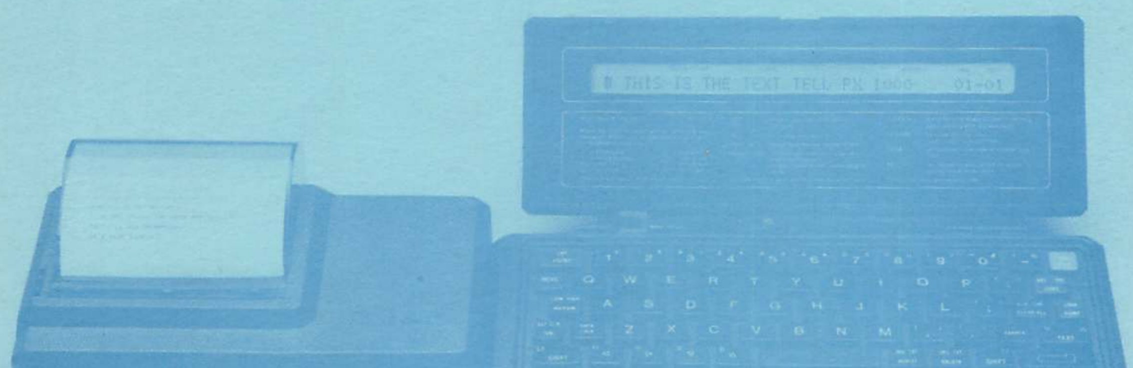
TEXT TELL®



TECHNICAL MANUAL
PX-1000 PXP40

SECTION A: PX1000

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CHAPTER 1

GENERAL INFORMATION

1.1 PX1000 PRODUCT DESCRIPTION

TEXT TELL's PX1000, the Pocket Telex is a pocketable data communications unit, for creating and sending/receiving text.
Text can be created using the standard QWERTY keyboard, and stored in the unit's memory. The memory will hold up to 7,400 characters, or 4 to 5 pages of standard A4. The text is viewed on a single line of 40 characters Liquid Crystal Display. Inbuilt in the unit is an easy to use, yet sohisticated word proccessor.
Text can be sent and received by telephone using the unit's on board simplex acoustic modem.
Also, text can be transferred to a printer or computer, via an RS232C compatible serial port. Via this port also, text can be received from a computer, or other data communications device.
The unit is powered from an internal rechargeable battery pack, which is charged from an external adaptor. The unit will operate for more than five hours after a full recharge. The memory contents are kept as long as the battery pack is charged.
There are visual indications on the LCD of the quality of telephone reception, the amount of memory used, when the battery pack is low, as well as other text information.
There is also an audio input/output audio socket which can be used for storage and retrieval of data from a standard tape recorder.

There are different versions of the PX1000 available. The basic unit is the Encrypt version which contains the extra function enabling text to be encrypted according to a key, which is selected by the user. The original text, once encrypted, is practically impossible to retrieve without knowledge of the exact key.
The Calc version has, instead of the encrypt function, the possibility to do basic arithmetic calculations.

1.2 SPECIFICATIONS

General

Dimensions	Lenght	: 225 mm
	Height	: 85 mm
	Width	: 29 mm
Weight		: 450 g
Operating Temperature Range		: -10 C to +40 C
Humidity Range		: 0-95% Rh
Storage Temperature Range		: -25 deg. C to 55 deg. C

Technical

Power Supply	: internal rechargeable 6V battery rechargeable from external 12V DC adaptor.
Power Consumption	: < 150 uA unit off < 30 mA normal use < 50 mA transmit/receive mode
Battery Charge Current	: 50 mA high charge : <2 mA trickle charge
Battery Life	: >5 hrs. (normal use) after full recharge
Memory capacity	: 8k (7.4k available to user)

Modem

Modulation Standard	FSK CCITT V.23 mode 1, 600 Bd.
Frequencies	MARK 1300 Hz, SPACE 1700 Hz
Baud Rates	300, 600 and 1200 selectable from keyboard
Data Format	1 start-bit, 7 data-bits, LSB first, 1 parity-bit, 2 stop-bits
Parity	Even
Header	Transmission starts with 0.5 sec. MARK, followed by 16 Null-Bytes, (ASCII 00) at the selected baud rate, 0.8 sec MARK, and 4 Null bytes
Speaker Output level	Set at factory to maximum level allowable by Telephone Authority in country of sale.
Receiver Sensitivity	<-30dBm.

Serial Port

Voltage Levels	Input	MARK -3 to -15V, SPACE 3 to 15V
	Output	MARK -5V (+-20%),SPACE 5V (+-20%)
Baud Rate		1200 Bd
Data Format		1 start-bit, 7 data-bits, LSB first, 1 parity-bit, 2 stop-bits.
Parity		Even

Audio Socket

Voltage Levels	Input	5.0 V p-p max.
	Output	1.6 V p-p in 120 ohm
Input impedance		120 ohm.
Signal Format		FSK CCITT V.23 600 Bd. Standard

CHAPTER 2

PX1000 THEORY OF OPERATION

The following is a detailed technical description of the theory of operation of the PX1000, Version H.

POWER SUPPLY

The PX1000 derives its power from a battery pack containing five rechargeable, Ni-Cd cells, connected in series, each with a nominal voltage of 1.2V. This generates a nominal voltage of 6V DC at the battery inputs, pins 1 and 2, on connector J5.
This voltage is applied directly to IC7, which is a QUAD-NAND, 74HC00. This IC controls the power on/off to the remainder of the circuit.
When the unit is off, power is turned on by pressing the key ON/STOP. This key is connected to the RESET input of a bi-stable made up of two NAND gates of IC7. In the off state, the output on pin 3, IC7 is low. When ON/STOP is pressed, this output goes high, turning on both transistors, T1 and T2, via current-limiting resistors R8 and R18. Because of zener diode, Z1, which is 5V7, the voltage on the emitter of T1, is now 5V. This is VCC. Pull-up resistor, R7, holds the bi-stable in set state. The bi-stable is reset by a low pulse from MPU port P22, which turns off T1 and T2.
A voltage convertor, IC6 (7660), is now powered up, and generates a voltage of approximately -5V at its output, pin 5, using reservoir and pump capacitors, C6 and C7.
The main RAM, IC4 (6264), is powered directly from the battery pack, via diodes D3 and D4, which ensure the correct supply voltage for this IC.

BATTERY CHARGE CCT.

The battery charge circuit consists of a dual voltage sensor IC, a 7665, (IC8), and a current drive circuit consisting of transistors T3, T11 and T12, and resistors R37, and R42. The operation of the circuit is such that discharged batteries are initially charged at a high rate of 0.3 C, where C is the battery capacity, which is 170 mAh, until they reach a specific voltage, of 7.5V, at which point the rate is reduced, to a trickle rate, of less than 0.01C.
When the charger is inserted, 12VDC appears at pin 38 of the hybrid. The low level of the battery voltage is detected at S1 of IC8, which turns on T3, via output OUT1 (T3 is actually turned on by pull-up R43, as OUT1 is now high-impedance). This, in turn, turns on transistors T11 and T12, via current-limiting resistor, R41. T11 shorts out resistor R42, so the current flowing into the batteries is equal to 0.7V divided by the value of R37, which is 13 ohms, giving a charge current of approximately 50 mA. Diode D8 prevents reverse current through this cicruit from the batteries. Capacitor C5 provides power supply decoupling.
After a short while, the battery voltage will rise to 7.5 V, which, when detected by S2 of IC8, will cause T3 to turn off (by shorting its base to ground), and also T11 and T12. Now the charge current is determined by the voltage accross R37 and R42 in series, giving a current of approximately 1mA.
The actual level at which the high rate of charge switches out is determined by potentiometer, P1.
IC8 also has an output pin, OUT2 which gives an indication to the MPU when the batteries are low, and need recharging. The level, at which this output switches, is set by the resistor network R12, R13 and R14; a low output indicating low batteries. Resistor R5 pulls the output high, when the internal switch is off.
Inbuilt hysterisis in IC8 prevents output oscillation. This involves outputs H1 and H2, which change state when the trip point is reached, thus, via R10 and R11, effectively changing the detection levels. The voltage must reach the new level, before the output will switch again.

