

## WIDEBAND STATION USING DATA SET 303-TYPE ECHO-FOX UHF RADIO SYSTEM

### DESCRIPTION

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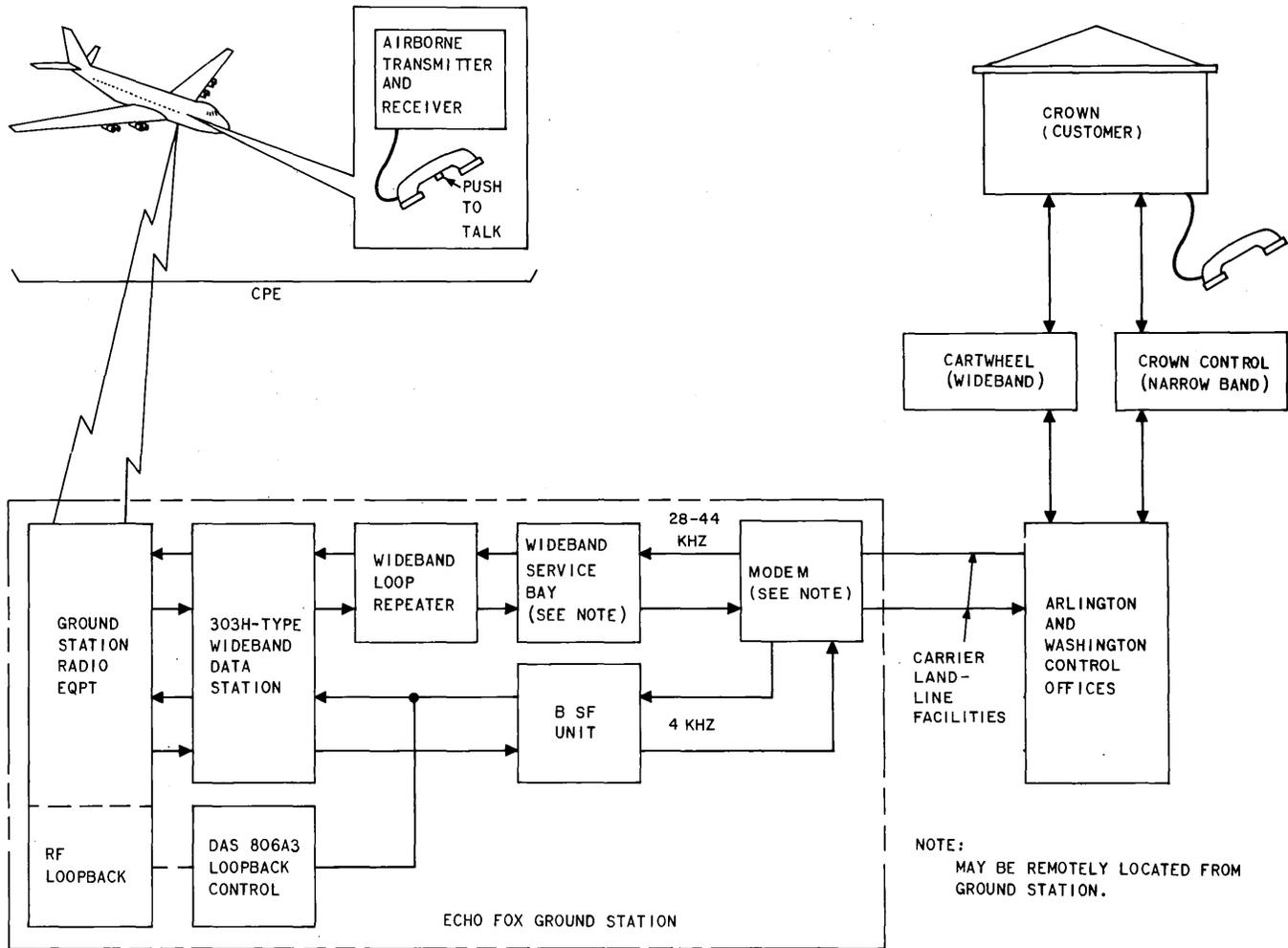
**1. GENERAL**

**1.01** The nationwide UHF air-ground Echo-Fox Radio System is a radio-telephone communications system designed to operate between designated airborne aircraft of the United States Government and a selected point in Washington, D. C. The present system consists of an airborne radio which can communicate with any ground stations located throughout the continental United States, which in turn are linked to Washington via telephone company facilities. All of the ground stations are equipped for full-duplex clear-voice operation (narrowband—4 kHz). In addition, approximately half of the stations are also equipped for full-duplex wideband encrypted-voice (data) communications with the aircraft.

**1.02** Switching facilities at the customer location (Crown) route outgoing narrowband messages through Crown Control; wideband messages are routed from Cartwheel to a concentrator switch in either of the two control offices (Arl 2 or Wash 1). The switch is controlled by the customer (Fig. 1). Calls are then routed through the Arlington or Washington telephone company control office, and over land lines to the appropriate ground station. The approximate location of the aircraft is generally known, and voice or data contact may be established by either the aircraft or the appropriate ground station.

**1.03** Calls from the in-flight aircraft are initiated by the calling party operating a push-to-talk button on the telephone handset, which keys the aircraft transmitter. When the transmitter is keyed, the first ground station receiver signal reaching the Crown Control console is used. Unused receivers are not cut through for the duration of a single transmission, or until the aircraft passes out of range of the receiver. Normally, receiver selection is automatic; however, ground control can manually select any desired receiver.

**1.04** The ground station consists of a radio transmitter and receiver interfacing with a 303-type Wideband Data Station and analog carrier facilities. Clear-voice facilities are provided to all stations, and provision is made for loop-back testing at the stations. Some remote unmanned clear-voice stations use Data Auxiliary Set (DAS) 806A2 for land-line loop-back, while the wideband stations use the DAS 806B7; both of these units use a 2800-Hz tone for looping back and restoring service. A DAS 806A3 is provided for RF loop-back; it uses a 2400-Hz tone. The data station serves as an interface between the land lines and the radio equipment and acts as a regenerative repeater, a data recognizer, and a control unit.



NOTE:  
MAY BE REMOTELY LOCATED FROM  
GROUND STATION.

Fig. 1—Echo-Fox Air/Ground Radio System—Block Diagram



*The terms TRANSMIT and RECEIVE must relate to some reference point. As used in this practice and related practices in this series, TRANSMIT (TRMT) refers to the aircraft-to-Washington direction; RECEIVE (RCV) refers to the Washington-to-aircraft direction. Also, illustrations in these practices generally are drawn with the aircraft-to-left, Washington-to-right concept, where applicable.*

