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TECHNICAL REFERENCE

WIDEBAND DATA STATIONS

303 TYPE

DECEMBER 1974

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Wideband Data Stations 303 Type

December 1974

MANAGER - DATA SYSTEMS

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This Technical Reference replaces the following Technical References:

"Wideband Data Stations — 303-Type — August 1966"
"Wideband Data Stations — 303-Type — Supplement 1 — March 1969"

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1. GENERAL

1.1 Content

This reference describes standard 303-type wideband data stations for use in the transmission of serial binary synchronous data at certain bit rates in the range from 19.2 kb/s to 460.8 kb/s; or nonsynchronous data with minimum signal element durations in the range from 52 to 2 microseconds. It describes interface arrangements, and discusses how the choices of data set code and station arrangement are made by the Telephone Company from a knowledge of customer service requirements and facilities engineering requirements. Customer operational features and the options required to provide these features are also discussed.

1.2 Purpose of Data Station

The 303-type wideband data station equipment is normally located at the customer's premises and provides the coupling between his business machine equipment and the wideband data transmission system. The transmission system provides a full-duplex wideband channel for high-speed binary data transmission using data sets 303-type; a full-duplex voice frequency channel is also provided for coordination.

The 303-type data station is a versatile terminal that can be used to couple any of several kinds of business machines to transmission facilities generally used for telephone service.

The data sets 303-type condition binary baseband signals for optimum performance over the various types of local and toll facilities encountered in the telephone plant. The overall transmission system can consist of either analog or digital facilities, or combinations of both, or, in certain cases, a PICTUREPHONE®facility. Local access facilites are used to connect the data station with the serving central office of the Telephone Company. These access facilities may be baseband or passband analog facilities, T1 digital facilities, or a PICTUREPHONE line. Since each of the facility types requires the use of a particular type of line signal, certain codes of data set 303 and station arrangements are uniquely applicable to each particular type of station access arrangement. When baseband or passband analog transmission is used, local cables must be specially conditioned through the use of wideband amplifiers which include equalizers to provide flat response over the required bandwidths. Where analog carrier systems are included in either local or toll facilities, special wideband modulators and demodulators must be provided to translate the data signals to and from the basic frequency spectrum of the half-group, group, or super-group facility used. These modems are used instead of the voice channel terminals normally used on carrier systems. The wide frequency spectrum that must be made available for these data services displace large numbers of voice channels. The service may be full time data or alternate data-voice. The alternation is under customer control. When digital facilities are involved in combination with analog facilities, modems must be installed at the facility interfaces to accomplish signal format conversions. Regenerative repeaters may be required for switched services using analog facilities. Because of the interrelationship between the flexibility of the wideband data set and the wide range of transmission facilities, custom engineering and installation of special equipment, these wideband data services may take considerable time to provide. In view of this, it is desirable that the prospective customer for any of these wideband services contact the Telephone Company at the earliest possible time in his planning stages.

Wideband data services can be provided on a point-to-point private line basis or by specially engineered private switched systems. In addition, an experimental 50 kb/s switched service is available in the common user DATAPHONE® network. This 6-wire switching arrangement provides a 2-wire voiceband channel and a 4-wire wideband channel. Call processing is handled over the 2-wire voice portion of the network; 4-wire wideband data circuit switching is slaved to the 2-wire voice switching.

The wideband data system plan requires that data sets have the appropriate type of line signal

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as a function of the interconnecting facility. Several types of line signals are available with various codes of data set 303-type. Restored polar, the name given to a system in which the dc and low frequency components are removed from the signal in the baseband transmitter of the wideband data set and reinserted at the data set receiver, is used typically with analog channels. This system can be used with T1 digital facilities also if modems are provided which convert the restored polar type signal to a polar type baseband signal before translation to the T1 line signal format. Balanced dc coupled line signals are used generally when the data set is connected directly to a digital system as in the case where the T1 line extends to the customer's premises. PICTUREPHONE type line signals are a special form of the dc-coupled line signal case and are used when the wideband data set is connected to the PICTUREPHONE network, when and where available.

Connections may combine the use of digital facilities with group or supergroup analog facilities, and the wideband data system plan is to operate with baseband signals at the input and output of each transmission facility. This requires that the dc and low frequency components of the data signal be removed before the signal enters an analog channel to facilitate transmission through the transformers and other blocking circuits that are encountered. Also, dc and low frequency components of the data signal must be removed to prevent interference with carrier recovery in the vestigial sideband (VSB) method of transmission employed by these facilites. The VSB carrier is transmitted at a low level and must be received at the demodulator without alterations in frequency and phase and without interference from extraneous signals. In half-group service, VSB modems are used at the data station, thus necessitating the removal of dc and low frequency components for this case also.

Data set 303-type codes which develop the restored polar type line signal are available for synchronous operation in commercial service at data transfer rates of 19.2, 50, and 230.4 kb/s. Rates of 18.75, 40.8, 32, 48 and 200 kb/s are available for special applications. When operated in the nonsynchronous mode, these restored polar type data sets will accept and deliver nonsynchronous signals with a minimum signal element width of 4.3 microseconds for operation over supergroup facilities, 20 microseconds for operation over group facilities, and 52 microseconds for operation over half-group facilities. There are available, in this line signal format, sets which are intended for nonsynchronous use only.

When the wideband data system transmission plan calls for connection of the wideband data set to a T1 digital subscriber line, data sets which develop a dc-coupled balanced one volt peak-to-peak line signal are usually used. Such sets are used in conjunction with a T1WM-4 wideband modem, which serves to properly encode the data signal into the standard 1.544 Mb/s T1 line format. Also included at the data station is a T1 line terminating unit, which provides for signal regeneration in addition to the features required for T1 line maintenance.

In certain applications requiring connection to a T1 digital line facility, wideband data sets using the restored polar line signal format have been used. These situations require modems at the interface with the digital facility which include a restored polar transmitter and receiver equivalent to those in the data set in order to develop an equivalent baseband polar signal for translation to the T1 line signal format. Typically, modems used for this purpose were the T1WM1 for single channel operation and the T1WB-type for multichannel operation. The restored polar type data set and T1WM1 modem combination can be used in cases where the T1 digital facility does not extend to the subscriber location. Historically, this combination was used before introduction of the dc-coupled balanced line signal type of data set 303 in all single channel applications to T1 carrier regardless of whether or not the T1 line was available at the subscriber location. The restored polar type data set and T1WB-type modem combination can be used in cases where a number of wideband channels are to be fed to the T1 line. The above cases involving restored polar type data set 303 applications to digital line facilities are mentioned here for completeness. Subsequent discussion relating to data set types, station arrangements, etc, for

use with digital facilities, will mention only the more typical arrangements using the dc-coupled balanced line signal type of data set 303.

The dc-coupled balanced line signal type of data set 303, for use with T1 line customer loops, is available in the same synchronous rates and nonsynchronous minimum signal element width ratings as the restored polar types. In addition, a synchronous rate of 460.8 kb/s is available for commercial service to provide a higher transmission rate over all digital and PICTUREPHONE transmission facilities. When this rate is used over T1 digital line facilities only, the maximum transmission distance is limited to that of the T1 system. A nonsynchronous only set is coded for operation with signal element widths to a minimum of two microseconds.

The data set 303-type intended for use over PICTUREPHONE facilities provides the appropriate signals and controls for interfacing on the line side with the 114A interconnecting unit in either the single-line or key-telephone-system type of PICTUREPHONE station. The line signal produced by this set is balanced dc at an amplitude of 0.75 volts peak-to-peak. This set is available for transmission of synchronous data at a bit rate of 460.8 kb/s.

Data sets 303-type which are used for synchronous data transmission in standard commercial service arrangements include scramblers and descramblers. The scrambler encodes or randomizes the customer binary signal train (including steady mark or space). This prevents the application of a strong single frequency signal on the line as would happen if a customer dotting signal were to be transmitted. Thus the signal energy is spread more uniformly over the passband to reduce the likelihood of interference with other services. The descrambler applies the inverse function, restoring the original customer data pattern.

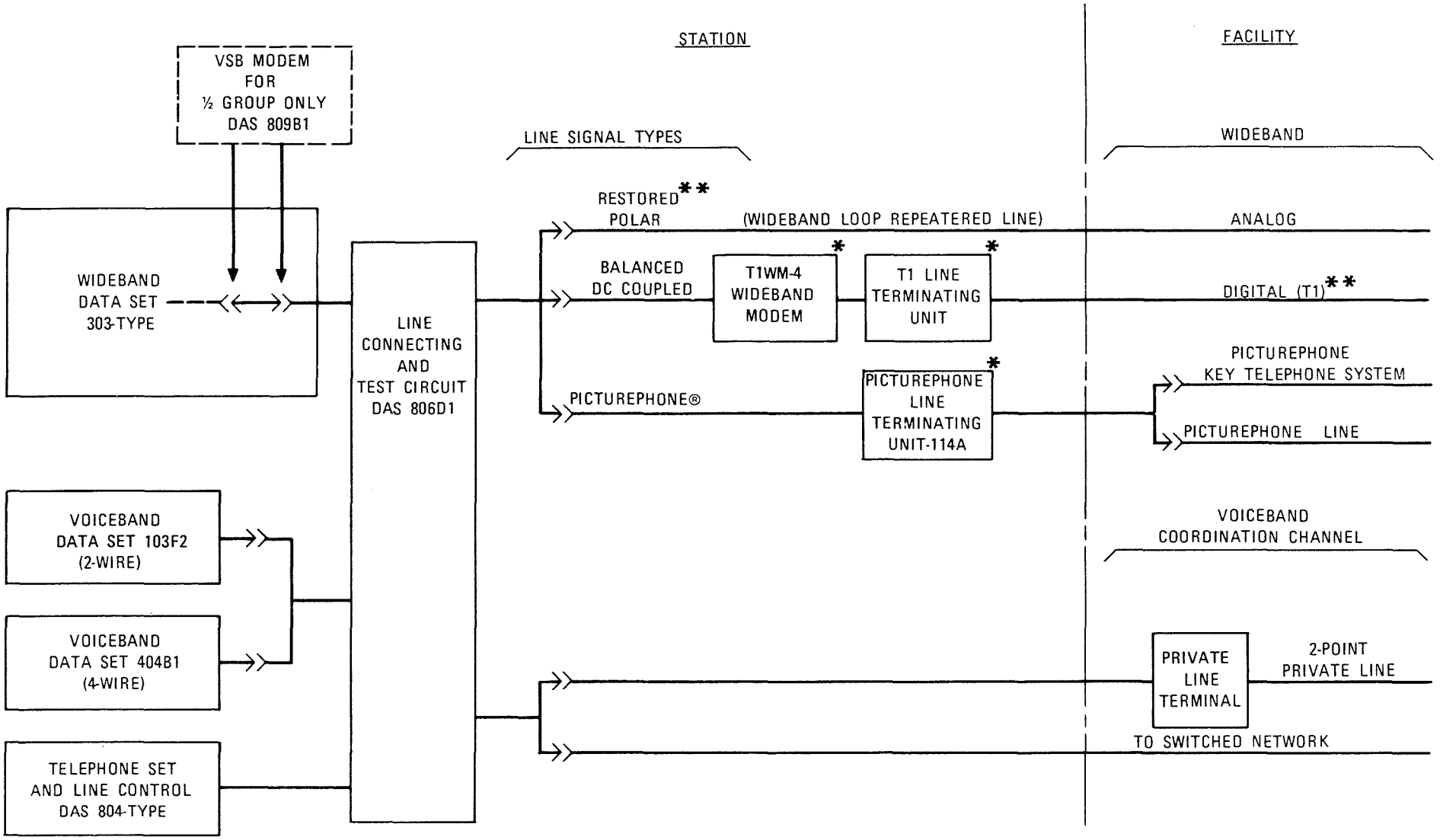
2. THE WIDEBAND DATA STATION

2.1 The Overall Station

The wideband data station consists of a wideband data set 303-type and such other data sets and data auxiliary sets as are appropriate to the functions of the particular type of station. The generalized configuration of a data station is shown in Figure 1. The wideband data station equipment can be housed in a cabinet, as shown typically in Figures 2 through 6, and located on the customer's premises within a maximum distance of 50 cable feet from his business machine equipment. It can also be mounted on relay racks without a cabinet where required. Block diagrams of typical synchronous and nonsynchronous data stations are shown in Figures 7, 8 and 9.

The nonsynchronous mode of operation is used with nonsynchronous serial, customer-provided terminals such as two-level black and white baseband facsimile equipment; the nonsynchronous mode of operation should not be used for synchronous signals. (See discussion entitled "Synchronous Operation in the Nonsynchronous Mode"). The synchronous mode is used with synchronous serial equipment such as magnetic tape terminals and computers. A data station that is equipped with a clock for fixed speed synchronous operation can also be operated in the nonsynchronous mode by the application of a control signal at the interface between the business machine equipment and the data station equipment. This arrangement should be attractive from the customer's standpoint since it makes it possible to operate with synchronous or nonsynchronous equipment, for example, on an alternate use basis, using the same data station equipment.

Synchronous business machines usually accomplish control functions and error check operations by means of information contained in the high-speed serial bit stream; however, certain facsimile machines have required the transmission of control functions over a channel separate from the wideband channel. Therefore, a separate voiceband data channel may be provided in 303-type wideband data stations intended for point-to-point service by the use of data set 404B1 which provides full-duplex low-speed data transmission on a four-wire basis. When voice rate data is required for control purposes in 303-type data stations intended for use in switched service with the normal six-wire switching arrangement, such as in the DATAPHONE 50 common user network, data set 103F2 is provided. This data set transmits low speed serial data on a full-duplex basis over the two-wire voice channel. Voiceband data



* MAY BE LOCATED REMOTELY FROM STATION

** THE RESTORED POLAR-TYPE TRANSMISSION INTERFACE CAN BE USED WITH DIGITAL FACILITIES WHEN MODEMS SUCH AS THE T1WM1 AND T1WB-TYPE ARE PROVIDED BETWEEN THE ANALOG AND DIGITAL PORTION OF THE TRANSMISSION SYSTEM. THESE MODEMS CONVERT THE RESTORED POLAR TYPE SIGNALS TO POLAR BASEBAND SIGNALS PRIOR TO ENCODING TO THE T1 SIGNAL FORMAT.