MPU CLOCK CIRCUIT

The heart of the system is the microproccessor, which, like every other MPU, must have a clock source from which to operate.
The clock circuit for the micro is made up from a 4.0 MHz parallel resonant fundamental crystal, AT cut. This, together with two capacitors, C1 and C2, provides a sine wave signal at the MPU pins XTAL and EXTAL, of 4MHz in frequency. This is divided down internally in the MPU, so that the system clock is 1MHz.

MPU

When VCC is applied to the MPU, by pressing ON/STOP as described above, the MPU comes out of reset, after a delay of 20mS, caused by the RC network, R3 and C4.
The states of ports P20, P21, and P22 immediately after coming out of reset decide in which mode the MPU will operate. P21 is tied to ground, P20 is low because it is connected to the port of an IC which is powered down, and P22 is pulled high, via R7. Consequently, the MPU operates in the Multiplexed Mode. This means that the DATA bus is multiplexed with the lower 8 lines of the ADDRESS bus.
The MPU inputs NMI and STB are tied to VCC, and so, are always inactive.
The ON/STOP key is also connected to the external interrupt i/p, IRQ. This input is pulled high by resistor R6, when the ON/STOP switch is open. Diode D5 prevents battery voltage appearing on this input.
Diode D2 provides immediate reset of the MPU, on power down, by rapid discharge of C4.
Switch S1, between MPU RST and GND, is included to provide the facility to completely reset the system.

ADDRESS AND DATA BUSSES

As mentioned above, the data bus, and lower address bus are multiplexed. So, to be able to separate the different signals, there is a latch, IC2 (74HC373), used for the address outputs.
The ouputs of this latch are always enabled, via pin 1, which is tied to ground. These outputs are controlled by the address strobe signal, AS, which is output from pin 39, of the MPU. When this signal is high, the outputs will follow the inputs. When the signal goes low, the outputs will remain until the signal goes high again.
The 8-bit data bus is connected to RAM,(IC4), ROM,(IC3), and the Keyboard. The upper four data bits are connected to the LCD module.
The address bus is connected to RAM, ROM and to the Keyboard.
The upper two address lines, A14 and A15, are connected to the decoder, IC5.
The system is an 8-bit data, 64K memory system.

DECODER

A decoder chip, IC5 (74HC138), is used to determine which part of the circuit the MPU wishes to address at any one time. The memory is divided into four equal parts, of which the following locations are used by the program :

\$0000 - \$001F	Internal Registers
\$0020 - \$007F	External Memory space
\$0080 - \$00FF	Internal RAM
\$0100 - \$1FFF	Main External RAM
\$2000 - \$3FFF	not used
\$4000 - \$4001	KEYBOARD
\$4002 - \$7FFF	not used
\$8000 - \$8001	LCM
\$8002 - \$DFFF	not used
\$E000 - \$FFFF	EPROM

The inputs to the decoder are A15, A14 and the E signal (system clock) from the MPU.
Any time the MPU addresses a valid part of the memory map, the relevant output will go low. Otherwise, all the outputs are high.

EPROM

The program memory is contained in 8K EPROM, IC3 2764, and is located at address \$C000 in the system memory. It is enabled when the i/p's G1, C and B, to the decoder, are as follows :

G1	C	B
1	1	X

This combination will bring output Y6 low, which is connected to the chip enable i/p, CE, of the EPROM.
This occurs when anywhere in memory above \$C000 is addressed.
Because only 8k Eprom is used, \$C000 to \$DFFF is redundant. When any other place in memory is addressed, the EPROM is disabled, because CE i/p is high, and so, its data o/p's are high-impedance.

RAM

RAM is located at address $0000 in memory, and takes up 8K. This includes the RAM internal to the microproccessor which is 128 Bytes, as well as the external RAM, which is an 8K HN6264, IC4. The external RAM is used mainly for text storage, but also is used by the program. The program uses up to 600 bytes, leaving 7.4K available for text storage.
There are two chip select i/p's to the RAM IC, CS1 and CS2. CS1, which is active low, is used by the decoder to access RAM during normal running. In this situation, CS2, which is active high, must be high. In power down mode, the contents of the RAM IC must be protected from corruption, which could occur while the power to the MPU is decaying, and its outputs are unpredictable. Power off is controlled by the MPU. Before cutting power, the MPU first brings o/p P13 low, which is connected to CS2. Also connected to this pin is a pull-down resistor, R1, which ensures that the RAM remains disabled until power-up again.
During running mode, RAM is enabled when the inputs to the decoder are as follows :

G1	C	B
1	0	0

This situation occurs when the MPU addresses any loaction in memory, between the locations $0000 to $3FFF.
Power to the RAM IC is fed directly from the battery voltage, to VDD, pin 28, via diodes D3 and D4. This ensures that RAM cotents are saved, for as long as the battery voltage remains above 5.9 V, theoretically. In actual practice, the contents remain valid for much lower voltage levels. Because of the low current consumption of the IC in standby, resistor R17 ensures that diodes D3 and D4 are turned on fully to provide the required voltage drop from the battery voltage. Capacitor C24 provides power supply decoupling.

KEYBOARD

The keyboard is included on the memory map, but is enabled seperately by the MPU, via output P16.
The keyboard is read in the following manner. First a quick scan is made to determine whether a key has been pressed. This involves enabling the keyboard by bringing P16 low. If no key is pressed, all data lines will be high. A pressed key will cause one data line to go low, via a combination of two of resistors, R1 to R16. To identify exactly which key has been pressed, each address line, A0 to A8, is brought low individually, and the data bus read as above.

LCM

The Liquid Crystal Display Module,the LCM, is custom designed for the PX1000. It is a one line X 40 character display, each character contained in a 5 x 7 dot font. Also on the display are up to seven miniature fixed messages, which are used to indicate the status of certain functions to the user.
The LCM is driven by four HD44100 LCD segment/column drivers and a HD44780 dot matrix controller. The controller IC also contains character generator ROM, as well as character generator RAM, which gives the user ability to define up to 14 extra characters.
The contrast of the LCD is fixed.
The MPU communicates with the LCM via a ten signal connection, J2. This connection contains the four upper data lines D5 to D7, as well as the following :

+Vcc : power supply
-Vcc : "
GND : "

R/W — R/W signal from the MPU, which tells the LCD controller whether the MPU wants to WRITE to, or, READ from, the LCM.

LCDE — active high enable signal from the decoder, via invertor of IC7, and a blocking diode, D1 and pull-up resistor, R2 which convert the high voltage output from IC5, which is connected directly to the battery, to normal TTL levels.

Rs — o/p from the LCM to indicate to the MPU that it is ready to recieve data and/or commands.

All data and commands for the LCM from the MPU, are sent in 4-bit nibbles, via the upper four data lines, D5 to D7, in a two-byte sequence.
Commands are written to location $8000, which access a write only register, while data is written and read at $8001.
All data for the operation of the display is saved and updated in the LCD controller IC. The MPU only writes data when it wants to update the display contents.

