CHAPTER 8

STATION INTERFACE GROUPS

8.1 INTRODUCTION

This chapter provides a functional description and maintenance procedures for the station interface groups.

8.2 FUNCTIONAL DESCRIPTION

This paragraph contains functional descriptions of the following:

- Coder PCA, decoder PCA, and interface motherboards
- Standard single-line interface group
- Long-loop single-line interface group
- Single-line off-premise extension (OPX) interface group
- Key telephone interface (KTI) group
- Electronic telephone interface (ETI) group

8.2.1 Coder PCA, Decoder PCA, and Interface Motherboards

Each interface group consists of a coder PCA, a decoder PCA, two to four interface PCAs, and an interface motherboard. This paragraph describes the function of the coder PCA, the decoder PCA, and the interface motherboard.

Interface groups translate analog voice or tone frequencies and data signals from stations or trunks into digital words; these digital words are transmitted and received on the intrashelf bus and the intershelf bus (ISB). Interface groups also translate the digital information on the intrashelf bus into analog signals that are transmitted to station equipment and trunks (Figure 8-1).

The 16-channel coder PCA converts samples of analog voice-frequency signals from external stations into a 12-bit digital word. This 12-bit word represents one encoded amplitude sample for a particular voice-frequency channel. The 16-channel decoder PCA converts 12-bit digital words on the intrashelf bus into analog equivalents that are sent to external stations or trunks via each interface PCA.

To connect two station or trunk groups in the CBX system, coder PCA transmit commands and decoder PCA receive commands are loaded into the connection table in the TDM network control group. The commands identify the shelf, slot, and channel of the two groups. When the coder PCA receives a transmit command via P2, it outputs the digital word to the intrashelf bus (Figure 8-2). When the decoder PCA gets a receive command, the digital word on the bus is input to the decoder PCA. The decoder PCA converts the digital word into analog values that are filtered to produce the original voice signal. The analog signal then is sent to the selected external station or trunk via the interface PCA (Figure 8-3).

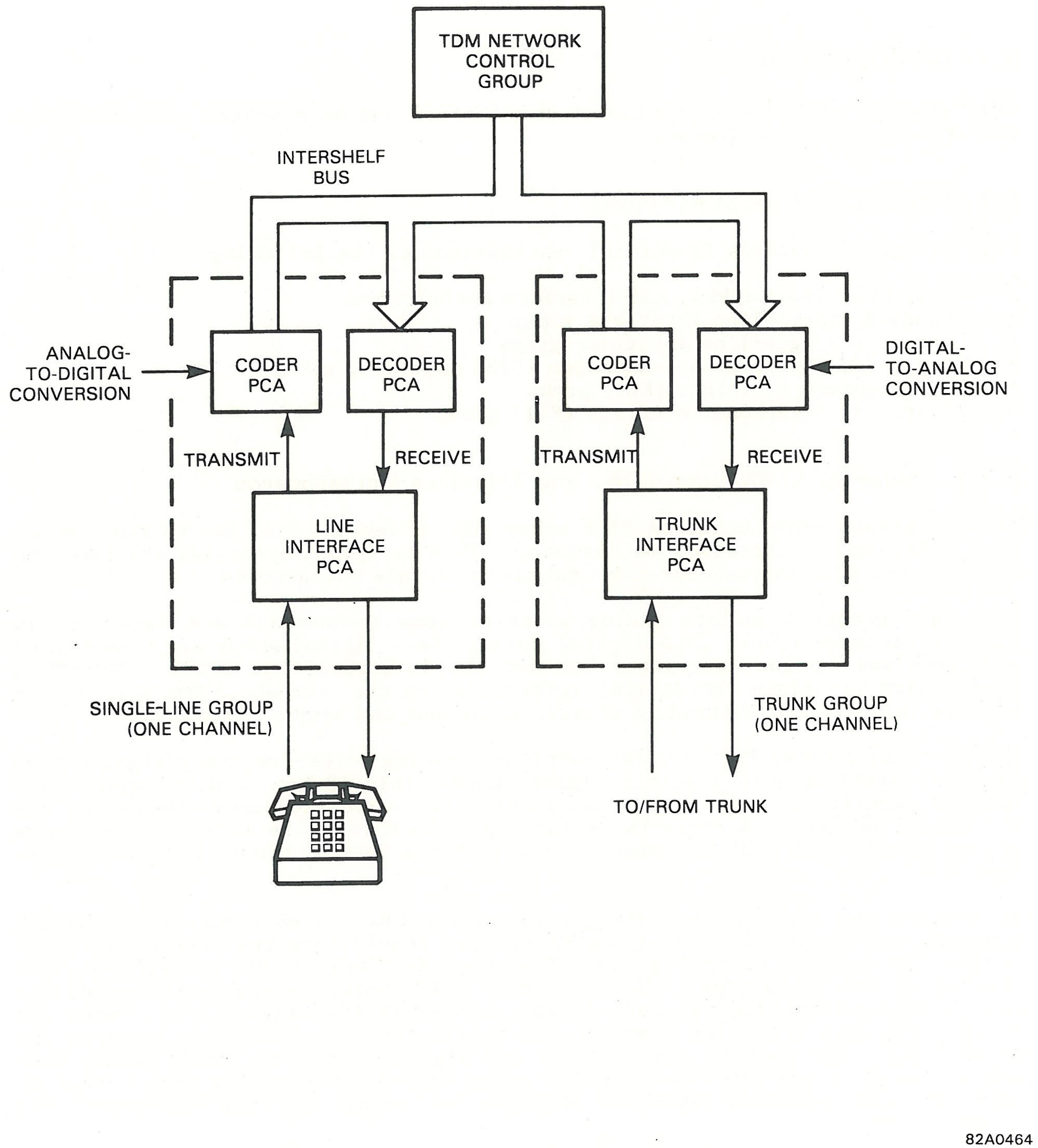


Figure 8-1. Interface Group Signal Flow

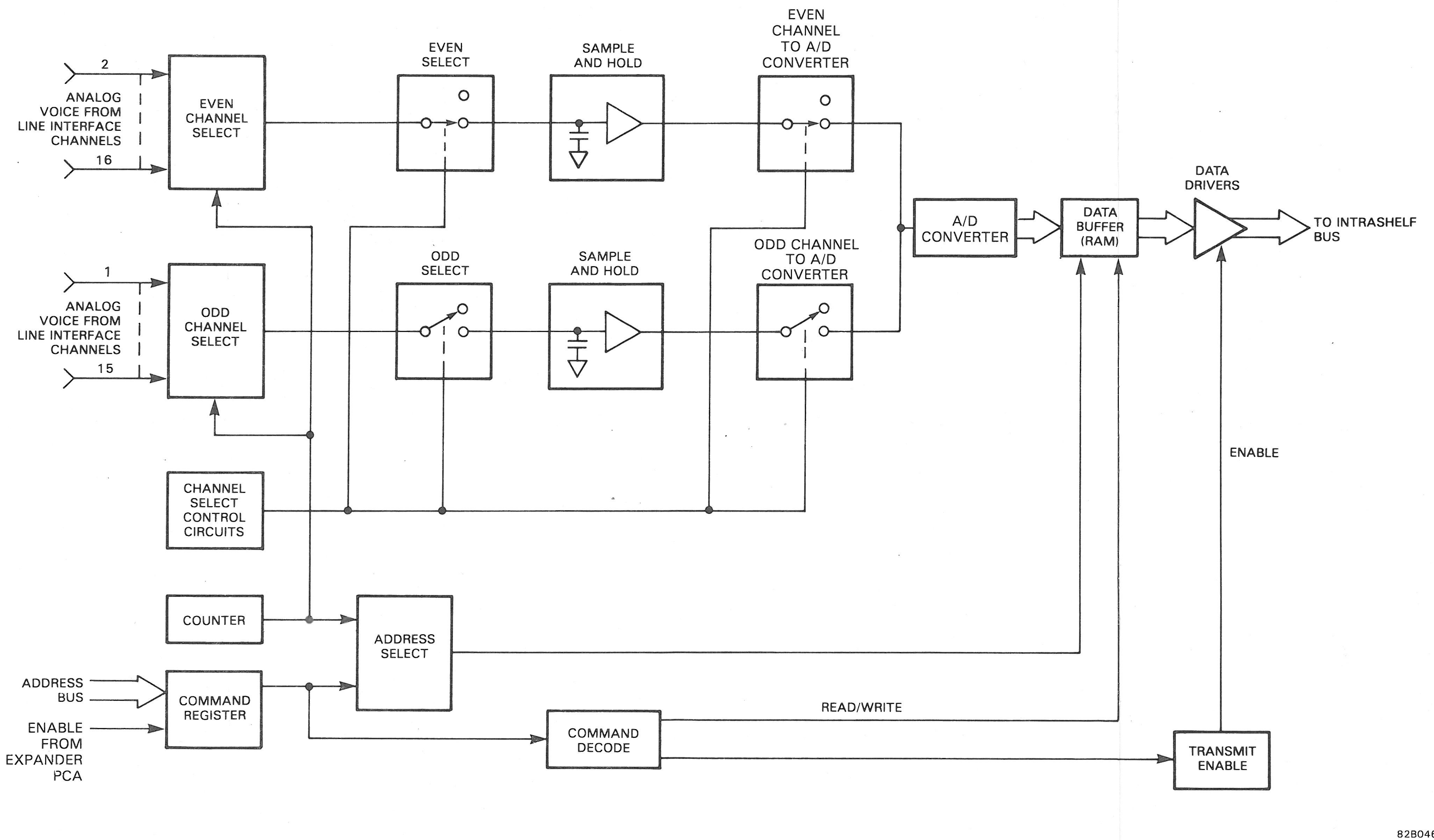


Figure 8-2. Coder PCA Block Diagram

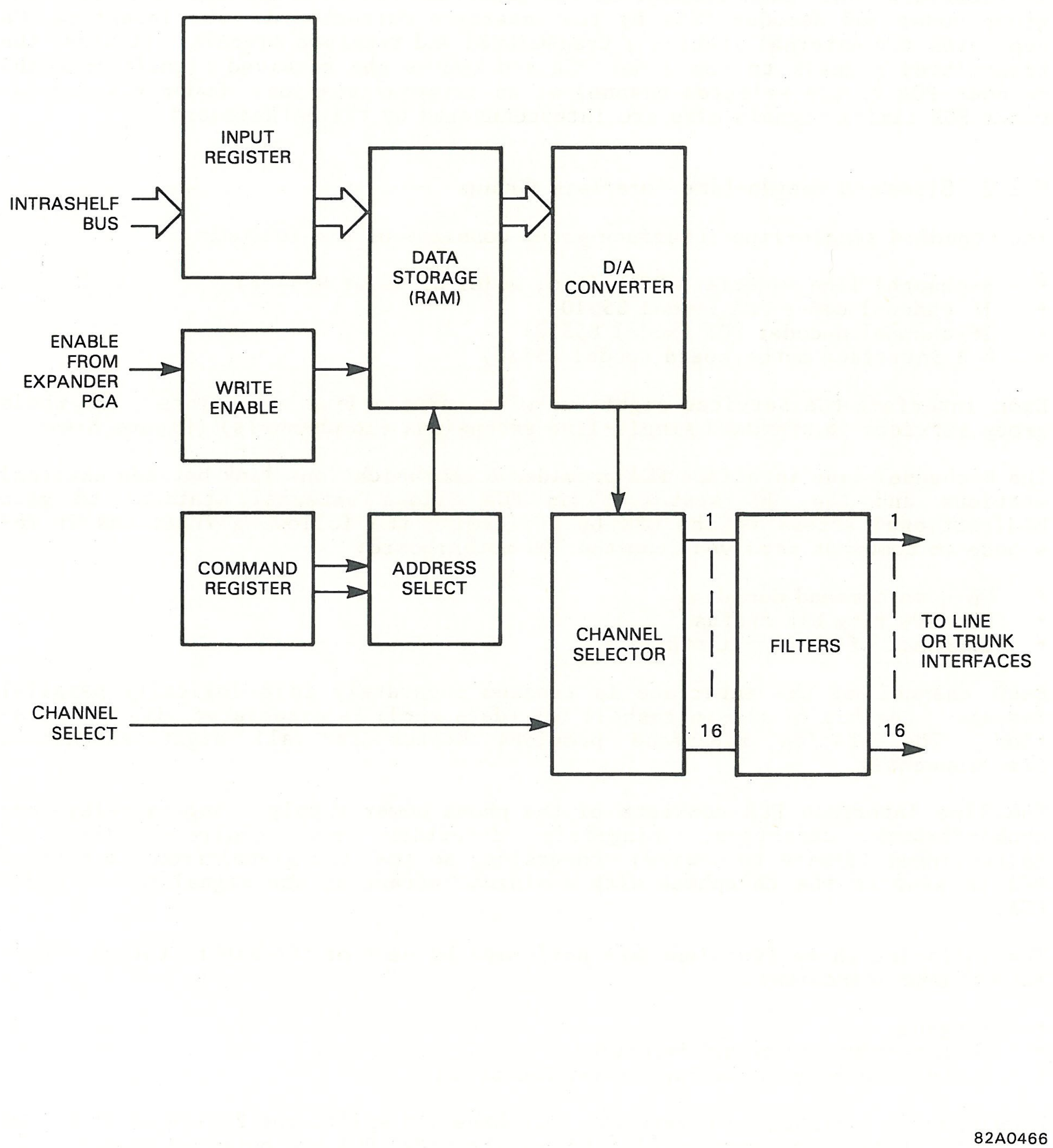


Figure 8-3. Decoder PCA Block Diagram

Each interface group contains an interface motherboard that interconnects the interface PCAs. The coder and decoder PCAs' bidirectional voice-frequency signals from external stations are connected to the interface motherboard by a 50-pin connector. The 4-1 and 6-1 motherboards use a single connector, and the 6-2 motherboard uses two connectors.

Each signal pair is connected by the interface motherboard to a channel input on an interface PCA. Each channel on the interface PCA is connected to or from the group coder and decoder PCAs by the interface motherboard. The interface PCA separates the external station's transmitted and received signals. It sends the transmitted signals to the coder PCA and routes the received signals from the decoder PCA to the selected channel of an external station. Coder PCA and decoder PCA timing signals also are interconnected by the motherboard.

8.2.2 Standard Single-Line Interface Group

The standard single-line interface group consists of the following:

- 8-channel line interface PCAs (two, model 85540 or 85540A)
- 16-channel coder PCA (model 85510)
- 16-channel decoder PCA (model 85520)
- 4-1 interface motherboard (model 85810)

Each interface PCA services eight two-wire, single-line extensions. The whole group services 16 standard single-line extensions (16 channels) (Figure 8-4).

The 8-channel line interface PCA provides a communications link between external stations and the CBX system. This PCA allows external stations to gain bidirectional access to the CBX by performing the following functions in response to commands received from the TDM motherboard:

- Up/down command decoding
- Receive ring bit status
- Transmit off-hook bit status

Each channel of the interface is treated separately in a logically parallel fashion. One bit of the intrashelf bus (data word) is associated with each station. The station interface provides status for all eight extensions simultaneously.

The line interface PCA consists of the phone power supply, ringing relay, on-hook/off-hook detection, ring-trip detection and bidirectional-to-unidirectional (2-wire to 4-wire) conversion, so that the signal from the decoder PCA is sent to the telephone with a minimal effect on the signal to the coder PCA.