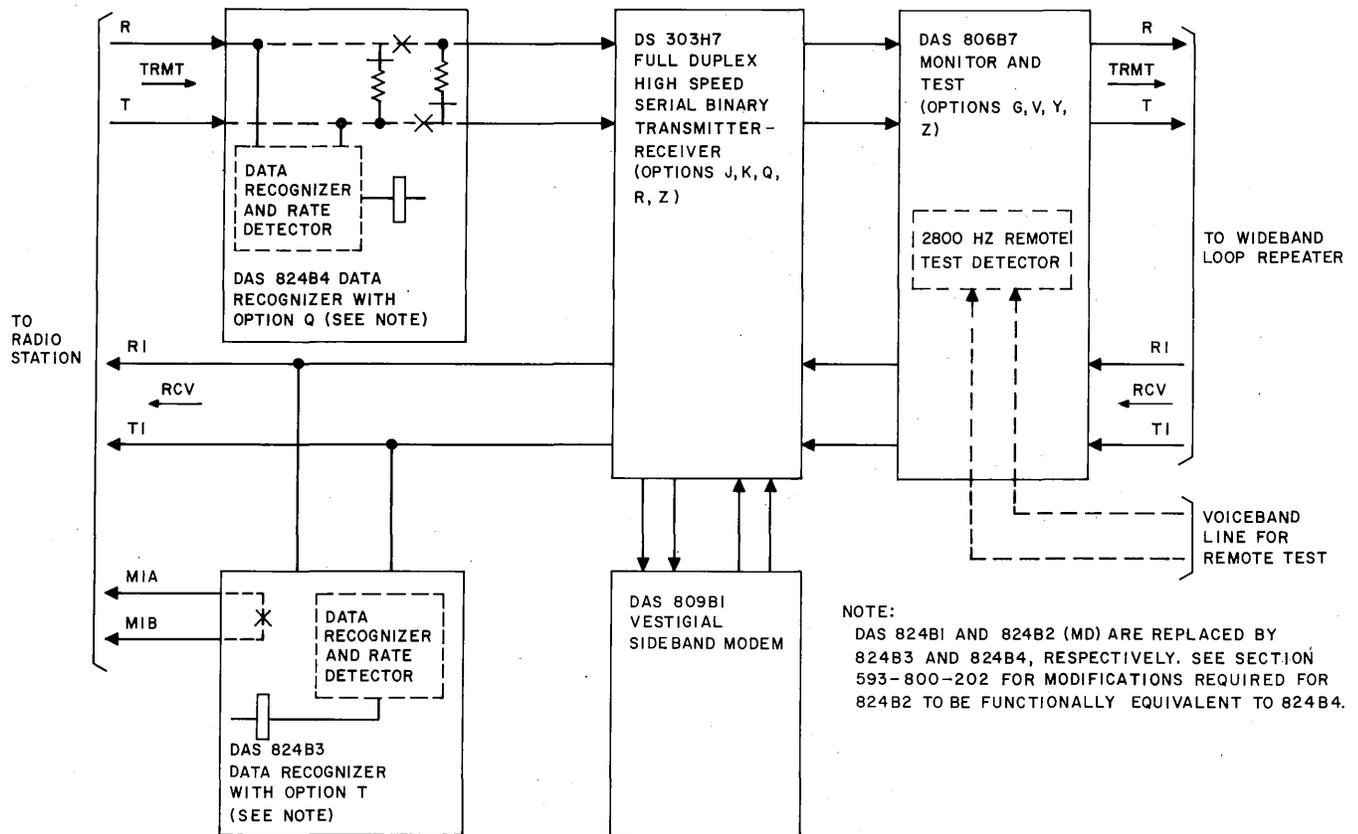
1.05 Portions of the system are customer-provided equipment (CPE) and are so identified in Fig. 1. This section covers only the wideband data station of the Echo-Fox System. Information

on other portions of the system may be found in the references listed in Part 3.

2. DESCRIPTION

2.01 The Echo-Fox 303-type Wideband Data Station (Fig. 2) consists of the following major components:

- DAS 824B1 or 824B3
- DAS 824B2 or 824B4
- Data Set (DS) 303H7
- DAS 809B1
- DAS 806B7



**Fig. 2—Echo Fox Wideband Data Station—Block Diagram**

#### DATA AUXILIARY SET 824B-TYPE

**2.02** Data Auxiliary Set 824B-type (Fig. 3) is designed to recognize 18.75 kilobit per second (kb/s) digital data signals. Upon receipt of such signals from the Washington station, the 824B1 or B3 provides a contact closure which operates a relay in the radio transmitter to transfer the system from the voice mode to the wideband mode.

**2.03** The 824B1 and B3 do not have internal power supplies; each one requires +18 Vdc and -18 Vdc at 300 mA, which is supplied by the associated DAS 806B7. The 824B2 and B4 are similar to the 824B1 and B3, except that they are equipped with a 26A power unit. Relay contacts in the 824B2 and B4 (with option Q) are in series with the wideband transmit line, and receive signals from the radio receiver.

**Note:** The discussion herein covers the DAS 824B3 and 824B4 data recognizers. This also applies to DAS 824B1 and 824B2 (rated MD) *after* they have been modified as outlined in Section 593-800-202. Future installations should be equipped with the DAS 824B3 and 824B4, which are the replacements for the 824B1 and 824B2, respectively.

**2.04** There are two circuit packs (CPs) in the DAS 824B-type, as follows:

- AR275 data recognizer
- AR276 data rate detector

**2.05** The data recognizer (Fig. 4 and 5) consists of a balanced differential amplifier, a differentiator, a pulse-forming network, and a slot filter. The balanced differential amplifier in the

**SECTION 593-800-102**

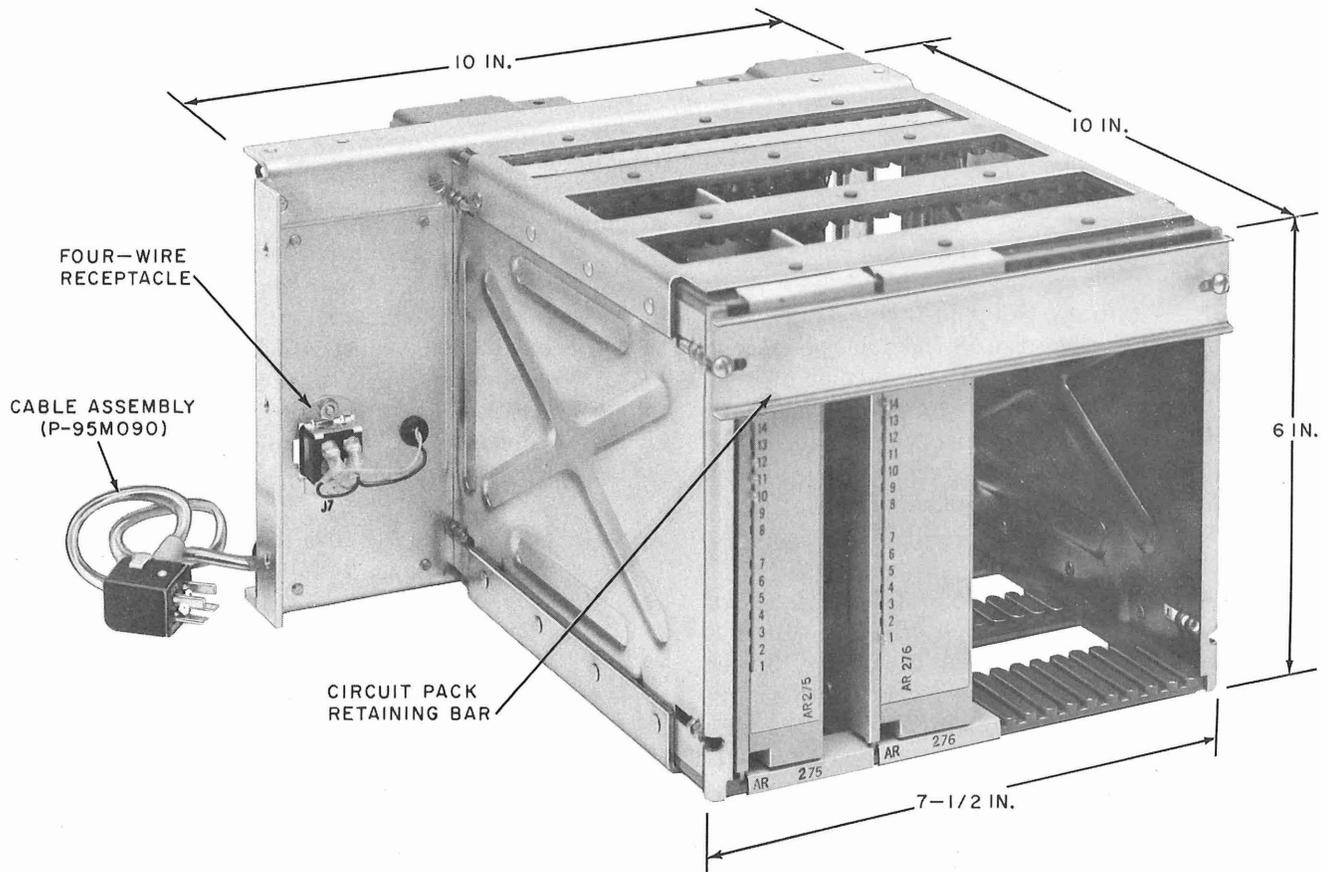
DAS 824B-type monitors the data line for presence of 18.75 kb/s data. Output of the differential amplifier is essentially a square wave with sharp leading and trailing edges. RC circuits differentiate the signal, and diodes pass only the positive spikes. These spikes are applied to a univibrator circuit, which generates an output pulse for each input spike. Since there is a positive spike corresponding to both the leading and trailing edge of the input pulse, there are two output pulses from the univibrator for each input pulse to the data recognizer.

