B1 DATA CARRIER TERMINAL
GENERAL DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section is a general description of the B1 data carrier terminal. The several circuits that make up a terminal unit are described in detail in separate sections. The B1 data carrier system is meant for use in the Wide Area Data Service (WADS) switching plant.

1.02 A fully equipped terminal unit derives six narrow-band data channels from a 4-wire voice facility channel. Six terminal units can be mounted in a terminal frame. Thus a fully equipped terminal frame will provide 36 data channels, using six 4-wire voice facility channels.

1.03 The B1 data carrier terminal is intended for use with trunk circuits (one per data channel) that use E- and M-type signaling. Each terminal unit contains a supervisory signaling circuit that will transmit and receive the ***E*** and ***M*** lead signals for six trunk circuits.

1.04 The data channels have a useful bandwidth of 250 cps and are centered at 1170 cps (f_1) for the originating to terminating direction, and at 2125 cps (f_2) for the other direction. The data channels are satisfactory for use with data sets 101- and 105-type and allow a data rate of 150 bits per second.

1.05 Automatic gain control (AGC) is provided in the transmitting side of each data channel. The AGC offsets differences in signal power at the input to the data terminal that result from the use of long subscriber lines or loss variations in the connecting facilities and thus secures a better signal-to-noise ratio for the data signals.

1.06 The direction of seizure is determined by the trunk circuit which applies an appropriate signal on the ***OG*** lead to the B1 terminal. This causes the modulating and demodulating frequencies to be arranged to match the direction of seizure.

1.07 The narrow bandwidth of the data channels prohibits the use of conventional address signaling methods, such as MF, and requires the use of the new narrow-band frequency shift pulsing (FSP) signaling system. The FSP signals are transmitted in the f_1 band (1170 cps) at a rate of 200 bits per second. The AGC circuit of a data channel is disabled during FSP signaling to allow the FSP signals to be transmitted at a higher level than data signals.

1.08 Conventional call progress tones cannot be transmitted through a narrow-band data channel. A new call progress tone generator is available which will transmit call progress tones to the originating subscriber in the f_2 (2125 cps) band.

2. CHANNEL FREQUENCY ALLOCATION

2.01 The B1 data carrier terminal unit translates the 1170-cps (f_1) and 2125-cps (f_2) data bands to line frequency bands centered at the frequencies indicated in Table A.

TABLE A

CHANNEL AND CARRIER FREQUENCIES

CHANNEL	CENTER OF LINE FREQUENCY BAND	LOWER CARRIER FREQUENCY	UPPER CARRIER FREQUENCY
	cps		
1	740	1910	2865
2	1217.5	2387.5	3342.5
3	1695	2865	3820
4	2172.5	3342.5	4297.5
5	2650	3820	4775
6	3127.5	4297.5	5252.5

2.02 The channels are separated by 477.5 cps. In order to translate a data frequency of 1170 cps to a line frequency of 740 cps a carrier frequency of 1910 cps is required. This is the fourth harmonic of 477.5 cps. Similarly, to translate a data frequency of 2125 cps to a line frequency of 740 cps a carrier frequency of 2865 cps is required. This is the sixth harmonic of 477.5 cps. All of the carrier frequencies used in the channel circuits are derived from a common base frequency of 477.5 cps. The B1 data carrier terminal carrier supply circuit serves this function for an entire terminal frame.

3. TERMINAL COMPONENTS

3.01 A fully equipped terminal frame contains one carrier supply circuit and six terminal units. Each of the terminal units has six channel circuits, one supervisory signaling circuit, one line circuit, one power supply, and six channel filters. The equipment arrangement of a terminal frame is shown in Fig. 1.

Channel Circuit

3.02 A channel circuit is divided into two parts: the transmitting and receiving, which are joined by a hybrid coil or 4-wire terminating circuit. The transmitting half translates the data frequencies to selected line frequencies and the receiving half returns the line frequencies from the distant terminal to the original data frequencies. (See Fig. 2.) Amplitude modulation, using an appropriate carrier frequency, is used in each case. Channel filters are used to select the desired sideband and reduce the amplitude of those frequencies which would cause interference in other data and message channels. The transmitting half also includes automatic gain control (AGC) to reduce signal amplitude variations. Reducing level variations makes it possible to transmit the maximum power permitted by crosstalk and noise requirements on the connecting line facilities, producing a maximum signal-to-noise ratio and hence best performance.

