KBX 3&6

Electronic Plansets

TMC Limited

Maintenance Handbook H.K. 1120

PHILIPS

SECTION 1 : SYSTEM DESCRIPTION

1.1 INTRODUCTION

The TMC KBX 3 and 6 are electronic plansets:

- KBX 3. This provides for up to three independent telephone terminals to be used with one exchange line.
- KBX 6. This provides for up to six independent telephone terminals to be used with two exchange lines.

With the exception of the number of terminals and exchange lines, and one switchable option, both versions offer similar facilities:

- All terminals can communicate with each other via a common intercom circuit.
- Any terminal can make or receive exchange calls.
- An exchange call can be:
  - Held by any terminal; with a KBX 6, both exchange lines may be held by the same terminal.
  - Transferred from one terminal to another as many times as required.
  - Connected as a conference call between any two terminals.
- Exchange lines are independent of and secret from the intercom.
- A power fail terminal is provided for each exchange line.
- In the KBX 6 only, one terminal can have exclusive use of one of the exchange lines.
- Each terminal has a user programmable divert facility enabling incoming calls to be diverted to another designated terminal.

Incoming call signalling is provided by the terminal's internal calling device for intercom calls and an exchange lamp (LED) for each exchange line. Each terminal can be user programmed to receive bell ringing for incoming exchange calls. The exchange lamps are also used to signal all other terminals that an exchange line is busy. These exchange lamps are also used to indicate that a terminal is trying to contact another terminal already engaged on an exchange call.

One or two external extensions may be connected in place of internal terminals. Normally, they can only make and receive calls via a third terminal. In a night service situation, one external extension can gain access to the local exchange.

The KBX 3/6 installation (Figure 1.1) comprises a Central Control Unit and the requisite number of terminals.

The Central Control Unit contains the control, switching, ringing and power supply circuits and provides the connection points for the exchange lines and terminals. The design of the Central Control Unit is such that it appears to be virtually transparent to any exchange to which it is connected.

This virtual transparency enables almost any telephone instrument equipped with resistive signalling and whose signalling circuits are compatible with the local exchange, to be used in a KBX 3/6 System.

The modification of a telephone instrument for KBX 3/6 use requires the incorporation of a number of resistive signalling keyswitches (four for a KBX 3 terminal and eight for a KBX 6 terminal) and an exchange lamp for each exchange line. The keyswitches are used to signal the required connection to the Central Control Unit.

The connections to the terminals consist of five wires; the speech circuit pair and three signalling wires, one for the keyswitches and one for the exchange lamps, plus a common return.

1.2 CENTRAL CONTROL UNIT

The Central Control Unit consists of:

- A baseplate on which are mounted the various circuit components and sub-assemblies.
- A two-part cover.
- A mounting plate.

The unit is designed for wall mounting, using the mounting plate, adjacent to the incoming exchange lines.

The components for the control circuits, ringing generator, intercom power and the interface circuits for one exchange line and three terminals are mounted on a single printed wiring board. The control boards for the KBX 3 and KBX 6 are basically similar. However, they are not interchangeable since the KBX 6 Control Board carries the additional circuit components associated with the connection and use of the second exchange line and three more terminals.

The interface circuits for the second exchange line and the second group of three terminals in a KBX 6 are carried on an extension board.

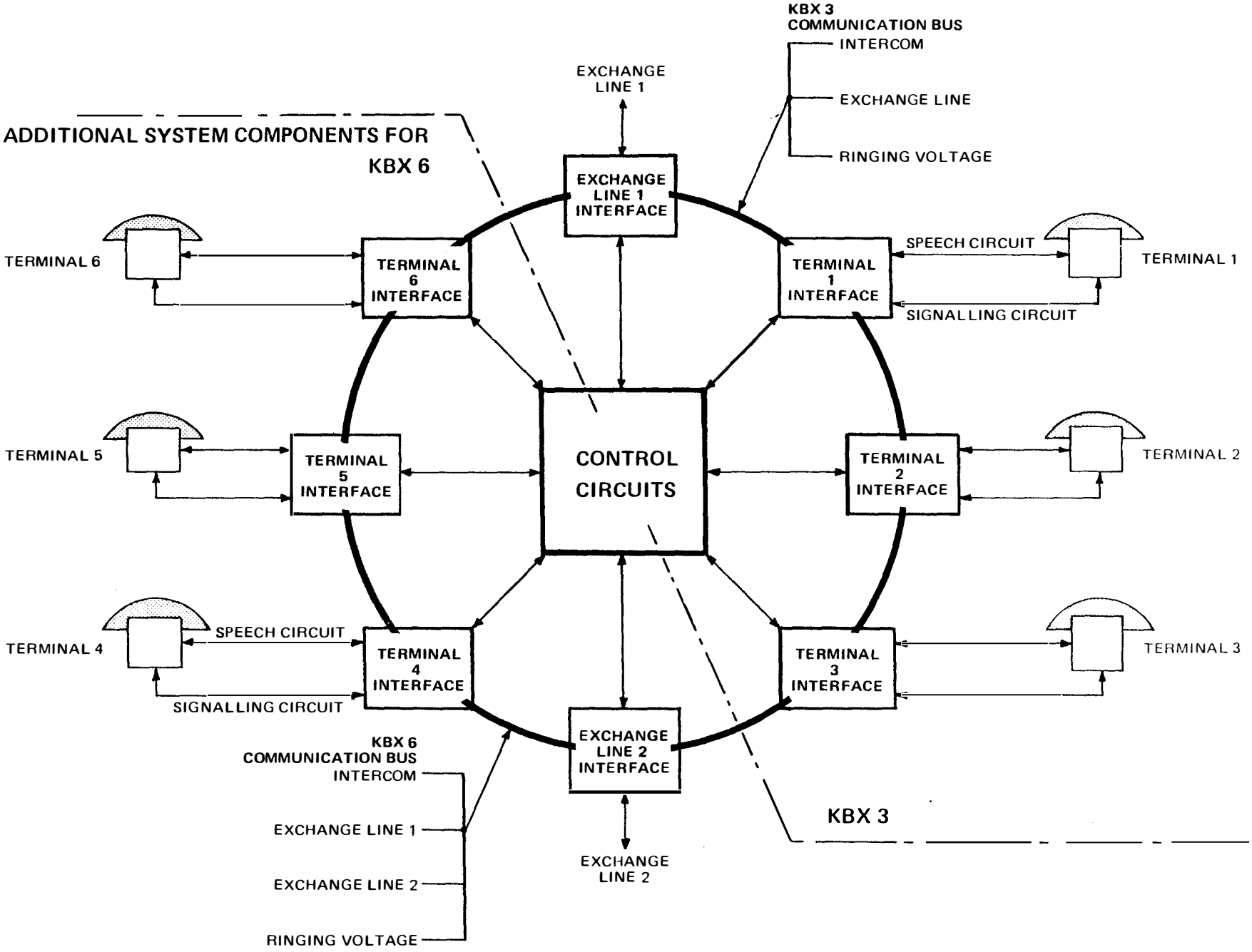


Figure 1.1 KBX 3 and 6 System

The control board is attached to the baseplate by two hinges and secured by spring clips. This allows the board to be swung out for servicing.

The extension board is mounted on the control board by means of hinges and connected to it by a flex strip, allowing the extension board to swing out for access during servicing.

The power supply unit is mounted on the right-hand side of the baseplate.

The printed wiring boards, the power supply unit and their connections are protected by the upper cover. This cover is located on tabs and fitted with anti-tamper catches to discourage unauthorised access.

The lower cover, secured by two captive screws, protects the exchange line and terminal connectors, the option switches, and mains connector and fuse.

1.3 TERMINALS

The only special requirements of a telephone to be used with a KBX 3 or 6 System are that it is compatible with the local exchange, and is fitted with the pushbutton switches required for terminal signalling and an LED indicator for each exchange line. Therefore, only the pushbutton switches and LED indicators, as fitted to a Type 1746 Telephone, are described.

1.4 LEADING PARTICULARS

FEATURES

- One exchange line and three terminals or two exchange lines and six terminals.
- Each terminal can:
  - Make and receive exchange calls
  - Hold one or both exchange lines
  - Transfer exchange calls
  - Set up conference calls between one exchange line and any two terminals
  - Program diversion of its incoming calls
  - Program incoming exchange ringing
- A power fail terminal for each exchange line.
- All terminals within a system can be identical.
- Virtually any type of telephone instrument may be easily modified for use with KBX 3 or 6.
- Switchable options provide:
  - External extensions (night service) in place of internal terminals.
  - C-wire signalling.
  - One terminal with exclusive access to an exchange line (KBX 6 System only).

DIMENSIONS

Central Control Unit	320mm width, 225mm height 85mm depth overall.
Terminal	Depends on telephone type. No increase in dimensions when modified for KBX 3 or 6 working.

WEIGHT

Central Control Unit	4kg
Terminal	250g added to overall weight of a telephone.

POWER SUPPLY

180V to 260V, 50Hz (30W) or 90V to 130V, 50Hz, (30W).

Input voltage determined by mains transformer.

ENVIRONMENT

Operates in the temperature range -5°C to +45°C to BS.2011, Humidity Classification 21 (R.H.95%). The units may be stored in the temperature range -20°C to +60°C.

LINE CONDITIONS

Total dc loop resistance between local exchange and any one terminal not greater than 1250 ohms with a local exchange battery voltage of 45V to 52V.

Total dc loop resistance between Central Control Unit and any one terminal not to exceed 250 ohms; this may be increased to 1000 ohms for limited facility external extensions.

2.1 SYSTEM COMPONENTS

A block diagram of the KBX 3/6 System is given on Figure 2.1. For simplicity only two terminals and one exchange line are shown. However, the block diagram and the following text apply equally to a KBX 3 and a KBX 6 except for the number of terminals and exchange lines, as noted in the text.

A KBX 3/6 System contains the following major components and circuits:

CONTROL CIRCUIT
This is a single NMOS device which receives information on the current state of the terminals (on-hook, off-hook) and the exchange lines (exchange ringing, exchange line looped).

At the same time, it scans the switch buttons on the terminals, looking for and identifying a depressed terminal button.

From this information, the Control IC determines any control action required and transmits control instructions to the Decode Circuit.

DECODE CIRCUIT
This is a single PMOS device which receives control instructions as a serial stream from the Control IC

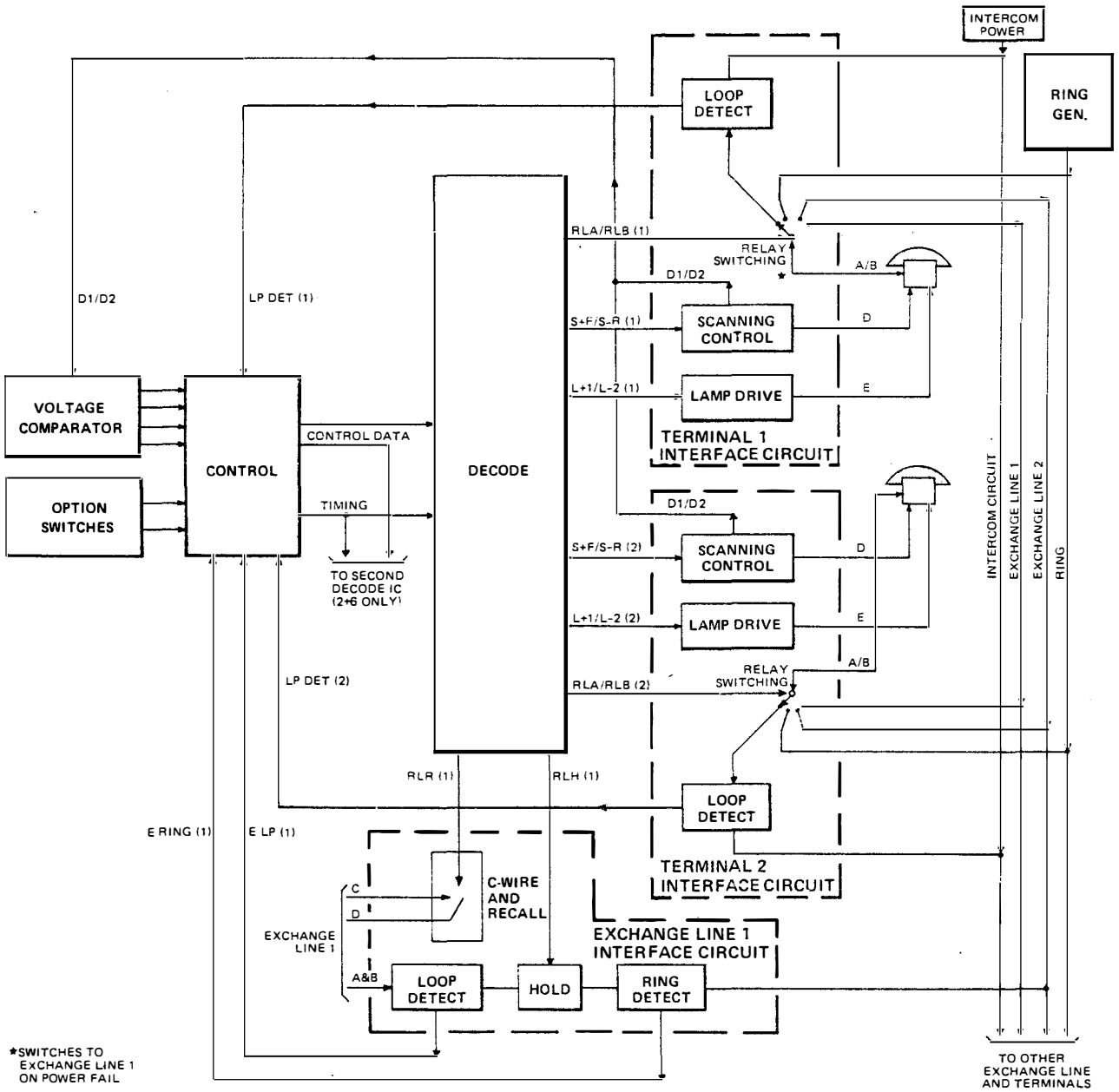


Figure 2.1 Simplified Block Diagram

and converts these to switching and LED indicator signals to the Terminal and Exchange Interface circuits.

Each Decode IC can service one exchange line and up to three terminals. Therefore, one is used in a KBX 3 and two in a KBX 6.

TERMINAL INTERFACE CIRCUITS
These circuits, one per terminal, provide the relay switching circuit between the terminal and the exchange, ring, and intercom lines, the Loop Detect and resistive signalling Scanning Control circuits, and the LED/lamp driver circuits.

The relay switching circuit contains two relays which switch the terminal's speech pair to the exchange or intercom lines, or the ring voltage line. In the System Idle State, the relay contacts connect to the intercom line, as shown on Figure 2.1. Lifting the handset connects the terminal to the intercom line and, via the Loop Detector circuit, generates a Loop Detect signal (LP DET) to the Control IC.

It should be noted that the two relays for Terminal 1 in a KBX 3 and Terminals 1 and 4 in a KBX 6 are energised to connect to the intercom line. In the unenergised or power fail condition, these relays connect Terminal 1 to Exchange Line 1 and, in a KBX 6, Terminal 4 to Exchange Line 2.

EXCHANGE LINE INTERFACE CIRCUIT
This circuit one per exchange line, provides the exchange line loop and ring detectors and the relay circuits for exchange line hold and recall signalling.

VOLTAGE COMPARATOR
This forms part of the resistive signalling circuits, enabling the Control IC to determine which button on a terminal has been operated. Each button on a terminal inserts a different resistance into circuit. The resulting current flow, via the Terminal Scanning Control circuit in the Terminal Interface, is applied to the Voltage Comparator which outputs a 4-bit word to the Control IC.

2.2 SYSTEM OPERATION

In the System Idle State, the Control IC:

- Waits for incoming exchange calls, detected by the Ring Detect circuit in the Exchange Line Interface and signalled on the E RING line.
- Scans the terminals, looking for an off-hook condition (active Loop Detect signal) and a depressed button. This indicates a request from a terminal to set up a call, e.g. ring a terminal on the intercom, connect to an exchange line, hold or transfer an exchange call, or set up a conference call. If the Facility (F) button has been depressed, the Control IC amends the programming at that terminal, by implementing or cancelling the exchange ringing or diversion facilities.

2.2.1 Making and Receiving Intercom Calls

During normal, power on, operation the switching relays in each Terminal Interface circuit connect to the intercom line. Depression of an Extension button is detected by the Control IC which switches the called terminal's switching relays (RLA/RLB signals) between the intercom and ring voltage lines at the internal ringing cadence (0.5Hz).

As soon as the called terminal's handset is lifted, its Loop Detect signal (LP DET) is set active and the Control IC returns the relay switching circuit to intercom connected.

The Control and Decode IC are not required to take any further action. At the end of the call, replacing the handsets, disconnects the speech circuits from the intercom line, with the relay switching circuits remaining on the intercom connected state.

In a power fail condition, or during night service, the relay switching circuits for Terminal 1 in a KBX 3 System and Terminals 1 and 4 in a KBX 6 System are de-energised and the Terminal Interface circuits are connected to the exchange lines (Terminal 1 to Exchange Line 1, Terminal 4 to Exchange Line 2). Lifting a handset connects the speech circuits to the exchange line enabling outgoing calls to be made or incoming calls to be answered.

2.2.2 Outgoing Exchange Calls

External calls are made by lifting the handset, pressing a free Exchange button and waiting for the exchange dial tone or the local exchange operator to answer.

Lifting the handset connects the speech circuits to the intercom line and sends a Loop Detect signal to the Control IC. On the scan following depression of the Exchange button, the Control IC will set the relay switching signals RLA and RLB to connect the terminal's speech circuits to the exchange line. When this occurs, the Exchange Line Interface will return an active Loop Detect (E LP) signal to the Control IC, causing all the LED indicators for that exchange line to be lit.

