# VOICE STORAGE SYSTEM AND MASS ANNOUNCEMENT SERVICE TRANSMISSION ENGINEERING CONSIDERATIONS

CONTENTS — PAGE



## 1. GENERAL

**1.01** The Voice Storage System (VSS) is a processor controlled system with the general ability to receive, store, administer, and deliver a voice message or voice announcement. It is designed to provide high quality voice reproduction for a variety of automated voice message services. Mass Announcement Service (MAS) is a public broadcasting service that is designed to provide broadcasting on demand. The MAS network consists of No. 4 ESS islands that serve broadcasting nodes. The islands are updated via the telecommunication message network from a remotely located VSS.

**1.02** This section is reissued to include descriptive information and engineering information of the Mass Announcement Service (MAS). Since this is a general revision, change arrows are omitted.

**1.03** In general, the VSS consists of an auxiliary 3A processor and its associated memory, memory for digital storage of voice, necessary hardware and controllers to administer and manipulate the stored voice, and voice and signaling interface circuits to connecting offices.

**1.04** The VSS provides the capability for three voice services on a centralized basis. These services are:

(a) Call answering, which provides an automatic answer and record service without per line equipment

(b) Advance calling, which provides a voice message delivery service to a telephone number selected by the subscriber, and

(c) Announcement service, which provides a terminating intercept and announcement service without ringing a subscriber's telephone.

**1.05** The VSS interfaces with the No. 1 ESS and No. 1A ESS. Up to 32 offices may be served by a VSS economically at distances in excess of 100 miles.

**1.06** The MAS network consists of No. 4 ESS with generic 4E5 equipped with an announcement reproducer. Some of the MAS services consist of local and national Public Announcement Service (PAS), Televote, and PAS with cut-through that emulates choke networks.

**1.07** The sponsor/producer or person providing an announcement will interface only with a VSS located as close as possible to the promoter.

**1.08** The VSS will then distribute an announcement to the appropriate No. 4 ESS(s) using an end-to-end transmission plan designed to minimize transmission quality degradation between the VSS and the No. 4 ESS(s).

**1.09** Normal callers will always be routed to the No. 4 ESS providing MAS for their island. They will receive both local and national announcements from the same MAS machine; they will not interface with the VSS.

## 2. SYSTEM DESCRIPTION—VSS

**2.01** Conventional methods of recording and reproducing voice messages or announcements usually consist of recording voice on a magnetic tape device (reel, cartridge, cassette) or on a magnetic drum device. The VSS employs a digital encoding and storage technique for its voice messages. An analog to digial converter, together with the inverse digital to analog converter, is called a CODEC (***Co***der-***Dec***oder) and translates incoming analog voice signals into a digital bit stream as found in the T carrier technology. This digital information is transferred from the CODEC to a high speed disk transport system for storage. The VSS control program administers the voice messages stored on disk memory. Upon a request for playback of a message, the stored digital information is transferred to a CODEC which converts the information back to its original analog form. The stored digital information is retained in memory until specifically erased by VSS. Thus, a message or announcement can be retrieved from memory without any degradation of the original quality of the recording.

**2.02** A block diagram of the VSS system is shown in Figure 1. Connections between connecting central offices and VSS are made over trunks on metallic or carrier facilities. The trunks are grouped into a single 2-way trunk group and shared by all VSS services. These trunks terminate at the VSS office in Voice Access Circuits (VAC).

**2.03** When an ESS office determines that a VSS service is required, it seizes a trunk to VSS, connects an MF transmitter, and sends to VSS a service identification code, the subscriber's telephone number, other necessary information, and then connects the calling party to the VSS trunk. The VSS handles the service from this point. If information must be transmitted back to the central office from VSS (message waiting indications, service activation or deactivation), a voice access trunk is seized by VSS and via MF signaling, the necessary information is transmitted to the appropriate central office.

**2.04** The VAC consists of: (1) A Trunk Access Circuit (TAC) board containing the trunk terminating hardware, TOUCH-TONE® receiver, and a CODEC, and (2) a buffer board. Two-wire E&M VACs will interface with metallic facilities and 4-wire E&M VACs with carrier facilities. The E&M signaling provides dial pulse reception capability for VSS and the TOUCH-TONE receivers are provided for TOUCH-TONE subscribers. The CODEC converts analog voice to a digital form for storage and reconverts digital signals back to analog voice for message retrieval. Each VAC is connected to a small network which provides access to the service circuits. These include MF receivers and transmitters, diagnostic facilities, and various test circuits for trunk testing capabilities. A solid-state switch provides access between any VAC and any storage subsystem.

**2.05** The storage medium for VSS consists of moving head disk transports each with a capacity for 300 megabytes (2.4 billion bits). The VSS system has a capacity of 64 disk transports.

**2.06** The heart of the VSS system is the auxiliary 3A processor. Based on the design of the 3A central control used in No. 3 ESS and No. 2B ESS, it provides for self-checking and duplex operation. The auxiliary processor is responsible for all feature processing and control functions of VSS. A network controller serves as a control interface between the auxiliary processor and VACs. The VSS will interface with Switching Control Center System (SCCS) operations as well as provide an interface to automatic trunk testing systems.

**2.07** The VAC requirements are calculated for each served ESS and combined to determine the total quantity required for the VSS. A maximum of 510 VACs may be provided per VSS system to serve up to 32 ESS offices.

> ***Note:*** There are 512 possible VACs but for every system, two VACs are dedicated to the maintenance facility.

