SWITCHING SYSTEMS MANAGEMENT
NO. 1 ELECTRONIC SWITCHING SYSTEM
(CTX-4 AND LATER GENERIC PROGRAMS)
OPERATIONAL FEATURES—LINE LOAD CONTROL

CONTENTS PAGE

1. GENERAL

1.01 This section describes the operation of line load control (LLC) in the 2-wire No. 1 Electronic Switching System (ESS) central office, incorporating SP-CTX-4, CC-CTX-4, and later generic programs.

1.02 Since this reissue covers a general revision, arrows ordinarily used to indicate changes have been omitted.

1.03 The primary purpose of the LLC in the No. 1 ESS is to provide a means by which

a relatively small group of lines identified as essential will be given preferential originating call treatment in those emergency situations that are accompanied by high originating call volumes. It is defined as a procedure by which originating service is selectively denied to some or all lines not considered essential. Essential lines are allowed to originate calls when line load control is activated. (ESS essential line service is available in the following fractions: 1/16, 2/16, 3/16, or 4/16.) The fraction of lines assigned ***essential*** is a parameter item established in the telephone equipment order. It is recommended that no more than 1/16 (6.25 percent) of the lines equipped be assigned to class A essential service. The number of subscribers assigned to essential service verticals should be held to less than 6.25 percent, if possible. LLC permits continuation of service to as many nonessential lines as possible. The initiation of LLC does not affect calls already established; and it does not prevent calls from being completed to lines temporarily denied originating service, thus allowing essential calls to reach any telephone at any time.

1.04 Essential lines are assigned to an essential group (described in Part 2) and cumulatively make up either 1/16, 2/16, 3/16, or 4/16 of the total lines in the office. In the No. 1 ESS, two different nonessential service line groups are rotated (scanned) for service requests every minute until all nonessential lines are denied service. This type of line scan rotation assures nonessential lines of receiving some degree of service during control activation. If the overload diminishes, internal checks made by the system will initiate restoration of service to the denied service groups one at a time.

1.05 Coin lines are normally included in essential groups to provide the general public with a means of obtaining communication service for urgent calls. However, all coin lines in a given area may not be included in essential groups if there is a large concentration of those telephones in that area; in this case, coin lines which are considered for assignment to essential groups may be selected for geographic dispersion. Important public locations where stations are sheltered and accessible can also be included. A list of essential coin lines and subscriber telephone numbers should be available from the local commercial group.

1.06 The consequences of the initiation of LLC must be carefully considered. It must be stressed that LLC has the ability to control the load distribution (described in 3.04) by denying originating service to lines in nonessential groups to a degree determined by the extent of the overload. While attempting to alleviate the overload, LLC also assures service to certain essential lines.

1.07 Before deciding upon a particular course of action when an overload occurs, all system indications must be taken into consideration. Observation of traffic control lamps at the master control console (MCC), as well as a thorough analysis of data contained in traffic overload and status printouts (TØC01, TØC02, and TC15s), must be used to evaluate the situation. Other items which should be considered are long E--E times, full buffers, failures to seize idle equipment and idle registers, failures of path hunts, failures of dial tone speed tests, and any other pertinent observations by office personnel. Such items as time of day and relationship to busy hour should also be considered. If at all possible, a determination of the overload cause should be made to identify whether it is an emergency situation. (Refer to DFMP, Division H, Section 6m, Abnormal Traffic/Load Conditions, for evaluation techniques and administrative procedures associated with the determination of an overload.)

1.08 It is not possible to prescribe the exact conditions under which LLC should be applied. In many cases, the condition will be a unique occurrence so that previous experience does not exist to serve as a guide. Each situation will require the balanced consideration of such items as cause (if known), time of day, and relationship to busy period. In general, the decision to use LLC (a) will be based on those factors which affect the local office and (b) will depend directly upon the magnitude of the overload. LLC activation should follow local procedures, based on system standards, and whenever possible should be ***jointly*** determined by the local Network Maintenance and Network Administration personnel.

