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MILITARY STANDARD

SUBSYSTEM DESIGN AND ENGINEERING STANDARDS

FOR TECHNICAL CONTROL FACILITIES

SLHC

DEPARTMENT OF DEFENSE

Washington, D.C.

SUBSYTEM DESIGN
AND ENGINEERING STANDARDS
FOR TECHNICAL CONTROL FACILITIES

MIL-STD-188-310A

1. This Military Standard is approved and mandatory for use by all Departments and Agencies of the Department of Defense in accordance with OASD (C^3I) Memo (see Appendix).

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: HQ AFCC/EPE, Scott AFB, Illinois 62225 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

NOTE: Special credit is given to the Air Force Communications Command, 1842 EEG, who were responsible for preparing this standard.

FOREWORD

1. In the past two decades, MIL-STD-188, a military standard covering military communications systems technical standards, has evolved from one applicable to all military communications (MIL-STD-188, MIL-STD-188A, and MIL-STD-188B) to one only applicable to tactical communications (MIL-STD-188C).

2. In the past decade, the Defense Communications Agency (DCA) has published DCA circulars promulgating standards and criteria applicable to the Defense Communications System and to the technical support of the National Military Command System (NMCS).

3. Future standards for all military communications will be published as part of a MIL-STD-188 series of documents. Military communications standards will be subdivided into Common Long Haul/Tactical Standards (MIL-STD-188-100 Series), Tactical Standards (MIL-STD-188-200 Series), and Long Haul Standards (MIL-STD-188-300 Series).

4. This standard provides for the interface between the various communication circuits entering and departing a technical control facility. The standard generically establishes a uniform philosophy of control, monitoring, circuit restoral and alternate routing by uniformity of interface parameters.

5. This revision implements recent developments in digital transmission systems. A forthcoming military standard will supply criteria for the all digital systems of tomorrow and further will deal with the long haul and tactical interfaces.

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APPENDIX

1. SCOPE

1.1 Purpose. This standard establishes criteria for engineering fixed Technical Control Facilities and associated Patch and Test Facilities in the Department of Defense.

1.1.1 Technical Control Facility description. The Technical Control Facility (TCF) is that element of a communications network with the necessary physical, electrical, and manpower capabilities to provide technical control functions, interface transmission elements of the system, and interface users with the system. The management of communication paths is accomplished at the TCF and subordinate Patch and Test Facilities (PTFs). The communication paths may be derived from submarine and land cables or from high frequency, tropospheric scatter, line of sight, and earth satellite radio transmissions subsystems.

1.1.2 Technical control functions. Technical control functions include technical direction, coordination, technical supervision of transmission media and equipment, quality control, communications service restoral, subsystems fault isolation, status reporting, and other functions as further defined in DCA Circular 310-70-1. All technical control functions are accomplished with six basic operations:

a. Patching/Switching (restoral, test, monitor, access).

b. Coordination (to far end, to user, to maintenance).

c. Testing (connotes insertion of known signal, and on an out-of-service basis).

d. Monitoring (connotes measuring existing circuit conditions or traffic, with or without test signal, on an in-service basis).

e. Reporting (includes all periodic and real-time reports required by the DCA and the O&M activity).

f. Circuit operating alignment (alignment necessary to restore circuit parameters).

1.2 Applicability. The criteria established by this standard apply during the design and engineering of technical control facilities. Existing systems need not be immediately converted to comply with the requirements of this standard. New systems and those undergoing major modifications or rehabilitation shall conform to these standards.

1.2.1 Red/Black engineering criteria. The criteria in this standard are applicable for a completely BLACK TCF. The inclusion of any RED provision in the TCF requires the compliance of this standard and further with current RED/BLACK

Engineering Installation Criteria, in MIL-HDBK-232(C). Criteria governing the provision of RED facilities within a technical control facility to meet security objectives will be developed separately and will be compatible with the criteria contained herein.

1.2.2 Patch and Test Facilities. The requirements of this standard shall also apply to those patch and test facilities which are required to provide surveillance or control of a transmission path. These standards shall apply to such patch and test facilities as those serving terminal, switching, or transmission equipment.

2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following documents in effect on the date of invitation for bids, or request for proposals, form a part of this standard to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-E-6051	Electromagnetic Compatibility Requirements, Systems.

STANDARDS

MILITARY

MIL-STD-188-100	Common Long Haul and Tactical Communication System Technical Standards.
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits.
MIL-STD-188-120	Military Communication System Standards Terms and Definitions.
MIL-STD-188-124	Grounding, Bonding and Shielding.
MIL-STD-188-311	Equipment Technical Design Standard for Multiplexers.
MIL-STD-461	Electromagnetic Interference Characteristics Requirements For Equipment.

HANDBOOKS

MILITARY

(C) MIL-HDBK-232	RED/BLACK Engineering Installation Criteria(u).
MIL-HDBK-414	Technical Control Facilities and Equipment.

PUBLICATIONS

MILITARY

DEFENSE COMMUNICATIONS AGENCY CIRCULARS (DCACs)

DCAC 300-175-9	DCS Operating-Maintenance Electrical Performance Standards.
DCAC 310-70-1	DCS Technical Control.

DEPARTMENT OF DEFENSE DIRECTIVE (DODD)

DOD Directive 3222.3	Department of Defense Electromagnetic Compatibility Program

(Copies of listed standards, handbooks, specifications, and industry associated documents adapted for use by the Department of Defense (DOD) should be obtained from the procuring activity or as directed by the contracting officer, from the DOD Single Stock Point, Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pa., 19120.)

2.2 Other Publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposals shall apply.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/IEEE-STD-488-1978

(Applications for copies should be addressed to American National Standards Institute Inc., 1430 Broadway, New York, NY, 10018.)

3. TERMS AND DEFINITIONS

3.1 General. Terms and definitions common to the MIL-STD 188 series are contained in MIL-STD-188-120. Terms and definitions unique to MIL-STD-188-310A are contained herein.

a. "D" Type Patch Bay. A patching facility designed for patching and monitoring of unbalanced data circuits at rates up to 1 Mb/s.

b. Digital Circuit Patch Bay. A patching facility where low level digital data circuits can be patched, monitored, and tested. This patch bay can be either "D" type or "K" type (unbalanced or balanced).

c. Digital Primary Patch Bay. A patching facility that provides the first appearance of most local user digital circuits in the TCF. The digital primary patch bay provides patching, monitoring and testing capabilities for high level digital circuits and low level digital circuits that require conditioning. Signals will have various levels and signal formats depending on the user terminal equipment. This patch bay can be either "D" type or "K" type (unbalanced or balanced).

d. Equal Level Patch Bay. An analog patching facility, at which all VF circuit inputs and outputs appear at a uniform level. This permits patching without making transmission level adjustments.

e. "K" Type Patch Bay. A patching facility designed for patching and monitoring of balanced data circuits at rates up to 1 Mb/s.

f. "M" Patch Bay. A patching facility designed for patching and monitoring of digital data circuits at rates from 1 Mb/s to 3 Mb/s.

g. "MM" Patch Bay. A patching facility designed for patching and monitoring of digital data circuits at rates exceeding 3 Mb/s.

h. VF Primary Patch Bay. A patching facility that provides the first appearance of local user VF circuits in the TCF. The VF primary patch bay provides patching, monitoring and testing for all VF circuits. Signals will have various levels and signaling schemes depending on the user terminal equipment.

4. GENERAL REQUIREMENTS

4.1 Concept of Technical Control Facility

4.1.1 Capabilities. Technical control and patch and test facilities will be configured and engineered to enable technical controllers to utilize the full capabilities of the equipment and personnel resources, through the efficient performance of the daily functions of coordination, technical direction, technical supervision, fault isolation, restoral and status reporting. Effective accomplishment of these functions requires a well designed critical control and orderwire communications network between the DCS and the technical control facilities, between technical control facilities, and between the technical control facility and subordinate patch and test facilities. These facilities, taking into consideration the missions of the military departments, will be designed to achieve the optimum standardization of equipment in terms of layout, procurement specifications, operating procedures, training, manning guidelines, and technical control functions. These facilities will be designed to enable the technical controller to effectively satisfy the following responsibilities:

a. Know the status and quality of designated transmission links, trunks, circuits, and communications equipment under the TCF's technical direction or supervision.

b. Take immediate action on any deterioration or failure of communications systems or equipment causing degradation of, or loss of, service to the users.

c. Expeditiously restore service to users, both DCS and non-DCS, by proper means in accordance with established restoration priorities.

4.1.2 Design baseline. The ultimate goal of these criteria is to create an efficient operational environment to optimize circuit quality, reliability, and restoration. In the design of the TCF, primary consideration shall be given to the following provisions:

a. The TCF shall provide means of determining, logging, and reporting status information of circuits, links, and trunks within the assigned area of responsibility by providing orderwire, status monitoring, and quality monitoring equipment.

b. The TCF shall have provisions for rapid restoral and re-routing on a priority basis in accordance with established procedures.

c. The TCF shall provide for the interface of circuit segments.

d. The TCF shall provide quality assurance and fault isolation capability and shall incorporate test points to allow for the rapid test and replacement of circuit segments or elements at all levels in the communication hierarchy.

e. The TCF shall provide the means for internal and external coordination.

f. The TCF design shall be accomplished in accordance with applicable portions of MIL-E-6051 to assure that electromagnetic compatibility design goals are achieved.

g. The procurement of equipment, subsystems and systems to be used in the provisioning of a TCF shall incorporate applicable portions of MIL-STD-461 to ensure that interference control measures are taken that will assure that objectives of DOD Directive 3222.3 are achieved. In the case of commercial off-the-shelf equipment, a suitable control plan, if required, shall be developed and applied.

h. The TCF design shall consider the utilization of automated technical control test and monitoring equipment and shall also address voice and data interface requirements with other DCS system control (SYSCON) elements.

i. Grounding, bonding and shielding practices shall be in accordance with MIL-STD-188-124.

4.1.3 Design objectives.

4.1.3.1 Modularity. All equipment should be modular in construction.

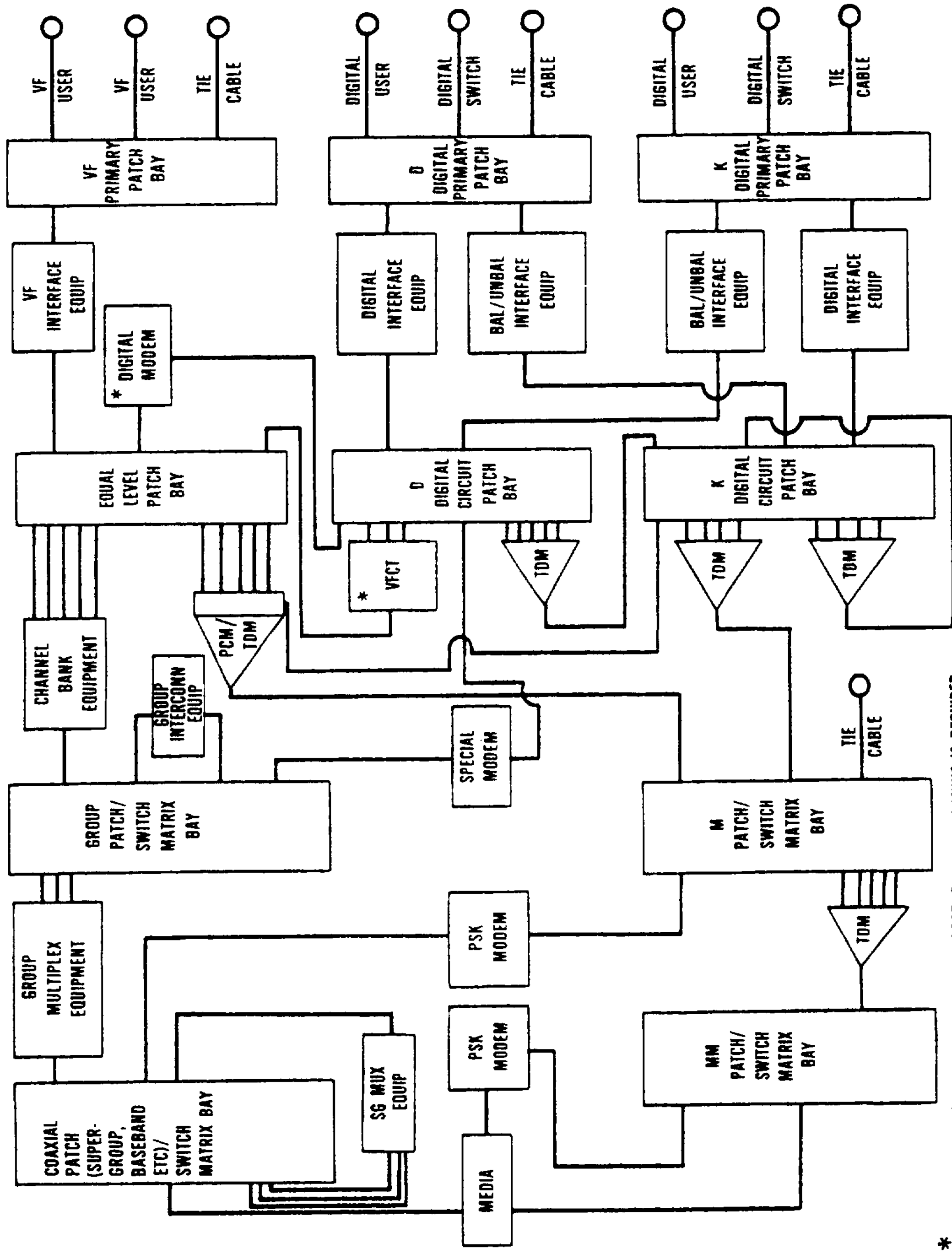
4.1.3.2 Automated equipment. Digital control switches and matrices, including time slot interchangers, should be considered and, if cost effective, should be used. Similarly, automated analog wideband patching should be used when cost effective. Particular consideration should be given to maximum utilization of built-in test equipment and patch and test facilities integral to the terminal or transmission equipment.

4.1.3.3. Common interface bus. All technical control test, monitor, and control equipment should be capable of being connected to a general purpose interface bus as prescribed in ANSI/IEEE STD-488-1978.