## 3. SYSTEM DESCRIPTION—MAS

**3.01** The MAS announcements are furnished by a No. 4 ESS equipped with generic 4E5. The MAS is accessed by callers dialing a local or

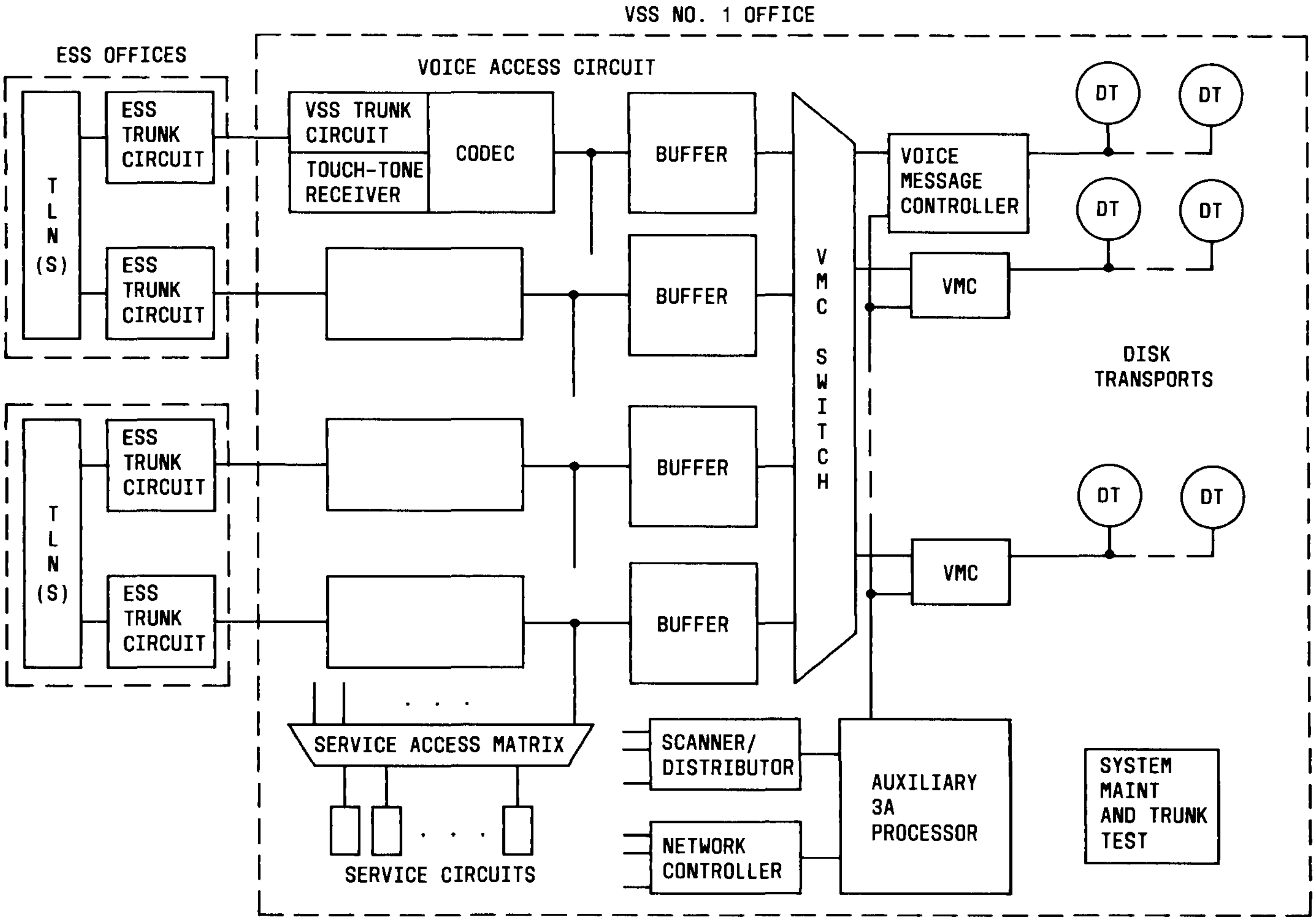



**Fig. 1—Block Diagram of Voice Storage System**

a toll number that is routed to the No. 4 ESS. The following steps are involved in MAS announcements:

(a) The initial announcement message is supplied by the sponsor over a dialed-up DDD connection to a nearby VSS system where the message is stored digitally. The client ESS to VSS trunk group is the same as used for normal VSS services.

(b) The VSS using a dedicated universal MAS trunk, via a second dialed-up connection over the telecommunication message network, updates the MAS system in those No. 4 ESS locations designated by the sponsor at the time the service order was established. The message is transmitted in analog format over the connection and digitally recorded at the MAS.

(c) The MAS customers dial a designated local or toll number to reach the MAS system, which is again routed via the telecommunication message network that depends on the location of the MAS callers serving central office with respect to the No. 4 ESS where the MAS is located.

**3.02** There are two types of hardware necessary in the No. 4 ESS for MAS announcement distribution. These are the announcement reproducer and the dedicated time slot interchange (TSI).

**3.03** The announcement reproducer is a disk-based system that stores voice messages as PCM encoded digital data. The data is read off the disk, buffered, and fed directly into the No. 4 ESS network, to be converted back to analog by a voice interface frame or L/T1 connector or a digital channel bank.

**3.04** Figure 2 shows the announcement reproduction system and its interconnections to the No. 4 ESS. The minimal configuration shown consists of the duplicated controllers, two MAS units that protect each other through phased redundancy, and two moving head disks for message storage.

## 4. TRANSMISSION PLAN

### A. VSS

**4.01** The purpose of the transmission plan is to control and minimize transmission impairments in order to provide a satisfactory grade of service. Transmission impairments include excessive or not enough loss, excessive noise, excessive crosstalk, and poor echo and/or singing return loss. Since at least two extra links are involved in the total communication process via VSS, there is potentially more loss and noise than that found in normal connections in the telephone message network. The objective of the plan is to provide for control of transmission impairments using standard transmission designs where possible.

**4.02** In the hierarchical structure, the VSS office is equal to a class 5 office. The purpose for this is to assure that trunking facilities connected to the VSS office do not need maintenance and/or administrative treatment especially different from that normally found in class 5 offices. For example, there will be no balance requirements for the VSS office.

**4.03** The VSS transmission plan will be more easily understood by describing the following segments of the overall connection:

(a) VSS Record Mode

(b) VSS Playback Mode.

#### VSS Record Mode

**4.04** Figure 3 shows a possible VSS record connection. This figure indicates that, depending on the caller to VSS distance, the average loss between the callers and VSSs class 5 offices could range from 0 to 7.2 dB and the average noise at the VSS class 5 office up to 26 dBrnc. Also, the loss in the caller station loop is 3.7 dB on the average, but could be as high as 9.5 dB.

**4.05** It is necessary to have a relatively uniform level at the VSS. Therefore, an AGC function is applied to all caller messages as they are recorded on the VSS disk. The nominal output level of the AGC is -13.5 dBm. This will yield a -17 dBm nominal level out of the VSS.