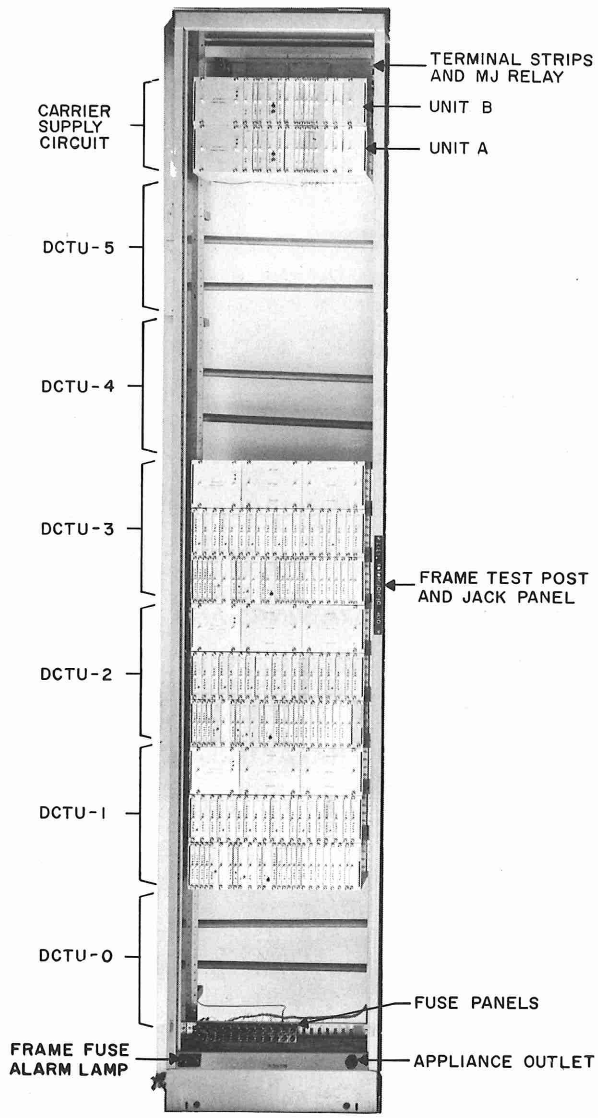

Fig. 1 — B1 Data Carrier Terminal Frame

3.03 Several pads and an amplifier are also used in the transmitting half for impedance and level control.

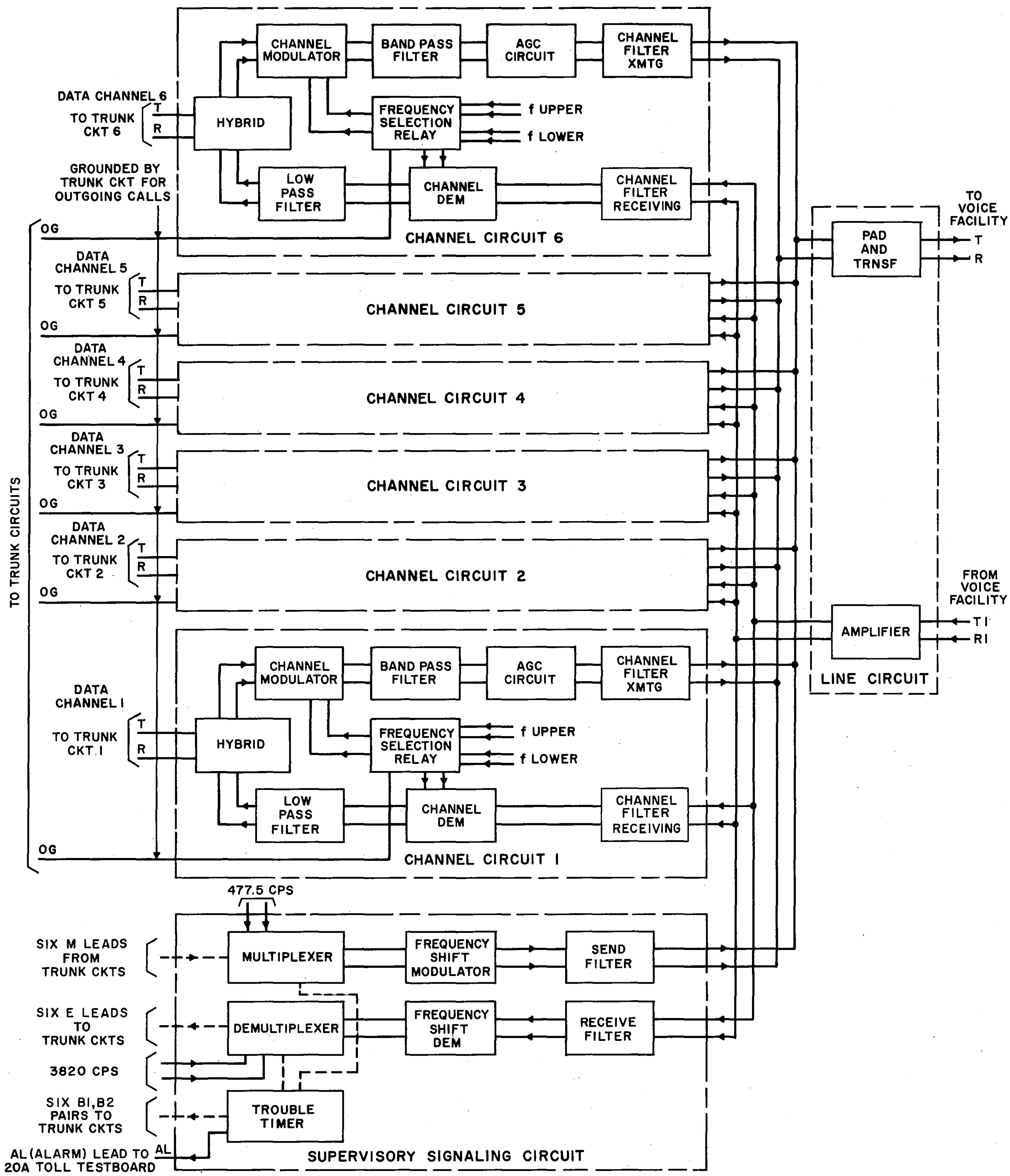

Fig. 2 — B1 Data Carrier Terminal Unit, Simplified Functional Diagram

3.04 The receiving half also includes pads and amplifiers for level control and to reduce the interaction between the demodulator and the connecting filters. The loss in the data trunk (between the 2-wire sides of the B1 terminal) at the nominal signal input is made zero by the use of receiving gain. Singing is not a problem within the data channel circuit because the frequencies (f_1 and f_2) used in the two directions are separated by 955 cycles. This permits sufficient filtering so that normal circuit net loss variations will not produce singing.