MODEM

The modem, IC9 TCM 3101, is an IC which basically converts digital signals to analoge signals and vice-versa. The reason is such that digital information from the MPU can be transformed into a signal which can be transmitted over the telephone network. Because of the characteristics of the telephone system, the digital signals are converted to audio signals, with the two different digital states represented by two different frequencies. This system is called Frequency Shift Keying. The modem in the PX1000 is used in simplex mode, i.e it is either transmitting or receiving. In transmit mode, digital data from the MPU o/p, P14, is fed to the modem Transmit Digital I/P on pin 14. The data is internally converted to a sine wave signal on the Transmit Analogue O/P, pin 11. This signal is 1.6V p-p, and has a frequency of 1700Hz for a '0' i/p, and 1300 Hz for a '1' i/p. In receive mode, an audio signal appearing on the Receive Analogue I/P, pin 4 on the modem, is converted to a digital signal at Receive Digital o/p, pin 8, and fed to the MPU i/p, P20. The audio frequencies are derived from a clock, made up from crystal XT2, and capacitors C9 and C10. The voltage level at the Carrier Detect Level i/p, pin 10, determines what level the modem will detect an analogue signal i/p. This level is set by the resistor combination R15 and R16, and decoupler capacitor C11 Potentiometer P2, in combination with C12, adjusts the distortion level of the received data, by varying the voltage level on this pin. Power to the modem is controlled by T6, which is turned on by the MPU output, P11, via resistors R26 and R40 only when the modem is in use. This reduces overall power consumption of the PX. T6 is in turn fed from VCC by a seperate transistor T2, and not by T1, because of the rather high current current consumption of the modem circuit. Zener diode, Z2, of value 5V6, ensures 5V to the modem, even though the battery voltage may vary. This is neccesary so that i/p's CDL and RXB remain constant. Capacitor C8 provides power supply decoupling. The frequencies used are of the CCITT Standard V23 for a baud rate of 600 Bd, regardless of the i/p baud rate to the modem. The data can be in any of three different speeds: 300, 600 or 1200 bits/s.

AUDIO OUTPUT AMPLIFIER

Analogue output from the modem IC, is fed through a complementary driver buffer stage, consisting of Darlington pairs, T8 and T9 ,and resistors R31 and R32, before being fed to the speaker. The signal is ac coupled via capacitors, C20 and C21. R33 varies the actual voltage across the speaker, and so, the output volume level.
Power to the output amplifier is switched with the modem by transistor T7, via resistors R27 and R28.

AUDIO INPUT AMPLIFIER

Analogue input, picked up on the microphone, is fed first to the limiting circuit D9, D10 and R35, then to the filter circuit, R34 and C18, and then to the first of two amplifier stages, via ac coupler C17.
The first is a transistor invertor type, with gain of 100, set by resistors R38 and R39. The output is ac coupled by C25.
The second consists of an audio op-amp, IC10 TA7330, with gain of 100, determined by feedback circuit of R30, R48, C16 and C19. The output from the op-amp is ac coupled by C14, then limited, by two germanium diodes, D14 and D15, and resistor R47, and ac coupled again by C23. This ensures a maximum i/p signal to the modem of 0.7v p-p, which is specified for this IC.
Because, the modem is only concerned with the frequency of the signal, possible clipping caused by these diodes will not effect performance.
IC10 is power supply decoupled by capacitor C13 and C15.

SERIAL OUTPUT CIRCUIT

The serial output circuit consists of transistor T5 and resistors R23 R24 and R25.
Serial data is fed from output P24 of the MPU, to the base of PNP transistor, T5, via R24, such that a '0' on P24 turns on T5, and a '1' turns it off. The emitter of T5 is connected to 5V, and the collector to -5V, via resistor R25. Serial output is taken from the collector of T5, via current limiting resistor, R26. The effect of the output circuit is such that a '1' on P24, MPU, gives -5V at the output, while a '0', gives +5V. These levels are compatible with the RS232C Standard.

SERIAL INPUT CIRCUIT

The serial input circuit consists of P23 of the MPU, R4, R11,D6, D7, and D11. It is used to indicate to the the MPU, whether an external device is ready to receive data from the serial output. It is designed for use with other RS232C Standard equipment.
The actual input pin is also used by the 12VDC battery charger. Diode D11 prevents current flow into the serial input circuit when the charger is inserted.
Diodes D6 and D7 limit voltage levels on the MPU to within accecptable limits, even when RS232C Standard voltages of up to 15V in magnitude appear at the serial input.
Resistor R19 is for current-limiting, and R4 is a pull-up to VCC.
A zero, or negative voltage on the serial input pin, appears as '0' on P23 of the MPU. A +5V, or positive voltage on the serial input pin appears as a '1' on the MPU.

LED DRIVE CIRCUIT.

The LED is turned by two different methods; either directly under control of the MPU, and/or when the 12VDC battery charger is inserted. When being driven by the MPU, the circuit involved consists of MPU output P17, transistor T4, resistors R20, R21, and R22, diode D13 and the LED itself.
A '0' on the MPU output turns on T4, giving a high on its collector, which drives the LED on, via current-limiting resistor R22. A '1' from the MPU will turn off the LED.
When the battery charger is inserted, the 12VDC drives the LED, through the circuit involving T13, D12, R44, R45, and R46. Resistors R44 and R45 provide bias for transistor T13, turning it on, which drives the LED on via current-limiting resistor R46. Diodes D12 and D13 act as blocking diodes to prevent either one of the LED drive circuits from interference with the other.
Both circuits are capable of operating together; when they do,the LED burns brighter because of higher current.

AUDIO TRANSDUCER

Audio input and output to and from the unit is via an audio transducer which acts as both microphone and speaker. Because the unit operates in simplex mode only, this transducer will either be microphone, or speaker at any one time.

AUDIO INPUT/OUTPUT SOCKET

Audio signals can be input and output, to and from the PX directly, as well as acoustically, via socket J4. When there is something connected in this socket, the audio transducer is disconnected from the i/o circuitry, and signals are fed directly from the external device to these circuits.

RFI REDUCTION CIRCUITRY

Circuitry is included to reduce the amount of Radio Frequency Interference, which is associated with the high rate of activity around the MPU and on the address and data lines.
Two methods of reduction are used. One is to actually reduce the amount of noise on the power lines. This is done by the capacitors C26 to C29.
The second method is to insert filters on the input and output signals. These filters are made up from capacitors C1 to C4, in conjunction with chokes L1 to L6.

DIFFERENCES BETWEEN H VERSION AND F VERSION

As well as the main differences, listed below, there are a few minor differences also :-

Some circuitry which is in discrete component form in version F is on the Hybrid on version H.
The numbering of certain components differs between both versions. Because of this, unless otherwise stated, the component numbers mentioned below, refer to the schematic for version F.

1. On the F version IC10, the audio input op-amplifier chip, is a M51304L. Its operaton is similar to IC10, (TA7330P), on the H version, except that its output is limited by an AGC (Automatic Gain Control), instead of the germanium diodes as used in the H version.

2. On version F, the CDL level input to the Modem, IC9, is set by potentiometer, instead of resistor divider, as on version H.

3. On Version F, the voltage sensor, IC8 is excluded. The battery charge rate is constant, at 25mA, set by resistors R18 and R37 in series. Transistor T3 is always turned on by pull-up resistor, R16, so R17 is shorted out.