GENERALIZED STATION CONFIGURATION
FIG. 1

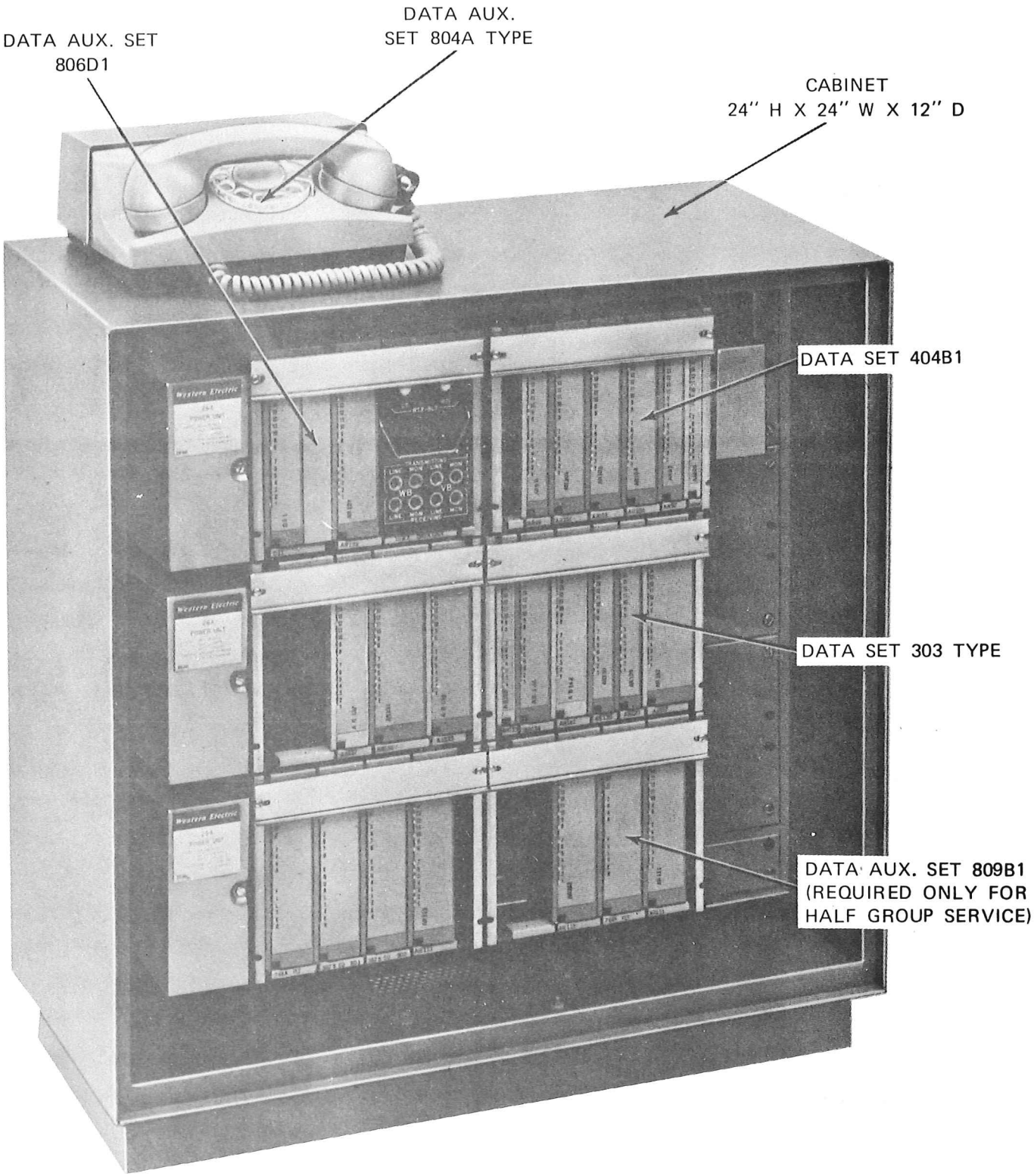


FIG. 2 — Front View, Cover Removed
303 Type Wideband Data Station for
Operation with Analog Line Facility

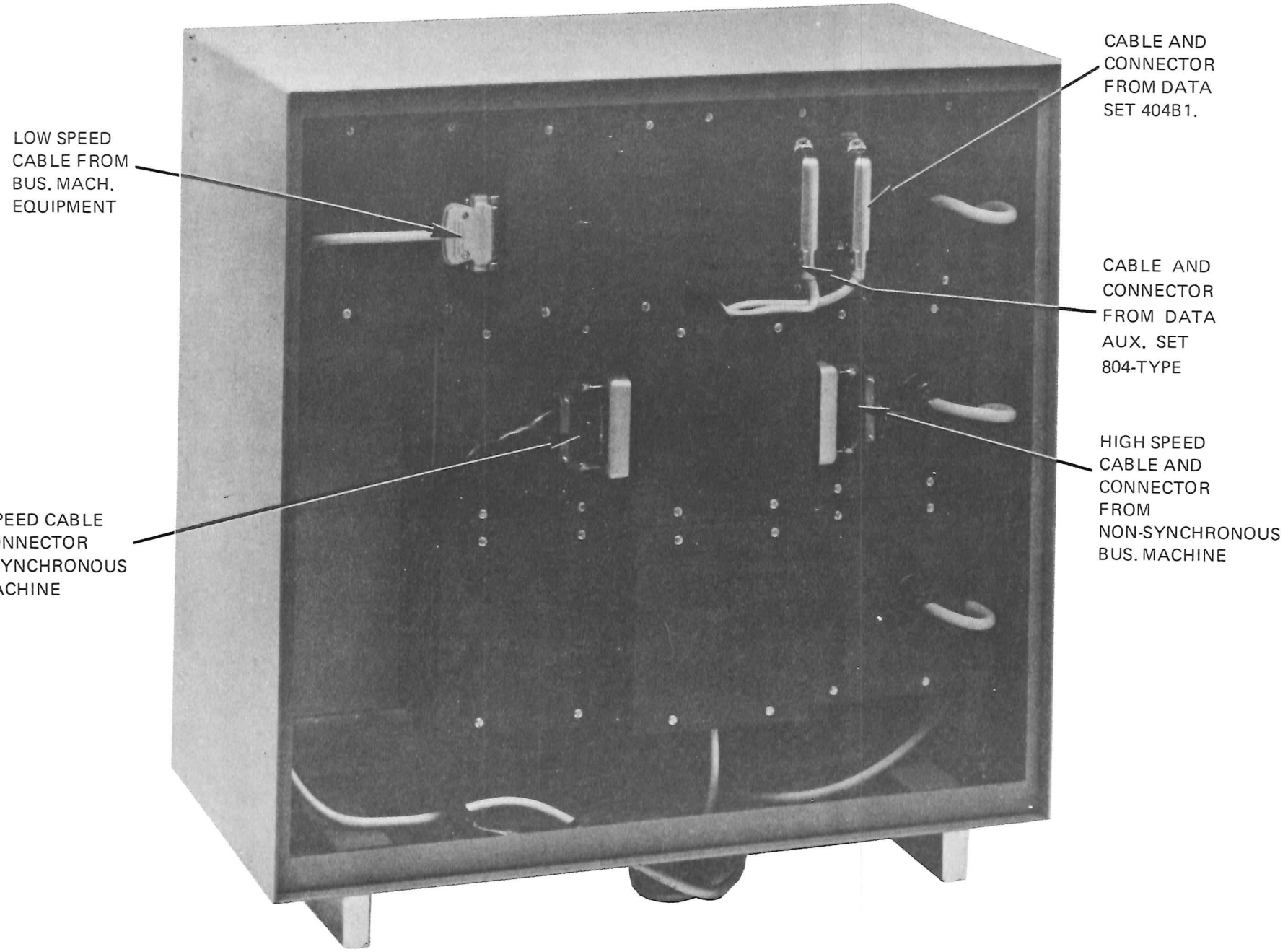


Fig. 3 – Rear View, 303 Type Wideband Data Station For Operation With Analog Line Facility

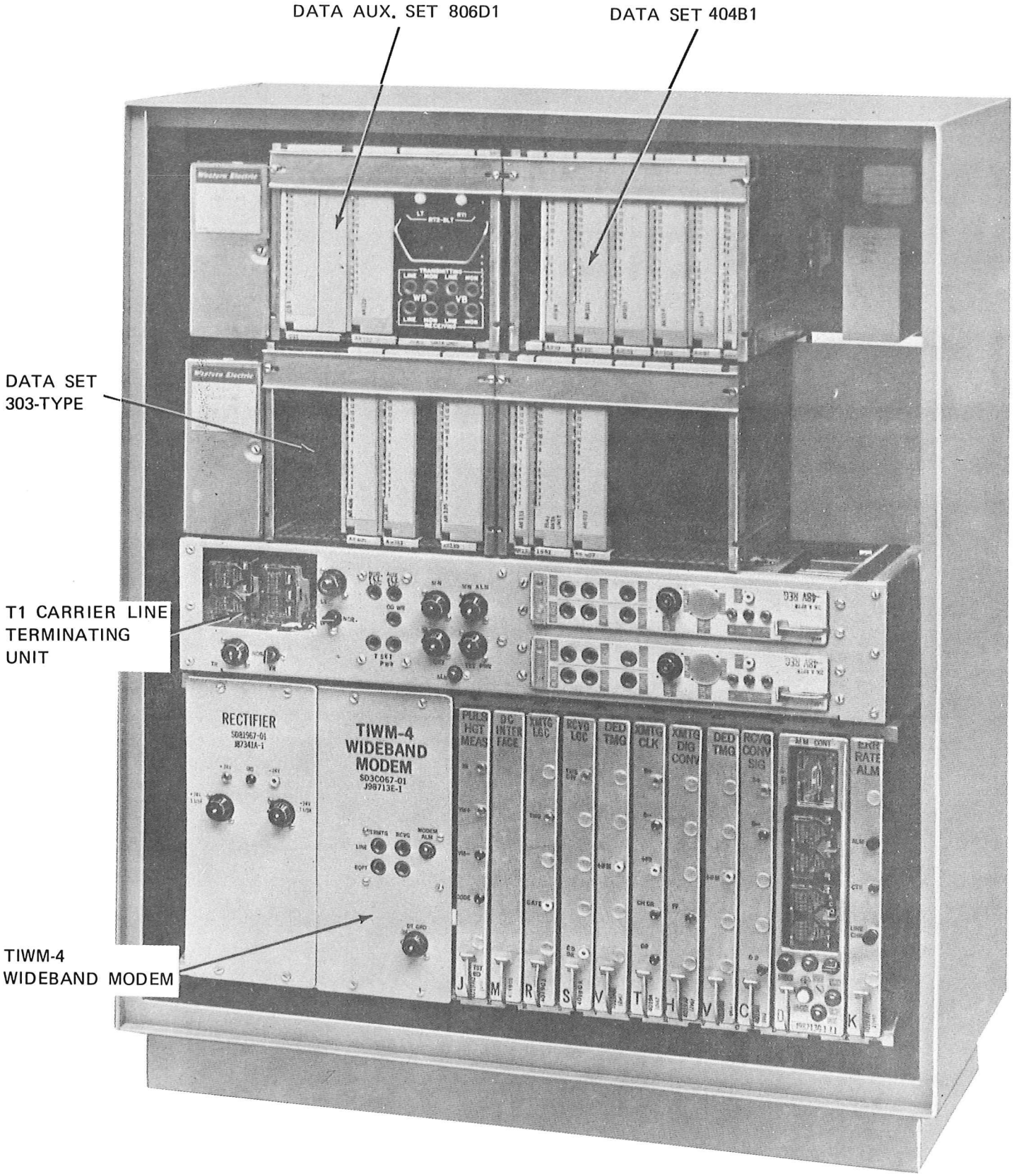


Fig. 4 — Front View, 303-Type Data Station For Operation With T1 Facility

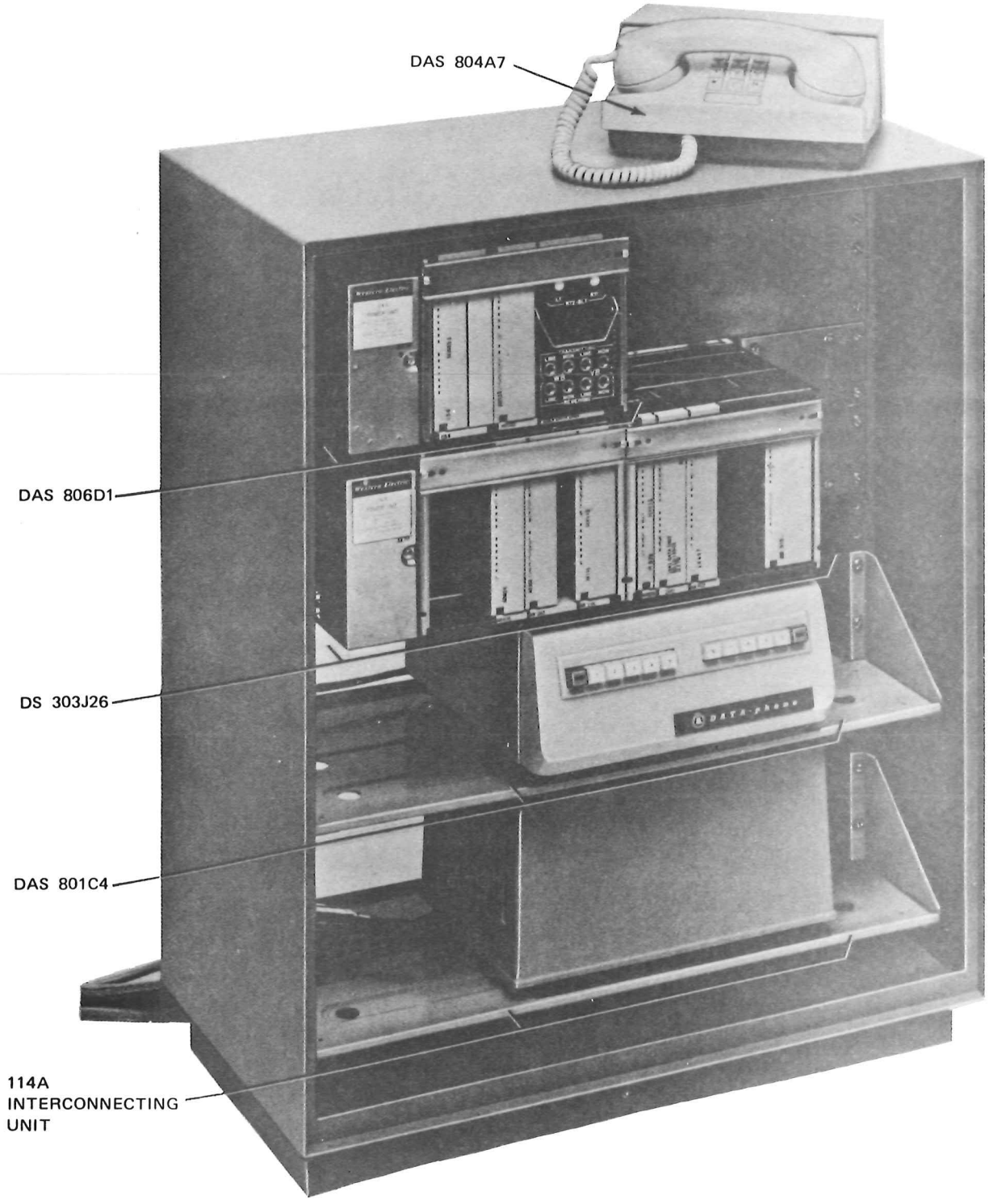


Fig. 5 – Front View, 303-Type Data Station For Operation With Picturephone Facility