1.09 The three states in which the LLC feature may be found are OFF, AUTOMATIC, and ON. When no emergencies exist, it is strongly recommended that the LLC feature be left in the OFF mode in attended offices (including those offices remotely monitored by a Technical Assistance Center [TAC]). To provide uniform service to all

lines, the line load control feature should not be left in the ON or AUTOMATIC mode during periods of normal machine operation. Preferential treatment should be restricted to disaster or emergency situations only. For hours when there is no local or remote Network Maintenance or Network Administration coverage, the AUTOMATIC mode may be appropriate in unattended offices. ***It is a management decision to provide preferential treatment to a group of subscribers.***

2. LINE GROUPS

Essential Lines

2.01 Essential lines in a central office are assigned to one of 16 line groups for LLC purposes. The 16 line groups are designated on the basis of the ferrod arrangement in the line scanner matrix. Refer to Fig. 1 for the ferrod arrangement of the 2:1 and 4:1 concentration.

2.02 Each of the 16 line groups is assigned a vertical designator for line load control purposes. The vertical designators range from 0 to 15. Vertical designators 0, 4, 8, and 15 are the essential verticals and are used for the assignment of essential lines. The related concentrator switch and level number depends on the concentration ratio. Fig. 2 provides a comparison of the line group vertical designations. For example, the line group vertical designation 4 in a 2:1 concentrator includes switch ***1,*** level ***00,*** and switch ***5,*** level ***00.*** The line group vertical designation 4 in a 4:1 concentrator has switch ***0,*** level ***04;*** switch ***1,*** level ***04;*** switch ***2,*** level ***04;*** and switch ***3,*** level ***04.***

2.03 The concentrator switch and level numbers which receive preferential treatment during line load control are given in Table A. The lines that do not appear on the essential verticals will receive nonessential service. The recommended fraction of lines that may be designated as essential is 1/16 or 6.25 percent. For the No. 1 ESS line load control feature to provide maximum preferential treatment to this fraction of lines, the essential lines must be assigned to the concentrator switches and levels associated with line group vertical designation No. 4. (Refer to Table A.)

3. LINE LOAD CONTROL OPERATION

3.01 No line groups are denied originating service unless the LLC program is activated, either manually using the ***LLC-ALLØW—ØN*** message or by the system after being placed in the automatic LLC mode by the ***LLC-ALLØW—AU*** message. Both messages can be entered on Maintenance or Network Administration (Traffic) teletypewriters (TTYs). A measured service overload must be occurring to cause the overload controls to be activated. The key measurements are dial tone delay (4 or 11 seconds) and incoming matching loss (10 percent blockage). The LLC feature is returned to its OFF state by deactivation of the feature as discussed in Part 6. The manual and automatic operation of the LLC feature, along with a description of the forced-on mode, are given in the following paragraphs.

A. Manual Operation

3.02 When the LLC-ALLØW—ØN message (5.02) is entered, the line load control feature is put in the forced-on mode. In this mode, the line load control program will deny originating service to some or all groups of nonessential lines if the system fails to meet certain dial tone speed and network performance standards (dial tone delays of less than 3 seconds and an incoming trunk link network matching loss of less than 10 percent). Dial tone speed tests are performed every 4 seconds, and network overload is determined every 3 minutes by measuring the extent of network path blockage affecting incoming calls. The LLC program either denies or restores service to nonessential groups, depending on the results of these measurements. The LLC program actions of the forced-on mode are described in 3.04. Once the ***LLC-ALLØW—ØN*** message has been entered, the LLC feature remains in the forced-on mode until it is changed by an appropriate TTY message. (Refer to Part 6.)

