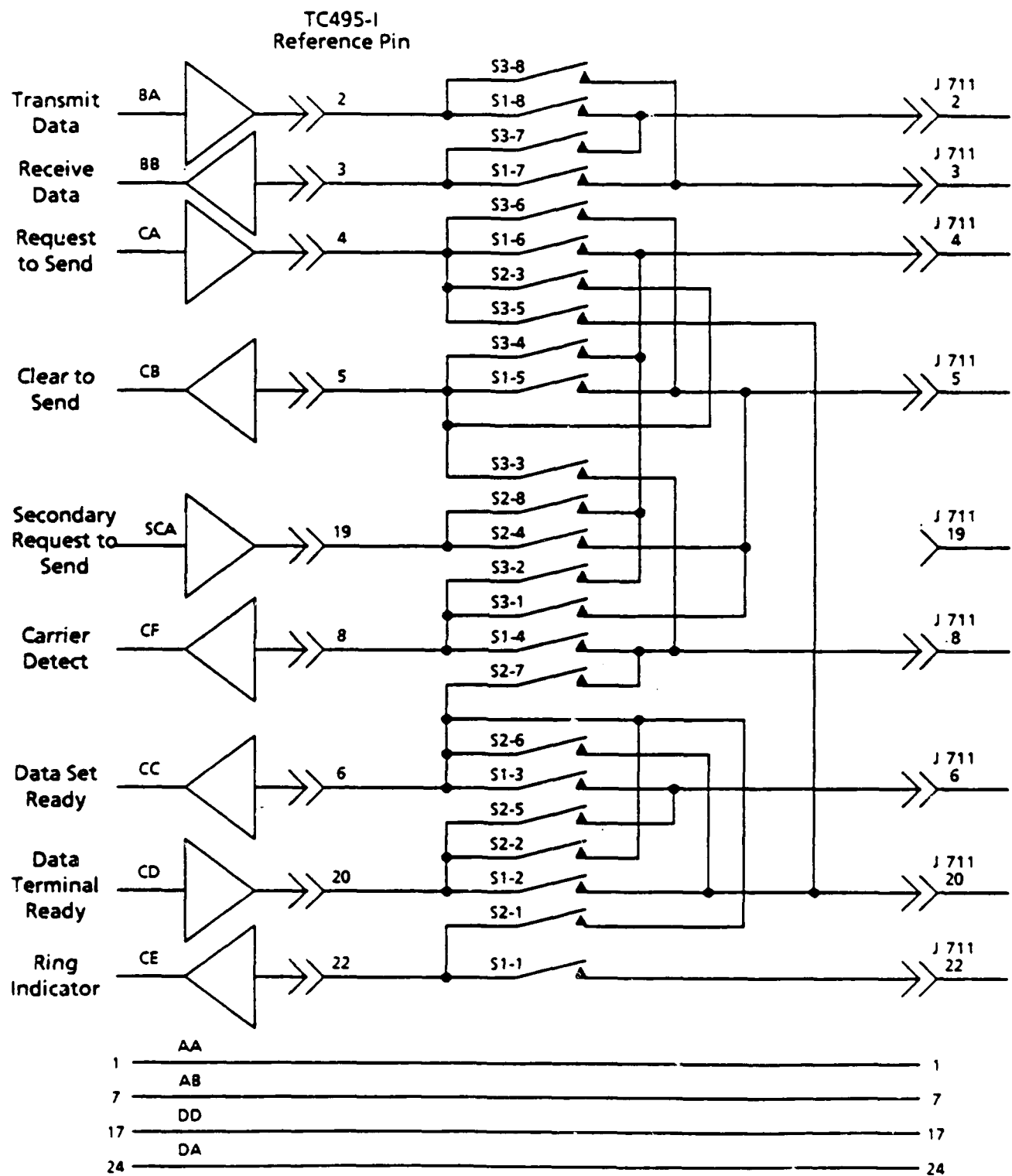


Figure 2-4c. RS-232-C Crossover Switch Schematic Diagram.

2.1.4 Cable and Connector Information.

A 10-foot, 25-conductor, male-to-male cable is provided for the RS-232-C interface connection (Xerox PN 152S24160); however, the interconnecting cable may extend to a maximum of 50 feet. Alternative cable lengths may be ordered from Xerox using the following reorder numbers:

<u>Cable Length</u>	<u>Male-to-Male Reorder Number</u>	<u>Male-to-Female Reorder Number</u>
10'	Standard	9R80250
15'	9R80252	9R80253
25'	9R80254	9R80255
50'	9R80256	Not available

The mating cable to the TC495-I must provide a 25-pin RS232 (male) connector plug.

2.2 SETTING ASYNCHRONOUS COMMUNICATION PARAMETERS.

Asynchronous communication, as used with the RS-232-C interface, requires that each string of bits that defines a transmitted data element be preceded by a "start" bit and followed by one or more "stop" bits.

The RS-232-C interface communications parameters are set by using a Xerox TC495-I RS-232 Interface Setup Card as shown in figure 2-5. The TC495-I scans this card and reads the marks placed in the various boxes that designate the communication parameter settings you desire.

Communications parameters that may be set using this card are:

1. Bit Rate: 110, 300, 600, 1200, 2400, 4800, 9600 bps or 19.2 Kbps.
2. Bits per Character: 7 or 8 bits.
3. Parity Bit: none, odd, or even.
4. Stop Bits: 1 bit, 1 1/2 bits, or 2 bits.
5. Signal Polarity: Normal or Inverted

The TC495-I will accomodate any combination of these parameters that the host computer requires; however, the parameters must be set before the communications link can be established. Additional parameters that can be set using the Xerox TC495-I RS-232 Interface Setup Card will be described later.

RS232 INTERFACE SETUP CARD



Figure 2-5b. RS-232 Setup Decal.

2.2.1 Asynchronous Transmission Rates.

The TC495-I RS-232 Interface may be configured to operate at data rates up to 19,200 bits per second (bps) using asynchronous transmission in a half duplex mode. "Half duplex" means that commands or data can be transmitted in both directions, but not at the same time.

In communications between devices a set of rules that govern the format of message exchanges called a protocol determines which device gets to "talk" and which one must "listen" at a given time. The protocol compatible with the RS-232-C interface is defined by the TC495-I and dictates the manner in which the host computer or other devices must communicate with the TC495-I.

2.2.2 Asynchronous Message Coding.

The TC495-I uses the American Standard Code for Information Interchange (ASCII). The ASCII character set is used for the interchange of information among a large number of data processing systems, communications systems, and associated equipment. Either seven bits or eight bits may be used to represent characters in the ASCII code. An 8-bit ASCII code set, as shown in figures 2-6a and 2-6b, is supported by the TC495-I/Host communications link.

The ASCII code set consists of three general categories: device control characters, data link control characters, and graphics characters. There are 32 control characters, and 224 graphics characters available in the TC495-I code set. (If the communications parameters are set to 7 bits per character, the mosaic-graphics characters and some unique European alphabetic characters will not be available since they require an eighth bit.)

2.2.3 External/Internal Character Sets.

The TC495-I has two character sets: an "external" character set and an "internal" character set. The external character set, as shown in Figure 2-6a, consists of 256 characters, including the standard ASCII 7-bit 128-character set (00H through 7FH). The standard ASCII control characters occupy the first 32 positions (00H through 1FH). With the eighth bit enabled, the external character set provides a complete set of mosaic-graphics (80H through BFH), line graphics (C0H through CAH), and certain special and foreign alphabetic characters (CBH through FFH).

In order to accommodate all of the required foreign alphabetic characters, an internal character set is utilized, as shown in Figure 2-6b, that eliminates the 32 ASCII control characters (00H through 1FH). Since these are "non-printing" characters, they are required only in the "external" environment. They are replaced in the internal character set by additional foreign alphabetic characters. These characters are accessed through a 2-byte sequence, the first byte of which is the ASCII control character "US" (shift-in or 1FH). The second byte, as illustrated in Figure 2-6c, determines which character prints. The "translation" between external and internal character sets is accomplished automatically by the TC495-I; however, you may wish to develop your own "translation" program to accomplish the 2-byte sequence with a single keystroke if using a language that requires these characters.

			B8=0								B8=1							
			0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
0	NUL	DLE	SP	0	@	P	'	p			.	.	=	-	i	ú	ó	
1		DC1	!	1	A	Q	a	q	*	:	:	:	:		i	ú	ó	
2		DC2	"	2	B	R	b	r	*	:	:	:	:	+	i	ú	ó	
3		DC3	#	3	C	S	c	s	=	:	:	:	:	r	i	ú	ó	
4			\$	4	D	T	d	t	.		:	:	:	L	e	æ	z	
5			%	5	E	U	e	u			:	:	:	7	C	Æ	z	
6			&	6	F	V	f	v	:	:	:	:	:	J	i	ú	ó	
7			'	7	G	W	g	w	:	:	:	:	:	T	i	ú	ó	
8	BS		(	8	H	X	h	x	.	:	:	:	:	L	i	ú	ó	
9	HT		)	9	I	Y	i	y	:	:	:	:	:	+	i	ú	ó	
A	LF		*	:	J	Z	j	z		:	:	:	:	o	ä	æ	ö	
B		ESC	+	:	K	[	k	(	:	:	:	:	:	ä	ä	Ë	É	
C	FF		,	<	L	\	l		=	:	:	:	:	-	ä	ü	ö	
D	CR		-	=	M	]	m	)	:	:	:	:	:	&	ä	ü	ö	
E			.	>	N	^	n	~	:	:	:	:	:	*	ä	ü	ö	
F			/	?	O	_	o	~	:	:	:	:	:	4	ä	ü	ö	

Figure 2-6a. TC495-I ASCII 8-bit Codes (External).

	B8=0								B8=1							
	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
0	0	-	SP	0	Q	P	'	P	.	.	.	.	i	i	U	o
1	1		!	1	A	Q	q	q	.	:	:	.	¥	i	U	o
2	2	+	"	2	B	R	b	r	.	:	:	.	5	i	U	o
3	3	r	#	3	C	S	c	s	.	:	:	.	X	i	U	o
4	4	'A	L	4	D	T	d	t	.	:	:	.	ß	e	.	o
5	5	'A	7	5	E	U	e	u	i	i	L	L	±	C	Æ	z
6	6	^A	J	6	F	V	f	v	.	:	:	.	X	i	U	o
7	7	:"A	T	7	G	W	g	w	P	P	E	E	4	i	U	o
8	8	~A	L	8	H	X	h	x	.	:	:	.	9	i	U	o
9	9	°A	+	9	I	Y	i	y	.	:	:	.	÷	i	U	o
A	'E	'	x	:	J	Z	j	z	i	i	L	L	0	.	o	o
B	'E	7	+	;	K	[	k	(	.	:	:	.	.	.	E	E
C	^E	/	,	<	L	\	l	l	.	:	:	.	-	.	ij	.
D	:"E	✓	-	=	M	]	m	)	.	:	:	.	.	.	D	B
E	~E	x	.	>	N	^	n	~	.	:	:	.	.	.	%	.
F	°E	✓	/	?	O	_	o	o	.	:	:	.	%	.	%	.

Figure 2-6b. TC495-I ASCII 8-bit Codes (Internal).

60	61	62	63	64	65	66	67
°	°	^	°	°	°	°	°
68	69	6A	6B	6C	6D	6E	6F
~	°	°	°	°	°	°	°
A	A	E	E	E	E	n	N
70	71	72	73	74	75	76	77
i	≠	§	×	β	±	α	γ
78	79	7A	7B	7C	7D	7E	7F
¶	÷	L	7	°	°	°	°

Figure 2-6c. Two-byte Character Set.

2.3 DATA LINK CONTROL PROCEDURES.

To successfully control the operation of the TC495-I, the host computer must be programmed to establish the necessary data link, transfer commands and data, and terminate the data link at the completion of an operation.

The TC495-I can be operated in any one of four modes: STANDBY, FACSIMILE, PENDING, or COMPUTER. The TC495-I's mode of operation is determined by signal level changes on specific lines of the RS-232-C interface or data contained in commands sent to it from the host computer.

Figure 2-7 presents a state diagram illustrating the transitions from mode-to-mode. Details regarding each mode are given in the subsequent text.

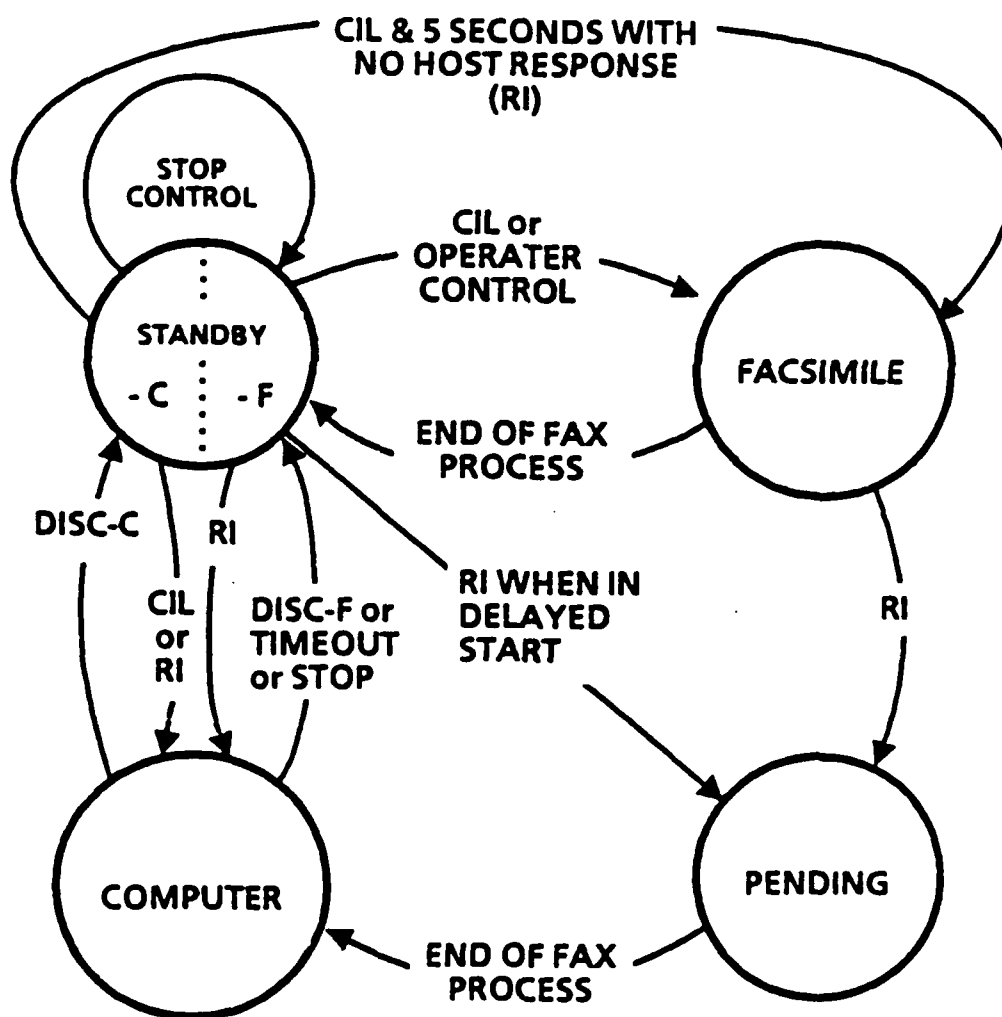


Figure 2-7. TC495-I State Diagram.

The data link between the host and the TC495-I is established by means of the procedures (protocol) explained in this section. When the host initiates communications it detects establishment of the data link, requests permission to send a message, and waits for approval from the TC495-I. Data transmission can begin only after the TC495-I grants its permission.

There are two distinct transmission modes or "levels" at which the TC495-I operates: the "TTY" or character mode and the "block" or message mode. In the TTY or character mode, transmission proceeds a character at a time. Both units look for and respond to the ASCII control characters. In the block or message mode, the two units look for and respond only to the formatted messages described in Section 4.

When the host initiates transmission, the TC495-I first informs the host that it's in COMPUTER mode at the "TTY level". Operator actions at the TC495-I control panel, except for STOP, are locked out and the host system can control the TC495-I's various features. When the TC495-I is in the COMPUTER mode, commands can be issued by the host computer and data exchanged between the two units.

At the "TTY level" the TC495-I can print ASCII characters on the local printer, answer SETIDM, REPORT, or REPIDM commands from the host, and move to the "block mode" when a JOB command is received. The TC495-I returns to "TTY mode" when the job is complete or when it receives a STOP command. Anytime the TC495-I receives a DISCONNECT command, it will terminate the job and return to the appropriate STANDBY mode.

