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MILITARY STANDARD

SUBSYSTEM, EQUIPMENT, AND INTERFACE STANDARDS

FOR COMMON LONG HAUL AND TACTICAL

TECHNICAL CONTROL FACILITIES

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DEPARTMENT OF DEFENSE

Washington, D.C. 20301

SUBSYSTEM, EQUIPMENT, AND INTERFACE STANDARDS FOR COMMON LONG HAUL AND TACTICAL TECHNICAL CONTROL FACILITIES

1. This Military Standard is approved and mandatory for use by all Departments and Agencies of the Department of Defense in accordance with the Office of the Under Secretary of Defense (Research and Engineering) Memorandum, dated 16 Aug 83 (see Appendix A).

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

FOREWORD

1. Originally, Military Standard 188 (MIL-STD-188) covered technical standards for tactical and long haul communications, but later evolved through revisions (MIL-STD-188A, MIL-STD-188B) into a document applicable to tactical communications only (MIL-STD-188C).

2. The Defense Communications Agency (DCA) published DCA Circulars (DCAC) promulgating standards and engineering criteria applicable to the long haul Defense Communications System (DCS) and to the technical support of the National Military Command System (NMCS).

3. As a result of a Joint Chiefs of Staff (JCS) action, standards for all military communications are now being published in a MIL-STD-188 series of documents. The MIL-STD-188 series is subdivided into a MIL-STD-188-100 series covering common standards for tactical and long haul communications, a MIL-STD-188-200 series covering standards for tactical communications only, and a MIL-STD-188-300 series covering standards for long haul communications only. Emphasis is being placed on developing common standards for tactical and long haul communications published in the MIL-STD-188-100 series.

4. This standard contains directives for the engineering, selection, and configuration of equipment and facilities required for the design, construction, and installation of analog and digital technical control facilities in both long haul and tactical environments. This standard supersedes MIL-STD-188-310A, 14 January 1980.

CONTENTS

CONTENTS (Continued)

CONTENTS (Continued)

CONTENTS (Continued)

FIGURES

FIGURES Cont'd

APPENDIX A

APPENDIX B

1. SCOPE

1.1 Purpose. This standard establishes design and engineering criteria for long haul and tactical Technical Control Facilities (TCFs) and associated Patch and Test Facilities (PTFs) in the Department of Defense (DOD).

1.2 Application. This document establishes standards to apply during the design, planning, and engineering phases of all facilities that perform or will perform the functions listed in paragraph 4.1. Existing TCF's need not be immediately converted to comply with the requirements of this document. New TCF's and those undergoing modification or rehabilitation shall conform to these standards subject to the applicable requirements of current procurement regulations. Several non-mandatory design objectives are included in this standard and should be adopted whenever economically feasible. Following is a list of these design objectives and their location in this standard.

OBJECTIVE	PARA
Automated tech control functions	4.2.1.1
Modular equipment bay design	4.2.1.2
Test equipment recording capability	4.2.2.5
Universal shelf concept	4.2.2.11
Transmission access	5.2.1.2
Low level digital interface	5.2.1.2.2
Multi-function conditioning equipment	5.2.2.2
Low level digital interface	5.2.2.3.1.1
Low level digital interface	5.2.2.3.8
Interbay trunk jacks	5.3.11

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 also with current RED/BLACK Engineering Criteria in NACSIM 5203.

1.2.2 Patch and test facilities. The requirements of this standard shall also apply to those PTFs that are required to provide monitoring, testing, or control of a transmission path. Equally, they shall apply to those PTFs serving terminals, switching, or transmission equipment.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this standard to the extent specified herein.

MILITARY SPECIFICATIONS

MIL-H-46855	Human Engineering Requirements for Military Systems, Equipment and Facilities

FEDERAL STANDARDS

FED-STD-1003	Telecommunications; Synchronous Bit Oriented Data Link Control Procedures
FED-STD-1037	Glossary of Telecommunications Terms
FED-STD-1041	Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment for Operation With Packet-Switched Communications Networks

MILITARY STANDARDS

MIL-STD-188-100	Common Long Haul and Tactical Communications System Technical Standards
MIL-STD-188-114	Electrical Characteristics of Digital Interface Circuits
MIL-STD-188-124	Grounding, Bonding, and Shielding
MIL-STD-188-311	Technical Design Standards for Frequency Division Multiplexers
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

MIL-STD-470	Maintainability Program for Systems and Equipment
MIL-STD-1472	Human Engineering Design Criteria for Military Systems, Equipment and Facilities

MILITARY HANDBOOKS

MIL-HDBK-411	Power and Environmental Control for the Physical Plant of DOD Long Haul Communications
MIL-HDBK-414	Technical Control Facilities and Equipment for Long Haul Communications
MIL-HDBK-419	Grounding, Bonding, and Shielding for Electronic Equipments and Facilities

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this standard to the extent specified herein.

NATIONAL SECURITY AGENCY PUBLICATIONS

(C) NACSIM 5203	Guidelines for Facility Design and RED/BLACK Installation (U)

DEFENSE COMMUNICATIONS AGENCY PUBLICATIONS

DCAC 300-175-9	DCS Operating-Maintenance Electrical Performance Standards
DCAC 310-50-6	Defense Communications Systems Orderwire
DCAC 310-70-1	Defense Communications System Technical Control
EP 3-83	DCS Network Synchronization Design Criteria

JOINT TACTICAL COMMUNICATIONS OFFICE PUBLICATIONS

ICD-001	Voice and Data Orderwire Content and Signaling Information

ICD-002	TRI-TAC System Orderwire
ICD-003	Framing and Synchronization Protocols

INTERNATIONAL AGREEMENTS

STANAG 4206	The NATO Multi-Channel Tactical Digital Gateway - System Standards
STANAG 4207	The NATO Multi-Channel Tactical Digital Gateway - Multiplex Group Framing Standards
STANAG 4208	The NATO Multi-Channel Tactical Digital Gateway - Signalling Standards
STANAG 4209	The NATO Multi-Channel Tactical Digital Gateway - Standards for Analogue to Digital Conversion of Speech Signals
STANAG 4210	The NATO Multi-Channel Tactical Digital Gateway -Cable Link Standards
STANAG 4211	The NATO Multi-Channel Tactical Digital Gateway -- System Control Standards
STANAG 4212	The NATO Multi-Channel Tactical Digital Gateway -Radio Relay Link Standards
STANAG 4213	The NATO Multi-Channel Tactical Digital Gateway - Data Transmission Standards
STANAG 4214	International Routing and Directing for Tactical Communication Systems

(Copies of specifications, standards, handbooks, drawings, and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2. Other Publications. The following documents form a part of this standard to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the [illegible] solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

ELECTRONIC INDUSTRIES ASSOCIATION

ANSI/EIA RS-310-C-77R82	Racks, Panels and Associated Equipment
EIA RS-530	High Speed 25-Position Interface for Data Terminal Equipment and Data Circuit -Terminating Equipment

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street NW, Washington DC 20006.)

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS

ANSI-C2-1987	National Electrical Safety Code
ANSI/IEEE STD-488-1978	IEEE Standard Digital Interface for Programmable Instrumentation

(Application for copies should be addressed to the Institute of Electrical and Electronics Engineers, Publication Sales Dept., 445 Hoes Lane, Piscataway NJ 08854.)

NATIONAL FIRE PROTECTION ASSOCIATION

NFPA 70-1987	National Electrical Code

(Application for copies should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy MA 02269)

INTERNATIONAL TELECOMMUNICATION UNION

CCITT Recommendation G.703 CCITT Red Book Volume III, Fascicle III.3 (This volume includes rec's G.700-G.956)	Physical/Electrical Characteristics of Hierarchical Digital Interfaces
CCITT Recommendation X.25 CCITT Red Book Volume VIII, Fascicle VIII.3 (This volume contained rec's X.20-X.32)	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Terminals Operating in the Packet Mode and Connected to Public Data Networks by Dedicated Circuit

(Application for copies should be addressed to the United States Department of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 or to Omnicom, 501 Church Street, Suite 304, Vienna VA 22180.)

2.3 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. TERMS AND DEFINITIONS

3.1 General. Terms and definitions common to the MIL-STD-188 series are contained in FED-STD-1037. Terms and definitions unique to MIL-STD-188-154 are contained herein.

a. Access. An electrical point for monitoring, testing, and rerouting electrical signals. Access systems in TCFs may be of the manual type, such as patch panels, or of the automated type in the case of electronic or electromechanical patching systems.

b. Analog baseband access. An access electrically located between the highest level FDM and the transmission media. It is used to monitor, test, and reroute baseband signals.

c. Automated access. A processor controlled method of monitoring, testing, and rerouting circuits. Using this method, manual patch panels may not be needed.

d. Digital channel efficiency equipment. A device used to increase the number of voice channels which may be transmitted over a digital system at a given data rate. Adaptive differential encoding techniques are commonly used in this equipment to reduce the number of bits needed to represent the analog signal.

e. Digital group. A number of voice channels or a number of data channels or both that are combined into a digital bit stream for transmission over various communications media.

f. Equipment jacks. Equipment jacks on all accesses shall be electrically connected in the direction of the interface conditioning equipment. The term "equipment jack" shall be the only term used to refer to jacks physically and electrically configured in this manner.

g. Group access (FDM). An access used for monitoring, testing, and routing analog signals at the group level.

h. High speed digital access. A generic term for the access of digital signals with bit rates greater than that allocated to a single unmultiplexed digitized voice channel.

NOTE: In long-haul systems, high speed digital capabilities includes, but are not limited to, 128 kb/s, 256 kb/s, 512 kb/s, 1.544 Mb/s, 3.088 Mb/s, 3.152 Mb/s, 6.176 Mb/s, 6.312 Mb/s, and 12.928 Mb/s. In tactical systems, high speed digital capabilities include but are not limited to 128 kb/s, 256 kb/s, 512 kb/s, and 2.048 Mb/s.

i. Line jacks. Line jacks on all patch modules shall be electrically located away from the local tech control interface conditioning equipment. The term "line jack" shall be the only term used to refer to jacks physically and electrically configured in this manner.

j. Long haul technical control facility. A fixed physical plant equipped and configured to perform testing, monitoring, and essential operational control over communications paths. The long haul TCF is a part of a communications system characterized by more stringent performance requirements, global distance between users, high volume and density of traffic, and fixed or recoverable assets. The long haul TCF has direct access to long haul transmission media and is normally a part of the Defense Communications System.

k. Low level digital interface. A station equipment interface operating in accordance with MIL-STD-188-114.

l. Low speed digital access. A generic term for access of digital signals with bit rates less than or equal to that rate which is allocated to a single unmultiplexed digitized voice channel.

NOTE: In long haul systems, digitized voice channels are usually 64 kb/s; tactical systems usually allocate 16 kb/s or 32 kb/s.

m. Low speed time division multiplexer. A sub-level multiplexer used for combining a number of voice channels or a number of low speed data channels or both into a digital bit stream. The aggregate of this multiplexer is typically interconnected to (but not limited to) a single channel of a first level multiplexer.

n. Orderwire. A network connecting technical control facilities for exchanging information regarding circuit status, circuit actions, trouble conditions, etc. Both voice and data circuits make up the orderwire network and provide the means of coordination between two or more facilities. The long haul orderwire is divided into three specific uses:

1. Link orderwire. Link orderwires are voice communications circuits interconnecting the two terminals of a radio or cable link.

2. Express orderwire. Express orderwires are voice communications circuits interconnecting DCS stations sharing a common FDM group or TDM digital group with VF circuit breakout. These circuits are normally assigned channels within the baseband.

3. System orderwire. System orderwires are voice communications circuits interconnecting the TCFs at major nodal sites within a theater. Used to permit direct coordination between widely separated nodal TCFs when troubleshooting system problems or participating in end-to-end circuit or system alignments.

The tactical orderwires are as follows:

1. Secure voice orderwire. This is a digital voice orderwire using encryption equipment operating at 16 kb/s.

2. Data orderwire. This is a 2 kb/s digital channel used to remote equipment alarm signals (telemetry) from radio and multiplex assemblies to the technical control facility. This data is used to let the tech controller know immediately that a fault has occurred and serve as an aid in the fault isolation process.

3. Combined digital orderwire. The secure voice orderwire and the data orderwire signals are combined into a single 32 kb/s bit stream for transmission purposes.

4. Maintenance orderwire. This is a clear analog voice channel used primarily for maintenance of cable systems.

o. Patch and test facility. An organic element of a station or terminal facility performing such functions as testing, restoral, monitoring, activation, and troubleshooting of equipment and circuits. The PTF performs these functions in support of and under the technical supervision of a designated TCF.

p. Receive. Receive refers to signal flow from the transmission media or local users towards the local tech control interface conditioning equipment or through-station crossconnect point. When using the term "receive", it must be associated with a particular access point or it must be qualified by indicating from whom or what.

q. Sub-level multiplexer. The multiplex equipment used for combining several low speed users. The aggregate output of a sub-level multiplexer is typically interconnected to (but not limited to) a single channel of the first level multiplexer. Examples of sub-level multiplexers are the voice frequency carrier telegraph and the low speed time division multiplexer.

r. Supergroup access (FDM). An access for routing, monitoring, and testing analog signals at the supergroup level.

s. Tactical interface. The point at which long haul and tactical systems are interfaced.

t. Tactical technical control facility. A physical plant normally configured in fixed size, self contained, and ruggedized shelters to perform testing, fault isolation and essential operational control over communications paths. The tactical TCF is a part of a communications system generally characterized by transportable or maneuverable equipment.

u. Transmission access. An access at which all circuits have been conditioned for equal transmission level point. Digital circuits are conditioned to equal levels and balanced or unbalanced operation. Such standard levels permit rerouting of VF circuits without further conditioning. Digital circuits having compatible rates and formats may also be rerouted at this access. This access is electrically located between the conditioning equipment and the transmission equipment such as the first level multiplexers.

v. Transmit. Transmit refers to signal flow from the local tech control interface conditioning equipment or through-station crossconnect point towards the transmission media or local users. When using the term "transmit", it must be associated with a particular access point or it must be qualified by indicating to whom or what.

w. Transmultiplexer. A device used for direct conversion of two FDM groups into a TDM digital group.

x. Universal shelf. A design concept employing an equipment mounting shelf having common electrical and physical characteristics such that the shelf is compatible with a variety of conditioning and ancillary equipment. This universal shelf provides for the flexible arrangement of conditioning modules into circuit strings through the use of prewired module connectors or an IDF located on the shelf.

y. User access. The electrical access providing the first appearance of local analog and digital user circuits in the TCF. This access is electrically located between the users and the conditioning equipment.

NOTE: The term "user access" is generic in nature and describes the initial appearance of user circuits in the TCF. It does not imply or require that analog and digital signals must be physically located together. Separate terms (such as VF primary patch bay, K primary patch bay, and D primary patch bay) were previously used to identify the various analog and digital accesses.

z. 1st level access. An access for routing, monitoring and testing of aggregate digital signals from first level time division multiplexers.

aa. 1st level multiplexer. The primary multiplexing equipment used for the concentration of analog or digital channels.

ab. 2nd level access. An access for routing, monitoring, and testing of aggregate digital signals from 2nd level time division multiplexers.

ac. 2nd level multiplexer. The second order multiplexer used for the concentration of individual 1st level multiplex inputs.

NOTE: Higher levels of multiplexers (and access points) may be used in some systems. The designation of the level of such multiplexers (and access points) will continue in increasing numerical order.

3.2 Special terms for long haul TCFs. The following terms have been used in previous standards describing access facilities for long haul TCFs. These terms may be encountered when designing, engineering, or installing additions to existing TCFs and may be used in design for new facilities.

a. "D" type patch bay. Equipment designed for patching and monitoring of unbalanced user data circuits. Rates are generally limited to 1 Mb/s.

b. Digital circuit patch bay. Equipment where low level digital data circuits can be patched, monitored, and tested. This patch bay can be either "D" type or "K" type and is electrically located the same as the transmission access.

c. Digital primary patch bay. Patching equipment that provides the first appearance of most local user digital circuits in the TCF. Signals will have various levels and formats depending on the user terminal equipment. This patch bay can be either "D" type or "K" type and is electrically located the same as the user access.

d. Equal level patch bay. Analog equipment at which all VF circuit inputs and outputs appear at a uniform level. This permits patching without making transmission level adjustments and is electrically located the same as the transmission access.

e. "K" type patch bay. Equipment designed for patching and monitoring of balanced user data circuits. Rates are generally limited to 1 Mb/s.

f. "M" patch bay. Equipment designed for patching and monitoring digital data circuits at rates from 1 Mb/s to 3 Mb/s. The "M" patch is normally used for the aggregate signals of first level multiplexers and some variations of the data rate specifications may be permitted.

g. "MM" patch bay. Equipment designed for patching and monitoring of digital data circuits at rates exceeding 3 Mb/s. The "MM" patch is normally used for the aggregate signals of second and higher level multiplexers.

h. VF primary patch bay. Equipment that provides the first appearance of local users VF circuits in the TCF. Signals will have various levels and signaling schemes depending on the user terminal equipment. The VF primary patch is electrically located the same as the user access.

3.3 List of acronyms. The following acronyms are used in this standard.

AC	Alternating Current
ADCCP	Advanced Data Communication Control Procedures
ALM	Alarm
ATACS	Army Tactical Communications System
AUTODIN	Automatic Digital Network
AUTOSEVOCOM	Automatic Secure Voice Communications
AUTOVON	Automatic Voice Network
BER	Bit Error Rate
BITE	Built-In Test Equipment
CCF	Circuit Concentration Facility
CDF	Combined Distribution Frame
CVSD	Continuously Variable Slope Delta-Modulation
DC	Direct Current
DCA	Defense Communications Agency
DCS	Defense Communications System
DFSU	Dual Frequency Signaling Units
DOD	Department of Defense
DSN	Defense Switched Network
DTMF	Dual Tone Multiple Frequency
FCO	Facility Control Office
FDM	Frequency Division Multiplex
IDF	Intermediate Distribution Frame
LSTDM	Low Speed Time Division Multiplex
MDF	Main Distribution Frame
MTTR	Mean Time to Repair
NICS	NATO Integrated Communications System
NMCS	National Military Command Systems
NRZ	Non-Return to Zero
OS	Out of Service
O/W	Orderwire
PBX	Private Branch Exchange
PCM	Pulse Code Modulation
PPL	Passive Peak Limiter
PTF	Patch and Test Facilities
QC	Quality Control
QCTC	Quality Control Test Center
RF	Radio Frequency
SF	Single Frequency
SFSU	Single Frequency Signaling Units
TCF	Technical Control Facility
TDM	Time Division Multiplex
TLP	Transmission Level Point
TTY	Teletypewriter
VF	Voice Frequency
VFCT	Voice Frequency Carrier Telegraph

4. GENERAL REQUIREMENTS

4.1 General description of a technical control facility.

4.1.1 General. This section contains the standards and design objectives for TCFs serving both long haul and tactical communications systems.

NOTE: These standards are applicable to both long haul and tactical TCFs. The underlying factor that classifies a TCF as long haul or tactical would be its membership in a long haul or tactical communications system. Long haul systems generally consist of fixed or recoverable assets while tactical systems are normally characterized by maneuverable facilities or equipment. The information which follows applies also to patch and test facilities (PTFs).

4.1.2 Organization. TCFs shall serve as the focal points for system control in long haul and tactical communications systems. TCFs shall be designed to enable system control personnel to effectively exercise the responsibilities designated in DCAC 310-70-1. TCFs may perform both DCS and non-DCS system control functions.

4.1.3 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 control 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 consider the utilization of automated technical control test and monitoring equipment, and shall also address voice and data interface requirements with other system control elements.

4.1.4 Major elements. TCFs perform their required functions through equipment and personnel. The facility may include, but is not limited to:

a. Analog and digital access and reroute capability.

b. Manual and/or automatic access and reroute capability.

c. Manual and/or computer assisted quality control test capability.

d. Signaling capabilities.

e. Conditioning capabilities.

f. Digital modem capabilities.

g. Orderwire and intercommunications systems capabilities.

h. Circuit distribution frame capability.

i. Reporting position capabilities.

j. Internal alarm system capabilities.

k. Power sources — alternating current (AC) and direct current (DC) capabilities.

l. Communications security capabilities.

m. Digital signal timing.

4.2 General design considerations. The following provisions shall apply to the planning, design, and installation phases of long haul and tactical TCFs.

4.2.1 General configuration. The electrical and physical configuration of all TCFs within a given system shall be essentially the same, whether the facility is located at a transmission nodal point or terminal point. The electrical and physical configuration of TCFs serving long haul and tactical systems may differ from one another because of the nature of each system's mission and the space limitations of the building or shelter housing the TCF.

4.2.1.1 Electrical configuration. Figure 1 illustrates the prescribed electrical configuration for long haul manual TCFs. The configuration of equipment illustrated in this figure shows the interrelationship among major equipment and patching facilities involved in the overall technical control function, and also identifies the signal flow and prescribed terminology. Technical control facilities may have some or all functions automated. This is a design objective for long haul TCFs, and should be retained as a future development for both the long haul and tactical environment. Electronic equipment may combine, in one physical unit, several tech control functions. Figure 2 illustrates an automated tactical TCF.

4.2.1.2 Physical configuration. Unlike the prescribed electrical configuration, the physical configuration is totally dependent upon the size and shape of the building or shelter in which the facility is to be installed. TCF equipment and facilities shall be configured to make effective use of available space while allowing for human engineering considerations (see 4.2.7), cost, technical considerations, and expansion capabilities. As a design objective, all equipment bays shall be modularly designed and as self-contained as possible. These equipment bays shall be pre-wired including AC and DC power. All connections to these bays shall be connectorized and accessible without disassembling any portion of the bay. The design shall be such that any equipment bay can be installed or removed from the facility by use of the connectorized cables.

4.2.1.2.1 Status reporting area. An area within the operational area shall be used to locate equipment required for record keeping and status reporting functions.