4.2. General configuration

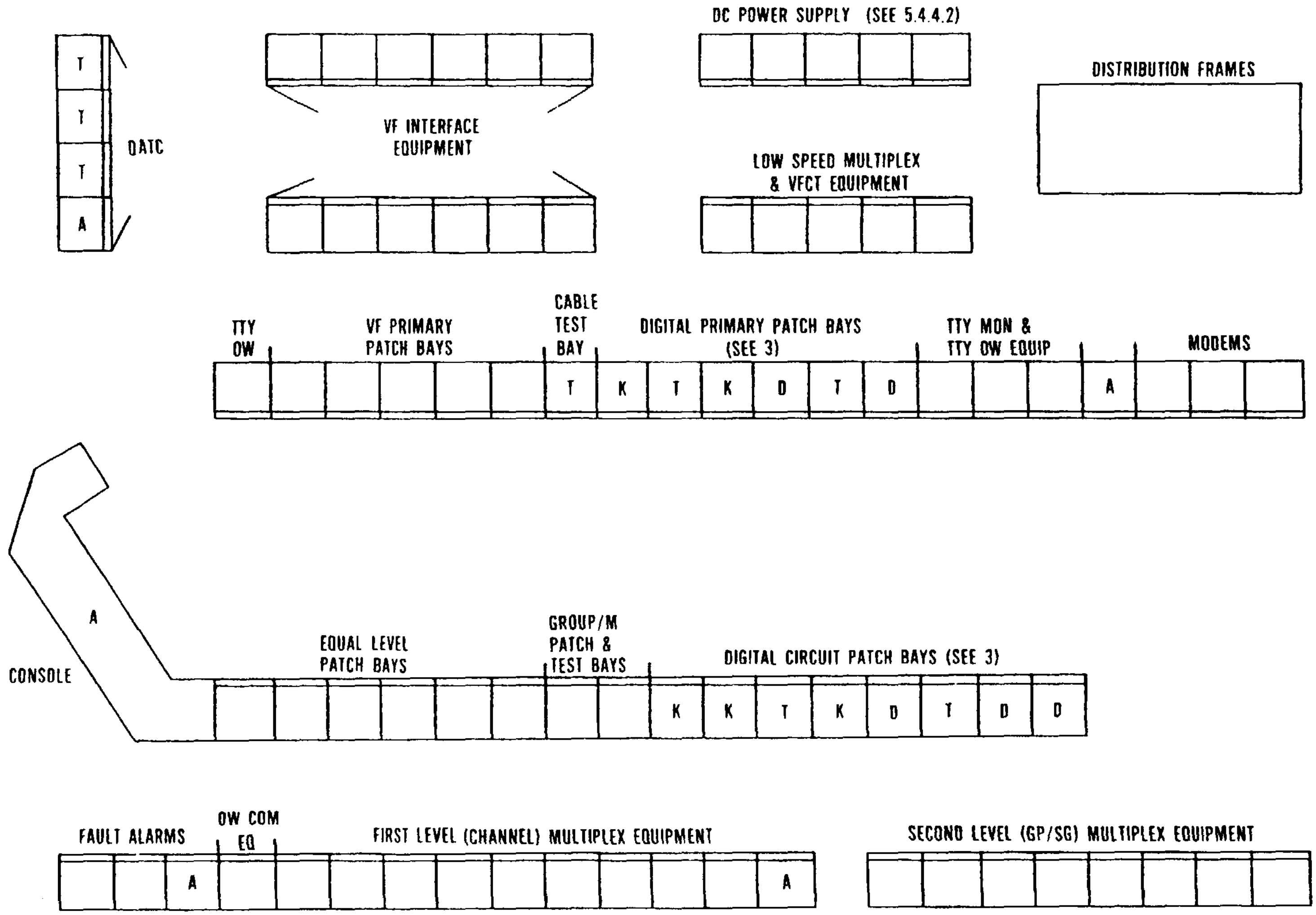
4.2.1 Block diagram. A block diagram of signal flow at a technical control facility is shown in Figure 1. This diagram illustrates the interrelationship of major equipment in the technical control facility with terminal equipment. Although the technical control facility of many stations may not require access to all transmission modes shown in Figure 1, the technical control configuration of all stations should be essentially the same, whether the station is located at a transmission nodal point or terminal point. Figure 1 includes all major equipment and patch facilities which are involved in the flow of traffic and control information through a TCF, however, it will not be necessary for all items to be located within the immediate TCF operating area.

4.2.2 Floor plan. A typical floor plan of a TCF is illustrated in Figure 2. The floor plan shows the optimum location and interaction between patch bays, orderwires, test centers, alarm systems, and the reporting and coordinating positions.



* WILL BE ROUTED TO PRIMARY PATCH BAY FIRST IF VF CONDITIONING IS REQUIRED

FIGURE 1. Signal flow block diagram



NOTE: T INDICATES A TEST BAY
A INDICATES POSSIBLE LOCATIONS OF AUTOMATED TECHNICAL CONTROL QUALITY MONITORING AND PERFORMANCE ASSESSMENT EQUIPMENT

FIGURE 2. Typical TCF floor plan

4.3 Criteria for facility equipment. Facility plans will be sufficient to support circuits which are current as well as all identified programmed requirements. Further, all engineering and installation plans shall also be based on the following criteria.

4.3.1 Expansion. Capability shall be provided for expansion. Expansion rates for technical control facilities should be based on all determinable factors, including:

a. Life expectancy (station and equipment)

b. Circuit growth

c. Technological forecasts

d. Long range plans

In the absence of determinable factors, growth in floor space, frame space, utilities, and station battery shall be assumed to be 25%, up to the total transmission media capacity entering or exiting the facility. This growth allowance provides vacant floor and rack/bay space into which future equipment may be installed. This growth allowance does not imply the quantity of "spare" equipment to be provided by the initial installation.

4.3.2 Standby equipment. Patch panel appearances, circuit conditioning, interfacing, and ancillary equipments will be furnished and installed to:

a. Allow for substitution for those units which are out of service because of test and maintenance of the facility. Proportions of standbys for this purpose shall be based on station equipment population and the test and maintenance schedule.

b. Allow for the substitution of equipment strings (circuit or wideband segments) as they occur between patch panel appearances. Since such equipment will be utilized to replace strings of equipment, numbers are not to be calculated on a per unit basis for this requirement. In general, the station shall be so wired and equipped that there shall be at least one standby string for every 10 strings (or portions thereof) of the same configuration. As a minimum, there shall be two standby strings of each configuration that has at least three strings. For example, 1 string would have 1 standby string, 3 strings would have 2 standby strings, 10 strings would have 2 standby strings, 20 strings would have 2 standby strings, 21 strings would have 3 standby strings, 31 strings would have 4 standby strings, etc.

4.3.3 Spares for government furnished equipment. In addition to the equipment provided for expansion and standby, spare equipment shall also be provided based on the following criteria:

a. Circuit conditioning, interfacing and ancillary equipment will be provided to allow for 10% expansion in each type of string.

b. Amplitude and delay equalizers shall be provided in sufficient quantities to condition at least 10% of all remaining spare DCS circuits egressing the TCF to S-3 schedule specifications as set forth in DCAC 300-175-9 which were not previously conditioned to S-3.

4.3.4 Minimum quantities. Minimum quantities of equipment shall be provided according to the rule which yields the highest number.

a. A minimum of two 6-way-4-wire VF bridges shall be furnished at each TCF in addition to those utilized for dedicated circuits.

b. At any TCF furnishing digital teleprinter service, telegraph regenerative repeaters shall be furnished for at least three percent of such circuits with no less than 2 repeaters per TCF.

c. At any TCF furnishing digital teleprinter service, a minimum of two digital hubbing repeaters shall be furnished in addition to those utilized for dedicated circuits. Each repeater shall be capable of accomodating up to six full duplexed circuits.

d. Monitor teleprinters shall be provided on the basis of one per 25 teleprinter circuits, with a minimum of three teleprinters required in each technical control facility servicing teleprinter circuits.

5. DETAILED REQUIREMENTS

5.1 Voice frequency (VF) circuits. Figure 3 depicts the arrangement of VF patching/monitoring and conditioning equipment within a TCF. All VF users, including AUTOVON, AUTODIN, and AUTOSEVOCOM switches, communications centers, PABXs, local switchboards, and tactical multiplexers, shall access the TCF via a VF primary patch bay. A four-wire fixed station multiplexer shall access the TCF via the equal level patch bay. All conditioning equipment required to provide compatibility between users and the long haul transmission facilities shall be electrically connected between the equal level patch bay and the VF primary patch bay. The VF primary patch bay shall terminate 2, 4, 6, or 8 wire users. The equal level patch bay shall serve as the principal point of interface and restoration in the TCF. Circuits at the equal level patch bay shall appear as 4-wire balanced pair circuits. The equal level patch bay shall be the zero (0 dB) transmission level point (TLP). Supervisory signals, other than user generated integral signaling not needing conversion, shall appear as 2600 Hz or 2600/2800 Hz tones at the equal level patch bay. User generated integral signaling does not need conversion if users at both ends of the circuit use identical signaling. Such users are using the DCS as a transparent transmission media.

5.1.1 VF circuit descriptions. The following paragraphs and corresponding illustrations describe voice frequency circuits which will be commonly found in a technical control facility. A TCF may service other circuits besides the ones included in the following descriptions. Figure 4 defines the symbols and abbreviations used in depicting the TCF configurations of VF circuits.

5.1.1.1 Two-wire VF circuits. Two-wire circuits are depicted in Figure 5 (Circuit numbers 1 thru 5). All two-wire circuits entering the TCF require conversion to four-wire. Echo suppressors may be necessary depending on the user requirements.

5.1.1.1.1 Two-wire voice user with standard integral signaling (Circuit #1). This is a two-wire user who has integral in-band signaling incorporated into the terminal telephone equipment. A 2-wire/4-wire terminating set performs the necessary hybrid functions, with pads and amplifiers installed for level adjustment.

5.1.1.1.2 Two-wire voice user with 20 Hz signaling (Circuit #2). The user for this circuit is either a two-wire switchboard or an individual two-wire user using 20 Hz ringing source. This circuit provides echo suppression and control in order to minimize echoes arising from four-wire to two-wire conversion. Between the primary patch bay and equal level patch bay, conditioning is provided by pads, amplifiers, and 2-wire/4-wire terminating sets. Signaling conversion is provided by E&M/20 Hz converters and 2600/2800 Hz dual frequency signaling units (DFSU).

5.1.1.1.3 Two-wire voice user with loop signaling (Circuit #3). The user for this circuit is either a two-wire switchboard or a two-wire individual user which uses loop signaling. The circuit flow diagram is similar to 5.1.1.1.2 except for the E&M/dial loop signaling converters.

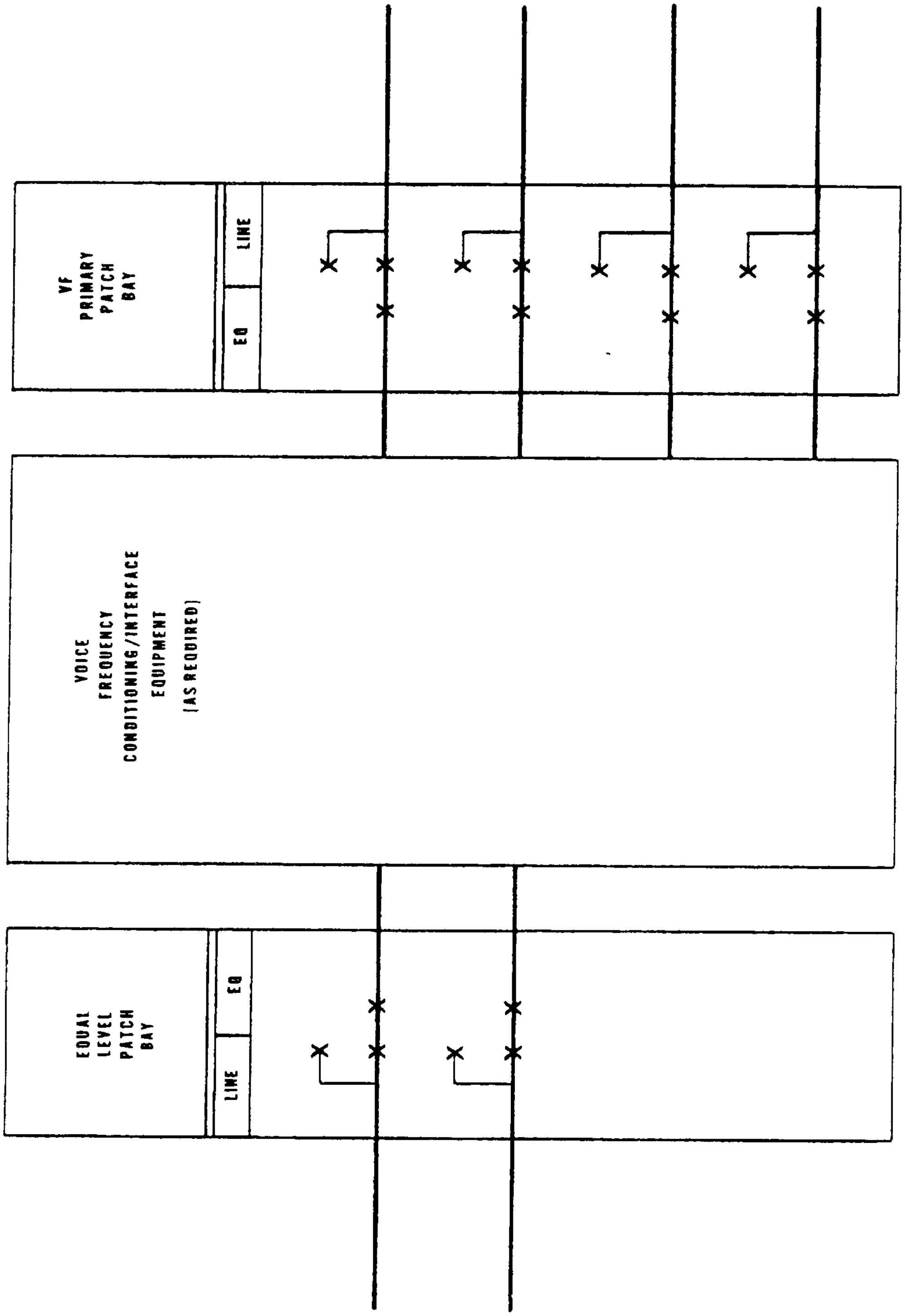
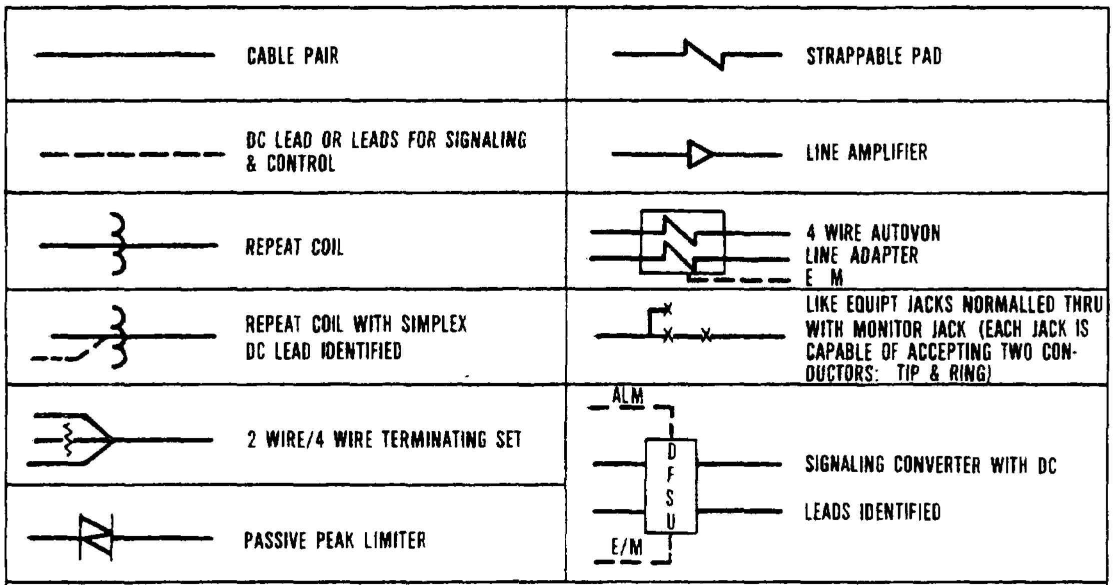


FIGURE 3. Arrangement of VF patching/monitoring and coordinating equipment



A, B	A&B SIGNALING LEAD	VFCT	VOICE FREQUENCY CARRIER TELEGRAPH
AE	AMPLITUDE EQUALIZER	MUX	MULTIPLEXER
E, M	E&M SIGNALING LEADS	PLR	PULSE LINK REPEATER
CH	CHANNEL	PMB	PILOT-MAKE-BUSY
DX	SIGNALING EXTENSION UNITS	REGEN	REGENERATIVE REPEATER
DE	DELAY EQUALIZER	DFSU	DUAL FREQUENCY SIGNALING UNIT AT 2600Hz/2800Hz
ES	ECHO SUPPRESSOR	SIG	SIGNALING UNIT
ESC	ECHO SUPPRESSOR CONTROL LEAD	VF	VOICE FREQUENCY
ALM	ALARM LEAD		
DS	OUT OF SERVICE LEAD		

FIGURE 4. Circuit flow diagram legend

NOTES (Applicable to Figures 5 through 14)

1 Repeat coils, echo suppressors, pads, amplifiers, and equalizers are shown in the general case. Specific employment of these items will depend on customer characteristics and requirements.