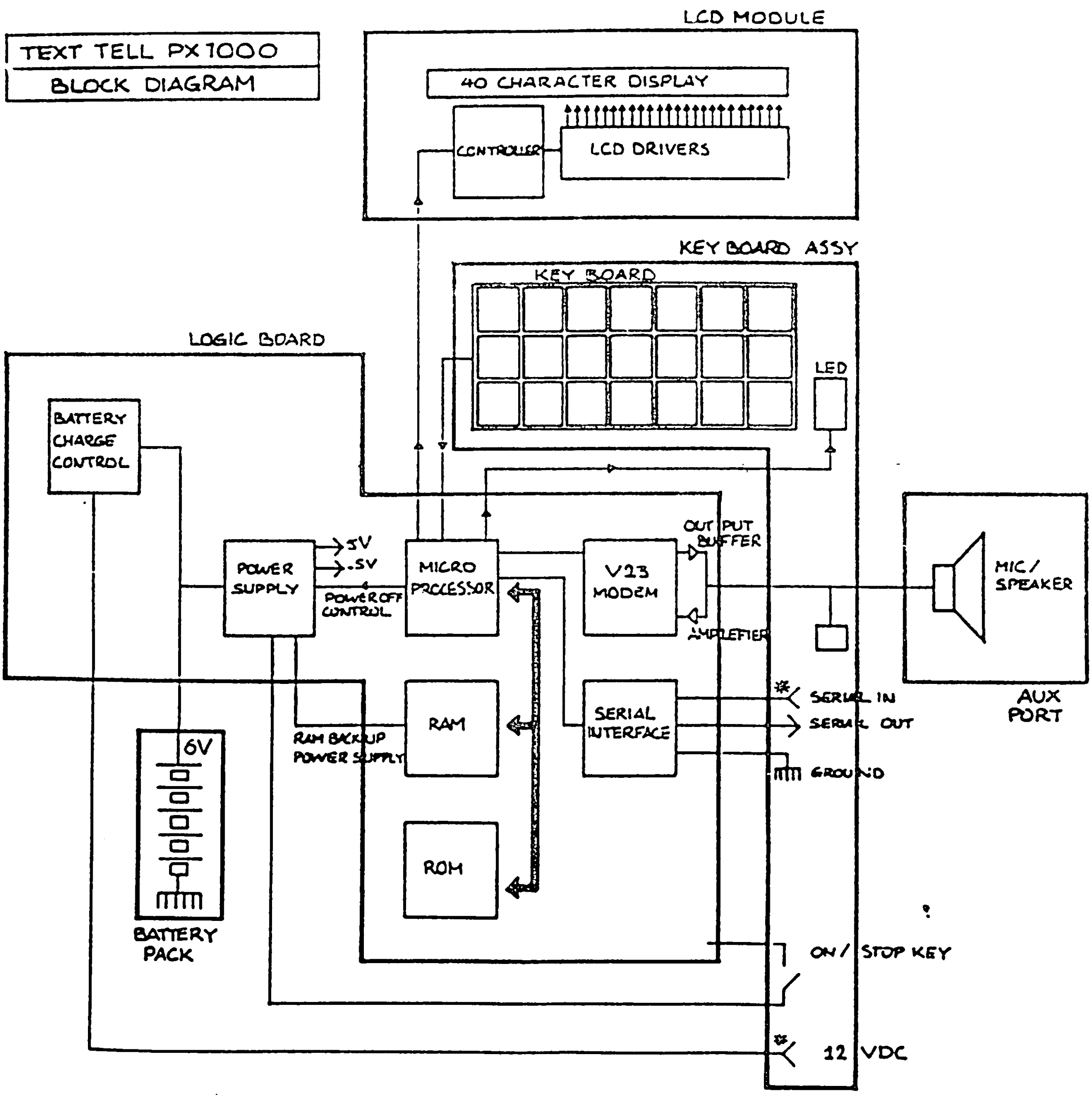
4. The 12VDC supply drives the LED via zener diode from cathode D8, of 6V2, and current-limiting resistor.

5. There is no resistor from RAM VDD to ground, in version F. On the H board this resistor ensures that diodes D3 and D4 are full biased, making the supply voltage for the RAM closer to specification.

6. The RFI reduction circuitry, involving capacitors C26 to C29, is not included in the F version.

TEXT TELL PX1000

BLOCK DIAGRAM



CHAPTER 3

SERVICE

3.1 DISASSEMBLY OF PX1000

The PX1000 can be dismantled, for repair and adjustment purposes, as follows :

1. Remove bottom housing by first unscrewing the six self-tap, cross-head screws, on the underneath side of the unit. Separate the bottom housing from the remainder of the unit, by first lifting the end nearest the audio socket, J4, and then sliding the other end from around the power socket, J3.

2. Disconnect the battery pack/speaker from the main circuit by slipping socket J5 from plug J5, on the logic board. The battery pack is fixed to the bottom housing with adhesive, but can be easily removed for replacement purposes. The speaker sits in a groove in the rubber sealing ring, and be eased out with the aid of a small flat top screwdriver or similar tool. Desolder the wires from the speaker to seperate it completely from the unit.
   The rubber accoustic sealing ring can be removed by slipping it through the hole in the housing.

3. Remove the logic board from the keyboard/LCM assembly by separating 32-pin socket J1, on the logic board from the 32-pin plug J1, on the keyboard PCB, using a small flat-head screw-driver.

4. To access the LCD module, first remove the instruction sticker from the LCD cover. Unscrew the nine cross-head screws, and remove the LCD cover.
   To separate the LCD module from the keyboard PCB, desolder the ten contacts of the flexi-PCB from the LCM PCB.

5. To access the rubber key-pad and keys, snip the tops off the plastic pillars which hold the keyboard PCB to the unit, and lift off the keyboard PCB. Replace the PCB by melting down the pillars over the PCB holes. (Because the pillars get smaller each time, this cannot be done too often.)
   The flexi-PCB can be separated from the keyboard PCB by desoldering the ten contacts, as with the LCM PCB. To remove the flexi-PCB from the unit completely, it must first be bent over, and then slid through the hinge.

3.2 CALIBRATION ADJUSTMENTS

The only adjustments which need to be done on the PX1000 are to two potentiometers on the logic board. These adjustments are done before the unit leaves the factory, but may, in some cases, need to be redone because of slipping of the setting due to vibration etc.
The two pots. to be adjusted are different depending on whether the board is an F or H version. To adjust both, first remove the bottom housing.

Pot. P2 serves a similar function on both boards. Its purpose is to minimise the distortion on the received modem signal. To adjust this, either directly or accoustical couple another PX to the unit. Press ON/STOP + D on the other unit. Press RCVE on the unit to be adjusted. Place the probe of an oscilloscope on pin 8 of IC1. A square wave TTL signal of 1200 Bd should appear on the scope screen. Adjust potentiometer P2, such that the mark/space ratio of this signal is equal.

Pot. P1 on logic board F is used to set the CDL (carrier detect level) on the modem IC. This pot. should be adjusted such that the voltage level appearing on pin 10 of the modem, IC9, should be between 0.64 and 0.74 times the voltage VDD at pin 1 of the modem.
This pot. is replaced by a resistor divider network on the H version logic board.

On logic board H, pot. P1 is used to adjust the level at which the battery charge current rate changes from high to low.
To fix this, first connect a variable voltage supply to connector J5 on the logic board instead of the battery terminals. Place a voltmeter accross this supply. Place either an oscilloscope or second voltmeter at pin 1 of IC8.
Turn on the unit, and keep it on by pessing ON/STOP+D.
Increase the voltage such that 7.45 V appears on the first meter.
Set P1 to maximum anti-clockwise position. Now turn P1 clockwise until the voltage level on the pin 1, IC8 goes low. Reduce voltage on the power supply to about 6.5 V, and then increase slowly until the voltage at pin 1, IC8 goes low. The reading on the first meter should now be between 7.4 V and 7.5 V.
This pot. is not present on the F version logic board as IC8 is not included in the circuit.

3.3 PX1000 TEST PROCEDURE

The following is a description of how the PX1000 should be tested, after repair work has been carried out, to ensure correct operation of the unit The test procedure involves checking the operation of the main functions of the unit.

First carry out the tests ON/STOP + Z and ON/STOP + M, as described at the end of this section. Then check the operation of each part of the unit as follows.

1. LCD

Type in one full row of 8's. Check the contrast of the display. Ensure that the viewing angle is correct and that there is no flickering. Check the operation of all dots and fixed messages.

