EK-2040
EK-3060
ELECTRONIC KEY TELEPHONE SYSTEM
MAINTENANCE MANUAL

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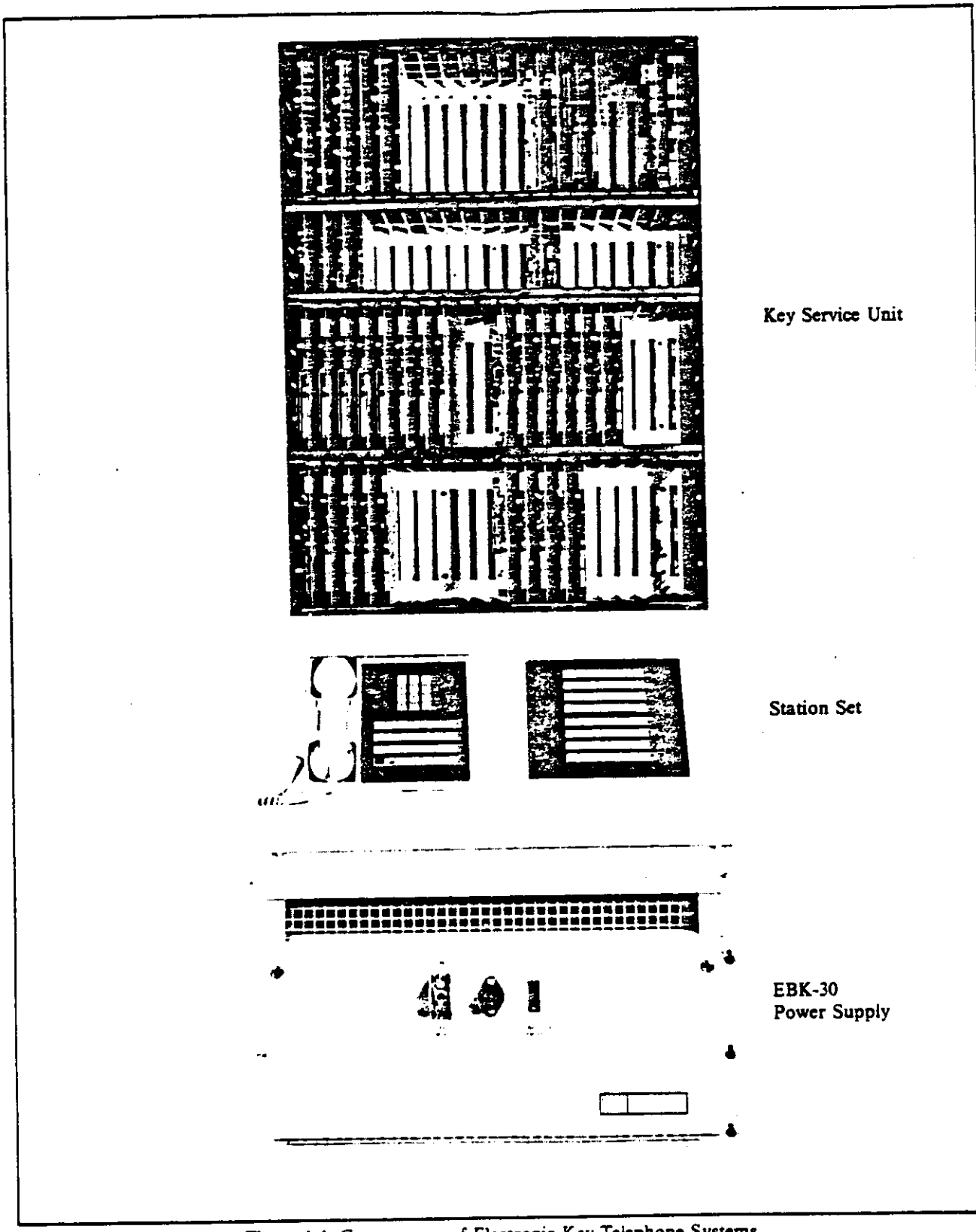


Figure 1-1 Components of Electronic Key Telephone Systems

SECTION I
INTRODUCTION

1-1. SCOPE OF MANUAL

1-2. This manual provides descriptive information, theory of operation, and maintenance instructions for the EK-2040 and EK-3060 Electronic Key Telephone Systems (Figure 1-1). These systems are manufactured by TIE/Communications, Inc., Shelton, Connecticut.

1-3. PURPOSE OF EQUIPMENT

1-4. The EK-2040 system provides telephone, intercom, paging, control, and matrix circuitry for up to 40 telephone stations; it can accomodate up to 20 C.O. lines. The EK-3060 system is an expanded version of the EK-2040 system. It provides the capability for up to 10 additional C.O. lines and 20 additional stations.

1-5. The EK-2040 and EK-3060 systems provide the following operating features:

1. Normal access to C.O. lines by station users.

2. Handsfree talkback, whereby the station user can answer intercom calls from across the desk or across the room without touching the telephone.

3. Handsfree origination of C.O. line calls, enabling the station user to call an outside party and conduct a handsfree conversation without lifting the handset.

4. Built-in speakerphone for handsfree operation or group discussions.

5. Call anouncing to individual stations and to external paging circuits.

6. Multi-trunk conference, which enables the station user to receive and establish two different calls, and then establish a conference between the calling station and the two outside parties.

7. Music-on-hold and background music, providing music to the outside party on a held line, and background music to the station users through the individual loudspeakers inside the station set.

8. Simultaneous call handling, which allows two simultaneous calls to be in progress on the station set — one on the handset, and the second on the speakerphone — without placing either call on hold.

9. Call privacy with privacy release capability on C.O. line calls should the station user wish to confer with one other inside party.

10. Paging access for "all call" paging and up to five different paging zones, accessed by dial codes.

11. I-hold indication to indicate to the station user which call or calls he has placed on hold.

12. Hot line capability, which permits connection of each station set to one other predesignated station set on a direct or "hot line" basis using a single access key.

13. Single key intercom for access to multipath dial intercom links from any station set.

14. Access, by invitation, to lines that do not appear on the station set (private lines).

15. Do not disturb feature, which makes the station appear busy to all internal calls.

16. Alternate point answering, whereby an internal ring down tone signal call may be answered from another station set in the system through use of the dial intercom.

17. Multiple user capability, which allows two groups of users to be separated by lines and stations, such that one group can havae outside lines that do not appear at stations within the second group.

18. Modular plugs and jacks for ease of installation.

19. Distributed control, with each station having its own microcomputer control.

20. Non-locking keys on station sets, with light-emitting diodes (LEDs) providing status indications of functions associated with the keys.

21. Standard DTMF dials or specialized dials such as OUTPULSE DIAL®, MEMORY® dial, and toll restrict dials.

1-6. SYSTEM DESCRIPTION

1-7. The EK-2040 and EK-3060 systems utilize microcomputor technology, a solid-state space division matrix, and time division distributed control. Each station set in the system operated over two pairs of wires, allowing two simultaneous conversations over the station set, and control of 38 function station keys. The EK-2040 consists of the following components:

1. EBK-30 Power Supply

2. Multi-button key telephones (station sets), one per station

3. Key Service Unit (KSU), with the following plug-in circuit cards and panel:

   a. Station cards, one per station, 40 maximum
   b. Line cards, one per C.O. line, 20 maximum
   c. Tone generator card, one per system

d. Page card (optional), one per system
e. Register cards, one or two per system
f. Link cards, up to six sets per system
g. DSS cards, one or two per DSS position
h. Selector panel, one per system

4. Direct Station Selection (DSS) Console, one or two per system.

1-8. The EK-3060 system consists of the same components as the EK-2040 system, plus one Expansion Cabinet with the following plug-in circuit cards:

1. Station cards, one per additional station, 20 maximum.
2. Line cards, one per additional C.O. line, 10 maximum.

1-9. The power supply supplies all DC operating power required by the EK-2040 or EK-3060 system. It operates from 117 volt, 60 Hz, single phase AC, and supplies +25 volt, -25 volt, and -10 volt DC to the KSU. The power supply is designed for wall-mounting.

NOTE

For additional details on the power supply, refer to the separate manual for that unit.

1-10. The telephone (station set) is a microcomputer controlled telephone which functions with an associated station card in the KSU. Data transfer between the station set and the KSU is accomplished over a standard quad. The station set consists of both a handset and a speakerphone. Twenty-eight keys are provided for function and C.O. line selection. Two volume controls for background music, paging, and C.O. Audible volume control.

1-11. The KSU is the major control center of the system. In the EK-2040 system, it consists of a single, totally enclosed unit, designed for wall mounting; it comprises a removable rear panel, a card cage, and a front cover. In the EK-3060 system, the KSU consists of the same basic unit as in the EK-2040 system, plus an expansion cabinet. The KSU basic unit is wall-mounted through the rear panel. The card cage is attached to the rear panel by removable hinges, and it may be swung outward on the hinges for testing and maintenance. All system interconnecting cables connect to cable connectors on an I/O panel at the rear of the card cage, and circuit cards plug into designated card positions at the front of the card cage. A selector panel, used for making private C.O. line assignments, is also located at the rear of the card cage. The expansion cabinet is similar in physical construction to the KSU basic unit, but has positions for only 20 station cards and 20 line cards in the card cage. Interconnecting cables connect to connectors on an I/O expansion panel at the rear of the card cage. The I/O expansion panel also connects to the I/O panel in the KSU basic unit.

1-12. One or two DSS consoles may be used in the system. The first DSS console is always located at station 58 in the system; the second, if used, is installed at station 59. Each DSS console is essentially an extension of the station set at the associated station. It consists of a desk-top console with 56 key switches and associated LEDs. The keys can be used by the attendant to access any station appearing at that DSS console on a hot-line basis, or to access any of the paging zones. The LEDs provide a display of the status of the assigned stations. The DSS console operates with one or two DSS cards in the KSU using quad cable.

1-13. SPECIFICATIONS

1-14. Refer to Table 1-1 for a summary of system specifications.

TABLE 1-1. SPECIFICATIONS

Characteristic	Specification
System Capacity:	
EK-2040	20 C.O. lines maximum, 40 stations maximum
EK-3060	30 C.O. lines maximum, 60 stations maximum
Station Loop	Standard, 4-wire, inside, random-twist, 24 guage quad to distances up to 2000 feet
Control	Distributed, with each station controlled by micro-computers in the station set and KSU
Power Requirements	117 +11.7 volts, 60 Hz, single phase AC standard; 220 volt, 50 Hz, single phase AC optional on special order
Dimensions:	
KSU Basic Cabinet	33.7 in. high, 24.0 in. wide, 14.7 in. deep (85.6 cm x 60.1 x 37.3 cm)
Expansion Cabinet	15.1 in. high, 24.0 in. wide, 14.7 in. deep (38.4 cm x 60.1 cm x 37.3 cm)
EBK-30 Power Supply	15.5 in. high, 22.5 in. wide, 9.6 in. deep (39.4 cm x 57.1 cm x 24.4 cm)
Station Set	4.5 in high, 9.0 in. wide, 9.5 in. deep (11.4 cm x 22.9 cm x 24.1 cm)
DSS Console	
Weight:	
KSU Basic Cabinet	Approximately 96 pounds, fully loaded
Expansion Cabinet	Approximately 35 pounds, fully loaded
EBK-30 Power Supply	Approximately 60 pounds
Station Set	Approximately 4.5 pounds
DSS Console	Approximately 3 pounds

SECTION II
THEORY OF OPERATION

2-1. GENERAL.

2-2. The key telephone system is a stored-program, microprocessor-controlled system that uses a solid-state, space division matrix with time division distributed control. The KSU and all station sets utilize microprocessors for control and status indication on a real time basis. Each station set operates over two pairs of lines, allowing two simultaneous conversations on the station set in addition to control of 28 functional station keys.

2-3. DATA AND VOICE TRANSMISSION METHOD.

2-4. Each station set in the system operates over two wire pairs, both of which are used for audio transmission; however, the pairs do not operates as the transmit and receive legs of a 4-wire system. Instead, the station set has the capability of handling two simultaneous calls, one on each pair. The station user may be engaged in a C.O. line call, and can receive an intercom call without interrupting the C.O. line call. The C.O. line call would be processed through the handset, and the intercom call through the built-in speakerphone.

2-5. A "A" pair is the audio pair for the originating station on C.O. line and intercom calls; this pair is both a receive and a transmit pair. The "B" pair is the audio pair for the receiving station on an intercom call; this pair is also both a receive and a transmit pair. In summary, when an intercom call is in progress the originating station is transmitting and receiving over its "A" pair, and the called station is receiving and transmitting over its "B" pair.

2-6. A third, "phantom" wire pair is composed of the "A" pair as one leg and the "B" pair as the other leg. This phantom pair is used to provide power to the station set and for data transmission between the station set and its associated station card in the KSU. The data is superimposed on the power leads, positive data on the positive power leg and negative data on the negative power leg. Input and output connections in each leg of the phantom pair are made to the center tap of an audio transformer. Current flowing in the phantom leg divides at the center tap, and equal currents flow through the two halves of the audio transformer winding in opposite directions, thereby producing equal and opposite voltages across the transformer winding halves. These two voltages cancel and the net voltage across the entire transformer winding is zero; therefore, the signal being transmitted over the phantom leg is not coupled through the transformer to the audio circuits.

2-7. DATA TRANSMISSION FORMAT.

2-8. The format used for transmission of data (commands and status information) between the station set and the associated station card in the KSU is shown in Figure 2-1. Data from the station *card* is sent in the form of voltage level changes, and is detected in the same manner by the station set. Data from the station *set* is sent in the form of current level changes, and is detected as current changes in a fixed load by the station card. The data is super-imposed on the positive and negative legs of the phantom wire pair between the station set and station card.

2-9. Data transmission occurs during each data frame, the timing of which is controlled by the station card. Each data frame is 23.8 milliseconds in duration. It consists of 34 words, each of which is 700 microseconds long and consists of five "T" times of 140 microseconds each. The first two words of every data message consist of frame sync, trans-mitted to ensure that the station set and station card are always in step with real time. Following the frame sync, 32 data words are transmitted between station set and station card. During the T1 time of each data word, a word sync pulse is sent from the staton card to the station set. During the T2 time of each data word, the station card transmits a command (if required) to the station set. Also during the T2 time period of each data word, the station set sends a marker pulse to the station card if the handset is on the hook; absence of this pulse initiates dial pulse detection by the station card, if required. The T3 and T5 times of each data word are always blank. The T4 time is used by the station set to send key commands to the station card; one data word is assigned to each of the station set keys. Table 2-1 defines the data bits for each time interval of each data word.

2-10. SYSTEM BLOCK DIAGRAM.
(See Figure 2-2.)

2-11. GENERAL. The key telephone system consists of four major components: the station sets, the DSS console(s), the key service unit (KSU), and the power supply. The KSU contains eight different type plug-in circuit cards: station cards, DSS cards, C.O. line cards, link A cards, link B cards, register card(s), a tone generator card, and a page card. The system configuration is shown in Figure 2-2.

2-12. STATION SET. Each station set is a microcomputer-controlled telephone. It consists of a dial, 28

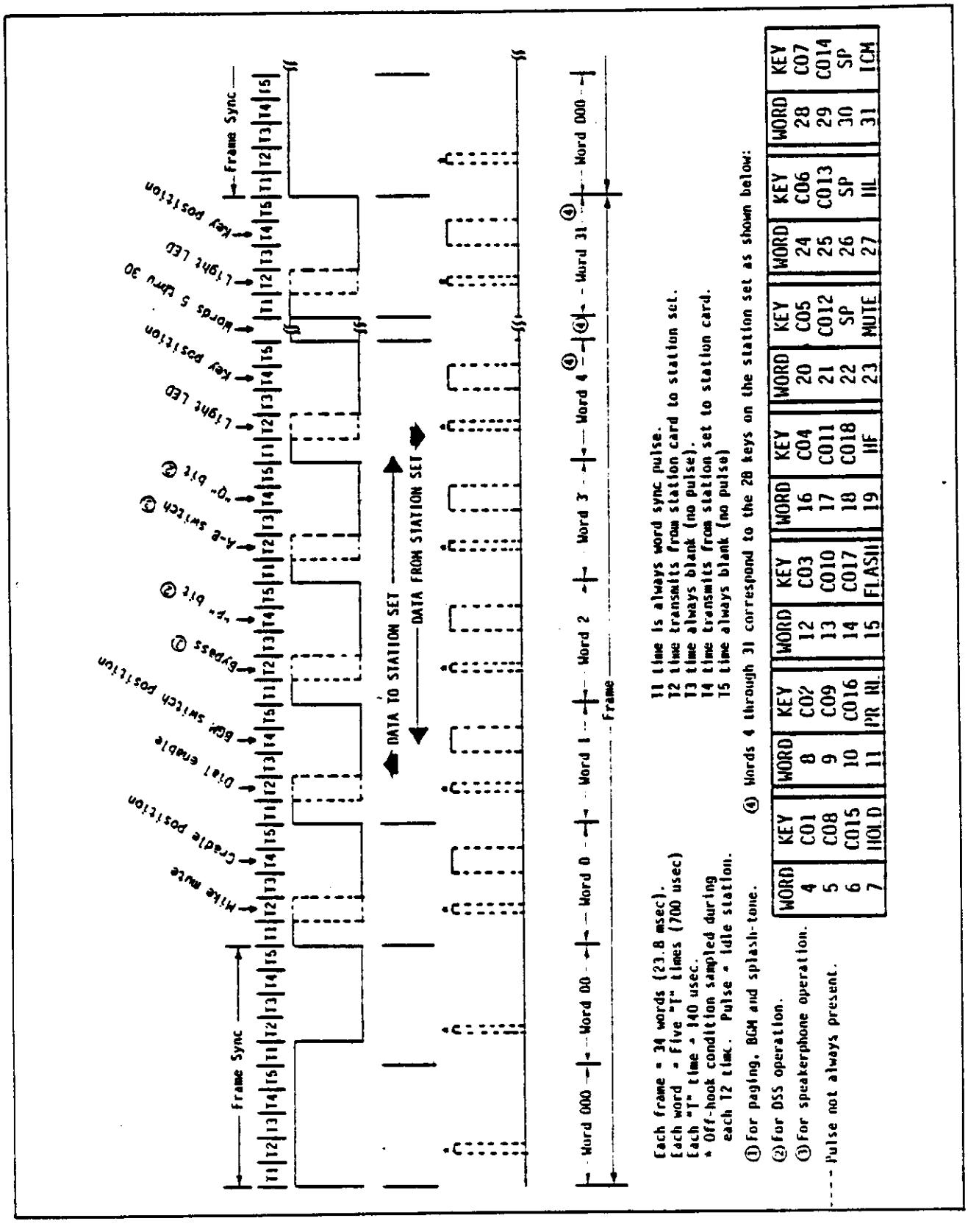
TABLE 2-1. DATA WORD FORMAT

Word	"T" Time	Function
000	T1-T5	Frame sync from station card to station set.
00	T1-T5	
0	T1	Word sync to station set.
	T2	Mike mute pulse (during BGM, splash tone, paging)
	T3	Blank
	T4	Cradle position
	T5	Blank
1	T1	Word sync to station set
	T2	Dial enable pulse, if not restricted by station card switch
	T3	Blank
	T4	BGM switch position to station card
	T5	Blank
2	T1	Word sync to station set
	T2	Bypass bit (permit BGM, splash tone, or paging to be heard)
	T3	Blank
	T4	"P" bit for DSS operation
	T5	Blank
3	T1	Word sync to station set
	T2	A-B switch pulse (switch speakerphone to "A" pair)
	T3	Blank
	T4	"Q" bit for DSS operation
	T5	Blank
4	T1	Word sync to station set
through	T2	Light LED in station key (see Figure 2-1)
31	T3	Blank
	T4	Key position to station card (see Figure 2-1)
	T5	Blank
All	T2	On-hook pulse from station set to station card

pushbuttons, a handset, built-in speakerphone, hookswitch assembly, and control circuitry. Each station set is connected through a 24-gauge quad to a separate station card in the KSU. Operating power for the station set is sent over the quad from the station card. Control messages and audio signals (telephone audio, intercom, paging, tones, etc.) are transmitted between the station set and its assigned station card under control of the station card. The 28 pushbuttons permit C.O. line selection and function switching. The dial permits dialing for C.O. line calls and for internal station calls.

2-13. DSS CONSOLE. The system may be equipped with one or two DSS consoles. Each DSS console may be equipped, through DSS cards in the KSU, to serve either 28 or 51 stations, and access all paging zones. When two DSS consoles are used, both may serve the same 51 stations plus paging, or each may serve different predetermined stations. The first DSS console is always located at station 58 in the system; the second DSS console, when used, is located at station 59. Each DSS console may be considered an expansion of the station set at the DSS console position. It contains two microcomputers which function with microprocessors located in the DSS-A and DSS-B cards in the KSU to implemen the functions of 56 keys on the DSS console. The DSS console enables the attendant at the DSS position to access directly the assigned stations plus the paging zones by merely pressing the appropriate key. LEDs in the keys continuously monitor the status of the assigned stations. Communication between each DSS console and its DSS cards in the KSU is accomplished through a quad cable.

2-14. KEY SERVICE UNIT. The KSU is the central control point for the system. It provides interfacing and control between the C.O. lines, the station sets, and the DSS consoles. Plug-in circuit cards are used to implement the various functions.



WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY
4	C01	8	C02	12	C03	16	C04	20	C05	24	C06	28	C07
5	C08	9	C09	13	C010	17	C011	21	C012	25	C013	29	C014
6	C015	10	C016	14	C017	18	C018	22	SP	26	SP	30	SP
7	HOLD	11	PR RL	15	FLASH	19	HF	23	MUTE	27	HL	31	ICM

Figure 2-1 Station Card/Station Set Data Transmission Format

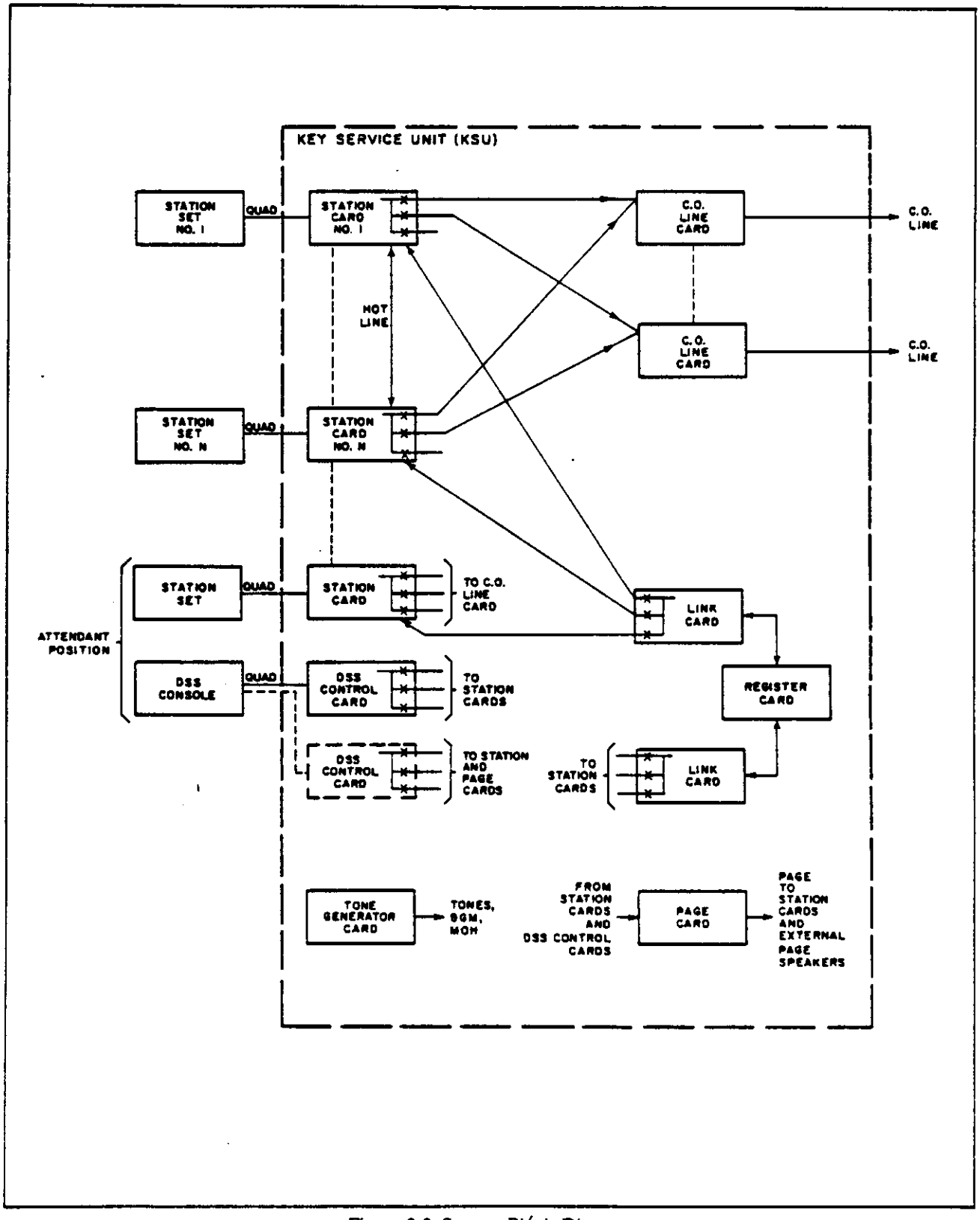


Figure 2-2 System Blóck Diagram

2-15. The KSU contains one C.O. line card per C.O. line, up to a maximum of 20 in the EK-2040 system and 30 in the EK-3060 system. Each C.O. line card provides all functions usually provided by a key system line card. It detects an incoming ring signal, and provides C.O. line seizure, hold, privacy release, and flash functions. It also provides a buffer between the tone generator card and the C.O. line for music-on-hold (MOH). The C.O. line card receives all its commands from the station cards.

2-16. One station card is contained in the KSU for each station set, up to a maximum of 40 in the EK-2040 system, and 60 in the EK-3060 system. Each station card, through its microprocessor, provides the required matrix connections to the C.O. line cards, the link cards, and the hot line to one other station card. It contains 23 cross-points: 18 C.O. line cards, 4 links, and 1 hot line. The station card has two passive ports by which it may be seized: a hot line port, which responds to a seizure from one other preselected station card and from the DSS console attendant, and a link port which responds to dialed intercom calls. The station card also interfaces audio tones, control signals, and background music from the tone generator card, and paging signals from the page card. The microprocessor in the station card controls the audio and supervisory signals that are enabled, as required, to process calls to the associated station set.

2-17. Link A cards provide one-half of the intercom talkpath system. Up to six link A cards may be used in the KSU. A total of 41 crosspoints are contained on each link A card. Thrity of these crosspoints provide intercom access to stations 30 through 59; seven cross-points provide access to five paging zones, all-call paging, and the DSS position; two cross-points are provided for busy tone and reorder tone; and two cross-points are provided for the audio paths to the register card circuits. When a station user depresses the ICM key at his station set, an active link port of the associated station card seizes the "A" port of an idle link, which is selected by the station card microprocessor. The seize current causes register card selection, connection, and processing by the link A card. The link A card stores the decoded dialed station number and calling mode information, both of which are supplied by the selected register. Calls are directed to the busy tone port when the link A card tests the passive port of the called station and finds it busy. Calls are directed to the reorder tone port if the caller fails to complete dialing with 8 seconds, or if an invalid code indication is obtained from the register. If none of these conditions occur, the "B" port of the link A card is closed to the passive port of the dialed station card to complete the intercom audio path between the originating station and the called station. When the intercom call is terminated, the "B" port of the link A card is opened to the dialed station card, the called address and calling mode information are removed from storage, and the link A card is reset in preparation for the next intercom call.

2-18. Link B cards make up the second half of the intercom talkpath system and provide access to C.O. lines not appearing at the calling station. Each link B card functions with a link A card. Each link B card contains 58 cross-points: thirty are used for stations 60 through 89, and two are used for each C.O. line (C.O. lines 17 through 29). Two types of cross-points used to access other stations within the system carry digital control information (in the form of current level changes) and analog audio signals. Access to the register cards, busy tone, reorder tone, paging, and the DSS position for the stations served by the link B card is provided through the associated link A card.

2-19. One or two register cards may be used in the KSU, depending upon the volume of traffic to be handled. A service request is provided to the register card from a link A card when the link A card is seized by the station originating the intercom call. The register card provides dial tone to the caller through the link A card, counts dial pulses or decodes DTMF tones, determines whether the dialed number is valid, provides a reorder signal to the link A card on invalid numbers, and provides cross-point data (number dialed) to the link A or link B card to cause closing of the cross-point between the calling station "A" port and the called station "B" port. Call mode information (i.e., voice page, ringing call, alternate point answer, page zone, or C.O. access) is transferred to the link A card to be held for the durration of the call. Once cross-point and mode information have been transferred to the link A card, the register releases and is available for another call.

2-20. One DSS control card is required per 28 active keys at each DSS console. If all keys on the DSS console are active, two DSS control cards are required: one DSS control card accesses stations 30 through 57, and the second DSS control card accesses stations 60 through 82 plus the five paging zones. Each DSS control card serves as an expander of the station card that serves the attendant's station set. It provides 28 cross-points for accessing the hot line ports of other station cards within the system. In addition, it contains a microprocessor which performs the following tasks for DSS calling:

1. It monitors the status of the associated station cards and transmits the station status information to the LEDs in the DSS console.
2. It places on hold the C.O. line most recently seized by the attendant when the attendant accesses a station.
3. It releases an attendant-accessed station if the attendant returns her handset to an on-hook condition or depresses another C.O. line key or station key at her position.

NOTE

The DSS control cards do not serve stations 58 and 59 (the DSS console positions), stations 83 through 89, or all-call; the normal ICM selection and dialing routine must be followed if the attendant wishes to access these stations.

2-21. The tone generator card supplies all flash rates and tones (except DTMF) required by the system. It also contains input boost or attenuator circuits for music-on-hold (MOH) and background music (BGM) when these features are used.

2-22. The page card is an optional card that provides all functions required for paging to all station sets and external paging zones. Two internal 2-watt amplifiers are provided for any two selected zones. The amplifiers provide sufficient power to drive one 8-ohm loudspeaker in each of the selected zones. An additional 600-ohm output is provided for each zone; these outputs can be used to drive external amplifiers for the respective zones. The page card also contains circuitry for C.O. night audible. Paging will override any C.O. audible in progress; it will also override background music to internal stations only.

2-23. POWER SUPPLY. The power supply converts 117 volt, 60 Hz, single-phase AC line power to +25 volt, -25 volt, and -10 volt DC. These DC voltages are distributed to the plug-in circuit cards through the KSU. All other DC voltages required for operation of the circuits on the plug-in cards and the station sets are derived from these DC voltages by circuits on the plug-in cards.

NOTE

The power supply is covered in a separate instruction manual.

2-24. STATION SET, DETAILED THEORY OF OPERATION

2-25. General. The station set is modular in design. It consists of six plug-in assemblies: a handset, a dial, a loudspeaker, a microphone, a hookswitch assembly, and a keystrip assembly. Each station set functions with one station card in the KSU. Data, power, and audio are transferred between the station card and the station set through a quad.

2-26. Data and Power Transmission. The phantom pair of the quad is used to provide DC power to the station set from the station card, and to transmit microcomputer message data between the station set and the station card. The data is superimposed on te power levels. The circuit arrangement for data and power transmission is shown in Figure 2-3.

2-27. The +25 volt DC supply in the station card powers the station set through transistor Q13 and the "A" path of the phantom circuit, and the -25 volt DC supply powers the station set through transistor Q14 and the "B" path of the phantom circuit. The conduction of transistors Q13 and Q14 (and thus the DC voltage levels supplied to the station set) is controlled by operational amplifiers U33- and U34-7, respectively. At the station set, the incoming DC is applied to regulator VR22, which develops a regulated +7.5 volt DC for use by the internal circuits of the station set. Zener diodes VR17, VR18, and VR19, connected between this +7.5 volt DC output and the -15 volt DC power leg from the station card, provide a regulated -7.5 volt DC for internal use by the station set.

2-28. The microcomputers in the station set and station card communicate over the same phantom pair. Data is superimposed on the DC. In the station card, signal $\overline{\text{DATA TX}}$, which represents data pulses that are to be transmitted from the station card microprocessor to the station set, is amplified by buffer U12-2 and operational amplifier U33-7, and the data signal is applied to transistor Q13, thereby causing the data signal to be superimposed on the positive DC as a voltage change. A portion of this voltage change is applied through voltage divider R150 and R152 to operational amplifier U34-7 which controls transistor Q14 in the negative DC power leg, and the data signal is superimposed on this circuit leg as a voltage change of opposite polarity. At the station set, the voltage changes on the positive and negative legs of the phantom pair are amplified by operational amplifier U17-1, shaped by voltage comparator U16-7, and applied to the INT 0 input of the microcomputer in the station set.

2-29. Data pulses developed by the station set microcomputer for transmission to the station card are applied to operational amplifier U17-7, which drives transistor Q16. The data signal causes current changes in the DC power legs. At the station card, voltages developed across resistors R145 and R153 in the two legs of the phantom pair as a result of the current changes drive operational amplifiers U26-7 and U25-7, and the data signal is further amplified by transistors Q12 and Q15, and operational amplifiers U33-1 and U34-1. The data pulses that comprise the data signal are then shaped by voltage comparator U41-7, and are supplied through buffer U12-10 to the microprocessor on the station card.

2-30. Microprocessor. The station set microcomputer is contained in integrated circuit U13. This single integrated circuit provides a complete 4-bit parallel processing system. It operates under control of a stored, non-volatile program. The microcomputer scans the keys and switches of the station set, assembles the resulting data into the proper data transmission format, and transmits

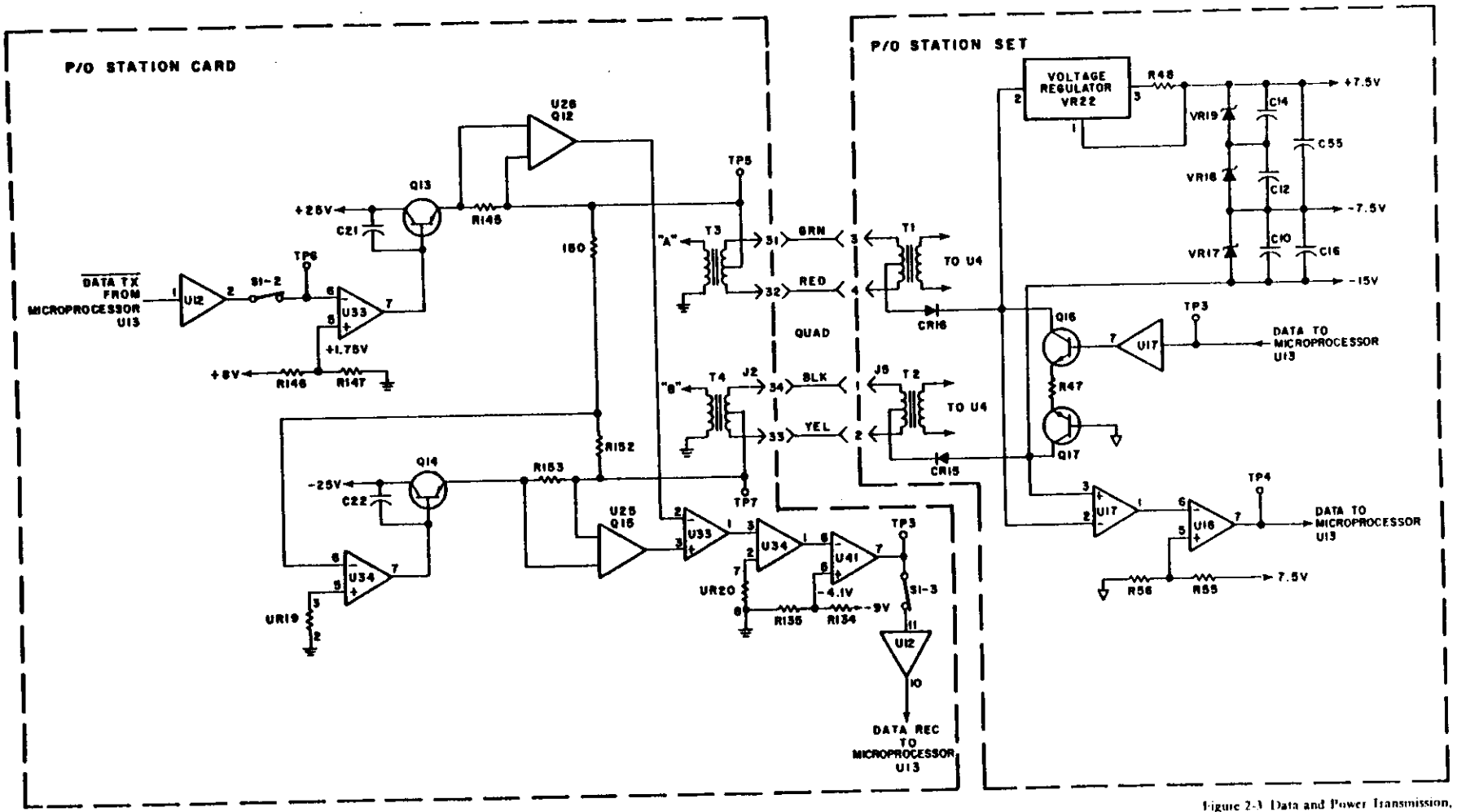


Figure 2-3 Data and Power Transmission, Station Set and Station Card, Simplified Block Diagram

the data to the microprocessor in the associated station card. It also receives and processes data messages from the station card, and generates control messages. Monostable multivibrator U19 resets the microprocessor when power is applied or when sync pulses are missing for more than two frames.

2-31. Key Switch Matrix. (See Figure 2-4.) The keys, hookswitch, and background music switch on the station set are arranged in a matrix. During the key scan routine of the microcomputer, the matrix is scanned for pressed keys and actuated switches. The microcomputer activates one row of the matrix at a time, and scans each column of that row sequentially. If any key or switch is actuated during the scan, current flows through the key or switch when the appropriate row and column are scanned, and the current flow is detected by the microcomputer. The results of the matrix scan are used by the microprocessor to develop the data message that is transmitted to the associated station card in the KSU.

2-32. LED Display Matrix. The LEDs in the keys of the station set are also arranged in a matrix, as shown in Figure 2-5. Lighting of the LEDs is controlled by the data message from the associated station card in the KSU. The LED matrix rows are activated in sequence through row drivers Q11 through Q14 by output signals R105 through R108 from the microcomputer, and the columns are scanned in sequence by the microprocessor. If the LED in the active column and row is to be lighted, the microcomputer activates its output (column signals D101 through D107), thereby turning on a Darlington transistor amplifier in array U18. With the row driver and the column transistor amplifier both on, current flows through the LED in that row and column, and the LED is lighted.

2-33. Incoming Commands. As shown in Figure 2-1, the data message received from the associated station card may contain any of the following commands: bypass, A-B switch, dial enable, mike mute, and light LED. Light LED commands control operation of the LED display matrix described in the preceding paragraph. Any of the other commands present in the data message are received and processed by the microcomputer, supplied to latch U12, and stored in the latch when the latch is clocked by the microcomputer. (See Figure 2-6.)

2-34. Bypass Command. The bypass command enables background music (BGM), splash tone, and paging signals to be heard over the speakerphone is the handset is on-hook. When a bypass command is present in the data message from the station card, the command is processed by the microcomputer in the station set and is applied to the DC input of latch U12 (Figure 2-6). When the latch is clocked, its Q0 output signal turns on transistor switch Q21 in the station set speakerphone audio circuits (paragraph 2-39), thereby permitting BGM, splashtone, and paging signals to be applied from transistor switch Q19 to the station set speaker. Transistor Q19 turns off when station set is off hook and attenuates level of page and splash tone via R90 in series with input signal. BGM bit in data message is no longer present and turns off Q4 on station card to disable BGM source.

2-35. A-B Switch Command. (See Figure 2-6.) The A-B switch command from the associated station card causes the speakerphone of the station set to be switched from the "B" pair of the quad to the "A" pair for speakerphone operation. After this command is received and processed by the station set microprocessor, it is applied to the D1 input of latch U12. When the latch is clocked, its complementary Q1 and $\overline{Q1}$ output levels reflect the input signal level. These output signals are applied to four transistor switches in integrated circuit U4, and the switches switch the "A" and "B" signal paths; the handset audio circuits are connected to transformer T2 of the "B" pair, and the speakerphone audio circuits are connected to transformer T1 of the "A" pair. The $\overline{Q1}$ output of latch U12 also conditions gate U10-3 to enable operation of the outpulse dial circuits when a dial enable command is received.

2-36. Dial Enable Command. (See Figure 2-6). The dial enable command is received from the associated station card in response to an off-hook condition or handsfree switch actuation at the station set. The dial enable command is supplied to the D2 input of latch U12 by the station set microprocessor. When the latch is clocked, its Q2 outut turns on transistor switch Q3, thereby supplying a logic high level to the power input circuits of the outpulse dial or the tone dial circuits, depending upon the type of dial used on the station set. If the station set is equipped with an outpulse dial, dial pulses produced by dialing are supplied through gates U9-10 and U9-4 to the INT 1 input of microcomputer U13 for transmission over the data signal path to the associated station card. If the station set is equipped with a DTMF dial, the tones generated during dialing are supplied through operational amplifier U8-7 and transformer T1 to the "A" pair of the quad for transmission to the associated station card. The Q2 output of latch U12, through gates U10-11, U10-4, and U9-11 and transistor switches Q1 and Q31, inhibits operation of the handset during dialing. Gate U10-4 also supplies a logic level to the speakerphone audio circuits to control operation of the speaker during dialing.

2-37. Mike Mute Command. (See Figure 2-6.) The mike mute command is received from the associated station card in response to station set MUTE key actuation, and during BGM, splash tone, and paging. The mike mute command is supplied to the D3 input of latch U12 after

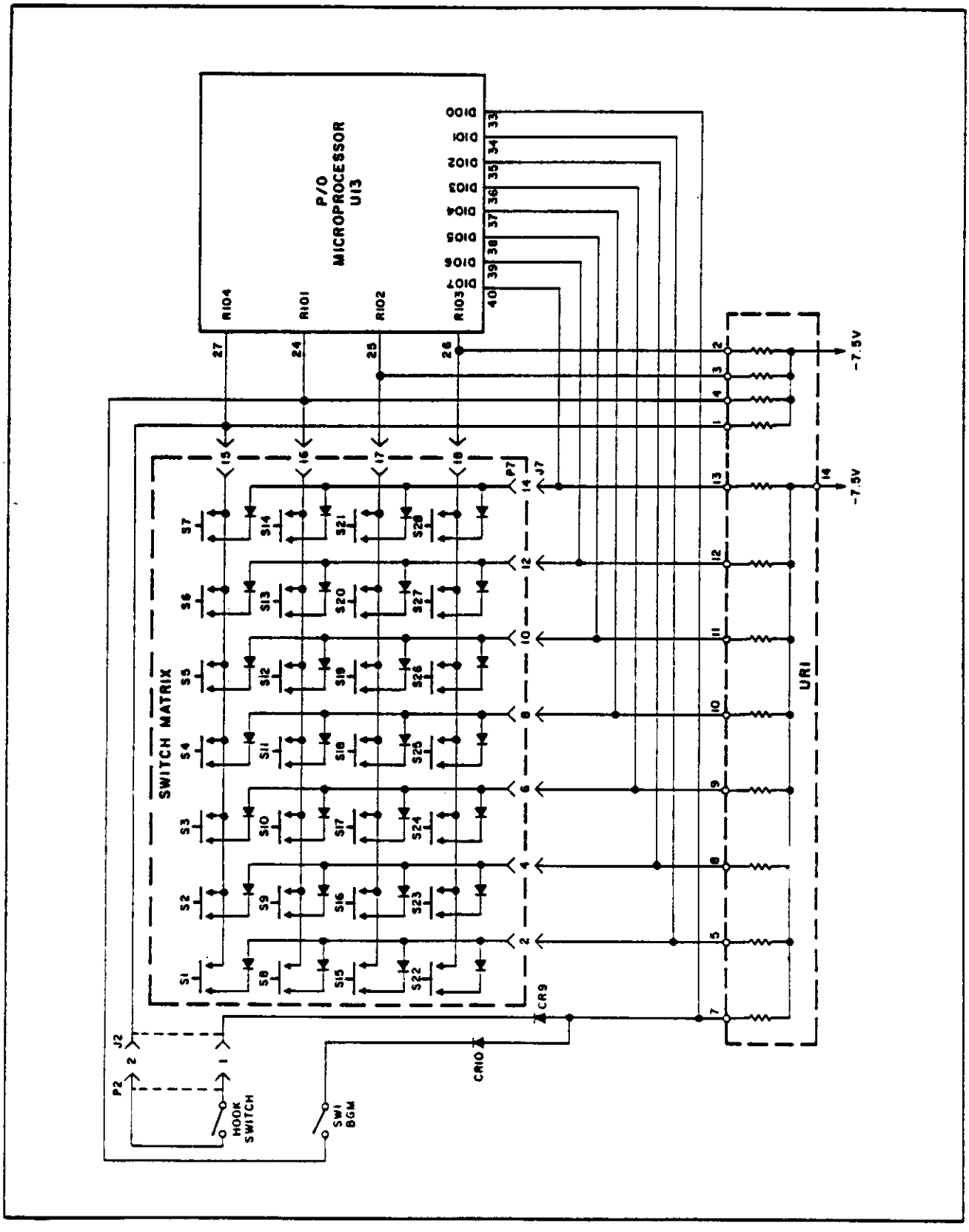


Figure 2-4 Station Set Key Switch Matrix, Simplified Block Diagram

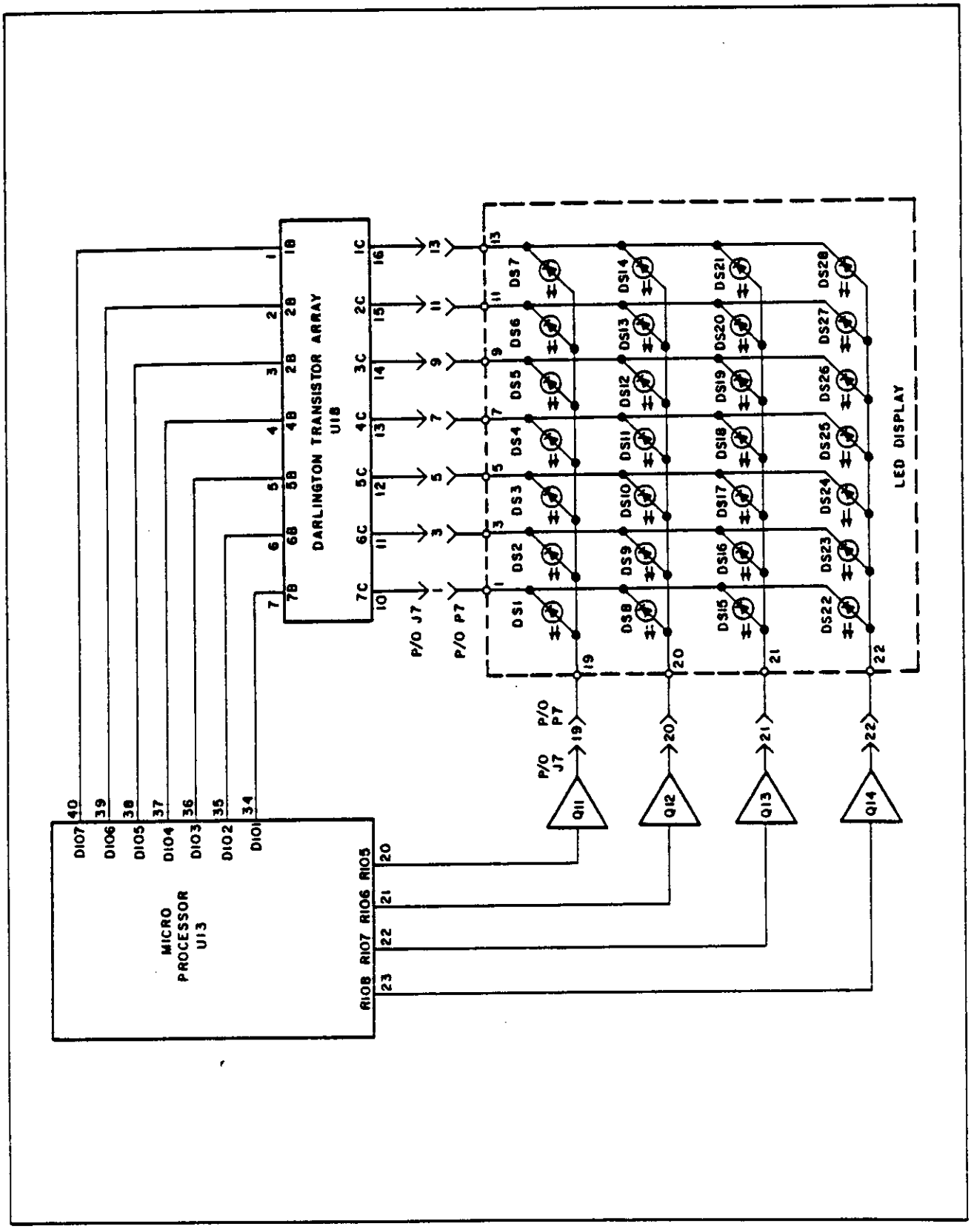


Figure 2-5 Station Set LED Matrix, Simplified Block Diagram

processing by microprocessor U13. When the latch is clocked, its Q3 output signal, through gate U9-3, supplies a mike mute signal to the speakerphone audio circuits. Transistor switch Q2 turns off DC power to the speakerphone microphone, and transistor switch Q32 grounds the audio path from the speakerphone microphone to mute the microphone. The Q3 output of latch U12 opens the voice path to the speakerphone speaker so that only BGM, C.O. audible, splashtone, and paging signals can be heard over the speaker.

2-38. Handset Audio Circuits. (See Figure 2-6.) The handset receiver is connected through transistor switch Q31, transformer T3, transistor switches U4, and either transformer T1 or transformer T2 to either the "A" or "B" pair of the quad, as determined by the status of the A-B switch command. Transistor switch Q31 is turned on by the output of gate U9-11 whenever the handset is off-hook (except during dialing). The handset transmitter is connected to transformer T3, and its operation is controlled by transistor switch Q1. During dial enable periods, transistor switch Q1 is turned off by the dial enable gate circuits, and operation of the handset transmitter is inhibited. At all other times when the handset is off-hook, transistor switch Q1 is turned on, and Dc is supplied through the switch to the handset transmitter. Audio signals developed by the handset transmitter are coupled through transformer T3 and transistor analog switches U4 to the appropriate pair of the quad. When the handset is returned to the on-hook condition, transistor switch Q1 is turned off through gate U9-11.

2-39. Speakerphone Audio Circuits. (See Figure 2-7.) The speakerphone audio circuits receive and transmit audio signals over the "A" or "B" pair of the quad, as determined by the status of the A-B switch command. Incoming audio signals for the speakerphone circuits are applied from the appropriate quad pair through transformer T1 or T2 and switches in integrated circuit U4 to transformer T6. The incoming audio signal is applied through a compensation and limiting network to transformer T7. One secondary winding of transformer T7 supplies an audio signal to the audio transmit/receive switching logic circuits. Another secondary winding of transformer T7 supplies the incoming audio signal to a diode shunt bridge attenuator, whose attenuation is controlled by the audio transmit/receive switching logic circuits. The output of the attenuator is coupled through transformer T8 to operational amplifier U1-7, whose output audio signal is supplied to the audio transmit/receive switching logic circuits and, through transistor switches Q28 and Q20, to operational amplifier U1-1 and transistors Q22 and Q23 which drive the speaker. Transistor switch Q28 is controlled through amplifier U16-1 by the dial disable circuits; the audio path to the speaker is attenuated by the opening of transistor switch Q28 during dial enable periods. Transistor switch Q20 is controlled by the mike mute command signal from latch U12; a mike mute command causes transistor switch Q20 to open the audio signal path to the speaker. Amplifier U1-1 also receives paging, BGM and C.O. audible signals from the "B" pair of the quad through transformer T2 and transistor switches Q19 and Q21. Transistor switch Q19 is on as long as the handset is on-hook; transistor switch Q21 is turned on by a bypass command from the associated station card. Potentiometer R140 at the front edge of the station set permits the operator to adjust the paging, BGM and C.O. audible signal level independently of the handsfree listening level; a switch associated with potentiometer R140 permits the station set user to turn off BGM, if he so desires.

2-40. The microphone of the speakerphone is activated through transistor switch Q2 as long as the mike mute command from the associated station card is inactive. Transistor switch Q2 is turned on to complete the DC power circuit for the microphone, and transistor switch Q32 is turned off to remove the ground from the outgoing audio signal path. The audio signal developed by the speakerphone microphone is amplified by operational amplifier U15-1, and the amplified audio signal is supplied to the audio transmit/receive switching logic circuits and to transformer T4. The outgoing audio signal is coupled through transformer T4, a series bridge attenuator, transformer T5, operational amplifier U15-7, transformer T6, and transistor switches in integrated circuit U4 to either the "A" or "B" pair of the quad. The attenuation of the series bridge attenuator is controlled by the audio transmit/receive switching logic circuits. Potentiometer R179 is factory adjusted to provide the proper speakerphone transmit level.

2-41. Audio Transmit/Receive Switching Logic Circuits. (See Figure 2-7.) The audio transmit/receive switching logic circuits develop a controlling DC bias for diodes in the attenuators in the speakerphone incoming and outgoing audio signal paths. By varying the bias, speakerphone transmit/receive switching is accomplished. The initial DC bias level, and thus the handsfree audio volume, can be adjusted by means of the handsfree volume control located at the front edge of the station set. Adjusting potentiometer R141 varies the input levels to operational amplifier U14-1, which develops the DC bias for the attenuator diodes. Audio signal levels at the input and output of the receive and transmit circuits are converted into proportional DC levels. Incoming audio signals at the secondary of transformer T7 are filtered by filter U5-1 to remove any 60 Hz line voltage components, and the filtered audio signal is rectified by rectifier U6-7. Incoming audio signals at the output of operational amplifier U1-7 are rectified by rectifier U7-7. Outgoing audio signals are similarly rectified to develop DC levels;

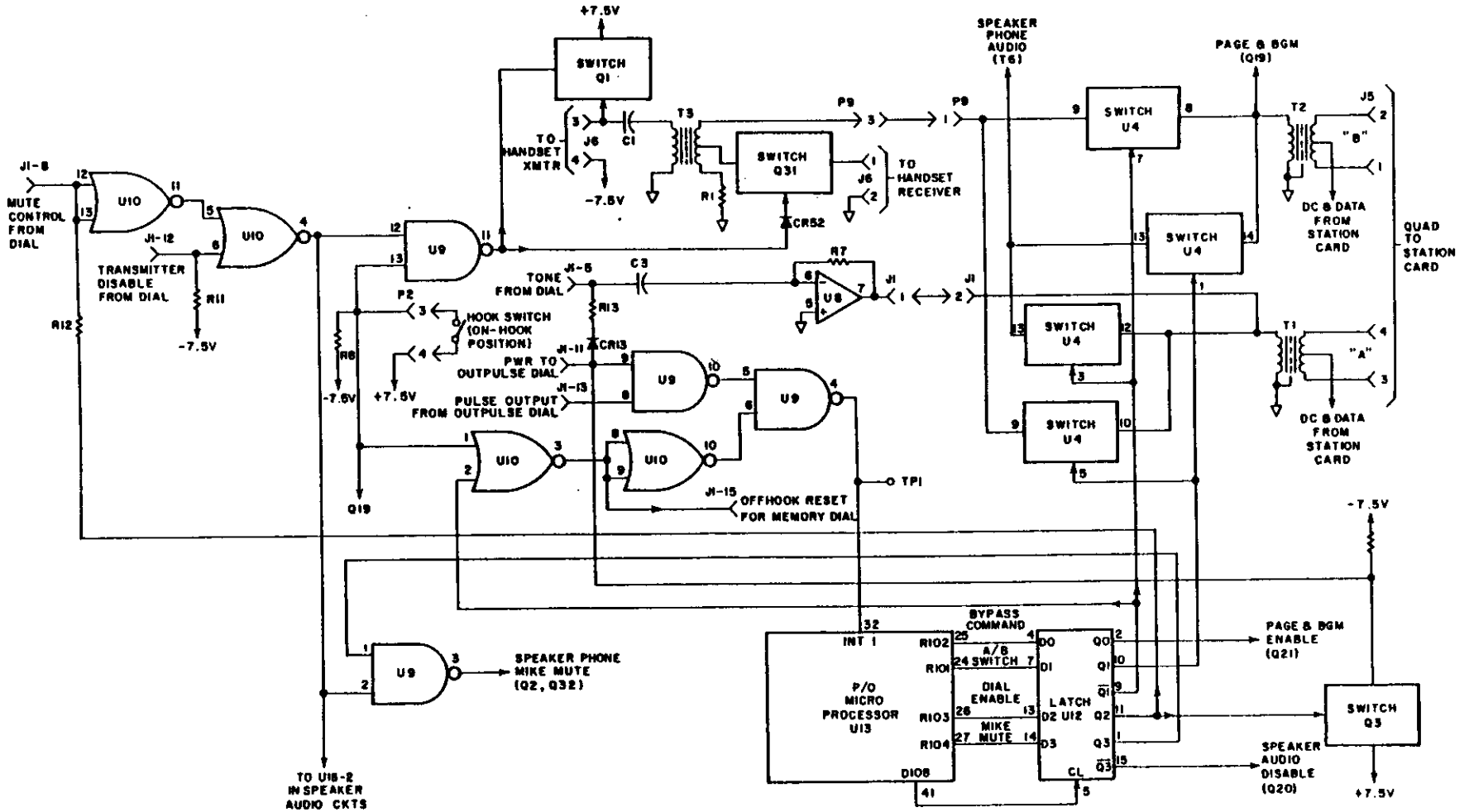


Figure 2-6 Station Set Command Circuits, Simplified Block Diagram

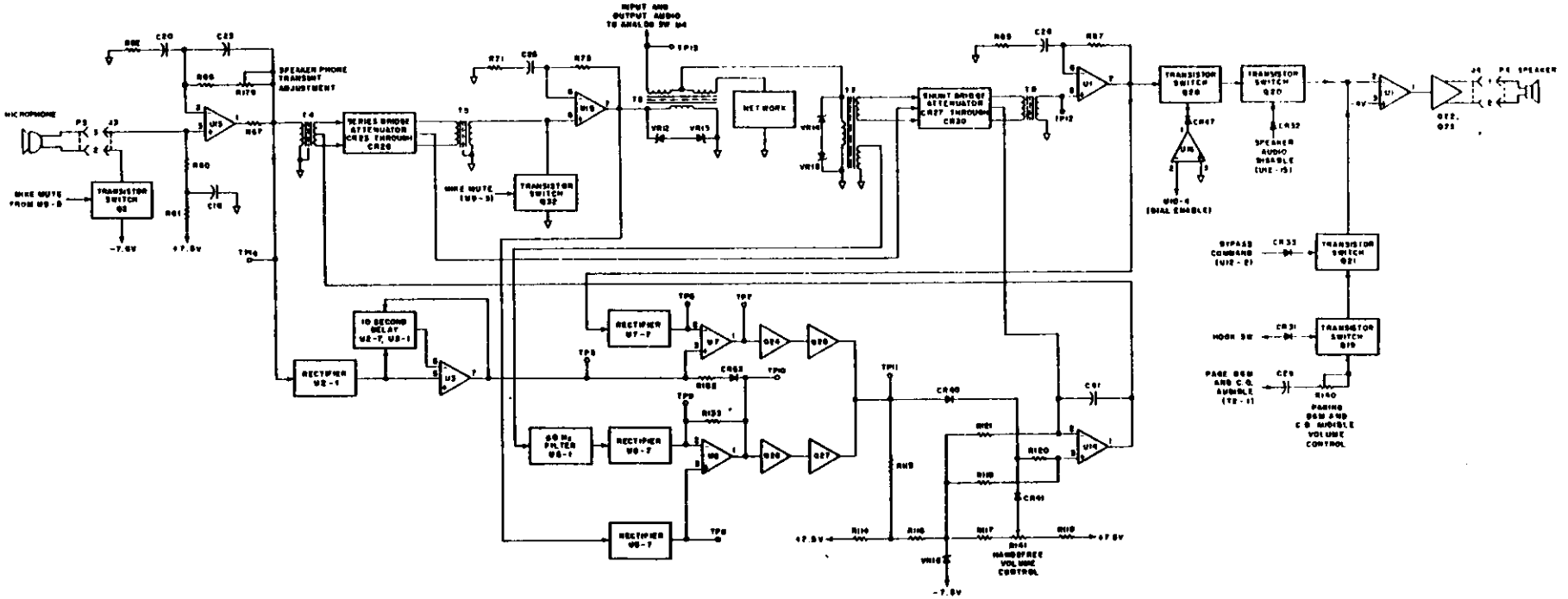


Figure 2-7 Station Set Speakerphone Audio and Audio Transmit/Receive Switching Logic Circuits, Simplified Block Diagram

a 10-second delay circuit is incorporated to eliminate transients of relatively long duration, such as noise from fluorescent lights. The DC levels are compared to develop switching signals for operational amplifier U14-1.

2-42. STATION CARD, DETAILED THEORY OF OPERATION

2-43. General. One station card is provided in the KSU (and expansion cabinet, if used) for each station set. The station card supplied DC power and data to its associated station set through the quad, and provides required switching to the C.O. line cards, the link cards, and the hot line to one other station card. The station card also interfaces audio tones and control signals from the tone generator card and paging signals from the page card. All operations are controlled by microcomputer circuits on the station card, which operate in accordance with a stored, non-volatile program.

2-44. Microprocessor Circuits. (See Figure 2-8.) The microprocessor of the station card utilizes CPU U4, EPROM U3, versatile interface adapter U1, and I/O U2. The microprocessor provides data storage and processing capabilities during station card operation. The microprocessor is controlled by a non-volatile program stored in EPROM U3. CPU U4 and its associated integrated circuits are clocked at a 1 MHz rate controlled by crystal Y1. The microprocessor is reset through oneshot multivibrator U42-7 and timer U43-3 when power is applied or if a sync pulse is missed. Switch S2-10 provides means for resetting the microprocessor circuits manually for test purposes. Data received from the associated station set is processed by the microprocessor and control signals required to initiate the operations specified by the received data are supplied to the other circuits on the station card. DXP status data for all points accessible through the keys on the associated station set is processed by the microcomputer and is transmitted to the associated station set to control operation of the LEDs in the station set keys.

2-45. Status Monitoring Circuits. (See Figure 2-9.) Each station card can monitor the status of up to 18 C.O. line cards, the paging group to which the station card is assigned, the link A cards that serve that station card, and the A port of the associated hot-line station card. (the system station cards are arranged in pairs for hot-line operation; that is, each station set can communicate with one other predesignated station card on a hot-line basis.) The status information is included in the data message that is transmitted from the station card to the associated station set. When the data message is processed by the microprocessor in the station set, the appropriate LEDs in the station set are activated to indicate the current status or operating condition. (Data message transmission between the station card and station set is described in paragraph 2-3.)

2-46. Status information is applied to multiplexers U35, U36, and U37 from the applicable cards in the system. The incoming status lines are scanned under control of the microprocessor circuits. Multiplexers U37, U36, and U35 are activated individually through voltage level shifters U28-1, U27-13, and U27-14, respectively, by signals $\overline{\text{ADD-1}}$, $\overline{\text{ADD-2}}$, and $\overline{\text{ADD-3}}$ from the microprocessor circuits. When each multiplexer is activated, its input lines are selected in sequence through decoding of the binary levels A, B, and C supplied through voltage level shifters U28-14, U28-13, and U28-2 from the microprocessor circuits. The status levels on the input lines are transmitted in serial fashion through operational amplifier U16-1 to voltage comparators U17-14, U17-13, and U17-2, which translate the status voltage levels to binary informaton. Signals $\overline{\text{D1}}$, $\overline{\text{D2}}$, and/or $\overline{\text{D3}}$ are activated in accordance with the status of the line being monitored, and these signals are supplied to the microcomputer circuits. The microcomputer circuits process this information to develop the status data that is to be transmitted to the station set.

2-47. Active Port Circuits. (See Figure 2-10.) The active port circuits of the station card handle routing and processing of calls originating at the associated station set. The station card active port circuits provide cross-point switching between the station set and the selected C.O. line card, a link card, or the hot line port of the associated hot-line station card, and supply current levels that define the function selected by the station set user.