2 Patch and test facilities associated with various customers have not been shown since they do not affect the routing through, or the functions performed by, the TCF.

3 Circuits will be cross-connected to the transmision media or to each other, as required.

4 When passive peak limiters are required on a circuit, they shall be wired to the line side of the VF primary patch bay if the TLP there is -2 dB or greater and they would not interfere with signaling. Otherwise, they shall be installed on the equipment side of the equal level patch bay. They may be physically located on the corresponding terminal board on the distribution frame.

5 Integral signaling units and 2-wire/4-wire terminating sets that are part of fixed station and tactical multiplexers shall not be utilized.

6 Numbers within circles, e.g. (1), indicate a circuit number.

7 Numbers within triangles, e.g. △3, indicate an applicable note.

8 Letters within a circle, e.g. (A), indicate a connection point.

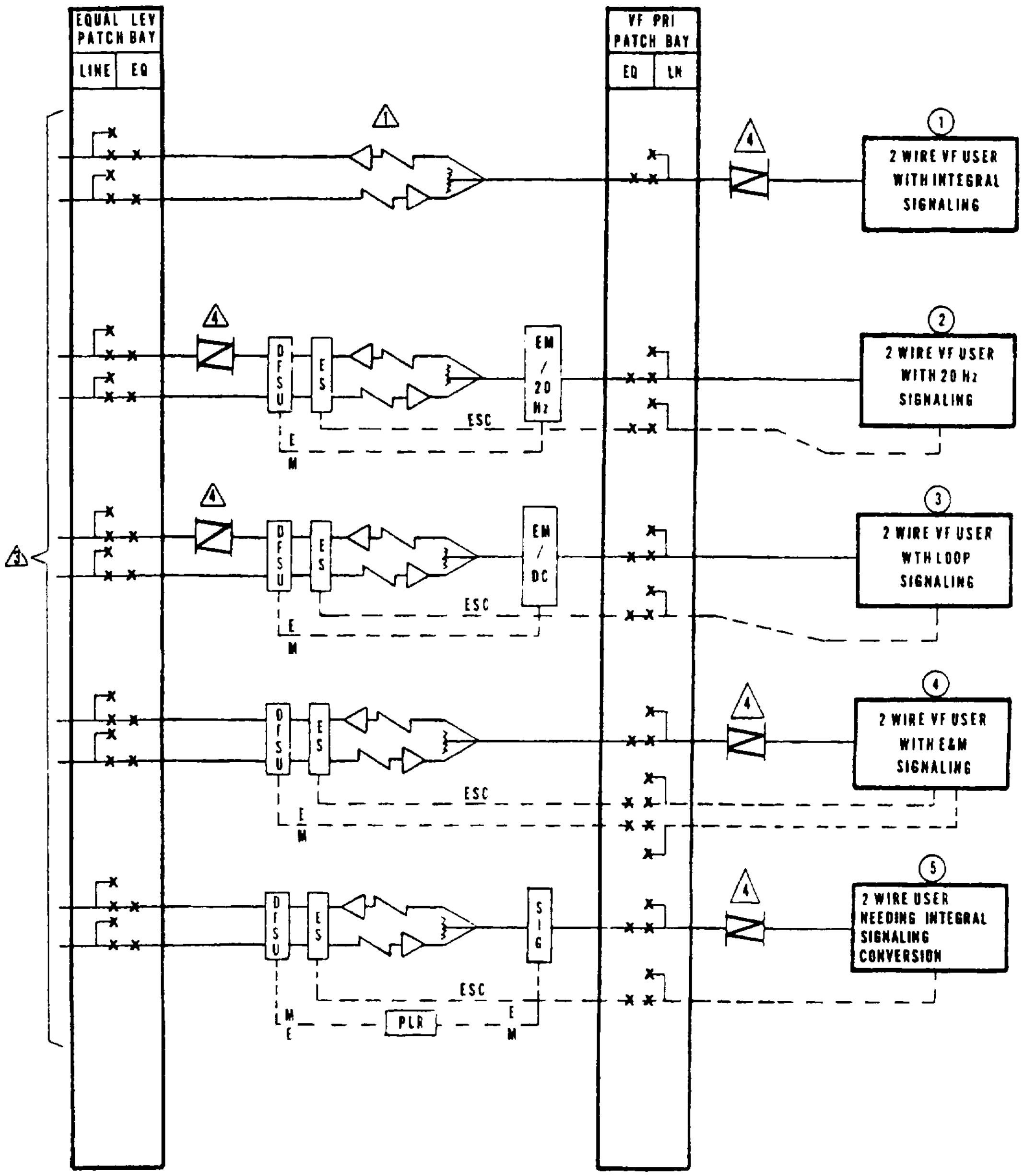


FIGURE 5. Two-wire voice frequency users

5.1.1.1.4 Two-wire voice user with E&M signaling (Circuit #4). The user for this circuit is either a two-wire switchboard or individual user with E&M signaling. It is noted that in this circuit the E&M (dc) leads from the subscriber location travel through the VF primary patch bay to the DFSU. Conditioning items are a 2-wire/4-wire terminating set, repeat coil, echo suppressor, with pads and amplifiers for level adjustment.

5.1.1.1.5 Two-wire voice user needing integral signaling conversion (Circuit #5). After entering the TCF via the primary patch bay, this circuit's integral signaling needs to be converted to standard 2600/2800 Hz in-band signaling before the circuit appears on the equal level patch bay.

5.1.1.2 Four-wire VF circuits. Four-wire VF circuits are depicted in Figure 6 (Circuit numbers 6 thru 10). The four-wire circuits enter the TCF at the VF primary patch bay and after all necessary interfacing are routed to the equal level patch bay.

5.1.1.2.1 Four-wire user with integral signaling (Circuit #6). This circuit provides its own in-band integral signaling at the user terminal or the circuit may be a data circuit with no signaling required. In any case, no signaling conversion is required at the TCF between the primary patch bay and equal level patch bay appearances. Repeat coils, pads and amplifiers are supplied for conditioning and level adjustment. Amplitude equalizers, delay equalizers, or both may be required, depending on the type of service.

5.1.1.2.2 Four-wire user with 20 Hz signaling (Circuit #7). The users for this circuit are either four-wire switchboards or individual four-wire users who employ 20 Hz signaling. A four-wire physical circuit is used for the on-base cabling. Conditioning and level adjustment between the primary patch bay and equal level patch bay consists of pads, amplifiers and repeat coils. E&M/20 Hz converters and DFSU's are required for telephone signaling conversions.

5.1.1.2.3 Four-wire user with loop signaling (Circuit #8). The user for this circuit can be either a four-wire switchboard or an individual user who employs loop signaling.

5.1.1.2.4 Four-wire user with E&M signaling (Circuit #9). A DX-1 signal unit and repeat coils are used at the user location to conserve cable pairs or because the loop resistance exceeds 50 ohms. The DX-2 unit is used in conjunction with the DX-1 unit to provide E&M leads to the DFSU.

5.1.1.2.5 Four-wire user using nonstandard in-band signaling (Circuit #10). After entering the TCF via the VF primary patch bay, this circuit's integral signaling needs to be converted to standard 2600/2800 Hz in-band signaling before the circuit appears on the equal level patch bay.

5.1.1.3 AUTOVON users collocated with a TCF and an AUTOVON switch. AUTOVON user circuits are depicted in Figure 7, (Circuit numbers 11 thru 14). When the AUTOVON switch is also collocated with the TCF the circuits do not

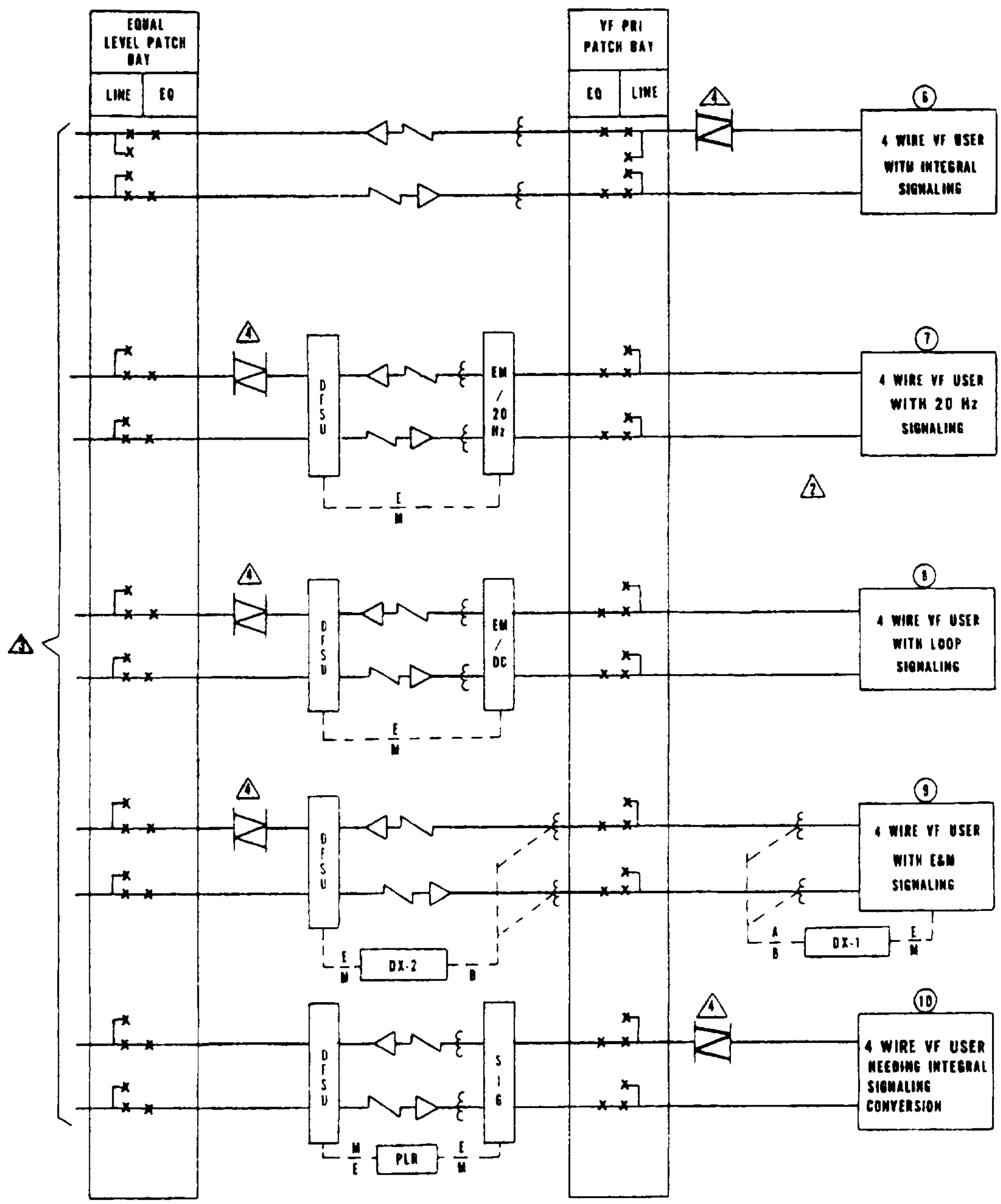


FIGURE 6. Four-wire voice frequency users

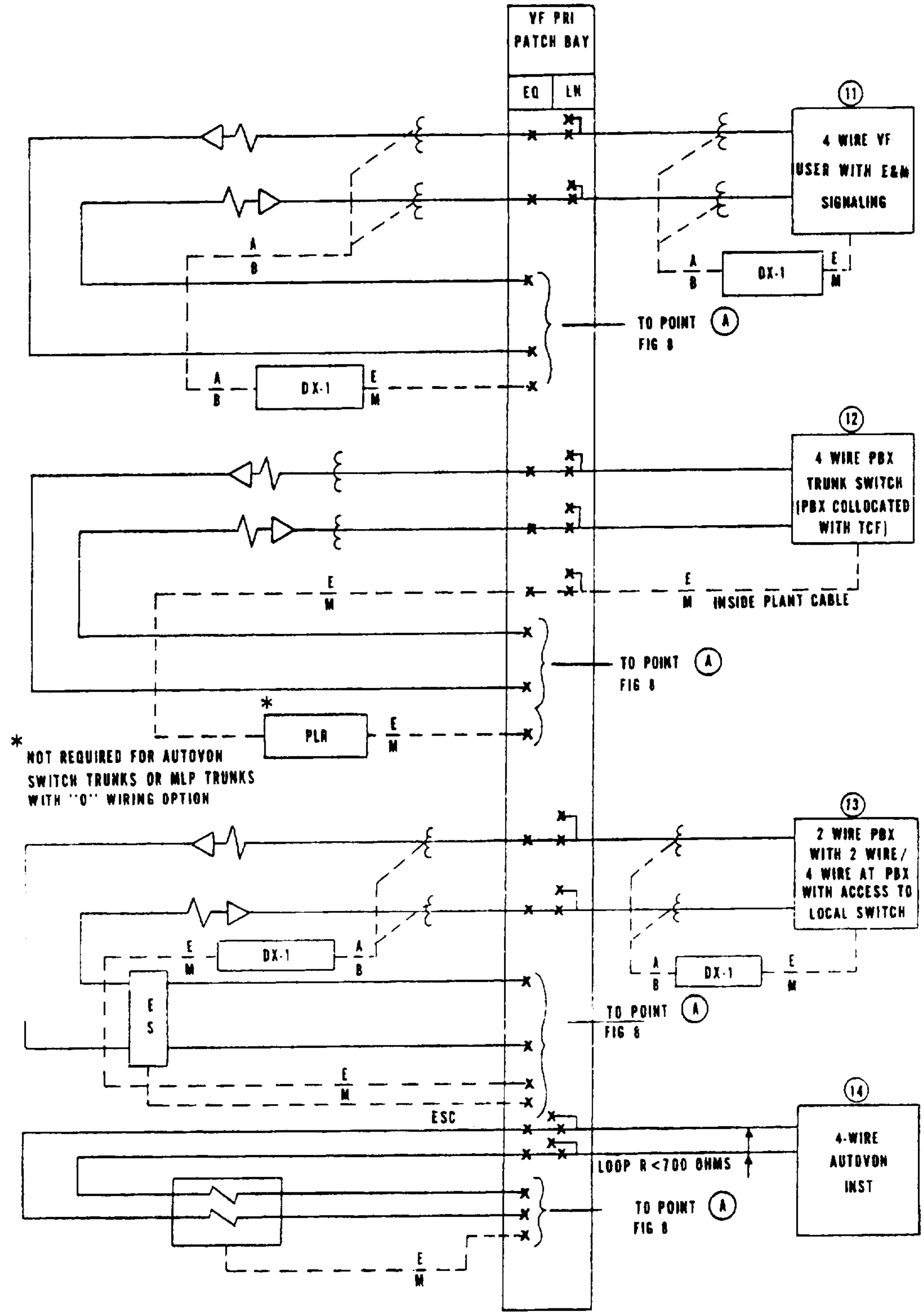


FIGURE 7. AUTOVON user collocated with TCF and AUTOVON switch

access the equal level patch bay. After passing the VF primary patch bay the circuits are conditioned for proper levels and E&M signaling and make another appearance at the VF primary patch bay before being connected to the AUTOVON switch.