3.05 A more detailed description of the channel circuit can be found in Section 314-017-150 and CD-73016-01.

Supervisory Signaling Circuit

3.06 The supervisory signaling circuit provides the E- and M-type signaling path for the six trunk circuits that connect to a terminal unit. The six ***M*** leads from the trunk circuit are sampled once every 94.24 milliseconds. The samples are combined with two synchronization pulses and a "trouble" pulse to form a 9-bit word or frame. This 9-bit frame is used to frequency modulate a 350 ±35 cps signal for transmission, with the modulated data signals, over the 4-wire voice facility to the distant office. In the receiving direction, a similar 350 ±35 cps signal is received from the distant office. This signal is demodulated to form the 9-bit binary signal which is demultiplexed and controls the six ***E*** leads that go to the associated trunk circuits. Signaling integrity alarm features are also included in the supervisory signaling circuit. For more detailed information see Section 314-018-150 and CD-73017-01.

Carrier Supply Circuit

3.07 One carrier supply circuit is installed in each terminal frame. It generates the eight modulation frequencies used in the channel circuits and the two frequencies (477.5 cps and 3820 cps) used to clock the supervisory signaling circuits. A 3820-cps crystal oscillator is counted down to 477.5 cps. The 477.5-cps signal then drives a harmonic generator which yields the required modulation frequencies. The crystal oscillator limits frequency errors to about 1/4 cps at the highest carrier frequency. Two crystal oscillators and countdown circuits are provided and provision is made for automatically switching the load from one to the other when trouble develops. The load is normally distributed between the two oscillators. The carrier supply circuit is described in Section 314-019-150 and in CD-73018-01.

Line Circuit

3.08 One line circuit is used in each terminal unit. It includes equipment which is common to the six data channels and the supervisory signaling channel of a terminal unit. There is a transmitting pad and a receiving line amplifier plus repeating coils for separating the balanced 4-wire line circuits from the unbalanced terminal circuits. The line circuit is described in Section 314-017-150 and CD-73019-01.

Power Supply Circuits

3.09 The principal power used in the B1 data carrier terminal is +12 volts with respect to ground. It is derived by the power supply unit from the −48 volt office battery. Two of these units are required in each carrier supply and one in each terminal unit. The −48 volts is also used throughout the terminal frame. The −48 volt current drain requirements for each carrier terminal unit, the single carrier supply circuit, and for an entire terminal frame are given below:

CIRCUIT	−48 VOLT DRAIN (amp)
Terminal Unit	1.25
Carrier Supply	0.62
Total for a Complete Terminal Frame	8.1

Channel Filters

3.10 A complete terminal unit is equipped with six 619-type channel filter units. Each unit contains four isolated filters, two that are used in the transmitting side of a channel and two that are used in the receiving side. The supervisory channel filter is a 620B filter that is included among the supervisory signaling circuit packages. The 620B filter contains separate transmitting and receiving filters.

4. ALARM FEATURES

4.01 The alarm features for a B1 data carrier terminal frame include carrier supply major and minor office alarms and a fuse circuit major office alarm. There is also a supervisory signaling alarm which appears at the 20A test board.

4.02 A carrier supply minor alarm appears when one of the two oscillator and countdown circuits in the carrier supply has failed. This is considered a minor alarm because the connected channel circuits continue to function satisfactorily. When the second oscillator and countdown circuit fails, a major alarm is given because all connected channel circuits will become inoperative.

4.03 When there is a carrier supply alarm, the supervisory signaling circuits receive an inhibit pulse (for a timed interval) which prevents false supervisory signals from being transmitted or received.

4.04 The office alarms may be cleared by the operation of reset keys. Once the trouble has been cleared the alarm reappears and is retired by returning the reset key to the normal position.

4.05 Circuits are provided as part of the supervisory signaling circuit to monitor various signals that can indicate that the ***E*** lead signals are not valid or reliable. The situations that are interpreted as trouble conditions are: the demultiplexing portion of the signaling circuit is out of synchronization, the received signal level is too low, sampling gate pulses have stopped, and the carrier supply circuit is temporarily in trouble. As soon as one or more of these situations is detected, the six connected trunk circuits are made busy and the trouble pulse (3.06) is transmitted to the distant end as a command to make busy. The red TBL lamp, on the supervisory signaling circuit tray, also lights and stays lit as long as a trouble situation persists. If a trouble persists longer than 3.75 seconds (nominal), an alarm signal is sent to the 20A toll testboard; and the ***E*** leads at both the local and the distant trunk circuits are opened to appear as on-hook or idle. The alarm signal is retired as soon as service is restored. Further details are in CD-73017-01.

5. TEST AND MAINTENANCE FEATURES

5.01 It is anticipated that troubles in a B1 terminal will be sectionalized to a particular terminal and/or channel by means of tests applied at the 20A toll testboard. After the defective terminal or channel is identified, further tests will be made at the terminal frame to localize the trouble to a particular circuit package (or to the frame wiring). Various test and maintenance features are provided in the B1 terminals to facilitate trouble localization and routine testing.

5.02 Four test tones are available at jacks in the terminal frame. The frequencies of 1070 cps (f_1 space), 1270 cps (f_1 mark), 2025 cps (f_2 space), and 2225 cps (f_2 mark) are provided. These tones are useful in making data channel transmission tests, and are at the maximum levels that can be applied to a channel without overloading the AGC circuit: −14 dbm for f_1 tones and −9 dbm for f_2 tones.

5.03 Special 9-foot cords are provided for making tests on the channel circuits. These cords have connectors suitable for connecting to the test points of the circuit packages and/or plugs suitable for connecting to variable attenuators or to the tone jacks. Where necessary, loops are provided on the cords to loop over a circuit package knob and relieve the strain on the test points.

5.04 Test points are provided that allow looparound tests to be made on the channel circuits without turning down all of the channels in a terminal.

5.05 Test points are provided on all circuits of a B1 data carrier terminal unit and on the B1 carrier supply circuit. This allows easy access to the various circuits for emergency trouble location tests or for routine level measurements.