NOTE 1 THE LSTDMS AND VFCTS ARE USED AS SUB-LEVEL MULTIPLEXERS IN THIS DIAGRAM

NOTE 2 USERS NOT REQUIRING CONDITIONING MAY CONNECT DIRECTLY TO EQUIPMENT SIDE OF TRANSMISSION ACCESS

NOTE 3 TYPICAL MODEM USE IS FOR TRANSMISSION OF DIGITAL USERS OVER FDM SYSTEMS

NOTE 4 PCM IS SHOWN AS ONE EXAMPLE OF ANALOG TO DIGITAL CONVERSION OF VF USERS. SOME SYSTEMS MAY USE OTHER METHODS

NOTE 5 SEE FIGURE 17, CIRCUIT 11, FOR ARRANGEMENT OF AUTOMATED CROSS-CONNECT EQUIPMENT

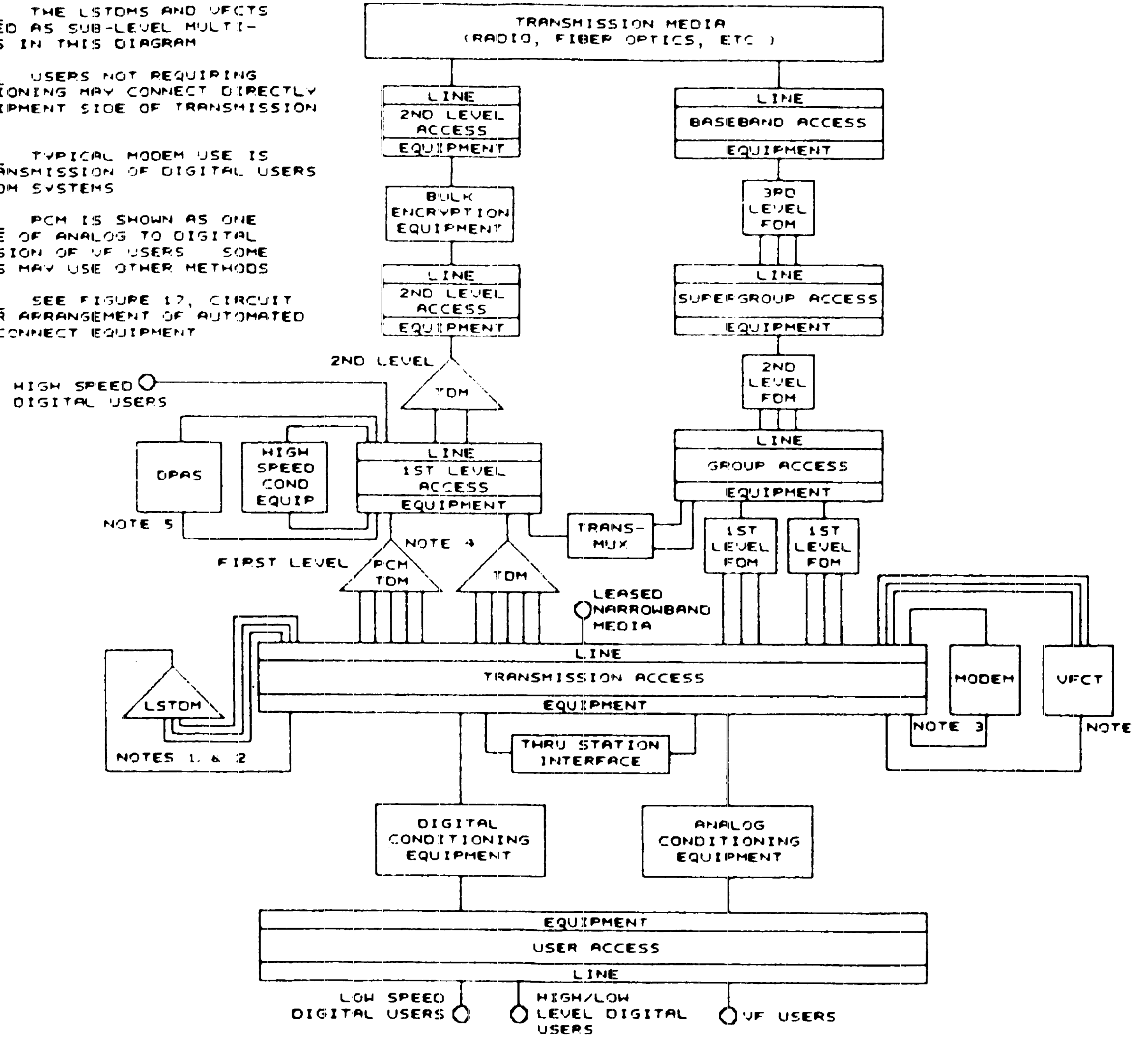


FIGURE 1 Typical electrical configuration for a long haul TCF

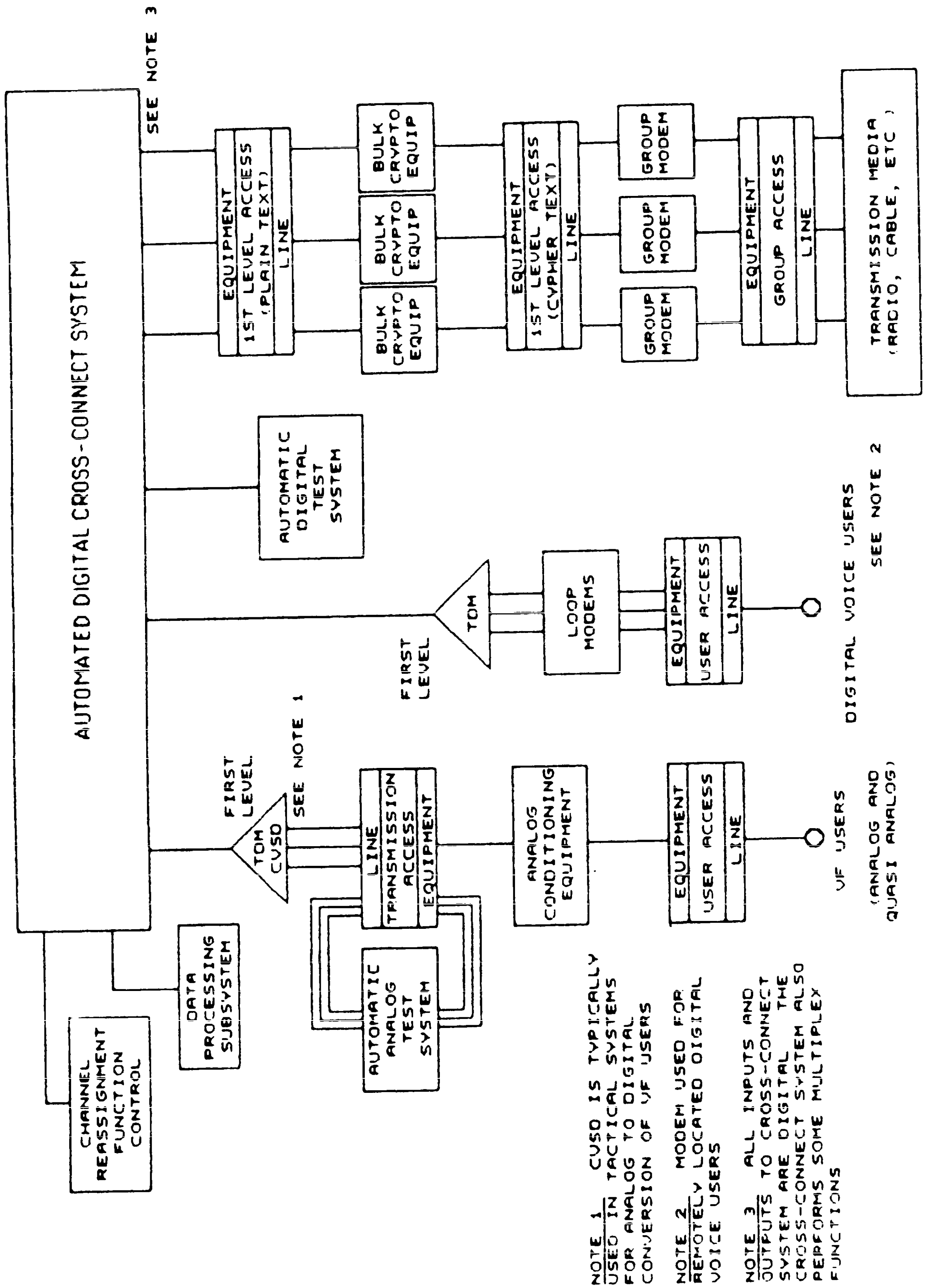


FIGURE 2 Tactical TCF with automated functions

4.2.1.2.2 Quality control (QC) test area. An area within the TCF should be provided for automatic and/or manual QC testing. Within this area, the test equipment required for QC testing shall be mounted in equipment bays.

4.2.1.2.3 Power plant area (DC). An area shall be provided to locate DC power and power distribution equipment required to operate TCF/PTF operational equipment. When storage batteries of the acid or alkaline electrolyte type are employed, the provisions of the National Electrical Safety Code, ANSI C2-1984, section 14, shall be followed.

4.2.2 Installation/fabrication/construction. The construction standards in the following paragraphs shall apply to all technical control facilities.

4.2.2.1 Floor plans. The floor plan shall make use of the available floor space to locate required equipment and allow TCF personnel to perform their functions in a safe and efficient manner.

4.2.2.2 Workmanship and processes. Workmanship and processes shall be in accordance with applicable requirements of MIL-STD-454.

4.2.2.3 Modularity. All patching facilities, test equipment, conditioning equipment mounting shelves, and paneled equipment such as orderwires, alarm panels, and fuse panels shall be designed for mounting in 19-inch electrical cabinets and racks conforming to EIA-RS-310-C-77.

4.2.2.4 Physical access. Access shall be provided to all equipments, as defined in MIL-STD-1472. Electronic equipment shall be operable in extended position (as with an extender card) for maintenance purposes.

4.2.2.5 Test equipment. Where practical, all test equipment shall employ digital readout displays and be capable of providing a serial or parallel data communications interface allowing remote control and remote reporting of test results. Serial data communication interfaces shall conform to EIA RS-530. Parallel interfaces shall conform to ANSI/IEEE STD-488-1978. For those cases where the quantity being measured is continuously variable in nature, conventional scale and pointer instruments may be provided. As a design objective, measurement instruments shall have the capability of recording the measured quantity.

4.2.2.6 Cabling. Signal, clock, and control cables employed in the TCF shall have a minimum of one overall shield per cable. Power distribution lines shall not be contained in the same cable as lines carrying information signals. The cabling used within the TCF should be assigned and routed such that each separate cable contains signals of equivalent type. TEMPEST test results or unique equipment or system characteristics may dictate special cable requirements in addition to those listed above. In some situations low level digital signals and analog signals may be contained in the same cable. However, special considerations should be given to levels, frequencies, and types of cable involved.

4.2.2.7 Cabinet cabling. Within all cabinets, cabling shall be neatly and efficiently routed. Cable clamps and ties shall be used to securely and neatly bundle the cables and attach them to cabinet frame members. The cabling shall be designed and constructed to permit all doors and sliding units to operate freely without binding, scraping, or in any way wearing or damaging the cables.

4.2.2.8 Interconnecting cables. All cables entering or leaving equipment cabinets shall go through the top or bottom of the cabinets. In instances in which cabinets are butted together (either with or without side panels), cables may be passed in a neat bundle through the sides of the cabinets. All cables entering or leaving cabinets shall be numbered. The number shall be clearly marked on or attached to each end of all cables.

4.2.2.9 Connectorized cables. Connectorized cables shall be used to the fullest extent possible.

4.2.2.10 Cabling layout plan. The cabling layout plan shall allow for neat, efficient routing of signal, power, and grounding cables between the various equipment cabinets, patch facilities, distribution frames, and power plant equipment. Cables shall be routed in overhead or subfloor, open or enclosed, raceways, racks or ducts.

4.2.2.11 Universal shelf concept. As a design objective, circuit conditioning equipment shall be mounted in equipment shelves employing the universal shelf concept. Where it is not practical to locate a unit of conditioning equipment employed within the universal shelf because of the manufacturers' design in terms of size, pin connection or other considerations, these units may be mounted in a separate mounting arrangement.

4.2.3 Criteria for facility equipment. Facility plans shall be sufficient to support all identified programmed requirements as well as circuits that are current. Further, all engineering and installation plans shall also be based on the criteria in paragraphs 4.2.3.1 and 4.2.3.2.

4.2.3.1 Expansion. Expansion capability shall be provided for long haul TCFs. Expansion rates 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, a growth rate 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.

NOTE: These factors provide vacant floor and rack/bay space into which future equipment may be installed and neither includes nor implies the quantity of spare equipment to be provided by the initial installation.

4.2.3.2 Standbys. Manual or automated access, circuit conditioning, interfacing, and ancillary equipments shall be furnished and installed to:

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

b. Allow for the substitution of equipment strings (circuit or wideband segments) as they occur between patch panel appearances. Because such equipment will be used to replace "strings" of equipment, numbers are not to be calculated on a per unit basis for this requirement. Long haul TCFs 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, with a minimum of two standby strings of each configuration that has at least three strings.

4.2.3.3 Spares. In addition to equipment provided for standby, spare equipment shall also be based on the following criteria:

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

b. Amplitude and delay equalizers shall be provided in sufficient quantities to condition at least 10 percent of all remaining transmission capabilities within long haul TCFs -- to the highest level of amplitude and delay equalization employed in the TCF. In tactical TCF's, delay equalizers shall be provided for the sole user, quasi analog data circuits designated for entry to the long haul systems.

4.2.3.4 Minimum quantities. Minimum quantities of ancillary equipment shall be provided according to the rule that yields the highest number as follows:

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

b. At any TCF furnishing digital teleprinter service, telegraph regenerative repeaters shall be provided for at least 3 percent of those circuits with no less than two repeaters per TCF.

c. Monitor teleprinters shall be provided on the basis of one per 25 teleprinter circuits.

d. At any TCF furnishing digital teleprinter service, a minimum of two digital hubbing repeaters shall be furnished. Each repeater shall be capable of accommodating up to six full duplex circuits.

NOTE: Items b, c, and d above apply to asynchronous teleprinter circuits operating at 75 bits per second or less.

4.2.4 Grounding, bonding, and shielding. The construction of the facility ground system shall comply with the approved grounding, bonding, and shielding methods and techniques as described in MIL-STD-188-124 and MIL-HDBK-419.

4.2.5 Electromagnetic compatibility. Electromagnetic compatibility and interference control shall be considered in all stages of TCF design. New systems, subsystems, and equipment procured for use in technical control facilities shall satisfy the applicable requirements of MIL-STD-461.

4.2.6 Maintainability. TCF planning and design shall take into consideration the maintainability of individual equipment items and the TCF as a whole. While there are no quantitative mean time to repair (MTTR) values developed for the TCF, the maintainability design guidelines of MIL-STD-470 shall be considered for incorporation into the TCF design.

4.2.7 Human engineering. The human engineering principles and practices contained in MIL-STD-1472 and MIL-H-46855 should be applied to the planning, design, and selection of TCF equipment, its physical configuration and placement, and the facility in which they are placed.

4.2.8 Environmental conditioning. Environmental conditioning for the TCF shall be provided as specified in MIL-HDBK-411.

5. DETAILED REQUIREMENTS

5.1 General. This section contains detailed requirements for TCF facilities, equipment, and internal subsystems. These requirements, unless otherwise noted, shall apply to TCFs employed in long haul and tactical environments.

5.2 Major facilities and equipment. The following specifications establish the utilization, configuration, and minimum performance required of major facilities and equipment used in the TCF.

5.2.1 Access facilities. The TCF shall employ specific analog and digital access points, either manual or automated, throughout the circuit path to permit routing, testing, and monitoring functions. These access points shall be grouped by function to be performed and consist of the following categories: user access, transmission access, wideband analog access, and high speed digital access. Analog and low speed balanced digital circuits can be combined in one patch bay or facility. Paragraphs 5.2.1.1 through 5.2.1.5 identify the specific interface points at which an access shall be employed.

NOTE: When differences exist in the make up and use of access facilities and equipment between long haul and tactical TCFs, they are pointed out and standards are provided which apply to their treatment within each environment.

5.2.1.1 User access. TCFs that are required to provide circuit conditioning for narrowband analog signals, quasi-analog signals at the voice frequency level, and low/high level, low speed digital data shall employ a user access. These signals are from users, in-house data modems, and sub-level multiplex equipment. This access shall be electrically located in the circuit path as shown in Figure 3. Low speed digital users should be separated into categories of operation: balanced/unbalanced, low/high level.

NOTE: No standard exists for the high level digital interface. However, MIL-STD-188-100 identifies various high level interfaces that may be encountered in some situations.

5.2.1.1.1 Physical interface. TCF conditioning/signaling equipment, shall terminate on the equipment side of the user access. The line side of the user access shall connect to in-house tie cable and outside plant cables required to connect the TCF with subscribers, users, and other systems.

5.2.1.1.2 Electrical interface. Circuits appearing at the user access may do so at any level or impedance necessary to interface the TCF with subscribers, users, and other systems.

5.2.1.1.3 Jack and patch logic. The jack and patch logic provided by a manual user access shall be the same as specified in 5.2.1.2.3, a through d. In the event 6-, 8-, or 9-wire terminations are required at the user access to provide for signaling and supervisory leads, it shall be handled by the use of additional accesses or by the use of multi-pin patch jacks. The specifications for these jackfields are the same as those specified in 5.2.1.2.3, a through d.

5.2.1.2 Transmission access. The transmission access shall be electrically located at a point between the FDM and TDM channel ends and the conditioning equipment that supports the channel. These access points shall be located in the circuit path as shown in Figure 3. VF circuits appearing at the transmission access shall normally be terminated on a 4-wire (transmit and receive) basis. Additional accesses shall be provided for signaling

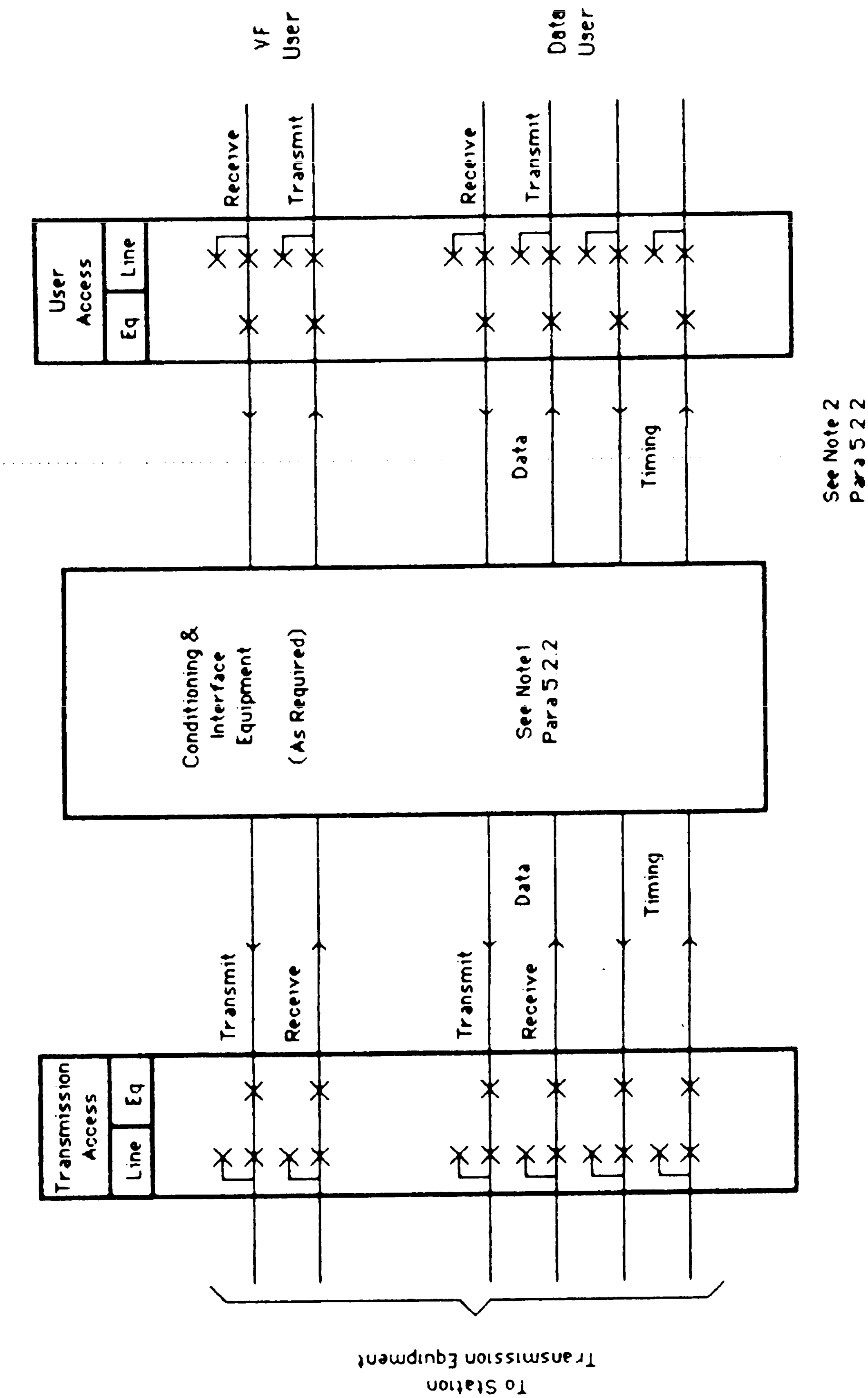


FIGURE 3. User access and transmission access

and supervisory leads associated with the VF circuits. For first level multiplexers with integral E&M signaling units, at least one third of the channels shall have the associated E&M signaling leads appear at the transmission access. As a design objective, E&M signaling leads for all channels shall appear at the transmission access. Certain digital circuits may require a number of lines (for example, 10 or more) and each shall be provided an access. The facilities shall be composed of modular jacks or jackfields if manual patching techniques are used. As a design objective, automated digital access facilities shall be considered for long haul as well as tactical TCFs.