The following three functions are performed by each of the eight station interface channel circuits:

- Ringing
- Dc loop-connection and detection
- Voice-frequency transmission and reception

Each channel continually powers the telephone and splits the 2-wire voice signal from the phone into incoming signals for the coder PCA and outgoing signals from the decoder PCA. When the ring bit is received, logic for the selected channel is enabled, and the telephone rings until an off-hook condition is detected or the ringing relay is opened by the hardware. Ringing consists of supplying 105 Vac rms 20 Hz to the station equipment. When the called party goes off hook, the

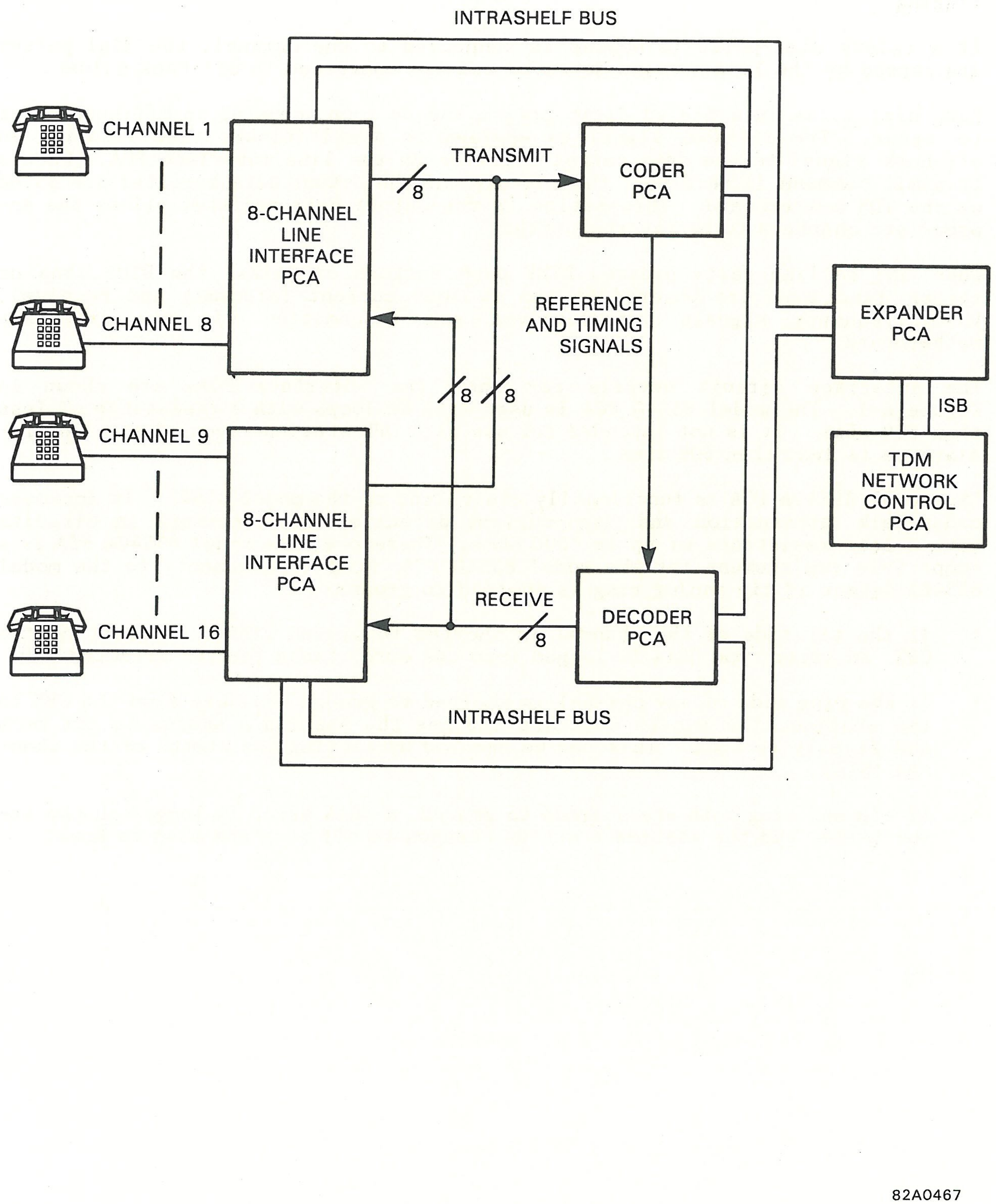


Figure 8-4. Single-Line Interface Group Signal Flow

CPU senses the off-hook condition and clears the ringing flip-flop, terminating ringing.

If a rotary dial-pulse telephone is connected to the channel, the dial pulses are sensed by the loop current detector and are converted to off-hook pulses.

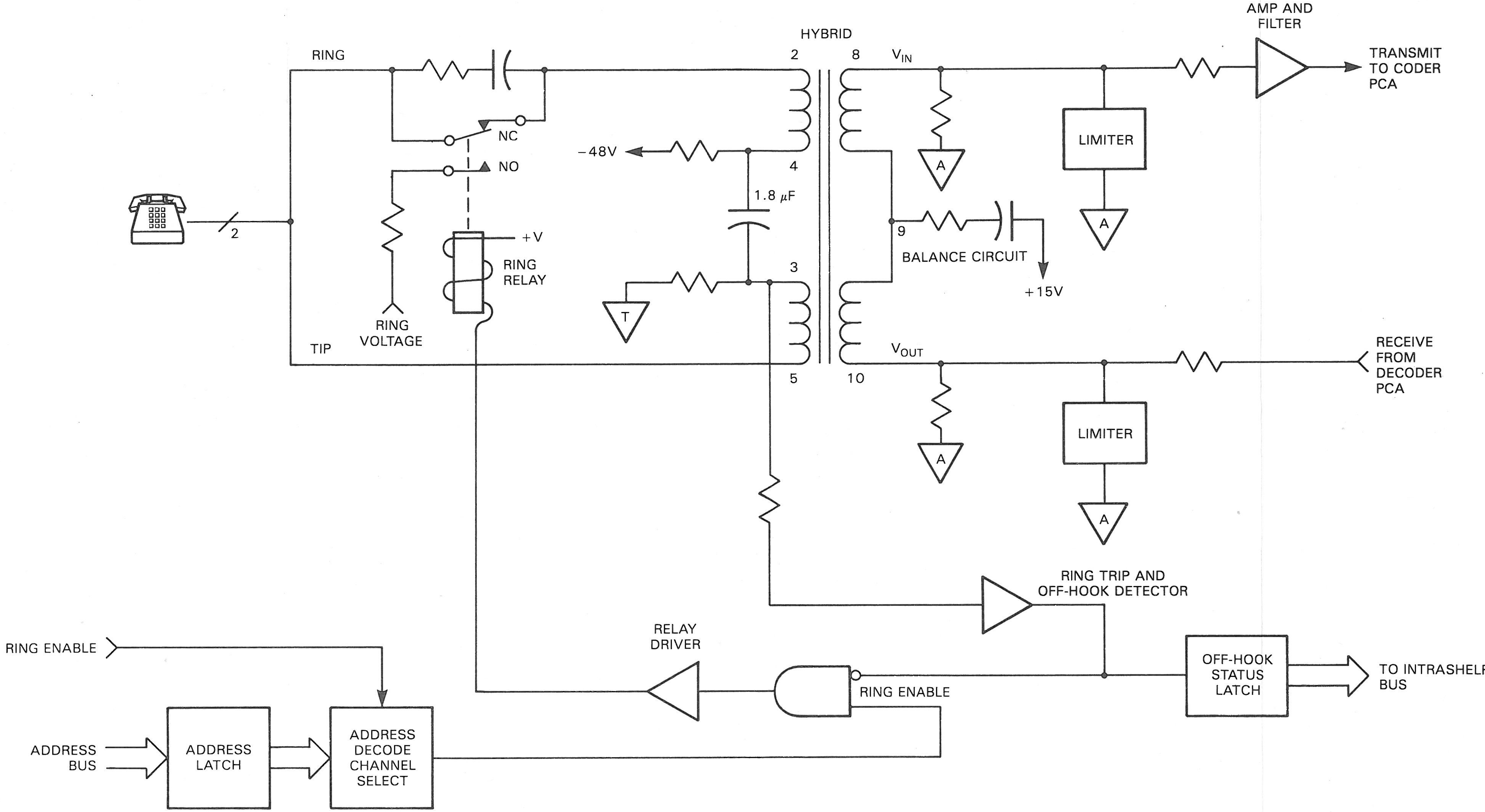
Each dial pulse in a dialed digit breaks the dc loop, causing an off-hook pulse to occur. The off-hook signal is applied to a multiplexer that supplies an off-hook signal to the data output register on the line interface PCA. When a transmit command is received, the contents of the output data register are gated on the TDM motherboard. Information in the output data register allows the appropriate channels to be interconnected.

When the calling party presses DTMF push buttons or talks, the DTMF tone or speech functions are powered by the dc loop current (transmit and receive). Voice-frequency signals are received and transmitted via the interface motherboard.

The interface circuit details for the line interface PCAs are shown in Figure 8-5. The model 85540 PCA is used with dc loops with a resistance of less than 600 ohms. It is not intended for use with OPX stations even if the loop resistance is less than 600 ohms.

The model 85540A PCA is functionally equivalent to the model 85540. It improves cross-talk attenuation and loop-current detection and functions in circuits with a loop resistance of up to 1200 ohms. Therefore, the model 85540A PCA is a compatible replacement for the model 85540 PCA. Some enhancements to the model 85540A detect if tip and/or ring is shorted to ground:

- If the tip side of the channel is shorted to ground within 450 feet of the CBX, an error type 0014 is logged into the error table for the affected PAD.
- If the ring side of any channel is shorted to ground anywhere from the CBX to the station, the system software changes the station's status to off hook and finally to howl. This can be checked by listing the status of the channel (STE).
- If tip and ring both are shorted to ground, a 0014 error is logged in the error table, and the station's status changes to off hook and then to howl.



NOTES: 1. (T) = TALK BATTERY GROUND (–48 VDC RETURN)

(A) = ANALOG GROUND

2. REFER TO CHAPTER 2 FOR 4-1 INTERFACE MOTHERBOARD J1 PINOUTS.

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Figure 8-5. 8-Channel Line Interface PCA Schematic Diagram (One Channel)

8.2.3 Long-Loop Single-Line Interface Group

The long-loop single-line interface group consists of the following:

- 4-channel line interface PCAs (four, model 85530)
- 16-channel coder PCA (model 85510)
- 16-channel decoder PCA (model 85520)
- 6-1 interface motherboard (model 85800)

The 4-channel line interface PCA is controlled via the intrashelf bus in the same way as the 8-channel line interface PCA. Ringing operation, off-hook detection, and voice-frequency paths are identical to those described for the 8-channel line interface PCA. The only difference between the PCAs, besides the number of channels serviced, involves supplying off-hook status bits (four bits per PCA instead of eight). The interface circuit details for the 4-channel line interface PCA are shown in Figure 8-6. This PCA is used with dc loops of up to 1200 ohms.

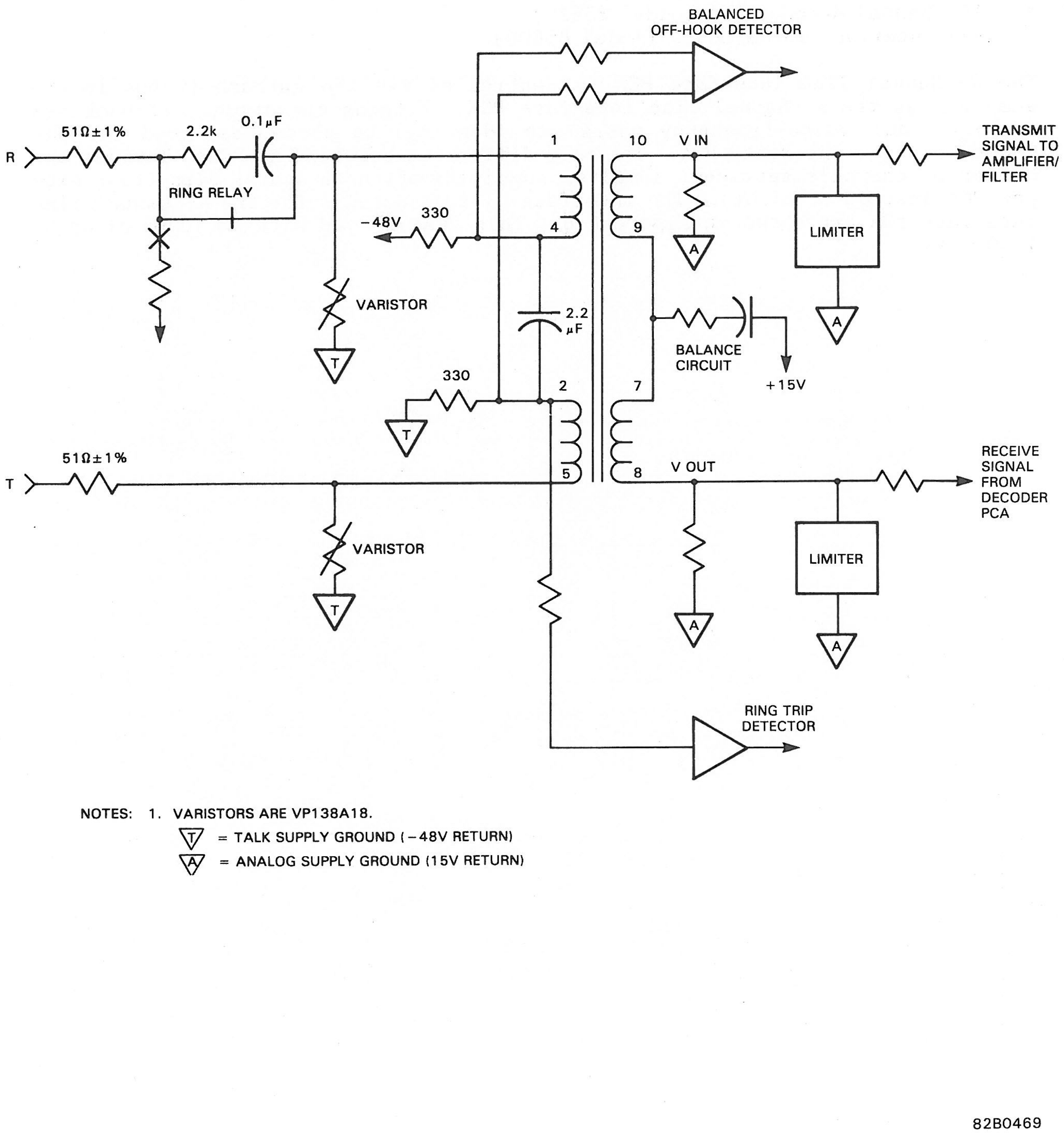


Figure 8-6. 4-Channel Line Interface PCA Simplified Schematic Diagram

8.2.4 Single-Line OPX or OPS Interface Group

The single-line OPX interface group consists of the following:

- 8-channel OPX line interface PCAs (two, model 85690) or 8-channel OPS line interface PCAs (two, model 85691)
- 16-channel coder PCA (model 85510)
- 16-channel decoder PCA (model 85520)
- 4-1 interface motherboard (model 85810)

NOTE

> Since May 1, 1983, the model 85691 8-channel OPS interface PCA has been shipped in all new systems in place of the model 85690 OPX PCA. The OPS PCA is FCC-registered and meets mandatory FCC regulations. The model 85690 OPX PCA has been re-registered with the FCC but has not been functionally modified.

The OPX and OPS interface PCAs differ only in transmission loss to the TDM bus. The OPS PCA has a 0 dB loss (FCC regulations) while the OPX PCA has a 2.5 dB loss. The system software must be configured to recognize the OPS PCA because all other line interface PCAs have a 2.5 dB loss.

CAUTION

OPS and OPX PCAs cannot be mixed in the same system. ROLM does not support OPS-to-OPX connections.

The OPX or OPS line interface PCA provides an interface between external stations, terminal equipment, and the system (Figure 8-7 and Figure 8-8). The PCA accommodates both standard and long-loop single lines. Long-loop is normally used for stations located off the premises.