2-48. Selection of the card to be connected and the desired function is made through key actuation at the station set. Key selection is indicated in the data message transmitted from the station set to the station card. The data message is received and processed by the microprocessor on the station card. Cross-point connections are established through latches U22, U31, and U39, which control cross-point transistor switches that make the required connections. The latches are activated in sequence by signals $\overline{\text{WES1}}$, $\overline{\text{WES2}}$, and $\overline{\text{WES3}}$ from the microprocessor. Each of the output lines of the activated latch is connected to the DA input line in turn through decoding of the A, B, and C signals from the microprocessor. The DATA output of the microprocessor is applied to the DA input lines of the latches through gates U45-3 and U45-4 and voltage level shifter U29-13. If a data pulse is present at the input when a particular output line when the latch is clocked. The output data signal turns on a cross-point transistor switch which connects the A pair of the station set quad through transformer T3 to the desired destination card. At the same time, a DC current that defines the selected function is supplied to the

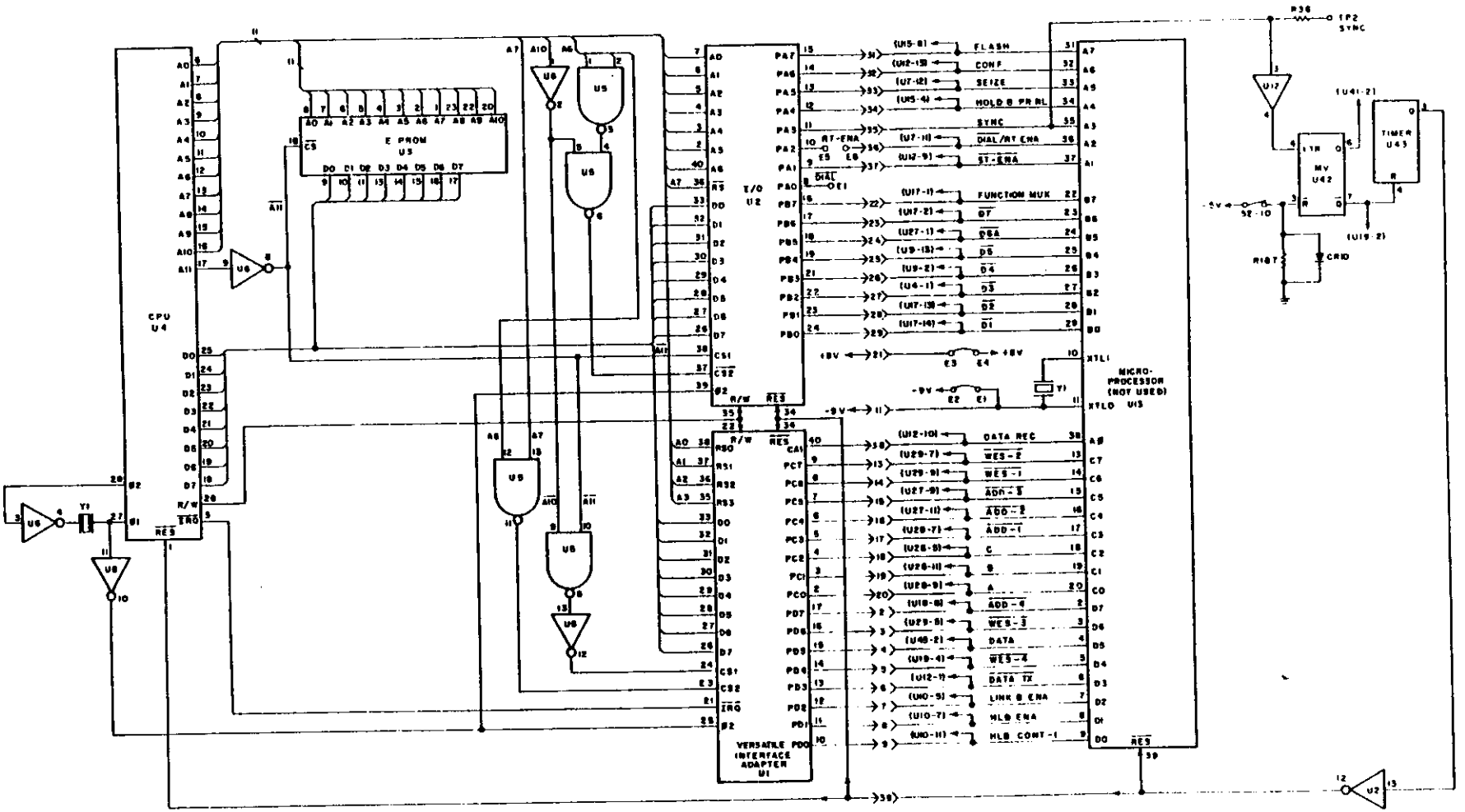


Figure 2-8 Station Card Microprocessor Circuits, Simplified Block Diagram

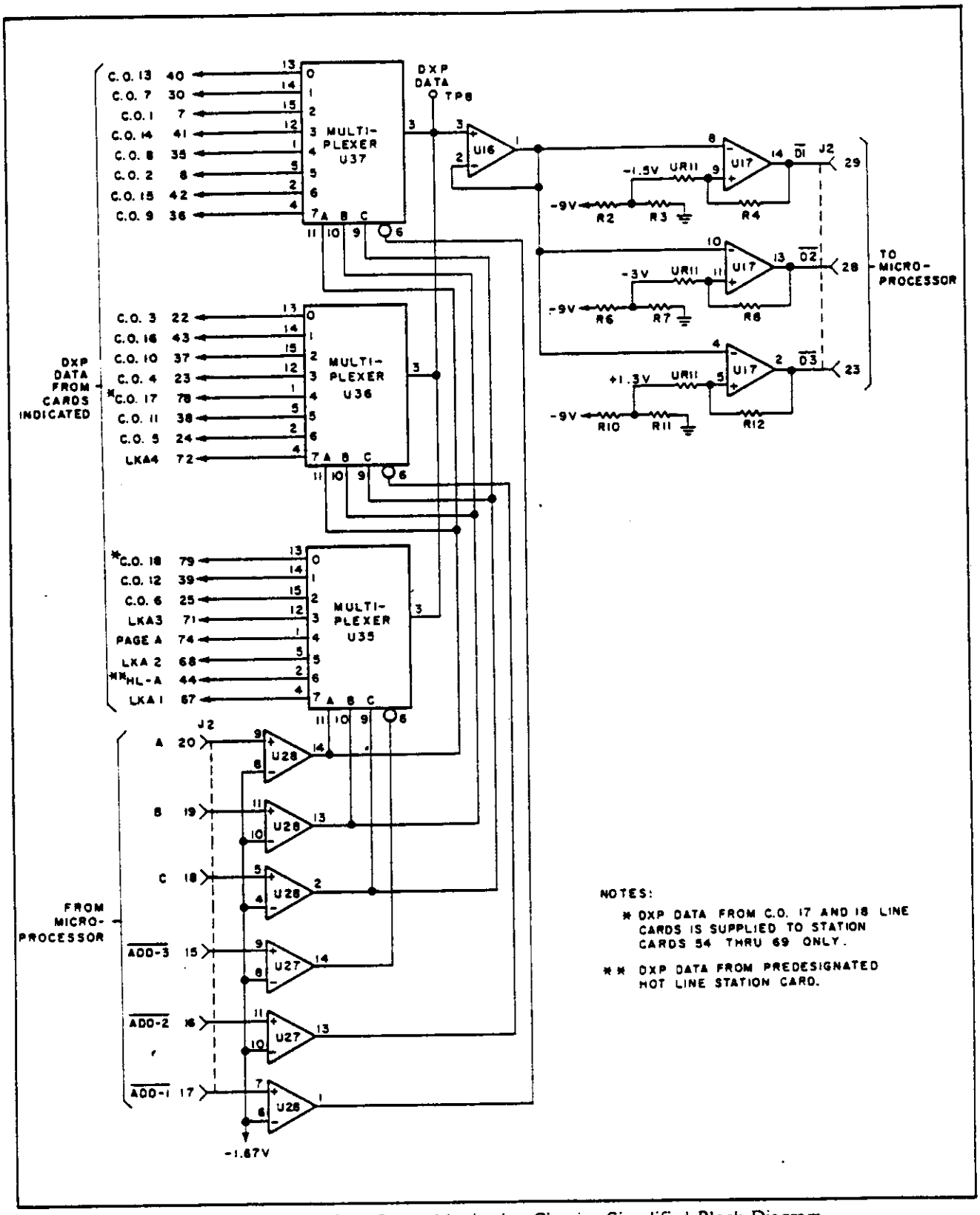


Figure 2-9 Station Card Status Monitoring Circuits. Simplified Block Diagram

Section II
Theory of Operation

A pair through current source Q1. The DC current is developed by voltage comparators U44-1, U15-2, U15-1, U15-14, U15-13, and U24-1 under control of commands from the microcomputer.

2-49. Switches S2-1 through S2-9 and S3-1 through S3-9 in the output circuits of the latches can be used to provide a dial disable function. These switches are all closed normally, but can be opened to implement the dial disable function for any C.O. lines desired. When all cross-point transistor switches are open, signal DIAL DISABLE is set high through voltage compartor U27-2, and relay K1 is de-energized through gates U1-11 and U1-10 and relay driver Q16. When a particular cross-point from the output of latch U22, U31, or U39 is selected by the station card microprocessor and the related cross-point dial disable switch is closed, LED DS6 lights and signal DIAL DISABLE goes low. Relay K1 is energized, and its contacts connect an impedance matching network to the A port. The impedance network circuitry (U24-7 and Q17) is not activated unless signal CONF from the microprocessor is active; when the impedance network circuitry is activated, the characteristic impedance is changed for a multi-line conference condition. If the same cr ss-point is selected but its associated dial disable switch is open, the audio connection is made to the destination card, but LED DS6 does not light and relay K1 is not energized. In this condition, signal $\overline{\text{DIAL DISABLE}}$ is high at the output of voltage level shifter U27-2 and multiplexer U18-15. The microprocessor detects this high and removes the dial enable bit from its data message to the station set.

2-50. Passive Port Circuits. (See Figure 2-11.) The station card has two passive ports by which it may be seized: a link port that responds to dialed intercom calls, and a hot line port that responds to hot line calls from one other predesignated station card (HL key) or from the DSS console. The passive ports supply audio signals to the station set over the B pair of the quad. The station card passive port circuits also interface certain tone and control signals from the tone generator card, and paging signals from the page card. The tones and paging signals are also supplied to the station set over the B pair of the quad.

2-51. The link port of the station card is seized when a dialed intercom call is received from another station card through a link A or link B card. When the station card is seized in this manner, a DC current that defines the selected function is applied through the primary winding of transformer T1 to transistor Q7, and a voltage level that defines the selected function is developed across resistor R99. The function levels are detected by voltage comparators U9-2, U9-13, and U4-1, and signals D3, $\overline{\text{D4}}$, and or $\overline{\text{D5}}$ are activated. Signal D3 defines a link port seize condition, signal $\overline{\text{D4}}$ defines an ICM ring condition, and signal $\overline{\text{D5}}$ defines a link call steal (alternate point answering) condition. These signals are supplied to the microprocessor, and the microprocessor supplies data in accordance with the defined conditions to latch U19 through gates U45-3 and U45-4, address information through voltage comparators U28-9, U28-11, and U28-5, and enabling signal $\overline{\text{WES-4}}$. Input data is loaded into the latch when it is clocked, and the latch output signals are activated in accordance with the input data.

2-52. The microprocessor also activates signal LINK B ENA directly. Signal LINK B ENA turns on transistor switches U11-9 and U11-13 through voltage level shifter U10-2 and gates U14-3 and U14-11, thereby permitting transmission of audio from the link A or link B card through transformers T1 and T4 and the B pair of the quad to the station set. Signal D3 from voltage comparator U4-1 activates signal $\overline{\text{LPS}}$ through gate U7-1 when the station card is seized through the link port. Signal LPS causes LPS LED DS2 to light, and conditions gates U6-13, U7-4, and U1-3 to disable transmission of a C.O. audible tone to the B pair of the quad should a $\overline{\text{C.O. AUD ENA}}$ signal be activated while the link call is in progress. Signal $\overline{\text{LPS}}$ also triggers one-shot multivibrator U8-6, which functions with associated circuits to allow a call steal (alternate point answering) of a ringtone-signaled intercom call via another station within a 30 second period.

2-53. The hot-line port of the station card can be seized from either one other predesignated station card (when the HL key on the station set served by that station card is pressed), or from the DSS control card (when the destination station key on the DSS console is pressed). The card from which the hot-line port is seized supplies a DC current through transformer T2 and transistor Q11 to define the desired function. DC levels are detected by voltage comparators U27-1, U9-1, and U9-14, which activate signals $\overline{\text{D6A}}$, $\overline{\text{D6B}}$, and or $\overline{\text{D6C}}$, depending upon the current. Signal $\overline{\text{D6A}}$, which corresponds to a HL SEIZE signal, is supplied directly to the microprocessor. Signals $\overline{\text{D6B}}$ and $\overline{\text{D6C}}$ are supplied to the microprocessor with other control signals through multiplexer U18 and voltage comparator U17-1. The microprocessor activates signals HL-B ENA and HL-B CONT 1 directly, and activates signal HL-B CONT 3 or HL-B CONT 2 through latch U19. The HL-B CONT s als supply the HL-B DXP signal to the associated hot-line station card and DSS control card to indicate the status of the hot-line port circu s. Signal HL-B ENA turns on transistor switch U11-9 thr ugh voltage level shifter U10-turns on transistor switch U11-12. 13 through gates U14-4 and U14-11, and turns off transistor switch U11-14 13 through gate U14-10. Transistor switches U11-9 and U11-12. 13 com-

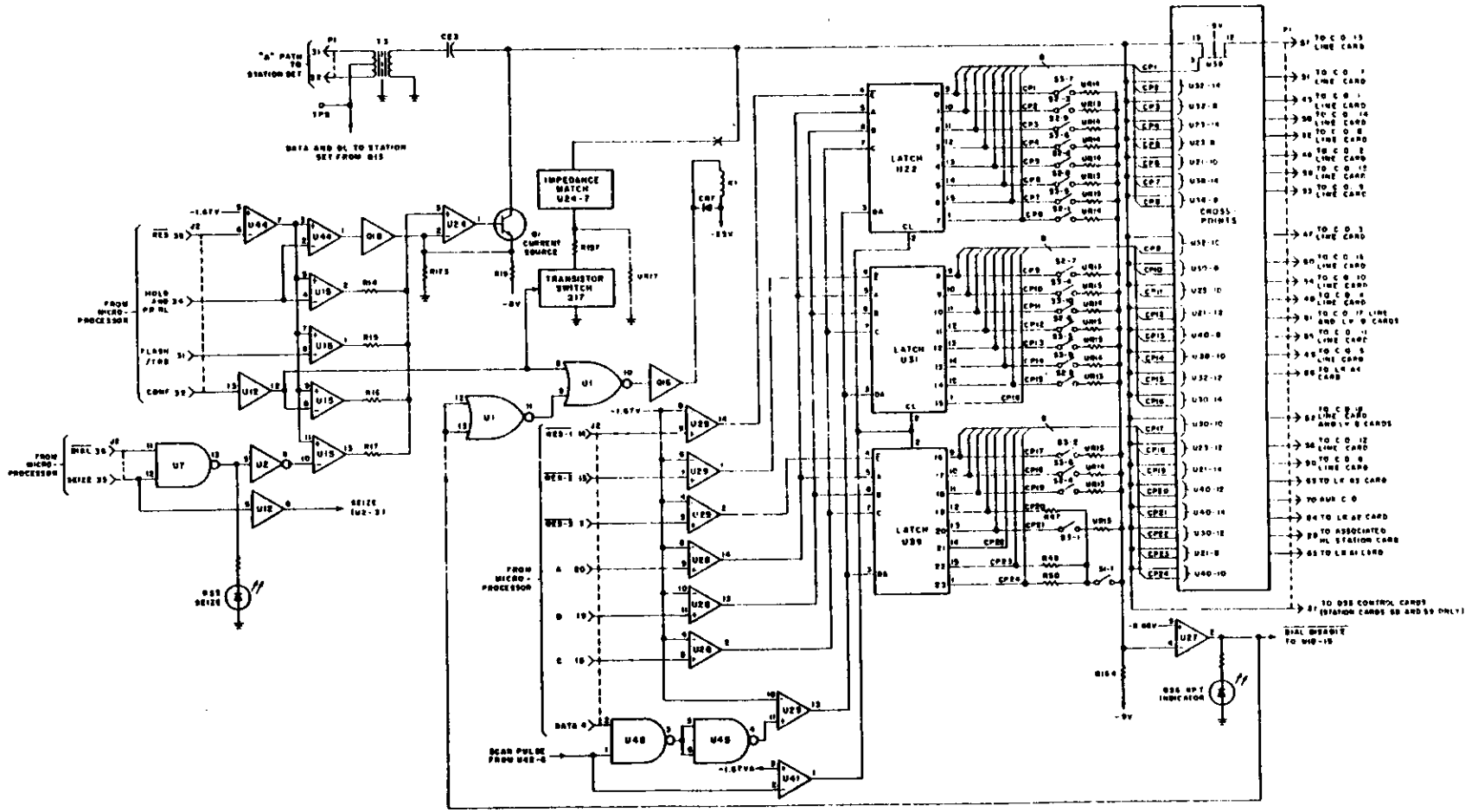


Figure 2-10. Station Card Active Port Circuits, Simplified Block Diagram

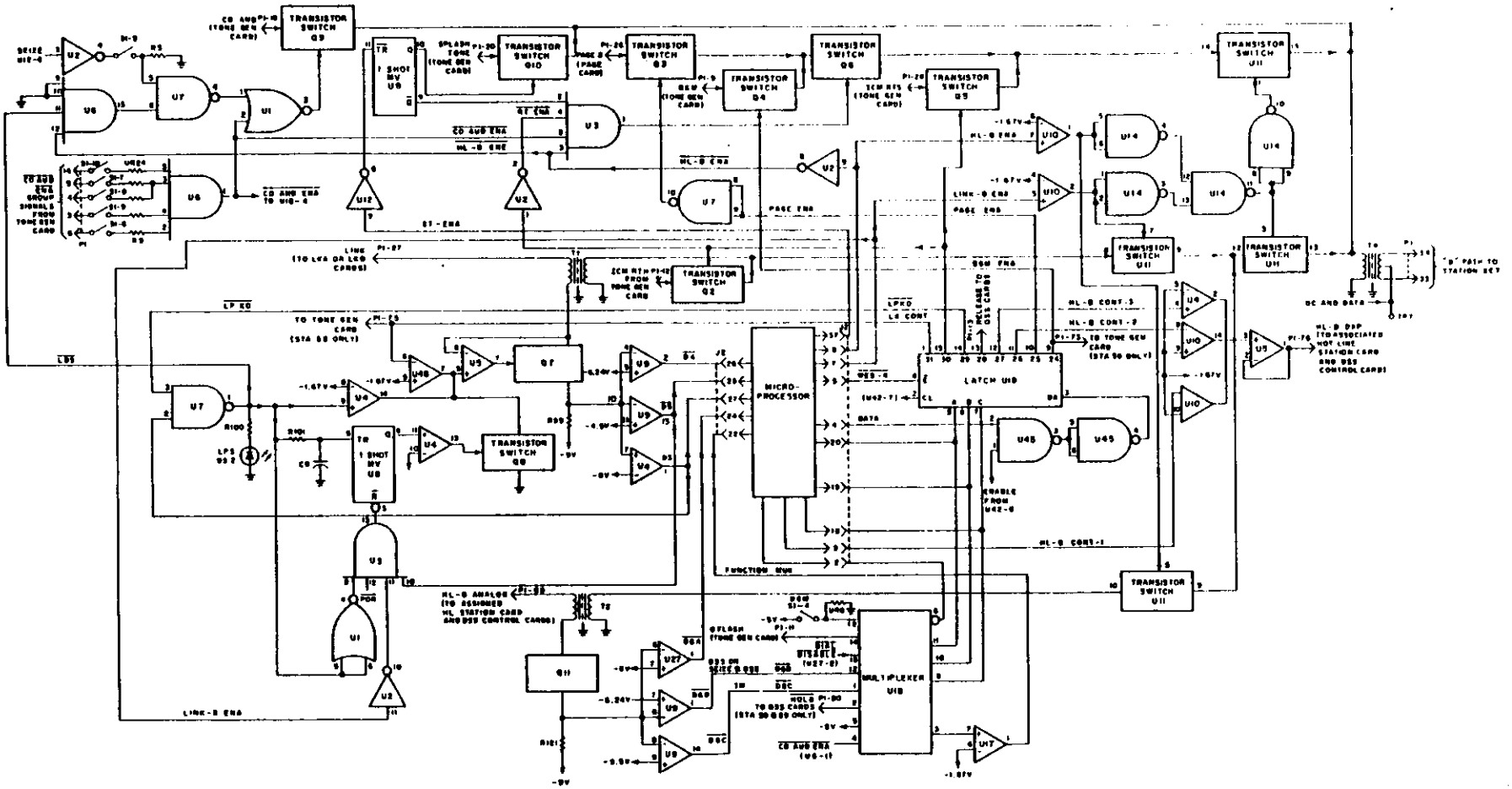


Figure 2-11 Station Card Passive Port Circuits, Simplified Block Diagram

plete the audio path through transformers T2 and T4 and the B pair of the quad to the station set. Transistor U11-14/13 prevents transmission of ICM RTS, BGM, and paging signals while the hot-line call is in progress. While the hot-line call is in progress, the link port circuits are turned off by the microprocessor.

2-54. Various tones, paging signals, and BGM can be transmitted to the station set over the B pair of the quad when neither a link call or a hot-line call is in progress. Selection of the signal to be supplied to the station set is made through latch U19 by the microprocessor in accordance with input data supplied through multiplexer U18. ICM RTS tone is supplied from the tone generator card through transistor switches Q5 and U11-14/13, and ICM RTH tone from the tone generator card is supplied through transistor switch Q2 when signal RT-ENA is activated through latch U19; signal RT-ENA turns off transistor switch Q6 through inverter U2-2 and gate U3-1 so that the ICM RTS tone overrides BGM and paging. (Note that BGM and paging are also overridden through gate U3-1 when signal HL-B ENA or C.O. AUD ENA is active, and when splashtone multivibrator U8-10 is active.) BGM is supplied to the station set from the tone generator card through transistor switch Q4 when signal BGM ENA is activated through latch U19. Page calls are supplied to the station set from the page card through transistor switch Q3 when signal PAGE ENA is activated through latch U19. Splashtone from the tone generator card is supplied to the station set through transistor switch Q10 for one second after signal ST-ENA is activated by the microprocessor; the one-second time interval is established by multivibrator U8-10. Finally, C.O. audible tone from the tone generator card may be supplied to the station set from the tone generator card through transistor switch Q9 when signal CO $\overline{\text{AUD ENA}}$ is activated through the tone generator card or private line selector panel jumper. Station cards are assigned to specific C.O. audible groups; the appropriate switches (S1-6 through S1-10) must be closed to permit C.O. audible operation of the station card withi its assigned group.

2-55. DSS CONSOLE, DETAILED THEORY OF OPERATION

2-56. **General.** The DSS console contains 58 keys with associated LEDs. I may be considered as an expansion of the station set at the DSS console position (station 58 or 59). The DSS console contains two identical channels. One channel functions with a DSS A control card in the KSU to implement the functions of the first 28 keys; the second channel functions with a DSS B control card in the KSU to implement the functions of the remaining 28 keys on the DSS console. Each channel contains its own microcomputer. Connections to the KSU are made through the quad; the DSS A control card uses the GRN/RD pair and the DSS B control card uses the BK/YL pair.

2-57. **DC Power And Data Transmission Circuits.** (See Figure 2-12.) DC operating power is supplied to the DSS console from the DSS A and DSS B control cards over the quad. Data is superimposed on the DC. Data transmitted from the DSS control cards in the KSU consists of light LED commands, which are implemented through the microcomputers in the DSS console. Data transmitted from the DSS console to the DSS control cards consists of status changes (key depressions) at the DSS console. The data word format is similar to that used for communication between the station set and the associated station card. (See Figure 2-1.)

2-58. Except for the quad pair being used, the data and power transmission circuits for the two channels of the DSS console are identical; therefore, only the circuits involved with the GRN/RED pair are discussed. Positive 25 volt DC from the power circuits on the DSS A control card is supplied through transistor Q3 on the DSS A control card and the green lead of the quad to the DSS console, and negative 25 volt DC is supplied through transistor Q4 and the red lead. At the DSS console, the DC is supplied through diodes CR2 and CR3 to the DSS console power circuits, comprising voltage regulators VR1 through VR4 and associated filter components. Voltage regulator VR1 develops a regulated DC output from which all other DC voltages are derived through the use of Zener diode regulator circuits. The regulated output voltages power all circuits in the corresponding channel of the DSS console except for the keypad circuits, which are powered directly from the positive 15 volt input.

2-59. Data messages that are to be transmitted from the microprocessor on the DSS A control card are supplied from the microprocessor to buffer U27-2 on the DSS A control card. The data signal is amplified by amplifier U31-1, and the amplifier output drives transistor Q3. The data signals modulate the output of transistor Q3, causing the output voltage to the DSS console to vary in accordance with the data. A portion of the data signal at the output of transistor Q3 is applied through a voltage divider to amplifier U30-7, which varies the output of transistor Q4 in the opposite direction. The data message is thereby superimposed on both leads of the GRN RED pair, and it is transmitted to the DSS console. At the DSS console, the incoming data message is amplified by amplifier U12-1 and shaped by voltage comparator U7-1, and is then supplied to the microcomputer, which decodes and implements the commands.

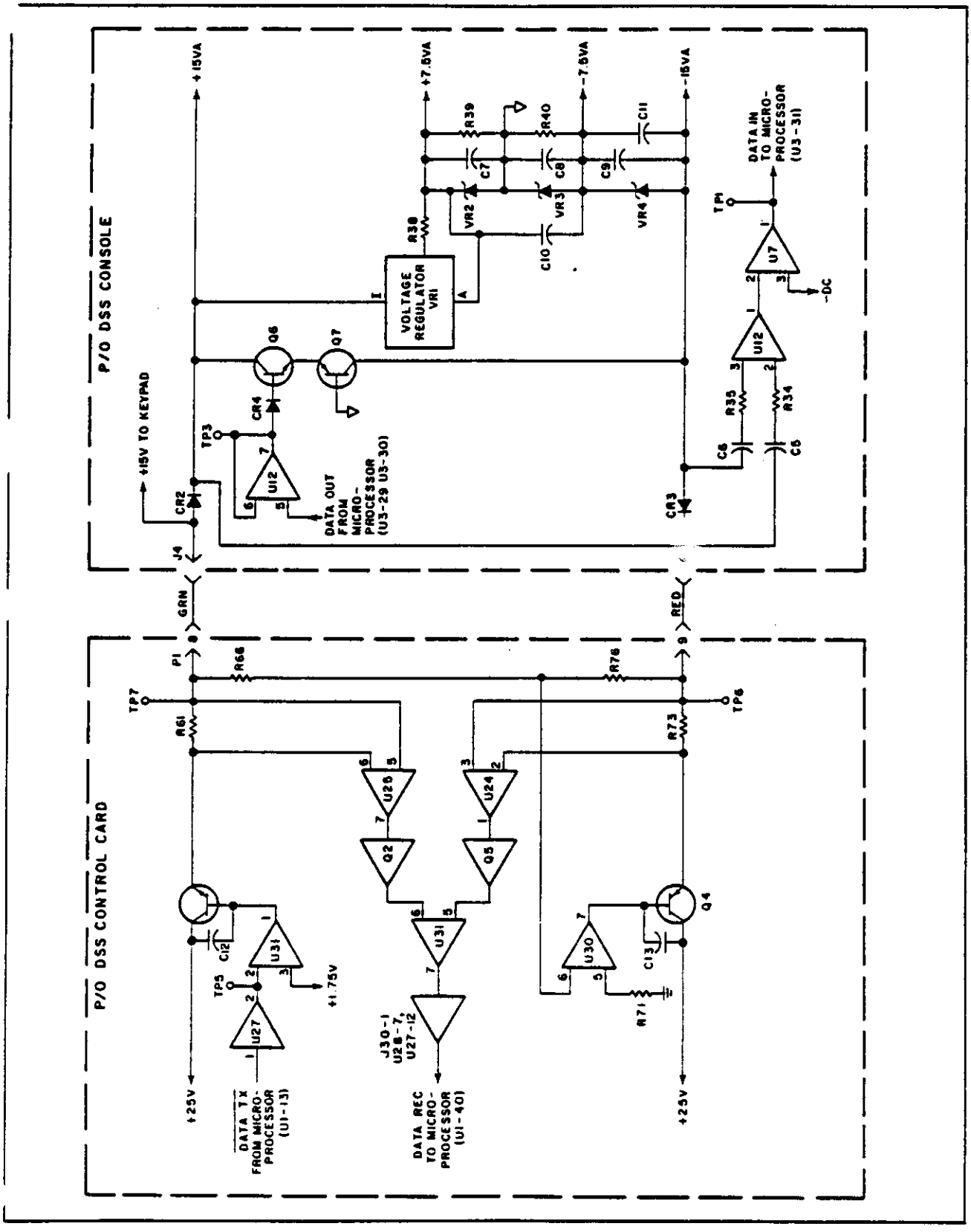


Figure 2-12 DSS Console DC Power and Data Transmission Circuits, Simplified Block Diagram

2-60. Outgoing data generated by the microcomputer in the DSS console is amplified by amplifier U12-7, and is then applied to transistors Q6 and Q7. Transistors Q6 and Q7 develop a current that varies in accordance with the data message; this current is transmitted over the quad to the DSS A control card. At the DSS A control card, the current develops data message voltages across resistors R61 and R73. The voltage developed across resistor R61 is amplified by amplifier U25-7 and transistor Q2, and the output signal from transistor Q2 is applied to one input of differential amplifier U31-7. The data signal developed across resistor R73 is similarly amplified by amplifier U24-1 and transistor Q5, and the output signal of transistor Q5 is applied to the other input of differential amplifier U31-7. The two data signals are opposite in polarity; therefore the driving signal of amplifier U31-7 is effectively the sum of the two input signals. The data signal developed at the output of amplifier U31-7 is further amplified by amplifier U30-1 and shaped by voltage comparator U28-7, and the data signal is then applied through buffer U27-12 to the microprocessor on the DSS A control card.

2-61. Microcomputers. (See Figure 2-13.) The DSS console contains two microcomputers, U3 and U10, which serve the GRN RED and YEL BK pairs of the quad, respectively. Each is a complete, 4-bit parallel microcomputer system, which operates under control of a stored, non-volatile program. Each microcomputer scans the DSS console keys assigned to it, assembles the key data into the proper format, and transmits the data to the associated DSS control card in the KSU. It also receives and processes data from the associated DSS control card, and implements received commands. The received commands consist primarily of instructions to light specific LEDs at the DSS console. Multivibrators U4 and U9 reset microcomputers U3 and U10, respectively, when power is turned on and if the sync signal is lost.

2-62. Key Switch Matrix. (See Figure 2-13.) The keys on the DSS console are divided into two sections. The first 28 keys are arranged in a matrix associated with microcomputer U3; the remaining 28 keys are arranged in a matrix associated with microcomputer U10. Each switch matrix is similar to the switch matrix of the station set (paragraph 2-31), and is scanned by the associated microcomputer in a similar manner. To scan its associated keys, each microcomputer activates row signals P101, R102, R103, and R104 in succession. While each row signal is active, column signals D101 through D108 are scanned in sequence. If a key switch in the row and column being scanned is closed, current flows through the closed key switch, and a voltage change is sensed at the column input of the microcomputer. Key switch data is assembled into the proper transmission format by the microcomputer and is transmitted to the associated DSS control card in the KSU.

2-63. LED Matrix. (See Figure 2-13.) Incoming commands received by the DSS console microcomputers consist of instructions to light specific LEDs in the keys on the DSS console. Light LED data is received and processed by each microcomputer to develop control signals for its associated LEDs. the LEDs assigned to each microcomputer are arranged in a matrix similar to that in the station set (paragraph 2-32), and are lighted in a similar manner. Each row of the matrix is activated individually by the R105 through R108 output lines of the microcomputers through transistors Q1 through Q4 (A channel) or transistors Q8 through Q11 (B channel). While each row is active, any light LED commands for the LEDs in that row cause activation of the corresponding D101 through D108 output lines of the microcomputers. Active output levels on these lines each activate a Darlington transistor in integrated circuit U2 to activate the corresponding column of the matrix. With a row and column of the matrix both active, the LED at that point of the matrix is lighted.

2-64. DSS CONTROL CARDS, DETAILED THEORY OF OPERATION

2-65. General. One or two DSS control cards are required in the KSU for each DSS console. DSS control card A serves stations 30 through 57, and DSS control card B serves stations 60 through 82 plus the five paging zones. Each DSS control card provides 28 cross-points for accessing the hot line ports of the other station cards within the system. In addition, each DSS control card monitors the status of the associated station cards and transmits the status to the DSS console, it places on hold the C.O. line most recently seized by the DSS console attendant when the attendant selects a station, and it releases the accessed station when the attendant returns to an on-hook condition or depresses another C.O. line or station key at his position. All operations are performed under control of a self-contained microprocessor with a stored, non-volatile program.

2-66. Microprocessor Circuits. (See Figure 2-14.) The microprocessor circuits of each DSS control card consist of a four-chip set (U4, U2, U1 and U3), which communicates with one of the microprocessors in the associated DSS console. The microprocessor provides data storage and processing during DSS operations; it is controlled by a non-volatile program stored in EPROM U3. CPU U4 and its associated integrated circuits are clocked at a 1 MHz rate controlled by crystal Y1. The microprocessor is reset on power-up and if a sync pulse is not present for more than two data frames by a reset pulse developed by one-shot multivibrator U36-7, timer U37-3,

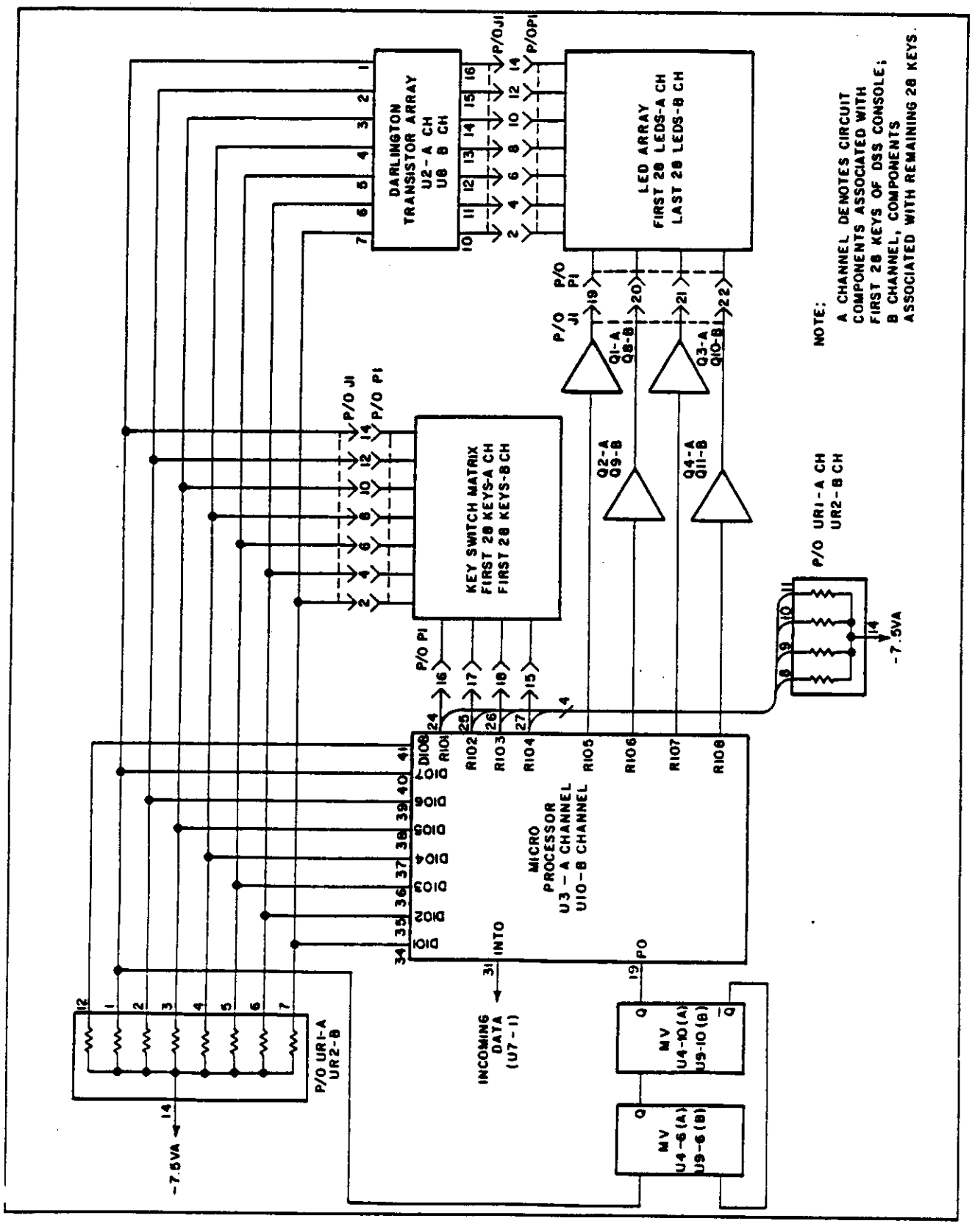


Figure 2-13 DSS Console Microprocessor and Keypad Circuits, Simplified Block Diagram

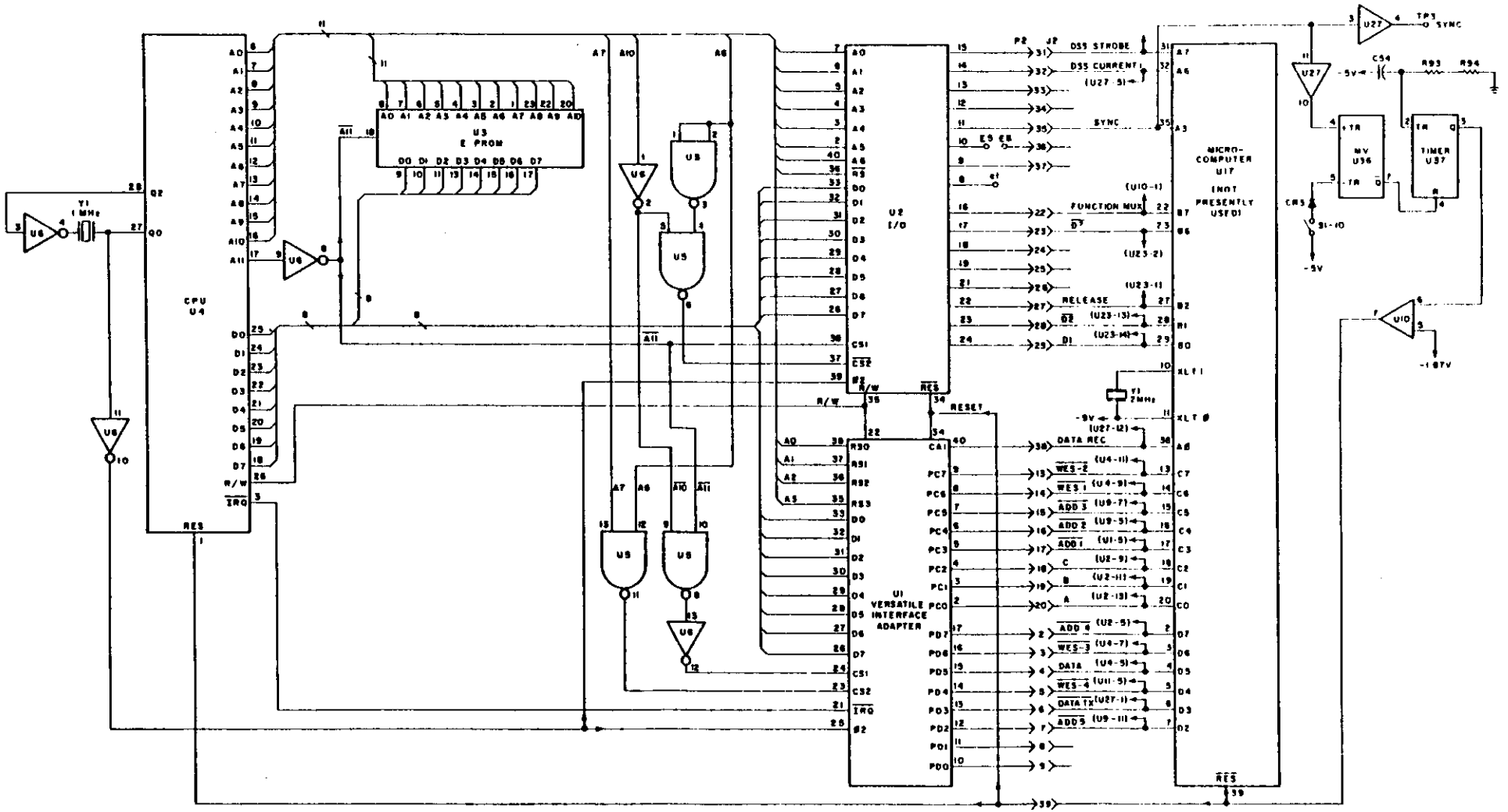


Figure 2-14 DSS Control Card Microprocessor Circuits, Simplified Block Diagram

and voltage comparator U10-1. Switch S1-10 is a manual reset. Data received from the associated DSS console microprocessor is processed by the microprocessor and control signals required to initiate operations specified by the received data are supplied to the other circuits on the DSS control card. DXP data information from the points assigned to the DSS control card processed by the microprocessor and is transmitted to the associated DSS console to control operation of LEDs in the DSS console.

2-67. Station Status Circuits. (See Figure 2-15.) The status of all stations assigned to a DSS control card is monitored continually through scanning of the DXP lines from the station cards. The status of any station is indicated by the level of the DXP line voltage from that station. Four eight-line multiplexers (U22, U26, U32, and U16) perform scanning of the DXP lines under control of the microprocessor circuits. The microprocessor circuits enable each multiplexer in turn by activating the $\overline{\text{ADD-1}}$, $\overline{\text{ADD-2}}$, $\overline{\text{ADD-3}}$, and $\overline{\text{ADD-4}}$ in the proper sequence. These signals are applied through voltage level shifters (integrated circuit U4) to the enable inputs of the multiplexers. When a multiplexer is enabled, digital control signals A, B, and C from the microprocessor circuits, applied through voltage level shifters U1-13, U1-14, and U1-1, cause the multiplexer to scan each of its input lines in sequence, and transfer the level on the input line being scanned to the output. The output level of the multiplexer is applied through operational amplifier U34-1 to voltage comparators U23-14, U23-13, and U23-2. The voltage comparators decode the DXP voltage level and develop output signals $\overline{\text{D1}}$, $\overline{\text{D2}}$, and $\overline{\text{D7}}$, which define the status of the station card being scanned. These output signals are supplied to the microprocessor circuits where they are used to develop the control data that is transmitted to the associated DSS console.

2-68. When status information is to be transmitted to the DSS console, the microprocessor circuits access the stored $\overline{\text{D1}}$, $\overline{\text{D2}}$, and $\overline{\text{D7}}$ levels for each station card in sequence. Multiplexer U3 is enabled through buffer U2-6 by signal $\overline{\text{ADD-4}}$ from the microprocessor circuits, and the A, B, and C levels to the multiplexer are activated in accordance with the $\overline{\text{D1}}$, $\overline{\text{D2}}$, and $\overline{\text{D7}}$ levels. Multiplexer U3 selects one of three input signals for connection to its output line, as determined by the A, B, and C signal levels. The three input signals are ground, a fixed positive level developed by voltage comparator U9-14, and a Q-FLASH signal supplied from the tone generator card. The selected signal is applied through operational amplifier U10-1 to the microprocessor circuits as signal FUNCTION MUX. The microprocessor circuits then transmit no pulse (ground selected), a steady pulse (fixed positive level selected), or a flashing pulse (Q-FLASH selected) during the transmitted data word assigned for the corresponding station card. The status of each of the points assigned to the DSS control card is transmitted to the DSS console in this manner in successive words of the data message. Data transmission is conducted over the quad as detailed in the description of the DC power and data transmission circuits of the DSS console. (Refer to paragraph 2-57.) At the DSS console, the LED for each station is controlled by the transmitted data for that station, and the DSS console LEDs provide a continuous status indication for all stations to the DSS console attendant.

2-69. Station Hot Line Accessing. (See Figure 2-16.) The attendant at the DSS console position can access the hot line port of any station card or paging zone controlled by the DSS console by pressing the appropriate key on the DSS console after lifting the handset or pressing the HANDSFREE key on the station set at the DSS console position. When a station or page zone key on the DSS console is pressed, the key position is transmitted to the DSS control card in the form of a pulse when the DSS console keys are scanned. This pulse is used by the microprocessor on the DSS control card to initiate operation between the station set at the DSS console position and the selected station or page zone on a hot line basis.

2-70. At the DSS control card, data derived from the data message received from the DSS console is supplied in serial form through voltage comparator U4-2 to latches U5 through U8. Each latch is capable of converting 8 bits of serial data into a parallel output. The proper latch is selected by signals $\overline{\text{WES-1}}$ through $\overline{\text{WES-4}}$ supplied to the enabling input of the latches through voltage level shifters U4-14, U4-13, U4-1, and U11-7 from the microprocessor circuits. Switching of the input data bits to the appropriate parallel output lines of the activated latch is controlled by signals A, B, and C from the microprocessor, which are applied to the address inputs of the latches through voltage level shifters U1-13, U1-14, and U1-1. An active level at the input of the activated latch activates the output line signal that controls the cross-point switch to the point selected by the key depression at the DSS console.

2-71. Signals CP0 through CP31 at the output of the latches each control one analog switch to the hot-line input port of one station card or to the analog input of one channel of the page card. When a connection is to be established, signal DSS CURRENT 1 is activated by the microprocessor circuits, thereby turning on transistor Q1 through buffer U27-6, voltage comparator U28-1, and operational amplifier U34-12. Transistor Q1 develops a seize current that is sent to the selected point through the activated analog switch. At the same time, signal DSS CURRENT 2 is activated through buffer U27-6, and this signal energizes relay K1 through inerter U35-11 and

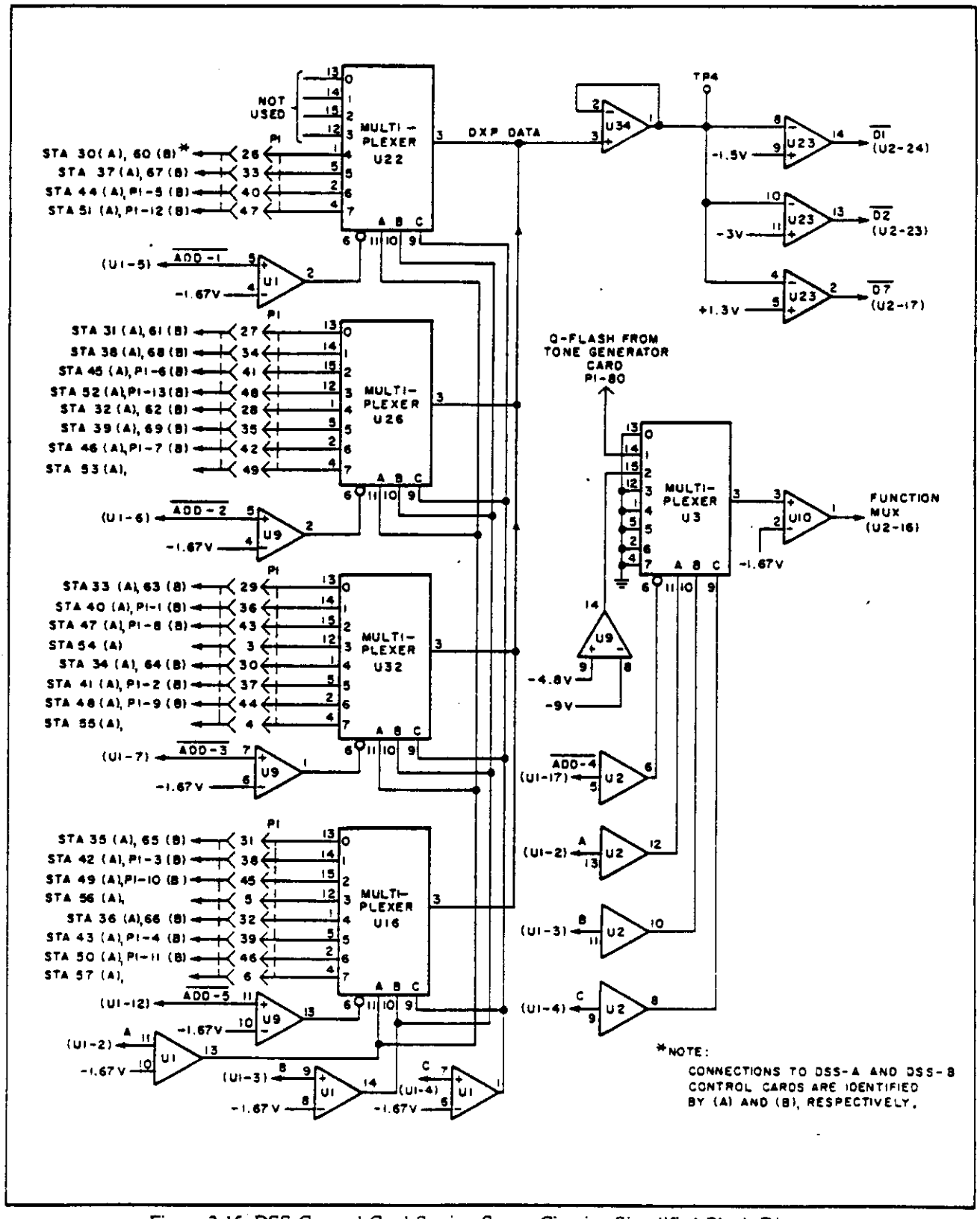


Figure 2-15 DSS Control Card Station Status Circuits, Simplified Block Diagram

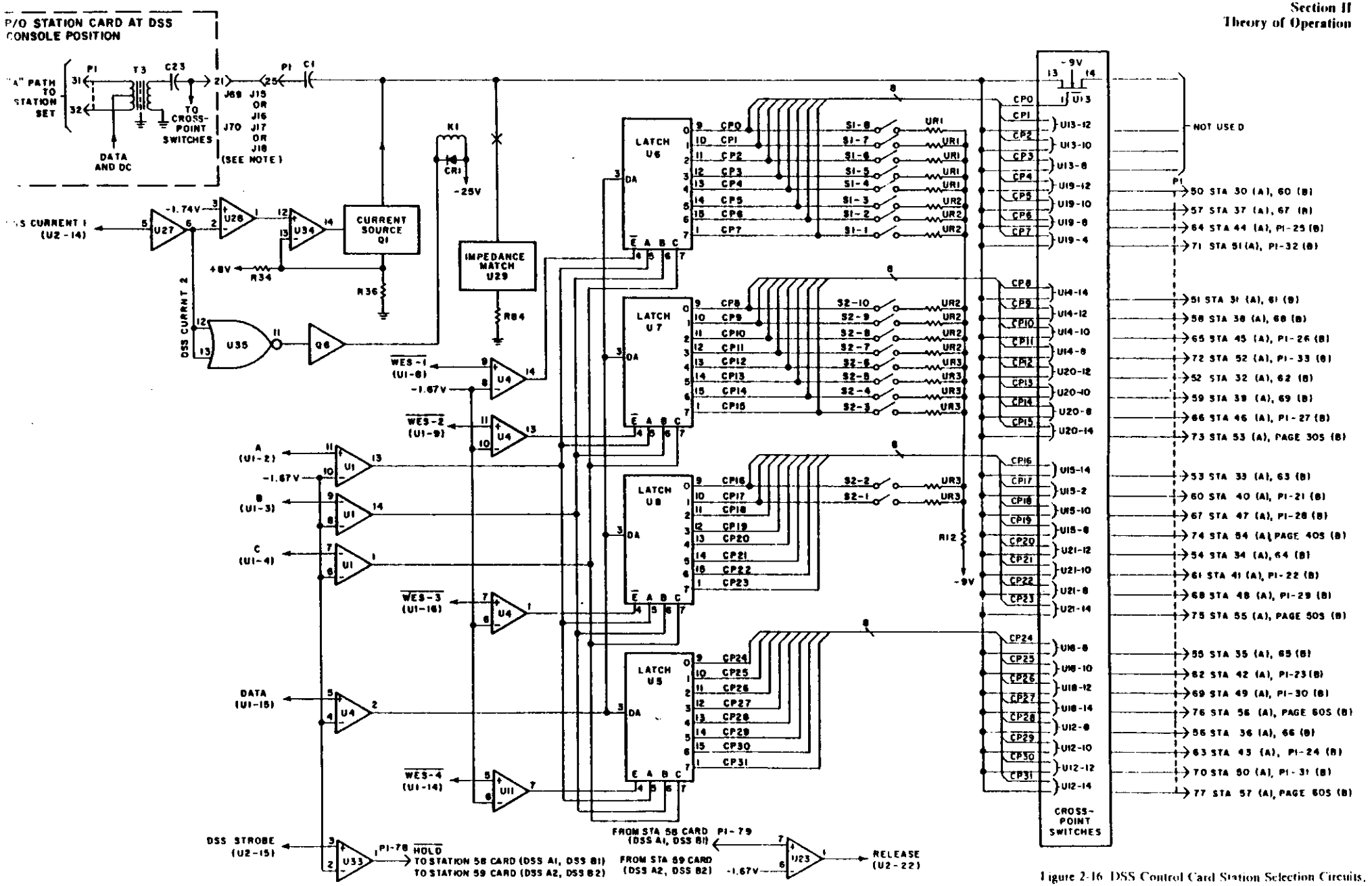


Figure 2-16 DSS Control Card Station Selection Circuits, Simplified Block

relay driver Q6. The contacts of the relay connect impedance match U29-7 to the analog line. The microprocessor circuits also activate signal DSS STROBE at the start of the accessing operation, and signal $\overline{\text{HOLD}}$ is transmitted through voltage comparator U33-1 to the station card at the DSS position. This $\overline{\text{HOLD}}$ signal places the C.O. line most recently seized by the attendant at the DSS position on hold automatically while the attendant accesses a station.

2-72. When the DSS connection has been established, the attendant at the DSS console can communicate with the user of the accessed station set using the handset or speakerphone of his station set. The DSS connection is maintained until the attendant returns the handset of the station set at the DSS console position to the on-hook condition or depresses a C.O. line key or another station key on his station set. Signal RELEASE is then sent from the DSS console position station set to the microprocessor circuits through voltage comparator U23-1, and the microprocessor circuits turn off the analog switch through the DATA signal path.

2-73. LINK A CARD, DETAILED THEORY OF OPERATION

2-74. **General.** The key system may be equipped with up to six links, each of which may be equipped with one or two link cards, designated link A and link B. Link A cards serve stations 30 through 59 plus the five paging zones; link B cards serve stations 60 through 89 plus C.O. lines 17 through 29. Stations originating calls through the intercom facility are assigned idle link A cards on a 4-out-of-6 basis as follows:

1. Stations 30 through 49 use link A card 1, 2, 3, or 4.
2. Stations 50 through 69 use link A card 2, 3, 5, or 6.
3. Stations 70 through 89 use link A card 1, 4, 5, or 6.

2-75. Link A cards provide one-half of the intercom talkpath system. They also route mode and address data to the associated link B cards that provide the second half of the intercom talkpath system; the link B card cannot function without its associated link A card. When a station user depresses the station set ICM key, an active link port on the associated station card seizes the A port of an idel link. The seize current from the originating station card port is detected on the link A card, and the link A card provides a service (link) request to the register cards. An idle register card provides a link connect response, provides dial tone to the caller through the link, decodes the dialed number to determine whether it is valid, provides a reorder signal to the link on invalid numbers, and returns cross-point data (the number dialed) and call mode information to the link A card.

2-76. At the link A card, calls are directed to the reorder tone port and register drops-off if the caller fails to complete dialing within 8 seconds or if an invalid code indication is received from the register. A valid code and mode information received from the register are stored in the link A card, and the register releases and is available for another call. The link A card processes the stored code and mode information. If the code represents one of the station cards or page card serviced by the link A card, the link A card closes its B port to the passive port of the called station or page card. If the passive port of the called station is found to be busy, the call is directed to the busy tone port. If the code represents one of the station or C.O. line cards serviced by the link B card, the code and mode information is transferred to the link B card. The link A card performs the bush test when the cross-point connection has been established by the link B card.

2-77. When the call is terminated and seize current from the originating station ceases, the current change is detected by the link A card. The B port of the link A card to the called station or page card is opened, the mode and code information is removed from storage, and the link is reset to idle and is ready to accept another call.

2-78. **Call Initiation Circuits.** (See Figure 2-17.) To call another station in the system, initiate a page call, or seize a C.O. line that does not appear on his station set (by invitation only), the station user presses his ICM key and lifts the handset or depresses the HF key (for handsfree operation) at the station set. The microprocessor on the associated station card processes this information and selects an available link A card. The A channel of the calling station set is connected to the selected link A card, and a seize current is transmitted to the A port (ALG LINK) input on the link A card.

2-79. The seize current is supplied through transistor switch U47-10, transformer T1, and transistor Q2 to voltage comparator U20-2, which detects the seize current and activates signals $\overline{\text{SEIZE}}$ and (through inverter U4-8) SEIZE. Signal SEIZE sets flip flop U3-1, and a link request to the register cards is initiated through gates U15-11 and U15-4. Signal $\overline{\text{SEIZE}}$ sets signal LINK DXP to the station cards low through gates U13-9 and U17-10, voltage comparator U1-1, and amplifier U11-1 to signal that the link A card has been seized. Signal $\overline{\text{SEIZE}}$ also inhibits operation of gate U15-10 to prevent activation of link reset signal LKR.

2-80. When the link request is received at the register cards, it causes an idle register card to initiate a search for the link A card that provided the link request. When the register finds the proper link A card signal LINK CONNECT at that link A card is set low by the register

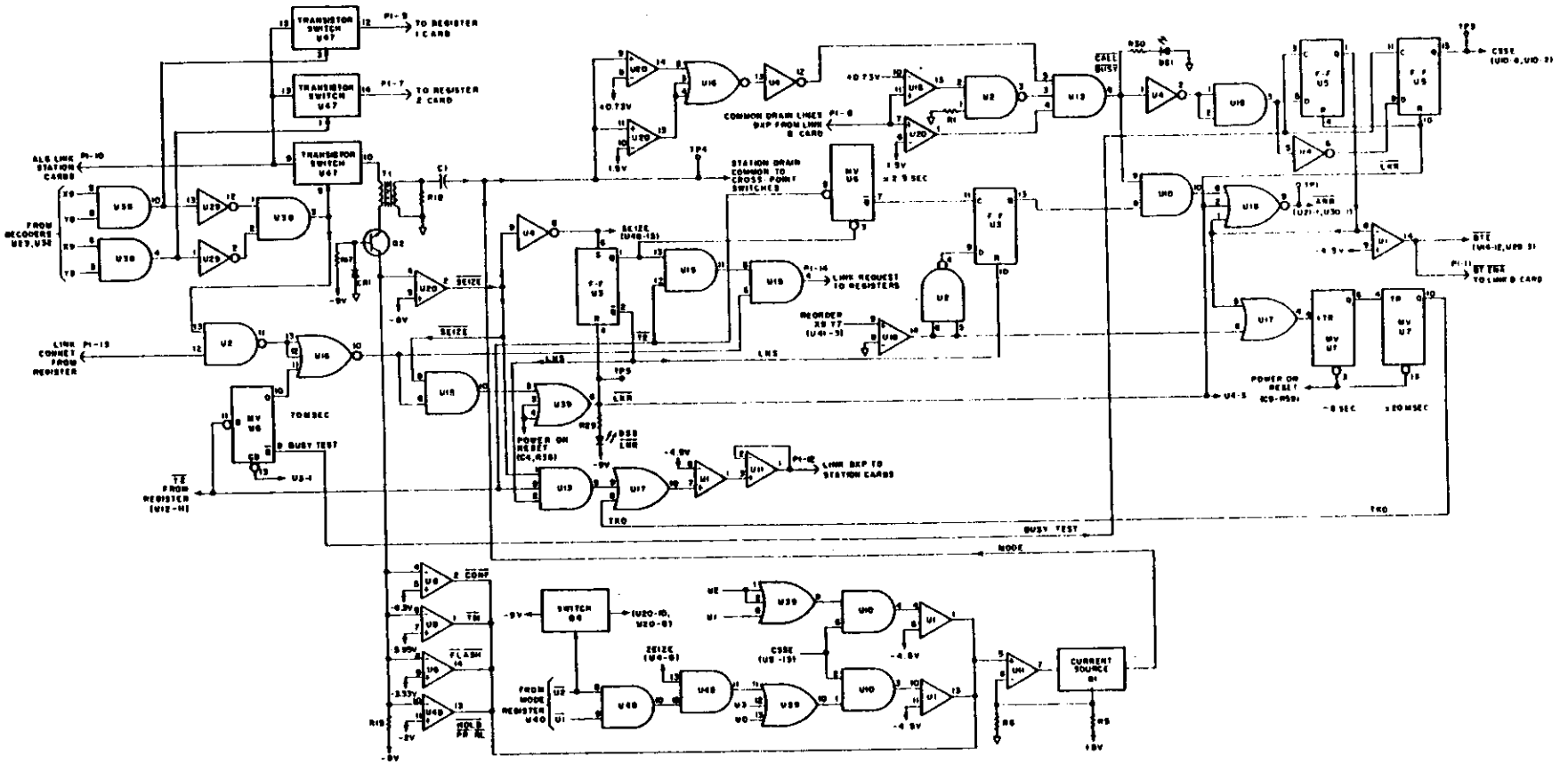


Figure 2-17 Link A Card Call Initiation Circuits, Simplified Block Diagram

card, and signal LINK REQUEST is deactivated through gates U2-11, U16-10, and U15-4. The register card stops the search and proceeds to handle the call.

2-81. The register card then sends register address and mode data and load signals to the link A card, and the register address and mode are loaded into latches on the link A card. The register address, when decoded, activates either signals X9 and Y8 (register 1 card) or signals X9 and Y9 (register 2 card). Assume that register 1 is processing the call. The X9 and Y8 signals turn on transistor switch U47-12 through gate U38-10, and turn off transistor switch U47-10 through gate U38-10, inverter U29-12, and gate U38-3. The ALG LINK line from the station card for the call originating station is thereby switched from the link A card circuits to the register 1 card.

2-82. The register 1 card then supplies dial tone to the calling station through the associated station card, receives and decodes the dialed number, and checks the dialed number for validity. Valid mode and address data derived from the dialed number are sent from the register 1 card to the link A card, and this data is loaded into mode and address latches on the link A card. The register 1 card then releases and is ready to handle the next call. Decoding of the mode data activates signal $\overline{T2}$. Signal $\overline{T2}$ triggers one-shot multivibrators U6-10 and U6-7, and signal LINK REQUEST is held inactive through gate U16-10. Decoding of the address data causes the station drain common line of the link A card to be connected through a cross-point switch to the dialed station card, C.O. line card, or paging circuit. When multivibrator U6-10 times out, signal BUSY TEST is activated, and the accessed point is checked for a busy condition. Voltage comparators U20-14 and U20-13 monitor the station drain common line to check for the presence of current (indicating a busy condition) to the accessed station card or page card, and voltage comparators U18-13 and U20-1 monitor the common drain line DXP from the associated link B card to check for a busy condition on any accessed C.O. line card. (Jumper J1 at the input of gate U2-3 is out for normal operation, and the DXP signal from an accessed C.O. line card must represent a hold condition for that C.O. line card to be seized through the link. Jumper J1 may be connected for test purposes; it holds the output of gate U2-3 high and permits seizur of the accessed C.O. line card if the C.O. line card is idle. If the accessed point is busy, signal $\overline{\text{CALL BUSY}}$ at the output of gate U13-6 is set low through the appropriate voltage comparators, gates, and or inverters, and the data inputs of flip-flops U5-1 and U5-13 are set high and low, respectively, through inverter U4-2, gate U15-3, and inverter U4-6. Signal BUSY TEST clocks flip-flops U5-1 and U5-13. If the called destination was found to be busy, flip-flop U5-1 develops a high output logic level which is supplied to the following points: to gate U16-9 to activate signal $\overline{\text{ARR}}$ which resets the mode and address latches on the link A card; to voltage comparator U1-14 to set signal BTE low to open the cross-point connection to the dialed destination and supply a busy tone (through the mode and address circuits) to the call originating station over the station drain common line; and to gate U17-4 to trigger one-shot multivibrators U7-6 and U7-10 which, after a delay, set the LINK DXP signal high momentarily to indicate to station cards that the call has been terminated. Flip-flop U5-13 holds signal CSSE low to prevent application of mode current to the station drain common line. If the called point is not busy, signal CALL BUSY is inactive during the busy test, and the data levels to flip-flops U5-1 and U5-13 are reversed. When the flip-flops are clocked, the output of flip-flop U5-1 is low, thereby establishing the proper BTE, ARR, and LINK DXP signal levels for normal operation. Flip-flop U5-13, when clocked, activates signal CSSE, and a DC current is sent to the accessed point over the station drain common circuit to signify the desired function.

2-83. The function current is supplied by current source Q1, which may be controlled, through voltage controller U8-2, U8-1, U8-14, or U8-13, by a current from the call originating station card, or by mode data developed from the dialed information and supplied from the register card. Gates U48-10, U48-11, U39-10, U39-9, U10-3, and U10-4, and voltage comparators U1-2 and U1-13 process the mode data stored in the mode latch on the link A card. Current source Q1 supplies a current that defines the required function to the station drain common line for transmission to the accessed point, and verbal communication can be carried out over the established link. At the end of the call, the call originating station card terminates the seize current, thereby deactivating signal $\overline{\text{SEIZE}}$. Signal LKR is then activated through gates U15-10 and U39-6, and the link A circuits are reset to await the next call.

2-84. If, during processing of the incoming call, the register card detects an invalid code, or if dialing is not completed within a preset time period, the register card sends a reorder address to the link A card instead of the address of the dialed destination. When the reorder address is decoded by the mode and address circuits on the link A card, signals X9 and Y7 are activated. These signals set the data input of flip-flop U3-13 low, and trigger one-shot multivibrator U7-6 and U7-10. The reorder address decode, through the mode and address circuits, causes a reorder tone to be sent to the calling station through a cross-point switch. When signal $\overline{T2}$ is activated, one-shot multivibrator U6-7 is triggered; after a 2.5 second delay, the output of multivibrator U6-7

clocks flip-flop U3-13. The low at the input of flip-flop U3-9 is transferred to its output, and signal ARR is held inactive through gates U10-10 and U16-9 to maintain the reorder tone. Multivibrators U7-6 and U7-10, after a delay, set signal LINK DXP to the station cards high momentarily. The station user originating the call then repeats his call initiation process.

2-85. Mode And Address Circuits. (See Figure 2-18.) The mode and address circuits of the link A card receive, store, and decode mode and address data, which define the dialed number, from the register card that is processing the call. Loading of input data is controlled by the register card; clearing of the storage registers is controlled by the call initiation circuits of the link A card.

2-86. Mode and address information is supplied from the register card in BCD parallel format, and is suplied to latches U12, U21, U30, and U40. Applied mode data is clocked into latches U12 and U40 when signals LD MODE and LDE are activated by the register card. These signals, operating through gates U2-10 and U48-4, clock latches U12 an U40, the applied BCD data is entered into the latches, and the stored mode data is available at the output lines of the latches for various control functions in the call initiation circuits. To load address data, the register card activates signals LD ADDRESS and LDE, thereby clocking address latches U21 and U30 through gates U2-10 and U48-3. The applied address data is loaded into the latches, and is available at the output lines of the latches. The output address data is level shifted by level shifters U22 and U31, and the level shifted address data is applied to decoders U23 and U32 on the link A card and to the associated link B card for decoding.

2-87. Binary coded address tens data is decoded by tens digit decoder U23 to activate one of ten output X lines, as determined by the tens digit of the address. Binary coded address units data is decoded by ones digit decoder U32 to activate one of ten Y output lines, as determined by the units digit of the address. The activated X-Y combination defines one of 100 possible addresses. The decoded data activates cross-point switches or control circuits required to establish the selected function.

2-88. Data loaded into latches U12, U21, U30, and U40 remains in storage until the latches are cleared or new data is loaded in from the register card. Mode latches U12 and U40 are cleared at the termination of the intercom call through inverters U4-4 and U4-10 and transistor Q3 when signal $\overline{\text{LKR}}$ is activated by the call initiation circuits. Address latches U21 and U30 are cleared by signal $\overline{\text{ARR}}$, which is activated by the call initiation circuits for a call busy, or call terminated condition.

2-89. Cross-Point Switch Circuits. (See Figure 2-19.) The cross-point switch circuits received decoded address information, and establish cross-point connections defined by the decoded data. The link A card cross-point switches control switching of busy and reorder tones from the tone card, and switching of the station drain common line (call from the call originating station) to stations 30 through 59 and the page card.

2-90. When a busy condition is detected by the call initiation circuits during the busy test, the address latches are cleared and signal $\overline{\text{BTE}}$ is set low. Clearing of the address registers results in a BCD zero output; signals X0 and Y0 are activated when then output is decoded by the address circuits. Transistor switch U49-14 is turned on through gates U14-4 and U41-11, and the busy tone output of the tone generator card is applied through transistor switch U49-14 to the station drain common line, and is thereby supplied to the calling party.

2-91. When a reorder command is supplied to the address circuits from the register card as a result of an invalid dialed number or failure to complete dialing within a preset time period, signals X9 and Y7 are activated through decoding of the reorder address. Transistor switch U49-8 is turned on through gate U41-3, and the reorder tone from the tone generator card is supplied through the transistor switch and the station drain common line to the calling party.

2-92. The cross-point connection to a dialed station, page zone, or all page is made when the corresponding dialed address is decoded. Station 30, for example, is connected through transistor switch U42-12 to the station drain common (and thereby to the call originating station) when signals X3 and Y0 are activated through decoding of a dialed 30. Gates U14-11 and U33-10 turn on transistor switch U42-12 to establish this connection. A similar gate and switch arrangement is used for each of the remaining stations assigned to the link A card, for each of the five paging zones, and for all page. Signal $\overline{\text{BTE}}$ from the call initiating circuits must be inactive to establish these cross-point connections.