5.2.1.2.1 Physical interface. FDM and TDM multiplex equipment shall be terminated on the line side of the transmission access. The equipment side of the access shall terminate to TCF conditioning/signaling equipment, VFCT multiplex equipment, and data modems. VF and low level users not requiring conditioning may terminate directly on the equipment side of the transmission access.

5.2.1.2.2 Electrical interface. Both the transmit and receive transmission level point (TLP) of all analog circuits appearing at the transmission access shall show a 0dBm0 test tone at an absolute power value of 0dBm for both fixed and tactical TCFs. The impedance at the transmission access shall be a nominal 600 ohms for VF circuits. All low level digital circuits, balanced or unbalanced, should meet the requirements of MIL-STD-188-114. As a design objective, all digital circuits should be balanced, low level.

NOTE: High level digital circuits may be encountered in some locations. MIL-STD-188-100 identifies some of the common high level digital interfaces.

5.2.1.2.3 Manual jack and patch logic. The jack and patch logic provided by the transmission access shall have the capability to:

a. Provide a "normal through" (no patch cords used) connection through the patching facilities.

b. Provide the ability to patch any line or equipment to any line or equipment on a temporary basis without special cords or equipment .

c. Accept inputs from the miscellaneous jackfield such as termination impedances, test signals, test equipment, and bridge.

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

NOTE: Standard pin assignments for multi-pin patching equipment have not been adopted by the military departments. However, when multi-pin patch equipment is used for patching of signals having standardized pin assignments (EIA RS-530 for example), the pin assignments of that particular standard shall be used.

5.2.1.3 Wideband analog circuits and frequency division multiplex facilities. Facilities for monitoring, testing and routing 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 if line, equipment, and line monitor jacks are provided.

5.2.1.3.1 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, access to permit rerouting or restoral shall also be included.

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

5.2.1.3.3 FDM group patching concept. The group patching concept shall be used to interface FDM equipment having different frequency allocations, pilot frequencies, impedances, or levels.

5.2.1.3.3.1 Basic requirements. The capability for connecting like and unlike multiplexers is necessary to permit rerouting and restoral. For multiplexers having identical impedance, level, and pilot frequencies, only a pair of group connectors shall be required. Other multiplexers that use the same frequency allocation plan but have different levels, impedances, or pilot frequencies shall be made compatible, for routing purposes, through the use of conditioning equipment as described below. There are certain types of multiplexers that use a nonstandard frequency allocation plan. These shall be accessible on the group access for monitoring and testing only.

5.2.1.3.3.2 Standard levels and impedances. Standard levels and impedances for FDM equipment are established by MIL-STD-188-311. 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, shall apply to either the MIL-STD-188-311 standard or the local levels and impedances adopted as standard.

5.2.1.3.3.3 Manual group routing procedures. Figure 4 illustrates the concept of group routing. The manual group access 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 routing within multiplexers of the same type shall be done at the section of the group access associated with that type. The group connector is the only equipment required for such connections. Normal connections and patching between different types of multiplexers shall be done at the standard section of the group access. Conditioning equipment strings connected between the standard section and each of the nonstandard sections of the group access 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 access.

5.2.1.3.3.4 Manual group access, standard section. A standard section of the group access 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.

5.2.1.3.3.5 Manual group access, nonstandard section. For each nonstandard multiplexer in the station, a nonstandard section of the group access 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.

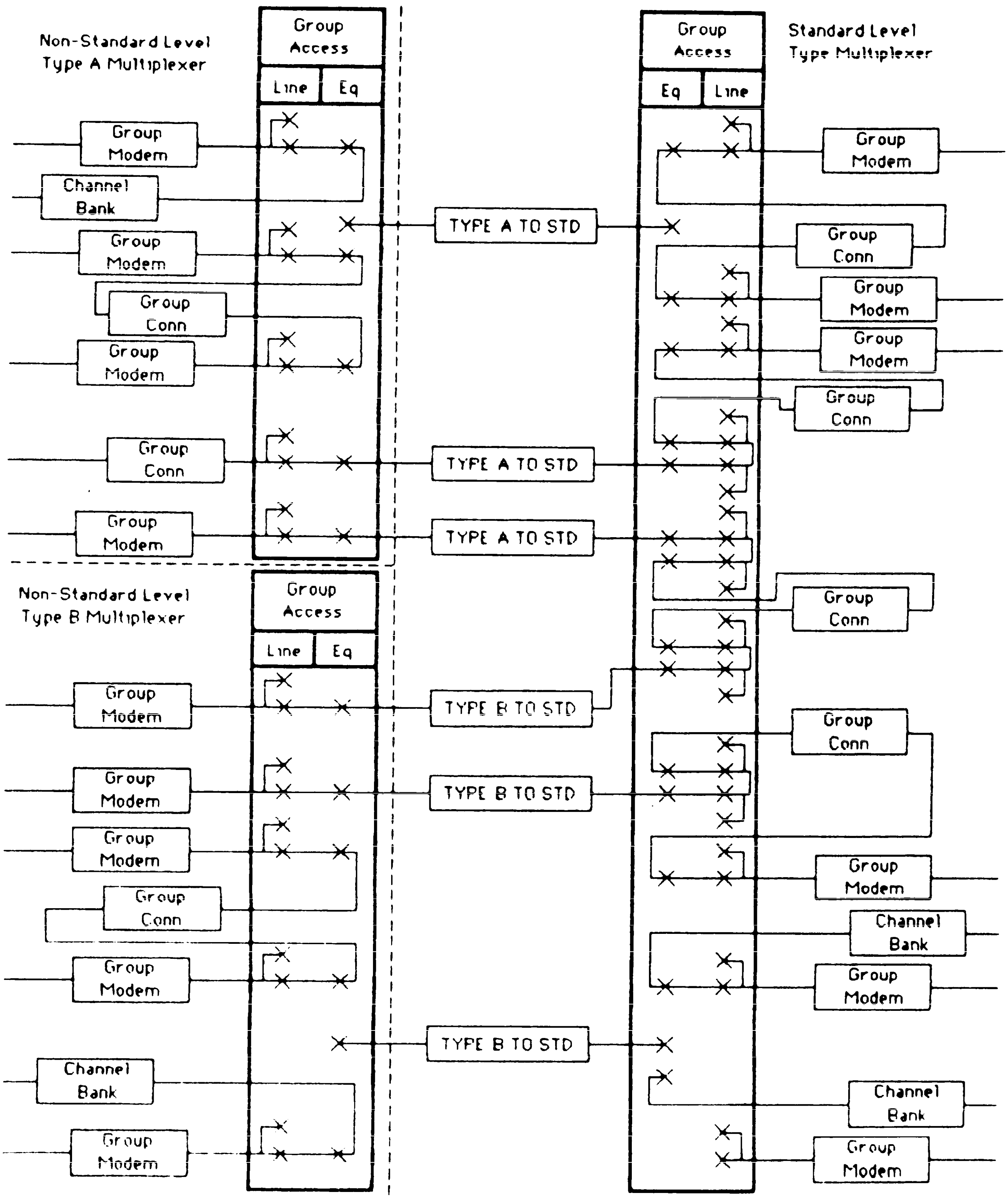


FIGURE 4 FDM group patching concept

5.2.1.3.4 Impedance matching. Impedance matching equipment shall be required to match the station multiplexer.

5.2.1.3.4.1 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 5.2.1.3.4 may be combined with the attenuators or amplifiers, or both, in integrated assemblies.

5.2.1.3.4.2 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.

5.2.1.3.5 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.

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

5.2.1.3.5.2 Minimum quantities. In the absence of network plans in sufficient detail to permit the application of the criteria of 5.2.1.3.5.1, 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.

5.2.1.3.5.3 Provision 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 percent 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 of five groups, for each type of multiplexer.

5.2.1.4 Manual high-speed digital patching facilities. The aggregate signals of first and second-level TDM equipment shall be routed through access facilities. Figure 5 shows the electrical placement of these facilities within the circuit path. These jacks shall provide the same jack and patch logic as specified in paragraph 5.2.1.2.3. All such access facilities should be consolidated in a single location to permit rerouting and restoral. They may be physically located with the equipment. Jacks integral to the equipment may be used to satisfy this requirement as long as they provide the jack and patch logic as specified in paragraph 5.2.1.2.3.

5.2.1.4.1 Manual high speed multiplex patching facilities. Balanced circuit elements carrying digital aggregate signals of first level TDM shall physically interface via a first level access facility, while aggregates of second level TDM shall interface via a second level access.

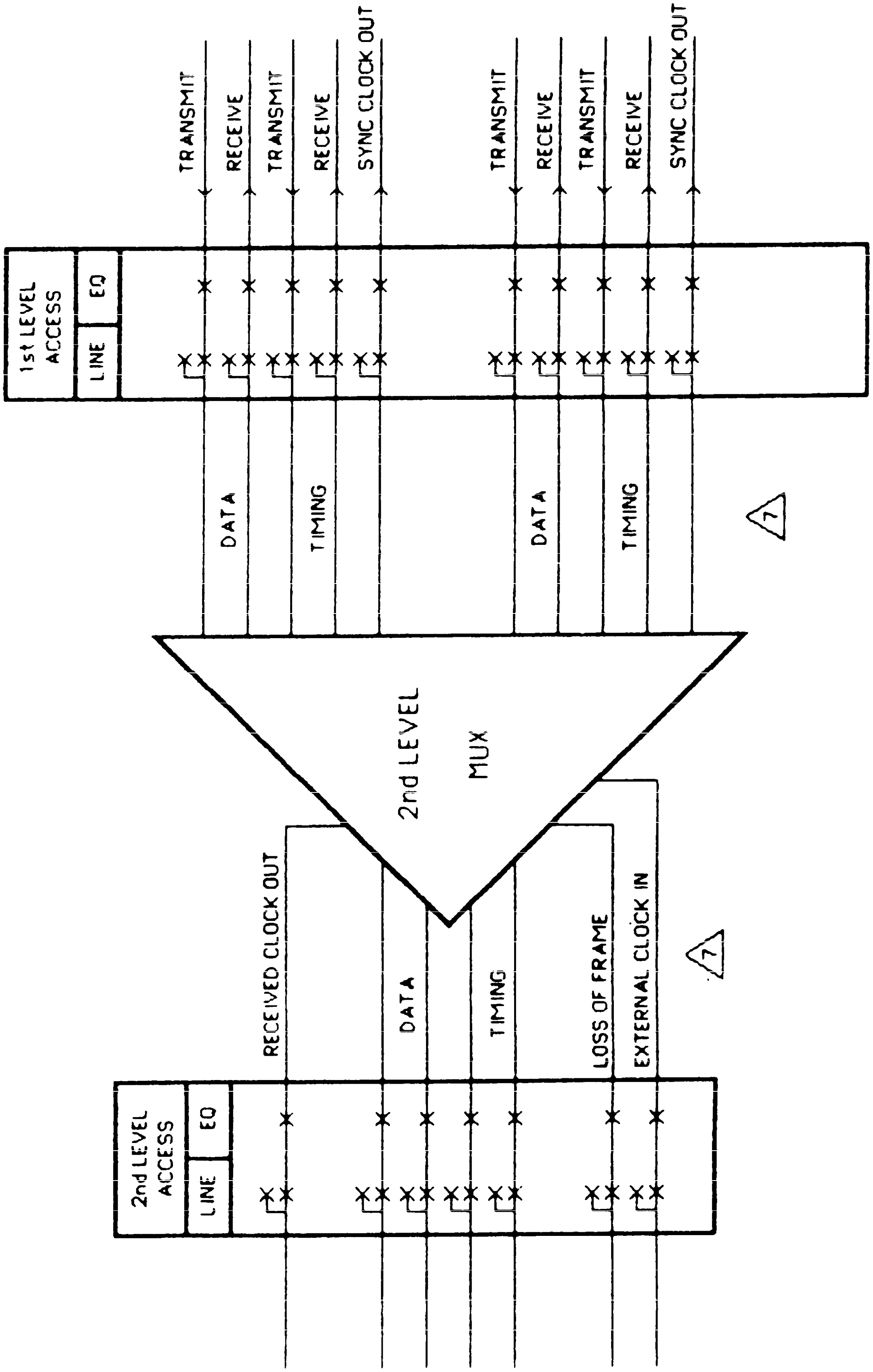


FIGURE 5 High speed digital access

5.2.1.4.2 Physical interfaces. The aggregate of first-level TDMs and special modems shall terminate on the equipment side of the first level access. The line jacks shall terminate the ports of second-level TDM equipment. The line jacks of the second level access shall terminate the transmission equipment or higher level TDM equipment. The equipment jacks shall terminate the aggregate of second-level TDM equipment. Automated access as described in paragraph 5.2.1.4.4 shall be located at the same electrical points.

5.2.1.4.3 Electrical interfaces. All circuits appearing at the high speed digital patch facilities shall be configured for balanced operation as defined in MIL-STD-188-114. An exception to this requirement is permitted for long haul multiplexers using common commercial data rates. Interfaces for such multiplexers shall be in accordance with CCITT Recommendation G.703.

5.2.1.4.4 Automated cross-connect and access systems. Selected stations may be equipped with automated digital cross-connect and access equipment. This equipment shall be capable of processing digital groups so that bit positions occupied by specific channels or groups of channels in incoming data streams, occur in bit positions in outgoing data streams as specified by the operator. The status of current channel assignments shall be stored by electronic means and updated automatically as assignments are made or deleted.

5.2.1.4.4.1 Tactical automated routing facilities. The tactical automated digital cross-connect system shall be designed to interface digital channel and group rates and multiplex signal formats as described in ICD-003, Framing and Synchronization Protocols. These systems shall be connected to access facilities as shown in Figure 2.

5.2.1.4.4.2 Long haul automated routing facilities. The long haul automated digital cross-connect system shall be designed to interface aggregate rates of first level multiplexers employing PCM/TDM techniques. These systems will be connected to access equipment as specified in paragraph 5.2.2.3.8 and Figure 17, Circuit 11.

5.2.1.4.5 Digital channel efficiency equipment. Selected long haul stations may be equipped with digital channel efficiency equipment. This equipment uses adaptive differential PCM techniques to permit increased VF channel capacity within a fixed bit rate. Access to all inputs and outputs of the digital channel equipment shall be provided as specified in paragraph 5.2.2.3.8 and Figure 17, Circuit 12.

5.2.1.4.6 Transmultiplexers. Selected long haul stations may be equipped with transmultiplexers during conversion from FDM to TDM transmission systems. This equipment allows two FDM groups (of 12 channels each) to be converted directly to a single TDM digital group (of 24 channels). Transmultiplexers should be installed on a temporary basis to permit easy removal as FDM equipment is replaced by TDM equipment. When a TCF is provided a transmultiplexer, access to all inputs and outputs shall be provided as specified in paragraph 5.2.2.3.8 and Figure 17, Circuit 13.

5.2.1.5 Tactical TCF manual digital patching facilities. Tactical TCF digital patching facilities may be required to handle both balanced and unbalanced digital group signals, which are defined in Section 5 of ICD-002. All incoming group signals shall be terminated and converted to low level balanced for distribution within the TCF. Within the tactical TCF, a first level access shall be provided to connect the group outputs of digital group formatting and crossconnect equipment to a second level multiplexer or to group modems. A typical digital connectivity for a tactical TCF is shown in Figure 2.

5.2.2 Analog (VF) circuits. Figure 3 depicts the arrangement of VF access for monitoring the conditioning equipment within a TCF. All VF users shall access the TCF via a user access. All conditioning equipment required to provide compatibility between users and transmission facilities shall be electrically connected between the user access and the transmission access. The transmission access shall serve as the principal point of interface and restoration in the TCF. The transmission access shall be a zero (0) TLP. Supervisory signals, other than user-generated integral signaling not needing conversion, shall appear as 2600 Hz or 2600/2800 Hz tones at the transmission access point. 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. The following paragraphs and corresponding illustrations describe VF 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.

NOTE 1: MIL-HDBK-414 contains general descriptions and recommended performance characteristics for various types of conditioning and signaling equipment. MIL-HDBK-414 can be consulted if more information on applications and operation of specific equipment is desired.

NOTE 2: The dotted line on Figure 3 indicates the general electrical point at which the transmit/receive sense is changed. In physical terms, this is commonly at the IDF located between the user access and the conditioning equipment.

5.2.2.1 Basic analog circuits. Figure 6 shows the symbols and abbreviations used in depicting the technical control configuration for VF circuits and channels. These are associated with the circuit descriptions which follow.

NOTES: (Applicable to Figures 5 through 17).

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

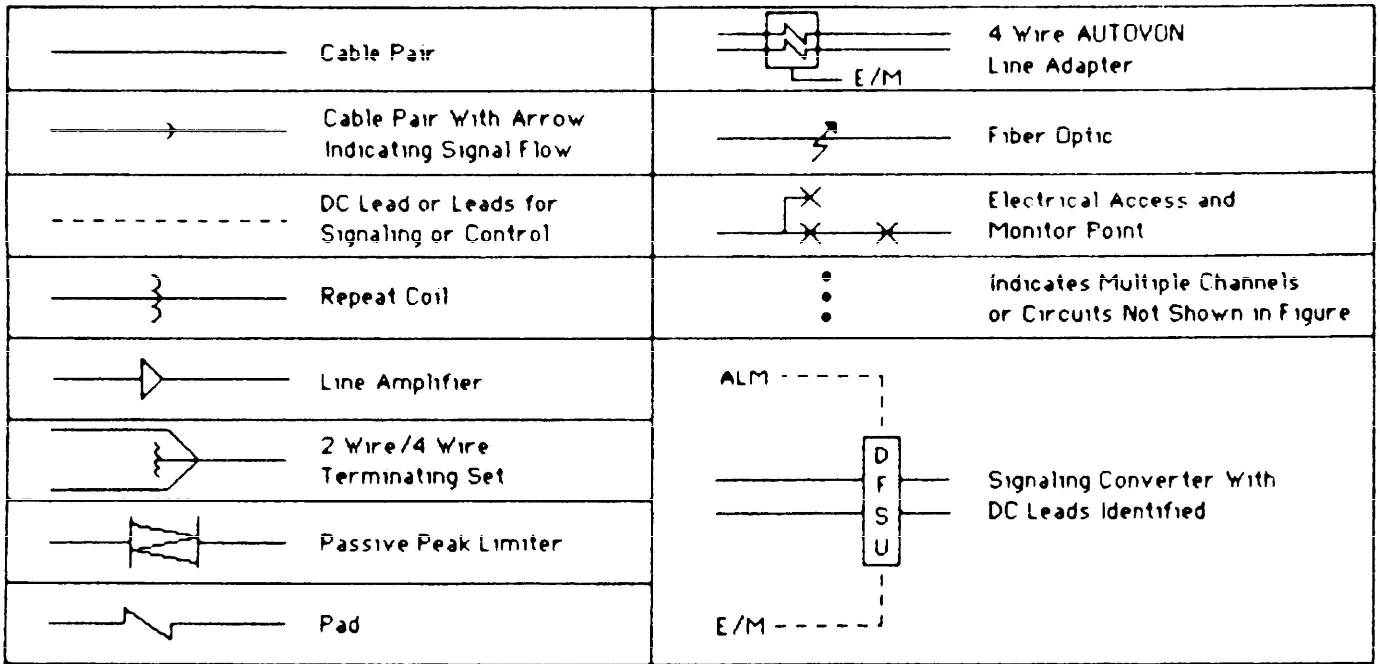
2. Patch and test facilities associated with various users have not been shown since they do not affect the routing through, or the functions performed by, the TCF.

3. Echo cancelers may generally be used in place of the echo suppressors shown. Echo cancelers shall be installed between the transmission access and the signaling converter.

4. When passive peak limiters are required on a circuit, they shall be wired to the line side of the user access if the TLP there is -2 dB or greater and they do not interfere with signaling. Otherwise, they shall be wired to the equipment side of the transmission access. An exception to this policy permits limiters that are integral to multiplex equipment to be used.

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

6. E&M signaling leads may be wired directly to 1st level TDM equipment which includes an integral signaling interface. In the event that leads are used in this manner, they shall have an appearance at the transmission access.



A, B	A & B Signaling Leads	MUX	Multiplexer
AE	Amplitude Equalizer	OS	Out of Service Lead
ALM	Alarm Lead	PLR	Pulse Link Repeater
CH	Channel	PMB	Pilot-Make-Busy
DE	Delay Equalizer	REGEN	Regenerative Repeater
DFSU	Dual Frequency Signaling Unit	SIG	Signaling Unit
DX	Signaling Extension Units	VF	Voice Frequency
E, M	E & M Signaling Leads	VFCT	Voice Frequency Carrier Telegraph
ES	Echo Suppressor		
ESC	Echo Suppressor Control Lead		

FIGURE 6 Symbols and abbreviations

7. For synchronous data transmission with separate lines for signal timing, access points will be provided as shown. Other transmission methods may not require separate lines for timing and thus will not require the timing access.

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

9. Numbers within triangles, e.g.,△2, indicate an applicable note from this list.

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

5.2.2.1.1 Two-wire VF circuits. Two-wire circuits are depicted in Figure 7 (Circuit #s 1 through 5). All 2-wire circuits entering the TCF require conversion to 4-wire. Echo suppressors or cancelers may be necessary depending on the user requirements. Single frequency (2600 Hz) signaling units may be used in place of the DFSUs.

Circuit 1 Two-wire voice user with standard integral signaling. This is a 2-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.

Circuit 2 Two-wire voice user with 20 Hz signaling. The user for this circuit is either a 2-wire switchboard or an individual 2-wire user using a 20 Hz ringing source. This circuit provides echo suppression or cancellation to minimize echoes arising from 4-wire to 2-wire conversion. Conditioning is provided by pads, amplifiers, and 2-wire/4-wire conversion. Signaling conversion is provided by E&M/20 Hz converters and 2600/2800 Hz dual frequency signaling units (DFSU) or 2600 Hz single frequency signaling units (SFSU)..