**2.06** The slot filter provides a narrow passband centered at 18.75 kHz. The slot filter monitors the period of the applied pulses and responds to the 18.75 kHz sinusoidal component of a random sequence.

**2.07** The data rate detector consists of a voltage doubler, an isolation diode, an integrator, a darlington circuit, a schmitt trigger, two level-shift

diodes, a relay driver, and a relay. The voltage is doubled by a C-CR voltage doubler circuit and applied to the integrator circuit, where capacitors are charged in small increments by the positive pulses. The darlington circuit acts as a buffer between the integrator circuit and the level detector (schmitt trigger). The schmitt trigger acts as a switch to prevent the relay driver from turning on until there is a signal out of the level detector. A positive output signal from the level detector turns on the relay driver, which actuates the relay. Voiceband signals, at any level, will not operate the relay.

**2.08** For Echo-Fox application, option T is required in DAS 824B1 or B3 to provide a contact closure which transfers the radio transmitter from the narrowband mode to the wideband mode. Option Q is required in the DAS 824B2 or B4 to remove a termination from the wideband transmit line in the presence of data.



**Fig. 3—Data Auxiliary Set 824B-Type—Front View**

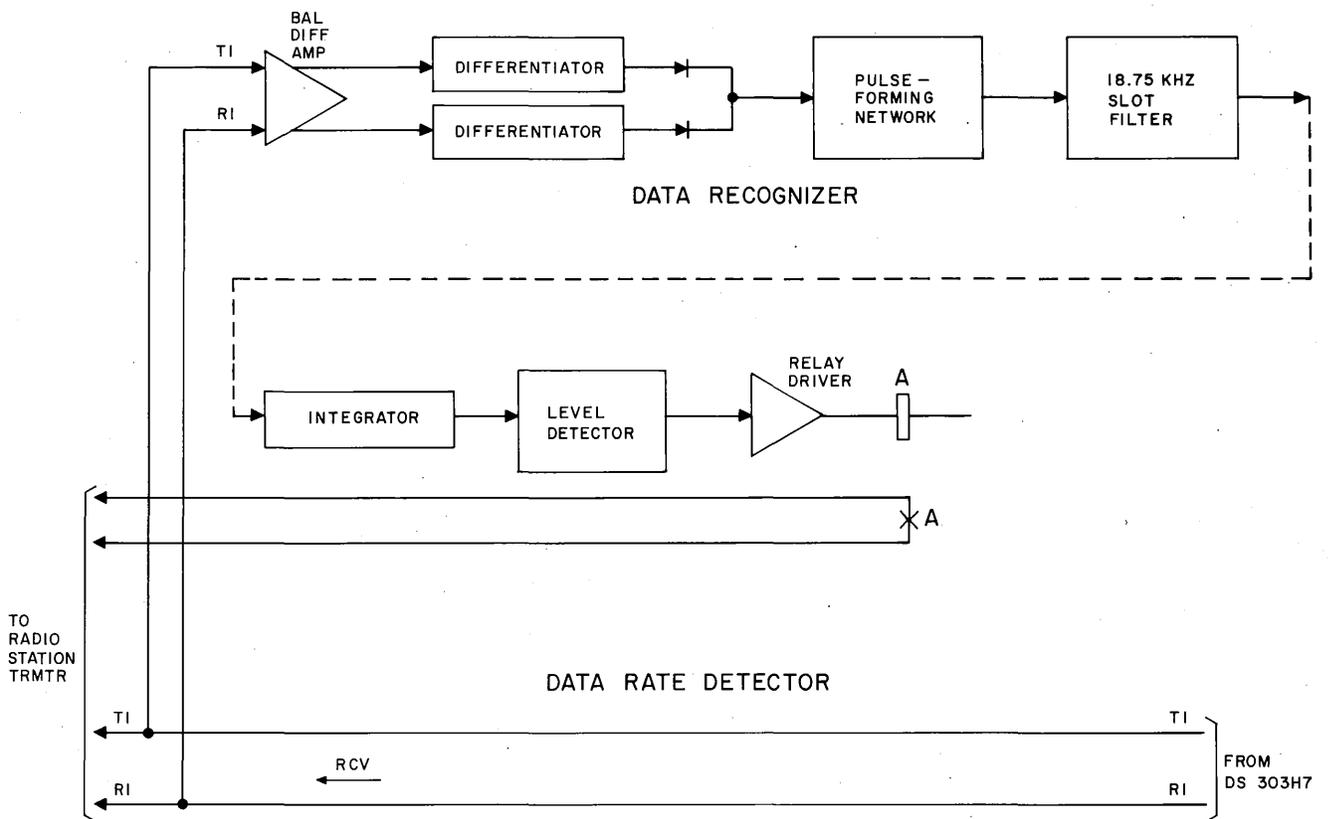


Fig. 4—Data Auxiliary Set 824B1 or B3 With Option T—Functional Diagram

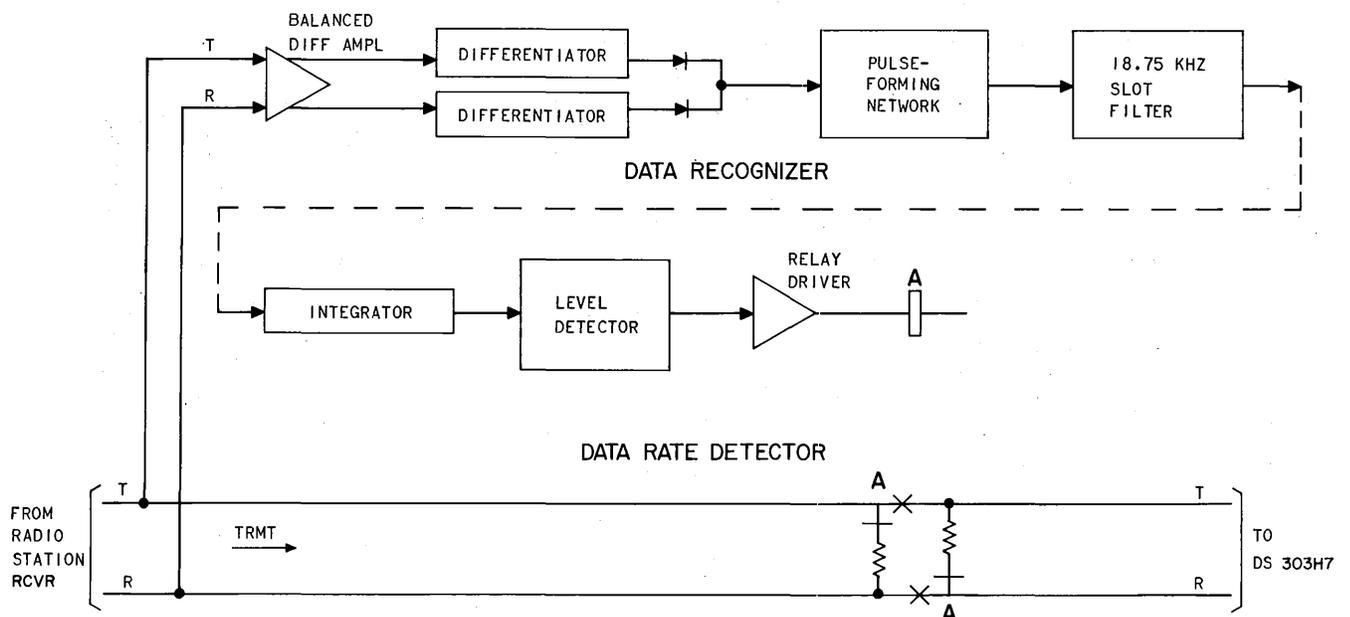


Fig. 5—Data Auxiliary Set 824B2 or B4 With Option Q—Functional Diagram

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**Note:** Remember that the DAS 824B3 and B4 are alike, except that the 824B4 contains its own power supply. Either one could be strapped to provide option T or option Q, but in the Echo-Fox application DAS 824B4 is strapped for option Q (relay contacts in series with transmit line).