**4.06** Because of the characteristics of the AGC, only idle circuit noise above 34.5 dBrnc will activate the AGC. Thus, the AGC will reduce the idle-circuit noise on the caller to VSS connection.

#### *VSS Playback Mode*

**4.07** Figure 4 shows a possible VSS playback mode connection. The effect of the AGC in the record mode is to transmit a signal to the recoder at a -13.5 dBm level. On the playback leg, a level of -17 dBm is transmitted through a net loss of 3.0 dB.

**4.08** The design of the VSS voice access circuits provides 2- and 4-wire interconnection capabilities with the ESS machine using type II E&M signaling. Basically, the trunking can be 2-wire metallic, or 4-wire on T-carrier or N-carrier systems. The facilities are analogous to interlocal trunks with a nominal inserted connection loss (ICL) of 3 dB.

### B. MAS

**4.09** The transmission quality of the recording ultimately perceived by the callers, if not controlled, may have unacceptably poor volume, excessive noise, discontinuities, etc, because of the multiple encodings and retransmissions, approaching ***three*** DDD connections in tandem. The caller dialing a local MAS number, however, expects to receive a clear and intelligible message having the transmission characteristics of a local call. Also, the promoter who goes through the effort of providing the message through professional recording expects to deliver a high quality message to the caller. The MAS objective is that the quality of the recording heard by the local caller should contain noise and loss parameters approaching local quality transmission (eg, average class 5 to class 5 loss is 4 dB and noise at the receiving class 5 is 13.3 dBrnc).

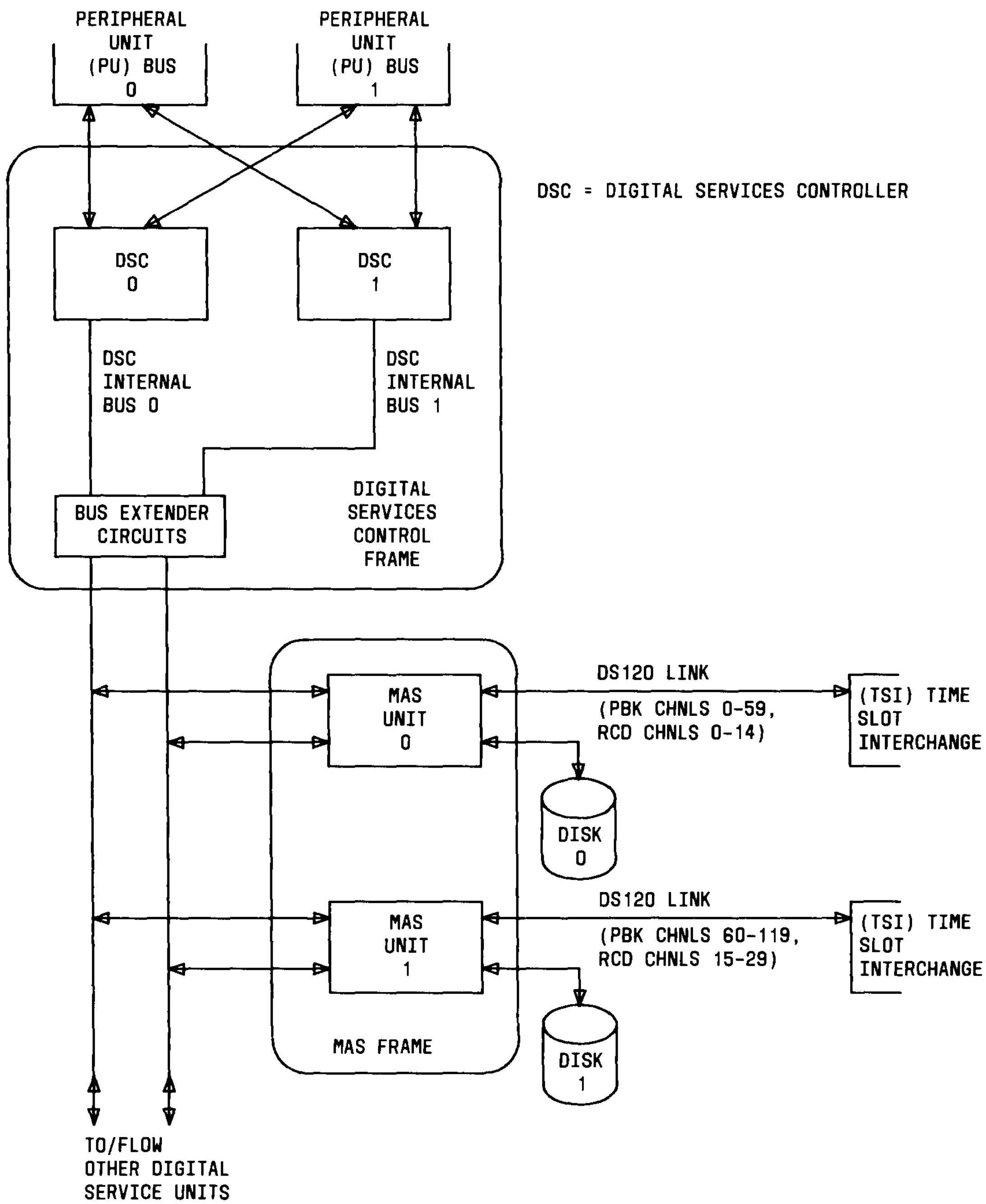



Fig. 2—No. 4 ESS With MAS

**4.10** As a summary, the transmission plan includes the following considerations:

(a) It is required that the customer receive clear and intelligible recordings. This is especially important in this type of service where the customer is a passive listener unable to request repetitions of misunderstood information.

(b) The loss and noise added to the promoters recordings must be controlled so the nominal level of the recordings delivered to the MAS callers class 5 offices is -24 dBm, with an average noise added during updating of 19 dBrnc or less.

(c) Special controls are needed for certain transmission impairments (such as excessive loss and noise, hits and dropouts on the network links during updating, clipping, and freezeouts due to voice operated devices such as echo suppressors and TASI) to ensure that the objectives in items (a) and (b) are met.