5.1.1.3.1 Four-wire circuit with DX signaling (Circuit #11). The user for this circuit is either an AUTOVON PBX access line or an AUTOVON four-wire user. DX-1 signaling units and repeat coils are used at the user location either to conserve cable pairs or because loop resistance exceeds 50 ohms.

5.1.1.3.2 Four-wire PBX circuit with E&M signaling to AUTOVON (PBX cable to TCF) (Circuit #12). This circuit is similar to the circuit described in 5.1.1.3.1 except there is no requirement for DX-1 signaling units at the user or the TCF. However, a pulse-link repeater is required to interchange the E&M leads when collocated with trunks not already having the interchange capabilities.

5.1.1.3.3 Two wire PBX cable access line to local AUTOVON Switch (two to four-wire conversion at the PBX) (Circuit #13). This circuit involves connection of a two-wire on-base telephone switchboard to a collocated AUTOVON switch. A 2-wire/4-wire terminating set shall be required at the PBX location. Normally the E&M leads will be extended as shown in Figure 7. Where loop resistance exceeds 50 ohms, signal extension units shall be required at the PBX location and at the TCF. When required, split controlled echo suppressors, pads and amplifiers shall be inserted into the circuit as shown.

5.1.1.3.4 Four-wire AUTOVON user telephone cable to TCF (loop resistance less than 700 ohms) (Circuit #14). This AUTOVON telephone is located so that the loop resistance from the collocated TCF and switch is less than 700 ohms. In this case the circuit shall access the VF primary patch bay, connect to the 4-wire AUTOVON line adapter, return to the VF primary patch bay, and then proceed to the collocated AUTOVON switch.

5.1.1.4 AUTOVON switch circuits. AUTOVON switch circuits are depicted in Figure 8 (Circuit numbers 15 and 16). These circuits are trunks emanating directly from an AUTOVON switch collocated with the TCF. These circuits connect to the VF primary patch bay where they are routed to the equal level patch bay for transmission. The alarm (ALM) and out of service (OS) leads from the DFSUs are routed to the switch for busying out the trunk when required.

5.1.1.4.1 Four-wire AUTOVON circuit (Circuit #15). This trunk circuit, emanating directly from an AUTOVON switch collocated with the technical control facility, is interconnected at the equal level patch bay for service to remote AUTOVON users. This circuit appears on the equal level patch bay with pads and amplifiers provided for level adjustment.

5.1.1.4.2 Four-wire AUTOVON special grade circuit (AUTOVON data users and inter-switch trunks) (Circuit #16). This circuit is similar to 5.1.1.4.1 except for the provision of amplitude, delay, or both types of equalization devices in this circuit for data use.

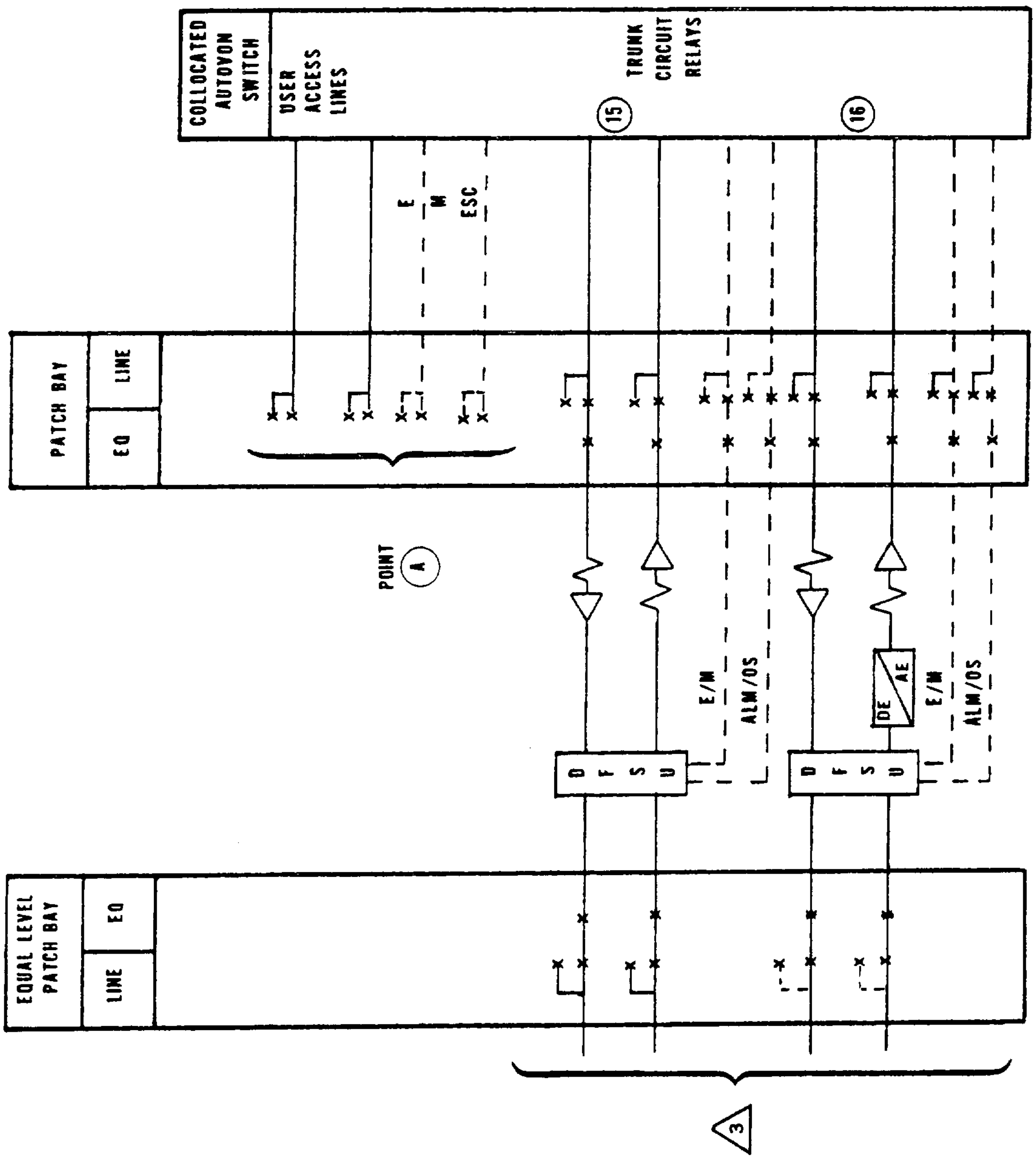


FIGURE 8. AUTOVON switch circuits

5.1.1.5 Voice frequency data circuits. VF data circuits are depicted in Figure 9 (Circuit numbers 17 thru 20). These circuits provide service to voice frequency data users. Individual circuits may require amplitude and delay equalization units in the equipment strings depending on the quality of service required. The data circuits enter the TCF at the primary patch bays where the necessary conditioning occurs prior to the circuit being routed to the equal level patch bay.

5.1.1.5.1 Two-wire data circuit with E&M signaling (Circuit #17). This circuit is similar to 5.1.1.1.4 except echo suppressors can not be used because of interference with the transmitted data. Data is usually transmitted and received in a simplex mode only.

5.1.1.5.2 Four-wire data circuit without signaling (Circuit #18). These circuits consist of data lines from AUTODIN interswitch trunks and secure voice circuits. In addition to level adjustment, amplitude or delay equalization units may be required in the conditioning equipment strings.

5.1.1.5.3 Four-wire data circuit using a low speed modem (Circuit #19). This digital circuit is routed through the modem from a digital circuit patch bay to the equal level patch bay. The circuit may be routed to the VF primary patch bay if conditioning equipment, such as amplitude and delay equalizers, is needed, prior to being connected to the equal level patch bay.

5.1.1.5.4 Four-wire data circuit using a voice frequency carrier telegraph (VFCT) (Circuit #20). This circuit consists of multiple teletypewriter signals which traverse the TCF through the digital primary and circuit patch bays and are then combined into a "tone package" by a voice frequency carrier telegraph. The VF tone package employs a nominal 4-kHz channel bandwidth and appears at the equal level patch bay as an audio signal. If pads and amplifiers are required, the circuit shall be routed through the VF primary patch bay and conditioning equipment prior to accessing the equal level patch bay.

5.1.1.6 HF radio circuits. These are voice and telegraph circuits using HF radio for long distance communications and are depicted in Figure 10 (Circuit numbers 21 thru 23). All such HF radio circuits shall have at least one appearance at the equal level patch bay. This means that HF radio circuits accessing the mux link may have two appearances at the equal level patch bay; one where all the HF radio circuits are grouped together and another where all the circuits going out on that mux link are grouped together. HF audio circuits that access the TCF via the DCS will enter at the equal level patch bay (circuit #22).

5.1.1.6.1 Four-wire diversity connections to HF radio systems (Circuit #21). The remote HF radio transmitter and receiver sites may access the TCF by either microwave radio or cable intersite links. When circuits access the TCF via cable, they shall be routed through the VF primary patch bay only if the cable loss is 0.5 dB or greater; otherwise, they shall access the equal level patch bay. When circuits access the TCF via a fixed station multiplexer, they shall be connected to

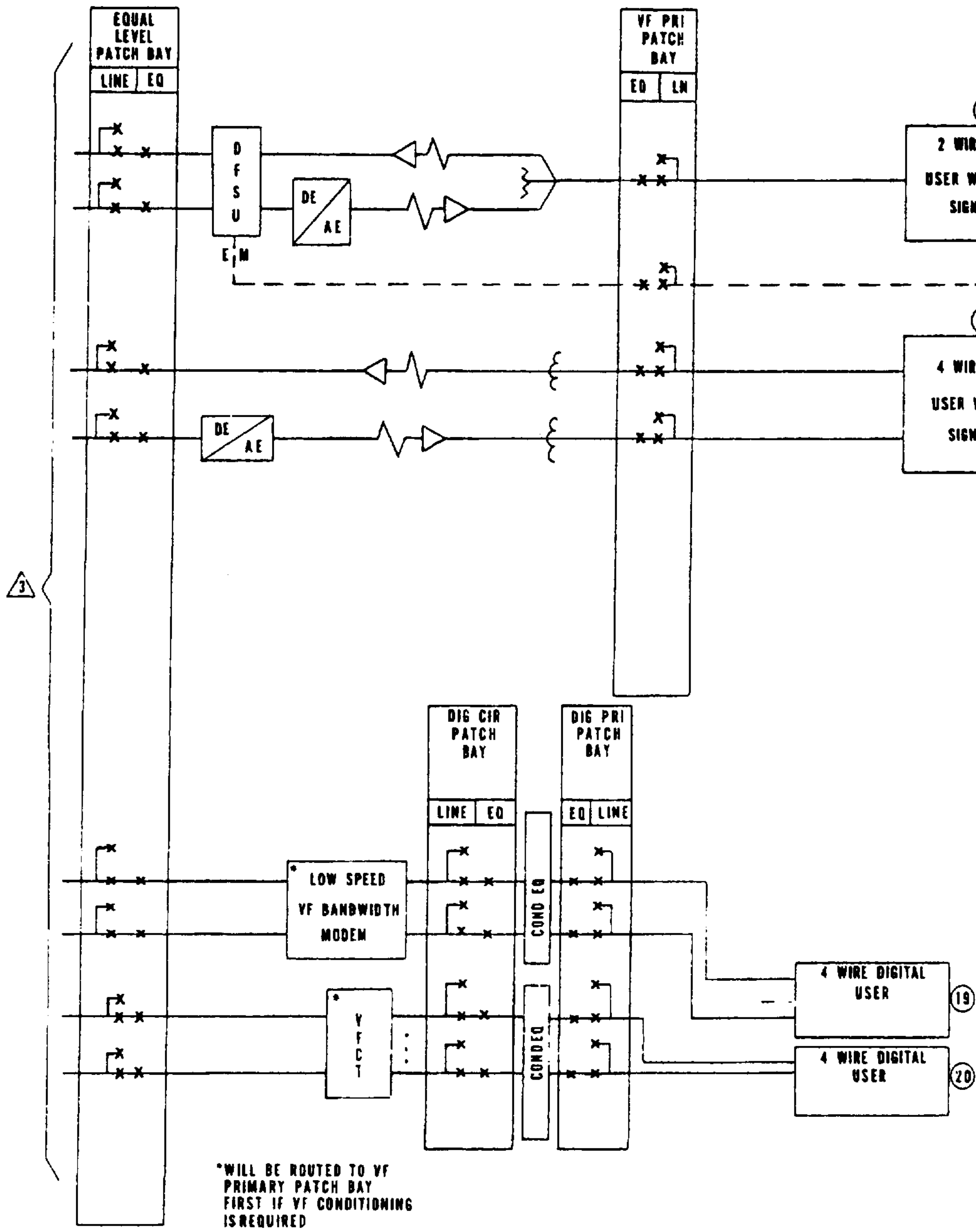


FIGURE 9. Data circuits

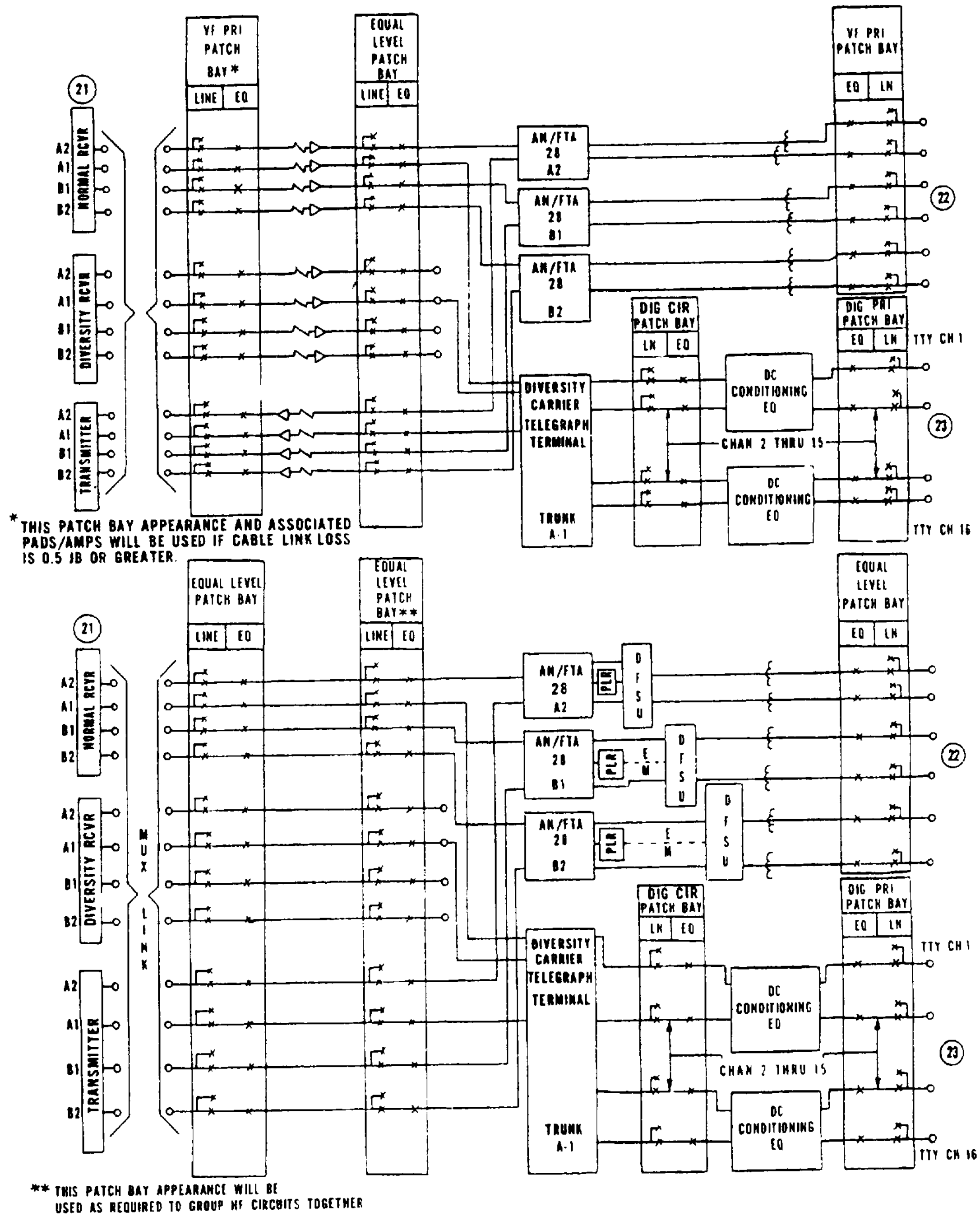


FIGURE 10. HF radio circuits

the equal level patch bay with other multiplex channels. If there are other HF circuit links in the station, all the HF circuits may be grouped together at a separate section of the equal level patch bay. This would require double appearances at the equal level patch bay for some circuits but it makes it convenient for alt-routing HF circuits.