The call may be terminated by replacing the handset. This resets the Loop Detect signal from the Terminal Interface. After a short delay of about 0.75s, the Control IC resets the RLA/RLB signals, causing the relay switcjing circuit to return to the intercom connected position.

The Exchange Line Interface Loop Detect signal is reset and the Exchange Line LED indicators are extinguished when the KBX 3/6 terminal is replaced.

If the external called party clears down first, the KBX 3/6 terminal remains connected to the exchange line and the Exchange Line LED indicators remain lit. This allows the terminal user to initiate an external follow-on call by hook flashing to obtain dial tone and then dialling another number.

The short delay before the relay switching circuits are reset allows the use of hook flashing at the KBX 3/6 Terminal to gain the Exchange Operator's attention.

2.2.3 Incoming Exchange Calls

An incoming exchange call causes the generation of a Ring Detect (E RING) signal by the associated Exchange Line Interface circuit. This is fed to the Control IC which:

- Rings any terminal programmed to receive exchange ringing (Section 2.2.7) by switching the terminal between the Intercom and Ring Voltage lines (signals RLA/RLB).
- Flashing the LED indicators (L+1 or L-2 signals) for that exchange line on all the terminals at the incoming cadence.

Normally, the rung terminal answers the call by going off-hook (LP DET) and pressing the appropriate Exchange button. This is detected by the Control IC and the relay switching circuits are reset (signals RLA/RLB) to connect the terminal to the exchange line. As soon as this connection is made, the Control IC changes all the LED indicators for that exchange line to lit steadily.

Any other free terminal may answer the incoming call by going off-hook and pressing the appropriate Exchange button as if it were the rung terminal.

If the terminal associated with that exchange line is busy, and no other terminals are programmed to receive exchange ringing on that line, all unconnected terminals will receive exchange ringing. The first terminal to go off-hook and press the Exchange button will be connected to the exchange line as described above.

The call is terminated as for a normal exchange call, as described in Section 2.2.2.

2.2.4 Holding an Exchange Call

An exchange call, either incoming or outgoing, may be held by operating the associated Exchange button. This holds the exchange line and connects the terminal to the intercom line, allowing an intercom call to be made. The LED indicators for that exchange line remain lit for the duration of the call, except that the LED indicator on the holding terminal flashes at 1 Hz while the call is being held. The held call is reconnected by operating the Exchange button again.

Operation of an Exchange button with an exchange line connected and active Loop Detect signals from the Terminal and Exchange Line Interface circuits is recognised by the Control IC as an instruction to hold the Exchange line. The Control IC sets the Hold Relay (RLH) line active to the Exchange Line Interface and resets the terminal's switching relays to connect it to the intercom. The intercom call is then set-up as described in Section 2.2.1.

The intercom call is terminated by replacing the called terminal's handset.

Operation of the Exchange button with RLH and the Exchange Line and Terminal Loop Detect signals (E LP and LP DET) active is recognised by the Control IC as a request to reconnect the held call. The Control IC resets the holding terminal's relay switching circuit to the appropriate exchange line and then de-energises the Hold Relay in the Exchange Line Interface. At the same time it resets the LED indicator for that exchange line to lit steadily at the holding terminal.

The call is terminated as for an outgoing exchange call as described in Section 2.2.2.

If the holding terminal's handset is replaced without reconnecting the held call, its sounder will be rung at a fast cadence (1 Hz) as a ring back signal after a short delay.

The Control IC senses the resetting of the holding terminal's Loop Detect signal while holding the exchange line (signal RLH active) and receiving an exchange line Loop Detect signal. It switches the relay signals RLA and RLB to switch the terminal between the Intercommand Ring Voltage lines. As soon as the terminal goes off hook again it is switched back to the held exchange call which can then be cleared by terminating the conversation and both parties replacing their handsets.

2.2.5 Call Transfers

A Call Transfer is initiated by pressing the button for the required extension. This holds the exchange call and connects the two extensions. The Control IC is receiving Loop Detect signals from both terminals and the Exchange Line Interface and is holding the Exchange Line Hold Relay energised.

The held exchange call may be transferred to the called extension in one of two ways:

- By replacing the calling extension's handset.
- By the called extension operating the appropriate Exchange button.

The Control IC recognises the loss of the Loop Detect signal from the calling extension or the operation of the called extension's Exchange button as a call transfer request. The RLA/RLB signals to the called extension are set to connect it to the exchange line and the exchange line Hold Relay is de-energised.

The call reverts to a normal exchange call, and can be cleared as described in Section 2.2.2.

2.2.6 Conference Calls

The Conference Call Procedure is similar to the Call Transfer Procedure up to the point where the Exchange Line is held and the calling extension is connected to the called extension via the intercom. The Control IC is receiving Loop Detect signals from the two terminals and the Exchange Line and is holding the Exchange Line Hold Relay energised.

Operation of the F button on the calling terminal is recognised by the Control IC as a request to set up a conference call between the calling and called extensions and the held Exchange Line. It sets the RLA/RLB signals to the extensions to set their relay switching circuits to connect to the exchange line, and de-energises the Hold Relay.

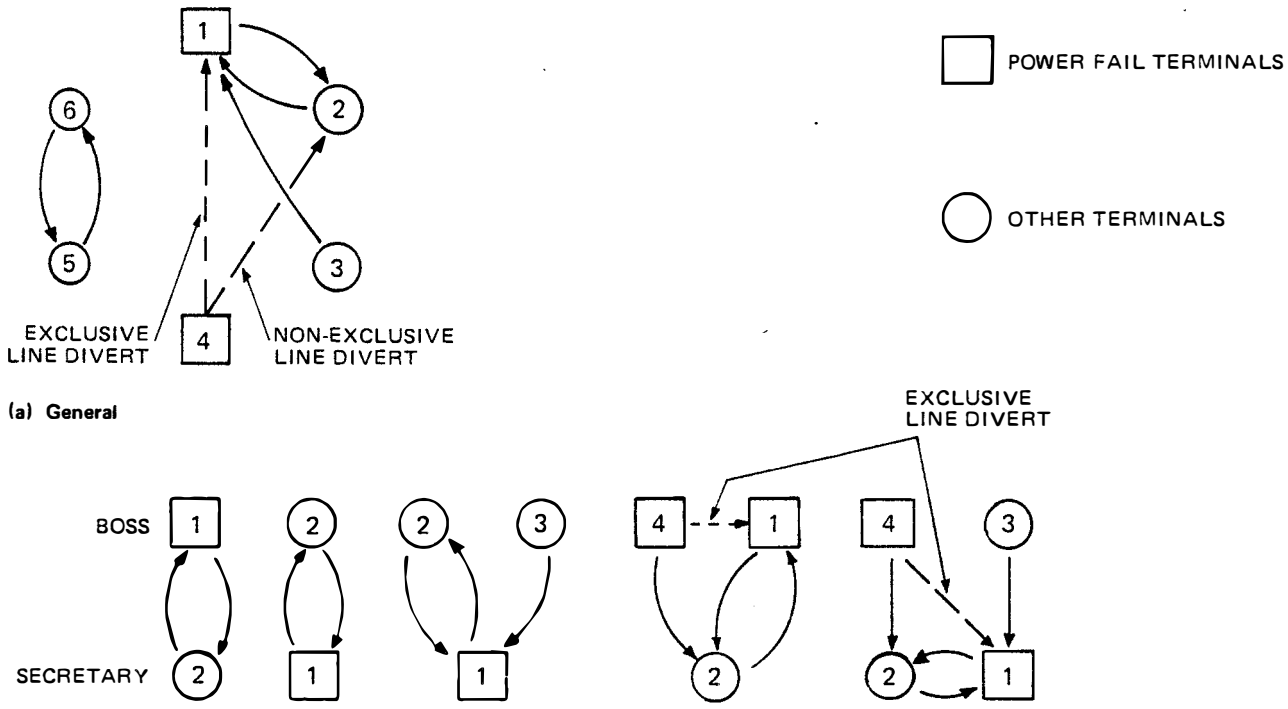
A conference call is terminated by replacing both extension handsets.

The Control IC recognises the resetting of a Loop Disconnect signal as an instruction to reset that terminal's relay switching circuit to connect to intercom.

2.2.7 Programmable Facilities

The Facility (F) button enables the KBX 3/6 terminals to be programmed to:

- Receive exchange ringing. Lift the handset and operate the F button followed by the required exchange button. Lifting the handset, operating the F button twice, and replacing the handset cancels all programmed exchange ringing to that terminal.



(a) General

(b) Typical Boss/Secretary Variations

NOTE: On KBX 3 – only Terminals 1, 2 and 3 are applicable.

Figure 2.2 Diversion Maps

- Incoming calls diverted to a designated terminal (Figure 2.2). Lift the handset and operate the F button followed by Extension 1 button, or Extension 3 button for an exclusive divert on Terminal 4 only. Diversion is cancelled by lifting the handset, operating Extension 2 button and replacing the handset.

In both cases, the Control IC recognises the operation of the F button followed by an Exchange or Extension button in the intercom mode as an instruction to store the required facility and implement it on future calls until cancelled.

Possible diversions are shown by the solid lines on Figure 2.2(a).

However, when the Exclusive Line Option is implemented (Section 2.2.9), Terminal 4 has two diversion options:

- To divert all calls to Terminal 1 (Divert).
- To divert all calls to Terminal 1 except those on Exchange Line 2, the exclusive line, which are still received at Terminal 4 (Exclusive Divert).

In all diversion modes, where a pair of terminals can divert to each other, only one terminal at a time may use the Divert facility.

2.2.8 Terminal Signalling

Terminal signalling is provided by four pushbutton switches in the KBX 3 and eight pushbutton switches in the KBX 6. Both variants employ resistive signalling. This consists of inserting a resistance at one end (the terminal) of the signalling loop and detecting the voltage drop at the other end of the loop (Control Unit).

The KBX 3/6 System employs four inserted resistance values: 100 ohms; 1.3k ohms; 3.6k ohms and 8.2k ohms. These values provide:

- Readily detectable changes in the voltage drop at the Control Unit.
- Sufficient separation in the four levels of current flow in the loop to allow for the maximum permissible loop resistance of 250 ohms, LED current, and line noise.

In the KBX 3, the four buttons are represented by the four resistors.

In the KBX 6, ambiguity is avoided by each button inserting two series resistors in circuit. These resistors are fitted with bypass diodes such that an applied voltage causes one resistor to be bypassed, and reversing the polarity causes the other resistor to be bypassed.

In operation, the Control Unit continuously scans the terminals looking for and identifying any depressed buttons.

Each terminal scan consists of applying a voltage to the loop, across which is connected a storage capacitor. This capacitor remains charged to the applied voltage while the signalling loop is open circuit.

When a button is depressed, the loop resistance and inserted resistance are connected across the storage capacitor, causing it to begin to discharge. At the next scan, the applied voltage recharges the capacitor to a level determined by the combined loop and inserted resistance. It is this voltage level which is detected by the Voltage Comparator and Control IC (Figure 2.1) and identifies the depressed button in a KBX 3.

In a KBX 6, the Control IC stores the result of the scan described above and reverses the applied voltage. This produces a second voltage level across the storage capacitor and dependent on the value of the other resistor inserted by the depressed button. From these two voltage levels, the Control IC identifies the depressed button.

A detailed description of the Terminal Signalling circuits is given in Section 3.4.

2.2.9 Options

The various options available in a KBX 3/6 System are shown in Table 2.1. These are implemented at the Control IC dependent on the input applied to the appropriate option pin.

Options 1 and 2 are user options implemented by the setting of miniature switches mounted on the Control Board. Options 3 to 6 are system and maintenance options which are not implemented at present.

OPTION	CONTROL IC PIN	CONNECTED TO			
		V_{SS}(+10V)	PHS 1	PHS 3	V_{DD}(+22V)
1	21	Options Off	External Extension 1	External Extension 3	★
2	20	Options Off	C-wire Signalling	Exclusive Line	★
3	6	Options Off	No Divert	No Programming	No Divert and No Programming
4	2	1+3 Scan	1+3 Scan	High Speed Test (2+6)	2+6 Scan
5	3	Options Off	No Conference	No Auto-Hold	No Conference and No Auto Hold
6	4	Options Off	Allowed Out of Service	No Exchange Ringing when rung Terminal is engaged and allowed out of service	★

★ **CAUTION: These pins have high current inter-clock pull downs. DO NOT connect to V_{DD}.**

Table 2.1 System Options

SECTION 3 : CIRCUIT DESCRIPTION

3.1 GENERAL

The following circuit description is based on the KBX 6. The KBX 3 is similar in construction and operation, except for the omission of the following circuits:

- Negative half of the voltage comparator; IC2
- *Second Decoder IC, IC5
- *Second Exchange Line Interface; 800 series components
- *Terminal Interface Circuits 4, 5 and 6; 400, 500 and 600 series components
- The reverse LED and switch button signal circuits for Terminal Interfaces 1, 2 and 3.

*These circuits are mounted on the Extension board in a KBX 6.

Any significant differences in circuit operation as a result of the omission of these circuits are described in the text.

The circuit diagrams for the KBX 3/6 System are given on Figures 3.6 to 3.9. Figures 3.10 onwards show the circuits of typical terminals. It should be noted that circuit references may change between terminals.

3.2 EXCHANGE LINE INTERFACE

There are two identical, but separate, Exchange Line Interface circuits: 700 series components for Exchange Line 1 and 800 series components for Exchange Line 2. Only the Exchange Line 1 circuit is described.

3.2.1 Protection Circuit

Protection against high voltage transients on the exchange line is provided by the three varistors, R713 to R715, delta connected between the A and B Exchange Lines and the protective earth.

3.2.2 Loop Detector

The loop condition exists when a terminal is connected to or holding the Exchange Line.

Detection of an Exchange Line loop condition is provided by the dual-coil, reed relay RLLD(1). This relay is rated as must operate at 18mA and must release at 5mA. Relay contact RLLD1 sets signal E LP(1) active (+22V) to the Control IC.

3.2.3 Ring Detector

This circuit (TR700, TR701 and TR702) detects exchange ringing in the range 15Hz to 65Hz with an ac voltage difference on the exchange lines of 35V peak-to-peak or greater.

Transistors TR701 and TR702 form a differential amplifier with capacitor C700 eliminating transient pick-up. Since these transistors are not biased, they can only turn on when the difference signal across their bases exceeds twice the base-emitter voltage, and therefore they function as a detector for one polarity only.

The resulting output is a pulse train corresponding to the ringing cadence and modulated at the ringing frequency. This is monitored and fed to the Control IC by transistor TR700 as signal E RING(1).

3.2.4 Exchange Line Hold

This facility is provided by the Hold Relay, RLH to maintain an exchange loop when an exchange call is to be held.

Signal RLH(1), when active from the Control IC, switches on relay driver, TR703. Relay contact RLH1 connects a 240 ohm resistor, R712, across the A and B Exchange Lines.

The release of relay RLH is delayed by a timer circuit in the Decoder IC to reduce relay switching clicks on the exchange line.

3.2.5 Exchange Line Recall

Operation of the Terminal F button provides exchange line earthed leg recall. Signal RLR, when active (F button operated), switches on relay driver TR704. With Exchange Terminals B and C looped, and the exchange earth line connected to Terminal D, relay contact RLR1 provides an earth loop back to the exchange.

3.2.6 C-wire Signalling

This facility is an option selected by Option Switch 3 and without a loop between Terminals B and C (Section 3.2.5).

With this option Terminals C and D are connected together by the contacts of relay RLR when the exchange line is idle or ringing. When it is active or in the HOLD condition the short circuit state is removed and the two terminals become open circuit. If during the active state the 'F' (or 'R') button is operated the short circuit condition will be re-applied while the button is held down.

3.3 TERMINAL INTERFACE CIRCUITS

There are six similar Terminal Interface Circuits, three on the Control board (Figure 3.6), 100, 200 and 300 series components, and three on the Extension board (Circuit Diagram, Figure 3.7), 400,

500 and 600 series components. Only the Interface Circuit for Terminal 1 is described.

The differences between the Terminal Interface circuits are in the Relay Switching circuits, RLx00 and RLx01 as follows:

- Terminal 1 : RL101 is energised to connect to the intercom line (normal condition). In the power fail condition (relays de-energised), Terminal 1 is connected to Exchange Line 1.
- Terminals 2 and 3: RL200/RL201 and RL300/RL301 are unenergised (normal condition to connect to the intercom line.
- Terminal 4: RL400 and RL401 are energised to connect to the intercom line (normal condition). In the power fail condition (relays de-energised), Terminal 4 is connected to Exchange Line 2.
- Terminals 5 and 6: RL500/RL501 and RL600/RL601 are unenergised (normal condition) to connect to the intercom line.

Terminal Interface Circuits 4, 5 and 6 are not applicable to the KBX 3.

3.3.1 Relay Switching Circuit

In the system idle condition, the Terminal Interface circuit is connected to the intercom line via the relay switching circuit of RL100 and RL101. RL100 and RL101 energised and unenergised provide connections to the ring voltage and exchange lines.

The relays are controlled by signals RLA(1) for RL100, and RLB(1) for RL101. These signals are generated by the Decode IC and switch the relay driver circuits, TR102 and TR103.

3.3.2 Loop Detect Circuit

While the Terminal is on-hook, transistors TR100 and TR101 are cut-off and signal LP DET(1) to the Control IC is inactive. When the terminal goes off-hook, the current flow through R104, the terminal loop (speech pair A and B), R103, and R100 raises the base-emitter potential of TR101, turning it and consequently TR100 on. Signal LP DET(1) goes active high to the Control IC.

Transistor TR101 switches on with a loop current of 16mA or greater and switches off with a loop current of 5mA, or less.

3.3.3 Exchange Lamp Circuit

This circuit consists of two transistors, TR110 and TR109, connected in series across the +22V and -22V rails. The common point, collector resistors R119 and R118, feeds the two LED in the terminal. These two LEDs are connected in parallel (with opposite polarity) to the 0V rail.

