

PRIVATE LINE TELEPHONE SERVICE
FOUR-WIRE SWITCHING PLAN USING NO. 5 CROSSBAR
DESCRIPTION

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1. GENERAL

1.01 This section describes the main features of a 4-Wire, No. 5 Crossbar Switching Plan. This system (plan) is used to switch private lines involving large numbers of trunks and subscriber loops in accordance with the requirements of the customer. A system such as this may be used for voice, data and encrypted (secure) voice. Additional descriptive information may be found in other Bell System Practices. This section is reissued to make numerous changes in the text. Marginal arrows indicating changes have been omitted.

2. DEFINITION OF TERMS

2.01 *SCAN—Switched Circuit Automatic Network.* SCAN is a private line dial switching network used by the Signal Corps and the Navy. The switching system consists of four 4-Wire, No. 5 Crossbar offices and serves 150 or more customer locations in the United States.

2.02 *Trunk Circuit.* As used in this system, trunk refers to the facilities and equipment used to connect two 4-Wire switching centers.

2.03 *Subscriber or Station Line.* The circuit between the switching office and the customer location.

2.04 *Secure Voice.* A term pertaining to a type of transmission where voice conversation is made unintelligible.

2.05 *Encrypted Voice.* This term means the same as secure voice except that it usually refers to a specific type of equipment used to produce the desired results.

2.06 *Emergency Transfer Circuit.* This circuit permits the retermination of the No. 5 Crossbar automatic lines and trunks as manual lines and trunks. This feature is used when some trouble or emergency condition prevents the use of the No. 5 Crossbar switching system. The 5D Switchboard operator handles these calls on a manual basis.

2.07 *Intercept.* This is a feature which is used when a call cannot be completed. The call is referred to an assistance operator or a recorded announcement. Any subscriber line may be put on intercept by the 19A Testboard. A vacant code call is referred to the 5D operator if the call is locally originated. If the call is through switched, a vacant code call is referred to a recorded announcement. A call to a particular line in trouble may be referred to the 5D operator by action taken at the 19A. Calls to unused and disconnected numbers are referred to the 5D operator by a cross connection at the number group frames.

2.08 *4-Wire, No. 5 Crossbar Switching System.* This is basically the same as a 2-Wire, No. 5 crossbar office in that it can share certain

items of equipment. However, it is quite sophisticated in other respects and provides many special features. Some of these are: 4-Wire switching, together with the 4-Wire touch tone and/or rotary dial telephone; expansion of classes by providing for special and priority handling of certain types of calls; 4-Wire manual operation using a 5D Switchboard in emergencies.

2.09 4-Wire Touch Tone Telephone Set. This is a six-button, 568HT-Type key telephone set equipped with pushbutton tone keys. These are arranged in three columns of four buttons each instead of the normal rotary dial. It signals by means of two predetermined frequencies transmitted simultaneously and selected between approximately 690 and 1500 cycles.

2.10 5D Assistance Switchboard. The switchboard is used as a 4-Wire Dial System 'A' switchboard. It is a modification of the No. 5 Switchboard originally designed to be used as a call order board for No. 4 Toll Crossbar systems.

2.11 Special Grade Trunks. These are used for transmission of encrypted voice or data. The selection of special grade circuits will be limited to 5D assistance switchboard positions and to stations requiring specially conditioned circuits for the transmission of encrypted calls or of high speed data calls. Stations always requiring special grade circuits will be provided with an appropriate class of service mark. All other stations must use an authorizing prefix ahead of the 7-digit number on calls requiring special grade circuits. Upon receipt of the prefix indications, the No. 5 Crossbar equipment will limit the trunk selection to special grade circuits.

2.12 Combined Grade Trunks accept all classes of service including administrative voice traffic.

2.13 Camp-on. This is an operational feature provided on calls requiring special grade circuits. Upon receipt of an authorizing prefix or recognition of the proper class mark, the originating switching office will attempt to select a direct special grade trunk to the terminating office. If all these trunks are busy, the originating register will thereupon monitor the trunks

and wait until one is idle. When a circuit is idle, the register will seize it. Once the circuit is seized, an information digit is prefixed to the called number passed to the terminating office. This requests automatic transfer to an assistance operator if the desired line is busy or does not answer promptly.

2.14 Terminating Office Priority. A feature provided to automatically transfer incoming priority calls encountering a busy line or don't answer condition to a 5D operator at the terminating office. This feature is accomplished by an information digit prefixed to the call by the originating switching office.

2.15 Call Privilege. There are three classes of call privilege:

- (a) Selection of special grade circuits.
- (b) Camp-on.
- (c) Terminating office priority.
 - (1) Automatic operator interception of busy and DA's after a predetermined time interval.
 - (2) Special operator attention on incoming priority calls requesting line transfers.
 - (3) Special operator attention on incoming priority calls to the operator's listed number.