B. Automatic Operation

3.03 When the LLC-ALLØW—AU message is entered, the line load control feature is put in the automatic mode. In this mode, the line load control program will take no action unless the dial tone speed test program encounters three successive dial tone delays greater than 11 seconds. At that point, the line load control program will automatically go into a state equivalent to the forced-on mode. (Refer to 3.04.) In extended dial tone speed testing,

if a regular 3-second test fails, the test on that line is not abandonded, but is extended an additional 8 seconds. Thus, the total length of the extended dial tone speed test is 11 seconds. Since the extended test starts out as a regular dial tone speed test, the extended tests are made at the same rate as the regular tests: one every 4 seconds. The extended dial tone speed tests will not affect the regular dial tone speed tests. The criterion for failing regular dial tone speed tests will still be a 3-second dial tone delay. There will continue to be 900 regular dial tone speed tests per hour (or 225 each quarter hour) and the traffic counts will record the number of dial tone speed tests which exceed both 3 and 11 seconds. When the LLC program has restored all nonessential lines to service, the system is returned to the automatic mode. Once the LLC-ALLØW—AU message has been entered, the system stays in the automatic mode until changed by an appropriate TTY message. (Refer to Part 6.)

C. Forced-On Mode

3.04 When the forced-on mode is activated, the actions of the LLC program include the following:

(a) ***Reducing the number of groups of nonessential lines served.*** Three successive dial tone speed test failures cause the LLC program to remove dial tone service from one-half of the nonessential levels of the input switches currently able to receive dial tone service. (A dial tone speed test failure is one which does not result in a simulated connection to an idle customer digit receiver within 3 seconds.) Also, every 3 minutes a count is made of the incoming matching loss failures to reserve talking paths for incoming calls. If one of these counts reveals that at least 10 percent of the incoming call path hunts between trunk link network (TLN) and line link network (LLN) have been blocked, the LLC program takes the same actions as it does for three successive dial tone speed test failures. Three more successive dial tone speed test failures or another 3-minute period with greater than 10 percent incoming matching loss between the LLN and the TLN will result in another 50 percent decrease in the number of nonessential levels served. After four such decreases in nonessential service, all lines on nonessential levels of the input switches will be denied dial tone service.

(b) ***Rotating the groups of nonessential lines served.*** Once per minute, a check is made to see if some, but not all, of the nonessential line groups are receiving dial tone service. If so, the two nonessential groups that have had such service for the longest period of time are denied originating service. At the same time the two groups of lines that have been without dial tone service for the longest period of time are permitted to originate calls.

(c) ***Increasing the number of groups of nonessential lines served.*** If the last check of network blocking has shown that less than 10 percent of the incoming call path hunts in the trunk link network have been blocked, each successful dial tone speed test will cause the LLC program to restore dial tone service to that group of lines which has been without such service for the longest period of time.

3.05 In summary, ***when the LLC program is forced on,*** the service measurements criteria control how many nonessential line groups should be denied service. When the service is good, the number of groups denied service is zero. Thus, under normal conditions, when there is little or no dial tone delay and/or network blocking, activating the LLC feature does not affect the service to any lines. ***If the LLC program is not forced on,*** no groups of lines are denied a chance to attempt to obtain dial tone, regardless of the length of the dial tone delays or the amount of network blocking. When the LLC feature is in the automatic mode, no condition will cause the LLC program to be forced on unless three successive extended dial tone speed tests fail.

4. LAMPS ASSOCIATED WITH LINE LOAD CONTROL

4.01 ***Master Control Center Lamps:*** TRAFFIC CONTROL lamps are provided to supervise LLC (CTX-4 and later generics).

(a) ***DT DEL Lamp (Amber):*** This lamp is lighted whenever a normal 3-second dial tone speed test fails or whenever the LLC program is denying originating service to one or more groups of lines.

(b) ***LLC ENAB Lamp (Red):*** This lamp is lighted when the LLC feature is enabled (ie, the LLC program may or may not be denying originating service to one or more groups of

lines, depending upon results of dial tone speed tests and network block). This lamp is lighted regardless of whether the LLC feature has been enabled automatically or manually.

5. PROCEDURES FOR ACTIVATING LINE LOAD CONTROL

5.01 With the CTX-4 and later generic program, the LLC feature is activated by TTY input messages. The following paragraphs are based on activating this feature from messages entered on local or remote Maintenance TTYs or the Network Administration TTYs. Activation of the feature is indicated by the appropriate lighted red lamp. To activate the LLC feature, it is necessary only to type in the appropriate input message.