2-93. LINK B CARD, DETAILED THEORY OF OPERATION

2-94. The link B card provides cross-point switching for the half of the intercom talkpath system (stations 60 through 89) not covered by the link A card, and provides access to C.O. lines that do not appear on the keys at the accessing station (private lines). (A station user may pick up a C.O. line that does not appear on the keys of his station set by dialing into that C.O. line *by invitation*; if jumper J1 on the link A card is not connected; this connection is possible only when that C.O. line has been placed on hold by the station user extending the invitation, or on a conference basis when that station user has

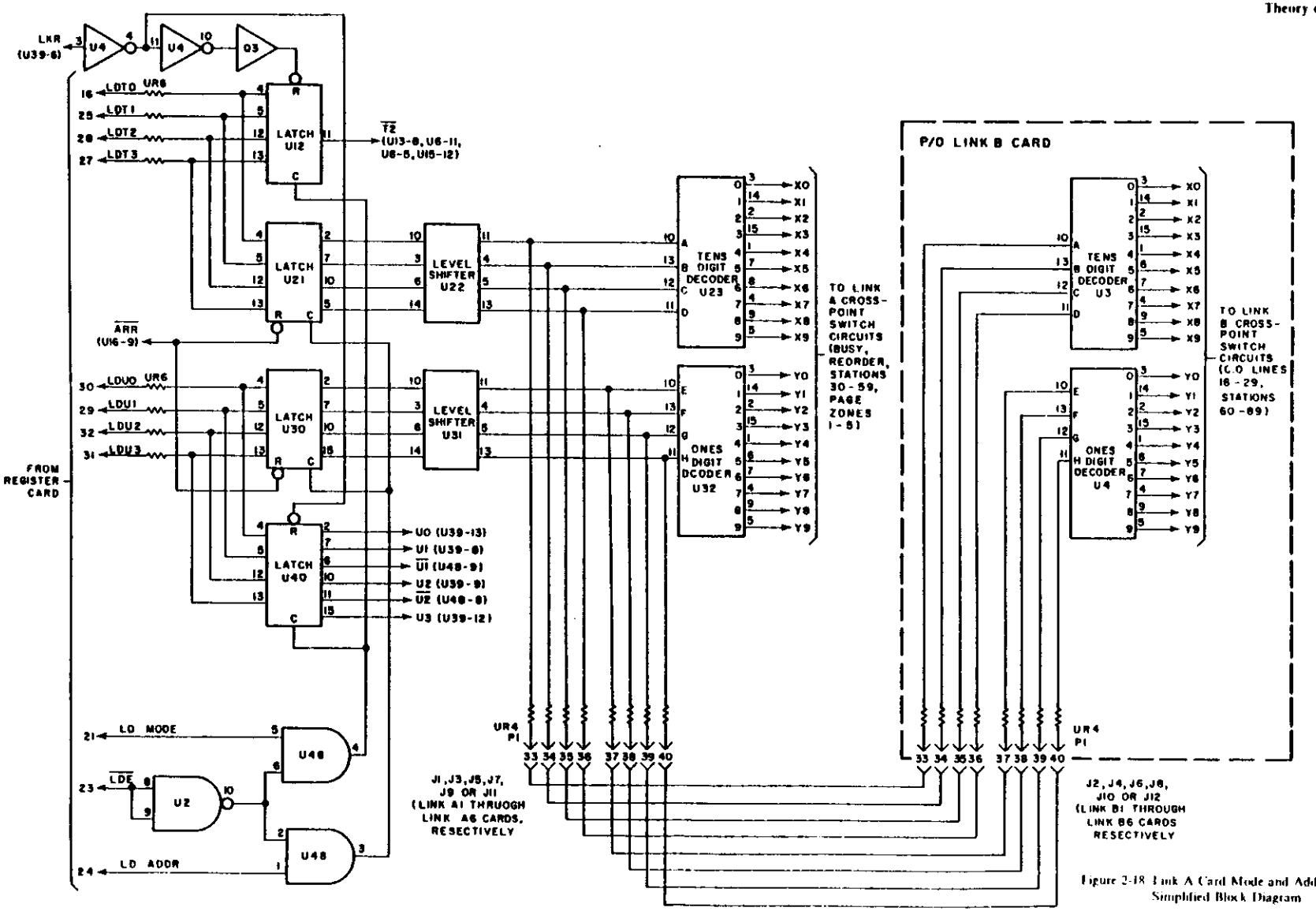
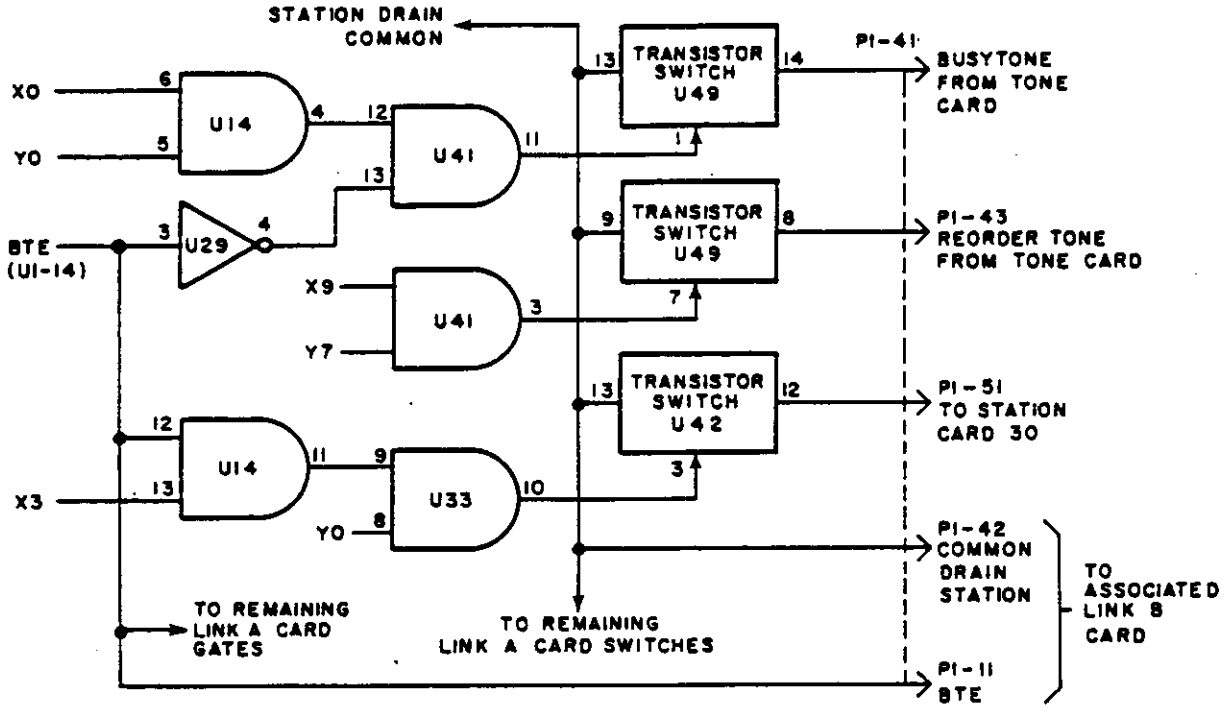


Figure 2-18 Link A Card Mode and Address Circuits, Simplified Block Diagram



REMAINING CROSS-POINT CIRCUITS

DESTINATION	CONTROL SIGNALS	GATES	SWITCH	OUTPUT CONN.	DESTINATION	CONTROL SIGNALS	GATES	SWITCH	OUTPUT CONN.
STATION 31	X3, Y1	U14-11, U33-4	U42-10	P1-52	STATION 49	X4, Y9	U14-10, U45-11	U51-14	P1-70
STATION 32	X3, Y2	U14-11, U33-3	U42-8	P1-53	STATION 50	X5, Y0	U14-3, U19-3	U28-8	P1-71
STATION 33	X3, Y3	U14-11, U43-3	U50-8	P1-54	STATION 51	X5, Y1	U14-3, U19-4	U28-10	P1-72
STATION 34	X3, Y4	U14-11, U43-4	U50-10	P1-55	STATION 52	X5, Y2	U14-3, U19-10	U28-12	P1-73
STATION 35	X3, Y5	U14-11, U43-10	U50-12	P1-56	STATION 53	X5, Y3	U14-3, U19-11	U28-14	P1-74
STATION 36	X3, Y6	U14-11, U43-11	U50-14	P1-57	STATION 54	X5, Y4	U14-3, U37-11	U46-14	P1-75
STATION 37	X3, Y7	U14-11, U27-11	U26-12	P1-58	STATION 55	X5, Y5	U14-3, U37-10	U46-12	P1-76
STATION 38	X3, Y8	U14-11, U27-3	U26-14	P1-59	STATION 56	X5, Y6	U14-3, U37-4	U46-10	P1-77
STATION 39	X3, Y9	U14-11, U36-4	U35-8	P1-60	STATION 57	X5, Y7	U14-3, U37-3	U46-8	P1-78
STATION 40	X4, Y0	U14-10, U34-10	U44-14	P1-61	STATION 58	X5, Y8	U14-3, U27-10	U26-10	P1-79
STATION 41	X4, Y1	U14-10, U34-11	U44-12	P1-62	STATION 59	X5, Y9	U14-3, U27-4	U26-8	P1-80
STATION 42	X4, Y2	U14-10, U34-3	U44-10	P1-63	OPERATOR (STATION 58)	X9, Y0	U36-10, U41-10	U49-12	P1-45
STATION 43	X4, Y3	U14-10, U34-4	U44-8	P1-64	PAGE ZONE 1	X9, Y1	U36-10, U25-4	U24-8	P1-46
STATION 44	X4, Y4	U14-10, U36-3	U35-4	P1-65	PAGE ZONE 2	X9, Y2	U36-10, U25-10	U24-10	P1-47
STATION 45	X4, Y5	U14-10, U36-11	U35-12	P1-66	PAGE ZONE 3	X9, Y3	U36-10, U25-11	U24-12	P1-48
STATION 46	X4, Y6	U14-10, U45-4	U51-8	P1-67	PAGE ZONE 4	X9, Y4	U36-10, U25-3	U24-14	P1-49
STATION 47	X4, Y7	U14-10, U45-3	U51-10	P1-68	PAGE ZONE 5	X9, Y5	U36-10, U33-11	U42-14	P1-50
STATION 48	X4, Y8	U14-10, U45-10	U51-12	P1-69	ALL PAGE	X9, Y6	U36-10, U41-4	U49-10	P1-44

Figure 2-19 Link A Card Cross-Point Switching Circuits, Simplified Block Diagram

pressed his privacy release (PR RL) key.) The link B card cannot function without its associated link A card because the link A card performs all call initiation and processing functions, and address data from the register card is supplied to the link B card through the link A card.

2-95. When any of stations 60 through 89 or one of the private lines is dialed, the intercom call initiation and processing is handled by the link A card and a register card as described in paragraphs 2-78 through 2-87. Valid address data for any of these stations or private lines, when decoded, has no effect on the link A card circuits. This address data is stored in the address latches on the link A card, and is supplied through level shifters on that card to the associated link B card. (See Figure 2-18.) The link B card contains decoding circuits that are similar to those on the link A card.

2-96. Address tens BCD-to-binary decoder U3 on the link B card (Figure 2-18) decodes the tens digit of the applied BCD address and activates one of signals X0 through X9, as defined by the tens digit of the dialed number. Address units BCD-to-binary decoder U4 decodes the units digit of the applied BCD address and activates one of signals Y0 through Y9, as defined by the units digit of the dialed number. The X signals may be considered the row selection signals for a matrix that controls C.O. line and station selection, and the Y signals may be considered the column selection signals. If signal $\overline{\text{BTE}}$ is set high by the link A card (valid number dialed), the activated X and Y output signals of the decoders activate a gate that turns on the associated cross-point transister analog switch to the corresponding station card or C.O. line card. (See Figure 2-20.) The dialed station or C.O. line card is then connected to the common drain to the link A card. When a station card connection is established, this connection is checked by the link A card for a busy condition as described in the link A card description. If one of the C.O. lines is dialed and J1 is appropriately strapped, two cross-point connections to the corresponding C.O. line card are established: an analog connection for analog audio signals, and a digital (DXP) connection for status information. The DXP connection is made through a second transistor cross-point switch to the DXP common drain line to the link A card. The digital DXP line is monitored during the busy test performed by the associated link A card; the dialed C.O. line card must be in the hold or privacy release condition and J1 must be appropriately strapped.

2-97. REGISTER CARD, DETAILED THEORY OF OPERATION

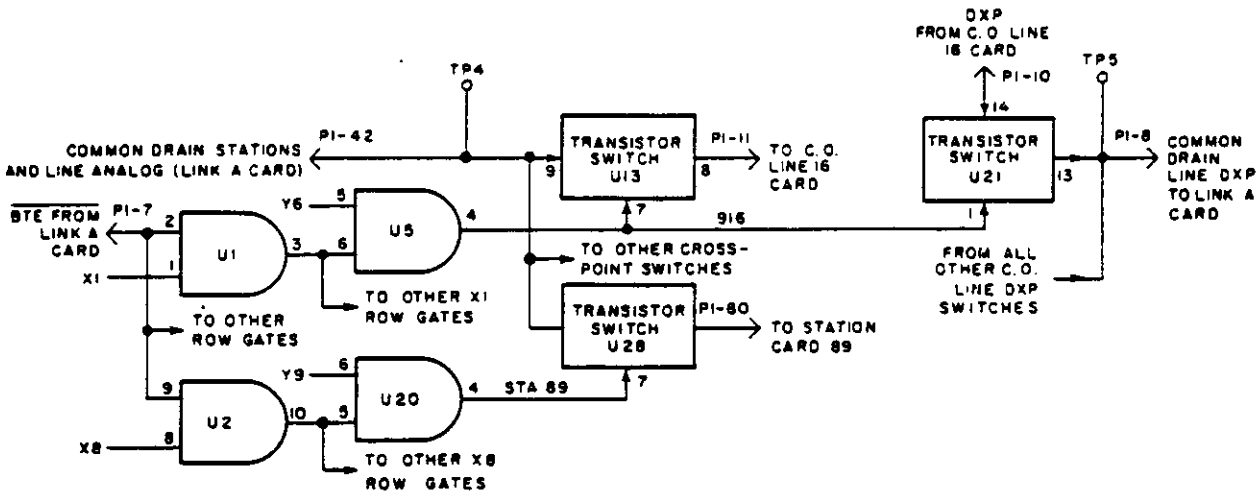
2-98. **General.** One or two register cards may be included in the KSU. Each register card functions with the link A cards to provide the intercom function. When a register card receives a service request from one of the link A cards, it provides dial tone to the caller through the link A card, counts dial pulses or decodes DTMF tones, determines whether the dialed number is valid, provides a reorder signal to the link A card on invalid numbers, and provides mode and address data to the link A card for valid numbers. Once the mode and address data has been supplied to the link A card, the register card releases and is available for another call. All register card functions are performed in discrete steps, controlled by register function counter U27.

2-99. **Register Function Counter Circuits.**

1. *Reset Idle Function.* (See Figure 2-21.) Register function counter U27 is reset through resistor R68 and capacitor C18 when power is applied to the register card, and through normal stepping action upon completion of each of its operating cycles. When counter U27 is reset, its no. 1 output line is activated, thereby setting latch U26-2, resetting latch U26-9 through gate U34-10, inhibiting clocking of counter U61 through gate U52-10, lighting STANDBY LED DS2 through inverter U2-6, and resetting flip-flop U62-1. When latch U26-2 is set, its high Q output causes lighting of READY LED DS3 through gate U12-11 and inverter U2-4, and initiates resetting of the dialtone and dialing circuits through gate U3-9, latch U26-9, and associated circuits. Resetting is indicated by lighting of RESET LED DS5. The high output of latch U26-2 also sets the D input of flip-flop U43-12 low through gates U35-3, U53-4, and U45-13. A 2 MHz clock signal, generated by an oscillator composed of inverters U19-2, U29-4, U19-6, and U19-8 and associated components, clocks flip-flop U43-12 through inverter U19-10 on the trailing edge of the clock pulse, and the low D input causes a high $\overline{Q}$ output from the flip-flop. This high output conditions gate U44-3, allowing counter U27 to be clocked through gates U44-3 and U33-11 by the leading edge of the next clock pulse, and the counter advances one count to the AWAIT LINK REQUEST function. When the counter advances one step, its count 1 output is set low, and further clocking through the RESET IDLE function circuits is inhibited.

NOTE

Switches S1-1 through S1-10, S2, and S3 are used for factory test purposes. Switch S2 perits manual clocking of counter U27 through flip-flop U26-1, and switch S3 permits manual resetting of the dialtone and dialing circuits through latch U26-9. Switches S1-1 through S1-10 are closed for normal operation.



REMAINING CROSS-POINT CONNECTIONS

STA OR C O LINE	CONTROL SIGNALS	GATES	TRANSISTOR SWITCHES	OUTPUT CONN	STA OR C O LINE	CONTROL SIGNALS	GATES	TRANSISTOR SWITCHES	OUTPUT CONN
C O 17	X1 Y7	U1-3 U5-3	U13-10(ANALOG) U21-12(DXP)	P1-9 P1-12	STA 65	X6 Y5	U2-4 U29-3	U25-8	P1-50
C O 18	X1 Y8	U1-3 U5-10	U13-12(ANALOG) U21-10(DXP)	P1-13 P1-14	STA 66	X6 Y6	U2-4 U9-11	U17-14	P1-49
C O 19	X1 Y9	U1-3 U5-11	U13-14(ANALOG) U21-8(DXP)	P1-15 P1-16	STA 67	X6 Y7	U2-4 U9-10	U17-12	P1-51
C O 20	X2 Y0	U1-11 U6-4	U14-8(ANALOG) U22-14(DXP)	P1-23 P1-18	STA 68	X6 Y8	U2-4 U9-3	U17-10	P1-53
C O 21	X2 Y1	U1-11 U6-3	U14-10(ANALOG) U22-12(DXP)	P1-21 P1-20	STA 69	X6 Y9	U2-4 U9-4	U17-8	P1-55
C O 22	X2 Y2	U1-11 U6-10	U14-12(ANALOG) U22-10(DXP)	P1-19 P1-22	STA 70	X7 Y0	U2-11 U11-11	U26-14	P1-63
C O 23	X2 Y3	U1-11 U6-11	U14-14(ANALOG) U22-8(DXP)	P1-17 P1-24	STA 71	X7 Y1	U2-11 U11-10	U26-12	P1-61
C O 24	X2 Y4	U1-11 U7-4	U15-8(ANALOG) U23-14(DXP)	P1-31 P1-47	STA 72	X7 Y2	U2-11 U11-3	U26-10	P1-59
C O 25	X2 Y5	U1-11 U7-3	U15-10(ANALOG) U23-12(DXP)	P1-29 P1-45	STA 73	X7 Y3	U2-11 U11-4	U26-8	P1-57
C O 26	X2 Y6	U1-11 U7-10	U15-12(ANALOG) U23-10(DXP)	P1-27 P1-43	STA 74	X7 Y4	U2-11 U10-11	U18-14	P1-64
C O 27	X2 Y7	U1-11 U7-11	U15-14(ANALOG) U23-8(DXP)	P1-25 P1-41	STA 75	X7 Y5	U2-11 U10-10	U18-12	P1-62
C O 28	X2 Y8	U1-11 U8-4	U24-8(ANALOG) U24-14(DXP)	P1-28 P1-32	STA 76	X7 Y6	U2-11 U10-3	U18-10	P1-60
C O 29	X2 Y9	U1-11 U8-3	U24-10(ANALOG) U24-12(DXP)	P1-26 P1-30	STA 77	X7 Y7	U2-11 U10-4	U18-8	P1-58
STA 60	X6 Y0	U2-4 U8-11	U16-14	P1-46	STA 78	X7 Y8	U2-11 U30-11	U27-14	P1-65
STA 61	X6 Y1	U2-4 U8-10	U16-12	P1-48	STA 79	X7 Y9	U2-11 U30-10	U27-12	P1-67
STA 62	X6 Y2	U2-4 U29-11	U25-14	P1-56	STA 80	X8 Y0	U2-10 U30-4	U27-10	P1-69
STA 63	X6 Y3	U2-4 U29-10	U25-12	P1-54	STA 81	X8 Y1	U2-10 U30-3	U27-8	P1-71
STA 64	X6 Y4	U2-4 U29-4	U25-10	P1-52	STA 82	X8 Y2	U2-10 U12-11	U19-14	P1-68
					STA 83	X8 Y3	U2-10 U12-10	U19-12	P1-70
					STA 84	X8 Y4	U2-10 U12-3	U19-10	P1-72
					STA 85	X8 Y5	U2-10 U12-4	U19-8	P1-66
					STA 86	X8 Y6	U2-10 U20-11	U28-14	P1-74
					STA 87	X8 Y7	U2-10 U20-10	U28-12	P1-76
					STA 88	X8 Y8	U2-10 U20-3	U28-10	P1-78

Figure 2-20 Link B Card Cross-Point Switching Circuits, Simplified Block Diagram

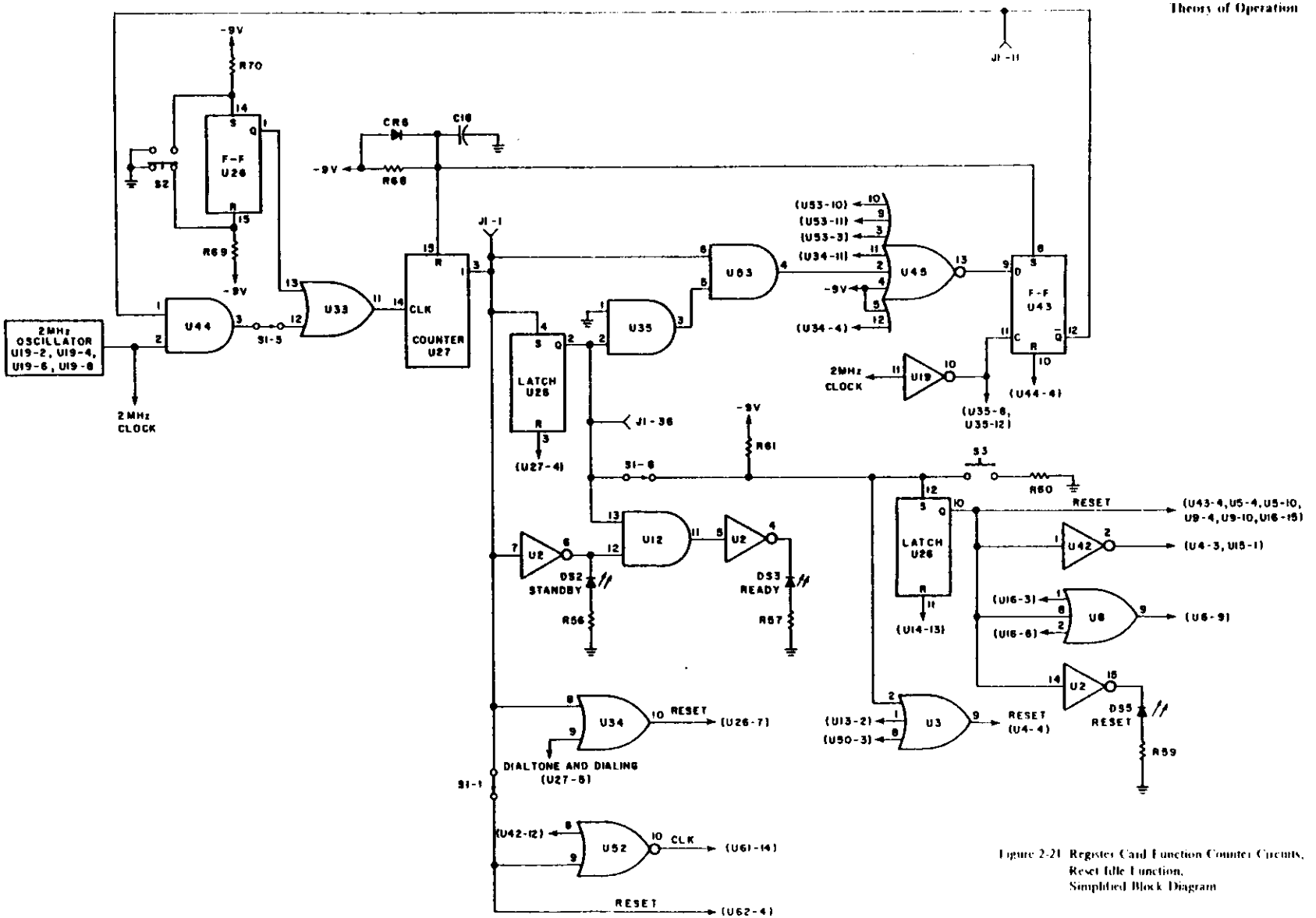


Figure 2-21 Register Card Function Counter Circuits, Reset Idle Function, Simplified Block Diagram

2. *Await Link Request Function.* (See Figure 2-22.) When counter U27 advances to the AWAIT LINK REQUEST function, its count 2 output line is set high, and the register card waits for a link request from one of the link A cards. While no LINK REQUEST signal is active, a low is supplied by inverter U4-10 on the link expander to gate U53-3, a high is supplied to the D input of flip-flop U43-12 through gates U53-3 and U45-13, and the resulting low $\overline{Q}$ output of the flip-flop inhibits further clocking of counter U27. When an intercom call is initiated, the station card that serves the call initiating station set seizes one of the link A cards, and the link A card activates its LINK REQUEST signal to the register card. An active LINK REQUEST signal sets the D input of flip-flop U43-12 low through gate U51-13, inverter U4-10, and gates U53-3 and U45-13. When flip-flop U43-12 is clocked by the next 2 MHz clock pulse through inverter U19-10, its $\overline{Q}$ output is set high, thereby enabling counter U27 to be clocked on the leading edge of the next clock pulse, and the counter advances to the FIND LINK function.

3. *Find Link Function.* (See Figure 2-23.) When the count 3 output line of counter U27 is set high, the register card searches for the link A card that initiated the link request. Flip-flop U62-1 is in the reset state, having been reset during the RESET IDLE function. The high $\overline{Q}$ output of flip-flop U62-1 conditions gate U44-10 and enables operation of buffers U1 and U59. Counter U61 is clocked by the 2 MHz clock signal through gates U44-11 and U44-10, inverter U42-12, and gate U52-10; flip-flop U62-1 is also clocked by the output from inverter U42-12. Counter U61 activates each of its output lines (and sets the LINK CONNECT output lines high through buffers U1 and U59 and associated inverters) in succession until the link A card that initiated the link request is found. For example, when the count 0 output line of counter U61 is active, a conditioning high is applied to gate U60-11 and a low LINK CONNECT signal is sent to the first link A card. If the link request originated at this link A card, the LINK REQUEST input to gate U60-11 from the link A card is high, and a high is supplied to the D input of flip-flop U62-1 through gates U60-11 and U2-13 and inverter U4-12. On the trailing edge of the clock pulse, flip-flop U62-1 transfers its high input to the Q output and sets the $\overline{Q}$ output low. The low $\overline{Q}$ output signal inhibits further clocking of counter U61. The high Q output inhibits further operation of buffers U1 and U59, thereby, in this case, terminating signal LINK CONNECT to the first link A card. The link A card terminates the LINK REQUEST signal. The high Q output of flip-flop U62-1 also resets flip-flop U43-12 through gate U44-4, thereby enabling counter U27 to be advanced one step through gates U44-3 and U33-11 to the REQUEST DATA LINK function on the leading edge of the next clock pulse, and conditions gate U35-4 for the REQUEST DATA LINK function.

NOTE

If the first link A card did not originate the link request, counter U61 is clocked by 2 MHz clock pulses until the link A card that originated the link request is found. At that time, the actions described in the preceding example occur through the appropriate integrated circuits to activate the LINK CONNECT signal to the proper link A card.

4. *Request Data Link Function.* (See Figure 2-24.) When counter U27 advances to the REQUEST DATA LINK function, its count 4 output line is activated. Latch U26-2 is reset, thereby terminating the reset signal to the dialtone and dialing circuits to prepare these circuits for operation. Latch U26-9 is set through gate U34-3. Operation of buffers U1-, U59, U58, and U57 is inhibited through gates U34-3 and U33-3. The D input of flip-flop U43-12 is set low through gates U34-3, U53-11, and U45-13, and $\overline{Q}$ output of the flip-flop is set high when the flip-flop is clocked through inverter U19-10 on the trailing edge of the clock pulse, and counter U27 is clocked through gates U44-3 and U33-11 on the leading edge of the next clock pulse to advance one step to the SEND REGISTER ADDRESS function. When the counter advances to the count 5 position, buffers U1, U59, U58, and U57 are enabled to operate through gate U35-4, (terminal U35-5 is held high by flip-flop U62-1), inverter U42-8, and gate U33-3, and the active LINK CONNECT signal from counter U61 in the find link function circuits is supplied through the appropriate buffer (71, U59, or U58) to the link A card that is processing the intercom call as signal LINK DATA ENABLE. The buffer enabling signal is maintained for the next two functions.

5. *Send Register Address Function.* (See Figure 2-25.) The send register address function circuits, which are activated when counter U27 steps to count 5, send a binary-coded register address to the link A card that is processing the call. The register address causes the analog line from the call-originating station card to be connected through the link A card to the register card for the dialtone and dialing function. When counter U27 steps to count 5, its active output line activates the A input of selectors U47 and, through gate U49-3, the A input of selector U41. The selectors select their X input data for transfer to their output lines. The X inputs of the two selectors are hard wired to provide a binary-coded 99 for the register 1 card or a binary-coded 98 for the register 2 card. The difference in binary coded is achieved by making the proper connection to terminal P1-35. The binary-coded address information is transferred through

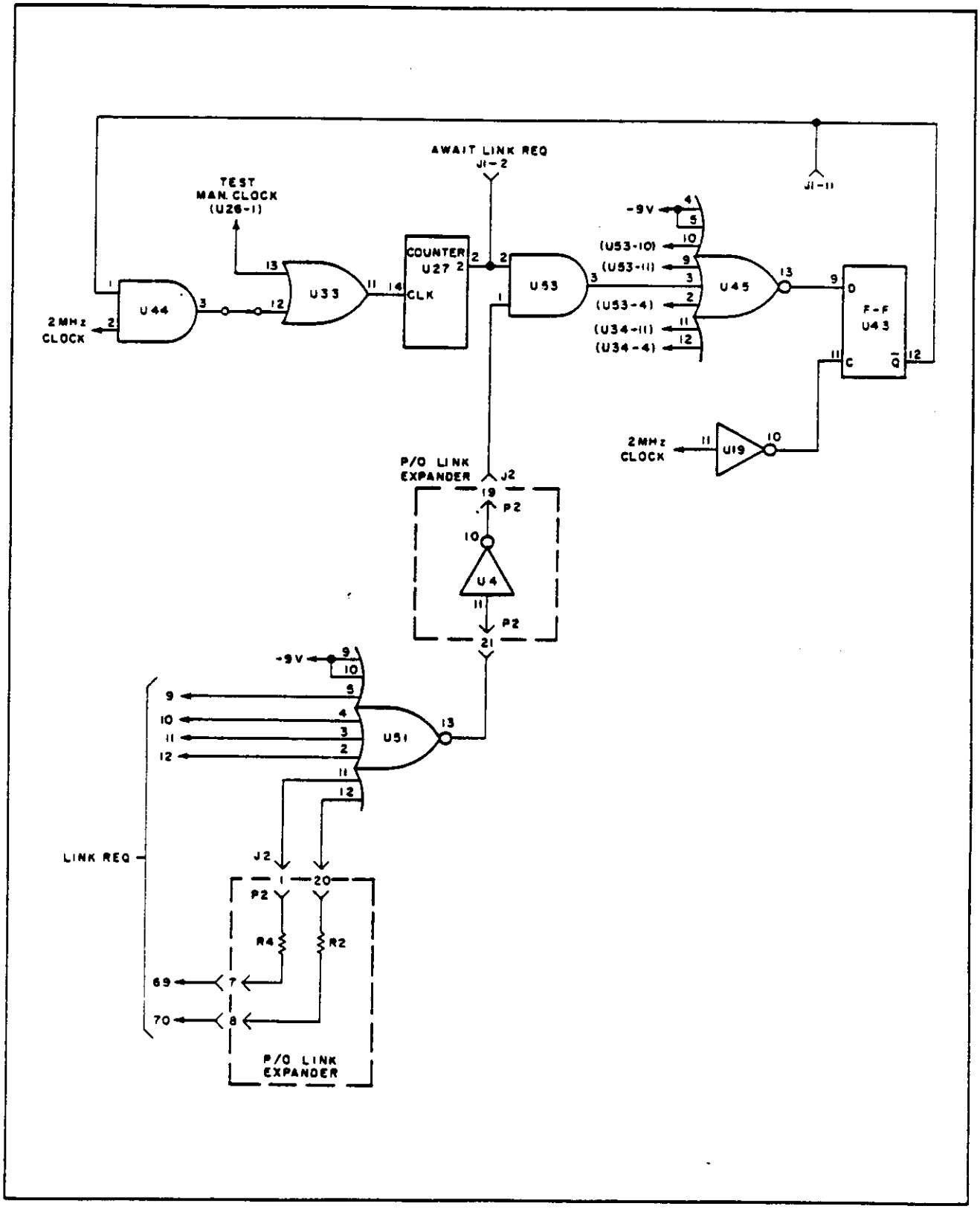


Figure 2-22 Register Card Function Counter Circuits, Await Link Request Function, Simplified Block Diagram

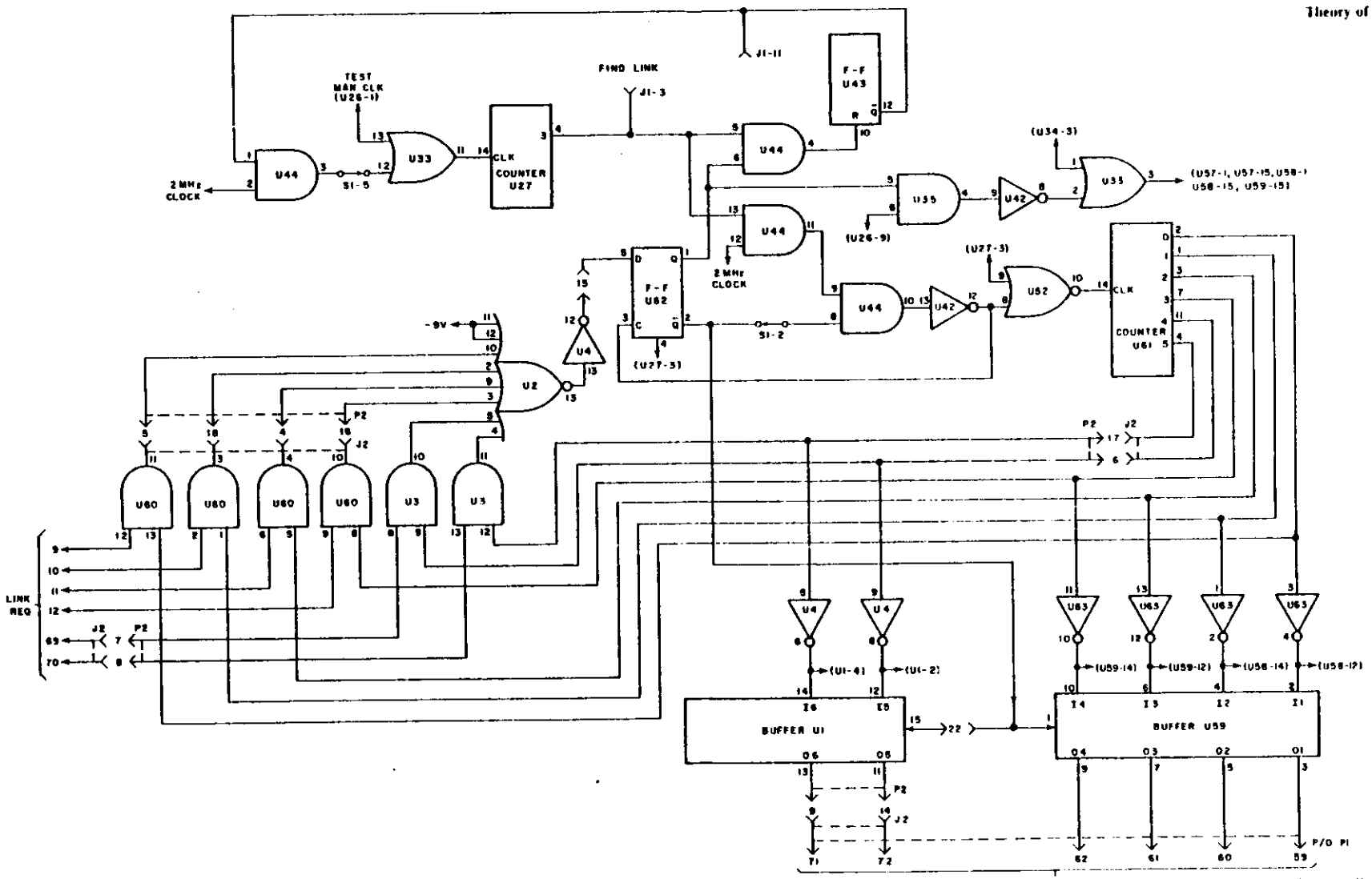


Figure 2-23 Register Card Function Counter Circuits, Find Link Function, Simplified Block Diagram

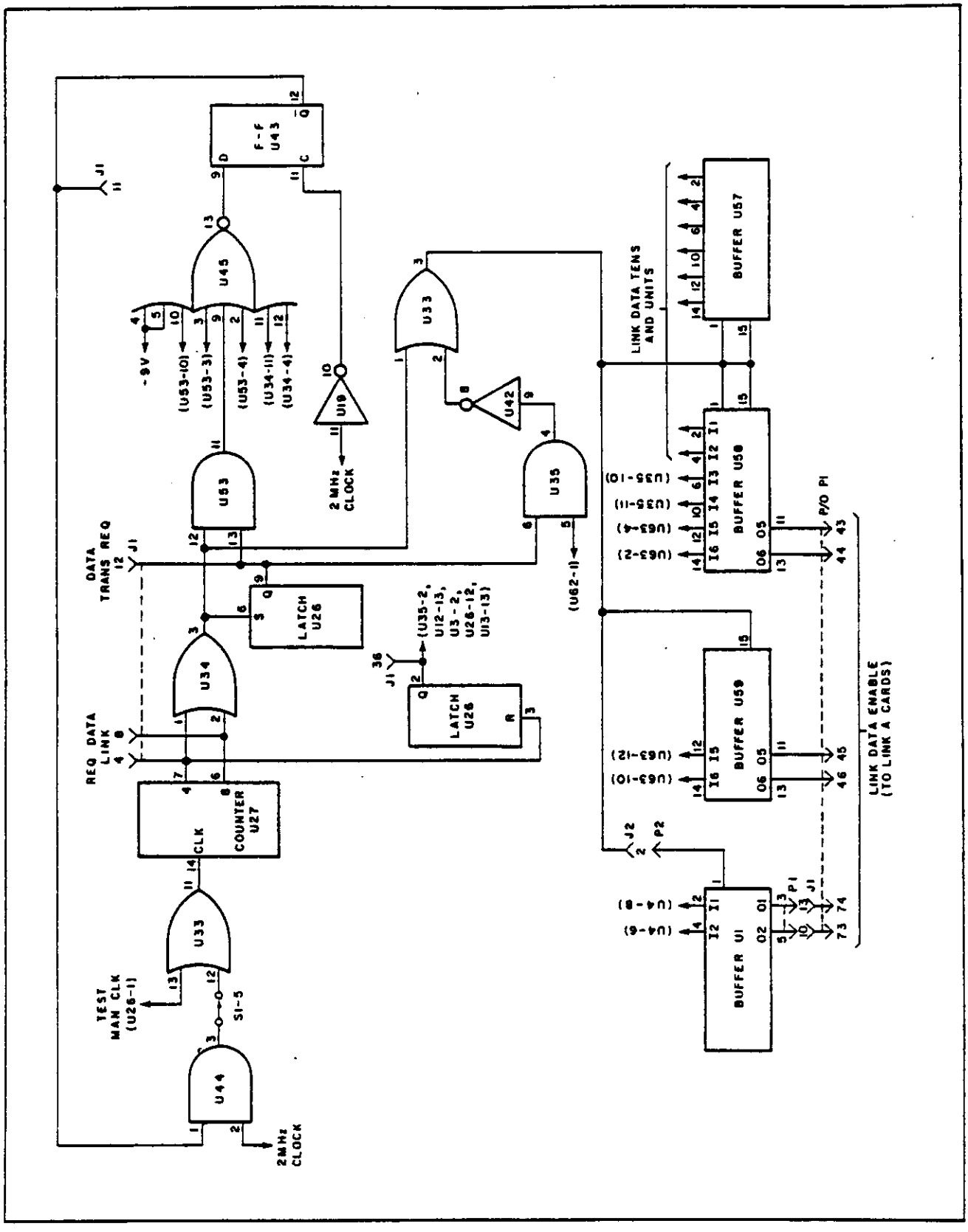


Figure 2-24 Register Card Function Counter Circuits, Request Data Link Function, Simplified Block Diagram

selectors U41 and U47 and associated gate and inverter circuits to buffers U57 and U58. Along with the address data, a load address strobe signal is supplied to buffer U58 on the trailing edge of the clock pulse through gates U34-4 and U35-10. The enabling input of both buffers is activated through gate U33-3, as described in the preceding paragraph; therefore, the register address data and the load address strobe are supplied through the buffers to the link A cards. This data is loaded into only the link A card to which a LINK DATA ENABLE signal is being supplied by the register card; at all other link A cards, the absence of a LINK DATA ENABLE signal prevents data transfer. The D input of flip-flop U43-12 is set low through gates U34-4 and U45-13, and the $\overline{Q}$ output is set high when the flip-flop is clocked through inverter U19-10 on the trailing edge of the clock pulse. Counter U27 advances one step when it is clocked through gates U44-3 and U33-11 on the leading edge of the next clock pulse.

6. *Send Register Mode Function.* (See Figure 2-26.) When counter U27 steps to count 6, gate U49-4 is activated and register mode information is supplied to buffer U57. Buffers U57 and U58 are still enabled through gate U33-3. The active output of counter U27 also triggers one-shot multivibrators U1-6 and U11-7, which establish the maximum permissible dialing time for the following dialtone and dialing function. (If the multivibrators time out before dialing is completed, the reorder address flip-flop is set through gate U3-10, inverter U13-10, and gates U33-10, U12-4, and U12-3, causing a reorder tone to be supplied to the calling party.) On the trailing edge of the clock pulse, a load mode strobe is supplied through inverter U19-10 and gates U34-11 and U35-11 to buffer U58, and the register mode data is loaded into the link A card to which a LINK DATA ENABLE signal is being supplied by the register card. The trailing edge of the clock pulse also clocks flip-flop U43-12, an the high $\overline{Q}$ output of the flip-flop enables clocking of ounter U27 through gates U44-3 and U33-11 on the leading edge of the next clock pulse.

7. *Dialtone and Dialing Function.* (See Figure 2-27.) Counter U27 steps to count 7 for the dialtone and dialing function, and remains at this step until dialing has been completed or a reorder command is generated by the dialtone and dialing circuits. In this step, the dialtone and dialing circuits of the register card supply dialtone to the calling party, receive and decode dialing pulses or DTMF tones, check the validity of the dialed number, and generate a REORDER ADDRESS signal for invalid numbers or develop binary-boded mode and address data from valid dialed numbers. When counter U27 steps to count 7, it supplies an enabling signal to the dialtone and dialing circuits to initiate their operation, and resets flip-flop U26-9 through gate U34-10 to inhibit operation of output buffers U1, U57, U58, and U59. The D input of flip-flop U43-12 remains high until dialing is completed or a reorder command is received; therefore clocking of counter U27 is inhibited. When either signal DIALING U34-10 to inhibit operation of output buffers U1, U57, U58, and U59. The D input of flip-flop U43-12 remains high until dialing is completed or a reorder command is received; therefore clocking of counter U27 is inhibited. When either signal DIALING DONE or signal REORDER ADDRESS is activated by the dialtone and dialing circuits, the D input of flip-flop is set low through gates U33-4, U53-10 and U45-13, and the Q output of the flip-flop is set high when the flip-flop is next clocked. Counter U27 is then clocked through gates U44-3 and U33-11 on the leading edge of the next clock pulse, and the counter advances one count to the request data link function.

8. *Request Data Link Function.* (See Figure 2-24.) When counter U27 advances to count 8, the register card circuits are conditioned for transfer of mode and address data derived from the dialed number to the link A card. latch U26-9 is set through gate U34-3, and an enablishing signal is supplied to output buffers U1, U57, U58, and U59 through gate U35-4, inverter U42-8, and gate U33-3. (This enabling signal remains active for the next two functions.) A LINK DATA ENABLE signal is supplied through buffer U1, U59, or U58 to the link A card that is processing the call to enable transfer of mode and address data to that card. The D input of flip-flop U43-12 is set low through gates U34-3, U53-11, and U45-13, and the $\overline{Q}$ output is set high when the flip-flop is clocked through inverter U19-10 on the trailing edge of the clock pulse. Counter U27 is then clocked through gates U44-3 and U33-11 on the leading edge of the next clock pulse, thereby advancing to the send mode function.

9. *Send Mode Function.* (See Figure 2-28.) Certain special operating features are available to the station set user by dialing a 1, 2, or 9 before dialing the number of the desired destination. Mode information is derived from the dialed special number in the dialtone and dialing circuits. When counter U27 advances to the 9 count, this mode information is sent to the link A cards, and a control current is generated and sent to the dialed destination to initiate the desired special feature. Binary-coded data derived from decoding of the dialed special feature number is supplied to the Y inputs of selector U47 from the dialtone and dialing circuits. If signal $\overline{\text{REORDER ADDRESS}}$ from the dialtone and dialing circuits is inactive (dialed number is valid), the B input of selector U47 is activated, and the Y input signals are selected for transfer to the output lines of the selector. The mode data is supplied through gates to output buffers U57 and U58, along with high levels supplied through gates U49-10, U50-11, and U52-4, and inverter U42-6, and this information is supplied through the buffers to the

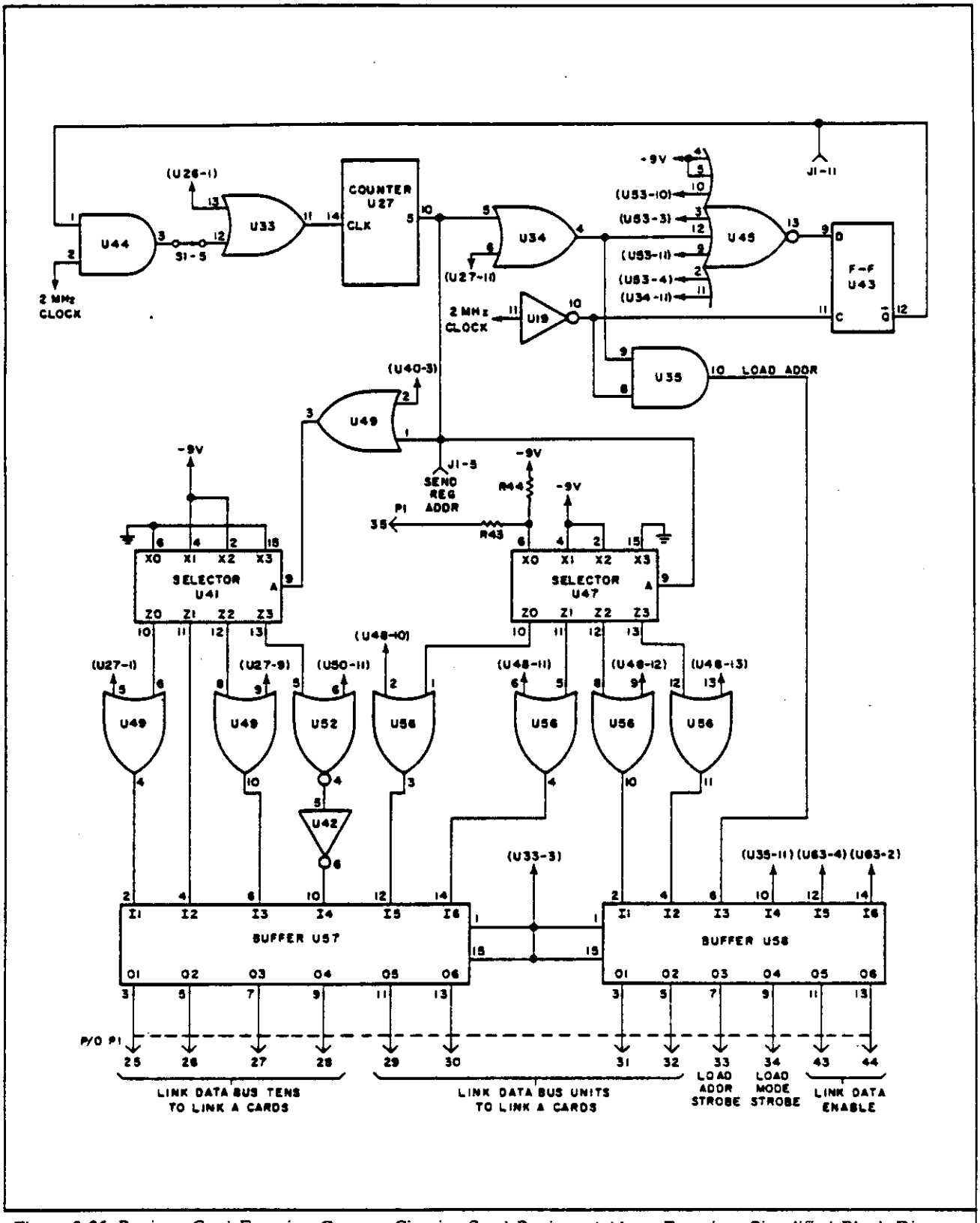


Figure 2-25 Register Card Function Counter Circuits, Send Register Address Function, Simplified Block Diagram

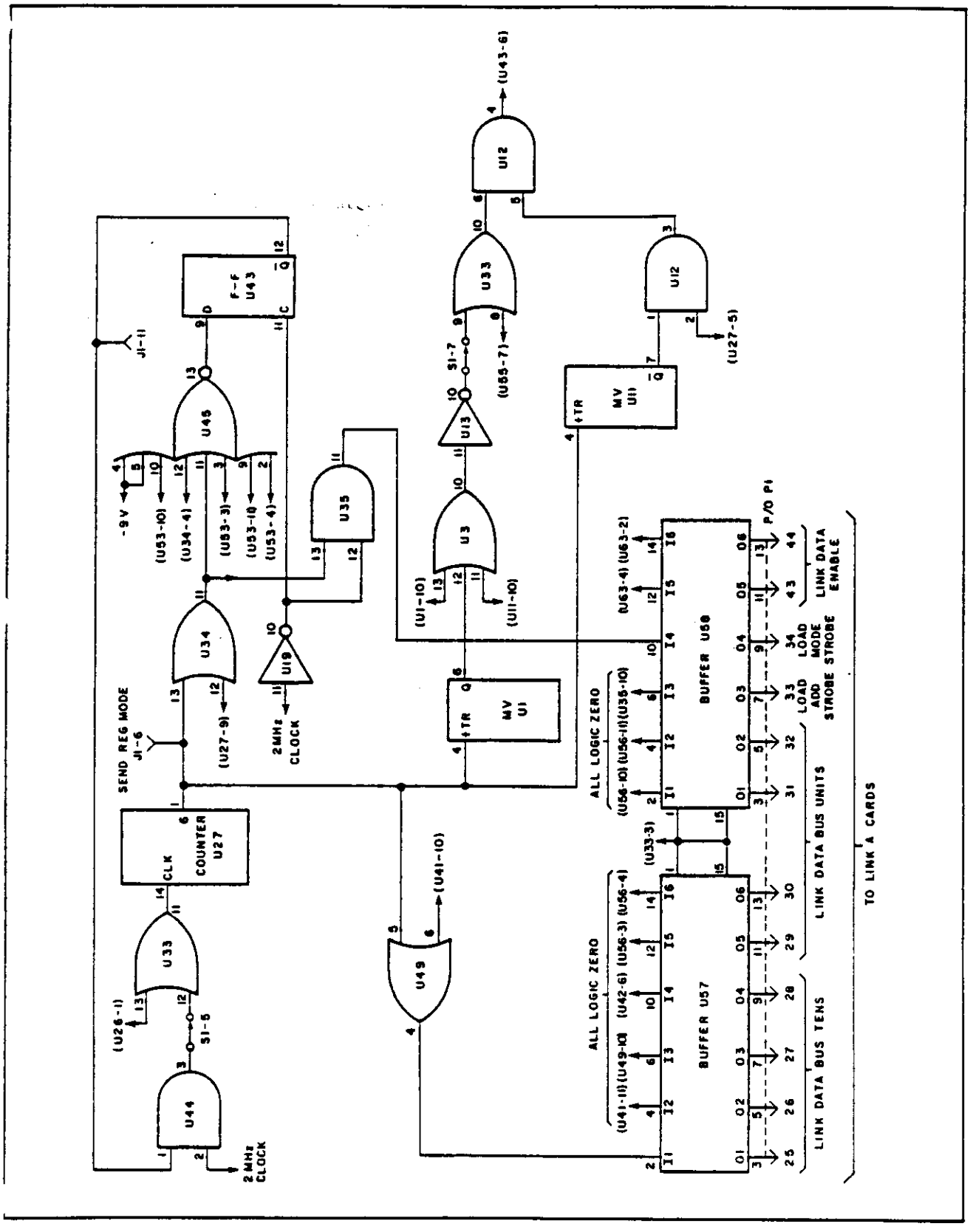


Figure 2-26 Register Card Function Counter Circuits, Send Register Mode Function, Simplified Block Diagram

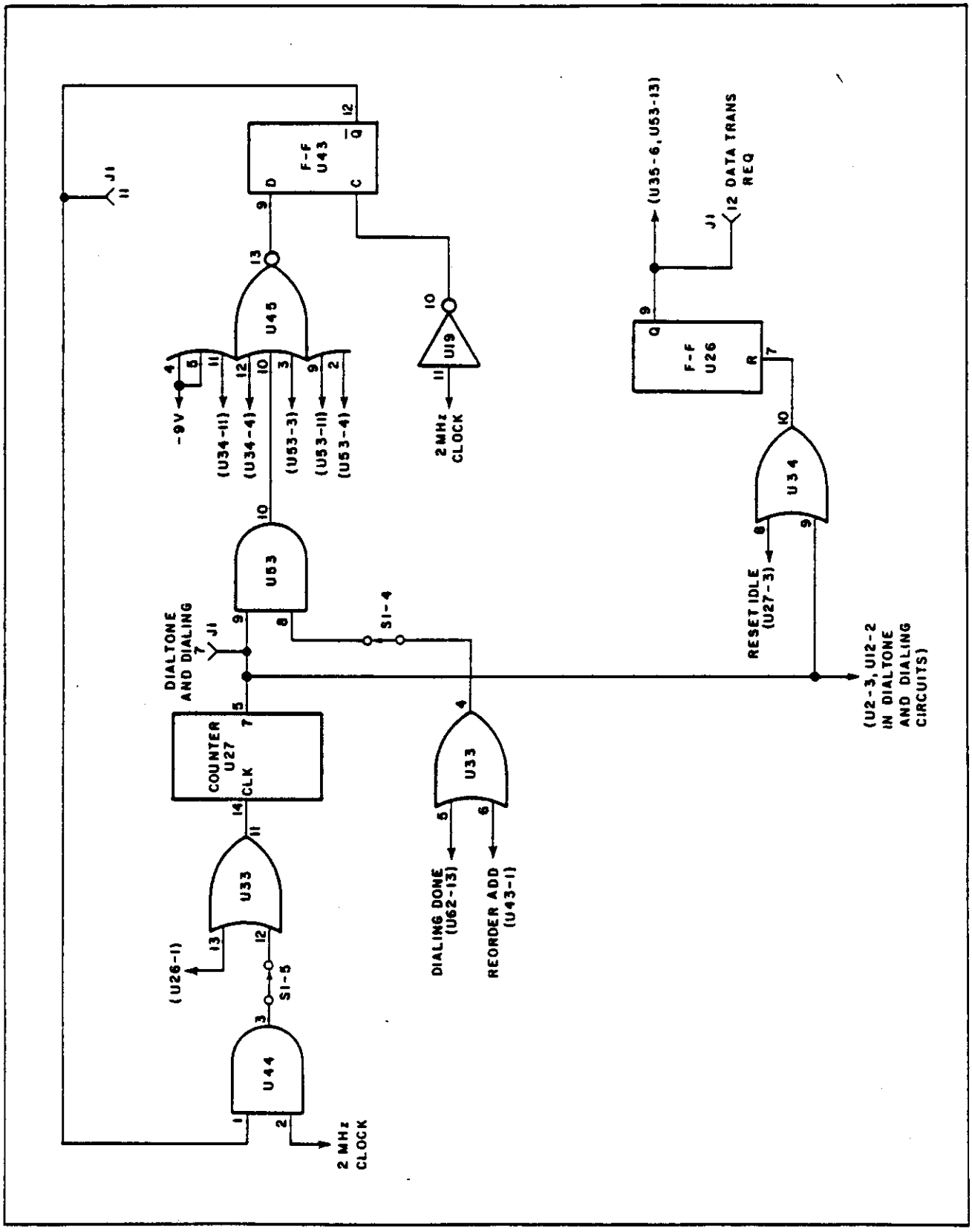


Figure 2-27 Register Card Function Counter Circuits, Dialtone and Dialing Function, Simplified Block Diagram

link A cards. On the trailing edge of the clock pulse, a load mode strobe is sent to the link A cards through gates U34-11 and U35-11, inverter U19-10, and buffer U58, and the mode information is loaded into the link A card to which an active LINK DATA ENABLE signal is supplied by the register card. On the trailing edge of the clock pulse, flip-flop U43-12 is also clocked through inverter U19-10, and the low supplied to the D input through gates U34-11 and U45-13 causes the $\overline{Q}$ output of the flip-flop to be set high. Counter U27 is then clocked through gates U44-3 and U33-11 on the leading edge of the next cloc pulse, and the counter advances one count to the send address function.

10. *Send Address Function.* (See Figure 2-29.) When counter U27 advances to the 10 count, the binary-coded dialed number (valid dialed number) or a binary-coded reorder address (invalid dialed number) is sent to the link A card to initiate cross-point switching of the analog line from the originating station set to the dialed destination, or to initiate the reorder operation. Selection of address data to be sent to the link A card is done by selectors U41 and U48. If the number 0 (operator) had been dialed, the A input of selector U41 is activated through gates U49-11, U40-3, and U49-3, and the A and B inputs of selector U48 are both inactive. Under these conditions, selector U41 transfers the signals on its X input lines to its output lines, and selector U48 provides an all-zero output. The X input lines of selector U41 are hard-wired to provide a binary-coded 9; therefore, the output of the two selectors is the binary-coded equivalent of the digits 9 and 0. If signal REORDER ADDRESS is activated through the dialtone and dialing circuits, the B input of selector U48 is activated through gate U40-10, and the A input of selector U41 is activated through gates U49-11, U40-3, and U49-3. Selector U41 selects its X input signals and selector U48 selects its Y input signals for transfer to the output lines. These inputs are hard-wired to provide the binary-coded equivalent of the digits 9 and 7, respectively, which is the reorder address. If one of the valid system destination numbers has been dialed, the B input of selector U41 and the A input of selector U48 are both activated through gate U4-4, and the selectors select the binary-coded dialed digits supplied from the dialtone and dialing circuits for transfer to their output lines. The output address data from the selectors is supplied to the link A cards through gate and inverter circuits and buffers U57 and U58. On the trailing edge of the clock pulse, a load address strobe is sent to the link A cards through gates U34-4 and U35-10, inverter U19-10, and buffer U58, and the address data is loaded into that link A card to which an active LINK DATA ENABLE signal is being supplied by the register card. On the trailing edge of the clock pulse, flip-flop U43-12 is also clocked through inverter U19-10, and the low supplied to its D input through gates &34-4 and U45-13 causes its Q output to go high. Counter U27 is then clocked through gates U44-3 and U33-11 on the leading edge of the next clock pulse, and the counter steps back to the reset idle function. The register card releases from the link A card, and is available to handle the next intercom call.

2-100. Dialing Function Counter Circuits. (See Figure 2-30.) All dialing functions are controlled by counter U16. The dialed number may be a single digit (0 for operator), a two-digit number (station address), or a three-digit number (special function number 1, 2, or 9 followed by a two-digit address). The dialing function counter circuits accomodate both two and three digit numbers and develop control signals used to process dialed number information by the other register card circuits.

2-101. Counter U16 is reset by latch U26-10 when register function counter U27 steps to the reset idle position, and when counter U16 is clocked past count 9 at the end of a three-digit dialing cycle. At count 0, gates U32-9 and U18-10 are enabled, and counter U16 is clocked through gates U18-10 and U25-4 by the 2 MHz clock. Counter U16 steps to count 1; because gate U32-9 is no longer enabled, clocking ceases and the counter remains at count 1 until dialing of the first digit is completed.

2-102. If DTMF tone dialing is used in the system, signal TONE DATA VALID is activated at the end of each valid dialed number; if pulse type dialing is used, a signal from detector U46-7 in the dialtone and dial counter circuits is activated at the end of each dialed number. Each of these signals clocks a flip-flop that locks out the other signals from the clocking input to counter U16. For example: if signal TONE DATA VALID is activated, it clocks flip-flop U5-13, and the low $\overline{Q}$ output of the flip-flop inhibits operation of gate U17-6. The high Q output of the flip-flop clocks flip-flop U10-1 through gates U18-3 and U25-3, and the high Q output of flip-flop U10-1 is supplied to the D input of flip-flop U10-13. On the next positive transition of the 2 MHz clock signal, the high input is clocked through flip-flop U10-13, and counter U16 is clocked through gates U18-11 and U25-4, advancing to the count 2 position. Flip-flop U10-13 resets flip-flop U10-1 through gate U18-4. In systems that use pulse-type dialing, operation is similar, except that flip-flop U5-1 and gate U17-6 are active instead of flip-flop U5-13 and gate U18-3.

2-103. When counter U16 advances to count 2, its count 2 output clocks flip-flop U9-1 through gates U7-4 and U25-10 if the first number dialed was any number other than 1, 2, or 9. (Any of these special function numbers inhibits operation of gate U7-4 through gate U32-6.) If flip-flop U9-1 is clocked, its $\overline{Q}$ output is set low to signify completion of dialing of digit 1 of the address. This low inhibits further operation of digit 1 counter U31 in the

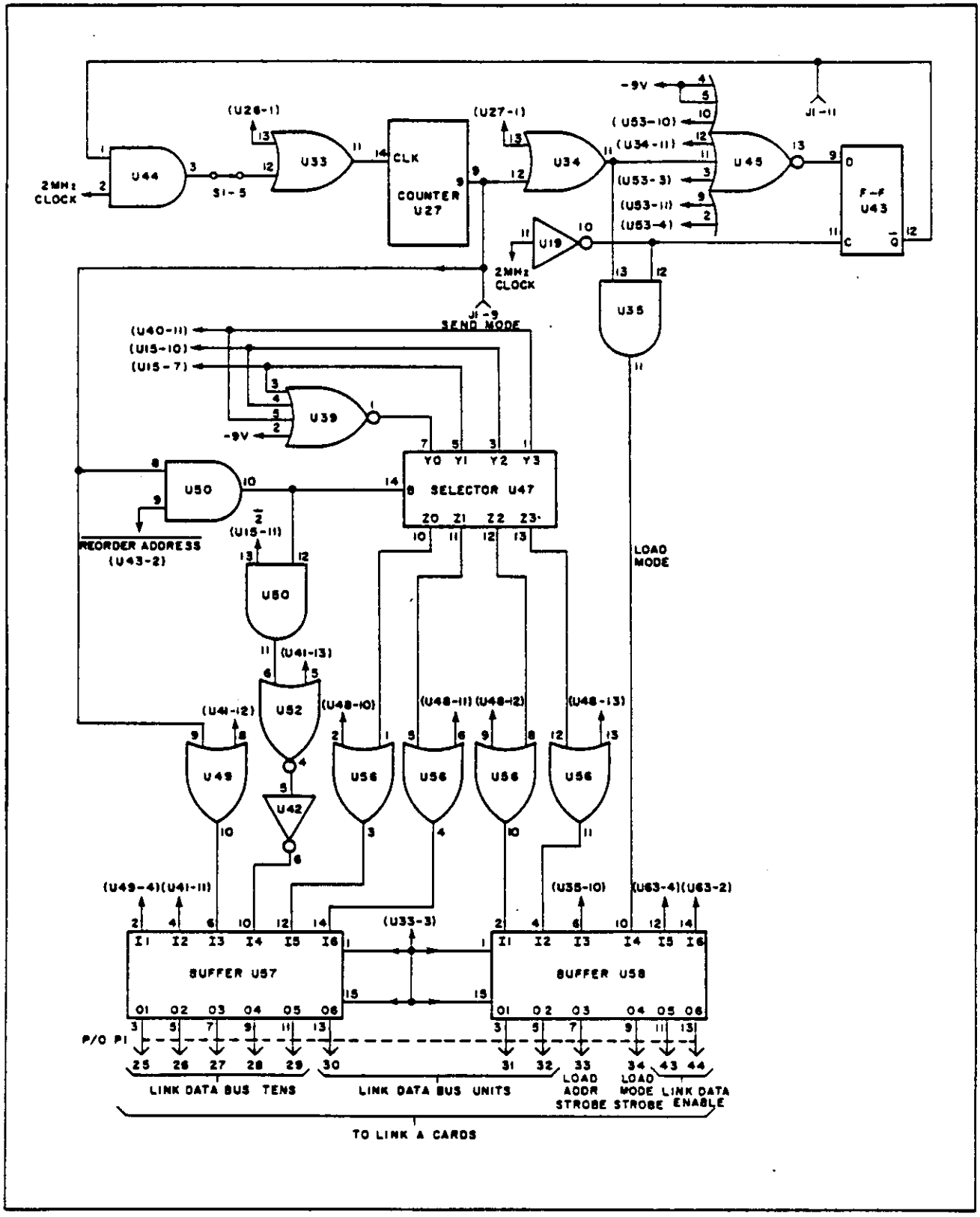


Figure 2-28 Register Card Function Counter Circuits, Send Mode Function, Simplified Block Diagram

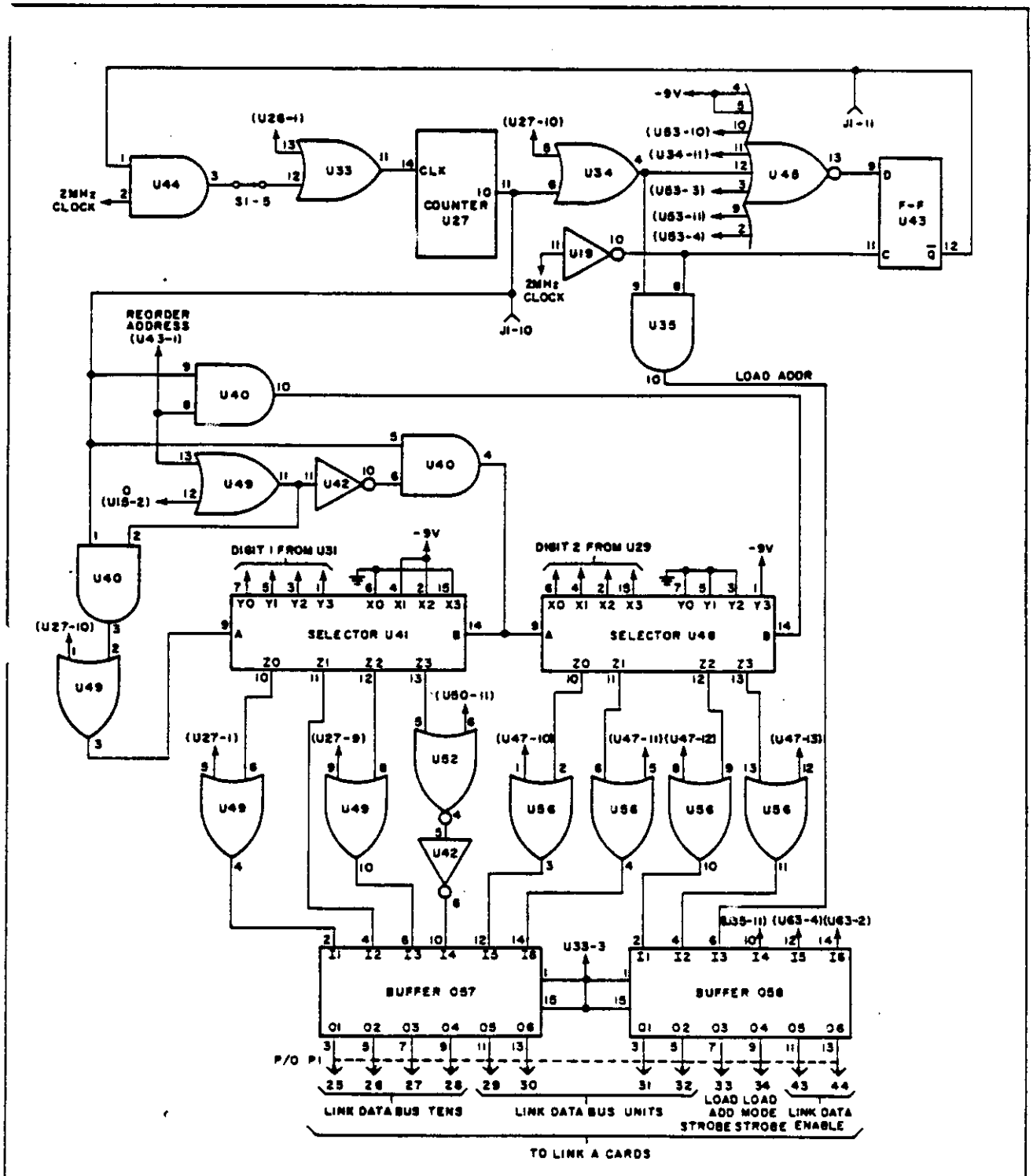


Figure 2-29 Register Card Function Counter Circuits, Send Address Function, Simplified Block Diagram

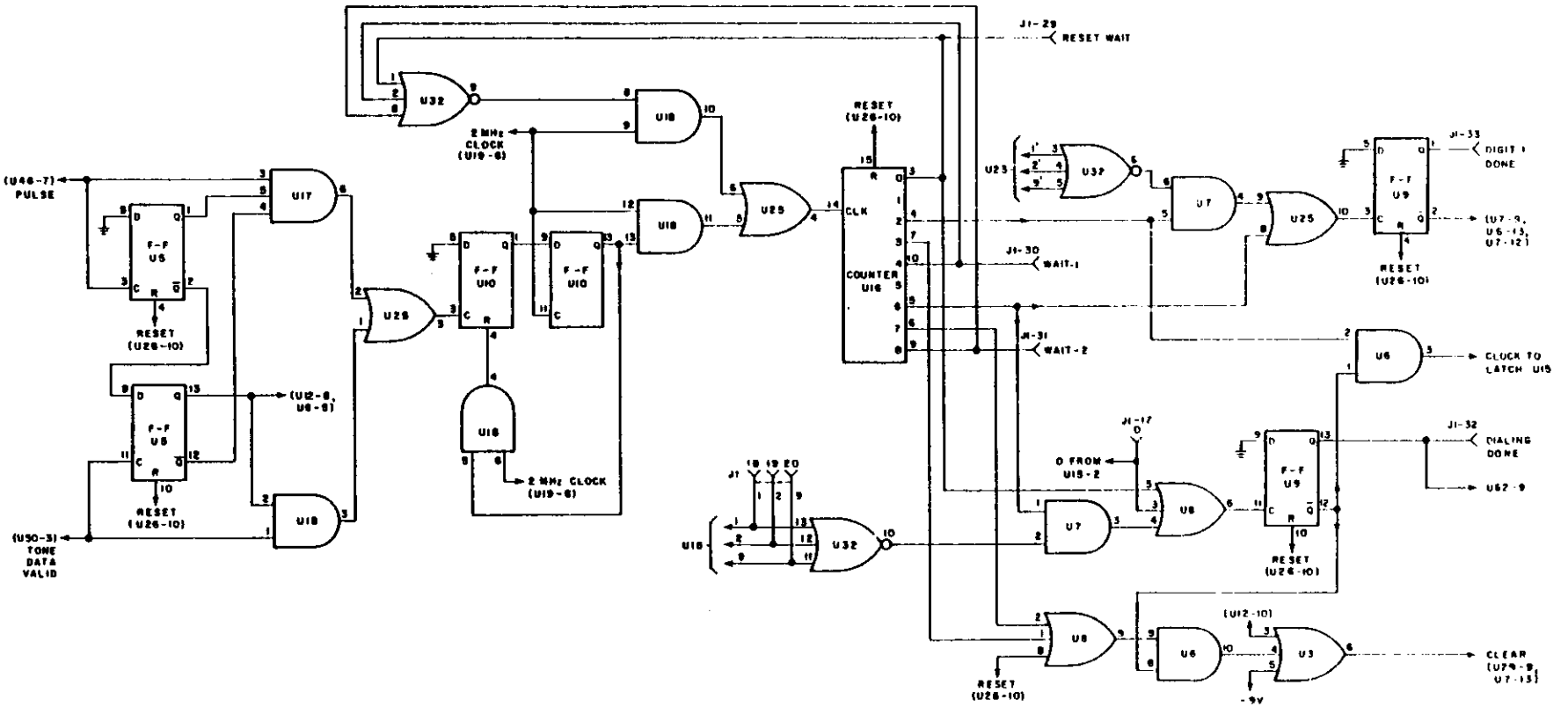


Figure 2-30 Register Card Dialing Function Counter Circuits, Simplified Block Diagram

dialtone and dial counter circuits. If a special function number has been dialed, flip-flop U9-1 remains in its reset state. The count 2 output of counter U16 also clocks latch U15 through gate U6-3 to cause storage of the special function number in the latch. All inputs to gate U32-9 being inactive, counter U16 is then clocked through gates U18-10 and U25-4 by the next 2 MHz clock pulse, and the counter advances to count 3.

