Bell System Data Communications

TECHNICAL REFERENCE

150 BAUD PRIVATE LINE CHANNELS

INTERFACE SPECIFICATION

February 1968

American Telephone & Telegraph Company

Engineering Director Data Communications

Bell System Data Communications

TECHNICAL REFERENCE

150 Baud Private Line Channels

Interface Specification

February 1968

ENGINEERING DIRECTOR - DATA COMMUNICATION

NOTICE

This specification is specifically intended for technical consultants and designers of data, telemetering and supervisory control equipment to be used with Bell System 150-Baud Private Line Channel service. The right to revise this specification for any reasons such as conformity with USASI, EIA or other standards or to utilize new advances in the state of technical arts is expressly reserved. Liability for difficulties arising from unknown or unforeseen technical limitations is disclaimed.

If additional details on the interface and its operation are needed, please contact:

Engineering Director – Data Communications
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

TABLE OF CONTENTS

	Page
1. DESCRIPTION	1
1.1 General	1
1.2 Physical	1
1.3 Power Requirements	2
1.4 Environment	2
2. INTERFACE – ELECTRICAL	2
2.1 General	2
2.2 Data Communication Equipment (DCE) – EIA Interface	2
2.3 Data Communication Equipment (DCE) – Additional Functions	4
3. TRANSMISSION CHARACTERISTICS OF CHANNEL	5
3.1 Channel Distortion – Definition	5
3.2 Channel Distortion – Factors	6
3.3 Performance Objectives	6
3.4 Turn-Around Time – Half Duplex Operation	6

FIGURES

Figure 1	Typical Undistorted Eight Level Start-Stop Signal	8
Figure 2	Distorted Eight Level Start-Stop Signal	8
Figure 3	Data Communication Equipment Interface	9
Figure 4	Photograph – 816A and 820D Data Auxiliary	10
Figure 5	Photograph – 816B Data Auxiliary Sets	11
Figure 6	Photograph – 130C Subset	12
Figure 7	Photograph – 820E Data Auxiliary Set	13
Figure 8A	Photograph – Multiple Data Set Cabinet KS 20018	14
Figure 8B	Photograph – Multiple Data Set Cabinet KS-20093	15

150 BAUD PRIVATE LINE CHANNELS
Interface Specifications

1. DESCRIPTION

1.1 General

1.11 The purpose of this specification is to define the interface of the 150 Baud Private Line Channel as presented to Customer-Provided Terminals (CPT).

1.12 These Private Line Channels are capable of transmitting two state ("mark-space," "binary") signals at speeds up to 150 Bauds for teletypewriter, data, metering, supervisory control and miscellaneous signaling purposes. For speeds of 75 Bauds and below, other channels are available and are described in separate Bell System Technical References. The term Baud is a unit of signaling speed derived from the duration of the shortest signaling element in seconds to be transmitted. Therefore, the minimum signaling element length permissible on 150 Baud Channels is 6.67 milliseconds.

1.13 150 Baud Service is different in nature than familiar voiceband private line and DDD networks. It (150 Baud Service) will consist of ac or dc terminal links interconnected by networks of narrow band tandem link transmission facilities. These private line channels are half or full duplex. There will be no overall end-to-end supervision (knowledge of circuit continuity) and the interface to business machines will be EIA Standard RS-232B type. The send and receive data leads of this interface will be compatible with existing voiceband private line services although the supervisory leads may not function exactly the same. The meaning of this is clarified in detail in the lead-by-lead description of the interface that follows.

Although the type of local loop facilities and transmission equipment arrangement provided by the Telephone Company will be subject to local conditions, the interface to the CPT will perform in essentially the same manner.

1.2 Physical

1.21 There are several possible transmission equipment arrangements for 150 Baud Channels.

1.22 One basic transmission equipment arrangement consists of the 820 D1 Data Auxiliary Set (DAS) for single station arrangements or an 820E DAS for multiple set arrangements. These Data Auxiliary Sets may be internally equipped with Data Sets 108- or 109-type by the Telephone Company.

An 820D Data Auxiliary Set is required with each Data Set 108- or 109-type for private line service at single station installations. The 820D DAS provides the housing, power, and interface connector for the data set and performs additional operating functions as described in Paragraph 2.21. Figure 4 is a photograph of this unit. For multiple set installations, the above functions are performed in an 820E DAS, illustrated in Figure 7, which may be mounted in either a relay rack or a multiple set cabinet such as those shown in Figure 8.

Two basic transmission systems are used with these first arrangements; one system uses ac transmission and the other low current dc transmission. The ac system (Data Set 108-type) will permit half-duplex (HDX) and full-duplex (FDX) operation over all loop lengths whereas the dc system (Data Set 109-type) is designed for HDX operation for those stations normally within the local exchange area of a hubbing office or for short-haul station-to-station circuits (maximum loop of 2000 ohms or 1.0 uf).

1.23 A second basic transmission equipment arrangement is interim in nature and consists of a 816-type Data Auxiliary Set plus a 130-type teletypewriter subscriber set arranged for 150 Baud Channel use. The 816 Data Auxiliary Set acts to convert the signals of the 130-type TTY subscriber set to the signals specified by EIA Specification RS-232B. In addition to conversion of the send and receive data signals, the 816 DAS provides the other control signals required for operation with the CPT's. The 816 DAS may be operated on a half-duplex or on a full-duplex basis.

The 816 Data Auxiliary Set is packaged either in an 816A single unit housing (see Figure 4) or in an 816B multiple unit housing for up to 10 units (See Figure 5), depending on the number of 150 Baud Channel terminations pro-

vided. The 130C Subset is normally wall or floor mounted in its case as shown in Figure 6.