At the "block mode" level, the TC495-I is in one of the modes indicated below, depending on the sequence of exchange of commands and responses:

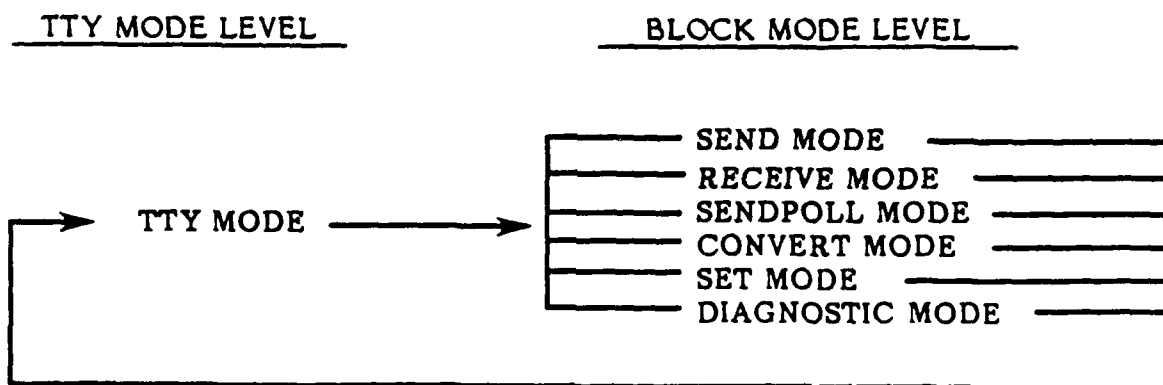


Figure 2-8. TTY Mode/Block Mode Levels.

2.3.1 Establishing the Data Link - Host to TC495-I.

The TC495-I normally waits in the low power (standby) state. There are two standby sub-states; C (computer) and F (facsimile). From the STANDBY-F sub-state the TC495-I will go to the FACSIMILE mode when the CIL (ring indicator) signal from the telephone line coupler, or the activation of a button on the operator's panel, is detected. In the FACSIMILE mode, operation by the host is locked out until facsimile operation is completed. The TC495-I operates normally for document transmission and reception in the FACSIMILE mode (i.e., the same as a TC495-I without the interface option).

If the Ring Indicator signal (pin 22) from the host becomes active while the TC495-I is in the FACSIMILE mode, it moves to the PENDING mode and stays in this mode until the current facsimile operation is completed. While in the PENDING mode, the TC495-I responds only to "REPORT", or "REPIDM" commands from the host computer. When the FACSIMILE operation is completed it moves directly into the COMPUTER mode.

If the Ring Indicator signal (pin 22) from the host becomes active while the TC495-I is in the STANDBY-C sub-state, or in the STANDBY-F sub-state, it moves directly into COMPUTER mode. The TC495-I sets its Data Terminal Ready (DTR) signal (pin 20) high, informing the host that it's in COMPUTER mode at the TTY level. Operator actions, except STOP, at the TC495-I control panel are locked out and the host system can control all of the TC495-I features.

The host system will release control of the TC495-I only under the following conditions:

- a. When the "STOP" control is depressed while in the COMPUTER mode, causing the Data Terminal Ready (DTR - pin 20) signal to turn off, terminating the job and returning the TC495-I to the STANDBY-F mode.
- b. If the Data Set Ready (DSR - pin 6) remains in an off state for more than 1 second, then the Data Terminal Ready (DTR - pin 20) signal is turned off, the job is terminated and the TC495-I goes to STANDBY-F mode.
- c. When the "DISCONNECT" command is received, the TC495-I replies with a "STATUS RESPONSE" message, then turns off the Data Terminal Ready (DTR -pin 20) signal, terminates the job and goes to STANDBY-C or STANDBY-F mode depending on the disconnect command.

2.3.2 Transferring Data - Host to TC495-I

The host detects establishment of the data link by checking the level of the Data Set Ready (DSR - pin 6) signal. If it's high, the host sets the Request To Send (RTS - pin 4) signal high and waits for a Clear To Send (CTS - pin 5) from the TC495-I. Data transmission can begin when the Clear To Send Signal goes high. If the Clear To Send signal remains low, transmission is delayed until it goes high.

Data transmission is initially enabled in the "TTY mode"; however, the host can transmit a "JOB" command shifting the TC495-I to the "block mode" level. The TC495-I returns to "TTY mode" level when the job is complete or when it receives a "STOP" command. Anytime TC495-I receives a "DISCONNECT" command, it terminates the job and returns to the appropriate STANDBY mode.

Figure 2-9 presents a diagram of the line protocol for the establishment of the data link and the transfer of data between the host and the TC495-I.



2.3.3 Data Flow Control Procedure.

Whenever the Ring Indicator (RI) signal is activated by the host computer, the TC495-I will enter the COMPUTER mode at the "TTY level". The signal flow in this mode is from host to TC495-I, and the data link is controlled by the TC495-I using XON-XOFF protocol.

If the TC495-I's receive buffer is busy, all data received from the host is ignored. The TC495-I turns off the Control Clear to Send signal (CCTS, pin 19) and simultaneously transmits an XOFF character (Hex 13) when the receive buffer is nearly full (2 bytes or less available). When the buffer is ready to receive more data (108 bytes or more available), the TC495-I turns the CCTS signal, pin 19, back on and transmits an XON character (Hex 11).

Additionally, the Data Terminal Ready (DTR) signal (pin 20) will go high when the TC495-I is in the COMPUTER mode. The host must set the TC495-I's Data Set Ready (DSR) input (pin 6) high within 4 seconds and send a message to shift to the "block mode level". Otherwise, the TC495-I will timeout and return to the STANDBY-F mode.

2.3.4 Transferring Data - TC495-I to Host.

Before attempting to transmit a message to the host, the TC495-I performs a check of the Received Line Signal Detect signal (RLSD - pin 8). If the RLSD signal is positive, all subsequent actions are disabled until the message being transmitted by the host has been received and acted upon.

If the RLSD signal is negative, indicating no transmission by the host, then the TC495-I turns on the Request to Send signal (RTS - pin 4). It then checks the Clear to Send signal (CTS - pin 5) and, if CTS is positive, transmits the message to the host. If the CTS signal is negative, transmission is delayed until CTS goes positive. Figure 2-10 illustrates the TC495-I/Host line protocol.

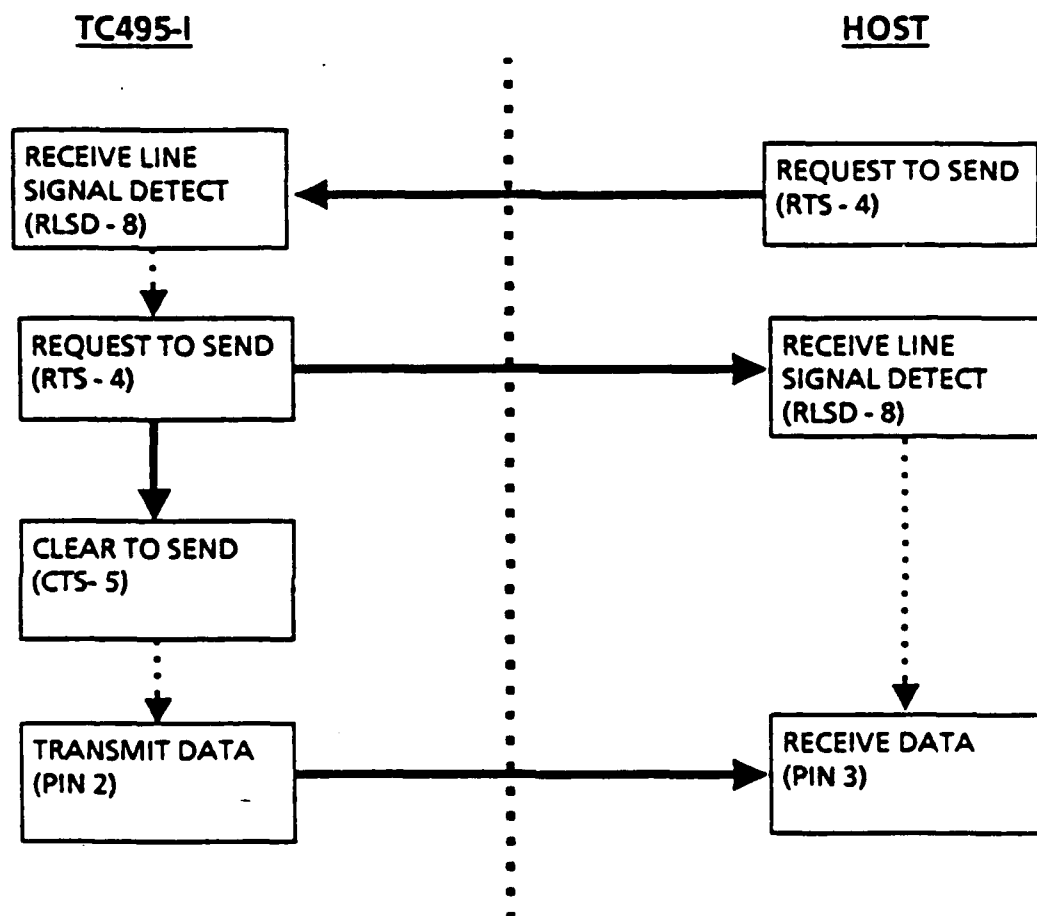


Figure 2-10. TC495-I/Host Line Protocol.

2.3.5 Transferring Data - TC495-I/Modem.

When the TC495-I is connected directly to the host, as shown in figure 2-1a, the RTS output is fed directly back to the CTS input assuring an immediate positive reply. However, in the case of the TC495-I to modem connection, as shown in figure 2-3a, the TC495-I has to wait until the modem indicates that it is ready to receive by setting the CTS input positive. Figure 2-11 illustrates the TC495-I/modem line protocol.

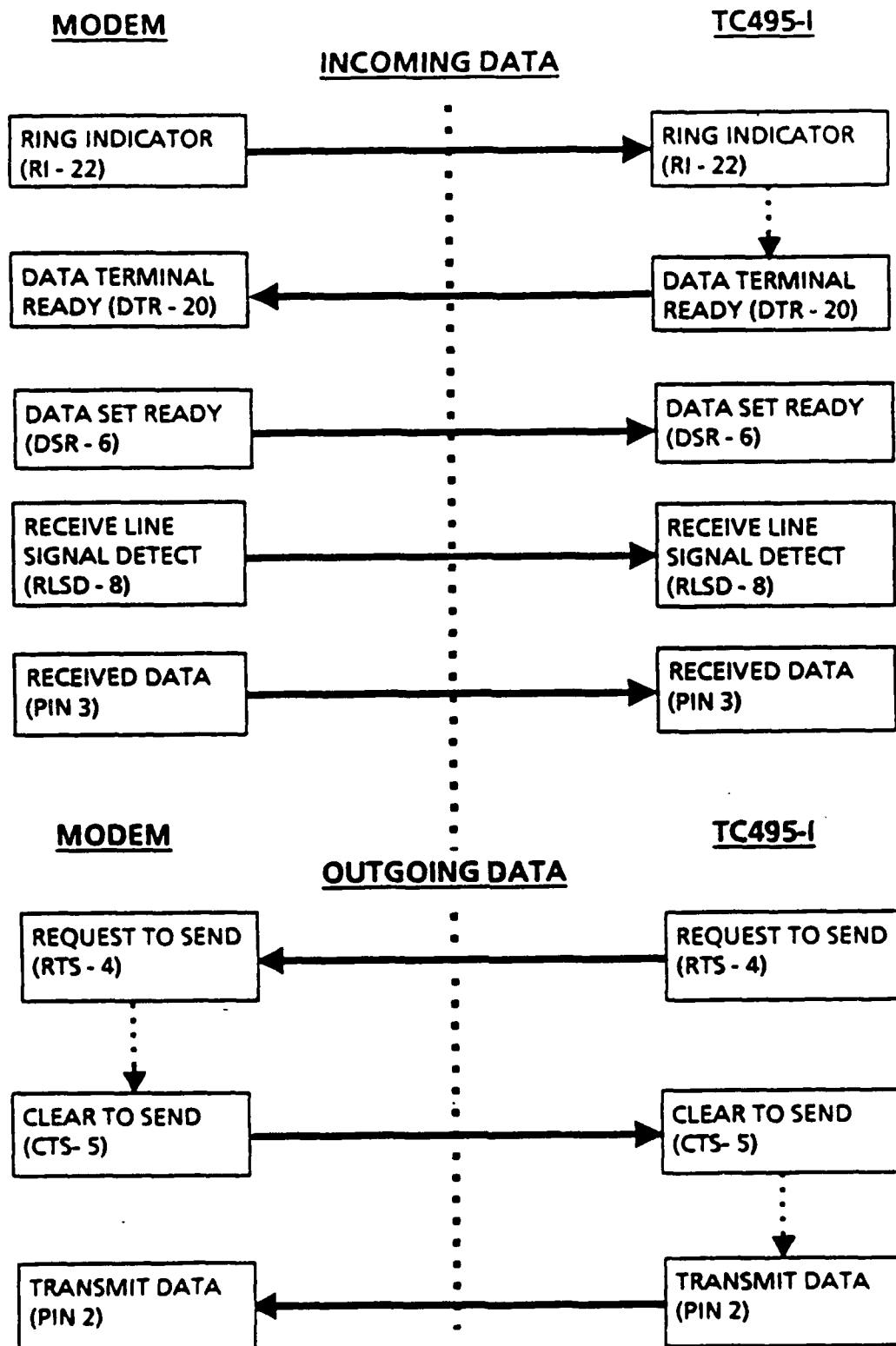


Figure 2-11. TC495-I/Modem Line Protocol.

SECTION THREE

PRINTING FORMATS

3.0 GENERAL.

In any type of printing, whether it's done on a typewriter, a character printer, or by a facsimile machine, there are certain basic characteristics of the output that have to be decided. In the case of the TC495-1, some of the printing characteristics are set by use of the RS-232 Interface Setup Card (figure 2-3) and others are set online by the host.

The following paragraphs describe the available parameter settings and the procedures for setting and resetting these parameters.

3.1 PAGE FORMATS.

The print characteristics that may be set (or reset) by the RS-232 Interface Setup Card determine the basic page format:

- a. Horizontal spacing (character pitch - default = 12)
- b. Vertical spacing (line pitch - default = 6)
- c. Page length (lines per page - default = 66)
- d. Left Margin (default = 0.5 inch)
- e. Right Margin (default = 0.0 inch).

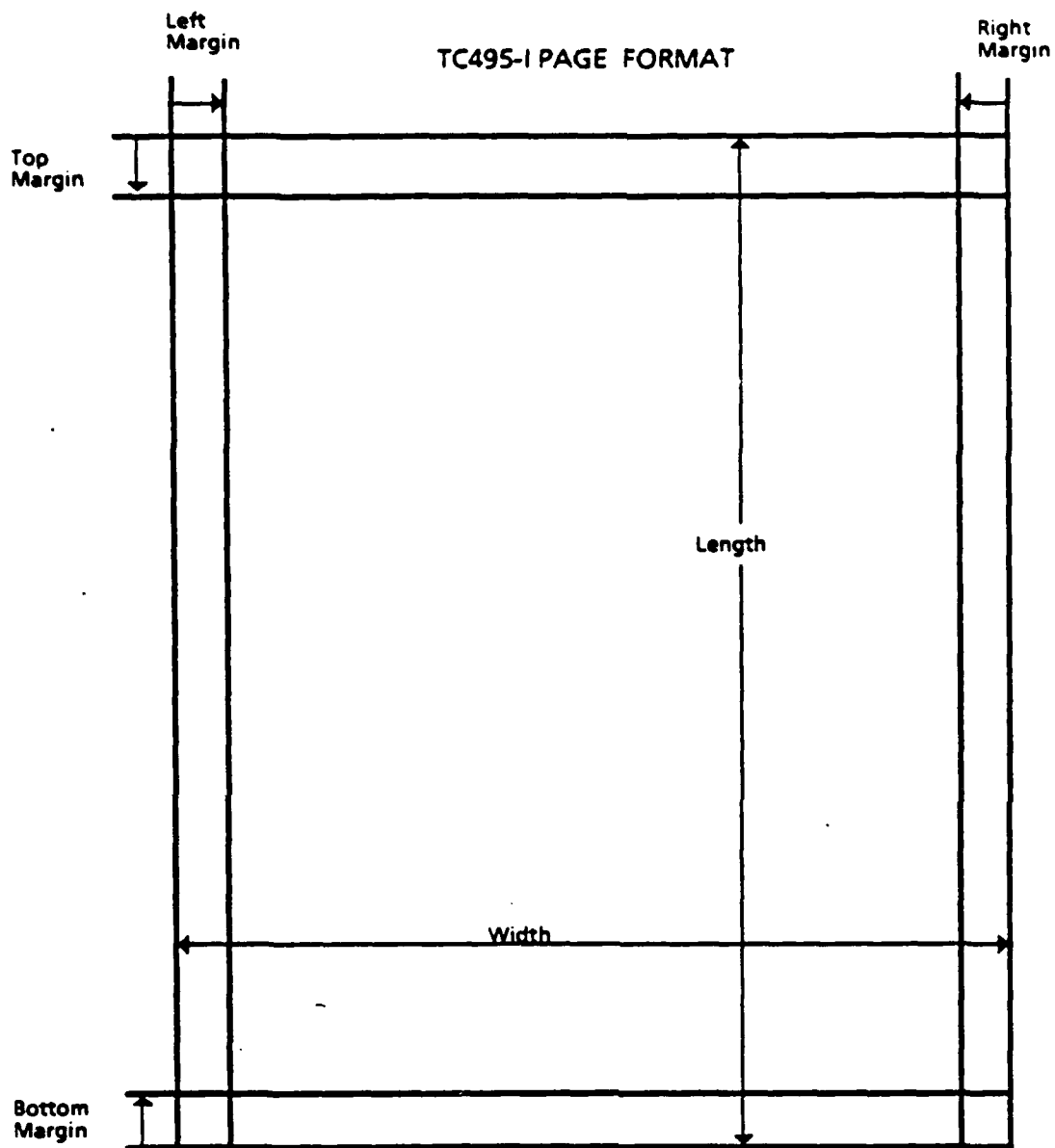
The left and right margins can be reset by a command from the host computer. In addition, both the top and bottom margins can also be reset by commands from the host.