**4.11** The VSS/MAS transmission plan can be described by looking at the following segments:

(a) Promoter to VSS/MAS Record Mode

(b) VSS to No. 4 ESS/MAS Connection

(c) Caller to the 4 ESS/MAS Connection

(d) Total MAS End-to-End Connection.

### *Promoter to VSS/MAS Record Mode*

**4.12** The promoter to VSS record connection is the same as descibed in paragraph 4.04 and Figure 3.

**4.13** The design of the VSS voice access circuit is the same as described in paragraph 4.08. The nominal ICL is 3.0 dB with the AGC disabled.

### *VSS to No. 4 ESS Connection*

**4.14** Figure 5 shows a connection from VSS to the No. 4 ESS machine. It represents a dialed connection through the telecommunication message network to a local or remote No. 4 ESS/MAS office. To assure a proper recording delivery during update, and to meet the loss and noise network objectives, the following features are provided in the transmission plan:

(a) A pilot tone is transmitted from the VSS to MAS, and both the tone level and the noise with the tone notched out is monitored by the MAS.

(b) A companding function is provided (compression by the VSS and adaptable gain plus expansion by the MAS) on the connection from VSS to MAS.

**4.15** The desired level at the local MAS callers class 5 office is -24 dBm (see paragraph 4.06). Referring this level back to the MAS office, a -21 dBm level is required. The compandor and the adaptive expandor will reduce the VSS to MAS loss to a nominal 4 dB. Thus, a -17 dBm output at the VSS is required (paragraph 4.07).

**4.16** The 2150 Hz pilot tone employed during updating is used for four main purposes:

(a) To monitor for the presence of fades or dropouts during updating.

(b) To initially reject those connections where the end-to-end loss exceeds the operating range of the compressor/expandor.

(c) To set the operating level of the adaptable expandor at the MAS location.

(d) To operate (or hold operated) any tone-activated devices in the connection, such as echo suppressor disablers and TASI derived trunks.

**4.17** The tone is initially sent at -16 dBm to operate tone-activated devices and then switched to -21 dBm to minimize additive noise to the connection while holding operated any tone-activated devices. The No. 4 ESS/MAS unit will monitor the pilot tone, measure its amplitude, and notch it out.

**4.18** The average received tone level during the first 3 to 5 seconds, before the update message is actually sent, is used to adjust the adaptive gain in the MAS so the VSS-to-MAS loss is 4 dB. The gain value is then fixed for the duration of the update message. A fade is detected if the tone level has decreased by more than 9 ± 3 dB from the average level for 65 to 100