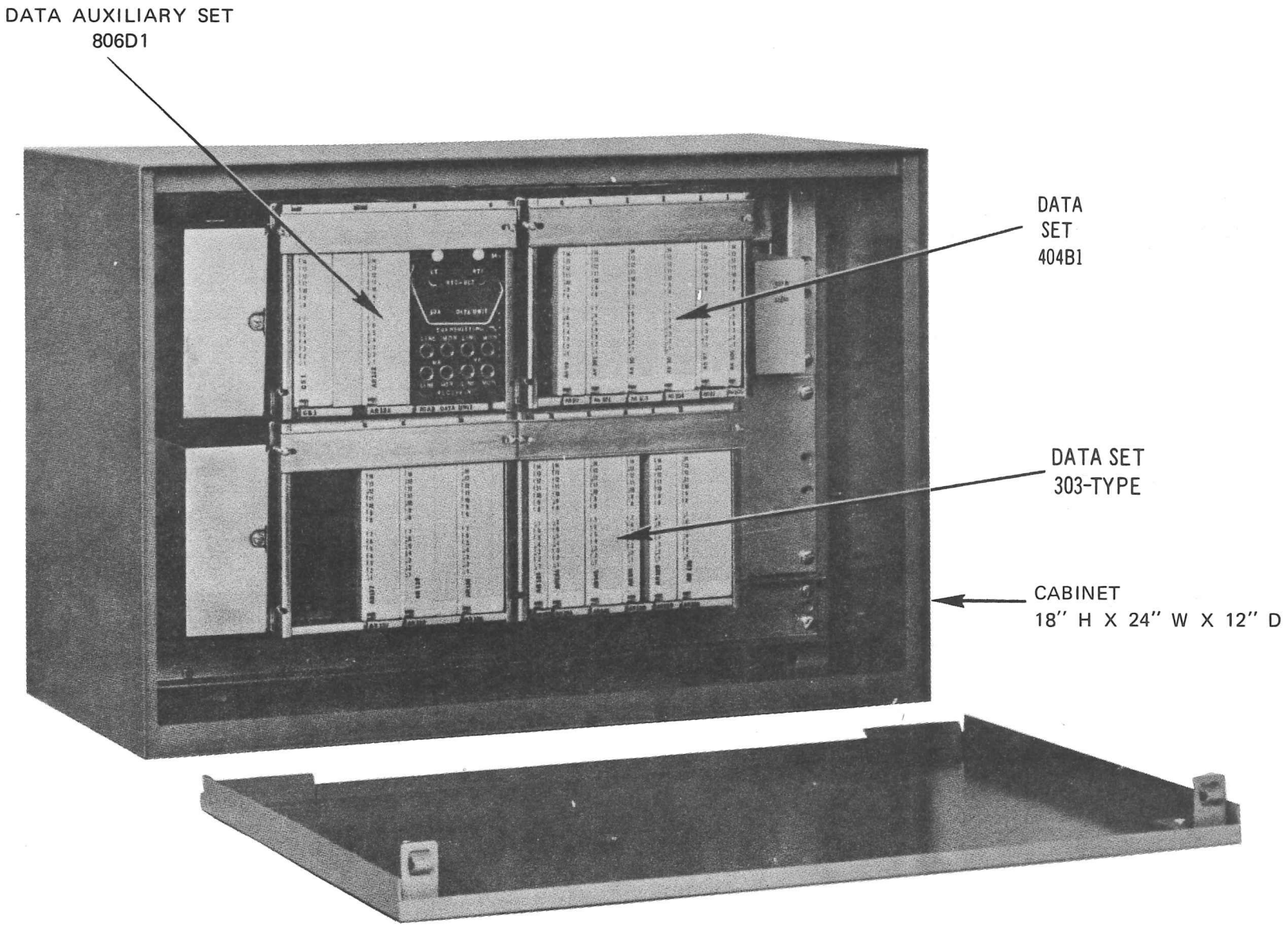


Fig. 6 – Front View – Station Apparatus Arranged In Eighteen Inch High Cabinet

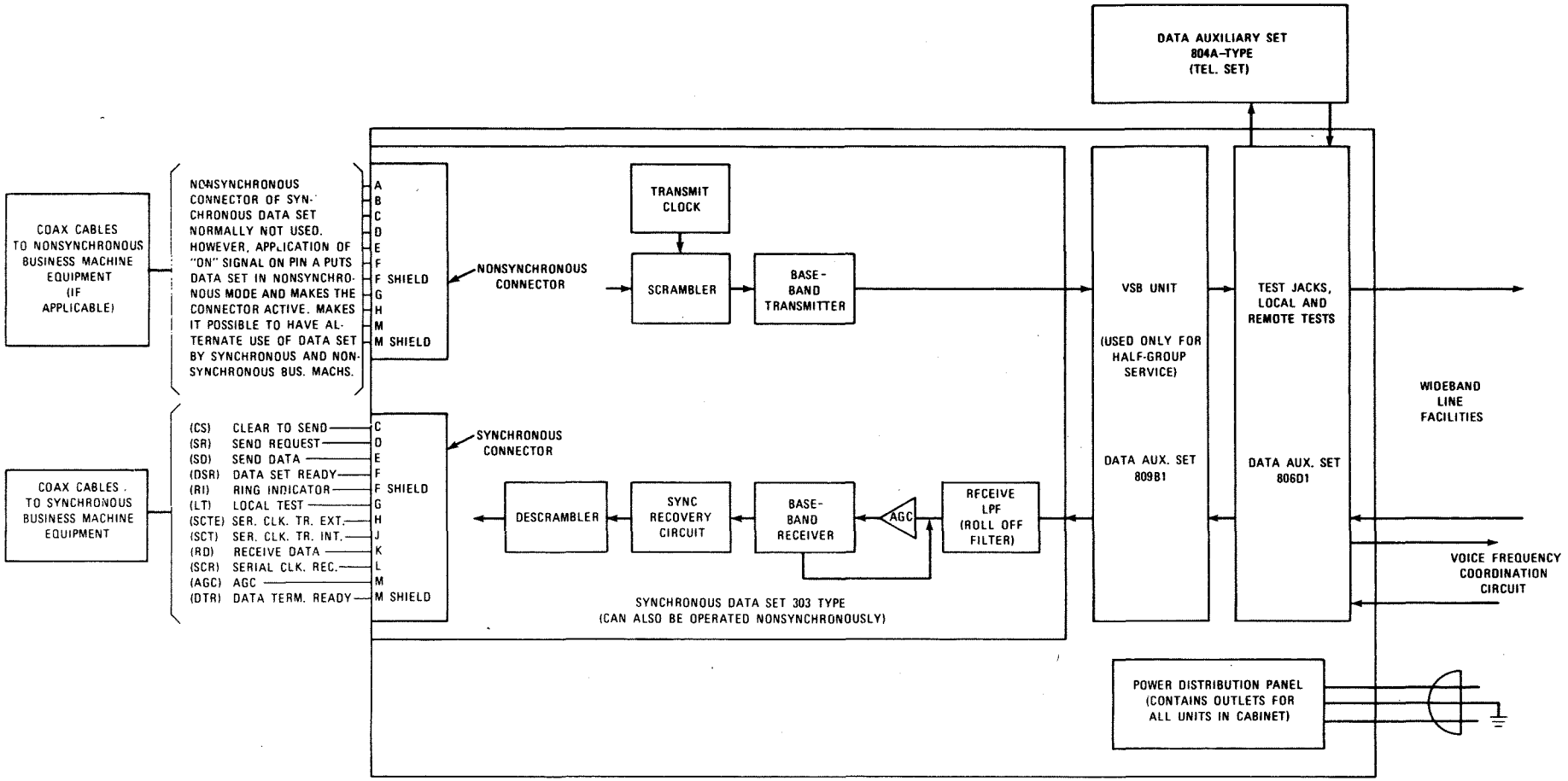


FIG. 7 – FUNCTIONAL CONFIGUATION OF TYPICAL SYNCHRONOUS DATA STATION USING RESTORED POLAR SIGNAL FORMAT

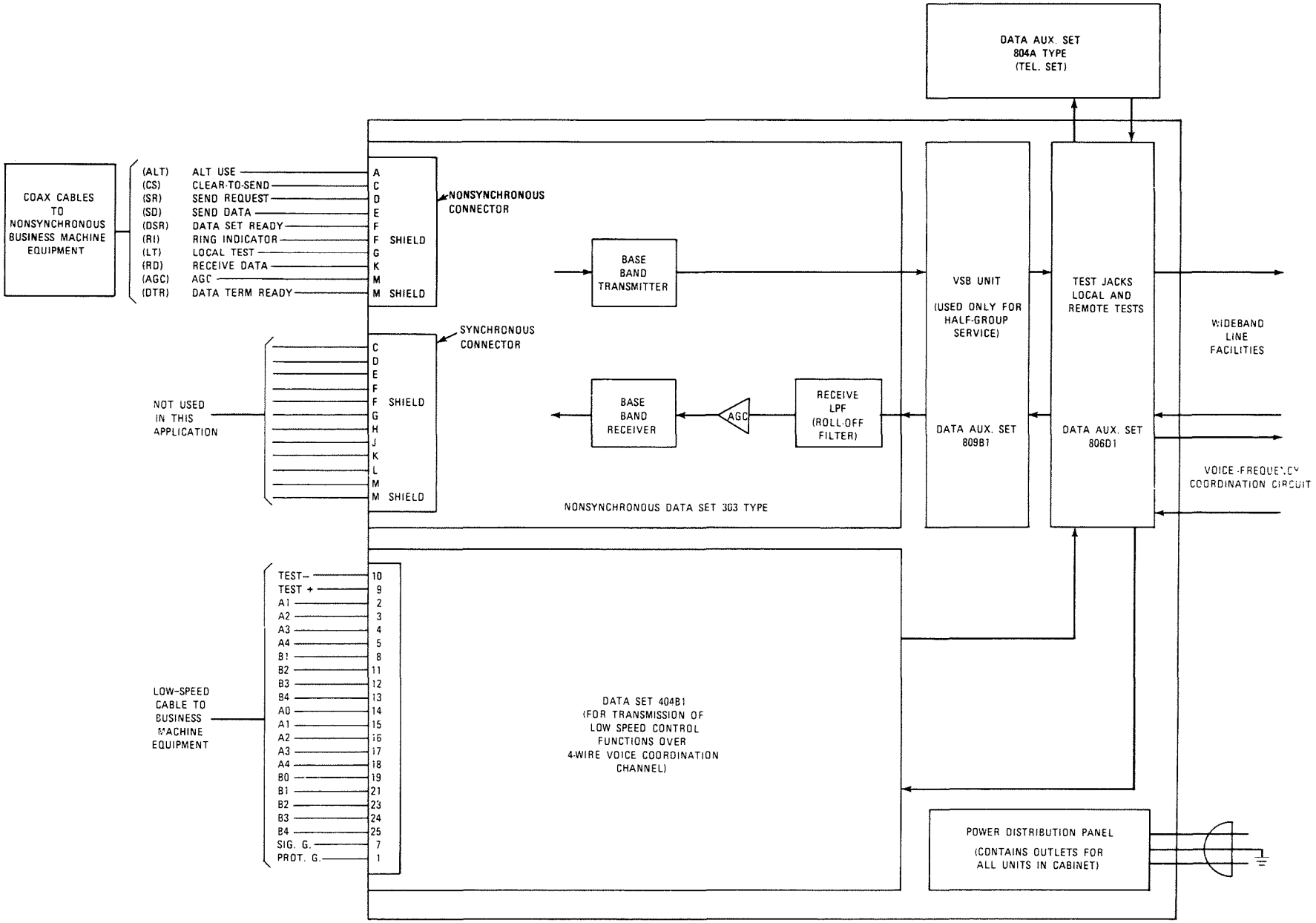


FIG. 8 – FUNCTIONAL CONFIGURATION OF TYPICAL NONSYNCHRONOUS DATA STATION USING RESTORED POLAR SIGNAL FORMAT AND ARRANGED FOR TRANSMISSION OF LOW SPEED CONTROL SIGNALS (AS REQUIRED BY CERTAIN FACSIMILE MACHINES)

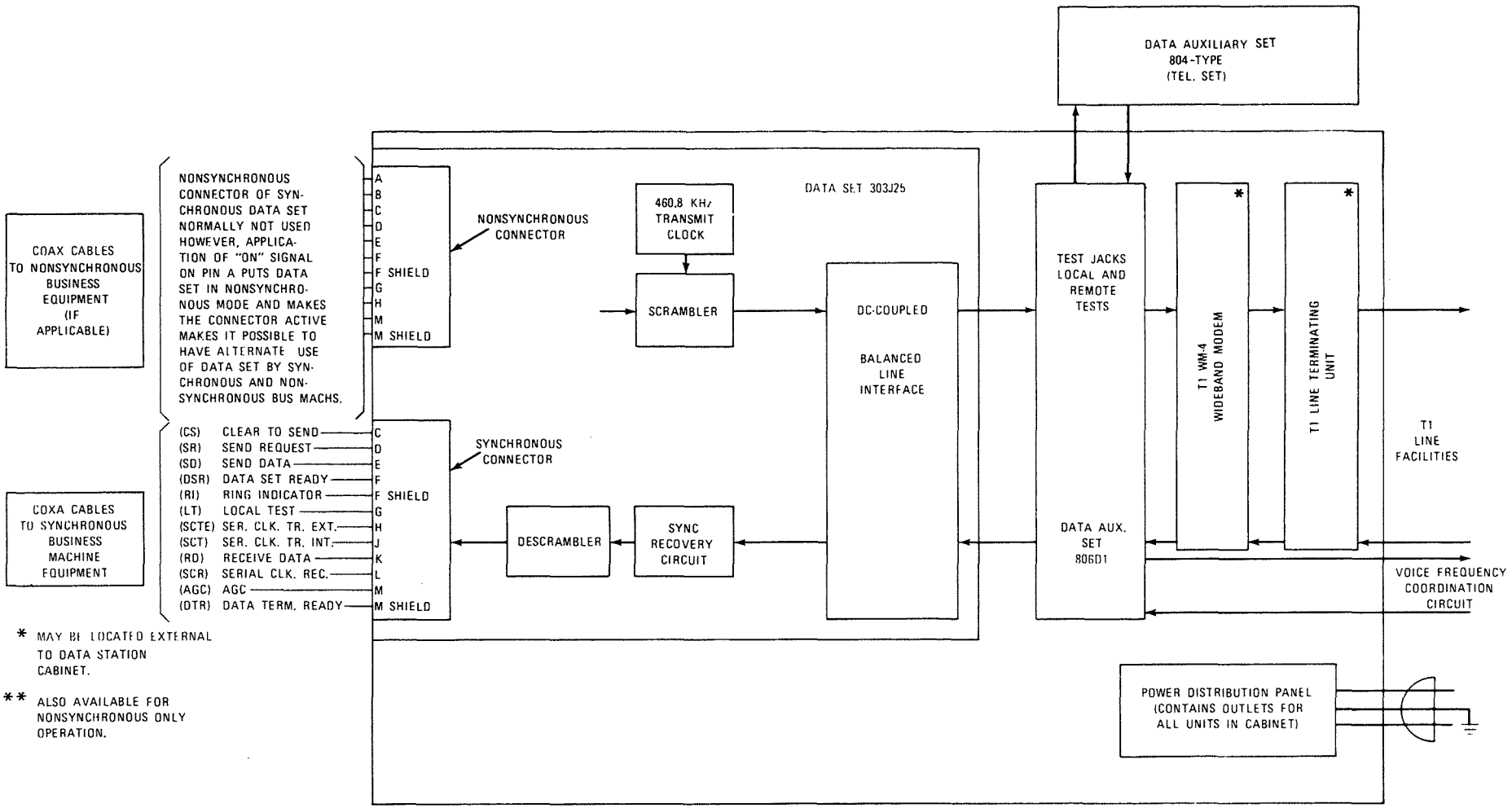


FIG. 9 – FUNCTIONAL CONFIGURATION OF TYPICAL SYNCHRONOUS DATA STATION (460.8 kb/s) ** FOR OPERATION OVER ALL DIGITAL FACILITIES

sets are not provided as part of the station arrangement in normal synchronous applications. Where no voiceband data sets are employed it is possible to talk at the same time wideband data is being transmitted.

The selection of component apparatus units comprising the various 303-type wideband data station arrangements is made by the Telephone Company based on the functional requirements and compatibility with the transmission path.

Basic components of each station for standard commercial service are a data set 303-type and data auxiliary sets 806D1 and 804-type. The particular code of data set 303-type used depends typically upon such factors as mode of operation, bit rate, and line signal format. Data auxiliary set 806D1, the line terminating and test unit, provides test access to the line facility, remote and local test controls, and means for interconnecting the apparatus units associated with the voice coordination channel. Data auxiliary set 804-type provides the telephone for voice communication, line control features, and station mode control and indication. The specific code of 804 used depends upon the system application.