5.1.1.6.2 VF circuits using radio telephone terminals (Circuit #22). Audio circuits access the VF primary patch bay and are conditioned for the HF radio system by the radio telephone terminal prior to accessing the equal level patch bay. In cases where the audio circuit enters via the DCS, the use of a dual frequency signaling unit is required to convert the standard supervisory signals at the equal level patch bay into signals compatible with HF radio transmissions.

5.1.1.6.3 Diversity carrier telephone terminal circuits (Circuit #23). These digital circuits access the digital primary patch bay and are conditioned before accessing the digital circuit patch bay. Circuits from the digital circuit patch bay provide inputs to the carrier telegraph terminal which then provides a VF tone package to the equal level patch bay for transmission.

5.1.1.7 Circuit connection to the media. Circuit transmission usually consists of one of three media: long haul DCS, tactical, or cable. Connections to the media are depicted in Figure 11 (Circuit numbers 24 thru 26).

5.1.1.7.1 DCS fixed station multiplexer (Circuit #24). Circuit #24 is the normal configuration of a VF circuit between the equal level patch bay and the fixed station multiplexer. If level adjustment is required, pads and amplifiers may be installed between the multiplexer and the equal level patch bay.

5.1.1.7.2 Tactical multiplexer circuit connection (Circuit #25). This circuit is provided to interface a tactical multiplexer with the DCS. It is similar to circuit #24 except a tactical multiplexer is used.

5.1.1.7.3 Four-wire toll cable (Circuit #26). This circuit is required for interconnection at the primary patch bay with any long distance commercial or military cable circuit. Level adjustment using pads and amplifiers shall be between the primary patch bay and equal level patch bay appearances. If the toll cable loss does not exceed 0.5 dB, this circuit may be connected directly to the equal level patch bay.

5.1.2 Functional description of VF terminating equipment. Functional descriptions of VF terminating equipment are given below. For detailed equipment characteristics refer to MIL-HDBK-414.

5.1.2.1 E&M signaling extension circuits (DX-1 and DX-2). These signaling extension units are designed to interconnect two signaling and supervision circuits when the metallic resistance between users exceeds operational limits. The units are also used to interconnect an E&M signaling circuit to a distant trunk circuit

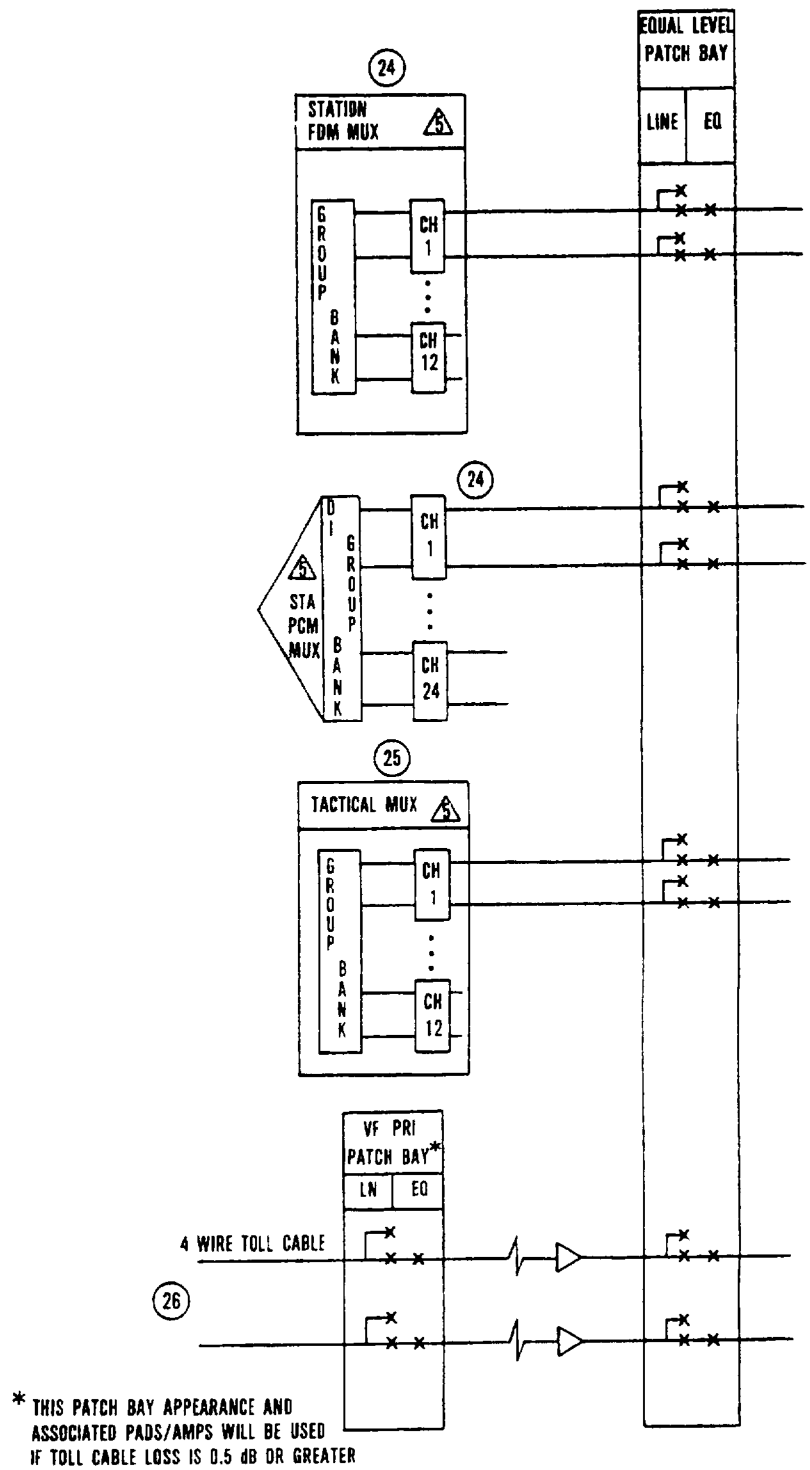


FIGURE 11. Media connections

which uses dual frequency signaling. E&M signaling extension units are usually required where the connecting facility (cable) resistance exceeds 25 ohms (50 ohm loop). Two types of DX units are used. DX-1 units are designed to accept standard E&M signals, while DX-2 units are designed to provide a source of E&M signals.

5.1.2.2 Pulse-link repeater. The pulse-link repeater connects two signaling circuits using E&M leads by converting an incoming E-lead potential to an outgoing M-lead potential in both directions of transmission. The pulse-link repeater does not connect to, or affect, the talking path; it is connected in the signaling path only.

5.1.2.3 Single frequency signaling unit (SFSU). SFSUs are designed to pass signals over the VF path of access lines without impairing their use for speech. They deliver and accept dc signals in the form of E&M lead controls. The two-state dc signals on the M-lead are converted to on-and-off 2600 Hz VF signals on the transmitting voice path. The on-and-off 2600 Hz VF signals received at the distant terminal are converted to two-state dc signals on the E-lead. This signaling scheme is in predominate use in the DCS now but it is anticipated that the DFSU, described in 5.1.2.4, will replace this scheme.

5.1.2.4 Dual frequency signaling unit (DFSU). DFSUs shall be used as the in-band signaling devices for four-wire voice-frequency circuits of the Defense Communications System. Primary applications will be on four-wire user access lines, PBX/PABX access lines, and interswitch trunks of the overseas AUTOVON. The DFSUs provide conventional E&M (supervisory and dial pulse) signaling functions on four-wire telephone circuits through the use of two in-band signaling tones, 2600 Hz and 2800 Hz. The unit incorporates a method to verify an off-hook condition and to provide end-to-end alarm indications when abnormal signaling conditions are encountered or when the associated circuits are taken out of service for maintenance purposes. The DFSUs additionally provide immunity to certain signaling anomalies which affect the conventional single frequency signaling units.

5.1.2.5 E&M to 20 Hz converter. The E&M to 20 Hz signal converter sends signals over the M lead to 2600 Hz/2800 Hz signaling equipment when a 20 Hz signal is received from a ringdown circuit. The unit also receives signals over an E lead from signaling equipment and transmits 20 Hz signals to the ringdown user circuit. This equipment shall be arranged to operate with signaling frequencies other than 20 Hz when required.

5.1.2.6 E&M loop converter (E&M to dc). The dial loop to E&M converter provides complete access between a central office and a dial user instrument over a carrier channel. There are two versions of this unit. One is called the central office dial loop to E&M converter. This unit receives 20 Hz from the central office and converts the 20 Hz signal to an M lead seizure for input to an SFSU or DFSU in the outgoing direction, and presents a closed loop to the central office when the E lead from the SFSU or DFSU indicates an incoming call. The other unit is called a subscriber dial loop E&M converter. This unit recognizes a closed loop when the user goes off-hook and indicates seizure to the M lead and converts dial pulses to M lead pulsing of the SFSU and DFSU. When a call is coming in to the subscriber the E lead causes a 20 Hz ringing signal to be sent to the end instrument.

5.1.2.7 Amplitude equalizer. An amplitude equalizer is a corrective network which is designed to make the amplitude characteristics of a circuit or system substantially equal over a desired frequency range. (Usually used for cable circuits.)

5.1.2.8 Delay equalizer. A delay equalizer is a corrective network which is designed to make the phase delay of a circuit or system substantially linear over a desired frequency range.

5.1.2.9 Two-wire/four-wire terminating set. In order to interconnect a four-wire tranmission path to a two-wire transmission path, a two-wire/four-wire terminating set is used. On the four-wire side the impedance of each pair shall be 600 ohms.

5.1.2.10 Repeat coil. A repeat coil is a transformer used for voice frequency energy transfer from one circuit to another. The coil is used to match circuit impedances for maximum transfer of energy or to connect unbalanced equipment to a balanced line. The coil can be used to provide dc isolation of telephone lines from the office facilities. Loop signaling or supervisory leads can be derived from the midpoints of the coil on the line side.

5.1.2.11 Pad. A pad intended for use in voice frequency balanced circuits shall have adjustable attenuation and provide a constant input and output impedance of 600 ohms.

5.1.2.12 VF Amplifier. A VF amplifier shall be matched to the circuit impedance and provide fixed or continuously adjustable signal gain.

5.1.2.13 Echo suppressor. An echo suppressor is a device which detects signals (such as speech) transmitted in either direction on a four-wire circuit, and introduces loss to suppress echoes resulting from hybrid network feedback. A controlled suppressor is switched in or out by a control circuit, as required, to enable or disable its normal function. A fixed suppressor is enabled at all times, hence it does not require a control circuit arrangement. All echo suppressors will have a unidirectional send, a unidirectional receive, and a bidirectional state.

5.1.2.14 Passive peak limiter (PPL). This device is used to automatically prevent system overload caused by excessive transmission levels from the user equipment. These devices shall be located on the line side of the VF primary patch bay if the TLP there is -2 dB or greater and they would not interfere with signaling. Otherwise, they shall be installed on the equipment side of the equal level patch bay. They may be physically located on the corresponding terminal board on the distribution frame. Reference MIL-HDBK-414 for the DCS standard PPL characteristics.

5.1.2.15 Six-way/four-wire bridge. This device provides a conferencing capability for 6 each 4-wire telephone circuits. The bridge shall be installed on the equipment side of the equal level patch bay.

5.1.3 VF patch logic. Jack and patch logic shall have the capability to accomplish the following functions at the equal level and VF primary patch bays:

a. Provide a "normal through" (no patch cords used) connection through the line and equipment jacks for the channel pair on the tip and ring contacts.

b. Provide the ability to patch any line to any equipment on a temporary basis.

c. Accept inputs from the miscellaneous jack field such as termination impedances, test signals, test equipment, 6-way/4-wire bridges, etc.

d. Provide bridge monitoring for at least the line jacks.

5.2 Digital data circuits. Digital data circuits are depicted in Figures 12 through 14.

5.2.1 General. Existing digital circuits consist of a wide variety of modulation rates, modes of operation, unit codes, and circuit configurations. The variety of circuits and various equipment arrangements at the user location has caused nonstandardization of digital technical control facilities. Some of the user configurations and operating modes are necessary in their present form, but maximum standardization will be the primary goal within the technical control facility. The following standards are considered minimum in the development of a suitable baseline. Implementation of these standards shall reduce the large variety of conditioning and conversions applied at the technical control facility and allow greater universality and standardization.

5.2.1.1 Signal modes. All digital circuits appearing at the circuit bays shall be configured for low-level polar operation as defined in MIL-STD-188-114. Conversion from unbalanced to balanced mode shall be accomplished at the source, if possible. All new systems shall be in a balanced configuration.

5.2.1.1.1 Low level operation. The digital circuit patch bay shall operate low-level in accordance with MIL-STD-188-114. Only low-level operation shall be employed within a RED equipment area when such an area is required to support the technical control facility. All teletype and data end equipment used within the facility shall be configured for low-level operation in order to provide flexibility during equipment substitution and to facilitate conversion to encrypted operation at a later date. For example, conversion from RS-232 to MIL-STD-188-114 should be made as close to the end equipment as practicable.

5.2.1.1.2 Provisioning for encrypted orderwire. Unencrypted data orderwire and reporting circuits may be required at many locations. These circuits are intended for encrypted service at a later date and shall be configured and routed in-station so that installation of the cryptographic device will not require major rewiring of the circuit.

5.2.1.2 Technical control access for digital data circuits. All technical control (TTY, orderwires, reporting circuits, etc.) and all in-station digital circuits not requiring interfacing equipment shall appear directly at their associated digital circuit patch bay.

5.2.1.3 Timing, control, and alarm circuits. Provisions shall be made on the digital circuit patch bay for the patching, testing and monitoring of all timing, control, and alarm circuitry associated with the digital circuits.

5.2.1.4 Monitoring of digital signals. All digital circuits shall appear on a digital circuit patch bay. The only difference among digital signals at the patch bay shall be in coding schemes, balanced or unbalanced mode, and data rates. Monitoring of digital signals shall be performed on a high impedance basis.