2-104. At count 3, a clearing signal to the digit counters in the dialtone and dial counter circuits is activated through gates U8-9, U6-10, and U3-6. If the first digit dialed was a special function number, this signal clears both counters in preparation for acceptance of dialed address digits; if the first number dialed was the first digit of the address, this signal clears the digit 2 counter only. On the next positive transition of the 2 MHz clock signal, counter U16 is clocked through gates U18-10 and U25-4, and the counter advances to count 4.

2-105. At count 4, further clocking of counter U16 through gate U18-10 is blocked because of the low developed by gate U32-9; therefore, the counter waits at this count until dialing of the next digit has been completed. At this point, signal TONE DATA VALID (DTMF dialing) or the signal from detector U46-7 (pulse-type dialing) is activated, and counter U16 is clocked as described in paragraph 2-102, thereby advancing to count 5. On the next positive transition of the 2 MHz clock, counter U16 is again clocked through gates U18-10 and U25-4 and it advances to count 6.

2-106. The second dialed digit may be the first digit of the address (if the first number dialed was a 1, 2, or 9), or it may be the second digit of the address (if no special function number was dialed). If a special function number had been dialed, the count 6 output of counter U16 clocks flip-flop U9-1 through gate U25-10 to signify completion of dialing of the first digit of the address. If the first number dialed had been the first digit of the address. If the first number dialed had been the first digit of the address, flip-flop U9-1 will have been already clocked, and the count 6 output of counter U16 has no effect on this flip-flop; however, the count 6 output clocks flip-flop U9-13 through gates U7-3 and U8-6 to signify completion of dialing (receipt of two *address* digits). If the first number dialed had been a special function number rather than an address digit, clocking of flip-flop U9-13 is inhibited by gate U32-10 since dialing has not yet been completed. Counter U16 is clocked through gates U18-10 and U25-4 on the positive transition of the next 2 MHz clock pulse, and the counter advances to count 7.

2-107. At count 7, a clear signal is activated through gates U8-9, U6-10, and U3-6 if dialing has not yet been completed. This signal causing clearing of digit 2 counter U29 in the dialtone and dial counter circuits in preparation for receipt of the second digit of the address. Counter U16 is then clocked through gates U18-10 and U25-4 on the positive transition of the next 2 MHz clock pulse, and the counter advances to count 8.

2-108. At count 8, counter U16 waits until dialing of the second digit of the address has been completed. Upon completion of dialing of this digit, clocking of counter U16 is initiated by signal TONE DATA VALID or the signal from detector U46-7, and counter U16 advances to count 9, then to count 0, on successive 2 MHz clock pulses. At step 0, flip-flop U9-13 is clocked through gate U8-6 to signify completion of dialing. All circuits will then be reset when the register card initiates another cycle of operation.

2-109. To summarize operation of counter U16:

1. *If a Valid Three-Digit Number Is Dialed:*
   a. The counter remains at count 0 until dialing of the special function number has been completed. The counter then advances to count 1 and count 2 on successive 2 MHz clock pulses.
   b. At count 2, the dialed special function number is stored in special function latch U15, and the counter advances to count 3 on the leading edge of the next 2 MHz clock pulse.
   c. At count 3, a clear signal to digit 1 counter U31 and digit 2 counter U29 is activated to clear the counters to receive the first digit of the address. Counter U16 advances to count 4 on the leading edge of the next 2 MHz clock pulse.
   d. At count 4, the counter waits for completion of dialing of the first digit 1 of the address. The counter is then advanced to count 5 and count 6 on successive 2 MHz clock pulses.
   e. At count 6, flip-flop U9-1 is clocked to activate signal DIGIT 1 DONE and inhibit further operation of digit 1 counter U31. Counter U16 advances to count 7 on the leading edge of the next 2 MHz clock pulse.
   f. At count 7, a clear signal that causes clearing of digit 2 counter U29 is activated, and counter U29 is cleared for reception of the second digit of the address. (This clear signal does not affect digit 1 counter U31 at this time because signal DIGIT 1 DONE has been activated.) Counter U16 is clocked to count 8 on the leading edge of the next 2 MHz clock pulse.
   g. At count 8, counter U16 waits for completion of dialing of the second digit of the address. When dialing of the second digit has been completed, the counter is clocked to count 9, then back to count 0, on successive 2 MHz clock pulses.

h. At count 0, flip-flop U9-13 is clocked to activate signal DIALING DONE. This signal initiates transfer of received address data from the register card to the link A card. Counter U16 remains at count 0 until the next operating cycle begins.

2. *If a Valid Two-Digit Address Is Dialed:*
   a. Counter U16 waits at count 0 until dialing of the first digit of the address has been completed. The counter is then advanced to count 1, then to count 2, on successive 2 MHz clock pulses.
   b. At count 2, flip-flop U9-1 is clocked to activate signal DIGIT 1 DONE and inhibit further operation of digit 1 counter U31. Special function latch U15 is also clocked; since no special function number has been dialed, all zeros are clocked into the special function latch. Counter U16 is clocked to count 3 on the leading edge of the next 2 MHz clock pulse.
   c. At count 3, a clear signal that clears digit 2 counter U29 is activated, and counter U16 is advanced to count 4 on the leading edge of the next 2 MHz clock pulse.
   d. The counter waits at count 4 until dialing of the second digit of the address has been completed. The counter then is advanced to count 5, then to count 6, on successive 2 MHz clock pulses.
   e. At count 6, flip-flop U9-13 is clocked thereby activating signal DIALING DONE which causes transfer of address data from the register card to the link A card. Counter U16 is then advanced to count 7, then to count 8, on successive 2 MHz clock pulses.
   f. Counter U16 waits at count 8 until it is reset at the beginning of the next register card operating cycle.

2-110. Dialtone and Dial Counter Circuits. (See Figure 2-31.) The dialtone and dial counter circuits supply dialtone to the calling party, and receives and processes dialed data. When register function counter U27 is at the reset idle function, latch U26-10 is set by signal RESET IDEL, and the latch activates a reset signal that resets flip-flops U5-1 and U5-13, and clears counters U31 and U29 through gates U8-9, U6-10, U3-6, and U7-11. Flip-flop U4-2 is also reset through gate U3-9 by signal RESET IDLE, and the flip-flop turns on FET switch Q2. Dialtone from the tone generator card is supplied through FET switch Q2, operational amplifier U54-1, transistor Q1, and the primary winding of transformer T1 to the analog line to the link A cards. When the register card begins processing of an intercom call, this dialtone is sent to the calling party through the link A card when register function counter U27 reaches the send register address function. When the register function counter advances to the send register mode function, a one-shot multivibrator (U11-7) is triggered. When the register function counter advances to the dialtone and dialing function, latch U26-10 is reset through gate U14-13 when multivibrator U11-7 times out. The latch deactivates signal RESET and clocks flip-flop U4-2 through inverter U42-2 to turn off FET switch Q2. The calling party then dials the first number. Either DTMF or pulse-type dialing may be used in the system.

2-111. If DTMF dialing is used, the DTMF dial signal is supplied from the station card serving the calling station set, through the active link A card, to transformer T1. The DTMF signal is applied through transformer T1, DTMF group filters U37 and U38, and operational amplifiers U36-1 and U36-7 to DTMF digital filter U20, which develops a binary-coded digital output that corresponds to the dialed number. At the end of each dialed number, the DTMF digital filter activates a strobe signal and a clock signal. The binary-coded digital output of DTMF digital filter U20 is supplied through buffers U28-6, U28-10, U28-2, and U28-4 to digit 1 counter U31 and digit 2 counter U29. The binary coded output is also checked by gates U21-1, U21-13, and U14-1 and inverters U13-8, U13-4, and U13-6. If the binary-coded output is equivalent to the number 11 or 12 (invalid numbers from key pad), activation of signal TONE DATA VALID is inhibited through gates U52-11 and U50-3, no further dialing action can take place, and a reorder signal is eventually sent to the calling party. If the dialed number is not 11 or 12, signal TONE DATA VALID is activated to enable clocking of dialing function counter U16. Signal TONE DATA VALID also resets flip-flop U4-2 through gate U3-9 to again send dialtone to the calling party, and clocks flip-flop U5-13. The high output of flip-flop U5-13 activates signal LOAD through gate U6-4 to cause loading of the binary-coded digital data into the digit 1 and digit 2 counters. If the binary-coded output of filter U20 corresponds to the number 10 (operator), signal CLEAR is activated through gates U14-1, U12-10, and U3-6, and this signal clears digit 1 counter U31 via gate U7-11. The output of digit 1 counter U31 is supplied to decoder U23 and to the register function counter circuits. The clock output of filter U20 clocks flip-flop U62-13, which signifies whether or not dialing has been completed.

2-112. If the first number dialed was a special function number (1, 2, or 9), this number is clocked into a special function latch under control of dialing function counter U16. Digit 1 counter U31 and digit 2 counter U29 are cleared through gates U8-9, U6-10, and U3-6 when dialing function counter U16 advances to count 3. If the first number dialed was the first digit of the address, signal DIGIT 1 DONE is activated at count 2 of dialing function counter U16, and only digit 2 counter U29 is cleared at count 3.

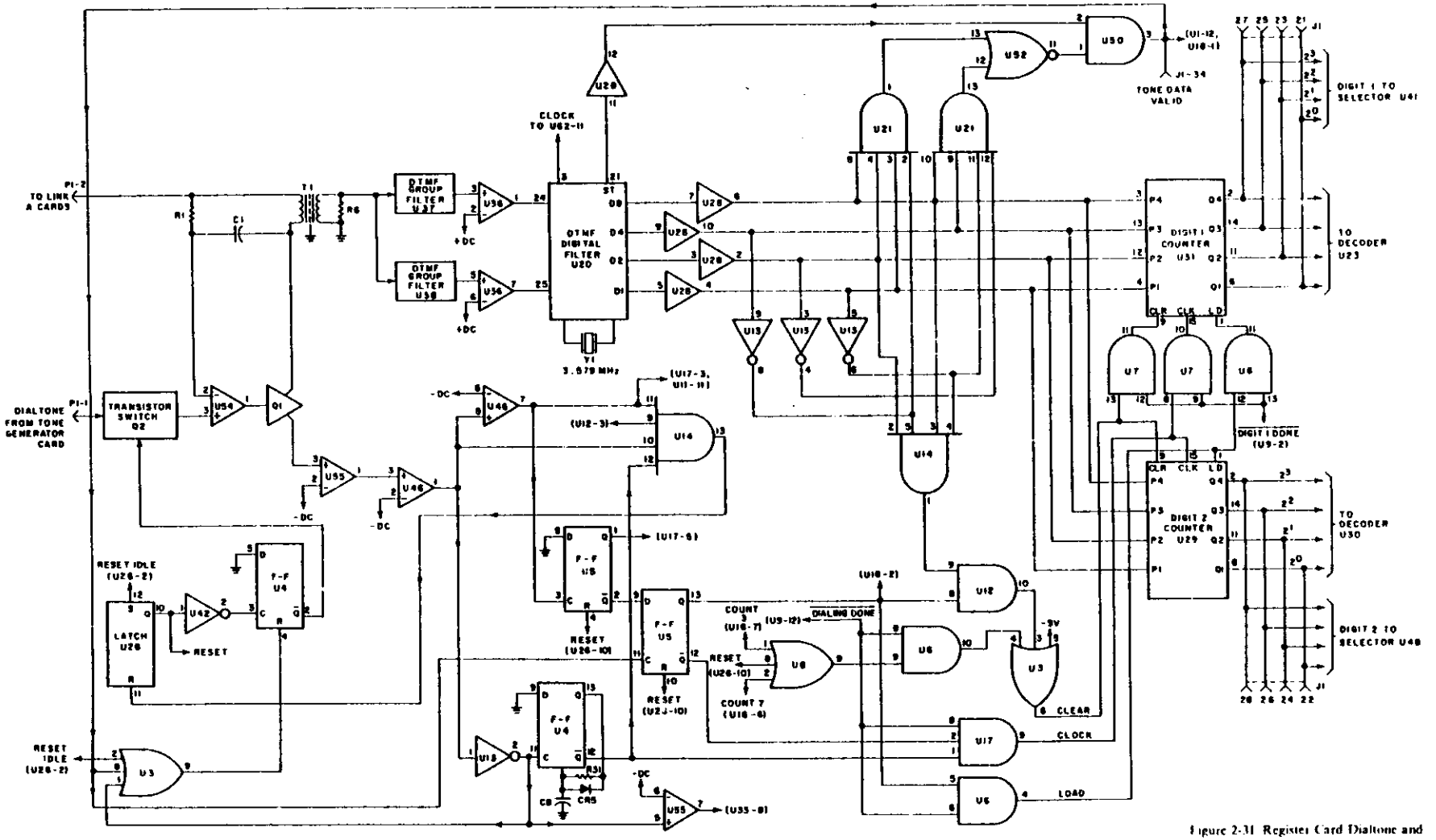


Figure 2-31 Register Card Dialtone and Dial Counter Circuits, Simplified Block Diagram

2-113. The following dialed digit(s) are handled in a similar manner. If the first number dialed had been a special function number, the first digit of the address is loaded into digit 1 counter U31, signal $\overline{\text{DIGIT 1 DONE}}$ is activated to prevent any further operation of counter U31, and the second digit of the address is loaded into digit 2 counter U29. When dialing has been completed, signal $\overline{\text{DIALING DONE}}$ is activated, and further clearing, clocking, or loading of the digit counters is inhibited. The address data stored in counters U31 and U29 is supplied to decoders U23 and U30, and to the register function counter circuits.

2-114. If pulse-type dialing is used in the system, dialtone is supplied to the calling party in the same manner as described for DTMF dialing. Dial pulses from the calling station are routed through the associated station card and the active link A card to operational amplifier U54-1 on the register card. The dial pulses are amplified and shaped by voltage comparators U55-1 and U46-1, and the pulses clock flip-flop U4-13, which is connected for toggle operation. Flip-flop U4-13 develops a low Q output pulse for each input dial pulse, and these pulses clock digit 1 counter U31 and/or digit 2 counter U29 (depending upon which digit is being processed) to enter the dialed number into the counters. The dial pulses are also applied through voltage comparator U55-7 to gate U33-10 in the validity checking circuits, and through gate U3-9 to the reset input of flip-flop U4-2. Flip-flop U4-2 turns on transistor switch Q2 to again supply dialtone to the calling party. Upon completion of dialing of a number, detector U46-7 clocks flip-flop U5-1 to enable clocking of dialing function counter U16 to the next step. Selection of digit 1 counter U31 and digit 2 counter U29 for clearing and clocking is controlled by signals $\overline{\text{DIGIT 1 DONE}}$, COUNT 3, and COUNT 7 from the dialing function counter circuits in a manner similar to that discussed for DTMF dialing.

2-115. **Validity Checking Circuits.** (See Figure 2-32.) The validity checking circuits check dialed numbers for validity. If an invalid number is dialed, or if dialing has not been completed within a preset interval, a REORDER ADDRESS is supplied to the link A card. Output binary-coded digital data from digit 1 counter U31 is decoded by decoder U23, and the output line that corresponds to the dialed number is activated. If the first number dialed was a special function number or 0, this number is loaded into latch U15 when the latch is clocked through gate U6-3 at count 2 of dialing function counter U16. This latch output is applied to the register function counter circuits to develop the mode signal that is sent to the link A card. The first digit of the address is then received from digit 1 counter U31, and this digit is decoded. Similarly, the second digit of the address is received from digit 2 counter U29, and this digit is decoded by decoder U30. The outputs from decoders U23 and U30 and latch U15 are supplied to gate circuits that hold the D input of flip-flop U43-1 low if the dialed number is system number. For example: if the number 991 had been dialed, the output level of gate U17-10 is set high by the 9 output of latch U15, the 9 output of decoder U23, and (through gate U22-13 and inverter U42-4) by the 1 output of decoder U30. The high output of gate U17-10 sets the D input of flip-flop U43-5 low through gate U39-13. Any other valid system number produces a similar effect through various gate and inverter circuits.

2-116. At the completion of dialing, flip-flop U9-13 is clocked from the dialing function counter circuits through gate U8-6 when the dialing function counter resets to count 0 (three-digit number dialed), or through gates U32-10, U7-3, and U8-6 on count 6 (two digit number dialed). Flip-flop U9-13 is also clocked immediately upon receipt of a 0 special function number. When flip-flop U9-13 is clocked, it sets the D input of flip-flop U62-13 high, and this high is transferred to the Q output when flip-flop U62-13 is clocked by DTMF digital filter U20, thereby activating signal DIALING DONE. This signal clocks flip-flop U43-1; if the dialed number is a vlid number, the low D input is transferred to the output, and signals REORDER ADDRESS and $\overline{\text{REORDER ADDRESS}}$ remain inactive. On the other hand, if the dialed number is an invalid system number, the D input of flip-flop U43-1 is set high, and the high is transferred to the output when the flip-flop is clocked, thereby activating signals REORDER ADDRESS and $\overline{\text{REORDER ADDRESS}}$. These signals are supplied to the register function counter circuits to cause transfer of a reorder address to the link A card. Signals REORDER ADDRESS and $\overline{\text{REORDER ADDRESS}}$ can also be activated through setting of flip-flop U43-1. Such setting occurs if dialing is not completed within a preset time. One-shot multivibrators U11-10, U1-10, and U1-6 are used to establish the required time intervals for dialing.

2-117. C.O. LINE CARD, DETAILED THEORY OF OPERATION

2-118. **General.** One C.O. line card is provided in the system for each C.O. line. The C.O. line cards receive commands from the station cards. Each C.O. line card provides all of the following functions:

1. It detects incoming ring signals.
2. It provides C.O. line seizure.
3. It implements the hold function.
4. It implements the flash function.
5. It provides a buffer between the tone generator card and the C.O. line for music-on-hold (MOH).

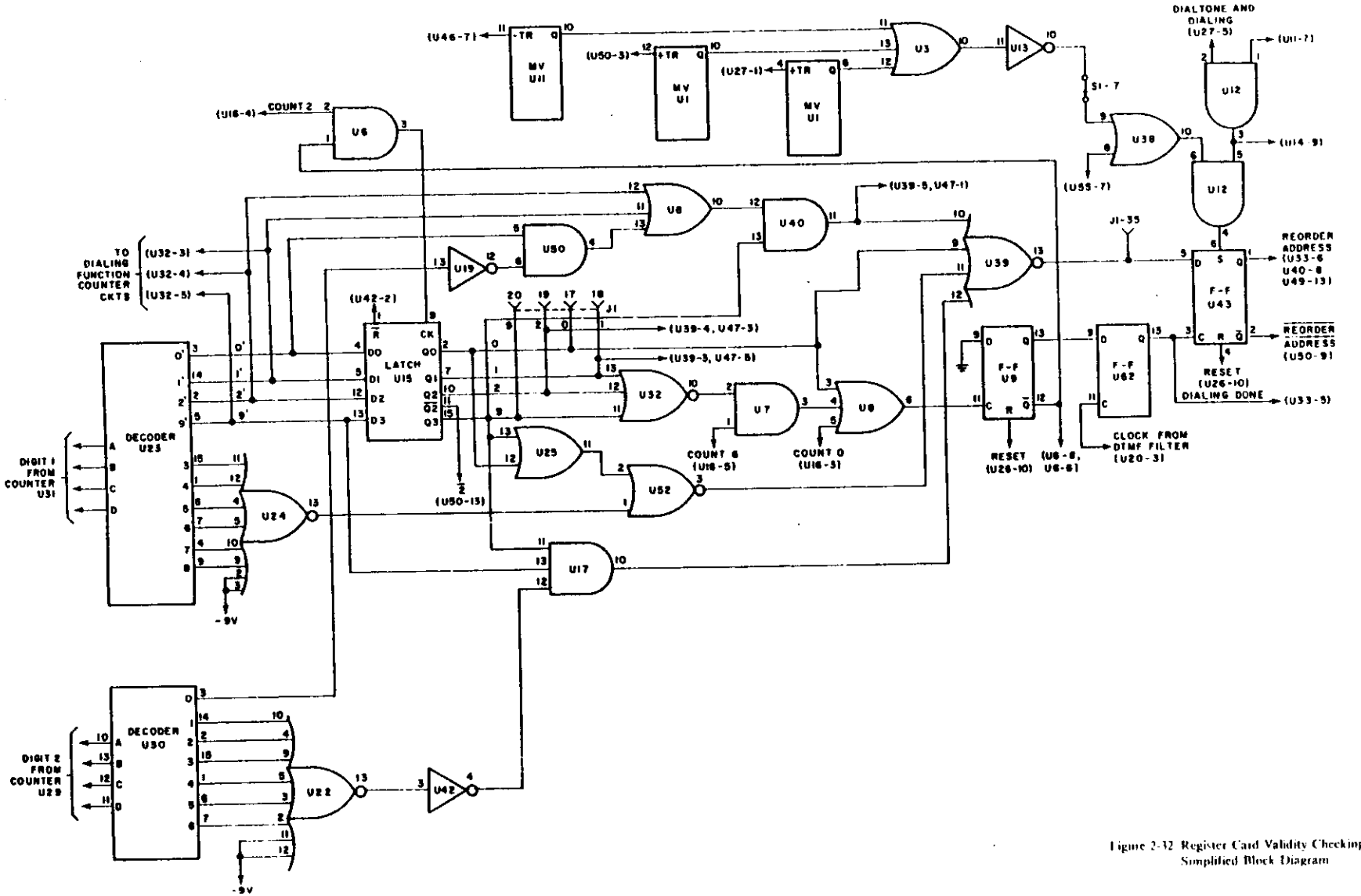


Figure 2-32 Register Card Validity Checking Circuits, Simplified Block Diagram

2-119. Ring Signal Detection Circuits. (See Figure 2-33.) A ring signal on the C.O. line served by the C.O. line card is detected by diode CR9, and the resulting signal is coupled through photo-coupler AT1, gate U13-11, and voltage comparator U4-7 to the trigger input of one-shot multivibrator U10-6. The multivibrator provides a high pulse output that conditions gate U14-9, and signal S-FLASH from the tone generator card is coupled through gates U14-9 and U12-9, transistor Q6, and operational amplifier U9-1 to the DXP input for that C.O. line on each of the station cards. This DXP signal causes the LED for that C.O. line on each station set to be flashed at the S-FLASH rate to indicate receipt of a ring signal. At the same time, multivibrator U10-6 activates signals I/C ENA-N through inverters U11-8 and U11-10.

2-120. One I/C ENA-N signal developed by each of C.O. line cards 1 through 18 is supplied to the tone generator card, where it is used to developa C.O. audible enable signal. The stations in the system can be assigned to groups associated with the various C.O. lines for C.O. audible enabling on an incoming ring signal. For example, signal $\overline{\text{COE GPA}}$ on the tone generator card is activated through gate U3-6 when a ring signal is detected on any of C.O. lines 1, 2, or 3, and this signal is supplied to station cards 30 through 35, which constitute the C.O. audible group A cards. Switch S1-7 on each of these station cards, when closed, enables the C.O. audible circuit on that station card to respond to the $\overline{\text{COE GPA}}$ signal. Signals $\overline{\text{COE GPB}}$ through $\overline{\text{COE GPG}}$ on the tone generator card are similarly activated by ring signals on other C.O. lines. C.O. audible group B consists of station cards 36 through 51 and responds to ring signals on C.O. line 4, 5, or 6; C.O. audible group C consists of station cards 52 through 47 and responds to ring signals on C.O. line 7, 8, or 9; C.O. audible group D consists of station cards 48 through 53 and responds to ring signals on C.O. line 10, 11, or 12; C.O. audible group E consists of station cards 54 through 59 and responds to ring sinals on C.O. line 13, 14, or 15; and C.O. audible group F consists of station cards 60 through 65 and responds to ring signals on C.O. line 16, 17, or 18. The station cards can be arranged in an alternate C.O. audible grouping if switch S1-7 is opened. Signal $\overline{\text{COE 15-18, 19}}$, which is activated by ring detection on any of C.O. lines 15 through 18, is supplied to station cards 30 through 53; any of these station cards can be assigned to this C.O. audible group by closing switch S1-6 on that station card. Station cards 54 through 69 can also be arranged in a similar manner to respond to ring detection on any of C.O. lines 15 through 18 through activation of signal $\overline{\text{COE 15-19 21}}$ and closing of switch S1-6 on these station cards. (Signals ENA19 and ENA21 are not presently used in this system.)

2-121. The C.O. audible signal can also be supplied to all page points in the system for night ring mode operation in response to an incoming C.O. line ring so long as the page circuits are inactive with another signal. When a ring is detected on any C.O. line, signal $\overline{\text{NR ENA}}$ on the tone generator card is activated through gates U22-10 and U9-11 and level shifter U14-7, provided that signals $\overline{\text{BGM DISABLE}}$ from the page card and LK CONT and BGM ENA from station card 58 (operator position) are all inactive. Signal $\overline{\text{NR ENA}}$ is applied from the tone generator card to the page card where it enables application of the C.O. audible signal from the tone generator card to the all-call paging circuits.

2-122. When the incoming call is answered by one of the station set users, a seize current is sent from the answering station card to the C.O. line card, and signal SEIZE on the C.O. line card is activated. Signal SEIZE resets multivibrator U10-6 through voltage comparator U1-1 and gate U13-10, thereby terminating the I/C ENA-N signals and turning off gate U14-9 to clock the S-FLASH signal from the DXP line. At the same time, a low is supplied from gate U2-10 in the seize circuits to gate U7-4; the resulting high output of gate U7-4 blocks any further ring signals at gate U13-11, and sets signal DXP to the busy voltage level through transistor Q5 and operational amplifier U9-1 to cause steady lighting of the associated C.O. line LED at the station sets to indicate that the C.O. line card is busy. If the user at the answering station set should place the call on hold, hold multivibrator U6-1 activates gate U14-6 to enable application of the F-FLASH signal from the tone generator card to the DXP circuits, thereby causing flashing of the C.O. line LED in each of the station sets at the F-FLASH (hold) rate. When the user at the answering station terminates the call, signal SEIZE becomes inactive and the output of gate U7-4 is set to the idle voltage level, thereby reflecting an idle line condition to the station cards and enabling gate U13-11 to process the next incoming ring signal.

2-123. Seize Circuits. (See Figure 2-34.) The seize circuits are activated by seize current supplied from the station card that serves the station set on which the corresponding C.O. line key was pressed. C.O. line selection can be made in response to an incoming ring signal on that C.O. line, or to originate an outgoing C.O. line call. Seize current is detected by voltage comparator U1-1, thereby activating the output SEIZE signal. Signal SEIZE resets hold flip-flop U6-1 through U2-3 and U2-4, and sets the output of gate U2-10 low. C.O. line relay K1 is then energized through gates U7-3 and U14-10, and relay driver Q3. LED DS1 lights to indicate the seize condition. The contacts of relay K1 connect the C.O. line through the C.O. line card analog network and bi-directional amplifier to the station cards. The low output of gate U2-10, through the SEIZE detection circuits, activates the DXP signal from the C.O. line card to the station cards to indicate that the C.O. line card is busy, and triggers one-

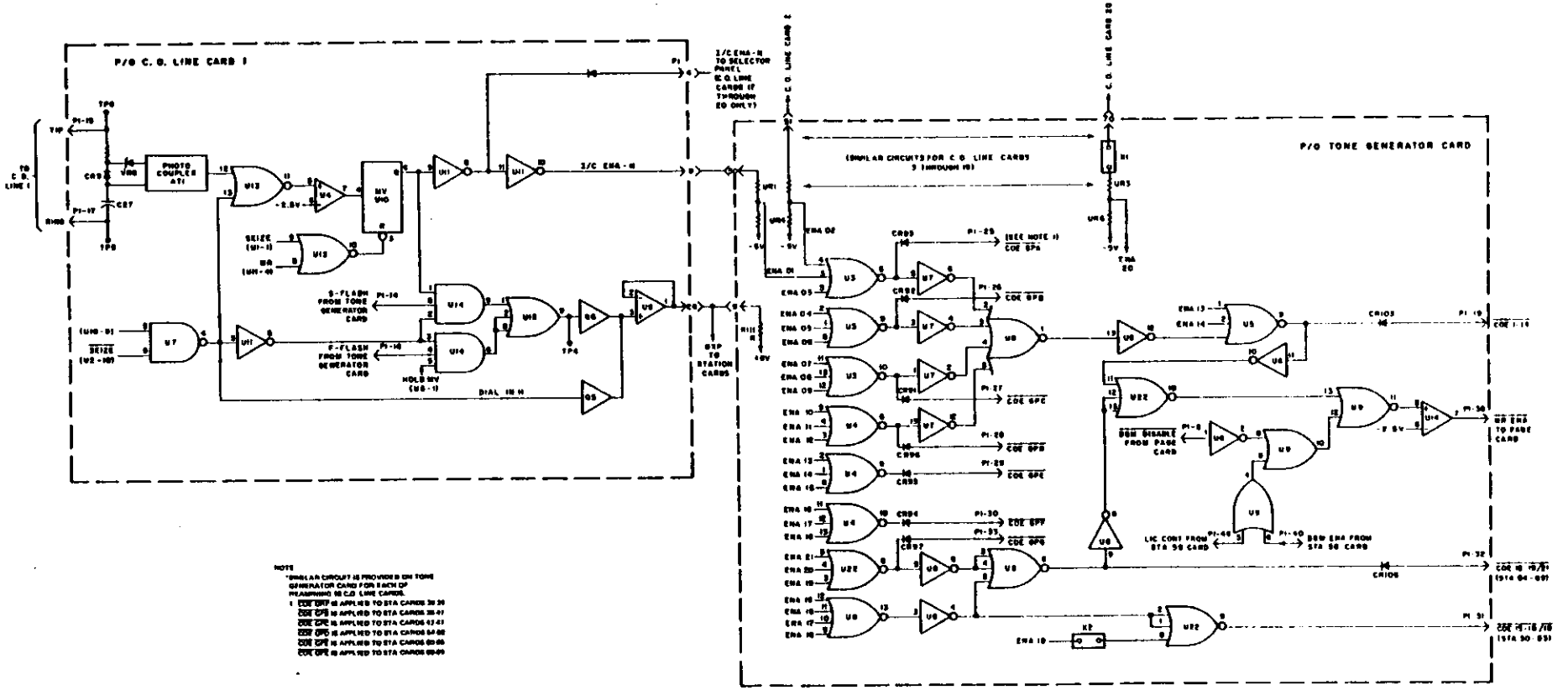


Figure 2-33. C.O. Line Card Ring Detection Circuits, Simplified Block Diagram

shot multivibrator U8-9. The output of multivibrator U10-9 ensures activation of gate U7-4 in the ring detection circuits and, through gate U7-10, turns on transistor switches Q9 and Q1 in the analog network to prevent communication over the analog network during the seize transition period. When multivibrator U8-9 times out, transistor switches Q9 and Q1 are turned off, and communication between the the C.O. line and the station card is possible. When the user at the station set terminates the call, signal SEIZE becomes inactive and one-shot multivibrator U10-9 is triggered, turning on switches Q9 and Q1 in the analog network temporarily through gate U7-10 to prevent transients over the analog network. When the multivibrator times out, the seize circuits are ready to handle the next seize command. If the C.O. line card should be seized before the multivibrator has times out, the multivibrator is reset through gate U13-U13-10 by the SEIZE signal.

2-124. Hold Circuits. (See Figure 2-34.) If the user of a station set that has seized the C.O. line card wishes to place a call on hold, he presses the HOLD key on the station set. A hold current pulse is then supplied from the associated station card to the C.O. line card. The hold current level is detected by voltage comparator U1-7, and hold flip-flop U6-1 is set through inverters U11-2 and U11-12. The output of inverter U11-12 sets the output of voltage comparator U3-1 low to block resetting of the hold flip-flop during hold pulse operation. The $\overline{\text{HOLD}}$ output of flip-flop U6-1 turns on transistor switch Q4 through voltage comparator U4-1, and music-on-hold (MOH) from the tone generator card is supplied through switch Q4, operational amplifier U9-7, and the analog network to the C.O. line. The HOLD output of flip-flop U6-1 is also supplied to gate U14-6 in the ring detection circuits to cause application of the F-FLASH signal from the tone generator card to the DXP line to indicate the hold condition. The HOLD output of flip-flop U6-1 holds relay K1 energized through gates U7-3 and U14-10 and relay driver Q3, and the relay contacts maintain the connection between the C.O. line and the analog network on the C.O. line card. When the hold sequence is terminated, current ceases, and flip-flop U6-1 is reset as a result of the station user re-seizing the held line.

2-125. Flash Circuits. (See Figure 2-34.) The flash circuits are used to break a C.O. line connection (for example, if a mistake is made during dialing) after the C.O. line card has been seized by a station card. When the user at the station set presses the FLASH key, flash current is sent to the C.O. line card from the associated station card. The flash current level is detected by voltage comparator U5-1, and signal FLASH is activated through voltage comparator U3-7. With jumper J3 strapped as shown in Figure 2-34, relay K1 is deenergized by the FLASH signal through gates U2-11 and U14-10 and relay driver Q3, and the relay contacts disconnect the C.O. line from the analog network on the C.O. line card. The flash current ceases when the FLASH key is released, and the C.O. line card circuits revert to the seize condition to permit redialing of the desired number.

2-126. An alternate jumper-selected option is available for those installations where the key telephone system is installed behind a PABX and FLASH key operation is required at the stations. For such installations, jumper J3 is removed, and jumpers J1 and J2 are installed. With this jumper configuration, relay K1 is held in the energized condition through relay driver Q3 and gates U14-10, U7-3, and U2-10 by signal SEIZE. When signal FLASH is activated, transistor Q8 is turned on through gate U2-11 and voltage comparator U3-7, thereby energizing relay K2, and the contacts of relay K2 ground the PABX line to break the connection.

NOTE

If no FLASH key capability is desired in the system, jumpers J2 and J3 are removed and jumper J1 is installed. With this jumper arrangement, relay K1 is controlled by signal SEIZE, and signal FLASH has no effect on C.O. line card operation.

2-127. Analog Network. (See Figure 2-35.) The analog network on the C.O. line card provides a two-way audio path between the C.O. line and the accessing station card. Dial tone and voice signals from the C.O. line are transmitted over this network to the station card, tones and voice signals from the station card are transmitted to the C.O. line, and BGM from the C.O. line card is transmitted over the network to the C.O. line. The C.O. line is connected to the analog network through contacts of relay K1, which is energized through the seize circuits or the hold circuits. If relay K1 is not energized, the C.O. line is disconnected, and resistor R5 terminates the network. Transistor switches Q9 and Q1 are controlled by gate U7-10in the seize circuits. These transistor switches are turned on momentarily by multivibrators U8-9 and U10-9, respectively, at the start of each seize operation and when seize current ceases. When the transistor switches are turned on, they shunt the audio paths in the analog network to block signal transmission during the seize transition periods. When the multivibrators time out, the transistor switches are turned off to permit normal signal transmission through the network. Incoming signals from the C.O. line are routed to the station card through the contacts of relay K1, network Z1, transformers T4 and T5, operational amplifier U15-1, and transformers T1 and T3. Outgoing signals are routed to the C.O. line through transformers T3 and T1, operational amplifier U15-7, transformer T4, network Z1, and the contacts of relay K1.

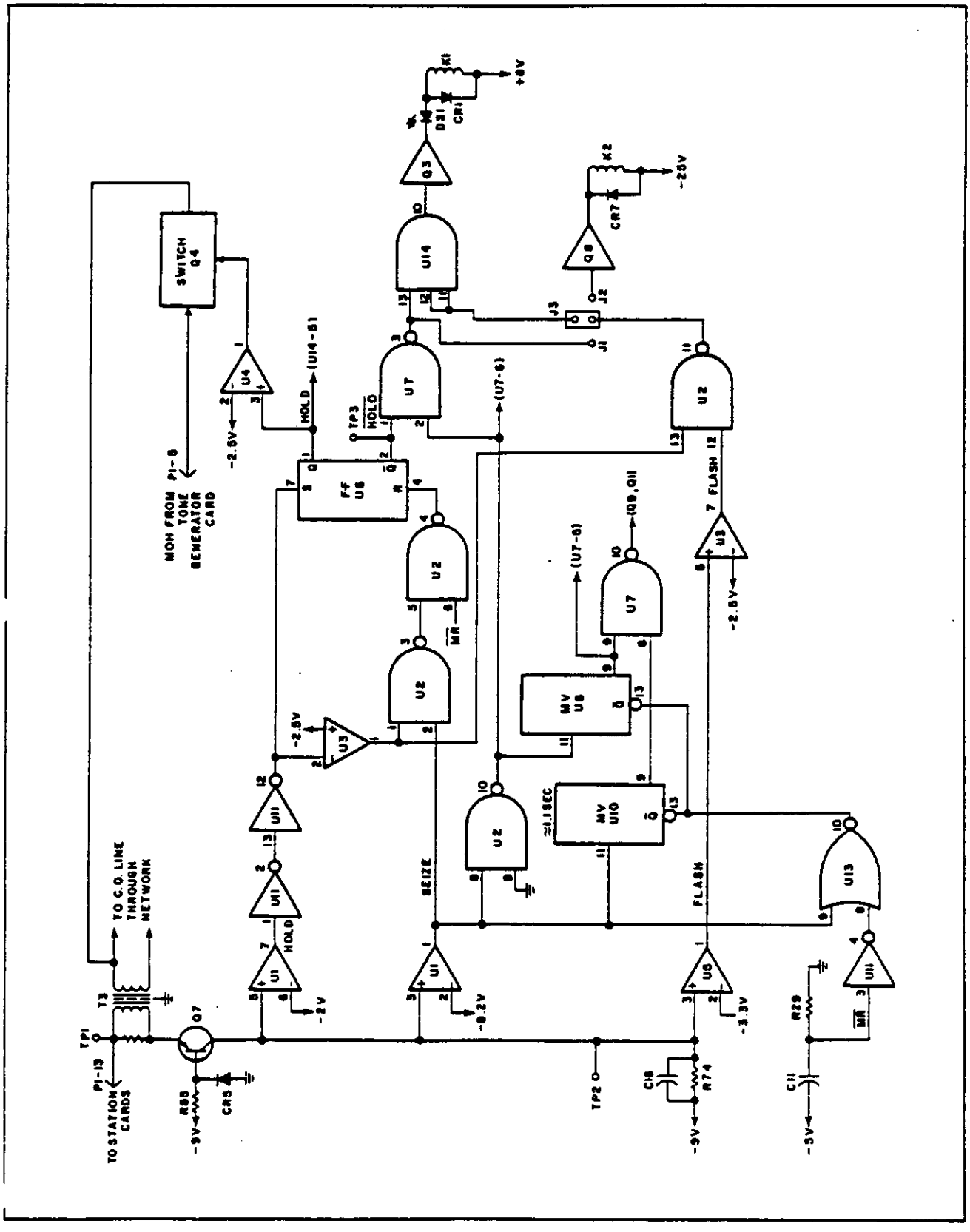


Figure 2-34 C.O. Line Card Seize, Hold, and Flash Circuits, Simplified Block Diagram

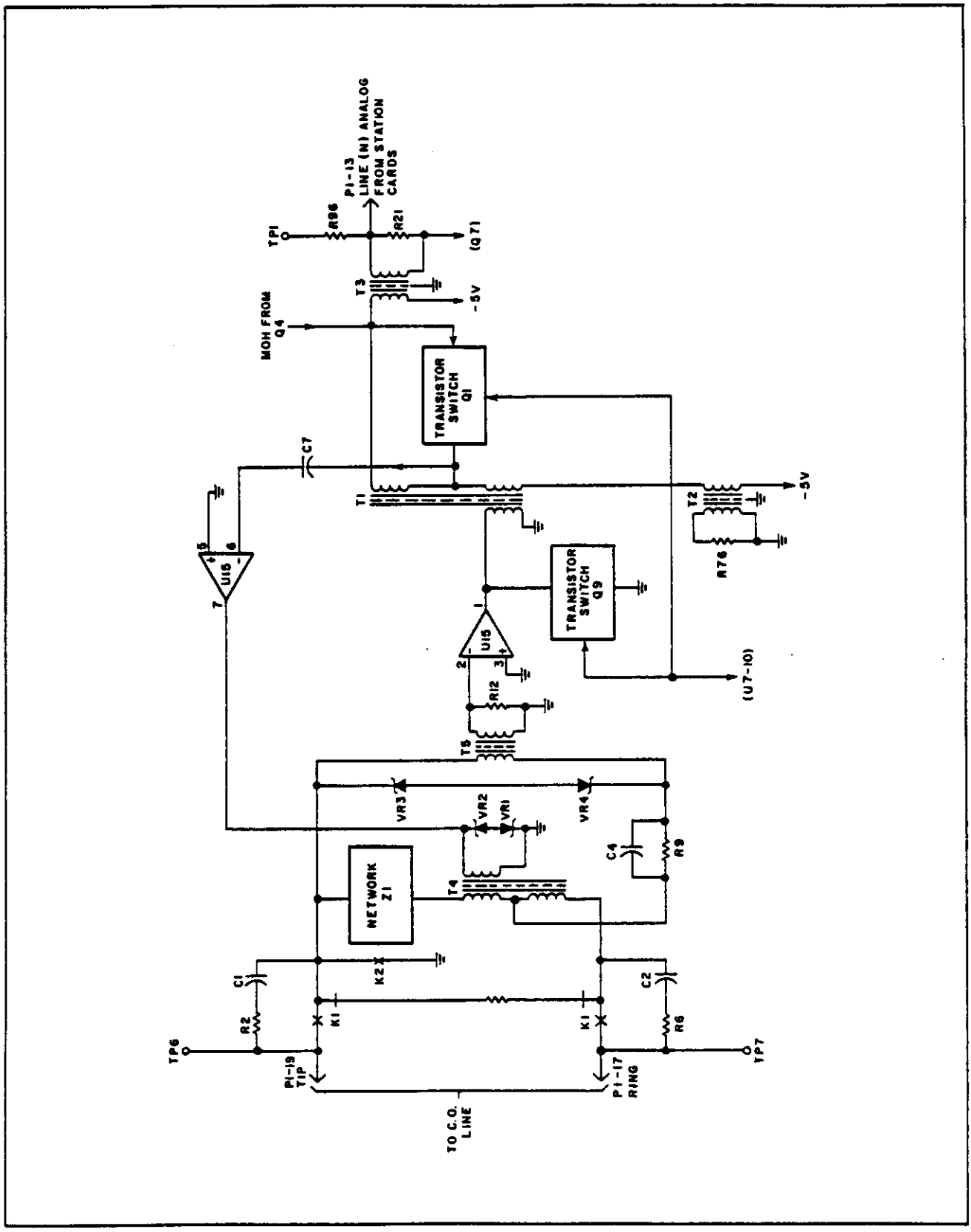


Figure 2-35 C.O. Line Card Analog Network, Simplified Block Diagram

2-128. TONE GENERATOR CARD, DETAILED THEORY OF OPERATION

2-129. General. The tone generator card supplies all flash rates and tones (except DTMF) required by the system. It also contains input boost or attenuation circuits for music-on-hold (MOH) and background music (BGM), and control circuits used in connection with paging. Seven tones are provided: dial tone, reorder tone, splash tone, busy tone, C.O. audible tone, ICM ringtone, and ICM RTS tone. Three flash rates are provided: I-hold (Q flash), hold (F flash), and incoming ring slow flash (S flash).

2-130. Tone And Flash Rate Circuits. (See Figure 2-36.) All output tone signals are derived from the output signals of two oscillator circuits. Amplifier U18-7 functions with associated circuitry to generate a -15 dB, 400 Hz (f^1) signal; amplifier U21-7 functions in a similar circuit to generate a -15 dB, 470 Hz (f^2) signal. The two signals are used directly for dial tone and splash tone, respectively, and in combination for the remaining system tones.

2-131. The dial tone output of the tone card is a 400 Hz, -7.5 dBm, continuous tone. The 400 Hz, -15 dB output signal from the 400 Hz oscillator circuit is amplified by operational amplifier U20-7 and transistors Q21 and Q22 to develop the required dial tone signal level. The dial tone signal is supplied to the register cards.

2-132. The splash tone output of the tone card is a 470 Hz, +6 dBm continuous signal. It is developed by amplifying the output signal of the 470 Hz oscillator circuits. Operational amplifier U20-1 and transistors Q23 and Q24 provide the required amplification. The output splash tone is supplied to all station cards.

2-133. All remaining tone signals are developed by combining the 400 Hz and 470 Hz signals. The two signals are summed at the input of amplifier U21-1, and the composite output signal of the amplifier is applied to similar channels for each of the remaining tones. Each channel consists of a transistor switch, followed by an output amplifier. The transistor switch controls application of the composite signal to the output amplifier, and the output amplifier provides the required amplification to develop the proper output signal level.

2-134. Signal C.O. AUDIBLE is a -10 dBm signal with a 1 second on, 1 second off, 1 second on, three second off rate; the rate is controlled by signal COAD developed by octal counter U13 and gates U23-1 and U23-13 in the flash rate circuits. The output C.O. AUDIBLE signal is supplied to all station cards and to the page card. Signals ICM RTS and ICM RING TONE are both -12 dBm signals with a 1 second on, 3 second off rate; the rate is controlled by signal ICM RTD developed by octal counter U19 in the flash rate circuits. Both of these signals are supplied to all station cards. The BUSY TONE signal is a -17 dBm signal with a 1 second on, 1 second off rate; the rate is controlled by signal BTD developed by binary divider U12 in the flash rate circuits. The BUSY TONE signal is supplied to all link A cards. The REORDER TONE is a -17 dBm signal with a 0.125 second on, 0.125 second off rate; the rate is controlled by signal RETD developed by binary divider U12 in the flash rate circuits. The REORDER TONE is supplied to all link A cards.

2-135. All flash rates are derived from a 64 Hz signal developed by oscillator U15. Potentiometer R3 is factory adjusted to provide a precise 64 Hz output frequency. The 64 Hz output signal of the oscillator clocks binary divider U12, and the frequency is divided by two at each successive output of the divider. At the Q3 output (U12-6), the input signal has been divided by 8, resulting in a 8 Hz frequency. This 8 Hz signal drives transistor switch Q1, which supplies the 8 Hz I-hold (Q flash) signal to all station and DSS control cards. The 8 Hz signal is also supplied as signal RETD to transistor switch Q7 in the tone circuits to control the REORDER TONE on-off rate.

2-136. The hold flash (F-flash) signal is developed by transistor switch Q2, which is driven by gate U5-10. Gate U5-10 is controlled by the Q3 (8 Hz), Q4 (4 Hz), and Q5 (2 Hz) output signals from divider U12. With these input 90% on, 10% off rate. This signal drives transistor switch Q2 to provide the F flash signal that is supplied to all C.O. line cards.

2-137. The slow flash (S-flash) signal is developed by transistor switch Q3, which is driven by the 1 Hz, Q6 output signal from divider U12. The 1 Hz S-flash signal is supplied to all C.O. line cards and all station cards. The 1 Hz, Q6 output of divider U12 is also supplied as signal BTD to transistor switch Q6 in the tone generating circuits to control the BUSY TONE signal rate, and as a clock signal to counter U19. Counter U19 is arranged so that its 0 output line is active for one second and off for 3 seconds. This output is supplied as signal ICM RTD to transistor switches Q26 and Q5 in the tone circuits to control the ICM RTS and ICM RING TONE signal rates.

2-138. Octal counter U13 is clocked by the 4 Hz, Q4 output of binary divider U12. Octal counter U13 functions with gates U23-1 and U23-13 to develop signal COAD, which is supplied to transistor switch Q4 in the tone circuits to control the C.O. AUDIBLE signal rate.

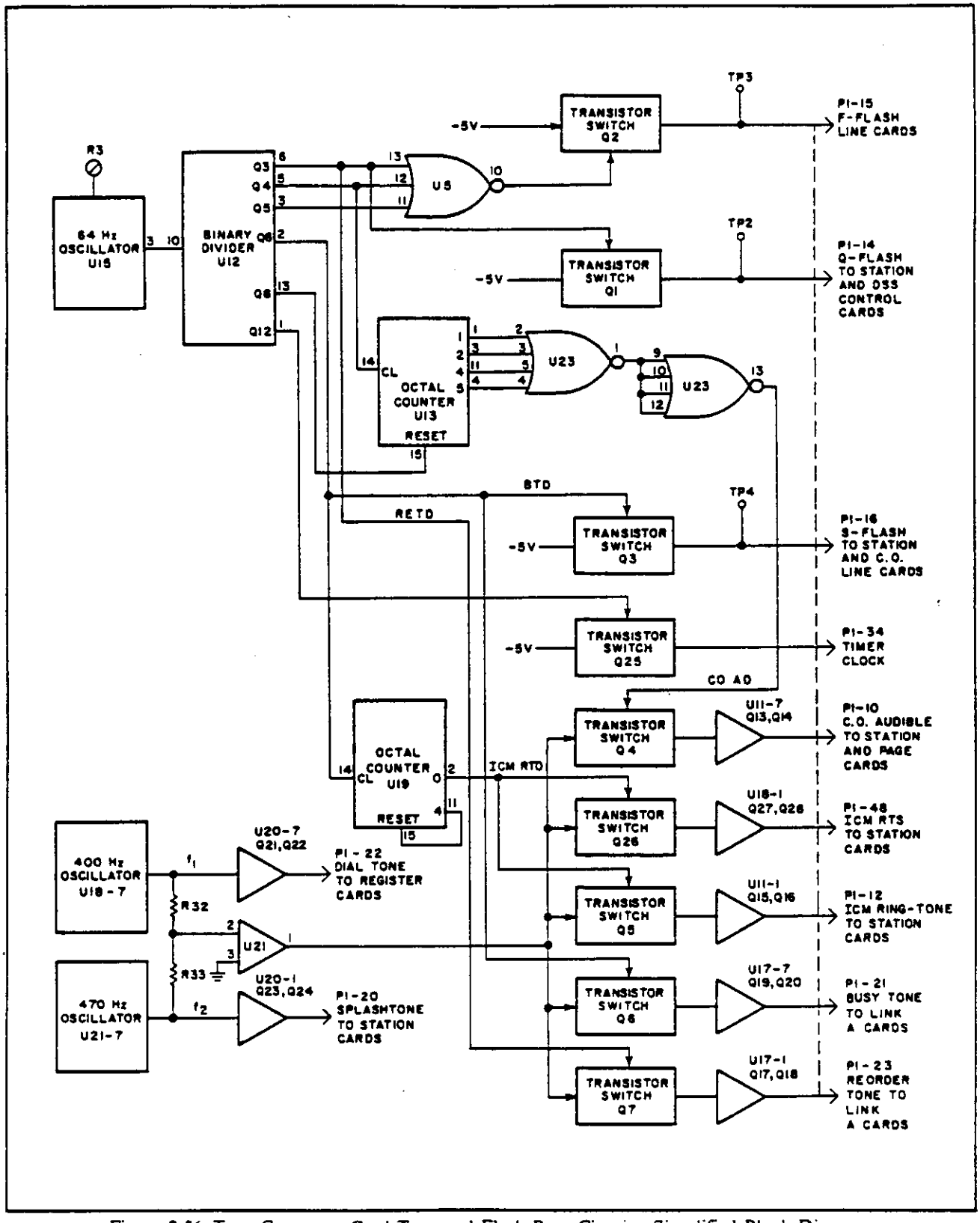


Figure 2-36 Tone Generator Card Tone and Flash Rate Circuits, Simplified Block Diagram

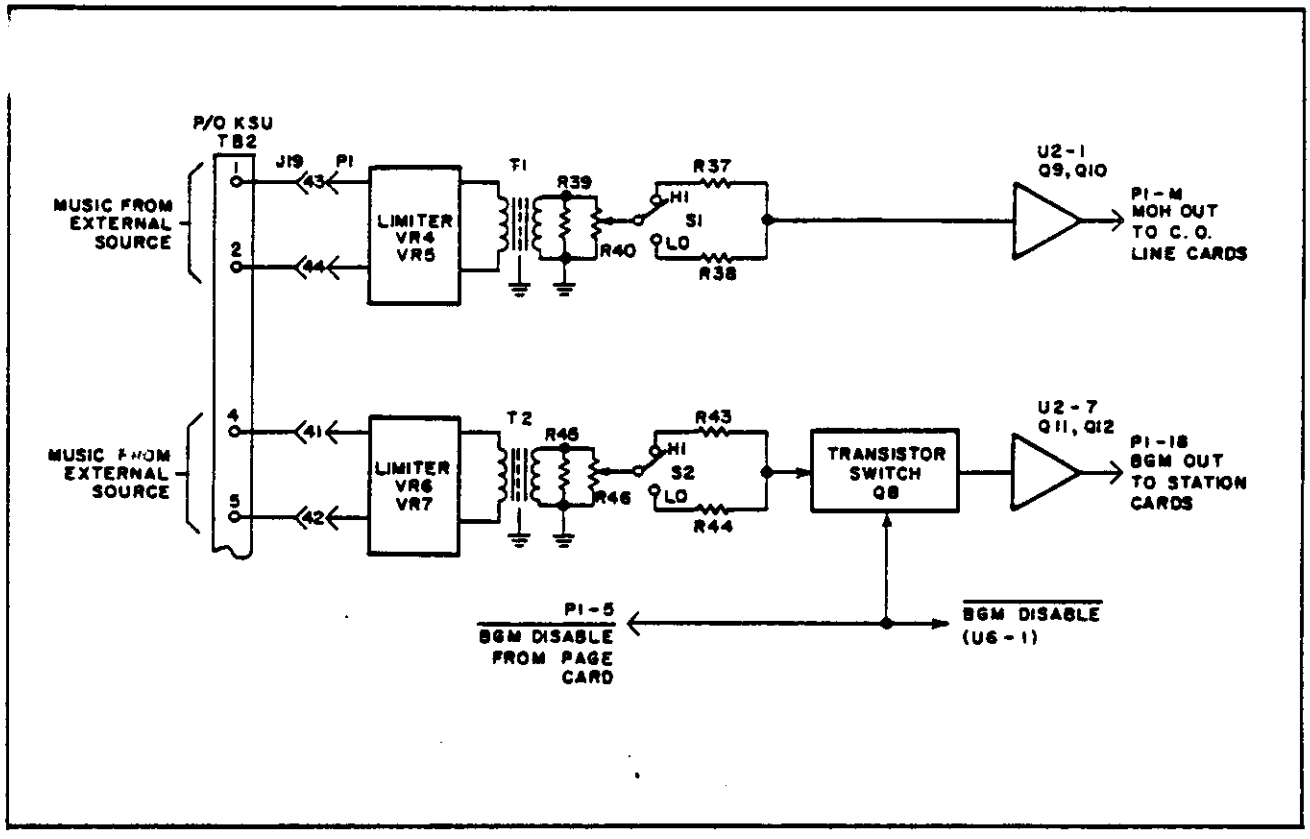


Figure 2-37 Tone Generator Card MOH and BGM Circuits, Simplified Block Diagram

2-139. MOH And BGM Circuits. (See Figure 2-37.) External music sources are required for music-on-hold and background music. The BGM signal is used to provide background music to station users through the station set speaker. The MOH signal is used to supply music to an outside party on a held line. The external music sources are connected to terminal board TB2 in the KSU. The MOH input is s[illegible]plied to transformer T1. Diode limiters VR4 and V[illegible]rotect against excessive signal amplitude. The M[illegible] signal developed in the secondary winding of transformer T1 is applied through a boost attenuator circuit to an output amplifier composed of operational amplifier U2-1 and transistors Q9 and Q10. Input source level switch S1 provides means for selecting either attenuation or amplification for the applied MOH signal. When switch S1 is set to the HI position, the applied MOH signal is attenuated by 15 dB; when the switch is set to the LO position, the applied MOH signal can be amplified by up to 30 dB. Potentiometer R40 provides means for adjusting the MOH OUT signal level; it is usually adjusted to provide a -10 dB output level.

2-140. The BGM circuit is basically similar to the MOH circuit, except for the addition of transistor switch Q8, which is included to provide means for cutting off background music during paging. Transistor switch Q8 is controlled by signal $\overline{\text{BGM DISABLE}}$ from the page card. The BGM OUT signal level is also adjusted to -10 dBm by means of potentiometer R46, and this output signal is supplied to all station cards.

NOTE

Potentiometers on the station sets permit individual adjustment of BGM levels to suit user preferences.

NOTE

The tone generator card also contains C.O. audible and NR ENA circuits. These circuits function with the C.O. line cards and the page card, and are covered in the description of the C.O. line card.

2-141. PAGE CARD, DETAILED THEORY OF OPERATION

(See Figure 2-38.)

2-142. General. The page card provides all functions required for paging, plus circuitry for night C.O. audible

processing. For purposes of paging, the stations in the key system are divided into five zones. Any of the five zones may be accessed for paging from any station set by dialing the assigned number for that zone through the intercom, or by pressing the designated key at the DSS console; all five zones may be accessed simultaneously from any station set by dialing the "ALL CALL" number through the intercom. Paging overrides any C.O. audible in progress, as well as BGM to internal stations only. The paging circuits for the five zones are identical, and only the zone 1 circuits are described.

2-143. Zone 1 Circuits. When a station set user initiates an intercom call and dials the assigned number for paging zone 1 (991), the call is processed by a link A card and a register card in the same manner as an ordinary intercom call. The cross-point connection to the page card from the station card serving the call originating station is made through the link A card. Decoding of the 991 number by the register card circuits results in transmission of a DC current from the link A card through transistor Q1 to the page card circuits. The DC current is detected by voltage comparators U13-7 and U13-1; the output levels of the voltage comparators, through gates U8-3 and U8-4, voltage comparators U15-1 and U15-7, and amplifier U12-1 latch on transistor Q1. In addition, a PAGE A DXP 30S signal is activated and transmitted to station cards 30 through 39 (the zone 1 station cards), and signal $\overline{\text{BGM DISABLE}}$ is activated through voltage comparator U2-U2-13 to shut off BGM during the page. The paging analog signal from the originating station is routed through the associated station card and the link A card to transformer T1 on the page card. The analog signal level is adjustable by means of potentiometer R5. The analog signal is routed through transistor switch Q2 (unless an all call page is occuring), and is amplified by amplifier U10-7 and transistor Q17 and Q18. The output analog signal is supplied to station cards 30 through 39 for routing to the associated station sets. Two other alternate analog outputs are available. The analog signal may be supplied through transformer T2 to an external amplifier which can be used to drive external loudspeakers at the corresponding stations, or the analog signal from input transformer T1 may be routed through a jumper on the page card to an internal 2-watt amplifier whose output can be used to drive the external loudspeakers for zone 1. Two 2-watt amplifiers are provided on the page card; these amplifiers may be assigned to any two paging zones by means of jumpers.

NOTE

Relay K1 and associated circuitry are not used at the present time.

2-144. The zone 1 paging circuits can also be accessed from the DSS console by key selection. When the ZONE 1 key at the DSS console is pressed, the zone 1 paging circuits on the page card are accessed directly through the DSS B control card, and the attendant at the DSS console can page the zone 1 stations from the station set at the DSS console position. The link A and register cards are not involved in this operation. Except for the current and analog signal source, operation of the zone 1 page circuits is the same as described in the preceding paragraph.

2-145. All Call Circuits. To page all stations simultaneously, the station user or DSS console attendant initiates an intercom call and dials the designated all call number (996). The call is processed by a link A card and a register card. The cross-point connection from the originating station to the page card is made through the link A card. The current level generated by the link A card as a result of decoding of the all call number is detected by voltage comparators U4-7 and U4-1. Transistor switch Q12 is turned on and signal $\overline{\text{BGM DISABLE}}$ is activated through gate U8-10; the DXP output signals from all five paging zone circuits are activated through voltage comparator U9-1, resistors R191 through R194, and diodes CR13 through CR16; the transistor switches in zones 1 through 5 are turned off through gate U5-6; and transistor Q13 is latched on through amplifier U3-1. The all call analog signal is then applied through switch Q12 and potentiometer R158 to the output amplifiers of all five paging zone circuits, and through potentiometer R145 to the internal 2-watt amplifier circuits; the all call analog signal is thereby distributed to all station cards and external speaker circuits for system wide paging.

2-146. The night C.O. audible signal also makes use of the all call output amplifier circuits. The night C.O. audible signal from the tone generator card is supplied through transistor switch Q11 and potentiometers R158 and R145 to the amplifier circuits in all five paging zones and to the internal 2-watt amplifiers. Transistor switch Q11 is turned on by signal $\overline{\text{NR ENA}}$ when the attendant at station 58 enables the night ring mode by turning the BGM switch off; the circuitry involved in this function is located on the tone generator card, and is shown in Figure 2-33.

2-147. DC POWER DISTRIBUTION CIRCUITS, DETAILED THEORY OF OPERATION

(See Figure 2-39.)

2-148. All operating power for the KSU, expansion cabinet, station sets, and DSS consoles is derived from the output DC voltages provided by the EBK-30 power supply. The power supply provides fused DC output voltages of -25 volts, +25 volts, and -10 volts. These DC voltages are supplied through the power supply cable to the I/O panel in the KSU. If an expansion cabinet is included in the system, the DC voltages are supplied

through the KSU I/O panel to the I/O panel in the expansion cabinet. In each I/O panel, the DC voltages are supplied to termina boards for distribution to the various shelves in the KSU and expansion cabinet. The DC power circuits for each shelf are fused separately in the I/O panels.

2-149. Each plug-in card in the KSU and expansion cabinet contains its own power supply circuits. These circuits consist primarily of integrated circuit voltage regulators with thermal overload protection, which reduce the applied DC voltages to the levels required for operation of the circuits on the plug-in card. Where required, DC voltages are further reduced by resistive voltage dividers and Zener diode voltage regulators. Fuses on the plug-in cards protect against overload, and LEDs indicate the presence of power.

2-150. The station sets receive operating power over the quad from the associated station cards in the KSU, as detailed in the description of the DC power and data transmission circuits of the station set. The DSS consoles similarly receive DC operating power from the DSS control cards in the KSU, as detailed in the description of the DC power and data transmission circuits of the DSS console.