As previously discussed, certain station arrangements for nonsynchronous operation may include a voiceband data set, the type depending upon whether the voice circuit is four-wire or two-wire. The voiceband data set is not normally included in stations arranged exclusively for synchronous operation.

Stations arranged for operation over half-group facilities (eg, at the 19.2 kb/s rate) and passband local facilities will include a VSB modem, data auxiliary set 809B1.

Data stations that are arranged to operate over an all digital facility (eg, T1 carrier) or are accessed by a digital facility typically use data sets which employ the balanced dc-coupled line signal format, and include a modem for signal format translation (T1WM-4) and a T1 line terminating unit. The units associated with the T1 line are usually but not necessarily placed in the data station cabinet. Such an arrangement is shown in the block diagram of Figure 9.

Stations arranged to process data over PICTUREPHONE facilities utilize a special code of data set 303-type and include a special line connecting unit which provides the proper termination for the PICTUREPHONE line.

In addition to the foregoing station arrangements for general commercial use, there is another class of data station arrangements which is used for special government services, primarily in cryptographic data and secure speech applications. These arrangements typically use data sets 303-type with a balanced customer interface, and a data recognizer unit (data auxiliary set 824-type). The data recognizer is used to direct the high-speed digital data from the customer to the wideband facilities, and signaling and supervisory tones to the voice channel. Typically, such stations do not use data auxiliary set 804A-type for voice communication nor do they use a voiceband data set. They do, however, include the 806D1 data auxiliary set. Standard station mounting arrangements are used, with data auxiliary set 824-type physically replacing data set 404B1.

A series of cabinets is available to house the components which comprise the various data station arrangements. The 24" high cabinet shown in Figures 2 and 3 can house all of the equipment that makes up the most complete wideband data station except for the equipment associated with the application to digital facilities. When the T1WM-4 modem and T1 line terminating unit are to be included in the station cabinet, a 30" high cabinet must be used. Such an arrangement is shown in Figure 4. The station arrangement for use with PICTUREPHONE lines is shown in Figure 5. An 18" high cabinet is available for use when all auxiliary equipment is not required (see Figure 6). This smaller cabinet is suggested for shelf mounted installations rather than for desk top or floor mounting. The unit shown on top of the cabinet in Figure 2 is the data auxiliary set 804-type which includes a telephone instrument and circuitry for controlling the use of the coordination channel and station operating modes.

Figure 3 shows a rear view of the data station and shows how units are interconnected by means of the cables between them. The synchronous and/or nonsynchronous high-speed business machine connectors are plugged directly into the rear of the wideband data set 303-type as shown. Where applicable

the low-speed connector is plugged directly into the rear of the voiceband data set as shown. The business machine cables are brought into the cabinet through an opening in the bottom.

The wideband data station cabinet contains a power distribution panel with ac outlets for the various units.

Only one ac power connection is required for the data station.

2.2 Data Set 303-Type

2.2.1 Features and Coding

The series of data sets 303-type can be divided into three basic types as a function of line signal used. These are:

1. restored polar line signal (usually interfaces with analog facility)
2. balanced dc line signal (interfaces with digital facility)
3. PICTUREPHONE type line signal (interfaces with PICTUREPHONE facility).

Within the first two categories specific codes combine certain available features such as bit rate, synchronous or nonsynchronous modes of operation, type of customer interface, and scrambling. The third category contains one code intended for synchronous operation at a data rate of 460.8 kb/s. For standard commercial service, all applicable codes include the unbalanced customer interface, internal clock (with external clock option available), and scrambling. The codes used for special government application typically include the balanced customer interface, and offer a choice of scrambling or not. All balanced customer interface codes regenerate customer's data (Send Data Signal) before entering the common carrier network.

Data set 303-type is coded with a suffix letter to denote speed capability, and a numeral to designate the specific combination of features that is provided by means of plug-in circuit boards. Available signaling rates and corresponding suffix letters are listed below:

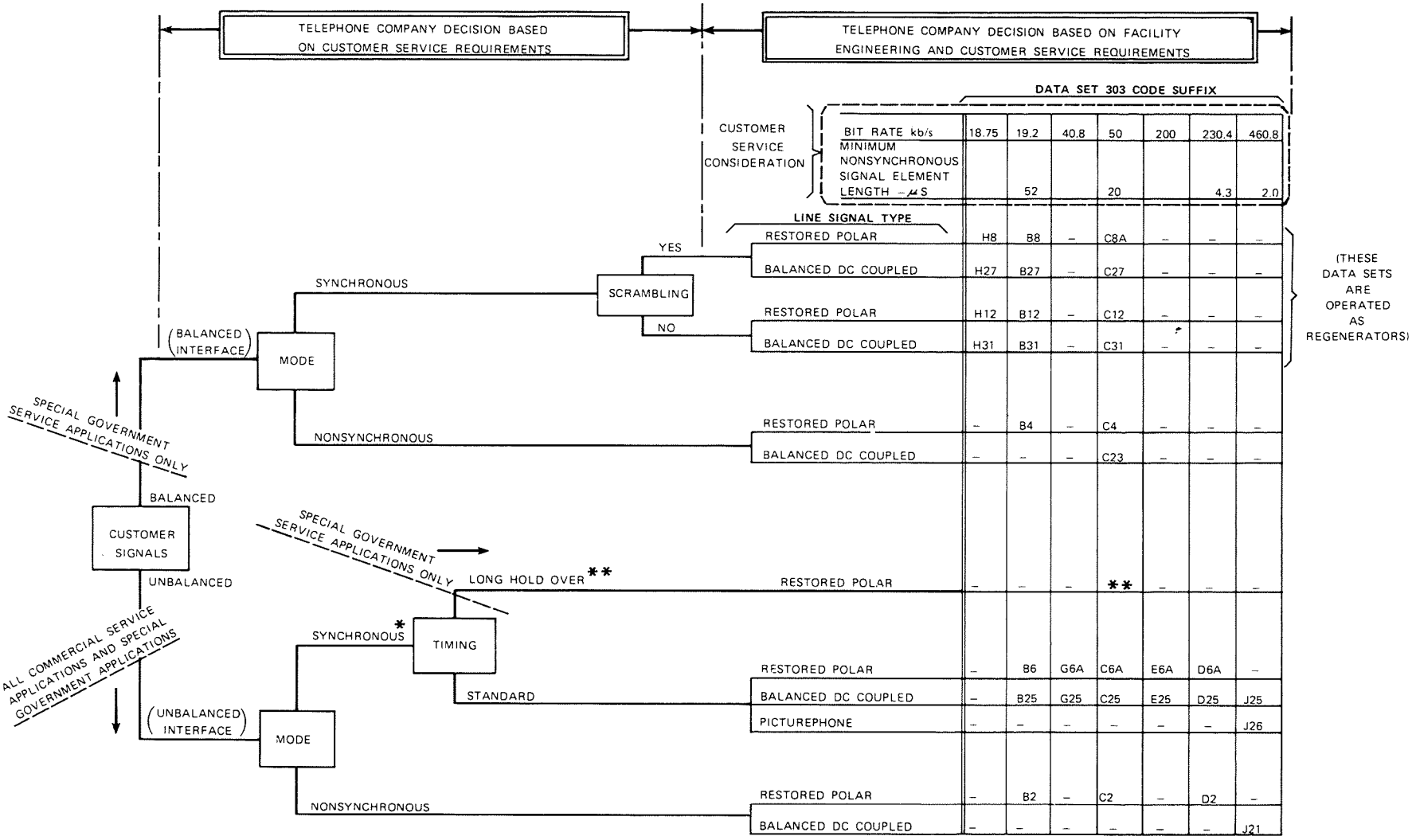
Data Rate	Suffix Letter
19.2 kilobits/second	B
50.0 kilobits/second	C
230.4 kilobits/second	D
200.0 kilobits/second	E
40.8 kilobits/second	G
18.75 kilobits/second	H
460.8 kilobits/second	J

The specific codes for available combinations of features are given in Figure 10.

Common to all types of data set 303 is the customer interface function. The unbalanced interface is used for all standard commercial service applications. This interface contains appropriate cable drivers and terminators and the logic circuitry associated with the various interface controls. A detailed discussion of these signals is given in the section entitled "Interface." The balanced interface is used in special government applications and does not provide interface control functions. It is discussed in the section entitled "Special Government Applications."

Data set 303-types coded specifically for nonsynchronous operation omit all transmitting clock and recovered timing functions, related control circuitry, and scrambling provisions. These sets include customer interface, transmitter and receiver with signal shaping filter and AGC (required only in restored polar line signal types), and line interface circuitry.

Data set 303-types coded for synchronous operation include all the circuitry of the nonsynchronous set and also transmitting clock and recovered timing, scrambling, and related control circuitry. Such codes which include the unbalanced customer interface are provided with internal transmit clock circuitry; those which include the balanced customer interface regenerate the customer's data using the equivalent of the timing recovery circuit used in the receiving branch of all synchronous data sets.



*ALL CASES REQUIRE SCRAMBLING
**NO STANDARD CODE AVAILABLE FEATURE IS OBTAINED BY MODIFICATION OF 303C6A

CODE SELECTION CHART
FIG. 10

2.2.2 Synchronous Operation in the Nonsynchronous Mode

There are restrictions associated with the nonsynchronous use of data set 303-type. Nonsynchronous wideband data service was originally offered to meet the needs of facsimile customers. The assumption was made that the transmitted copy would be sufficiently random in nature to result in a nearly random line signal. As long as nonsynchronous data service is used for facsimile, this assumption is sufficiently valid to assume that any interference will be within tolerable limits. Nonsynchronous data sets are not to be used where the customer intends to use the service for a synchronous data signal at some rate other than one of the standard clock rates. This is not permitted because nonsynchronous service has no provision for scrambling the data signal to eliminate repetitive patterns. These repetitive patterns create strong single frequency tones on the transmission line which may seriously disrupt other services on adjacent channels.

In addition to the risk of interference, regeneration en route is sometimes desirable but is possible only for synchronous signals of standard rates. Wideband regenerative repeaters are available which have the capability to detect synchronous data signals and to retime these signals at standard data rates. If a signal at a nonstandard rate were detected by this regenerator, it would be garbled by the regenerative action.

2.2.3 Data Scrambling

Scramblers and descramblers are included in the data sets used with synchronous business machines. The scrambler is automatically self-synchronizing and is employed primarily to spread the signal energy throughout the available bandwidth. This technique is employed to eliminate repetitive patterns which otherwise could generate crosstalk on analog type carrier facilities.

Wideband transmission systems are particularly susceptible to single frequency tone interference. A repeated bit pattern, eg, alternate ones and zeroes, produces a strong single frequency or tone within the data set. More complex repetitive patterns produce several single frequency tones. If these tones were to be transmitted continuously over carrier facilities, they could cause crosstalk between voice channels in the carrier system. The use of a scrambler in the data set spreads the transmitted energy over the entire frequency spectrum of the wideband data channel and eliminates continuous tones. This reduces the chance of crosstalk to a tolerable risk and permits operating the data channel at optimum signal power levels to produce a good signal to noise ratio.

The serial data stream from the business machine at the transmit end is randomized by the scrambler. At the receiving end, the incoming data stream is descrambled so that the resultant data output to the receiving business machine is the same as that produced by the business machine at the transmit end.

The scrambler now standard in the data set is such that there are no constraints placed on the business machine data format.

When synchronous data sets 303-type are connected to a line they are usually arranged to stay in bit synchronism even when the Request-to-Send signal is OFF. This is possible because the sending data set normally transmits scrambled 1's during this time. The receiving data set descrambles these signals and delivers all 1's or "Mark Hold" to the business machine. The receiving data set maintains bit synchronism from the idling scrambler line signals. If the transmission line is opened so that no signals reach the receiver, two things occur: (1) the AGC lead goes OFF, and (2) the descrambler circuit will cause the receiver to deliver to the business machine a repeating pattern of one mark then 31 spaces or one space then 31 marks, depending upon the state of the receiver when the line is opened.

2.2.4 Start-up Sequence

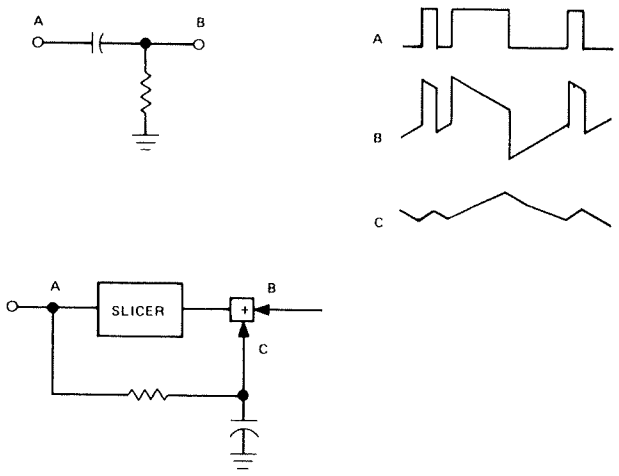
No start-up sequence is involved with the scrambler, and the first data bit presented to the scrambler will be properly encoded. In the descrambler, proper decoding takes place once the registers are filled; this takes at most 20 bits. This means that the first data bit will be properly decoded if at least 20 bits of scrambler idle code

precede it. Note that in the initial start-up of the system 3000 bits of either scrambled data signal or scrambler idle code should have been transmitted to guarantee that the sync recovery circuit goes into phase lock.

2.2.5 Restored Polar Transmission Interface

Operation of the restored polar data set is basically the same for all available bit rates. After passing through the unbalanced customer interface circuits, the data signal is clocked and scrambled before being applied to the baseband transmitter of the data set (in the case of a synchronous set) or applied directly to the baseband transmitter in the case of a nonsynchronous set. The dc and low frequencies are removed in the baseband transmitter. The polar data signal is passed through a simple R-C high pass filter circuit with time constant equal to 4 bits duration (cutoff at approximately four percent of the bit rate) which removes the dc component and about one-eighth of the ac spectral energy. The resultant signal which is transmitted to the line has been termed the "restored polar" line signal. While this signal has little low frequency content, it is important that the transmission facilities are controlled sufficiently at the low frequency end to prevent nonlinear phase effects from distorting reduced data signal components lying within three octaves below the transmitter cutoff.

At the receiver, the signal is first passed through the receiving signal shaping filter which is shaped in the passband region to provide the Nyquist rolloff for the overall data signal spectral density characteristic. This low pass filter with a modified raised cosine shape reaches cutoff at a frequency equal to the bit rate and consequently is called a 100 percent rolloff filter. If a VSB modem is required to demodulate the line signal back to baseband, as in the 19.2 kb/s data sets for half-group transmission, the modem is strapped into the circuit ahead of the rolloff filter. After shaping in the rolloff filter, the incoming signal level is set by a peak-detecting AGC circuit to the correct value for dc re-insertion in the regenerative slicer. The process involved in restoring the dc and low frequency components of the signal in the regenerative slicer arrangement is shown in Figure 11. The dc



PRINCIPLE OF D-C RESTORATION
FIGURE 11

reinsertion circuit is a low pass R-C configuration having a time constant to match the highpass section at the transmitter. In Figure 11 the waveforms displayed are for ideal signals. The principle applies equally well to band limited signals. The slicer output is a binary polar signal which is applied (in the synchronous data set) to a sync recovery and regenerator circuit where timing is recovered and the scrambled data signal is retimed. In the initial start-up of the system, at least 3000 bits of either random data or scrambler idle code is essential to guarantee that the timing recovery circuit goes into phase lock. The standard timing recovery circuit will bridge a gap of up to 500 bits in the received signal. A special arrangement for bridging interruptions longer than 500 bits is discussed in the section entitled "Special Government Applications." After retiming, the signal is presented to the descrambler for restoration of the original customer data pattern. Descrambler output is then applied to the unbalanced customer interface for delivery to the customer. In nonsynchronous data sets the sliced output of the receiver is applied directly to the unbalanced customer interface.