**2.09** For further details on DAS 824B-type, refer to the section entitled Data Auxiliary Set 824B-Type—18.75 Kilobit Data Recognizer—Description (598-060-101), and CD-1D134-01.

**DATA SET 303H7**

**A. General**

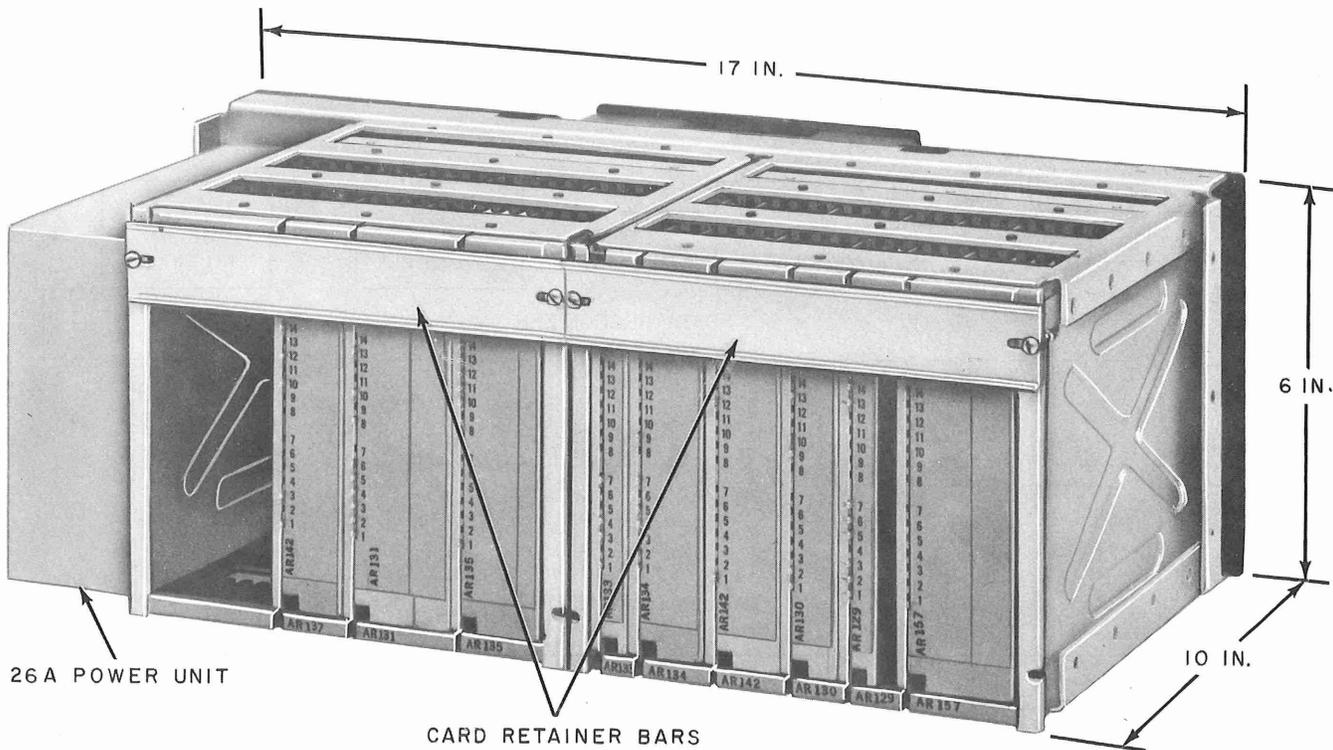
**2.10** Data Set 303H7 has the following features and characteristics:

- Synchronous operation
- 18.75 kb/s speed
- Internal transmit clock
- Rolloff filter (see note)

- Operates on half-group facilities
- Internal scrambler-descrambler
- Balanced interface
- Restored polar signal
- Uses 9A2 Data Mounting
- Signal control
- Receiver and automatic gain control (AGC)

**Note:** Initially, the Echo-Fox system was equipped with a 50% rolloff filter in DS 303H7. This filter (coded CP AR157) has been rated MD, and is replaced by a 100% rolloff filter (coded CP AR413). Either filter will perform satisfactorily in the Echo-Fox system.

**2.11** The DS 303H7 (Fig. 6) employs restored polar-type balanced interface synchronous signals. The data set accepts high speed on-off baseband signals, and conditions these signals for optimum transmission performance over telephone



**Fig. 6—Data Set 303H7—Front View**

facilities by removing the dc component from the signal and attenuating the low frequencies. Received high speed signals are reconstructed into suitable form by the data set. This process is known as restored polar transmission. An additional modulation step is performed by the vestigial sideband (VSB) modem DAS 809B1 to permit operation over a half-group portion of the analog facility.

**2.12** The following CPs are used in the 303H7:

- AR157 or AR413 rolloff filter (see note following 2.10)
- AR307 AGC
- AR130 receiver
- AR241 sync recovery and signal regenr (2)
- AR134 scrambler-descrambler (A&M)
- AR133 signal control
- AR136 balanced interface
- AR131 transmitter and line interface

**Note:** The DS 303H7, *without* suffix A, is provided with option ZA (AR134) which is rated additions and maintenance (A&M). The same set, *with* suffix A, is provided with option ZB (16A1 Data Unit). It is expected that the Echo-Fox system will continue to use DS 303H7.