Circuit 3 Two-wire voice user with loop signaling. The user for this circuit is either a 2-wire switchboard or a two-wire individual user that uses loop signaling. The circuit flow diagram is similar to Circuit #2 except for the E&M/dial loop signaling converters.

Circuit 4 Two-wire voice user with E&M signaling. The user for this circuit is either a 2-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 via the user access to the DFSU. Conditioning items are a 2-wire/4-wire terminating set, echo cancelers, with pads and amplifiers for level adjustment.

Circuit 5 Two-wire voice user needing integral signaling conversion. After entering the TCF via the user access, this circuit's integral signaling needs to be converted to standard 2600/2800 Hz in-band signaling before the circuit appears on the transmission access.

5.2.2.1.2 Four-wire VF circuits. Four-wire VF circuits are depicted in Figure 8 (Circuit #s 6 through 10). The 4-wire circuits enter the TCF through the user access and after all necessary interfacing are routed through the transmission access.

Circuit 6 Four-wire user with integral signaling. 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 user access and transmission access points. 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.

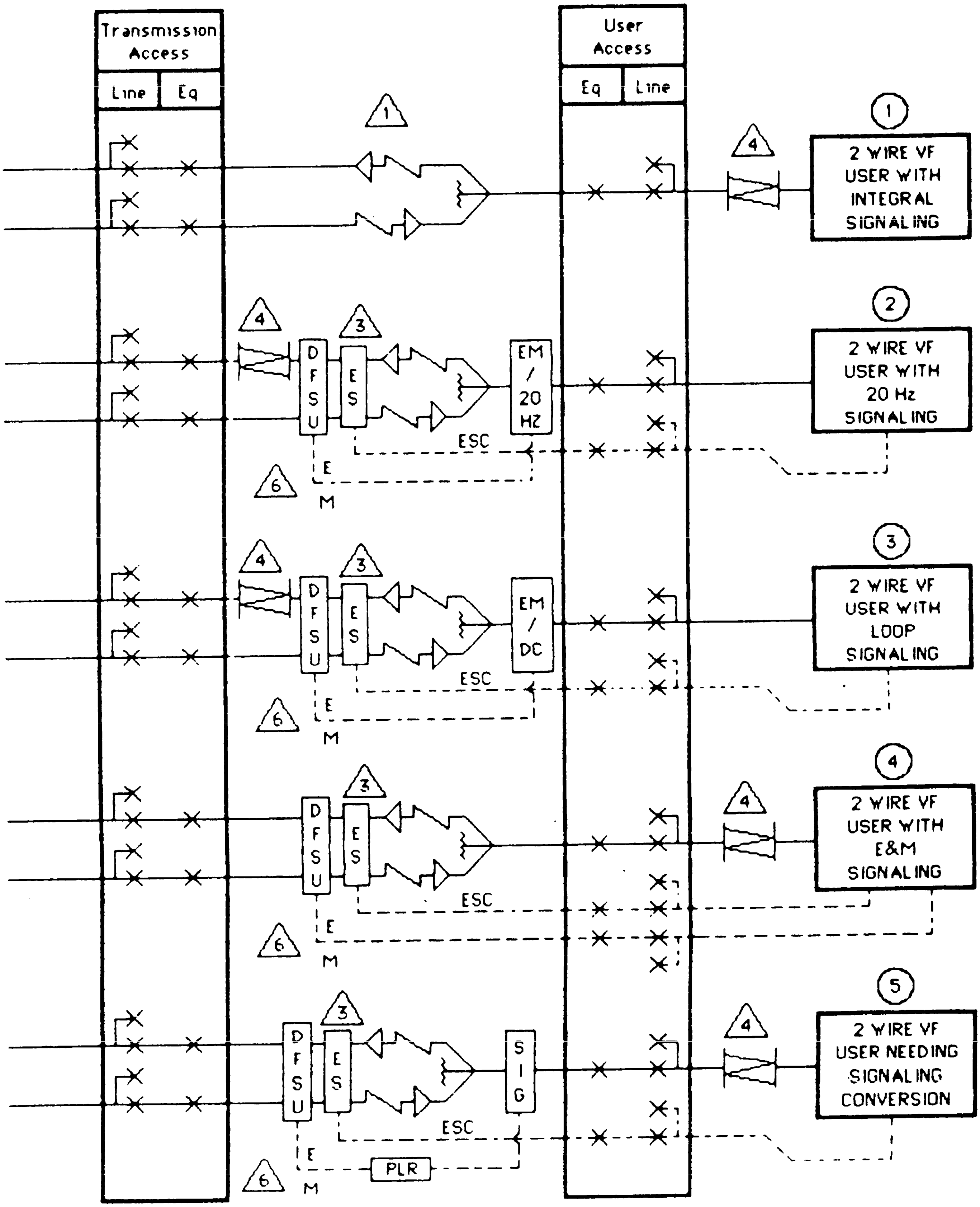


FIGURE 7 Two-wire VF circuits

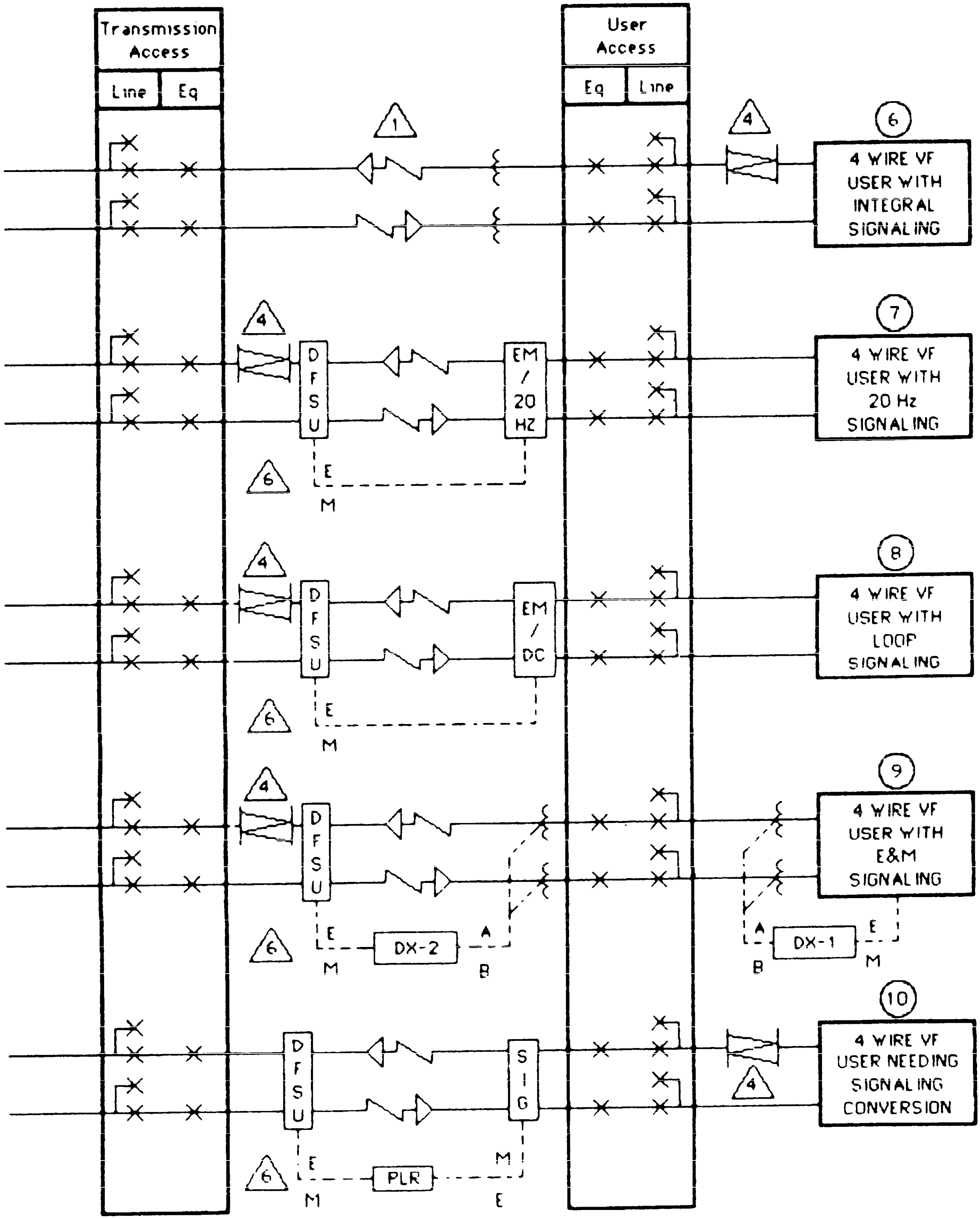


FIGURE 8 Four-wire VF circuits

Circuit 7 Four-wire user with 20 Hz signaling. The users for this circuit are either 4-wire switchboards or individual 4-wire users who employ 20 Hz signaling. A 4-wire physical circuit is used for the on-base cabling. Conditioning and level adjustment between the user access and transmission access consists of pads and amplifiers. E&M/20 Hz converters and DFSUs (or SFSUs) are required for telephone signaling conversions.

Circuit 8 Four-wire user with loop signaling. The user for this circuit can be either a 4-wire switchboard or an individual user who employs loop signaling.

Circuit 9 Four-wire user with E&M signaling. 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.

Circuit 10 Four-wire user using nonstandard in-band signaling. After entering the TCF via the user access this circuit's integral signaling needs to be converted to standard 2600/2800 Hz in-band signaling before the circuit appears on the transmission access.

5.2.2.1.3 AUTOVON users collocated with a TCF and an AUTOVON switch. AUTOVON user circuits are depicted in Figure 9 (Circuit #s 11 through 14). When the AUTOVON switch is also collocated with the TCF the circuits do not require a transmission access. After passing the user access, the circuits are conditioned for proper levels and signaling and make another appearance at the user access before being connected to the AUTOVON switch.

Circuit 11 Four-wire circuit with DX signaling. The user for this circuit is either an AUTOVON PBX access line or an AUTOVON 4-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.

Circuit 12 Four-wire PBX circuit with E&M signaling to AUTOVON (PBX cable to TCF). This circuit is similar to circuit #11 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.

Circuit 13 Two-wire PBX cable access line to local AUTOVON Switch (2- to 4-wire conversion at the PBX). This circuit involves connection of a 2-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. 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 cancelers, pads and amplifiers shall be inserted into the circuit as shown.

Circuit 14 Four-wire AUTOVON user telephone cable to TCF (loop resistance less than 700 ohms). 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 appear at the user access point, connect to the 4-wire AUTOVON line adapter, return to the user access, and then proceed to the collocated AUTOVON switch.

5.2.2.1.4 AUTOVON switch circuits. AUTOVON switch circuits are depicted in Figure 10 (Circuit #s 15 and 16). These circuits are AUTOVON trunks which are

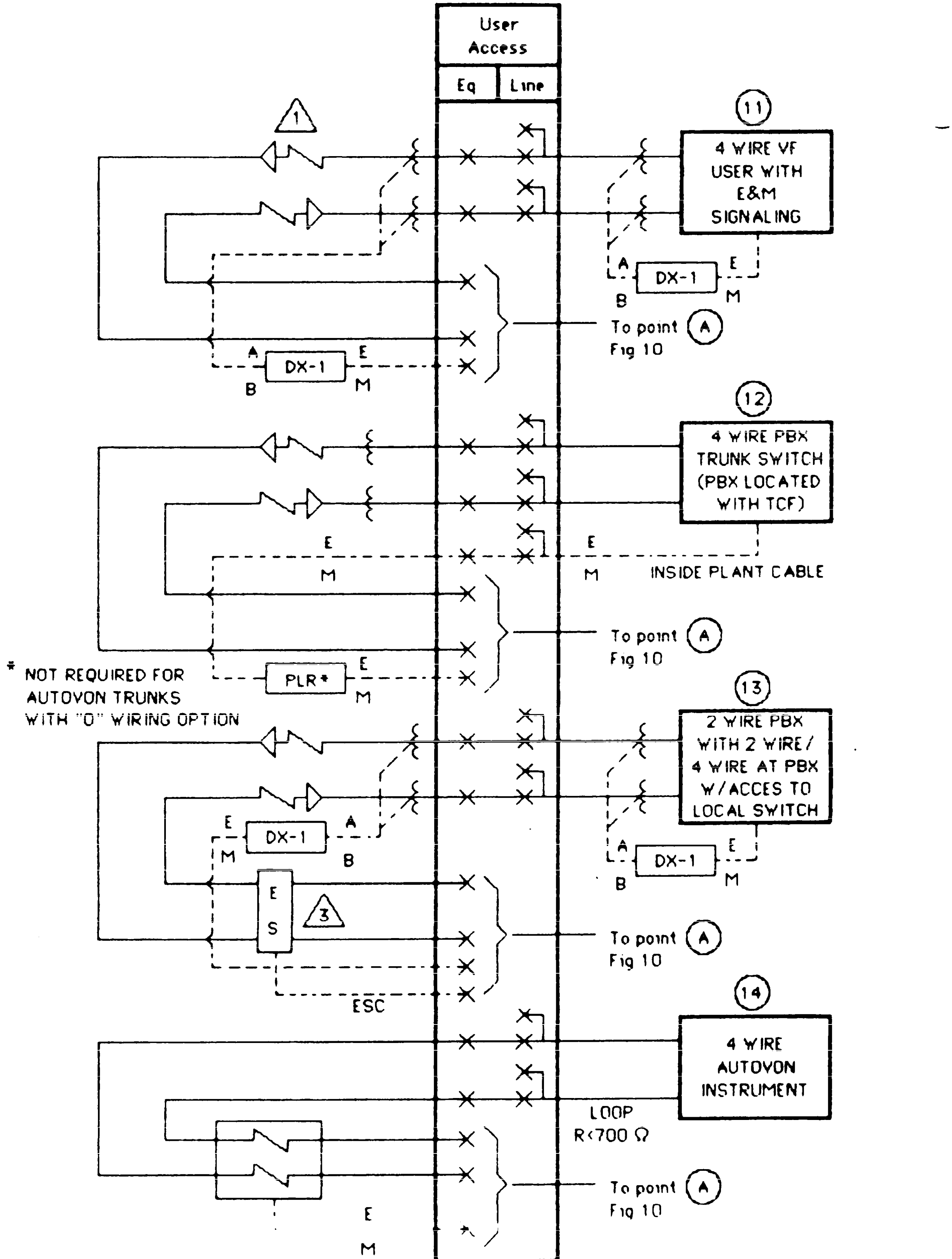


FIGURE 9 AUTOVON users collocated with TCF and AUTOVON switch

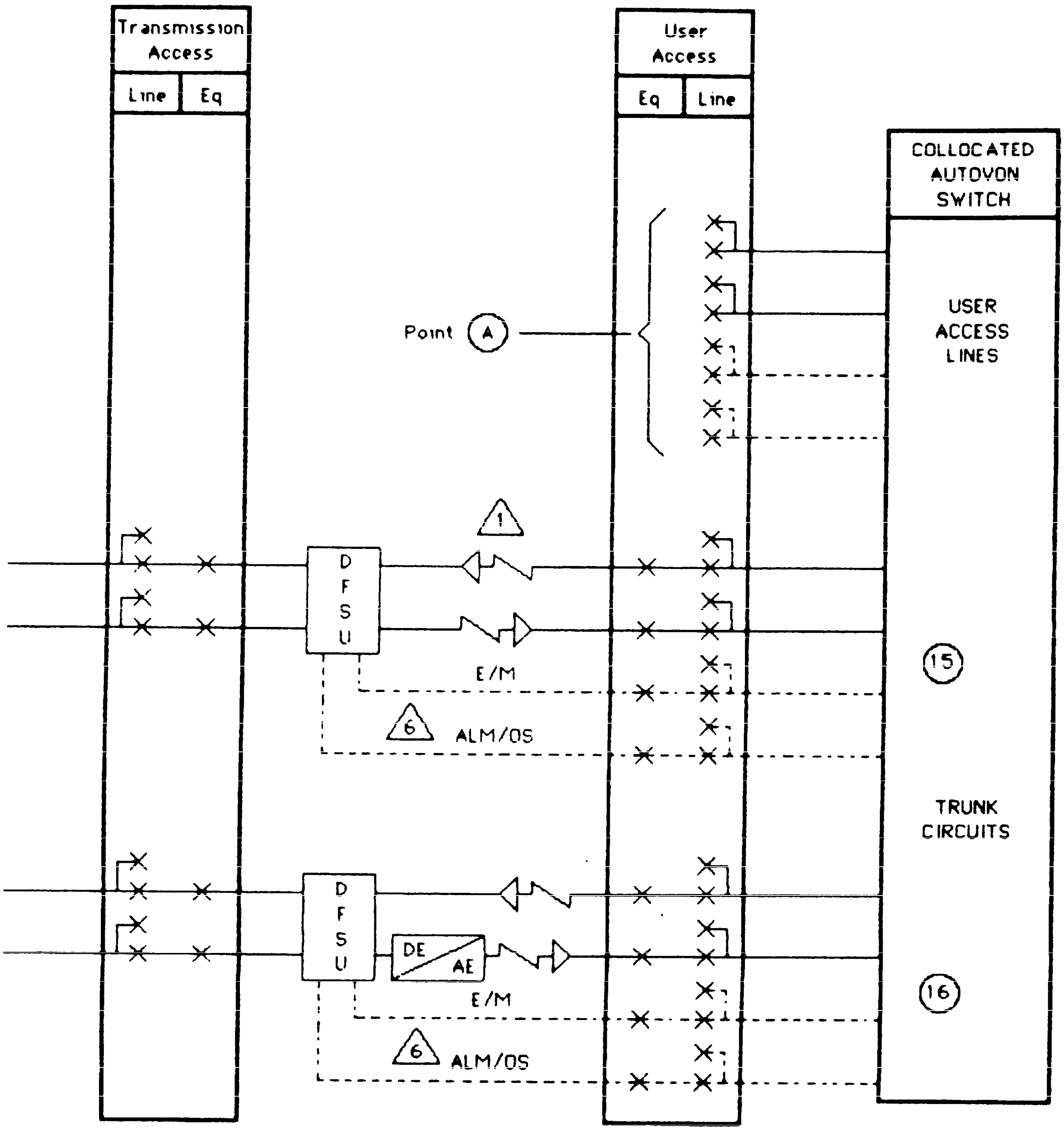


FIGURE 10 AUTOVON switch circuits

connected directly between an AUTOVON switch and a collocated TCF. These circuits connect through the user access where they are routed through appropriate conditioning equipment to the transmission access. The alarm (ALM) and out of service (OS) leads from the DFSUs are routed to the switch for busying out the trunk when required.

Circuit 15 Four-wire AUTOVON circuit. AUTOVON trunk circuits are connected directly to the collocated TCF user access for service to remote AUTOVON users. These circuits are conditioned with pads and amplifiers for level adjustments.

Circuit 16 Four-wire AUTOVON special grade circuit (AUTOVON data users and interswitch trunks). This circuit is similar to Circuit #15 except for the provision of amplitude, delay, or both types of equalization devices in this circuit for data use.

5.2.2.1.5 Voice frequency data circuits. VF data circuits are depicted in Figure 11 (Circuit #s 17 through 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 user access then through the necessary conditioning equipment prior to being routed to the transmission access.

Circuit 17 Two-wire data circuits with E&M signaling. This circuit is similar to Circuit #4 except echo suppressors are not used because of interference with the transmitted data. Circuit operation is usually simplex.

Circuit 18 Four-wire data circuit without signaling. 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.

Circuit 19 Four-wire data circuits using a low speed modem. This circuit appears twice at the transmission access; once as a digital signal and once as a quasi-analog signal. The circuit may be routed to the user access if conditioning equipment (level converters, regenerative repeaters, etc) is needed before being reconnected to the transmission access.

Circuit 20 Four-wire data circuit using voice frequency carrier telegraph (VFCT). This circuit consists of multiple teletypewriter signals which traverse the TCF through the user and transmission access and are then combined into a quasi-analog signal by a VF carrier telegraph. The digital signals shall be routed through the user access if conditioning is required. The quasi-analog signal employs a nominal 4-kHz channel bandwidth and traverses through the transmission access as a VF signal. If pads and amplifiers are required, the circuit shall be routed through the user access and conditioning equipment before its appearance at the transmission access.

5.2.2.1.6 HF radio circuits. These are voice and telegraph circuits using HF radio for long distance communications and are depicted in Figure 12 (Circuit #s 21 through 23). All such HF radio circuits shall have at least one appearance at the transmission access. This means that HF radio circuits accessing the mux link may have two appearances at the transmission access; 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 transmission access (Circuit #22).