1.24 Where a large number of channels are to be terminated at a single location, the physical arrangements of the equipment arrangements may vary due to space and maintenance considerations. Therefore, it is strongly recommended that these be discussed with the Telephone Company representatives well in advance of installation.

1.25 The general term Data Communication Equipment (DCE) will be used in this document hereafter to designate all of the complete transmission equipment arrangements provided by the Telephone Company and described in Paragraphs 1.21, 1.22 and 1.23. The size and weights of the arrangements are shown in Table A.

1.3 Power Requirements

1.31 The customer must provide a receptacle supplying continuous 117 volt, 60 Hz ac power. The regulated power supplies provided in the DCE will work properly over a frequency deviation of ±0.45 Hz and a voltage range of 105 to 129 volts. The DCE is equipped with a demountable, 10-foot long gray cord equipped with a U-bladeground type plug. The power receptacle provided must accept such a plug and supply a valid ground to the ground pin. It is preferred to have this ground the same as the one used by the CPT.

The power consumption per channel of the 820-type DAS equipment arrangements will be less than 15 watts. The 130-type subset plus 816 Data Auxiliary Set arrangement draws about 70 watts per channel.

1.4 Environment

1.41 The DCE will operate properly over an ambient room temperature range of 40° to 120°F and over a relative humidity range of 20 per cent to 95 per cent.

2. INTERFACE – ELECTRICAL

2.1 General

2.11 Interface Connector

The CPT equipment should be equipped with a cable terminating in a Cinch or Cannon DB-19604-432 plug mounted in a Cinch DB-51226-1 hood assembly.

Normally the cable should not exceed 50 feet in length.

A detailed discussion of the characteristics of the interface connector is found in:

Bell System Data Communications
Technical Reference
Data Set
Interface Connectors

which is available from:

Engineering Director – Data Communications
American Telephone and Telegraph Company
195 Broadway
New York, New York 10007

2.12 Pin Assignments in the interface connector are shown in Table B and in Figure 3.

2.2 Data Communication Equipment (DCE) – EIA Interface

2.21 General

All interface circuits between a CPT and the DCE (Figure 3) should be designed to meet the EIA Standard RS-232B.

2.22 Functional Description

A description of the required operation of the interchange leads and the signals appearing on each are as follows:

Pin 1) AA – Protective Ground: Electrically bonded to the machine or equipment frame and ac power service ground.

Pin 2) BA – Transmitted Data: The BA circuit is designed to accept serial binary data from the CPT. The DCE sends a marking signal to the line facility when the EIA connector is removed or when the CPT power is OFF.

Pin 3) BB – Received Data: The BB circuit is designed to deliver serial binary data to the CPT. The BB circuit is held marking when received carrier or line current is not detected by the DCE.

TABLE A

	# of 150 Baud Channel Termination	Weight of Data Aux. Set or Empty Cabinet	Dimensions (inches) Width Depth Height	Mounting Wall (W) Floor (F) Table (T) Cabinet (C)
1. 820-Type Data Auxiliary Sets equipped with Data Sets 108 or 109-type				
820D Data Auxiliary Set	1	11-1/2 #	11 x 5-1/2 x 10-1/2	(T)
820E Data Auxiliary Set	up to 3	22-1/2 #	23 x 8-3/4 x 6	(C)
Associated Cabinets				
KS 20018 List 1	up to 3	14-1/2 #	24 x 12 x 11	(F)
List 2	up to 6	17-1/2 #	24 x 12 x 18	(F)
List 3	up to 9	23-1/2 #	24 x 12 x 24	(F)
List 4	up to 12	27-1/2 #	24 x 12 x 30	(F)
KS 20093	up to 48	300 #	34 x 30-1/2 x 72	(F)
2. 816-Type Auxiliary Sets				
816A Data Auxiliary Set	1	11-1/2 #	11 x 5-1/2 x 10-1/2	(T,W)
816B Data Auxiliary Set	up to 10	37 #	21 x 9-1/4 x 9	(C)
130C Sub Set with Cover	1	60 #	26 x 9-1/2 x 16-7/8	(F,W)
Associated Cabinets				
KS 20018 List 1	up to 10	14-1/2 #	24 x 12 x 11	(F)
List 3	up to 20	23-1/2 #	24 x 12 x 24	(F)
KS 20093	up to 140 ϕ	300 #	34 x 30-1/2 x 72	(F)

ϕ This is a maximum based on space in the cabinet. If room temperature exceed 90 degrees Fahrenheit, this quantity should be reduced and the telephone company should be consulted.

TABLE B

ALLOCATION OF PINS AT THE CUSTOMER INTERFACE

Pin Number	Circuit	Description
1	AA	Protective Ground
2	BA	Transmitted Data
3	BB	Received Data
4	CA	Request to Send
5	CB	Clear to Send
6	CC	Data Set Ready
7	AB	Signal Ground
8	CF	Data Carrier Detector
9	(Telephone Co. use only)	Data Set Test (+P)
10	(Telephone Co. use only)	Data Set Test (-P)
12	CX	Local Mode (Note 1)
11, 13 to 25	Not used in this application	

Note 1: Available only with 820D or 820E DAS equipment arrangements. (See Paragraph 2.33)

Pin 4) CA – Request to Send: The CA circuit is directly connected to the Clear to Send (CB) circuit.

Pin 5) CB – Clear to Send: The CB circuit is directly connected to the Request to Send (CA) circuit.

Pin 6) CC – Data Set Ready: The CC circuit presents an ON signal at all times except for the following conditions:

a) When the power to the DCE is off.

b) When the DCE is in either a test mode or local mode if implemented. (CC circuit held OFF)

Pin 7) AB – Signal Ground: Establishes the common reference potential for all interchange circuits except circuit AA.

Pin 8) CF – Data Carrier Detector: The CF circuit delivers an ON signal to the CPT when the DCE is receiving carrier or line current and an OFF when received carrier or line current is not detected by the DCE.