The OPX or OPS interface group provides external stations with bidirectional access to the system by performing the following functions in response to commands received from the TDM motherboard:

- Ringing
- Dc loop connection and detection
- Voice-frequency transmission and reception
- Wink-off control

Each channel of the line interface PCA continually powers the telephone and splits the 2-wire voice signal from the phone into incoming signals for the coder PCA and outgoing signals from the decoder PCA. Station tip and ring leads are connected through the distribution frame to the terminal equipment (telephone set, dictation equipment). When the ring bit is received, logic for the selected channel is enabled and the telephone rings until an off-hook condition is detected or the ringing relay in the line interface PCA is opened by the software. Seizure is accomplished when the terminal equipment places a nominal 1,200-ohm loop across the tip and ring leads. When the called party goes off

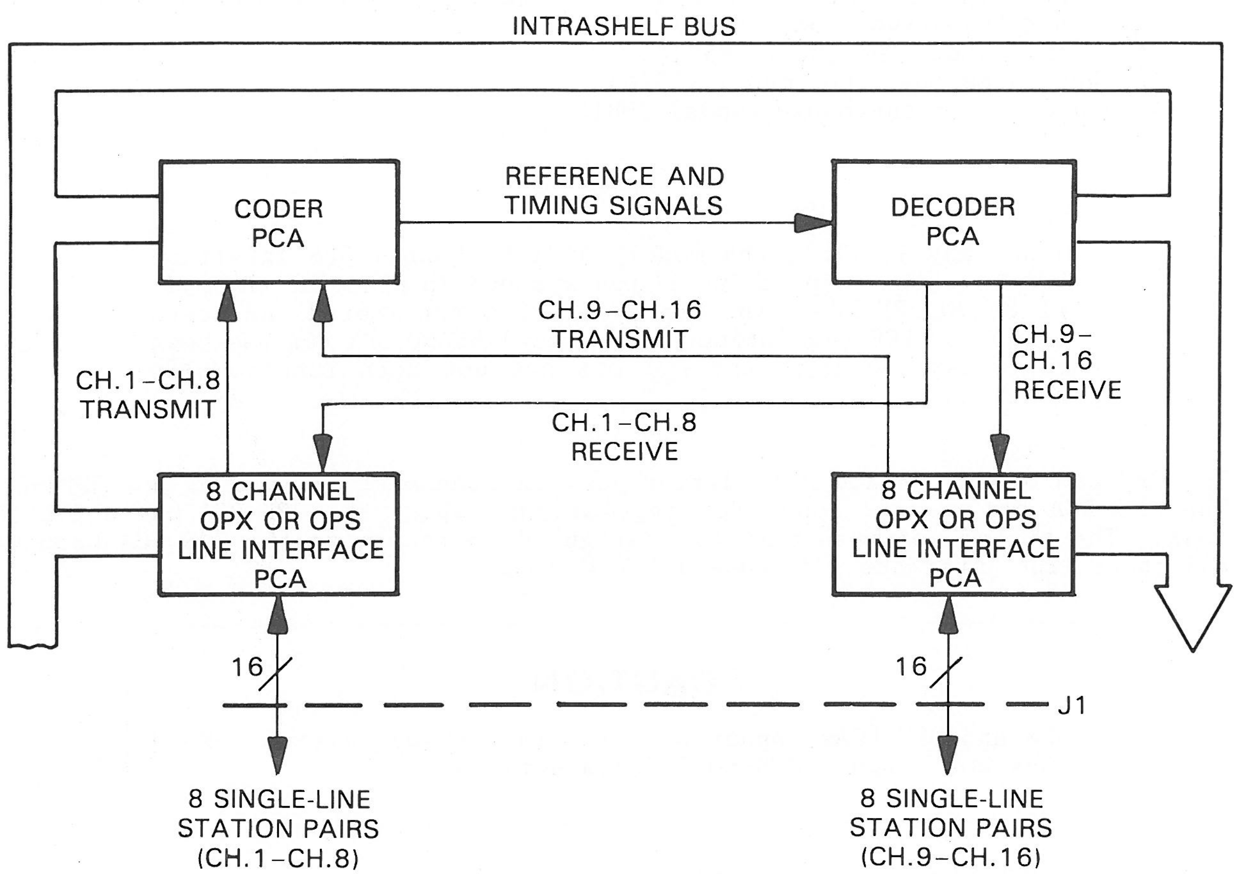
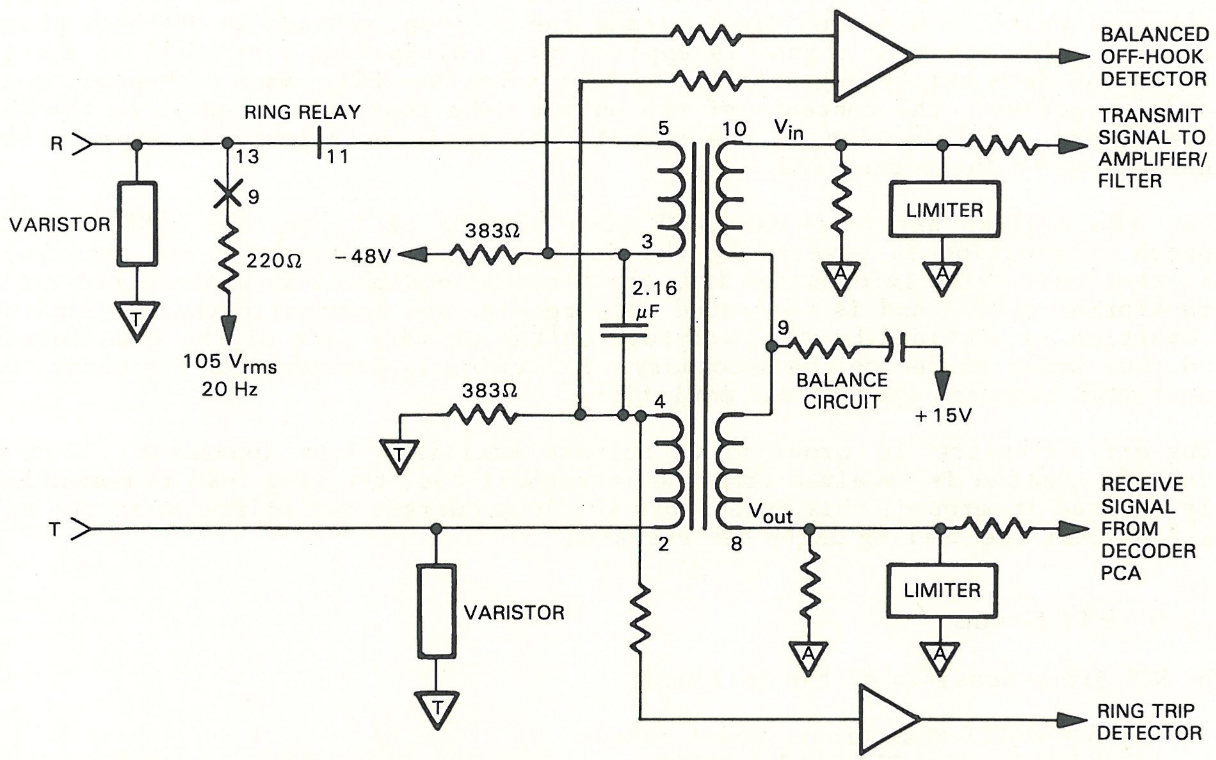


Figure 8-7. OPX or OPS Single-Line Interface Group Block Diagram



NOTES: 1. REFER TO CHAPTER 2 FOR TIP AND RING PINOUT INFORMATION AT MOTHERBOARD PLUG (J1).

2. VARISTORS ARE VP130A10.

3. (T) = TALK SUPPLY GROUND (-48V RETURN)

(A) = ANALOG SUPPLY GROUND (15V RETURN)

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Figure 8-8. Model 85690 8-Channel OPX Line Interface PCA Simplified Schematic Diagram hook, dc loop current flows. This is sensed by a dc loop-current detector in the line interface PCA, and the off-hook bit is set. The CPU senses the off-hook condition and clears the ringing flip-flop, which terminates ringing.

If a rotary dial-pulse telephone is connected to the channel, the dial pulses are sensed by the loop-current detector and are converted to off-hook pulses. Each dial pulse in a dialed digit breaks the dc loop, causing an off-hook pulse to occur. The off-hook signal is applied to a multiplexer that supplies a signal to the data output register on the line interface PCA. When a transmit command is received, the contents of the output data register are gated on the TDM motherboard. Information in the output data register allows the appropriate channels to be interconnected.

When the calling party presses DTMF push buttons or talks, the DTMF tone or speech information is powered by the dc loop current (transmit and receive). Bidirectional voice information from the terminal equipment is transferred via a transformer hybrid and is separated into receive and transmit paths. Transient protection is provided by two varistors on the primary side of the transformer and four Zener diodes on the secondary. Filtering is provided for the coder PCA input with standard operational amplifiers.

Wink-off circuitry is provided to release auxiliary line apparatus. When a wink-off command is received from the intrashelf bus, the ring lead is momentarily shorted to ground; this interrupts the loop current and indicates to the apparatus that the calling party has released.

8.2.5 KTI Group

The KTI group consists of the following:

- 4-channel KTI PCAs (four, model 85560)
- 16-channel coder PCA (model 85510)
- 16-channel decoder PCA (model 85520)
- 6-2 interface motherboard (model 85820)

The group (Figure 8-9) processes telephone traffic between the TDM network and up to 16 key telephone adapters (KTAs). Each KTI PCA can service four KTAs, each of which services a six-button or ten-button key telephone. The whole group services 16 KTAs. Each channel consists of two pairs: a standard voice-frequency pair and a serial data pair.

a. 4-Channel KTI PCA. The KTI PCA is controlled via the intrashelf bus by the following 5-bit commands:

- Receive data-channel X
- Transmit data-channel X
- Up PCA
- Down PCA

When the receive-data command is received, the data word from the intrashelf bus in loaded into the KTI PCA. The word may represent a lamp command or a ringing command. A lamp command contains a button address for the particular key telephone button lamp and flash code: on, wink, flash, or off. A ringing command represents one of the following conditions: ring 1, ring 2, ring off, buzzer, test, or reset. Two ring cadences are available (ring 1 and ring 2), plus a separate buzzer command.

The following are the main functions of the four channels:

- Ringing
- Dc loop connection and detection
- Voice-frequency transmission and reception

Each channel of the station interface continually powers the telephone and splits the 2-wire voice signal from the telephone into incoming signals for the coder PCA and outgoing signals from the decoder PCA. When the ring bit is received via the TDM motherboard along with a receive command, the ringing logic for the selected channel is enabled. The telephone then rings until an off-hook condition is detected or the ringing relay in the interface is opened by the hardware. When the called party goes off hook, dc loop current flows. The current is sensed by a dc loop current detector in the interface. The CPU senses the off-hook condition and clears the ringing flip-flop, terminating ringing.

The KTI PCA contains hybrid circuits similar to those used with single-line channels for converting the 2-wire voice input to the 4-wire scheme required by the coder/decoder side of the PCA. It also contains logic for reading key telephone line status and writing information into the KTA. The KTI PCA supplies talk battery to the key telephone, detects off-hook conditions, and provides status polling for each of its four channels.

A parallel-to-serial and serial-to-parallel converter on the PCA formats the data as required by its transmit direction. Toward the KTA, serial format is required, and toward the TDM network, parallel format is required.

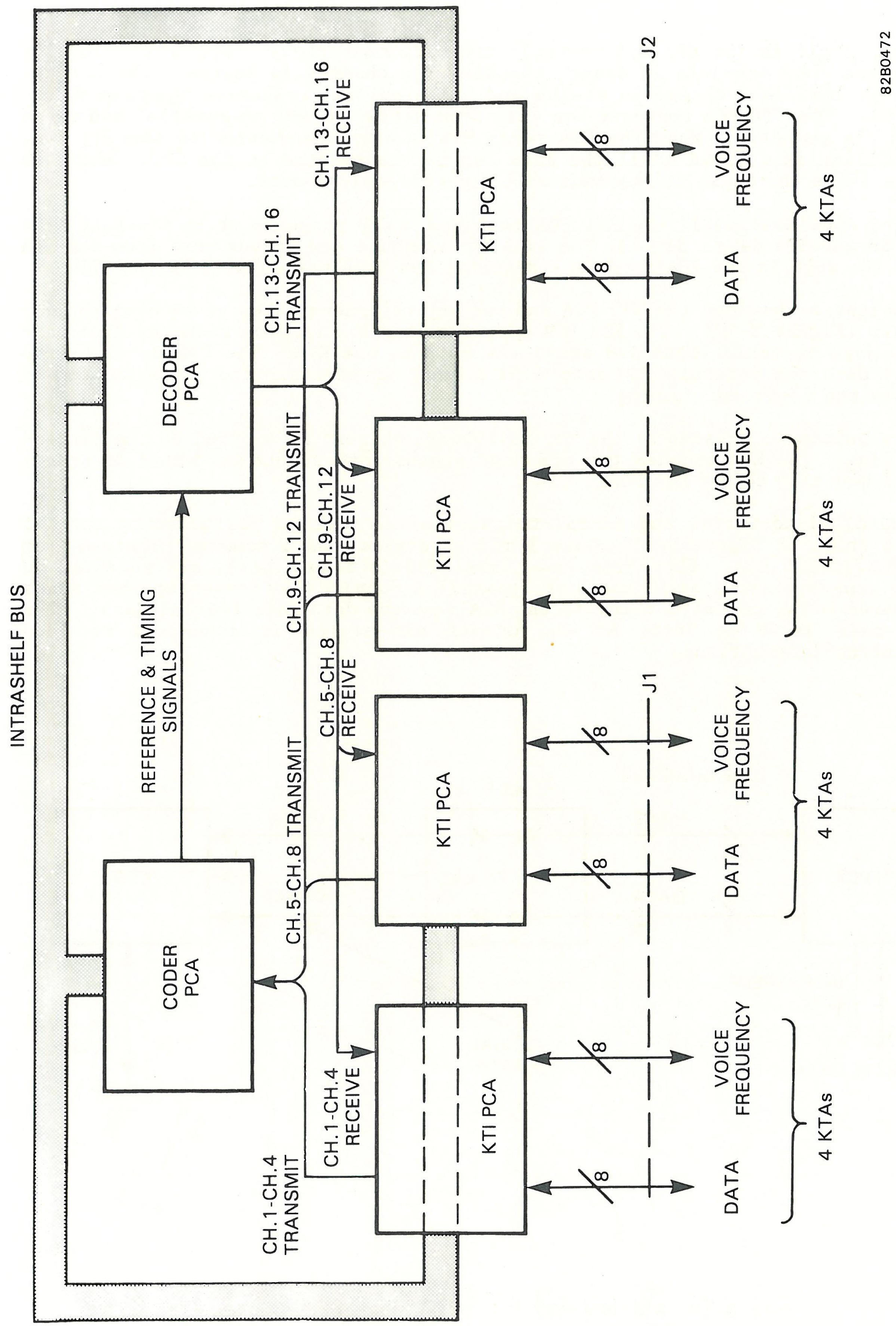

Figure 8-9. KTI Group Block Diagram

Polling logic in the KTI PCA controls the data converter. The PCA continually polls the four channels in order, checking for changes in status. The KTA detects an immediate change in status and, when polled, transmits the data to the KTI PCA. The KTI PCA converts the data from serial format to parallel and sends it to the computer. When the KTA sends new status information to the KTI PCA, the polling is stopped until the data can be transmitted to the CPU. When the CPU receives the data, it responds with a data-received word.

Polling continues until the KTI PCA receives a CPU response or is instructed to send or receive data. The KTI PCA will not accept a new status word from the KTA until the word in the PCA's receive register has been transmitted to the CPU.

Communication between the KTI PCA and the key telephone takes place over the data pair (Figure 8-10). The KTI PCA converts lamp and ringing commands from parallel data to serial data and sends the data to the KTA. The KTA receives the serial data and reformats it into a data word representing the voltages used to operate the lamps and ringing.

When a button is pressed at the key telephone, current is applied to the particular line. The KTA encodes the off-hook status into a data word that is transmitted serially to the KTI PCA.

The parallel-to-serial and serial-to-parallel conversion performed by the KTI PCA is shown in Figure 8-11. Case 1 illustrates a ring 2 command received from the intrashelf bus. The three code bits, 010 (off, on, off), are received on three separate lines simultaneously (parallel data). The converter then sends the three bits, one at a time, to the KTA over the data pair (serial data). The data pair is a dc loop, so the on/off bit status is converted to loop current/no-loop current.