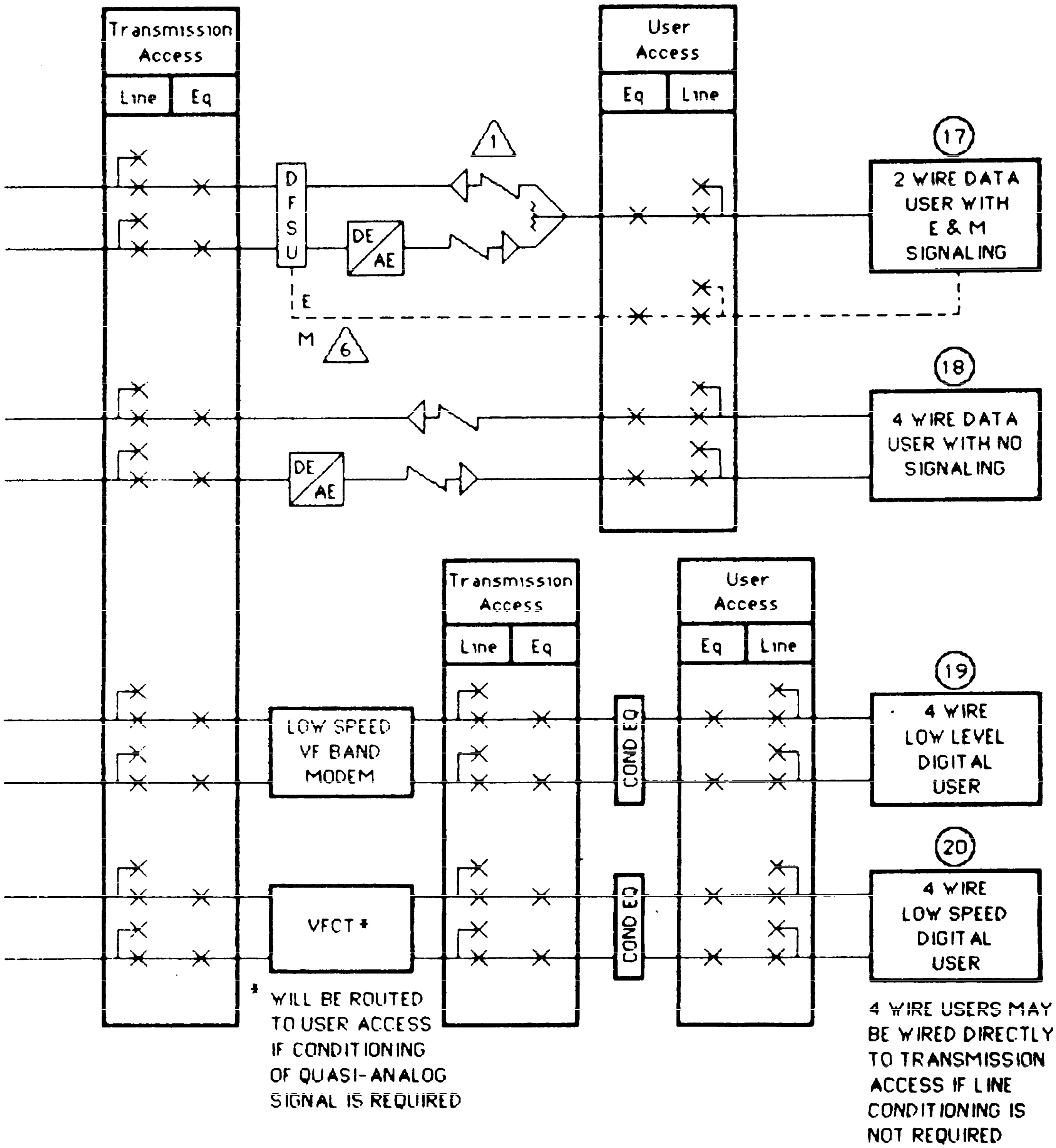
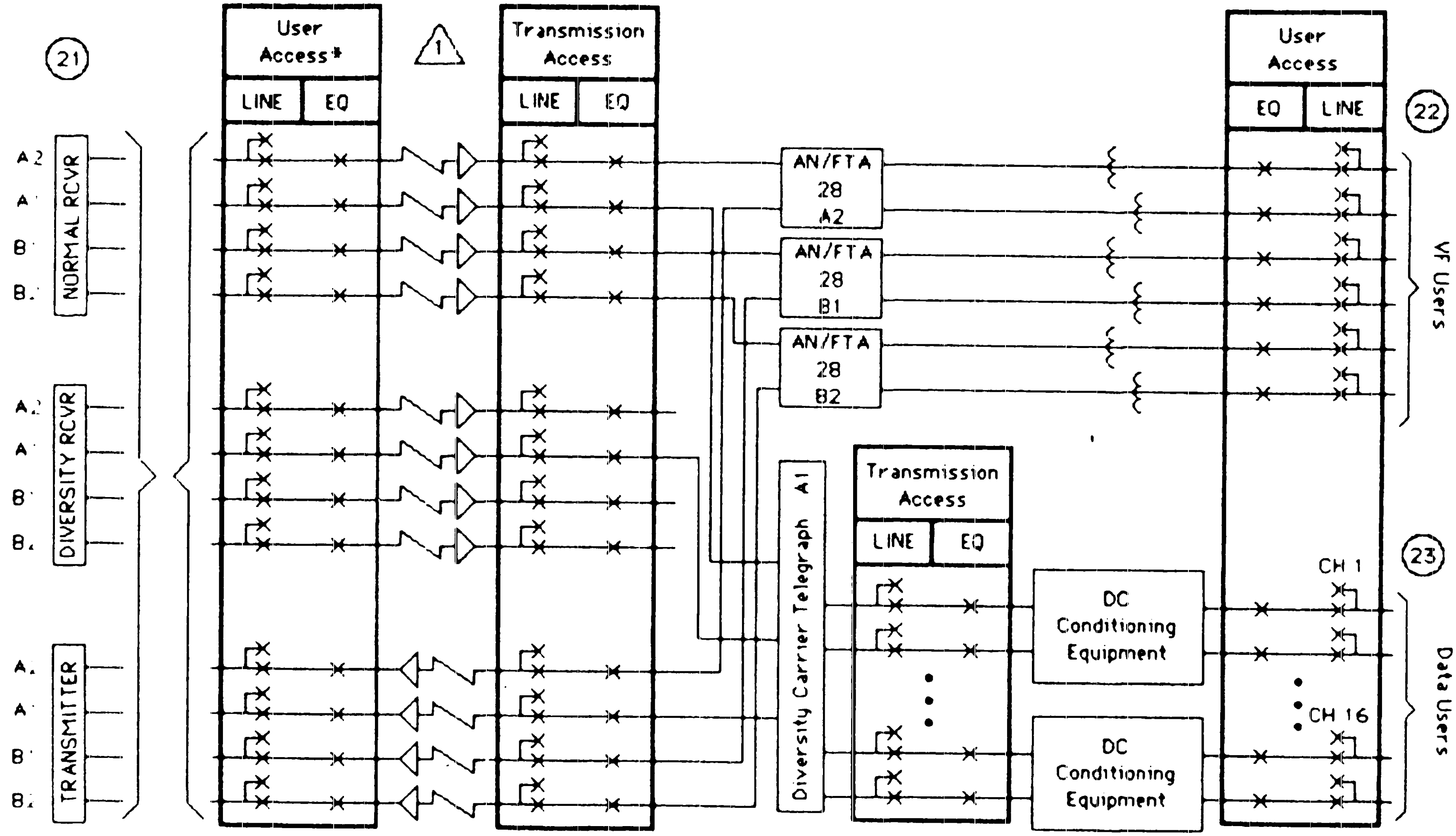
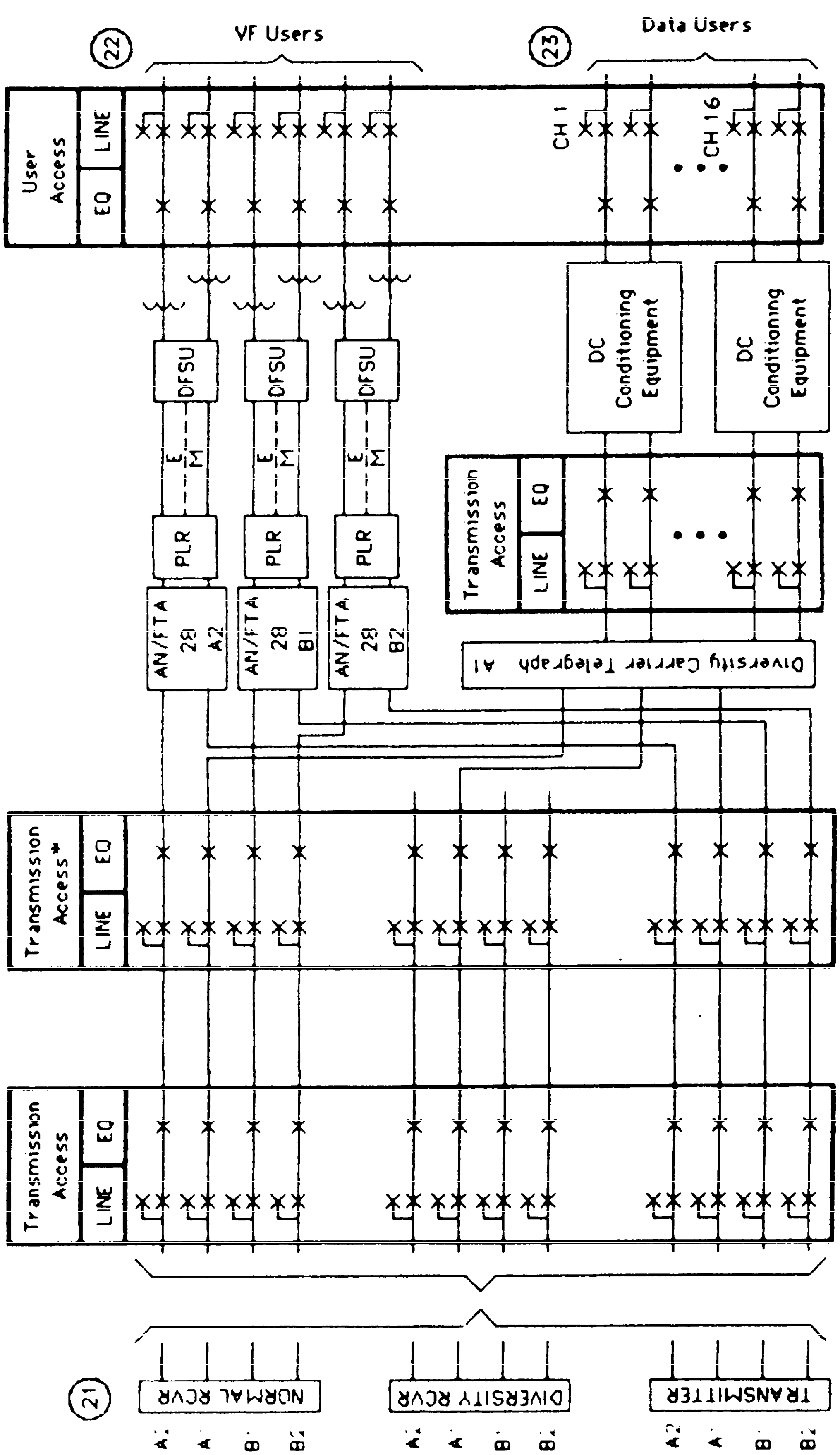


FIGURE 11 VF data circuits



* Patch bay, amps, and pads will be used if cable link loss is 0.5 dB or greater

FIGURE 12. HF radio circuits



* Access will be used as necessary to group HF circuits together

FIGURE 12 HF radio circuits - Continued

Circuit 21 Four-wire diversity connections to HF radio systems. 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 user access only if the cable loss is 0.5 dB or greater; otherwise, they shall interface directly to the transmission access. When circuits access the TCF via a fixed station multiplexer, they shall be connected through the transmission access 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 transmission access. This would require double appearance at the transmission access for some circuits making it convenient for alternate routing of HF circuits.

Circuit 22 VF circuits using radio telephone terminals. Audio circuits interface at the user access and are conditioned for the HF radio system by the radio telephone terminal before passing through the transmission access. 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 for the transmission access into signals compatible with HF radio transmissions.

Circuit 23 Diversity carrier telephone terminal circuits. These digital circuits interface at the user access and are conditioned before passing through the transmission access. Circuits from the transmission access provide inputs to the carrier telegraph terminal which then provides a quasi-analog signal through the transmission access.

5.2.2.1.7 Circuit connection to the media. VF circuit transmission usually consists of connection to either first level multiplexers or four-wire toll cable. Connections to the media are depicted in Figure 13 (Circuit #s 24 and 25).

Circuit 24 First level multiplexer. Circuit #24 is the normal configuration of a VF circuit between the transmission access and the first level multiplexer. If level adjustment is required, pads and amplifiers may be installed between the multiplexer and the transmission access. The connections for TDM and FDM systems are identical. The multiplex equipment may be either long haul or tactical.

Circuit 25 Four-wire trunk cable. This circuit is required for interconnection through the user access with any long distance commercial or military cable circuit. Level adjustment using pads and amplifiers shall be between the user access and transmission access. If the trunk cable loss does not exceed 0.5 dB, this circuit may be connected directly through the transmission access.

5.2.2.2 Functional description of VF terminating equipment. Functional descriptions of VF terminating equipment are given in Appendix B. As a design objective, TCFs shall employ conditioning equipment performing multiple functions on single circuit cards or modules.

NOTE: MIL-HDBK-414 provides additional detailed information on many of these items.

5.2.2.3 Digital data circuits. Digital data circuits are depicted in Figures 14 through 17.

5.2.2.3.1 General. 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 TCF technical facility and allow greater universality and standardization.

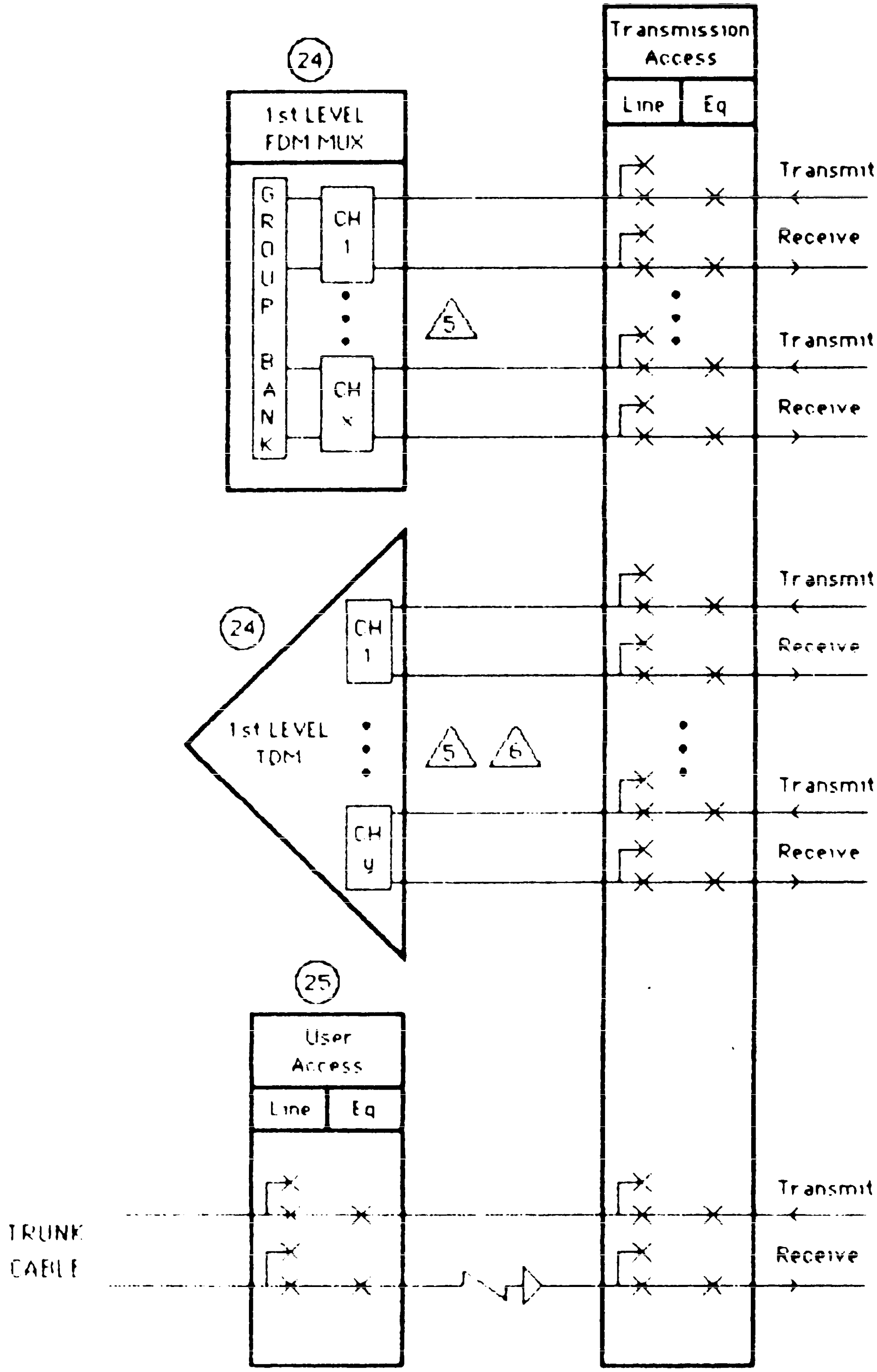


FIGURE 13. Circuit connections to the media

5.2.2.3.1.1 Low level operation. As a design objective, all digital circuits appearing at the transmission access shall be configured for low-level balanced operation as defined in MIL-STD-188-114. Conversion from unbalanced to balanced mode shall be accomplished at the source, if possible. Only low-level operation shall be employed within a RED equipment area when such an area is required to support the TCF. All teletype and data end equipment used within the facility shall be configured for low-level operation to provide flexibility during equipment substitution and to facilitate conversion to encrypted operation at a later date. All new systems shall be in a balanced configuration.

5.2.2.3.1.2 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 should be configured and routed in-station so that installation of the cryptographic device will not require major rewiring of the circuit.

5.2.2.3.2 Technical control access for digital data circuits. All technical control (TTY, orderwires, reporting circuits, etc.) and all in-station digital circuits not requiring conditioning equipment shall interface directly to the equipment side of the transmission access.

5.2.2.3.3 Timing, control and alarm circuits. Provisions shall be made on the user and transmission access for the routing, testing, and monitoring of all timing signals associated with the digital circuits. Control and alarm signals for the digital circuits may also be routed through the user and transmission accesses.

5.2.2.3.4 Monitoring of digital signals. All digital circuits shall have a transmission access. The only difference among digital signals at the access shall be in coding schemes, balanced or unbalanced mode, and data rates. Monitoring of digital signals shall be performed on a high impedance basis.

5.2.2.3.5 Digital multiplexers. Digital multiplex equipment shall be provided with access points as specified below.

5.2.2.3.5.1 Access to through-groups. Channels demultiplexed solely to accommodate a digital-to-analog conversion and planned to be routed through the TCF at some future time shall be treated as a through-group. There is no need to terminate each such digital or VF channel in the TCF.

5.2.2.3.5.2 Access to local circuits. All local circuit inputs/outputs of digital multiplexers shall appear at the TCF frame and shall be provided an access when configured to be used operationally or as a spare. This requirement may be satisfied by use of jacksets integral to the multiplex equipment. When the requirement is met in this manner, TCF appearances can be limited to:

a. All utilized channels

b. All spare channels

c. A 20 percent expansion capability in cable trunking.

5.2.2.3.6 VF access. Multiplexers that are used for both VF and digital signals shall have inputs and outputs appear in the TCF operations area. A minimum of five (64 kb/s) data channels (seven through eleven) will be wired to each first level TDM equipment for all long haul systems. Data and timing signals shall be grouped together at the transmission access point.

5.2.2.3.7 Digital 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.

5.2.2.3.8 Basic digital circuits. The following paragraphs and corresponding illustrations of Figure 14 through 17 describe the various digital circuits.

Circuit 1 Unbalanced digital data user using an unbalanced system. These circuits shall be routed via the user access. 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 before appearing on the transmission access.

Circuit 2 Unbalanced digital data user using a balanced system. These circuits shall appear on the user access. The circuit shall then be converted to balanced, low level operation and conditioned prior to appearing at the transmission access. If the circuit requires timing, then the timing signal shall also be routed with the data in a similar manner.

Circuit 3 Balanced digital data user using an unbalanced system. These circuits shall appear on the user access. The circuit shall then be converted and conditioned and continue via the transmission access. 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.

Circuit 4 Balanced digital data user using a balanced system. These circuits shall appear on the user access. 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 before continuing via the transmission access.

Circuit 5 Digital circuits using a VFCT. These digital circuits, normally teletype, are routed to the VFCT via their associated transmission access. The quasi-analog signals shall then make an appearance at the transmission access .

Note: Some VFCTs may operate at high level and cannot be converted internally for low level, requiring level converters between the VFCT and the transmission access.

Circuit 6 Digital circuits using a sublevel multiplexer/concentrator. These circuits are routed to the multiplexer via their associated transmission access. They may be synchronous, asynchronous, or isochronous. As a design objective, these circuits should operate in a low level balanced mode. The aggregate output shall then be routed back to the transmission access.

Circuit 7 Digital circuits using first level multiplexers. These circuits are routed to the multiplexer from their associated transmission access. They may be synchronous or asynchronous and should be configured for low level balanced operation. The aggregate output shall then be routed via the first level access.

Circuit 8 Digital circuits using second level multiplexers. These circuits are routed to the multiplexer from the first level access. The aggregate output shall then be routed via the second level access and connected to the media.