Signal L+1(1) switches on transistor TR110, forward biasing the Exchange 1 LED. Signal L-2(1) is inverted by TR108 before switching on TR109 to forward bias the Exchange 2 LED. The two LED signals, L+1(x) and L-2(x) are multiplexed in the Decode IC.

In a KBX 3, only one exchange lamp is required. Therefore the L-2 signals to all three Terminal Interface circuits are inoperative and the TR108/TR109, TR208/TR209 and TR308/TR309 circuits are omitted.

Four-button terminals (one exchange line) for use in a KBX 3 or KBX 6 System are fitted with a reverse-connected protection diode in place of the second LED.

3.3.4 Scanning Control

These circuits, TR104 to TR107, form part of the terminal signalling circuits described in Section 3.4.

When signal S+F(1) is active, the normally on transistor, TR104 is turned off. This allows TR107 base current to flow through diode, D102, and resistor R109, turning on TR107. Current flows from the +22V rail, through resistor R901, the D2 line, and TR107 allowing capacitor C100 to charge as described in Section 3.4.

When signal S-R(1) is active, the normally off transistor TR105 is turned on. This allows TR106 base current to flow, turning on TR106. Current now flows from the -22V rail, through resistor R900, the D1 line, and TR106, reverse charging capacitor C100 as described in Section 3.4.

Diodes D103 and D104 provide reverse voltage protection to transistors TR106 and TR107 respectively.

3.4 TERMINAL SIGNALLING

The KBX 3/6 uses resistive signalling and storage capacitors to determine when a terminal button is depressed and to identify the button.

In the system idle condition, the Control IC continually scans each terminal in turn using the S+F signals from the Decode IC. Each S+F signal is active for 2ms, with a 1ms pause following the scans of the third and sixth terminals. This gives a total scan cycle time of 14ms. In a KBX 3, each of the three terminals are scanned for 2ms. with additional pauses to

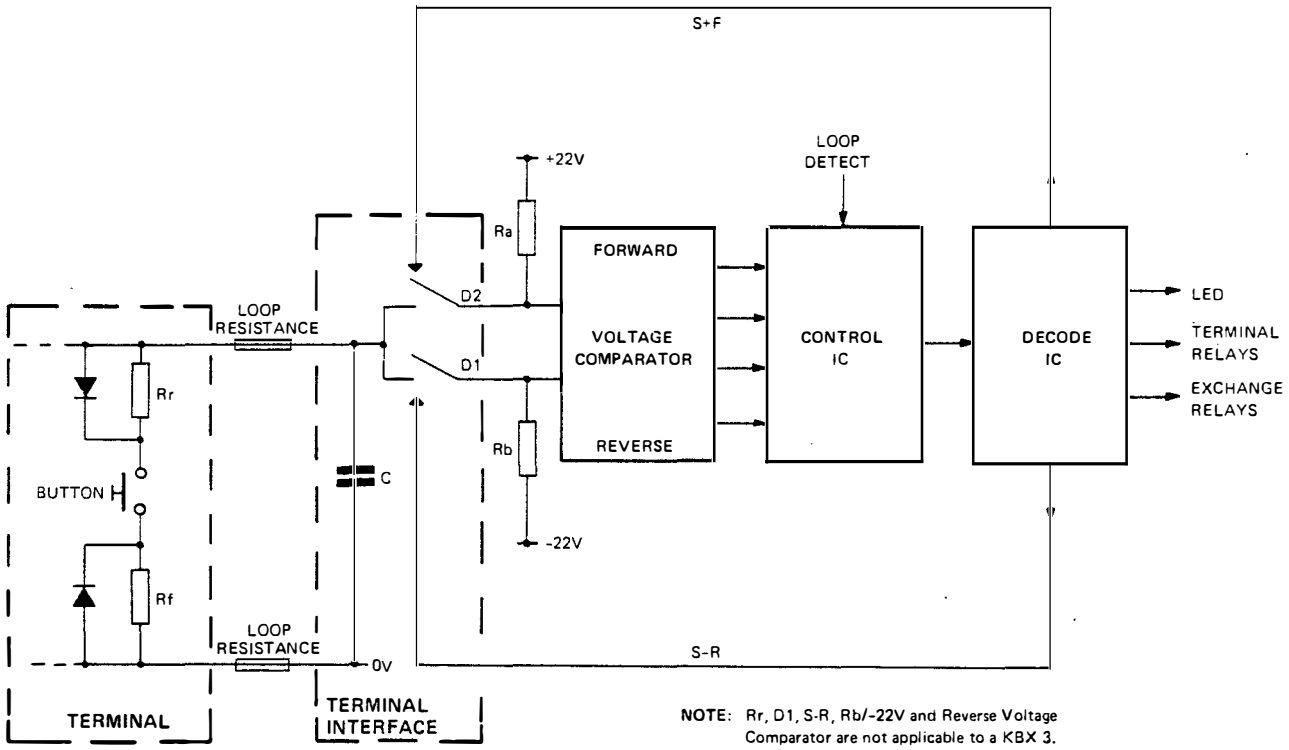


Figure 3.1 Terminal Signalling

maintain a scan cycle time of 14ms. Figure 3.1 shows in simplified form, the scanning and signalling circuits associated with one terminal.

Each S+F signal turns on the forward section of the Scanning Control circuit in the Terminal Interface. This connects the +22V supply via a resistor (Ra) in the voltage comparator circuit and the D2 line to a storage capacitor, maintaining its charge at approximately +22V. (Figure 3.2). This voltage level is sensed by the voltage comparator and converted to a four-bit parallel word to the Control IC; at this point the four-bit word indicates 'no button depressed'.

When a terminal button is depressed, two resistors and diodes are brought into circuit across the storage capacitor C. These resistors and diodes are arranged such that one resistor (Rf) conducts with a positive applied voltage and the other (Rr) conducts with a negative applied voltage.

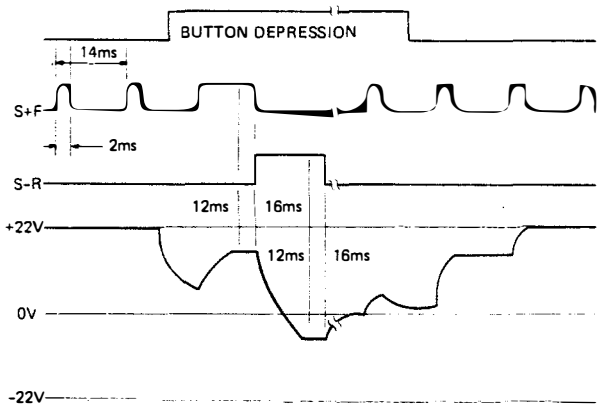


Figure 3.2 Signalling Circuits – Timing Diagram

Capacitor C begins to discharge through the connected resistor, in this case, Rf. At the next scan of the terminal, the voltage across C will have fallen to a level depending on the value of Rf and the time between the depression of the button and the beginning of the scan. This reduced level is sensed by the voltage comparator and fed to the Control IC. The actual level is not significant, since at this point, the Control IC is looking for a change in level to indicate a depressed button (Table 3.1).

When the Control IC detects a depressed button and the LP DET line is active (terminal off hook), the scan is halted. Signal S+F is maintained active, allowing capacitor C to recharge to a level determined by the value of Rf (and the loop resistance to a lesser extent). After a further 10ms, the charge on C should have stabilised and the Control IC reads and stores the four-bit word representing the voltage across C sensed by the voltage comparator. After a further 4ms, the Control IC checks the four-bit word output of the voltage comparator against the previously stored word. If the two words match, they are accepted as a valid indication of the voltage across C. Signal S+F is reset.

Signal S-R is immediately set active, turning on the reverse section of the Scanning Control circuit. The -22V supply is now connected, via Rb, to the storage

BUTTON		RESISTANCE		4-BIT WORD	
FUNCTION	SWITCH NO.	FORWARD	REVERSE*	FORWARD	REVERSE*
EXCH 1	S8	R1/100	R5/100	0111	0111
EXCH 2*	S2*	R1/100	R7/3.6K	0111	0001
EXT 1	S7	R2/1.3K	R6/1.3K	0011	0011
EXT 2	S1	R3/3.6K	R3/3.6K	0001	0001
EXT 3*	S5*	R3/3.6K	R5/100	0001	0111
EXT 4*	S4*	R2/1.3K	R5/100	0011	0111
EXT 5*	S3*	R3/3.6K	R6/1.3K	0001	0011
F	S6	R4/8.2K	R8/8.2K	0000	0000

*Not applicable to KBX 3

Table 3.1 Terminal Button Functions, Resistance Values and 4-Bit Words

capacitor C and terminal button resistor Rr. After 12ms, to allow the charge across C to stabilise, the voltage across C is read via the voltage comparator and stored; and then rechecked after a further 4ms, as for the forward scan of the button. This data word and the data word for the forward scan defines the depressed button. Signal S-R is reset and the scan of the terminals continues.

The eight terminal buttons use four different resistance values for Rf and Rr, with each button switching in a different combination of resistors. Thus, for each scan, forward and reverse, the voltage comparator senses one of four levels with the combination of the two levels read by the Control IC identifying the depressed button.

Once a button depression has been detected and identified, the control IC does not pause or respond to any further button data from that station until an all button released condition is received for at least 4ms.

The terminal signalling in a KBX 3 is similar to that described, except that a reverse scan of the depressed button is not performed. Consequently, the circuits associated with the reverse scan are not implemented. Since a KBX 3 Terminal only employs four signalling buttons, the four different resistance values for Rf are sufficient to identify the depressed button.

The range of terminal button resistor values is such that the voltage comparator can separate and detect the four voltage levels with the minimum or maximum permissible loop resistance inserted, with LED current flowing and line noise.

The various actions resulting from the operation of one or two terminal buttons are listed in Table 3.2.

ACTIVE SIGNAL	TERMINAL KEYSWITCH	ACTION
LP DET	Any Extension keyswitch	Rings that extension
LP DET	Any Exchange keyswitch	Connects terminal to that exchange line
LP DET	F followed by EXT 1	Diverts incoming calls
LP DET	F followed by EXT 2	Cancels diversion
LP DET	F followed by EXCH 1	Programs exchange line 1 ringing
LP DET	F followed by EXCH 2	Programs exchange line 2 ringing
LP DET	F twice	Cancels exchange ringing
E LP	Any Extension keyswitch	Holds exchange line and rings that extension
E LP	Associated Exchange keyswitch	Holds exchange line
	Other Exchange keyswitch	Holds first exchange line and connects other exchange line
LP DET and E LP	F following a transfer	Connects both terminals to exchange line, i.e. a conference call
LP DET and E LP	EXCH after hold	Reconnects held exchange call

Table 3.2 Terminal Button Actions

3.5 CONTROL IC

This is a type TMC 1215, NMOS device specially developed for the KBX 3/6 System. It receives inputs representing the states of the terminals (off-hook, button depressed, etc) and the exchange lines (ringing, looped, etc). From this information, it determines what action; if any, is required and transmits appropriate control data to the decoder devices.

It should be noted that compatibility between the NMOS Control IC and the PMOS Decoder ICs is achieved by powering the Control IC from the +22V and +10V (junction of R944 and D910) rails and the Decoder ICs from the +22V and 0V rails.

In the KBX3 configuration the Control IC treats the system as an under equipped KBX6 with the exception that with the 1+3 scan option selected there is no attempt made by the Control IC to reverse the polarity of the station signalling line (D) during a button identification/validation sequence. Access to the unused stations and exchange line functions within the Control IC are debarred by the restricted button input codes allowed by the single polarity scan and the absence of data on the respective input lines i.e. Lp Dets.

Operation of the Control IC is time controlled to produce a basic operational cycle of 14ms. This is divided into six 2ms output time slots with two inactive 1ms phase shift periods. Timing is controlled by an internal 24kHz clock, giving 48 clock cycles per time slot.

During each 2ms time slot, a valid, 24 bit control data word is sent to one group of three stations via a Decode IC and one of the stations is scanned for a possible button depression. These data words are described in Section 3.6.

Within the Control IC (Fig 3.3a) the current system status is held in an eight-stage recirculating register, the Main Status Register, clocked at 24kHz. The eight stages of the register are organised as four pairs (Fig 3.3b) as follows:

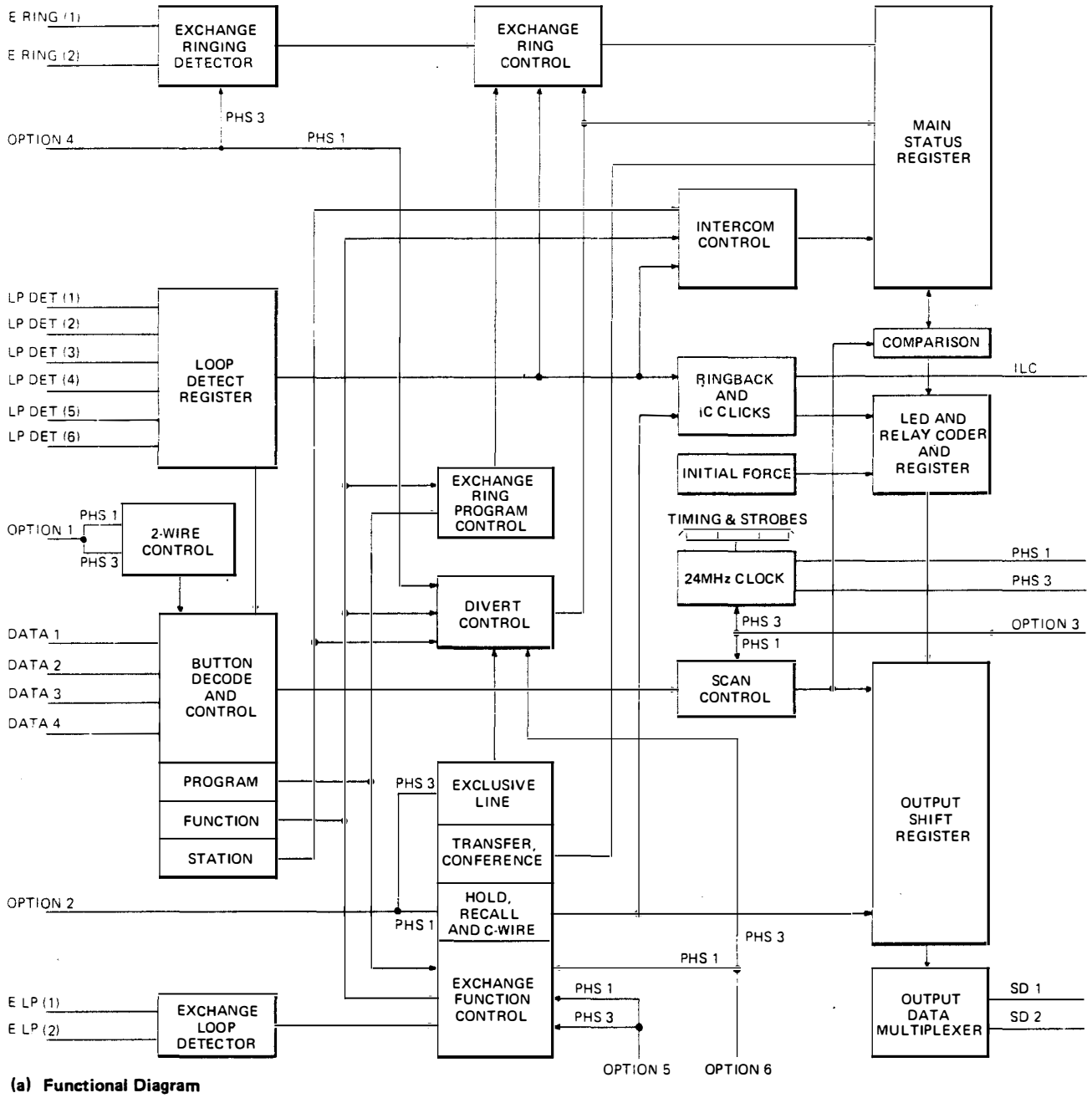
- First Pair (Main 1 and Slave 1). The code of the station (main) currently connected to or holding Exchange Line 1 and, if applicable, the code of the station (slave) last called by the main during a hold, transfer, or conference connection.
- Second Pair (Main 2 and Slave 2). The main and slave station codes for Exchange Line 2.
- Third Pair (Call 1 and Destination 1). The codes of the calling and called stations currently connected via the intercom.
- Fourth Pair (Call 2 and Destination 2). The codes of a second pair of calling and called stations connected via the intercom. Although only one intercom call at a time is feasible, this pair of codes provides for the temporary situation where a station wishes to hold or transfer an exchange call with an intercom call already in progress.

Station codes are loaded into the appropriate Main Status Register stages by the various control circuits. For example, lifting a handset and pressing a button for another extension produces two inputs to the Control IC, a loop detect signal for the calling station and button depression data for the called station. The loop detect signal enables the button depression data to be decoded and the two together cause the loading of the codes for the calling and called stations into the Call 1 and Destination 1 stages of the Main Status Register. The called station code is loaded via the Divert. Control. Thus, if a diversion exists on the called station, the diverted station code is forced into the Main Status Register.