The TC495-1 is an all-points-addressable (APA) printer with approximately 200 X 200 pel per inch resolution. The dimensions of the individual print "cells" in which a character or an image is printed is 16 pixels by 24 scans. The available printing width of 8.5 inches per scan contains 1728 pixels, while a vertical page length of 11 inches contains 2287 scans.

The maximum number of characters and line positions for ISO A4 or North American letter size pages is shown below.

	<u>A4</u>	<u>No. Amer.</u>	
<u>10 CPI</u>	84	84	<u>characters per line</u>
<u>12 CPI</u>	105	106	<u>characters per line</u>
<u>6 LPI</u>	70	66	<u>lines per page</u>
<u>8 LPI</u>	93	88	<u>lines per page</u>

Figure 3-1 illustrates the page layout parameters.



	<u>SIZE</u>	<u>Number of Lines (6LPI)</u>	<u>Number of Lines (8 LPI)</u>		<u>Maximum</u> <u>Number of Characters per line</u>	
					<u>LETTER</u>	<u>A4</u>
LETTER	8.5x11 in.	66	88	10CPI	84	84
A4	210x297 mm	70	93	12 CPI	106	105

Figure 3-1. TC495-I Page Layout Parameters.

3.2 PRINTING CONTROLS.

Table 3-2 provides a listing of the control codes for setting various parameters and controlling the output format.

3.2.1 Horizontal and Vertical Spacing.

The TC495-I printing format is dependent on horizontal character spacing and vertical line spacing. The system values are 12 or 10 character per inch horizontally and 6 or 8 lines per inch vertically. The choice of these parameters should be made at the time the system is set up by appropriately marking the RS-232 Interface Setup Card.

3.2.2 Page Length (Lines per Page).

The page length can be set to North American Letter size (8.5 X 11 inches) or European A4 size (210 X 297 mm.) with the TC495-I's RS-232 Interface Setup Card. Variable page lengths from 26 to 255 lines per page may be set if 8-bit ASCII code is used; however, the upper limit is 127 lines per page if 7-bit ASCII code is used. The upper page limit is set by transmitting the sequence `"!ESC I FF (binary value)"`, where the binary value is equal to the desired number of lines per page. (Actual page length depends on whether the vertical spacing is set to 6 lines per inch or 8 lines per inch.) Default values are 66 lines per page for North American letter size pages and 70 lines per page for European A4 size pages (both at 6 lines per inch vertical spacing). The TC495-I will cut the receiving paper to either size.

3.2.3 Top and Bottom Margins.

The host system can also set the top and bottom margins of a page by transmitting the sequence `"!ESC I T"` or `"!ESC I L"`, respectively, when the virtual carriage is set at the desired top or bottom margin position. Otherwise the default margins of 2 lines top and bottom are utilized.

3.2.4 Right and Left Margins.

The host can also set the right and left margins by transmitting the sequence `"!ESC I 0"` when the virtual carriage is set at the desired right margin position or `"!ESC I 9"` when the virtual carriage is set at the desired left margin position. Otherwise default margins of 8 characters for the left margin and 0 (zero) characters for the right margin are utilized. (Actual length of margins depends on the character pitch.)

3.2.5 Resetting Margins.

All four of the margins (top, bottom, left and right) can be cleared by transmitting the sequence `"!ESC I C"`. Clearing the margins with this command automatically sets the right and left margins to zero and the top and bottom margins to two lines.

3.2.6 Carriage Return and Line Feed.

A carriage return code from the host ('0D' Hex) performs a combination carriage return/linefeed (CR/LF). The virtual carriage moves to the left edge of the printable area and the paper moves up one line. Whenever the characters to be printed exceed the right-hand margin, a combination carriage return/linefeed is automatically executed, and the virtual carriage returns to the left-hand margin.

Whenever the virtual carriage crosses the lower margin, the recording paper is fed out to the next page and printing resumes at the top margin. The same function is performed whenever the TC495-I receives the form feed code 'FF' ('OC' Hex) from the host. A line feed code from the host ('OA' Hex) is ignored.

3.2.7 Horizontal Tabulation.

The host may set horizontal tab stops by positioning the virtual carriage to the desired tab position(s) and then transmitting the sequence "!ESC I 1". All previously set tab stops may be cleared by transmitting the sequence "!ESC I 2". Individual tab stops may be cleared by positioning the virtual carriage to the stop position to be cleared and transmitting the sequence "!ESC I 8". The default tab stops are set at every eighth character position.

When the TC495-I receives the code 'HT' (horizontal tab), the virtual carriage moves to the right to the first tab stop. If there is no tab stop to the right of the current carriage position, then an automatic carriage return/linefeed is executed and the next character is printed at the left edge of the printable area. If the TC495-I receives an 'HT' code when no tab stops are set, it automatically converts the 'HT' code to a space.

3.2.8 Back Spacing.

The backspace (BS) code moves the virtual carriage 1 space to the left. The last character received prior to a BS code is replaced with the character following the BS code. If the last character in a line is followed by a BS code, the BS code is ignored. (The BS code is treated as the first character of the next line.) A carriage return (CR) code cannot be replaced for the same reason.

Table 3-2. TC495-I Control Codes.

<u>CODE (Hex)</u>	<u>NEMONIC</u>	<u>FUNCTION</u>
08	BS	Backspaces carriage one position and delete previous information
09	HT	Moves carriage to next tab stop
0C	FF	Form feed (moves to top of form)
0D	CR	Carriage return/linefeed
1B,30	ESC 0	Set right margin at carriage position
1B,31	ESC 1	Set tab stop at carriage position
1B,32	ESC 2	Clear all tab stops
1B,38	ESC 8	Clear tab stop at carriage position
1B,39	ESC 9	Set left margin at carriage position
1B,0C,n	ESC FF,n	Set lines per page to 'n', where 'n' = 26 to 127 (7 bits) or 255 (8 bits) (binary)
1B,43	ESC C	Clear top, bottom, left, and right margins
1B,4C	ESC L	Set bottom margin at carriage position
1B,54	ESC T	Set top margin at carriage position

SECTION FOUR

COMMAND/RESPONSE MESSAGES

4.0 GENERAL

The data link between the host and the TC495-I is established by means of the procedures (protocol) explained in Section 2. When the host initiates communications it detects establishment of the data link, requests permission to send a message, and waits for approval from the TC495-I. Data transmission can begin only after the TC495-I grants its permission.

The TC495-I starts in COMPUTER mode at the TTY level. Operator actions at the TC495-I control panel, except for STOP, are locked out and the host system controls the TC495-I. At the TTY level the TC495-I prints ASCII characters on the local printer, answers SETIDM, REPORT, or REPIDM commands from the host, and moves to the block mode when a JOB command is received. The TC495-I returns to TTY mode when a job is completed or when it receives a STOP command. Anytime the TC495-I receives a DISCONNECT command, it will terminate the job and return to the appropriate STANDBY mode.

4.1 BLOCK MODE MESSAGE FORMAT

The block mode supports data exchanges between the host and the TC495-I. If the data unit is 8-bits, then all data flow paths defined in Appendix A, Table A-1 are available. If the data unit is restricted to 7-bits, then image and compressed (MH/MR) data can neither be sent nor received by the host computer. Figure 4-1 presents the message format for all data blocks. Detailed explanations of the block content and of the acronyms used follows.

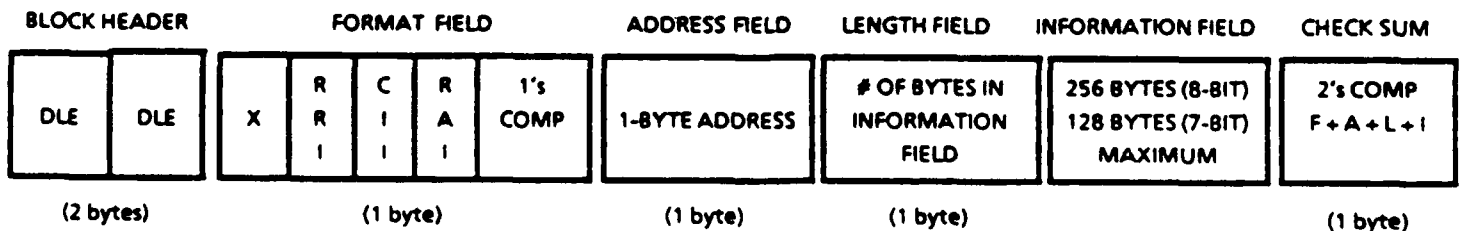


Figure 4-1. Block Mode Message Format.

4.1.1 Block Header.

The "block header", which precedes each "block mode" message, is a pair of "DLE" characters (10 Hex).

4.1.2 Format Field.

The format field is a single byte, which consists of three "switch" settings. The first bit of the format field is an "undefined" bit if 8-bit bytes are transmitted. All "undefined" bits in "block mode" messages should be set to 0 (logic zero) whenever possible. The "undefined" bit is not present if 7-bit bytes are transmitted. The other bits are determined as follows:

- a. RRI: Retransmit Request Indicator - set to "1" if retransmission of the last message is desired. The length, information and check-sum fields of this message are ignored when retransmission of the previous message is requested. RRI is set to "0" if the previous block is accepted.
- b. CII: Check-Sum Included Indicator - set to "1" if a check-sum is included in this message. CII is set to "0" if a check-sum is not included.
- c. RAI: Resend Available Indicator - set to "1" if the transmitting unit has the ability to resend this message. If a check-sum error is detected by the receiving unit, it may request retransmission by setting its RRI to "1". RAI is set to "0" if a check-sum error is to be ignored by the receiving unit. The block is processed as received.
- d. COMP: Least significant three bits are the one's complement of the three preceding "switch" or "flag" bits in this field.

4.1.3 Address Field.

A 1-byte field set by the RS-232 Interface Setup Card. The default value for this field is 00H. When the host is transmitting, this field indicates the address of the recipient of the message. The host will transmit no other blocks until a valid response is received from the addressed unit or a timeout occurs. A TC495-I will process only those blocks containing its assigned address.

When the TC495-I is transmitting, this field indicates the address of the source of the message. A valid response will contain the address of the TC495-I generating the response. This allows multiple TC495-I units to communicate with a single host computer.

4.1.4 Length Field.

A 1-byte field that indicates the number of bytes contained in the following information field. The receiving unit ignores all data which exceeds the length of the information field as given in this field. If the data received is less than the number of bytes specified, then the data received is processed and timeout will occur 100ms after receipt of the last byte. The total number of bytes that can be transmitted is determined by whether the data unit is 7-bits or 8-bits. The largest number that can be expressed in a 7-bit byte is 127 (1111111 binary). Therefore, the longest message length that can be transmitted using 7-bit data units is 128 bytes. This is accomplished by programming the TC495-1 to recognize the number 0 (zero) as indicating an information field length of 128 bytes.

8-bit Data Unit:

00H	-	indicates 256 bytes
01H	-	1 byte
02H	-	2 bytes
.	.	.
.	.	.
.	.	.
FEH	-	254 bytes
FFH	-	indicates 255 bytes

7-bit Data Unit:

00H	-	indicates 128 bytes
01H	-	1 byte
02H	-	2 bytes
.	.	.
.	.	.
.	.	.
7EH	-	126 bytes
7FH	-	indicates 127 bytes

4.1.5 Information Field.

This field, which contains either commands, data, or both is variable in length from a minimum of a single byte to a maximum of 128 bytes (7-bit data unit) or 256 bytes (8-bit data unit). The data in this field may be ASCII, Image, or Compressed (Modified Huffman or Modified Read).

4.1.6 Check-Sum Field.

This field, which is optional, contains a single byte check-sum of the preceeding bytes (except for the block header). The check-sum is the two's complement of the sum of the format, address, length, and information fields.

4.2 COMMAND MESSAGES.

For the purpose of the discussion that follows, COMMANDS are messages generated by the host computer and RESPONSES are messages generated by the TC495-I. Four types of commands may be received by a TC495-I and two types of responses may be generated:

<u>COMMANDS</u>	<u>RESPONSES</u>
Privileged Commands	Status Responses
Job Commands	Status Responses
Data Transfer Commands	Data Transfer Response
Set ID/Time Command	Status Response

Commands and responses are contained in the information fields of messages exchanged between the TC495-I and the host computer.

4.2.1 Privileged Commands.

The privileged commands, which may be issued any time the TC495-I is in the computer mode, and their expected responses, are listed below.

<u>PRIVILEGED COMMANDS</u>	<u>CODES</u> <u>BINARY</u> <u>HEX</u>	<u>LENGTH</u> <u>(BYTES)</u>	<u>NORMAL</u> <u>RESPONSE</u>	<u>ERROR</u> <u>RESPONSE</u>
DISCONNECT	X0010000 10	2	STATUS	NONE
STOP	X0010001 11	1 or 2	STATUS	NONE
REPORT	X0010010 12	1	STATUS	NONE
REPIDM	X0010011 13	1	STIDM	NONE

- DISCONNECT Command - returns TC495-I to appropriate STANDBY. (DISCONNECT is not considered a privilege command during the PENDING Mode.)

	<u>Byte 1</u>	<u>Byte 2</u>
- Fax Standby Disconnect (DISC-F)	10H	00H
- Computer Standby Disconnect	10H	01H

- STOP Command - forces job termination without a DISCONNECT.
 - Two byte STOP Command is used to terminate Touch Tone jobs.
- REPORT Command - interrogates TC495-I for STATUS.
- REPIDM Command - requests time/date and local ID from the TC495-I.

These commands would appear in a data block as follows:

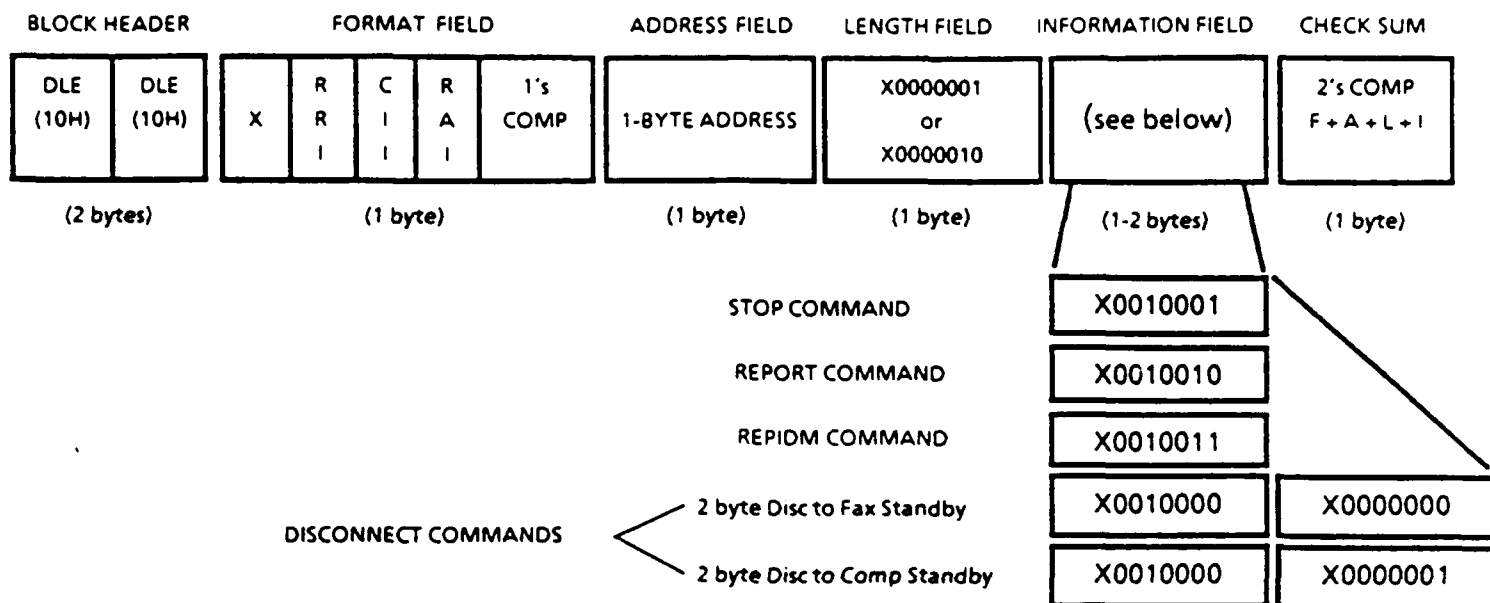


Figure 4-2. Privileged Command Message Formats.

4.2.2 Job Commands.

The job commands are all 5-byte commands, three of which may be accompanied by additional data. The job commands, and their expected responses, are listed below.

JOB COMMANDS	CODES BINARY HEX	LENGTH (BYTES)	NORMAL RESPONSE	ERROR RESPONSE
DIAGNOSTIC	X0100000 20	5	STATUS	NONE
SEND	X0100001 21	5*	STATUS	NAK
RECEIVE	X0100010 22	5*	DATA	NAK
SENDPOLL	X0100011 23	5*	STATUS	NAK
CONVERT	X0100100 24	5	STATUS	NAK
COPY	X0100101 25	5	STATUS	NAK

* indicates the 5-byte command sequence may be followed by up to a 28-digit telephone number and/or up to a 21-digit remote identification.