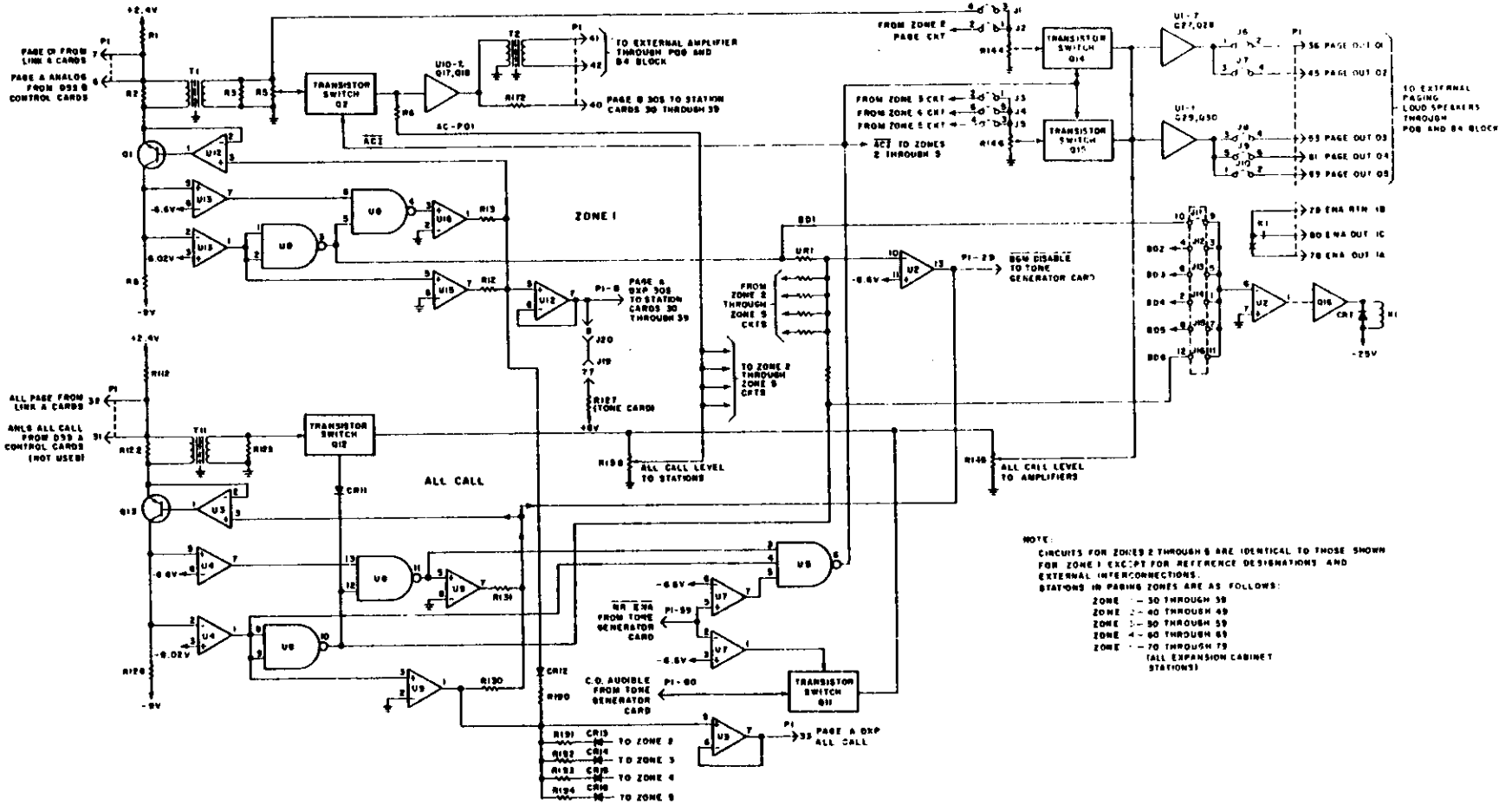


Figure 2-38 Page Card.
Simplified Block Diagram

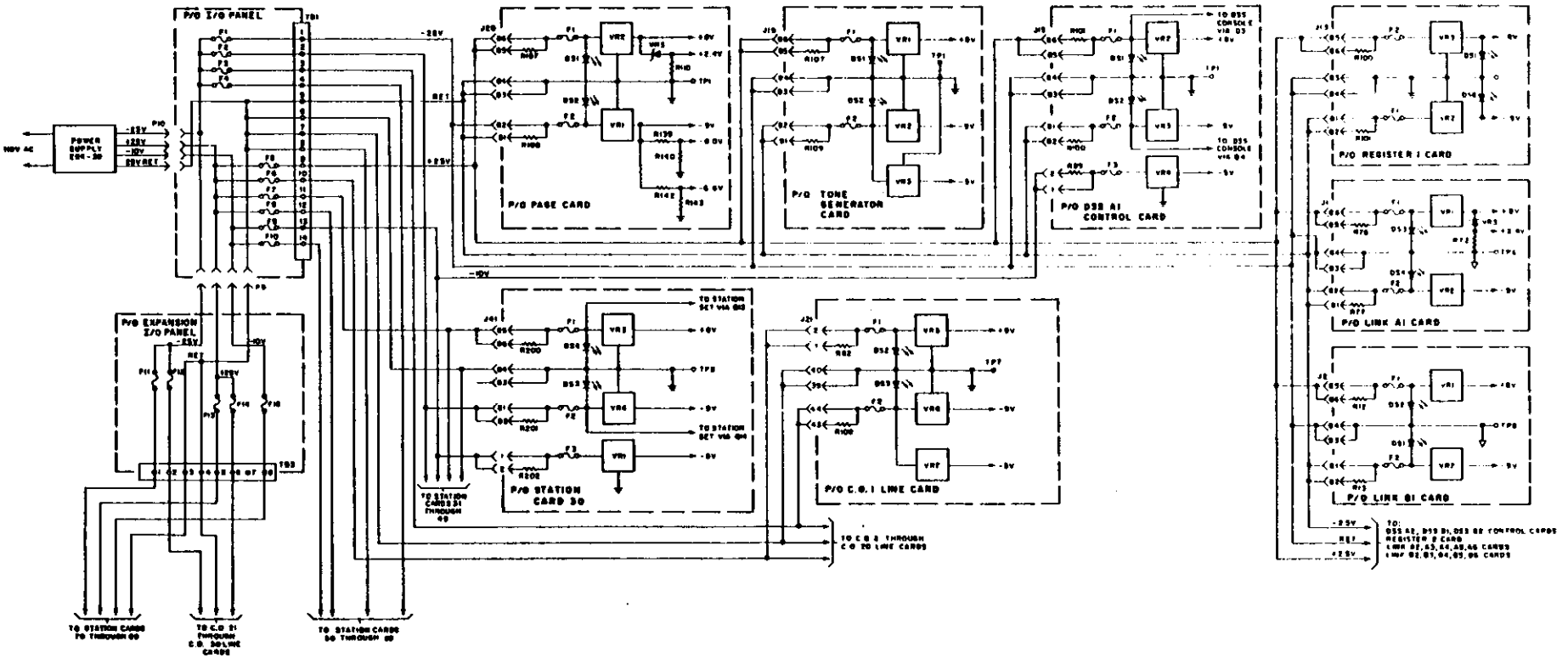


Figure 2-39 DC Power Distribution Circuits, Simplified Block Diagram

SECTION III
MAINTENANCE

3-1. GENERAL.

3-2. This section contains maintenance and replacement instructions for the key telephone system and its major components. Included is a list of test equipment required for maintenance, symptomatic troubleshooting procedures designed to localize a malfunction to a plug-in card or replaceable assembly, and switch positioning information for replacement plug-in cards.

3-3. TEST EQUIPMENT REQUIRED.

3-4. Test equipment required for maintenance is listed in Table 3-1. Equipment of equivalent characteristics may be substituted for any item listed.

3-5. MINIMUM PERFORMANCE CHECKS.

3-6. Before beginning troubleshooting, check each station set and the DSS console(s) for operation under all normal system conditions. Note carefully any signs of abnormal indication, and the portions of the system where abnormal indications are obtained.

3-7. PRELIMINARY INSPECTION.

3-8. **Visual Checks.** If equipment malfunctions, perform a thorough visual check of suspect components before performing electrical tests. Visual checks often help to isolate the cause of malfunction quickly and simply. Inspect the KSU and expansion cabinet, if used, for loosely seated plug-in cards, loose cable connections, and blown fuses. Inspect station sets and the DSS console(s) for loose connections to the quad, and signs of wiring damage.

3-9. **Power Checks.** Failure of the key telephone system or parts thereof may be caused by incorrect DC operating voltages. If a problem is common to more than one station in the system, check the output voltages of the EBK-30 power supply (refer to the separate maintenance manual for that unit); if power supply output voltages are normal, perform the checks in Table 3-2 before proceeding with other tests.

TABLE 3-1. TEST EQUIPMENT LIST

Nomenclature	Model No.
Card extender	86 Pin: SK 1070
*Butt set	44 Pin: SK 1050
DC volt-ohmmeter	1101G Type or equivalent
**Oscilloscope	Simpson 260 or equivalent

*For C.O. line testing only
**Optional item, required only for test point checks

TABLE 3-2. POWER SUPPLY CHECKS

Step	Procedure	Normal Indication	Possible Cause of Abnormal Indication
1	Using DC volt-ohmmeter, measure DC voltages between following terminals in KSU:		
	a. TB1-5 (=) and TB1-1	25 to 30 volts	Defective fuse F1
	b. TB1-6 (=) and TB1-2	25 to 30 volts	Defective fuse F2
	c. TB1-7 (=) and TB1-3	25 to 30 volts	Defective fuse F3
	d. TB1-8 (=) and TB1-4	25 to 30 volts	Defective fuse F4
	e. TB1-9 (=) and TB1-5	25 to 30 volts	Defective fuse F5
	f. TB1-10 (=) and TB1-6	25 to 30 volts	Defective fuse F6
	g. TB1-11 (=) and TB1-7	25 to 30 volts	Defective fuse F7
	h. TB1-12 (=) and TB1-8	25 to 30 volts	Defective fuse F8
	i. TB1-7 (=) and TB1-13	9 to 12 volts	Defective fuse F9
	j. TB1-8 (=) and TB1-14	9 to 12 volts	Defective fuse F10
2	If an expansion cabinet is used in the system, measure DC voltages between following expansion cabinet terminals:		
	a. TB3-3 (=) and TB3-1	25 to 30 volts	Defective fuse F11
	b. TB3-4 (=) and TB3-2	25 to 30 volts	Defective fuse F12
	c. TB3-5 (=) and TB3-3	25 to 30 volts	Defective fuse F13
	d. TB3-6 (=) and TB3-4	25 to 30 volts	Defective fuse F14
	e. TB3-3 (=) and TB3-8	9 to 12 volts	Defective fuse F15

3-10. IDENTIFICATION OF MAJOR ASSEMBLIES.

3-11. See Figures 3-1 and 3-2 for the location of the major assemblies of the KSU and expansion cabinet.

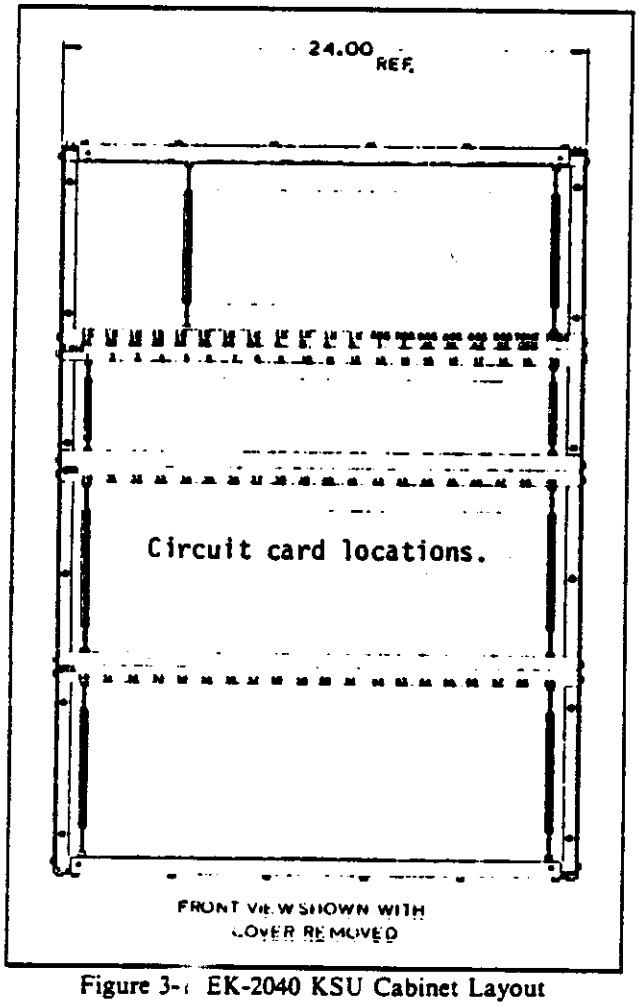


Figure 3-1 EK-2040 KSU Cabinet Layout

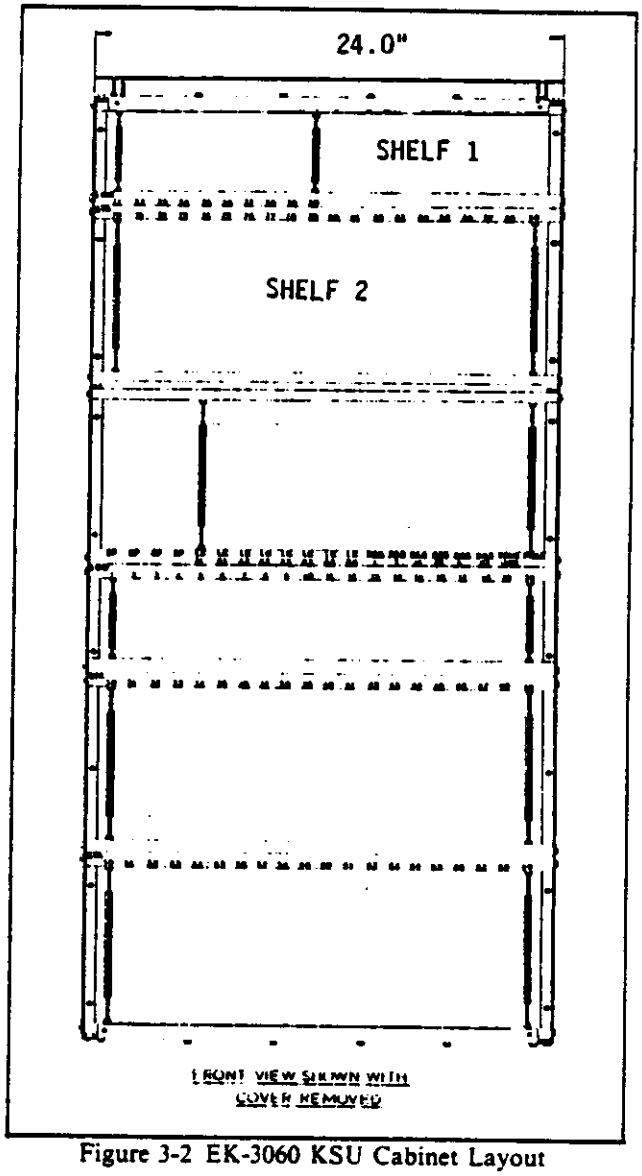


Figure 3-2 EK-3060 KSU Cabinet Layout

3-12. TROUBLE LOCALIZATION.

3-13. **Symptomatic Troubleshooting.** Because the system utilizes distributed control, whereby each station is controlled by its own microcomputers on the associated station card in the KSU and in the station set, symptomatic troubleshooting is facilitated. Careful observation of the nature and extent in the system of a malfunction can help localize the cause of the problem to a limited portion of the system. The trouble can be further localized to a plug-in card, a station set, or a DSS console, which is replaced, or to a quad. Table 3-3 lists symptoms of malfunctions with portions of the system to be checked for each of these symptoms.

TABLE 3-3. SYMPTOMATIC TROUBLESHOOTING CHART

Symptom	Probable Cause of Malfunction
All stations inoperative	Defective power supply (refer to separate power supply manual)
Stations 30 through 49 inoperative; all others operate normally	Defective fuse F3, F7, or F9

TABLE 3-3. SYMPTOMATIC TROUBLESHOOTING CHART (Cont.)

Sympton	Probable Cause of Malfunction
Stations 50 through 69 inoperative; all other operate normally	Defective fuse F4, F8, or F10
Stations 70 through 89 inoperative; all other operate normally	Defective fuse F11, F13, or F15; defective cable connection between KSU and expansion cabinet
C.O. lines 1 through 20 inoperative; all others operate normally	Defective fuse F2 or F6
C.O. lines 21 through 30 inoperative; all others operate normally	Defective fuse F12 or F14; defective cable connection between KSU and expansion cabinet
Tone, BGM, MOH, paging, DSS console, and intercom all inoperative; C.O. line calls normal except for missing tones and flash signals	Defective fuse F1 or F5
Problem limited to one station set in system; all other stations operate normally	Defective KSU-to-station-set quad (refer to paragraph 3-16)
	Defective station card (refer to paragraph 3-17)
	Defective station set (refer to paragraph 3-21)
BGM inoperative: System wide	Potentiometer R16 or switch S2 on tone generator card set incorrectly.
	Defective music source or music source connection to I/O panel
	Defective tone generator card (refer to paragraph 3-23)
	Defective page card (refer to paragraph 3-26)
	Switch S1-4 on associated station card closed. BGM switch on station set, set to off position.
One station set only	Defective station card (refer to paragraph 3-17)
	Defective station set (refer to paragraph 3-21)
C.O. line 17 or 18 inoperative at station set	Loose or missing jumper connection at selector panel
	Defective C.O. line card for affected line (refer to paragraph 3-29)
One C.O. line inoperative system wide	Defective C.O. line card for affected line (refer to paragraph 3-29)
	Defect in C.O. line
C.O. line that does not appear at station set cannot be seized when user is invited to pick up call	Defective link B card (refer to paragraph 3-32)
	Defective register card (refer to paragraph 3-36)
Music-on hold function inoperative: System wide	Potentiometer R40 or switch S1 on tone generator card set incorrectly
	Defective music source or music source connection to I/O panel
	Defective tone generator card (refer to paragraph 3-23)
One C.O. line only	Defective C.O. line card for affected line (refer to paragraph 3-29)

TABLE 3-3. SYMPTOMATIC TROUBLESHOOTING CHART (Cont.)

Symptom	Probable Cause of Malfunction
One or more tones or flash signals unavailable system wide	Defective tone generator card (refer to paragraph 3-23)
C.O. audible unavailable for all stations in C.O. audible group	Switch selection on station cards incorrect Defective tone generator card (refer to paragraph 3-23)
Status indications for one or more C.O. lines inoperative system wide	Defective C.O. line card for affected C.O. line (refer to paragraph 3-29) Defective tone generator card (refer to paragraph 3-23)
Intercom function inoperative at all stations (in systems using one register card)	Defective register card (refer to paragraph 3-36)
Intercom function to stations 30 through 59 sometimes inoperative; sometimes operates normally	Defective link A card (refer to paragraph 3-40) Defective register card in two register card system (refer to paragraph 3-36)
Intercom function to stations 60 through 89 and C.O. lines 17 through 29 sometimes inoperative; sometimes operates normally	Defective link B card (refer to paragraph 3-32) Defective link A card (refer to paragraph 3-40) Defective register card in two register card system (refer to paragraph 3-36)
Paging inoperative system wide	Defective page card (refer to paragraph 3-26)
External paging inoperative; internal paging operates normally	Defective paging amplifier (refer to paragraph 3-26) Defective page card (refer to paragraph 3-26) Open connection between I/O panel and speakers
Stations 30 through 57 inaccessible from DSS console; accessible through hot line circuit of preassigned station sets **NOTE** If two DSS consoles are used in the system, but not in parallel, the preceding condition is normal at the second DSS console, and the following condition is normal at the first DSS console.	Defective DSS-console-to-DSS-control-card quad (refer to paragraph 3-44) Defective DSS A control card (refer to paragraph 3-45) Defective DSS console (refer to paragraph 3-48)
Stations 60 through 82 and paging zones inaccessible from DSS console; accessible through hot line circuit of preassigned station sets	Defective DSS-console-to-DSS-control-card quad (refer to paragraph 3-44) Defective DSS B control card (refer to paragraph 3-45) Defective DSS console (refer to paragraph 3-48) Defective DSS A (station keys 30 through 57) or DSS B (remaining keys) control card (refer to paragraph 3-45)
One key function inoperative at DSS console	Defective DSS console (refer to paragraph 3-48)

3-14. Test Point Data. Test points are provided on the plug-in cards to facilitate trouble localization to a specific group of circuits on the cards. Since the aim of troubleshooting in this manual is to localize trouble only to the plug-in card level, checking of signals and voltages at test points is not normally required; test point data, where provided, is for reference only.

3-15. Use of Card Extender. To perform visual checks of plug-in cards during operation, it may be necessary to operate the plug-in cards outside the card cage in the KSU. An extender card is available for this purpose. To use the card extender, pull the plug-in card out of its connector in the KSU, insert the card extender in its place, and plug the plug-in card into the card extender.

3-16. Station Set Quad Troubleshooting. Do not attempt to use a butt set to troubleshoot the station set-to-station card quad; the butt set loads the quad and causes various station set malfunctions. When continuity checks are required, use a DC volt-ohmmeter. Effects of various quad malfunctions are:

1. If the A pair conductors of the quad are shorted together, audio transmission from the station set to the station card is not possible.

2. If the B pair conductors of the quad are shorted together, no audio will be received at the station set.

3. If either or both of the A pair conductors are shorted to either or both of the B pair conductors, the 25 volt fuses on the associated station card will blow and/or voltage driving circuitry will shut down (thermal overload) +25-volt driver.

4. If any one of the quad conductors is open, chattering will be heard from the loadspeaker at the station set, and all LEDs at the station set will flicker. When the handset is lifted, the chatter will be heard in the handset, and the LEDs will stop flickering.

3-17. Station Card Troubleshooting. (See Figure 3-3.) Each station card in the system serves only one station set; therefore, failure of a station card normally will affect operation of the associated station set only. When a problem appears to be related to a station set/station card combination, *check the quad first before troubleshooting the station card and station set.*

3-18. The station card contains six LEDs. The LEDs and their functions are listed below:

LED	Function
DS1 HPS	When lighted, indicates that the hot-line port of the station card has been seized either by the associated hot-line station card or by the DSS console.
DS2 LPS	When lighted, indicates that the link port of the station card has been seized by a link A or link B card (receiving ICM call).
DS3 -25V	When lighted, indicates that -25 volt DC is available to internal circuits (fuse F2 is *not* open).
DS4 +25V	When lighted, indicates that +25 volt DC is available to internal circuits (fuse F1 is *not* open).
DS5 SEIZE	When lighted, indicates that seize current is being supplied to the destination card; LED also flashes at outpulse rate when using outpulse dial.
DS6 XPT IND	When lighted, indicates that the turn-on signal to one of the cross-point FET switches has been activated to establish a cross-point connection to a C.O. line card, a link card, or the associated hot-line station card; will not light if station card dial disable switch is actuated for a particular cross-point.

3-19. The station card has ten test points. The test points and the data they monitor are as follows:

Test Point	Data Monitored
TP1 LINK B	Received current from link card.
TP2 SYNC	Microcomputer sync signal
TP3 RB DATA	Data received from associated station set
TP4 I SEND	Current being sent to accessed destination card
TP5 + QUAD	Positive DC level and superimposed data being sent to station set
TP6 DATA TX	Data being transmitted to associated station set
TP7 - QUAD	Negative DC level and superimposed data being ent to station set
TP8 DXP DATA	Incoming DXP data
TP9 GRD	System ground
TP10 "A" PORT	Output to cross-point switches

3-20. If a problem appears to be related to a station set/station card combination, the problem can be localized to the station card or station set by swapping the station card with one that operates normally at a different location in the KSU (observe switch settings); if the problem travels with the station card, the station card is

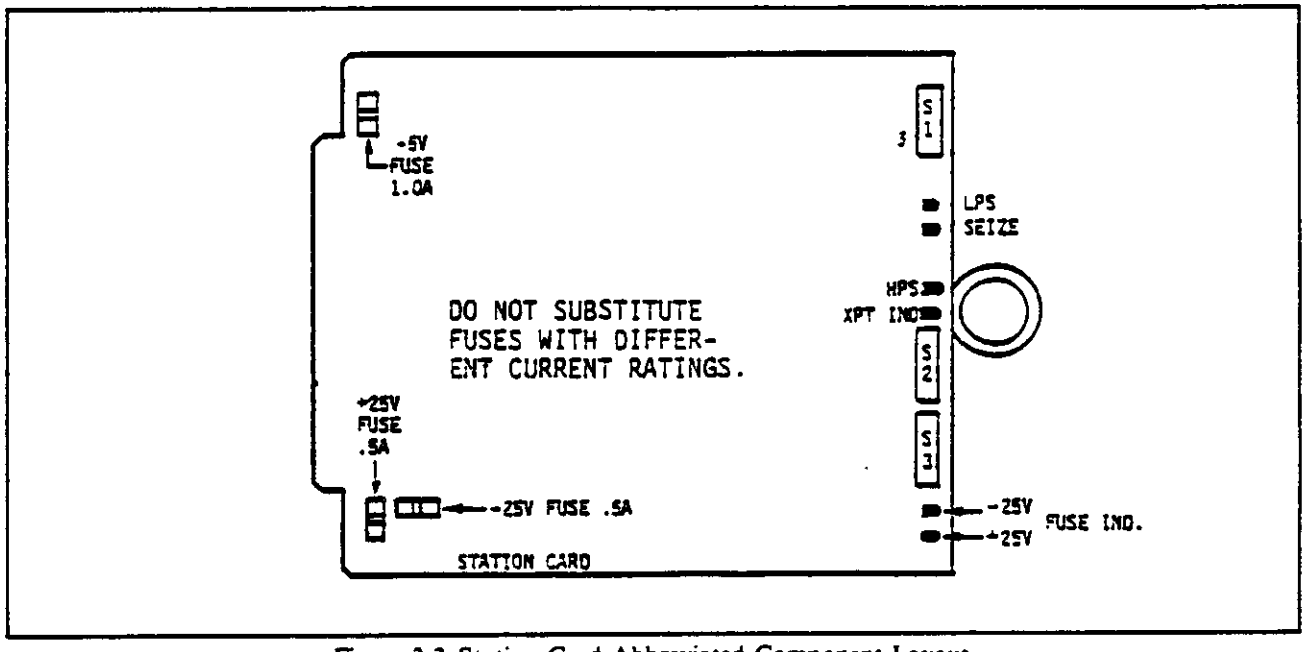


Figure 3-3 Station Card Abbreviated Component Layout

defective. If LEDs DS3 and DS4 are both lighted, check fuse F3 on the station card. If any fuse is blown, inspect the station card thoroughly for wire clippings, short circuits, and touching components leads; after clearing the problem, replace the fuse. *Do not substitute a fuse with a different rating.* If a replacement fuse blows, replace the station card. Also replace the station card if any other problem is localized to the station card. Before installing a replacement station card, ensure that all switches on the replacement station card are set to the same positions as the corresponding switches on the station card being replaced. If switch settings have been disturbed inadvertently, refer to Table 3-4 for switch setting information.

3-21. Station Set Troubleshooting. If a problem appears to be related to a station card/station set combination, the station set can be checked by swapping it after the quad and the station card have been eliminated as the source of the problem. If swapping indicates that the station set is defective, it should be replaced unless the problem can be related to one of the six plug-in assemblies of the station set; a defective plug-in assembly can be removed and replaced.

3-22. The six plug-in assemblies of the station set are: the handset, the dial, the loudspeaker, the microphone, the hookswitch assembly. To replace any of these assemblies, proceed as follows:

1. Remove the front panel of the station set by inserting a screwdriver under the lower edge of the front panel at the corners and prying up.

2. Remove the upper station set housing by loosening the captive screw in the front lower center of the housing. This exposes the entire printed circuit board. (See Figure 3-4.)

3. To remove the handset or line cord modular connectors (not in early sets), unplug the spade tips of the modular jack from their connectors, and remove the modular jack. Install in the reverse order.

4. To remove the dial, unplug the dial from its connector. Note the position of the dial connector in its socket; tone and Outpulse dial connections are different. Loosen the dial mounting screws at the *top* sides of the dial mounting brackets and remove the dial. Install the replacement dial in the reverse order.

5. To remove the loudspeaker, unplug it from its connector, and remove the two screws that secure the loudspeaker. Install the replacement loudspeaker in the reverse order.

6. To remove the microphone, unplug it from its connector, and lift the microphone with its rubber boot out of the holding slot. Install the replacement microphone in the reverse order, observing plug polarity.

7. To remove the hookswitch assembly, unplug it from its connector, and remove the screw that secures the hookswitch assembly to the printed circuit board. Install the replacement hookswitch assembly in the reverse order, being careful not to overtighten the screw; stripping of threads in the plastic base housing may result from overtightening.

8. To remove the keystrip assembly, disengage the

front tabs by pressing rearward while lifting the front of the assembly upward, slide the assembly to the left with an upward motion, and disconnect the ribbon cable. To install the replacement keystrip assembly, insert the ribbon cable into its connector, insert the rear tabs into the cutouts in the base of the station set, slide the complete assembly to the right, and press the front tabs rearward to engage the front tabs in their slots.

9. To install the upper housing, make sure that the loudspeaker is plugged in; then, with the rear tab of the upper housing in its slot at the center rear of the station set, close the upper housing and tighten the retaining screw. To avoid mechanical interference, be careful to keep speaker wires away from hookswitch assembly.

10. To install the front panel, insert the tabs into the top slots and push down on the lower part of the front panel.

TABLE 3-4.
STATION CARD SWITCH SETTINGS

Switch	Setting
S1-1	Open (if closed, intercom calls will be
S1-2	Close
S1-3	Close
S1-4	Open for background music
S1-5	Open for off-hook signaling
S1-6	Close for Group 5 C.O. Audible
S1-7	Close for Group 4 C.O. Audible
S1-8	Close for Group 3 C.O. Audible
S1-9	Close for Group 2 C.O. Audible
S1-10	Close for Group 1 C.O. Audible
S2-1	Open for Dial Disable on C.O. line 9
S2-2	Open for Dial Disable on C.O. line 8
S2-3	Open for Dial Disable on C.O. line 7
S2-4	Open for Dial Disable on C.O. line 6
S2-5	Open for Dial Disable on C.O. line 5
S2-6	Open for Dial Disable on C.O. line 4
S2-7	Open for Dial Disable on C.O. line 3
S2-8	Open for Dial Disable on C.O. line 2
S2-9	Open for Dial Disable on C.O. line 1
S2-10	Open (Manual Reset)
S3-1	Spare
S3-2	Open for Dial Disable on second private C.O. line
S3-3	Open for Dial Disable on first private C.O. line
S3-4	Open for Dial Disable on C.O. line 16
S3-5	Open for Dial Disable on C.O. line 15
S3-6	Open for Dial Disable on C.O. line 14
S3-7	Open for Dial Disable on C.O. line 13
S3-8	Open for Dial Disable on C.O. line 12
S3-9	Open for Dial Disable on C.O. line 11
S3-10	Open for Dial Disable on C.O. line 10

3-23. Tone Generator Card Troubleshooting. (See Figure 3-5.) The tone generator card is one of the common cards in the system; that is, it supplies signals system wide. Failure of the tone generator card will result in the loss of all or some of the following: tones, flashrates, MOH, and/or BGM at all stations in the system or (in the case of C.O. audible) at all stations within a specific C.O. audible group.

3-24. The tone generator card has two LEDs: DS1 indicates te presence of +25 volt DC (fuse F1 *not* blown), and DS2 indicates the presence of -25 volt DC (fuse F2 *not* blown). Four test points are provided for oscilloscope monitoring of flash rates. These test points are as follows:

Test Point	Data Monitored
TP1	System ground
TP2	I-Hold flash rate (8 Hz)
TP3	Hold flash rate (2 Hz)
TP4	Slow flash rate (1 Hz)

NOTE

Do not attempt to use a butt set to monitor any of the tones or flash rates of the tone generator card.

3-25. When the tone generator card is suspected as the source of a problem, check LEDs DS1 and DS2. If either or both are not lighted, the corresponding fuse on the card is defective; inspect the card thoroughly for wire clippings, short circuits, and touching component leads, correct the problem, and replace the defective fuse, using a fuse of the same rating only. If the replacement fuse blows, replace the tone generator card. If both LEDs are lighted and the problem persists, ascertain that the tone generator card is the source of the problem by substituting a spare tone generator card. If substitution corrects the problem, replace the removed tone generator card. Before installing the replacement tone generator card, make sure that the two switches (MOH input and BGM input) on the replacement card are set to the same positions as the corresponding switches on the defective tone generator card. Adjustment of the MOH and/or BGM potentiometers on the tone generator card may also be required. Refer to paragraph 3-50 for this adjustment.

3-26. Page Card Troubleshooting. (See Figure 3-6.) The page card is a common card; it supplies paging signals to all system points (all page) or to all parts within a specific paging zone. Failure of the page card will produce symptoms of malfunction at the corresponding system points. Note that one external loudspeaker in each of two paging zones may be driven by the page card, and that external paging amplifiers, connected to the B4 block of the KSU, may be used to drive external paging loudspeakers in each of the paging zones. If internal

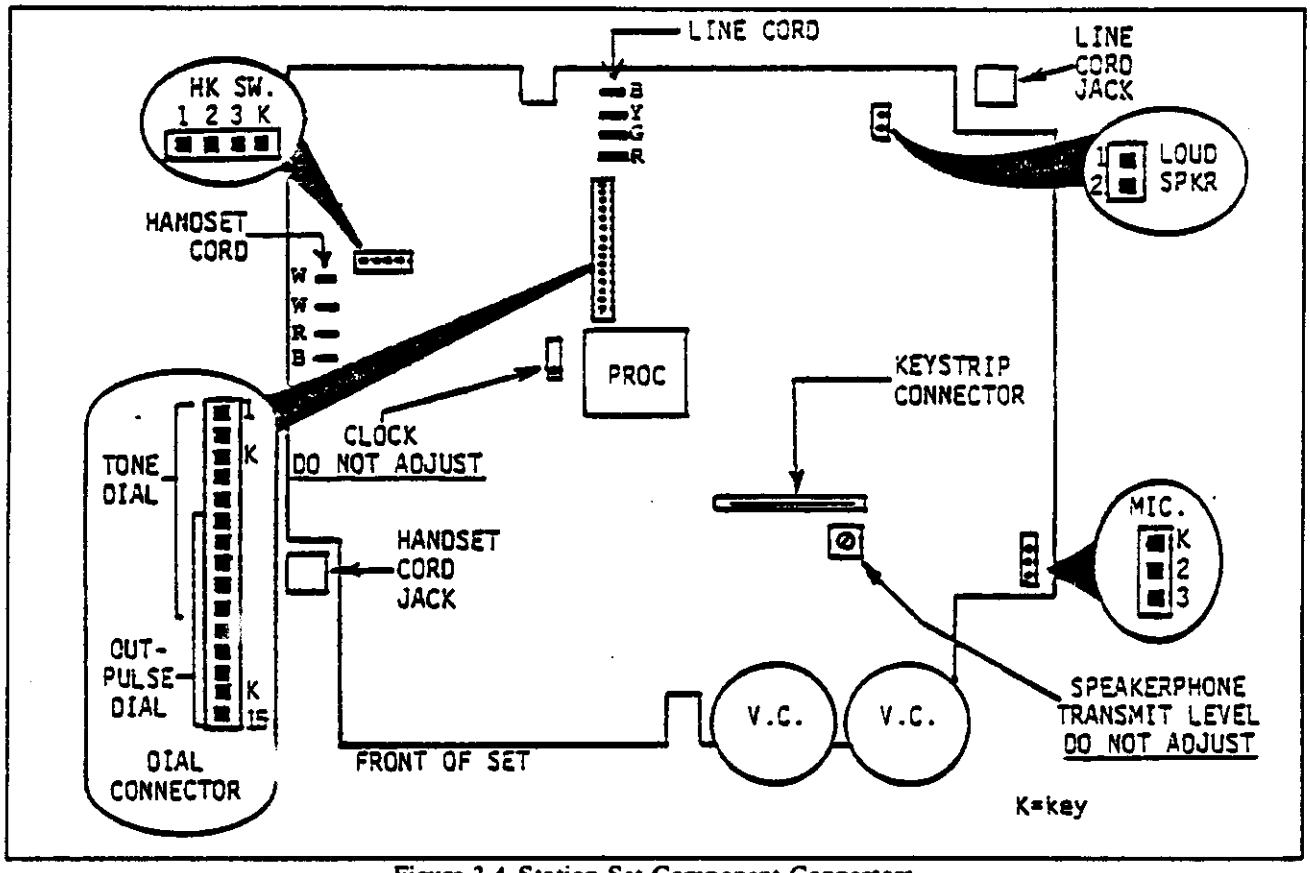


Figure 3-4 Station Set Component Connectors

paging operation is normal while external paging loudspeakers malfunction, the external paging amplifiers may be the source of the problem.

3-27. The page card has two LEDs: DS1 indicates the availability of +25 volt DC (fuse F1 *not* blown), and DS2 indicates the availability of -25 volt DC (fuse F2 *not* blown). There are no test points except for test point TP1, system ground.

3-28. If a problem appears to be related to the page card and the LEDs are both lighted, the page card should be replaced. Before installing the replacement page card, make sure that the strap connections at connectors J1 through J10 on the replacement card are the same as those on the card being replaced. If a fuse on the page card is blown (one or both LEDs are not lighted), inspect the page card thoroughly for wire clippings, short circuits, and touching component leads; correct the problem and replace the blown fuse with a fuse of the same rating. If the replacement fuse blows, replace the page card.

3-29. C.O. Line Card Troubleshooting. (See Figure 3-7.) One C.O. line card is provided for each C.O. line. Failure of a C.O. line card usually will affect operation of the associated C.O. line only; however, note that circuits in the tone generator card are involved in C.O. audible and C.O. line DXP, and that jumper connections at the selector panel of the KSU control assignment of C.O. lines to keys CO17 and CO18 at station sets 30 through 53.

3-30. The C.O. line card has three LEDs: DS1, when lighted, indicates that the C.O. line card has been seized or is on hold, DS2 indicates the availability of +25 volt DC (fuse F1 *not* blown), and DS3 indicates the availability of -25 volt DC (fuse F2 *not* blown). LED DS1 also flashes at the outpulse rate when using an outpulse dial, and will go out when the FLASH key is actuated for open loop operation. Seven test points are provided; the test points and data monitored are as follows:

Test Point	Data Monitored
TP1	Current level received from station card
TP2	Voltage drop from station card
TP3	HOLD pulse
TP4	FLASH pulse
TP5	Ring to C.O. line
TP6	Tip to C.O. line
TP7	Ground

NOTE

A butt set may be used at test points TP5 and TP6 only; an oscilloscope must be used at all other test points.

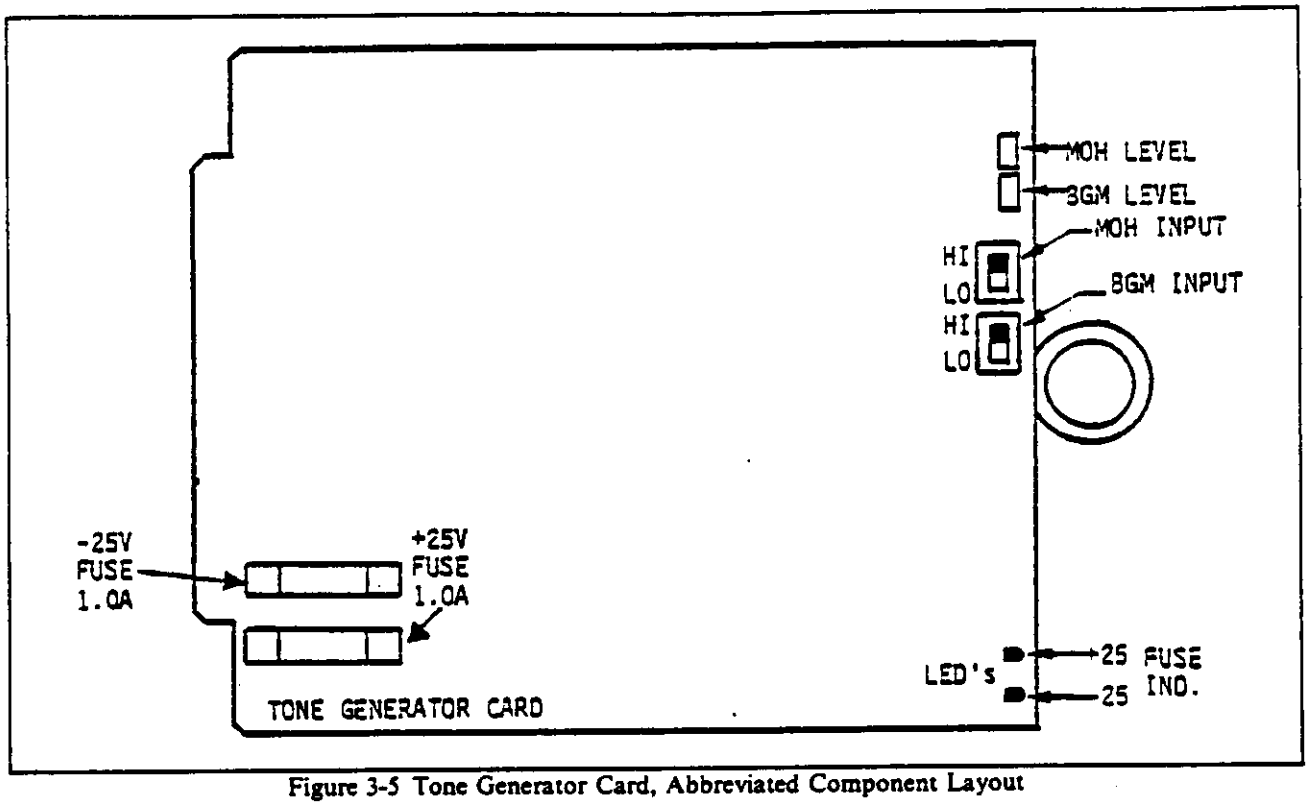


Figure 3-5 Tone Generator Card, Abbreviated Component Layout

3-31. If a problem appears related to a C.O. line card and the LEDs are lighted, the suspect C.O. line card can be checked by substituting a spare C.O. line card; if substitution clears the problem, the removed C.O. line card is defective and should be replaced. If a fuse on the C.O. line card is blown (DS2 or DS3 not lighted), inspect the card throughly for wire clippings, short circuits, and touching component leads; clear the problem and replace the fuse with one of the same rating. If the replacement fuse blows, replace the C.O. line card. Before installing a replacement C.O. line card, make certain that the flash key strapping at connectors J1 through J3 is the same as that on the card being replaced. Also, if the ground flash option is needed, the replacement card must contain relay K2.

3-32. **Link B Card Troubleshooting.** (See Figure 3-8.) Up to six link B cards may be used in the system. Operation of each link B card requires proper operation of an associated link A card. Links are assigned to handle intercom calls on an available basis by the microcomputer in the station card processing the intercom call; for this reason, failure of a specific link B card may appear to be an intermittent problem, since operative link B cards may sometimes be selected by the microcomputers. Each link B card handles intercom calls to stations 60 through 89 and C.O. lines 17 through 29 (the C.O. lines that do not appear at all station sets).

3-33. The link B card contains two LEDs: DS1 indicates the availability of -25 volt DC (fuse F2 *not* blown), and DS2 indicates the availability of +25 volt DC (fuse F1 *not* blown). Six test points are provided; the test points and data that they monitor are as follows:

TP3 DECODE

Test Point	Data Monitored
TP1 $\overline{\text{BT ENA}}$	Busy tone enables pulse from link A card
TP2 DECODE	Logic level to open and close DXP to station 60
TP3 DECODE LINE	Logic level to open and close DXP to C.O. line 916
TP4 COM DRAIN	DXP voltage, audio and current sink
TP5 COM	Current through DXP to C.O. line card
TP6 GND	Ground

3-34. If a problem appears related to a link B card and the LEDs on all link B cards are lighted, the defective link B card can be located as follows:

1. Remove all link A and link B cards except those in the LK A1 and LK B1 positions in the KSU.

NOTE

The tests in the following steps must be made from stations accessible to the link A1 and link B1 cards.

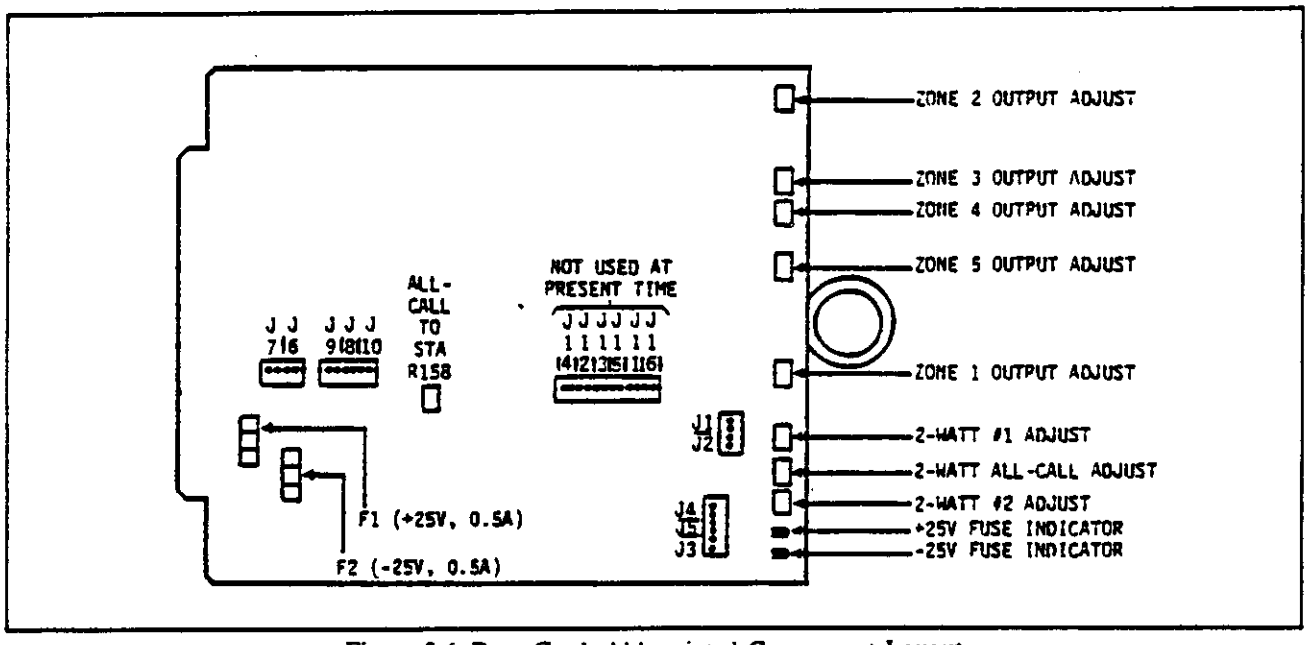


Figure 3-6 Page Card, Abbreviated Component Layout

2. Initiate an intercom call of the type that produced the symptom of malfunction. If the malfunction again occurs, verify that the link B card is the cause of the problem by substituting a spare link B card. If substitution clears the problem, the link B card removed from the LK B1 position is defective; replace the card.

3. If the intercom call is handled normally in step 2, insert each of the remaining link B cards, in succession, into the LK B1 position in the KSU, and check each link B card as in step 2. When the defective link B card is found, replace it.

4. After the defective link B card has been found, install all other link A and link B cards in their normal operating positions in the KSU.

3-35. If one or both LEDs on a link B card are not lighted, inspect the card thoroughly for wire clippings, short circuits, and touching component leads. Correct the problem and replace the blown fuse with a fuse of the same rating. If the replacement fuse blows, replace the link B card.

3-36. **Register Card Troubleshooting.** (See Figure 3-9.) One or two register cards may be used in the KSU. Intercom calls are handled by the register cards on an available basis. If two register cards are used, a register card defect may only cause delays in processing intercom calls, since the calls may be handled by the operable register card. Alternately, the problem may appear as an intermittent problem, providing symptoms only when the defective register card attempts to handle the call.

3-37. The register card contains six LEDs. The LEDs and their functions are as follows:

LED	Function
DS1 +8V	When lighted, indicates availability of +8 volt DC (fuse F2 *not* blown)
DS2 STANDBY	When lighted, indicates that register card is in reset idle condition
DS3 READY	When lighted, indicates that register card is ready to handle incoming incoming call
DS4 DIALING	When lighted, indicates that register card is performing dialtone and dialing function
DS5 RESET	When lighted, indicates that register card dialing circuits are in the reset condition
DS6 -9V	When lighted, indicates availability of -9 volt DC (fuse *F1* not blown)

3-38. If a problem appears to be related to a register card and LEDs DS1 and DS6 on both register cards are lighted, the defective register card can usually be located by observing the other LEDs when an intercom call is initiated. The LEDs on an operating register card will cycle, returning to standby, then ready upon completion of the register cycle. On a defective register card, the LEDs will not cycle, or will not complete the cycle. If one register card seems to handle all intercom calls, remove this register card and check to see if the remaining register card now operates. The condition of a register card

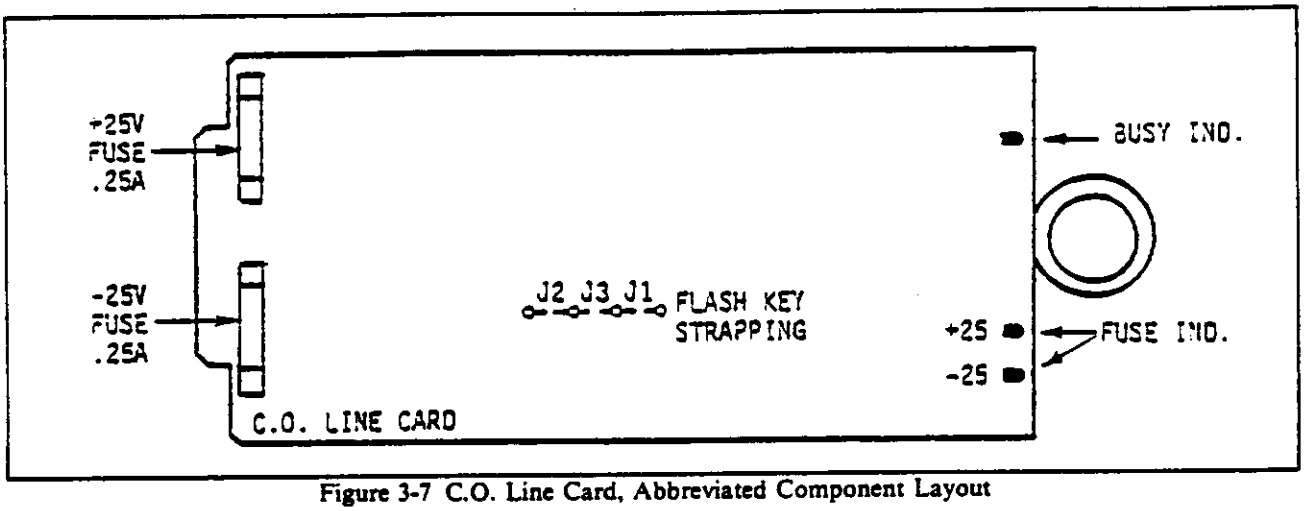


Figure 3-7 C.O. Line Card, Abbreviated Component Layout

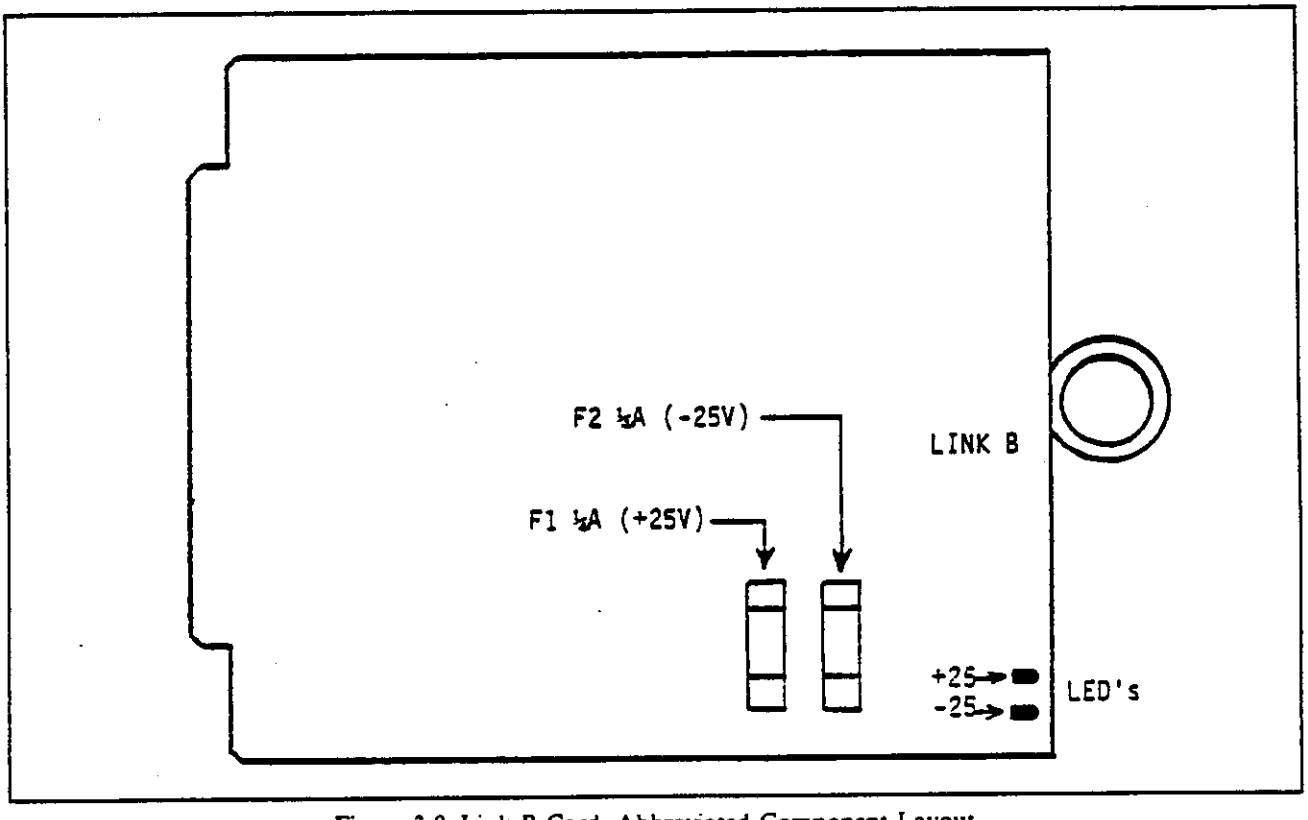


Figure 3-8 Link B Card, Abbreviated Component Layout

suspected of being defective can be verified by substituting a spare register card; if substitution clears the problem, the removed register card is defective and should be replaced.

3-39. If one or both LEDs DS1 and DS6 on a register card are not lighted, inspect the card thoroughly for wire clippings, short circuits, and touching component leads. Clear the problem and replace the blown fuse with one of the same rating. If the replacement fuse also blows, replace the register card.

NOTE

Before installing a replacement register card, make certain that all miniature switches at the front edge of the card are set to the ON position.

3-40. Link A Card Troubleshooting. (See Figure 3-10.) Up to six link A cards may be used in the system. Each link A card controls operation of one link B card. Links are assigned to handle intercom calls on an available basis by the microcomputer on the station card initiating the intercom call. Failure of a specific link A card may appear to be an intermittent problem, since operative link A cards may be selected by the microcomputers. Each link A card handles intercom calls to stations 30 through 59, and supplies control signals to its associated link B card to handle intercom calls to stations 60 through 89 and C.O. lines 17 through 29.

3-41. The link A card contains four LEDs: DS4 indicates the availability of -25 volt DC (fuse F2 *not* blown); DS3 indicates the availability of +25 volt DC (fuse F1 *not* blown); DS2 indicates that the link A circuits have been reset and are ready to handle a call; and DS1 indicates that the called station has answered the call. Six test poins are included; the test points and the data monitored are as follows:

Test Point	Data Monitored
TP1 ARR	Address register reset
TP2 A PORT	A port seize current and audio
TP3 CSSE	Called station send enable pulse
TP4 B PORT	DXP voltage, audio, and current sink
TP5 LKR	Link reset
TP6 GND	System ground

3-42. If a problem appears to be related to link A card and LEDs DS3 and DS4 on all link A cards are lighted, the defective link A card can be located as follows:

1. Remove all link A and link B cards except those in the LK A1 and LK B1 positions in the KSU.

2. Initiate an intercom call of the type that produced the symptom of malfunction. If the malfunction occurs again, verify that the link A card is the cause of the problem by substituting a spare link A card. If substitution clears the problem, the link A card removed from the LK AL position is defective; replace the card.

3. If the intercom call is handled normally in step 2, insert each of the remaining link A cards, in succession, into the LK AL position in the KSU, and check each link A as in step 2. When the defective link A card is found, replace it.

4. After the defective link A card has been found, install all other link A and link B cards removed in step 1.

3-43. If one or both LEDs DS3 and DS4 on a link A card are not lighted, inspect the card thoroughly for wire clippings, short circuits, and touching component leads. Correct the problem and replace the defective fuse with a fuse of the same rating. If the replacement fuse blows, replace the link A card.

NOTE

Before installing a replacement link A card, check to see that the option strap in the upper corner of the card is connected the same as on card being replaced.

3-44. DSS Console Quad Troubleshooting. If a problem appears to be related to a DSS console/DSS control card combination, check the quad before troubleshooting the DSS console or the DSS control card. The red-green pair of the quad serves stations 30 through 57 through the DSS A control card in the KSU; the yellow-black pair serves stations 60 through 82 plus paging through the

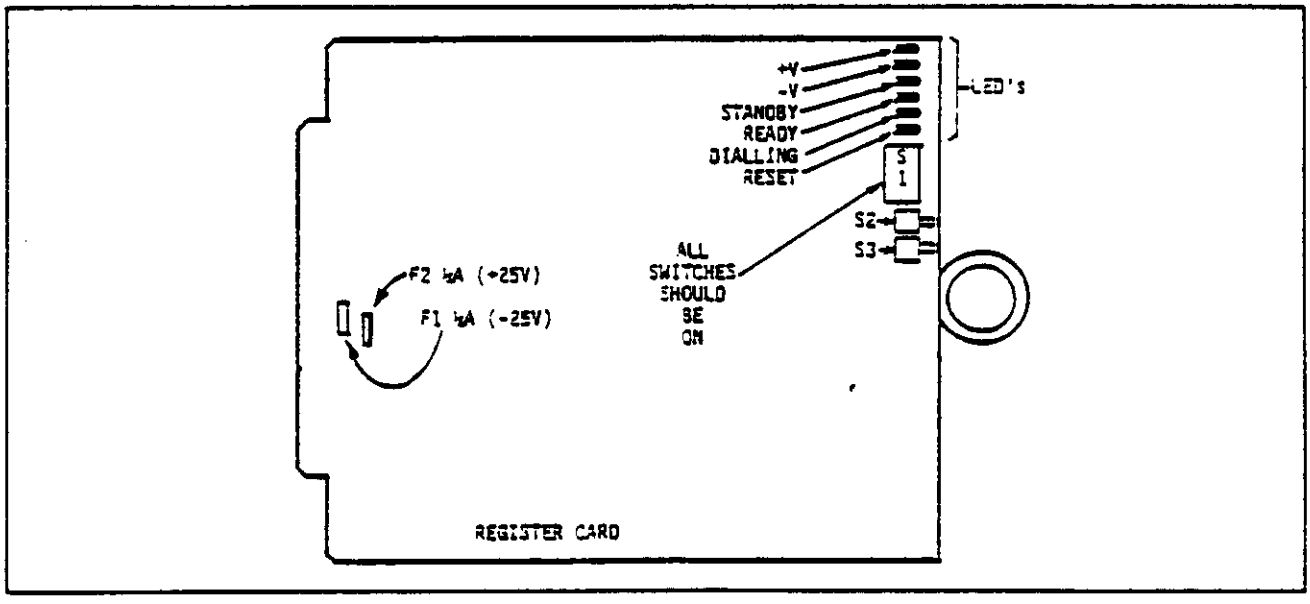


Figure 3-9 Register Card, Abbreviated Component Layout

DSS B control card in the KSU. A shorted quad pair will cause fuses on the associated DSS control card to blow. For continuity checks of the quad, use a DC volt-ohmmeter; do not attempt to use a butt set for this purpose.

NOTE

If there are two DSS consoles which are *not* operating in parallel, only one pair of each quad will be used.

3-45. DSS Control Card Troubleshooting. (See Figure 3-11.) One or two DSS control cards are used in the KSU for each DSS console. The cards in the DSS A1 and DSS B1 slots function with DSS console 1, and the DSS A2 and DSS B2 cards function with DSS console 2. All DSS control cards are identical. The A1 and B1 cards function with the respective DSS consoles to serve stations 30 through 57; the A2 and B2 cards function with the respective DSS consoles to serve stations 60 through 82 plus paging.

3-46. The DSS control cards contain two LEDs: DS1 indicates the availability of +25 volt DC (fuse F1 *not* blown), and DS2 indicates the availability of -25 volt DC (fuse F2 *not* blown). Eight test points are included; the test points and the data monitored at each test point are as follows:

Test Point	Data Monitored
TP1 GND	System ground
TP2 I-SEND	DC current to selected station card
TP3 SYNC	Microcomputer sync
TP4 DXP DATA	DXP data from station cards
$\overline{\text{TP5 DATA TX}}$	Data signal to DSS console
TP6 - QUAD	Minus DC voltage to DSS console
TP7 + QUAD	Plus DC voltage to DSS console
TP8 RB DATA	Data signal from DSS console

3-47. If a problem appears to be related to a DSS control card/DSS console combination, first check the appropriate pairs of the quad. Then, by noting which DSS console and which stations are affected, determine which DSS control card is the likely source of the problem. Verify that this card is the problem source by card swapping or substitution with a spare DSS control card. Once the defective card has been located, check the fuses on that card. If any fuse is blown, inspect the card thoroughly for wire clippings, short circuits, and touching component leads; correct the problem and replace the blown fuse with a fuse of the same rating. If the replace-

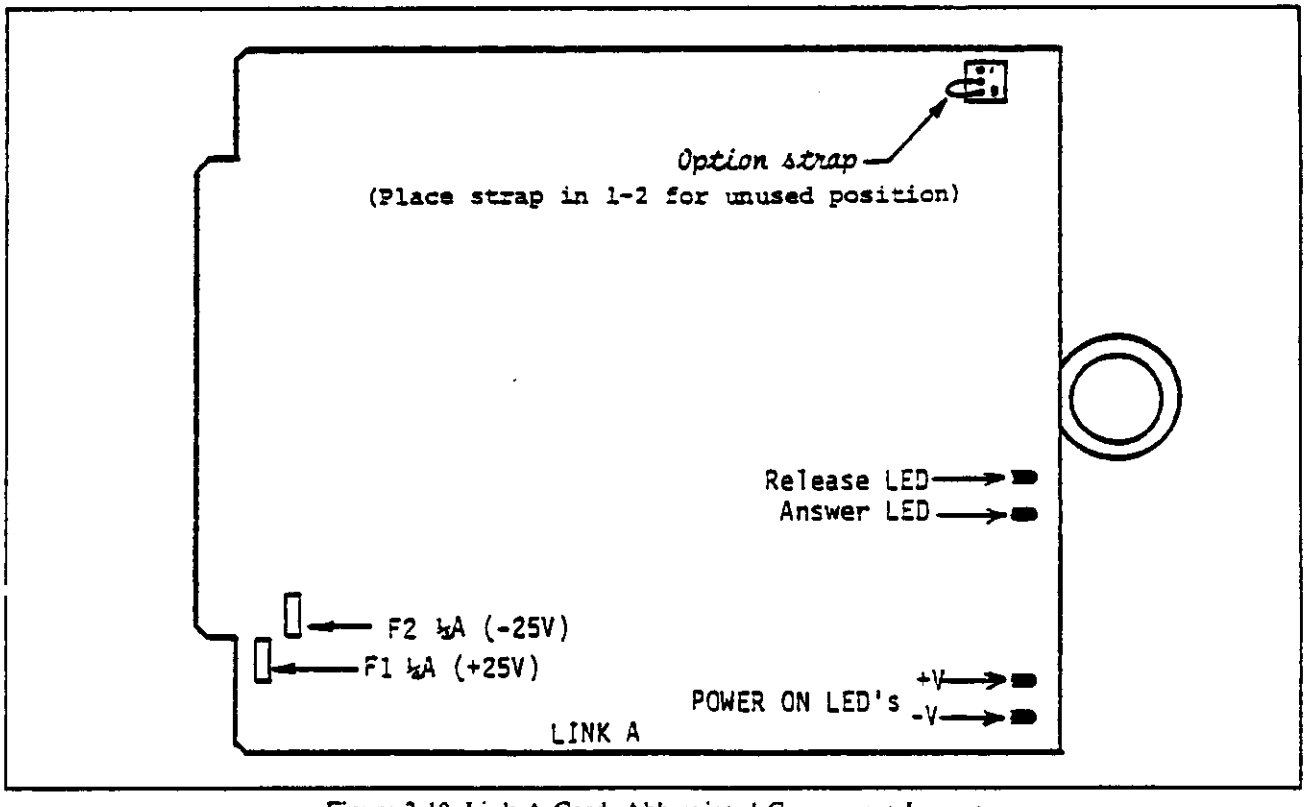


Figure 3-10 Link A Card, Abbreviated Component Layout

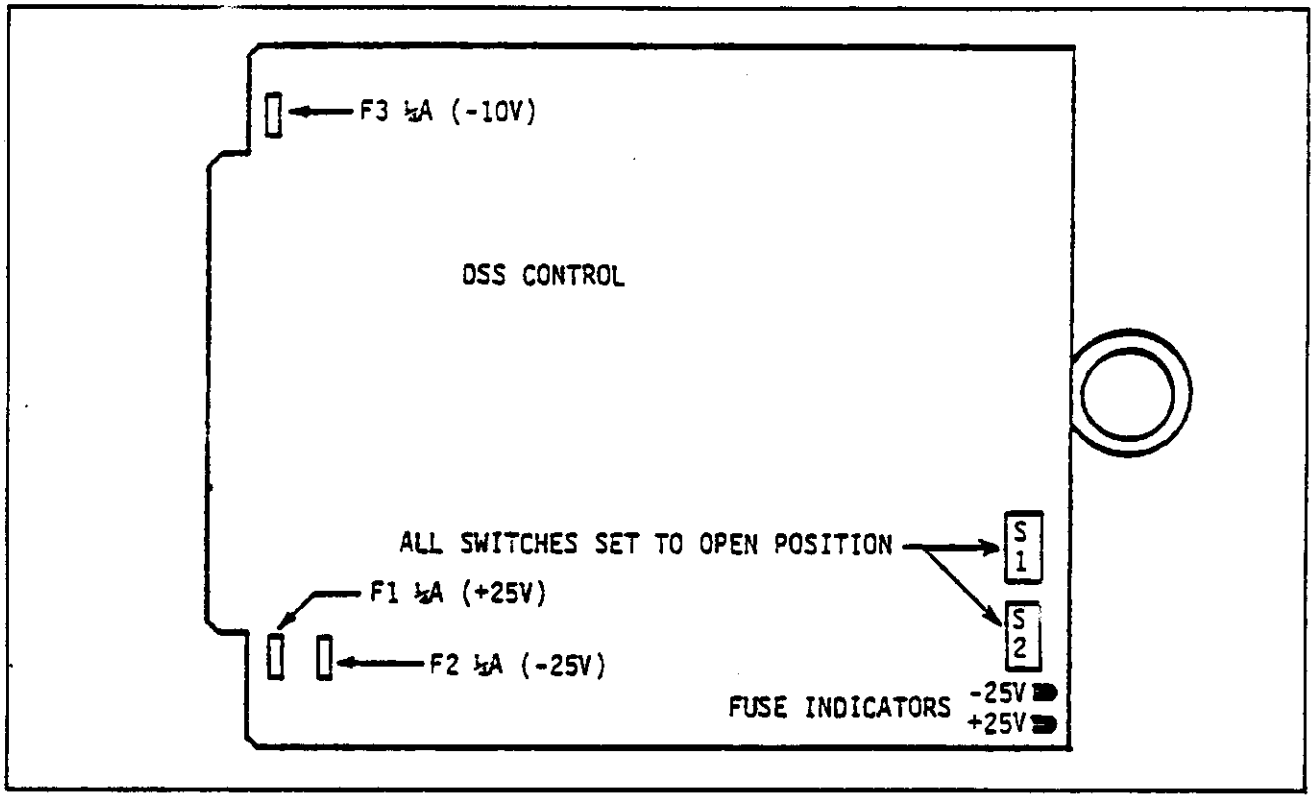


Figure 3-11 DSS Control Card, Abbreviated Component Layout

ment fuse blows, or if the fuse is not the source of the problem, replace the DSS control card. Before installing a replacement DSS control card, make certain that all 20 miniature switches at the front edge of the card are in the open position.

3-48. DSS Console Troubleshooting. (See Figure 3-12). One or two DSS Consoles may be used in the system. If two DSS consoles are used, they may be operated in parallel or separately, depending upon the DSS control card combination in the KSU. In parallel operation, all keys on both DSS consoles are active; for separate operation, one DSS console may serve stations 30 through 57, and the second may serve stations 60 through 82 plus paging.

3-49. If a problem appears to be related to a DSS console DSS control card combination, first check the quad and the DSS control cards. If theproblem has been isolated to the DSS nsole, replace the DSS console unless the problem c. be related to one of the keystrip assemblies or the line cord of the D. 5 console. The keystrip assemblies are replaceable plug-in assemblies; the line cord also plugs in for easy replacement. To replace either the keystrip assembly or the line cord, proceed as follows:

1. Remove the front panel of the DSS console by inserting a screwdriver tip under the lower edge of the front panel at the corners and prying upward.
2. Remove the upper DSS console housing by loosening the captive screw at the front lower center of the housing. The entire printed circuit board assembly is now exposed.
3. To remove a keystrip assembly, disengage the front tabs by pressing rearward while lifting the front of the assembly upward, slide the assembly to the left with an upward motion, and disconnect the ribbon cable. To install the replacement keystrip assembly, insert the ribbon cable into its connector, insert the rear tabs into the cutouts in the base of the set, slide the complete assembly to the right, and press the front tabs rearward to engage the front tabs in their slots.
4. To remove the line cord, unplug the spade tips from their connectors. To install a new line cord, connect the colored leads to the appropriate connectors, dress the line cord through the entrance hole, and push the strain relief hook down on the strain relief tab adjacent to the hole.
5. Insert the rear tab of the DSS con le housing into its slot at the center rear of the conso and close the housing. Tighten the retaining screw.
6. Insert the tabs on the front panel into the top slots and push down on the lower part of the panel.