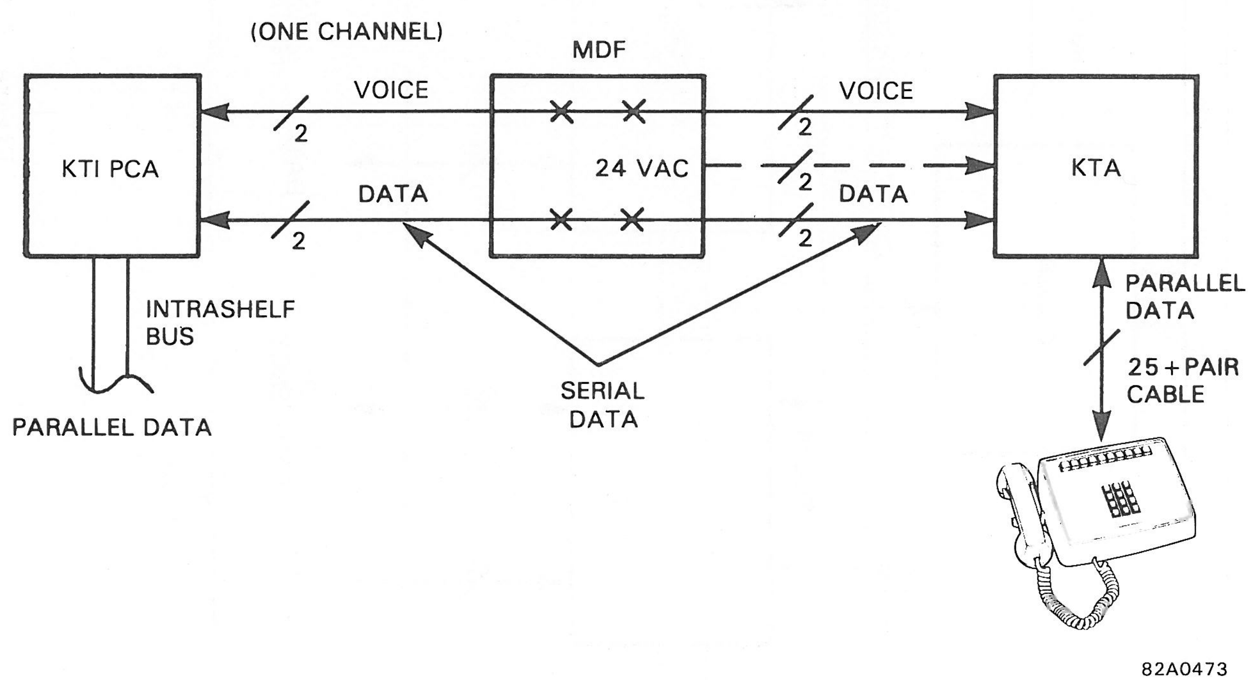

Figure 8-10. KTI PCA/KTA/Key Telephone Interconnections

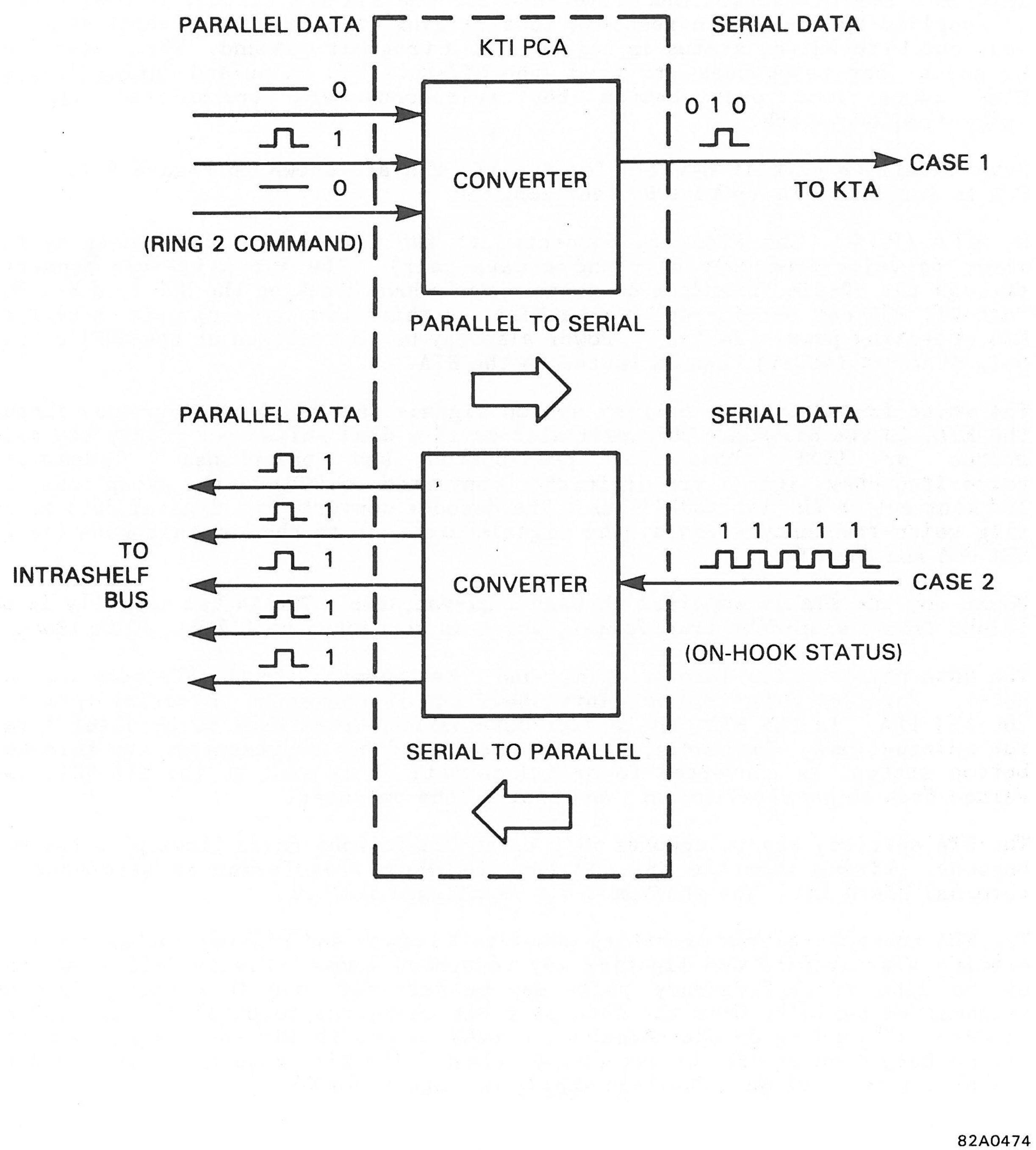

Figure 8-11. KTI PCA Data Conversion

Case 2 illustrates a 5-bit serial word, representing the on-hook status of the key telephone, sent by the KTA. The five dc loop current pulses (11111) are converted to five separate bits by the KTI PCA and are sent out on the intrashelf bus simultaneously.

The voice-frequency path for the KTI PCA operates almost the same as the line interface PCA circuits. The difference for the KTI PCA circuit is that ringing is supplied by the KTA in response to a ringing command, and off-hook status is sent out with button status in response to a transmit command. When rotary (dial pulse) key telephones are used, the off-hook bit is pulsed during dialing. DTMF tones from push button key telephones are transmitted via the voice-frequency path.

Some interface circuit details for the KTI PCA are shown in Figure 8-12. This PCA is for data loop up to 1000 feet long.

b. KTA (KTA). The KTAs are connected to the CBX equipment cabinets by four wires (a voice-frequency pair and a data pair). The two pairs are connected through the 50-pin interface connector punch-down block on the MDF to a KTI PCA. Each KTI PCA can service up to four KTAs. A third local wiring pair is used for KTA operating power (24 Vac). Power also may be centralized at the MDF; a third pair of wires (power) then is routed to the KTA.

The voice-frequency pair carries speech signals from the key telephone, through the KTA, to the KTI PCA. This pair also carries dial pulses for rotary key telephones or DTMF tones for push-button key telephones. Transmitted voice-frequency signals are digitized (converted to PCM) by the group coder PCA and sent out on the intrashelf bus. The decoder converts the digital data to analog voice-frequency signals; the signals are sent to the key telephone via the KTI PCA and the KTA.

Power for the KTA is supplied through a 24-Vac pair. The 24 Vac normally is obtained from a step-down transformer, which is connected to 117 Vac 60 Hz power.

The data pair carries lamp, ringing, and reset commands to the KTA from the computer. Parallel data from the intrashelf bus is converted to serial format by the KTI PCA. In the KTA, the serial data is converted back to parallel format for internal use. Similarly, the KTA parallel data, representing key telephone button status, is converted to serial format; it is sent to the KTI PCA, converted back to parallel format, and sent to the computer.

The KTA services key telephones with up to ten buttons (nine lines plus the HOLD button). Wiring from the CBX and the step-down transformer is terminated at terminal board TB1. The station cable is plugged into P1.

The KTA converts 24-Vac operating power to dc power and ringing voltages for operating KTA circuits and lighting key telephone lamps. Figure 8-13 shows that up to nine voice-frequency pairs may be serviced, one at a time. Commands transmitted serially over the data pair are converted to parallel data and are decoded. Depending on the command received, a particular key telephone button may be turned on or off, or may wink or flash. The wink rate is 1.984 Hz and the flash rate is 0.992 Hz. The lamp supply voltage is 10 Vdc.

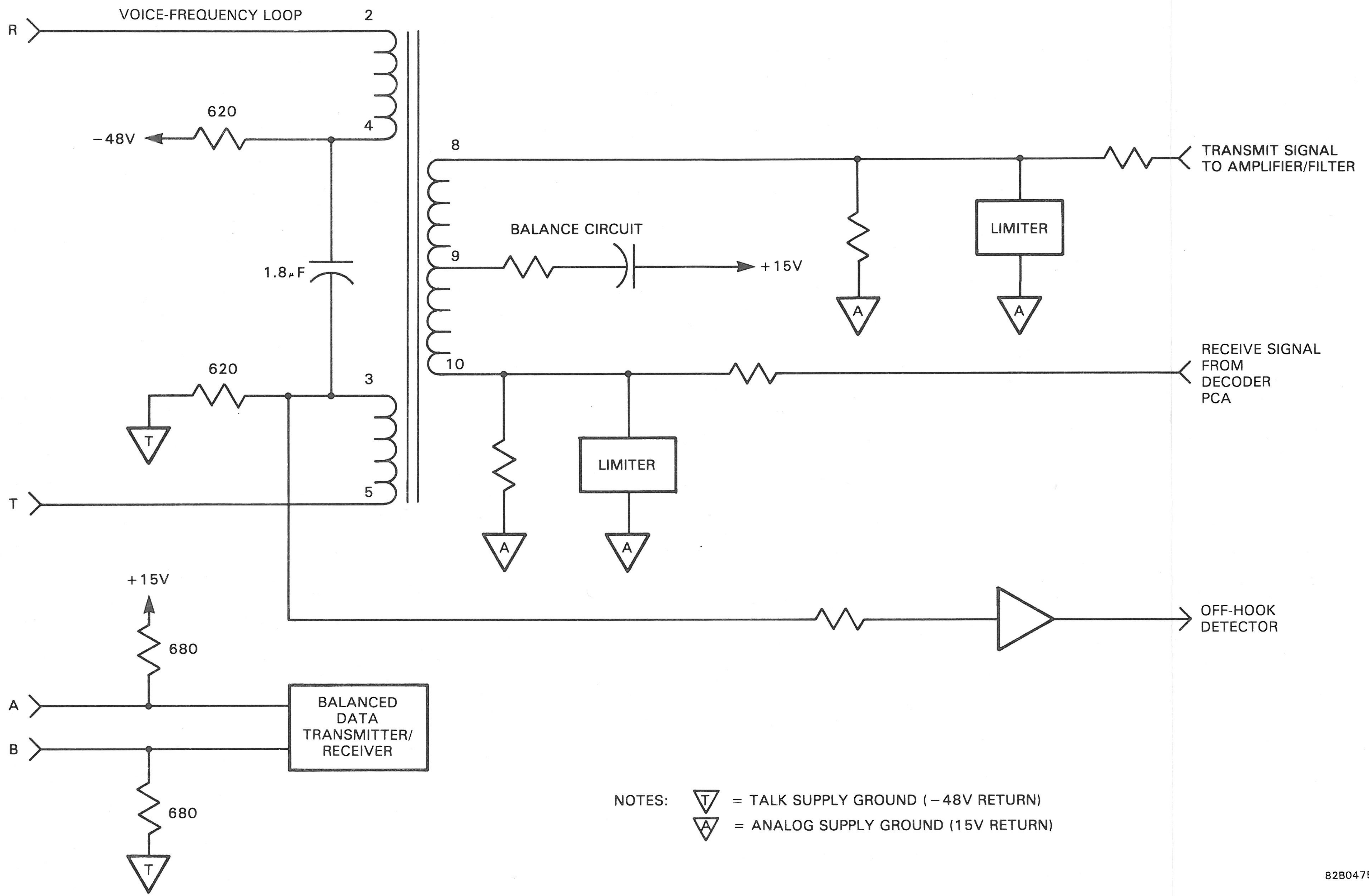

Figure 8-12. KTI PCA Simplified Schematic Diagram

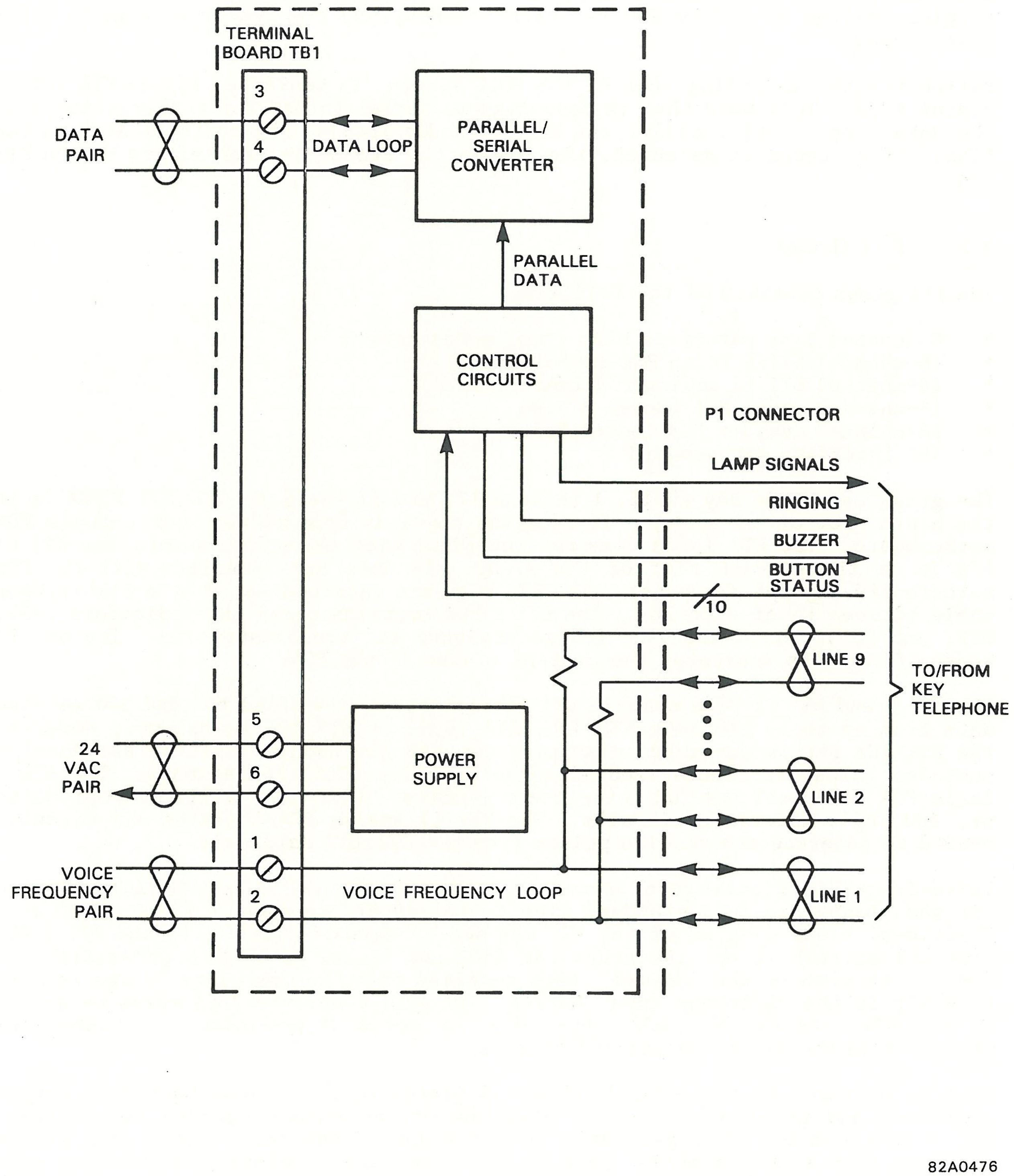

Figure 8-13. KTA Block Diagram

Ringing commands allow ringing at one of two cadences (19.84 Hz, single or double pulse). A buzzer command supplies a 119-Hz signal to operate a buzzer. The ringing voltage is 150 to 200 Vac peak-to-peak, and the buzzer voltage is 5 Vac peak-to-peak.

Button status, including that of the HOLD button, is converted by the KTA into a status word. This word then is converted to serial format for transmission over the data loop. Periodically, the KTI PCA scans (polls) the button status on the KTAs. If a change is detected, the new button status is transmitted to the KTI PCA.

8.2.6 ETI Group

The ETI group consists of the following:

- 8-channel line interface PCAs (two, model 85540)
- 16-channel ETI I logic PCA (model 85660)
- 16-channel ETI II analog PCA (model 85670)
- 16-channel coder PCA (model 85510)
- 16-channel decoder PCA (model 85520)
- 5-2 interface motherboard

The group can be on any shelf, 1 through 17, except shelf 3. The ETI I PCA is in the ninth slot of the group. It receives commands from address bus 1 on the TDM motherboard. The ETI I PCA does not interface with the motherboard. The ETI II PCA is in the seventh slot of the group. It does not interface with the TDM motherboard, except for power. The ETI PCAs are interconnected by a flat-ribbon cable between P4 of each PCA. The ETI I PCA contains three LED indicators (DS1, DS2, and DS3), which are used for maintenance and troubleshooting. The on/off state of the LEDs indicates the current status of the PCA.