5.06 A special test circuit, the 908A logic circuit test set, is used to make many of the tests necessary to isolate trouble to a particular circuit package. The logic circuit test set is basically a pulse detector and a frequency meter. It can detect the presence of logic level pulses and can determine the average frequency of a logic level signal if it is less than 5000 cps. The frequency of a low level signal (above −30 dbm) can be determined for frequencies between 50 and 5000 cps. A bias metering circuit is also included in the 908A.

5.07 A locking key, labeled TEST, is provided on each supervisory signaling circuit to connect the modulator section to the demodulator section through a 14-db pad and to disable the trouble timing features of the circuit. Operating the key disables the regular supervisory signaling capability of a terminal unit and for this reason the key is arranged so that the six trunk circuits are made busy and the 20A testboard alarm is activated when it is operated to the TEST position. The TBL lamp on the supervisory signaling circuit continues to indicate the presence of trouble conditions, as usual, when the TEST key is operated.

5.08 One of the test points on the supervisory signaling circuit provides a means of causing the multiplexer portion of the circuit to generate a 95.5-bit-per-second dotting signal instead of the usual 9-bit binary word. Grounding the test point (DG) activates the dotting generator function. This feature is useful when a standard signal is needed for proper adjustment of the BIAS control on circuit package 8 (CP8) of the supervisory signaling circuit.

6. EQUIPMENT ARRANGEMENT

6.01 Most of the equipment packaging of the B1 data carrier terminal circuits is done on removable printed wiring board assemblies that are referred to as circuit packages. (CPS). Each board is 1/16 inch thick, approximately 5 inches wide, and 8-1/2 inches long. They have printed wiring on one side and one end is formed into a 20-terminal plug that mates with a 906B connector. The boards are riveted into extruded aluminum frames which are designed to be wide enough so that none of the circuit components protrude beyond the frame. The three frame widths used are 0.550, 0.850, and 1.150 inches. A faceplate is attached that is the same width as the frame and about 1/2 inch longer at each end. Spring-loaded, 1/4-turn fasteners are provided to secure the CP in the equipment tray. Test points are mounted in the faceplate and a knob is provided for easy removal of the CP.

6.02 The equipment tray is fabricated from aluminum sheet metal. It has two side plates, a top, and a bottom. The front flanges have slotted holes to engage the quarter-turn fasteners on the CPs. The rear flanges mount the 906B connectors. The inside tray dimensions are about 5 inches high by 21 inches wide by 8 inches deep. The outside dimensions are about 6 by 23 by 9 inches. It is designed to mount in a standard 23-inch No. 5 crossbar frame.

6.03 A fully equipped 11-foot 6-inch B1 data carrier terminal frame mounts six data carrier terminal units (DCTU). The frame layout is shown in Fig. 1. DCTU-0 is mounted on the bottom above the fuse panel. DCTU-5 is mounted on top, directly below the carrier supply unit.

6.04 A DCTU contains three trays of equipment and is shown in Fig. 3. The bottom tray contains the supervisory signaling circuit which is made up of 23 CPs and a 620B filter which is also a plug-in CP. The middle tray can hold six channel circuits (less their filters) and a line circuit. A channel circuit consists of three CPs. The line circuit is a single CP which is common to all six channels. Any channel CP is interchangeable with any other similarly designated channel CP. The third tray contains the +12 volt power supply and the six channel circuit filters. The power supply is a plug-in unit and uses about 6 inches of horizontal mounting space. Each channel filter is housed in a hermetically sealed can having dimensions of 2 by 6.2 by 7.8 inches. These are stacked three in a column and are stud mounted to the rear of the tray and permanently wired in the circuit. Although the DCTU may not be fully equipped with channel circuits, the filters are always provided.

6.05 The carrier supply circuit is a 2-tray unit consisting of A and B carrier supplies and is shown in Fig. 4. The lower tray is carrier supply A. Except for the 621A and B filters, both trays are identical and supply the six DCTUs on the frame. All of the CPs are plug-in units. There is a wire-spring relay and a resistor distributing card mounted within each tray that are not removable.

6.06 Directly above the carrier supply unit are three 251F terminal strips and a wire spring relay. This relay is part of the fuse alarm circuit which is mounted at the bottom of the