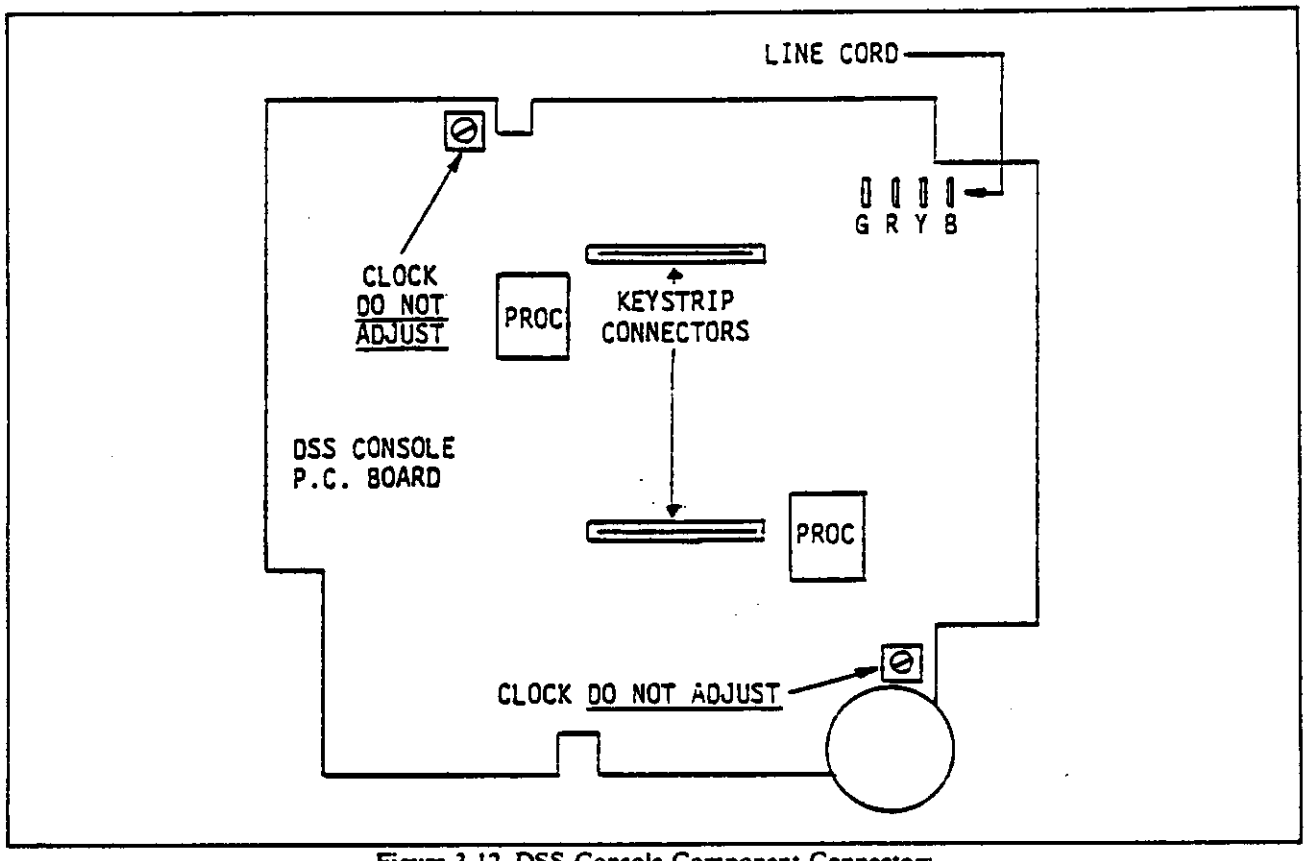


Figure 3-12 DSS Console Component Connectors

3-50. ADJUSTMENT PROCEDURES.

3-51. The only field adjustments are those that control BGM and MOH levels; all other potentiometers for factory adjusted and should not be disturbed in the field. BGM and MOH adjustment control are located on the tone generator card (Figure 3-5). The adjustment procedures are as follows:

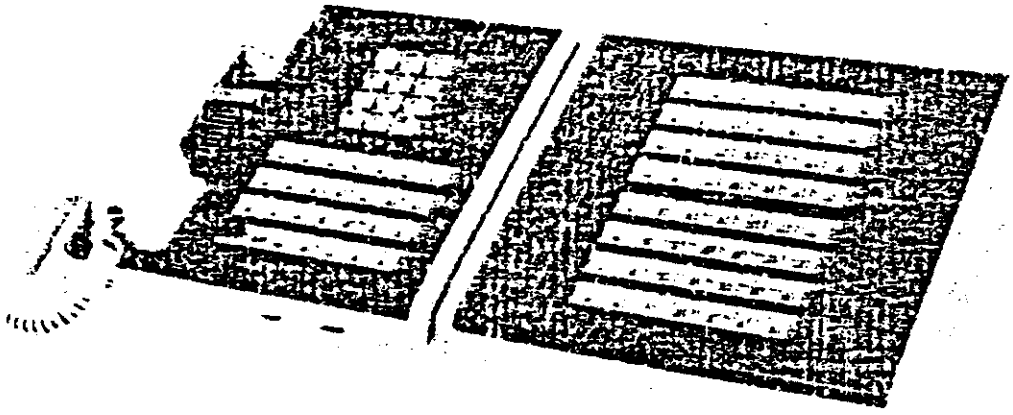
NOTE

It may be more convenient to adjust the external music sources for BGM and MOH. Wherever possible, adjust these sources instead of the tone generator card controls.

1. If the BGM level is too high or too low, adjust the BGM LEVEL potentiometer as required to provide the desired level. If the potentiometer has insufficient range, set the BGM INPUT switch to the HI position to reduce the level or to the LO position to increase the level, and readjust the BGM LEVEL potentiometer.

2. If the MOH level is too high or too low, adjust the MOH LEVEL potentiometer as required to provide the desired level. If the potentiometer has insufficient range, set the MOH INPUT switch to the HI position to reduce the level or to the LO position to increase the level, as applicable, and readjust the MOH LEVEL potentiometer.

SECTION 3851
Issue 2
December 1979



EK-3060 2040

ELECTRONIC KEY TELEPHONE SYSTEM

INSTALLATION MANUAL

NOTICE TO CUSTOMERS

TIE's EK-2040/3060 Key Telephone Systems are registered in accordance with provisions of Part 68 of the Federal Communications Commission's Rules and Regulations. Customers are advised that under FCC regulations the following provisions must be adhered to:

MEANS OF CONNECTION

Connection to telephone company lines must be made with FCC approved plugs and jacks. Connections to TIE's EK-2040/3060 systems must be made with the RJ-21X standard connectors.

NOTIFICATION TO TELEPHONE COMPANY

Customers must give sufficient notice to the telephone company before connecting and disconnecting customer provided equipment to telephone company lines. Customers must further advise the telephone company as to the particular lines affected and the FCC Registration Number and Ringer Equivalence Number of the equipment.

EK-2040/3060 Registration Number: BJ286G-69726-KF-E

EK-2040/3060 Ringer Equivalence: 2.6B

INCIDENCE OF HARM

The telephone company shall notify customers, where practical, in the event that customer provided equipment causes harm to the telephone network of possible temporary discontinuance of service. In the event of such discontinuance of service, the telephone company must attempt to advise the customer prior to such discontinuance, afford customers an opportunity to correct the problem and advise customers of their right to bring complaint procedures before the FCC.

COMPATIBILITY TO TELEPHONE NETWORK

Customers shall be given prior notification of any alteration to telephone company equipment, operations or procedures which may be expected to affect customer provided equipment operation.

RESPONSIBILITY TO GRANTEE

Installation and maintenance of the equipment is to be effected only by an authorized agent of TIE/communications.

Alterations or modifications of the equipment not expressly shown in TIE installation procedures are prohibited.

The customer is advised to disconnect the equipment from telephone company lines in the event of suspected equipment malfunction. Disconnections MUST be made at the RJ-21X connectors.

The TIE EK-2040/3060 systems are not authorized for in coin or party line applications.

Warning: This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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TELEX 643804 CABLE: TIE SHELTON CT.

INTRODUCTION

The purpose of this manual is to provide the descriptive and procedural information necessary to install, test and maintain the TIE EK-2040/3060 Electronic Key Telephone System. It is assumed that the installer has a basic understanding of key systems theory and operation. With that knowledge and this manual, the installer will be able to install, test, maintain and troubleshoot the TIE EK-2040/3060 Key Telephone System.

The TIE EK-2040/3060 key service unit and telephones are the fundamental units of the TIE EK-2040/3060 electronic key telephone system. Information on installation, connections, strapping and testing, as well as maintenance, is provided in this manual.

It is recommended that the installer thoroughly familiarize himself with the information contained in this manual prior to initiating installation of the system.

It is further recommended that this manual and other job related information be left on the job site to aid personnel on repair or rearrangement visits to the site. Options and any special wiring should be recorded for use by personnel on future visits to the job. This can save both time and money.

If, during installation, or service calls, problems or questions arise that cannot be resolved by using the information contained in this and related manuals, assistance is available from the TIE Technical Service Department, Monday through Friday, as follows:

For assistance in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington & Wyoming, between 8:30 AM and 5:30 PM, Pacific time, call:

415-592-1929

For assistance in Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, & Wisconsin, between 8:30 AM and 5:30 PM, Central time, call:

312-595-4400

For assistance in all other states, between 8:30 AM and 5:30 PM, Eastern time, call:

203-929-7373

For EMERGENCY assistance at times other than above, call:

203-929-7920

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ENGINEERING TECHNICAL LETTER #0027

December 10, 1980

SUBJECT: Power Line Surge Protection in All TIE Electronic Key Telephone Systems.

TO ALL TIE CUSTOMERS

This letter is issued for the following purposes:

1. To recommend that all of TIE's electronic key telephone systems presently in production (EK-308, EK-516, EK-717, EK-1236, EK-2040, and EK-2260) and all future systems be equipped with a power line surge protection device.

2. To recommend that TII® Model 428 Plug-In Powerline Surge Protector, or an equivalent device, be used for this purpose.

EXPLANATION

The failure of electronic circuit components occurring after thunderstorms has been investigated. This investigation has revealed that systems without power line surge protection are more susceptible to damage from power line surges than protected systems. The cost of a surge protector is small compared to the cost of extensive component replacement or repair. Its installation will prevent or minimize the damage resulting from violent thunderstorm activity, while preserving customer satisfaction with TIE/communications' electronic key systems.

DESCRIPTION OF THE SURGE PROTECTOR

The TII® #428 Plug-In Powerline Surge Protector is a 15-amp self-contained unit which plugs into a standard 3-prong, parallel blade, grounded 117VAC wall outlet. The system power supply should be plugged into the duplex receptacle on the surge protector. A cover plate screw holds the TII #428 unit in place.

The unit contains a long-life pilot lamp which glows when normal AC line voltage is present and extinguishes when power is off or during power line surges. The TII #428 unit contains a gas tube surge protector which operates at 300V or higher potentials. MOV voltage clamping diodes are connected across the output to reduce low-level transients and ripple effects. The unit measures 4.9 x 3.3 x 3 inches and weighs 10 ounces.

The TII #428 unit is available from TII® Industries, Inc. or from the telephone-equipment supply houses.

ASSISTANCE

If technical questions or problems arise in this matter, consult TIE's Technical Service Department.

USCU-C INSTALLATION WITH 4K24A3 PROGRAM ROM

1.00 INTRODUCTION

1.01 This addendum is issued to provide installation information for using USCU-C circuit cards in the EK-2040/3060 key telephone system.

1.02 This addendum supplements the information contained in the EK-2040/3060 Installation Manual and Addendums 3851, issues 1, 2 and 3.

2.00 GENERAL

2.01 The USCU-C Station Control Unit circuit card has an improved circuit layout and is more economical for production than the USCU-B card.

2.02 The USCU-C card is a direct replacement for the USCU-B and is installed in the same manner, except for the provisions specified in this addendum.

2.03 All USCU-C cards presently in production utilize the 4K24A3 program.

3.00 ATTENDANT'S STATION

3.01 NO special program chip is required when the USCU-C card is installed for the attendant station (station 58). A switch is provided on the card which enables the attendant program when required.

4.00 USCU-C INSTALLATION

4.01 When the USCU-C card is to be installed, two factors must be considered to determine which action must be taken by the installer. These factors are:

- USCU-C cards in KSUs with pull-up resistors.
- USCU-C cards in KSUs without pull-up resistors.

4.02 KSUs WITH pull-up resistors:

4.03 A small printed circuit board is located in the upper left corner of the KSU on the wiring side of the swing-out gate (above connectors J17-J20). The board is designated "Analog X-PT Pull-up PCBD".

4.04 If the KSU is equipped with the pull-up resistors, all USCU-C cards, all USCU-B cards, or any combination of Bs and Cs may be installed without any further consideration except proper switch settings.

4.05 KSUs WITHOUT pull-up resistors:

4.06 If the KSU is NOT equipped with the pull-up resistor P.C. board, at least ONE card must be a USCU-B card. All other cards may be USCU-B or USCU-C cards.

5.00 SWITCH PROGRAMMING:

5.01 Figure 1 shows an abbreviated layout of the USCU-C card. The figure shows program switch locations, LED locations, and fuse locations.

5.02 Table 1 provides programming information for the four switch assemblies on the card.

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S1-1	MUST BE IN OPEN POSITION*
S1-2	Transmit Data } Must always be
S1-3	Receive Data } CLOSED.
S1-4	Close to enable handsfree dialling on C.O. lines.
S1-5	Open for OFF-HOOK signalling.
S1-6	Close for Group 5 C.O. Audible.
S1-7	Close for Group 4 C.O. Audible.
S1-8	Close for Group 3 C.O. Audible.
S1-9	Close for Group 2 C.O. Audible.
S1-10	Close for Group 1 C.O. Audible.

* If S1-1 is placed in the CLOSED position, intercom calls will be distorted.

S2-1	Open to disable dial on line 9.
S2-2	Open to disable dial on line 8.
S2-3	Open to disable dial on line 7.
S2-4	Open to disable dial on line 6.
S2-5	Open to disable dial on line 5.
S2-6	Open to disable dial on line 4.
S2-7	Open to disable dial on line 3.
S2-8	Open to disable dial on line 2.
S2-9	Open to disable dial on line 1.
S2-10	Spare - leave in OPEN position.

S3-1	Spare - leave in OPEN position.
S3-2	Open to disable dial on 2nd P.L.
S3-3	Open to disable dial on 1st P.L.
S3-4	Open to disable dial on line 16.
S3-5	Open to disable dial on line 15.
S3-6	Open to disable dial on line 14.
S3-7	Open to disable dial on line 13.
S3-8	Open to disable dial on line 12.
S3-9	Open to disable dial on line 11.
S3-10	Open to disable dial on line 10.

S4-1	Open for BGM at station.**
S4-2	Manual Reset - MUST BE OPEN.
S4-3	Close for attendant program.
S4-4	Spare - Leave in OPEN position.
S4-5	Close to disable C.O. recall##.
S4-6	Spare - Leave in OPEN position.
S4-7	Open for PAGE & Nite Audible.
S4-8	Close to originate handsfree on hotline calls.
S4-9	Spare - Leave on OPEN position.
S4-10	Spare - Leave in OPEN position.

** Close if no BGM source is connected to eliminate any ambient loudspeaker noise at the stations.

Audible recall on held calls.

LED INDICATORS

DS1	Lit when hotline port is seized.
DS2	Lit when link port is seized.
DS3	Lit when -25VDC is present.
DS4	Lit when +25VDC is present.
DS5	a) Lit when station is active. b) Flashes during dialling when station has OUTPULSE DIAL©.
DS6	Lit during C.O. line calls.

6.00 FUSING

6.01 The USCU-C card is equipped with pico type fuses. These are miniature fuses with wire leads on both ends. The leads are pushed into "push-on" terminals. NO SOLDERING IS REQUIRED.

SERIOUS CARD DAMAGE MAY RESULT IF A PIECE OF WIRE IS SUBSTITUTED FOR THE FUSE.

6.02 Under certain conditions it is possible that power may not be present at the station set and both fuse LEDs (-25V & +25V) are lit; indicating power is present to the quad. The USCU-C card has a regulator circuit which will shut off power to the quad when a short exists between the quad pairs. When the short is removed, power to the quad will be restored automatically. Fuses F1 and/or F2 may not blow when this condition occurs, unless there is a malfunction in the regulator. If the negative pair (BK/YL) is grounded, the F2 fuse should blow. If the positive pair (GN/RD) is grounded, the regulator will shut off and the +25 LED will remain lit. If no power is present at the station with both LEDs lit, a short between the quad pairs, a grounded GN/RD pair or excessive current being drawn by the station set is indicated.

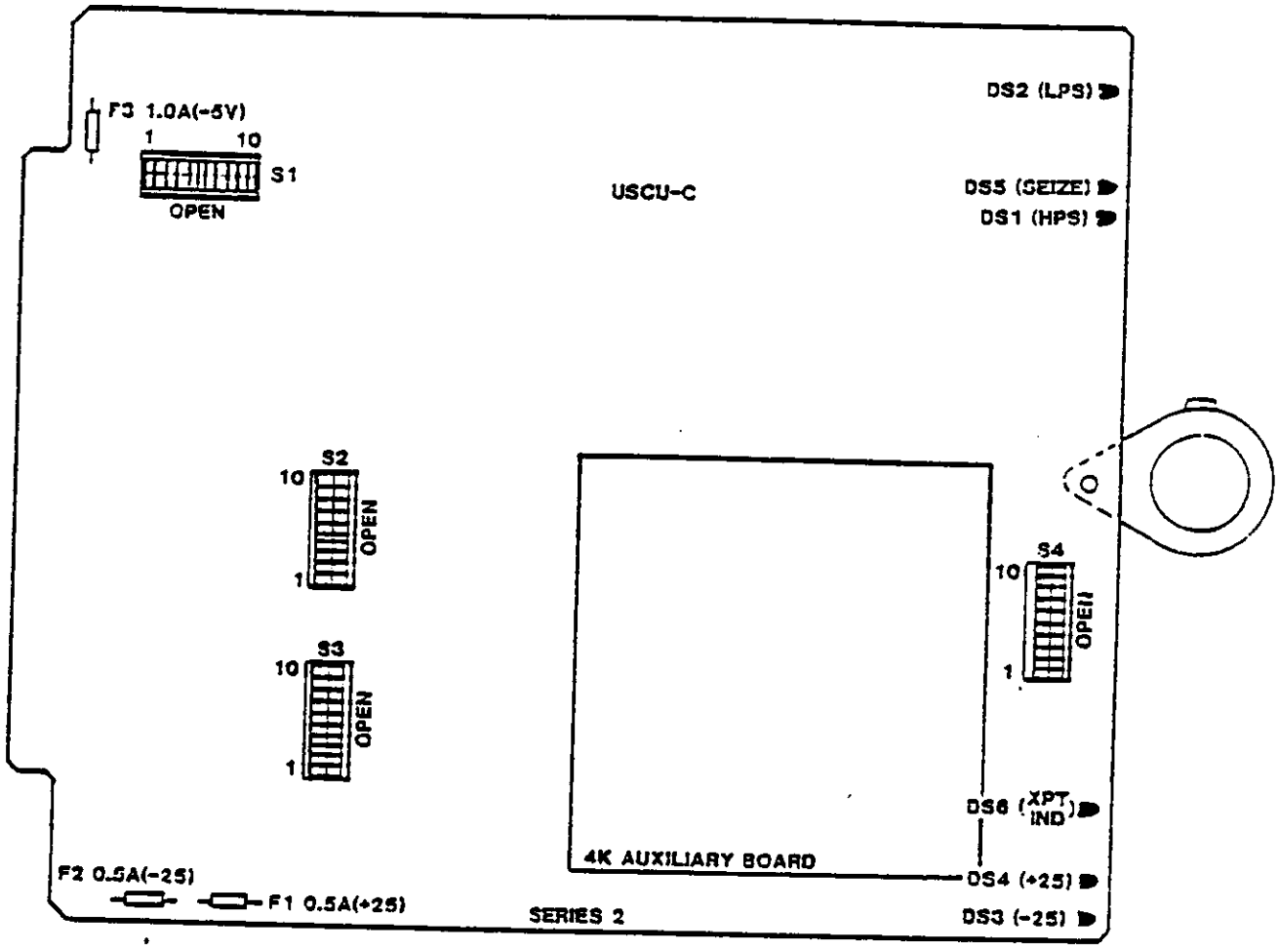

Figure 1 - Abbreviated USCU-C Card Layout

NIGHT C.O. AUDIBLE WITHOUT PAGING IN EK-2040/3060 KEY TELEPHONE SYSTEMS

1.00 INTRODUCTION

1.01 This addendum is issued to inform installation personnel that the PAGE card must be provided in the system if the night transfer of C.O. audible feature is to be provided.

1.02 This addendum supplements the information contained in the EK-2040/3060 Installation Manual and Addendum 3851, Issues 1 and 2.

2.00 GENERAL

2.01 When paging is not provided in the 2040/3060 system and night transfer of C.O. audible is required, the PAGE card must be installed.

2.02 The circuitry for control of the night transfer feature is located on the PAGE card. When the C.O. audible/ paging volume control on the attendant's set is moved to the extreme right position (off), the night audible circuitry is activated.

2.02 PAGE card installation details are provided under par. 8.37 in section 1.

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USCU-B INSTALLATION WITH 4KA3 PROGRAM ROM

1.00 INTRODUCTION

1.01 This addendum is issued to provide information for setting the option switches on the USCU-B Station card when the USCU-B is equipped with a 4KA3 program ROM.

1.02 This addendum supplements the information contained in the EK2040/3060 Installation Manual and Addendum 3851, Issue 1.

2.00 GENERAL

2.01 Only series 3 or later USCU-B cards should be installed. USCU-B cards should be installed in accordance with Addendum 3851, issue 1, revised July 1980.

2.02 When USCU-B cards are equipped with a 4KA3 program ROM (Read Only Memory), any USCU-B card may be used as the attendant's station card. The station card for the attendant is always installed in card slot 58 in the KSU. When the USCU-B is used as the attendant's station card, switches S4 1-10 must be set as shown paragraph 2.05.

2.03 Switches S4 1-10 are located beneath the 4K Auxiliary card (see figure 1). The switches are set by the factory in one of two configurations; one for conventional stations and the other for the attendant station(s). The following paragraphs define both arrangements.

2.04 Switches S4 1-10 are set at the factory for conventional stations in the following manner:

S4-1	Open	S4-6	Open
S4-2	Open	S4-7	Open
S4-3	Open	S4-8	Closed
S4-4	Open	S4-9	Open
S4-5	Closed	S4-10	Open

2.05 Switches S4 1-10 are set at the factory for attendant station operation in the following manner. The cards are marked "Operator's Card". These cards are installed instead of the 2KA1 operator's cards previously used.

S4-1	Open	S4-6	Open
S4-2	Open	S4-7	Closed
S4-3	Closed	S4-8	Open
S4-4	Open	S4-9	Open
S4-5	Open	S4-10	Open

2.06 If, for some reason, a change is required in the switch settings of S4, the 4K auxiliary board must be removed for access to the switches. The functions for each switch on S4 are:

S4-1, S4-2 Not used.
S4-3 Close to enable operator program.
S4-4 Dial enable via link on CO.
S4-5 Close to disable recall on held calls.
S4-6 Not used.
S4-7 Close to disable page calls.
S4-8 Close to enable hotline. handsfree originate.
S4-9, S4-10 Not used.

2.07 To remove the 4K auxiliary card for access the S4 switches:

a) Loosen and remove the nuts which secure the auxiliary board.

b) Lift the auxiliary board upward to unplug it.

c) Set switches S4 as required.

d) Carefully plug the auxiliary board back into its connector.

e) Replace the nuts which secure the auxiliary board to the USCU-B.

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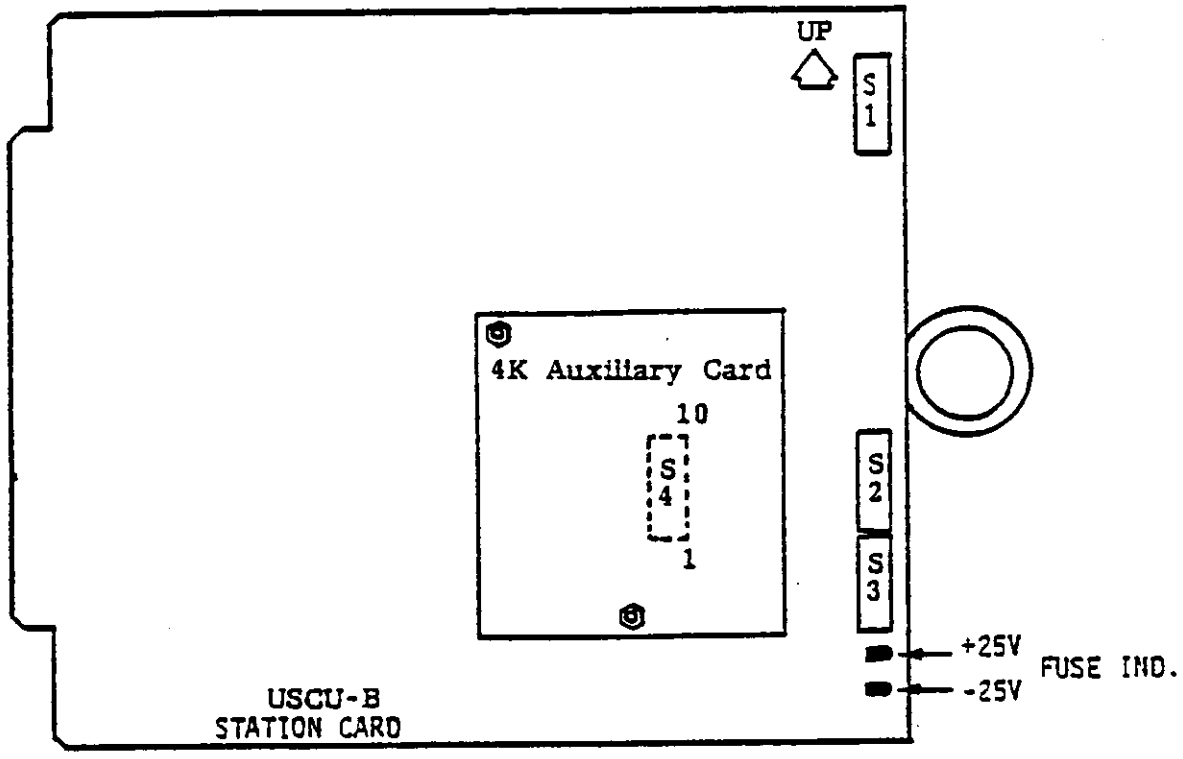

Figure 1 - USCU-B Station Card Switch Locations

USCU-B & SPLIT RINGING INSTALLATION IN EK-2040/3060 SYSTEMS

1.00 INTRODUCTION

1.01 This addendum is issued to provide installation information for using USCU-B circuit cards in the EK-2040/3060 key telephone system and to provide strapping information for split ringing in the system.

1.02 This addendum supplements the information contained in the EK-2040/3060 Installation Manual.

2.00 GENERAL

2.01 The USCU-B Station Control Unit circuit card is an expanded version of the USCU-A circuit card used in earlier 2040/3060 systems. Only series 3 or later USCU-B cards should be installed.

2.02 When the USCU-B is installed in the system, the installer should check for the following:

a) The UTNU-A Tone Generator card should be a series 7 or later card.

b) The URGU-A Register card should be a series 6 or later card.

c) All UCOU-A C.O. Line cards should be series 9 or later cards.

d) When paging is required in the system, the UPGU-A Page card should be a series 6 or later card.

3.00 ATTENDANT'S STATION

3.01 Station 58 is used as the attendant's station. The register will only recognize "0" (zero) as station 58. If "58" is dialled, the caller will receive a reorder signal. The USCU-B installed in card position 58 of the KSU must be equipped with an attendant program. This is required to provide "night ringing" control by the attendant. The attendant's station will NOT receive background music (BGM), if BGM is provided in the system. There will be no "hotline" between stations 58 and 59 in the system.

3.02 The USCU-B used for the attendant station is equipped with a special program IC chip. The IC is identified by a white dot on top of the chip. 2K24 AT is marked on the USCU-B box. USCU-B's for use as attendant station cards should be ordered using TIE part number 25107.

3.03 The USCU-B used for all other stations must NOT be equipped with the attendant program IC. USCU-B boxes for the regular stations are marked "4K24".

3.04 The BGM switch is used for control of night ringing by the attendant station. Moving the C.O. audible/paging volume control (left control as in figure 17) on the attendant's set to the extreme right position (off position) activates the night ringing feature.

4.00 USCU-B INSTALLATION

4.01 The USCU-B station card is an expanded version of the USCU-A circuit card. It is installed in the same manner as the USCU-A, as detailed under paragraph 8.34 (page B21) with the following exceptions:

a) Station options are programmed using switches S1 1-10, S2 1-10 and S3 1-10. Program in accordance with table 3 (page B23).

Switch S1-4 must ALWAYS be left in the OPEN position on the attendant station card (station 58). If S1-4 is closed, the system will revert to the night ringing condition.

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b) Table 4A (page B24) is used for programming C.O. audible groups 1 and 2. Programming for C.O. audible groups 3, 4 and 5 is accomplished in accordance with table 1 of this addendum. DO NOT use table 4B to program USCU-B station cards.

c) If split ringing is required for a particular installation which can not be accomplished using either table 4A or table 1, refer to paragraph 5.00 of this addendum.

4.02 Figure 12 (page B22) shows the component layout of the USCU-B card. The +25V and -25V fuses have been changed from 0.25A (USCU-A) to 0.50A.

5.00 SPLIT RINGING

5.01 As indicated in paragraph 4.01c), provision has been made for split ringing in the 2040/3060 KSU. A Split Ringing Select circuit board has been added to the all KSU's manufactured at revision level "L", or later. Refer to the KSU identification sticker on the rear panel of the KSU for revision level.

5.02 Figure 1 shows the layout of the split ringing select board. The board consists of three jack fields for cross-connecting the C.O. lines to the stations for audible ringing arrangements as follows:

a) The top jack field is made up if 2 common jacks for each station in the system. The jacks are designated "A" and "B" and each station location is shown.

Table 1 - Programming for C.O. Audible Groups 3, 4 & 5

	STATION GROUP	C.O. LINES	SWITCH CLOSED	AUDIBLE GROUP
	30 through 35	1, 2, 3	S1-7	4
	36 through 41	4, 5, 6		
	42 through 47	7, 8, 9		
	48 through 53	10, 11, 12		
	54 through 59	13, 14, 15		
	60 through 65	16, 17, 18		
	30 through 69 and 70 through 89 (Exp Cabinet)	1 through 14	S1-8	3
	30 through 53	15 through 18	S1-6	5
KSU's WITHOUT RING SELECT BOARD ONLY	54 through 69 and 70 through 89 (Exp Cabinet)	15 through 18		

Refer to table 4A for groups 1 and 2 (page B24).

b) The middle field consists of 12 sets of common multiple jacks designated 1 through 12 for each set and A through F for each jack in the set.

c) The bottom field consists of 19 sets of common multiple jacks designated 1 through 19 for each C.O. line and A through D for each jack in the line mutiple. C.O. line 19 is reserved for future use (use 1-18 only).

5.03 Three different jumper kits are available for connecting the C.O. line jacks to the station jacks, as follows:

a) A kit containing 5 diode jumpers and 30 wire jumpers. This kit may be ordered using TIE part number 25130.

b) A kit containing 30 wire jumpers only. This kit may be ordered using TIE part number 25131.

c) A kit containing 5 diode jumpers only. This kit may be ordered using TIE part number 25132.

5.04 Diode jumpers are required when 2 or more C.O. lines are connected to 2 or more stations and isolation is required between the C.O. lines. See figure 2, conditions 4 & 5 for examples.

5.05 The RED diode jumper lead is ALWAYS connected toward the C.O. line jack.

5.06 If appropriate C.O. audible configurations cannot be implemented from table 4A (page B24) and table 1 of this addendum, use figure 2 as a guide, and strap the split ringing field for the required configurations.

When the split ringing field is used, switch S1-6 on the USCU-B must be placed in the closed position to activate the field.

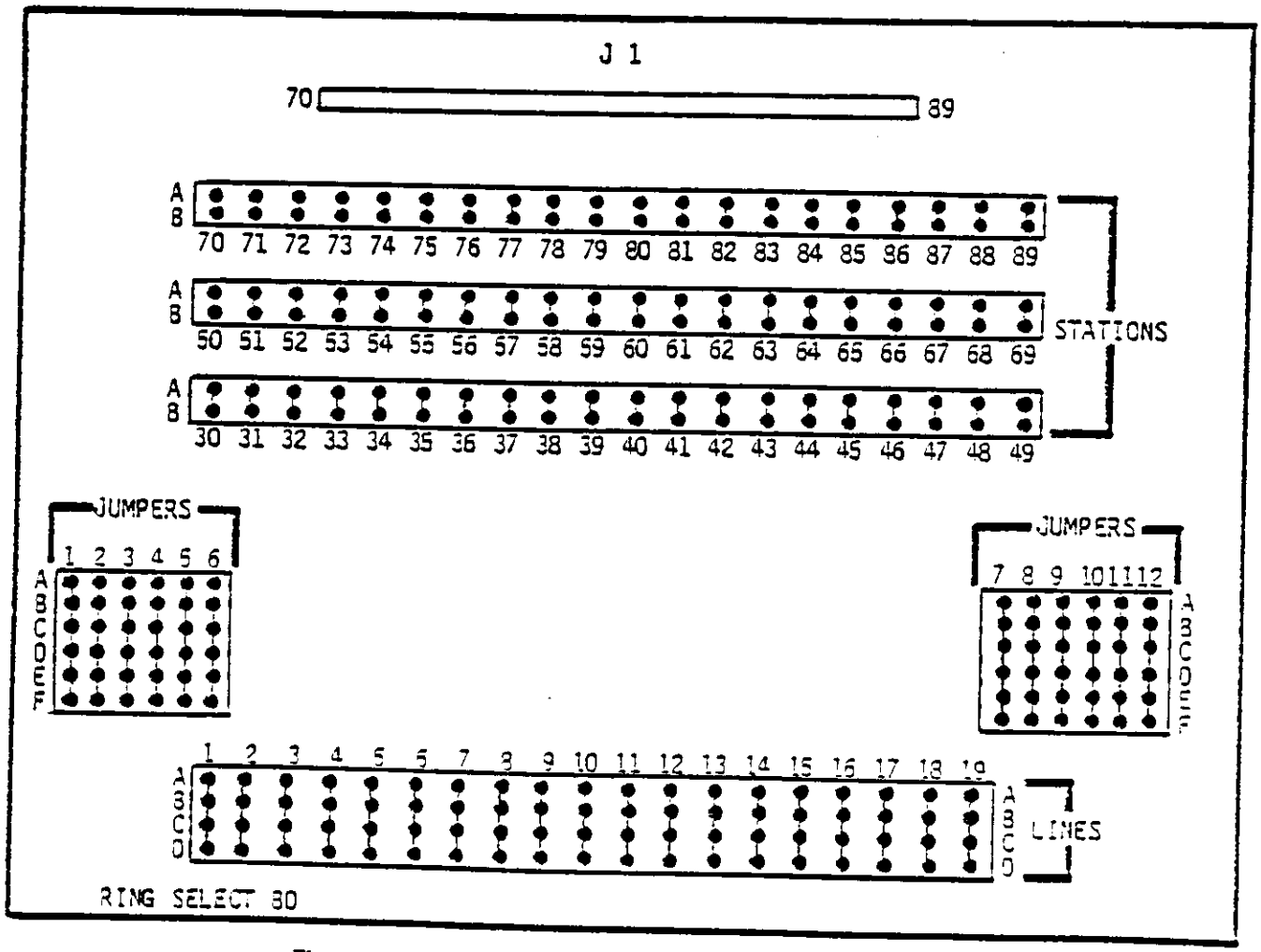


Figure 1 - RING SELECT BOARD Jack Layout

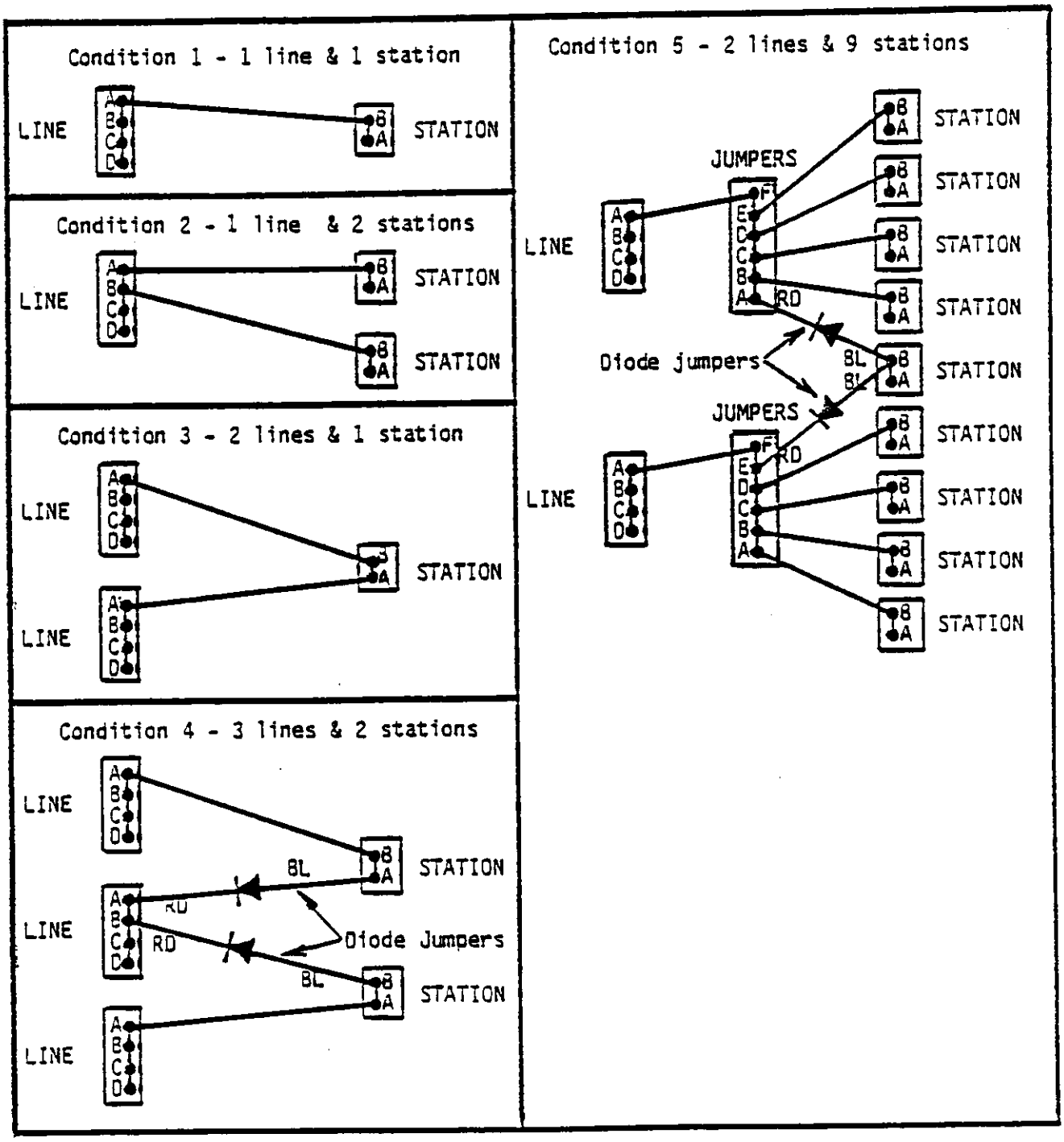


Figure 2 - Split Ringing Configuration Examples

TIE EK-$\frac{3060}{2040}$ KEY TELEPHONE SYSTEM

GENERAL DESCRIPTION, OPERATION, & INSTALLATION INFORMATION

1.00 INTRODUCTION

1.01 This section provides a general description, operational, installation and maintenance information required for the TIE EK-2040 key telephone system.

1.02 As the TIE EK-3060 is an expanded version of the TIE EK-2040 system, section -1 of this manual refers in most part to the TIE EK-2040 system. The EK-3060 expands the capability of the 2040 by 10 C.O. lines and/or 20 stations. Detailed information which applies to the expansion unit will be provided in section -2 of this practice.

2.00 GENERAL

2.01 The TIE/communications EK-2040 system is an electronic key telephone system which utilizes a solid state space division matrix with a time division distributed control, using micro processor technology. See figure 1.

2.02 The system operates on two pairs of wires allowing two simultaneous conversations on the telephone in addition to the control of the 28 functional station keys.

2.03 The TIE EK-2040 is one of a family of electronic systems, all using the same printed circuit board assemblies, telephone instruments and operating procedures. This simplifies the training of installation and maintenance personnel, the user's operating procedures, and eliminates the need for extra inventory due to the commonality of circuit boards and instruments.

2.04 The TIE EK-2040 utilizes one or two register circuits, as required, to process internal calls. In most cases one register will handle all required traffic, as the register is immediately released after the last digit has been dialled, which in most applications is only 2 digits.

2.05 All stations are arranged for handsfree answerback without the need to limit the duration of the call. All telephones have built-in speakerphones. The system consists of three major items:

- The Key Service Unit (KSU).
- The power supply.
- Multi-button key telephones.

3.00 SPECIFICATIONS

3.01 Physical dimensions

KSU

Height - 33.7" (85.6 cm)
Width - 24.0" (60.1 cm)
Depth - 14.7" (37.3 cm)

Power Supply (EBK-30)

Height - 15.5" (39.4 cm)
Width - 22.5" (57.1 cm)
Depth - 9.6" (24.4 cm)

Telephone

Height - 4.5" (11.4 cm)
Width - 9.0" (22.9 cm)
Depth - 9.5" (24.1 cm)

3.02 System Capacity

3.03 Up to 20 C.O. lines may be equipped in the basic KSU cabinet. 10

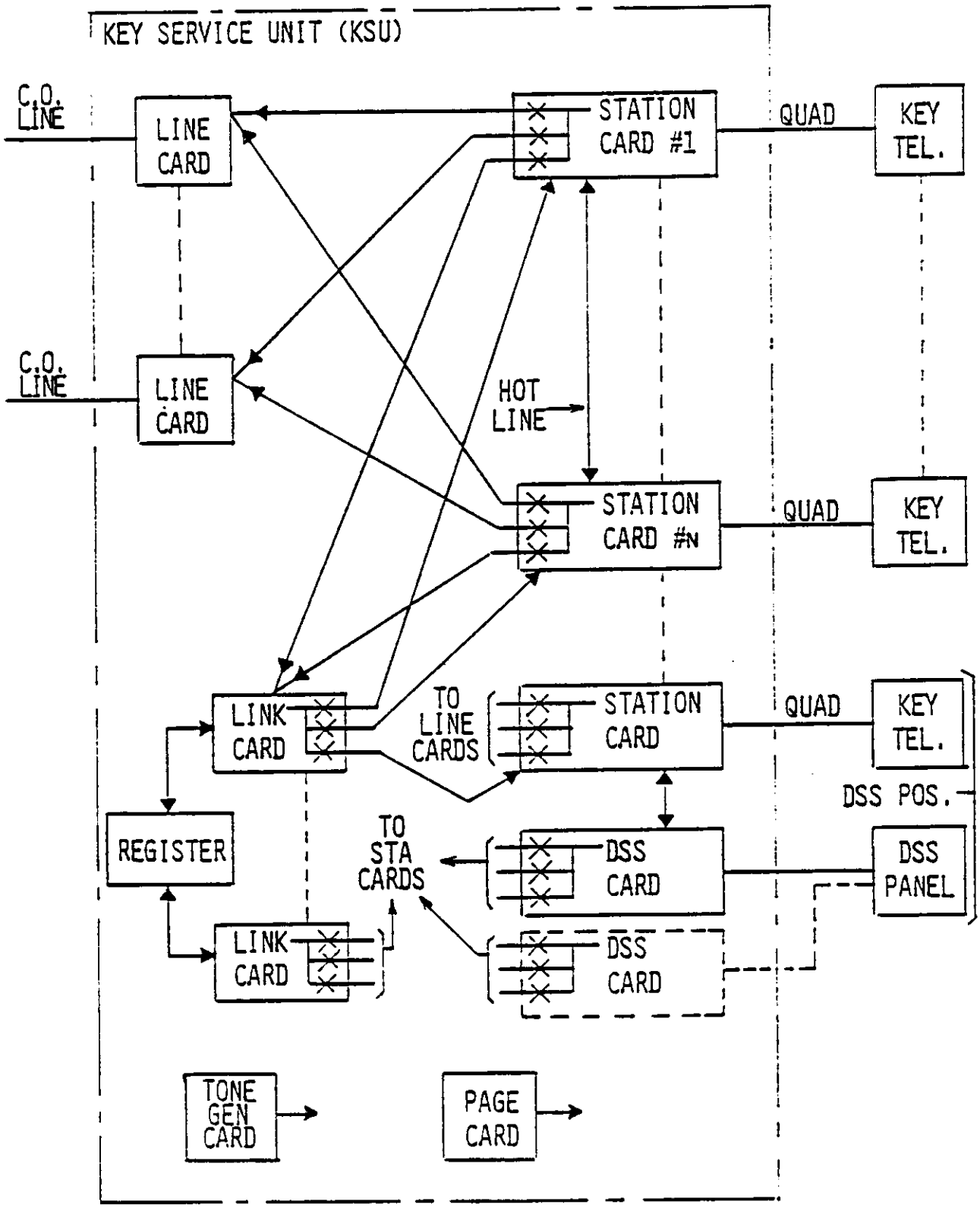


Figure 1 - EK-$\frac{3060}{2040}$ SYSTEM BLOCK DIAGRAM

additional C.O. lines may be equipped in the expansion cabinet. Up to 40 stations may be equipped in the basic cabinet with 20 additional stations equipped in the expansion cabinet.

3.04 Power Requirements

3.05 AC power requirements for the system are: 117 VAC, ±10%, 60 Hz, single-phase.

3.06 The EBK-30 power supply provides three outputs to the KSU; +25 VDC, -25 VDC and -10 VDC.

3.07 220 VAC, 50 Hz power supplies are available by special order.

3.08 Station Loop

3.09 The system functions on standard 4-wire, inside, random-twist, 24-gauge quad up to a distance of 2000 feet.

3.10 Control

3.11 The TIE EK-2040 system utilizes distributed control, whereby each station is controlled by its own microprocessors in the KSU and the station set.

3.12 System Internal Numbering Plan

0	Operator
30-69	Internal Voice Page Calls (*Basic Cabinet*)
70-89	Internal Voice Page Calls (*Expansion Cabinet*)
130-169	Internal Tone Signalling Calls (*Basic Cabinet*)
170-189	Internal Tone Signalling Calls (*Expansion Cabinet*)
230-289	Alternate Call Pickup *
917-920	Pickup of Lines Not on a Station (*Basic Cabinet*)
921-930	Pickup of Lines Not on a Station (*Expansion Cabinet*)
991-996	Paging Zones and All-Call

* *Can only be used when the called station is signalled in the tone signalling mode; not in the handsfree mode.*

4.00 SYSTEM COMPONENTS

4.01 The TIE EK-2040 system is comprised of the following components:

KSU - One per system.

Power supply - One per system.

Telephones - As required.

Station Cards - One per station.

DSS Position - 1 or 2 per system.

DSS Cards - 1 or 2 per DSS pos. (*see paragraph 4.02*)

Line Cards - One per C.O. line.

Tone Generator Card - One per system.

Page Card - Optional, one per system.

Register Card - 1 or 2 per system.

Link Cards - Up to 6 sets per system (*see 4.03*).

Selector Panel - 1 per system.

4.02 One DSS Control card is required for each 28 DSS keys used at each DSS position; maximum 4 per system.

4.03 Each link can be made up of 1 or 2 Link cards (A & B). "A" link cards serve stations 30 through 59. "B" cards serve stations 60 through 89 plus C.O. lines 17 through 30. Maximum six links per system.

5.00 FEATURES

5.01 The TIE EK-2040 is designed to provide the following features:

a) Handsfree Talkback

The station user can answer intercom calls from across the desk or across the room without touching the telephone.

b) Handsfree Origination on C.O. Line Calls

By depressing the 'Handsfree' key and a C.O. line key, the station user can call an outside party and conduct a handsfree conversa-

tion without ever lifting the handset.

c) Built-In Speakerphone

All stations have built-in speakerphones for handsfree operation or group discussions. The lifting of the handset automatically switches the speakerphone to the handset to allow private conversation.

d) Call-Announcing

The system has internal call-announcing to individual stations and to external paging circuits when equipped.

e) Multi-Trunk Conference

The system is equipped with standard multi-trunk conferencing with compensated loss of transmission level. This allows the station user to receive or establish two different calls and then by depressing both keys, establish a conference between the controlling station and the two outside parties. All three parties can talk and hear one another due to the compensated transmission level.

f) Modular Plugs and Jacks

The station functions on only two pairs of wires arranged for modular plugs and jacks for ease of installation.

g) Distributed Control

Each station has its own microprocessor control. If a failure in control should occur in the system, it will only affect that one station or that line.

h) Micro-Processor

This system is individually microprocessor controlled with non-volatile programs. Therefore, there is no problem of start-up time when the system comes back into service from such conditions as a commercial power failure.

i) Non-Locking Keys

The telephone sets have non-locking keys with built-in long-life, light emitting diodes (LED's) providing the status of functions associated with the keys.

j) Cable Requirements

The system functions on standard 24-gauge inside, random-twist, 4-wire cable (quad) up to a distance of 2000 feet.

k) Types of Dials

The system uses standard type DTMF dials or specialized dials such as OUTPULSE DIAL®, MEMORY® dial, and Toll Restrict Dials.

l) Music-On-Hold & Background Music

The system is equipped with connections to provide music-on-hold to the outside party on a held line and background music to the station users through the individual loudspeakers inside the telephone. The telephones have a separate volume control with an off switch to allow the individual station user to control the background music, paging or C.O. audible to his instrument without affecting the handsfree listening level. See paragraph 10.00.

m) Simultaneous Call Handling

The system allows two simultaneous calls to be in progress on the telephone; one on the handset and one on the loudspeaker/microphone without placing either call on hold. An example of this would be the station user using the handset on a C.O. line call and at the same time, the attendant announces a call to him over the handsfree intercom circuits. Neither call needs to be interrupted.

n) Installer Options

No installer options are required within the telephone as all options are provided for in the KSU. Therefore, the installer is not required to open the telephone at the time of installation.

o) Privacy of Calls

The system provides for privacy on all calls with privacy release capability on C.O. line calls should

the station user wish to conference with another inside party. Privacy Release permits 1 additional party to enter the call.

p) Paging Access

The system provides for "All-Call" paging and up to 5 different paging zones accessed by dial codes. Zone 5 serves all stations in the expansion cabinet.

q) I-Hold Indication

The system provides a special "I-Hold" indication to indicate to the individual user which call(s) he placed on HOLD. This differentiates from the other lines that appear on the telephone that have been placed on HOLD by other stations. Therefore, when the station user wishes to return to a held call or to forward the call to another station the "I-HOLD" indication immediately identifies that particular line.

r) DSS Console(s)

The system may be equipped with one or two attendant positions, each incorporating a Direct Station Selection (DSS) console. The DSS attendant has immediate priority access to any station in the system by a single momentary depression of the corresponding station key in the array appearing on the DSS console.

Each DSS console may be equipped (in the KSU) to handle either 28 or 56 keys, depending on system size and requirements. When both DSS positions are equipped, both positions may serve all stations in the system (in parallel) or each DSS may serve up to 28 different stations. This application is useful for departmentalizing the system or enhance the multiple user capability of the system.

An LED in each DSS key gives the attendant prior knowledge of the status of each telephone appearing on her console. Depression of the key causes the outside call being served to automatically be placed on hold, and establishes a direct voice connection to that telephone. After a short tone is heard by both the DSS attendant and the called station, both may engage in a two-way conversation which is handsfree at the called end.

The attendant releases from the called station by either returning to an on-hook condition or by selecting another C.O. line or another station.

s) Modular Growth

System growth is accomplished on a line-by-line and station-by-station basis. Beyond 20 lines and 40 stations, an expansion cabinet is required for use with the basic KSU cabinet, increasing the size capacity to 30 lines and 60 stations.

Each intercom talk-path, or link, can be added individually up to a maximum of 6 links. A second register may be added also, if needed. As stated previously, a second DSS position may be added to the system.

Because there is an absolute minimum of common equipment, the system is never burdened with more circuitry or physical hardware than is actually required for the job.

t) Hot Lines

Each telephone may be arranged to contact one other predetermined telephone on a direct or "Hot Line" basis, using a single access key. In this manner, accessibility to the other station is guaranteed, even if that station is already engaged in another call. The originator has prior knowledge of the status of the 2nd station by the unique indications of the LED in his HL key. This is especially useful in the "principal/secretary" configuration and does not add traffic to the dial intercom paths.

u) Single Key Intercom Operation

The multipath dial intercom links are accessed by a single ICM key on any station set. The first available path is selected, which in turn, connects to an available register. Optional, handsfree intercom calling may continue for unlimited periods without tying up the register(s). The called party may reply handsfree when called on the intercom. To gain greater privacy, or if room conditions warrant, the call may be transferred to the handset by removing it from its cradle.

v) Access to Lines That Do Not Appear on the Telephone

In a system having lines (*above C016*) that do not appear on every telephone, such as a non-square system, or a system having private lines, limited access to these lines is still available to all telephones in the system.

By invitation, a station user may pick up a line that does not appear under a key on his telephone by dialling into that line using the intercom. He may have this access only when the line is on hold or if another station user has operated his privacy release (*PR RL*) key. Under these conditions, exclusion and non-availability is retained under all other circumstances.

w) DO NOT DISTURB

The HANDSFREE key may be used as a DO NOT DISTURB key. Depressing the HANDSFREE key only will make the station appear busy to all internal calls. A second depression of the HANDSFREE key will restore the station to normal traffic availability.

x) Alternate Point Answering

An internal call may be answered from another telephone in the system by using the dial intercom. Dialling "2" followed by the station number of the telephone to be answered, will cause the call to be directed to the alternate answer point. *Only tone signalled stations may be answered this way.*

y) Wall Mount

An optional kit is available which provides wall-mounting capability for any ULTRACOM™ telephone without modification to the telephone itself.

z) Directory Tray (*future*)

A pull-out directory tray is available which can be mounted beneath the telephone, to display telephone numbers and other information when needed. No modification is required to the telephone for this feature.

aa) Multiple User Capability

The system has the capability to allow 2 groups of users to be separated by lines and stations, such that one group can have outside lines that do not appear at stations within the other group. This configuration has application when more than one department wish to be serviced by the same telephone system. Refer to DSS operation also. Commonality of equipment can be provided while separation of service is maintained (*maximum 2 private lines per station*).

6.00 OPERATING PROCEDURES - STATION SET

6.01 C.O. line call operation

a) To originate: Lift the handset off-hook or depress the HANDSFREE key and depress an idle C.O. line key. The LED in that key will go steady "on". When dial tone is received, the user may dial and proceed with the call.

b) To hold: Depressing the HOLD key causes the previously seized line to be placed on HOLD. The LED in that line key exhibits the I-Hold flutter, providing a unique indication of a line placed on hold at that telephone. This line key on all other telephones will show the slower conventional HOLD wink rate. The user may also place an outside line on hold by depressing his HL key to originate a 'Hot Line' call.

c) To release: A call may be terminated by returning the handset to its cradle, by a second depression of the HANDSFREE key, depressing the FLASH key, or by selection of another C.O. line.

d) Identify: If the station user must identify which outside line he is speaking on, he can cause the LED in the corresponding LINE key to flutter at the I-hold rate while depressing the PR RL (*Privacy Release*) key.

6.02 C.O. Line Conference
(2 stations - 1 C.O. line)

a) Station user informs another inside party that he is invited to join a conversation (*see 6.07a*). After returning to the C.O. line, he then depresses the PR RL key and holds it down until the 2nd party joins the conversation by going off-hook and depressing the corresponding C.O. line key at his telephone. A three-way conference is now underway. The outside call remains connected until both inside parties hang-up.

b) If a 2nd C.O. line is involved in the conference, it would have been established as stated in paragraph 6.03.

6.03 C.O. Line Conference
(1 station - 2 C.O. lines)

a) The station user is involved in a call on 1 C.O. line. To establish a conference with a 2nd outside party, the user places the call on hold via the HOLD key. He then depresses a 2nd idle C.O. line key and originates a call to the 2nd outside party. When the 2nd party answers and the normal courtesies have been exchanged, the user places the 2nd C.O. line on HOLD. Depressing the HOLD key again (*the 2nd time*) will light the HOLD LED. The user may then depress the two line keys, one-by-one, to establish the conference. The conference will be be dropped when the inside party hangs-up.

6.04 Seizing a Line That Does Not Appear On That Telephone

a) On certain occasions, a station user may be invited to pickup a call on a line that does not appear on his telephone. Once the call has been placed on HOLD by the original participant, and the 2nd station user has been advised of a call on a particular line, the 2nd party then depresses his ICM key, thereby seizing an available link and register. When internal dial tone is received, the 2nd user dials "9", followed by the number of the line on which the call is waiting.

b) At that time, the line is removed from the HOLD condition and is available to him. He then may proceed with his conversation to the outside party. Upon completion of his call, he may either release the line or return it to the HOLD condition.

c) A party may enter a line that does not appear on his telephone ONLY under this condition. Safeguards are provided to prevent unauthorized parties from seizing non-appearing C.O. lines to originate calls, and from entering calls al-

ready in progress in any other circumstances. The user may, however, join a call on a non-appearing line on a conference basis. In this manner, it is under control of the original user's Privacy Release key.

6.05 FLASH key

6.06 Depression of the FLASH key while connected to an outside line causes that line to be released while the key is depressed and immediately reconnected when the key is released, providing new dial tone to the station user.

6.07 Internal Calls

a) Station-to-station Dial Intercom

1. Normal Voice Page Originate: To call another station in the system, the user lifts the handset or depresses the HANDSFREE key (*if the station has this option*). An available link and register are selected and the user receives dial tone. The user then dials the 2-digit number of the station he wishes to reach. Upon completion of dialling, he is immediately cut through to the destination station on a handsfree basis. A short tone is heard immediately at both stations and conversation may commence immediately.

2. Stations within the same local area (*close proximity to each other*) should not utilize the 'handsfree originate on internal calls' option. This is due to acoustical feedback possibilities which may cause howling.

3. Either party may switch from handset to handsfree operation or vice-versa, by lifting the handset or depressing the HANDSFREE key as appropriate.

4. If the called station is busy on an outside call, the internal caller will still be able to reach the called party and have a simultaneous conversation which will not interrupt the outside call. If the called station is busy on an inside call, the calling party will receive a busy signal.

b) Tone Signalling Originate:

To call another station and cause that station to be signalled by calling tone, rather than cut-through 'handsfree', the originator simply dials "1" before the 2-digit number of the station which he wishes to reach. The called party must lift the handset to answer the call.

c) Alternate Point Answering

To pickup an internal call which has just signalled a nearby station (*tone signal call only*) or is still ringing, a station user can raise the handset or depress the HANDSFREE key at his station, depress the ICM key and when dial tone is received, dial "2" plus the number of the ringing station. The call is then routed to the alternate station and conversation may take place in the normal manner.

d) Hot Line Calls

1. In addition to the dial intercom, one "Hot Line" (HL) key appears on each telephone in the system. This enables a station user to be in touch with another predetermined station on a single-button direct access basis.

2. To originate a hot line call, the user lifts the handset, or depresses the HANDSFREE key and the HL key. He is immediately cut through to the destination station. A short tone is heard immediately at both stations and the calling party may commence the conversation.

3. If the destination station is busy on either an inside or outside call, the user initiating the HL call should already be aware of the status of the called station. The LED in the HL key of the calling station exhibits a descriptive indica-

tion, out (*idle*), lit steady (*busy*) or flutter (*I-talk*), prior to depression of the HL key.

4. Depending upon the condition of the busy destination station (*originating or receiving an inside or outside call*), the new caller will always reach the destination station. He may come in handsfree or he may come in on the handset, but he will always have prior knowledge of how the call will come in at the called station.

e) Paging

1. After depressing the ICM key and receiving dial tone, the user may access any of the 5 paging zones in the system or access all 5 simultaneously (*All-Call*) by dialling one of the 3-digit numbers 991-996.

991 - Zone 1, stations 30 through 39
992 - Zone 2, stations 40 through 49
993 - Zone 3, stations 50 through 59
994 - Zone 4, stations 60 through 69
995 - Zone 5, stations 70 through 89
996 - All-Call, all stations paged.

2. Accessing a paging zone provides a one-way voice path to all telephones and external loudspeakers within the zone or all zones in the case of All-Call.

3. After dialling, the user may page after a short tone is heard.

7.00 INSTALLATION

7.01 General

7.02 The KSU is wall-mounted as detailed later in this section. Fuses are provided in the KSU and power supply to protect the system circuitry from shorts or reversals.

7.03 Fuses are provided on most of the circuit cards in addition to the main KSU and power supply fuses.

7.04 The system is comprised of a power supply (*EBK-30*), the KSU and seven types of circuit cards. The circuit cards are installed in positions as shown in figure 2. The circuit card installation details are provided under paragraph 8.00.

7.05 The installer should become familiar with the specifications and features to be provided on this particular job before attempting circuit card installation. Items which the installer must be cognizant of are:

a) Number of C.O. lines and stations.

b) Number of DSS positions required.

c) The numbering scheme to be used in the system; as to 'for whom' and 'where' particular station numbers are to be designated. Keep in mind the paging zone numbering arrangement as covered under paragraph 6.07e.

d) Is the system large enough for both "A" and "B" Link cards? Are non-appearing C.O. lines equipped in the system? "B" Links are required for C.O. lines 17 and up.

e) Will the DSS require both "A & B" DSS cards to reach all stations? If 2 DSS positions are required, will both serve all stations? Is DSS paging required?

f) Which C.O. lines will appear on LK17 and LK18 at each station? This information is required for strapping the "Selector Panel" on the I/O board (*see 9.00*).

g) Keep in mind the hotline numbering scheme (*see 9.03*).

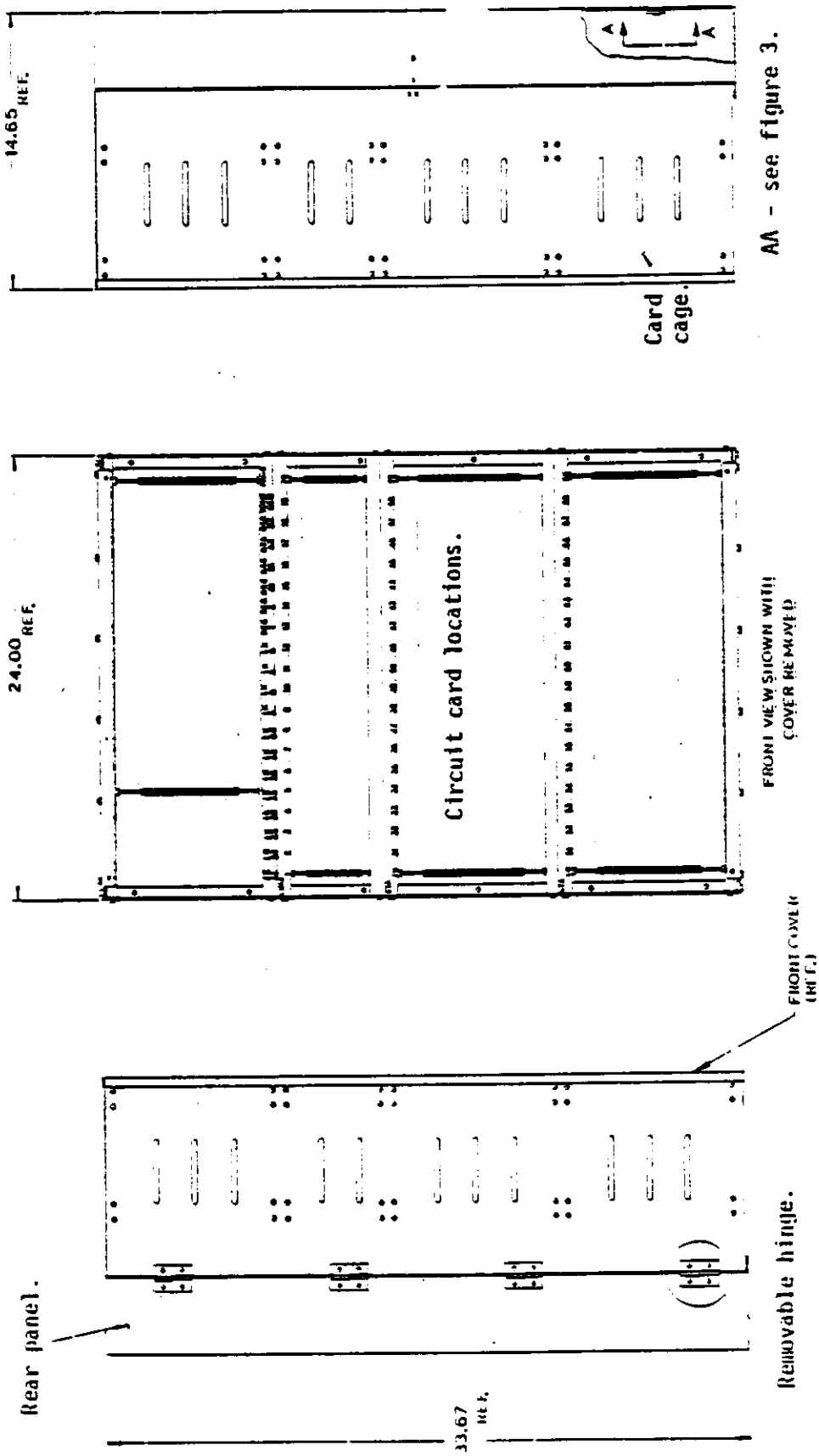


Figure 2 - KSU Cabinet Layout and Dimensions

7.06 Selection of Equipment Location

7.07 Considering the factors listed below, select a suitable site for the KSU, the power supply and the station blocks.

a) Availability of a separately fused 105 to 125 volt, 60 Hz, single phase, 3-wire (*parallel blade and ground*) power outlet. Refer to paragraph 7.13.

b) Location of the CO/PBX line terminations.

c) Location of the majority of stations. The practical objective of equipment location is to minimize wire runs.

d) Location of telephone ducts, or conduit, if provided.

e) Availability of space to allow for accessing and servicing the equipment.

f) A well ventilated area having a temperature range of from +32° (*0C*) to +104° (*40C*) Fahrenheit is recommended.

g) A good earth ground must be provided, using 14-gauge or larger wire. A cold-water pipe with joints and meters by-passed by 14-gauge or larger straps will provide a suitable ground.

7.08 KSU Mounting

When a concrete, masonry, or damp surface is selected for the mounting site, the KSU MUST be mounted on a customer-provided backboard.

7.09 On the surface to which the KSU is to be mounted, locate 6 points which correspond to the 6 keyhole type holes in the removable back panel of the KSU assembly (*see figure 3*).

The TIE EK-2040 KSU is designed for wall-mounting only. Refer to figure 4 for recommended location layout. The back panel utilizes removable hinges.

7.10 The method of fastening the assembly is determined by the surface to which it is to be fastened. Using suitable hardware, secure the assembly to the mounting surface.

7.11 Mounting the Power Supply

7.12 It is recommended that the EBK-30 Power Supply be wall-mounted.

7.13 Select a mounting location close enough to the EK-2040 KSU to permit the 3-foot power tail from the KSU to plug into the EBK-30 power supply and close enough to an 110 VAC outlet to permit the 6-foot power supply cord to be plugged in.