Pin 12) CX – Local Mode: The 820D or 820E DAS may be placed in the local mode as described below by an ON signal on the CX circuit.

The local mode will not be initiated from an open circuit condition caused when the CPT power is OFF or when the EIA connector is removed.

2.3 Data Communication Equipment (DCE) – Additional Functions

In addition to providing the above interfaces, the DCE provides the functions described below.

2.31 Local Copy

When used for HDX service, the DCE provides local copy on the BB circuit of data sent on the BA circuit. When receiving local copy, the DCE passes received spacing signals (breaks) over the BB circuit to the CPT. There is an installer's option on the DCE to disable local copy if it is not desired.

2.32 Test Mode

2.321 As an aid in determining whether trouble is located in the local ac terminal link including the DCE or in the CPT, a Test Mode is provided on the 816 DAS and the 820 DAS arrangements. This mode permits the telephone company to check both the send and receive transmission path from the serving test center on a loop-back basis. The test mode of the 820-type DAS is inoperable when equipped with the half duplex dc Data Set 109.

2.322 When the DCE is placed in the test mode by operation of the Test key, it acts as follows. Where differences exist between the various DCE arrangements, these are indicated.

1. Connects the BB circuit (Received Data) to the BA circuit (Transmitted Data) in the DCE.

2. (a) 820 DAS Arrangement – Opens BA circuit on the data set from the BA circuit of the CPT.

   (b) 816 DAS Arrangement – Opens the BA circuit on the data set from the BA circuit of the CPT and, in addition, terminates BA lead toward the CPT in 3K ohms.

3. (a) 820 DAS Arrangement – an installer's option is available to either hold a steady marking condition on BB lead or to allow data to be re-received on BB lead.

   (b) 816 DAS Arrangement – A steady marking condition appears on BB lead.

4. (a) 820 DAS Arrangement – CA lead remains connected to CB lead. Holds CC lead OFF towards the CPT.

   (b) 820 DAS Arrangement – Opens CA lead toward the CPT. Holds CB lead and CC lead OFF towards the CPT.

5. Lights the TEST lamp.

6. (a) 820 DAS Arrangement – Disable local mode if operated.

   (b) 816 DAS Arrangement – No action since no local mode available.

7. Disables HDX "local copy" option if used.

8. (a) 820 DAS Arrangement – If received carrier is present, CF lead is ON towards CPT. Loss of received carrier squelches transmitted carrier and turns CF lead OFF towards CPT.

   (b) 816 DAS Arrangement – CF lead head ON towards CPT.

A second operation of the Test key releases the DCE from this mode.

A test lamp is provided on the DCE to indicate when the DCE is in the Test Mode as initiated by the above method. An arrangement is provided to allow the use of an external indicator lamp as an installer's option when the DCE is not in view of the attendant.

2.33 Local Mode

In order to permit the CPT to be tested through the EIA interface interconnection on a local basis, the 820 DAS arrangements provide a Local Mode of operation. This test feature is activated by an ON signal on the CX circuit (Local Mode) except when the DCE is in the Test Mode. When activated, the local mode circuit acts as follows:

1. Delivers local copy of data placed on the BA circuit to the BB circuit.

2. Clamps the data set transmitter marking towards the line.

3. Opens the received data path of the data set to the BB circuit.

4. Holds the CC circuit OFF toward the CPT.

The Local Mode is released by an OFF signal or an open on the CX circuit.

2.34 Received Carrier Detector Option

An installer's option is provided in the 820 DAS equipped with a Data Set 108 arrangement which will allow loss of received carrier to squelch outgoing carrier. This option can be used to automatically notify the telephone company test center that the station has lost its incoming carrier. As discussed in Paragraph 2.322, in the Test Mode, this action is always provided.

3. TRANSMISSION CHARACTERISTICS OF CHANNEL

3.1 Channel Distortion – Definition

The 150 Baud Channels are normally lined up and maintained by the telephone company using "start-stop" data characters as a source of test signals. The exception to this is when the CPT always uses synchronous signals and the channel requires regenerative repeaters. The characters generally will be transmitted at the highest rated speed of the channel; namely 150 Bauds. The received signals will be measured in terms of telegraph distortion.

Each start-stop data character is composed of several elements; a single unit start element which is always a space, 5, 6 or 7 single unit information elements and sometimes a single unit parity element which may be mark or space, and a stop element which is always a mark and is one unit or longer in length. A typical 8-element character is illustrated in Figure 1.

Telegraph distortion is the measure of the displacement of any mark-to-space or space-to-mark transition from its proper location. The reference point used when measuring telegraph distortion is the initial mark-to-space transition of each character which occurs at the beginning of each start element. The slicing level for all measurements is at about the 50% point on the rising and falling waveforms. Sensing of signal elements is assumed to be timed for the nominal center of each element. The waveforms at the interface meet the rise and decay times

specified in RS-232-B. Spurious short duration impulses (on the order of 1/10 a signal element) are not characteristic of the channel and would be regarded as trouble condition.

Referring to Figures 1 and 2, transitions measured at the slicing level should occur at integral multiples t_e from the start transition for no distortion. If a transition occurs at a time t earlier or later than this time, the distortion is:

$$\text{Per Cent Distortion} = \frac{\Delta t \times 100}{t_e}$$

For example, refer to Figure 2 and let us examine the distortion of information element No. 3 which is in the space condition. Assume the nominal element length t_e = 10 milliseconds and that t_2 = 1 millisecond and that Δt_3 = 2 milliseconds.

$$\text{Peak Distortion Per Character} = \frac{\Delta t \text{ max.}}{t_e} \times 100 = \frac{2}{10} \times 100 = 20\%$$

Thus, although the element is 30 per cent shorter than its nominal length, its telegraph distortion, as defined, is 20 per cent.