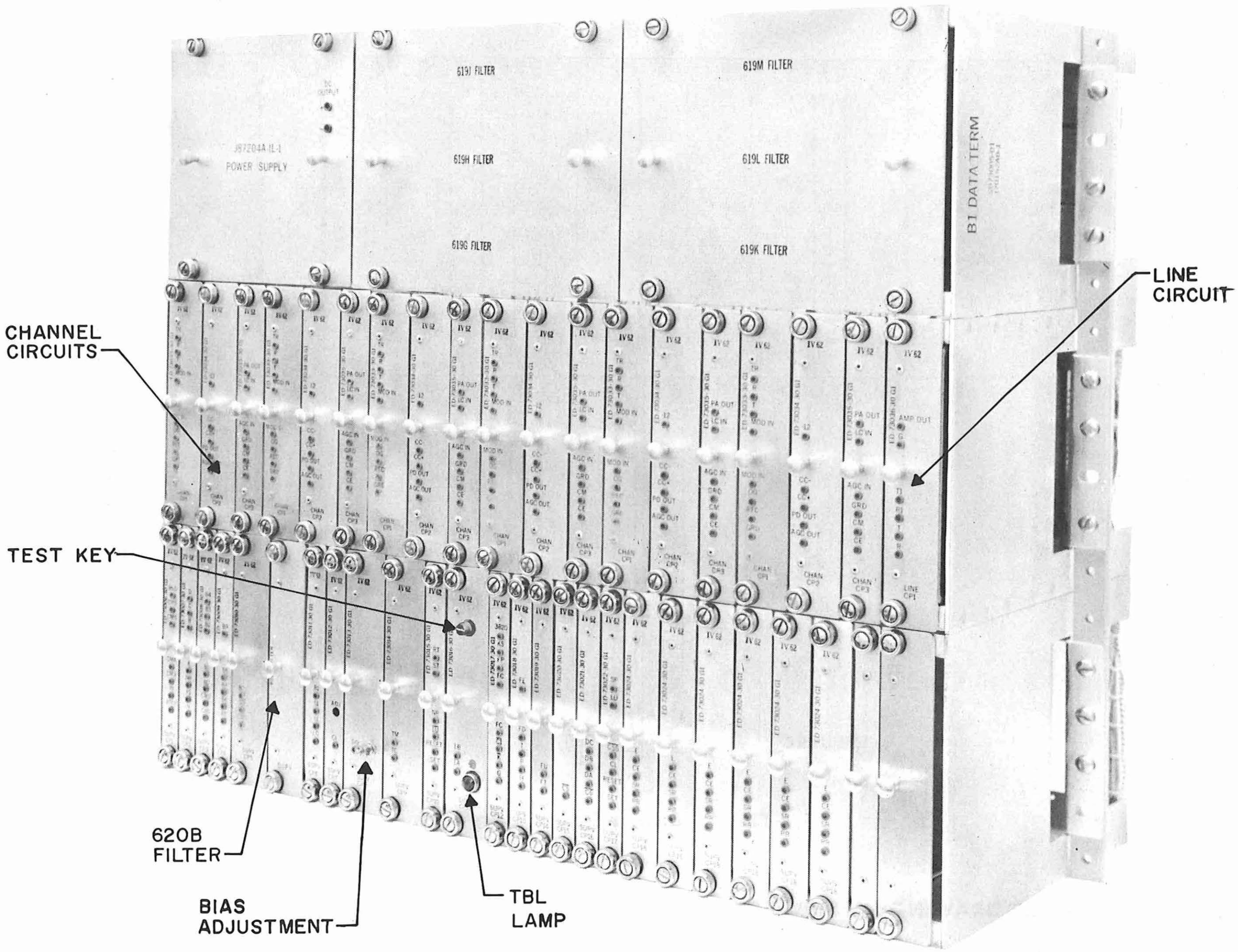

Fig. 3 – B1 Data Carrier Terminal Unit

frame on the fuse panel assembly. The red fuse alarm lamp is mounted on the left side of the frame base and a 3-pronged appliance outlet is provided on the right.

6.07 On the front right vertical frame column is mounted a key, lamp, and jack strip. The assignment on this strip is as follows: (a) the two lower positions are the telephone jacks, (b) the next four positions are the test frequency jacks, (c) after a blank position are the ACMJ and ACMN keys (major and minor alarm cut-off keys), and (d) the top two positions are the carrier supply alarm lamps CSA and CSB.

6.08 The DCTUs are the only units that are not part of the common equipment on this frame but are ordered on a job basis. However, the frame is equipped with a local cable that provides the frame wiring for six DCTUs. Intra-office connections are made at the top of the frame on the terminal strip assembly.

6.09 The −48 volt battery and ground is brought into the frame from the overhead distribution network. These wires are run inside the vertical column and are connected at the fuse panel assembly at the bottom of the frame. A vertical ground bus (No. 6 wire) that is insulated from the frame is provided on the right rear side.

6.10 The color of the frame, trays, and card faceplates is light grey (525A). A fully equipped DCTU weighs 84 pounds. The carrier supply unit weighs 42 pounds. The fully equipped frame will not exceed 750 pounds.