5.02 ***Manually Activated Line Load Control:*** To manually activate the LLC feature, proceed as follows:

(a) Type in

LLC-ALLØW—ØN

on the Maintenance or Network Administration TTY. The system responds with ØK or NG.

(b) If the system response is NG, repeat (a), making sure the input message is correctly typed.

(c) If the system response is ØK, the LLC-ENAB lamp (red) is lighted and a major alarm sounds. A TØC01 message is printed out on the Maintenance and Network Administration TTYs with the bell on the Network Administration TTY being rung. Starting on the next quarter hour, TC15 TTY messages will be printed out on the Maintenance and Network Administration TTYs on each succeeding quarter hour until the LLC feature is deactivated. An LC01 message will be printed out when the first group of lines is denied service, and another will be printed out after all groups have been restored to service. Refer to Fig. 3 for TTY response output.

5.03 ***Automatic Line Load Control:*** To activate the automatic mode of the LLC feature, proceed as follows:

(a) Type in

LLC-ALLØW—AU

on the Maintenance or Network Administration TTY. The system responds with ØK or NG.

(b) If the system response is NG, repeat (a), making sure the input message is correctly typed.

(c) If the system response is ØK, the system types out on the Maintenance and Network Administration TTY a TØC02 traffic and overload status message.

(d) When an overload condition occurs, (1) the LLC program becomes active, (2) the LLC-ENAB lamp (red) is lighted, (3) a major alarm sounds, and (4) a TØC01 message is printed on the Maintenance and Network Administration TTYs with the bell on the Network Administration TTY being rung (the TØC01 printout and alarm will occur only if the LLC feature has been activated for the first time within a 15-minute period). Starting on the next quarter hour, TC15 TTY messages will be printed out on each succeeding quarter hour until the LLC feature is deactivated. As with manual activation, an LC01 message will be printed out when the first group of lines is denied service, and another will be printed out after all groups have been restored to service. Refer to Fig. 3 for TTY response output.

6. DEACTIVATION OF LINE LOAD CONTROL

6.01 When the forced-on mode of the LLC feature is in effect, the system gradually restores service to all lines as the load subsides. An LC01-AGR (all groups restored) TTY message informs personnel when service has been restored to normal. However, to prevent the LLC feature from becoming effective again should a new overload condition occur, the line load control feature is deactivated by the following procedure:

(a) Type in

LLC-INH-

on the Maintenance or Network Administration TTY. The system should respond with ØK.

(b) If the system response is ØK, the system types out a TØC02 traffic and overload

status message. If the LLC-ENAB lamp was on, it will be extinguished. Refer to Fig. 3 for TTY response output. If LLC-INH is entered when some groups are still being denied, the LLC program action will be inhibited.

Note: The dial tone inhibit (DT-INH) message will also inhibit the LLC PROGRAM; therefore, DT-INH should be used with caution. The dial tone allow (DT-ALLOW) message will return the system to the mode specified by the last LLC input message.

7. SERVICE DENIAL—STATUS

7.01 To determine the number of line groups which are being permitted or denied originating service, type in

LLC-MASK-PRNT

on the Maintenance or Network Administration TTY. This message requests a printout of the present state of the LLC scan mask word. The printout is in the form of an LC02 message, which includes a 16-bit binary representation indicating the number of line groups being served and/or denied by the LLC program as described in Part 3. Each bit position in the scan mask represents one of the 16 line groups in the office. A zero in a bit position means that the associated line group is being denied service, while a one in a bit position means that the associated line group is receiving normal service. A zero in bit position N of the scan mask indicates that the Nth vertical of each line scanner in an office is disabled. The bit positions are counted from right to left starting with N = zero. Fig. 4 relates the bit positions to the concentrator switch and level numbers. The results of the LC02 printout may be used in evaluating an existing overload condition and aid in determining when a system should be returned to normal. The number of nonessential lines returned to service after LLC has been enabled is an indication of how much the load has subsided.