5.2.1.5 Digital patch logic. Jack logic for the "D", "K", and "M" digital patch bays shall have the capability to accomplish the following functions:

a. Provide a "normal through" (no patch cords) connection for the signal and timing leads through the line and equipment jacks.

b. Provide the ability to patch any line to any equipment on a temporary basis.

c. Accept inputs from the miscellaneous jackfield such as a "mark" hold, "space" hold, test signals, termination impedances, test equipment etc.

d. Provide bridge monitoring for at least the line jacks.

5.2.1.6 Digital multiplexers. Channels demultiplexed solely to accommodate an A/D conversion and planned to be through di-grouped at some future time shall be treated as a thru-group. There is no need to terminate each such digital or VF channel in the TCF.

5.2.1.6.1 Digital multiplexer circuits. Individual digital multiplexers shall be configured in an all balanced circuit mode or in an all unbalanced circuit mode. There shall be no intermixing of balanced and unbalanced circuits on a multiplexer.

5.2.1.6.2 Digital patch bay appearances. All circuit inputs and outputs of digital multiplexers shall make an appearance on a digital patch bay. The requirement can be satisfied by appearance at a DCS patch and test facility of all inputs and outputs. When the requirement is met in this manner, TCF appearances can be limited to:

a. All utilized dedicated channels.

b. All spare dedicated channels.

c. A 20% expansion capability in jack appearances and cable trunking.

5.2.1.6.3 VF patch bay appearances. PCM's which are utilized for both VF and digital signals shall have all possible VF inputs/outputs appear in the TCF operations area.

5.2.1.7 Dc hubbing repeater. This device shall enable a predetermined group of users to operate such that if any one user transmits a message, it shall be received by all others in the group. This device shall allow any user to transmit as long as only one station is transmitting at any particular moment. The hubbing repeaters may be used as the interface device between a send only device and several receiving terminals.

5.2.2 Basic digital circuits. The following paragraphs and corresponding illustrations of Figures 12 to 14 describe the various digital circuits.

5.2.2.1 Unbalanced digital data user utilizing an unbalanced system (Circuit #1). These circuits shall access the TCF at the "D" digital primary patch bay. If a circuit requires timing, the timing shall be routed with the data in the same manner. The circuits shall then be processed by any conditioning equipment necessary to correct nonstandard levels, regenerate the signal, reshape signal waveforms, or to provide system isolation prior to accessing the "D" digital circuit patch bay.

5.2.2.2 Unbalanced digital data user utilizing a balanced system (Circuit #2). These circuits shall access the TCF at the "D" digital primary patch bay. The circuit shall be converted and conditioned prior to accessing the "K" digital circuit patch bay. If the circuit requires timing, then the timing signal shall also be routed with the data in a similar manner.

5.2.2.3 Balanced digital data user utilizing an unbalanced system (Circuit #3). These circuits shall access the TCF at the "K" digital primary patch bay. The circuit shall then be converted and conditioned and access the "D" digital circuit patch bay. If the circuit requires timing or if timing recovery is used, the timing signal shall also be routed with the data in a similar manner.

5.2.2.4 Balanced digital data user utilizing a balanced system (Circuit #4). These circuits shall access the TCF at the "K" digital primary patch bay. If the circuit requires timing, the timing signal shall be routed with the data. The circuits shall then be processed by any conditioning equipment necessary to correct nonstandard levels, regenerate signals, reshape signal waveforms, or to provide system isolation prior to accessing the "K" digital circuit patch bay.

5.2.2.5 Digital circuits utilizing a VFCT (Circuit #5). These digital circuits are routed to the VFCT from their associated digital circuit patch bays. The voice frequency composite signals shall then make an appearance at the equal level patch bay. (Note: Some VFCTs may operate at high level and cannot be converted internally for low level, thus requiring level converters between the VFCT and the digital circuit patch bay).

5.2.2.6 Digital circuits using a sublevel multiplexer/concentrator (Circuit #6). These circuits are routed to the multiplexer from their associated digital circuit patch bays. They may be synchronous, asynchronous, or isochronous. The aggregate output shall then be routed back to the "D" or "K" digital circuit patch bay, as appropriate.

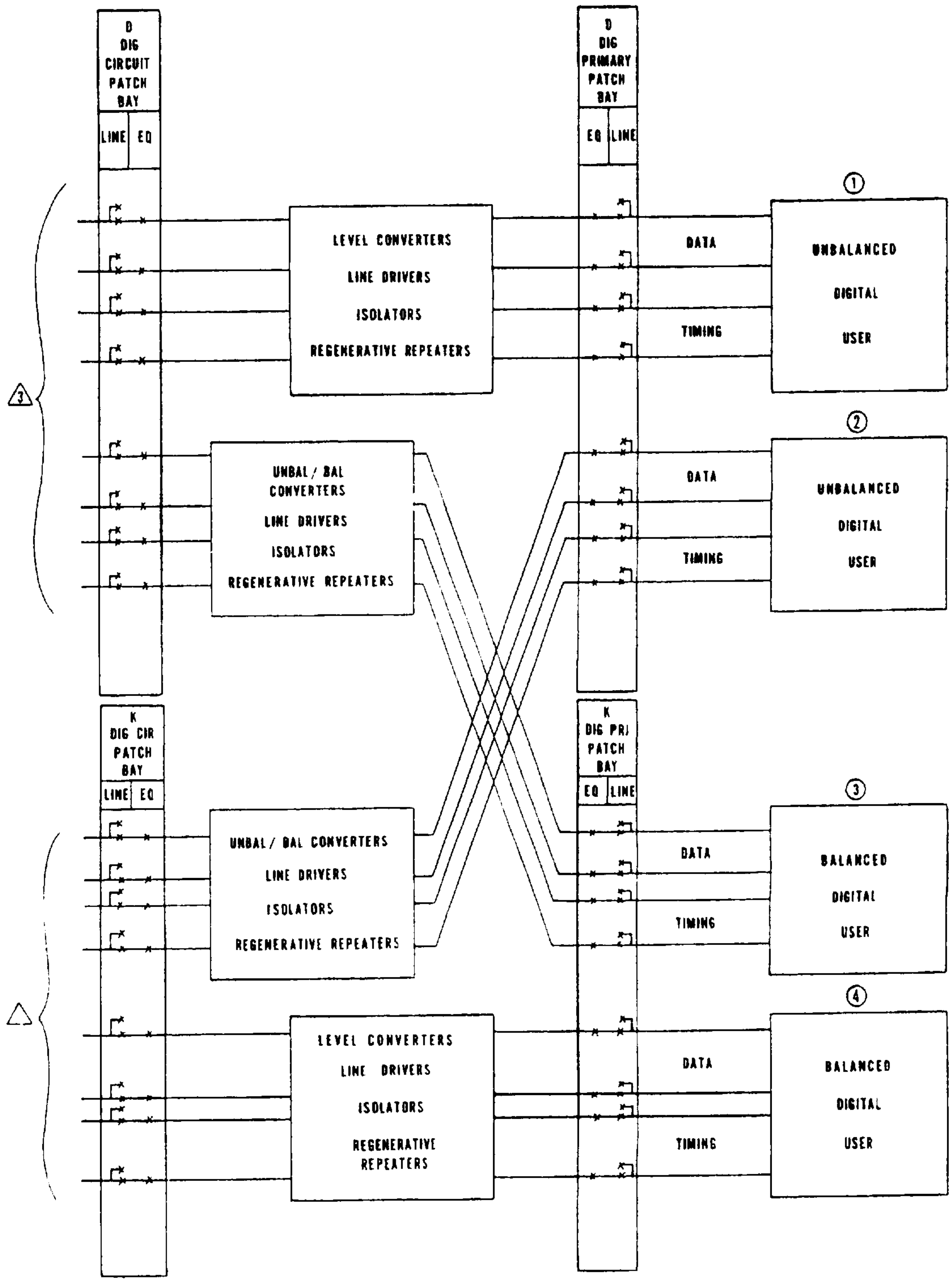


FIGURE 12. Digital data users (0 to 1 Mb/s)

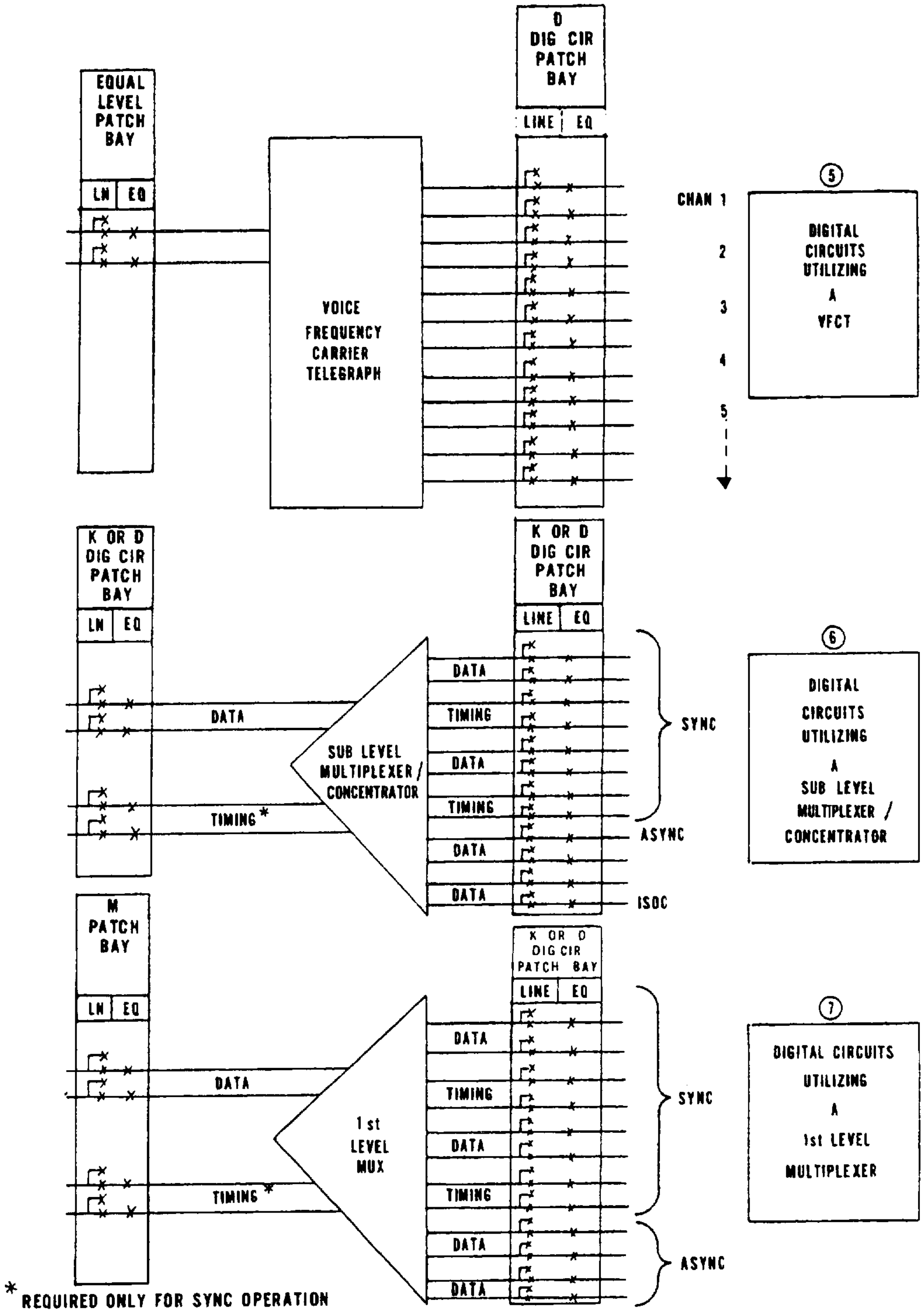


FIGURE 13. Digital circuits (0 to 1 Mb/s)

5.2.2.7 Digital circuits utilizing first level multiplexers (Circuit #7). These circuits are routed to the multiplexer from their associated digital circuit patch bays. They may be synchronous or asynchronous. The aggregate output shall then be routed to the "M" patch bay.

5.2.2.8 Digital circuits utilizing second level multiplexers (Circuit #8). These circuits are routed to the multiplexer from the "M" patch bay. The aggregate output shall then be routed to the "MM" patch bay and connected to the media.

5.2.2.9 Digital circuits utilizing fiber optics as the transmission media (Circuit #9). The transmit circuit shall be routed to the fiber optic transmitter from the "MM" patch bay. The receive circuit is routed from the fiber optic receiver to the "MM" patch bay, then to the bit synchronizer for timing recovery, and finally back to the "MM" patch bay.

5.2.3 Dc conditioning equipment. Dc conditioning equipment is used to interface various types of digital users to the DCS. This equipment is usually connected between the digital primary patch bay and digital circuit patch bay. Functional descriptions of some dc conditioning equipment are given below.

5.2.3.1 Level converters. Level converters are devices used to change signal levels from one electrical interface standard to another.

5.2.3.2 Unbalanced/balanced converters. A device used to convert unbalanced transmission lines to balanced transmission lines and vice versa.

5.2.3.3 Isolators. A device inserted into a circuit or transmission line to prevent or reduce unwanted interaction between circuits on each side of the insertion point.

5.2.3.4 Line drivers. Line drivers are used to extend the line distance over which data may be transmitted.

5.2.3.5 Regenerative repeaters. These devices are used to re-time and re-shape digital signals for onward transmission. These units are usually designed for a specific range of data rates and specific signaling codes and are intended for use before signals reach the maximum distortion limit, usually 49%.

5.3 Analog facilities.

5.3.1 General. Facilities for monitoring, testing and patching of wideband circuits (20 - 48 KHz) and multiplex groups and monitoring of basebands shall be provided at stations in accordance with criteria given below. These facilities may be integrated into the wideband equipment.

5.3.1.1 Wideband facilities. Wideband circuit monitoring and testing facilities shall be provided at all stations which control such circuits. At stations where alternate routes or spare equipment for such circuits are available, patching facilities to permit re-routing or restoral shall also be included.