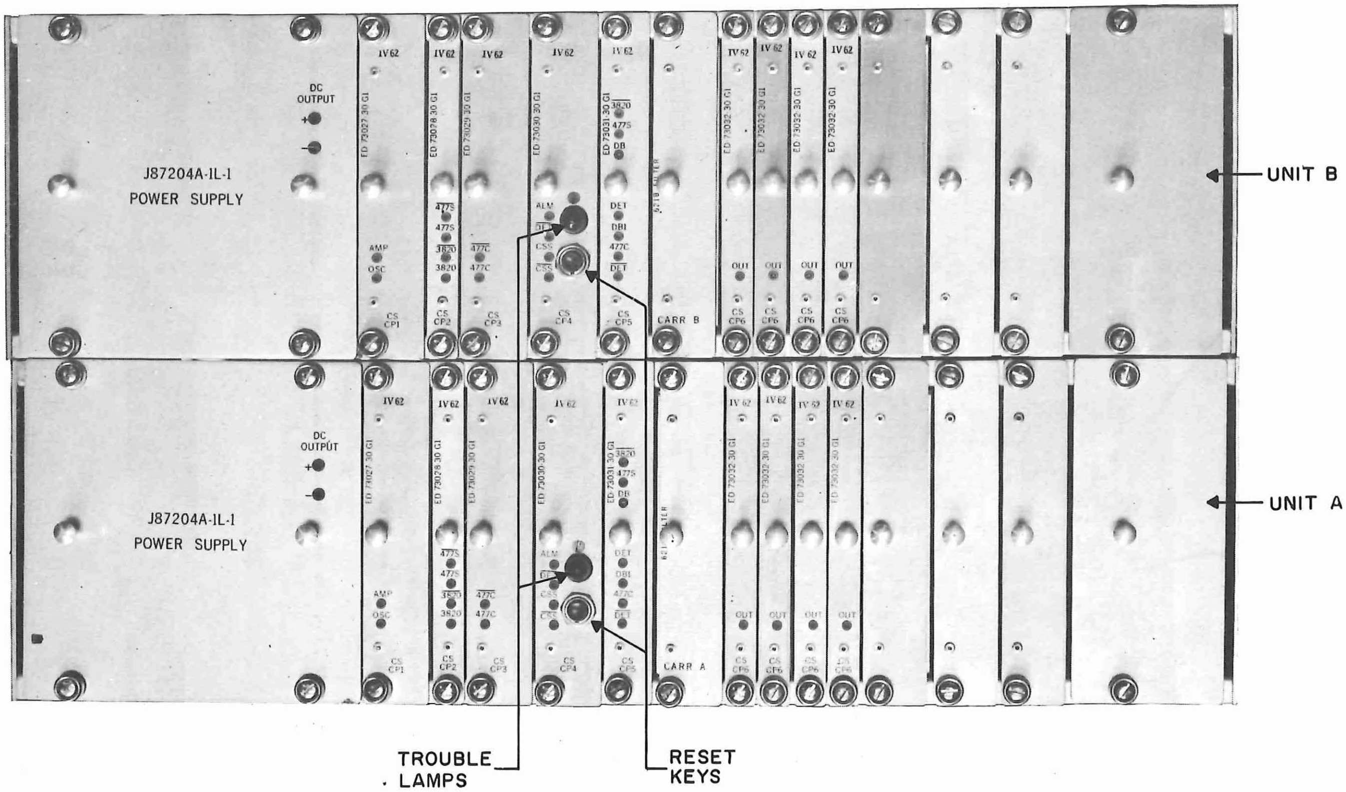

Fig. 4 – Carrier Supply Circuit

7. LIST OF CIRCUIT DRAWINGS AND BSP SECTIONS

CIRCUIT	CIRCUIT DRAWING	SECTION
B1 Data Carrier Terminal		
Channel	SD-73016-01	314-017-150
Supervisory Signaling	SD-73017-01	314-018-150
Carrier Supply	SD-73018-01	314-019-150
Line	SD-73019-01	314-017-150
Application Schematic	SD-73020-01	
Power Supply	SD-81608-01	
Frequency Shift Pulsing		
Transmitting	SD-99300-01	
Receiving	SD-99301-01	
Outgoing Sender	SD-27624-01	
Incoming Register	SD-27625-01	
Test		
906A Data Distortion Test Circuit	SD-73022-01	314-016-161
908A Circuit Logic Test Set	SD-73021-01	100-171-101
Toll Testboard No. 20A	SD-56535-01	314-016-160
Call Progress Tone Generator	SD-81611-01	167-725-306
Extender	SD-73025-01	

8. FOUR-WIRE VOICE-BAND FACILITIES

8.01 This section discusses the voice-band facilities that are used to interconnect B1 data carrier terminals. A typical facility is shown in Fig. 5. The 4-wire facilities are arranged to transmit B1 data signals without appreciable distortion. Low distortion is achieved by the addition of equalizers and by keeping the number of facility sections to a minimum (facility section: cable facility over 1.2 miles or carrier channel). A brief description of the types of recommended facilities is given in this section. A more detailed treatment of the transmission considerations that have to be used in engineering B1 facilities will be found in the AB83.060 series.

Carrier Channels

8.02 The major portion of the facilities consists of voice-band carrier channels of the type used in the standard intertoll plant. Specifically, synchronized carrier systems using A-type channel banks are recommended. Such systems include K carrier, L carrier, L multiplex on radio, etc. In addition, short-haul carrier systems such as N1 and ON can be used on B1 data trunks that have one or both terminals in a WADS secondary office. Short-haul carrier systems should be engineered in accordance with Sections AB25.190.05 and AB25.191 to meet the message noise and impulse noise objectives of Section AB83.060.2. Where several carrier systems have to be connected in tandem to form a facility for B1 application, it is recommended that connection be made at supergroup or group frequencies, where possible, since this results in a lower distortion circuit.

Voice Frequency Extensions

8.03 The cable facilities that connect the line test and patch jacks of the 20A testboard to carrier channel are called voice frequency extensions. The length and make-up of these extensions depend on the geographical location of the WADS office. In some cases voice frequency extensions will consist of only a few hundred feet of office cabling while in other locations several miles of outside plant cable will be encountered. Longer extensions require repeaters and associated equalizers. Recommended cable facilities are nonloaded cable for short extensions and H44 loaded cable for longer extensions up to 10 miles. Above 10 miles the use of carrier is recommended.

Equalizers

8.04 The B1 data carrier requires facilities that can pass a band of frequencies from 300 cps to 3250 cps with little distortion. To meet this requirement most carrier channels require equalization at the lower and upper ends of the voice frequency spectrum. As shown in Fig. 5, equalizers are inserted between the voice frequency extension and the carrier channel. The number and types of equalizers (envelope delay and sometimes attenuation) depend on the number and types of carrier channels used in the connection. In addition to carrier channels, long voice frequency extensions also require equalization. A description of equalizers and their application to B1 data facilities will be found in Section AB83.060.3.

9. DATA CHANNEL CHARACTERISTICS AND LIMITATIONS

Channel Attenuation Characteristic

9.01 Fig. 6 shows the typical attenuation characteristic of a data channel as measured through two B1 data carrier terminal units. The useful data band extends out about ±125 cycles from the center of the data channel. However, the most important frequencies are the marking (+100) and spacing (−100) frequencies. It will be noted that in this typical characteristic there