The ETI I and ETI II PCAs contain all the components required to send and receive data from up to 16 ETS 100A/ETS 100, ETS 100D, or ETS 300 telephones; however, the ETI PCA set is designed to support two ETS 200 phones (used as attendant's consoles (ATCs) in centralized attendant service (CAS) operations). The ETI I logic PCA holds all the TDM interface circuitry: RAM, ROM, a Z80A microprocessor, and logic interface circuits. The ETI II analog PCA contains all circuits needed to generate and receive pulses from the ETI/ETS data pair.

Voice-frequency signals are processed by the 8-channel line interface PCAs in the same manner as in a standard single-line interface group. Figure 8-14 is a functional block diagram of the ETI PCA set. Commands received by the ETI I PCA from the intrashelf bus interrupt the Z80A and vector it to an appropriate subroutine to process the command. Data received from the backplane is stored temporarily in the backplane input buffer. In idle time, the Z80A moves this data to the ETS data buffer (echo data only) or sorts it according to channel and stores it in one of 16 ETS channel buffers.

Data to be input to the intrashelf bus is placed in one of four backplane output registers and gated onto the bus when the proper output command is received. The output command also generates an interrupt to the Z80A, which then places new data into that register. Data is formatted and transmitted bit by bit over the flat cable to the ETI II PCA, which then sends the bits out on the data pair to the ETS. Data from the ETS is received serially at the ETI II PCA. The ETI II PCA converts TTL logic data and clock pulses into a bipolar data stream and transmits this data over the flat cable to the ETI I PCA. The received data is checked for errors and is stored in the ETS data buffer if correct.

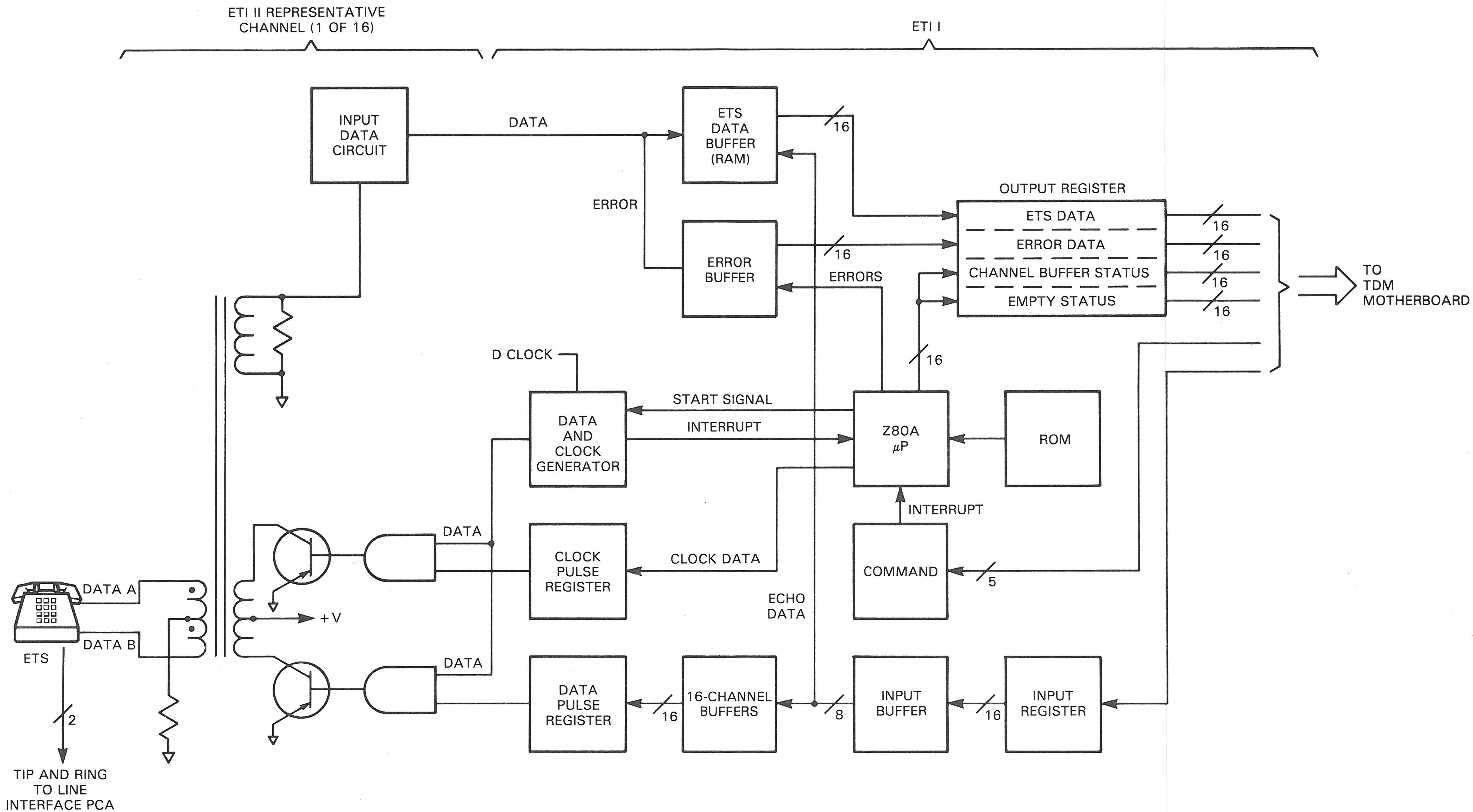

Figure 8-14. ETI PCAs Block Diagram

8.2.7 Message Waiting Lamp Single-Line Interface Group

The message waiting lamp (MWL) single-line interface group consists of the following:

- 8-channel MWL interface PCAs model 75520 (two)
- 16-channel coder PCA model 85510
- 16-channel decoder PCA model 85520
- 4-1 MWL interface motherboard model 75540

The MWL single-line interface group and the standard-line interface group (paragraph 8.2.3) are functionally identical except for the MWL interface motherboard. This motherboard interconnects the two 8-channel MWL interface PCAs with the group's coder and decoder PCAs. The interface motherboard also has a piggyback power supply that provides 160 Vdc to light the message waiting lamps (Figure 8-14a and Figure 8-14b). The power supply circuitry interprets commands from the CPU and sends the 160 Vdc across the tip and ring leads to light the station message waiting lamp. Depending on the command, the lamp flashes to indicate a message alert or lights steadily to indicate a do-not-disturb or forward state.

8.2.8 ROLMphone Telephone Interface Group

The ROLMphone telephone interface (RPI) group can support as many as 48 ROLMphone 400 telephones, depending on the group configuration. The 16-channel group consists of the following:

- RPI 1 PCA model 78011
- RPI 2 PCA model 78012
- 4-1 RPI motherboard model 78020

The 32- and 48-channel groups use a different motherboard (6-3 motherboard, model 78030) and additional pairs of RPI 1 and RPI 2 PCAs. The 32-channel group requires two pairs of PCAs, and the 48-channel group requires three pairs.

RPI groups can occupy any shelf, 1 through 17, except shelf 3. The RPI 1 PCA occupies the first slot of the group and contains the TDM bus interface circuitry, the control processor, and the signal control circuitry. The RPI 1 controls the voice volume and ring cadence of the phones and processes all CBX-generated phone commands. The RPI 2 resides in the second slot of the group. It contains the timing circuitry used to manage the digital link to the phones and the channel interface circuitry needed to communicate with the phones over the digital link. The RPI 2 PCA interfaces with as many as 16 ROLMphone 400 telephones.

The ROLMphone 400 telephone interfaces with the CBX via the digital link (Figure 8-14c). The digital link is a single twisted-pair wire (24 to 26 AWG) that carries a high-frequency digital signal (256 kbps), superimposed on the -48V talk battery.

PIGGYBACK POWER SUPPLY

ILLIG 12804

Figure 8-14a. MWL Interface Motherboard (Rear View)

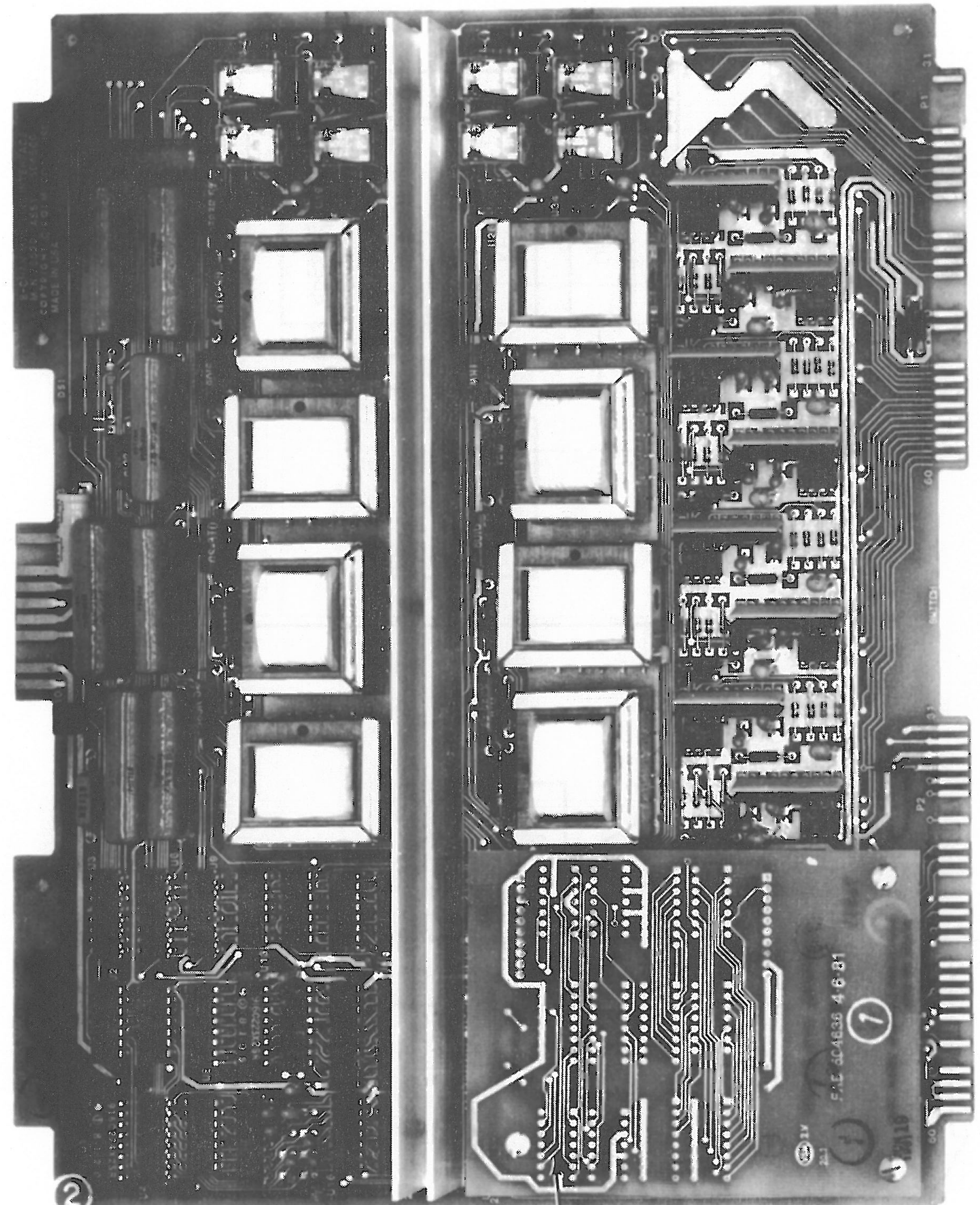

Figure 8-14b. 8-Channel MWL Single-Line Interface PCA

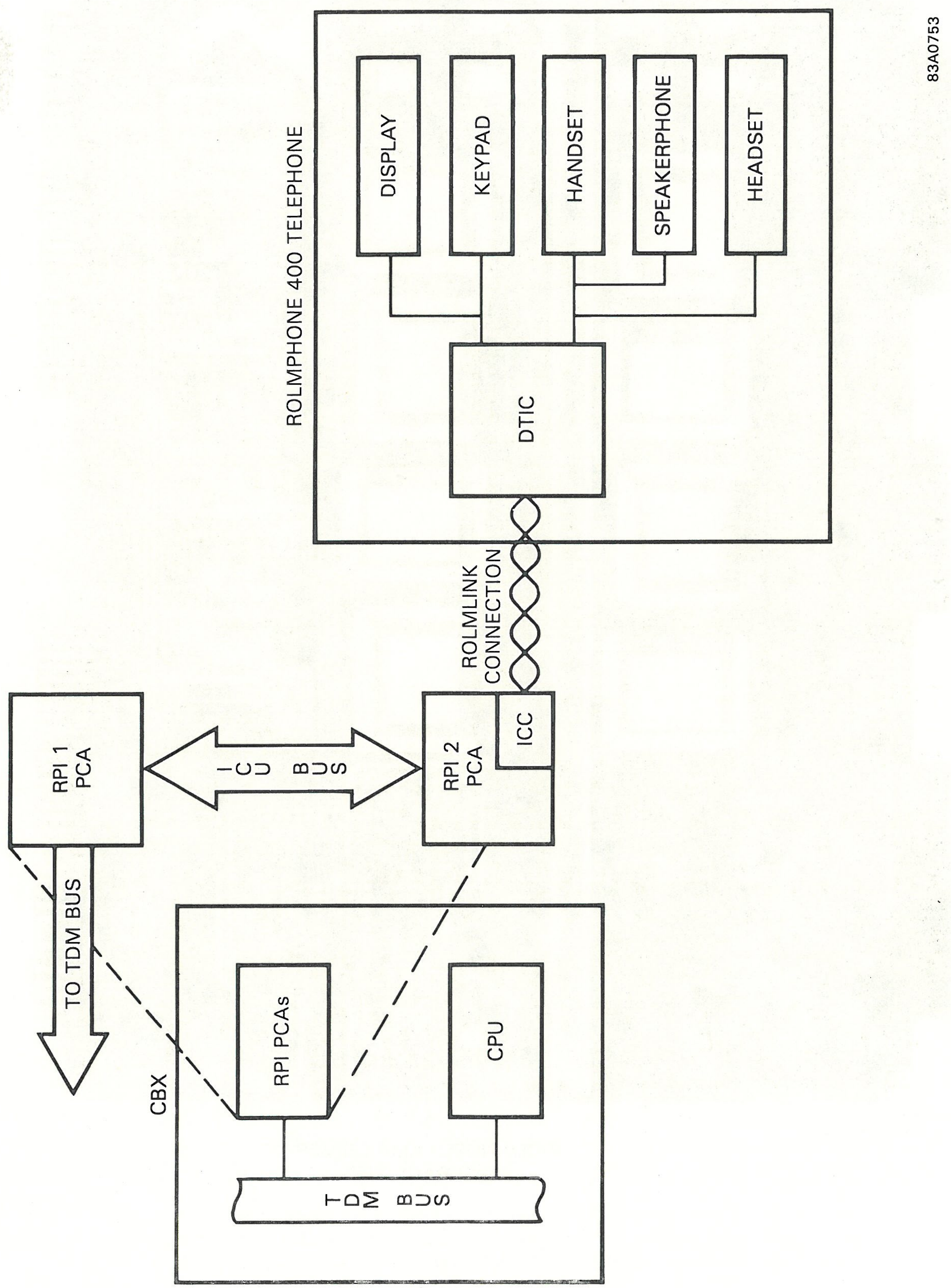

Figure 8-14c. ROLMphone 400 System Diagram

The digital telephone integrated circuit (DTIC) in the ROLMphone 400 telephone and the integrated channel circuit (ICC) on the RPI 2 PCA control the link. The DTIC controls multiplexing and demultiplexing of voice and control messages, as well as coding and decoding the voice signals received via the handset or speakerphone. The ICC converts the signal received over the link to a format compatible with the CBX TDM bus.

Sound is sampled 8000 times per second and converted to an 8-bit digital signal in the telephone. This signal travels over the digital link to the RPI 2 PCA. The data is then placed in the TDM buffer on RPI 1. The signal processor controller moves the data to a signal processor that converts it to its 12-bit linear equivalent. This 12-bit digital signal goes back into the TDM buffer and onto the TDM bus at the appropriate time.

Voice data on the TDM bus is in the format of 12-bit data words appearing on the bus at a 12-kHz rate. Thus the return path of voice data signals is the reverse of the above path. The 12-bit word is taken from the TDM bus and placed in the TDM buffer on the RPI 1 PCA. It is then converted to its 8-bit companded equivalent and is transmitted over the digital link at an 8-kHz rate, where it is converted to sound in the handset or speakerphone.