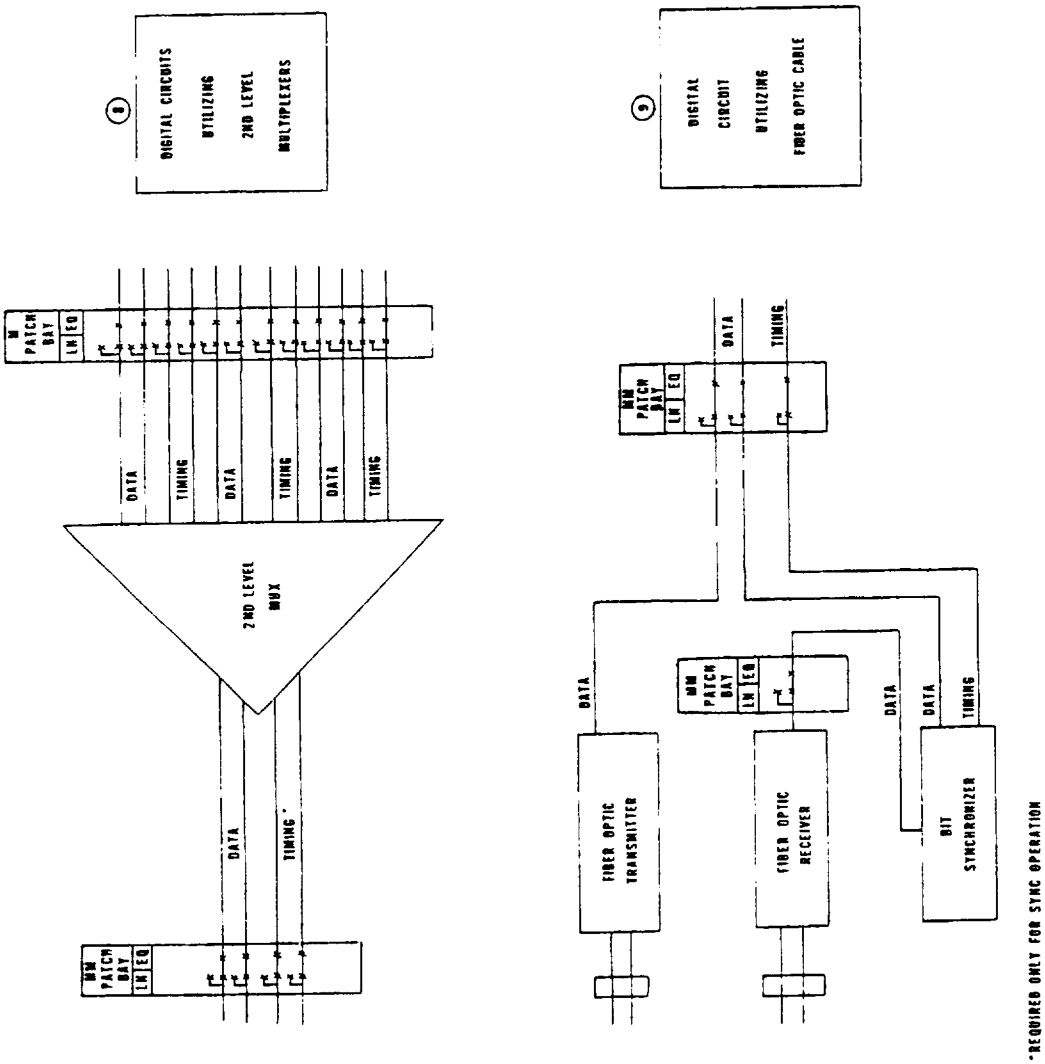


FIGURE 14. Digital connections to the media

5.3.1.2 Group facilities. Group monitoring, testing and patching facilities shall be provided at all stations having more than two multiplex link terminals, and may be provided at smaller stations to meet special requirements. Normally, at stations having only one or two multiplex link terminals, the patch modules integral to the multiplexers shall be adequate for these purposes.

5.3.2 Group patching concept.

5.3.2.1 Basic requirements. The capability for patching among like and unlike multiplexers is necessary to permit re-routing and restoral. For multiplexers having identical impedance, level, and pilot frequencies, only a pair of group connectors shall be required. Other multiplexers which utilize the same frequency allocation plan but have different levels, impedances, or pilot frequencies shall be made compatible, for patching purposes, through the use of conditioning equipment as described below. There are certain types of multiplexers in use which utilize a non-standard frequency allocation plan and therefore cannot be patched at the group level even with conditioning. Appearances for such equipment shall be provided on the coaxial patch bay for monitoring and testing only.

5.3.2.2 Standard levels and impedances. Standard levels and impedances are established by MIL-STD-188-311; however, many types of multiplexers are in use which utilize other levels and impedances. In stations where the majority of the multiplexers do not conform to MIL-STD-188-311 standard levels and impedances, the local levels and impedances may be adopted as the standard for that station. The term "standard", when used hereafter in this section, shall apply to either the MIL-STD-188-311 standard or the local levels and impedances.

5.3.2.3 Patching procedures. Figure 15 illustrates the concept of group patching. The group patch bay is divided into different sections according to how many nonstandard multiplexers there are in the station. There will be one section for the "standard" multiplexer and one section for each type of nonstandard multiplexer. Normal connections and patching within multiplexers of the same type shall be done at the section of the group patch bay associated with that type. The group connector is the only conditioning equipment required for such connections. Normal connections and patching between different types of multiplexers shall be done at the "standard" section of the group patch bay. Conditioning equipment strings connected between the "standard" section and each of the nonstandard sections of the group patch bay shall be used for this purpose. No conditioning equipment strings are provided directly between any two nonstandard sections because connections between any two types of nonstandard multiplexers shall always be made at the "standard" section of the group patch bay.

5.3.2.4 Group patch bay standard section. A "standard" section of the group patch bay shall be provided. The "standard" section shall include appearances of the groups of all multiplexers operating at the standard levels and impedances, including the group connectors designed to operate at those levels and impedances, and one end of each conditioning string (See Figure 15).

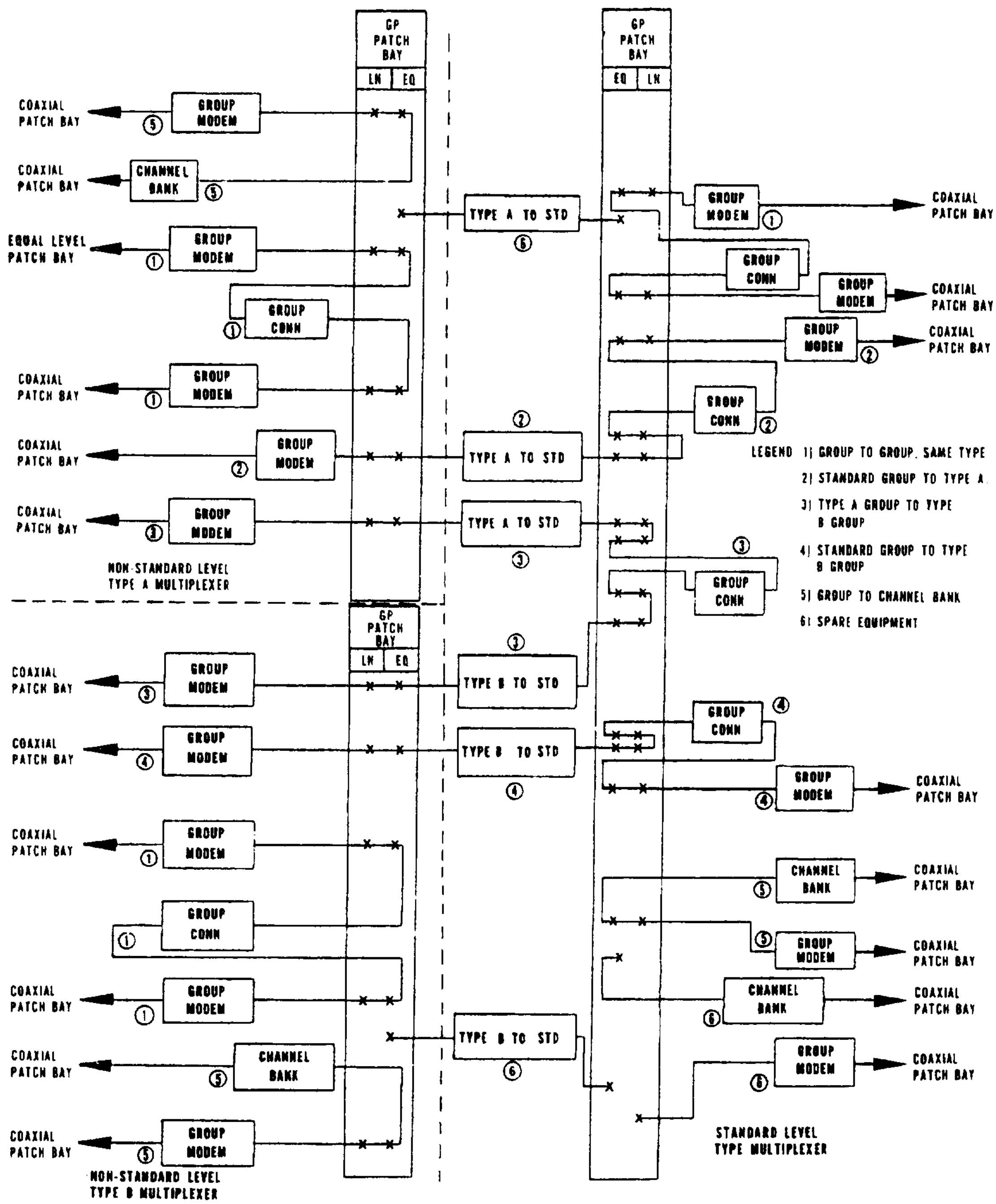


FIGURE 15. Group patching flow diagram

5.3.2.5 Group patch bay nonstandard section. For each nonstandard multiplexer in the station, a nonstandard section of the group patch bay shall be provided. The nonstandard section shall include appearances of the groups of all multiplexers operating at those levels and impedances, including the group connectors, and one end of each conditioning string associated with those levels and impedances (See Figure 15).

5.3.3 Group conditioning equipment. Conditioning equipment chains or strings shall be made up of various types of components, although not all components are required for every string. Only those components necessary to match the levels, impedances and pilot frequencies of a particular type of multiplexer to the station "standard" shall be included in each string.

5.3.3.1 Impedance matching. Impedance matching equipment shall be required to match a variety of impedances encountered in different types of multiplexers, including 600, 150, 135, and 124 ohms balanced, and 75 ohms unbalanced. Not all of these impedances will ordinarily be encountered in the same station.

5.3.3.2 Level adjustment. Level adjusting equipment shall be used to change the levels of the groups of nonstandard multiplexers to the standard levels. This equipment includes adjustable attenuators and wideband amplifiers. The impedance matching feature described in 5.3.3.1 may be combined with the attenuators or amplifiers, or both, in integrated assemblies.

5.3.3.3 Pilot frequency conversion. Group pilot frequency conversion equipment is used to change nonstandard group pilot frequencies to standard frequencies without changing the level. This equipment removes the incoming group pilot, converts it to the desired frequency and reinserts it at the same level as the incoming pilot. The reinserted pilot level shall track any variations in the incoming pilot level with an accuracy of $\pm$ 0.5 dB. Pilot alarm equipment, to indicate variations in pilot level beyond allowable limits, shall be associated with the frequency conversion devices.

5.3.4 Provisioning of group conditioning equipment. In stations where wideband patching facilities are provided and where two or more different types of multiplexers are installed or programmed for installation, group conditioning equipment shall be provided in accordance with the following criteria.

5.3.4.1 Requirements. One two-way group conditioning string shall be provided for each existing or planned through-group connection between standard and non-standard multiplexers, plus 10 percent spare strings or a minimum of one spare string of each type.

5.3.4.2 Minimum quantities. In the absence of network plans in sufficient detail to permit the application of the criteria of 5.3.4.1, one complete two-way group conditioning equipment string shall be provided for each group of five nonstandard multiplexers installed in the station. In any case, a minimum of two group strings shall be provided.

5.3.4.3 Provisioning of group connectors. These items are normally procured as part of a multiplexer installation for use with a specific type of multiplexer but may be procured separately. Quantities shall be sufficient to provide for all existing and planned through-group connection plus 10% spare strings or a minimum of one spare string. In the absence of detailed network plans, one two-way group connector should be provided for each five groups, for each type of multiplexer.

5.4 Internal systems. The internal systems include all of the non-traffic handling subsystems. Some of these systems are listed below and are described in subsequent paragraphs:

a. Intercommunications.

b. Orderwire.

c. Alarm, fault reporting and display.

d. Station power supplies.

e. Distribution frames.

f. Intra-facility cabling.

g. Administrative equipment.

h. Reporting position.

i. Station timing standard.

j. Teletypewriter equipment.

5.4.1 Intercommunication (intercom) system. The intercom system shall provide technical coordination internal to the TCF and to supporting and using agencies located in the vicinity of the TCF.

5.4.1.1 Methods. Intercom service shall be provided in either of two ways: use of existing administrative telephone circuits which contain the intercom features or application of a multi-station intercom system. The intercom system shall share common equipment and operator panels with the orderwire system if cost effective.

5.4.1.2 Quantities. The number of intercom station locations shall vary with operational mission and actual TCF configuration. More than one intercom station shall be required in a larger area to allow prompt response to calls. The audio and digital patch bays shall be equipped with a sufficient number of intercom stations to allow access from each working location.

5.4.1.3 Integration into the orderwire equipment. Intercom facilities may be supplied as part of the orderwire equipment.

5.4.2 Orderwire system. An orderwire network shall be provided for efficient technical control procedures. Information regarding circuit and facility status, circuit orders work, and maintenance and trouble conditions will be transmitted over this network. Voice and data circuits make up the orderwire network and provide the necessary means of coordination between two or more technical control facilities, between a technical control facility and an associated patch and test facility, and between a technical control facility and special communications users. The number and type of orderwire circuits required at a techical control facility shall vary from site to site as dictated by station size, mission and location.

5.4.2.1 Voice orderwire. The overall voice orderwire system shall be configured as follows:

a. The capability to interconnect any voice orderwire circuit appearing in the technical control facility with any other voice orderwire circuit shall be provided. All orderwires shall have jack appearances to facilitate monitoring, testing and re-routing.

b. The orderwire terminal equipment shall have the capability of selectively signaling any facility served by the orderwire network.

c. The orderwire terminal equipment (operator positions) shall be capable of utilizing all orderwire circuits appearing in the technical control facility, commensurate with the operational requirements. Typical end instrument locations are the group patch bays, the equal level patch bays, the circuit patch bays, the primary patch bays, the "M" and "MM" patch bays, and the various test bays, equipment bays, and supervisor positions.

d. As a minimum, each DCS station shall be provided with at least one voice orderwire and one voice orderwire access unit.

5.4.2.2 Teletypewriter orderwire. The number and type of teletypewriter orderwire circuits required at a technical control facility shall be based on local data operational requirements and configured and engineered to provide the TCF with sufficient communications to accomplish hard-copy orderwire functions or satisfy operational requirements. Teletypewriter orderwire circuits and terminating equipment shall be configured as follows:

a. The teletypewriter equipment shall be located in the operational area, near the digital patching facilities.

b. All technical control teletypewriter orderwires shall be operated low-level and appear at the appropriate patch bay.

5.4.3 Alarm system. An audible and visible alarm shall be provided to alert the technical controller and maintenance technicians of equipment degradations or failures that affect communications circuit status. Information presented by the alarm system shall enable prompt action toward the restoration or re-routing of circuits and the repair of faulty equipment. The display of alarms shall be at a central location in the TCF operating area. Parallel presentation of appropriate portions of the alarm display shall be required in supervisory or service maintenance areas which are remote from the central display. The amount and type of equipment necessary to satisfy this requirement is dependent on TCF size and may vary from site to site. Provisions in the alarm system shall be provided so that at least two levels of alarms (major and minor) can be identified.

5.4.3.1 Status display required. All alarm outputs shall be accessible at the main distribution frame (MDF). According to equipment types, alarms shall be designated as "go/no-go" or analog types (for adaptation to more sophisticated monitoring). Alarms displayed shall include the following:

a. All radio paths.

b. Cable carrier system.

c. Data circuit monitor alarm (example: modem alarm).

d. Circuit having an alarm feature (example: DFSU).

e. Common equipment unit which could affect service.

f. Low transmitter output.

g. Low receiver input.

h. High received noise on the radio channel.

i. Failure of standby equipment.

j. Failure of primary equipment.

k. Signal level, high or low.

l. Power source being used (primary, auxiliary, battery, etc.).

m. High or low power voltage.

n. Open fuse alarm.

o. High or low pilot level.

p. Failure of supervisory and ringing signaling supplies.

q. Low fuel supply for generator.

r. Open door or window (at unattended station).

s. Failure of obstruction or warning light.

t. Loss of waveguide pressurization.

u. Fire in equipment area.

v. Failure of environmental control system.

w. Alarms required by other applicable directives.