3.2 Channel Distortion – Factors

The amount of inherent channel distortion encountered on 150 Baud Channels is a function of the channel length and its complexity (number of transmission links in tandem between any two stations). If the CPT character code format and Baud rate is any one of those listed in Table C, the telephone company may place a regenerative repeater in the channel to insure that it will perform as specified in Paragraph 3.3. For this reason, the telephone company will generally ask for the speed and code format used by the CPT.

However, if the CPT uses the channel for transmitting other codes, variable length bits or characters, or if the CPT uses it alternately at different signaling rates and/or different character code formats, standard regenerative repeaters can not be provided and the inherent distortion of the channel is not specified.

TABLE C
COMMON DATA CHARACTERS FORMATS

Start-Stop

Start Element	– Unity length – Always "Space"
Information Elements	– 5,6,7 or 8 per character – Unity length – "Mark" or "Space"
Stop Element	– Unity or greater in length – Always "Mark"

Synchronous

All Elements	– Unity length – "Mark" or "Space"

COMMON DATA RATES

(0-75 Bauds)*	(76-150 Bauds)
45.55 Bauds	110.00 Bauds
50.00 Bauds	134.46 Bauds
56.85 Bauds	
61.12 Bauds	
66.67 Bauds	150.00 Bauds
74.23 Bauds	
75.00 Bauds	

* These data rates may, of course, be used on 150 Baud Channels; however, other channels are available at reduced rates for transmission speeds up to 75 Bauds. These are described in separate Bell System Technical References.

3.3 Performance Objectives

The long term objectives of 150 Baud Channels is to have an average performance of 1 error in 10^5 bits transmitted. The CPT should deliver no more than 5% telegraph distortion at the interface and should be capable of processing received data signals at the interface with up to 40% telegraph distortion. CPT's unable to meet these requirements may expect that special engineering and possible associated charges may be incurred.

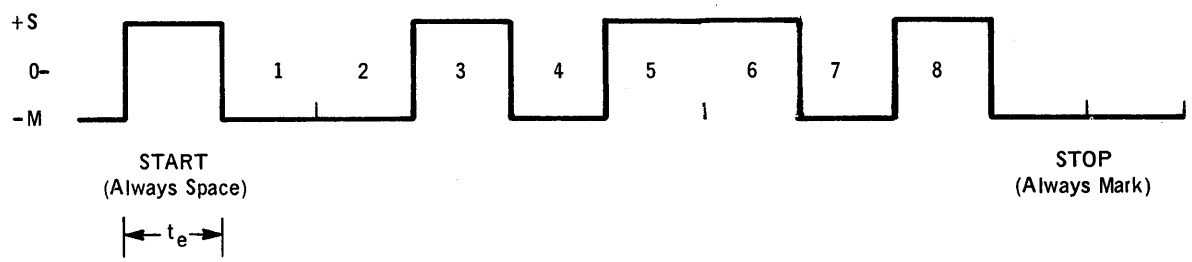
3.4 Turn-around Time – Half-duplex Operation

3.41 Near-end Turn-around Time

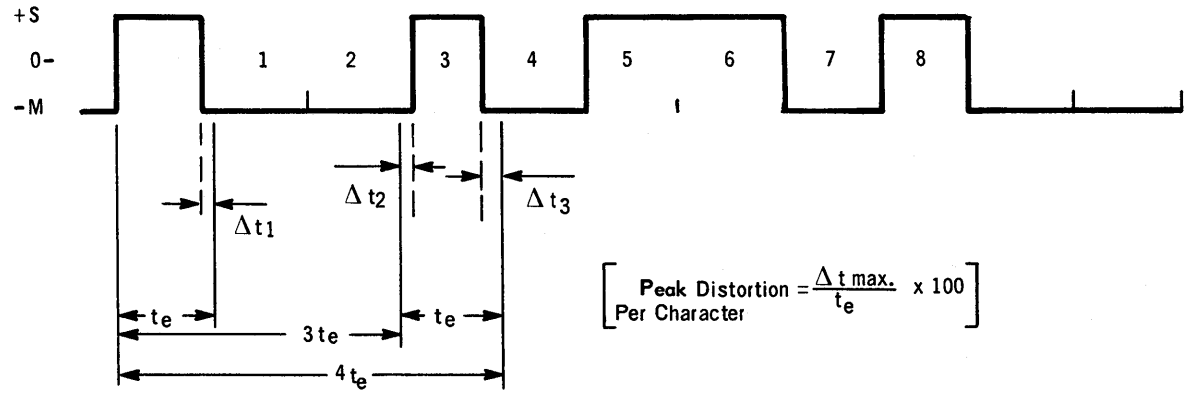
The near-end or local turn-around time of a half-duplex 150 Baud Channel (the required time interval for any telephone company supplied local transmission equipment to condition itself to reverse the direction of transmission) is essentially zero. However, the CPT should not be arranged to reverse its direction of transmission until it has received the entire nominal length "stop" pulse of the last received character in a message.