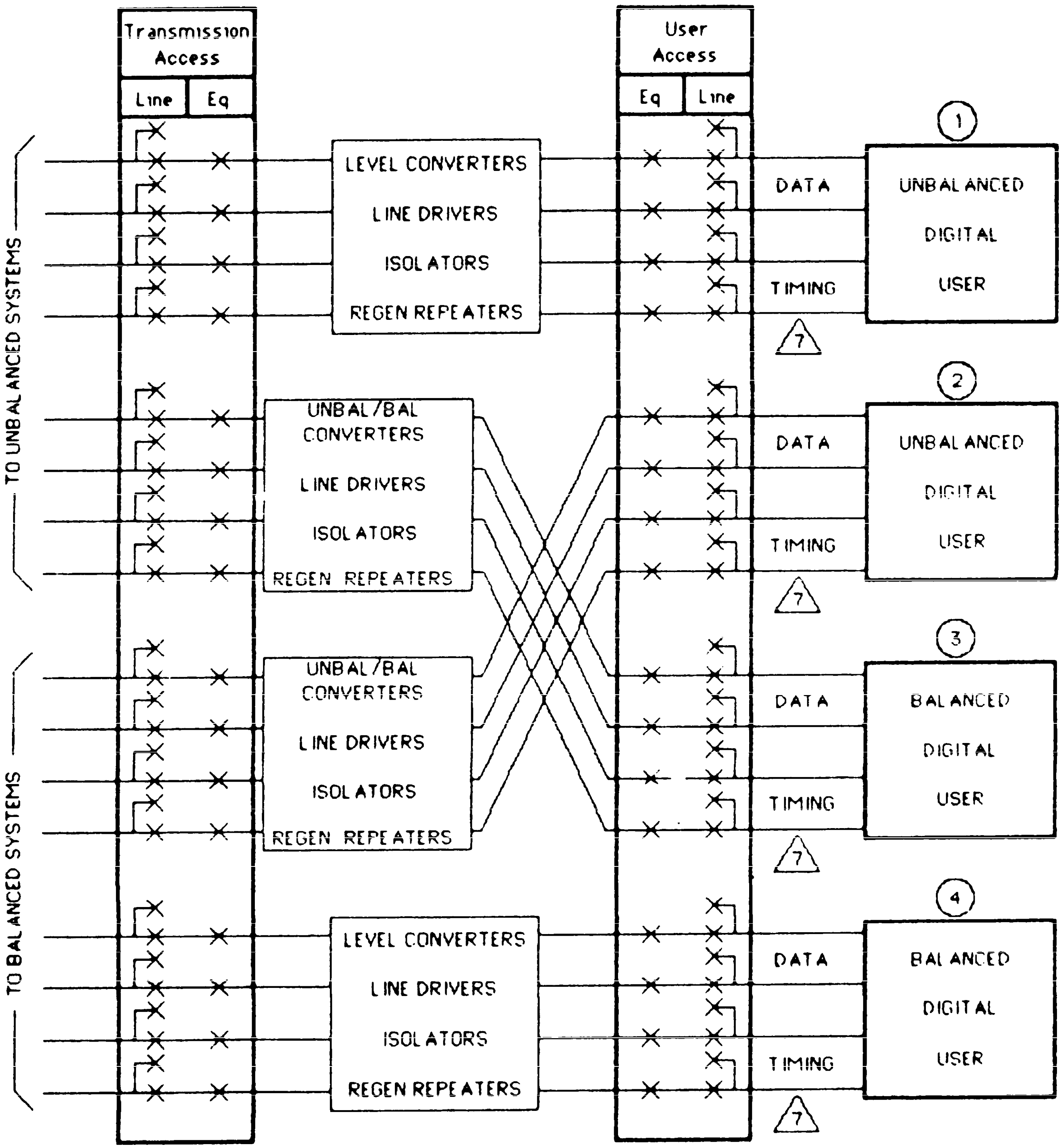


FIGURE 14 Digital data users

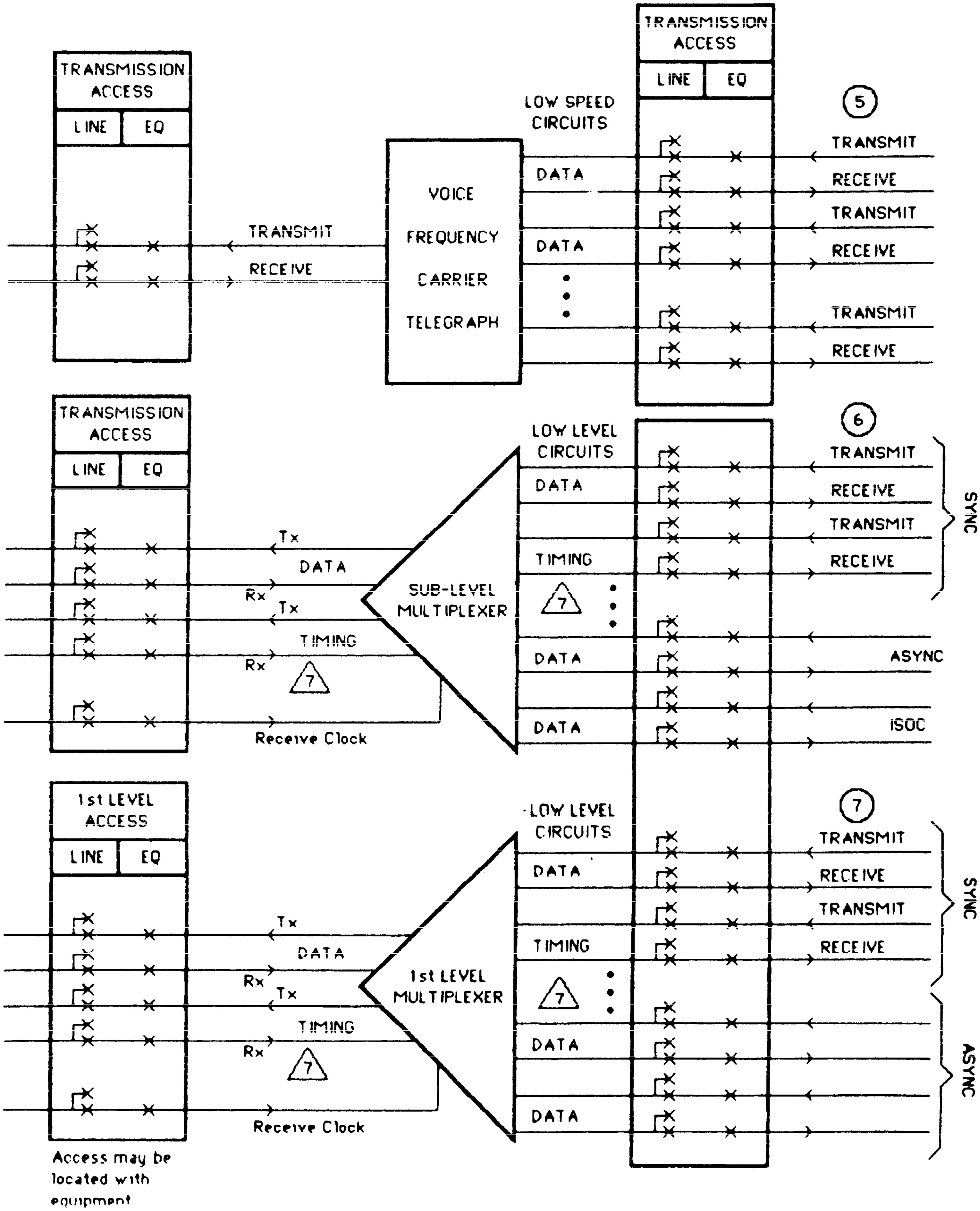


FIGURE 15 Digital circuit multiplexing

Circuit 9 Digital circuits using fiber optics as the transmission media. Fiber optic transmission systems may be used at various multiplex levels and data rates. Circuits using fiber optic transmission equipment shall be routed through an appropriate access. For example, if the fiber optic system is transmitting a 1st level multiplex aggregate, the circuit shall be routed through a first level multiplex access. The transmit circuit shall be routed to the fiber optic transmitter via the appropriate access. The receive circuit is routed from the fiber optic receiver via the appropriate access, then to the bit synchronizer for timing recovery, and finally back to the appropriate access.

Circuit 10 Optical fiber systems not using external synchronizers. The transmit circuit shall be routed to the fiber optic transmitter via the appropriate access (for example, the 2nd level access if the data is a 2nd level multiplexer aggregate). The receive circuit is routed from the fiber optic receiver to the same access.

Circuit 11 Systems using digital cross-connect equipment. All inputs and outputs to digital cross-connect equipment shall be provided an access. Digital cross-connect equipment shall be connected to the line side of the 1st level access for connecting to 1st level multiplexers. For connection to 2nd level multiplexers, digital cross-connect equipment shall be connected to the equipment side of the 1st level access. Connections to individual VF and data channels for tactical digital cross-connect equipment shall be as shown in Figure 2.

Circuit 12 Systems using digital channel efficiency equipment. All inputs and outputs to digital channel efficiency equipment shall be provided an access. Digital channel efficiency equipment shall be connected to the line side of the 1st level access for connecting to 1st level multiplexers. For connection to 2nd level multiplexers, digital channel efficiency equipment shall be connected to the equipment side of the 1st level access.

Circuit 13 Systems using transmultiplexers. All inputs and outputs of transmultiplexer equipment shall be provided an access. Transmultiplexer connection to the FDM system shall be on the equipment side of the group access. Transmultiplexer connections to the TDM system shall be on the equipment side of the 1st level access.

5.2.2.3.9 Digital conditioning equipment. Digital conditioning equipment is used to interface various types of digital users to the DCS. This equipment is usually connected between the digital user access and digital transmission access . Functional descriptions of some digital conditioning equipment are given in Appendix B.

NOTE: MIL-HDBK-414 provides additional information on application and performance characteristics of digital conditioning equipment.

5.2.3 Multiplex and transmission media equipment. Multiplex and transmission media equipment which are supported by long haul and tactical TCFs shall be located and configured electrically as follows.

5.2.3.1 Long haul requirements. Multiplex and transmission media equipment that are operated in long haul systems may be physically collocated with the TCF. Exceptions such as economic factors and equipment or facility sizing considerations may rule out collocation of multiplex and transmission media equipment with the TCF.

5.2.3.1.1 Alarm features. Whether multiplex and transmission media equipment are collocated with the TCF or located remotely from the TCF, the alarm features of the equipment shall be extended to and integrated with the local alarm systems of the TCF.

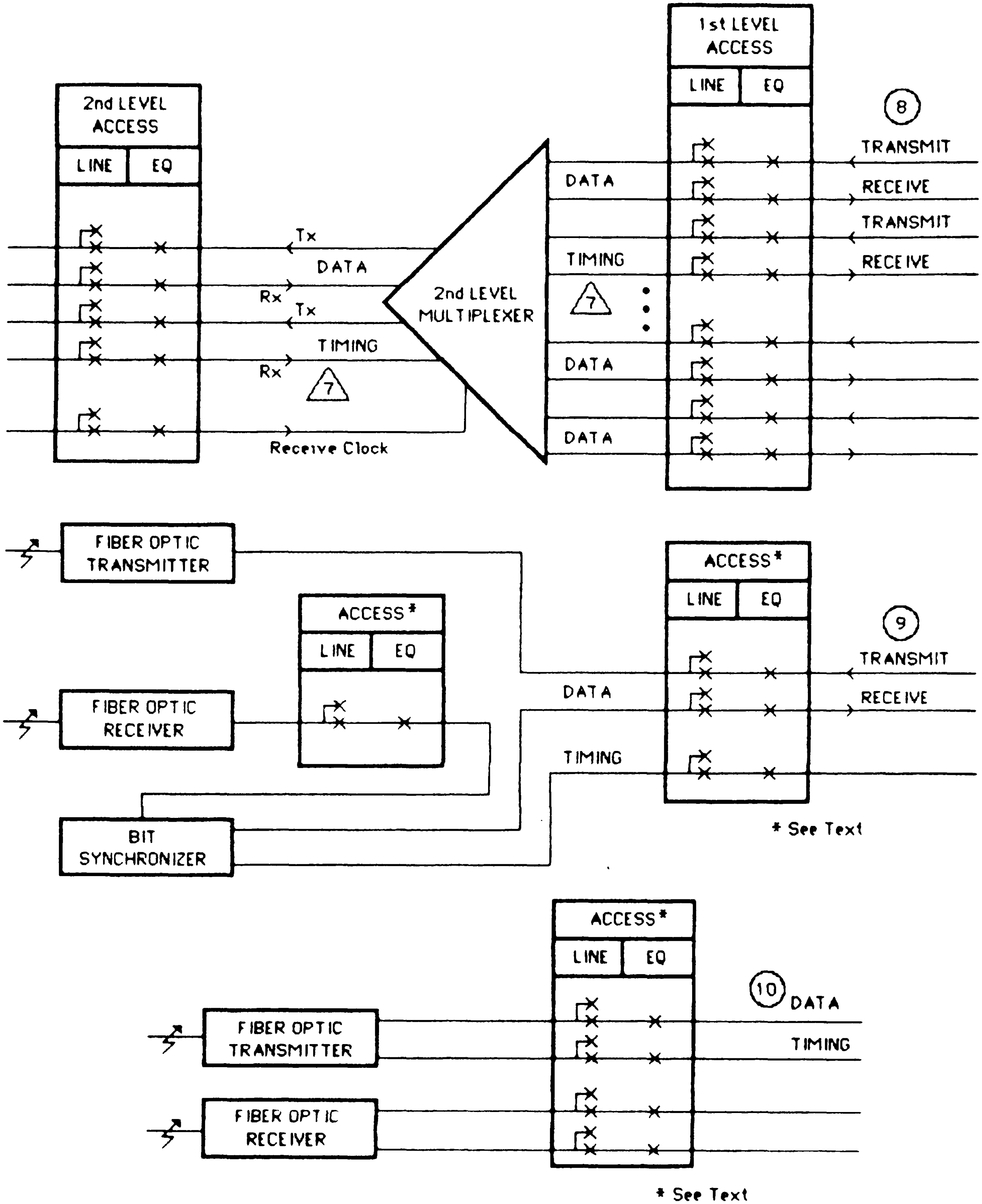


FIGURE 16 Digital connections to the media

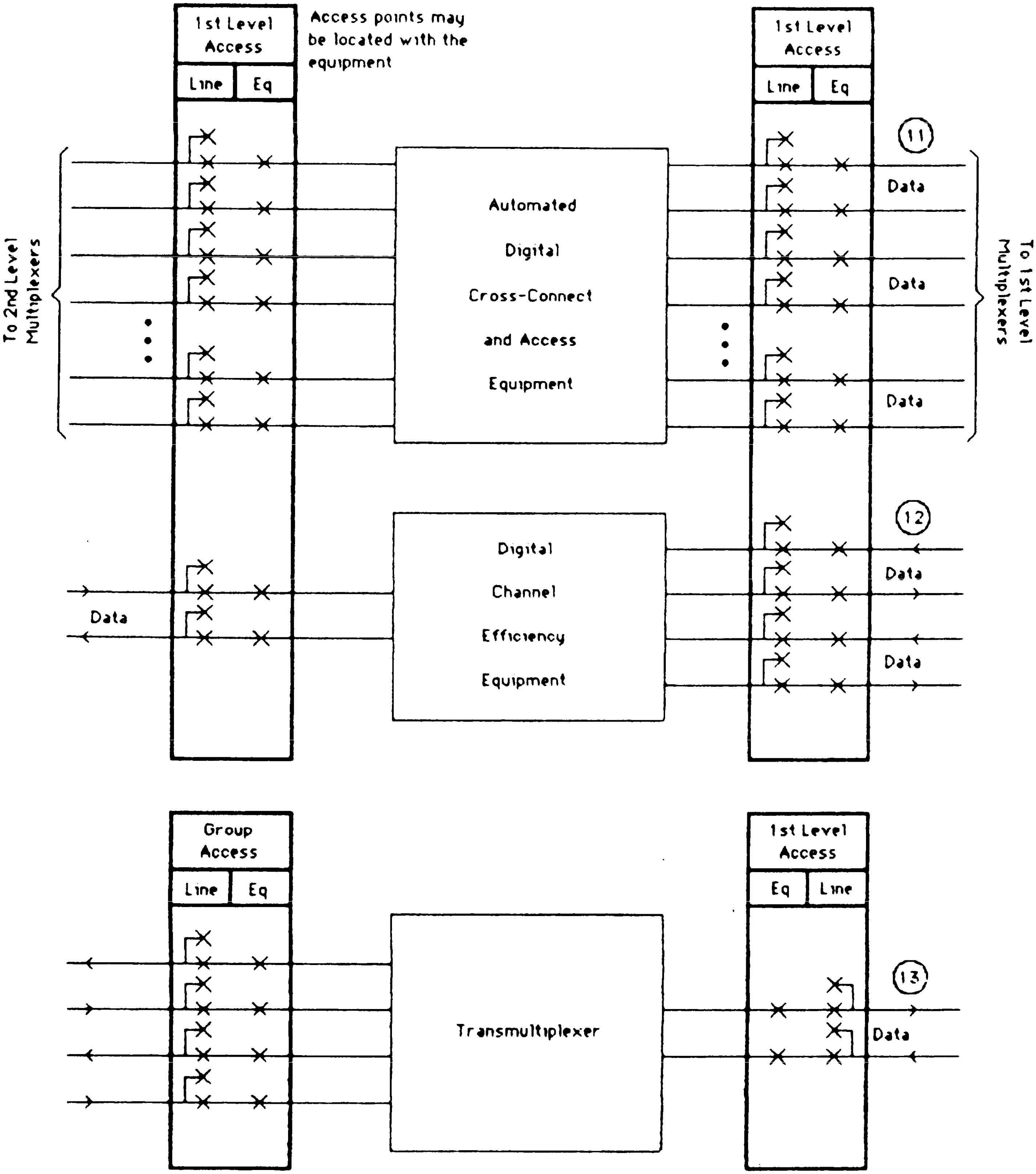


FIGURE 17 Special high speed digital connections

5.2.3.2 Tactical system requirements. Multiplex and transmission media equipment that are supported by tactical TCFs are not required to be physically located with the TCF. This equipment may be located in separate transportable shelters.

5.2.3.2.1 Alarm features. The output of summary alarms found on tactical multiplex and transmission equipment should be remoted by electronic means to the TCF for electronic storage and processing. Tactical TCFs with processor capability shall be capable of receiving telemetry alarms sent from multiplex and transmission equipment via orderwires defined in ICD-002 and ICD-003, and carrying alarms formatted as per ICD-001.

5.2.4 Special network switching equipment. Location and configuration of network switching equipment (end offices, circuit switches, message switches, etc) used in fixed and tactical systems shall be considered in the TCF design as described in the following paragraphs.

5.2.4.1 Fixed system requirements. End offices, multi-function nodes, stand-alone nodes and technical control facilities may be physically collocated. As a minimum, economic factors, equipment locations, and facility sizing shall be considered when determining a location for the TCF. When colocated with the TCF, network switching equipment need not be provided a patch and test facility (PTF).

5.2.4.1.1 Alarm features. When network switching equipment is collocated with the TCF, the on-site alarm features of the equipment should be integrated into the local alarm system of the TCF. When the network switching equipment is not collocated with the TCF, the alarm features of the equipment should be extended to and integrated with the local TCF alarm system. Alarms peculiar to the network switching equipment however, need not be extended.

5.2.4.1.2 Cable termination. The input, output, signaling, and control lines of network switching equipment collocated with the TCF shall be terminated directly to a distribution frame within the TCF, without being routed through an intermediate distribution frame in the switching equipment area.

5.2.4.2 Tactical system requirements. Circuit and message switching equipment are not required to be physically located with the tactical TCF. The equipment may be located in separate transportable shelters.

5.2.4.2.1 Alarm features. The output of built-in test equipment (BITE) incorporated in tactical circuit and message switching equipment may be remoted by electronic means to the servicing TCF for electronic storage and processing. When this is done, the transmission system shall use the ADCCP link protocol defined in FED-STD-1003, CCITT Recommendation X.25, and FED-STD-1041.

5.3 Internal subsystems. The configuration and minimum performance standards required of internal subsystems used in all TCFs is as follows.

5.3.1 Distribution facilities. All TCFs shall employ distribution facilities as the means to terminate and distribute all outside plant and in-house tie-cables, units and strings of conditioning equipment, and internal TCF operating equipment.

5.3.1.1 Types of distribution facilities. Distribution facilities shall be used as outlined in the following paragraphs.

5.3.1.1.1 Main distribution frame (MDF). MDFs shall be used as required to provide a termination point and a means of interconnecting outside plant and in-house tie cables. Outside plant cables shall be terminated on surge protector blocks. Where equipped with vertical and horizontal terminal blocks, the vertical side shall terminate the cables entering the facility and the horizontal shall terminate the tie cables to and from the intermediate distribution frame.

5.3.1.1.2 Intermediate distribution frame (IDF). IDFs shall be used to provide a termination point and a means of interconnecting in-house tie cables, units and strings of conditioning equipment, and internal TCF operating equipment. Outside plant cables shall not be terminated on the IDF. When equipped with vertical and horizontal terminal blocks, tie cables and station equipment shall be terminated on the vertical side; the horizontal side shall be used to terminate jackfields and battery terminations.

5.3.1.1.3 Combined distribution frame (CDF). The CDF fulfills the function of the MDF and IDF at a complex where there are space limitations or where one frame is sufficient to support mission requirements. CDFs shall be used to provide a termination point and a means of interconnecting outside plant and in-house tie cables, units and strings of conditioning equipment, and internal TCF operating equipment. Outside plant cables shall be terminated on surge protector blocks. When equipped with vertical and horizontal terminal blocks, outside plant and tie cables, and station equipment shall be terminated on the vertical side; the horizontal side shall be used to terminate jackfields and battery connections.

5.3.1.1.4 Circuit concentration facilities (CCF). CCFs shall be used to provide a termination point and means of interconnecting tie cables, conditioning equipment, jackfields, and TCF internal operating equipment. The CCF may be located within an enclosed or open equipment bay or rack, or on the rear of conditioning equipment shelves. The CCF may also be used for the local termination or interconnection of high speed circuits that would be impaired or degraded by excessive cable runs to patch or other distribution facilities in the TCF.

5.3.1.2 Terminal blocks. Terminal blocks used on all types of distribution frames shall allow solderless connection techniques, such as wire wrap or connectorization, as the means of terminating permanent wiring. All terminal blocks shall be clearly marked to indicate the cable number, equipment bay, and equipment type. Cross-connects may be wire wrap, solder, punch, or connectors.

5.3.2 Common equipment. TCFs shall be provided with equipments which furnish common signals and currents to user and subscriber circuits and to station equipment. Standards for the clocks and signaling supplies used in this manner are described in the following paragraphs. Requirements for station power are contained in paragraph 5.5.

5.3.2.1 Station timing standard system. The TCF shall be provided with a timing standard system in accordance with EP 3-83, DCS Network Synchronization Design Criteria. 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 (MIL-STD-188-114) timing shall appear at the transmission access to provide a synchronizing clock to data equipment timing inputs.