2.16 One or a combination of these privileges may be given automatically to every call initiated on selected subscriber lines by appropriate class of service assignments. Or, if desired, the privilege(s) can be on a controlled basis so that selected subscriber lines can activate it on specific calls by adding a two-digit prefix to the desired subscriber number, or by the operation of the "P" or "SG" button on the touch tone telephone.

2.17 19A Testboard. A new toll testboard used for making overall and sectional tests. It is also used to patch the lines and trunks terminating in the 4-Wire, No. 5 Crossbar office.

2.18 Loop Back. An arrangement whereby the customer may operate a switch on the premises and loop back the line facilities for testing from the 19A Testboard (SD-69167-01 Figs. 6, 32 and 98 at customers' premises).

2.19 Line Load Control. A feature provided whereby the Plant Department may control the number of originating subscribers who have access to the machine. In the case of abnormally high traffic loads due to a national emergency, serious traffic overloads or other conditions which would cause common control equipment to be overloaded, the line load control may be preset so that selected users will be able to complete calls. Line load control may be divided into three classes such as A-20% of the lines, B-40% of the lines, and C-40% of the lines. Class A will never be denied originating service. Class B or C, or both B and C at the same time, may be denied originating service by the operation of line load control equipment. *Incoming service will not be denied to any customer.*

Outlined below is a short description of the equipment and lamp indications for the transfer circuit. The keys and lamps may be mounted in a line load control cabinet or on the recorder bay of the master test frame.

- (a) A red lamp (G) indicates an overload on each line link frame.
- (b) A red lamp (ORST) indicates the marker has found all originating registers are busy.
- (c) A red lamp (MBA) indicates all markers are busy.
- (d) An office load meter indicates the approximate total office 48-volt load.
- (e) A key designated (B) with an associated white lamp and a key designated (C) with an associated green lamp are provided for each line link frame to control the associated frame relays which deny service on Class B and Class C lines, respectively.
- (f) A key designated (CLB) with an associated white lamp and a key designated (CLC) with an associated green lamp are provided as a master control key for each group.

2.20 Auxiliary Line Circuit. This is used when the loop resistance between the 4-Wire, No. 5 Crossbar office and the station exceeds the limits of the subscriber line circuit. These circuits will provide the proper conversion between loop signaling and E & M signaling, where re-

quired, for carrier circuits or other circuits which are extended to the customers' premises.

2.21 Class of Service Mark. This is a designation for the privileges a subscriber may be assigned. For some subscribers, the call privileges will be automatic on all calls. For other subscribers, special call privileges may be exercised by the use of a special two-digit authorizing prefix ahead of the desired station number. The class mark is a feature of the No. 5 Crossbar machine. The assignment of a class mark to a subscriber line is determined by the call privileges required by the subscriber and is specified by the customer. Table I shows typical classes of service.

TABLE I

CLASS OF SERVICE	USE	
AA	PBX	Subscriber Line with ES* (4W Class Mark)
BB	PBX	Subscriber Line without ES (2W Class Mark)
CC	Data	Regular Single User (4W Class Mark)
DD	Data	Candidate for Camp-on, Single User (4W Class Mark)
EE	Secure Voice	Candidate for Camp-on, Single User (4W Class Mark)
FF	Dual Use	Voice and Data with ES on Subscriber Line (4W Class Mark)
HH	Dual Use	Voice and Secure Voice with ES on Subscriber Line and Future Camp-on Candidate (4W Class Mark)
II	5D	ES not required in Intercity Trunk (4W Class Mark)
JJ	5D	ES is required in Intercity Trunk (2W Class Mark)
KK	Selected User (VIP)	(4W Class Mark)

* Echo Suppressor

3. DESCRIPTION OF SYSTEM

3.01 This system provides customers with a large volume of private line traffic with a versatile switching plan. Almost any operational feature is available or can be made available on a 4-Wire basis station to station.

3.02 This system requires many new items of equipment in order to provide the required operational features. The main new equipment items are:

4-Wire, No. 5 Crossbar switching system

5D Switchboard

19A Testboard

4-Wire, Touch Tone or Dial Telephone

3.03 The switching plan is a fully automatic system which provides direct access 4-Wire subscriber-to-subscriber dialing. It will automatically select a direct route or one of two alternate routes for any call.