8. SYSTEM REINITIALIZATION

8.01 The No. 1 ESS machine has the ability, via automatic or manual means, to reinitialize its system configuration. Procedures for system reinitialization are given in Bell System Practices Section 231-113-301. These system reinitialization processes are called emergency action (EA) phases and they are executed in progressive order. Each phase has a more serious effect (the erasing of call store) on call processing. Active traffic controls are lost when the system reinitializes with a phase 4 or higher emergency action.

8.02 When the system takes an emergency action and no calls are processed, a backlog of work is created. When call processing is resumed, the surge of work may overload the system. The automatic overload control program prevents this surge from harming the system, but it can increase the dial tone delay on all lines. To minimize this delay, the first scan of lines after the emergency action will look for originations only on essential lines. The state of line load control after the first scan of lines will be determined by the parameter set card ***LLCS.*** If this set card places the LLC feature in the ***AUTOMATIC*** mode after a phase action, it may be necessary for the network administrator to insert the ***LLC-INH*** message via the Network Administration TTY. The ***LLC-INH*** message restores the LLC feature to ***OFF.***

8.03 At least weekly the status of LLC should be verified in the ESS, even when nothing has been done to change the mode. To do this, type in

TØC-STATUS-.

The system will respond with an ØK and a TØC02 indicating the present LLC mode.

9. PARAMETER SET CARDS

9.01 The two parameter set cards used in the implementation of the line load control are LLCS and EVL. The former card designates the state of line load control (OFF, ON, or AUTOMATIC) after a system reinitialization. The latter card, EVL, designates those vertical numbers (line groups) allocated for essential lines. The remaining verticals are treated as nonessential line groups.

10. ABBREVIATIONS AND ACRONYMS

ABBREVIATION	TITLE
EA	Emergency Action
ESS	Electronic Switching System
LLC	Line Load Control

LLN	Line Link Network
MCC	Master Control Console
TLN	Trunk Link Network
TTY	Teletypewriter
TAC	Technical Assistance Center

11. REFERENCES

11.01 Additional information concerning line load control may be obtained by consulting the following sources.

(a) Dial Facilities Management Practices, Division H, Section 6m, Abnormal Traffic Load Conditions

(b) Bell System Practices Section 231-122-302, Issue 2, Line Load Control, Toll Network Protection and Emergency Manual Line Service, Application

(c) PD-1A075-01, Line Load Control and Toll Network Protection Program

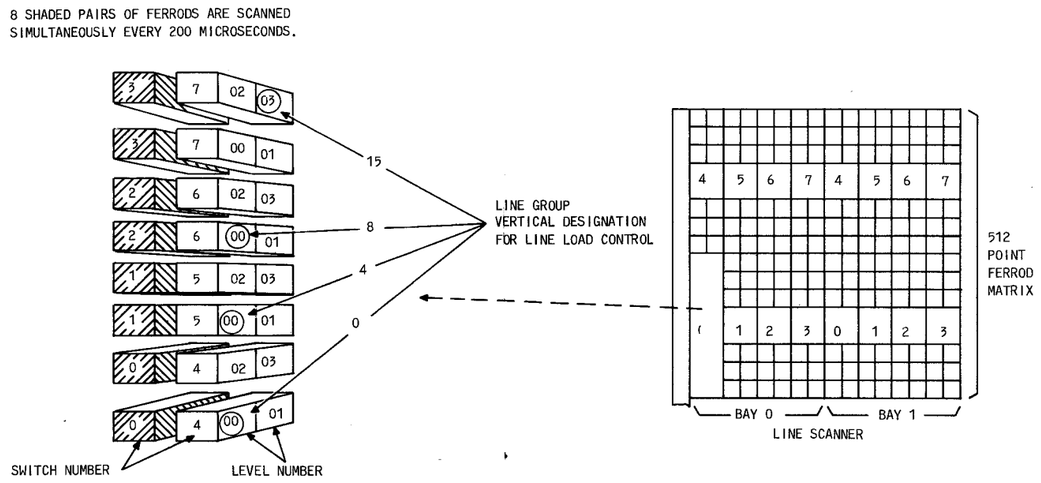
(d) PD-1A076, Automatic Overload Control Program