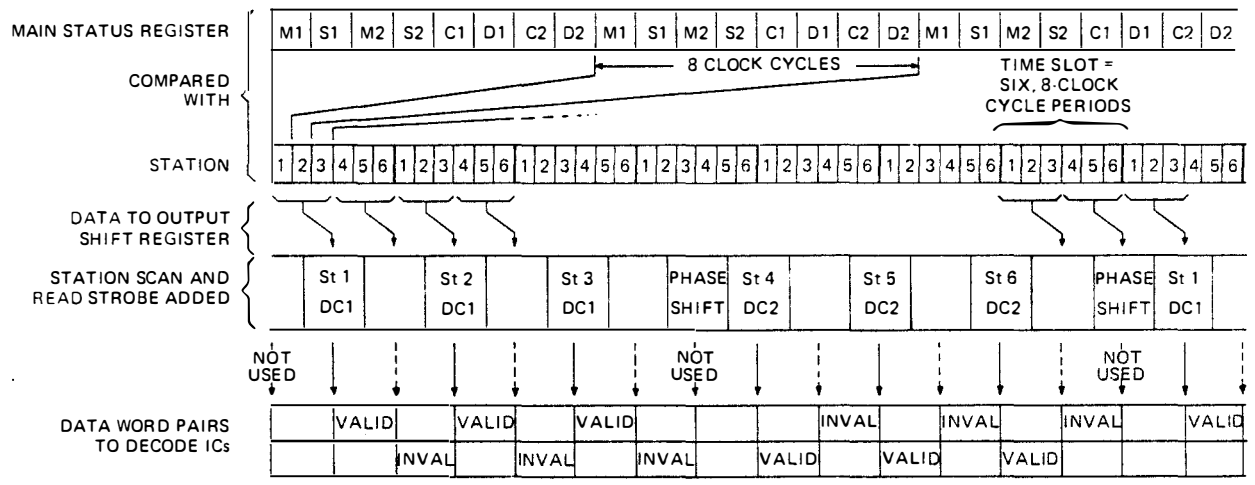
Alternatively, an incoming exchange call (e.g. exchange line ringing detected on line 1) causes the Exchange Line Ring Control to read the Divert Status Register to determine whether to ring Station 1 or a diverted station, the Loop Detect Register to determine if Station 1 or its diverted station is free, or if not, to read the Exchange Line Calling Program Register and the Loop Detect Register to determine which stations are free and programmed to receive exchange ringing.

Each time slot is divided into six, 8-clock cycle periods, one for each of the six stations. During each period, the code of the station allocated to that period is compared stage by stage with any station codes held in the Main Status Register. If that station's code is detected, its position within the Main Status Register is flagged to the LED and Relay Coder which loads its register with an appropriate bit.

After three periods, sufficient data will have been loaded into the LED and Relay Register to construct a complete data word for Decoder 1 (IC3) for Stations 1 to 3. This data is loaded into the output register and transmitted serially, via SD1 and SD2 to both Decode IC's together with a scan control bit. A read strobe is only transmitted with the data stream from SD1, thus only Decoder IC1 reads the data. During the time (24 clock cycles) this word is being transmitted, data on the second three stations is received and loaded into the LED and Relay Register. This data is loaded into the Output Register at the end of the time slot (after transmission of the control data word to Decoder 1). It is then transmitted



(a) Functional Diagram



(b) Timing Diagram

Figure 3.3 Control IC, Functional and Timing Diagram

serially via SD1 and SD2 but without any scan control bits. A read strobe is only transmitted with the data via SD2 thus Decoder IC2 will read this data stream. During the next two time slots, the foregoing procedure is repeated with scan control bits being transmitted to Stations 2 and 3 respectively.

The scan control bits are added to the control data words at transmission time to allow 2ms for any returned button depression data to stabilize (Section 3.4) before the Control IC halts to decode a button depression. Hold, recall, and c-wire signalling data is also loaded directly into the Output Status Register as described later.

After Stations 1 to 3 have been scanned it is necessary to shift the button scan information by half the 2ms scan period in order to allow for the 1ms time difference between Decoder IC1 reading its data and Decoder IC2 reading its data. The decision to continue scanning to Station 4 (or 1) or stop at Station 3 (or 6) for a button decode must be taken after the scanning data to Station 4 (or 1) for that period has been sent. Thus the instruction to scan the next Station must wait until half way through the next 2ms scan period. The scanning and data sequences for the next 3 Stations follow the same pattern as above with a similar phase shift or delay after the 3rd Station.

If a valid button depression is detected before the transmission of the next valid control data word, the operation is halted as described in Section 3.4.

Operation of the Control IC during the various call connection configurations is as follows:

- *Intercom Call.* An active loop detect signal allows button data from the calling station to be decoded as a required station. The codes for the calling and called stations are then loaded into the Main Status Register.
- *Incoming Exchange Call.* Exchange ringing detection causes the Exchange Ring Control circuit to scan the Loop Detect Register (which stations are free) the Divert Control circuit (any diversions in operation) and the Exchange Ring Program control (which stations are programmed to receive exchange ringing) before loading the selected station's code into the Main 1 or Main 2 stage of the Main Status Register.

  If all stations programmed to receive exchange ringing are engaged, the Control IC generates a click type signal (ILC) which is superimposed on the intercom line.
- *Outgoing Exchange Call.* An active loop detect signal allows button data from the calling station to be decoded as a required exchange line (function output from the Button Decode circuit). The calling station's code is then loaded into the Main 1 or Main 2 stages of the Main Status Register.
- *Hold, Transfer, and Conference.* With an exchange call in progress (active exchange loop signal), the Exchange Function Control circuits receive button decode data. This causes the appropriate transfer or conference station codes to be loaded into the Main Status Register, or hold, recall, or c-wire data to be loaded directly into the Output Shift Register. The Ringback circuit detects the loss of the loop detect signal if a held exchange call is not recalled before the call is cleared.
- *Diversion.* Operation of a Function button followed by an extension button when the station is not connected to an exchange line is interpreted by the Divert Control circuits as a programmed diversion: the loop detect signal from the diverting station must be active.
- *Programmed Exchange Ringing.* Operation of a Function button followed by an Exchange button when the station is not connected to an exchange line is interpreted by the Exchange Ring Program Control circuits as a programmed ringing instruction: the loop detect signal from the programming station must be active.
- *Options.* The various options are implemented by connecting the options pins as listed on Sheet 2 of Figures 3.6 and 3.8. Input circuits (not shown on Figure 3.6(a) detect the presence of a PHS 1 or PHS 3 connection and causes the appropriate circuits to implement the option.

The Initial Force circuit controls the Station Interface circuit relays for Stations 1 and 4. Relays RL101 and RL401 respectively are forced into the normally energised state to connect these station circuits to the intercom, except when engaged on an exchange call.

3.6 DATA TRANSFERS

Control instructions are generated by the Control IC as a serial stream of 24-bit word pairs, one word for each Decode IC. The serial stream is sent separately to both Decode IC on the SD1 and SD2 lines. Each word pair includes a Read Synch pulse indicating which word is valid for that Decode IC, e.g. word 1 to the first Decode IC (IC3) has an active Read Synch Pulse and word 2 to the second Decode IC (IC5) has an active Read Synch pulse. The Read Synch pulses are generated by setting the inter-bit gap, following the 24th bit, active.

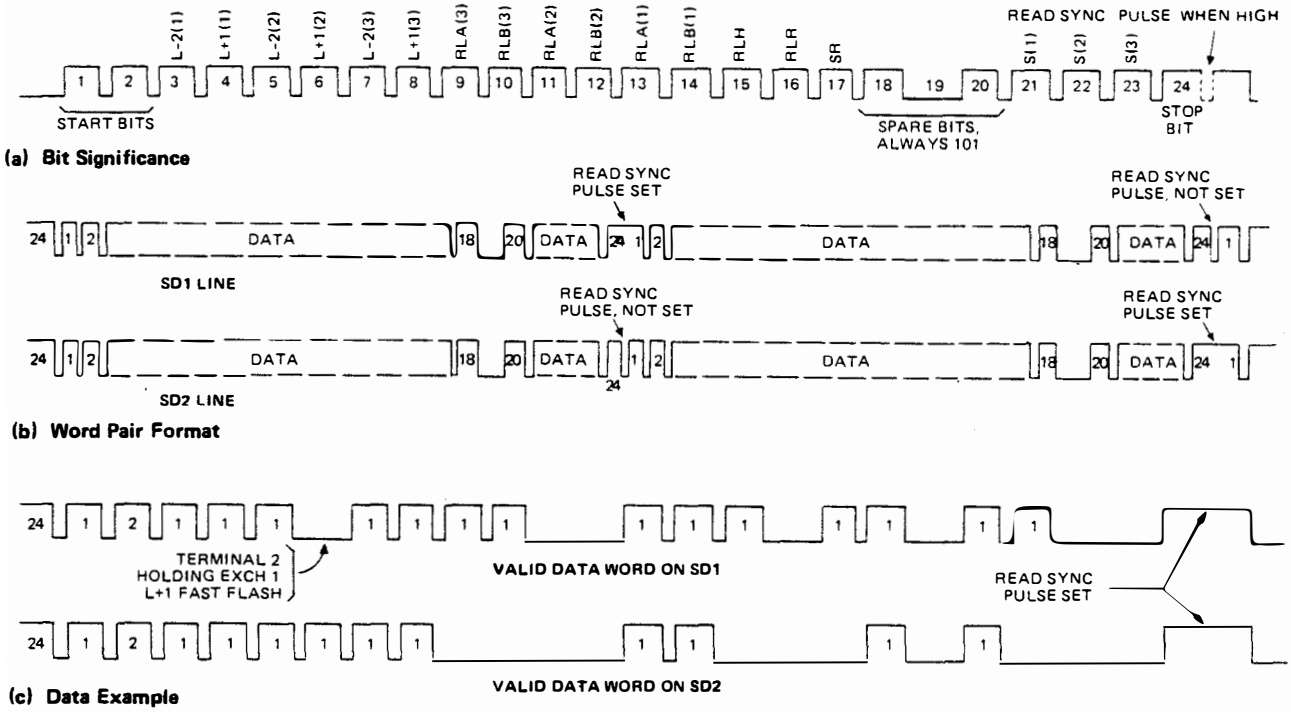


Figure 3.4 Data Transfers

The word format is shown on Figure 3.4(a) and Figure 3.4(b) illustrates a word pair format.

Figure 3.4(c) illustrates typical valid data words for the conditions listed in Table 3.3.

Terminal 1 buttons are being scanned (S+F(1)) as shown by bits 17 and 21 set active in the valid data word on the SD1 line.

L+1 to terminal 2 is being flashed to indicate the held exchange line.

In a KBX 3, the same type of serial, word-pair stream is sent to the Decode IC (IC3). However, the second word is not decoded since a second Deocde IC is not fitted.

The transmission rate of 24k bauds is synchronised with the 24kHz PH1/PH3 clock signals to give a transmission time of 1ms per 24-bit word (2ms for a word pair).

TERMINAL	STATE	RLx00	RLx01	L1	L2
1	On-hook, connected to intercom	Energised	Energised	Lit	Lit
2	Off-hook, holding Exchange Line 1, speaking to Terminal 4	Unenergised	Unenergised	Fast Flash	Lit
3	Off-hook, connected to Exchange Line 2	Energised	Energised	Lit	Lit
4	Off-hook, speaking to Terminal 2	Energised	Energised	Lit	Lit
5	On-hook, connected to intercom	Unenergised	Unenergised	Lit	Lit
6	On-hook, connected to intercom	Unenergised	Unenergised	Lit	Lit

Table 3.3 Some Conditions for Data Transfer

3.7 DECODE IC

This is a PMOS device specially developed for the KBX 3/6 System. The block diagram of the Decode IC is shown on Figure 3.5. Each Decode IC can drive three Terminal Interface circuits and one Exchange Line Interface circuit.

The leading 23 bits of each incoming word from the Control IC (Section 3.6) are loaded into the 23-bit shift register.

The 24th bit and the Read Synch pulse (active or inactive) are detected by the Read Strobe Extractor. If the Read Synch pulse is active, a strobe pulse is generated which transfers the data bits to the LED Data, Relay Data and Signal Data Latches, overwriting (but not necessarily changing) the data already held in these latches.

If the data word is not valid for the Decode IC (Read Synch Pulse inactive), the data bits remain in the shift register until overwritten by the next data word.

Since the Read Synch pulse is received once every two words (2ms), the strobe output of the Read Strobe Extractor provides a 2ms clock signal to the 10ms Timer.

The six LED signals, two for each terminal, are multiplexed at 50Hz (÷2 output of the 10ms Timer) before being applied to the LED Output Drivers. Multiplexing of each pair of LED signals (L+1 and L-2) causes the drive to the LED to alternate, allowing the use of common wires to the terminal. The LED cadences, on, fast flash, slow flash, and off, are controlled by the Control IC. This sets the appropriate data bits:

- Active in each data word for steadily lit.
- Active for 192ms (96 data words) and inactive for 320ms (160 data words) for a fast flash (2Hz).
- Active for 384ms (192 data words) and inactive for 640ms (320 data words) for a slow flash (1Hz).
- Inactive in each data word for off.

The eight individual relay data bits are also held active in each data word for the period of energisation of the relays. Data bits 13, 14 and 16 are applied directly to the Relay Output Drivers to produce signals RLA(1), RLB(1) and RLR respectively. The remaining relay data bits 9 and 10, 11 and 12 and 15 are applied to the Relay Output Drivers via delay circuits.

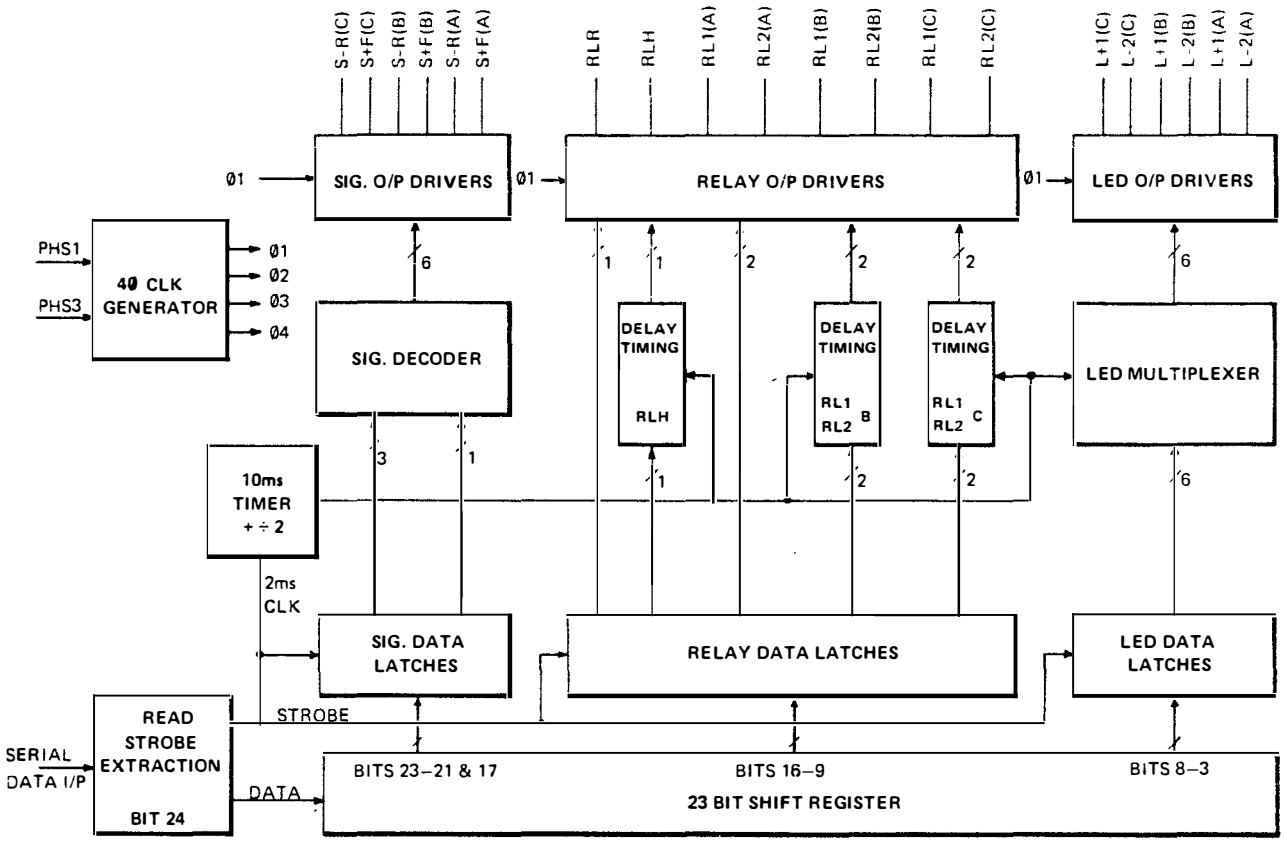


Figure 3.5 Decode IC Block Diagram

Data bits 9 and 10 (RLB(3) and RLA(3)), and 11 and 12 (RLB(2) and RLA(2)) are delayed to reduce clicking on the exchange line when these relays are switched. Data bit 15 (RLH) is delayed to reduce transients and erroneous clear pulses.

The four Signal Data bits (17 and 21 to 23) are coded as follows:

- Bit 17 active represents a forward scan of a terminal's signalling resistors and when inactive a reverse scan, S+F and S-R respectively.
- Bits 21 to 23 represent the terminal to be scanned. Only one at a time is set active.

Table 3.4 illustrates the coding of bits 17 and 21 to 23.

Since each terminal is scanned for 2ms in the forward direction, each bit is active (A) or inactive (I) for one data word (one word pair period). When a depressed button is detected, the S+F signal followed by S-R signal are set active for 16ms each (eight data words). These four bits are decoded to produce the six Signal Data signals, S+F and S-R for each of the three terminals connected to the Decode IC. These signals are fed to the terminals via the Signal Output Drivers.

DATA BIT	17	21	22	23
S+F(1)	A	A		
S-R(1)	I	A		
S+F(2)	A		A	
S-R(2)	I		A	
S+F(3)	A			A
S-R(3)	I			A

Table 3.4 Coding of Data Bits 17 and 21 to 23

Bits 17 and 21 to 23 are then sent to the second Decode IC in the same pattern to complete the scanning of the other three terminals in the System.

In a KBX 3, the scan pattern generated by the Control IC does not include the reverse scan or the signals to the second, non-existent, Decode IC.