2. KEYBOARD

Press "CAPS LOCK" ; LOCK should appear in the upper middle part of the display.
Type in the following:

ABCDEFGHIJKLMNOPQRSTUVWXYZ 1234567890-!% (Return)
abcdefghijklmnopqrstuvwxyz

Make sure the proper character appears on the display for each key pressed. Make sure there is a bleep as each character is pressed.

Press each of the following function keys in turn, and make sure of the correct response to each key depressed. Press ON-STOP to cancel each function each time.

Key	Response on display
MARGIN	: SET RIGHT MARGIN AT 40 + PRESS AGAIN
CODE	: EN/DECRYPT TEXT 01 ? + PRESS AGAIN
CALC	: *** CAN NOT CALCULATE ***
CLEAR ALL	: ERASE ALL TEXT ? + PRESS AGAIN
DUMP	: START 'RECORD' ON TAPE + PRESS AGAIN
SEARCH	: SEARCH FOR + PRESS AGAIN
LEFT SHIFT + TEXT	: displays moves to next text
TAB	: cursor moves to next tab point on display
RIGHT SHIFT + TEXT	: displays moves back to previous text
INSERT	: cursor changes to insert cursor
DELETE	: character to the left of cursor is deleted
◁	: cursor moves left one space
▷	: cursor moves right one space
SHIFT + ▷	: cursor moves to end of current line
SHIFT + ◁	: cursor moves to beginning of current line
SHIFT + ▽	: cursor moves to end of the current text
SHIFT + △	: cursor moves to beginning of current text

3.LED
Check that LED lights up, to the correct brightness, in each of the following modes:
(i) TRANSMIT (Press transmit key on left hand side of unit)
(ii) RECIEVE (Press RCVE)
(iii) 12 VDC. connected to socket J3.

Ensure that the LED does not flicker when the 12V DC plug is moved in the socket.

4. TRANSMIT
Check that the unit will transmit (acoustically) a full message correctly to a good PX, at the high transmit speed, as follows:
Enter a message to the PX. Press RIGHT SHIFT + MARGIN. Close lid of PX. Place PX onto the good PX, with the speakers facing each other. Put the good PX into recieve mode by pressing RCVE. Press the transmit key on the left hand side of the PX under test. When the LED on the test jig PX has stopped flashing, the message from the PX under test should appear on the test jig PX, with four little square blocks beside a telephone symbol in the top left hand corner of the display.

Ensure that the LED is operational while transmitting; if 12 VDC is connected to the unit the LED will flicker while transmitting; if 12 VDC is not connected, the LED will flash on and off while transmitting.

5. RECEIVE
Test that the PX recieves correctly and completely a full message transmitted acoustically from a good PX at high speed, as follows;
Put the PX into recieve mode by pressing RCVE. Place PX onto the good PX, with the speakers facing each other.
Enter a message into the good PX. Press RIGHT SHIFT + MARGIN on the good PX. Press the transmit key on the good PX. After the LED on the test jig has stopped flashing, the message entered to the good PX should appear in the PX under test. A perfect reception is indicated by four squares appearing after the telephone symbol in the top left hand corner of the display

Ensure correct operation of LED while recieving; its operation is similar to that of the transmit mode.

(Ensure minimal amount of environmental noises during transmit/recieve tests.)

6. PRINT
Test the print function of the PX as follows:
Insert message containing all the different characters available on the PX. Connect good PXP40 printer to PX via socket J3. Press PRINT on the PX. Make sure the printer prints the message completely as sent from PX.

7. SERIAL INPUT/OUTPUT
Construct the following circuit, using a cable, with a 3.5 mm stereo plug at one end, and the other end open. (see diagram 3.3.1)

a. Connect a LED between wire A, (white), and ground (C), with cathode to ground.
b. Connect a latch action switch between wire B, (red), and ground.

Test the opertion of the serial port as follows :

i) Turn on PX.
ii) Insert the special cable, with switch open, into socket J3 on PX.
iii) Type text of at least 15 lines into PX.
iv) Press PRINT. LED should flicker at high speed.
v) Close switch. LED should go off.
vi) Open switch. LED should flicker again.
vii) LED eventually stops flickering after PLEASE WAIT disappears from the screen.

8. AUDIO INPUT/OUTPUT SOCKET
Construct the following circuit, using a cable with a 2.5mm mono plug at one end, and the other end open. (See diagram 3.3.2)

a. Connect PX speaker across open terminals.

Test socket J4 as follows :

i) Turn on PX. Press ON/STOP + D.
ii) Sound should be heard from PX speaker.
iii) Insert 2.5 mm plug of special cable into socket J4 of PX.
iv) Now there should be sound from the external speaker, and none from the speaker in the PX.

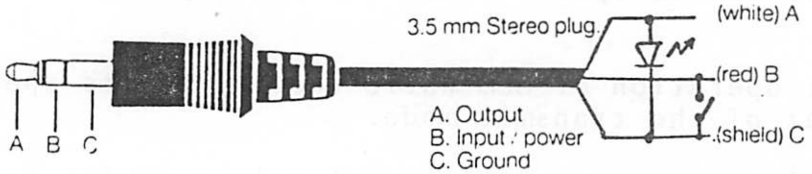


FIG. 3.3.1

FIG. 3.3.2

9. SELF-TEST FACILITIES INCLUDED IN SOFTWARE

The following is a description of facilities that are present on the PX1000 (only those with software version V2 or later), that will assist unit testing. The tests are iniated by pressing the ON/STOP key in combination with another key.

ON/STOP + Z
When pressed is equivalent to a cold start of the unit, i.e. as if the unit is being turned on for the first time.
The text memory is cleared. A copy-right message, giving the software version number, will appear briefly on the display,and the unit does a self-test routine. This routine consists of operational checks on the LCD module, the RAM, the audio o/p and the LED.
The results of these tests are indicated as follows:

Three beeps and three LED flashes:-
The unit has attempted to WRITE and READ to every location in the RAM, IC4, including those locations needed by the program itself, but has found that it is not reading correctly what it has written into some, or all locations. This could be because of a faulty RAM IC, or open cct. between the MPU (IC1), and the RAM or between the decoder (IC5) and RAM.

Two beeps and two LED flashes:-
This indicates that the RAM test has been successful, but that there has been an error when checking the LCD. This could have been because of a faulty LCD module, or open cct. between the LCD and the main unit.

One beep and one LED flash:-
This indicates that the above two tests have been successful.

A fault in either the LED cct. and/or the audio o/p cct. can be detected if, either the beeps, and/or the LED flashes, do not operate as described above.

ON/STOP + D
When pressed, the LCD screen is cleared, and the modem transmits a continious mark/space signal at 1200 Bd., without header.
This signal can be used as the input signal when tuning potentiometer P2 on the logic board of another unit.
The signal output is stopped by pressing ON/STOP.

ON/STOP + E
When pressed, the LCD is cleared, and the modem transmits a continious 10 sec. mark/ 10 sec. space signal without header.
This feature can be used to checked the quality of the modem output, e.g. signal amplititude, frequency.
The signal output is stopped by pressing ON/STOP.

ON/STOP + M
When pressed, the unit does a WRITE/READ test of the text RAM area.
If this test is successful, the message "MEMORY OK" appears on the display.
If unsuccessful, the message is "MEMORY ERROR".