3.42 Far-end Turn-around Time

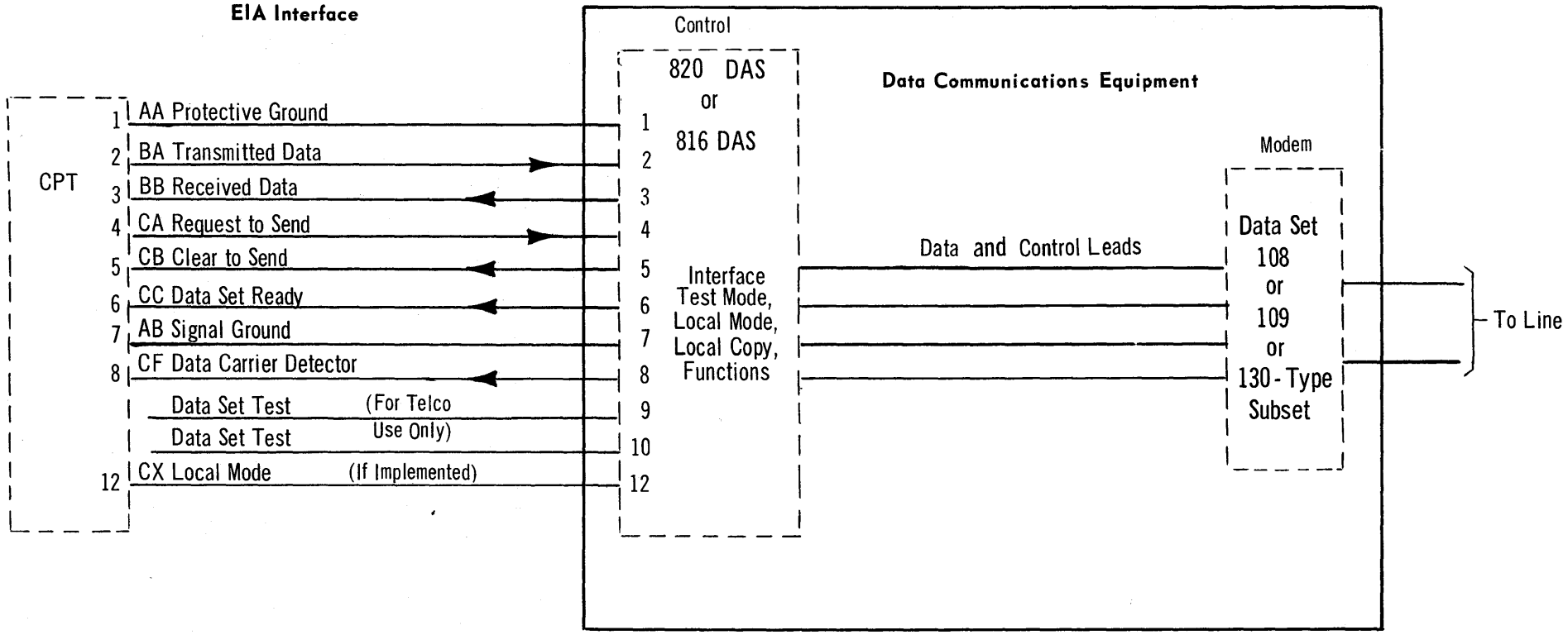
The far-end or distant turn-around time of a half-duplex channel (the time interval consisting of the two-way propagation time of the channel, delay through regenerative repeaters and directional control circuit operation in the transmission equipment) may be as high as 500 milliseconds. However, if far-end turn-around time is critical to the CPT operating procedure, it is recommended that the specific case be discussed with the local telephone company representatives.