The following paragraphs contain detailed functional descriptions of the individual components in the RPI group.

a. RPI 1 PCA. The RPI 1 PCA processes all CBX-generated phone commands. It controls the interface between the CBX and the ROLMphone 400 telephones. The following circuitry is located on the RPI 1:

- TDM interface
- TDM buffer
- Control processor
- Signal processor controller
- Signal processors (four)
- ICU bus interface

Figure 8-14d shows each block and its relationship to the PCA.

1) TDM Interface. The TDM interface circuitry controls the interface between the TDM bus and the TDM buffer on the RPI 1 PCA. The RPI 1 enable signal sent by the CPU initiates transmit-type communications (AB0), while the RPI 2 enable signal initiates receive-type communication (AB1) with the TDM bus.

2) TDM Buffer. The TDM buffer is a 5-port, fast-access RAM that allows communication between asynchronous devices. The TDM bus accesses the buffer via two ports, transmit and receive. The control processor, the signal processor controller, and the ICU bus interface all read and write functions to the buffer via a single port. A priority logic scheme handles communication to the buffer. The priorities are as follows:

1. TDM transmit
2. Signal processor controller
3. TDM receive
4. ICU bus
5. Control processor

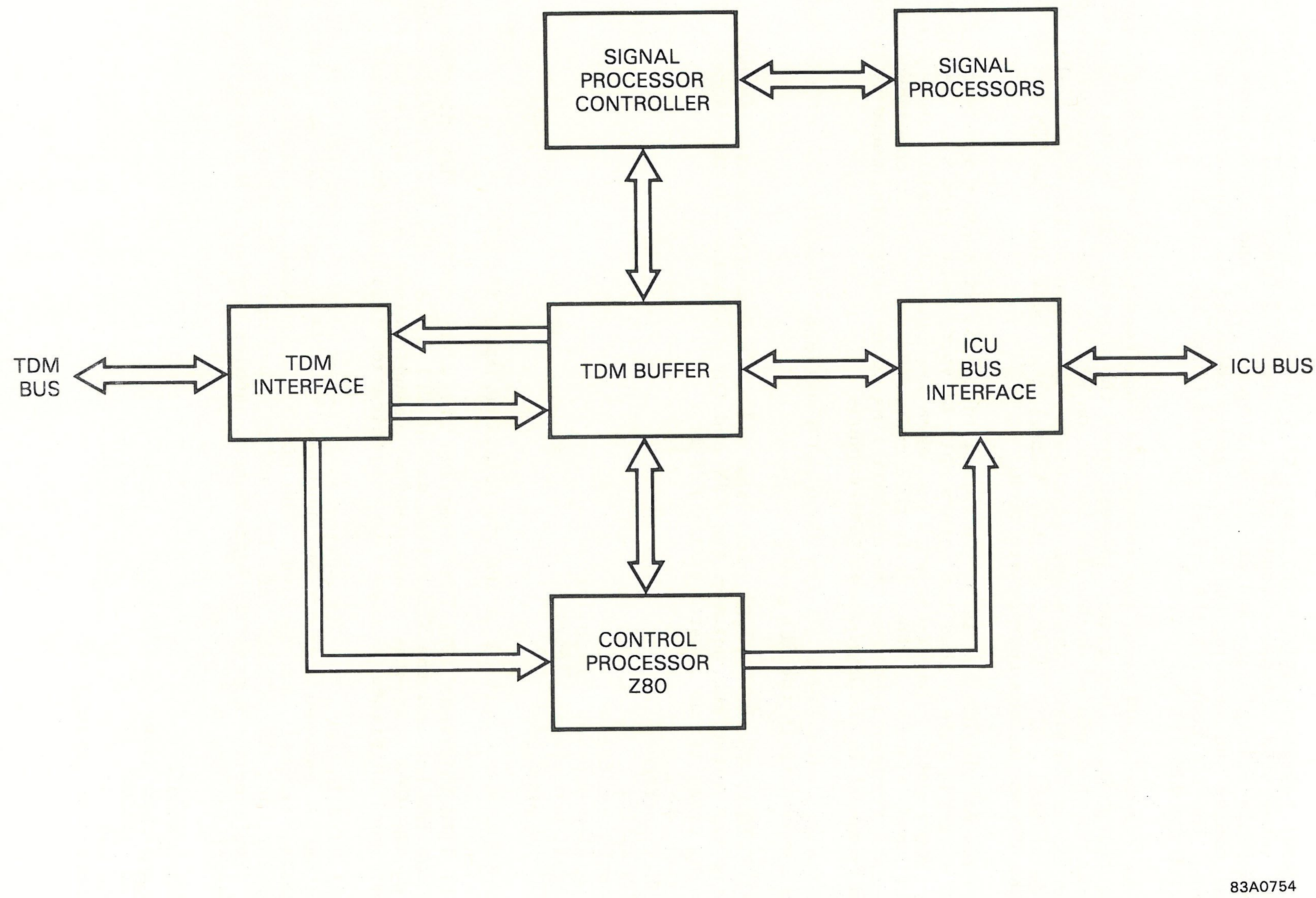

Figure 8-14d. RPI 1 PCA Block Diagram

3) Control Processor. The control processor is a Z80 microprocessor that performs control functions on the RPI PCAs and the ROLMphone 400 telephone. It controls ringing, cadence, and LED on/off commands, as well as controlling the received voice path volume and phone-generated uplink codes. The control processor also performs off-line diagnostics for the RPI 1 and RPI 2 PCAs.

4) Signal Processor Controller. The signal processor controller governs the movement of data between the signal processors and the TDM buffer, while coordinating the processing tasks of the signal processors. This circuitry is also responsible for tone generation.

5) Signal Processor. The signal processors are designed to convert digital signals from one format to another. The TDM bus operates at a frequency of 12 kHz carrying 12-bit words, while the voice information coming from the ROLMphone 400 telephone has been sampled at an 8-kHz rate and put in an 8-bit format. Thus the signal processors must convert the 8-bit digital signals from the phone into 12-bit digital signals for the TDM bus. The reverse conversion must also take place for signals traveling from the bus to the phone. The signal processors perform the frequency conversion.

6) Integrated Channel Unit Bus Interface. The integrated channel unit (ICU) bus is an 8-bit bidirectional bus that carries all voice and control information between the RPI PCAs. The ICU bus interface circuitry consists of controlled counters that access the TDM buffer at the appropriate time, providing the memory address to read uplink or write downlink information.

b. RPI 2 PCA. The RPI 2 PCA provides the timing signals to manage the communication link between the ROLMphone 400 telephones and the CBX. Also located on this PCA is the circuitry that controls the ICU bus and the 16-channel interfaces (ICC chips). Figure 8-14e illustrates a simplified block diagram of the RPI 2 PCA.

1) Clock Circuitry. To generate the numerous timing signals needed by the ROLMphone 400 telephone and the link control circuitry, both phase lock loop and clock divider circuits are utilized. The phase lock loop provides frequency translation between DCLK and the 8.192-mHz signal required by the ICC chip. The divider circuits provide clock signals ranging from 16.384 mHz to 1 kHz.

2) Integrated Channel Circuits. The integrated channel circuits (ICCs) are custom chips designed to communicate with the ROLMphone 400 telephone on a single twisted-pair link in a full-duplex 256-kbps synchronous mode. The ICCs act as impedance matching devices between the RPI 2, the link, and the ROLMphone 400 telephone.

3) Channel Select Circuit. The channel select circuitry serves as a multiplexer in concentrating the information bits coming from the ICCs and transferring 8-bit data words to and from the shift register.

4) Shift Register. The shift register converts serial data (coming from the ICCs) into parallel 8-bit data words that are transferred to the ICU bus. It also performs the opposite conversion on data coming from the ICU bus.

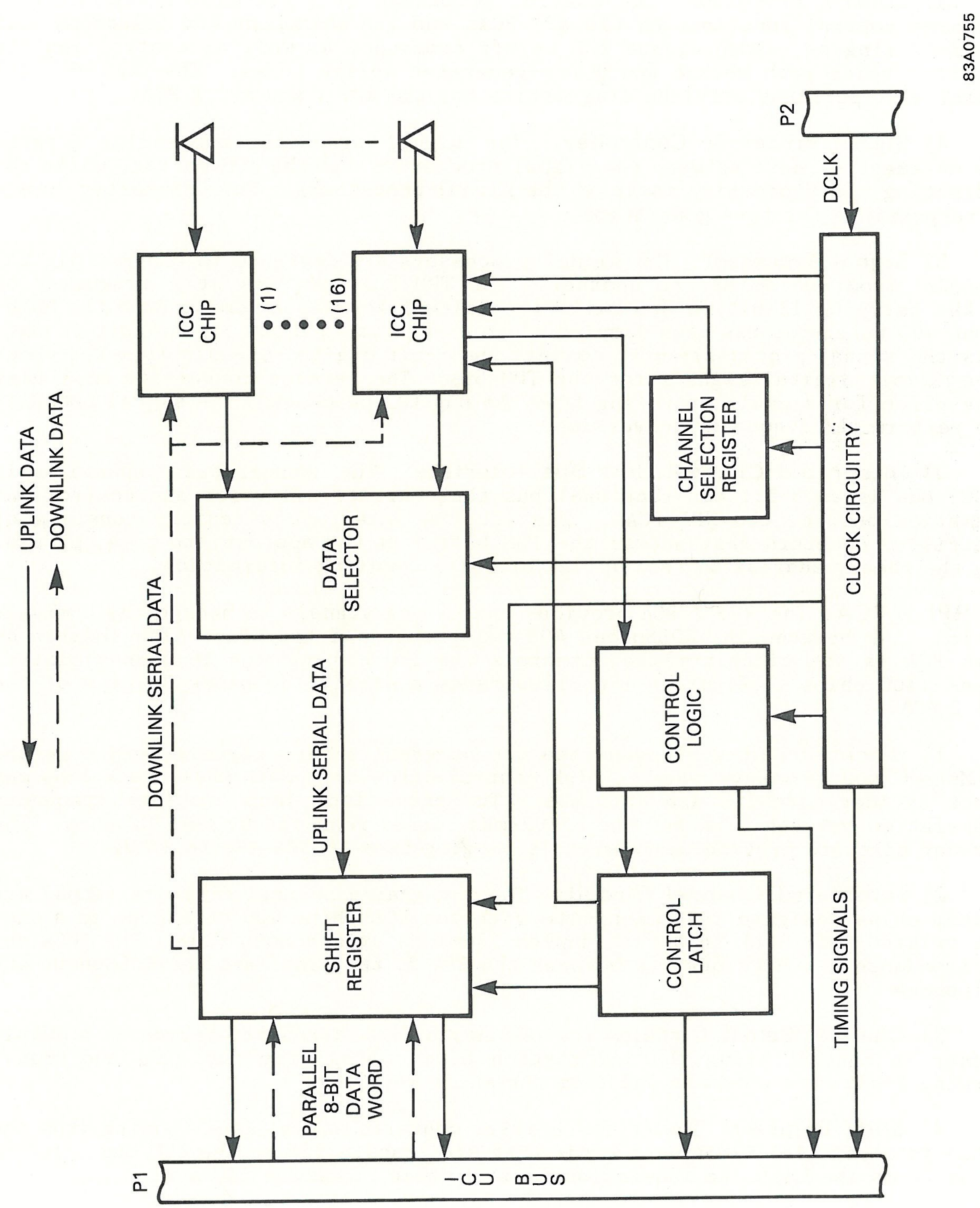

Figure 8-14e. RPI 2 PCA Block Diagram

8.3 MAINTENANCE

This paragraph contains troubleshooting and removal and replacement procedures for the station interface groups.

8.3.1 Troubleshooting

The following paragraphs explain how to troubleshoot the single-line group, the KTI and ETI groups, and music-on-hold and chimes.

a. Single-Line Group. For a detailed overview of the call process, refer to Chapter 11.

A call from an extension involves the following system components:

- Station instrument and house wiring
- Interface motherboard
- Interface PCAs
- Coder/decoder PCAs
- Expander PCA and TDM network control PCAs
- Computer
- DTMF register PCA/rotary register PCA/rotary sender PCA for outgoing calls
- Tone generator PCA
- Trunk interface PCAs for outgoing calls
- KTI PCA for calls processed by the attendant
- Power distribution system

1) Troubleshooting from the Station. When verifying a trouble report from a station, check the following, then refer to Table 8-1:

1. The talk battery and dial tone are normal at the instrument and the modular connector; no talk battery indicates a wiring fault between the station and the CBX.
2. The station rings when called; ringing stops when the station goes off hook.
3. The station rings normally (single interrupted for internal calls and double interrupted for external calls).
4. The error tone is heard when the instrument remains off hook for 10 seconds (or whatever time is set for system parameters 8 and 9) without dialing or when a dialing error is made.
5. Dial tone breaks normally when dialing begins.
6. Internal and external calls are completed normally.

8. Audio levels are normal between calling and called stations.

9. A connection is maintained between parties until either party hangs up. (Conference connections remain while at least one internal party is on the line.)

Table 8-1. Single-Line Station Troubleshooting

SYMPTOM	PROBABLE CAUSE
No talk battery	a. Station defect. b. Wiring problem. Check for open and shorted pairs, and check frame cross-connects. c. Line interface PCA[1]. d. -48V battery[2]. Verify presence at line interface PCA.
No dial tone	a. Station defect. b. Channel not assigned. Check system configuration printout. (Use LEX command to verify). c. Channel test failed[9]. Channel downed by software; check error table or STE the extension. d. Line interface PCA[1]. e. Decoder PCA[1 2 9]. f. Tone generator/tone sender PCA[3 9]. g. Expander PCA[2 9] (located on shelf of suspect tone generator PCA). h. Coder PCA[9].
Howler tone present at all times (off-hook detection problem)	a. Station defect or wiring problem. b. Line interface PCA[1 2]. c. Expander PCA[1 2 9] (on same shelf).
Unable to trip ringing by going off-hook	a. Station defect[1]. b. Line interface PCA[1 2]. c. Expander PCA[1 2 9] (on same shelf).

*Footnotes explained at end of table.

Table 8-1. Single-Line Station Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Called station does not ring	a. Configuration (dial 0 to verify extension number), cancel forwarding, DND, etc. b. Station defect[1]. c. Wiring problem (open tip-ring pair). d. Line interface PCA[1,2]. e. 105-Vac ringing current. Verify presence at line interface PCA. f. Expander PCA[1,2,9] (on same shelf).
Continuous ringing	a. Line interface PCA[1,2]. (Software down and up PCA before replacing.)
Cannot break dial tone (push-button station)	a. Configuration (use LEX command; check dial type). b. Station defect[1]. c. Tip-ring leads reversed. d. Line interface PCA,[1,2]. e. Coder PCA[1,2]. f. DTMF register PCA[2,3,9]. g. Expander PCA[2,9] on same shelf as d. h. Expander PCA[2,9] on same shelf as f.
Cannot break dial tone (rotary station)	a. Configuration (use LEX command; check dial type). b. Station defect[1]. c. Line interface PCA[1,2]. d. Rotary register PCA[2,3,9]. e. Expander PCA on same shelf as c[2,9]. f. Expander PCA on same shelf as d[2,9].

Table 8-1. Single-Line Station Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Cannot complete call or call is completed incorrectly (push button station)	a. Configuration (be sure call being attempted is allowed). b. Station defect[1]. c. DTMF register PCA[2,3,9]. d. Tone generator/tone sender PCA[3,4,5,9]. e. Rotary sender PCA[3,4,6,9]. f. Expander PCA[1,2,9] on same shelf as c, d, or e.
Cannot complete call or call is completed incorrectly (rotary dial station)	a. Configuration (be sure call being attempted is allowed). b. Station defect. c. Rotary register PCA[2,3,9]. d. Rotary sender PCA[2,3,6,9]. e. Tone generator/tone sender PCA[2,3,5,9].
After connection has been established, calling station is unable to hear called station or trunk	a. Called CBX station or direct trunk defective[2,3]. b. Called station line or trunk interface PCA[1,2]. c. Called station or trunk coder PCA[1,2]. d. Calling station decoder PCA[1,2].
After connection has been established, called station or trunk is unable to hear calling station	a. Calling station defect[1]. b. Called station or trunk decoder PCA[1,2,9]. c. Called station line or trunk interface PCA[1,2]. d. Calling station or trunk coder PCA[1,2].