3.04 Each subscriber on the system has a directory which lists all authorized users and other pertinent information for efficient operation of the system. To originate a call, a subscriber dials the distant location switching center code and the required number assigned to the specific user or PBX. Priority calls which cannot be completed are routed to the assistance position for disposition. PBX operators may originate calls into the dial network in the same manner as other subscribers. The call is also automatically routed to the called station. Outlined below is a discussion of the main features of the 4-Wire switching plan using No. 5 Crossbar.

4. 4-WIRE, NO. 5 CROSSBAR SWITCHING OFFICE

4.01 The switching system may be used as a segregated No. 5 Crossbar office or it can share certain common control equipment and other items. These include power, building space, distributing frames, etc., which can be shared with the normal 2-Wire, No. 5 office used for the switched message network.

4.02 Some of the special features of this system are:

- (I) 4-Wire switching with 4-Wire touch tone telephone provides station-to station 4-Wire circuits.
- (II) Expansion of the use of classes of service.
 - (A) Adds class distinctions for new and special features.
 - (B) Uses prefixes when special or priority handling is desired.
 - (C) Uses information digits when pulsing between offices.
- (III) Special call privileges.
 - (A) Selection and use of special grade circuits.
 - (a) Circuits for data.
 - (b) Circuits for encrypted voice.
 - (B) Camp-on feature.
 - (C) Automatic transfer of incoming priority calls encountering busy line and don't answer conditions to an operator at the called center.
 - (D) Uses a separate group of dial "O" trunks at 5D Switchboards for calls requiring special attention.

5. 5D ASSISTANCE SWITCHBOARD

5.01 The 5D Switchboard is used as the 4-Wire DSA Switchboard for the 4-Wire No. 5 Crossbar system. This switchboard is a modification of the No. 5 Switchboard originally designed as a call order board for the No. 4 Toll Crossbar system. Talking connections are established by means of twin plugs inserted in twin jacks, thereby obtaining 4-Wire transmission through the board. The switchboard provides operating arrangements for the following items of traffic:

- (a) Dial "O" assistance for both priority and regular lines.
- (b) Verification.
- (c) Handling of incoming priority calls to busy lines or to lines that do not answer within a predetermined time.

- (d) Monitoring on busy lines and trunks.
- (e) Conference calls.
- (f) Trouble reports.
- (g) Information calls.
- (h) Intercept calls.
- (i) Permanent signal traffic.
- (j) Request for transfer on incoming calls.
- (k) Calls for operators' listed number (equivalent to 121 traffic).

5.02 Some of the arrangements, operating features and capacities of the 5D Switchboard are as follows:

- (a) All lamps in the switchboard are mounted in combined lamp socket and designation strip holders.
- (b) Two dial "O" assistance trunk groups are provided, one for priority traffic and the other for regular traffic. The priority group is selected when a data or encryption station user operates the "P" button and then dials "O".
- (c) On the intertoll trunks, one busy and three answering lamps are provided. The busy lamp is for monitoring purposes and the answering lamps are for the following purposes:
 - (1) A lamp is provided to indicate that operator attention is required on an incoming priority call. Examples are: Priority call encountering a busy or DA exceeding the predetermined time interval, incoming priority call requiring line transfer or an incoming priority call to the operator's listed number.
 - (2) A lamp is provided to indicate that operator attention is required on a regular incoming call on which line transfer is required.
 - (3) A flashing lamp is provided to indicate that operator attention is required.
- (d) Visual monitoring on a busy line or busy hunting group is accomplished when the plug of a line busy monitoring cord is inserted in an idle line indicating jack. The associated cord lamp signal will be dark while the line

or hunting group is busy and will flash when a line becomes idle.

(e) The 5D Switchboard has appearances of vacant code trunks and permanent signal trunks. These are in addition to multipurpose tone and announcement trunks associated with the 4-Wire, No. 5 Crossbar equipment which:

- (1) Give 60 IPM tone to signify line busy.
- (2) Give 120 IPM tone to signify all trunks busy.
- (3) Give a recorded announcement from a single channel announcement machine on vacant code and partial dial calls.
- (4) Store permanent signal calls which exceed the capacity of the regular P.S. trunks.

(f) Monitoring on a "camp-on" call originated by the 5D operator is accomplished by observation of lamp signals on the cord. A steady lamp signal indicates that the call is "camping." When an outgoing trunk is seized to advance the call, the lamp flashes. In addition to the lamp signals, "camp-on" tone (a double zip tone) can be heard every three seconds.

6. 19A TESTBOARD

6.01 The 19A Testboard associated with the 4-Wire, No. 5 Crossbar installation is a combination of basic units from existing testboards and should not present any new problems.

6.02 One testboard and one patch bay can accommodate about 180 trunks and 160 station lines. Also, one test bay per office is associated with the testboard to include the necessary testing apparatus for use in the maintenance of a private line network.