#### B. Functional Description

**2.13** Signals from DAS 824B2 or B4 are applied to the sync recovery and signal regenerator AR241 (Fig. 7), and then to the signal control AR133. The signal is then applied to the sampler, where it is compared with a clock for timing the scrambler. The scrambler serves to randomize the binary signal train, thus preventing application of a strong single-frequency signal on the line, such as would occur if a dotting signal were

transmitted. The scrambler breaks up the signal into a quasi-random pattern and spreads the signal energy uniformly over the passband. The descrambler in the receiving circuit restores the original data signal.

**Note:** The scrambler-descrambler process should not be confused with the encrypting process employed by the customer at the point of origin of the communication.

**2.14** The clock frequency is supplied internally by option Z wiring (TB2 terminals 10 and 11 strapped).

**2.15** The signal is fed from the sampler through the scrambler, then into the signal logic gate. From the signal logic gate the signal goes to the transmitter, through the VSB modulator 809B1, and then through the roof filter and amplifier. The roof filter serves to reduce out-of-band signal energy before the signal passes through an impedance-matching transformer and to DAS 806B7.

**2.16** Received signals from DAS 806B7 are coupled through an impedance-matching transformer through the VSB receiver of DAS 809B1, then to the roll-off filter. The roll-off filter eliminates out-of-band noise and shapes the signal to reduce interference.

**2.17** Output from the roll-off filter is applied to the AGC circuit, and then to the receiver. The AGC and the receiver operate as a closed loop to regulate amplitude variations in the received signal. The receiver reinserts the dc and low-frequency components of the signal which were removed by the transmitter.

**2.18** From the receiver, the signal passes through a second sync recovery and signal regenerator (AR241), through the signal control and descrambler, then to the RD gate and limiter, and then to the cable driver through a transformer to DAS 824B1 or B3; the data interface is balanced on the receive pair.

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**2.19** The following options apply to DS 303H7 in the Echo-Fox application:

OPTION	FUNCTION
J	Provides squelch feature. <i>Do not use</i> Y option.
Q	Free-running scrambler
R	Supplies permanent send request to VSB unit
Z	Internal transmitter clock
ZA (A&M)	CP AR134 scrambler-descrambler

**2.20** For further details on DS 303H7, refer to the sections entitled Data Set 303-Type—Description (593-012-100) and Wideband Data Station Using Data Set 303-Type—Description and Operation (593-800-100).

### DATA AUXILIARY SET 809B1 (VSB MODEM)

#### A. Transmitter

**2.21** Data Auxiliary Set 809B1 (Fig. 8) converts the baseband data signals from DS 303H7 to a VSB spectrum in the 28- to 44-kHz range for transmission. The set also demodulates the received 28- to 44-kHz signals to the baseband frequency spectrum for presentation to the DS 303H7 receiver. A baseband local test (BLT) relay is connected between the input and the output of both the transmitter and the receiver to remove the VSB modem from the system for test purposes.

**2.22** Three CPs and four filters are used in the DAS 809B1 modem to accomplish VSB modulation and demodulation, as follows:

- AR113 transmitter
- AR112 receiver
- AR111 phase-locked loop.
- 387B filter (2)
- 744A filter (2)

**2.23** To obtain VSB modulation, a 59.2-kHz crystal-controlled oscillator is divided by 2 in a binary counter (Fig. 9). The counter supplies

two 29.6-kHz carrier signals, which are 180 degrees out of phase, to the switching transistors of a double-balanced modulator. Baseband signals from DS 303H7 pass through a low-pass filter which prevents foldover in the modulation process. The signal is then amplified and applied to the modulator input. The modulator output has an energy spectrum consisting of sidebands about all the odd harmonics of the carrier signal; the carrier itself is suppressed.

**2.24** A reduced level carrier signal and the modulator output signal are added by a summing amplifier.

**2.25** The summed signal next goes through a vestigial filter and equalizer which passes a small part of the lower fundamental sideband (the vestige), the carrier, and all of the upper fundamental sideband, with a symmetrical cutoff characteristic in the region of the carrier. The resulting spectrum is known as the VSB spectrum (Fig. 10). The signal is amplified and returned to DS 303H7 for further processing before passing through DAS 806B7 and to the analog transmission system.

#### B. Receiver

**2.26** The receiver in DAS 809B1 accepts incoming 28- to 44-kHz VSB signals and demodulates them to the baseband frequency spectrum (Fig. 9).

**2.27** The signal is attenuated, filtered, reshaped, and then amplified under control of an AGC circuit which holds the output within  $\pm 0.5$  dB for input variations of +6 to -12 dB.

**2.28** Next, the signal passes through a double balanced switched demodulator, which returns the 28- to 44-kHz signal to the original baseband frequency spectrum before being applied to DS 303H7.

**2.29** There are no wiring options applicable to DAS 809B1.

**2.30** For further details on DAS 809B1, refer to the sections entitled Data Auxiliary Set 809B1—Identification and Operation (598-034-100), and Wideband Data Station Using Data Set 303-Type—Description and Operation (593-800-100).