Table 8-1. Single-Line Station Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Low voice level at calling station	a. If trunk call, check at network side for correct level. b. Calling station coder PCA[1,2]. c. Called station line or trunk interface PCA[1,2]. d. Called station or trunk coder PCA[1,2]. e. Calling station line interface PCA[1,2,9].
Low voice level at called station or trunk	a. If trunk call, check at network side for correct level leaving CBX. b. Calling station line interface PCA[1,2]. c. Calling station coder PCA[1,2]. d. Called station or trunk decoder PCA[1,2]. e. Called station line or trunk interface PCA[1,2].
Noise at calling station	a. Direct trunk in trunk call. b. Calling station or decoder PCA[1,2]. c. Called station or trunk coder PCA[1,2]. d. Called station line or trunk interface PCA[1,2]. e. Calling station line interface PCA[1,2].

Table 8-1. Single-Line Station Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Noise at called station or trunk	a. If trunk call, check at network side for noise from CBX. b. Calling station line interface PCA[1,2]. c. Calling station coder PCA[1,2]. d. Called station or trunk decoder PCA[1,2]. e. Called station line or trunk interface PCA[1,2].
Cross-talk at calling station (originated in CBX)	a. Calling station decoder PCA[1,2]. b. Called station or trunk coder PCA[1,2]. c. TDM network control PCAs[1,2,9].
Cross-talk at called station or trunk (originated in CBX)	a. Calling station coder PCA[1,2]. b. Called station or trunk decoder PCA[1,2]. c. TDM network control PCAs[1,2,9].
Call dropping in established connections	a. Network trunk. b. Station defect[7]. c. Line or trunk interface PCA[1,2,7]. d. Computer common control[9].
Cross-connections between established connections	a. Wiring problems. Shorted or miswired pair. b. Expander PCA[1,2,9]. c. Computer common control[9].

Table 8-1. Single-Line Station Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Phone rings--no one there when answered	a. Station user flashes one call when attempting to release, then makes second call. First call rings back on completion of second call. b. Extension number is same as one of local exchanges--some station users forget to dial trunk access code, then remember after dialing seven digits and hang up.

NOTES
[1] Fault affects single channel.
[2] Fault can affect multiple channels.
[3] Fault can be system wide.
[4] Fault can affect all trunks.
[5] Outgoing DTMF trunk call.
[6] Outgoing rotary trunk call.
[7] Intermittent.
[8] Run off-line diagnostics.
[9] Should be listed in error table.

2) Troubleshooting from the Switch Room. The teleprinter can be used to obtain station configuration and status information to help isolate the fault condition.

To troubleshoot from the switch room, proceed as follows:

1. LEX the extension(s) to check the physical address (PAD), class of service (COS), dial type, system forwards, and pick-up and COM groups. See Figure 8-16 for a sample LEX listing.

2. TCHT on the associated channels. NO CHANNEL TESTED will be printed if the station is in use when the command is entered or if the extension is configured for NOTEST.

3. RDT 5 (tone generator/tone sender PCA and DTMF register PCA test) if the problem is system wide.

4. STE (continuous) the extension(s) in question. See Figure 8-17 and Table 8-2 for a sample STE listing.

NOTE

If the status is continuously monitored (FLAG:1), press RUBOUT or ABORT before entering any new commands. While the status is continuously monitored, most changes in status will be listed on the next line. If more than one change occurs while a line is being printed, only the most recent change will be listed. The status will not be updated if a party is placed on hold by the monitored extension while connected to a third party or trunk.

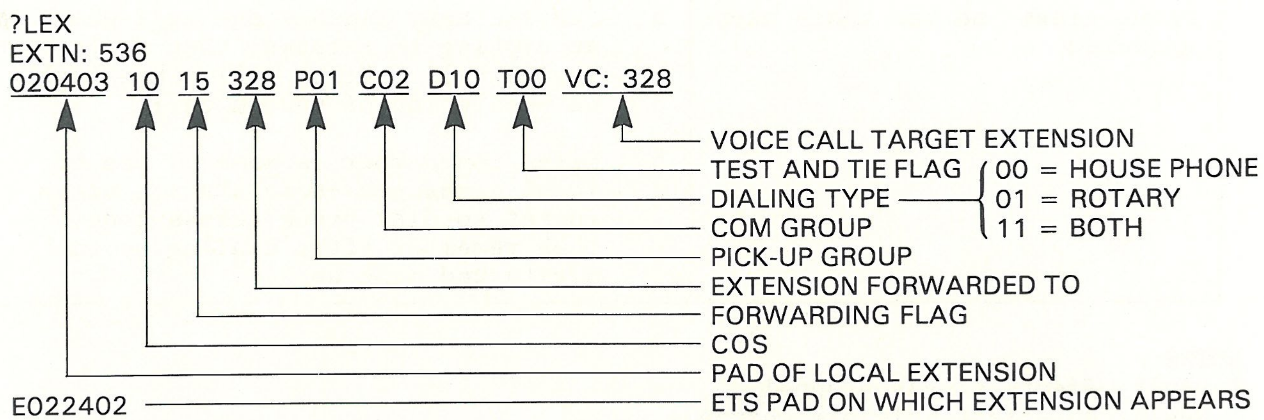

Figure 8-15. Sample List Extension (LEX) Listing

?STE
EXTN: 4455

EXT #	STATE	AC	DIGITS	FWRD-TO	ADND	ABLK	DND	MW	REG-ADDR
4455	IDLE								
4455	DIAL		2						062401
4455	DIAL		2373						
4455	RINGING x2373		2373						
4455	CONN TO x2373								
4455	IDLE								
4455	IDLE								
4455	DIAL								062404
4455	DIAL	9	7						062404
4455	OUTP	9	767632						062404
4455	CONN TO T00015	9	7676325						062404
4455	IDLE								

ABORT
?

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Figure 8-16. Sample Extension Status (STE) Listing

5. Check the attendant block forwarding or DND. DOWN will be printed if the channel assigned to the extension has been downed.

6. Call the extension from a maintenance phone.

7. Monitor the teleprinter to verify that the station is being rung in software. The extension may not be ringing even if RUNG BY appears under STATE on the teleprinter.

8. Verify that the extension is ringing by using the following procedure:

   a. Call a nearby extension and ask the user to go off hook on the monitored station.

   b. Verify that STATE goes from IDLE to DIAL. If STATE does not change, the line interface PCA is not monitoring the on-hook/off-hook status. This indicates a faulty line interface PCA.

9. If one channel appears to be failing, CDN the interface group (CDN XXYY00-coder slot).

10. Interchange the line interface PCAs in the group.

11. UP the group and press the carriage return.

12. Determine if the problem follows the suspected channel on the line interface PCA. If channel 4 is the suspected bad channel and the PCAs are interchanged, channel 12 should show the same faults as channel 4 did.

13. If the problem does not follow the suspected channel, replace the coder or decoder PCA.

14. If all odd or all even channels are listed as failing, replace the coder or decoder PCA.

15. Check voltages at the affected shelves and at shelf 3.

16. Check the PDP for blown fuses. (Check for error type 0006-0020.)

17. Refer to power distribution troubleshooting in Chapter 12 if a fuse alarm accompanies a user complaint or if the error table lists multiple shelf failures or multiple PCA failures on a shelf.

18. Check the system configuration printout and the hardware map when checking COS features.

19. Use the LCSF command (Figure 8-17) to list the features assigned to a particular COS (Table 8-3).

Table 8-2. Extension Status (STE) Listing Definitions

ENTRY	DEFINITION*
EXT#	Extension number
STATE	What extension is doing: IDLE =Idle DIAL =Dialing RINGING =Ringing to another extension OUTP =Outpulsing to trunk RUNGBY =Being rung by X CONN TO =Being connected to X or T TONE =Receiving tone (error, busy) HELD BY =Being held by another extension CAMPED =Camped on X or T HOLDING =Holding incoming call HOWL =Receiving howler tone
AC	Access code dialed.
DIGITS	Other digits dialed.
FWRD-TO	Extension to which calls are forwarded if station forwarding is in effect.
ADND	X = Attendant or control station has restricted incoming calls (same as the unavailable state for an ACD station).
ABLK	X = Attendant or control station has restricted outgoing calls.
DND	X = Station user has used do not disturb (same as the work state for an ACD station).
REG-ADDR	PAD of register connected to station during dialing.

*X = Extension number, T = Trunk number

```
?LCSF
COS#:10
FEATURE#-01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
           1  1  1  0  1  1  1  1  1  0  1  1  0  0  1  0  0  0  0  1  0  0  0  0  0  0
```

''1'' INDICATES THAT THIS COS HAS THE ABOVE FEATURE.

''0'' INDICATES THAT THIS COS DOES NOT HAVE THE ABOVE FEATURE.

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Figure 8-17. Sample List Class of Service (LCSF) Listing

Table 8-3. COS Features

FEATURE NO.	MNEMONIC	FUNCTION
1	FOC (Flash after making Outgoing Call)	Indicates that the station user can flash to use features after making an outgoing call.
2	MOH (Make Outside call with a party on Hold)	Indicates that the station user can call an outside party while the user has a call on hold.
3	PRV (PRiVate call)	Prohibits call interruption by executive override, camp-on, attendant busy override, etc. PRV may be initiated before placing a call or during the calling period. Data transmission interruption also is prevented.

Table 8-3. COS Features (Cont.)

FEATURE NO.	MNEMONIC	FUNCTION
4	EOV (Executive OVerride)	Overrides a call in progress (after giving warning tone), placing initiator of EOV in conference with both parties. EOV also may interrupt extension in the do-not-disturb mode.
5	CFW (Call ForWarding)	Forwards all calls to another extension.
6	ECP (Extension Call Pickup)	Allows a call that is ringing or on hold to be answered from any other extension.
7	SVD (SaVe Dialed number)	Permits an outside called number to be stored. The user may recall the number using RPT (repeat). SVD primarily is used if the called party is busy or does not answer.
8	SPD (Station sPeeD call)	Expedites the dialing of up to ten commonly called numbers by assigning a one-digit code to each number.
9	DND (Do Not Disturb)	Blocks all incoming calls. The DND feature may be overridden by EOV. If the extension placed in DND is in a COM group, DND may be overridden by an extension in the same COM group. DND also allows ACD agents to enter the WORK state.
10	DTS (Direct Trunk Select)	Permits direct access to a specific trunk via a trunk number dialed by the user.
11	SYC (SYstem speed Call)	Allows access to a maximum of 999 system speed numbers. Access is allowed to 99 numbers using two-digit codes (01 to 99) or to 999 numbers using three-digit codes (001 to 999).
12	TKQ (TrunK Queuing)	Allows trunk groups to be queued.
13	NFL (No FLash allowed)	Indicates that the station user cannot flash to activate system features.

Table 8-3. COS Features (Cont.)

FEATURE NO.	MNEMONIC	FUNCTION
14	CAS (CAS branch trunk)	Indicates the incoming portion of a tie trunk at a CAS branch.
15	APK (Automatic camP-on)	Allows automatic camp on to a busy station.
16	CSF (Control of Station Features) *	Allows the station user to control station features (forwarding, inward restriction) for other stations, and allows ACD agents to be placed in the unavailable state.
17	NOH (NO Howler if left off hook)	Allows the station user to leave the phone off hook without receiving the howler tone.
18	UNV (UNaVailable)	Allows the ACD agent to enter the work code. After entering the code, the agent is in the unavailable state (unavailable to receive new calls).
19	INT (INTercept)	Allows the attendant to intercept if the station user leaves the phone off hook too long or if a time-out occurs while dialing.
20	VDC (Voice Call)	Allows the station user to speak through the loudspeaker of an ETS 100 by dialing an access code plus the extension number that appears on the ETS 100.
21	MON (silent MONitoring)	Allows the ACD supervisor to silently monitor an agent's telephone conversation.
22	NAC (No Account Code)	Allows the station user to place a call without entering an authorization code, although the system has the forced authorization code feature.
23		Reserved for future use.

Table 8-3. COS Features (Cont.)

FEATURE NO.	MNEMONIC	FUNCTION
24	TER (TERminate only)	Release 6 only. Allows the dictation machine to which an internal phone is dedicated to hang up when the calling party hangs up. A station with this feature cannot be used to place a call and may not be assigned any other COS feature.
25	CAA (Control Agent Availability)	Release 6 only. Allows the ACD/CAS supervisor to control the AVAIL/UNAVAIL status of ACD agents or the CAS operator.
26	FRO (Forced Route Override)	Release 6 only. Allows the user to receive SCC ID TONE and use access code ##7 to access the SCC route override feature.
27	MSR (Maid Status Room)	Release 6 property management system interface feature only. Allows a hotel maid to enter a room status code from a guest room telephone.
28	MSC (Maid Status Control)	Release 6 property management system interface feature only. Allows a hotel maid to enter a room status code from a designated control station telephone.
29	CND (Calling Number Destination)	Release 6 property management system interface feature only. The COS of a designated extension allows calling number communication messages to be sent to the PMS computer when calls are answered at the designated telephone. The messages contain the calling and called extension numbers.
30	CCC (Code Call)	Allows the user to page individuals with a series of cadenced tones from stations with this COS.
33	IPP (Internal Precedence and Preemption)	AUTOVON systems only. Allows the user to place the highest available internal precedence call for the particular COS.

*CSF and DND should not be assigned to the same class of service if DND is invoked by #5.

3) Flashphone Troubleshooting. Maintenance and troubleshooting procedures for the Flashphone are the same as those for standard single-line telephones. If the flashpad or network is found to be defective, the entire set should be returned to Stromberg Carlson for repair. In some cases, system parameter HFLASH will need to be changed to accommodate the Flashphone. This depends on your system's size and features. To verify that HFLASH is correctly set, contact your ROLM Field Service representative.

b. KTI and ETI Groups. Troubleshooting procedures for key telephones are generally the same as for single-line stations. Stations can be configured to ring or not ring. Use the LKB command (Figure 8-18) to determine which extensions on a keyset are configured to ring.

To troubleshoot a key telephone, go through the check lists for single-line troubleshooting (paragraph a). Adapt the single-line procedures to conform to key telephone/KTA procedures; that is, instead of running channel test, run the KTA/ETI/ETS diagnostic test (RDT 9). List the error table and check for type 0013 errors.

At the station, check the following:

- Lamps light normally when the corresponding line key is pressed.
- Lamps flash (.992 Hz) normally when the corresponding line is ringing in.
- Lamps wink (1.984 Hz) normally when the corresponding line is put on hold.

Refer to Table 8-4 for a symptom/cause analysis of typical key telephone faults.

```
          ┌---- PAD
?LKB  012401      (CR)
0001 783    R --------- FLAGGED TO RING
0002 766    R
0003 3083   R
0004 3084 ------------ FLAGGED NOT TO RING
0005 3085   R
0006 3100
0007 5233
0008 5234
0009 ----------------- VACANT KEY BUTTON
```

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Figure 8-18. Sample LKB Listing

Table 8-4. Key Telephone Troubleshooting

SYMPTOM	PROBABLE CAUSE*
No talk battery	a. Station defect[1]. b. KTI PCA[1 2]. c. -48V battery[2]. Verify presence at line interface PCA.

*Footnotes explained at end of table.

Table 8-4. Key Telephone Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
No dial tone	a. Station defect. b. Wiring problem[1]. Check for reversed data pair or open or shorted pairs. Check for correct voltage at KTA fuse. c. Channel not assigned. Check system configuration printout for the system (LEX, LBK). d. Channel test failed[2,9]. Channel downed by software; check error table. e. KTI PCA[1,2]. f. Decoder PCA[1,2]. g. Tone generator/tone sender PCA[3,9]. h. Coder PCA[1,2]. i. Expander PCA[1,2,9] (on same shelf as tone generator PCA).
Unable to select one or more lines	a. Station defect. Check A and A lines for appropriate button. b. 24V to KTA[1]. Check for presence if all lines fail (fuse in KTA). c. Wiring problem[1]. Check for open and shorted pairs to the MDF. d. KTA[1]. e. KTI PCA[1,2]. f. Expander on same shelf as e[1,2].
Lamp flash, lamp wink or steady lamp signal fails	a. Station defect[1]. b. KTA[1]. c. KTI PCA[1,2]. d. Expander PCA on same shelf as c[1,2].

Table 8-4. Key Telephone Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Cannot put call on hold	a. Station defect[1]. b. KTA[1]. c. KTA PCA[1 2]. d. Expander PCA on same shelf as c[1 2].
Station does not ring or buzzer is inoperative	a. Station defect. b. LKB--check for ring flag. c. KTA[1]. d. KTI PCA[1 2]. e. Expander PCA on same shelf as c[1 2].
Unable to trip ringing	a. Station defect[1]. b. KTA[1]. c. KTI PCA[1 2]. d. Expander PCA on same shelf as c[1 2 9].
Continuous ringing	a. Software down then up KTI PCA. b. KTA[1]. c. KTI PCA[1 2].
Cannot break dial tone (push-button station)	a. Wrong dial type (LEX, check dial type). b. Station defect[1]. c. Tip-ring leads reversed. d. KTI PCA[1 2]. e. Coder PCA[1 2 9]. f. DTMF register PCA[2 3 9]. g. Expander PCA on same shelf as c[2 9]. h. Expander PCA on same shelf as e[2 9].