6.03 Some of the tests which can be performed on station lines and trunks are:

- (a) Busy tests.
- (b) Talking and monitoring.
- (c) Originating outgoing or incoming calls to test lines in the same or distant offices or to station lines.

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- (d) D.C. voltmeter and milliammeter tests on metallic station lines.
- (e) Signaling tests.
- (f) Transmission and noise tests.

6.04 The trunks may be taken out of service by locking them out when idle or when in service. The trunk lockout feature is also used for cross-office identification of outgoing trunks.

6.05 Station lines are removed from service by forcing incoming calls for the station lines to be thrown to intercept at the 5D Switchboard. Spare LLF appearances permit reassigning a station line when its LLF appearance develops trouble. The patching jack arrangement permits substituting spare toll terminal equipment for working equipment located between the trunk circuit of the LLF appearance and the voice frequency patch bay.

6.06 Codes 101, 102 and 103 test lines are available for use with trunk circuits. Codes 101 and 102 are also available for use with station lines. A station line test circuit is available by cross-office selection through the testboard for station tests.

6.07 Arrangements are available to switch trunks and station lines from the No. 5 Crossbar equipment to the No. 5D Switchboard for emergency manual operation. Interoffice and intraoffice trunks for plant communication are also available.

7. 4-WIRE, TOUCH TONE TELEPHONE

7.01 The pulsing frequencies for the touch tone telephone set are in two bands. The low band is from 697 to 941 cycles and the high band is from 1209 to 1477 cycles. All frequencies are within ± 10 cycles. Table II shows the frequencies for each pushbutton on the set.

TABLE II

PUSHBUTTON ON SET

FREQUENCY	PUSHBUTTON ON SET		
	1209 CYCLES	1336 CYCLES	1477 CYCLES
697 cycles	1	2	3
770 "	4	5	6
852 "	7	8	9
941 "	P	0	SG

7.02 When a button is operated on the telephone set, two tones are transmitted. For instance, if the "2" button is pushed, the tones transmitted are 697 and 1336 cycles. If the "SG" button is pushed the tones are 941 and 1477 cycles.

8. CIRCUIT NUMBERING AND ROUTING PLANS

8.01 The basic numbering plan for a system such as "SCAN" consists of seven digits. The first three digits designate the switching office and the last four the subscriber line number. For example, the station number (7 digits) appears in the customer directory as follows:

Frederick, Md.	231 + Customer 4-digit code No.
Rockdale, Ga.	431 + " " " "
Hillsboro, Mo.	631 + " " " "
Santa Rosa, Calif.	831 + " " " "

8.02 For plan purposes, each of the individual subscriber lines and interswitching system trunks are numbered and designated in accordance with normal practices.

8.03 The digit "0" is used for dialing the operator to obtain assistance and information. The initial digit "1" is used as part of a two-digit prefix to indicate the type of special handling or priority desired on a call.

8.04 All routing is assigned by the Traffic Department. The routing may change as the traffic load requirements change.

9. CUSTOMER STATION EQUIPMENT

9.01 The station equipment consists of touch tone telephone sets, government operated PBX switchboards and government owned and operated data and encrypted voice equipment.

9.02 In addition to the regular equipment, each data encrypted voice or dual user will have facilities provided to loop back the subscriber line for test purposes. This feature will be for Plant's use and will consist of a lamp and key at the customer location.

9.03 A touch tone telephone set similar in appearance to the 500-type six-button key telephone set is also provided. The space normally provided for the rotary dial is occupied by an assembly of twelve touch tone buttons in three columns of four buttons each. Ten of the buttons are equivalent to the operation of a conventional rotary dial. The remaining two buttons are designated "P" and the other "SG". Both are used singularly or in combination to establish a privilege call. The six-button arrangement at the base is similar to that of a standard set using illuminated pushbutton control keys. Locking keys are provided for four-wire network lines and for local lines. Nonlocking keys are used for hold, encryption transfer, data transfer and for signaling functions. The station set provides four-wire and two-wire termination in any combination up to five lines, depending on the number of special control arrangements employed.

9.04 Data machines are provided by the customer and may be IBM card transceivers, type 65-66 or Friden dual teledata. Collins Keneplex TE-206 — 8 channel, Bell System dataphone 202A or IBM RPQ 519 (100 cards per minute) input parallel output serialized may also be used.

9.05 Encrypted voice equipment is customer owned and maintained (COAM) terminal equipment and only the required channel conditioning will be provided by the Telephone Company.

9.06 Dual user applies to a customer that requires more than one type of service over a single line. The service provided could be Voice-Encrypted Voice, Voice-Data or Data-encrypted Voice. In any case the tributary line should meet the requirements of the highest grade of service to be provided.