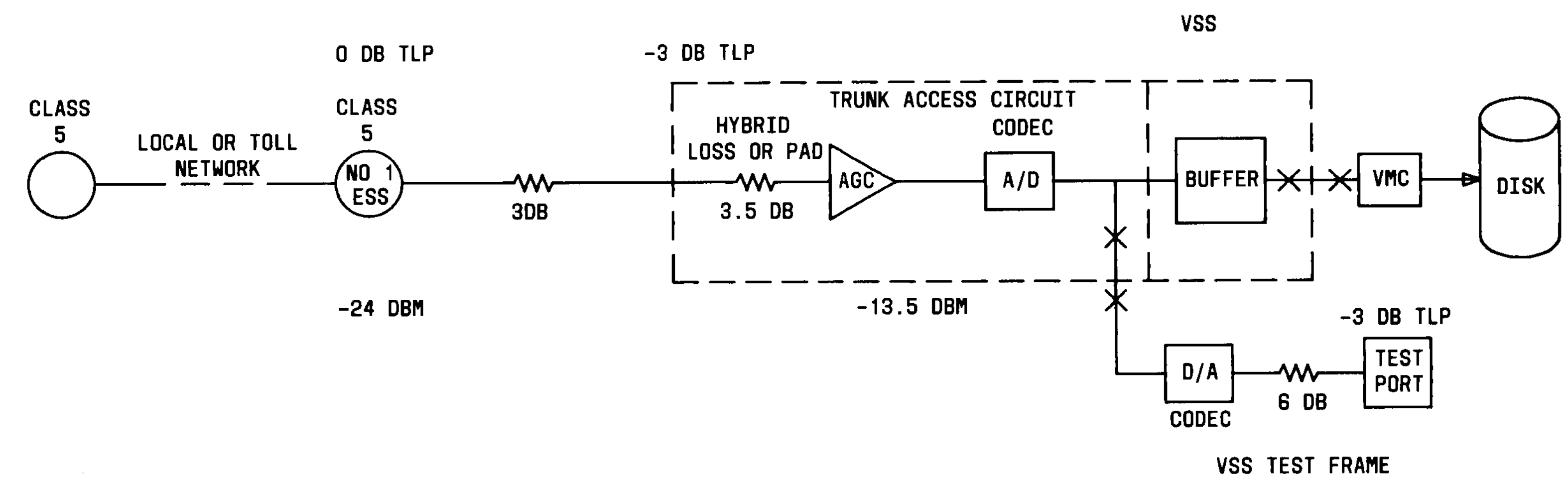



**Fig. 3—VSS Record Mode Fig. 4—VSS Playback Mode**

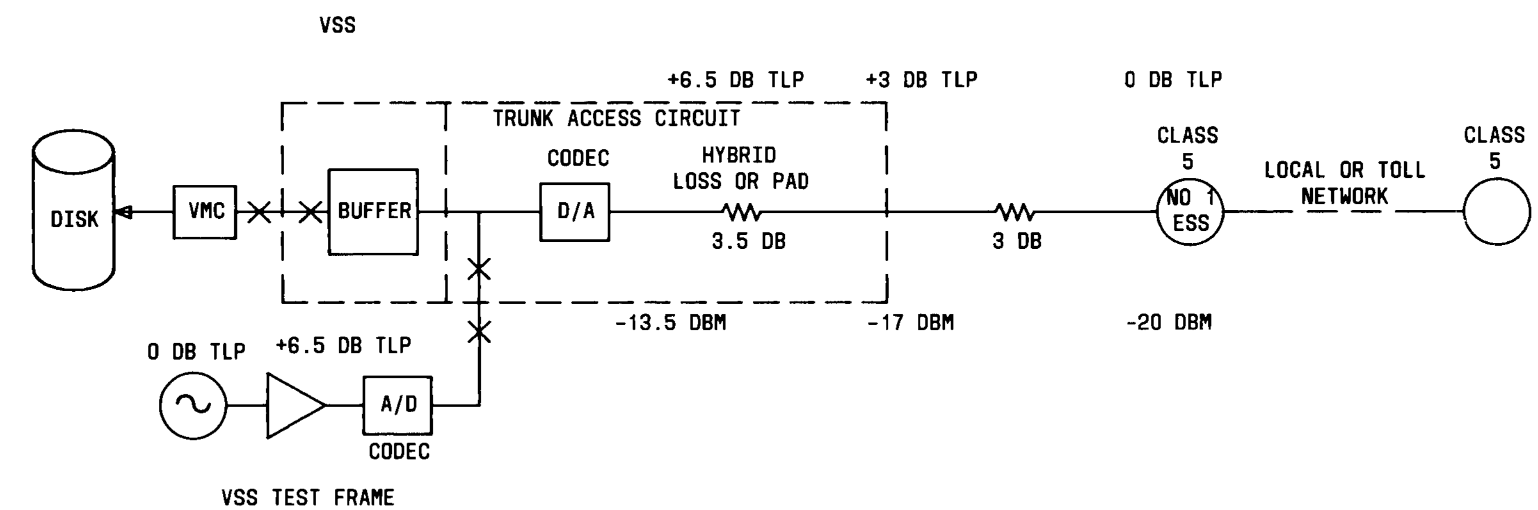



**Fig. 4—VSS Playback Mode**

milliseconds. If a fade is detected, a retransmission is requested. The 65 milliseconds are chosen to be long enough to accommodate radio switching protection, to prevent the loss of one syllable (100 milliseconds) of the announcement, and to meet a tentative criterion for maximum duration of open intervals. If the fade is persistent for longer than 100 milliseconds, a new connection request is initiated.

**4.19** The loss per intertoll link is via net loss (VNL) and ranges from 0 to 2.9 dB. The maintenance variation on each link is ±3.7 dB around its nominal value. This indicates that it is possible for a MAS update call that has a 7-link connection to have a loss approaching 20 dB. The chances of such a connection are remote, but protection must be made against it. A more likely situation is to have the overall VSS-to-MAS loss to be approximately 13 dB. Allowing for generator and detector variations, the pilot tone from the VSS is monitored and any connection that has a loss greater than 15 dB is rejected.

**4.20** A noise measurement device is provided in the MAS unit. The device will measure the noise with the pilot tone notched out for 3 to 5 seconds prior to each recording update and report it to the 1A processor. The No. 4 ESS will accept only channels that meet the proper noise criteria and reject the ones that are exceptionally noisy. The noise criteria that will reject channels is 43 dBrnc or higher noise level on the incoming connection before gain or expansion is applied.

### *Caller to the No. 4 ESS Connection*

**4.21** The caller dialing a MAS number will be connected to the No. 4 ESS as shown in Figure 6. The loss from the class 5 office to the MAS unit is nominally 3 dB + VNL and the noise will be in the 19-dBrnc range for local MAS calls. Callers dialing a remote MAS will experience increased noise as a function of mileage, as they normally would on long distance calls.

### *The Total MAS End-to-End Connection*

**4.22** The average speech at the callers class 5 office is -24 dBm, which is about what exists on the average, through a metropolitan network connection. The contribution to the noise heard by the caller from the MAS recording referred to the callers class 5 office is approximately 19 dBrnc.

## 5. TRUNK DESIGNS

### 2-Wire Metallic Trunks

**5.01** Figure 7 shows a typical layout of a 2-wire voice access trunk using Metallic Facility Terminals (MFT) with DX signaling modules. The nominal 3 dB ±0.5 dB loss is measured between the output of the client ESS Trunk Link Network for ESS outgoing trunks and the input to the VSS voice access circuit.

**5.02** Figure 8 shows a typical layout for an intrabuilding case. The shorter cable run will require an external 2-dB pad in the voice path to produce the necessary loss. The characteristic impedance of the pad must be 900 ohms to match the impedance of the trunks. Figure 8 also shows the interconnection of the E&M signaling lead without the use of a DX signaling unit or PLR.

### 4-Wire T-Carrier Trunks

**5.03** Figure 9 shows a typical layout of a VSS voice access circuit on T-Carrier using D3 or D4 channel units. A 2-wire, E&M, 900-ohm channel unit is used at the ESS location and a 4-wire E&M channel unit at the VSS location. Pad adjustments are necessary in the 2-wire channel units to adjust the transmission level point (TLP) of the channel unit. See Sections 365-150-101 and 365-170-101 for additional information. External pads are required at the VSS location to meet the TLP requirements of the 4-wire circuits and VSS voice circuit requirements. The pad values shown in Fig. 9 provide the necessary nominal 3-dB trunk loss.

### 4-Wire N-Carrier Trunks

**5.04** Figure 10 shows a typical layout of a VSS voice access circuit on N-Carrier using F-type SF signaling units. A 2-wire, E&M, 900-ohm SF unit is used at the ESS location and a 4-wire, E&M SF unit at the VSS location. Pad adjustments on the SF units will provide the proper TLP adjustment at both ends of the circuit.

**5.05** Specific circuit design information for trunks associated with VSS I is included in ***S***tandard ***ME***ssage ***T***runk ***D***esign ***S***ystem (SMETDS).

## 6. MAINTENANCE

**6.01** Trunk maintenance facilities for VSS are shown in Fig. 11. The service access matrix will interconnect the voice access trunks to various test lines including a 52A responder for testing with centralized automatic reporting on trunks (CAROT).