2.2.6 DC-Coupled Transmission Interface

In services involving limited distance transmission over digital subscriber lines or connection to T1 line customer loops, a different type of line signal is required from the data set. Data sets 303-type coded for use in these services transmit and receive a dc-coupled balanced one volt peak-to-peak line signal. This signal from the data set then is applied to the T1WM-4 wideband modem which encodes the data set signal into the proper format for transmission over the T1 line. In addition a T1 line terminating unit is required to properly terminate the T1 line. Data sets 303-type in this category with suffix J25 or J21 provide respectively 460.8 kb/s synchronous service or nonsynchronous facsimile type data service with a minimum permitted signal element width of two microseconds. These data sets are designed to transmit over digital line facilities only and the maximum transmission distance is subject to the constraints imposed by the digital system. Other data set codes in this category provide data transmission at all 303 synchronous and nonsynchronous rates that are available for the restored polar type of operation.

This type of data set omits the restored polar transmitter, line interface, rolloff filter, automatic gain control, and restored polar receiver circuitry of the restored polar series. A dc-coupled balanced line interface circuit pack is used in the transmitter and line interface circuit pack location. Synchronous sets use the clock, sync recovery, scrambler, and signal control circuitry as provided in other 303 codes; nonsynchronous codes omit these circuits. No changes have been made in other portions of the data set, and signals to and from the customer's business machine are the same as for other data sets 303-type.

2.2.7 PICTUREPHONE Line Signal Transmission Interface

Still another type of line signal is required of the data set when data set 303-type is to be used over PICTUREPHONE facilities to provide for synchronous data transmission at the 460.8 kb/s rate. The appropriate transmission interface is provided by data set 303J26. In this service the data set interfaces with the 114A interconnecting unit of the PICTUREPHONE facility.

As in the case of data sets 303-type intended for use with T1 line facilities, this data set produces a balanced dc line signal. Signal amplitude is set at 0.75 volts peak-to-peak into 100 ohms, however. Additional differences are that a low pass filter to block out-of-band components is included in the transmitting branch and a low pass filter to provide signal shaping and to block out-of-band noise is included in the receiving branch. Signals to and from the customer's business machine are the same as for other data sets 303-type.

2.3 Vestigial Sideband Unit — Data Auxiliary Set 809B1

Data auxiliary set 809B1 is a vestigial sideband modem in which the transmitter portion modulates the output of data set 303B-type (19.2 kb/s rate) to the proper band for transmission over half-group facilities. The receiving portion demodulates the incoming passband signal from the half-group facility to baseband for processing in the data set. When provided, this unit is considered part of the data station and is mounted in the data station cabinet. The VSB unit occupies the lower tier of the station cabinet as shown in Figures 2 and 3. Connections between the data auxiliary set 809B1 and the data set 303-type are made by means of a cable supplied with the 809B1. This cable cannot be seen in the photograph since it is underneath the rear cover plates of the apparatus.

2.4 Voiceband Data Set 404B1

Data set 404B1 is a 4-wire low-speed multifrequency transceiver capable of parallel transmission at a speed of up to 20 characters per second. It is used for the transmission of low-speed data for business machine control functions where required, typically with certain facsimile machines when the data station is provided in the standard 4-wire point-to-point private line service. The interface with the business machine has the electrical

characteristics of EIA Standard RS232B*. The data set occupies the right half of the top tier of the wideband cabinet as shown in Figure 2. This data set is not provided in standard synchronous applications.

2.5 Voiceband Data Set 103F2

Data set 103F2 is a 2-wire low-speed voiceband data set. It is used to transmit low-speed serial data on a full-duplex basis over the two-wire voiceband channel where required, typically with certain facsimile machines when the data station is provided in the standard 2-wire common user switched network service. Maximum data rate is 200 bits per second. The interface with the business machine has the electrical characteristics of EIA Standard RS232B. In the standard arrangement, the data set is located on a shelf occupying the lower tier of a three tier cabinet. This data set is not provided in standard synchronous applications.

2.6 Line Terminating and Test Unit — Data Auxiliary Set 806D1

Data auxiliary set 806D1 provides line access and interfacing, local and remote test features, and interconnection arrangements for the component units of wideband data stations using data sets 303-type. The set is an integral part of all such standard wideband station arrangements. Jacks are provided on the front panel for Telephone Company testing purposes. The 806D1 can put the wideband station in either of two remote test modes by means of signals applied from the telephone central office over the voice frequency coordination channel. In the first of these remote test modes, the wideband line is looped back toward the central office; in the second, the data set is looped back at the customer interface. In addition, the wideband data station can be put into the local test mode by the customer by means of an ON signal from the customer's business machine equipment through the high-speed interface, or by means of the test button on data auxiliary set 804-type. The local test mode can be established from the 806D1 data auxiliary set by Telephone Company personnel. In this mode the customer's equipment can transmit to itself through the data set with the telephone line disconnected. This feature is extremely valuable in isolating troubles on a system with a minimum of lost time, particularly if the business machine can also transmit to itself locally without the data set.

Data auxiliary set 806D1, with self-contained power supply, occupies the left half of the top tier of the cabinet shown in Figure 2.

2.7 Data Auxiliary Set 804-Type

This set provides a telephone instrument, and circuitry for controlling the voice frequency coordination channel and wideband facilities. It is powered from data auxiliary set 806D1. The specific type of set provided depends upon the nature of the service. The set will be at a location convenient to the customer but not exceeding 75 cable feet from the data station. Data auxiliary set 804-type is shown on top of the wideband data station cabinet in Figure 2.

2.8 Auxiliary Line Apparatus

Wideband data stations 303-type which use other than the restored polar line signal format require additional line connecting apparatus. Such units, when required, are located electrically between data auxiliary set 806D1 and the transmission facility. These units insure that the data set output signal is compatible with the particular line facility used. At this writing there are two such situations requiring the additional line connecting units. These are operation over a T1 line and operation over a PICTUREPHONE line, as indicated in Figure 1.

* EIA Standard RS232C includes a requirement that signals must be monotonic in the transition region between the +3 and -3 volt states. EIA Standard RS232B did not control this region. These data sets include interchange circuits controlled through relay contacts which, while meeting the voltage requirement of RS232C, may reverse direction during the transition period between states.

When the connecting facility is a T1 digital line the data signal must be translated to a bipolar signal at a line rate of 1.544 Mb/s. This translation is achieved in the T1WM-4 wideband modem. In addition to the T1WM-4, a T1 line terminating unit is also required. This unit provides the proper termination for the T1 line and it includes line testing provisions and the terminal repeater required to establish the equal level point required by the wideband data set. Both of these units are used with the balanced dc-coupled line signal 303 series of data sets with the exception of data set 303J26. Both units may be located physically within the data station cabinet or located external to the cabinet. When located externally, the separation between the data set and the T1WM-4 modem may not exceed 1000 cable feet, and the separation between T1WM-4 modem and T1 line terminating unit may not exceed 750 cable feet.

When the connecting facility is a PICTUREPHONE line, connection is made to the 114A interconnecting unit, a part of the line. This unit provides the normal termination for the PICTUREPHONE facility and may be installed in the data station cabinet or located remotely at a distance not to exceed 100 cable feet from the data apparatus. Data set 303J26 is used in this arrangement.

2.9 Physical Characteristics, Environmental Considerations, and Power Requirements

The wideband data station apparatus is intended for operation over a temperature range of from 40 F to 120 F and a relative humidity of up to 95 percent.

Commercial ac power is fed to the wideband data station through a ten foot detachable 3-wire power cord equipped with a parallel blade polarized grounding plug for connection to a customer-provided 105 to 129 volt, 60 +0.1Hz source not under switch control. It should be on the same ac circuit which serves the associated business machine equipment so that the same ground bus is used for both. This is necessary to prevent impulse noise potentials which might otherwise develop between grounds.

The maximum power drain for a completely equipped station depends upon the apparatus configuration. Practically, three cases should be considered. When the station develops a restored polar type line signal for operation over analog facilities, the maximum apparatus configuration consists of data sets 303-type and 404B1 and data auxiliary sets 809B1, 806D1 and 804A type. In this case the maximum power dissipation is 62 watts. When the station develops the balanced dc-coupled line signal format for operation with T1 facilities, the maximum apparatus configuration consists of data sets 303-type and 404B1, data auxiliary sets 806D1 and 804-type, T1WM-4 wideband modem, and T1 line terminating unit. In this case the maximum power dissipation is 130 watts. When the station is intended for operation with a PICTUREPHONE facility, the typical apparatus arrangement includes data set 303J26, data auxiliary sets 804A-type and 806D1, and the 114A interconnecting unit. The maximum power dissipation for this arrangement is 66 watts. Addition of an automatic calling unit will increase the dissipation by an additional 15 watts.

The power requirements, dimensions and weight of the individual units that make up the wideband data stations are listed below. The wideband data station cabinet is finished in two-tone grey. Brackets are available for mounting the wideband data station apparatus in either 19-inch or 23-inch racks.

3. INTERFACE

This section describes the business machine interface arrangements of the wideband data set 303-type and low-speed data sets 404B1 and 103F2. It describes the electrical characteristics of each type of interface and covers the operation of the station from an interface standpoint on a lead-by-lead basis giving specific pin assignments.

There are two high-speed interface connectors at the rear of the wideband data set 303-type. One is for synchronous operation, the other is for nonsynchronous operation. Note that an "ON" signal (greater than 23 ma) must be held on a Pin A of the "NONSYNC" connector

ITEM	POWER REQUIREMENTS	DIMENSIONS	WEIGHT
Wideband Data Station Cabinet (KS20018, L4)		30" H 24" W 12" D	27.5 lbs.
Wideband Data Station Cabinet (KS20018, L3)		24" H 24" W 12" D	24 lbs.
Wideband Data Station Cabinet (KS20018, L2)		18" H 24" W 12" D	17 lbs.
Data Set 303-Type	26 watts	6" H 17" W 10" D	23 lbs.
Data Auxiliary Set 806D1	20 watts*	6" H 10" W 9" D	16 lbs.
Data Set 404B1	(Powered from 806D1)	6" H 11" W 10" D	15 lbs.
Data Set 103F2	20 watts	5 1/2" H 11" W 10 1/4" D	15 lbs.
Data Auxiliary Set 804-Type	(Powered from 806D1)	4 1/2" H 9" W 9" D	7 lbs.
Data Auxiliary Set 809B1	16 watts	6" H 17" W 10" D	20 lbs.
Wideband Modem	* *	shelf assembly of six 1-3/4 x 23 inch mounting spaces	
T1 Line Terminating Unit	**	two 1-3/4 x 23 inch mounting spaces	
114A Interconnection Unit	25 watts	6" H 7 1/2" W 12" D	12 lbs.

*Dissipation is 15 watts when 806D1 is not powering data set 404B1.

**Maximum dissipation of complete data station utilizing these units is 130 watts.

(Alternate Use lead) to operate in the nonsynchronous mode. As an option, the Telephone Company can, if requested, strap the data set permanently in the nonsynchronous mode. There are also low-speed connectors located on the rear of data sets 404B1 and 103F2 for use when business machine control signals are transmitted over the voice frequency coordination channel.

3.1 The High-Speed Connectors

The high-speed business machine interface connector on the data set 303-type is the 12-pin Burndy MD12 MXR-8T coaxial connector. The business machine should be equipped with a cable not exceeding 50 feet in length which is equipped with a Burndy MD12 MXP-17TC plug and a Burndy M2H50RC-1P2 protective shield. When used with the synchronous connector, this cable must provide for 10 coaxial circuits. When used with the nonsynchronous connector, 8 coaxial circuits must be provided for.

An exception to the 50-foot cable length exists when the balanced customer interface is provided in data set 303-type for special applications. Cable lengths in excess of 50 feet are possible. The same Burndy plug and shield are used; however, the pin assignments are different. These arrangements are covered in the section entitled "Special Government Applications."

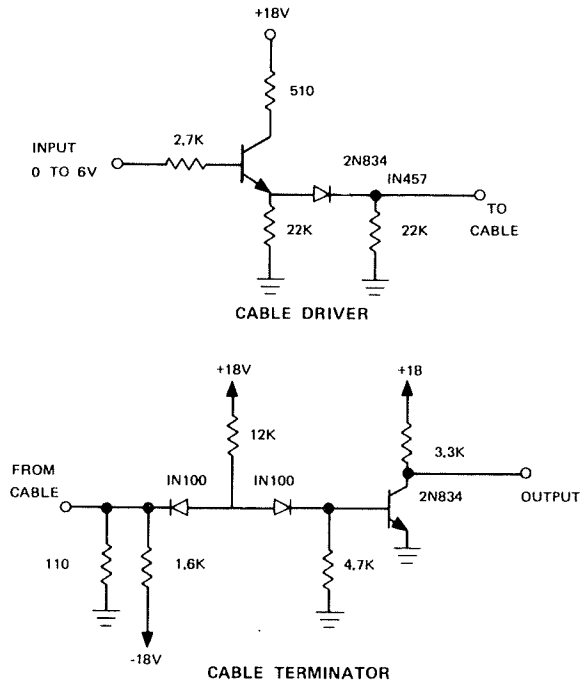
3.2 Description of High-Speed Interface Signals (Unbalanced for General Commercial Use)

For general commercial use, the wideband data set 303-type is provided with cable drivers and cable terminators which become part of the interchange circuits that interconnect the data set and the business machine. The cable drivers operate into, and the cable terminators operate from coaxial cables or from 75 ohms to 120 ohms characteristic impedance. The high speed interface is provided on a current switching basis with the exception of two functions, Data Terminal Ready and Ring Indicator, which have the electrical characteristics of EIA Standard RS232B.

In the wideband data set, cable drivers are provided where signals are delivered from the data set to the connecting business machine equipment and cable terminators are provided where signals are delivered from the business machine equipment to the data set. A binary "1", Control "OFF" or "marking" signal is represented by a current of less than 5 ma into 100 ohms. A binary "0", control "ON" or "spacing" signal is represented by a current of greater than 23 ma into 100 ohms. All interchange circuits are fail-safe in that an open circuit is considered a control OFF or Mark Hold condition.

The above-mentioned currents are supplied at the output of the cable drivers. The open circuit voltage of the terminator will range between -1.3 and -0.8 volts. The negative voltage is added by a bias in the terminator. With greater than 23 ma into 100 ohms supplied to a cable terminator, the terminator input voltage is more positive than +1.0 volts. An open circuit must be recognized by a terminator as OFF as mentioned above.

It is expected that the business machine will be supplied with cable drivers and terminators and with the coaxial cables. Circuit diagrams for typical drivers and terminators are shown in Figure 12.