3.8 RINGING VOLTAGE GENERATOR

The Ringing Voltage Generator is provided by the astable multivibrator, TR905 and TR907 and the Darlington Pair transistors, TR900 and TR901, and TR908 and TR909. The KBX 3 and KBX 6 use the same circuit configuration.

Transistors TR905 and TR907 generate two anti-phase 20Hz square waves (controlled by R925/C901 and R932/C902). These outputs are rounded by the shaping network R923, R933, D902, D905 and C900 and fed to transistors TR900/TR901 and TR908/TR909.

Each pair of Darlington Pair transistors function as high gain followers, driving the RING(A) and RING(B) lines with 20Hz, 40V peak-to-peak rounded square waves.

A terminal sounder connected to the RING(A), RING(B) lines will see the difference between the two lines, that is 80V peak-to-peak approximately.

3.9 INTERCOM POWER SUPPLY

Power for the intercom line is provided from the +22V(Q) and -22V(Q) power supply outputs via the noise filter (TR910) and the constant current sources (TR911 to TR914).

Noise reduction on the intercom power supply is provided by:

- Taking separate outputs from the power supply units ($\pm$22V(Q)) rails.
- The noise filter TR910. Resistors R935 and R936, and capacitors C904 and C905, connected across the $\pm$22V (Q) rails provide a noise free input to the regulator TR910.

The constant current sources, TR912/TR914 and TR911/TR913 and the capacitor C906 provide a low dc resistance and high ac impedance power source for the intercom lines I/C(A) and I/C(B). This type of circuit is known as a double-gyrator, providing maximum power to the intercom line with minimum attenuation of the speech paths and minimum common-mode pick up.

3.10 POWER SUPPLY UNIT

The circuit diagram for the power supply unit, which is the same for the KBX 3 and KBX 6, is given in Figure 3.9.

The power supply unit provides the +22V dc and -22V dc rails required by the KBX 3/6. Apart from the polarity changes to the diodes and electrolytic capacitors and the use of n.p.n. and p.n.p transistors, the +22V and -22V regulator circuits are identical. Therefore only the +22V circuit is described.

The incoming mains supply, nominally 110V ac or 240V ac is stepped down to 30V-0-30V by trans-

former T1 and full wave rectified. The power supply unit will function correctly with mains input of 90V to130V (110V version) or 180V to 260V (240V version. It should be noted that a tapped primary winding is used for the alternative mains input. This tap is wired during manufacture.

The output voltage of the +22V regulator circuit, across capacitor C10, is monitored by resistors R16 and R18 and transistor TR8. The voltage at the junction of R16 and R18 is compared with the reference voltage across zener diode, D12 by TR8. When the output voltage is low, TR8 is cut off. Consequently, TR6 (via R26) is also cut off, allowing the Darlington pair, TR4 and TR2 to conduct. This pulls TP2 (Test Point 2) up towards the input voltage (pin G) with the voltage across inductor L2 approximately equal to the difference between the input and output voltages.

Due to the inductance of L2, the current through it rises linearly. This current feeds the output, via R13, causing the output voltage to rise until TR8 is turned on, turning off TR4 and TR2 via TR6.

The energy stored in L2 when TR2 cuts off, pulls TP2 negative until diode D6 conducts at -0.7V. This energy is then released to the output.

The output voltage then drops due to the load current which discharges the output capacitor, C10, until TR8 turns off and the process is repeated. The frequency of operation may vary between 15kHz and 80kHz.

Hysteresis is provided for the output sensing circuit by R10 and the regenerative switching ensured by R8 and C6. These together ensure clear switching and eliminate instability.

When TR2 turns off and the voltage on TP2 is pulled towards 0V, the slew rate is limited by C4 and D8. These components allow TR2 to turn off fully before the voltage across it becomes too high. This ensures that the switching losses in TR2 are kept low. When TR2 is switched on again, resistor R2 discharges C4 ready for the next transition. Diode D10, prevents any spikes on TP2 from reverse biassing TR2.

Current flowing from L2 to the output passes through resistor R13. When the voltage drop across R13 is high enough, due to a high output current, TR10 is turned on, switching on TR6 and switching off TR2 early. Consequently, the output voltage drops and a current limit is produced.

Capacitor C8 and resistor R14 filter the waveforms on R13 to an average value with a small ripple, ensuring that the current limit does not vary with frequency of operation.

The current limiting circuit operates at currents greater than 900mA and limits the short circuit current to less than 1.5A approximately.

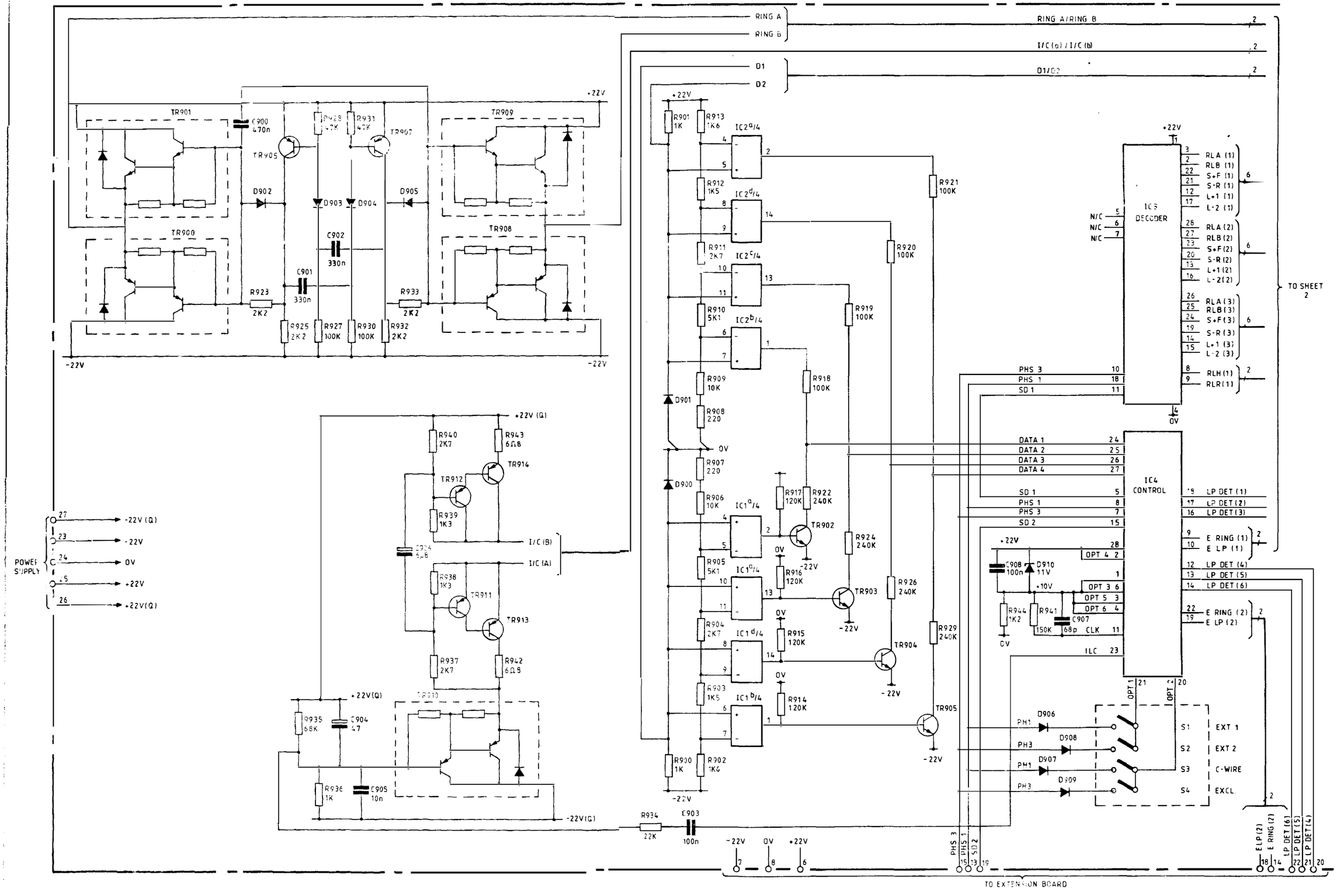
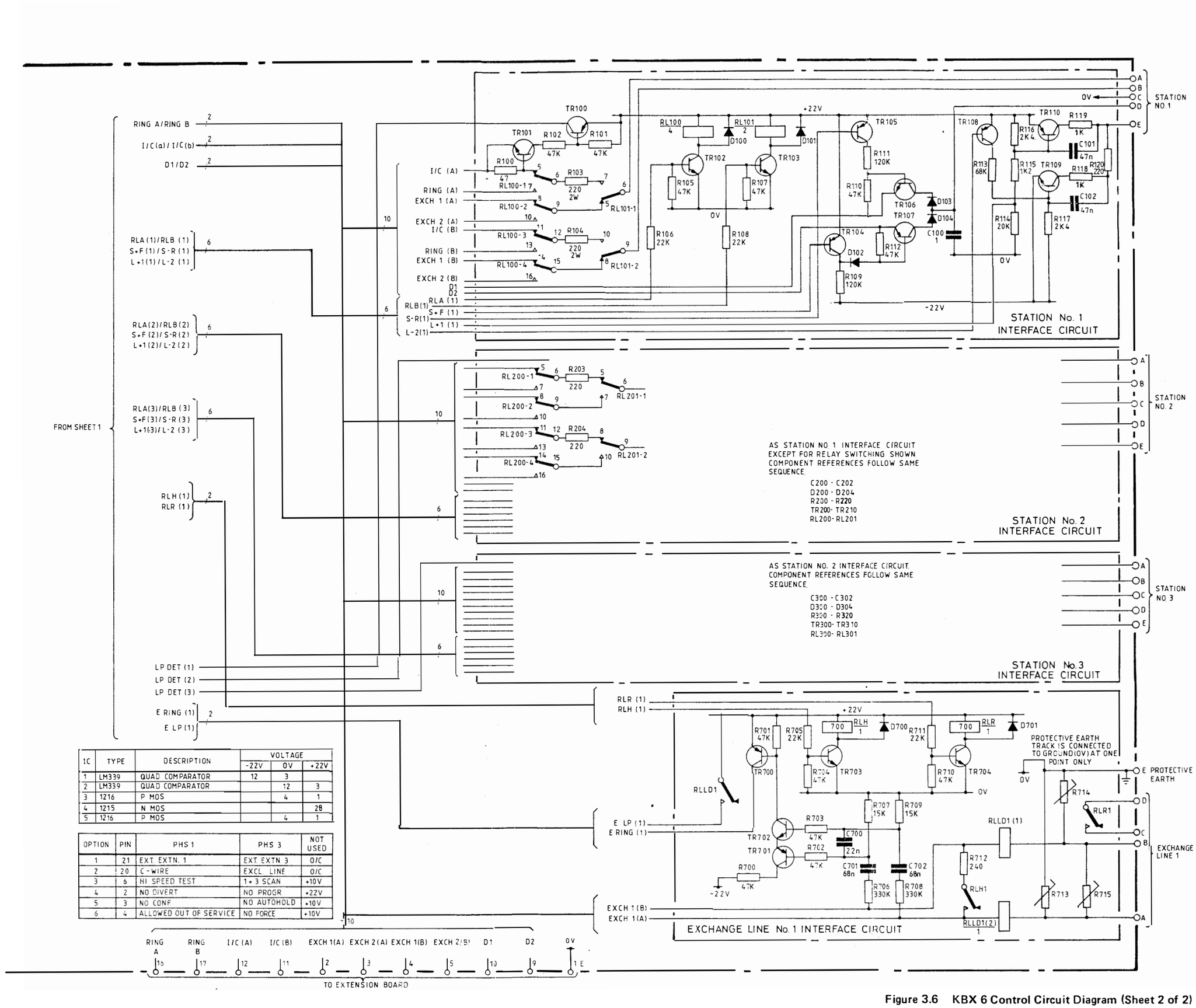


Figure 3.6 KBX 6 Control Circuit Diagram (Sheet 1 of 2)



IC	TYPE	DESCRIPTION	VOLTAGE		
			-22V	0V	+22V
1	LM339	QUAD COMPARATOR	12	3	
2	LM339	QUAD COMPARATOR		12	3
3	1216	P MOS		4	1
4	1215	N MOS			28
5	1216	P MOS		4	1

OPTION	PIN	PHS 1	PHS 3	NOT USED
1	21	EXT EXTN. 1	EXT EXTN 3	O/C
2	20	C-WIRE	EXCL LINE	O/C
3	6	HI SPEED TEST	1+3 SCAN	+10V
4	2	NO DIVERT	NO PROGR	+22V
5	3	NO CONF	NO AUTOHOLD	+10V
6	4	ALLOWED OUT OF SERVICE	NO FORCE	+10V

Figure 3.6 KBX 6 Control Circuit Diagram (Sheet 2 of 2)