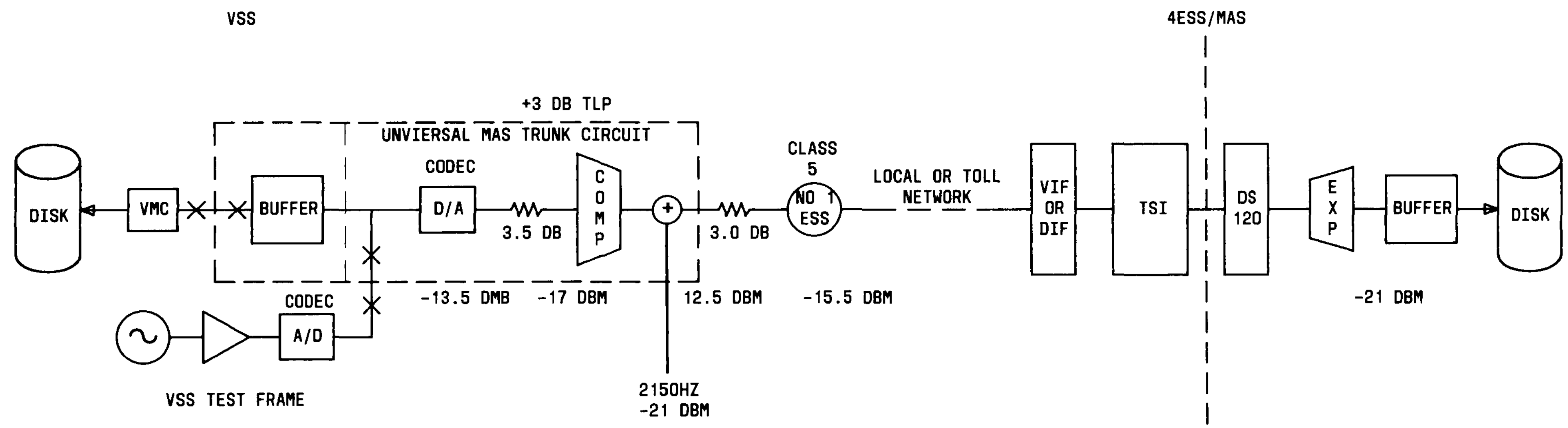



Fig. 5—VSS to MAS Update Mode Fig. 6—MAS Playback Mode

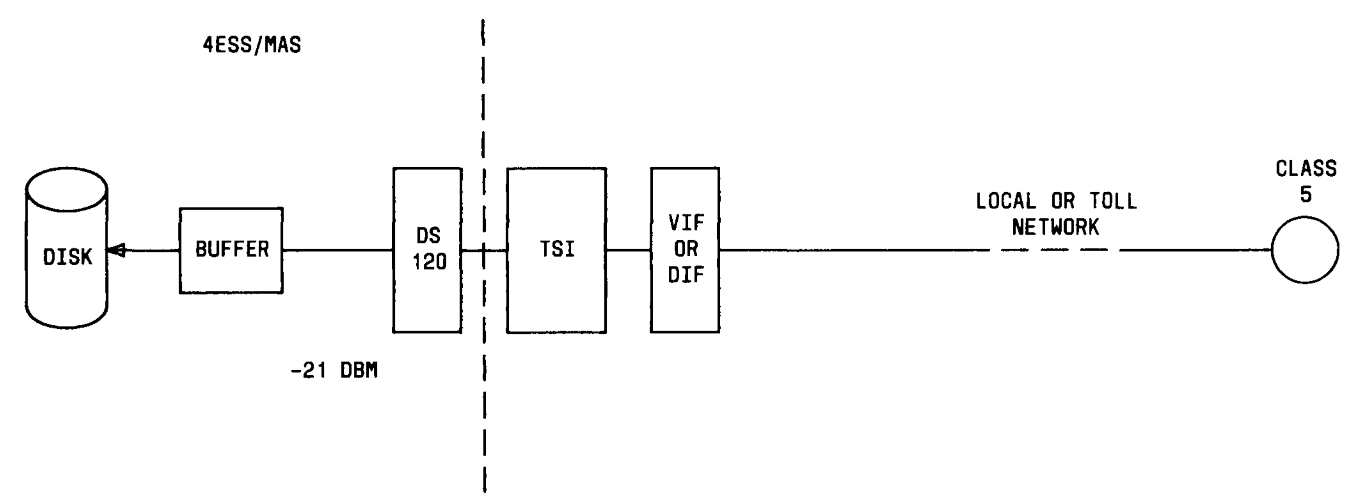



Fig. 6—MAS Playback Mode

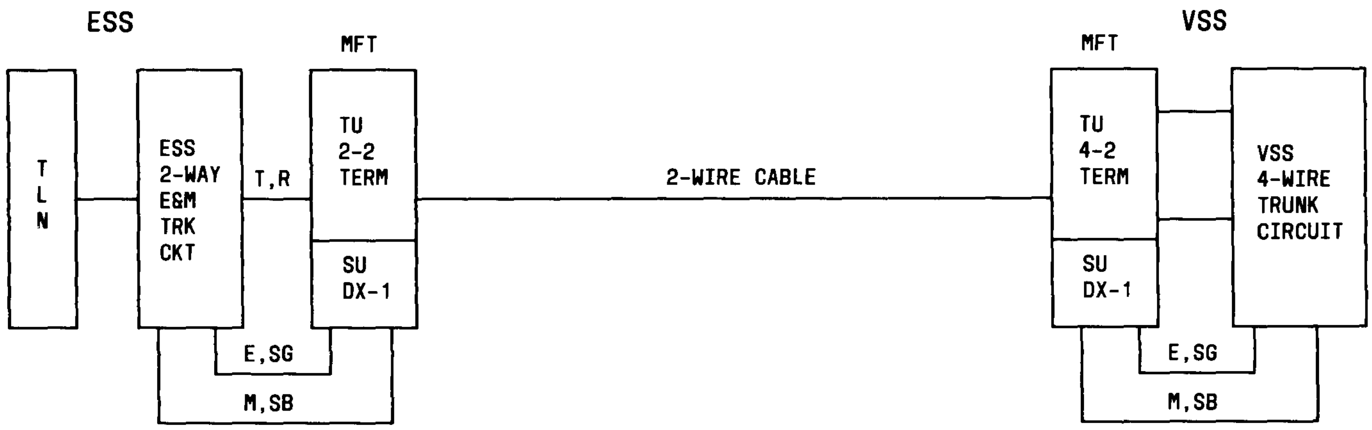



Fig. 7—Typical 2-Wire Metallic Voice Access Trunk