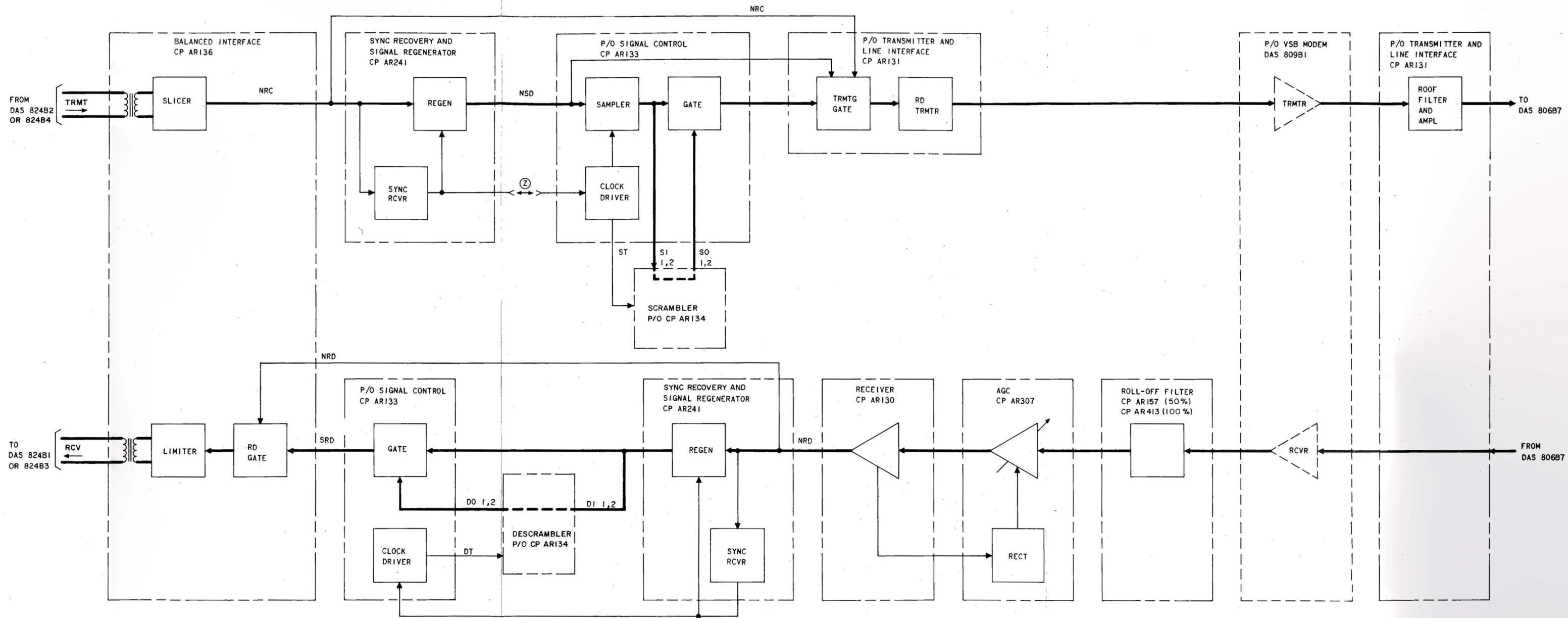


Fig. 7—Data Set 303H7—Functional Diagram

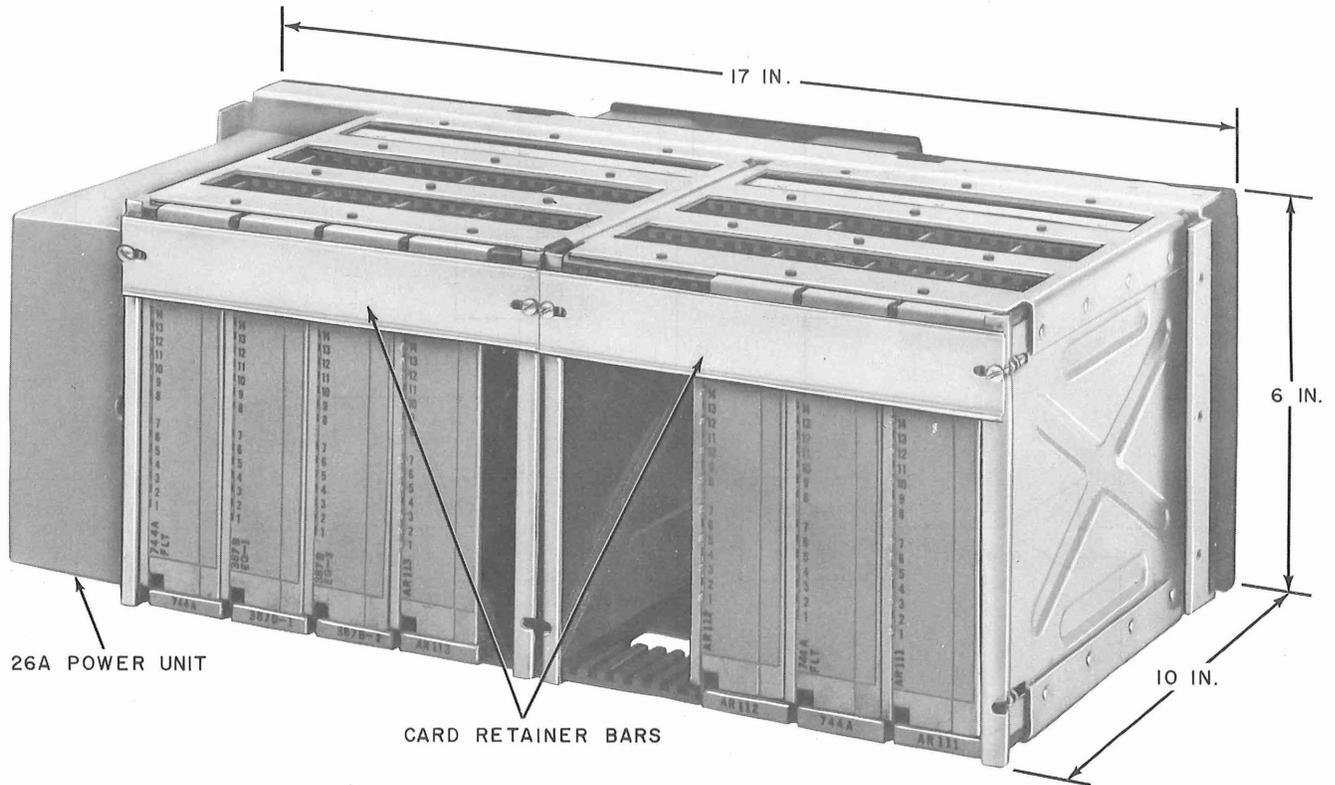


Fig. 8—Data Auxiliary Set 809B1—Front View

### DATA AUXILIARY SET 806B7

**2.31** Data Auxiliary Set 806B7 (Fig. 11) provides the capability at the data station for testing local loops and the data station. Line and equipment jacks and the necessary circuit board logic are provided to permit loop-back from the control office for remote testing (Fig. 12). Both wideband and voiceband lines pass through DAS 806B7. Remote loop-back tests are accomplished by applying 2800 Hz to the voiceband line from the control office.

**2.32** Access to the lines and equipment for test purposes is provided by the 10A2 Data Unit, which is a part of DAS 806B7. A 2800-Hz detector and a sequential relay circuit are provided to actuate loop-back relays for remote testing. Applying 2800 Hz from the control office to DAS 806B7 for at least 10 seconds and then removing the signal will loop back the lines only. A second application and removal of 2800 Hz will loop back on the far side of the data station, to permit remote testing

of the data set. A third application of 2800 Hz restores the data station to normal. ***The station must be returned to normal after loop-back testing; otherwise the circuit will be inoperative for customer use.***

**2.33** The nonlocking LRT key on the front of DAS 806B7 allows the data set to be looped back in the same manner as for remote tests. The LRT key must be depressed in the same sequence and for the same duration as specified for the remotely applied 2800-Hz signal.

**2.34** The data station is placed in the local test mode by turning the LT key. This operates relays which loop the wideband transmit pair to the wideband receive pair, so that the connecting data terminal equipment can send to itself. Also, relays are operated to isolate the facility from station equipment and terminate the wideband transmit and receive pairs into 135 ohms. Similarly, another relay performs these functions on the