4.2.2.1 DIAGNOSTIC Command - initiates a diagnostic test of the TC495-I, reporting the results back to the host. The same test may be initiated by depressing the !STOP1 and !TEST1 buttons on the TC495-I control panel.

The DIAGNOSTIC command would appear in a data block as follows:

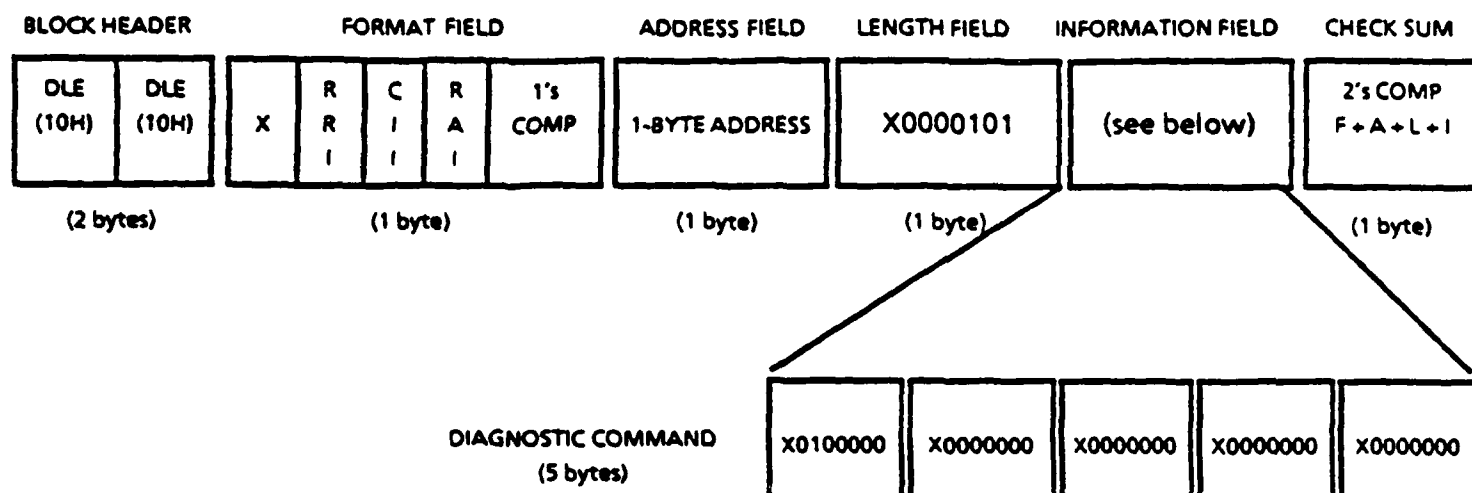


Figure 4-3. DIAGNOSTIC Command Message Format.

4.2.2.2 SEND Command - initiates transmission of data depending on the source and destination addresses specified.

<u>DATA SOURCE</u>	<u>DATA TYPE</u>	<u>DESTINATION</u>	<u>DATA TYPE</u>
Host Computer	ASCII	Remote Gp 3	MH/MR
		Remote Gp 1/2	Image
		Local Printer	Image
	Image	Remote Gp 3	MH/MR
		Remote Gp 1/2	Image
		Local Printer	Image
	MH/MR	Remote Gp 3	MH/MR
		Remote Gp 1/2	Image
		Local Printer	Image
Local Scanner	Image	Remote Gp 3	MH/MR
		Remote Gp 1/2	Image

4.2.2.3 RECEIVE Command - initiates reception of data depending on the destination and source addresses specified. This command will also allow transfer of touch-tone digits to the host from the TC495-I.

<u>DESTINATION</u>	<u>DATA TYPE</u>	<u>DATA SOURCE</u>	<u>DATA TYPE</u>
Host Computer	MH/MR	Remote Gp 3 Remote GP 1/2 Local Scanner	MH/MR Image Image
	Image	Remote Gp 1/2 Local Scanner	Image Image
	ASCII	Local Scanner Remote Touch-Tone	Mark-sense DTMF tones
Local Printer	Image	Remote Gp 3 Remote Gp 1/2	MH/MR Image

4.2.2.4 SENDPOLL Command - initiates polling of a remote facsimile device by the TC495-I for reception of documents upon completion of the SEND operation.

4.2.2.5 COPY Command - initiates COPY function of the TC495-I. It is similar to a SEND command except that the source must be SCANNER and the destination must be PRINTER. The resolution must be 7.7 scans per mm. In addition, the telephone and remote ID options do not apply; therefore, the 'T' and 'I' flags must be set to 0 (logic zero).

The last four job commands (SEND, RECEIVE, SENDPOLL, and COPY) would appear in a data block as follows:

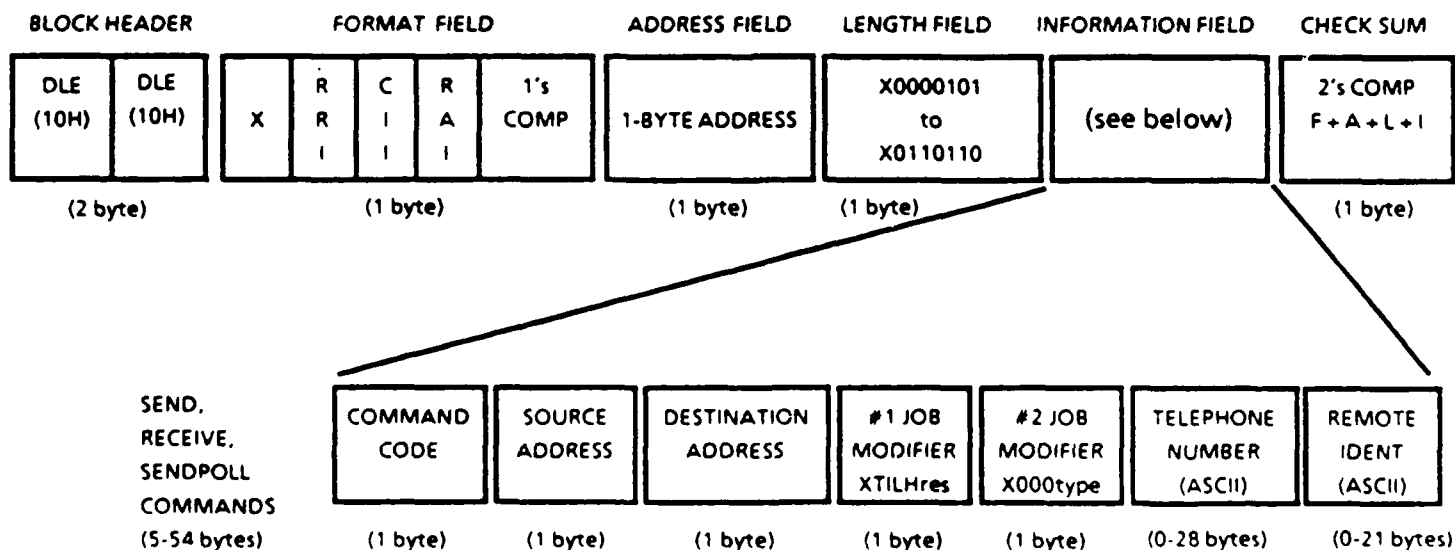


Figure 4-4. Job Command Message Formats.

#2 JOB MODIFIER:

type (data type)

- = 0000 for Modified Huffman
- = 0001 for Modified Read
- = 0010 for Image
- = 0011 for ASCII (Touch-Tone digits or Mark sense)

TELEPHONE NUMBER:

Optional field. If used, "T" flag in #1 Job Modifier must be set to "1". Variable length ASCII field that is terminated by (CR) (Hex 0D). Maximum length is 27 digits plus (CR).

REMOTE IDENT:

Optional field. If used, "I" field in #1 Job Modifier must be set to "1". Variable length ASCII field that is terminated by (CR) (Hex 0D). Maximum length is 20 characters plus (CR).

4.2.2.6 CONVERT Command - initiates the conversion of compressed (MH or MR) documents to uncompressed (Image) format.

The CONVERT command would appear in a data block as follows:

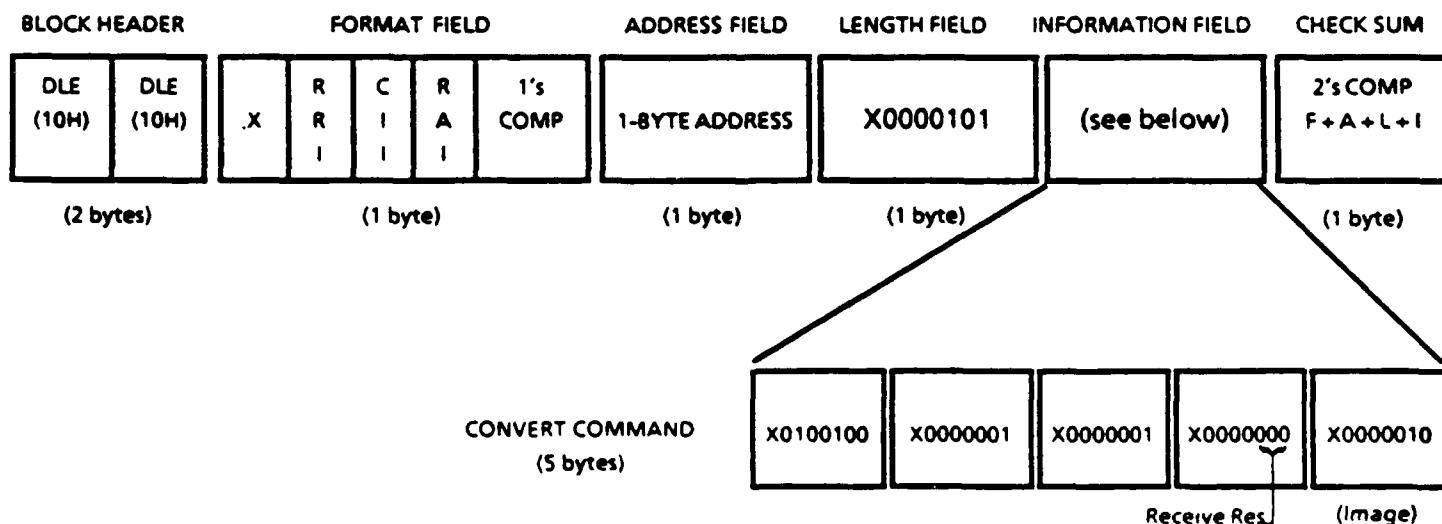


Figure 4-5. CONVERT Command Message Format.

4.2.3 Data Transfer Commands.

The data transfer commands order the actual exchange of facsimile data between the TC495-I and the host computer. The data transfer commands, and their expected responses, are listed below.

DATA TRSF COMMANDS	CODES		LENGTH (BYTES)	RESPONSE	
	BINARY	HEX		NORMAL	ERROR
READ	X0110000	30	1	DATA	NAK or STATUS
WRITE (1)	X0110001	31	3	ACK	NAK or STATUS
WRITE (2)	X0110001	31	2 *	ACK	NAK or STATUS

* indicates the command is 2-bytes plus the length of the data contained in the remainder of the information field.

4.2.3.1 READ Command - instructs the TC495-I to transmit a block of data using a DATA response.

The READ command would appear in a data block as follows:

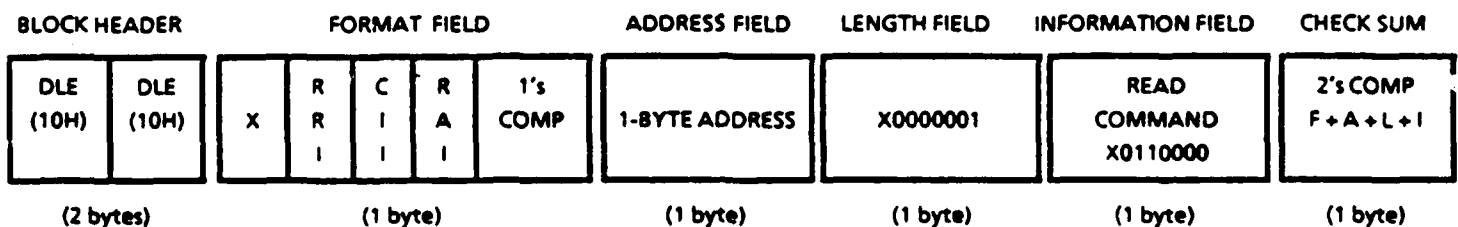


Figure 4-6. READ Command Message Format.

4.2.3.2 WRITE Command - initiates transmission of data from the host to the TC495-I. A type 1 WRITE command sets up the data flow and type 2 accomplishes the actual transfer. The next paragraph identifies the order of data sequence.

The WRITE commands would appear in a data block as follows:

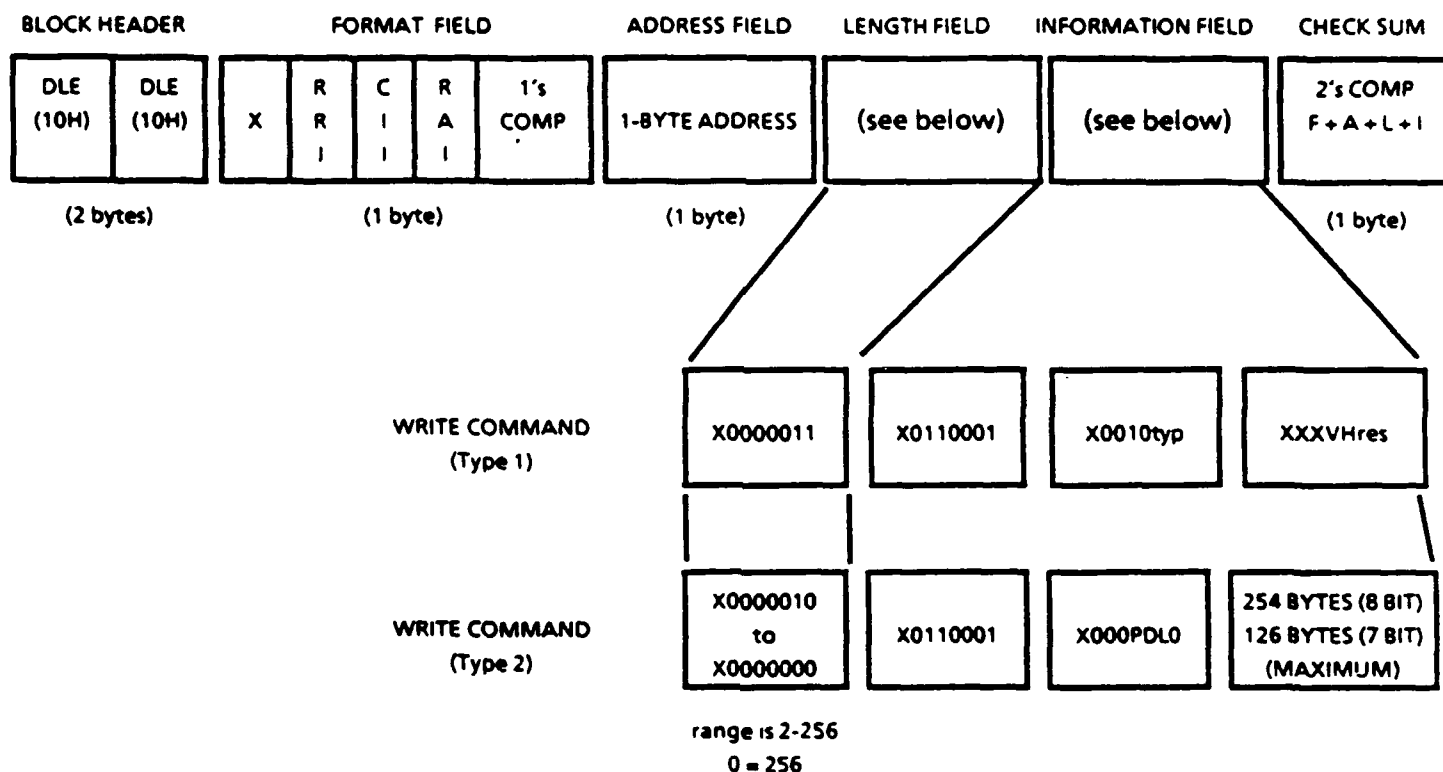


Figure 4-7. WRITE Command Message Formats.

Individual fields for each command are defined as follows:

TYPE 1 WRITE COMMAND:

DATA TYPE:

typ = 000 for Modified Huffman
 = 001 for Modified Read
 = 010 for Image
 = 011 for ASCII

DOCUMENT INFORMATION:

V = 0 for 6 lines per inch
 = 1 for 8 lines per inch

H = 0 for 12 characters per inch
 = 1 for 10 characters per inch

res = 001 for 7.70 scans per mm
 = 010 for 3.85 scans per mm
 = 100 for 2.57 scans per mm
 = if data type is ASCII, res is Don't Care

TYPE 2 WRITE COMMAND:

PAGE INFORMATION:

P = 1 for Page end
 D = 1 for Document end
 L = 1 for Line Hold

4.2.3.3 Data Formats.

The byte sequence for each scan line is right to left, least significant bit to most significant bit, as shown in the diagrams below. The image data format in WRITE commands and WRITE responses is always 216 bytes long in order to accommodate the full 1728 bits per scan line ($216 \times 8 = 1728$).