Typical Undistorted Eight Element Start-Stop Signal
Figure 1

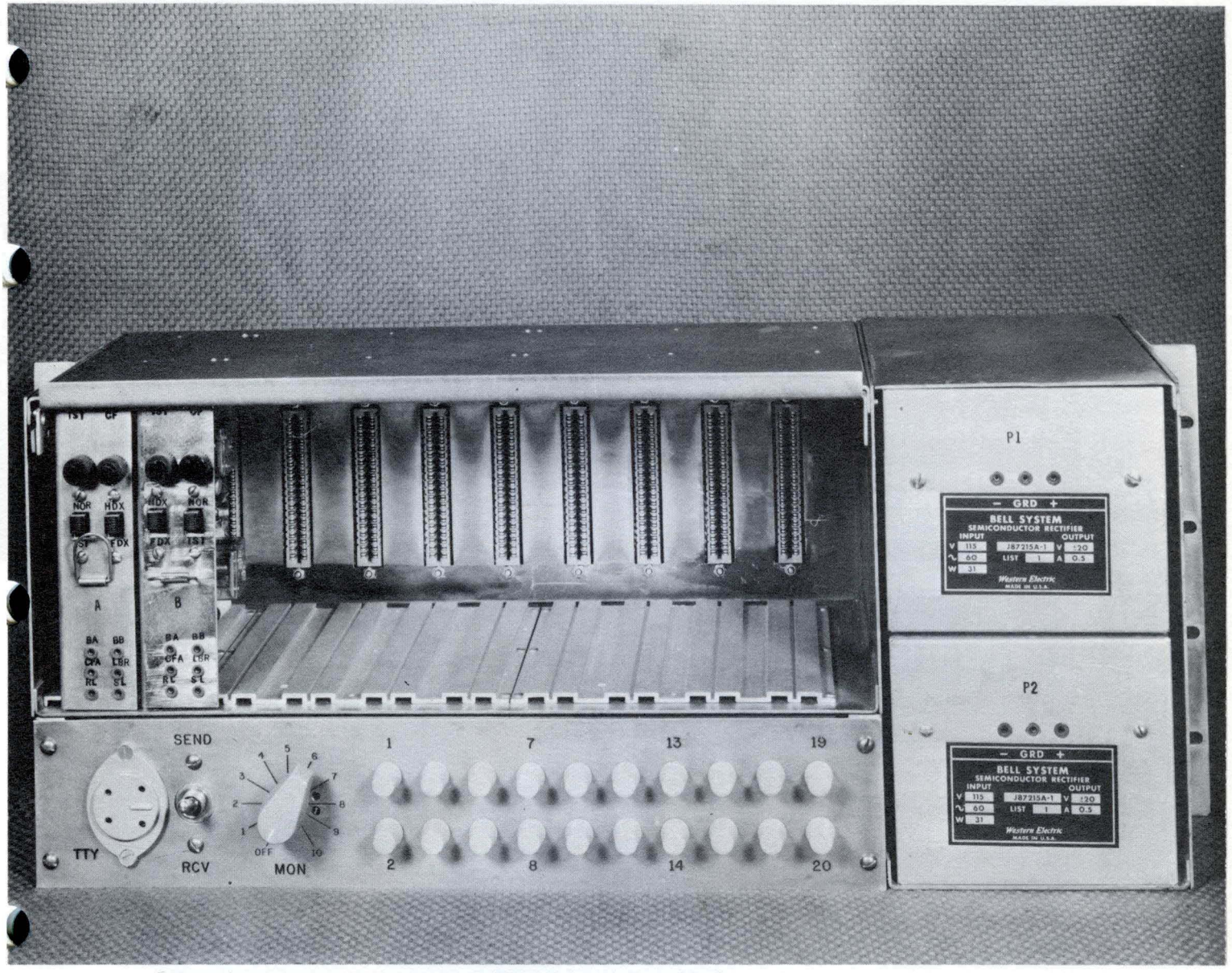


Distorted Eight Element Start-Stop Signal
Figure 2

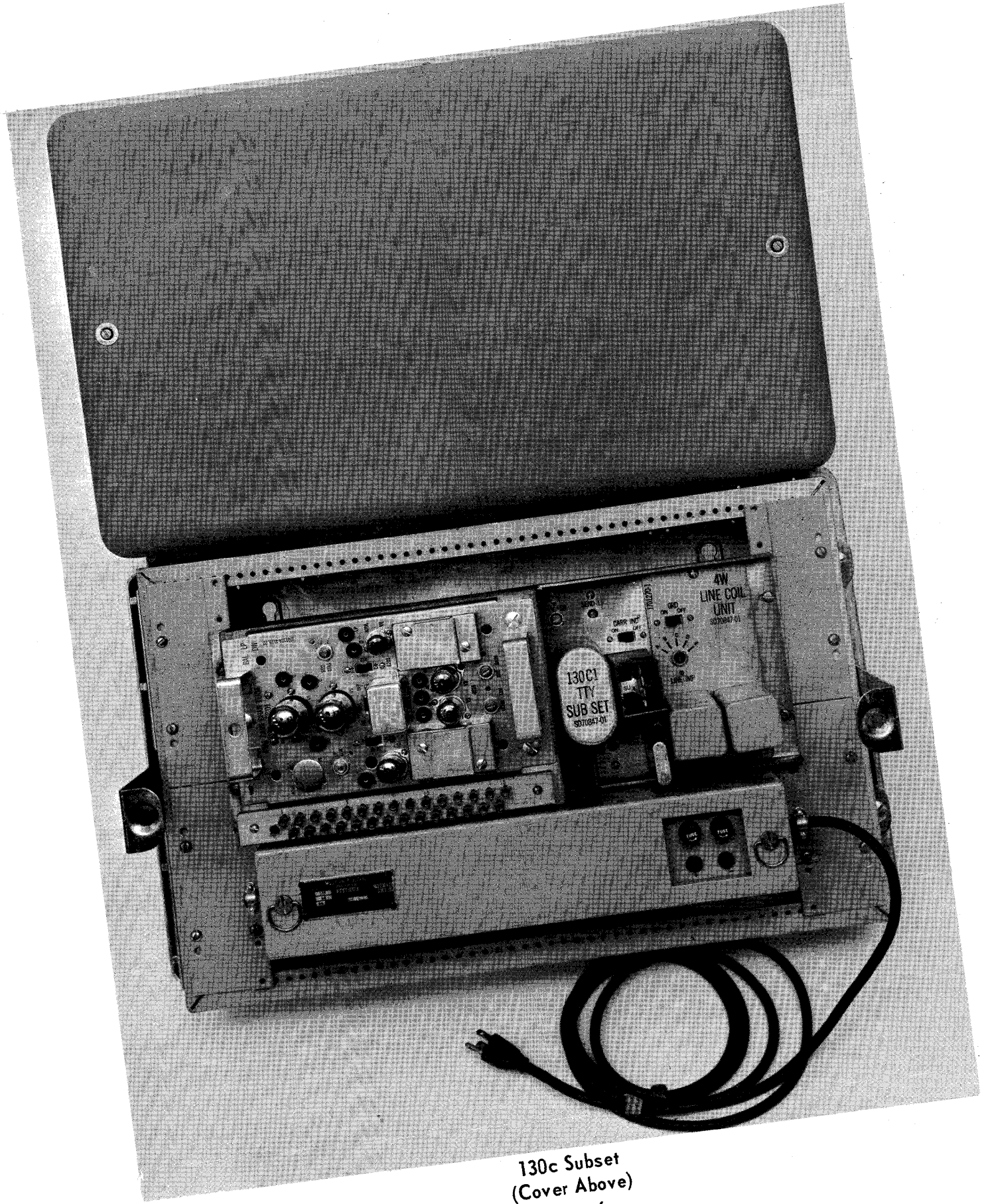