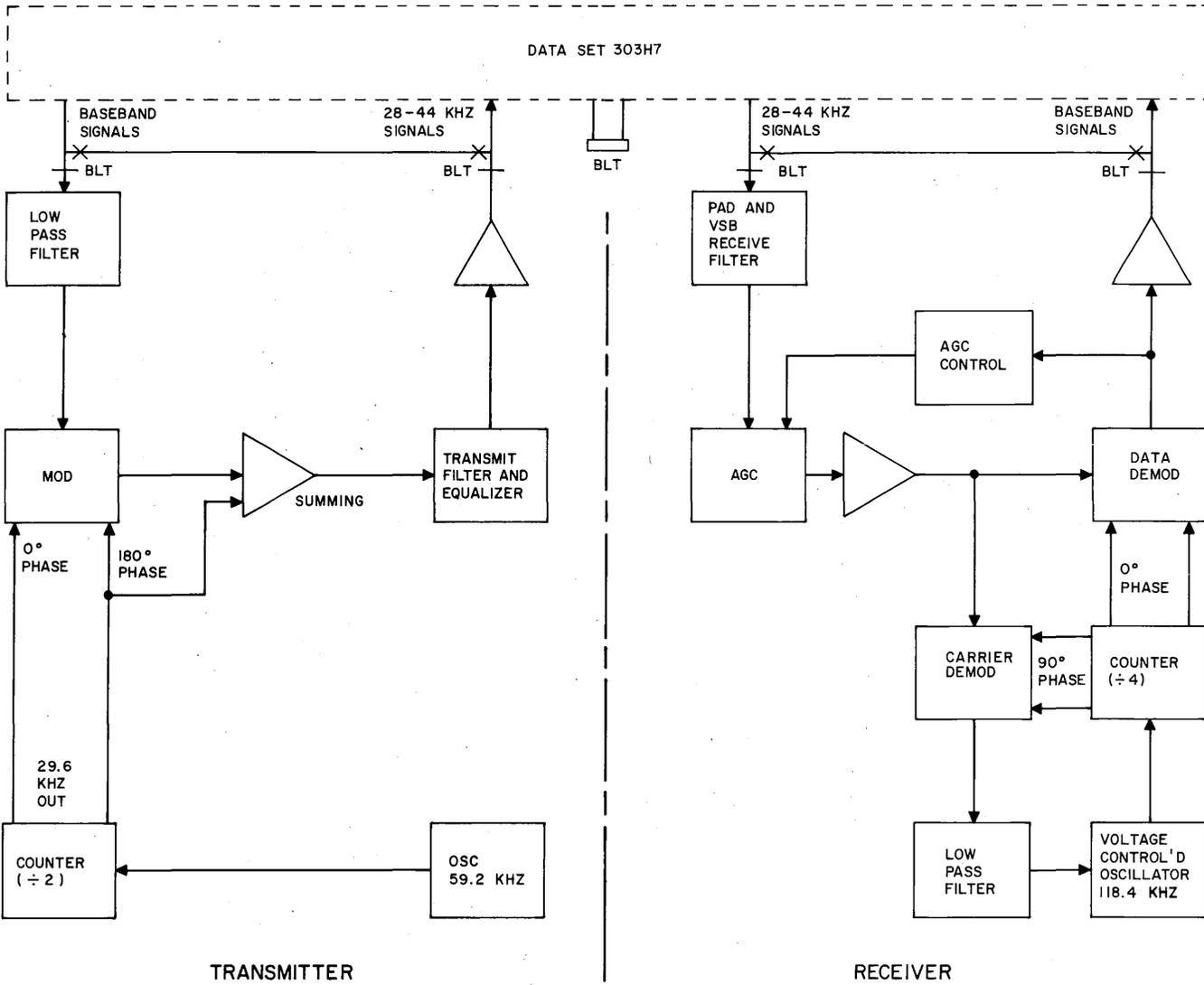
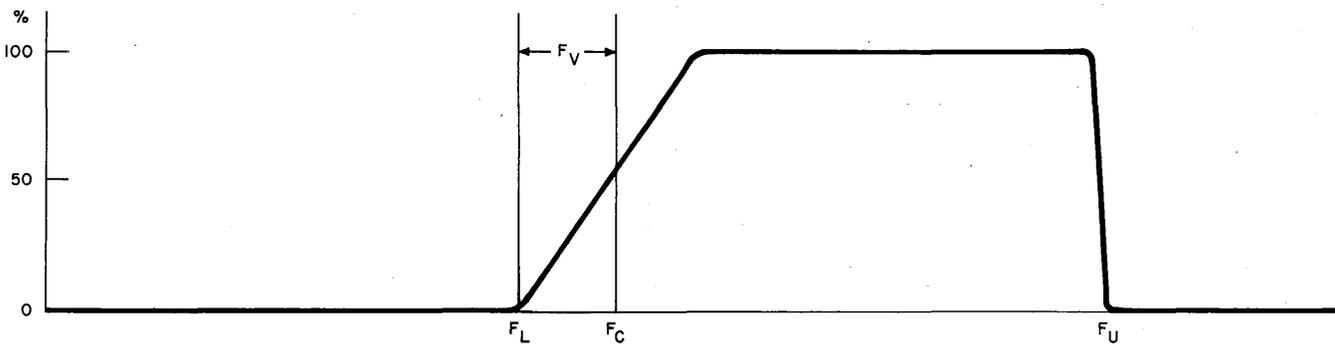


Fig. 9—Data Auxiliary Set 809B1—Block Diagram



LEGEND  
 $F_L$  = LOWER CUTOFF FREQUENCY  
 $F_C$  = CENTER FREQUENCY  
 $F_U$  = UPPER CUTOFF FREQUENCY  
 $F_V$  = VESTIGAL SIDEBAND

NOTES:  
 1. LOWER SIDEBAND IS ELIMINATED, EXCEPT FOR  $F_V$ .  
 2. FREQUENCY SCALE IS ARBITRARY.

Fig. 10—VSB Spectrum

voiceband facility. Operation of the BLT button while the LT key is operated actuates the BLT relay (Fig. 9), causing the DAS 809B1 to be bypassed. This bypass is removed when the LT key is returned to normal (horizontal) position. This feature permits the data station to be tested locally both at baseband and line frequencies to sectionalize trouble in DS 303H7 or DAS 809B1.

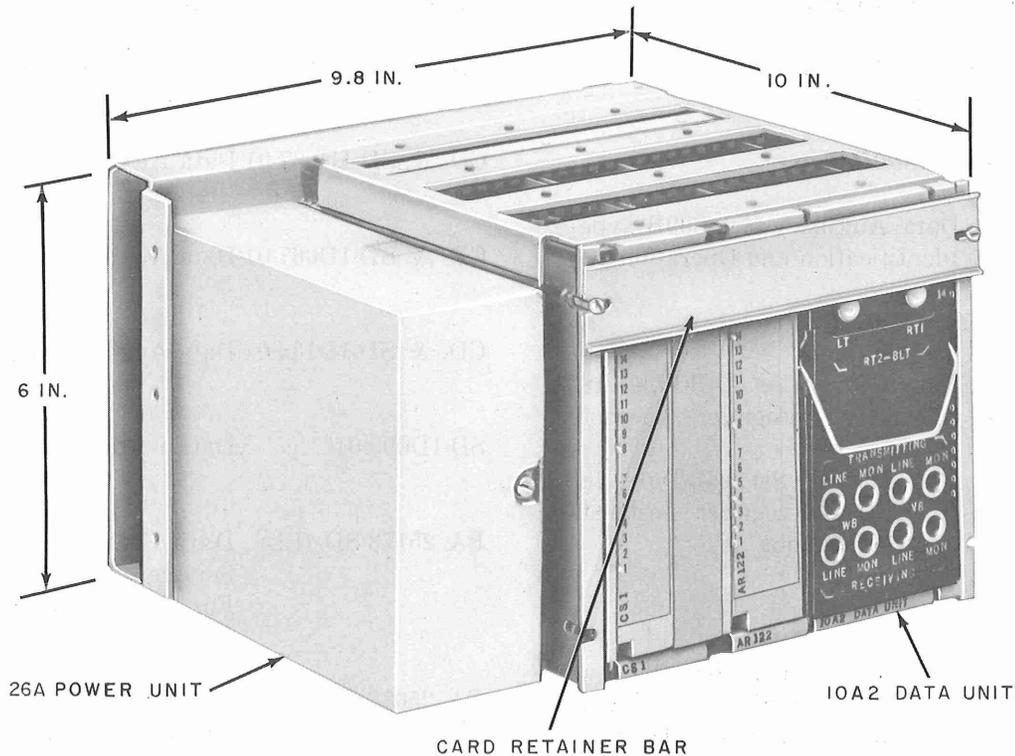
**2.35** The DAS 806B7 is provided with a +18 and a -18 Vdc power supply to energize internal circuitry. In addition, power is supplied to DAS 824B1 or B3, which has no internal power supply.