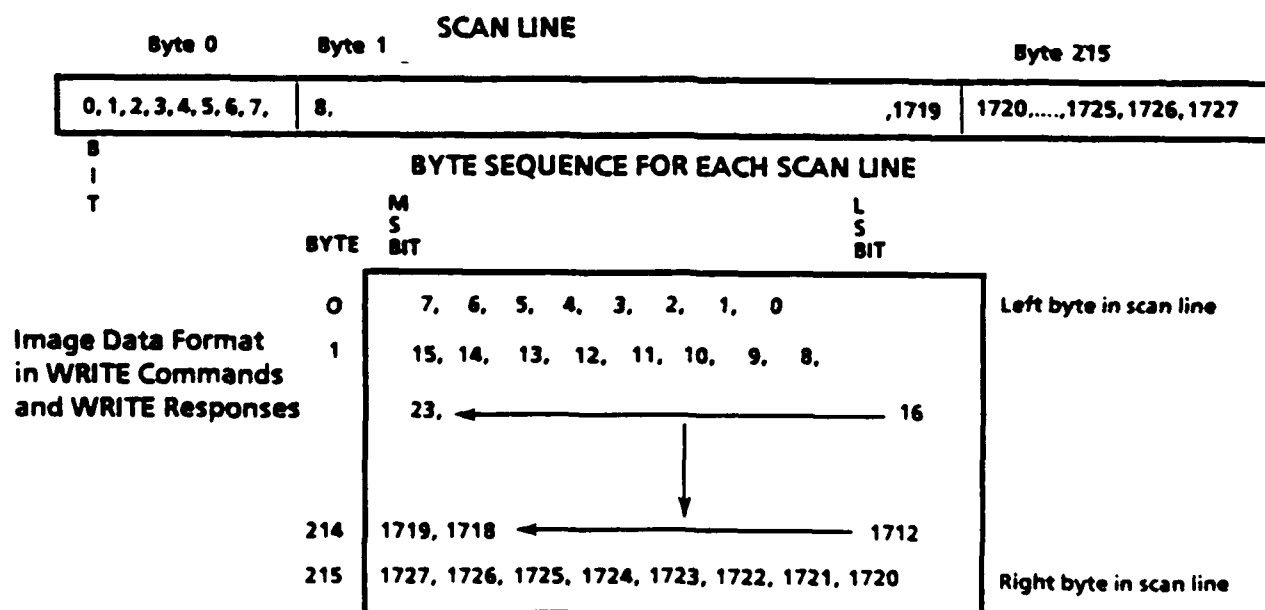


Figure 4-8a. Image Data Format.

The compressed data format is similar to the image data format, except that the length of the information field varies according to the nature of the data being transmitted.

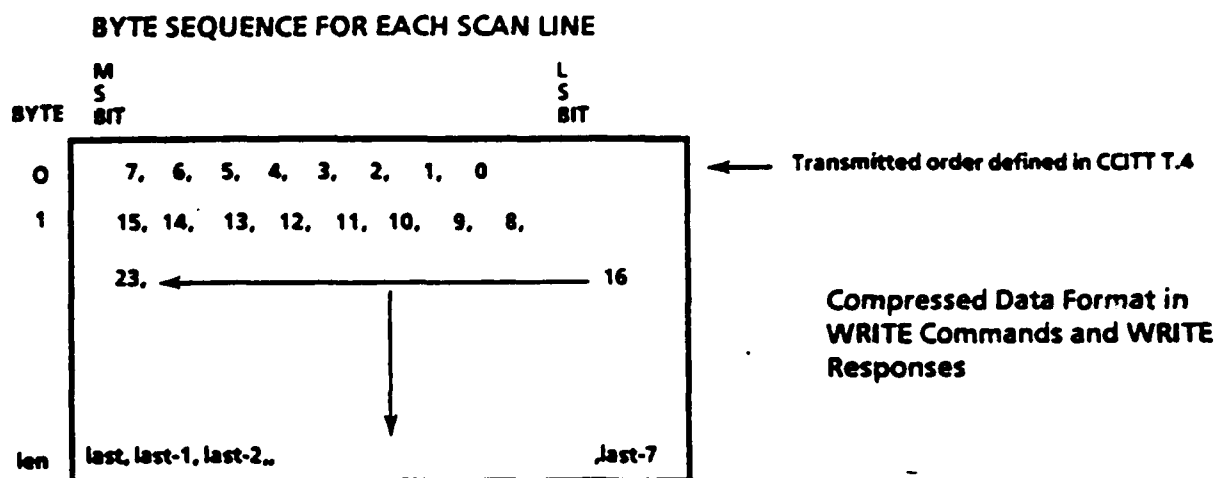


Figure 4-8b, Compressed Data Format.

4.2.4 SETIDM Command.

The SETIDM command is used to initialize either Time/Date, local ID, or both. The normal response to a SETIDM command is a STATUS report. There is no error response to a SETIDM command. The SETIDM command would appear in a data block as follows:

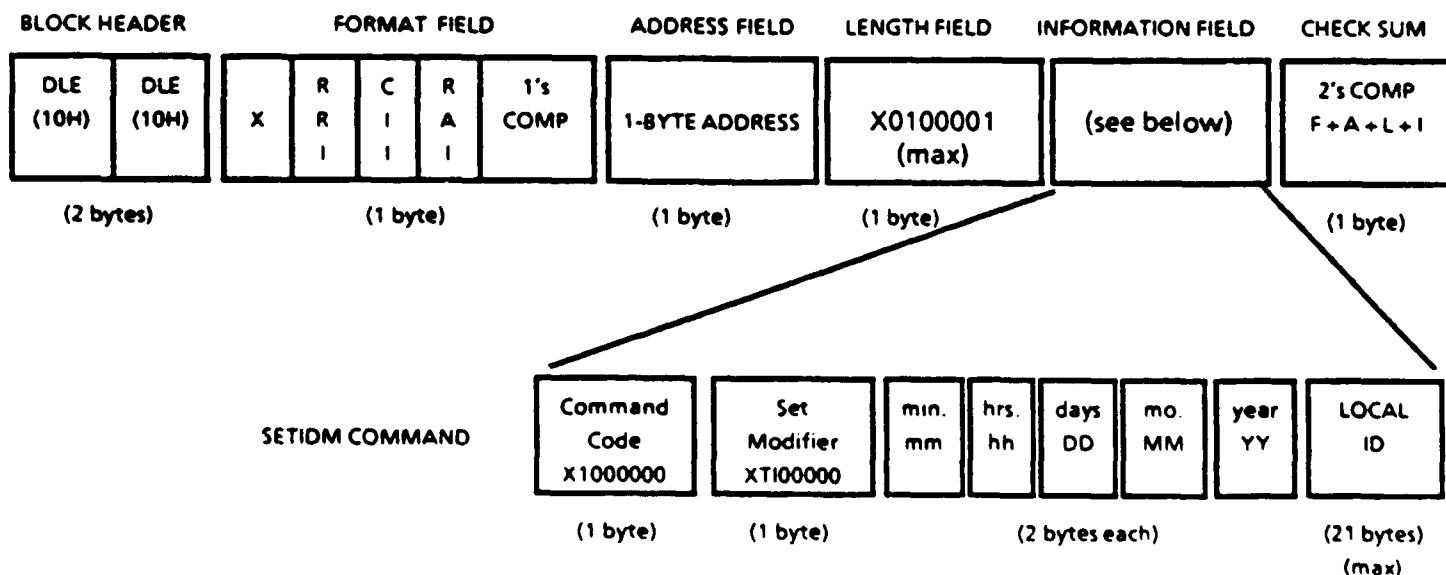


Figure 4-9. SETIDM Command Message Format.

Time/date settings include both a units and a tens digit (i.e., 2 bytes each).

Set Modifier:

X = 0 (set undefined bit to zero)

T = 1 if Time Setting included
= 0 if Time Setting not included

I = 1 if Local ID included (*)
= 0 if Local ID not included

- (*) If local ID is less than 21 bytes, you must:
a. end ID with a carriage return (CR or '0D' Hex)

4.3 RESPONSE MESSAGES.

Each of the commands explained in the preceeding paragraphs has an accompanying response message. When a command or a block of data is transmitted by the host to the TC495-I, it waits for a response message. The response message may be a "normal" response, indicating that the transmission was accomplished correctly, or it may be an "error" response, indicating that some sort of error was encountered and the transmission will have to be repeated.

There are a total of six different responses that may be sent in reply to the fourteen commands; however, each command will receive different responses depending on the circumstances.

Table 4-1 presents possible command/response combinations, and designates whether a particular combination is normal or an error condition. Note that receipt of a NAK (negative acknowledgement) or no response indicates an error condition. The other responses (ACK, STATUS, STIDM, or DATA) indicate a normal condition.

Table 4-1. Command/Response Combinations.

<u>COMMANDS</u>	<u>RESPONSES</u>					
	<u>ACK</u>	<u>NAK</u>	<u>STATUS</u>	<u>STIDM</u>	<u>DATA</u>	<u>NONE</u>
STOP			NORMAL			ERROR
REPORT			NORMAL			ERROR
REPIDM				NORMAL		ERROR
DISCONNECT			NORMAL			ERROR
DIAGNOSTIC		ERROR	NORMAL			
SEND		ERROR	NORMAL			
RECEIVE		ERROR	NORMAL			
SENDPOLL		ERROR	NORMAL			
CONVERT		ERROR	NORMAL			
COPY		ERROR	NORMAL			
READ		ERROR	ERROR		NORMAL	
WRITE (1)	NORMAL	ERROR	ERROR			
WRITE (2)	NORMAL	ERROR	ERROR			
SETIDM			NORMAL			ERROR

4.3.1 The ACK (Acknowledge) Response.

The ACK response is sent in reply to both WRITE commands. It indicates that either the initial WRITE1 command or the data contained in a WRITE2 commands'information field was correctly received. The ACK response would appear in a data block as follows:

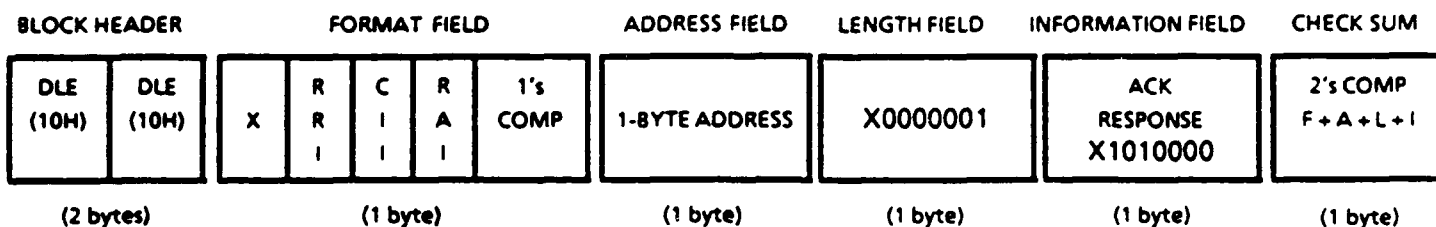


Figure 4-10. ACK Response Message Format.

4.3.2 The NAK and STATUS Responses.

Although a NAK (negative acknowledgement) is always an error response and a STATUS response is always normal, the two are identical in format. The only difference between the two is in the response code. These responses appear in a data block as follows:

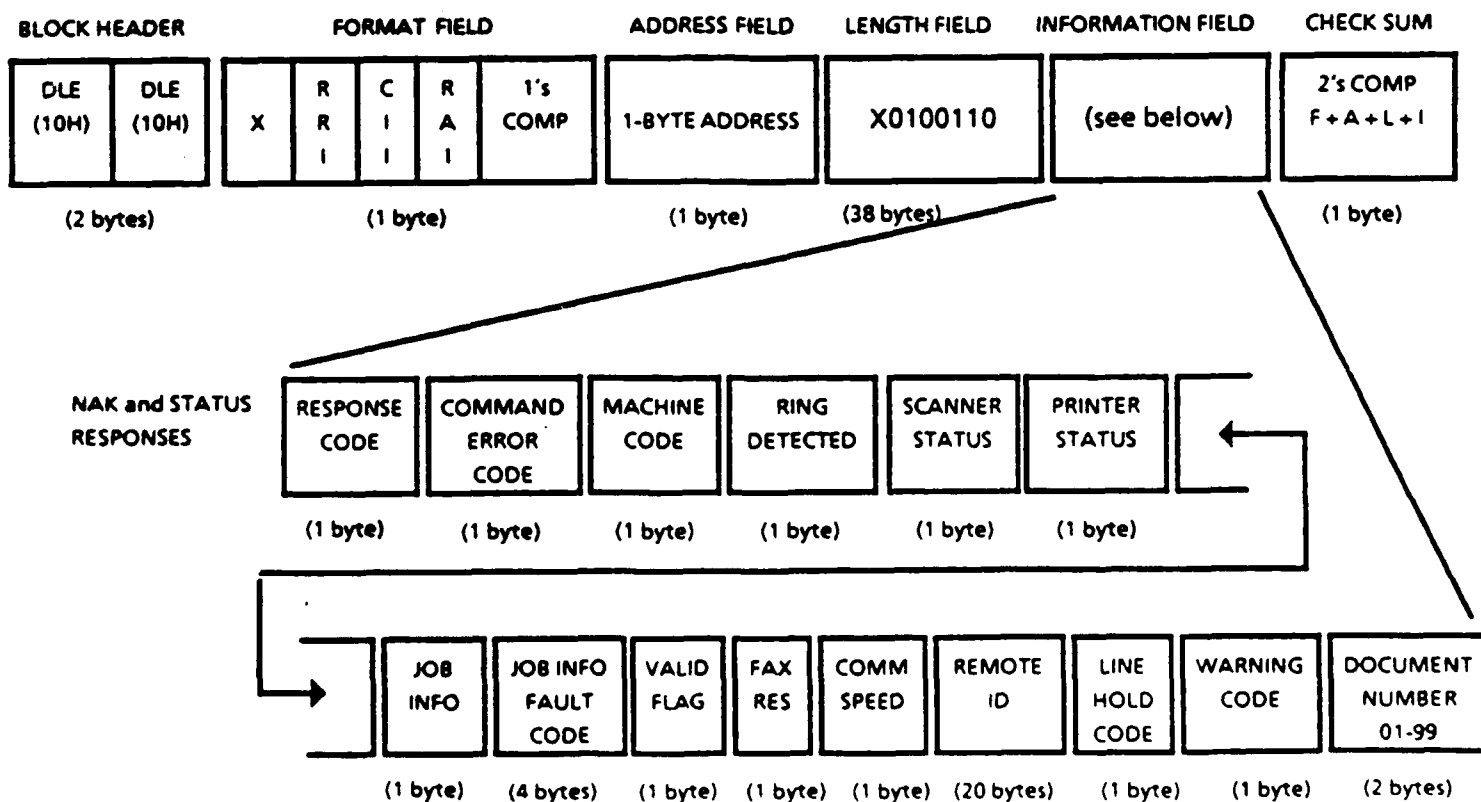


Figure 4-11. NAK and STATUS Response Message Formats.