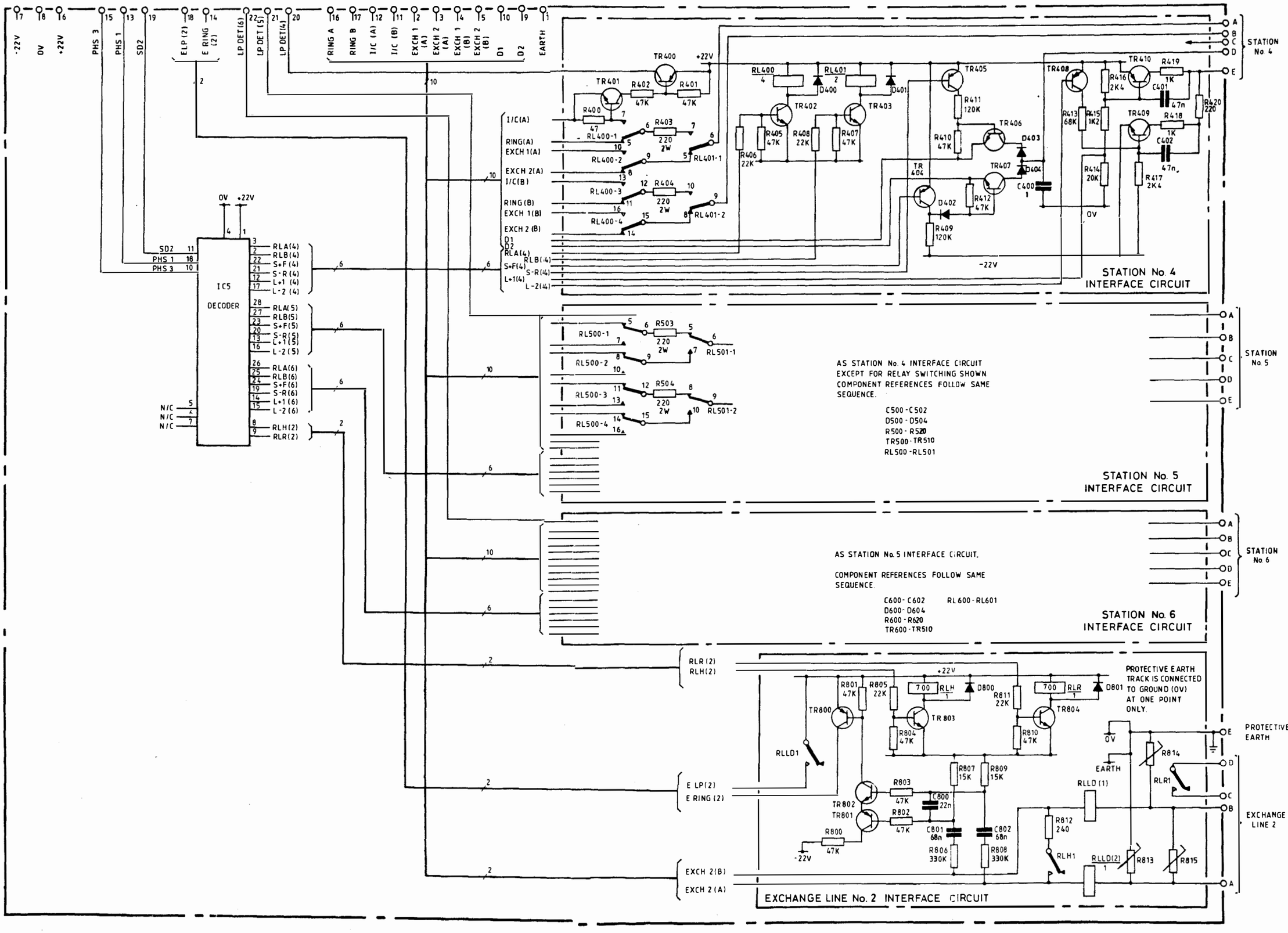


Figure 3.7 KBX 6 Extension Board Circuit Diagram

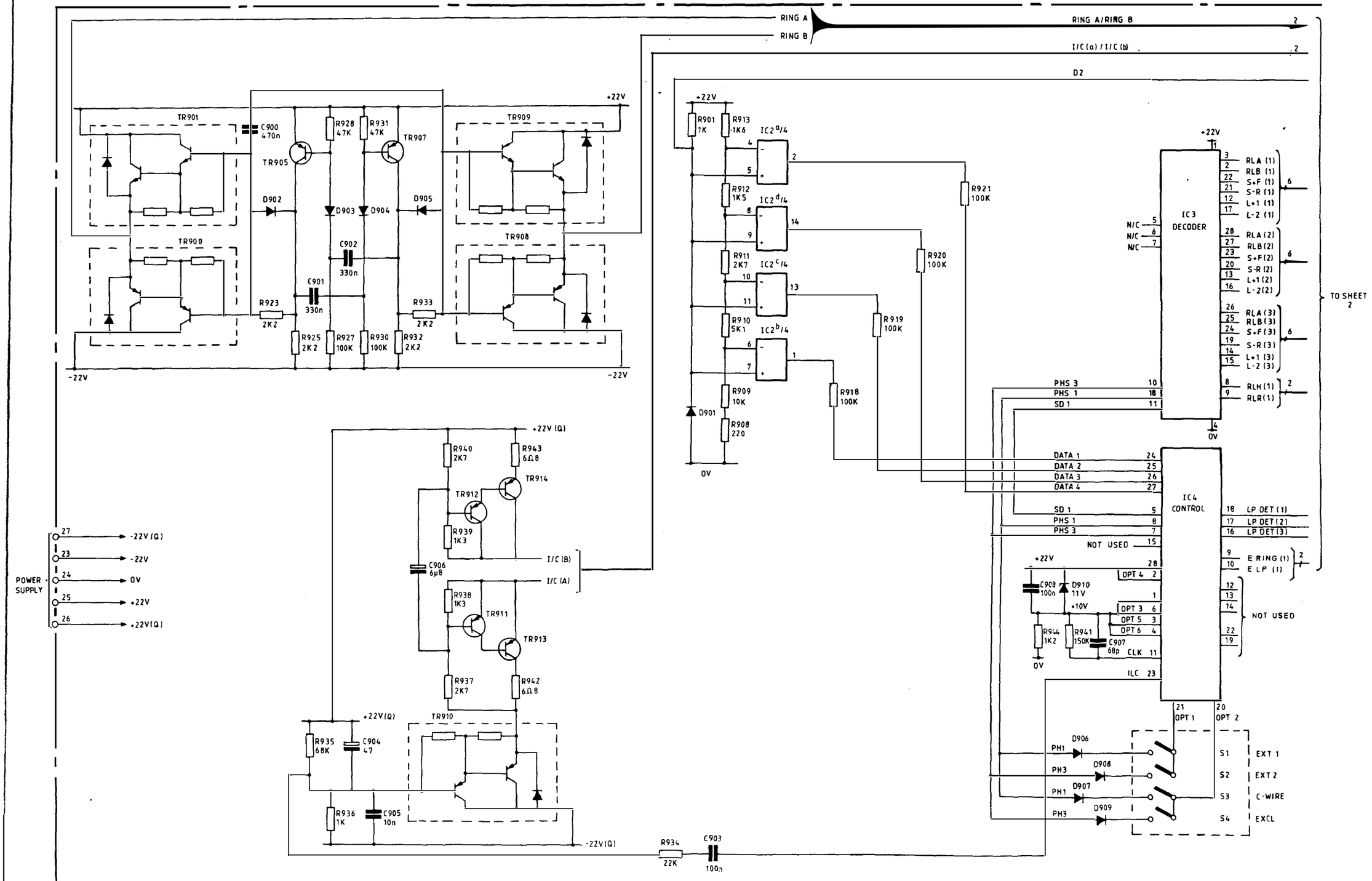
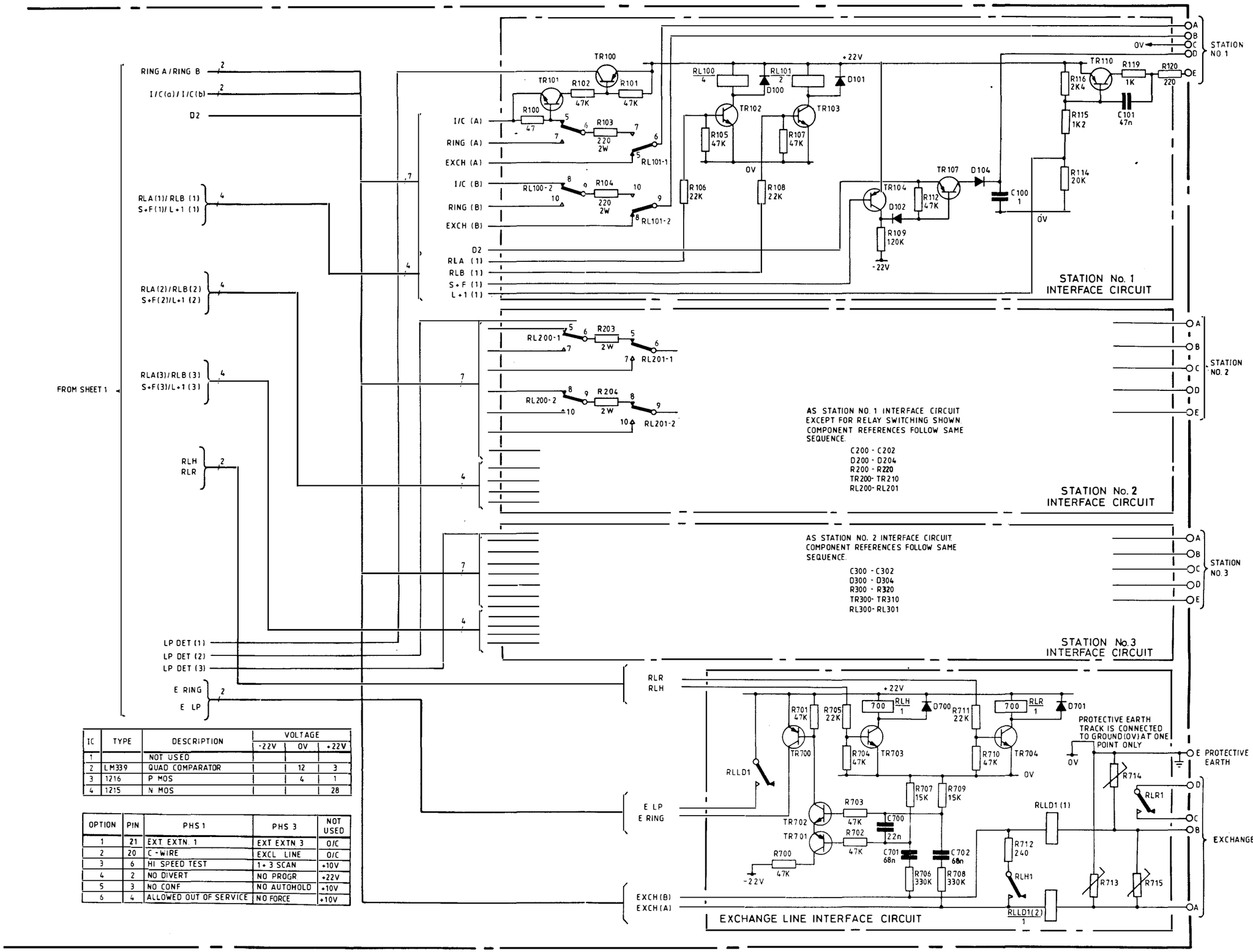


Figure 3.8 KBX 3 Control Circuit Diagram (Sheet 1 of 2)



IC	TYPE	DESCRIPTION	VOLTAGE		
			-22V	0V	+22V
1		NOT USED			
2	LM339	QUAD COMPARATOR		12	3
3	1216	P MOS		4	1
4	1215	N MOS			28

OPTION	PIN	PHS 1	PHS 3	NOT USED
1	21	EXT EXTN. 1	EXT EXTN 3	O/C
2	20	C-WIRE	EXCL LINE	O/C
3	6	HI SPEED TEST	1+3 SCAN	+10V
4	2	NO DIVERT	NO PROGR	+22V
5	3	NO CONF	NO AUTOHOLD	+10V
6	4	ALLOWED OUT OF SERVICE	NO FORCE	+10V

Figure 3.8 KBX 3 Control Circuit Diagram (Sheet 2 of 2)