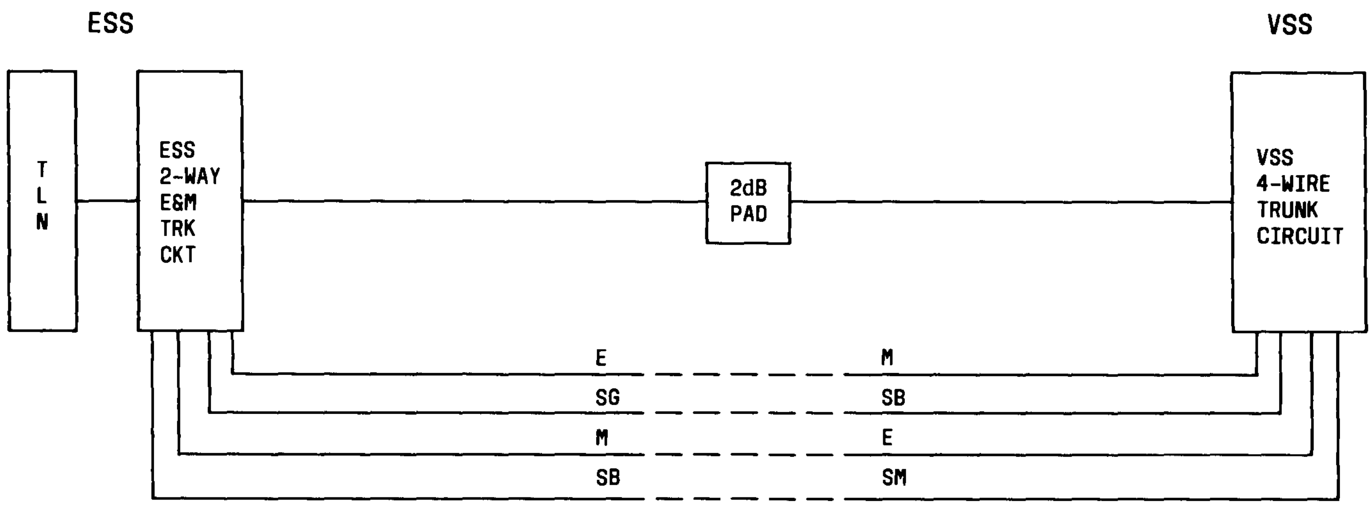



Fig. 8—Typical 2-Wire Intrabuilding Voice Access Trunk

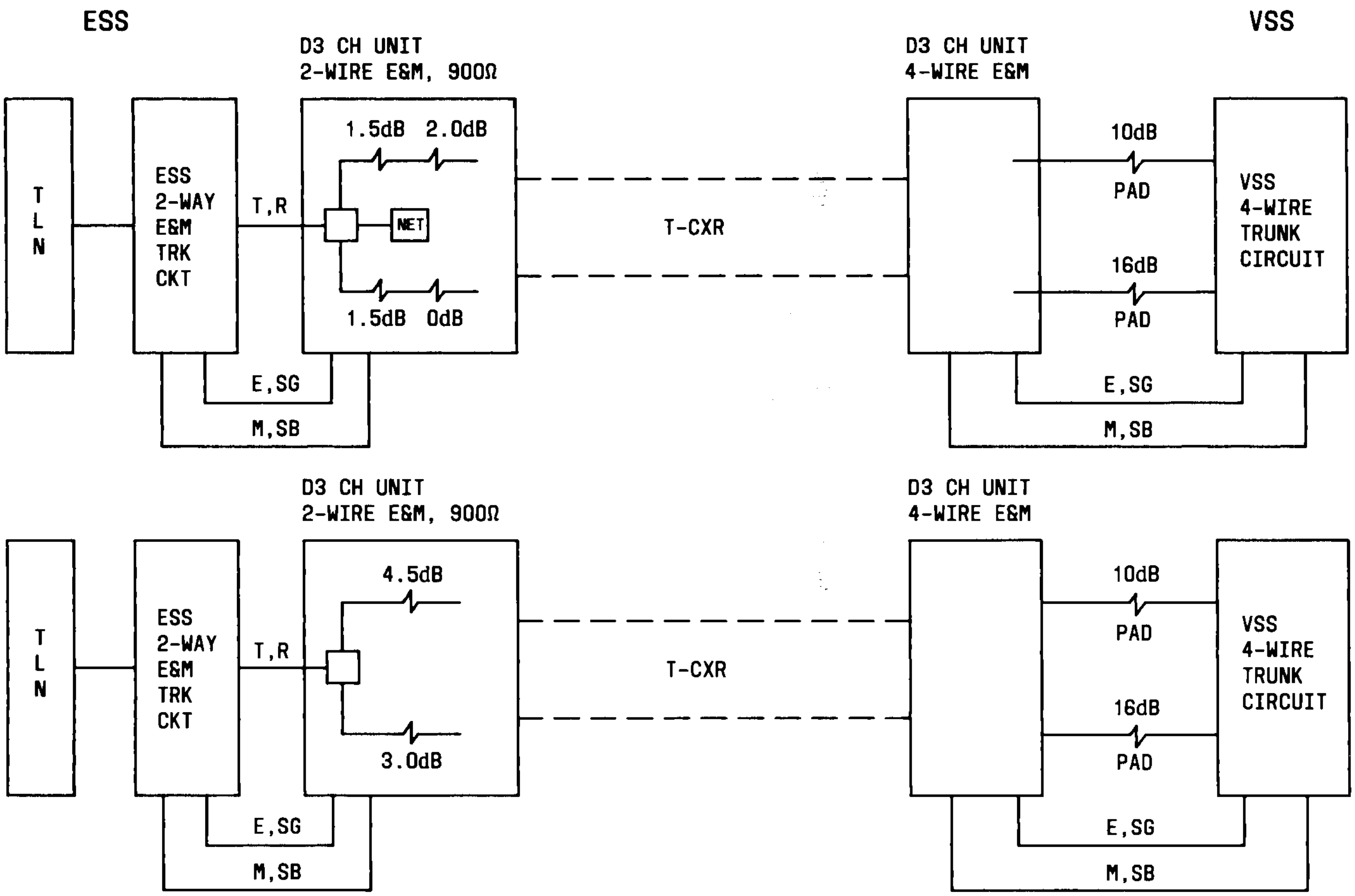



**Fig. 9—Typical 4-Wire Digital Carrier Voice Access Trunk With D3 or D4 Channel Banks**

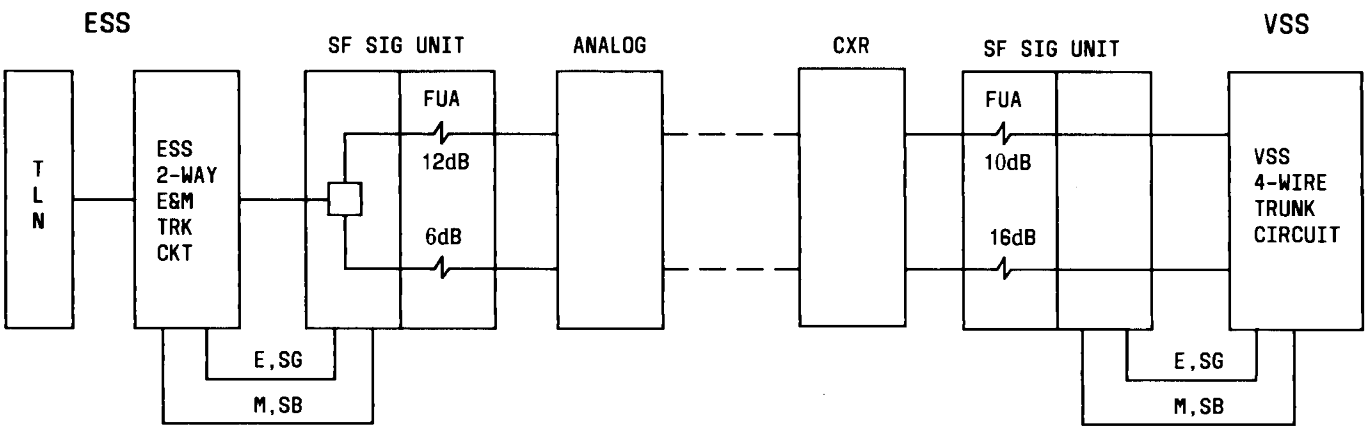
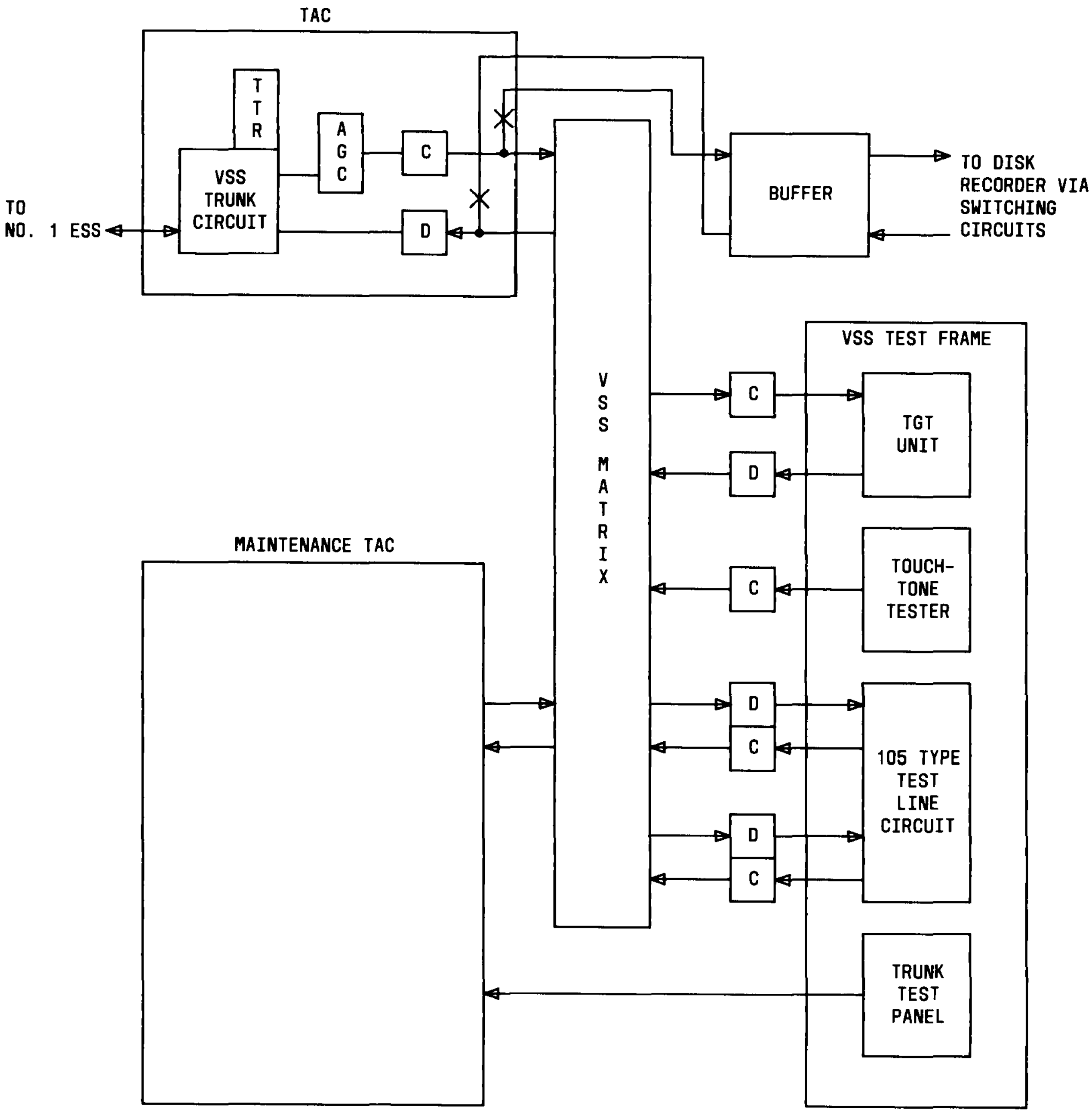



**Fig. 10—Typical 4-Wire Analog Carrier Voice Access Trunk With SF Signaling Units**




AGC – AUTOMATIC GAIN CONTROL

TGT – TRUNK ACCESS CIRCUIT GAIN TEST

TTR – TOUCH-TONE RECEIVER

VSS – VOICE STORAGE SYSTEM

D – DECODER

C – CODER

**Fig. 11—VSS Test Frame Interfaces**