CHAPTER 4

REPAIR

4.1 INTRODUCTION

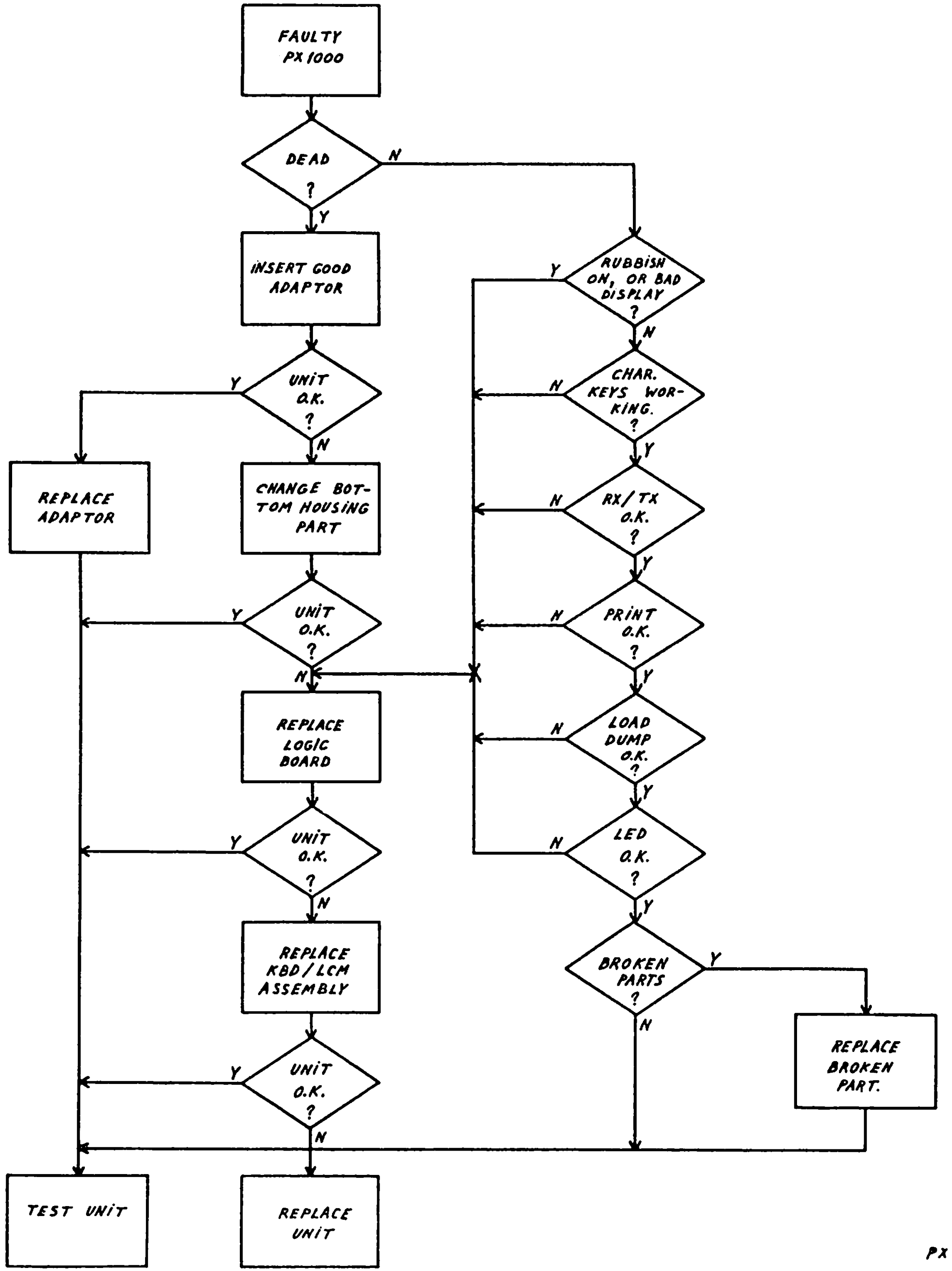
The PX1000 is a high quality electronic unit, which should give little trouble to the user. However, if there does happen to be a problem with the unit, this chapter describes how that problem can be solved.

The unit can be broken down on a modular basis. These separate modules can be purchased from WEST TEC LTD. All problems with the unit can be isolated to one of these modules. To bring a faulty unit back to working order, all is needed is to replace the faulty module. Because of the construction of the individual modules, little if any repair work can be done on them. This does not apply to the logic board, and a seperate repair procedure for this is described in section 4.3.

4.2 MODULAR REPAIR PROCEDURE

The following list indicates some potential technical problems with the PX1000 and the suspected module. Some modules still have some value, even if faulty, and these should be returned to WEST TEC LTD.
If there is physical damage to the unit, e.g. scratches, or cracks in the housing, or stickers or rubber feet are missing, these parts can also be replaced.
A list of the separate modules, and their part numbers is given in the Appendices at the end of this manual.

PROBLEM SYMPTOMS	FAULTY MODULE
1. Blank or black display, but unit appears to function otherwise, i.e. keys click, transmit and print ok.	LCD Module
2. Unit will work only with mains adapter inserted	Battery pack
3. No audio signal when sending, no key click.	Speaker
4. Random characters on display, no response from keyboard, even after reset.	Logic Board
5. One or more keys not functioning	Keyboard
6. Unit will not recharge, and LED does not burn when adapter inserted, and no 12V DC output from adapter.	Adapter


FAULTY PX 1000
DEAD ?
N
Y
INSERT GOOD ADAPTOR
UNIT O.K. ?
Y
N
REPLACE ADAPTOR
CHANGE BOTTOM HOUSING PART
UNIT O.K. ?
Y
N
REPLACE LOGIC BOARD
UNIT O.K. ?
Y
N
REPLACE KBD/LCM ASSEMBLY
UNIT O.K. ?
Y
N
TEST UNIT
REPLACE UNIT
RUBBISH ON, OR BAD DISPLAY ?
Y
N
CHAR. KEYS WORKING. ?
N
Y
RX/TX O.K. ?
N
Y
PRINT O.K. ?
N
Y
LOAD DUMP O.K. ?
N
Y
LED O.K. ?
N
Y
BROKEN PARTS ?
Y
N
REPLACE BROKEN PART.

4.3 PX1000 LOGIC BOARD REPAIR PROCEDURE

Basically, the PX1000 logic board can be split into two distinct parts; the analogue part and the digital part. The make up of these separate parts is as follows :

ANALOGUE	DIGITAL
UNIT ON/OFF CCT.	MPU
BATTERY CHARGER	ROM
AUDIO I/O CCT.	RAM
MODEM	DECODER
DC/DC CONVERTOR	LATCH
SERIAL I/O	
LED ON/OFF CCT.	

Any faults which occur on the logic board can almost always be divided down to being in either one, or the other of these two categories.

EQUIPMENT NEEDED TO CARRY OUT BOARD REPAIR

The following is a list of the equipment which is required to be able to track down, and repair faults on the logic board :

Oscilloscope (more than 10MHz. BW, 2 channels, divide by 10 probes)
Ohmeter (DVM)
Circuit Schematic
Component layout diagram
Component listing
Working Keyboard/LCM Module
Power Supply and speaker jig (see diagram 4.3.1)

It is useful, also, to have a good working logic board, for comparison purposes.
To examine a suspected faulty logic board, first fix it to the good keyboard/LCM module, and the power supply/speaker jig. That way there is little possibility of faults in these parts effecting your work. Also, the extended cable on the power supply/speaker jig, enables easier access to the PCB for probing etc.