5.3.3 Signaling supplies. The TCF shall be provided with the necessary signaling supplies needed to provide signaling currents to subscribers and TCF equipment. The separate signaling supplies shall be capable of redundant operation with means for automatically selecting the output of the alternate unit in event of failure to the primary unit. All signaling supplies shall be capable of providing local audible and visual alarms and a means of remoting the alarm information in the event of unit failure.

5.3.3.1 20-Hz signaling supplies. Electrical characteristics required of the 20-Hz signaling supply are listed below:

a. Input voltage -48 VDC

b. Output voltage 60-105 volts peak

c. Output frequency 20-25 Hz sinusoidal

The output of the signaling supply shall be directed through ballast lamps before application to subscriber circuits.

5.3.3.2 Signaling requirements. Electrical characteristics required of signaling supplies are listed below:

a. SF supplies: (Single Frequency)

   1. Input voltage -48 VDC

   2. Output Frequency

      570 Hz ± 2 Hz
      1200 Hz ± 2 Hz
      1600 Hz ± 2 Hz
      2400 Hz ± 2 Hz
      2600 Hz ± 2 Hz

b. DFSU: (Dual Frequency Signaling Unit)

   1. Input voltage -48 VDC
   2. Output frequencies 2600 Hz ± 2 Hz and 2600/2800 Hz ± 2Hz

The output frequency requirements will be determined by anticipated interface requirements. Long haul TCFs shall use 2600 Hz or 2600/2800 Hz units unless interfacing with a tactical unit.

5.3.4 Orderwires. Both long haul and tactical TCFs shall be provided conditioning and terminal orderwire equipment for supporting all communication links, trunks, channels, and circuits. This orderwire equipment shall be for the exclusive use of technical control and maintenance personnel exercising the functions of technical control. Each TCF shall have at least one orderwire circuit. All TCF orderwires shall be engineered and installed in accordance with the following paragraphs:

5.3.4.1 Long haul orderwire systems. Three individual orderwire systems shall be provided for long haul TCFs in accordance with DCAC 310-50-6 and the following paragraphs.

5.3.4.1.1 Link orderwires.

a. A link orderwire shall be installed on every Government-owned DCS wideband radio and Government-owned cable link.

b. The link orderwire may appear in either the (0-4 KHz) or (8-12 KHz) portion of the supervisory baseband on analog radio systems and channel 1 of the three channel supervisory multiplex associated with digital radio systems.

c. The link orderwires shall be accessible at the applicable radios in addition to appearance in the TCF/PTF.

d. The link orderwires shall be bridged through unmanned sites which do not have VF mission channel breakout.

e. The link orderwires shall terminate at manned sites which have VF mission channel breakout.

5.3.4.1.2 Express orderwires.

a. Express orderwires shall normally be configured for party-line operation.

b. Where two DCS stations have a high volume of mutual coordination, a dedicated point-to-point express orderwire should be provided between the two stations to relieve the traffic on the party-line express orderwires.

5.3.4.1.3 System orderwires.

a. All facility control offices (FCOs) will have access to at least one system orderwire.

b. The FCOs may be connected together in smaller groups on multiple system orderwires within the local theater of operation to limit the number of users on each system orderwire party line.

c. Whenever more than one system orderwire is used within a theater, the capability shall be provided for conferencing among the system orderwires.

d. The system orderwires shall be assigned within the mission baseband/bit stream.

e. The system orderwires shall not be used for coordination of routine circuit problems.

5.3.4.2 Voice orderwires.

a. All conditioning equipment supporting orderwire circuits shall be physically located with the orderwire equipment in the TCF.

NOTE: Tactical voice orderwires are normally not conditioned, due to considerations of space limitation and fluidity of operations.

b. The inputs and outputs of all voice orderwire conditioning equipment shall have access to facilitate monitoring, testing, and rerouting. Manual patch panels used to provide such appearances shall conform to the jack and patch logic outlined in 5.2.1.2.3.

c. Voice orderwire access units shall be provided commensurate with the operational requirements of the TCF. Access to the orderwires shall be available from the RF equipment bays, QA test bays, the supervisor position and the PTFs.

d. All TCFs having access to two or more voice orderwire circuits shall be provided with a conference capability between or among those circuits.

e. All voice orderwire terminal and access units shall be equipped with visual and audible signaling indicators capable of being remoted.

NOTE: For tactical installations, the remoting capability may be waived.

f. All voice orderwires shall be capable of selective signaling. Selective signaling shall be implemented as indicated below.

1. The following long haul TCF voice orderwires shall use DTMF selective signaling:

(a) All system orderwires

(b) All express orderwires

(c) Link orderwires when two or more links may be connected in tandem.

2. Long haul VF link orderwires may use 2600 Hz or 2800 Hz ringdown signaling except when two or more links may be connected in tandem.

3. Tactical TCF voice orderwires may be either analog or digital according to the transmission medium.

(a) Analog tactical TCF orderwires shall use inband SF ringdown signaling. The frequencies of inband SF signals used for orderwire circuits shall be chosen from the list contained in paragraph 5.3.3.2.a.

(b) Digital tactical TCF orderwires shall use the 16 unique signaling codes as specified in the Signaling Code subsection of ICD-001.

(c) Analog maintenance orderwires for tactical systems shall use 1600 Hz signaling.

5.3.4.3 Tactical data orderwires.

a. Capability to multiplex and demultiplex 13-150 bits per second (b/s) telemetry channels into one 2.0 kilobits per second (kb/s) or 2.4 kb/s channel.

b. The standard bit rates of the data orderwire patch panel shall be 75 b/s, 150 b/s, 2 kb/s, 2.4 kb/s, and 4 kb/s as defined in ICD-001 and ICD-002.

c. All data circuits routed through the data orderwire patch shall be operated as low-level balanced, nonreturn to zero (NRZ) as specified in MIL-STD-188-114.

5.3.5 Intercommunications (Intercom) system. Each TCF shall be provided with intercom equipment on which technical coordination internal to the TCF and using agencies located in the vicinity of the TCF shall be conducted. Intercom service shall be provided through the use of existing administrative telephone circuits which contain intercom features or through the provision of a multi-station intercom system. The minimum requirements of the intercom system are listed below.

a. The intercom system should share common equipment and operator panels with the station voice orderwire equipment.

b. Any station within the system shall be capable of selectively signaling any other given station within that system.

c. Manual analog and digital accesses shall be equipped with a sufficient number of intercom stations to allow access from each working location.

d. All tactical TCFs shall be equipped with an alternate intercommunications system.

5.3.6 Alarm system. An alarm system shall be provided to alert the technical controller and maintenance technicians of equipment degradations or failures that affect communications status. Information presented by the alarm system shall facilitate prompt action toward the restoration or rerouting of circuits and the repair of faulty equipment.

5.3.6.1 Display of alarms. Display of alarms shall be at a central location provided in the TCF operating area. Parallel presentation of portions of the alarm display is required in maintenance and operating areas remote from the central display (supervisory, maintenance, or service areas). The amount and type of equipment necessary to satisfy this requirement is dependent on TCF size and shall vary from site to site. Audible and visual alarms shall conform to the requirements of MIL-STD-1472.

5.3.6.1.1 Alarm Display. All TCF alarm outputs shall be accessible at a distribution frame. According to equipment types, alarms shall be designed as "go/no-go" or analog types (for adaptation to more sophisticated monitoring). The alarms shall include, but not be limited to, the following:

a. Radio

1. Receive signal levels
2. Transmit power levels
3. RSL Fade
4. Failure
   (a) Transmitter
   (b) Receiver
5. A/B operating
6. TWT failure

b. Multiplexer

1. Primary/Standby operating

2. Failure

(a) Primary
(b) Standby

3. Faults

c. Site

1. A/C Failure
2. High temperature alarm
3. Low temperature alarm
4. Fire alarm

5. Intruder
(a) Door open
(b) Window open

6. Antenna internal temperature
7. Waveguide pressure
8. Tower light out/disabled

d. Power

1. Generator #1/2 operating
2. Commercial/Primary operating
3. Rectifier failure
4. Rectifier operating (A/B)
5. Fuel Low
6. Rectifier sharing load
7. Fuel pump operating
8. Open fuse alarms
9. High or low station (AC/DC) power

e. Encryption Devices

1. Loss of synchronization/frame

The alarm system shall provide for incremental expansion. The system shall be so designed that activations, deactivations, and change of transmission systems, TCF subsystems, and circuits can be accommodated without affecting the operation of the basic systems. The system shall consist of a local equipment and functions alarm subsystem and a remote station equipment and functions alarm subsystem.

5.3.6.1.2 Equipment features. The following features are required of all alarm and display equipment:

a. Audible and visual alarms.

b. Audible alarm capable of being disabled.

c. Self-test capability.

d. Individual visual alarm for each input.

e. Manual reset.

f. Capable of sensing opening or closing of switch contacts as status and alarm indicators.

g. Parallel presentation in maintenance and operating areas remote from the central display.

5.3.6.2 Remote alarm and display systems. The remote alarms and display system consists of remote sensing and control equipment, telemetry channels, and alarm and display units. The requirements of each of these systems components are described in the following paragraphs.

5.3.6.2.1 Remote sensing and control equipment. The remote sensing and control equipment shall be capable of the following:

a. Accepting analog and discrete input signals and comparing them against stored predetermined thresholds.

b. Sampling on a predetermined or polled basis.

c. Digitizing output.

d. Accepting commands to perform control actions.

e. Automatically generating formatted alarm and status reports.

f. Providing local alarm and status display as described in 5.3.6.1.

g. Accepting changes to stored parameter thresholds.

5.3.6.2.2 Alarm and display unit. The alarm and display unit which supports the remote status and display system shall consist of an input/output terminal with hard copy print-out capability. Other requirements of the alarm and display unit are listed below:

a. Contain an audible alarm.

b. Contain keyboard with function capability.

c. Capable of unattended operation.

d. Provide a summary of total system status.

e. Provide alarm/status information from any given site within the system.

f. Capable of displaying the value of assigned alarm thresholds at each remote location.

g. Capable of automatic receipt of alarm and status reports.

h. The ability to request status reports.

i. The ability to change alarm thresholds.

j. Capable of displaying alarm and status reports in plain text.

5.3.7 Reporting position. All TCFs shall contain a reporting position within its operational area. As a minimum, the below listed requirements shall govern the establishment of the reporting area:

a. The reporting position shall be located in a manner that affords maximum visibility of all working areas when possible.

b. The reporting position shall be provided telephone (both standard and immediate precedence AUTOVON or tactical equivalent) and input/output devices to conform with established system reporting requirements.

c. The reporting position shall have access to the TCF intercom system and all orderwire circuits.

5.3.8 Monitoring. TCFs shall be provided equipment that will enable TCF personnel to monitor analog and digital circuits. As a minimum, two types of monitors - an audio amplifier with speaker and a teleprinter shall be provided. The first shall be rack mounted and have input terminated on the miscellaneous jackfield of the bay in which it is mounted. Further requirements of the monitoring units are described in the following paragraphs.

5.3.8.1 Audio amplifier and speaker monitor.

a. Balanced input impedance: 10k ohms minimum

b. Amplifier output power: 2-5 watts

c. Features:

(1) Variable volume control

(2) Amplifier and speaker unit on single panel

(3) Self-contained loud speaker

5.3.8.2 Teleprinter monitor (for TCFs providing teleprinter service).

a. Configured for low-level operation.

b. Capable of multiple page printing.

c. Input terminated on a miscellaneous jackfield located in a digital circuit access.

d. Variable speed control: 45.45, 50, 74.2, and rates based on 75×2^n

5.3.9 Testing. The TCF shall be provided the necessary test equipment to conduct operational and quality control (QC) testing of analog and digital circuits for which it is responsible. For the purpose of this standard, operational testing describes those actions associated with routine in-service testing and troubleshooting, and QC testing describes those actions associated with elaborate out-of-service testing requirements, such as acceptance and scheduled quality control testing. The identification, physical and electrical placement, and configuration of test equipment required to perform digital and analog operational and QC testing are listed below.

5.3.9.1 Operational testing. Test equipment used to perform routine testing and troubleshooting shall be located in or near the equipment bays housing manual analog and digital patch equipment. The input and output of this equipment shall be terminated on the miscellaneous jackfield of the bay in which it is located. The quantity of in-service test equipment required for any given TCF is dependent on the number and type of circuits for which it is responsible. At patch bays where VF signals are present, the ability to measure signal levels and channel noise shall be provided. In addition, standard test and signaling tones shall also be provided. At patch bays where digital signals are present, the ability to measure DC voltages and current, signal distortion and speed, observe signal waveform, bit error rate (BER), measure block error rate and timing jitter, shall be provided.

5.3.9.2 QC testing. QC testing shall be conducted on a manual or automated basis at a QC test center (QCTC) located within the TCF. The QCTC shall be constructed from equipment racks, jackfields, and test equipment required to perform analog and digital QC circuit testing as outlined in DCAC 310-70-1 DCAC 300-175-9, or system publications that contain system circuit performance standards. Each equipment bay shall be provided jackfields or automated switching in sufficient quantities as required to terminate interbay trunking circuits from all analog and digital circuit patching or automated access facilities within the TCF. The QCTC shall be provided access to all orderwires and intercom stations either through provision of an orderwire panel or interbay trunking capability.

5.3.9.3 Cable test bay. Selected TCFs may be provided cable test bays. The cable test bay shall be capable of accomplishing the following measurements:

a. Cable resistance

b. Leakage resistance

c. Loop resistance test

d. DC voltage

e. DC current

f. AC voltage

g. Cable capacitance

Access to the cable test bay shall be provided through the use of interbay trunks to the user access bays.

5.3.10 Miscellaneous jack panels. All TCFs shall be provided miscellaneous jack panels for terminating test tones, signaling tones, resistive terminations, monitoring and test equipment, circuit bridging arrangement, and arrangements for providing parallel connections. Miscellaneous jack panels are required for all patching facility bays.

Miscellaneous jack panels are divided into analog and digital types and shall possess the minimum features described below. The jack positions on the panel shall be clearly marked to identify their functions.

5.3.10.1 Analog miscellaneous jack panel. Each analog miscellaneous jack panel shall provide the capabilities which are described in the subsequent paragraphs.

5.3.10.1.1 600 ohm termination jacks. These resistors are provided for the temporary termination of multiplex channel ends, circuit strings or for test purposes.

5.3.10.1.2 1004 Hz test tone jack. In TDM transmission systems, the 1004 Hz test tone jack positions will be provided in both long haul and tactical facilities at levels of 0, -10, and -15 dBm at 600 ohms. These tones are provided for test and alignment purposes.

5.3.10.1.3 20 Hz ringing tone jack. One or more jack positions for the termination of the station 20 Hz ringing generator will be provided. This tone is provided for test and alignment purposes. The 20 Hz ringing tone shall appear only on miscellaneous jack panels mounted in user access areas.

5.3.10.1.4 Monitoring and test equipment jacks. There shall be jack positions to terminate inputs/outputs of the monitoring and test equipment listed below:

a. Monitor speaker

b. Signal generator

c. Level meter

5.3.10.1.5 Six-way/4-wire bridge jacks. The input/output connections of 6-way/4-wire conference bridge arrangements shall be terminated on the miscellaneous jack panels mounted in the transmission access. The 6-way/4-wire jacks are provided for use in the establishment of on-call conference circuits.

5.3.10.1.6 Parallel circuit jacks. Jack positions to enable the parallel connection of two groups of four jacks shall be provided. The parallel circuit jacks are provided for test purposes.

5.3.10.2 Digital miscellaneous jack panel. Each digital miscellaneous jack panel shall provide the features described in the following paragraphs.

5.3.10.2.1 Monitoring and test equipment jacks. There shall be jack positions to terminate inputs/outputs of the below listed monitoring and test equipment:

a. Voltmeter

b. Ammeter

c. Data test set

(1) Pattern generator/error detector

(2) Distortion analyzer

d. Oscilloscope

5.3.10.2.2 Regenerative repeater jacks. The input and output of at least one regenerative repeater shall appear on the miscellaneous jack panel associated with the digital transmission access at TCFs providing teleprinter service.

5.3.11 Interbay trunks. All TCFs shall be provided a means of trunking signals from one bay or area to another. This requirement shall be satisfied by the use of jack panels configured to provide dedicated trunks between selected bays within the TCF. As a design objective, the jacks shall be equipped with a light on each associated position which shall be lit when the jack is in use. Interbay trunks shall be provided between transmission access bays, between user access bays, and from the QCTC bays to the transmission and user access bays.

5.3.11.1 Guidelines. Interbay trunking schemes shall be designed around individual TCF requirements. It is a desired goal to provide an approximately equal amount of trunks between the bays. For determining the required quantities of interbay trunks, the following shall be considered:

a. The reroute, restoral, and patching requirements expected at the station.

b. Interbay trunks shall be so configured that no patch will require a patch cord exceeding 6 feet in length.

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

d. Trunking to the QCTC shall be predicated upon the number of controllers available to perform tests and the total number of circuits which can be tested simultaneously.

e. As a minimum, the number of full duplex interbay trunks shall be 8 percent of the number of circuit appearances in each patch bay. At least 10 percent of these interbay trunks should be allocated to trunking to the QATC and cable test bays.

5.4 System interoperability. TCFs shall serve as the primary interconnection points in support of system interoperability.

NOTE: The capability for interoperation among different systems is required to provide alternate communications paths and to extend system transmission facilities. This standard is not intended to set policy in the area of system interoperability. It serves to provide the technical guidelines for the manner in which fixed and tactical TCFs are provisioned in the event that specific interconnect/interoperability methods cited herein are adopted. The following paragraphs contain technical guidelines in the form of electrical and physical requirements for TCFs covered by this standard. Operational and administrative requirements such as switch routing doctrine, numbering plans, system management and control, and network architecture are not specified.

5.4.1 Communications system interoperation. TCFs serving as system interconnect points shall be capable of providing the proper physical and electrical conditioning to ensure proper interface among the various system to be serviced. This shall be accomplished in such a manner that the circuit parameters resulting from interconnection will conform to the established standards of the systems over which they travel. TCFs covered by this standard shall be capable of supporting interoperation with the following systems:

a. DCS

b. DOD Tactical Systems

c. NATO Integrated Communications System (NICS)

d. U.S. and foreign commercial systems

e. Allied Tactical Systems

f. Base communications.

5.4.2 Interfacing methods. Interfacing methods shall include, but not be limited to, the analog 4 kHz voice bandwidth channel, analog multiplex groups and supergroups, and digital multiplex mission bit streams.

NOTE: Under each method of interfacing, there may be some action required on the part of the planner/designer to provide interfacing equipment/devices to accommodate the differences of circuits and equipment operated in a system foreign to their own.

5.4.2.1 Analog 4 kHz voice bandwidth channel interface. Equipment common to the TCF, such as amplifiers, pads, transformers, repeat coils and amplitude and delay equalizers shall be used to provide the required matching of 4 kHz voice channel parameters from one system to another. Listed in paragraph 4.4.3.2 of MIL-STD-188-100 are the 4 kHz voice channel parameters required of long haul and tactical TCFs.

5.4.2.2 Analog multiplex group and supergroup interface. To accommodate the interfacing of analog multiplex groups and supergroups not standard to the system to which it is interconnected, the station shall be provided conditioning equipment strings as outlined in paragraph 5.2.1.3.3. In instances in which long haul and tactical systems are interfaced at the analog multiplex group or supergroup level, the conditioning equipment strings shall be located within the long haul station. The known analog multiplex group and supergroup operating parameters of systems required to interoperate are listed in MIL-STD-188-311 and MIL-STD-188-100, paragraph 4.4.3.3.

5.4.2.3 Digital multiplex interface. Limited methods have been developed to accomplish the interfacing of systems employing digital multiplex equipment of differing modulation schemes, codes, levels, bit rates, and signaling methods. Certain automated cross-connect equipment (paragraph 5.2.1.4.4) and digital channel efficiency equipment (paragraph 5.2.1.4.5) may operate at and interface with a limited number of bit rates. When such equipment is used in a station, it shall be configured as specified in paragraph 5.2.2.3.8.

NOTE: As interfacing methods and equipment are developed, specific direction for treatment of system interface at the digital multiplex level will be provided. Listed in Figure 18 are the bit rates and quantity of traffic channels presently in use by various military systems and by large commercial carriers. Figures 19 and 20 show interfaces commonly available for user data transmission in long haul TCFs.