Table 8-4. Key Telephone Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Cannot break dial tone (rotary dial station)	a. Wrong dial type (LEX, check dial type). b. Station defect[1]. c. KTI PCA[1,2]. d. Rotary register PCA[2,3,9]. e. Expander PCA on same shelf as c[1,2]. f. Expander PCA on same shelf as d[1,2].
After a connection has been established, calling station is unable to hear called station or trunk	a. Called CBX station or direct trunk defective. b. Called station line or trunk interface PCA[1,2]. c. Called station or trunk coder PCA[1,2]. d. Calling station decoder PCA. e. Expander PCA on same shelf as b and c[1,2].
After a connection has been established, called station or trunk is unable to hear calling station	a. Calling station defect[1]. b. Called station or trunk decoder PCA[1,2]. c. Calling station coder PCA. d. Called line or trunk interface. PCA[1,2]. e. Called station or trunk. f. Expander PCA on same shelf as c and d[1,2].

Table 8-4. Key Telephone Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Low voice level at calling station	a. If trunk call, check at network side for correct level. b. Calling station decoder PCA[1,2]. c. Called station line or trunk interface PCA[1,2]. d. Called station or trunk coder PCA[1,2]. e. Calling station line interface PCA[1,2].
Low voice level at called station or trunk	a. If trunk call, check at network side for correct level leaving CBX. b. Calling station line interface PCA[1,2]. c. Calling station coder PCA[1,2]. d. Called station or trunk decoder PCA[1,2]. e. Called station line or trunk Interface PCA.
Noise at calling station	a. CO in trunk call. b. Calling station decoder PCA[1,2]. c. Called station or trunk coder PCA[1,2]. d. Called station line interface or Trunk Interface PCA[1,2]. e. Calling station line interface PCA[1,2].

Table 8-4. Key Telephone Troubleshooting (Cont.)

SYMPTOM	PROBABLE CAUSE
Noise at called station or trunk	a. If trunk call, check at network side for noise from CBX. b. Calling station line interface PCA[1 2]. c. Calling station coder PCA[1 2]. d. Called station or trunk decoder PCA[1 2]. e. Called station line or trunk interface PCA[1 2].
Cross-talk at calling station (originated in CBX)	a. Calling station decoder PCA[1 2]. b. Called station or trunk coder PCA. c. TDM network control PCA[1 2].
Cross-talk at called station or trunk (originated in CBX)	a. Calling station coder PCA[1 2]. b. Called station decoder PCA[1 2]. c. TDM network control PCAs[1 2].
Call dropping in established connections	a. Network trunk. b. Station defect[7]. c. Line trunk interface PCA[1 2]. d. Computer common control[8 9].
Cross-connections between established connections	a. Wiring problems (fixed), shorted or miswired pairs. b. Expander PCA[1 2]. c. Computer common control[8 9].

NOTES
[1] Fault affects single channel.
[2] Fault can affect multiple channels.
[3] Fault can be system wide.
[4] Fault can affect all trunks.
[5] Outgoing DTMF trunk call.
[6] Outgoing rotary trunk call.
[7] Intermittent.
[8] Run off-line diagnostics.
[9] Should be listed in error table.

To troubleshoot an ETS, list the error table (check for type 0013 errors) and run the KTA/ETI/ETS diagnostic test (RDT 9). The LEDs on the ETI I PCA (Figure 8-19) indicate the current status of the PCA. Make the checks listed for a single-line station. Refer to the ETS System Service Manual, ROLM stock number 300373, for detailed troubleshooting and repair procedures.

c. Music-On-Hold and Chimes. Music-on-hold interconnects to the CBX from customer-supplied equipment through a single-line channel. The optional night chimes interconnect from customer-supplied equipment in the same manner. Both music-on-hold and chimes are coded to a single-line channel as MUSIC and CHIME in place of an extension number when the operating system is defined.

Music-on-hold connections involve the same circuits as a single-line station call, except for the DTMF register, tone generator, rotary sender, rotary register, and conference bridge PCAs. Chimes involve the same circuits; however, the chimes are not actually connected. The chimes' single-line channel is run until the incoming call is picked up.

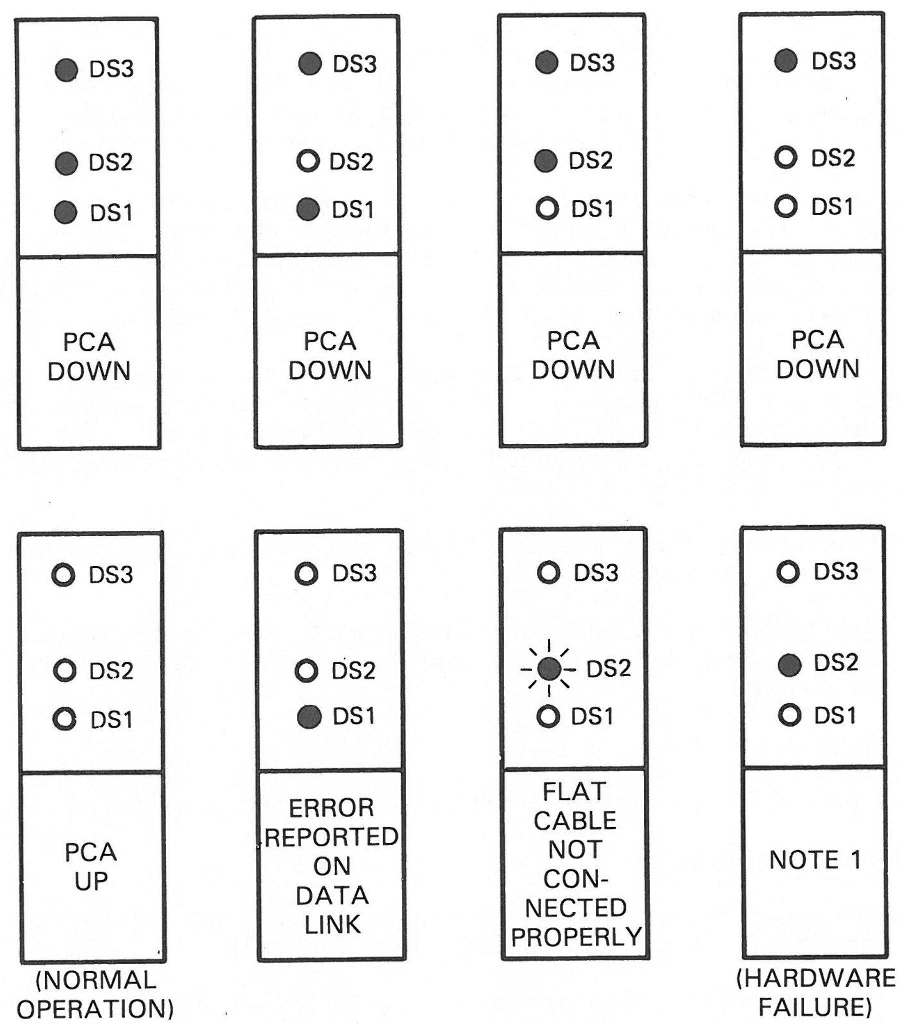
Music-on-hold uses only the transmit side of the channel. Chimes involves only ring voltage through the channel.

1) Music-on-hold Troubleshooting Check List. To troubleshoot music-on-hold problems, list the error table, run the channel test (RCHT), and check each of the following:

1. Talk battery is normal.
2. Music is present without cross-talk or excessive noise for a held call.
3. Music level is normal.
4. MDF cross-connections between the single-line channel interface and music source blocks are intact and punched down securely.
5. Wiring from the MDF to the music source is intact and securely terminated on the music source.
6. Primary power is applied to the music source.
7. Music configuration is limited to a single-line channel assignment.
8. Music source is operable.

2) Chime Troubleshooting Check List. To troubleshoot night chime problems, check each of the following:

1. Talk battery is normal. (Chime source may need -48V bias to operate from the ring voltage).
2. Chimes ring normally when the ATC is in night mode.
3. Chimes ring in the cadence configured for incoming calls.
4. MDF cross-connections between the single-line channel interface and the chime source blocks are intact and punched down securely.
5. Wiring from the MDF to the chime source is intact and securely terminated on the chime source.



NOTES:

1. WHEN DS3 IS OFF AND DS2 IS ON, A HARDWARE FALURE WAS DETECTED BY THE ETI I PCA.

   THIS FAILURE MAY BE INTERMITTENT; THE PCA WILL RESET AND RESUME NORMAL OPERATION. IF THE FAILURE IS INTERMITTENT, DS2 MAY BE TURNED OFF BY SENDING THE PCA AN UP COMMAND (UCD).

   IF DS2 DOES NOT GO OUT AFTER THE UP COMMAND, THE PCA HAS SUFFERED PERMANENT HARDWARE FAILURE OR IS LOCKED INTO A MODE THAT CAN BE RELEASED IF POWER IS REMOVED MOMENTARILY FROM THE PCA.

2. ○ = OFF

   ● = ON

   ☀ = WINKING

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Figure 8-19. ETI I LED Indicators

6. Output wiring from the chime source to the chime (bell, chime, remote speakers) is intact and securely terminated at both ends. If routed through the MDF or an intermediate distribution frame (IDF), wiring also is intact and securely punched down.

7. Power is applied to the chime source.

8. Chime configuration is limited to a single-line channel assignment.

9. Chime source is operable.

3) Checking Configuration. Unlike a regular single-line extension, the music-on-hold and chime configuration is limited to a single-line channel assignment as music or chime. Referring to the hardware map or listing channel identification (CHID) on the teleprinter provides the only clues to the configuration of these features. If all circuits directly involved with these features check out and their channels are coded for music and chime, a suspected problem is probably related to the computer.

4) Music-On-Hold and Chime Sources. To troubleshoot the music source or the chime source, refer to the manufacturers' service manuals.

5) Music Source Level. When the music level is too low and cannot be adjusted to a satisfactory level (refer to the music source manufacturer's service manual), replace the 8-channel line interface PCA containing the music channel.

8.3.2 Removal and Replacement

This paragraph explains the removal and replacement procedures for interface group motherboards and PCAs.

a. Interface Motherboards. Interface motherboards include line interface, trunk interface, ETI, and bypass interface motherboards, all located in the upper half of all shelves except shelf 3. To remove and replace an interface motherboard, proceed as follows:

1. Label the 25-pair cables at the rear of the switch as either J1; J1 and J2; or J1, J2, and J3, depending on the type of motherboard (4-1, 5-2, 6-3).

2. Courtesy down the interface channels (CDN XXYY00).

3. Inhibit self-test at the service teleprinter by typing RDT 0.

4. Use the umbilical cord and PCA extractor to unseat all PCAs in the group (coder, decoder, line interface, ETI I, ETI II , and so forth).

5. Remove the 25-pair cable(s) from the rear of the motherboard.

6. With a 5/16-inch nut driver, remove the nuts that secure the motherboard to the shelf.

7. Install the new motherboard, but do not tighten the screws completely.

8. Reinstall the 25-pair connector(s) to the rear of the motherboard.

9. Use the umbilical to reseat the PCAs in the group. Make sure that the connectors of both interface and TDM motherboards are aligned with the slots and P1 and P2 on the PCAs.

10. Tighten all screws at the rear of the motherboard.

11. Press the carriage return on the service teleprinter to enable self-test.

12. Run the self-tests (RDT 1 through 9).

13. List the error table (LET 0) and troubleshoot any errors.

b. PCAs. All PCAs in the station interface groups can be removed and replaced with power on if the umbilical cord is used. The umbilical cord maintains power on the PCA to prevent glitches on the ISB or other signal lines. It also normalizes the PCA for insertion.

Use the procedure in paragraph 3.6 to remove and replace all station interface group PCAs, then proceed as follows:

1. Check the new PCA according to the appropriate troubleshooting procedures (paragraph 7.3.1).

2. Reinstall the original PCA if the new PCA is bad.

1) 8-Channel OPS or OPX Line Interface PCA. To install or replace a registered OPS or grandfathered OPX PCA, proceed as follows:

1. Verify that the system contains either OPS or OPX PCAs, not both.

CAUTION

Do not mix OPS and OPX PCAs in the same system. Do not set up connections between OPS PCAs and model 85630 grandfathered ties; only set up connections between OPS PCAs and model 85631 registered ties. ROLM does not support OPS-to-OPX connections or OPS-to-grandfathered tie connections.

2. Check the software configuration printout to be sure the system is coded for OPS PCAs before installing them.

3. Use the list extension (LEX) command to verify that all OPS extensions are configured correctly.

4. Set the balance option selector to the option that provides the best voice connection. Be sure the arrow on the balance option selector PCA points to the P1 or P2 connector (Figure 8-20).

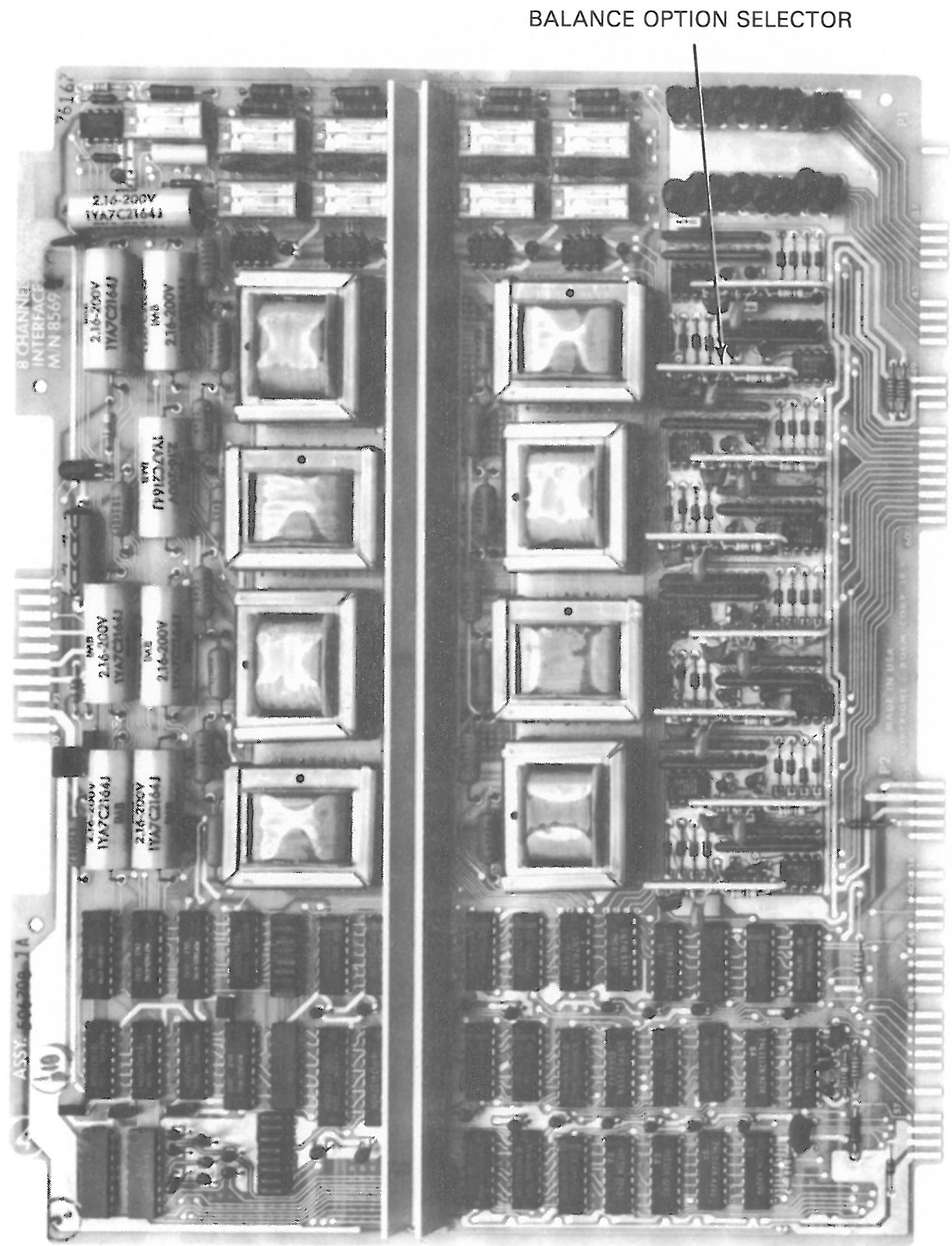

Figure 8-20. Model 85691 8-Channel OPS Line Interface PCA