SYSTEM SELF TEST

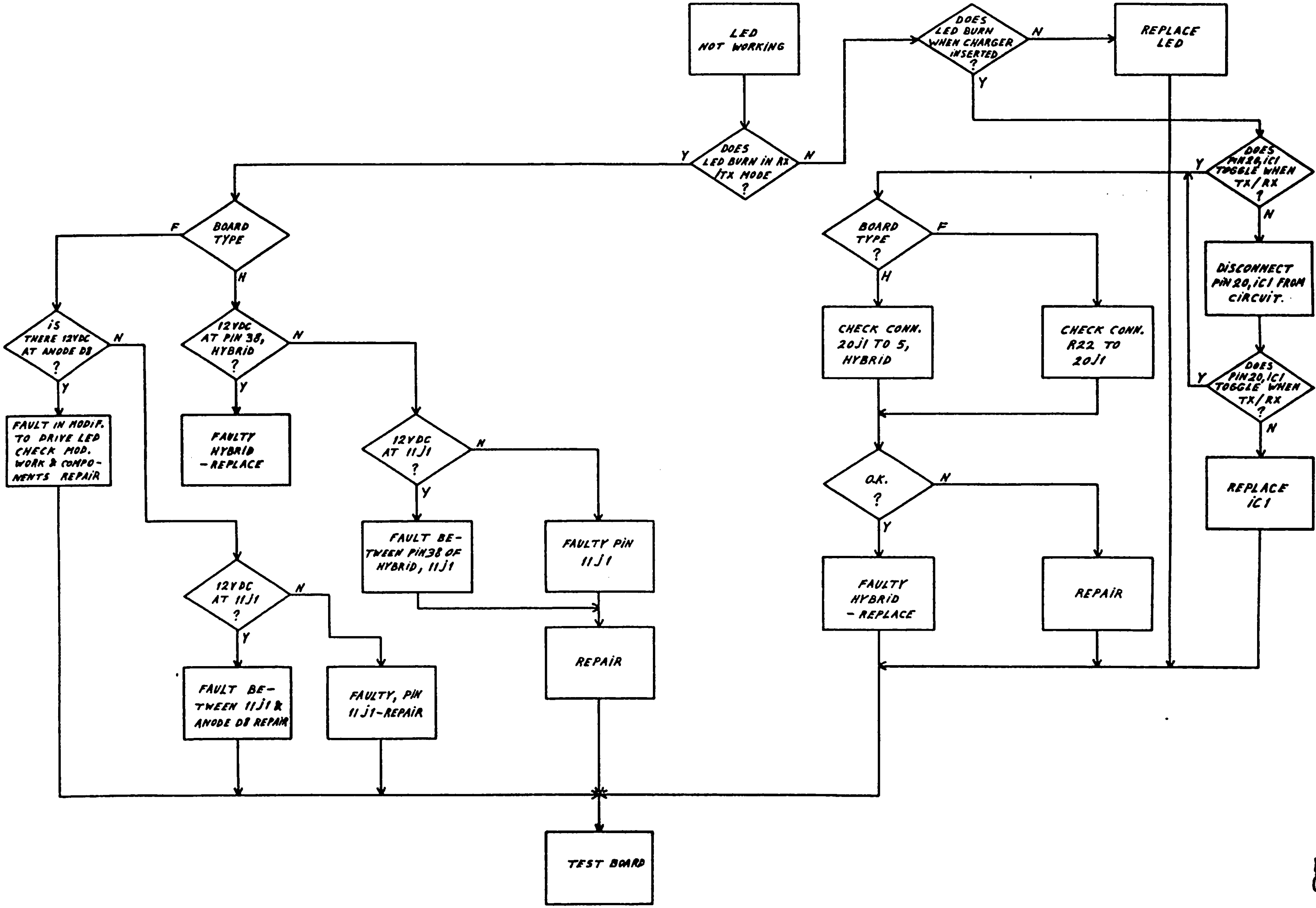
The system software in the PX1000 contains an in-built simple self-test routine, to assist in checking the operation of the following:

a. RAM
b. path to the LCM
c. LED cct.
d. audio o/p stage, (which could point to a fault in the digital side, e.g. a s/c between audio o/p signals from the MPU.)

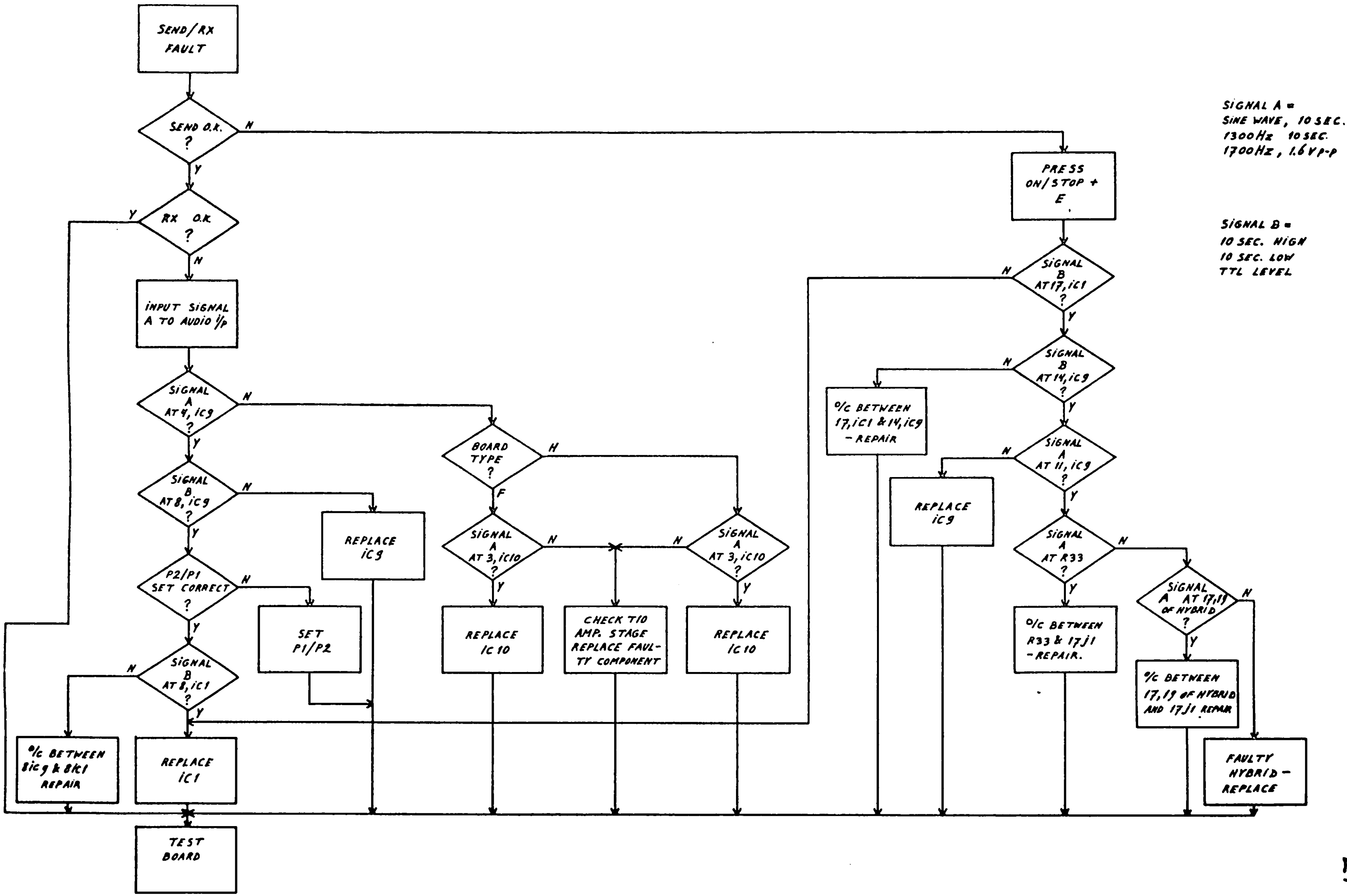
The operation of this test routine is described in section 3.3