Individual fields for the responses are defined as follows:

FIELD NAME:	BINARY CODE:	INDICATION:
RESPONSE CODE:	= X1010001 = X1010010	- NAK - STATUS
COMMAND ERROR:	= X1000000 = X1000001 = X1000010 = X0000000	- Undefined command - Command error - Post script error - Command correct
MACHINE CODE:	= XXXXX00X = XXXXXX1X = XXXXX10X	- Pending mode - Computer mode - Pending/delayed start
RING DETECTED:	= X0000000 = X0000001	- No call-in - Auto answered
SCANNER STATUS:	= XXXXXXXX1 = XXXXXX1X = XXXXX1XX = XXXX1XXX	- Document in scan position - No document in ADF - Tx jam - Tx jam (too long)
PRINTER STATUS:	= XXXXX1XX = XXX0XXXX	- Rx jam - No paper
JOB INFORMATION:	= XXXXXXXX1 = XXXXXXX01 = XXXXXXX11 = XXX1XX11 = XX1XXX11 = X1XXXX11 = XXXX0000 = XXXX0010 = XXXX0100 = XXXX0110 = XXXX1000 = XXXX1010 = XXXX1100	- In job (gen. format) - In job (waiting) - Job active - Ready to receive data - Data available - Retransmit last block - Job Complete - Fault ended job - Tone detected - Abandon call (# 1) - Remote Busy (# 1) - Diagnostic fault - Off hook

(# 1 - result of dialing)

JOB INFORMATION
FAULT CODE:
(ASCII)

= (See Section 6 for Fault Codes)

VALID FLAG:
(Indicates
corresponding
field/message
is valid for
this message)

= XXXXXXXX1	- Facsimile resolution
XXXXXX1X	- Communication speed
XXXXX1XX	- Remote ID
XXXX1XXX	- Document number
XXX1XXXX	- Line hold requested from remote terminal
XX1XXXXX	- Warning - caution code

(NAK and STATUS response message fields, continued)

FIELD NAME:	BINARY CODE:	INDICATION:
FACSIMILE RESOLUTION:	= XXXXX001 = XXXXX010 = XXXXX100	XMT / RCV - FINE mode/7.70 scans/mm - STD mode /3.85 scans/mm - FAST mode/2.57 scans/mm
COMMUNICATION SPEED:	= XXXXX000 = XXXXX001 = XXXXX010 = XXXXX011 = XXX000XX = XXX010XX = XXXXX100 = XXXXX101 = XXXXX110 = XXXXX111 = XXX001XX = XXX011XX = XXX101XX = XXX111XX	- Group 3 (2400 baud) - Group 3 (4800 baud) - Group 3 (7200 baud) - Group 3 (9600 baud) - Modified Huffman - Modified Read - 2 minute - 3 minute - 4 minute - 6 minute - RX - White line skip - CCITT - U.S.
REMOTE ID: (ASCII)	= (Up to 20 digits of identification - blank fill)	
LINE-HOLD CODE: (ASCII)	= "1" = "2" = "3" = "4" = "5" = "6"	- End of message (PRIEOM) - End of page (PRIEOP) - Multiple page scan (PRIMPS) - PIP - PIN - Tonal Recall
CAUTION CODE: (ASCII)	= "1" = "2"	- Receive device in different line density (CEP) - Receive device in fast print mode (CEP)
DOCUMENT NUMBER: (ASCII)	= (2-digit page number of transmitted document)	

4.3.3 The STIDM Response.

The STIDM response is sent in reply to an REPIDM command. The STIDM response would appear in a data block as follows:

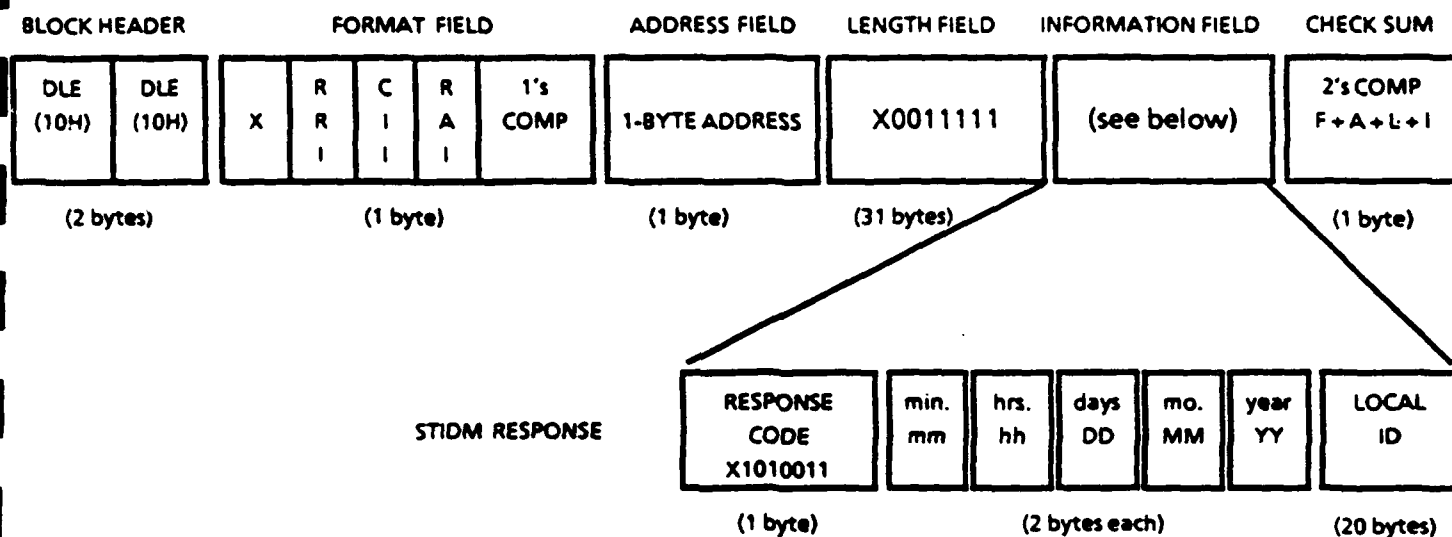


Figure 4-12. STIDM Response Message Format.

The individual fields of this response are defined as follows (bytes 2 through 31 are ASCII):

TIME: mm = minutes (10 digit, 1 digit)
 hh = hours (10 digit, 1 digit)

DATE: DD = days (10 digit, 1 digit)
 MM = month (10 digit, 1 digit)
 YY = year (10 digit, 1 digit)

LOCAL ID: (Up to 20 digits of identification - zero-fill)

4.3.4 The WRITE Response.

The WRITE commands initiate transmission of data from the host to the TC495-1. A type 1 write command sets up the data flow and type 2 accomplishes the actual transfer. The responses to the two WRITE commands would appear in a data block as follows:

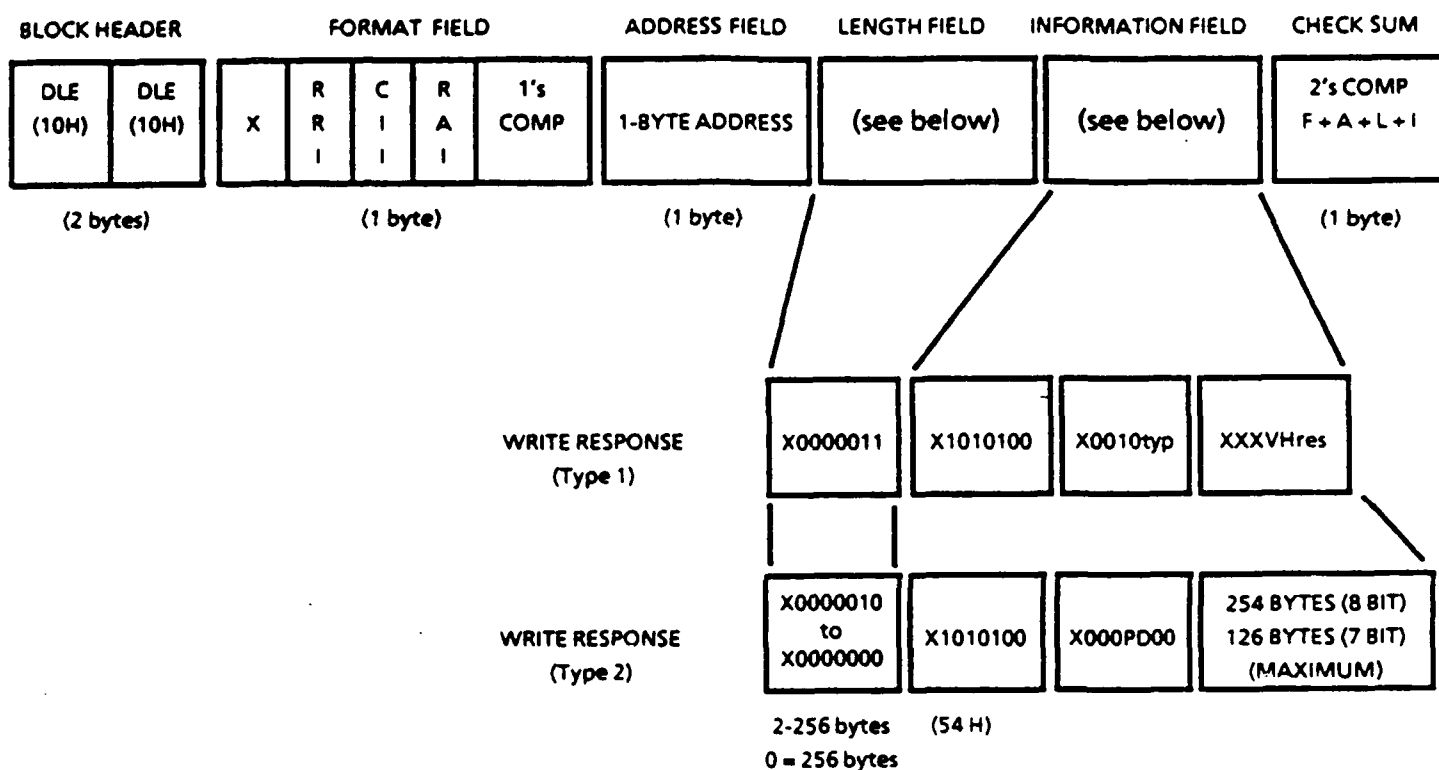


Figure 4-13. WRITE Response Message Formats.

Individual fields for each command are defined as follows:

TYPE 1 WRITE RESPONSE:

DATA TYPE:

typ = 000 for Modified Huffman
= 001 for Modified Read
= 010 for Image

DOCUMENT INFORMATION:

V = 0 for 6 lines per inch
= 1 for 8 lines per inch

H = 0 for 12 characters per inch
= 1 for 10 characters per inch

res = 001 for 7.70 scans per mm
= 010 for 3.85 scans per mm
= 100 for 2.57 scans per mm

TYPE 2 WRITE RESPONSE:

PAGE INFORMATION:

P = 1 for Page end
D = 1 for Document end

4.4 Mark-Sense Card Data Transmission.

The "generic" mark-sense card can serve as a means for identifying documents being transmitted. It may also be used as a method of specifying distribution, routing, and file storage. Typically a mark-sense card would precede each document as a "header" sheet.

The header sheet provides for multiple marks per row. The data is processed in hex form with two bytes per row; a total of 64 bytes for the 32 rows on the card. Identification of the mark-sense card as the data source is accomplished in Job Modifier 2. The information on the card is block formatted as a Type 2 WRITE response message of 66 bytes (64 data bytes plus the 2 bytes required for message identification and page information).

Figure 4-14 shows the data format and figure 4-15 illustrate the layout of the card.

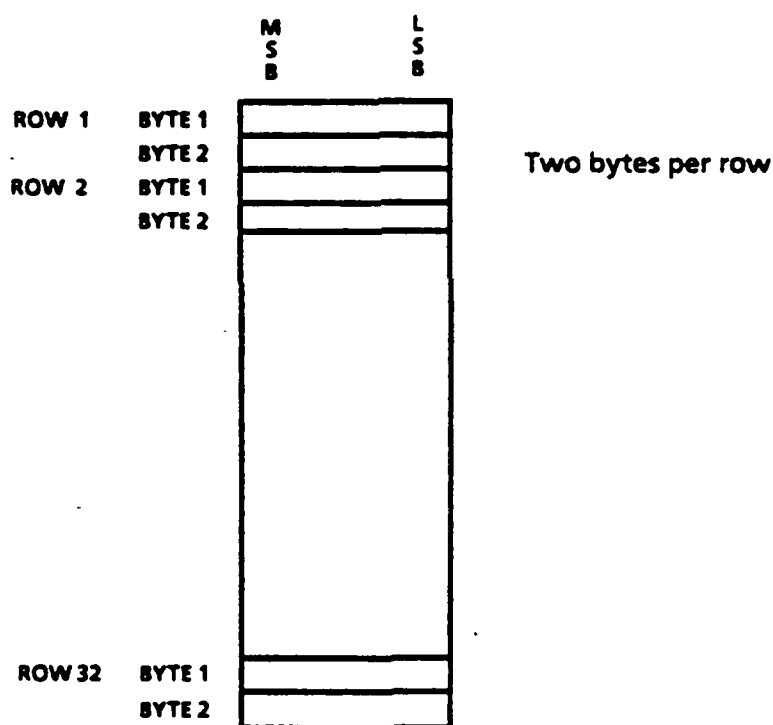
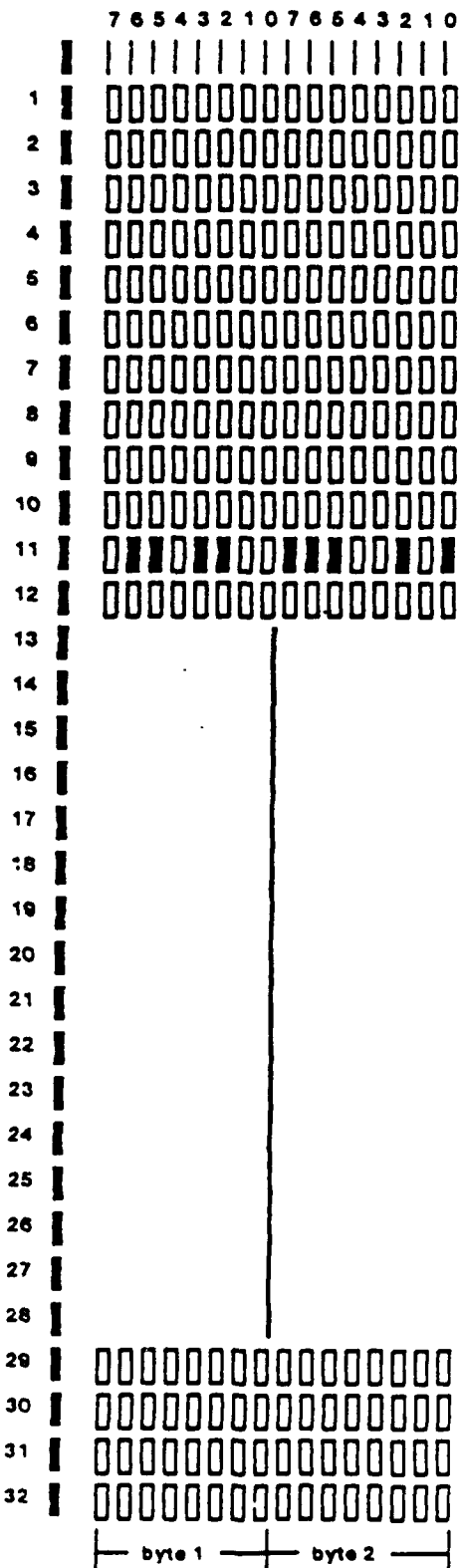


Figure 4-14. Mark-sense Data Buffer Format.



GENERIC MARK SENSE CARD LAYOUT

NOTES:

Sixteen bits per row (two bytes)

32 Rows

Bit 7 is most significant bit, with bit 0 as the least significant bit

The byte sequence is byte 1, byte 2 for row 1 followed by the byte pair for row 2 and so on.

The most significant bit is ignored for 7 bits/character

Example: Row 11 is coded to be 6C hex, E5 hex

(this page intentionally left blank)

SECTION FIVE

COMMAND/RESPONSE SEQUENCES

5.0 GENERAL

The previous section dealt with the individual message formats for various commands. In order to accomplish any meaningful functions with the TC495-I, it is necessary to write a program that encompasses sequences of commands and responses. This section describes those various sequences and the command/response messages that comprise them.

5.1 IDLE SEQUENCE

In the idle state, the host should monitor the status of the TC495-I using the REPORT command at set intervals. Figure 5-1 presents a recommended flow chart.

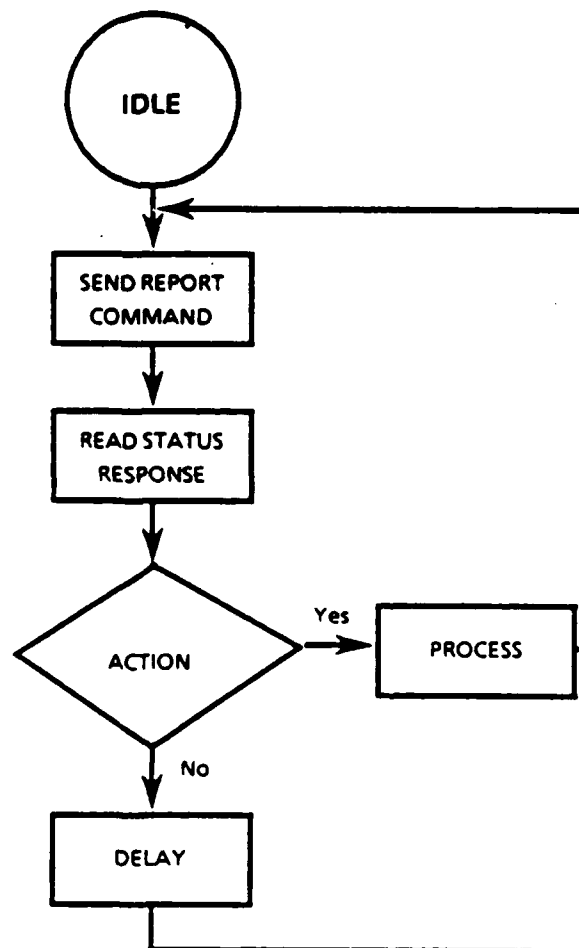


Figure 5-1. IDLE Sequence Flow Chart.

5.2 JOB START SEQUENCE

The host should delay issuing a job command until the TC495-1 enters its idle state. Figure 5-2 presents a recommended flow chart for this function.