(e) GL-72-01-195, No. 1 ESS (2-Wire) Line Load Control

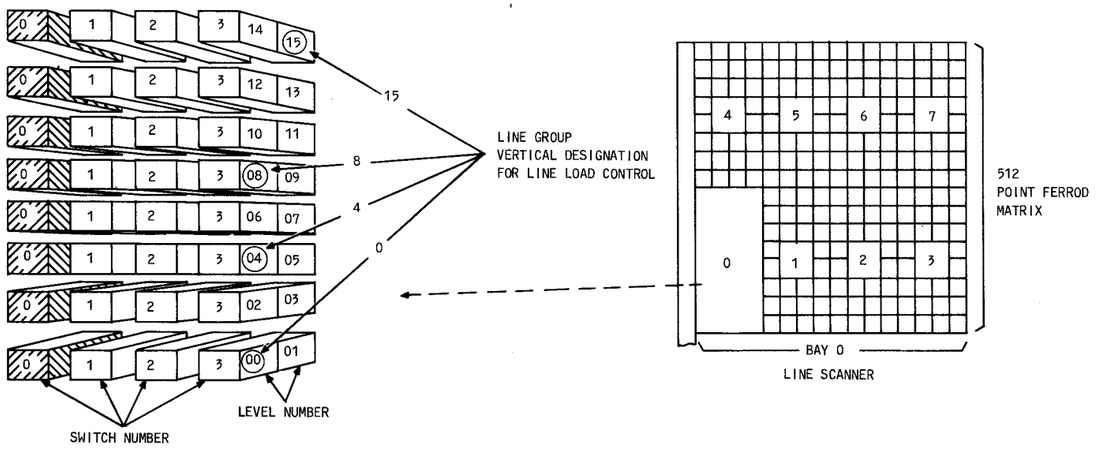
(f) Translation Guide, TG-1A, Division 3, Preparation of Forms

(g) IM-1A001, Input Message Manual, No. 1 ESS (2-Wire)

(h) OM-1A001, Output Message Manual, No. 1 ESS (2-Wire)



A. FERROD ARRANGEMENT FOR A 2:1 CONCENTRATOR RATIO. (LINE SCANNER 0)



B. FERROD ARRANGEMENT FOR A 4:1 CONCENTRATOR RATIO. (LINE SCANNER 0)

Fig. 1—Concentrator Ferrod Arrangements

A

LINE LOAD CONTROL
VERTICAL DESIGNATION
SCANNING MATRIX
(2:1 CONCENTRATOR)

LINE GROUP VERTICAL DESIGNATION	SWITCH	LEVEL
0	0, 4	00
4	1, 5	00
8	2, 6	00
15	3, 7	03

B

LINE LOAD CONTROL
VERTICAL DESIGNATION
SCANNING MATRIX
(4:1 CONCENTRATOR)

LINE GROUP VERTICAL DESIGNATION	SWITCH (ALL SWITCHES)	LEVEL
0	0, 1, 2, 3	00
4	0, 1, 2, 3	04
8	0, 1, 2, 3	08
15	0, 1, 2, 3	15