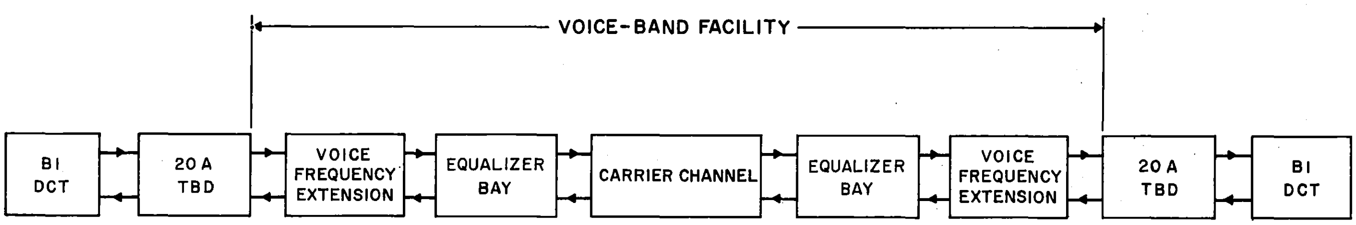

Fig. 5 – Typical Connection Between Two B1 Data Carrier Terminals

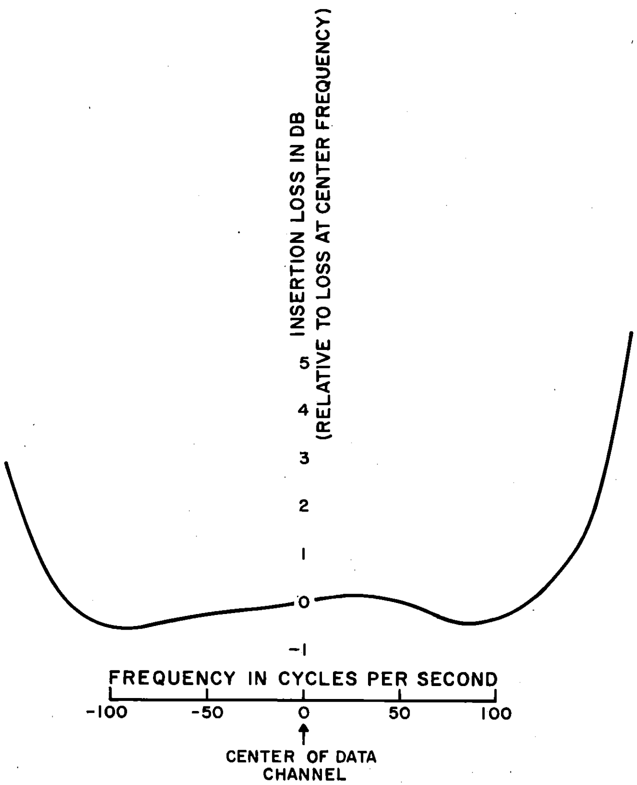

Fig. 6 — B1 Data Carrier Terminal, Typical Channel Loss Characteristics

is about 0.2-db difference in attenuation at these two points. The characteristic shown is controlled, almost entirely, by the channel filters in the terminals and thus these characteristics will vary as the filters vary. Differences between filters will produce changes of the order of a few tenths of a db in the relative loss characteristic.

Channel Delay Characteristic

9.02 Fig. 7 shows the typical envelope delay characteristic of a data channel as measured through two B1 data carrier terminal units (identified by the word COMBINED). In the same manner as for the attenuation characteristic, the delay characteristic is controlled by the channel filters in the terminals. It will be noted that the delay distortion between the marking and spacing frequencies is about 250 microseconds. In addition to the over-all or combined delay characteristic, the delay characteristics for the several filters which make up the channel filters are also shown in Fig. 7. It should be noted that the transmitting No. 2 filter includes delay equalization which compensates for the delay distortion in the transmitting No. 1 and receiving filters.

Attenuation and Delay Distortion in the Line Facility

9.03 The characteristics mentioned in 9.01 and 9.02 have been measured on a back-to-back basis without line facilities. Any distortion in these facilities will add algebraically to the distortion in the terminal and in most cases will exceed it. As indicated in Part 8, the facilities will be equalized. It is the intent that on the longest connections involving three tandem switched trunks and long subscriber lines, the delay distortion will rarely exceed ±1.5 milliseconds between the marking and spacing frequencies. Similarly, the attenuation distortion will not exceed ±3 db.

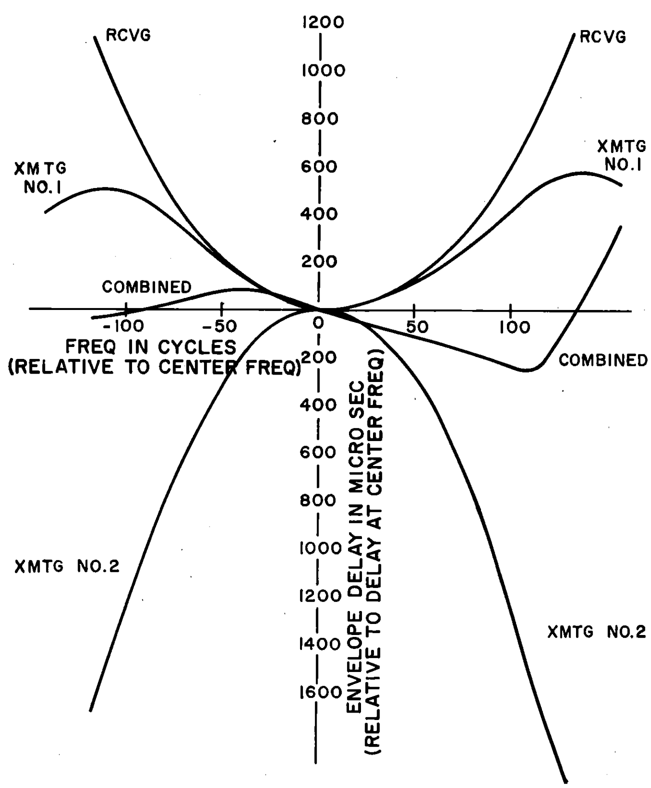

Fig. 7 — B1 Data Carrier Terminal, Typical Channel Delay Characteristics

Noise Considerations

9.04 The most serious producer of data distortion is circuit noise. Noise on message circuits which could hardly be detected by a listener will cause data distortion and, if it has sufficient magnitude, will produce errors. In those cases where the noise encountered is white noise, the signal power must exceed the noise power in the narrow data band by more than 20 db for good data transmission. Impulse noise is also important and in many cases may be a controlling factor with regard to data transmission performance. For details relative to the noise requirements for the line facilities see Section AB83.060.