Data Communication Equipment Interface
Figure 3

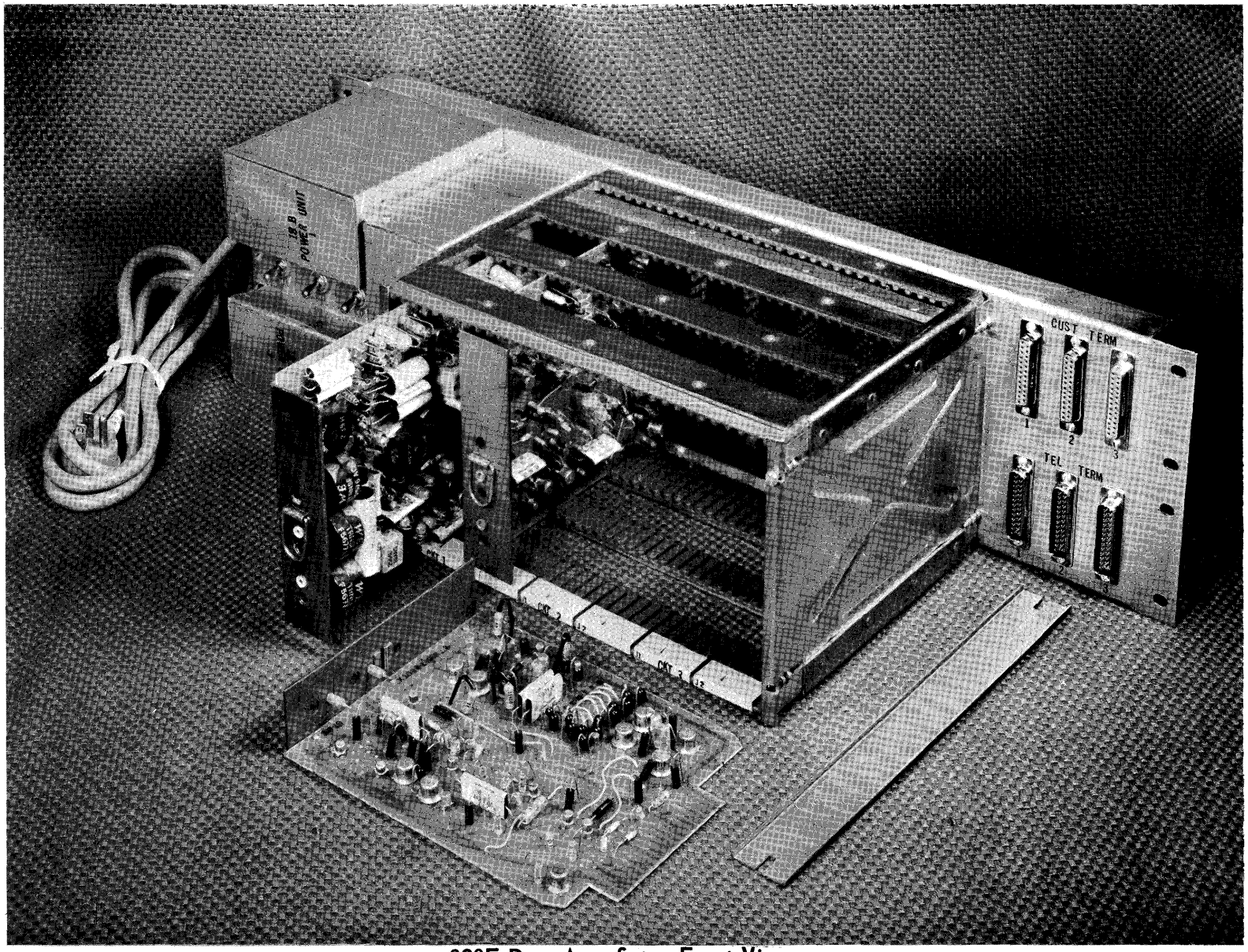
816A Data Auxiliary Set
(Normally Mounted Vertically)
820D Data Auxiliary Set
Equipped with Data Set 108 or 109
Figure 4