Number of Channels	MILITARY SYSTEMS					COMMERCIAL CARRIERS			
	DCS at 64 Kb/s	Tactical* at 16 Kb/s	Tactical* at 32 Kb/s	EUROCOM* at 16 Kb/s	EUROCOM* at 32 Kb/s	N. Amer. at 64 Kb/s	Japan at 56 Kb/s	Europe at 64 Kb/s	UK at 64 Kb/s
3	192								
45		72	144						
6	384								
8	512	128	256						
9		144	288						
12	768								
16		256	512	256	512				
18		288	576						
24	1544					1544	1544		1536
32		512	1024					2048	
36		576	1152						
48	3168		1536						
64		1024	2048						
72		1152	2304						
96	6336					6312			
120							7876		
128	8192	2048	4096					8448	
144	9504	2304	4608						
192	12928								
240							16016		
672						44736			

All bit rates in Kb/s   *Includes 1/2 or more overhead channels

FIGURE 18 Sample military and commercial carrier multi-channel transmission systems

PORT CHANNELS

RATE	ELECTRICAL CHARACTERISTICS		DATA PORTS			VF PORTS	
b/s	CONDIT'D DIPHASE	NON-RTN TO-ZERO	SYNC	ASYNC*	ISOC	PCM	CVSD
≤35		X		X			
37.5		X			X		
45.45		X		X			
50		X		X	X		
56.8		X		X			
61.12		X			X		
74.2		X		X			
75	X	X	X	X	X		
110		X		X			
150	X	X	X	X	X		
300	X	X	X		X		
600	X	X	X		X		
1200	X	X	X				
2400	X	X	X				
4800	X	X	X				
7200	X	X	X				
8000	X	X	X				
9600	X	X	X				
14.4k		X	X				
16k	X	X	X				X
19.2k		X	X				
32k	X	X	X				X
64k		X	X			X	X

AGGREGATE (DATA TRUNK) CHANNEL

RATE	CONDIT'D DIPHASE	NON-RTN TO-ZERO	SYNC	ASYNC*	ISOC	PCM	CVSD
1.2k	X	X	X				
2.4k	X	X	X				
4.8k	X	X	X				
9.6k	X	X	X				
14.4k		X	X				
16k	X		X				
32k	X		X				
50k	X	X	X				
56k	X	X	X				
64k	X	X	X				
128k		X	X				
192k		X	X				
256k		X	X				

FIGURE 19 Low speed (LSTDM) interface characteristics

* See Text

RATE	ELECTRICAL CHARACTERISTICS		TIMING MODES		
b/s	NON-RTN TO-ZERO	CONDIT'D DIPHASE	SYNC	ASYNC	ISOC**
≤35	X			X	
37.5*	X				X
45.45*	X			X	
50.0*	X			X	X
56.8*	X			X	
61.12*	X				X
74.2*	X			X	
75.0	X	X	X	X	X
110	X			X	
134.5	X			X	
150	X	X	X	X	X
300	X	X	X	X	X
600	X	X	X	X	X
1200	X	X	X	X	X
1800*	X			X	X
2000*	X			X	X
2400	X	X	X	X	X
3600*	X			X	X
4800	X	X	X	X	X
7200*	X	X	X	X	X
8000	X	X	X		X
9600	X	X	X	X	X
16k	X	X	X		X
19.2k*	X	X	X	X	X
32k	X	X	X		
50k*	X		X		
56k	X		X		
64k	X	X	X		
128k	X		X		
192k	X		X		
256k	X	X	X		
384k	X		X		
512k	X	X	X		
768k	X		X		
1544k	X (BIPOLAR PREFERRED)		X		
2048k	(BIPOLAR ONLY)		X		

*NONPREFERRED RATES

**ISOCHRONOUS RATES BELOW 2400 B/S ARE LSTDM

FIGURE 20 Long haul user data transmission characteristics

5.4.3 Supervisory signaling. TCFs required to interconnect with other TCFs or other interconnection points of different systems shall be capable of interfacing with in-band, common channel, or E&M supervisory signaling methods.

5.4.3.1 In-band signaling. Interconnection of circuits employing in-band signaling shall be treated in the following manner.

a. TCFs shall not translate the in-band supervisory signaling tones of circuits interconnected on a VF basis to standard signaling tones of their system when such circuits do not terminate at TCFs within their system.

b. TCFs shall translate nonstandard in-band signaling tones of circuits interconnected on a VF basis to standard signaling tones employed in their system when such circuits terminate at TCFs within their system. Translation of the in-band signaling tones shall take place at the point of system interconnect.

c. In-band signaling parameters SF tone conditions

SIGNAL	TONE	OPERATION	LEAD	CONDITION
ON-Hook	ON	Sending	M	Ground
		Receiving	E	Open
Off-Hook	OFF	Sending	M	Battery (-48V)
		Receiving	E	Ground

SF Tone Level	
Idle	-20 dBMO ± 1.5 dB
Pulsing	-8 dBMO ± 1.5 dB

5.4.3.2 E&M Signaling. The interface parameters for interconnected circuits employing E&M signaling are listed below.

	E Lead	M Lead
On-Hook	Open	Ground
Off-Hook	Ground	Battery (-48 Volts ± 5 Volts)

5.4.4 Cable entry panel. Fixed TCFs required to interconnect with tactical TCFs located within their immediate vicinity shall be provided an outside cable entry panel on which to terminate paired cables used for interconnect. The cable entry panel shall be located in an area that will allow transportable vehicles, housing tactical TCFs, to park along side the fixed TCF building and have ready access to the entry panel.

5.5 Station power. The TCF shall be provided an efficiently designed power generating source, auxiliary power source, and power distribution system to accommodate its technical and non-technical requirements. The standards and conditions under which station power shall be provided are contained in the following paragraphs.

5.5.1 Safety. All TCF electrical power subsystem installations shall adhere to all applicable regulations of the National Electrical Code, NFPA 70-1987, and applicable regulations imposed by the host nation.

5.5 Requirements.

5.5.2.1 Primary and auxiliary power. The TCFs shall be provided primary and auxiliary power, in accordance with the applicable guidance and recommendations cited in MIL-HDBK-411.

5.5.2.2 DC supplies and no-break power. The TCF shall be provided with sufficient DC power supplies both in quantity and capacity to satisfy all DC power requirements for the equipment installed and to allow for future requirements. Supplies shall be provided in all voltages necessary to support facility equipment and, whenever required, to support separate RED and BLACK systems. The equipment comprising the critical technical load within the TCF shall be supplied with no-break power. Such no-break power shall be supplied from a battery float system contained within the facility. The 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. Certain equipment items with critical power requirements in excess of these times may be equipped with their own internal uninterruptible power supplies. Tactical TCFs shall not be required to meet this standard but shall, as a desirable feature, have as much battery backup as weight and space constraints permit.

6. NOTES

6.1 Subject term (key word) listing.

Access
Conditioning
Multiplexer
Orderwire
Patch
Patch bay
Quality control
Signaling
System control
Technical control
Test
Transmission

PROPOSED MIL-STD-188-154

APPENDIX A

Under Secretary of Defense Memorandum

10. General. This appendix is a copy of The Under Secretary of Defense (Research and Engineering) memo which makes the use of MIL-STD-188-154 mandatory for use by all Departments and Agencies of the Department of Defense.

10.1 Under Secretary of Defense (Research and Engineering) memorandum.

THE UNDER SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

RESEARCH AND ENGINEERING

16 AUG 1983

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, LOGISTICS & FINANCIAL MANAGEMENT)
ASSISTANT SECRETARY OF THE NAVY (SHIPBUILDING & LOGISTICS)
ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH DEVELOPMENT & LOGISTICS)
COMMANDANT OF THE MARINE CORPS
DIRECTOR, DEFENSE COMMUNICATIONS AGENCY
DIRECTOR, NATIONAL SECURITY AGENCY

SUBJECT: Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series

On May 10, 1977, Dr. Gerald Dinneen, then Assistant Secretary of Defense(C^3I), issued the following policy statement regarding the mandatory nature of the MIL-STD-188 series telecommunications standards:

"...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 MIL-STD-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 MIL-STD-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 statement has been reviewed by this office and continues to be the policy of the Department of Defense.

1 Input voltage -48 VDC

APPENDIX B

General Description of Technical Control Facility Functions and Equipment

10. General. This appendix provides additional general information on the organization and functions of technical control facilities. Brief descriptions of common technical control equipment items are also included. The information contained in this appendix is not mandatory.

10.1 Facility capabilities. Technical control and patch and test facilities are 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 transmission facilities 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, are 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 are 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.

10.2 Overview of technical control system concepts. Technical control systems are actually subsystems within the telecommunications systems they are intended to control--from both the organizational and physical points of view. Organizationally, they consist of the personnel throughout the system assigned the responsibilities of performing the technical control functions. The organizational structure contains the elements of supervision and line responsibility, and its configuration is determined by the network plan of the telecommunications system. The physical structure consists of technical control facilities and patch and test facilities in a hierarchical arrangement that permits the organizational structure to function properly. In principle, the technical control system occupies an intermediate position between system management and system users. This is reflected organizationally in that system management establishes technical control policy and exercises direction over the technical control organization. The technical control facility carries out the policy established by system management, responds to management directives, and furnishes management with the information it requires to perform the management objectives. The system users demand (in the technical sense) service, and the technical control enables the telecommunications system to provide this service. The technical control also provides information and instructions to users concerning the use of the telecommunications system and routine and emergency operational matters.

10.3 System control. The functions performed by technical control facilities are in support of the higher level goals of system control. System control is the function which ensures user to user service is maintained under changing traffic conditions, user requirements, natural or manmade stresses, disturbances, and equipment disruptions on a near term basis. System control encompasses the following interrelated functions as specified in DCAC 310-70-1.

a. Facility surveillance, which provides real time equipment, transmission network and terminal data concerning the status of the system, network, and facilities, and their near term performance over a period of time. It also includes associated near term data reduction and analysis to support near term network and technical control. It provides data to support mid and long range system management, engineering operation and maintenance.

b. Traffic surveillance, which provides real time data concerning systems and network loading, data processing queue status, message back log, and buffer fill rate data and other measures to describe system, network and or facility congestion and traffic load. It also includes associated near term data reduction and analysis to support traffic control. It provides data to support mid and long-range system management engineering, operation, and maintenance.

c. Network control, which includes real time and near term control of switched networks and associated transmission circuitry; reconstitution, restoral, and extension supervision; and satellite system and payload control, and resource allocation.

d. Traffic control, which includes real time and near term control of traffic flow and routing, such as code cancellation, code blocking, alternate route cancellation, line load control, and user prioritization.

e. Technical control, which includes real time transmission system configuration control, quality assurance, quality control, alternate routing, patching, testing, directing, coordinating, restoring, and reporting function necessary for effective maintenance of transmission paths and facilities.

10.4 Relationships to other systems and facilities. The TCF serves as the focal point for connection to all types of users and different systems. For example, the TCF provides the interface between long haul and tactical communications systems. An example of this application might allow tactical users separated by long distances to communicate using a fixed TCF as a gateway to the long haul communications networks. TCFs serving at nodal locations typically provide major reconfiguration and restoral capabilities on a system basis. Figure 21 illustrates these gateway and nodal functions as they might be performed in a large network. Within these large networks, many large subsystems (such as telephone switches, message switches, satellite terminals, etc.) are provided their own patching and testing capabilities. These capabilities are provided in a patch and test facility (PTF). Generally, a PTF is associated with a subsystem to a specific transmission medium and contains all of the equipment needed to monitor and test that subsystem for maintenance purposes. PTFs are also equipped with orderwires and intercom systems to perform the necessary coordination within the overall technical control function. Although patch and test facilities are actually facilities for exercising technical control, the term technical control facility is generally reserved for the equipment assembled at a higher organizational level. The assembly of the equipment is arranged along certain formalized patterns for the purpose of standardization and interoperability throughout the telecommunications system and with other telecommunications systems adhering to the same standards.

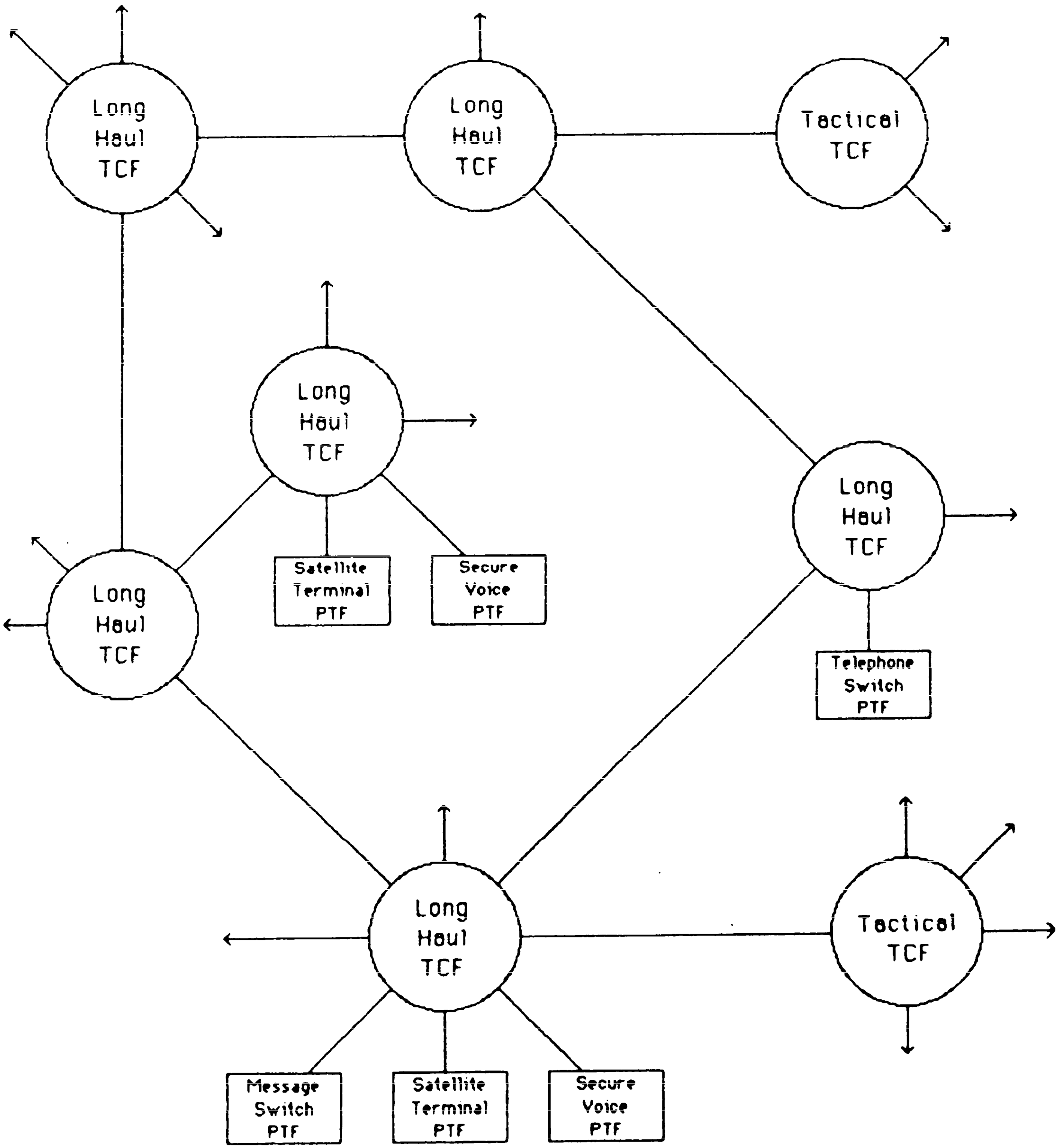


FIGURE 21 Sample long haul and tactical TCF connectivity in a large network

10.5 TCF physical configuration. While no standards exist for facility physical configurations, TCFs are planned to optimize the location and interaction between access facilities, orderwires, test centers, alarm systems, and the reporting and coordinating position. A sample floor plan is illustrated in Figure 22.

10.6 TCF equipment descriptions. Technical control facilities frequently contain a variety of equipment necessary to interface and interoperate with the systems and users they support. Brief descriptions of common equipment used for these purposes in TCFs are contained in the following paragraphs.

10.6.1 Functional description of VF terminating equipment. Functional descriptions of VF terminating equipment are given below.

NOTE: These brief descriptions are provided for immediate reference. MIL-HDBK-414 provides additional detailed information on many of these items.

10.6.1.1 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 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.

10.6.1.2 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.

10.6.1.3 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 control leads. 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.

10.6.1.4 Dual frequency signaling unit (DFSU). DFSUs are used as in-band signaling devices for 4-wire VF circuits of the DCS. Primary applications will be on 4-wire user access lines, PBX access lines, and interswitch trunks of the overseas AUTOVON. The DFSUs provide conventional E&M (supervisory and dial pulse) signaling functions on 4-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 SFSUs.

10.6.1.5 E&M to 20 Hz converter. The E&M to 20 Hz signal converter sends signals over the M lead to 2600/2800 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 can be arranged to operate with signaling frequencies other than 20 Hz when required.

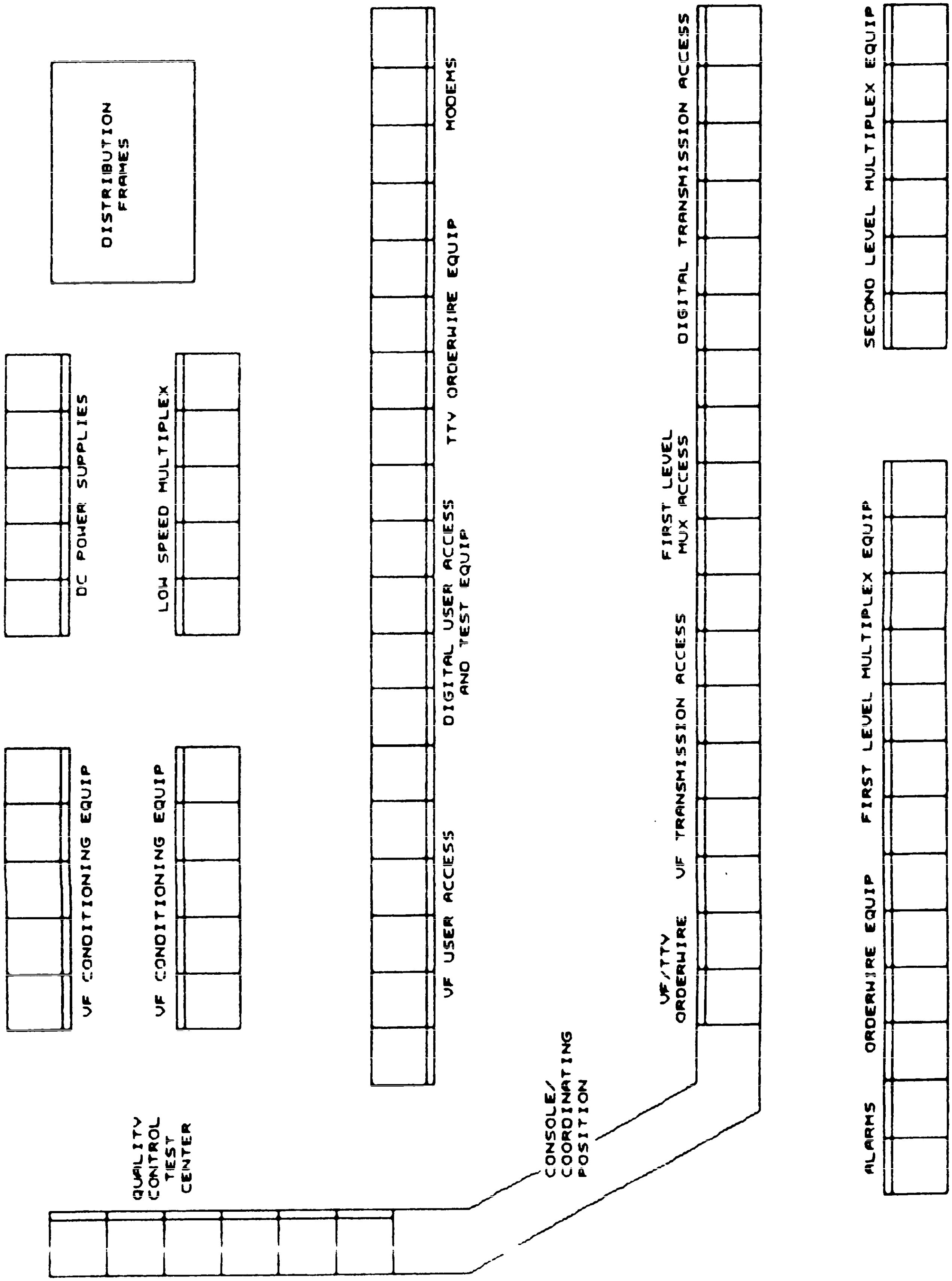


FIGURE 22. Sample floor plan for a long haul TCF

10.6.1.6 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.

10.6.1.7 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.

10.6.1.8 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.

10.6.1.9 Two-wire/4-wire terminating set. To interconnect a 4-wire transmission path to a 2-wire transmission path, a 2-wire/4-wire terminating set is used. On the 4-wire side, the impedance of each pair is 600 ohms. By strap options, the two-wire side can be made to match a variety of common cable impedances.

10.6.1.10 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.

10.6.1.11 Pad. A pad intended for use in VF balanced circuits provides adjustable attenuation and a constant input and output impedance of 600 ohms.

10.6.1.12 VF amplifier. Amplifiers intended for use in VF-balanced circuits provide a 600 ohm constant input and output impedance with continuous adjustable gain from 0 to 35 dB.

10.6.1.13 Echo suppressor. An echo suppressor is a device that detects signals (such as speech) transmitted in either direction on a 4-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 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 have a unidirectional send, a unidirectional receive, and a bidirectional state.

10.6.1.14 Echo canceler. The echo canceler differs from an echo suppressor in that it digitally computes an echo estimate which is then subtracted from the return-path signal rather than attenuating the signal. The canceler located on the near-end of the circuit works for the far-end subscriber.

10.6.1.15 Passive peak limiter (PPL). This device is used to automatically prevent system overload caused by excessive transmission levels from the user equipment. These devices are located on the line side of a manual VF user access if the TLP there is -2 dB or greater and they would not interfere with signaling. Otherwise, they are installed on the equipment side of a manual transmission access. They may be physically located on the corresponding terminal board on the distribution frame.

10.6.1.16 Six-way/4-wire bridge. This device provides a conferencing capability for 6 each 4-wire telephone circuits. The bridge is installed on the equipment side of the transmission access.

10.6.1.17 Multi-function conditioning equipment. In some cases, multiple VF circuit conditioning functions may be provided on a single circuit board or plug-in module. This equipment may combine such functions as the SFSU, amplifier, pad, and 2-wire/4-wire terminating set. Using such multi-function equipment in TCF programs can result in lower cost, smaller space requirements, and, in some cases, less power consumption.

10.6.2 Digital conditioning equipment. Digital conditioning equipment is used to interface various types of digital users to the DCS. This equipment is usually connected between the digital user access and digital transmission access . Functional descriptions of some digital conditioning equipment are given below.

NOTE: MIL-HDBK-414 provides additional information on application and performance characteristics of digital conditioning equipment.

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

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

10.6.2.3 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.

10.6.2.4 Cable line drivers. Line drivers are used to extend the distance over which data may be transmitted on metallic transmission lines.

10.6.2.5 Regenerative repeaters. These devices are used to retime and reshape digital signals for 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 or exceed the maximum acceptable distortion limit.

10.6.2.6 Digital 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.

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