TYPICAL CABLE DRIVERS AND CABLE TERMINATORS
FIGURE 12

For Commercial use the connector labeled "NONSYNC" in Figures 7, 8 and 9 has the following pin assignments:

Pin Assignment	Function
A	(ALT) Alternate Use
B	
C	(CS) Clear-to-Send
D	(RS) Request-to-Send
E	(SD) Send Data
F	(DSR) Data Set Ready (center conductor)
F	(RI) Ring Indicator (outer conductor)
G	(LT) Local Test
H	
J	
K	(RD) Receive Data
L	
M	(AGC) AGC (center conductor)
M	(DTR) Data Terminal Ready (outer conductor)

The connector labeled "SYNC" in Figures 7, 8, and 9 has the following pin assignments:

Pin Assignment	Function
A	
B	
C	(CS) Clear-to-Send
D	(RS) Request-to-Send
E	(SD) Send Data
F	(DSR) Data Set Ready (center conductor)
F	(RI) Ring Indicator (outer conductor)
G	(LT) Local Test
H	(SCTE) Serial Clock Transmit (External Sync)
J	(SCT) Serial Clock Transmit (Internal Sync)
K	(RD) Receive Data
L	(SCR) Serial Clock Receive
M	(AGC) AGC (center conductor)
M	(DTR) Data Terminal Ready (outer conductor)

A description of signals between the business machine equipment and the wideband data set 303-type follows:

1. (ALT) Alternate Use (Signal Originates in Business Machine)

   The Alternate Use circuit permits selection of the mode of operation (synchronous or nonsynchronous) and activates the appropriate high-speed connector. If the lead is in the ON condition, the nonsynchronous mode is selected and the NONSYNC connector is active. If the lead is in the OFF condition (or if the circuit is open) the synchronous mode is selected and the SYNC connector is active. A data set of the "nonsynchronous only" type can be used with two different nonsynchronous machines, if desired, by connecting one machine to the SYNC connector, the other machine to the NONSYNC connector, and using the Alternate Use circuit to switch between connectors.

2. (RS) Request-to-Send (Signal Originates in Business Machine)

   The Request-to-Send lead must be in the ON condition to send wideband data. Should a permanent Request-to-Send ON condition be desirable, this condition may be wired in the business machine equipment or it can be wired in the wideband data set by the Telephone Company if requested by the customer.

   It should be noted here that a wiring option exists in the data set which permits the Request-to-Send signal to be used additionally to control gating of the scrambler output. This usage is explored in the section entitled "Customer Operational Features Provided by Strapping Options."

3. (CS) Clear-to-Send (Signal Originates in Data Set)

   This control signal from the wideband data set is the logical AND of a signal from the wideband data set and data auxiliary set 804-type on the voice

frequency coordination circuit. It will indicate that both are in a condition that will permit the transmission of data, or test signals in the local test mode, and in so doing it will go to the ON state after Request-to-Send is turned ON. In service such as facsimile where a voiceband data set is used on the coordination channel, it is not possible to talk on the voice line at the same time that control signals are being transmitted between voiceband data sets. Therefore, Clear-to-Send ON also indicates that the voice frequency coordination channel is not in the "talk" mode. For services where no voiceband data sets are employed, it is possible to talk on the voice line while wideband data is being transmitted. The Telephone Company can, if requested, wire the data stations to permit simultaneous talking and transmission of wideband data. In this case, Clear-to-Send means only that the data station has Request-to-Send ON and is not in the Remote Test mode.

The Clear-to-Send lead does not have a time delay built in to signify that the receiving end has had time to come into bit synchronization in synchronous applications. Since these synchronous systems usually transmit data or the scrambled Mark Hold continuously in both directions, bit synchronism is constantly maintained. It is only in the initial start-up time that the receiver must be brought into synchronism. It takes up to a maximum of 3000 bits of either the scrambled data signal from the Send Data lead or the scrambler idle code when the Send Data lead is OFF to bring the receiver timing circuits into proper bit synchronism with the transmitter. This subject is covered more fully under the "Serial Clock Receive" lead discussion. When a voiceband data set is employed on the coordination channel, there is an interval generated in data auxiliary set 804 type which delays the Clear to Send ON signal by five seconds.

4. (SD) Send Data (Originates in Business Machine)

   The Send Data Circuit accepts serial binary data from the customer's data equipment. For nonsynchronous service the minimum permissible element length of these signals is determined by the code of wideband data set specified for the service arrangement. Typically, these signals can be as short as 52, 20, and 4.3 microseconds in length when supplied to data stations intended for operation over half-group, group, and supergroup analog facilities, respectively. When the data station is intended for operation over an all digital facility, transmission of an element length as short as 2.0 microseconds is possible.

   For synchronous service, this data will be timed by the business machine using the internal serial clock of the data set, or the external clock of the business machine. In either case the data should be changed at or near (within 25 percent of a bit interval of) the positive going transitions of the timing signal (SCT or SCTE). The data signal should be maintained on the Send Data lead for the full clock cycle. The data is sampled by the data set coincident with the negative going transition of the timing signal. The synchronous speeds available are 18.75, 19.2, 40.8, 50, 200, 230.4 and 460.8 kb/s. Of these, the 19.2, 50 and 230.4 kb/s rates are normally identified with standard half-group, group and supergroup analog transmission services. The 460.8 kb/s rate is associated with an all digital or PICTUREPHONE service. Remaining rates are available for special applications.

5. (SCT) Serial Clock Transmit (Originates in Data Set)

   This function will be used only in synchronous service. The SCT signal is used by the customer when the data set supplies the timing signal (data set operating with internal clock option).

When operated in this manner, the data set supplies a square wave with a 50 percent ± 5 percent duty cycle at a rate equivalent in cycles to the bit rate at a tolerance of plus or minus .01 percent, e g , the clock for a 230.4 kb/s data rate would be 230.4 kHz (plus or minus .01 percent). The customer should change data on the Send Data circuit coincident with the positive going transition of the SCT signal as measured at the data set connector. The data is sampled by the data set coincident with the negative going transition of the SCT signal.

6. (SCTE) Serial Clock Transmit External (Originates in Business Machine)

   The SCTE circuit is used only in synchronous service and only when the data set is to be driven by the customer's clock signal. When operated in this manner, the customer's timing source must supply a square wave with a 50 percent ±5 percent duty cycle at a rate equivalent in cycles to the bit rate; e g , the clock for 230.4 kb/s operation would be 230.4 kHz. The frequency tolerance requirement is ± .01 percent on external clocks. Positive going transitions of the clock signal and transitions of the data signal should be coincident (within 25 percent of the bit interval). The data will be sampled by the data set coincident with the negative going transition of the SCTE signal.

7. (RD) Receive Data (Originated in Data Set)

   Received data is delivered serially on the Receive Data circuit to the customer's data equipment. In the nonsynchronous case, when random length pulses that meet the minimum pulse width requirement are presented to the data set transmitter, it is expected that the pulses delivered at the receiver will have a peak jitter of less than 17 percent (or a degree of isochronous distortion of less than 34 percent). This means that after a correction is made for absolute delay, a received data transition will be within the distortion limits shown in the following table:

Bit Rate-kb/s	Minimum Element Duration – μs	Max. Isochronous Distortion – μs
230.4	4.3	1.46
50	20	6.8
19.2	52	17.7

The jitter specified is measured at the 14 ma current level. Rise and fall time of the regenerated transitions will be less than 0.2 microseconds between the 7 ma and 21 ma levels.

For synchronous operation the received data pulses will be regenerated and therefore in phase with the recovered serial clock. The rise and fall time of the received data transitions will be less than 0.2 microseconds. The negative clock transition will be centered within ±10 percent in the nominal bit interval.

8. (SCR) Serial Clock Receive (Originates in Data Set)

   This signal applies only to synchronous operation. The data set receiver derives Serial Clock Receive as a bit synchronization signal by means of using transitions in the received data to control the frequency of a local oscillator which runs at approximately the speed of the transmitter oscillator in the absence of transitions. Up to 3000 bits of either scrambled data signal or scrambler idle code is required to pull the receiver clock to within 10 percent of the frequency of the data being received. The standard receiver clock will hold frequency long enough to bridge a gap of up to 500 bits in length in the received random data at the input to the receiver. A special arrangement for

bridging interruptions in excess of 500 bits is discussed in the section entitled "Special Government Applications". The peak jitter of the received serial clock is expected to be less than 10 percent.

The data on the Receive Data lead will be changed coincident (within 0.3 microseconds) with the positive going transition of SCR. The customer's business machine should sample the received data on the Receive Data lead coincident with the negative going transition of the SCR signal.

9. (LT) Local Test (Originates in Business Machine)

   This circuit provides for electrical control of looping, toward the business machine, of both the wideband data set and the voiceband data set, if provided, on the line side. When the data sets are in the local test mode, the lines are terminated in the case of an analog facility or looped toward the telephone office in the case of a digital facility. (It is a requirement that a signal must be maintained on digital lines.) When the business machine equipment changes this lead to the ON state, the data station will go into the local test mode. This mode permits the business machine equipment to send to itself through the wideband data set and the voiceband data set, if provided, for local testing. In addition to this interface lead control, buttons on data auxiliary sets 804-type and 806D1 enable this function to be performed on a manual basis. Whenever the station is in the local test mode a lamp lights under the test button. This lamp also lights when the data station is in the remote test mode.

10. AGC (Originates in Data Set)

    An ON signal on this lead is an indication of a high probability that signals on the Receive Data lead are reliable. The signal comes on quickly, after about five milliseconds of random data, and remains on for about two seconds of no transitions. When this lead is in the ON state, it is an indication that the signals being received over the wideband facilities have an adequate amplitude. If this lead goes to the OFF state while data transitions are still present on the Receive Data lead, it is an indication that the automatic gain control circuitry is approaching the end of its range because of a weak signal and that the data probably contains errors. The foregoing discussion applies only when the transmission is over analog group and super group facilities. There is no signal output from this lead when the data station interfaces with a digital line facility and accordingly employs the balanced dc line signal type of wideband data set. In the case of analog half-group facilities, with the VSB modem (809B1 data auxiliary set) located at the data station, the presence or absence of VSB carrier is detected and the indication delivered to the AGC lead.

    It should be noted that in both types of AGC indications, the ON state obtains before the data set will be in bit synchronism on the initial start up of the system since the data set may require the reception of up to 3000 bits of data or scrambler idle code in order to get into bit synchronism.

11. (DSR) Data Set Ready (originates in Data Set)

    An ON condition on this lead indicates to the business machine equipment that the data station is capable of operating and can receive wideband data (and can transmit and receive voiceband data if so equipped) and, provided the Clear-to-Send circuit is ON, it can transmit wideband data. If DSR is in the OFF condition it indicates:

a. A local test, remote test or power off condition.

b. That the voice frequency coordination channel is not capable of processing voiceband data.

c. That the local data station is not connected to the communication channel.

The ON condition appears at all other times. The ON condition should not be interpreted as an indication of the status of any remote station or equipment.

12. (DTR) Data Terminal Ready (Originates in Business Machine)

Signals on this lead are generated within the business machine equipment to control the switching of the data station to the communication channel. When automatic answering and termination of calls is required, the Data Terminal Ready lead must be turned ON by the business machine equipment in order for the data station to answer a call automatically and turned OFF for at least 100 milliseconds to terminate the call. It is also necessary that the DTR lead be in the ON state in order for the data station to enter and hold the data mode. It is possible to have this lead wired to the ON state in the data station by the Telephone Company in certain cases where automatic answering is not used; however, under no circumstances should the DTR lead be wired to the permanently ON state either in the business machine or data station when the data station is to operate in a switched network. In all cases where the data station is to operate on a switched service basis, the DTR lead must be controlled by the business machine.

On switched systems, the following rules regarding the control of the DTR interface lead apply. On manually answered calls the business machine must present an ON signal to the DTR lead before the data station can be placed in the data mode. On automatically answered calls the business machine must present an ON signal to the DTR lead in order to answer the incoming call. Both manually and automatically answered calls may be dropped manually by depressing the TALK button on the 804-type data auxiliary set and then hanging up the handset. If the DATA button is depressed, the handset can be replaced without dropping the call. In this case (also corresponding to the automatic answer case) the call can be dropped only by the business machine causing the DTR lead to be in the OFF state for at least 100 milliseconds at that terminal. When termination of the call is to be controlled from the originating end of the telephone circuit, an end of transmission code should be sent from the originating business machine. The transmission of this code should instigate DTR OFF at the originating end of the circuit and reception of the code at the far end should instigate DTR OFF from that business machine.

This signal, although appearing on the high-speed connector, has the electrical characteristics of EIA Standard RS232B.

13. (RI) Ring Indicator (Originates in Data Set)

Signals on this circuit are generated within the wideband data station to indicate to the business machine equipment that a ringing signal is being received from a remote station. This circuit is independent of the condition on the Data Terminal Ready lead.

The Ring Indicator will be turned ON for each ring on the voice frequency coordination line. It is useful when arranging a station to answer a call automatically. It follows the rings to permit the answering data terminal to prepare itself (such as getting a motor up to a stable speed) if necessary, before the business machine equipment signals to answer the call by placing an ON state on the Data Terminal Ready lead. When Data Terminal Ready goes to the ON state, the call will be answered and Data Set Ready will go to the ON state about five seconds later.

This signal, although appearing on the high-speed connector, has the electrical characteristics of EIA Standard RS232B.

3.3 Low-Speed Connector (4-Wire Service)

This connector is associated with the data set 404B1 that operates over the 4-wire voice frequency coordination channel. The voice frequency coordination channel is used for voice communication and alternatively for the transmission of low-speed data signals to control business machine equipment when required.

The 25-pin connector commonly associated with Bell System Voiceband Data Sets is used. This connector is equivalent to a Cinch or Cannon DB-19604-433 Connector. The business machine should be equipped with a cable not longer than 50 feet and a Cinch or Cannon DB-19604-432 Plug mounted in a Cinch DB-51226-1 Hood Assembly.

The data station will include, when required (as with certain facsimile equipment), a data set 404B1 for the transmission of low-speed control signals and an 804-type data auxiliary set. When the 404B1 is omitted, the low-speed cable is omitted also, since the functions of Data Terminal Ready and Ring Indicator, which are related to data auxiliary set 804-type operation, are assigned to the high-speed connector.

3.4 Description of Signals on Low-Speed Connector (Data Set 404B1)

The electrical characteristics of all low-speed signals (as well as Data Terminal Ready and Ring Indicator on the high-speed connector) conform to those outlined in Electronic Industries Association Standard RS232B. These characteristics are described briefly in the following paragraphs.

The eight Transmit and ten Receive Circuits are considered Control circuits. A Control signal is in the "ON" condition when the voltage on the circuit is more positive than +3 volts with respect to signal ground and the signal is considered to be in the "OFF" condition when the voltage is more negative than -3 volts with respect to signal ground.

The maximum open circuit voltage to either Protective Ground or Signal Ground on any interchange circuit should not exceed 25 volts, and the maximum short circuit current flow between any two conductors (including grounds) should not exceed one-half ampere.

The terminating impedance of the receiving end of interchange circuits should have a dc resistance of not less than 3000 ohms or more than 7000 ohms, and the voltage in open circuited condition should not exceed -2 volts. The source impedance of the sending end of interchange circuits is not specified.

Pin assignments for the low-speed connector are listed below:

Pin Assignment	Function
1	Protective Ground
2	Transmit A1
3	Transmit A2
4	Transmit A3
5	Transmit A4
6	(Not Used)
7	Signal Ground
8	Transmit B1
9	(Reserved for Telephone Company Testing)
10	(Reserved for Telephone Company Testing)

Pin Assignment (Cont'd)	Function (Cont'd)
11	Transmit B2
12	Transmit B3
13	Transmit B4
14	Receive A0
15	Receive A1
16	Receive A2
17	Receive A3
18	Receive A4
19	Receive B0
20	(Not Used)
21	Receive B1
22	(Not Used)
23	Receive B2
24	Receive B3
25	Receive B4

The eight transmit circuits in the interface are provided in two signaling "channels", A and B. At any given time, Channel A will send one of five signaling tones and simultaneously, Channel B will send one of five signaling tones. These will be turned on by the appropriate interface leads A1, 2, 3, 4 and B1, 2, 3, 4. The fifth tone, A0,will be sent in Channel A, if none of the four "A" interface leads are turned ON. Similarly a fifth tone, B0, will be sent in Channel B when all the "B" interface leads are OFF. Thus five signal outputs are presented at the receiver for each channel for a total of ten receive outputs. If two or more transmit circuits are turned ON in either channel, no tone will be transmitted for that channel and all five receive outputs for that channel will be OFF at that time.