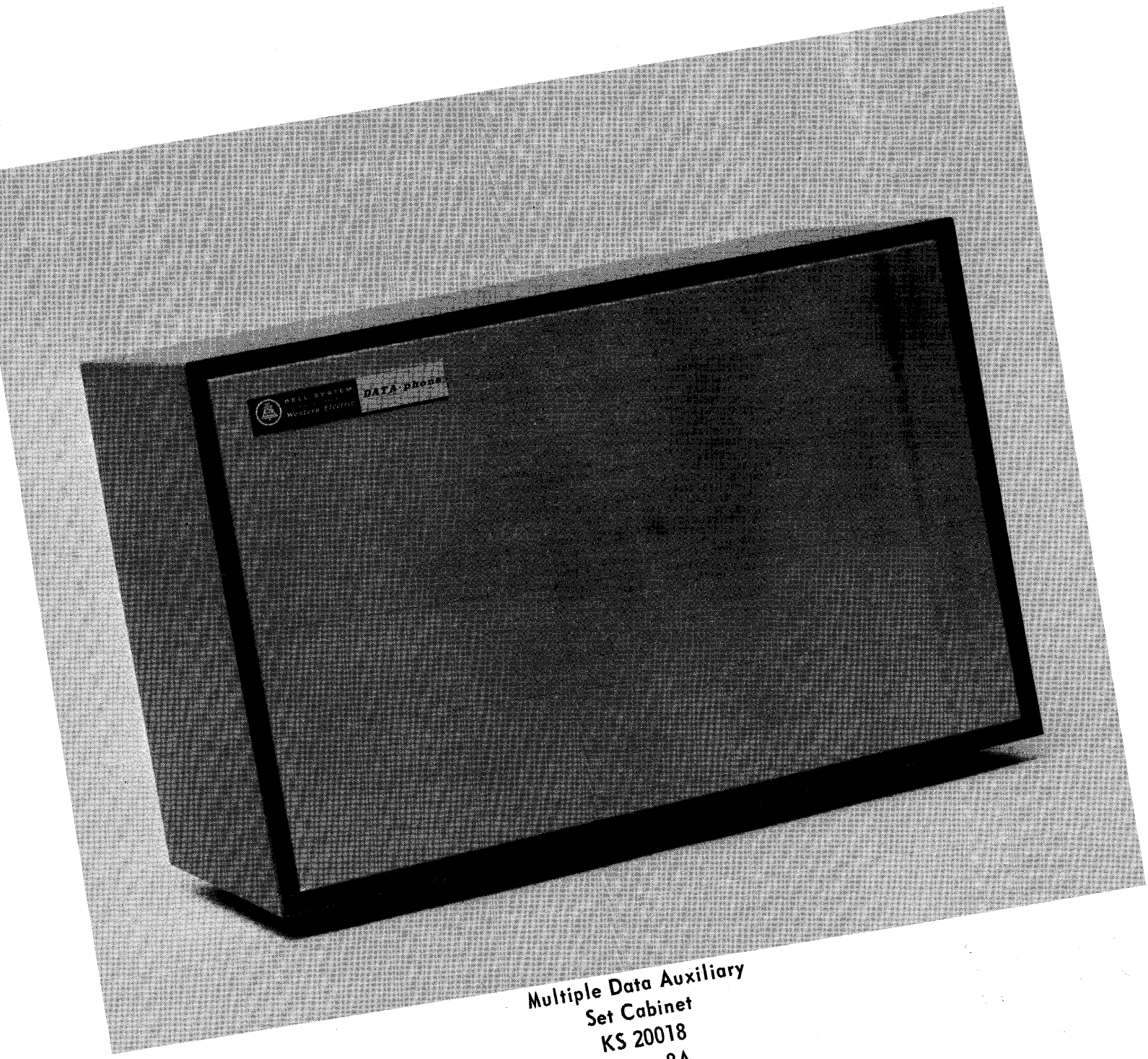
816B Data Auxiliary Set
Figure 5



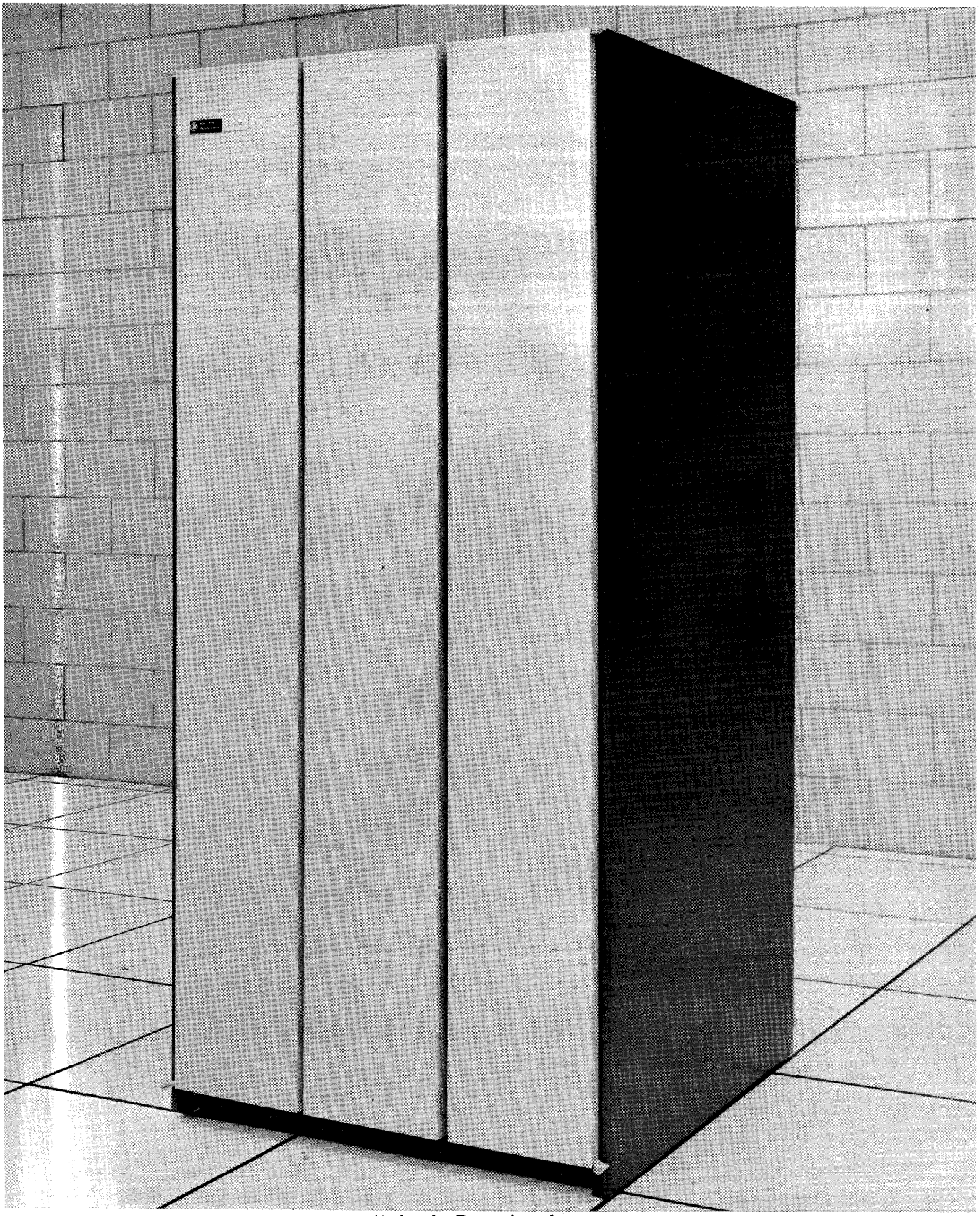
130c Subset
(Cover Above)
Figure 6



820E Data Aux. Set – Front View
1 – 108 Data Set & Interface Card Installed in Set
1 – 109 Data Set Displayed in Front
Figure 7



Multiple Data Auxiliary
Set Cabinet
KS 20018
Figure 8A



Multiple Data Auxiliary
Set Cabinet
KS 20093
Figure 8B


BELL
SYSTEM