Input Level Operating Range

9.05 The B1 data carrier terminal may receive its input signals from a large variety and length of connecting circuits. This means that the data signal power applied to the B1 data carrier terminal will vary considerably depending on the nominal loss of the connecting circuit and its variations. Connections to B1 data carrier terminals involving remote exchange subscriber access lines or TWX subscribers connected via the DDD network are typical of cases presenting low nominal data signal power with wide variations. It is expected that the input signal power for f_1 and f_2 will have values in accordance with Table B.

9.06 An automatic control of the gain in the transmitting side of the terminal is provided to compensate for these signal power variations and thereby provide the highest margin between the signal and line noise permitted by the line facility which is used between the data terminals. A typical characteristic for the AGC is given in Fig. 8. The three sigma limits corresponding to the signal power figures given in Table B are indicated below the input-output characteristic.

TABLE B

NOMINAL SIGNAL LEVELS

DATA BAND	SIGNAL POWER AT THE INPUT TO THE B1 DATA CARRIER TERMINAL UNIT			
	NOMINAL & STD DEVIATION			
	dbm			
	maximum*		minimum*	
f_1	−18	2.3	−21.7	3.4
f_2	−13	2.3	−18.7	1.8

* Maximum refers to the condition where the data set output is adjusted 1 db high, and the connecting circuits do not include remote exchange subscriber access lines or connections through the DDD network. Minimum refers to the condition where the data set output is adjusted 1 db low and the connecting circuits do include connections through the DDD network.

Over-All Net Loss

9.07 The over-all net loss of a data channel in the B1 data trunking system, at nominal input (−19 dbm for f_1 and −14 dbm for f_2) and excluding line facility variations, is 0 db with standard deviation of 1.0 db. When the input increases, the net loss increases by almost an equal amount as determined by the AGC characteristic. Loss changes in the line facilities will add to the net loss of the terminals. However, except in the last B1 data trunk, these changes are corrected in the AGC circuits associated with the following data trunk.

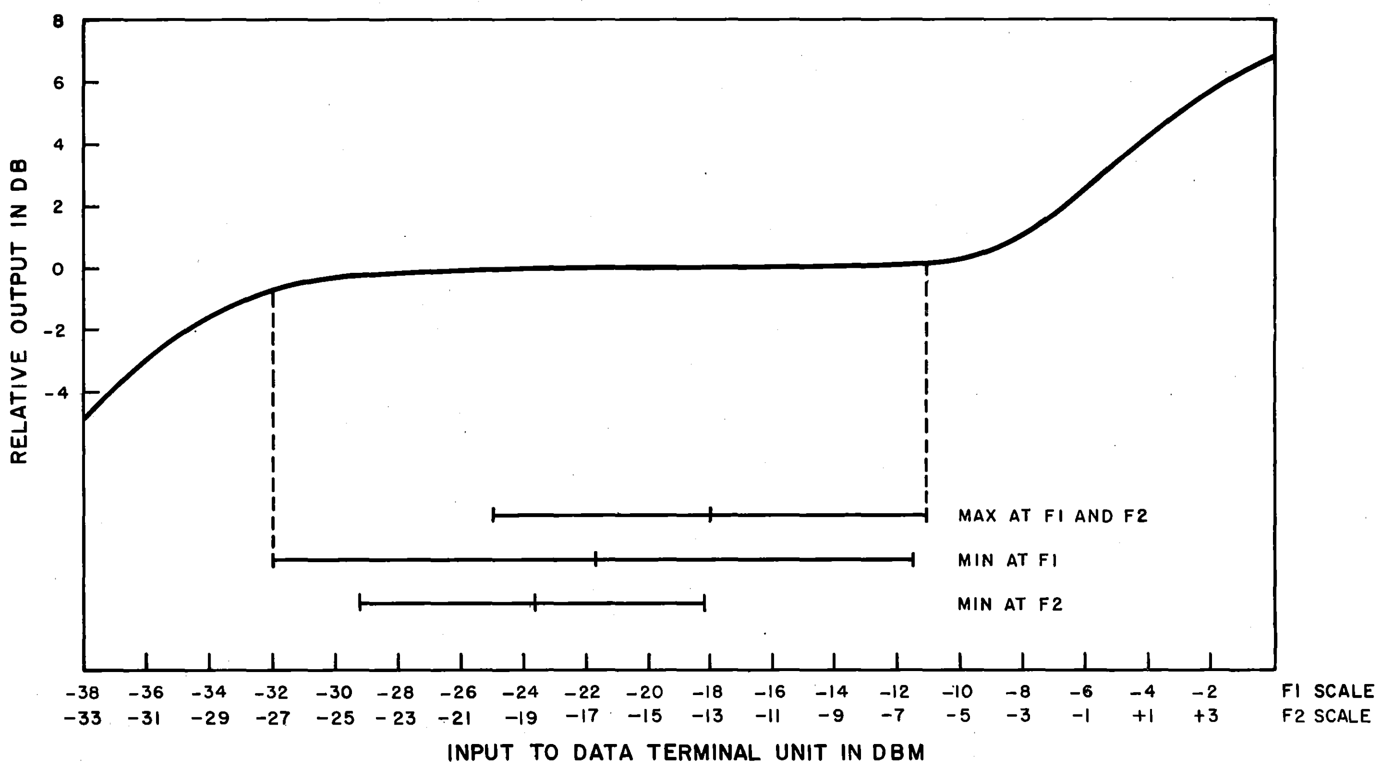

Fig. 8 – AGC Characteristics