**2.36** The following factory-supplied options apply to DAS 806B7 in the Echo-Fox application:

OPTION	FUNCTION
G	Connects voice channel through DAS 806B7
V	4-wire voiceband circuit
Y	10-dB wideband transmit line pad
Z	Provides remote testing capability in the absence of a DAS 804-type.

**Note:** Options E, F, H, J, K, M, N, Q, R, S, T, W, and X are not required and should be removed if present.

**2.37** For further details on DAS 806B7, refer to the sections entitled Data Auxiliary Set 806B-Type—Identification (598-042-100) and Wideband Data Station Using Data Set 303-Type—Description and Operation (593-800-100).



**Fig. 11—Data Auxiliary Set 806B7—Front View**

**SECTION 593-800-102**

**3. REFERENCES**

**3.01** The following Bell System Practices provide additional information on the data set, data auxiliary sets, radio station, and associated equipment used in the Echo-Fox UHF Radio System.

<b>SECTION</b>	<b>TITLE</b>
<b>Data Set 303-Type</b>	
593-012-100	Data Set 303-Type—Description
593-800-100	Wideband Data Station Using Data Set 303-Type—Description and Operation
593-800-200	Wideband Data Station Using Data Set 303-Type—Installation and Connections
593-800-500	Wideband Data Station Using Data Set 303-Type—Test Procedures

**Data Auxiliary Set 806B-Type**

598-042-100	Data Auxiliary Set 806B-Type—Identification
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**Data Auxiliary Set 809B-Type**

598-034-100	Data Auxiliary Set 809B-Type—Identification and Operation
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**Data Auxiliary Set 824B-Type**

598-060-101	Data Auxiliary Set 824B-Type—18.75 Kilobit Data Recognizer—Description
598-060-201	Data Auxiliary Set 824B-Type—18.75 Kilobit Data Recognizer—Installation and Connections

**Radio Station**

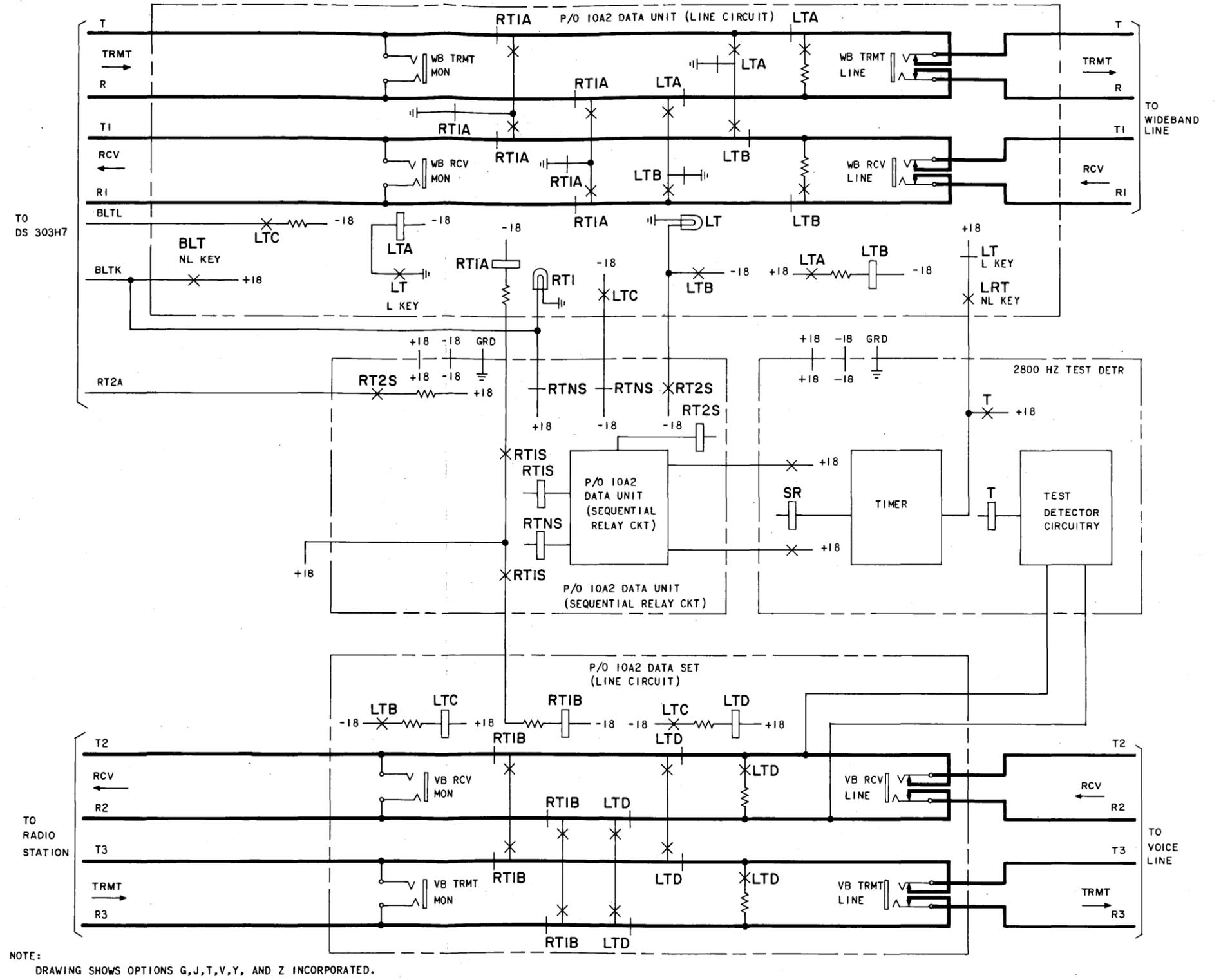
406-116-100	Air-Ground Radio Private Systems—Echo-Fox UHF Radio System—Overall System Description
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**Echo-Fox Data Station**

593-800-202	Wideband Station Using Data Set 303-Type—Echo-Fox UHF Radio System—Installation and Connections
593-800-302	Wideband Station Using Data Set 303-Type—Echo-Fox UHF Radio System—Maintenance
593-800-502	Wideband Station Using Data Set 303-Type—Echo-Fox UHF Radio System—Test Procedures

**3.02** The following circuit descriptions (CDs) and schematic drawings (SDs) provide additional information on the data set and data auxiliary sets used in the Echo-Fox UHF Radio System.

<b>NUMBER</b>	<b>TITLE</b>
CD- & SD-1D100-01	Data Set 303-Type
CD- & SD-1D097-01	Data Auxiliary Set 806B-Type
CD- & SD-1D067-01	Data Auxiliary Set 809B-Type
CD- & SD-1D134-01	Data Auxiliary Set 824-Type
SD-1D099-01	Data Station Arrangements
FA 25173-SD (LL)	Data Station For Wideband Service Using Data Set 303H7 For Echo-Fox
FA 25077-SD (LL)	Echo Fox Data Switch (Control Office Concentrator Switch)



NOTE: DRAWING SHOWS OPTIONS G, J, T, V, Y, AND Z INCORPORATED.

Fig. 12—Data Auxiliary Set 806B7—Block Diagram