5.4.3.2 Alarm system design. The alarm system shall provide for incremental expansion. The system shall be so designed that activations, deactivations and changes of transmission systems, TCF sub-systems and circuts can be accommodated without affecting the operation of the basic alarm system. The system shall consist of a local equipment and function alarm subsystem and a remote station equipment and function alarm subsystem.

5.4.4 Power and power supplies

5.4.4.1 No-break power. The equipment comprising the critical technical load within a technical control facility shall operate from 48 Vdc. (DO) This power shall be supplied from an uninterruptible power source and shall not be located in the same room as the TCF operations area. The dividing line between critical and non-critical load shall be drawn according to whether the failure of interconnected equipment would interrupt operation of communication circuits or essential performance monitoring equipment. Critical technical load no-break power and uninterruptable power system are further defined in MIL-HDBK-411. The ac and dc voltage levels and capacities of this system shall be sufficient to maintain the critical technical load in operation for at least 60 minutes for attended locations and 8 hours for unattended locations.

5.4.4.1.1 Floating battery rectifier system. At stations which are not served by an uninterruptable power source, critical technical power shall be derived from a floating battery rectifier system.

5.4.4.1.2 Station battery filtering/noise suppression. When equipment which produce noise are connected to the station battery bus, that equipment shall be isolated, by appropriate low-pass filters or other techniques for suppression of noise, to limits prescribed for the most susceptible device served by that bus.

5.4.4.2 Dc power supplies. Technical control facilities shall be furnished all necessary dc power supplies required to operate conditioning equipment and circuits. The following are examples of dc power supplies that may be necessary:

a. 6 Vdc power supply (BLACK). A redundant series regulated $\pm$ 6 Vdc power supply that furnishes signal and control line battery requirements for BLACK circuits.

b. 6 Vdc power supply (RED). A series regulated ± 6 Vdc power supply provided to RED equipment areas (encrypted orderwires, reporting circuits, etc.). This system shall serve the RED signal and control line requirements exclusively and shall be interconnected to associated equipment and circuits via a separate RED distribution frame.

c. 48 Vdc power supply. Furnishes -48 Vdc to operate dc powered conditioning equipment and test equipment.

d. 60 Vdc power supply. Furnishes ± 60 Vdc for high level digital circuits and equipment (loop battery, level converters, mark hold, space hold, etc.).

e. 130 Vdc power supply. Furnishes ± 130 Vdc for high level digital circuits and equipment (loop battery, level converters, mark hold, space hold, etc.).

5.4.4.3 Signaling supplies. Technical control facilities shall be furnished all necessary signaling supplies to operate the various VF circuits and equipment. The following are examples of signaling supplies that may be necessary:

a. 20 Hz signaling supply. A signaling supply shall be available to furnish 20 Hz to conditioning equipment requiring it (E&M/120 Hz converters, dial loop converters).

b. 2600/2800 Hz signaling supply. A signaling supply shall be available to furnish 2600 Hz to single frequency signaling units (SFSUs) and 2600/2800 Hz to dual frequency signaling units (DFSUs). If all SFSUs and DFSUs at a station have integral signaling power, then a separate supply shall not be required.

5.4.5 Distribution frames. The distribution frames shall terminate and interconnect all office cabling and strings of communication conditioning equipment, both active and spare. In addition, the MDF shall contain alarmed surge protectors for all outside plant cable pairs entering the technical control facility.

5.4.6 Intra-facility cabling. The cabling used within the facility shall be assigned and routed such that each separate cable shall contain signals of equivalent mode and level, e.g., RS 232C, MIL-STD-188-114, high level TTY, low level ac or dc power supply, and alarm control. The different signals shall occupy separate cables and shall not be combined in the same cabling.

5.4.7 Interbay trunks. The number and configuration of interbay trunks required at a given station shall vary depending upon the number of circuits, as well as re-route, restoral, and patching requirements at that station.

5.4.7.1 Considerations for determining quantities. For determining the required quantities of interbay trunks, the following shall be considered:

a. The re-route, restoral, and patching requirements expected at the station.

b. Interbay trunks shall be so configured that no patch will require a patch cord exceeding six feet in length.

c. No more than 15 percent of the circuits may be expected to be in a patched condition at any given instant.

d. Trunking to the Quality Assurance Test Center (QATC) shall be predicated upon the number of controllers available to perform tests and the total number of circuits which can be tested simultaneously.

5.4.7.2 Minimum quantities. As a minimum, the number of full duplex (6 wire) interbay trunks shall be 8% of the number of circuit appearances at each of the composite patch bays (equal level patch bay, primary patch bay and digital patch bay). At least 10% of these interbay trunks should be allocated to trunking to the QATC and cable test bays.

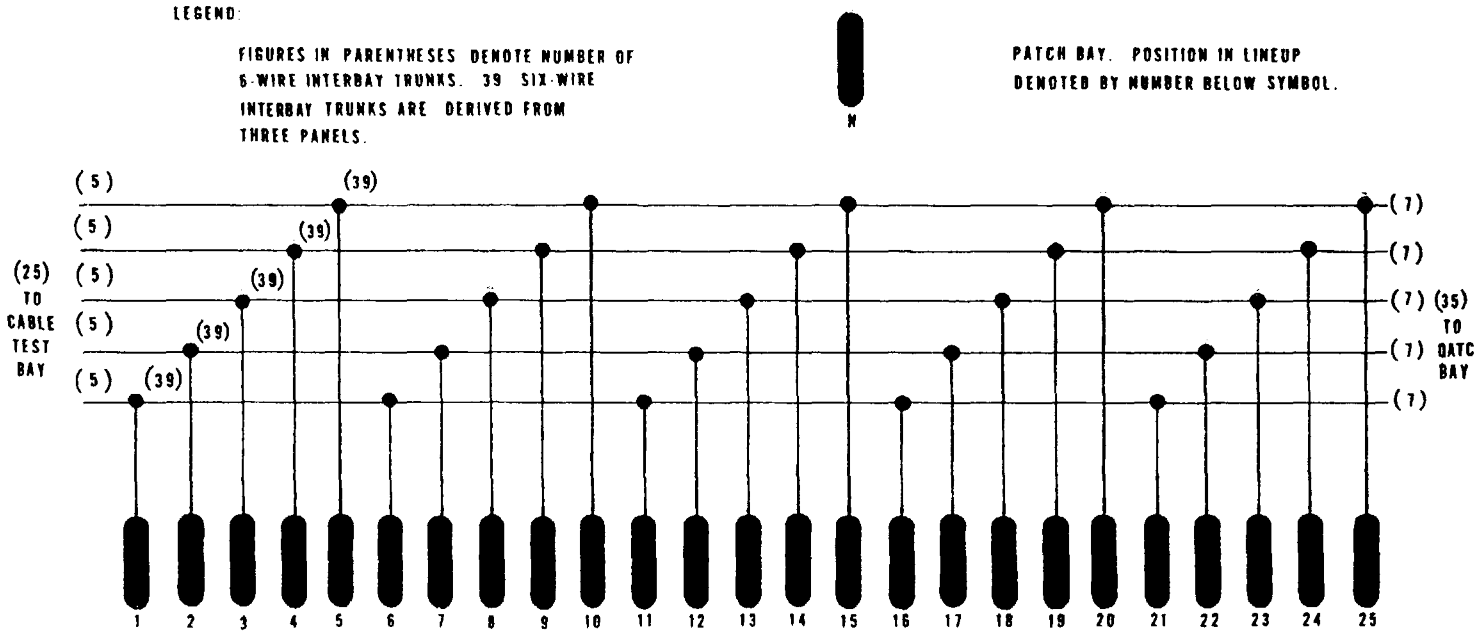
5.4.7.3 Typical arrangement. A typical arrangement suitable for a 2400 circuit composite patchfield is shown in Figure 16. This arrangement is configured for 5 each five bay multiples, and provides 195 six-wire interbay trunks when three 26-jack (13 send/receive pairs) interbay trunk modules are used per bay. The 195 trunks will effectively provide approximately 8% interbay trunk capability.

5.4.8 Reporting/coordinating position. The reporting position shall be located in the technical control facility in a position that gives visual access to all working positions. The reporting position must be provided teletype equipment and telephones, both local and AUTOVON, in order to meet reporting requirements of the Defense Communications Agency and the O&M Agency. The position shall also contain all intercom and orderwire lines. This position is the central focal point within the TCF for operational records, reports, and external coordination matters.

5.4.9 Station timing standard system. The TCF shall be provided with a timing standard system. The timing system shall provide low-level clocking signals at rates compatible with standard modulation and data signaling rates specified in MIL-STD-188-100 and MIL-STD-188-114 as required by TCF equipment that can accept external timing. The station timing standard system shall be used in lieu of integral equipment timing where possible. This timing system shall be capable of accepting or providing network synchronization. The low-level timing shall appear at the digital circuit patch bays to provide a synchronizing clock to receive data equipment timing inputs when the line is purposely interrupted.

5.5 Monitor and test.

5.5.1 General. Operational test equipment shall be rack mounted. Test equipment shall be mounted in the bays with all input and output terminals cabled to the miscellaneous jackfields. Test equipment shall have provisions for internal and external synchronization. The correct bridging, terminating impedances, and balancing networks shall be applied internally.



NOTES:

1. ARRANGEMENT SHOWN IS FOR 25 EQUAL LEVEL BAYS. REPEAT FOR PRIMARY PATCH AND DC PATCH INTERBAY TRUNKS.

2. THE ARRANGEMENT SHOWN IS FOR A STATION HAVING A MAXIMUM OF 2400 CIRCUITS AND CONSTITUTES A WORST CASE. 195 SIX-WIRE INTERBAY TRUNKS ARE ACCOMMODATED. SMALLER STATIONS REQUIRE PROPORTIONATELY FEWER INTERBAY TRUNKS. DEPENDING UPON THE NUMBER OF PATCH BAYS, SMALLER QUANTITIES OF INTERBAY TRUNKS MAY BE DERIVED BY REDUCING THE NUMBER OF PANELS PER BAY OR BY REARRANGING THE BAY MULTIPLES (5 BAY MULTIPLES SHOWN).

3. INTERBAY TRUNKS TO QATC OR CABLE TEST CENTER SHALL BE CONNECTED TO THE RESPECTIVE INTERBAY TRUNK PANEL AT THE QATC. TRUNKS FROM THE EQUAL LEVEL, PRIMARY AND DC PATCH BAYS SHALL NOT BE MULTIPLIED AT THE QATC OR CABLE TEST CENTER, BUT SHALL BE INDIVIDUALLY TERMINATED. INTERBAY TRUNKS TO THE QATC SHALL BE GROUPED ON THE RIGHT HAND SIDE OF EACH INTERBAY TRUNK PANEL, WHILE INTERBAY TRUNKS TO THE CABLE TEST CENTER SHALL BE GROUPED ON THE LEFTHAND SIDE.

FIGURE 16. Typical interbay trunk arrangement for a large station

5.5.1.1 Capability. A signal measurement capability shall be provided at each patch bay within the technical control facility. At patch bays where VF signals are present, the ability to measure signal levels and idle channel noise shall be provided. In addition, standard test tones shall be provided at the equal level patch bay. At patch bays where low speed digital signals are present, the ability to measure dc voltage or current, depending on the signal level, shall be provided. The necessary equipment shall be supplied to a minimum of one bay in three.

5.5.1.2 Teleprinter equipment. The teleprinter equipment used for monitoring shall be multiple page printers, configured for low-level operation. Keyboard Send/Receive (KSR) equipment configured for low-level operation shall be used in the RED area for crypto "set" purposes.

5.5.2 Quality assurance tests. Specific test and test parameters required to be performed in technical control facilities are found in DCA Circular 310-70-1.

5.5.2.1 Quality assurance test center (QATC). A quality assurance test center shall be required. The QATC shall be provided with all test equipment necessary for testing VF circuits and analog wideband circuits as required by DCA.

5.5.2.2 Digital test bay. Digital test bays shall be provided on the basis of one test bay for one to four digital patch bays, two test bays for five to eight digital patch bays, etc. The test bays shall be so installed so that no more than two digital patch bays shall be on either side. The digital test bay shall contain the following test equipment: data error rate measuring equipment, digital data analysis equipment, dual trace oscilloscope, interbay trunk jacks, and miscellaneous jacks. Test equipment shall be configured for its associated patch bay (balanced or unbalanced).

5.5.2.3 Cable test bay. When required because of numerous cable circuits, a cable test bay shall be provided on the basis of a minimum of one per station. These test bays shall include a four cycle interrupter, a signaling test set, a Wheatstone Bridge, a cable fault locator (time domain reflectometer), interbay trunk jacks, and miscellaneous jacks.

Custodians:
Army - SC
Navy - EC
Air Force - 90

Review Activities:
Army - SC, CR
Navy - AS, YD, MC, CG, OM, NC
Air Force - 1, 11, 13, 17, 99

User Activities:
Army - SC
Navy - YD, SH
Air Force - 90

Preparing Activity:
Air Force - 90

(Project SLHC - 3101)

Other Interest:
NSA - NS
DCA - DC
DOD ECAC
TRI-TAC-TT

APPENDIX

OASD (C^3I) Memo

10. General. This appendix is a copy of the OASD (C^3I) memo which makes the use of MIL-STD-188-310A mandatory for use by all Departments and Agencies of the Department of Defense.

10.1 Office of Assistant Secretary of Defense (C^3I) Memo.

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

MIL-STD-188-310A
14 January 1980

10 MAY 1977

INICATIONS, COMMAND,
OL, AND INTELLIGENCE

MEMORANDUM FOR Assistant Secretary of the Army (I&L)
Assistant Secretary of the Navy (I&L)
Assistant Secretary of the Air Force (I&L)
Commandant of the Marine Corps
Director, Defense Communications Agency
Director, National Security Agency

SUBJECT: Mandatory use of military standards in the 188 Series

On January 3, 1972, the Assistant Secretary of Defense (I&L) found it necessary to make a significant change in the DoD Standardization Manual 4120.3M because of recurring misapplications of military standards in general. The essence of the change is that military standards as a general rule are now cited as "approved for use" rather than "mandatory for use" in the Department of Defense.

This deference to the judgment of the designing and procuring agencies is clearly appropriate to standards dealing with process, component ruggedness and reliability, paint finishes, and the like. It is clearly not appropriate to standards such as those in the MILSTD 188 series which address telecommunication design parameters. These influence the functional integrity of telecommunication systems and their ability to efficiently interoperate with other functionally similar Government and commercial systems. Therefore, relevant military standards in the 188 series will continue to be mandatory for use within the Department of Defense.

To minimize the probability of misapplication of these standards, it is incumbent upon the developers of the MILSTD 188 series to insure that each standard is not only essential but of uniformly high quality, clear and concise as to application, and wherever possible compatible with existing or proposed national, international and Federal telecommunication standards. It is also incumbent upon the users of these standards to cite in their procurement specifications only those standards which are clearly necessary to the proper functioning of the device or systems over its projected lifetime.

This direction is in consonance with the recommendations made by the Director, Defense Materiel Specifications and Standards Office, in his letter of March 4, 1977, which was addressed to the U.S. Army Electronics Command.

Gerald P. Dinneen

cc:
OASD(MRA&L), DMSSO
Co-Chairman, JSC, ECOM (DRSEL-CE-CS)
Co-Chairman, JSC, DCEC (R110)
OJCS (J-3), Telecom Div

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MIL-STD-188-310A

NAME OF ORGANIZATION AND ADDRESS OF SUBMITTER

☐ VENDOR ☐ USER ☐ MANUFACTURER

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A. GIVE PARAGRAPH NUMBER AND WORDING

B. RECOMMENDED WORDING CHANGE

C. REASON FOR RECOMMENDED CHANGE(S)

2. REMARKS

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	DATE

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