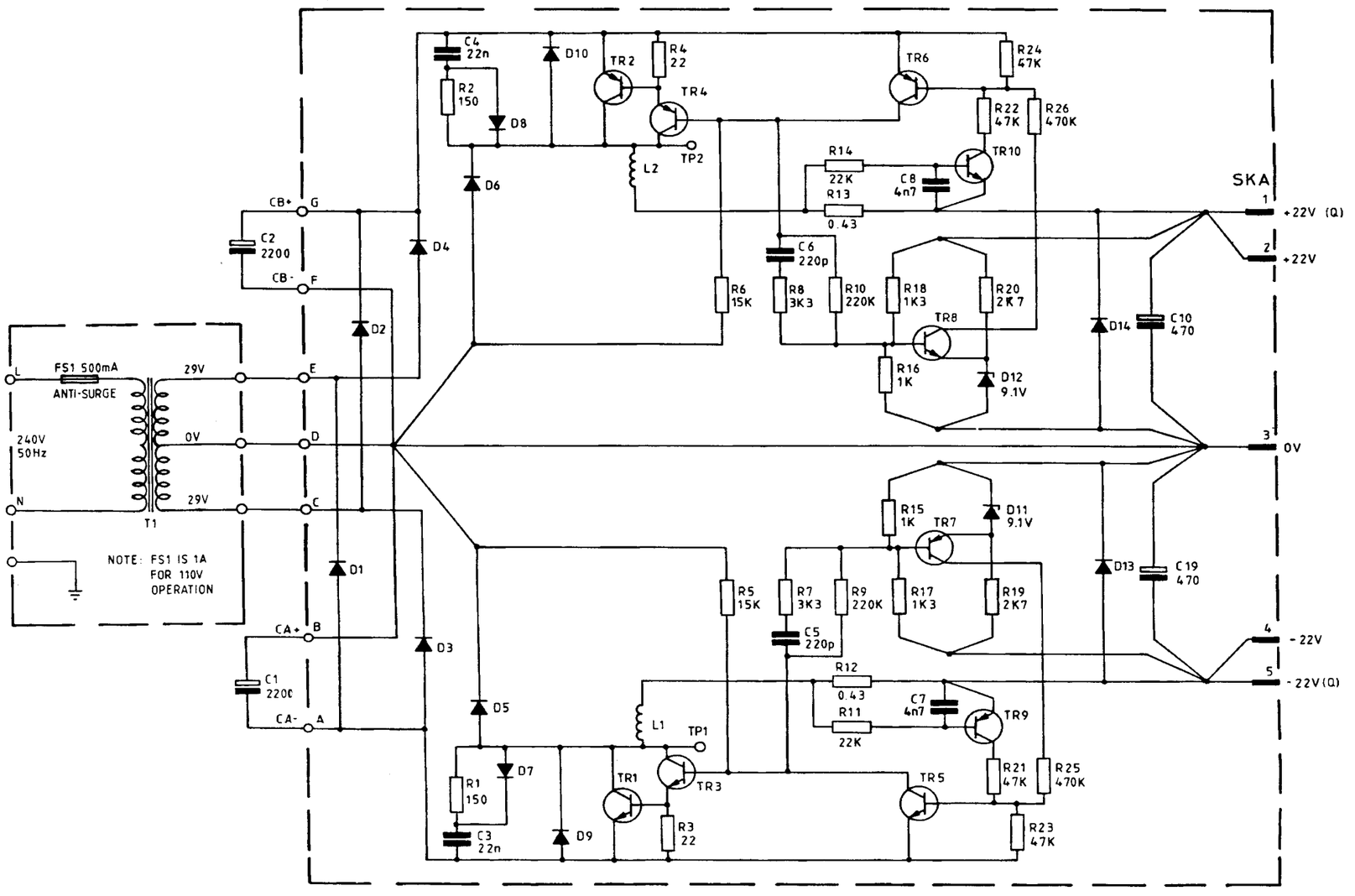


Figure 3.9 Power Supply Unit Circuit Diagram

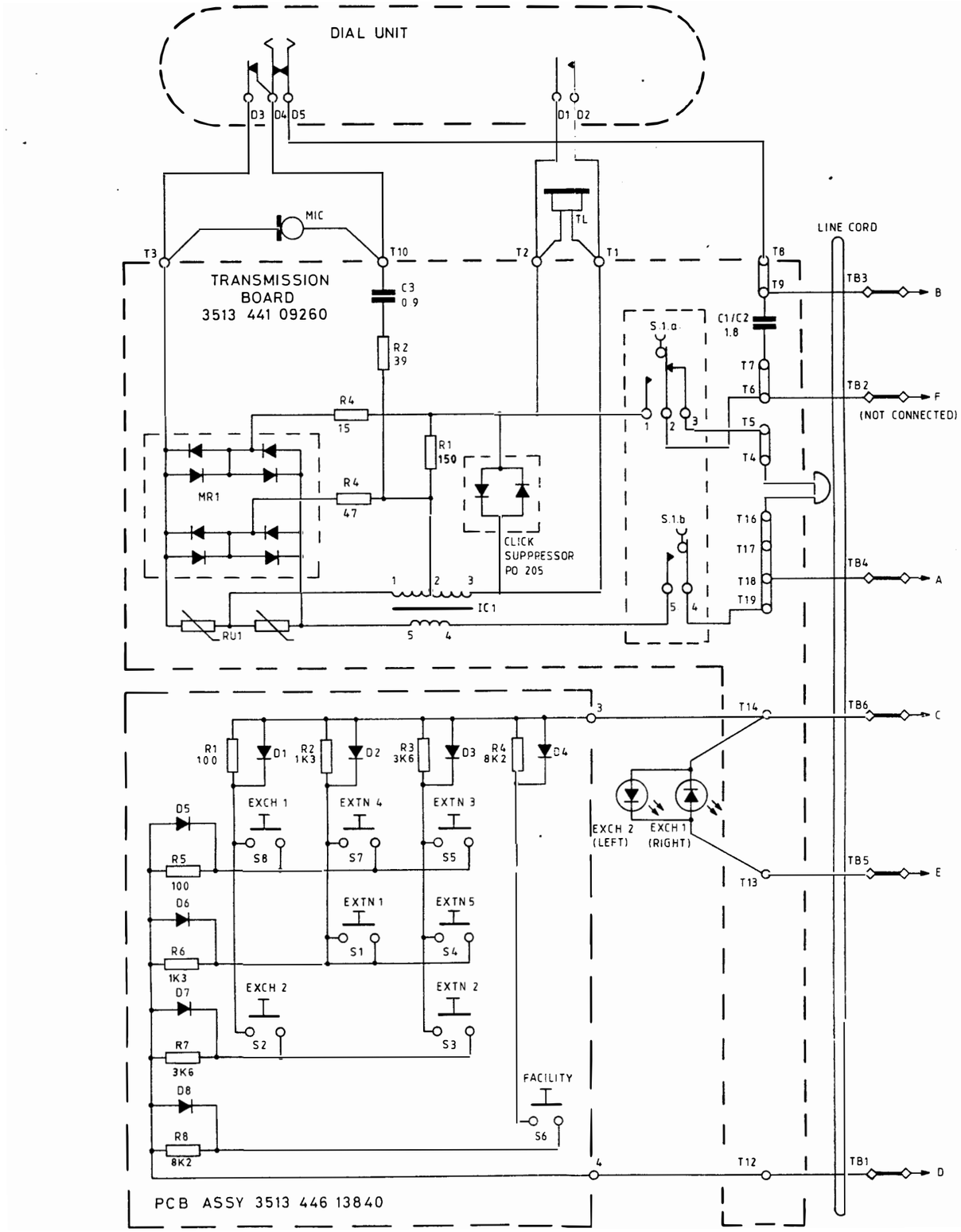


Figure 3.10 KBX 6 Terminal Circuit Diagram

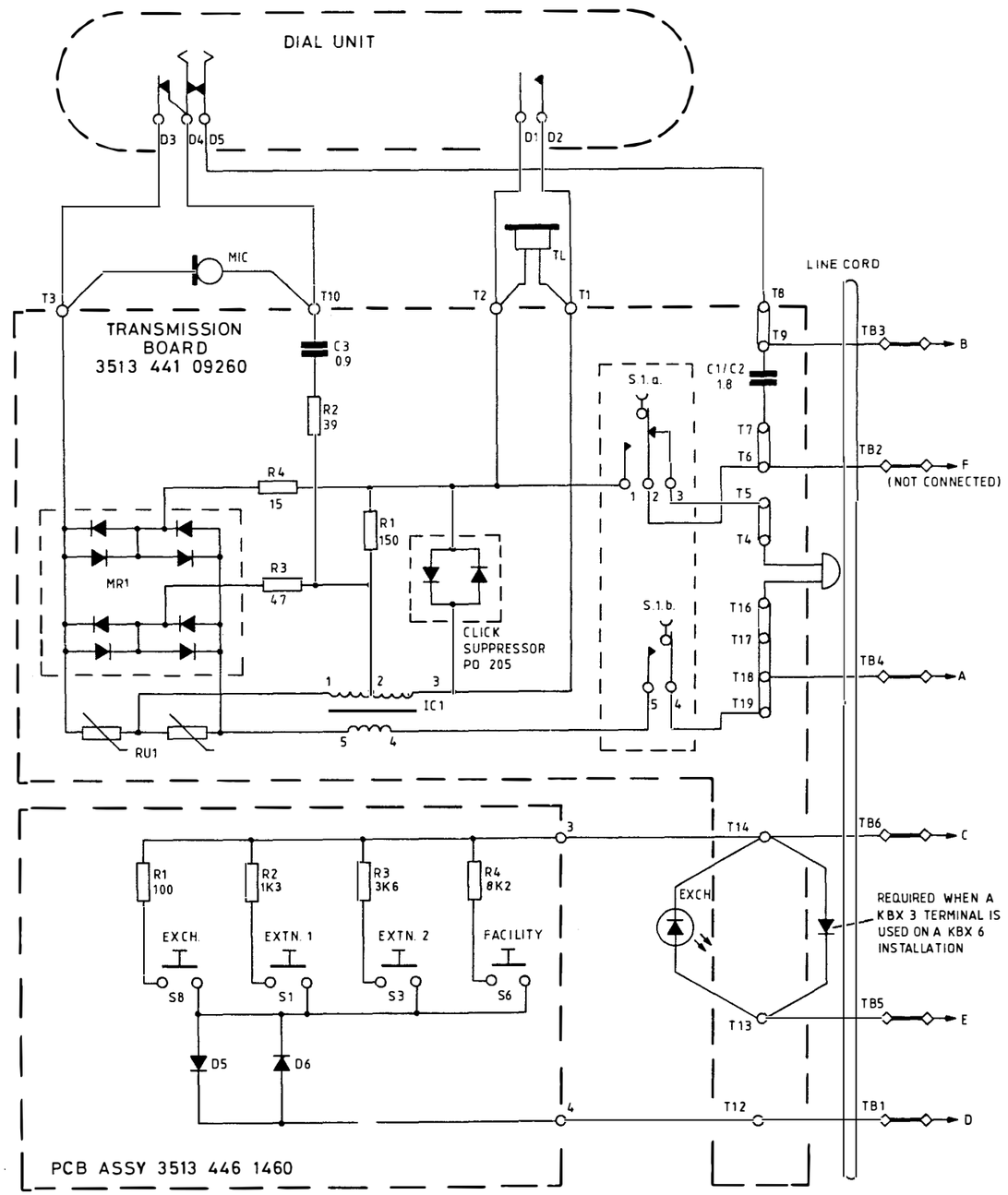


Figure 3.11 KBX 3 Terminal Circuit Diagram

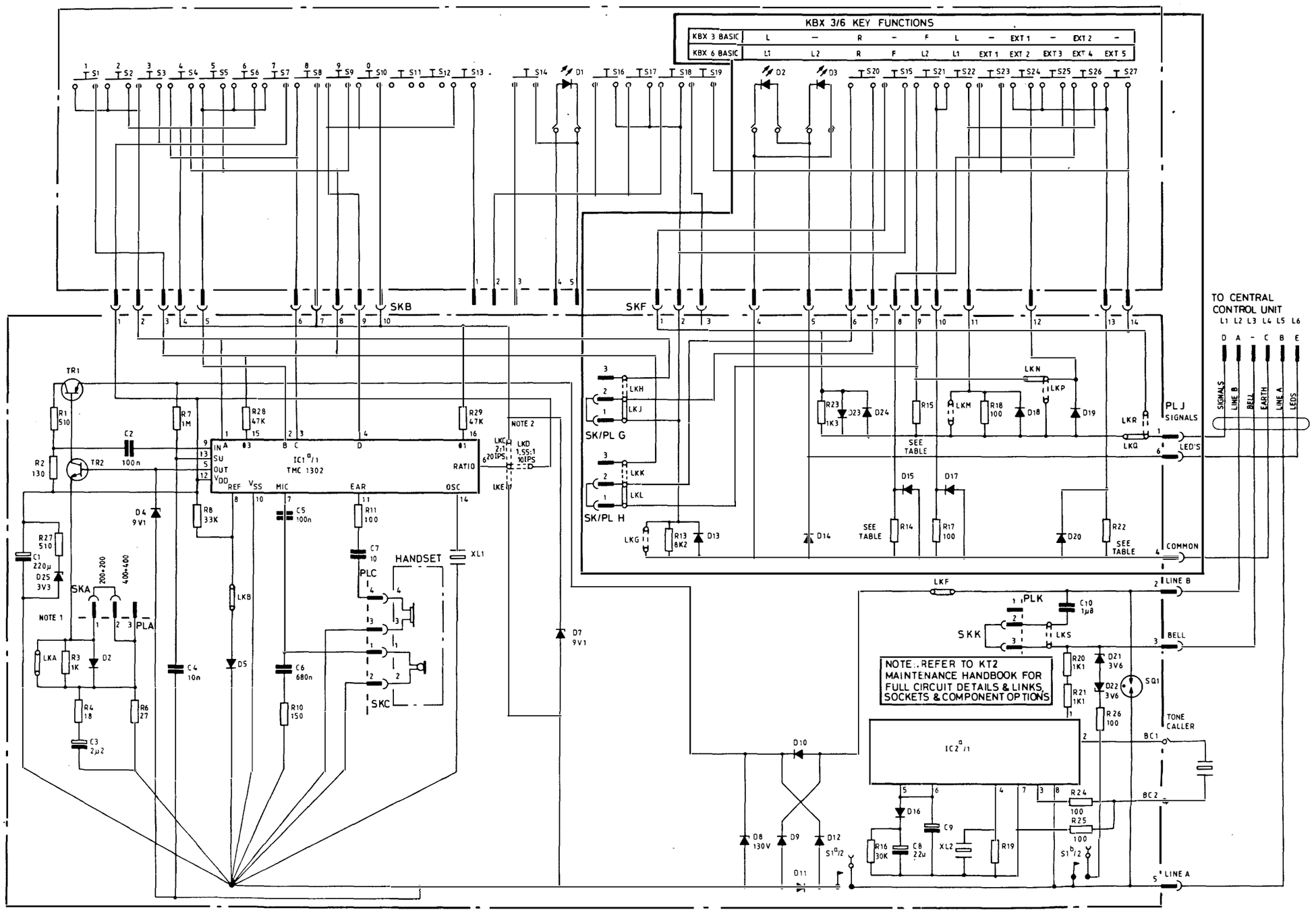


Figure 3.12 KT2 Terminal Circuit Diagram

4.1 GENERAL

This section of the handbook gives instructions for the removal, replacement and, where applicable, the testing of component parts of a KBX 3/6 with the exception of the speech circuits in the terminals. Reference should be made to the appropriate handbook for maintenance and fault diagnosis information on the type of terminal fitted in a particular KBX 3/6 installation.

CAUTION:
THE MOS INTEGRATED CIRCUIT MAY BE DAMAGED BY INCORRECT TESTING AND REPAIR METHODS.
Unless workshop facilities for handling this type of equipment are available, it is strongly recommended that the instrument should be returned to the manufacturer for repair or that the manufacturers be approached for advice on how this type of maintenance is carried out.

4.2 REPAIR POLICY

On-site fault diagnosis and repair should be limited to the location of the fault to a sub-assembly and the renewal of the complete sub-assembly.

These sub-assemblies are as follows:

CENTRAL CONTROL UNIT

- Mains transformer
- Power supply printed wiring board
- Control board in a KBX 3
- Control board and Extension board in a KBX 6 constitute one sub-assembly
- Miscellaneous items
  - Both covers
  - Mounting plate

Damage to the base plate of the Central Control Unit should be rectified by renewal of the complete Central Control Unit to keep repair time on site to a minimum.

TERMINALS

- Keyswitch sub-assembly
- Individual exchange lamps (LED)
- All other components and sub-assemblies as recommended in the maintenance and repair instructions for that type of terminal.

Before removing a faulty sub-assembly from the customer's site, it should be labelled with its fault symptoms. Instruments repaired at the Maintenance Centre should also be checked for other possible faults before being passed as serviceable.

Maintenance work on faulty sub-assemblies should be performed at a suitably equipped Maintenance Centre with workshop facilities and the necessary test equipment for the diagnosis of circuit faults. Whether minor repairs and replacements are done on subscriber's premises or at the Maintenance Centre will depend upon the operating Authority's practice.

4.3 RENEWAL OF CENTRAL CONTROL UNIT SUB-ASSEMBLIES

WARNING: **Disconnect the mains supply to the KBX 3/6 System before proceeding.**

4.3.1 Access

Loosen the two large headed screws securing the lower cover and remove the cover. Release the upper cover catches and lift the cover off its upper locating tabs.

4.3.2 Mains Transformer

CAUTION:
RENEWAL OF THE MAINS TRANSFORMER REQUIRES THE REMOVAL OF THE CENTRAL CONTROL UNIT FROM ITS MOUNTING PLATE. BEFORE PROCEEDING, IDENTIFY AND LABEL THE EXCHANGE AND TERMINAL LINE CONNECTIONS AND DISCONNECT THEM FROM THE CENTRAL CONTROL UNIT.

Loosen the screw securing the Central Control Unit to its mounting plate. Lift the Central Control Unit off its mounting plate. Remove the small plate on the rear (lower left-hand corner) of the Central Control Unit, secured by a single cross-headed screw and identified by a High Voltage Warning Label. Disconnect the two wires from the mains transformer (primary winding) at the fuse holder and mains connector.

Disconnect the three wires from the upper connector strip on the transformer (secondary winding). Remove the four bolts securing the transformer to the base plate. Carefully lift the transformer, pulling the two primary winding wires through the hole in the bulkhead.

Replacement is the reverse of the removal procedure.

4.3.3 Power Supply Printed Wiring Board

Disconnect the three connections to the mains transformer. Disconnect the 5-way connector from the rear of the printed wiring board. Remove the four cross-headed screws securing the printed wiring board to the baseplate and remove the board.

Replacement is the reverse of the removal procedure.

4.3.4 KBX 3 Control Board

Disconnect the exchange line and terminal connections to the Control Board at the terminal blocks. Unclip the right-hand edge of the Control Board and swing the board fully to the left. Disconnect the 5-way connector at the Power Supply printed wiring board and unclip its cable from the baseplate: this cable and connector forms part of the Control Board Assembly. Remove the hinge pins from the two hinges, supporting the board as the pins are removed.

Replacement is the reverse of the removal procedure.

NOTE: If access to the rear of the Control Board is required for in-situ servicing, the board may be unclipped and swung to the left without disconnecting any of the cables.

4.3.5 KBX 6 Control and Extension Boards

These items should be removed as a single item.

Disconnect the exchange line and terminal connections to the Extension Board at the terminal blocks. Unclip the right-hand edge of the Extension Board and swing it to the left.

Disconnect the exchange line and terminal connections to the Control Board (lower board) at the terminal blocks. Unclip the right-hand edge of the Control Board and swing it fully to the left. Disconnect the 5-way connector at the Power Supply printed wiring board and unclip its cable from the baseplate: this cable forms part of the Control and Extension Board Assembly. Remove the hinge pins from the Control Board hinges, supporting the Control and Extension Boards as the pins are removed.

Replacement is the reverse of the removal procedure.

NOTE: If access to the front and rear of the Control and Extension Boards is required for in-situ servicing, both boards may be unclipped and swung to the left without disconnecting any of the cables.

4.4 RENEWAL OF TERMINAL COMPONENTS

The following paragraphs provide general principles on the renewal of the keyswitch block and the exchange lamps as fitted to a Type 1746 Terminal. Specific details depend on the type of terminal in use. Reference should be made to the appropriate terminal Maintenance Handbook for access details and the renewal of all other terminal components.

4.4.1 Keyswitch Block

The keyswitch block is normally fitted in a special mounting bracket in front of the cradle switch. It is held securely in place by a spring clip.

Note the connections and dressing of the two wires connecting the keyswitch block to the terminal's connecting block, and the orientation of the keyswitch block. Disconnect these wires and lift the keyswitch block clear of its mounting bracket.

Insert the new keyswitch block, correctly orientated, into its mounting bracket and secure with the spring clip; undue force should not be necessary. Connect the two wires to the terminal's connection block using the dressing and connections previously noted.

4.4.2 Exchange Lamps

These LED are normally secured to the side of the cradle switch mounting using clips or special brackets. When correctly fitted, they should show clearly through the lenses mounted in the cover of the terminal.

Note the connections and dressing of the two wires connecting the single LED (KBX 3) or dual LED (KBX 6) to the terminal's connecting block. Disconnect these wires and remove the LED and wiring from the terminal.

Replacement is the reverse of the removal procedure.

4.5 FAULT LOCATION AND RECTIFICATION

The following table provides a guide to the rapid location of a fault to a renewable sub-assembly. Once located, the faulty sub-assembly should be renewed and the faulty item returned to a Maintenance Centre for repair together with full details of the fault symptoms and action taken.

When using the table, the possible faults and actions should be considered in the order given.

WARNING: Many of the following actions require the operation of the Central Control Unit with mains applied and the covers removed.

4.5.1 Testing the Terminal Keyswitches

The following tests provide a rapid check on the correct operation of the terminal keyswitches without dismantling of the terminal.

SYMPTOM	POSSIBLE FAULT	ACTION
1. System only functions on night service.	A. Loss of power supply	(i) Check fuse. (ii) Check incoming mains supply. (iii) Check mains transformer. (iv) Check outputs of Power Supply printed wiring board.
	B. Control Circuit failure	(i) Renew Control board (including Extension board if fitted).
2. System does not function on night service.	A. Interface Circuit failure	(i) Renew Control board (including Extension board if fitted).
3. Speech or signalling fault on one terminal.	A. Terminal Speech circuit	(i) Check the terminal as detailed in its Maintenance Handbook. (ii) Check the terminal to Central Control Unit cabling and connections.
	B. Central Control Unit Control or Extension board line switching circuit	(i) Renew Control board (including Extension board if fitted).
4. Speech or signalling fault on all terminals.	A. Power supplies	(i) Check fuse. (ii) Check incoming mains supply. (iii) Check mains transformer. (iv) Check outputs of Power Supply printed wiring board.
	B. Control circuits	(i) Renew Control board (including Extension board if fitted).

Table 4.1 System Fault Location

KBX 3

Disconnect the C (blue) and D (black) signalling wires from the terminal at the wall mounted terminal block. Connect an ohmmeter to these two wires. Operate each of the terminal keyswitches in turn and verify that the indicated resistance is as shown in Table 4.2. Any deviation from these readings indicates that the keyswitch assembly must be renewed.

KEYSWITCH	RESISTANCE ± 5%
EXCH	100
EXT 1	1K3
EXT 2	3K6
F	8K2

Table 4.2 KBX 3 Keyswitch Resistance Values

KBX 6

Disconnect the C (blue) and D (black) signalling wires from the terminal at the wall mounted terminal block. Connect an ohmmeter to these two wires. Operate the keyswitches in turn and verify that the indicated resistance for each switch is as shown in one of the resistance columns of Table 4.3. Reverse the ohmmeter connections and verify that the indicated resistance for each switch is now as shown in the other resistance column of Table 4.3. Any deviation from these readings indicates that the keyswitch assembly must be renewed.

KEYSWITCH	RESISTANCE ± 5%	RESISTANCE ± 5%
EXCH 1	100	100
EXCH 2	100	3K6
EXT 1	1K3	1K3
EXT 2	3K6	3K6
EXT 3	3K6	100
EXT 4	1K3	100
EXT 5	3K6	1K3
F	8K2	8K2

Table 4.3 KBX 6 Keyswitch Resistance Values

SECTION 5 : INSTALLATION

5.1 GENERAL

A summary of the following Installation Instructions is contained in the KBX 3–6 Installation Instructions Leaflet, 3513 300 04890 issued with each KBX 3/6 System.

5.2 INSTALLATION PARTS

5.2.1 KBX 3

The following items are required for a fully equipped KBX 3 installation:

ITEM	PART NO.	QTY
KBX 3 Central Control Unit		
for 110V operation	9504 000 34110	1
for 240V operation	9504 000 34100	1
KBX 3 Terminals	As reqd	3
Terminal blocks, colour to match Terminals	As reqd	3
Cable, 3-pairs		As reqd
Mains cable		1
Mains connector	As reqd	1
Woodscrews/self-tapping screws to mount Central Control Unit and Terminal Blocks	As reqd	9

5.2.2 KBX 6

The following items are required for a fully equipped KBX 6 installation:

ITEM	PART NO.	QTY
KBX 6 Central Control Unit		
for 110V operation	9504 000 35110	1
for 240V operation	9504 000 35100	1
KBX 6 Terminals	As reqd	6
Terminal blocks, colour to match Terminals	As reqd	6
Cable, 3-pairs		As reqd
Mains cable		1
Mains connector	As reqd	1
Woodscrews/self-tapping screws to mount Central Control Unit and Terminal Blocks		15

5.2.3 Special Installations

The following alternative items may be specified to meet a customer's special requirements:

EXTERNAL EXTENSIONS

These may be fitted in place of Terminals 1 and/or 3 in either a KBX 3 or KBX 6. They are two-wire telephone instruments whose speech circuits are compatible with the local exchange. They may be installed up to 1 km from the Central Control Unit with the proviso that the total loop resistance between the local exchange and the external extension does not exceed 1250 ohms assuming a 45V to 52V local exchange battery and a 2 x 200 ohm feeding bridge.

MIXED TERMINAL TYPES

It is possible to fit a KBX 3 terminal into a KBX 6 System with the following changes to its facilities:

- The terminal may be fitted at any terminal position.
- It can make and receive exchange calls on Exchange Line 1
- It can be called by all other terminals.
- It can call only Terminals 1 to 3.

NOTE: Before a KBX 3 Terminal is connected to a KBX 6 System, a protective diode must be fitted across the Exchange LED, as shown on Figure 5.1.

5.3 TOOLS AND TEST EQUIPMENT

Special tools and test equipment are not required for the installation and testing of a KBX 3/6 System.

5.4 SITE REQUIREMENTS

The KBX 3/6 System is intended for normal office environment. Therefore there are no special site requirements apart from the availability of a suitable 180V to 260V or 90V to 130V mains supply.

5.5 UNPACKING INSTRUCTIONS

There are no special unpacking instructions. Before proceeding to the site, all items should be unpacked, checked for correct type against the customer's Delivery Note, and examined for obvious signs of damage. Any damaged item should be rejected.

5.6 INSTALLATION INSTRUCTIONS

These instructions should be read carefully before proceeding with the installation of a KBX 3/6.

5.6.1 General

The Central Control Unit is wall mounted, using a special mounting plate, adjacent to the incoming exchange lines and a suitable power point. Before commencing the installation, check that the Central Control Unit is suitable for the local mains supply, 90V to 130V, or 180V to 260V, 50Hz to 60Hz.

5.6.2 Terminals

The terminal blocks should be mounted in suitable positions adjacent to the terminals, using woodscrews or self-tapping screws. The wiring connections for the terminal blocks are shown on Figure 5.1.

Install the cables between the terminal blocks and the Central Control Unit position.

5.6.3 Central Control Unit

Secure the mounting plate to the wall using suitable woodscrews or self-tapping screws. The fixing centres for these screws are shown on Figure 5.2. The Central Control Unit may be fixed directly to the wall or mounted on battens depending on the nature of the wall.