Fig. 2—Comparison Of Line Load Control Line Group Vertical Designation Matrices

INPUT MESSAGE	CONDITION			
	SYSTEM NOT IN OVERLOAD		SYSTEM IN OVERLOAD	
	TTY MESSAGE RESPONSE	OTHER SYSTEM RESPONSE	TTY MESSAGE RESPONSE	OTHER SYSTEM RESPONSE
LLC-INH-.	ØK TØC02 LØF	.LLC-ENAB LAMP (RED) GOES OUT	ØK TØC02 LØF	.LLC-ENAB LAMP (RED) GOES OUT
LLC-ALLØW-AU (EXTENDED DIAL TONE SPEED TEST IN EFFECT)	ØK TØC02 LØF LAU		(1) ØK TØC02 LØF LAU AAA (See Note) (2) TØC01 LAU LØN AAA (See Note) (3) LC01 FGD (WHEN FIRST GROUP IS DENIED SERVICE (4) LC01 AGR (WHEN ALL GROUPS ARE RESTORED)	.LLC-ENAB LAMP (RED) LIGHTS .MAJOR ALARM SOUNDS .TRAFFIC TTY BELL SOUNDS .DT DEL LAMP (AMBER) LIGHTS
LLC-ALLØW-ØN	ØK TØC01 LØN	.LLC-ENAB LAMP (RED) LIGHTS .MINOR ALARM SOUNDS .TRAFFIC TTY BELL SOUNDS (3 RINGS)	SAME AS ABOVE (FASTER REACTION TIME)	SAME AS ABOVE
LLC-MASK-PRINT	ØK LC02 1111111111111111 16 BIT BINARY (NO DENIAL OF SERVICE)	NO ADDITIONAL RESPONSE	ØK LC02 xxxxxxxxxxxxxxxx 16 BIT BINARY WITH 0 INDICATING THE LINE GROUPS BEING DENIED SERVICE	NO ADDITIONAL RESPONSE

Note: Additional information may be included in the TØC messages, such as reason for the overload, etc.

Fig. 3—No. 1 ESS Response To LLC Input Messages

A. SCAN MASK BIT POSITION*

X 15	X 14	X 13	X 12	X 11	X 10	X 9	X 8	X 7	X 6	X 5	X 4	X 3	X 2	X 1	X 0

B. CONCENTRATOR–SWITCH–LEVEL – REFERENCE

BIT POSITION	ESSENTIAL GROUP				LINE GROUP VERTICAL DESIGNATION	2:1 CONCENTRATOR		4:1 CONCENTRATOR	
	1	2	3	4		SWITCH	LEVEL	SWITCH (ALL SWITCHES)	LEVEL
0				X	0	0, 4	00	0, 1, 2, 3	00
1					1	0, 4	01	0, 1, 2, 3	01
2					2	0, 4	02	0, 1, 2, 3	02
3					3	0, 4	03	0, 1, 2, 3	03
4	X	X	X	X	4	1, 5	00	0, 1, 2, 3	04
5					5	1, 5	01	0, 1, 2, 3	05
6					6	1, 5	02	0, 1, 2, 3	06
7					7	1, 5	03	0, 1, 2, 3	07
8		X	X	X	8	2, 6	00	0, 1, 2, 3	08
9					9	2, 6	01	0, 1, 2, 3	09
10					10	2, 6	02	0, 1, 2, 3	10
11					11	2, 6	03	0, 1, 2, 3	11
12					12	3, 7	00	0, 1, 2, 3	12
13					13	3, 7	01	0, 1, 2, 3	13
14					14	3, 7	02	0, 1, 2, 3	14
15			X	X	15	3, 7	03	0, 1, 2, 3	15

* *Note:* A zero in a bit position = DENIED SERVICE.
A one in a bit position = NORMAL SERVICE.

Fig. 4—Bit Position To Concentrator Level—Reference

TABLE A

ESSENTIAL LINE ASSIGNMENTS

ESSENTIAL GROUPS	FRACTION OF LINES ESSENTIAL	PER CENT OF LINES ESSENTIAL	LINE GROUP VERTICAL DESIGNATION	2:1 TYPE CONCENTRATOR		2:1 TYPE CONCENTRATOR	
				SWITCH	LEVEL	SWITCH (ALL SWITCHES)	LEVEL
1	1/16	6.25%	4	1, 5	00	0, 1, 2, 3	04
2	2/16 (1/8)	12.5 %	4, 8	1, 2, 5, 6	00	0, 1, 2, 3	04, 08
3	3/16	18.75%	4, 8, 15	1, 2, 5, 6 --- 3, 7	00 --- 03	0, 1, 2, 3	04, 08, 15
4	4/16 (1/4)	25.0 %	0, 4, 8, 15	0, 1, 2, 4, 5, 6 --- 3, 7	00 --- 03	0, 1, 2, 3	04, 08, 15, 00