7.14 Using suitable fasteners, secure the power supply to the mounting surface.

7.15 Grounding the System

7.16 After the KSU and power supply have been wall-mounted, the power supply MUST be properly grounded.

DO NOT USE THE
3RD WIRE (GREEN)
OF THE AC CORD
FOR EARTH GROUND.

7.17 It is recommended that the AC service outlet be of the 3-wire (*parallel blade and ground*) type. A 3-wire to duplex adapter SHOULD NOT be used.

7.18 An additional earth ground must be provided for proper operation of the system. In most installations, a metallic cold-water pipe will provide a good earth ground. The installer should check that the cold-water piping is metallic throughout and has no joints or sections of non-metallic pipe. If the cold-water system is found to be inadequate for grounding purposes, an alternate grounding means must be found.

7.19 The wire used to ground the power supply should be as short as possible and 14-gauge or larger. This wire should be connected to the grounding lug

Fully loaded 2040 KSU weighs approx. 96 pounds.
Fully loaded 3060 KSU weighs approx. 130 pounds.

Mount cabinet to wall using suitable fasteners for type of mounting surface.

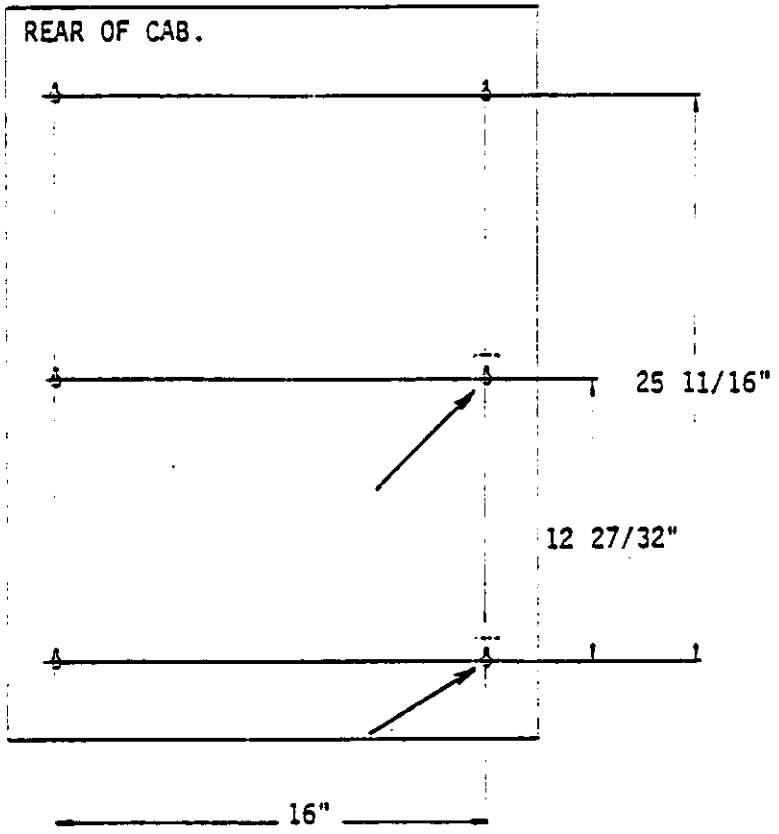


Figure 3 - Wall Mounting Template

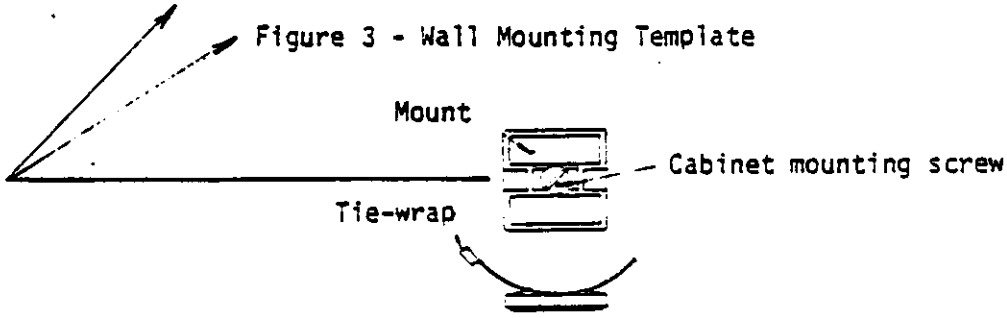


Figure AA - Tie-wrap detail

inside the door of the power supply. See figure 5.

7.20 Station Block Mounting

.21 Four station blocks are recommended for connection of the station quads to the KSU. Connections for the station quads are as follow:

B1 block for stations 30 thru 41.
B2 block for stations 42 thru 53.
B3 block for stations 54 thru 65.
B4 block for stations 66 thru 69.

7.22 DSS console and paging connections are made on block B4.

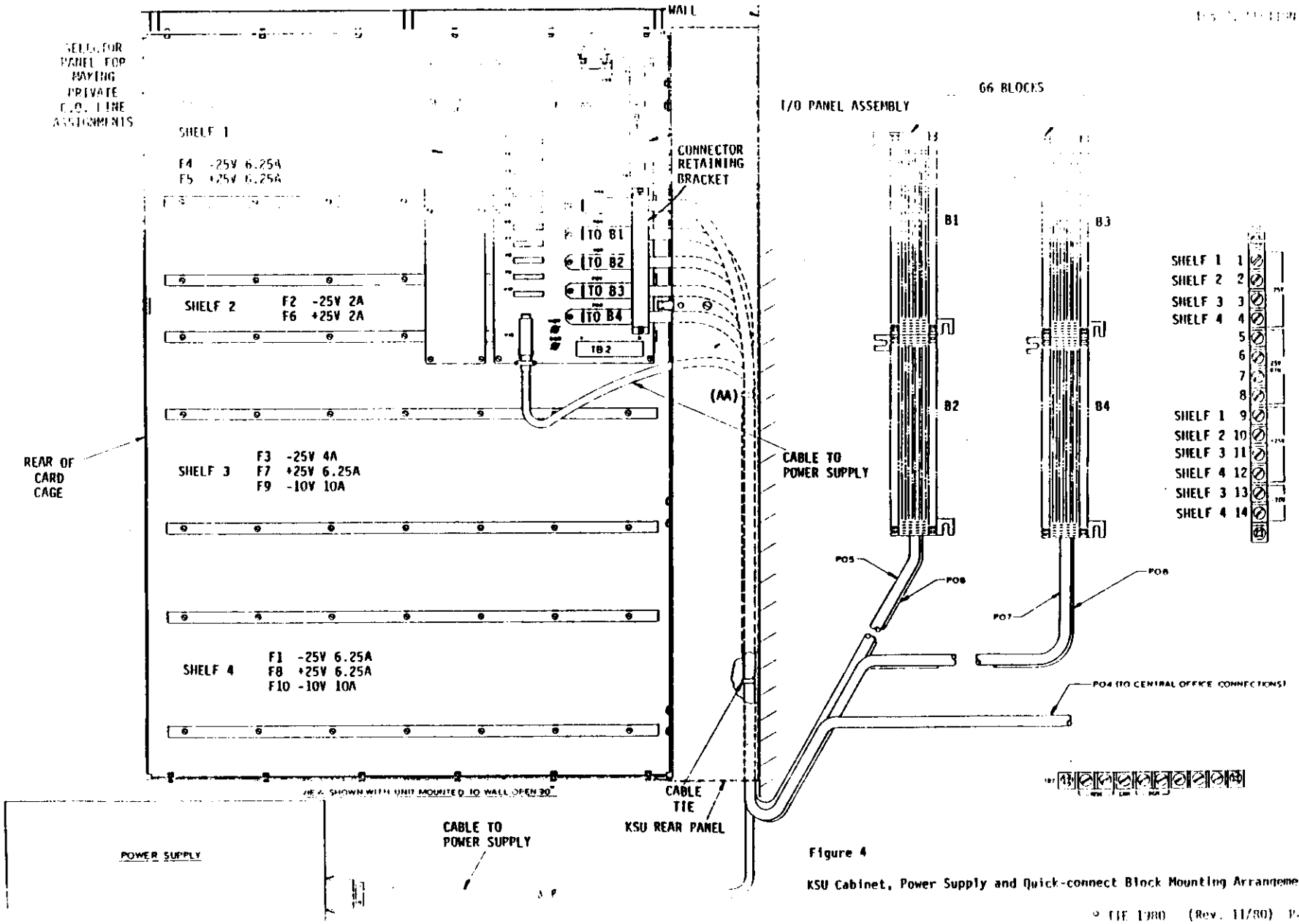


Figure 4

KSU Cabinet, Power Supply and Quick-connect Block Mounting Arrangement

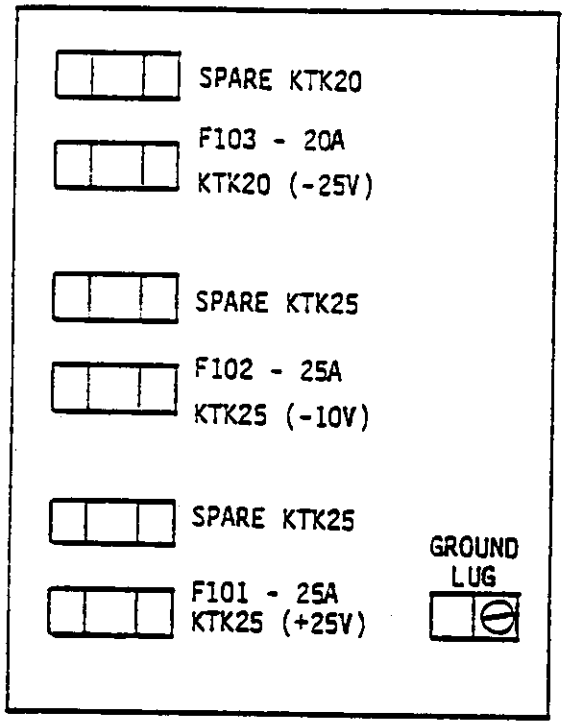


Figure 5 - Power Supply Fuse Panel

7.23 It is recommended that the blocks be the 66M50 type, used with "B" bridging clips to facilitate any testing or troubleshooting which may be required later on. Figure 6 illustrates the method of connecting to the blocks.

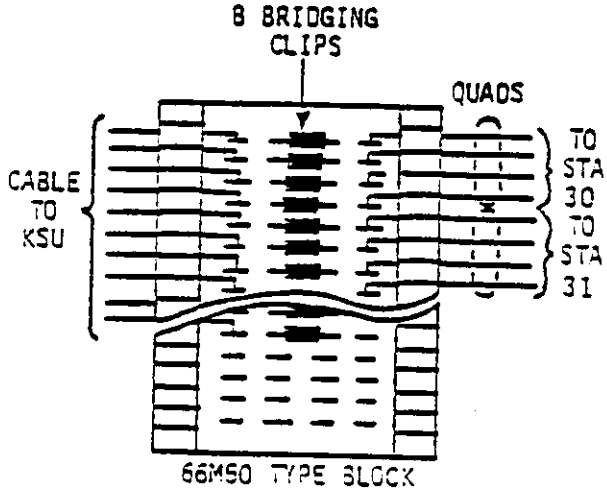


Figure 6 - B1 - B4 Block Configuration

7.24 On the back of the KSU swing-out gate (*figure 4*) are 5 Amphenol (*57 series*) type connectors for connection to the KSU tail cables. Connectors P05 through P08 should be cabled to the B1 through B4 blocks. Table 1 shows the cable lead assignments for the connectors.

The 1st (top) connector (P04) MUST be cabled directly to the telephone company C.O. line terminations (USOC code - RJ-21X). The RJ-21X is an Amphenol type connector which should be provided by the telephone company, to within 25-feet of the KSU, in accordance with FCC rules, part 68. P04 is a male connector.

7.25 A bracket is provided to secure the tail cables before they exit the KSU. The cables should be tie-wrapped to prevent dislodging the connectors from their mates. Dress the cable loop for opening and closing the swing-out gate (*see figures 3 and 4 for tie-wrap locations and mounting detail*).

7.26 Power Supply Cable

7.27 At the lower left (*bottom*) of the I-O board (*figure 4*) is the connector for the power supply cable. Plug the P.S. cable into the connector and dress the cable as required to the power supply. Leave a slack loop for opening and closing the swing-out gate. Plug the cable into the power supply connector on the left side of the supply.

Table 1 - EK-2040 Tail Cable Conductor Assignments

TAIL CABLE			B1 BLOCK		B2 BLOCK		B3 BLOCK		B4 BLOCK		TO TELCO	
PLUG PIN	CABLE COLOR	CLIP	LEAD	DEST	LEAD	DEST	LEAD	DEST	LEAD	DEST	LEAD	DEST
26 1	WH-BL BL-WH	1 2	GN RD	STA. 30	GN RD	STA. 42	GN RD	STA. 54	GN RD	STA. 66	T R	C.O. 1
27 2	WH-OR OR-WH	3 4	BK YL		BK YL		BK YL		BK YL		T R	C.O. 2
28 3	WH-GN GN-WH	5 6	GN RD	STA. 31	GN RD	STA. 43	GN RD	STA. 55	GN RD	STA. 67	T R	C.O. 3
29 4	WH-BR BR-WH	7 8	BK YL		BK YL		BK YL		BK YL		T R	C.O. 4
30 5	WH-SL SL-WH	9 10	GN RD	STA. 32	GN RD	STA. 44	GN RD	STA. 56	GN RD	STA. 68	T R	C.O. 5
31 6	RD-BL BL-RD	11 12	BK YL		BK YL		BK YL		BK YL		T R	C.O. 6
32 7	RD-OR OR-RD	13 14	GN RD	STA. 33	GN RD	STA. 45	GN RD	STA. 57	GN RD	STA. 69	T R	C.O. 7
33 8	RD-GN GN-RD	15 16	BK YL		BK YL		BK YL		BK YL		T R	C.O. 8
34 9	RD-BR BR-RD	17 18	GN RD	STA. 34	GN RD	STA. 46	GN RD	STA. 58	DO NOT CONNECT TO THESE CLIPS		T R	C.O. 9
35 10	RD-SL SL-RD	19 20	BK YL		BK YL		BK YL				T R	C.O. 10
36 11	BK-BL BL-BK	21 22	GN RD	STA. 35	GN RD	STA. 47	GN RD	STA. 59	RD GN	#1 DSS A UNIT	T R	C.O. 11
37 12	BK-OR OR-BK	23 24	BK YL		BK YL		BK YL		BK YL	#1 DSS B UNIT	T R	C.O. 12
38 13	BK-GN GN-BK	25 26	GN RD	STA. 36	GN RD	STA. 48	GN RD	STA. 60	RD GN	#2 DSS A UNIT	T R	C.O. 13
39 14	BK-BR BR-BK	27 28	BK YL		BK YL		BK YL		BK YL	#2 DSS B UNIT	T R	C.O. 14
40 15	BK-SL SL-BK	29 30	GN RD	STA. 37	GN RD	STA. 49	GN RD	STA. 61	Z1A Z1B	ZONE 1 AMP.	T R	C.O. 15
41 16	YL-BL BL-YL	31 32	BK YL		BK YL		BK YL		Z2A Z2B	ZONE 2 AMP.	T R	C.O. 16
42 17	YL-OR OR-YL	33 34	GN RD	STA. 38	GN RD	STA. 50	GN RD	STA. 62	Z3A Z3B	ZONE 3 AMP.	T R	C.O. 17
43 18	YL-GN GN-YL	35 36	BK YL		BK YL		BK YL		Z4A Z4B	ZONE 4 AMP.	T R	C.O. 18
44 19	YL-BR BR-YL	37 38	GN RD	STA. 39	GN RD	STA. 51	GN RD	STA. 63	Z4A Z5B	ZONE 5 AMP.	T R	C.O. 19
45 20	YL-SL SL-YL	39 40	BK YL		BK YL		BK YL		ESG ES1	EXT.* L.S. 1	T R	C.O. 20
46 21	VI-BL BL-VI	41 42	GN RD	STA. 40	GN RD	STA. 52	GN RD	STA. 64	ESG ES2	EXT.* L.S. 2		
47 22	VI-OR OR-VI	43 44	BK YL		BK YL		BK YL		ESG ES3	EXT.* L.S. 3		
48 23	VI-GN GN-VI	45 46	GN RD	STA. 41	GN RD	STA. 53	GN RD	STA. 65	ESG ES4	EXT.* L.S. 4		
49 24	VI-BR BR-VI	47 48	BK YL		BK YL		BK YL		ESG ES5	EXT.* L.S. 5		
50 25	VI-SL SL-VI	49 50										

* Maximum power for loudspeakers cannot exceed 2 watts - two 8-ohm voice coils.

8.00 PLUG-IN CIRCUIT CARDS

Removal of power is not required for insertion or removal of cards.

8.01 The following paragraphs provide information to install the circuit cards in the KSU. The front cover of the KSU should be removed by loosening the 4 screws which secure the cover to the gate. Refer to figure 2 for the KSU card layout.

8.02 C.O. Line Cards

8.03 If the TIE EK-2040 is not installed behind a PABX, there are no installer options to be implemented. Simply plug the cards into their respective C.O. card positions in the KSU (*see figure 2*).

8.04 If the EK-2040 is to be installed behind a PABX and FLASH keys are required at the stations, the installer must provide 1 or 2 straps on each line card to provide this function. Figure 7 shows an abbreviated card layout. The fuses, LED's with their functions, and the strapping locations are shown.

8.05 To provide FLASH key operation, strap each line card as shown in table 2. Refer to figure 7 for location of the straps. When ground flash is required, #24021A ECOU card must be installed.

8.06 No other strapping or adjustments are required.

Table 2 - FLASH Key Strapping

OPTION	STRAPS REQUIRED	REMARKS
CASE 1	J1	NO FLASH KEY
CASE 2	J2 J1 USE #24021A ECOU CARD	GROUNDS PABX LINE
CASE 3	J3 FAC. STRAP	OPENS PABX LOOP

8.07 Tone Generator Card

8.08 There are no strapping options required on the tone generator.

8.09 Figure 8 shows an abbreviated card layout. Fuses, LED's with their functions, switches, and potentiometers are shown.

8.10 Two switches are provided on the tone card for attenuation of the music-on-hold level (*top switch*) and the background music level (*bottom switch*). Each switch has a HI and LO position. The HI position attenuates the MOH or BGM signal by 15 dB and the LO position boosts the incoming signal by 30 dB.

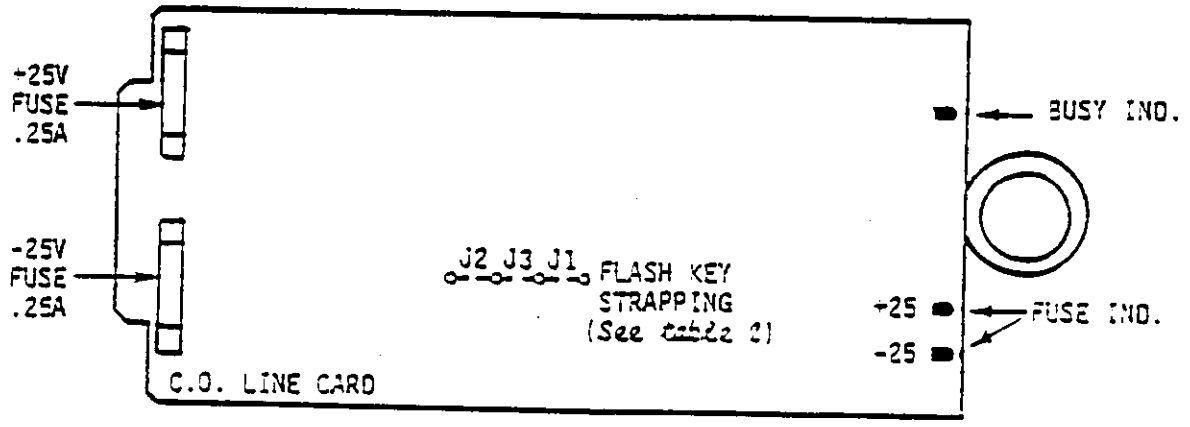


Figure 7 - C.O. Line Card, Abbreviated Component Layout

8.11 There are two potentiometers in the front of the card; MOH level adjust and BGM level adjust. These two pots may be adjusted to provide the desired signal loudness at the stations.

A 3rd potentiometer (not shown on the figure 8) is located in the middle of the card. This pot is factory adjusted and SHOULD NOT be adjusted in the field. This pot controls the tone card interrupter timing.

8.12 Register Cards

8.13 One or two register cards may be installed in the system. When one register is installed, the card should be plugged into the REG1 position (*refer to figure 2*).

8.14 If the system is equipped with one register and significant delays are encountered in getting dial tone, the 2nd register should be installed. The 2nd register is plugged into the REG2 position (*see figure 2*).

8.15 There are no strapping options on the register card. However, located on the front edge of the card are 10 miniature switches and 2 push-buttons. The switches should always be in the ON position. The switches and the buttons are used for out-of-system tests and should be left alone in the field.

8.16 Figure 9 shows an abbreviated layout of the register card. The switches, 2 fuses, and 6 LED's are shown. The fuses are the +25 and -25 volt fuses and are monitored by the +V and -V LED's. LED designations and use as well as the fuse ratings are shown also.

8.17 Link Cards

8.18 The system may be equipped with up to 6 links. Each link may be equipped with 1 or 2 link cards, designated "A" and "B".

8.19 The "A" link card serves stations 30 through 59. The "B" link serves stations 60 through 89 plus C.O. lines 17 through 30.

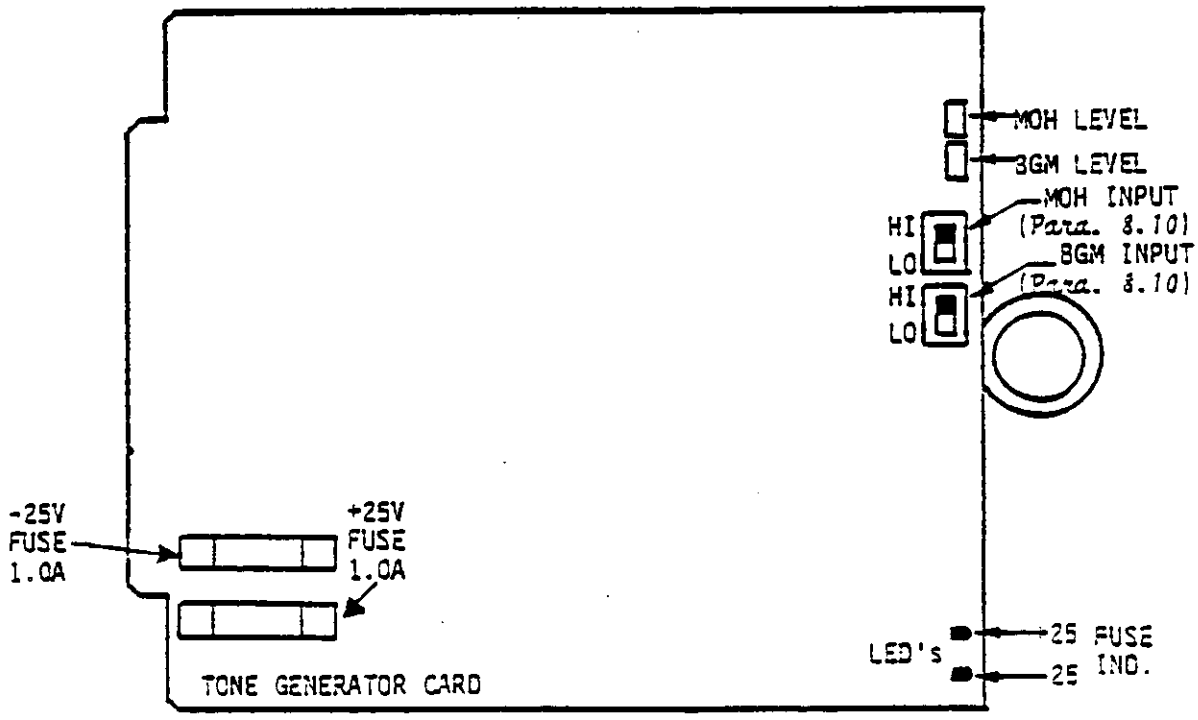


Figure 8 - Tone Generator Card, Abbreviated Component Layout

8.20 The "A" link card is different from the "B" link card. The "A" link card is designated on the lower edge of the component side of the card. The "B" link card is designated next to the pull ring on the component side of the card.

8.21 Link "A" cards are always installed in the LK A card positions and the link "B" cards in LK B positions. Figure 10A shows an abbreviated layout of the "A" card. Fuses, with their ratings and LED monitors are shown. Answer and Release LED's are shown also.

8.22 Figure 10B shows an abbreviated layout of the "B" card. Fuses, with their ratings and LED monitors are shown.

8.23 Graded Links: The system is programmed for assigning available links on a graded basis when intercom calls are originated. Stations originating calls will be assigned a link on a 4-out-of-6 basis as follows:

Stations 30-49 will use links 1,2,3 or 4.
Stations 50-69 will use links 2,3,5 or 6.
Stations 70-89 will use links 1,4,5 or 6.

8.24 Strapping: The link "A" card has 1 strapping option. This strap is shown in figure 10A. With the strap NOT installed (*factory standard*), stations have dial access to C.O. lines (*17-30*) ONLY when they are on HOLD or if the user station's PR RL key is depressed. If the strap is installed, any station user will have dial access to C.O. lines 17 through 30 while they are idle also.

8.25 There are no strapping options on the "B" link card.

8.26 Equipped links should always occupy the lowest numbered link card positions in the KSU. See 8.23.

8.27 DSS Cards

8.28 The system may be equipped with 1 or 2 DSS consoles. Each DSS console may be equipped (*with DSS cards in the KSU*) to serve either 28 or 51 stations plus direct access to paging. When 2 DSS consoles are equipped, both may serve 51 stations and paging or each may serve different stations.

8.29 The DSS positions are always stations 58 and 59.

8.30 One or two DSS cards are required per DSS console, in the KSU. DSS card "A" serves stations 30 through 57. DSS card "B" serves stations 60 through 82 plus paging.

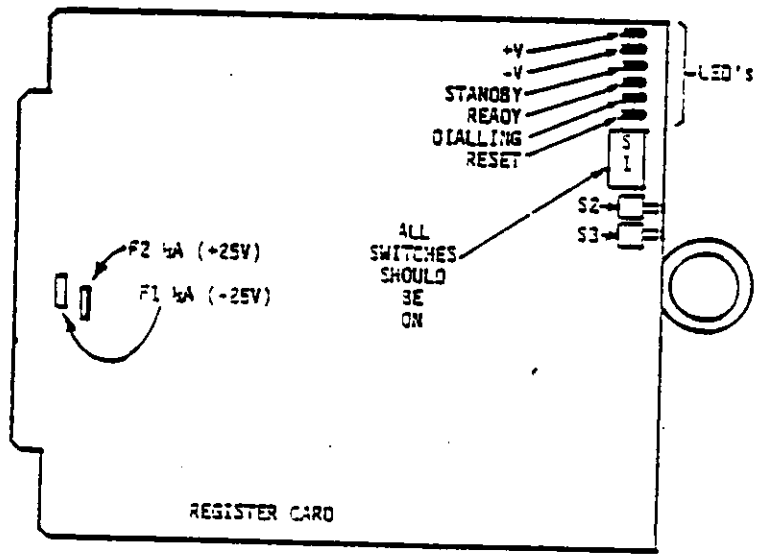


Figure 9 - Register Card, Abbreviated Component Layout

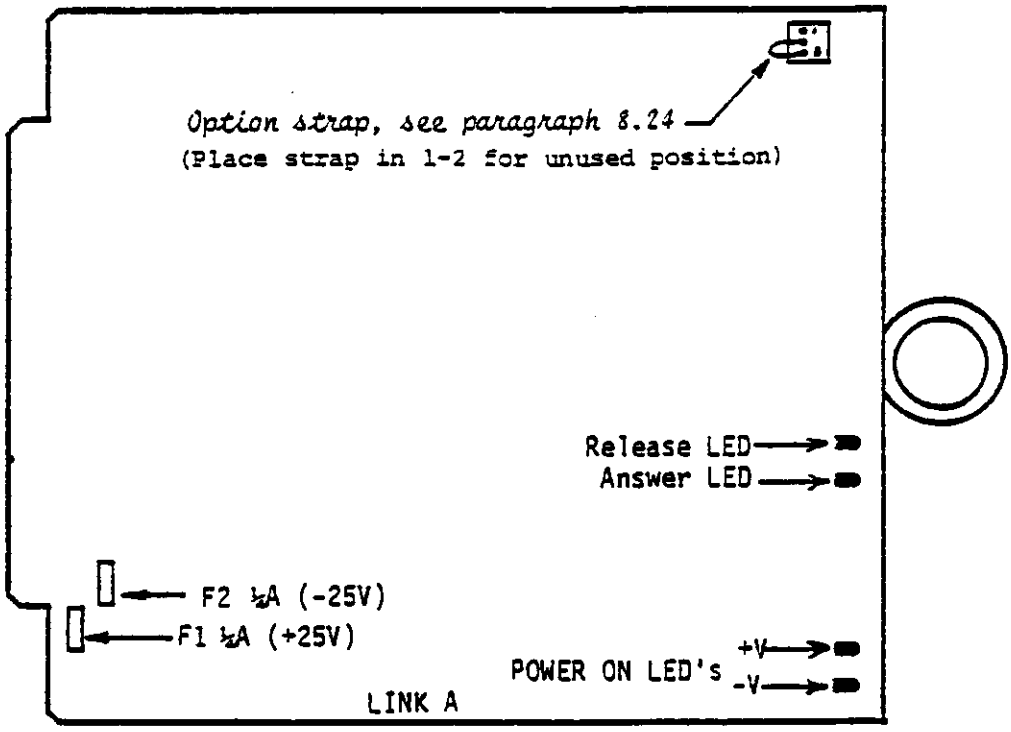


Figure 10A - Link "A" Card, Abbreviated Component Layout

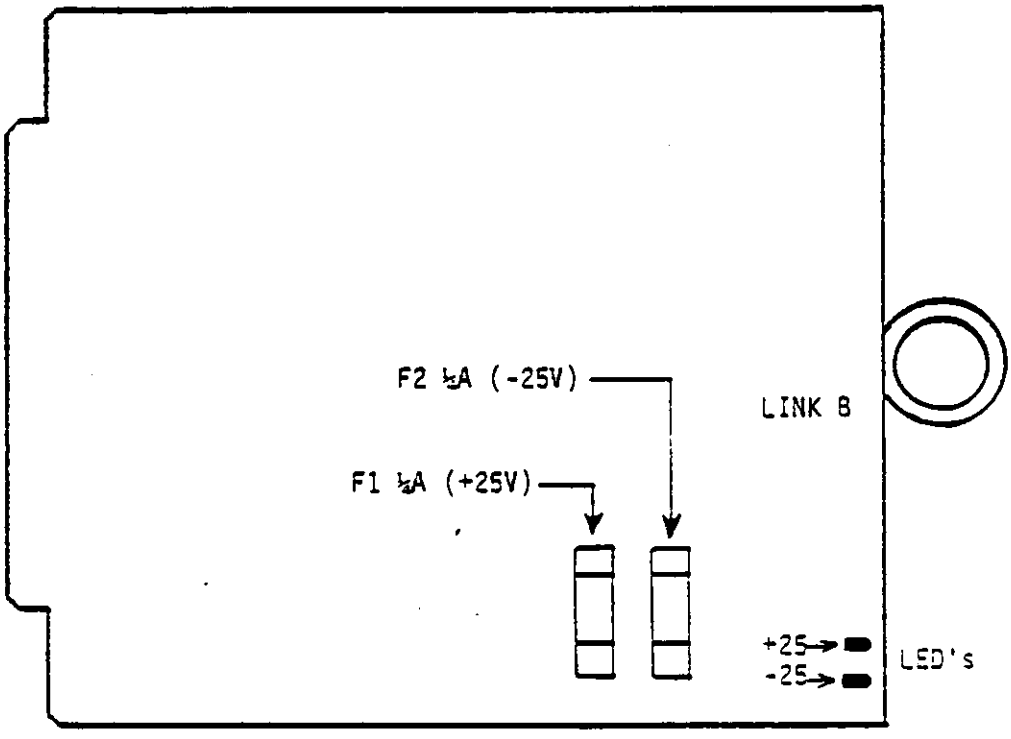


Figure 10B - Link "B" Card, Abbreviated Component Layout

8.31 Two types of DSS operation are available when 2 DSS consoles are equipped:

a) Parallel operation: Both DSS consoles serve all stations except 83-89. In this configuration, DSS cards are installed in the DSS A1 and DSS A2 card positions for stations 30 through 57 (*see figure 2*); DSS cards are installed in DSS B1 and DSS B2 for stations 60 through 82 plus paging.

b) Separate operation: Assuming that the 1st DSS (*station 58*) serves stations 30 through 57, a DSS card would be installed in card position DSS A1. With the 2nd DSS console (*station 59*) serving stations 60 through 82 + paging, a DSS card would be installed in the DSS B2 position. This configuration could be reversed by installing the DSS cards in card positions DSS B1 and DSS A2.

c) Stations 83 through 89 cannot be accessed directly by the DSS console.

If both DSS consoles must have direct access to paging, parallel operation must be used. All-Call is accessed from the DSS console by depressing the ICM (Call) key and dialling 996.

8.32 There are no strapping options on the DSS cards. However, each DSS card has 2 sets of miniature switches located next to the front edge of the card. These switches (*all 20*) should be in the "OPEN" position. These switches are used for out-of-system testing.

8.33 Figure 11 shows an abbreviated layout of the DSS card. Fuses, with their ratings, 'power on' LED and the switches are shown.

8.34 Station Card

When installing station cards in the EK-2040 KSU set the bottom S2 switch (S2-10 - RESET) to the OPEN position when the card is installed in its connector.

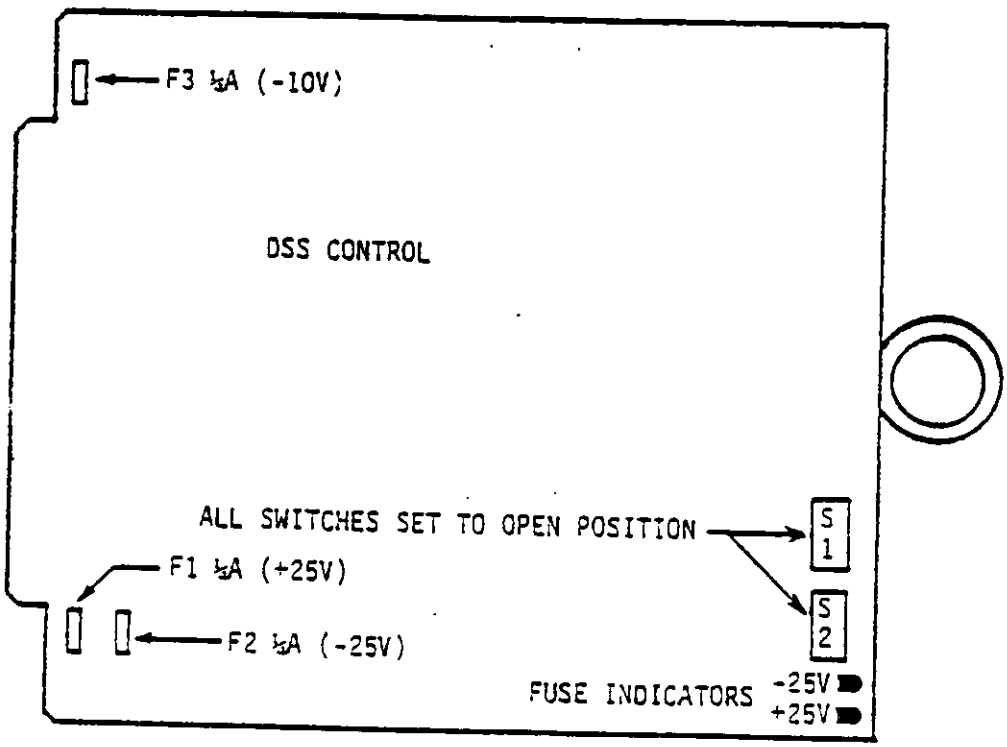


Figure 11 - DSS Control Card, Abbreviated Component Layout

8.35 Figure 12 shows an abbreviated card layout. Fuses, LED's and their functions, switches and potentiometers are shown.

8.36 There are no strapping options on the station card. However, there are switches, which must be set in their proper positions. Table 3 details the switch positions to implement the optional station requirements. Tables 4A and 4B provide programming instructions for C.O. audible groups 1 through 5.

8.37 Page Card (*Optional*)

8.38 The Page card is an optional card which, when required, is plugged into its own dedicated KSU card slot. Refer to figure 2. The Page card is not required for an operational system.

8.39 Figure 13 shows an abbreviated card layout of the Page card. Fuses, LED's with their functions, potentiometers, and the option terminals are shown.

8.40 On the front of the card are 5 potentiometers. These 5 pots are the level adjustment controls for each zone. Zone 1 is the bottom pot and zone 5 is the top pot.

8.41 Table 5 shows the strapping connections required to implement the options available for each paging zone.

8.42 Two outputs for external paging, in each zone, appear on the B4 block (*see table 1*). Clips 39 through 48 (*5 pair*) can be arranged to provide up to 2 watts of power to drive a single 8-ohm loudspeaker load (*2 zones, maximum, may have this feature*). If more power is required, external power amplifiers must be provided, as required, on a zone basis, (*all 5 zones*), and connected to clips 29 through 38 (*5 pair*). Adjustment of the level to the external loudspeakers must be done at the external amplifier.

8.43 Stations served by each zone are as follow:

Zone 1 - 30 thru 39
Zone 2 - 40 thru 49
Zone 3 - 50 thru 59
Zone 4 - 60 thru 69
Zone 5 - 70 thru 89 (*all sta. in the expansion cabinet*).

8.44 When external loudspeaker wiring is to be installed, it is recommended that shielded wire be used to reduce noise and cross-talk in the system. Figure 14 shows methods of splicing and shielding when installing the wiring.

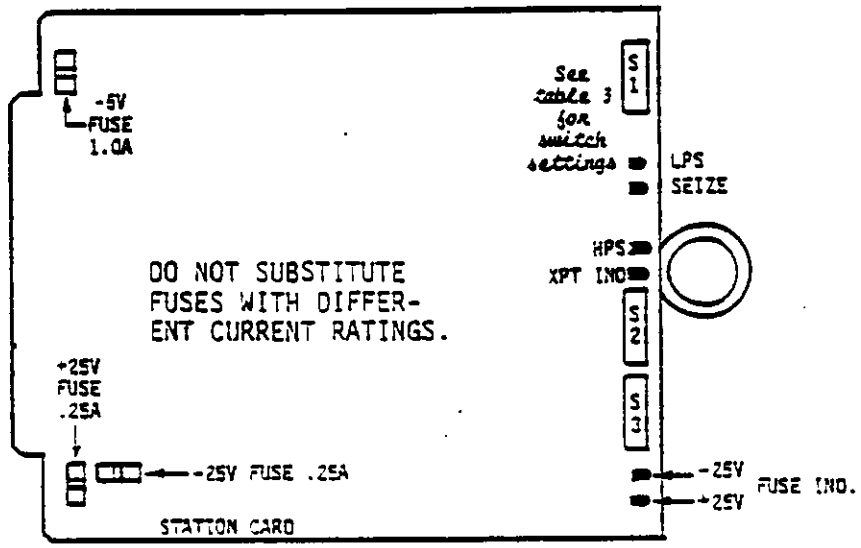


Figure 12 - Station Card, Abbreviated Component Layout

Table 3 - Station Card Switch Positions

USCU-A

S1

10	Close for Group 1 C.O. Audible.
9	Close for Group 2 C.O. Audible.
8	Close for Group 3 C.O. Audible.
7	Close for Group 4 C.O. Audible.
6	Close for Group 5 C.O. Audible.
5	Open for OFF-HOOK Signalling.
4	Open for Background Music.
3	Receive Data
2	Transmit Data — Must always be in the CLOSED position.
1	MUST BE IN OPEN POSITION - See note.

NOTE: If S1-1 is placed in the CLOSED position, intercom calls WILL be DISTORTED.

DS2 ○ LPS - Lit when link port is seized.

DS5 ○ SEIZE - a) Lit when card is active (circuit in use).
b) Flashes at outpulse rate when OUTPULSE DIAL ® is equipped in the station set.

DS1 ○ HPS - Lit when Hotline port is seized.

DS6 ○ XPT IND - Indicates C.O. line in use (unless dial restricted).

S2

10	Manual Reset. Must be OPEN for station card operation.
9	Open for Dial Disable on C.O. line 1.
8	Open for Dial Disable on C.O. line 2.
7	Open for Dial Disable on C.O. line 3.
6	Open for Dial Disable on C.O. line 4.
5	Open for Dial Disable on C.O. line 5.
4	Open for Dial Disable on C.O. line 6.
3	Open for Dial Disable on C.O. line 7.
2	Open for Dial Disable on C.O. line 8.
1	Open for Dial Disable on C.O. line 9.

S3

10	Open for Dial Disable on C.O. line 10.
9	Open for Dial Disable on C.O. line 11.
8	Open for Dial Disable on C.O. line 12.
7	Open for Dial Disable on C.O. line 13.
6	Open for Dial Disable on C.O. line 14.
5	Open for Dial Disable on C.O. line 15.
4	Open for Dial Disable on C.O. line 16.
3	Open for Dial Disable on 1st private C.O. line.
2	Open for Dial Disable on 2nd private C.O. line.
1	Spare

DS3 ○ -25V - Lit when -25 VDC is present (F2).

DS4 ○ +25V - Lit when +25 VDC is present (F1).

Table 4A - Programming for C.O. Audible Groups 1 and 2

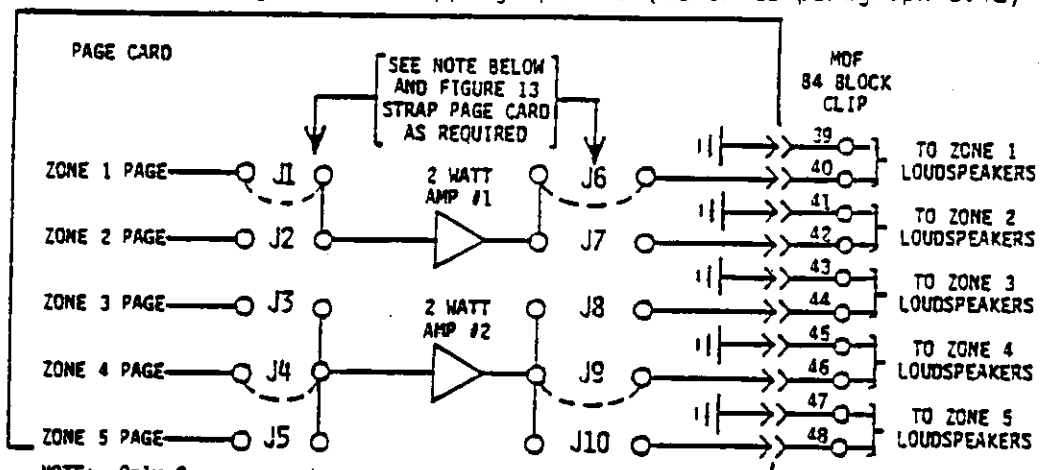
STATIONS IN GROUP	C.O. LINES														LINE KEY 17	LINE KEY 18
	17	18	19	20	21	22	23	24	25	26	27	28	28	30		
30, 31, 32, 33	X	X	X	X											C.O. GP 1 S1-10 TO CLOSED FOR C.O. AUD.	C.O. GP 2 S1-9 TO CLOSED FOR C.O. AUD.
34, 35, 36, 37	X	X			X	X										
38, 39, 40, 41	X	X					X	X								
42, 43, 44, 45	X	X							X	X						
46, 47, 48, 49	X	X									X	X				
50, 51, 52, 53	X	X											X	X		
Any station 30 through 53 can select via the Selector Panel any 2 of the 4 C.O. lines indicated by "X" to appear on line keys 17 and 18. Switches S1-9 and S1-10 enable the C.O. audible for the 2 C.O. lines selected. See paragraph 9.00.																

Table 4B - Programming For C.O. Audible Groups 3, 4 and 5

STATION GROUP #	C.O. LINES	PROGRAM SWITCH S1 CLOSED	C.O. AUDIBLE GROUP
30 through 35	1, 2, 3	S1-7	4
36 through 41	4, 5, 6		
42 through 47	7, 8, 9		
48 through 53	10, 11, 12		
54 through 59	13, 14, 15		
60 through 65	16, 17, 18		
30 through 69 and 70 through 89 (*Exp. Cabinet*)	1 through 12	S1-8	3
30 through 53	10, 14, 15, 16	S1-6	5
54 through 69 and 70 through 89 (*Exp. Cabinet*)	13 through 18		

Refer to table 4A for groups 1 and 2.

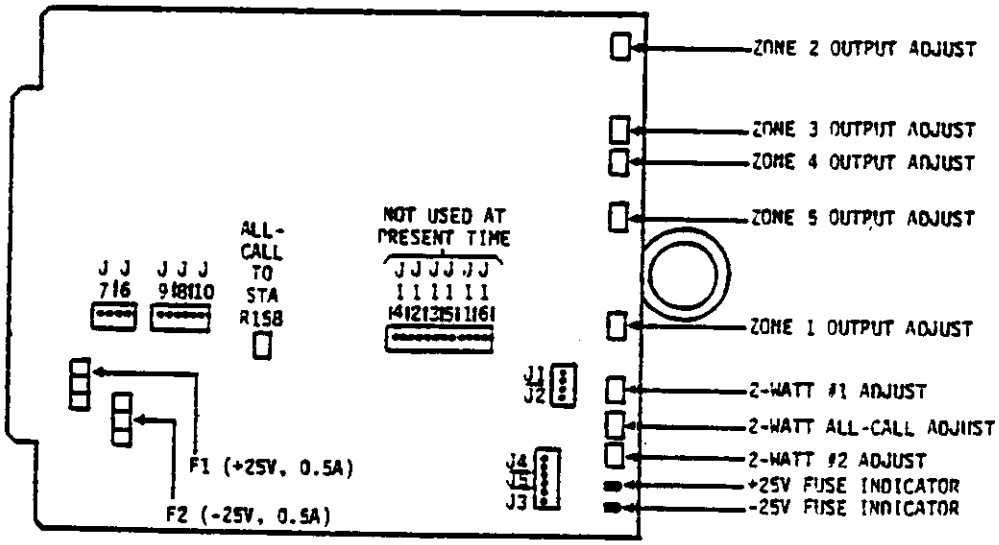
Table 5 - Page Card Strapping Options (Refer to paragraph 8.42)



NOTE: Only 2 zones may be connected to the amplifiers. Connect the input from the page zone to the amplifier as shown. Connect the amplifier output to the MDF 84 block clips for the zone corresponding to the input connections. Use amplifier #1 for zone 1 or 2 and amplifier #2 for zone 3, 4 or 5.

Figure 13

Page Card - Abbreviated Component Layout



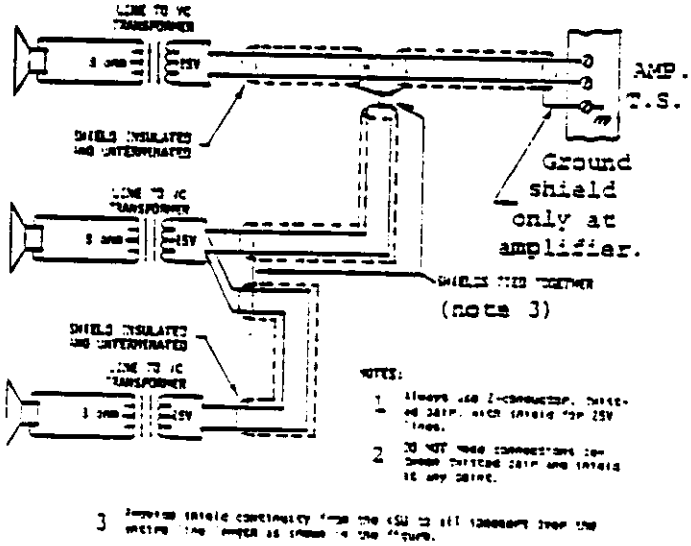


Figure 14 - External Loudspeaker Wiring Guide

9.00 SELECTOR PANEL AND HOTLINE ASSIGNMENT

9.01 Located on the rear of the swing-out gate, next to the I/O panel, is a panel marked "Selector Panel" (*see figures 4 and 15*).

9.02 This panel is used by the installer to assign C.O. lines 17 through 30 to stations within the system. The following rules must be adhered to for proper operation of the C.O. lines not appearing on all station sets. C.O. lines 01 through 16 appear on all station sets.

a) Only stations 30 through 53 may be assigned 1 or 2 of the 14 lines not appearing at all other stations (*lines 17-30*).

b) These C.O. lines are always assigned to C.O. line keys 17 and 18 at each station.

c) The choice of lines available at each station (*2-out-of-4*) is shown in table 4A.

d) Connections can be made on the Selector Panel ONLY with the special "Selector Panel Jumper" (*see figure 16*). Note that each jumper plug is keyed for proper insertion.

e) Jumpers may ONLY be run horizontally on the panel.

DO NOT attempt to use wire-wrap connections to other horizontals on the panel.

f) When assigning the C.O. lines to their line key locations, place the appropriate C.O. audible switch (*see table 4A or 4B*) in the ON position for at least one of the station appearances.

g) These C.O. lines cannot be picked up by the DSS consoles.

h) All C.O. lines, 17 through 30, MUST be assigned to at least one station (*30 to 53*) within the system.

.03 Hotlines

9.04 Hotlines are factory wired in the system between pairs of stations as

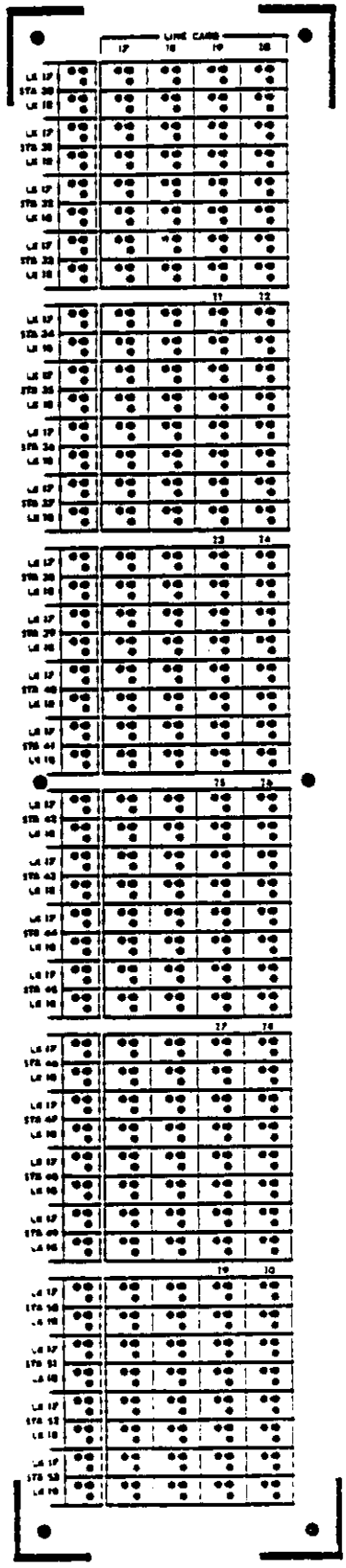


Figure 15 - Selector Panel Layout

in table 6.

9.05 The Hotline appears as the 2nd key from the right in the bottom row of keys on each station. Depressing this key will automatically signal the other station as detailed under paragraph 6.07d.

9.06 The normal use of the hotlines might be as a 'principal/secretary' arrangement. The hotline station pair (*i.e., 30-31, 32-33, etc.*) should be taken into consideration when making up the station numbering scheme for each job.

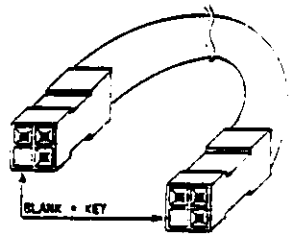


Figure 16 - Selector Panel Jumper

Table 6 - EK-$\frac{3060}{2040}$ STATION HOTLINE CONFIGURATION

STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY	STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY	STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY	STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY	STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY	STA WITH HOT-LINE KEY	DEST OF HOT-LINE KEY
30	31	40	41	50	51	60	61	70	71	80	81
31	30	41	40	51	50	61	60	71	70	81	80
32	33	42	43	52	53	62	63	72	73	82	83
33	32	43	42	53	52	63	62	73	72	83	82
34	35	44	45	54	55	64	65	74	75	84	85
35	34	45	44	55	54	65	64	75	74	85	84
36	37	46	47	56	57	66	67	76	77	86	87
37	36	47	46	57	56	67	66	77	76	87	86
38	39	48	49	58	59	68	69	78	79	88	89
39	38	49	48	59	58	69	68	79	78	89	88

10.00 BACKGROUND MUSIC AND MUSIC-ON-HOLD

10.01 The TIE EK-2040 is designed to provide background music through the loudspeakers in the telephones and to provide music-on-hold to the distant party when a C.O. line is placed on HOLD. The background music is controlled individually by a volume control and off switch in each station set (*see figure 17*).

10.02 If paging is provided in the system, the background music will be removed when the paging circuit is seized. Music will resume after the announcement is completed.

10.03 The music source (*i.e., tape deck, tuner, etc.*) for the background music and/or music-on-hold must be provided from customer-provided equipment.

10.04 The input impedance of the music source equipment should be 600 ohms or higher. The input is transformer coupled into the system. Attenuation, or ost is provided on the Tone Generator ard (*see paragraph 9.10*) as well as output level controls.

10.05 BGM and MOH input terminals are located on the I/O board in back of the swing-out gate. Two "phono" type jacks are provided on the I/O board for the MOH and/or BGM inputs to the system in addition to the conventional screw terminals on TB2 (*see figure 4*).

11.00 STATION WIRING

11.01 All station wiring is home-run in this system. Bridged or extension stations are NOT permitted.

11.02 Station wiring should be 24 or 22-gauge, non-twisted, 4-conductor, inside wiring cable (*quad*). However, feeder cables may be used from the equipment site to distribution boxes when required. Standard 24-gauge inside wiring cable should be used for this purpose. Refer to table 1 for KSU tail cable quick-connect block conductor assignments.

11.03 The cable length limitation for TIE EK-2040 stations is 2000 cable feet for 24-gauge wire.

11.04 At the station location, the quad should be terminated in 625 type or 404M type modular jacks. All EK-2040 system telephones are equipped with modular plug-ended line cords.

Balanced cable pairs are very important in the EK-2040 system. The installer should keep in mind that the shorter the cable runs from the station are, the more important good (tight) connections become. As an example:

100 feet of 24-gauge quad has a loop resistance of approximately 5 ohms. If a bad (loose) connection of 5 ohms exists in one side of the pair, the result is 2½ ohms in one side and 7½ in the other. Thus one can see that, on short cable runs the unbalance is much more acute than if the cable runs were much longer.

The installer should also become familiar with the information contained in paragraphs 13.08 through 13.11 in order to avoid problems caused by cabling errors.

12.00 STATION INSTALLATION

The installer should be familiar with paragraph 13.10e before plugging in the station sets. A short between the A and B quad pairs will blow fuses on the station cards.

Inside the station on the P.C. board, next to the microprocessor integrated circuit, is a potentiometer. This pot is factory adjusted and SHOULD NOT be adjusted in the field. This pot adjusts station internal clock functions.

12.01 TIE EK-2040 station sets are shipped from the factory with either a DTMF tone dial or a TIE OUTPULSE DIAL ® installed. If no special dial is required, the installer does not have to open the set at time of installation. Simply plug the set into its modular jack as covered in paragraph 11.04.

12.02 Figure 17 shows the telephone, with its key functions, volume controls, etc. Figure 18 shows the key layout of the DSS console panel.

12.03 Designate the keys of each station to conform with station assignments (*hotlines, C.O. numbers, etc.*). The system requires accessing C.O. lines by dialling 9+ the C.O. line number on the ICM line when the C.O. does not appear at the station. The numerical designation of the line within the system, the access code, (*i.e., 917, 918, 919, etc.*) should be designated on each C.O. line key 17 and 18 at each station. When a call is to be passed to a station where a C.O. line does not appear, the 1st party must tell the 2nd party which line to access. For this reason, it is important that the C.O. line keys 17 and 18 be so designated. The C.O. directory number of the company should be designated on the number plate beneath the handset (*Refer to figure 17*).

12.04 Information for installing special dials (*i.e., memory or restrictor types*) is supplied in a separate section(s).

12.05 DSS Console

12.06 The Dss console is installed in

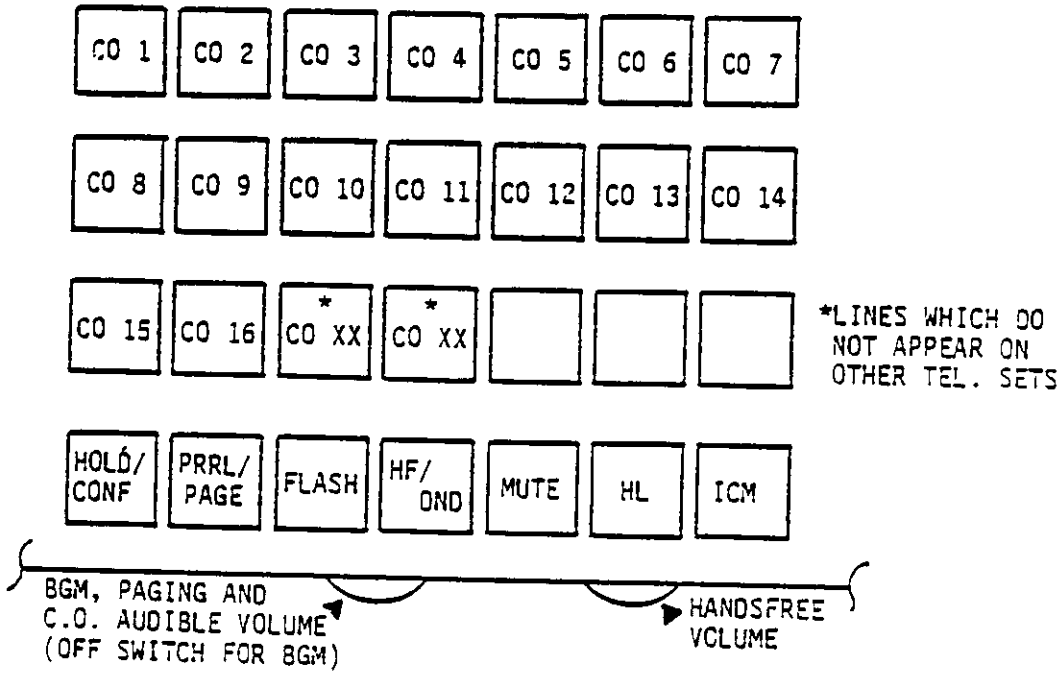


Figure 17 - EK-2040 Telephone Key Layout

the same manner as the station set. One quad from the 84 block at the KSU is required to connect the DSS console into the system (*refer to table 1 for lead termination location and paragraph 8.27 for DSS system configuration*).

12.07 As stated in paragraph 8.31b, the 1st DSS position is station 58 and the 2nd, when equipped, is station 59.

12.08 The quad for station 58 should be terminated on clips 21 through 24 of the 84 block. Station 59 should be terminated on clips 25 through 28.

There is no reason to open the DSS console during installation. However, should the installer do so, he SHOULD NOT attempt to adjust either of the 2 potentiometers located on the P.C. board inside the console. These pots control the DSS timing functions (clock) and cannot be adjusted properly in the field. The volume control, located on the front of the set serves no purpose at this time.

STA 30	STA 31	STA 32	STA 33	STA 34	STA 35	STA 36
STA 37	STA 38	STA 39	STA 40	STA 41	STA 42	STA 43
STA 44	STA 45	STA 46	STA 47	STA 48	STA 49	STA 50
STA 51	STA 52	STA 53	STA 54	STA 55	STA 56	STA 57
STA 60	STA 61	STA 62	STA 63	STA 64	STA 65	STA 66
STA 67	STA 68	STA 69	STA 70	STA 71	STA 72	STA 73
STA 74	STA 75	STA 76	STA 77	STA 78	STA 79	STA 80
STA 81	STA 82	ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5

Figure 18 - DSS Console Key Layout

13.00 MAINTENANCE

13.01 General

13.02 The following paragraphs provide information which may help the installer or maintenance personnel should problems arise during or after installation.

13.03 No periodic or scheduled maintenance is required on the system.

13.04 Troubleshooting - General

13.05 The TIE EK-2040 system is designed so that a fault in the station set, station card or line card will not affect the performance of the entire system. Each station card contains its own microprocessor which controls the station set and the switching between the station card and the other cards in the system.

13.06 The use of plug-in type circuit cards facilitates fast replacement and reduces downtime to a minimum. To further reduce downtime, an adequate supply of circuit cards should be available at all times. Usually, an analysis of the trouble report or a brief operational check is enough to localize the malfunction to the station set or station card, line card, common cards, or the C.O. line. Substitution of a suspect card can then quickly define the area of the problem and thus, its solution.

13.07 Most of the installation effort required for the EK-2040 system is used in running the quads for all the stations, terminating them (*both at the station and the KSU*), and checking all the station features. For this reason, most of the installation errors, if they exist, will be in the cabling system. Thus, cabling problems will be discussed first.

13.08 Troubleshooting - Station Cables

13.09 Balanced Pairs: The EK-2040 system uses "phantom" pair operation to supply power, for data transmission, and audio transmission between the station card and the station set. In using this method, it is important that the quad station cables have well balanced pairs throughout the installation. This means that the installer should try to minimize the number of terminations in the station quad run, i.e., the station quad should be a direct homerun to the KSU without distribution boxes in between, whenever possible. By taking care to provide good connections in the quad wiring, the installer will ensure the best quality in the voice switching circuits.

The installer should keep in mind also that the shorter the cable runs from the stations are, the more important good (tight) connections are. As an example;

100 feet of 24-gauge quad has a loop resistance of approximately 5 ohms. If a bad connection of 5 ohms exists in one side of the pair, the result is 2½ ohms in one leg and 7½ ohms in the other. Thus one can see that, on short cable runs the unbalance is more acute than if the cable runs were much longer.

13.10 Shorted or Reversed Pairs

a) Reversals: Figure 19 shows the quad cable connection between the station card and the station set. Looking at figure 19, we can see that each end of a quad pair goes to a transformer. Therefore, we can see that reversal of either the "A" pair or the "B" pair will cause no problems.

b) Swapped "A" and "B" Pairs: If the "A" pair (GN/RD) is swapped with the "B" pair (BK/YL) the station will be 'dead'. No fuses will blow. When the pairs are restored to their proper configuration, the station should function properly.

c) Shorted "A" Pair: If the "A" pair conductors are shorted together, the result is no audio transmission from the station set.

d) Shorted "B" Pair: If the "B" pair conductors are shorted together, the result is no audio received at the station set.

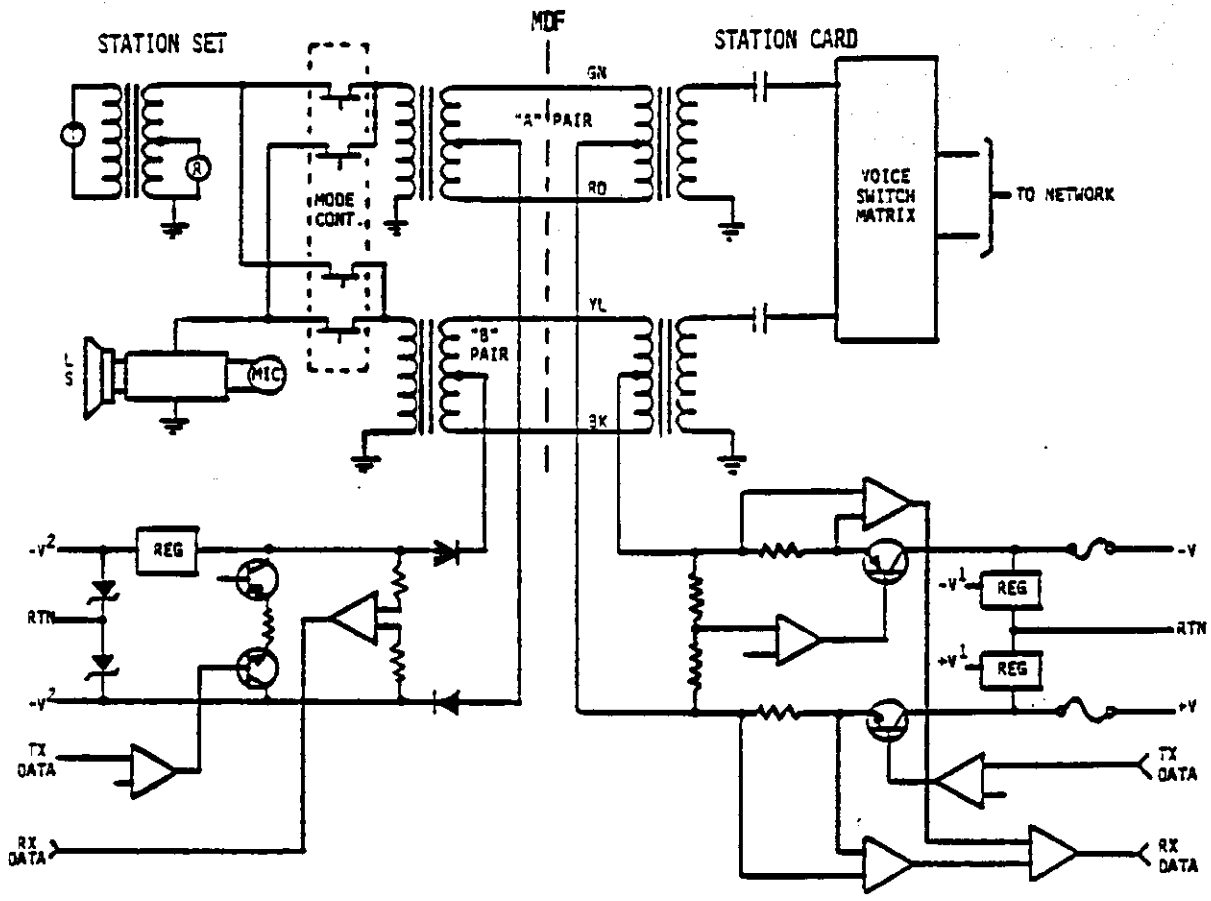


Figure 19 - Station Card/Station Set Data, Power and Audio Transmission Arrangement

e) Shorted "A" to "B" pair: If either or both of the "A" pair conductors are shorted to either or both of the "B" pair conductors, the ±25V fuses will blow on the station card. See figure 12 for location of the fuses.

13.11 Open Quad Conductor: If any one of the 4 quad conductors is opened (*lead broken, etc.*) chattering will be heard from the loudspeaker of the station set. All LED's will flutter. When the handset is lifted, the chatter is heard in the handset, and the LED's stop fluttering.

13.12 Use of "Butt Set" for Station Testing

Use of the butt set for station testing is USELESS. The butt set loads either quad pair (both in talk or monitor positions) and makes the station set malfunction in a variety of ways, depending upon where the butt set is connected. When continuity testing is required, use of a volt/ohm meter is recommended.

13.13 Quad Pair Functions

13.14 As an aid to installers and maintenance personnel, the following paragraphs will explain the functions of the quad cable pairs. This information may be helpful in trying to find a cable fault. See also paragraphs 13.08 through 13.11.

13.15 As previously explained, the system operates over two pairs, both of which are used for audio transmission. However, they do not operate as the transmit and receive legs of a 4-wire system.

The telephone has the capability of receiving two simultaneous calls, one on each pair. The station user may be talking on a C.O. line call and receive and answer an intercom call without interrupting the C.O. call. The C.O. line call would be via the handset and the intercom call would come in over the speakerphone.

13.16 Actually, the quad cable is three pairs; the third pair being a "phantom", composed of the "A" pair as one leg and the "B" pair as the other leg. Refer to figure 19.

13.17 Explanation of the Pairs

13.18 The "A" Pair: The "A" pair is the audio pair for the originating station on C.O. line and intercom calls. This pair is both a receive and transmit pair.

13.19 The "B" pair: The "B" pair is the audio pair for the receiving station on an intercom call. This pair is both a receive and transmit pair.

13.20 In summary, when an intercom call is in progress, the originating station is transmitting and receiving over the "A" pair. The called station is transmitting and receiving over the "B" pair.