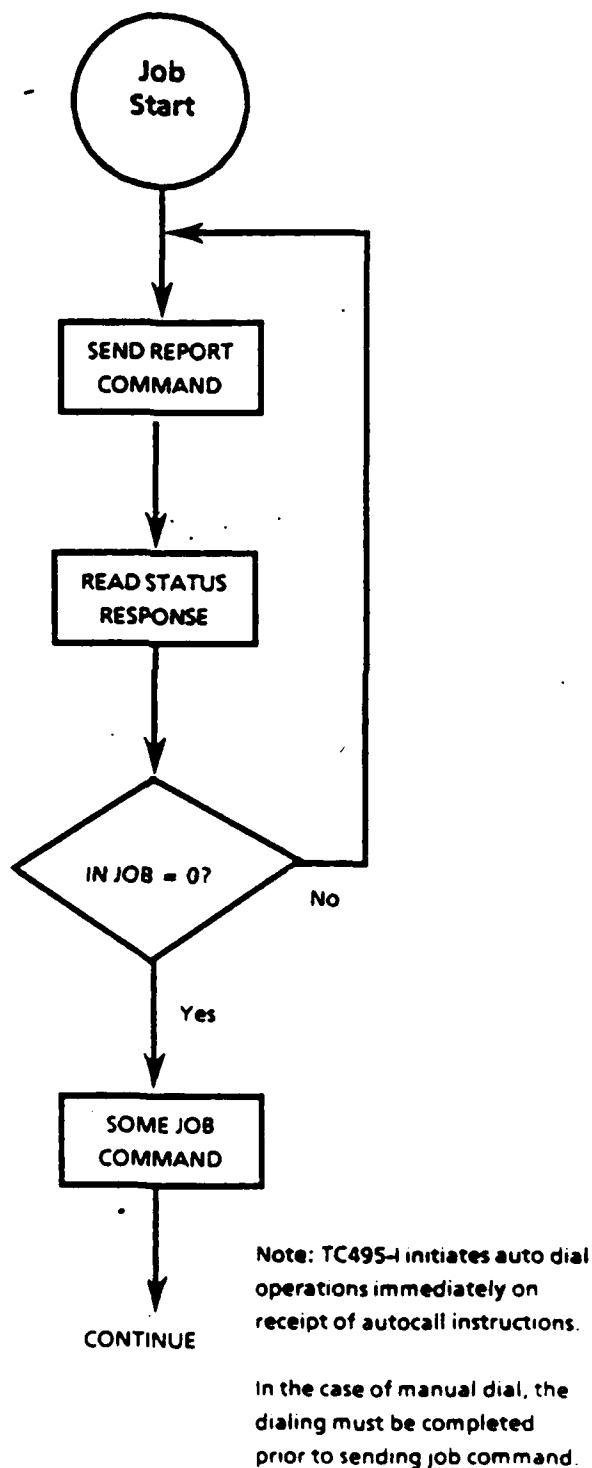


Figure 5-2. Job Start Sequence Flow Chart.

5.3 JOB END SEQUENCE

The REPORT command should be used to determine when a job has ended. Figure 5-3 presents a recommended flow chart for the job end function.

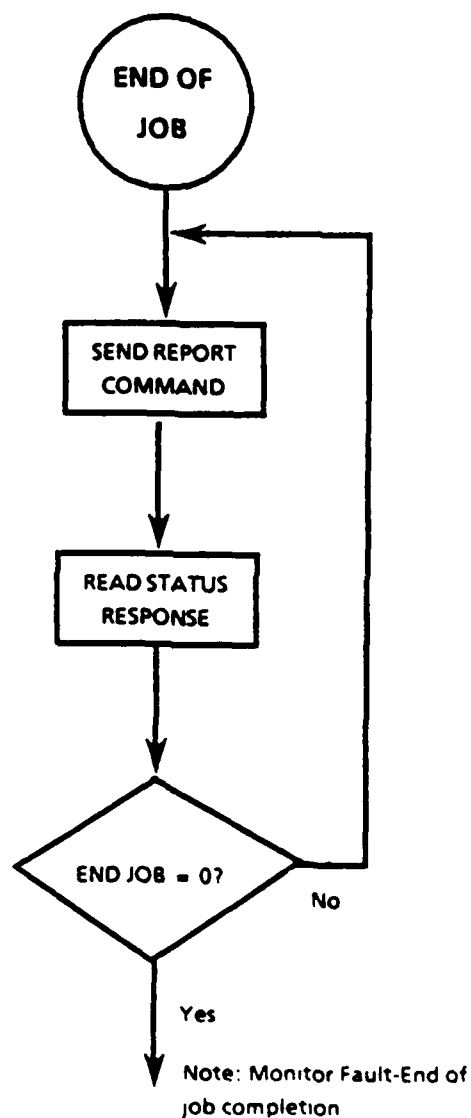


Figure 5-3. Job End Sequence Flow Chart.

5.4 ABNORMAL JOB END SEQUENCE

The STOP command is used by the host to force end of job. Figure 5-4 presents a recommended flow chart for the forced end of job sequence.

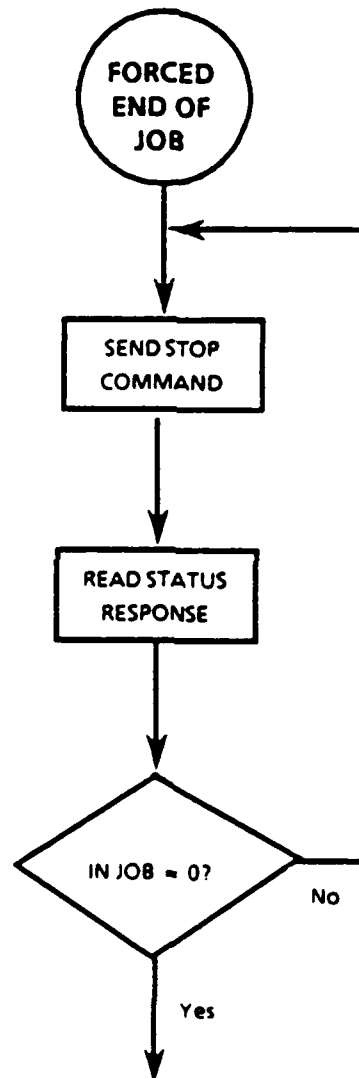


Figure 5-4. Abnormal Job End Sequence Flow Chart.

5.5 DISCONNECT COMMAND FROM HOST

The DISCONNECT command is used to place the TC495-I in standby mode. Figure 5-5 presents a recommended flow chart for the disconnect sequence.

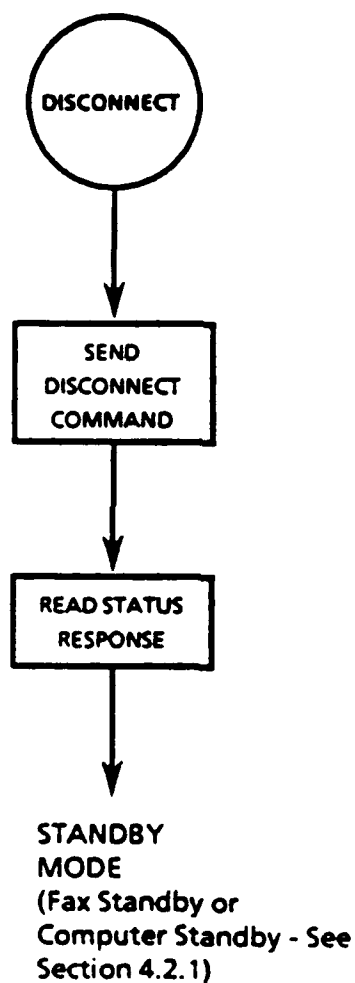


Figure 5-5. Disconnect Sequence Flow Chart.

5.6 TELEPHONE SEQUENCES

The host program must be able to handle several sequences concerned with handling the receipt of incoming calls through the telephone line attached to the TC495-I itself.

5.6.1 Call-in detect sequence.

The REPORT command is used to determine whether or not a ring has been detected on the the TC495-I's telephone connection. Figure 5-6 presents a recommended flow chart for the call-in detection function.

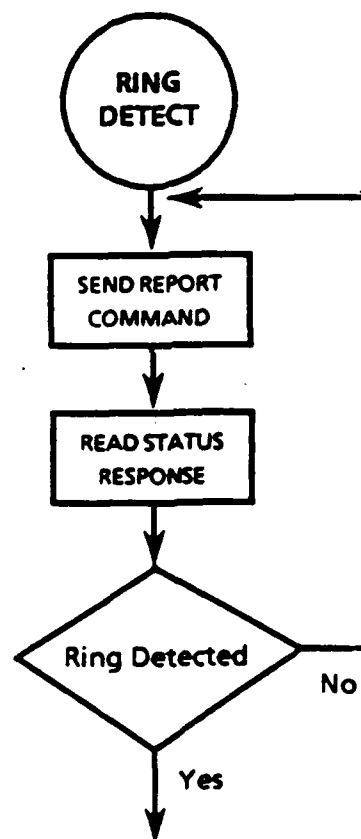
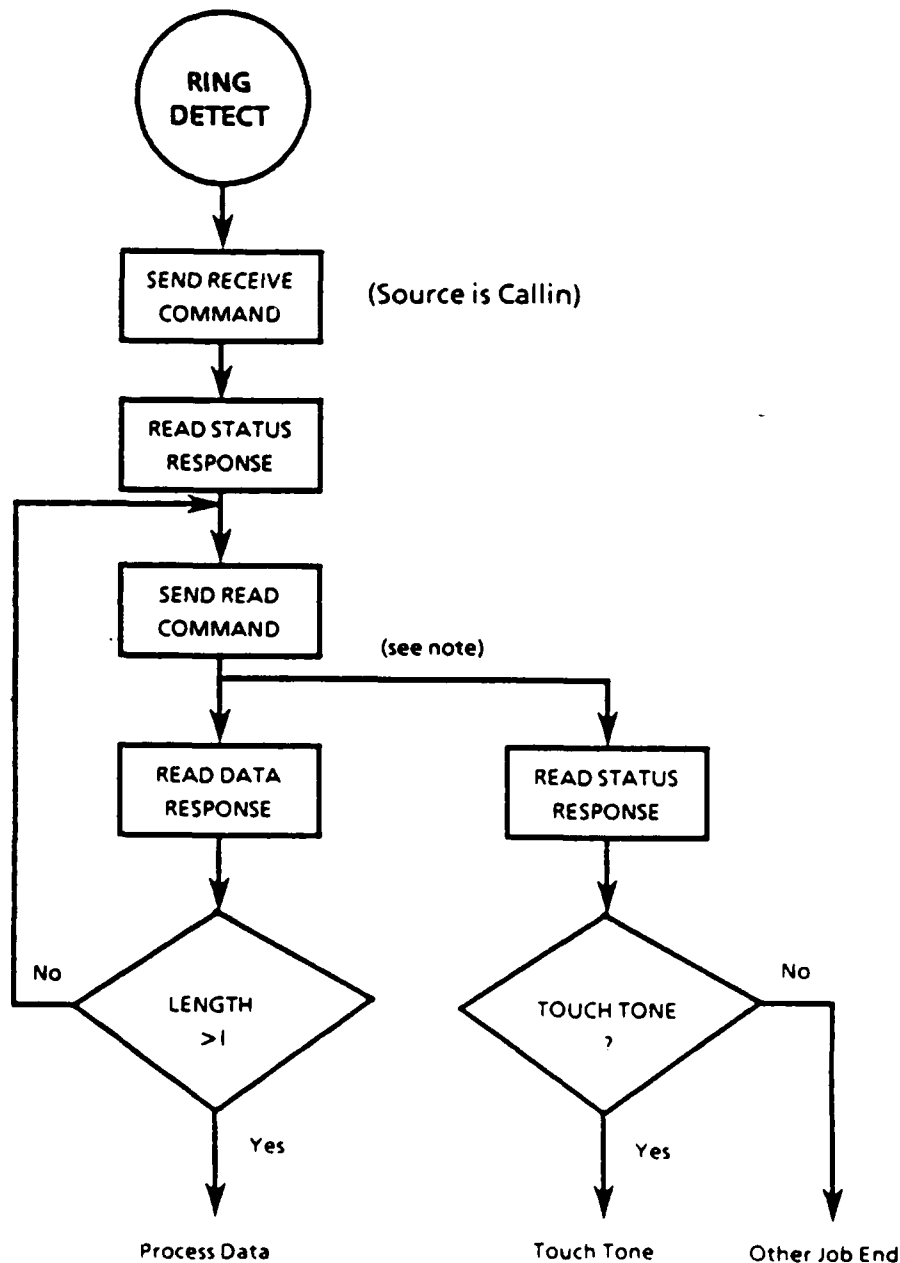


Figure 5-6. Call-In Detect Sequence.

5.6.2 Touch tone detect sequence.

Once a call-in has been detected, the next requirement is to determine whether or not the incoming data contains touch-tone codes. Touch tones can be detected at the start of the READ command sequence as shown in Figure 5-7.



Note: When Touch Tone is detected a STATUS response is generated by TC495-1 in response to READ command

Figure 5-7. Touch Tone Detect Sequence.

5.6.3 Touch tone data transfer sequence.

If touch tone data is detected, touch tone data transfer occurs byte by byte. The host reads the data using READ commands until enough data numbers are transferred. Figure 5-8 presents a recommended flow chart for the touch tone data transfer function.

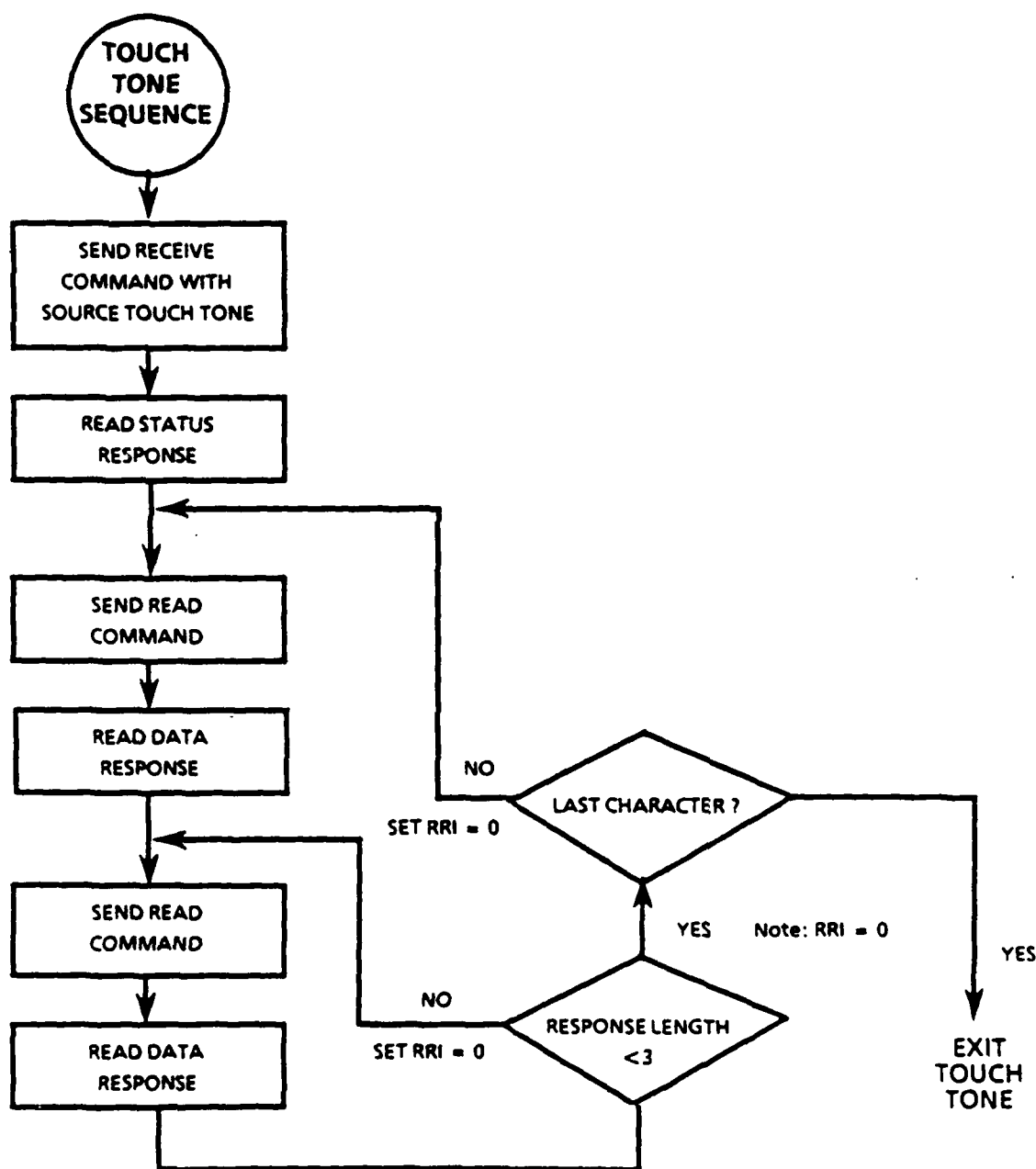


Figure 5-8. Touch-Tone Data Transfer Sequence.

5.7 DATA TRANSFER SEQUENCE (HOST TO TC495-I)

There are several different circumstances under which data must be transferred from the host to the TC495-L.

5.7.1 One page transfer sequence.

The host must wait until the DATA INVITE flag is set by the TC495-I before sending data. Figure 5-9 presents a recommended flow chart for transferring a page of data from the host to the TC495-L.

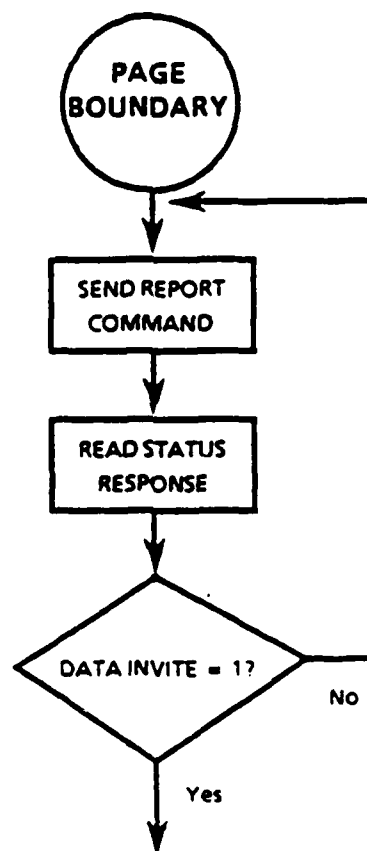


Figure 5-9. Data Transfer Sequence (Host to TC495-I).