This arrangement accepts and delivers a restricted two-out-of-ten code allowing for twenty-five possible symbols. These control signals can be sent in both directions simultaneously since the voice frequency coordination channel is full-duplex.

A character input to the transmitter consists of a positive potential applied to one lead in one or both of the two groups of transmitting leads for not less than 25 milliseconds followed by a period of not less than 15 milliseconds when all transmitting leads are held at a negative potential. The total time of these states representing one character must not be less than 50 milliseconds. A received character is delivered as a positive potential on one lead in each of two groups of control leads approximately 12 milliseconds after the multifrequency signal is received and persists until after the input is removed. Character synchronization of the receiving business machine is achieved by making use of the return to negative between characters for receiving leads A1-A4, B1-B4.

3.5 Low-Speed Connector (2-Wire Service)

This connector is associated with data set 103F2 which operates over the 2-wire voice frequency coordination channel associated with the DATAPHONE 50 common user switched network and some private switched systems. The voice frequency coordination channel is used for voice communication and alternatively for the transmission of low-speed data signals to control business machine equipment when required. This data set may be required for use with certain nonsynchronous facsimile systems. It is normally not provided in synchronous applications.

The low-speed cable from the business machine is plugged directly into the connector on the rear of data set 103F2. This connector is equivalent to a Cinch or Cannon DB-19604-433 Connector. The business machine should be equipped with a cable not longer than 50 feet and a Cinch or Cannon DB-19604-432 Plug mounted in a DB-51226-1 Hood Assembly.

When data set 103F2 is omitted, the low-speed cable is omitted also since the functions which are related to the operation of data auxiliary set 804-type are assigned to the high-speed connector. Detailed information on data set 103F2 is available in the "Data Set 103F Interface Specification, May 1964."

3.6 Description of Signals on Low-Speed Connector (Data Set 103F2)

The electrical characteristics of all low-speed signals (as well as Data Terminal Ready and Ring Indicator) conform to those outlined in Electronic Industries Association Standard RS232B. A brief description of these characteristics is given in the section concerning the customer interface for data set 404B1.

Pin assignments for the low-speed connector are listed below:

Pin Assignment	Function
1	(AA) Protection Ground
2	(BA) Send Data
3	(BB) Receive Data
4	(CA) Request-to-Send
5	(CB) Clear-to-Send
6	(CC) Data Set Ready
7	(AB) Signal Ground
8	(CF) Carrier Detection
9	(+P) (Reserved for Telephone Company Testing)
10	(-P) (Reserved for Telephone Company Testing)
11	(CY) Originate, Answer, Mode Control
12	(CX) Local Operating Mode

Customer data signals are fed to the data set on Send Data lead BA. Output data signals are delivered to the customer on Receive Data lead BB. Bit rates up to a maximum of 200 bits per second may be used.

The functions of the control leads are defined as follows:

1. Data Set Ready (CC) (Originates in Data Set) An ON voltage on this lead indicates that the data set is in the proper mode for data communication and that the power supply in the data set is operating.
2. Request-to-Send (CA) (Originates in Business Machine) An ON voltage applied to this lead turns the transmitted carrier ON. An open circuit, short circuit to ground or OFF voltage turns the carrier off.
3. Clear-to-Send (CB) (Originates in Data Set) An ON voltage on this lead provides an indication to the customer that the data set is prepared to transmit data. An ON signal will appear on this lead approximately 265 milliseconds after the application of an ON Request-to-Send signal if the data set is not in the test mode.
4. Carrier Detection (CF) (Originates in Data Set) An ON voltage on this lead indicates that carrier is being detected.
5. Local Operating Mode (CX) (Originates in Business Machine) An ON voltage on this lead puts the data set in the local operating mode. The local mode of operation provides a looping of the customer transmitted data leads to his received data leads.
6. Originate, Answer, Mode Control (CY) (Originates in Business Machine) An ON voltage on this lead corresponds to operation of the data set in the originating mode while an OFF voltage results in operation in the answering mode.

4. DETERMINATION OF STATION ARRANGEMENT AND DATA SET 303-TYPE CODE (FOR COMMERCIAL SERVICE)

4.1 Station Arrangement, Facility Relationships

The selection of station configuration and code of data set 303-type is made by the telephone company after consideration of the customer's service requirements and facility engineering requirements. Involved in the consideration of customer's service requirements are such factors as type of business machine, synchronous or nonsynchronous operational mode, type of service, e g , 2-point or switched (private or common user network), and, for cases of synchronous operation, data transfer rate and timing provisions. Telephone facility engineering determines the desirable method of access to the data station and methods of interconnection with and treatment of the transmission facilities.

4.2 Determination of Wideband Data Set Code

As has been discussed in previous sections, several basic types of data set 303 are available for operation over the several types of wideband

line facilities that are available for these services. The choice of code of data set 303-type which will provide the combination of features to satisfy a specific combination of customer service and facility requirements can be obtained from a procedure as illustrated in the flow diagram of Figure 10. This chart illustrates a procedure for the cases of both standard commercial service and special government service applications. A detailed discussion of station arrangements and interface considerations involved in special government service applications is given in a subsequent section.

5. CUSTOMER OPERATIONAL FEATURES PROVIDED BY STRAPPING OPTIONS (FOR COMMERCIAL SERVICE)

It has been mentioned that the selection of station arrangement and specific code of data set 303-type is made by the Telephone Company after considering the customer's service requirements and the facility engineering requirements.

Still another group of choices must be made prior to implementation of the station arrangement. These concern the choice of strapping options having to do mainly with the procedural matters of operating the data station in conjunction with the customer's business machine, and generally require consideration on the part of both the customer and the Telephone Company. Certain other strapping options are dictated by the combinations of station apparatus and as such are of interest solely to the Telephone Company. In all cases, however, implementation of the strapping is by Telephone Company personnel.

The choices available, their meaning, and implementation in the data station, are tabulated in Figure 13 and discussed in the following paragraphs.

1. Permanent Alternate Use Signal

   When the Alternate Use signal (ALT) is OFF, the connector for the SYNC cable is active. When the Alternate Use signal is ON, the connector for the NONSYNC cable is active. A nonsynchronous business machine may be connected to either connector of a nonsynchronous data set. A nonsynchronous data set will operate only nonsynchronously, regardless of which connector is chosen. The NONSYNC connector is permanently activated by installation of the A option which provides the equivalent of a permanent ON state of the Alternate Use control lead. The A option is not used when station operation is in the synchronous mode or alternate use mode when using a synchronous data set, or when the alternate use control is used to switch between two nonsynchronous business machines connected to a nonsynchronous data set.

2. Permanent Line Status Signal (Data Auxiliary Set 804-Type Provided or Not Provided As a Function of Need for Voice Communication).

   If the customer has no need for voice communication, it is possible to arrange the data station for operation on a 2-point private line, wideband data only basis. In this instance, data auxiliary set 804-type is omitted from the station arrangement and a permanent line status indication must be provided by installing option K, permanent line status, in the data set 303-type.

3. Internal or External Transmitter Clock

   Where synchronous operation is specified, the timing signal or clock may originate in either the data set or in the business machine. All standard codes of the data set 303-type intended for synchronous operation with unbalanced customer interface include a transmitter clock circuit. However, if the clock signal is to be provided by the data set, option Z or "internal clock" strapping option must be incorporated in the data set. When

the clock signal is to be provided by the business machine, strapping option E or "external clock" must be provided in the data set. The E and Z options are mutually exclusive. It is recommended that the transmit clock circuit pack be removed from the data set when E option is provided in order to avoid the possibility of crosstalk between clocks.

4. Customer Controlled Request-to-Send or Permanent Request-to-Send

   When the customer controls the Request-to-Send signal, the Request-to-Send lead (RS) on the interface connector must be ON to transmit wideband data. If the associated 804-type data auxiliary set is in the data mode (or in the absence of the 804, if a permanent line status option is wired into the data set), the presence of the ON condition of the RS lead from the customer equipment will cause the wideband data set to respond with an ON state on the Clear-to-Send (CS) lead. This method of operation must be used when the option for "Request-to-Send Control of Scrambler Idle Code" is provided in the data set 303-type (see 5.) The customer may also request it due to requirements of his business machine. When the customer control of Request-to-Send is desired, option T is omitted.

   If desired, a permanent Request-to-Send ON condition may be wired into the data set by the Telephone Company with the use of strapping option T. This option is applied only when requested by the customer. When installed, it makes unnecessary the use of the RS lead by the customer. It should not be used when "Request-to-Send Control of Scrambler" is required.

5. Free Running Scrambler Idle Code or Request-to-Send Control of Scrambler Idle Code (Applies Only to Synchronous Data Sets)

   The synchronous data set for standard commercial service is equipped with a scrambler that essentially randomizes whatever data signal is presented at its input, including steady mark or space signals. This scrambled data is descrambled at the receiving data set. (Balanced customer interface synchronous data sets may include scrambling.)

   The data set is normally arranged to transmit steady mark signals to the far end when the Request-to-Send lead is turned OFF. When the data set is provided with the "Free Running Scrambler Idle Code" option, Q, this marking signal is scrambled and presented to the line, as is data presented on the Send Data lead when Request-to-Send is turned ON. Thus, a signal is being transmitted continuously to the receiving data set, and the transmitting and receiving data sets will remain in bit synchronism once the initial start-up period of up to 3000 bits in length has been exceeded. This option, Q, must be used when it is desired to recover meaningful data without further synchronizing delays after the initial start-up delay time has been exceeded. The option is not allowed on a multipoint private line system.

   The data set can be wired to stop transmission when the Request-to-Send lead is in the OFF state by the use of option M, "Request-to-Send Control of Scrambler Idle Code". Use of this option will require that no meaningful data be sent until after 3000 bits of scrambler idle code have been transmitted after each turn-on of the Request-to-Send signal. Thus, when option M is used, the receiving data set must be brought into synchronism with each application of Request-to-Send. This option

must be used on a multipoint private line system. A selection of one of the options M and Q must be made for synchronous operation. The options M and Q are mutually exclusive.

6. Manual Answer or Automatic Answer

Where data auxiliary set 804-type is provided to control the wideband and voiceband channels, call handling may be exclusively manual, exclusively automatic or by a combination of the two methods. After a determination of operating method has been made, implementation is by means of options in data auxiliary set 804-type to introduce the automatic answering feature, and in data auxiliary set 806D1 to provide the appropriate path for the Data Terminal Ready (DTR) control signal.

When voice coordination must always precede the transmission of data, answering should be on an exclusively manual basis, and the automatic answering option, G, should be omitted from data auxiliary set 804-type. (If option G is omitted, it is not necessary to remove option B.) The button used to select the automatic mode can be blocked.

When the automatic answering feature is provided (options B and G provided in data auxiliary set 804-type), the AUTO button is functional and depression of this locking button and the provision of an ON state of the DTR lead will enable the data station to seize and hold the line, and enter the DATA mode, in response to ringing on the voice coordination circuit. When the AUTO key is not depressed the call must be answered manually.

Regardless of the answering mode employed, an ON state of the Data Terminal Ready (DTR) lead is required in order for the station to enter the data mode. When manual answering is employed in two-point private line service, DTR may be under customer control or wired permanently ON either in the business machine or by the Telephone Company in the data station. When the application is in a switched network or automatic answering is required, the DTR lead must be controlled by the customer's business machine. Also, the DTR lead must be under customer control in order to machine terminate a call regardless of the method used in placing or answering the call.

The appropriate path for the DTR control signal is provided by a strapping option in data auxiliary set 806D1. When the DTR lead is to be controlled from the business machine (or wired permanently ON in the business machine), option S should be installed. When the DTR lead is to be wired permanently ON in the data station, option T should be installed. Options S and T are mutually exclusive.

7. Combinations of Talking and Data Modes

The capability of talking and transmitting wideband data in stations equipped with the standard data auxiliary set 806D1 is offered in the following combinations as implemented with strapping options in the 806D1 and in data set 303-type as the case may require. The strapping options involved are designated N and S in data set 303-type, and ZB, ZC and ZD in data auxiliary set 806D1. The combinations of options specified below apply equally to 2-point or switched arrangements.

At stations in which a voiceband data set is used for coordination data

OPERATIONAL FEATURE	MEANING AND USE	OPTION DESIGNATION AND LOCATION			PROVISION
		DS 303–TYPE	DAS 806 DI	DAS 804–TYPE	
Permanent Alternate Use	Activates NON SYNC connector – same as permanent ON signal on Alternate Use (ALT) control lead.	A			Provide or omit as required.
Permanent Line Status	Puts 303-type data set permanently in data condition – used when DAS 804-Type is omitted from station.	K			Provide only when DAS 804-Type is omitted.
Internal Clock	Transmit Clock furnished in data set.	Z			Provide one.
or					
External Clock	Transmit Clock furnished by customer.	E			
Permanent Request to Send	Same as permanent ON signal on Request to Send control lead.	T			Provide or omit as required – when omitted, RS is controlled by Customer.
Free Running Scrambler	Scrambler output always presented to line (receiving data set stays in sync when no customer data).	Q			Provide one.
or					
Request to Send Control of Scrambler	Scrambler output presented to line only when RS is ON. (Receiving data set must go through synchronizing start-up period with each application of RS signal.)	M			
Manual Answering	Customer control of Data Terminal Ready (DTR)– (required for machine termination of call).		S		Provide one.
or					
	Permanent DTR (same as permanent ON on DTR control lead).		T		
Automatic Answering	Provides circuitry and button selection control for AUTO answer mode. (When button depressed, station answers and holds in data mode upon detection of a ringing signal.)			B, G	Provide
	Customer control of Data Terminal Ready (DTR) lead		S		Provide
STATION CAPABILITY					
Either DATA or TALK	TALK button on DAS 804-Type depressed to talk or DATA button depressed to send data – cannot talk while sending data.				Omit options N, S, ZB, ZC, ZD
or					
Capability of Talking While Wideband Data is Being Transmitted (as a Permanent Model.	Generally used in SYNCHRONOUS operation. (Cannot be used when voiceband data set is provided for use on coordination channel)		ZB, ZC		Provide
or					
Simultaneous Wideband Data and Talking in SYNCHRONOUS Mode, DATA or TALK in NON SYNCHRONOUS Mode; Conditions Under Control of Alternate Use (ALT) Lead.	Coordination channel used for talking simultaneously with the transmission of SYNCHRONOUS wideband data when ALT is OFF – DAS 804-Type must be in DATA mode in order to transmit NON SYNCHRONOUS wideband data and low-speed data when ALT is ON.	N	ZB, ZD		Provide
or					
Simultaneous Wideband Data in NON SYNCHRONOUS Mode, DATA or TALK in SYNCHRONOUS Mode; Conditions Under Control of Alternate Use (ALT) Lead.	Coordination channel used for talking simultaneously with the transmission of NON SYNCHRONOUS wideband data when ALT is ON – DAS 804-Type must be in DATA mode in order to transmit wideband data when ALT is OFF.	S	ZB, ZD		Provide

CUSTOMER OPERATIONAL FEATURES PROVIDED BY STRAPPING OPTIONS
FIG. 13

while transmitting wideband data (as in facsimile operation), or stations in which the need for voice coordination always precedes and/or follows the transmission of wideband data, or where operating procedures are to be consistent with the standard low-speed DATA-PHONE® operating procedures, provision for talking and sending wideband data simultaneously will not be made and therefore data auxiliary set 804-type must be put in the DATA mode for wideband data to be transmitted. This mode of operation is achieved by omitting the options N, S, ZB, ZC, and ZD.