Remove the lower cover from the Central Control Unit by unscrewing the two large-headed captive screws and lift-off the cover. There should not be any need to remove the upper cover during installation.

NOTE: If required, the upper cover is removed by releasing the catches at the lower corners of the cover and lifting the cover off the upper locating tabs. The cover is replaced by seating it correctly on the locating tabs and pushing home the catches. See Figure 5.3.

Locate the Central Control Unit on the tabs of the mounting plate and secure with the fixing screw, Figure 5.3.

(a) Using BT Master Line Jack Unit

Connect line jack units to central unit as per table, using 3 pair cable.

Central Control Unit Extension Connections	LJU Connections
A	2
B	5
C	4
D	1
E	6

(b) Using Western Electric Sockets

Connect Western Electric Sockets to central unit as per table, using 3 pair cable

Central Control Unit Extension Connections	Western Electric Socket Connections
A	4
B	3
C	5
D	1
E	6

Figure 5.1 Terminal Block Connections

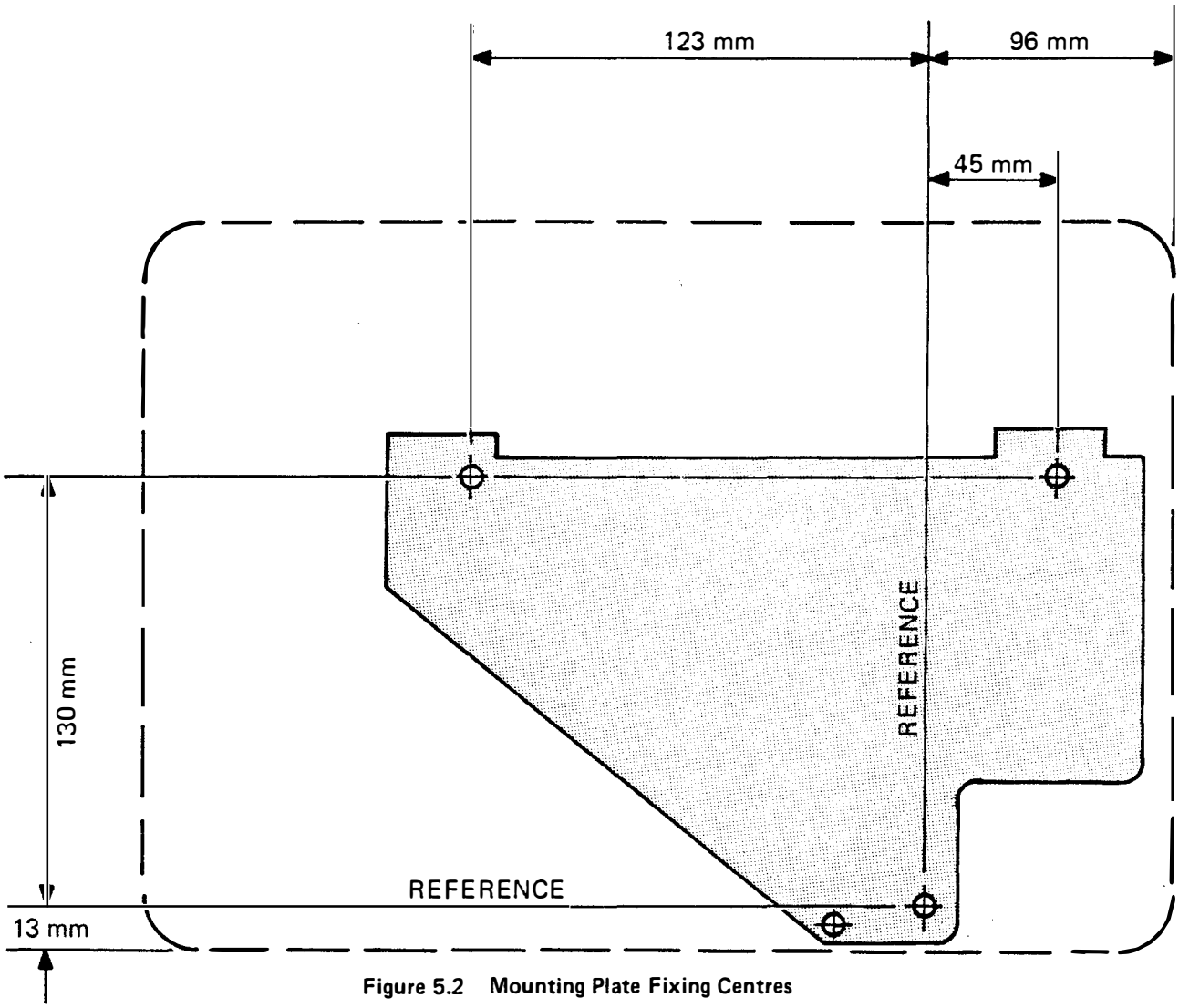
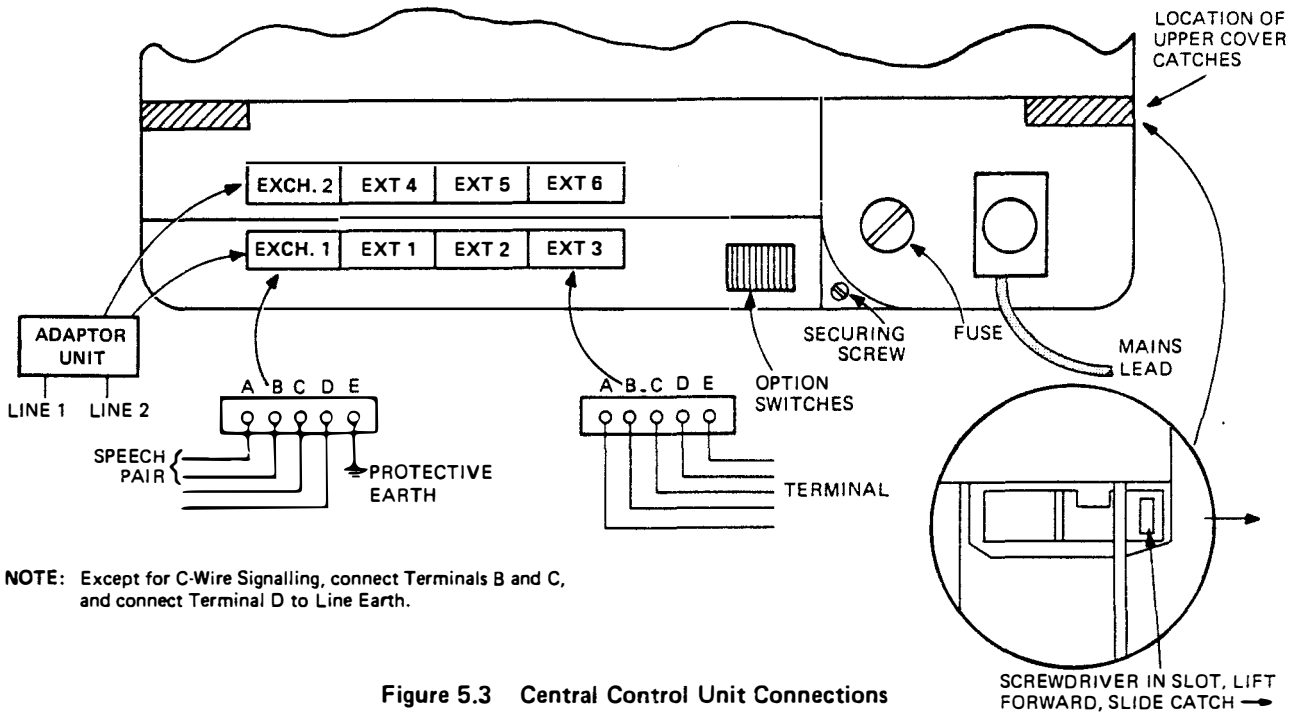


Figure 5.2 Mounting Plate Fixing Centres



NOTE: Except for C-Wire Signalling, connect Terminals B and C, and connect Terminal D to Line Earth.

Figure 5.3 Central Control Unit Connections

Connect the exchange lines and terminal cables as shown on Figure 5.3. The tails on these cables should be sufficiently long to allow the Control board to be unclipped and swung fully to the left for servicing. Connect the mains cable to an adjacent power point and switch on the supply.

Set the Option Switches (Figure 5.3) as required for the installation, to the positions shown below:

External Extension 1	S1 on
External Extension 3	S2 on
C-wire Signalling	S3 on
Exclusive Line (Terminal 4)	S4 on

5.6.4 System Test

Check the operation of each terminal by testing all its functions, facilities, and options.

5.7 OPERATING INSTRUCTIONS

Except for the additional exchange line and terminals available, these instructions apply equally to a KBX 3 installation or a KBX 6 installation.

Extension Buttons	– used to call another extension.
EXCH button	– used to connect a terminal to an exchange line.
F button	– used to set up conference calls and to program the Divert and Exchange ringing facilities.
R button	– Provides a Recall function when connected to a PABX.
Exchange Lamp	– Has five states: OFF (at all terminals) – exchange line free ON (at all terminals) – exchange line engaged FAST FLASH (one terminal only) – exchange line is being held by that terminal SLOW FLASH (two terminals) – terminal is being called while connected to an exchange line. FLASHING in time with exchange ringing – incoming exchange call.
Internal Calling Device	– Exchange ringing if programmed. Even ringing indicates an intercom call.

5.7.1 Making and Receiving Intercom Calls

Lift the handset and press the Extension button for the required extension. (If the Intercom is in use speech will be heard as the handset is lifted). The internal calling device in the called extension will ring on an even cadence (on, off, on, off ---).

Lifting the handset at the called terminal connects the call. The call is cleared by both parties replacing their handsets.

5.7.2 Making an Exchange Call

Lift the handset and press a free EXCH button (lamp not lit). The lamp for that exchange line will light on all terminals, indicating that the line is engaged. The call can now be set up by direct dialling or connection through the operator.

The hook switch (cradle switch) can be flashed to obtain the exchange operator's attention, or the F button flashed to obtain a PBX operator's attention. The call is cleared by both parties replacing their handsets.

5.7.3 Receiving an Exchange Call

An incoming call (exchange ringing) causes the associated exchange lamp on every terminal to flash and the calling device to ring at those terminals programmed to receive exchange ringing (see Exchange Ringing below).

The call may be answered from any terminal by lifting the handset and pressing the associated EXCH button. The Exchange lamps on all terminals will change to lit steadily, indicating that the exchange line is engaged, and the ringing will cease.

When the only terminal programmed to receive exchange ringing is engaged, an incoming call on that line will ring all other free terminals.

The call is cleared by both parties replacing their handsets.

5.7.4 Holding an Exchange Call

Press the associated EXCH button once. This holds the exchange call and connects the terminal to the Intercom; the associated Exchange lamp flashes rapidly. The holding terminal can now make or receive an Intercom or, with a KBX 6 System, make or receive another exchange call if the other exchange line is free. Alternatively, the required Extension button may be pressed to hold the Exchange line and ring the Extension.

In either case, if the handset is replaced without reconnecting the held call, the holding terminal's calling device will ring at a fast rate until the call is reconnected.

The held exchange call is reconnected by pressing the associated EXCH button again, when the exchange lamp returns to its steady-on state.

There is no limit to the number of calls which may be made or extensions rung to obtain an answer while holding an exchange call. In the KBX 6 System, a terminal can hold both exchange lines simultaneously.

5.7.5 Transferring an Exchange Call

Press the required Extension button, or the connected EXCH button followed by the required Extension button: the exchange line is held and the Extension rung. When the Extension answers, the call may be transferred by replacing the handset at the transferring terminal or pressing the associated EXCH button at the called terminal. In the latter case, the transferring terminal will remain connected to the Intercom and make make a follow-on call.

An exchange call may be transferred as many times as required.

5.7.6 Conference Calls

This facility enables any two terminals to be connected to an exchange call.

With an exchange call in progress, press the required Extension button (this holds the exchange call). When the called Extension answers, press the F button to connect both terminals to the held exchange call and to free the intercom.

The conference call set up is cleared when both terminals have replaced their handsets.

5.7.7 Power Fail Operation

Terminal 1 (and Terminal 4 for Exchange Line 2 in a KBX 6) is the power fail terminal. Exchange calls to or from these terminals remain connected at power failure. During power failure, a power fail terminal can make and receive exchange calls. Calls in progress at power restoration are not interrupted.

All other terminals and facilities are inoperative and any calls in progress at power failure are lost.

5.7.8 Night Service

Night service (power off) is provided as follows:

- Terminal 1 in a KBX 3 or Terminals 1 and 4 in a KBX 6. This is similar to the Power Fail operation.
- An External Extension connected in place of Terminal 1 (refer to External Extensions Option).
- Incoming exchange calls (Exchange Line 1 only in a KBX 6) ring the sounder of the External Extension. The call is answered by lifting the handset.
- Outgoing exchange calls are made by lifting the handset of the External Extension and waiting approximately 10 to 15 seconds for exchange dial tone or the local exchange operator to answer.

5.7.9 Programmable Facilities

The Divert and Exchange Ringing facilities can be programmmed into or out of a Terminal at any time.

It should be noted that facilities programmed in are lost if the power to the Central Control Unit is switched off or fails. They must therefore be re-programmed at restoration of power.

DIVERT

Any terminal can divert all incoming calls to another terminal as shown below and in Figure 2.2.

*Terminal 1 to Terminal 2
*Terminal 2 to Terminal 1
Terminal 3 to Terminal 1
Terminal 4 to Terminal 2
*Terminal 5 to Terminal 6
*Terminal 6 to Terminal 5

*Where a pair of terminals can only divert to each other, only one terminal at a time can use the Divert facility.

To initiate a Divert, lift the handset, press the F button, followed by the Extension 1 button and replace the handset. All calls will now be diverted to the terminal as above.

The Divert facility is cancelled by lifting the handset, on the Diverting terminal, pressing the F button followed by the Extension 2 button, and replacing the handset.

EXCHANGE RINGING

Any terminal may be programmed to receive incoming exchange ringing on its calling device, in addition to the flashing Exchange lamp signalling.

Lift the handset, press the F button followed by the EXCH button for which ringing is required and replace the handset. Repeat the procedure for the other EXCH button if ringing is required from both exchange lines.

Programmed exchange ringing is cancelled by lifting the handset, pressing the F button twice and replac-

ing the handset. Under Power Fail conditions Exchange Line 1 is connected to Terminal 1 and Exchange Line 2 is connected to Terminal 2 automatically.

5.7.10 Options

The various options available on the KBX 3 and KBX 6 may be implemented or cancelled at any time by the local Service Engineer.

EXCLUSIVE LINE (KBX 6 Only)
This option allows exclusive use of Exchange Line 2 by Terminal 4 or its diverted terminal. Once an external call has been set up to Terminal 4, it can be transferred to any other terminal in the normal way.

When the exclusive line option is operative, diversion from Terminal 4 is possible in two modes and is controlled from Terminal 4:

- DIVERT. All calls are diverted to Terminal 1, not Terminal 2 as described under Divert.

  A diversion is implemented by lifting the handset, pressing the F button followed by the Extension 1 button and replacing the handset. All calls will be diverted to Terminal 1 until the Divert is cancelled.

- EXCLUSIVE DIVERT. All calls are diverted to Terminal 1 except incoming calls on Exchange Line 2.

  An Exclusive Divert is implemented by lifting the handset, pressing the F button followed by the Extension 3 button, and replacing the handset. All calls except those on Exchange Line 2 will be diverted to Terminal 1 until the Divert is cancelled.

The Divert or Exclusive Divert facilities are cancelled by lifting the handset, pressing the F button followed by the Extension 2 button, and replacing the handset.

The Exclusive Divert may be changed to non-exclusive divert by lifting the handset, pressing the F button followed by the Extension 1 button, and replacing the handset. All calls will now be diverted to Terminal 1.

EXTERNAL EXTENSIONS
External Extensions with limited facilities may be fitted in place of Terminals 1 and/or 3.

During normal (daytime) use, lifting the handset connects the External Extension to Terminal 2. The call can then be connected to another KBX Terminal (Terminal 2 rings the terminal and replaces the handset when the call is answered or transfers the External Extension to an Exchange Line – presses a free exchange button and replaces the handset when the Exchange Line is connected).

If Terminal 2 fails to answer within 15 seconds, an External Extension connected in place of Terminal 1 will be automatically connected to a free Exchange Line.

C-WIRE SIGNALLING
C-wire signalling may be implemented by operation of Option Switch No.3.

SECTION 6 : SPARES

The following tables list the spares holding for the KBX 3 (9504 000 34100) and KBX 6 (9504 000 35100) Central Control Units. Except where stated otherwise in the % Holding column, the recommended holding is 2% of the total number of KBX 3 or KBX 6 Central Control Units in service.

6.1 KBX 3 SPARES HOLDING

ITEM	PHILIPS 12NC CODE	% HOLDING
Cover and Label Assembly	3513 441 62200	5%
Printed Circuit Board, Control	3513 446 28140	
Printed Circuit Board, PSU	3513 446 28440	
Mounting Plate	3513 441 62300	
Base and Terminal Assembly	3513 441 62400	
Mains Cover Plate	3513 401 13630	
Fuse, 500mA, anti-surge	2413 086 01203	5%

6.2 KBX 6 SPARES HOLDING

ITEM	PHILIPS 12NC CODE	% HOLDING
Cover and Label Assembly	3513 441 62210	5%
Printed Circuit Board, Control	3513 446 28240	
Printed Circuit Board, Extension	3513 446 28340	
Hinge	3513 401 13670	
Printed Circuit Board, PSU	3513 446 28440	
Mounting Plate	3513 441 62300	
Base and Terminal Assembly	3513 441 62400	
Mains Cover Plate	3513 401 13630	
Fuse, 500mA, anti-surge	2413 086 01203	5%

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