5.7.2 Data transfer for CONVERT function.

The host sends a block of compressed data (MH or MR) to the TC495-I which may contain several scan lines. The TC495-I decompresses the data, sending it back to the host as individual 216-byte scan lines in image data format. A single transmission from the host may require several transmissions from the TC495-I.

Figure 5-10 presents a recommended flow chart for performing this data transfer.

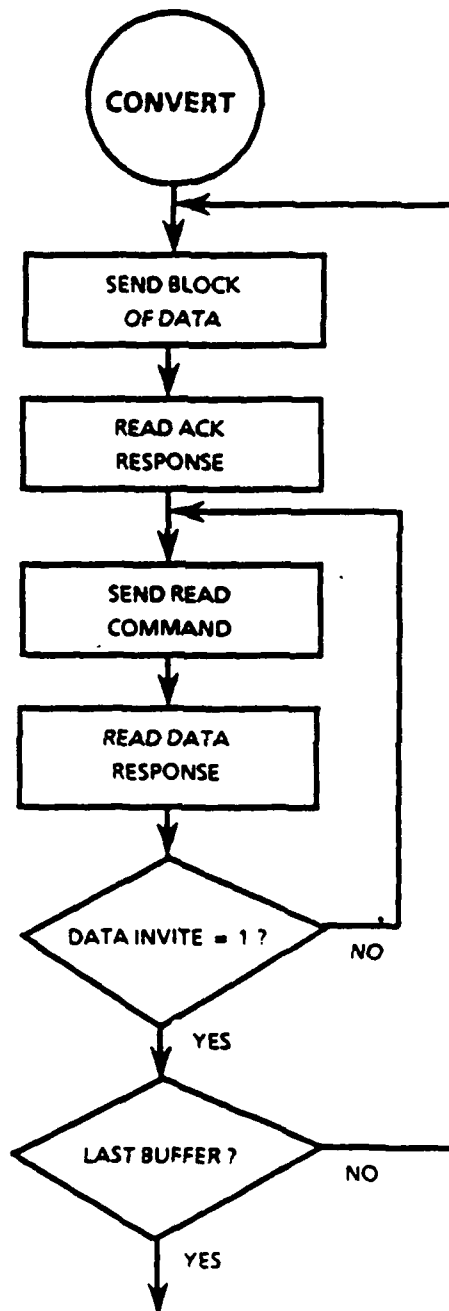


Figure 5-10. Data Transfer for Convert Function.

5.7.3 Receive buffer busy.

When the TC495-I is receiving, and its buffer is full, the retransmit flag is set in its STATUS response. The host normally repeats this frame until the resend request flag (RR) is set to 0. Figure 5-11 presents a recommended flow chart for performing this function.

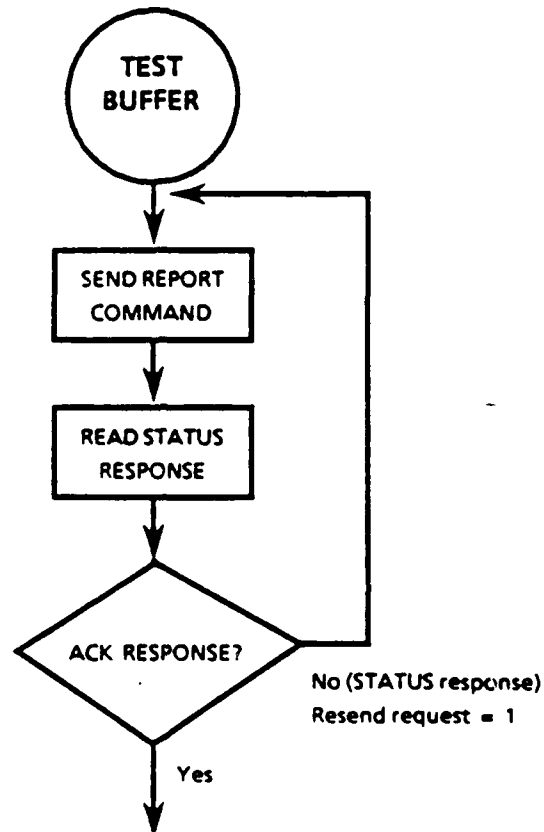


Figure 5-11. Receive Buffer Busy Sequence.

5.8 DATA TRANSFER SEQUENCE (TC495-I TO HOST)

5.8.1 One page transfer sequence

Figure 5-12 presents a recommended flow chart for performing this function.

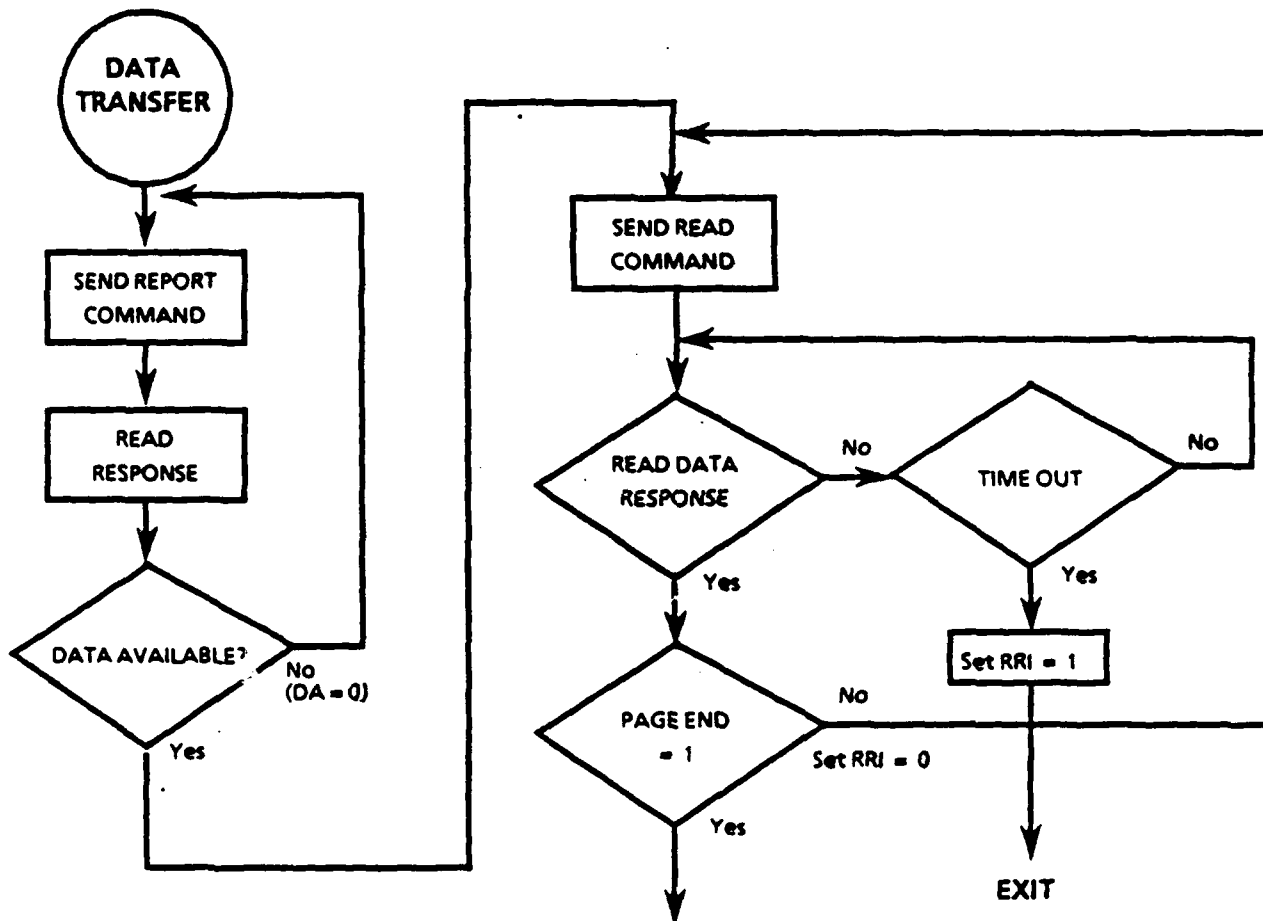


Figure 5-12. One Page Transfer Sequence Flow Chart.

5.9 TIME & ID SEQUENCES

5.9.1 Set Time & ID sequence

Figure 5-13 presents a recommended flow chart for performing this function.

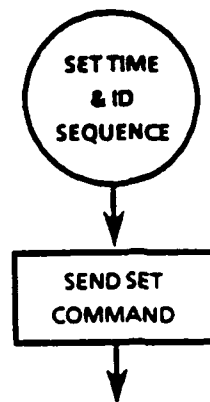


Figure 5-13. Set Time & ID Sequence Flow Chart.

5.9.2 Read Time & ID sequence

Figure 5-14 presents a recommended flow chart for performing this function.

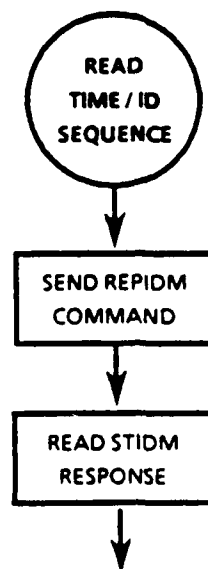


Figure 5-14. Read Time & ID Sequence Flow Chart.

5.10 Expanded Flow Charts.

Figures 5-15 and 5-16 provide flow charts combining a number of the individual functions described previously into typical send/receive sequences for transferring data between the host computer and the TC495-1.

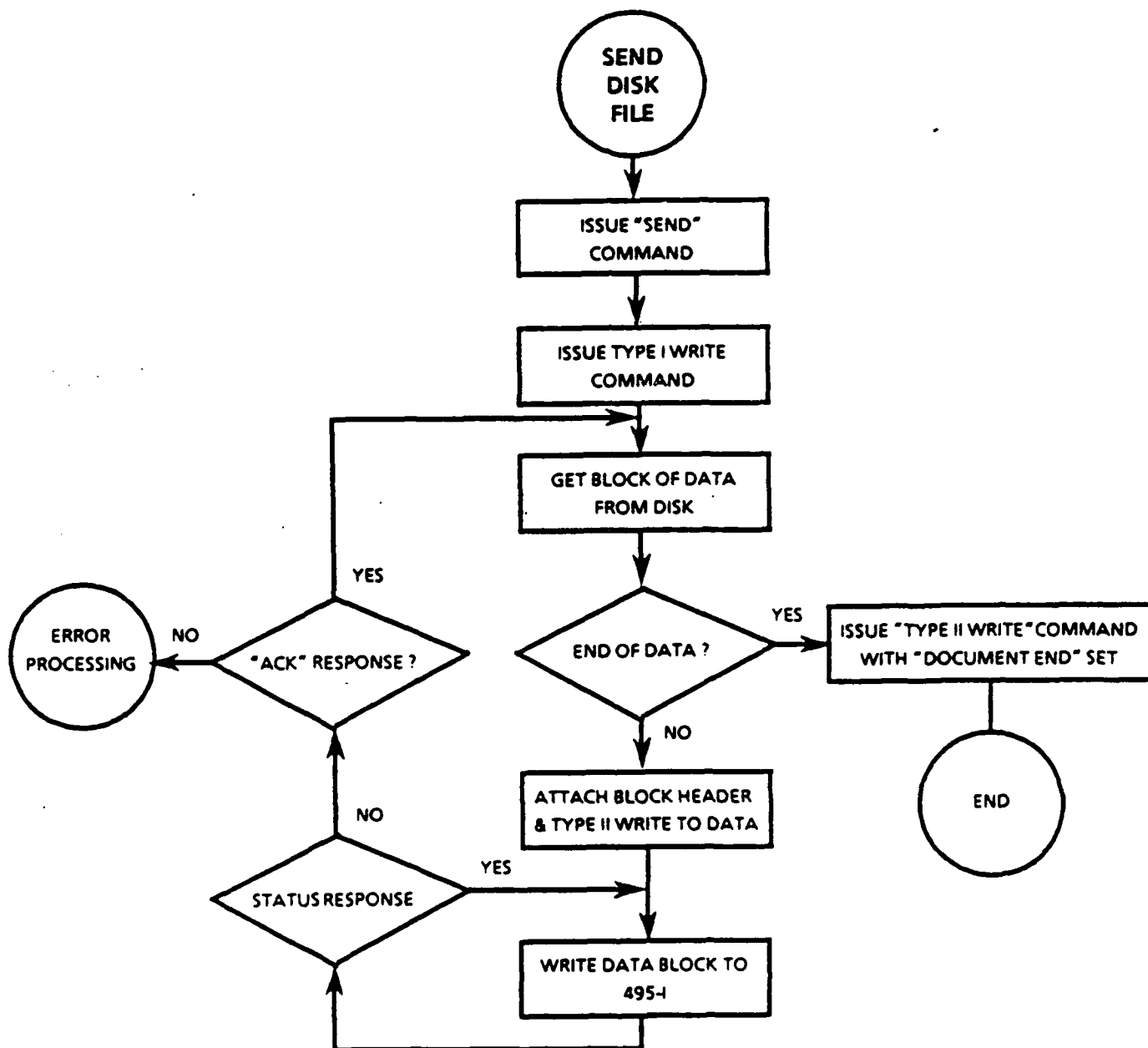


Figure 5-15. Typical Send Function.

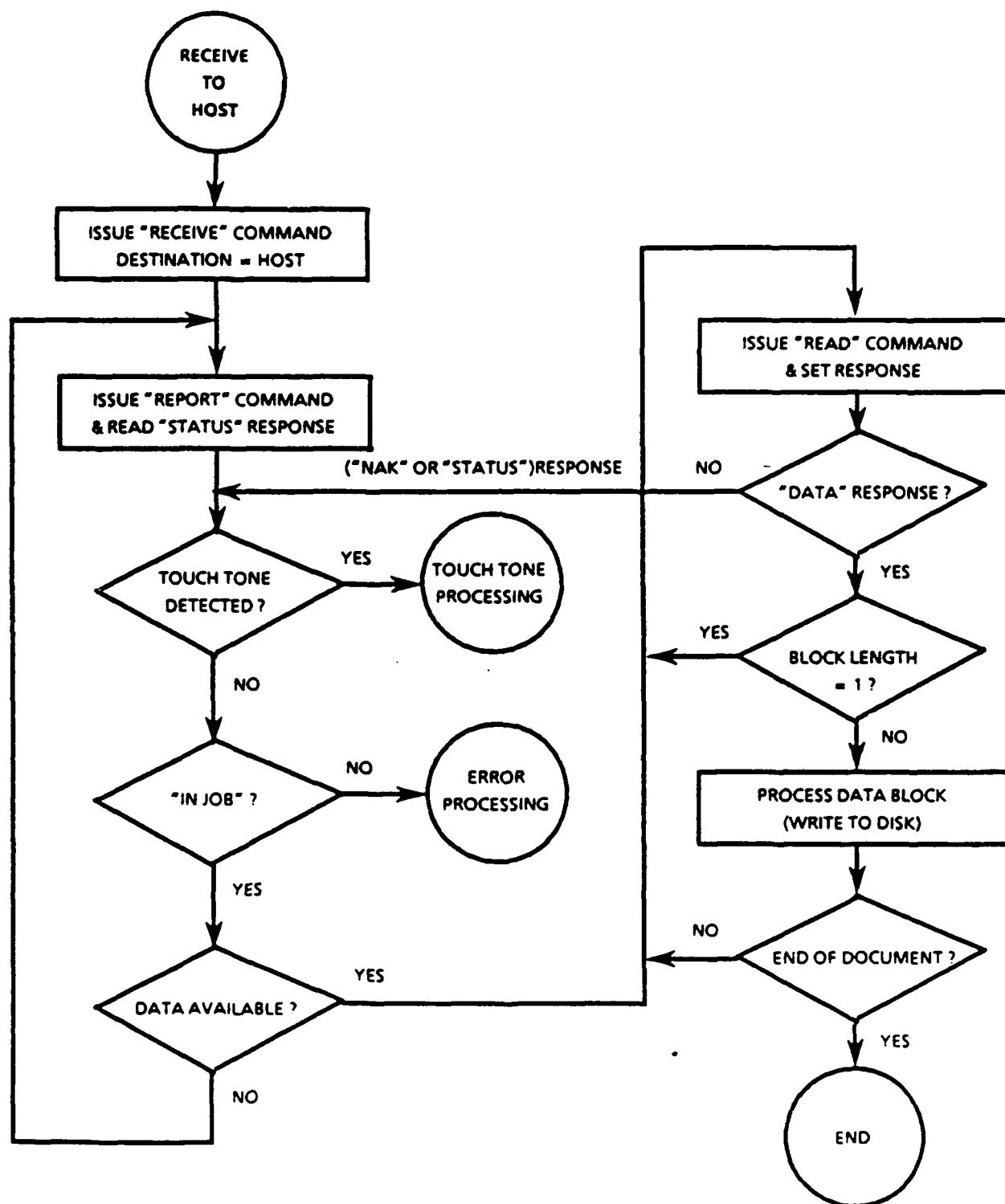


Figure 5-16. Typical Receive Function.