When it is desired to have, as a permanent station feature, the capability of talking while wideband data is transmitted (as in the cases of synchronous operation and when no voiceband data set is provided), the options ZB and ZC are installed in data auxiliary set 806D1 and options N and S are omitted from data set 303-type. When the data station is so arranged, an initial operation of the DATA button on the 804-type data auxiliary set is required to put the station in the data mode. After this initial operation, the talk mode can be entered at will while maintaining wideband data transmission. This ability ceases when the call is terminated, and the data mode must be reinitiated on the next call.

It is possible to arrange the operation of the data station so that the combination of wideband data and talking capability is a function of the state of the Alternate Use (ALT) lead. This feature typically would have applicaton when the station is used for synchronous and nonsynchronous transmission on an alternate use basis with a voice rate data set used when the station is in the nonsynchronous condition. In this case, simultaneous wideband data and talking capability would be provided when in the synchronous mode, and talk or data only when in the nonsynchronous mode. The possibilities available under control of the Alternate Use (ALT) lead are as follows:

a. Simultaneous TALK/DATA — Synchronous Mode TALK or DATA — Nonsynchronous Mode

   This option permits the use of the coordination channel for voice simultaneously with the transmission of wideband data, when the data set is arranged for synchronous operation and when the Alternate Use (ALT) lead is OFF. When ALT is ON (interface switched to the nonsynchronous connector), the 804-type data auxiliary set must be in the data mode in order to transmit nonsynchronous wideband data (and low-speed data if voiceband data set provided). Simultaneous talking is not possible when ALT is ON. This option would be needed to restrict talking in the nonsync mode to allow the transmission of low-speed data. This case requires the installation of options N, ZB and ZD.

b. Simultaneous TALK/DATA — Nonsynchronous Mode TALK or DATA — Synchronous Mode

   This option is the reverse of the case discussed under (a.) above. It permits simultaneous talking and transmission of wideband data when a nonsynchronous data set is used or when a synchronous set has been switched to the nonsynchronous mode by turning the Alternate Use (ALT) lead ON. When ALT is OFF, data auxiliary set 804-type must be in the data mode to transmit wideband data.

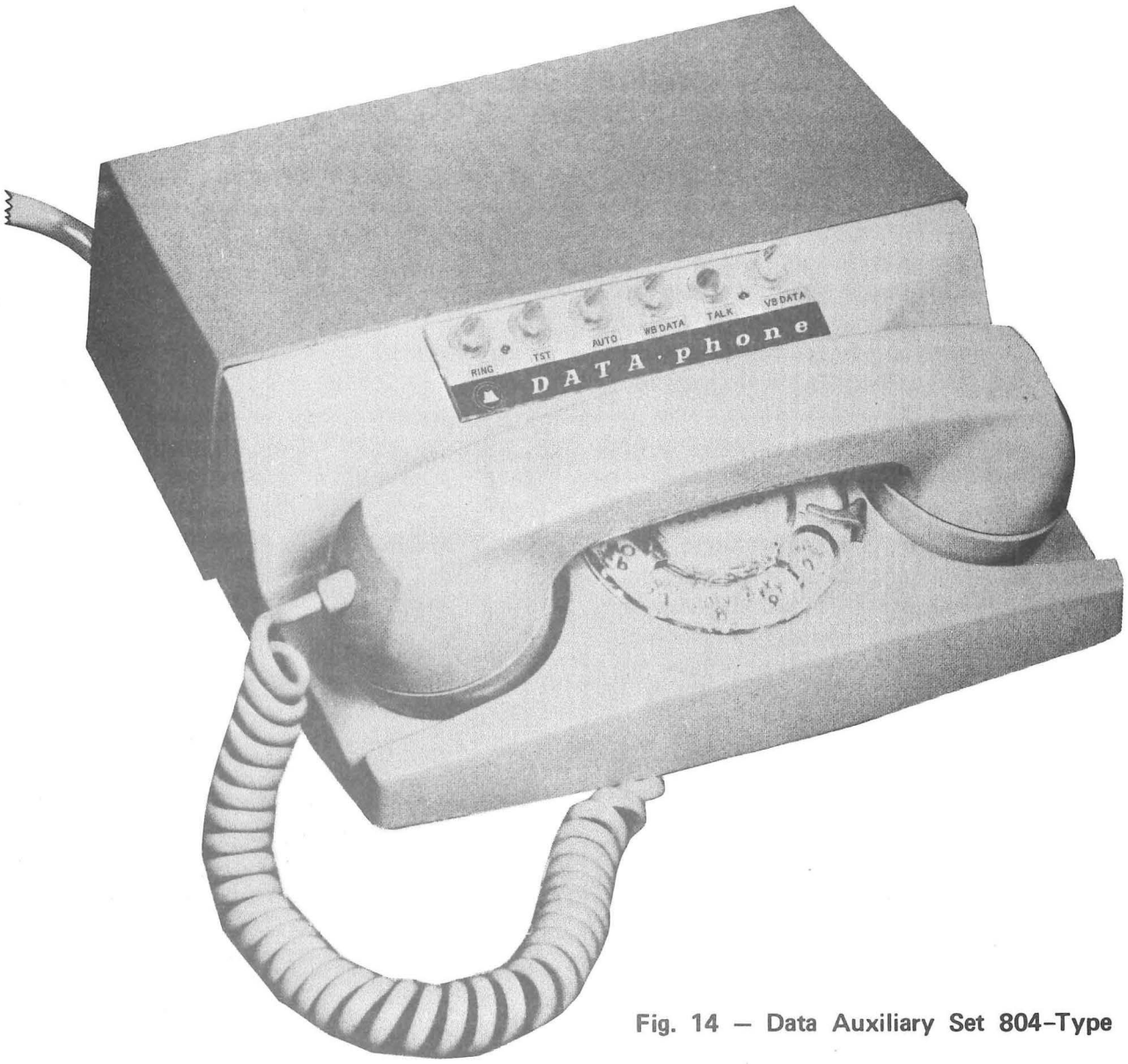


Fig. 14 — Data Auxiliary Set 804-Type

Simultaneous talking is not possible when ALT is OFF. This case requires the installation of options S, ZB and ZD.

In addition to the aforementioned options of Figure 13 which are determinnd mainly by customer operational requirements, there are others associated with data set 303-type which are determined by the overall station arrangement and are of concern only to the Telephone Company.

6. CONTROLS ACCESSIBLE TO THE STATION ATTENDANT

The telephone instrument and line control unit of the data station is the 804-type data auxiliary set. This unit includes, in addition to the signaling device such as the rotary dial or TOUCH-TONE® pad, 6 control buttons and associated lamps. The unit is located for customer convenience anywhere up to but not exceeding 75 cable feet from the data station. Data auxiliary sets 804A5 and 804A7 are used in the standard commercial service offering. Where a rotary dial type is required, the 804A5 is

specified; where TOUCH-TONE signaling is used, as in the DATAPHONE 50 network, the 804A7 is specified. Data auxiliary set 804A5 is shown in Figure 14.

The functions of the six control buttons of data auxiliary set 804A-type, listed in order from left-to-right, are as follows:

1. RING — When point-to-point ringing is required, this nonlocking button is used. When depressed it initiates ringing to the far end station. At the called station the associated lamp lights (in addition to an audible ring) to indicate that the station is being signaled. This button and associated lamp are not activated nor are they designated in the switched network case.

2. TST — A locking button that allows the station attendant to loop the wideband data station on the telephone line side. This permits the business machine equipment to send to itself through the data station for local testing. When the button is depressed or when the high-speed interface Local Test Control Circuit is in the ON state, the lamp associated with this button lights. When any other button is depressed, this button releases. The lamp also lights when the data station has been placed in the remote test mode by the Telephone Company.

3. AUTO — A locking button that selects the automatic answering mode when that feature is provided.

4. WB DATA or WB CHAN — The button is blocked from operating and only the associated lamp indication is used. When the lamp is lighted it indicates that the wideband data station is operable. The designation WB DATA is provided when the application is to a point-to-point private line system. In the switched network case the designation is changed to WB CHAN.

5. TALK — A locking button that should be depressed in order to talk on the voice coordination circuit. This button is released when any other button is depressed. Placing the station in the TALK mode prevents the transmission of wideband data when a voice frequency data set is used for transmission of low-speed control signals. Transmission of wideband data can take place simultaneously with the talk mode in arrangements where no voiceband data set is provided and the simultaneous wideband data and talking feature is provided. In this case the TALK button must still be depressed in order to talk.

6. VB DATA or DATA — A nonlocking button that is pressed to place the wideband data station in the data mode. The VB DATA designation is provided when the application is to a point-to-point private line system; DATA is provided in the switched network case. The button is depressed momentarily and the associated lamp lights. (The lamp is omitted in the case of stations arranged for switched network operation that do not include a voiceband data set; in this case the visual indication is from the WB CHAN lamp.) When the station is arranged with the simultaneous wideband data and talking feature, the DATA button is operated only to enter the data mode initially. Once in the data mode the telephone handset can be cradled. After entering the data mode initially, the telephone handset can be cradled in the data mode and the talk mode can be entered at will by depressing the TALK button when the handset is off-hook. Stations on a switched network will be disconnected from the voice line if the telephone instrument is cradled while the TALK button (locking) is depressed.

7. SPECIAL GOVERNMENT APPLICATIONS

The application of the 303-type data station in special government services at this writing typically falls into two categories. One of these involves either the synchronous transmission of cryptographic data signals at the 50 kb/s data transfer rate or corresponding nonsynchronous transmission, and the other, 50 kb/s synchronous transmission systems which remain in bit synchronism in spite of interruptions in line signal of up to 6 seconds in duration.

The first category typically utilizes standard 303-type data station arrangements in which the data set 303-type operates with a balanced customer interface and, in the synchronous application, as a regenerator. Usually the scrambling feature is omitted. Typically, the data set accepts the serial bit stream at 50 kb/s and delivers this stream, without a clock, at the receiving end of the circuit. No clock signals are exchanged between government equipment and the data set for these applications. Such stations usually incorporate a digital data recognizer and switching circuit which monitors the customer line and directs the high-speed digital data to the data set 303-type and thence to the wideband facilities, and directs signaling and other supervisory tones to the voice coordination channel. These station arrangements usually consist of an 824-type data auxiliary set data recognizer, a balanced customer interface code of data set 303-type, and data auxiliary set 806D1. The telephone set and line control unit 804-type data auxiliary set is typically not used. Apparatus units may be rack mounted or combined in the standard KS-200 18-type station cabinet.

Codes of data set 303-type used in this application have interface circuits that are of 135 ohms impedance and are electrically balanced. With the balanced customer interface, the SYNC connector is used for either synchronous or nonsynchronous operation. Circuits appearing on the customer interface are Send Data and Receive Data. The same Burndy plug and shield mentioned in the section entitled "High-Speed Interface" is used. Pin assignments for the data set connector are as follows: pins E and K-Send Data, pins C and D-Receive Data. The power of the Send Data signal at a terminal data set is expected to be 0 dBm ±6 dB into 135 ohms. The Receive Data signal delivered to the customer's line is 0 dBm ±1.0 dB into 135 ohms. In the case of synchronous balanced interface sets performing regeneration of data signals (scrambling omitted), the customer data is expected to be within ±.01 percent of the bit rate specified for the data set, and not to contain transitionless gaps greater than 40 bits in length. Since no control signals are interchanged across the balanced customer interface, no option choices need be made which require consideration on the part of both customer and the Telephone Company.

Government 50 kb/s cryptographic data systems that require synchronous data sets usually operate without scramblers. This type of operation is permissible since the data is already random. In some encryption applications, however, the scrambler may be required to keep the data set AGC stabilized where fast system start-up is required. In such cases, compatibility problems must be recognized.

The method of code selection for this use category is shown in Figure 10. In this figure, balanced customer interface codes of data set 303-type are qualified as operating as regenerators. This means that the conventional transmit clock circuit is omitted and a second sync recovery and regenerator circuit is used to develop timing from the transitions of the customer's data signal. The "internal clock" option is used in these data sets. Codes for data transfer rates other than 50 kb/s were developed for rather restrictive applications.

The second category, that of the long holdover timing arrangement for the 50 kb/s rate, indicated in Figure 10, at present writing is not implemented through standard coded arrangements but rather through field modification of a synchronous, unbalanced customer interface standard code of data set, the 303C6A. This arrangement is expected to have rather limited application. The modification consists of the addition of several chassis leads and replacement of the standard timing circuit packs by standard code circuit packs which contain the new long holdover timing circuitry. When modified for long holdover operation,

data set 303C6A retains the interface arrangement of the unbalanced customer interface codes as previously mentioned. All characteristics of the data set remain as for the standard code with the exception of the added ability to maintain synchronism in the face of extended duration line signal outages. Both the sending and receiving data sets must be equipped with the new circuits to achieve long holdover performance. Regenerative repeaters, type WRR-1, are not arranged for using long holdover sync recovery circuits and so cannot be used as part of the transmission facility.

8. CONSIDERATION OF DISCONTINUED CODES VERSUS STANDARD CODES

Prior to this issue of the technical reference, certain codes of data set 303-type now discontinued were available. As user requirements and application patterns became more evident and system requirements hardened, certain features were eliminated from the coding pattern thereby reducing the total number of data set codes available. In this category were codes which omitted the transmitting clock circuitry (intended for external clock operation), those which incorporated a 50 percent roll-off receiving filter (all synchronous restored polar codes were previously available with both 50 percent and 100 percent roll-off receiving filters), and those codes which, although intended for standard commercial service, omitted the scrambling circuitry. Available standard codes requiring a receiving filter now provide the 100 percent roll-off characteristic. The only question of compatibility of obsolete codes involves an earlier, now obsolete version of the scrambling circuitry. This earlier version, coded as circuit pack AR 134, placed some restraints on customer data patterns allowed and was replaced by the 16A1 data unit which removed all such restraints. These two types are physically interchangeable. However, the early version is not functionally compatible with the currently standard unit. Data sets at both ends of a circuit must be equipped with the same version of the scrambler circuit. Telephone Companies generally substitute the new scramblers in synchronous data sets in the field as they are available. Because of the incompatibility situation, it is imperative that all scramblers working together on a switched network or two-point private line be changed simultaneously.

Prior to standardization of line and test unit data auxiliary set 806D1, the functions of local and remote test, line access, and voice coordination channel implementation were achieved with the 806B-type series of data auxiliary sets which provided for these functions in various combinations. The standard 806D1 data auxiliary set is a substitute for the discontinued 806B1-7 series and as such provides all the features obtainable with the most complete of the 806B codes, as well as additional features. In general, the functional operation is the same. An operational difference that should be discussed involves use of the simultaneous data and talking feature of the data station. Station arrangements using the 806B7 in 2-point private line service where this feature was provided were always in the data mode, and it was necessary only to depress the TALK button of the telephone set when talking was desired. In switched network stations employing this feature it was necessary to depress the data button initially to put the station in the data mode. After this initial operation the station remained in the data mode with subsequent operations of the TALK button. In stations using the standard 806D1 where the simultaneous data and talking feature is provided, it is necessary to operate the DATA button initially to put the station in the data mode in both the 2-point and switched network case. A mixture of types therefore leads to the above administrative difference and for that reason it is desirable to use the same code at both ends of a 2-point service or at stations which will be working together on a switched network.