13.21 Pair Swap: Normally the "A" pair is connected through the mode control switching circuit to the handset of the telephone. The "B" pair is connected to the speakerphone circuits. When the HANDSFREE key is depressed *(turning on the speakerphone)*, the "A" pair is then connected to the speakerphone and the "B" pair is connected to the handset. This is accomplished by the mode control switching circuits *(see figure 19)*.

13.22 Phantom Pair: The phantom pair is used to provide power to the station set and for data transmission between the station card and the station set. The data is superimposed on the power leads, positive data on the positive power leg and negative data on the negative power leg. This data can be seen with an oscilloscope at the test points covered under paragraph 13.25h. Review figure 21 before attempting to understand the scope information from TP5 and TP7 of the station card.

13.23 Explanation of Figure 21

13.24 Figure 21 illustrates the data transmission scheme between the station card and the station set and vice-versa. Following is an explanation of what is shown:

a) The data frame consists of 34 words *(000 through 31)* and is transmitted each 23.8 msec.

b) Each data word is 700 usec long and consists of five "T" times of 140 usec each.

c) The first two words of the data message are "frame sync". This is so the station set and the station card are always in step with real time.

d) The data from the station set is sent in the form of current level changes and is detected as current changes in a fixed load by the station card *(see figure 19)*.

e) The data from the station card is sent in the form of voltage level changes and is detected in that manner by the station set.

f) As previously stated, the data message is superimposed on the positive and negative legs of the phantom. When looking at TP5 and TP7 of the station card, we see the exact complement of each other.

g) As the station card is always in command, it controls the timing of each frame. During each "T1" time, a sync pulse *(also called a marker pulse)* is sent as the first pulse of each data word.

h) During each "T2" time, the station card gives a command to the station set, when required *(see table 7)*.

i) Also during each "T2" time, the station set sends a marker pulse *(indicated by an asterisk "*")* to the station card when the set

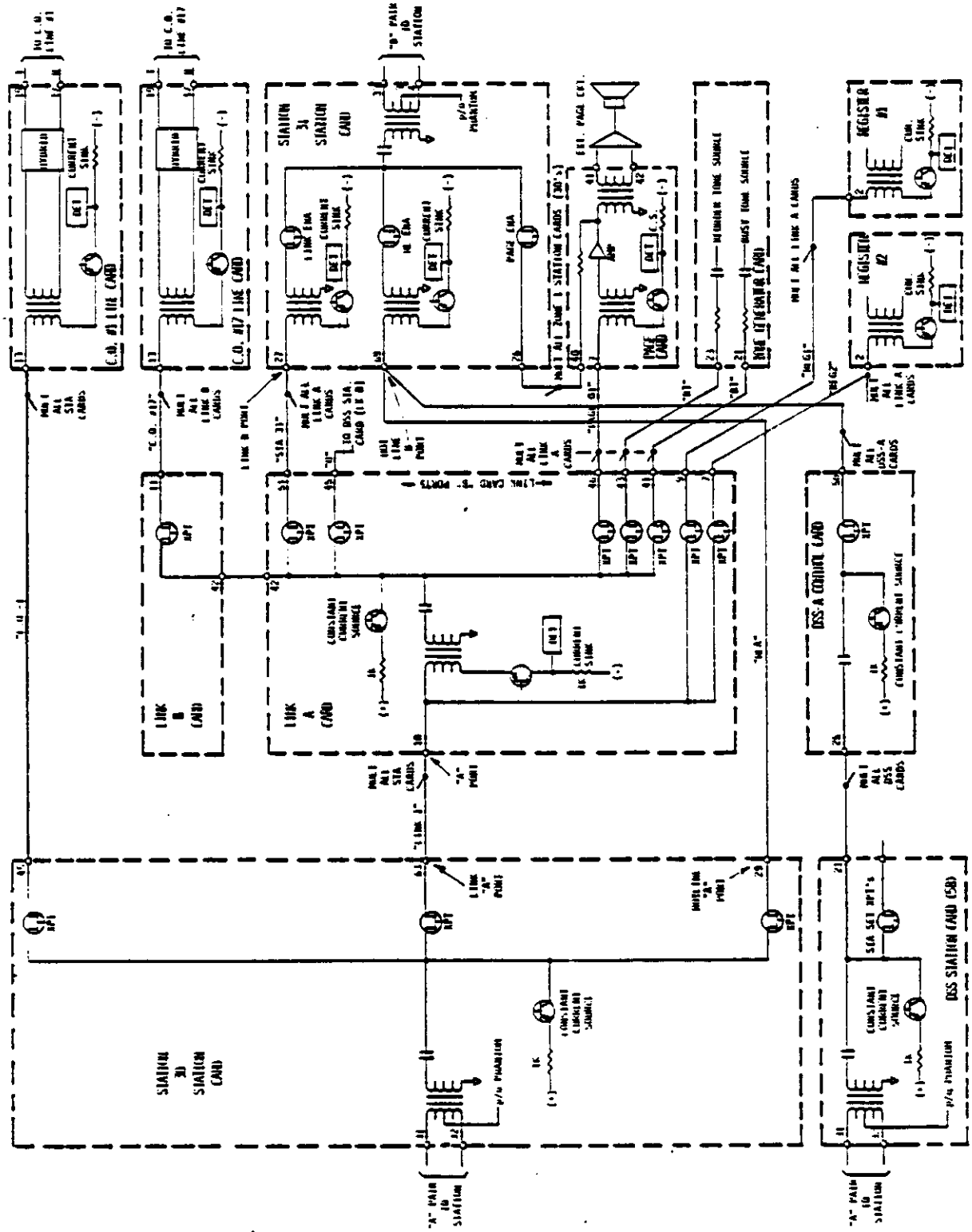
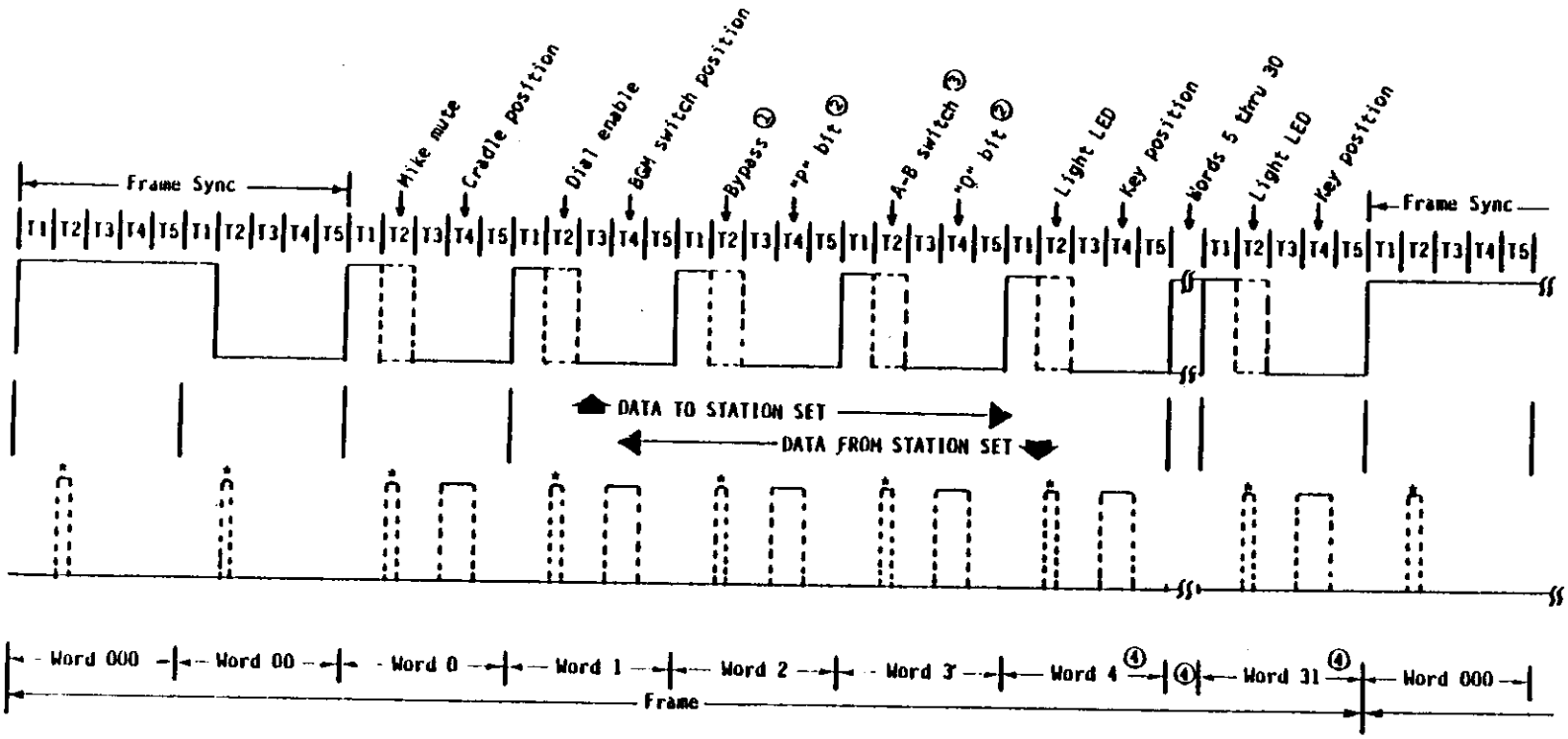


Figure 20 - EK-2040/3060 System Analog (Audio) Paths

ELECTRONIC KEY TELEPHONE SYSTEM - KSU / STATION DATA MESSAGE



Each frame = 34 words (23.8 msec).
Each word = Five "T" times (700 usec)
Each "T" time = 140 usec.
* Off-hook condition sampled during each T2 time. Pulse = idle station.

① For paging, BGM and splash-tone.

② For DSS operation.

③ For speakerphone operation.

----- Pulse not always present.

T1 time is always word sync pulse.
T2 time transmits from station card to station set.
T3 time always blank (no pulse).
T4 time transmits from station set to station card.
T5 time always blank (no pulse)

④ Words 4 through 31 correspond to the 28 keys on the station set as shown below:

WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY	WORD	KEY
4	C01	8	C02	12	C03	16	C04	20	C05	24	C06	28	C07
5	C08	9	C09	13	C010	17	C011	21	C012	25	C013	29	C014
6	C015	10	C016	14	C017	18	C018	22	SP	26	SP	30	SP
7	HOLD	11	PR RL	15	FLASH	19	HF	23	MUTE	27	HL	31	ICM

Figure 21

is on hook (*open loop*). This is the means used by the station card to detect dial pulses, when required. Each dial pulse (*60 msec, approximately*) can be seen by the station card for about 2½ frames, for repetition to the C.O. line.

j) "T3" and "T5" times are always blank (*no pulse present*).

k) "T4" time is used by the station set to send data to the station card (*see table 7*).

13.25 Troubleshooting - KSU and Power Supply

a) Power Supply

Before replacing blown fuses, check for shorts in the affected circuitry. Improper DC outputs can cause malfunctions in the KSU and its associated circuit cards.

Full load '+25V' and '-25V' should be within the "25 to 30" voltage range limits. The '-10V' line should be within the 9 to 12 voltage range.

If the DC voltages are outside the above stated limits the input power is suspect. The input AC line should be between 105 and 125 volts. Insure that the AC input source is not overloaded. The system should be connected to a separately fused circuit so that other electrical equipment has no effect on the performance of the system.

Table 7 - EK-2040 Data Word Format

WORD	"T" TIME	FUNCTION
000	T1-T5	Frame sync from station card to station set.
00	T1-T5	
0	T1	Word sync to station set.
	T2	Mike mute pulse, i.e., during BGM, splash-tone, paging, etc.
	T3	Blank.
	T4	Cradle position to station card.
	T5	Blank.
1	T1	Word sync to station set.
	T2	Dial enable pulse, if not restricted by station card switch for that C.O. line, to the station set.
	T3	Blank.
	T4	BGM switch position to station card.
	T5	Blank.
2	T1	Word sync to station set.
	T2	Bypass bit, permit BGM, splash-tone or paging to be heard.
	T3	Blank.
	T4	"P" bit for DSS operation.
	T5	Blank.
3	T1	Word sync to station set.
	T2	A-B switch pulse. Switch speakerphone to "A" pair.
	T3	Blank.
	T4	"Q" bit for DSS operation.
	T5	Blank.
4-31 See Fig 21 ④	T1	Word sync to station set.
	T2	Light LED in station key.
	T3	Blank.
	T4	Key position to station card.
	T5	Blank.
All	T2	On-hook pulse from station set to station card.

b) Line Card:
(See paragraph 8.02 and figure 7)

The C.O. line card provides all functions normally provided by a key system line card.

Detects incoming ring signal.
Provides C.O. seizure.
Hold.
Privacy release.
Flash (*holding or C.O. audible*).

It also provides a buffer between the tone generator card and the C.O. line for music-on-hold. *Remember that the level control for MOH is on the Tone card.*

The line card receives all its commands from the station card (*see 13.25h*).

Test Points:
(See figures 24A, 24B and 24C)

Seven designated test points are provided on the front edge of the line card.

TP1 - Current level from the station card. Refer to figure 24A.

TP2 - Voltage drop (*current sink*) from the station card. Refer to figure 24B.

TP3 - $\overline{\text{HOLD}}$ pulse.
Refer to figure 24C.

TP4 - FLASH pulse

TP5 - Ring to C.O.

TP6 - Tip to C.O.

TP7 - Ground

Use of a "butt set" IS permitted on TP5 and TP6.

c) Tone Generator Card
(see paragraph 8.07 and figure 8)

The Tone Generator card supplies all flash rates and tones (*except DTMF*) required by the system. Also contained on the card are input boost or attenuator circuits for the MOH and BGM inputs when utilized.

Six tones are provided for the system:

Dial Tone - 350 Hz at -10 dB. continuous.

Reorder Tone - 350 & 440 Hz at -10 dB. with 8 Hz, 50% flash rate.

Splash Tone - 440 Hz at -1 dB. for ½ second.

Busy Tone - 350 & 440 Hz at -10 dB. with 1 Hz, 50% flash rate.

C.O. Audible - 350 & 440 Hz at -10 dB. with 1 sec. on, 1 sec. off, 1 sec. on and 3 sec. off rate.

ICM Audible - 350 & 440 Hz at -10 dB. with 1 sec. on, 3 sec. off rate.

Three flash rates are provided:

"I-Hold" - 8 Hz (*480 IPM*) at 50%.

"Hold" - 2 Hz (*120 IPM*) with 90% on, 10% off wink.

Slow flash - 1 Hz (*60 IPM*) at 50%.

Test Points:
(See figures 25A, 25B & 25C)

Four test points are provided on the tone card. They are designated and are located on the front edge of the card.

The test points are for use with an oscilloscope. DO NOT attempt to use a "butt set" to listen for tones or flashes.

TP1 - System ground (*reference, 0 volts*).

TP2 - I-Hold flash rate (*8Hz*).
Refer to figure 25A.

TP3 - Hold flash rate (*2 Hz*).
Refer to figure 25B.

TP4 - Slow flash rate (*1 Hz*).
Refer to figure 25C.

d) Register card:
(See paragraph 8.12 and figure 9)

The Link card provides a service request to the register when the link is seized. The register provides dial tone to the caller (*through the link*), counts dial pulses or decodes DTMF tones, determines whether the dialled number is valid, provides a reorder signal to the link on invalid numbers, and provides cross-point data (*number dialled*) to the link for closing the cross-point between the calling station "A" port and the called station "B" port.

Call mode information (*i.e., voice page, 'ringing' call, alternate point answer, page zone, or C.O. access*) is also transferred to the link (*to be held for the duration of the call*).

As shown in figure 9, 6 LED's are provided for register status indications. The +V and -V LED's monitor the ±25V power sources to the register card. The RESET LED is lit at all times except during the dialling sequence. The DIALLING LED is lit during the dialling sequence. The READY LED is lit when the register is ready for use. When the READY LED is lit on 1 register, the STANDBY LED will be lit on the other when they are both idle.

Once cross-point and mode information is transferred to the link, the register releases and is available for another call.

There are no test points on the register card. A set of 10 miniature switches, 2 push-buttons, and a connector (*J1*) are provided for out-of-system tests. These components are to be used with a "register analyzer" circuit.

If any problem occurs in the register circuit, replacement of the register is required; with the following exception: Fuses F1 and F2 may be replaced. However, a thorough inspection of the card is required. Some form of short circuit, such as a wire clipping, solder cross or component leads touching each other, should be the object of the inspection. Should the replaced fuse open a 2nd time, the card should be replaced.

When fuses are replaced on the Register card, fuses other than the correct value MUST NOT be substituted. See figure 9.

e) Link "A" Cards
(See paragraph 8.17 and fig. 10A)

Link "A" cards provide ½ of the intercom talkpath system. The Link "A" cards store the decoded called station number and the calling mode information which was provided by the register.

The Link "A" card contains 41 cross-points. 30 provide access to stations 30 through 59. 7 additional cross-points are provided for access to 5 zones of paging, All-call, and the DSS position. 2 more are provided for Busy Tone and Reorder Tone.

Calls are diverted to the Busy Tone port when the link 'tests' a called station's passive port and finds it busy.

Calls are diverted to the Reorder Tone port if the caller fails to complete dialling within 30 seconds or if an invalid code indication is received from the register.

Finally, 2 cross-points are provided for the audio paths to the two register circuits. Connection of the calling station to one of these ports is made when the register acknowledges that it is available for service.

When the link responds to the register information, the "B" port of the Link A card is closed to the passive port of the corresponding station card *(see figure 20)*.

When a station user depresses the ICM *(Call)* key on his telephone, an active link port *(see para. 8.23)* of his station card seizes the "A" port of the idle link *(selected by the station card processor)*. The "seize" current from the active station card port is detected at Link A's "A" port causing register selection, connection and call processing. This results in the links "B" port being closed to the corresponding station card's passive port *(see figure 20)*.

When the call is terminated and "seize" current from the calling station card ceases, the current change is detected by the link A card. The "B" active port from the link to the called station card is opened, the calling mode information and the called address is removed from storage, then the link is reset and ready for another call.

Tests Points:

There are six test points on the Link A card. They are designated and located on the front edge of the card.

TP1 - "ARR". Address Register Reset.

TP2 - "A PORT". "A" port seize current and audio.

TP3 - "CSSE". Called Station Send Enable pulse.

TP4 - "B PORT". DXP *(Digital Cross-point)* voltage, audio and current sink.

TP5 - "LKR". Link Reset.

TP6 - GND". Reference *(0 volts)*.

Fuses and LED's: *(See figure 10A)*

As shown on figure 10A, there are 2 fuses and 4 LED's located on the link A card. The +V and -V LED monitor the ±25V power sources to the card. The LKR LED indicates that the link is reset and available for a call. The ANS LED indicates when the called station has answered the call *(called station not busy on busy test)*.

If a problem appears to be related to a specific Link A card, the problem location can be verified by swapping the card with another Link A card in the system. If the problem travels with the suspect card, it should be replaced. However, the fuses should be checked

and replaced, if necessary. If a fuse is blown, a thorough inspection of the card for wire clippings, some form of short circuit or component leads touching each other. If the replaced fuse opens a 2nd time, the card should be replaced.

f) Link "B" Cards:
(See paragraph 8.17 and fig. 10B)

The Link "B" cards make up the 2nd half of the intercom talkpath system and provide the access to C.O. lines not appearing at the accessing station. The Link B card will not function without its associated Link A card.

There are 58 cross-points on the Link B card. 30 cross-points are used for stations 60 through 89. Access to C.O. lines 17 through 30 requires 28 cross-points. Each C.O. line connection to the Link B card requires 2 cross-points; one digital cross-point and one analog cross-point.

Cross-points used to access other stations within the system carry both digital control information *(in the form of current level changes)* and analog audio signals.

Access to the registers, busy tone, reorder tone, paging and the DSS position for the stations served by the link B card, is still provided through the link A card *(see figure 20)*.

Test Points:

There are six test points on the Link B card. They are designated and located on the front edge of the card.

TP1 - "$\overline{\text{BT ENA}}$". Busy Tone Enable pulse to the link A card.

TP2 - "DECODE STA." Logic level to open and close DXP to station.

TP3 - "DECODE LINE" Logic level to open and close DXP to line.

TP4 - "COM DRAIN STA/LINE ANLG" DXP voltage, audio and current sink.

TP5 - " COM " DRAIN LINES Current through DXP to C.O. line card.

TP6 - "GND". Reference *(0 volts)*.

Fuses and LED's: *(See figure 10B)*

As shown on figure 10B, there are 2 fuses and 2 LED's located on the Link B card. The +25 and -25 LED's monitor the ±25V power sources on the card.

If a problem appears to be related to a specific Link B card, the problem location can be verified by swapping the link B card with another link B card in the system. If the problem travels with the suspect card, it should be replaced. However, the fuses should be checked and replaced if necessary. If a fuse is blown, a thorough inspection of the card for wire clippings, some sort of short circuit or component leads touching each other. If the replaced fuse opens a 2nd time, the card should be replaced.

g) DSS Control Cards:
(See paragraph 8.27 and figure 11)

The DSS Control card functions as an expander of the conventional station card which serves the attendant's telephone. The DSS console provides the additional keys required.

Each DSS Control card provides 28 cross-points for accessing the Hot Line ports of other station cards within the system.

In addition to the 28 cross-points, each DSS card contains a microprocessor for performing other tasks associated with DSS calling, as follow:

- Monitor the status of the associated station cards and transmit that status to the LED's in the DSS console.
- Place on HOLD the most recently seized C.O. line (*by the attendant*) when the attendant accesses a station.
- Release an attendant accessed station if the attendant returns to an on-hook condition, or depresses another C.O. line key or depresses another station key at her position.

As previously stated in paragraph 8.30, two DSS Control cards may be associated with the DSS console. The 1st card, DSS-A, accesses 28 stations (*30 through 57*) and the 2nd card, DSS-B, accesses 23 stations (*60 through 82*) plus the 5 paging zones.

Should the attendant desire to access stations 58 or 59 (*the other DSS station or station 59 if it is not a DSS station*), stations 83 through 89, or All-Call (*code 996*), she must use the ICM key and dial in the conventional manner.

Test Points:

TP1 - "GND". Reference (*0 volts*).

TP2 - "I-SEND".

TP3 - "SYNC".

TP4 - "DXP DATA".

TP5 - "DATA TX".

TP6 - "-QUAD 1".

TP7 - "+QUAD 1".

TP8 - "R8 DATA".

As stated in paragraph 8.32, there are 2 sets (*2x10*) of miniature switches located on the front edge of the DSS Control card. These switches (*all 20*) are used for out-of-system testing and must always be left in the "open" position when the card is in service. If problems are encountered and suspected to be associated with a DSS control card, these switches should be checked, to ascertain that they are in their proper positions.

Fuses and LED's (*See figure 11*)

As shown in figure 11, there are three fuses and 1 LED. The LED is a fuse indicator for the ±25V power sources on the card. There is no LED indicator for the -10V fuse. *See para. 13.41 - 13.43.*

If a problem appears to be related to a specific DSS Control card and the miniature switches have been checked for proper position, the problem location can be verified by swapping the DSS Control card with another DSS card in the system, if equipped. If the problem travels with the suspect card, it probably should be replaced. However, the fuse (F3) should be checked and replaced if necessary. Fuses F1 and F2, if open would be indicated by the LED. If a fuse is blown, *and the quad has been checked*, a thorough inspection of the card should be made for wire clippings, some sort of short circuit or component leads touching each other. If the replaced fuse opens a 2nd time, the card should be replaced.

h) Station Card
(See paragraph 8.34 and fig. 12)

The Station card provides the required switching to the C.O. line cards, the link cards and the hot line to another Station card. It contains 23 cross-points:

- 18 C.O. Line cards.
- 4 Links *(see paragraph 8.23)*.
- 1 Hot line.

The Station card contains the system program by which its microprocessor controls the switching and commands to the lines and links.

The Station card supplies power and data to its associated station set via the quad *(see paragraph 13.13 and figures 19 and 21)*.

Control of the C.O. line, hot line or link is accomplished by the Station card sending a specific constant current via the cross-point for the following functions:

- Idle - 0 mA.
- Seize - 1.6 mA.
- Conference *(2 sta. & 1 C.O. line)* - 3.2 mA.
- Flash - 6.4 mA.
- Hold & PR RL - 20 mA for 50 msec.

Acknowledge of the seizure *(or other function)* is returned to the Station card in the form of a voltage level change at the DXP on the Station card.

The Station card has 2 passive ports by which it is seized:

- Hot line port - This port responds to a seizure from another station card *(HL key)* or from the DSS attendant.
- Link port - This port responds to dialled intercom calls.

In addition to the active cross-points (A) and the passive ports (B), the station card interfaces audio tones and control signals from the Tone card, such as; ICM ring, C.O. audible, splash-tone, flash rates, C.O. audible enable signals, and background music. The Station card also interfaces paging signals from the Page card.

The Station card's micro-processor controls the audio and supervisory signals which are enabled, as required, to process calls to the station set.

Test Points:

Ten test points are provided on the Station card. They are designated and located on the front edge of the card.

TP1 - "LINK B".

TP2 - "SYNC".

TP3 - "RB DATA".

TP4 - "I SEND".

TP5 - "+QUAD".

TP6 - "DATA TX".

TP7 - "-QUAD".

TP8 - "DXP DATA".

TP9 - "GRD". Reference *(0 volts)*.

TP10 - "A" PORT.

Fuses and LED's *(See figure 12)*

As shown on figure 12, there are 3 fuses and 4 LED's. The -25V and +25V LED's monitor the ±25 volt power sources on the card. There is no LED indicator for F3 which is the -10V source. Two additional LED's, LPS and HLS are busy indicators for the Link port or the Hot line port, respectively.

A short between the A and B pairs of the quad will blow fuses on the Station card. Review paragraph 13.10e and figure 19.

If a problem appears to be related to a station card/station set combination, swapping the station card or the station set should

verify which circuit appears to be at fault, *after the quad has been checked.*

If a problem appears to be related to a specific Station card, and the fuse indicators are lit, fuse F3 should be checked. If F3 is not blown, the problem location can be verified by swapping the card with another card in the system. If the trouble travels with the card, it should be replaced. If any fuse, F1, F2 or F3 is blown, a thorough inspection of the card should be made for wire clippings, some sort of short circuit or component leads touching each other. If a replaced fuse opens a 2nd time, the card should be replaced.

DO NOT substitute fuses with different ratings when fuse replacement is necessary.

If problems are encountered in any of the optional features provided by the card, tables 3, 4 and 5 should be reviewed and the switches S1, S2 and S3 checked for proper orientation before replacing the card.

i) Page Card
(See paragraph 8.37 and fig. 13)

The Page card provides all the functions required for paging to all the station sets and external paging zones. Circuitry is provided for either amplified, or non-amplified *(externally)*, outputs in each of the 5 zones.

Two 2-watt amplifiers are provided which may be used in any 2 of the 5 zones. These amplifiers will provide sufficient power to drive 1 8-ohm loudspeaker in each zone. The outputs are strapped to the B4 block, clips 39 through 48 *(see table 1)*.

An additional 600 ohm output, which requires external amplification, is provided for each zone. These outputs appear on the B4 block, clips 29 through 38 *(see table 1)*.

The Page card also provides circuitry for C.O. audible. Paging will override any C.O. audible in progress.

When background music is provided, paging will override the BGM to internal stations only.

There are no test points on the Page card.

There are 4 potentiometers not shown in figure 13. These pots are shown in figure 22. These pots are:

- All-call level to stations and the 600 outputs *(R158)*;
- All-call level to both 2 watt amplifiers *(R145)*;
- External page level for the 2-watt amplifier #1 *(R144)*;
- External page level for the 2 watt amplifier #2 *(R146)*.

These pots are factory adjusted and should not need adjustment in the field.

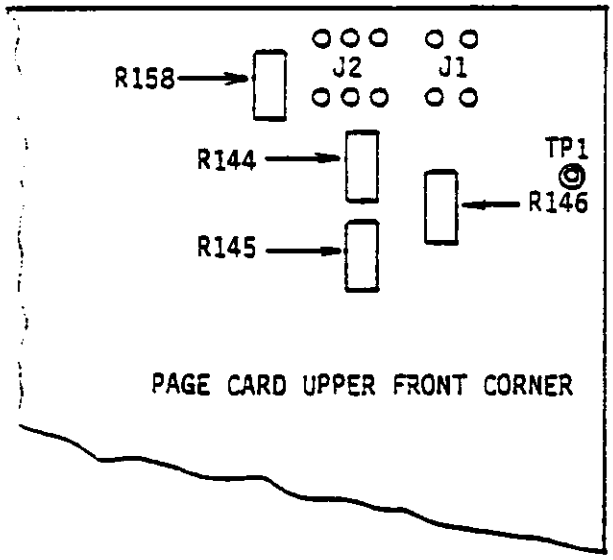


Figure 22

Page Card All-Call & 2-Watt Level Control Potentiometer Locations

Fuses and LED's (*See figure 13*)

As shown in figure 13, there are 2 fuses and 2 fuse indicator LED's. The fuses and LED's are for the ±25V power sources on the card.

If a problem appears to be related to the Page card, and the fuse indicators are lit, the card should be replaced. If a fuse is blown, a thorough inspection of the card should be made for wire clippings, some sort of short circuit or component leads touching each other. If the replaced fuse opens a 2nd time the card should be replaced.

j) Input/Output Card (I-O)

The I-O card contains all the input terminals and connections to the power supply. Fuses are provided for all the power busses within the system. In the upper right corner of the I-O board are the power distribution points for the -25, +25 and -10 volt lines to the system. These points are designated on the I-O board. There are no "test points" on this board. See figure 4.

13.26 Troubleshooting - Station Set

13.27 The EK-2040 key telephone set is a micro-computer controlled telephone which functions in unison with the micro-computer controlled station card. Data transfer between the station set and the station card is via the quad. Refer to paragraphs 13.13 through 13.24 and figures 19 and 21.

13.28 The micro-computer in the station set implements the commands received from the station card processor and transmits to that processor any change in status of the station set on a real time basis.

13.29 If a problem appears to be related to a station card/station set combination, swapping the station card or the station set should verify which circuit appears to be at fault, after the quad has been checked.

13.30 If swapping circuits makes the station set suspect, it should be replaced unless the problem can be related to one of the six plug-in assemblies within the set, as detailed in the following paragraphs. If a fault is found to be within the printed circuit board of the set, the entire set should be replaced.

13.31 The station set is modular in design, in that it contains 6 plug-in assemblies:

- Handset
- Dial
- Loudspeaker
- Microphone
- Hookswitch assembly
- 1 Keystrip assembly

13.32 The line cord and handset cord modular jacks are spade-tip ended and plug-in to spade-tip connectors on the P.C. board.

13.33 Figure 23 shows the layout of the P.C. board with the connector locations for all plug-in assemblies.

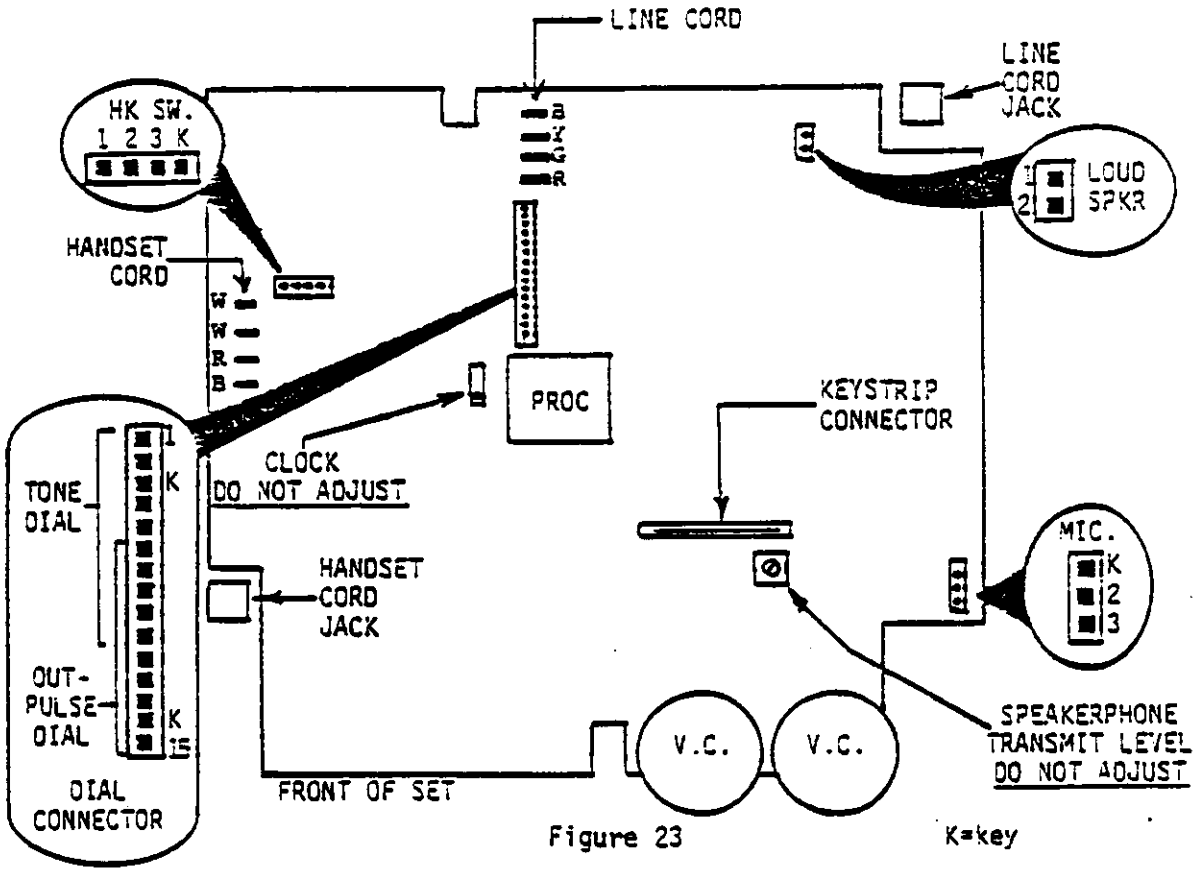


Figure 23

STATION SET COMPONENT REPLACEMENT CONNECTORS

On the P.C. board are 2 potentiometers (see figure 23). These pots are factory adjusted and should not be adjusted in the field.

13.34 Figure 19 shows how the station set is connected to the station card through the quad inside wiring cable. It should be noted that shorts within the quad may blow the fuses on the station card.

13.35 To replace any of the plug-in assemblies in the station set, proceed as follows:

a) Remove the front panel of the set by inserting a screwdriver under the lower edge of the panel at the corners and prying up.

Remove the upper set housing by loosening the captive screw in the front lower center of the housing. This exposes the entire printed circuit board.

b) To remove the handset or line cord modular connectors (*not equipped in early sets*), unplug the spade-tips from their connectors and remove the modular jack. Refer to figure 23.

c) To remove the dial, unplug the dial from its connector. Note the position of the dial connector in its socket (*tone and Outpulse dials are different*). Loosen the dial mounting screws at the TOP of the dial mounting brackets and remove the dial. Install in reverse order.

d) To remove the loudspeaker, un-

plug the speaker from its connector. Remove the 2 screws which secure the speaker. Install in reverse order.

e) To remove the microphone, unplug the mike from its connector. Lift the mike, with its rubber boot out of the holding slot. Install in reverse order, noting the position of the key in the microphone connector.

f) To remove the hookswitch assembly, unplug the assembly from its connector. Remove the screw which secures the assembly to the P.C. board. Replace in reverse order, noting the position of the key in the hookswitch connector.

g) To remove the keystrip assembly, disengage the front tabs by pressing rearward while lifting the front of the assembly upward. Slide the assembly to the left with an upward motion. Disconnect the ribbon cable. To install the assembly, insert the ribbon cable into its connector. Insert the rear tabs into the cutouts in the base of the set. Slide the complete assembly to the right. Press front tabs rearward to engage the front tabs in their slots.

13.36 To replace the upper housing, make sure that the loudspeaker is plugged in, then, with the rear tab of the housing in its slot (*center rear of set*), close the housing and tighten the retaining screw. Replace the front panel by inserting the tabs into the top slots and pushing down on the lower part of the panel.

13.37 Troubleshooting - DSS Console

13.38 The DSS Console may be considered as an expansion of the DSS station set. It is connected via a quad to the DSS-A and DSS-B Control cards in the KSU.

13.39 The DSS Console contains two micro-computers. These computers function in unison with the micro-computers located on the DSS-A and DSS-B cards. One computer works with the DSS-A Control card to implement the functions of the 1st 28 DSS keys. The 2nd computer works with the DSS-B card to implement the functions of the last 28 DSS keys.

13.40 Data transfer, via the quad, between the DSS A & B cards is accomplished using the same type word format as the station card/station set combination. The micro-computer in the DSS Console implements the commands received from the DSS card computer and transmits to that processor any change of status (*key depression*) of the console on a real time basis.

13.41 The DSS-A Control card utilizes the GN/RD pair of the quad and the DSS-B card uses the BK/YL pair.

A shorted pair of the DSS quad will blow the fuses on the DSS Control card.

13.42 If a problem appears to be related to the DSS Console/DSS card combination, swapping the DSS A & B cards should verify which circuit appears to be at fault, after the quad has been checked. If the system is not equipped with DSS B cards, or two DSS Consoles, replacement of one or the other will be required to verify which circuit is at fault.

13.43 If swapping or substitution makes the DSS Console suspect, it should be replaced unless the problem can be related to one of the keystrip assemblies within the console. If a fault is suspected to be on the P.C. board of the console, the console should be replaced.

13.44 The DSS Console is modular in design, in that it contains plug-in assemblies for replacement purposes. The keystrip assembly and the line cord simply plug-in for easy replacement. Figure 23A shows the layout of the P.C. board and the connector locations for the keystrips and the line cord.

On the console P.C. board are 2 potentiometers (see figure 23A). These pots are factory adjusted

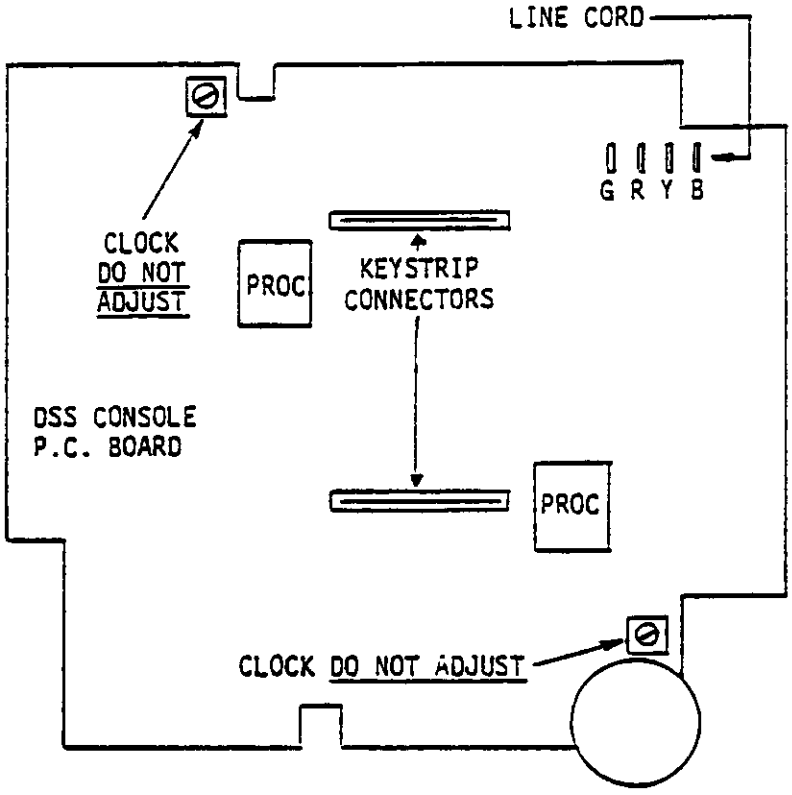


Figure 23A - DSS Console Component Replacement Connectors

to set the processor timing functions of the console and MUST NOT be adjusted in the field.

13.45 To replace a keystrip assembly in the console, proceed as follows:

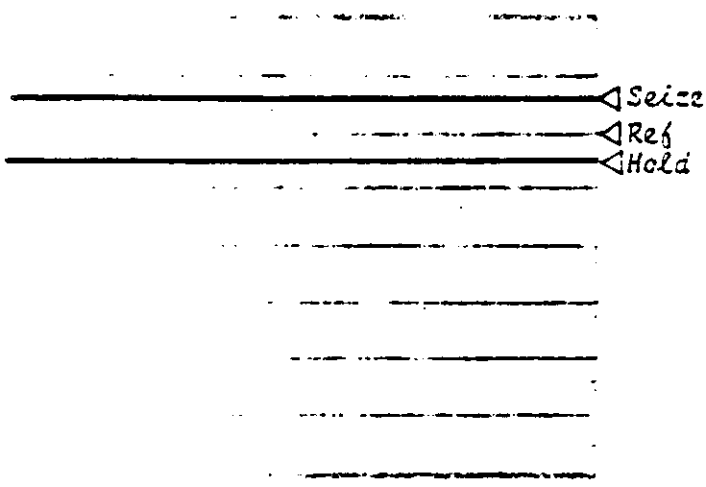
a) Remove the front panel of the console by inserting a screwdriver under the lower edge of the panel at the corners and prying up.

b) Remove the upper console housing by loosening the captive screw in the front lower center of the housing. This exposes the entire P.C. board assembly.

c) To remove a keystrip assembly, disengage the front tabs by pressing rearward while lifting the front of the assembly upward. Slide the assembly to the left with an upward motion. Disconnect the ribbon cable. To install the assembly, insert the ribbon cable into its connector. Insert the rear tabs into the cutouts in the base of the set. Slide the complete assembly to the right. Press front tabs rearward to engage the front tabs in their slots.

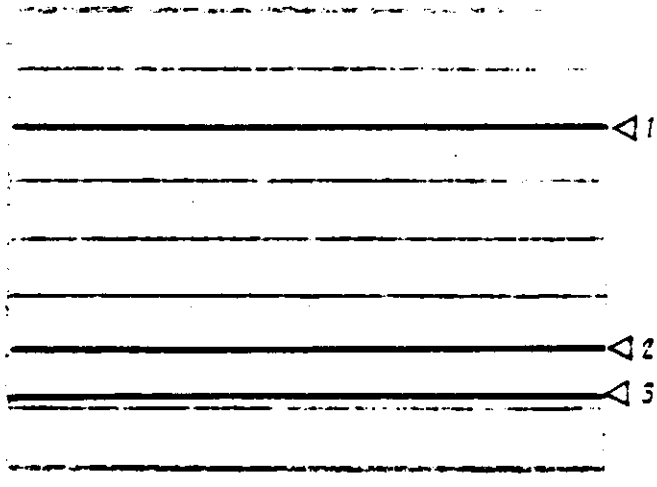
d) To remove the line cord, unplug the spade-tips from their connectors. To install a new line cord, refer to figure 23A for location of each colored cord lead and insert them into their connector. Dress the cord through the entrance hole and push the strain-relief hook down on the strain-relief tab adjacent to the hole.

13.46 To replace the upper housing, insert the rear tab of the housing into its slot (*center, rear of set*) and close the housing. Tighten the retaining screw. Replace the front panel by inserting the tabs into the top slots and pushing down on the lower part of the panel.



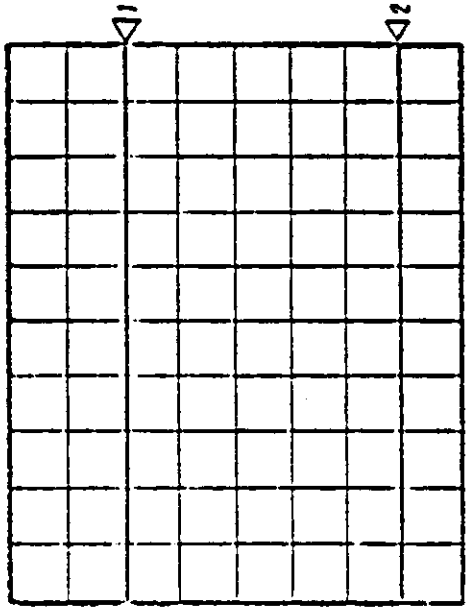
Circuit Card: Line Card
Test Point: TP1 Reference Point: T.Gen. TP1
Volts/Div: .2V Time/Div: 5 msec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☑ Norm ☐ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *Modulated voice signal present when seized and voice is present.*

Figure 24A - Current Level from Sta.Card



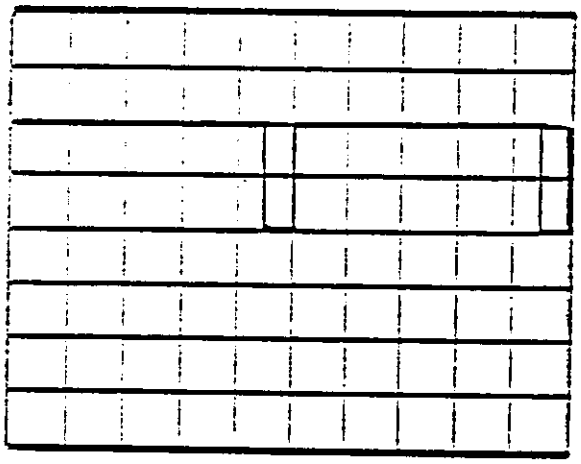
Circuit Card: Line Card
Test Point: TP2 Reference Point: T.Gen. TP1
Volts/Div: 2V Time/Div: 5 msec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☑ Norm ☐ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *1=gnd 2=seized 3=idle or hold*

Figure 24B - Voltage Drop from Sta. Card



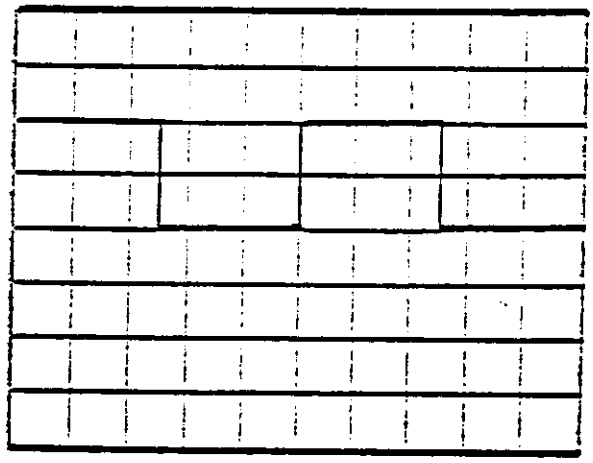
Circuit Card: Line Card
Test Point: TP3 Reference Point: T.Gen. TP1
Volts/Div: 1V Time/Div: 0.2 sec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☑ Norm ☐ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *1=Ref. & Seized 2=Hold*

Figure 24C - $\overline{\text{HOLD}}$ Pulse



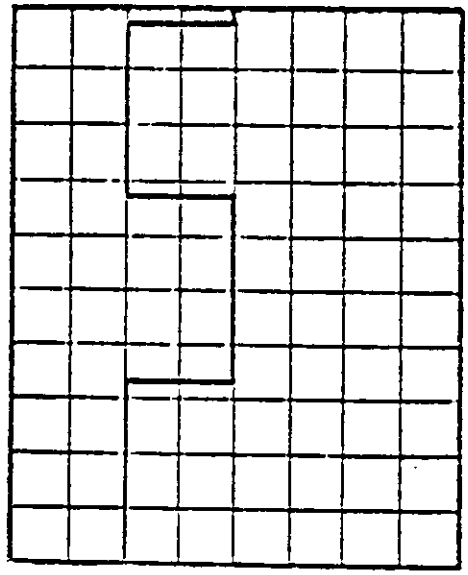
Circuit Card: Tone Generator
Test Point: TP3 Reference Point: TP1
Volts/Div: 2V Time/Div: 0.1 sec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☐ Norm ☑ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *500 msec duty cycle, 90/10 wink.*

Figure 25B - Hold Flash Rate (2Hz)



Circuit Card: Tone Generator
Test Point: TP4 Reference Point: TP1
Volts/Div: 2V Time/Div: 0.2 sec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☐ Norm ☑ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *1 sec duty cycle*

Figure 25C - Slow Flash Rate (1 Hz)



Circuit Card: Tone Generator
Test Point: TP2 Reference Point: TP1
Volts/Div: 2V Time/Div: 20 msec
10X Probe: Yes ☑ No ☐
Trigger Source: Line ☐ Int ☑ Ext ☐
External Trigger Source: _____
Trigger Mode: Auto ☐ Norm ☑ Sgl Sw ☐
Trigger Potential: Pos (+) ☑ Neg (-) ☐
Remarks: *125 msec duty cycle.*

Figure 25A - 1-Hold Flash Rate (8Hz)

TIE EK-3060/2040 KEY TELEPHONE SYSTEM

EK-3060 EXPANSION CABINET INSTALLATION

1.00 INTRODUCTION

1.01 This section provides the installation information required to expand the EK-2040 key telephone system to be a EK-3060 system. The material provided in this section supplements the information in section -1 and will only cover installation of the EK-3060 expansion cabinet.

2.00 GENERAL

2.01 The materials required to expand the capacity of the EK-2040 to 30 C.O. lines and/or 60 stations includes the following:

- 1 - EK-3060 Card Cage.
- 1 - EK-3060 Rear Enclosure.
- 1 - EK-3060 Front Cover.
- 3 - 50-conductor ribbon cable assemblies.
- 2 - 66M50 type quick-connect blocks.
- "B" bridging clips, as required.
- 2 - 25-pair female amphenol-ended tail cables with sufficient length to reach the quick-connect blocks.
- 1 - 25-pair amphenol-ended cable (male-female) to reach Telco RJ-21X.
- Tie-wraps and cable clamps, as required.
- Up to 10 C.O. Line cards.
- Up to 20 Station cards.
- Up to 20 Station sets.

2.02 Physical dimensions of the EK-3060 expansion cabinet are:

Height 15.1" (38.4 cm).
Width 24.0" (60.1 cm).
Depth 14.7" (37.3 cm).

2.03 A maximum of 10 C.O. lines and a maximum of 20 additional stations may be added to the EK-2040 system.

2.04 C.O. lines 21 through 30 are equipped in the expansion cabinet. Access codes for these lines are 921 through 930.

2.05 Stations 71 through 89 are equipped in the expansion cabinet. These stations are all in paging zone 5; accessed by dialling code 995 or All-call, code 996.

2.06 If the initial system was equipped with less than 17 C.O. lines and less than 30 stations, "B" link cards may not be equipped. "B" link cards must be installed to access stations 60 through 89 and C.O. lines 17 through 30.

3.00 EXPANSION CABINET INSTALLATION

3.01 The installation information in the following paragraphs assumes that the basic EK-2040 KSU has been installed in accordance with the information provided in section -1 of this manual.

3.02 Expansion Cabinet Mounting

3.03 Figures 1, 2 and 3 provide an aid to the installer for mounting and attaching the expansion cabinet to the basic KSU.

3.04 To install the expansion cabinet, proceed as follows:

TIE / COMMUNICATIONS, INC.
5 RESEARCH DRIVE
SHELTON, CT., 06484 (203) 929-7373

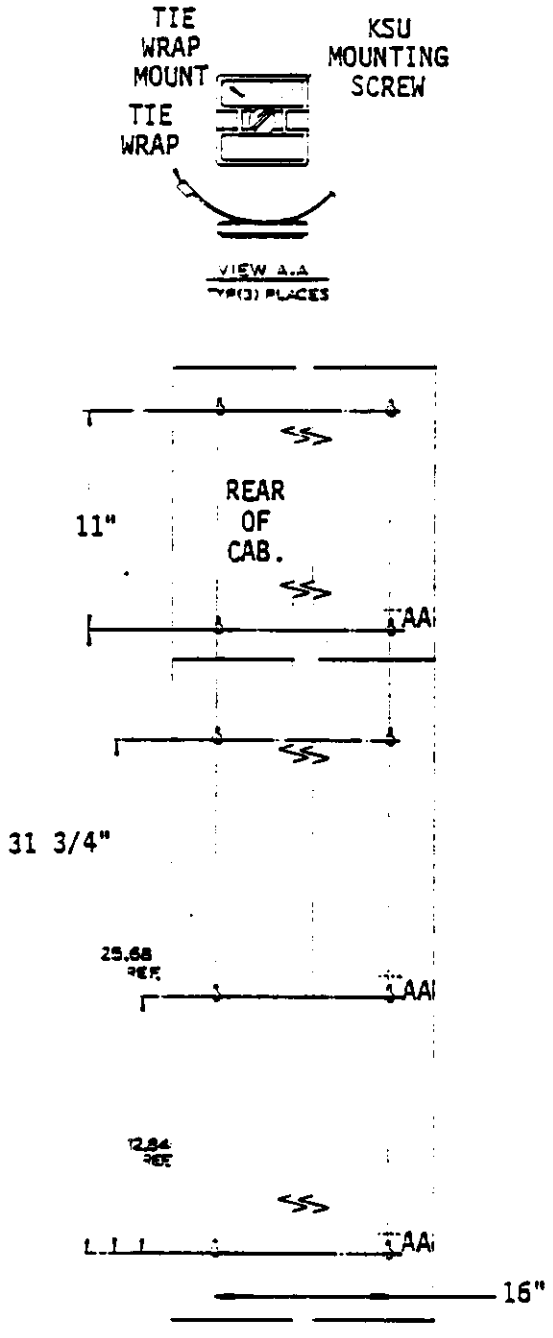


Figure 1

Wall Mount Template and Tie-wrap Detail

a) Using figure 1, locate and drill the mounting holes in the surface to which the expansion cabinet is to be mounted. If the basic KSU is already mounted, remove the expansion cage from the rear panel. Place the rear panel on top of the basic rear panel and mark the hole locations on the mounting surface.

A fully loaded expansion cabinet weighs approximately 35 pounds. This weight should not be entirely supported by the basic KSU.

b) After the mounting holes have been drilled for the expansion cabinet, secure the 2 rear panels together using 9 screws, flat washers, lock washers and nuts (*provided with exp. cab.*). Then secure the rear panel to the mounting surface with appropriate hardware for the mounting surface. A tie-wrap mount should be placed under the lower left mounting screw (*see figure 3*).

c) Remove the front and top covers from the basic card cage.

d) Reattach the expansion cage to the rear panel. Attach the two card cages together. 6 screws with flat washers, lock washers and nuts are used along the rear edge of the cages. 6 additional screws are used in the tapped holes on the sides of the cages.

e) Reattach the top cover, removed in step c, to the expansion card cage using the screws removed in step c.

f) After circuit card installation is complete, install the new, large front cover over both cages using the remainder of the screws from step c.

g) Plug the tail cable from the expansion I/O Panel into the inter-cabinet connector located at the top of the I/O Panel in the basic cabinet.

3.05 Three 50-conductor ribbon cables are required to connect the backplane wiring from the basic KSU to the backplane wiring of the expansion cabinet. These ribbon cables are provided with the expansion unit in three different lengths. Plug the ribbon cables into the connectors on the I/O Panels as follow (*see figure 3*).

a) The short cable (8 3/4") connects P01 of the basic I/O Panel to P14 of the expansion I/O Panel.

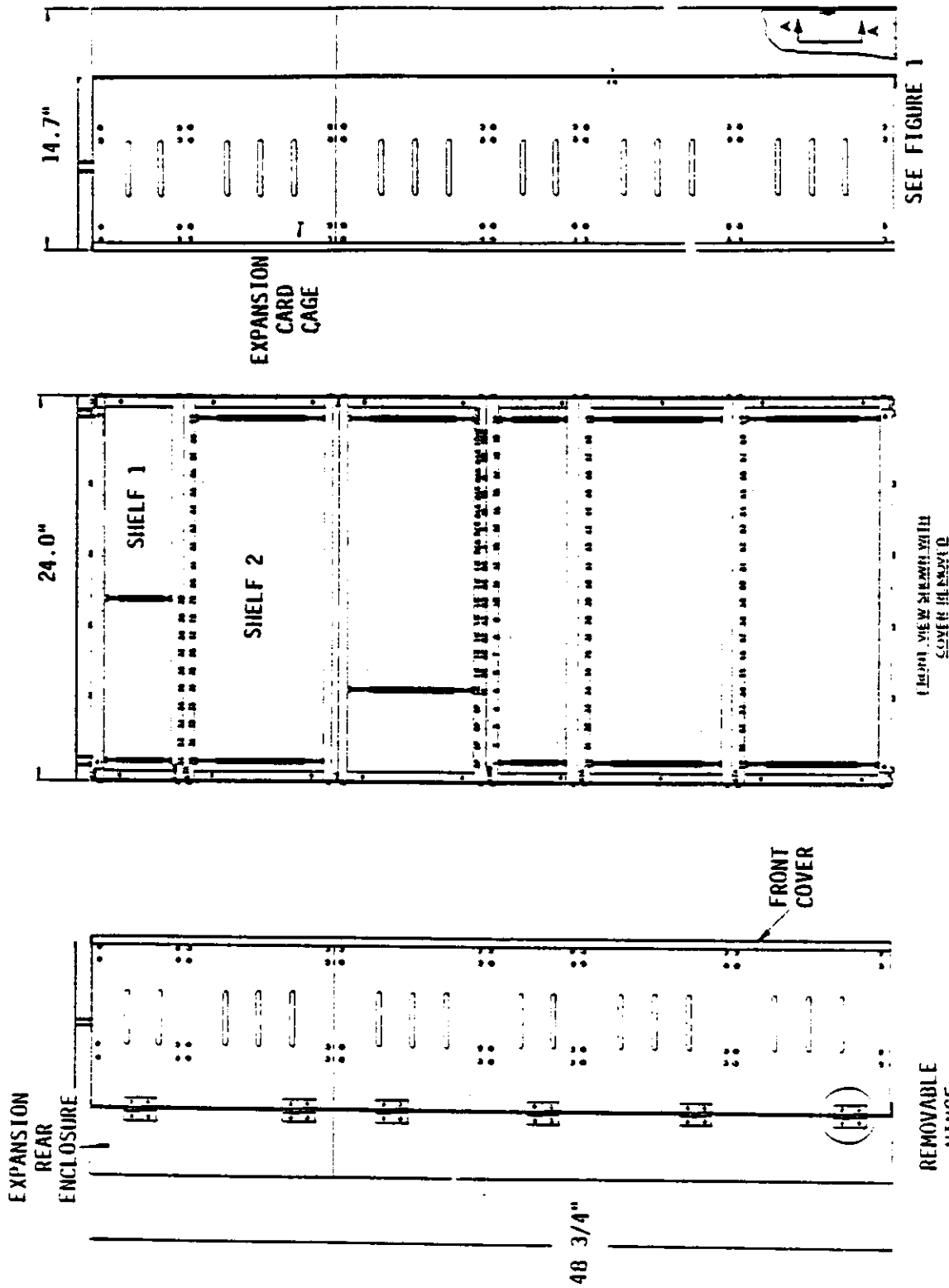


Figure 2 - EK-3060 KSU Cabinet Layout and Dimensions

b) The middle-size cable (*10 1/8"*) connects P02 of the basic I/O Panel to P13 of the expansion I/O Panel.

c) The long cable (*11 1/2"*) connects P03 of the basic I/O Panel to P12 of the expansion I/O Panel.

3.06 Station Block Mounting

3.07 Two additional station blocks are recommended for connection of the station quads (*70 through 89*) to the KSU. Connections for the quads 70 through 81 are on block 85 and connections for quads 82 through 89 on block 86.

3.08 It is recommended that the additional station blocks be used with "B" bridging clips as detailed in paragraph 7.23 and figure 6 of section -1.

3.09 On the back of the expansion cabinet swing-out gate (*figure 3*) are 3 Amphenol (*57 series*) type connectors for connection of the expansion cabinet tail cables. Connectors P15 and P16 should be cabled to the new B5 and B6 blocks. Table 1 shows the cable lead assignments for the connectors.

The top connector on the expansion I/O Panel (P17) MUST be cabled directly to the telephone company C.O. line terminations (USOC code - RJ-21X). The RJ-21X is an amphenol type connector which should be provided by the telephone company, to within 25-feet of the KSU, in accordance with FCC rules, part 68. P17 is a male connector.

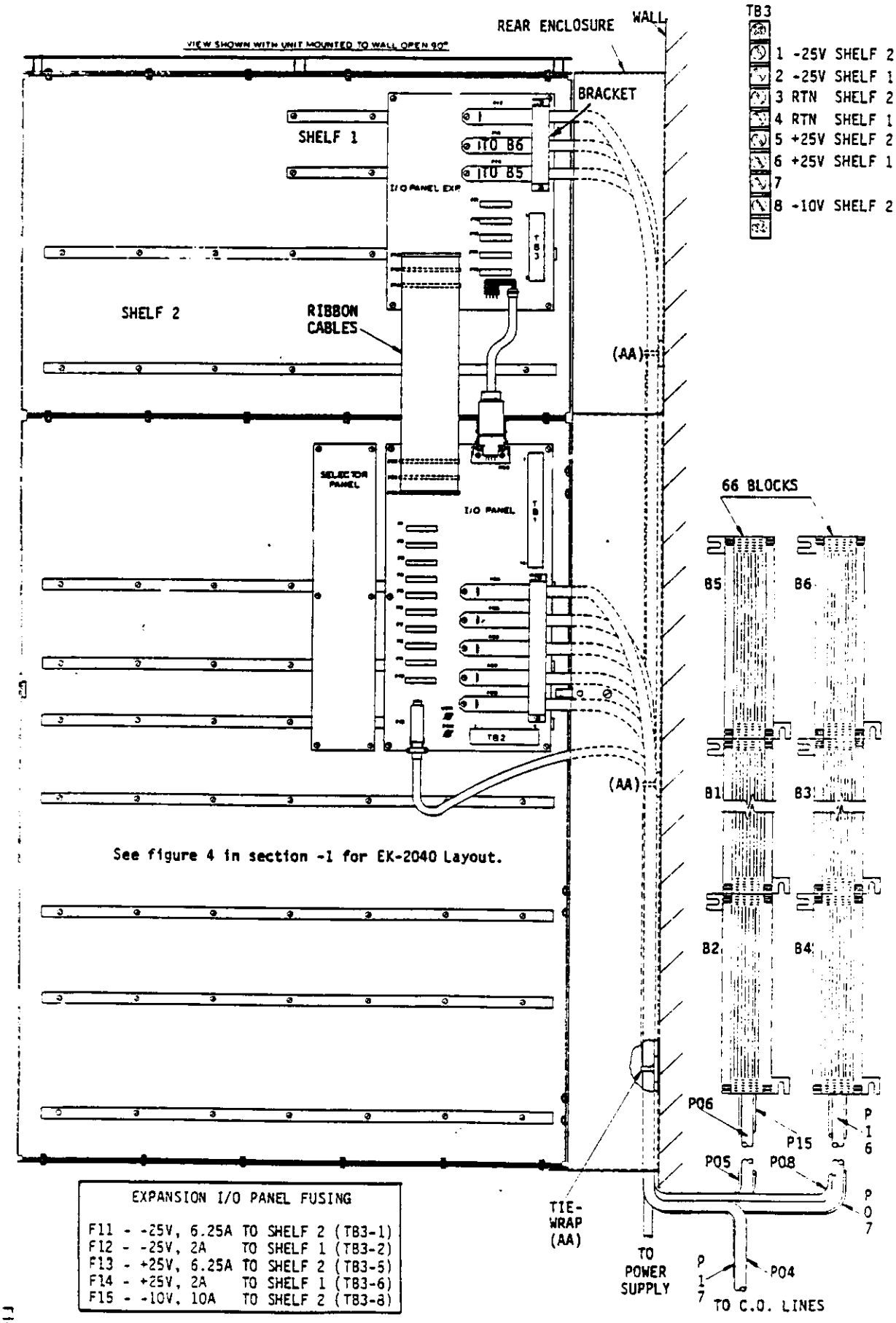
3.10 A bracket is provided to secure the tail cables before they exit the expansion cabinet. The cables should be tie-wrapped to prevent dislodging the connectors from their mates. Dress the cable loop for opening and closing the swing-out gate (*see figure 3 for tie-wrap locations*).

4.00 PLUG-IN CIRCUIT CARDS

Removal of power is not required for insertion or removal of circuit cards.

Table 1 - Tail Cable Conductor Assignments

TAIL CABLE			B5 BLOCK		B6 BLOCK		TO TELCO	
PLUG PIN	CABLE COLOR	CLIP	LEAD	DEST	LEAD	DEST	LEAD	DEST
26	WH-BL	1	GN	STA. 70	GN	STA. 82	T	C.O. 21
1	BL-WH	2	RD		RD		R	
27	WH-OR	3	BK		BK		T	C.O. 22
2	OR-WH	4	YL		YL		R	
28	WH-GN	5	GN	STA. 71	GN	STA. 83	T	C.O. 23
3	GN-WH	6	RD		RD		R	
29	WH-BR	7	BK		BK		T	C.O. 24
4	BR-WH	8	YL		YL		R	
30	WH-SL	9	GN	STA. 72	GN	STA. 84	T	C.O. 25
5	SL-WH	10	RD		RD		R	
31	RD-BL	11	BK		BK		T	C.O. 26
6	BL-RD	12	YL		YL		R	
32	RD-OR	13	GN	STA. 73	GN	STA. 85	T	C.O. 27
7	OR-RD	14	RD		RD		R	
33	RD-GN	15	BK		BK		T	C.O. 28
8	GN-RD	16	YL		YL		R	
34	RD-BR	17	GN	STA. 74	GN	STA. 86	T	C.O. 29
9	BR-RD	18	RD		RD		R	
35	RD-SL	19	BK		BK		T	C.O. 30
10	SL-RD	20	YL		YL		R	
36	BK-BL	21	GN	STA. 75	GN	STA. 87		
11	BL-BK	22	RD		RD			
37	BK-OR	23	BK		BK			
12	OR-BK	24	YL		YL			
38	BK-GN	25	GN	STA. 76	GN	STA. 88		
13	GN-BK	26	RD		RD			
39	BK-BR	27	BK		BK			
14	BR-BK	28	YL		YL			
40	BK-SL	29	GN	STA. 77	GN	STA. 89		
15	SL-BK	30	RD		RD			
41	YL-BL	31	BK		BK			
16	BL-YL	32	YL		YL			
42	YL-OR	33	GN	STA. 78				
17	OR-YL	34	RD					
43	YL-GN	35	BK					
18	GN-YL	36	YL					
44	YL-BR	37	GN	STA. 79				
19	BR-YL	38	RD					
45	YL-SL	39	BK					
20	SL-YL	40	YL					
46	VI-BL	41	GN	STA. 80				
21	BL-VI	42	RD					
47	VI-OR	43	BK					
22	OR-VI	44	YL					
48	VI-GN	45	GN	STA. 81				
23	GN-VI	46	RD					
49	VI-BR	47	BK					
24	BR-VI	48	YL					
50	VI-SL	49						
25	SL-VI	50						



EXPANSION I/O PANEL FUSING		
F11 - -25V, 6.25A	TO SHELF 2	(TB3-1)
F12 - -25V, 2A	TO SHELF 1	(TB3-2)
F13 - +25V, 6.25A	TO SHELF 2	(TB3-5)
F14 - +25V, 2A	TO SHELF 1	(TB3-6)
F15 - -10V, 10A	TO SHELF 2	(TB3-8)

Figure 3. EK-3060 Expansion net and Quick-connect Block Wiring Arrangement

4.01 C.O. Line Cards

4.02 Refer to paragraphs 8.02 through 8.06 in section -1 for C.O. Line card installation details. Figure 2 in this section shows the expansion cabinet card layout.

4.03 Station Cards

4.04 Refer to paragraphs 8.34 through 8.36 for Station card installation details.

5.00 MAINTENANCE

5.01 Paragraphs 13.00 through 13.46 in section -1 provide maintenance details for the KSU, all plug-in circuit cards, the station sets, and the DSS console. Refer to those paragraphs if a problem is encountered when installing the expansion cabinet unless the problem appears to be related to the expansion cabinet fusing and power distribution.

5.02 Expansion Cabinet I/O Panel

5.03 The I/O Panel in the expansion cabinet contains all the backplane and power wiring connections from the basic cabinet. Fuses are provided (*+25V, -25V and -10V*) on the I/O Panel and also the power distribution terminals (*TB3*) for each shelf. Refer to figure 3 for fuse location, fuse ratings and power terminal locations.