ANALOGUE FAULT REPAIR

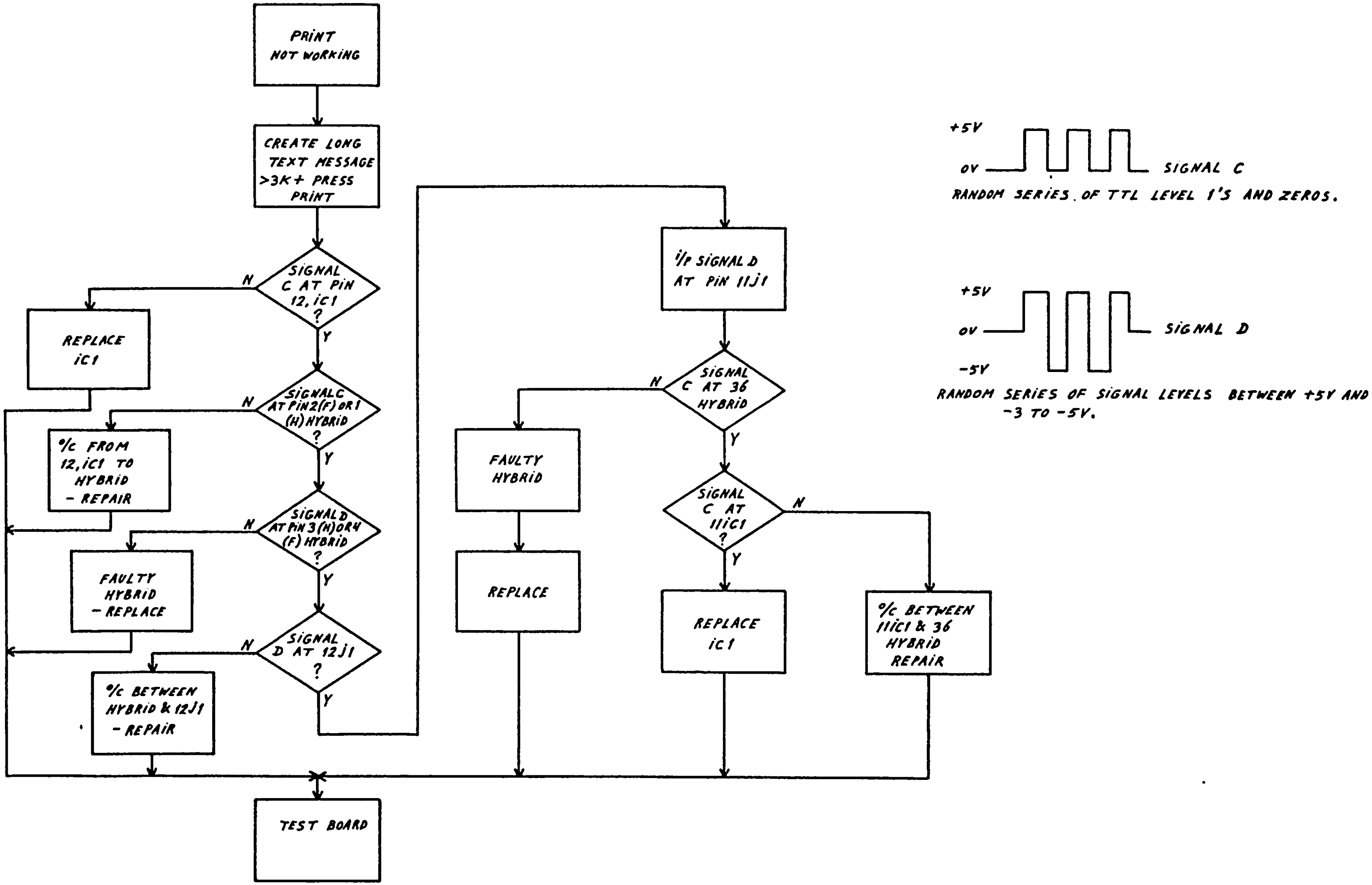
Faults in the analogue part of the circuit are generally relatively easy to track down, by tracing through the relevant circuit.
For example, if there was a fault in the LED drive circuit, one would first check to see if the LED worked in either of the two modes in which it normally operates, (i.e. when transmitting or receiving, or when the adaptor is inserted). If it is found that it never works, then one would check the LED itself, and work back to see where the fault occured. In this way, the fault, which could be an open or short cct., or, faulty transistor or faulty LED, would be quickly traced.
A similar approach would be used for other faults in this category.
See accompanying flowcharts on the following pages.



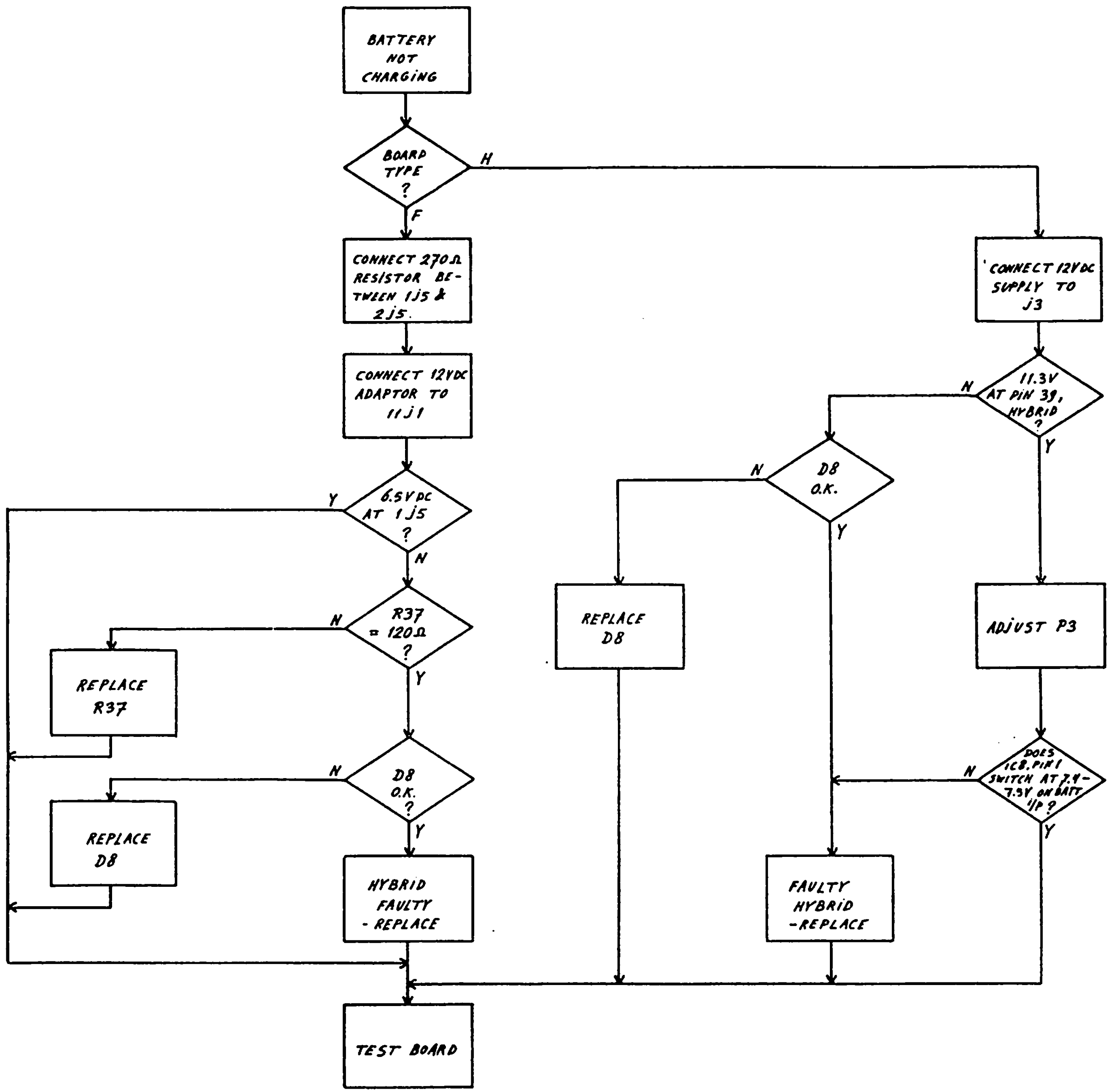
(1) LOGIC BOARD REPAIR PROCEDURE.



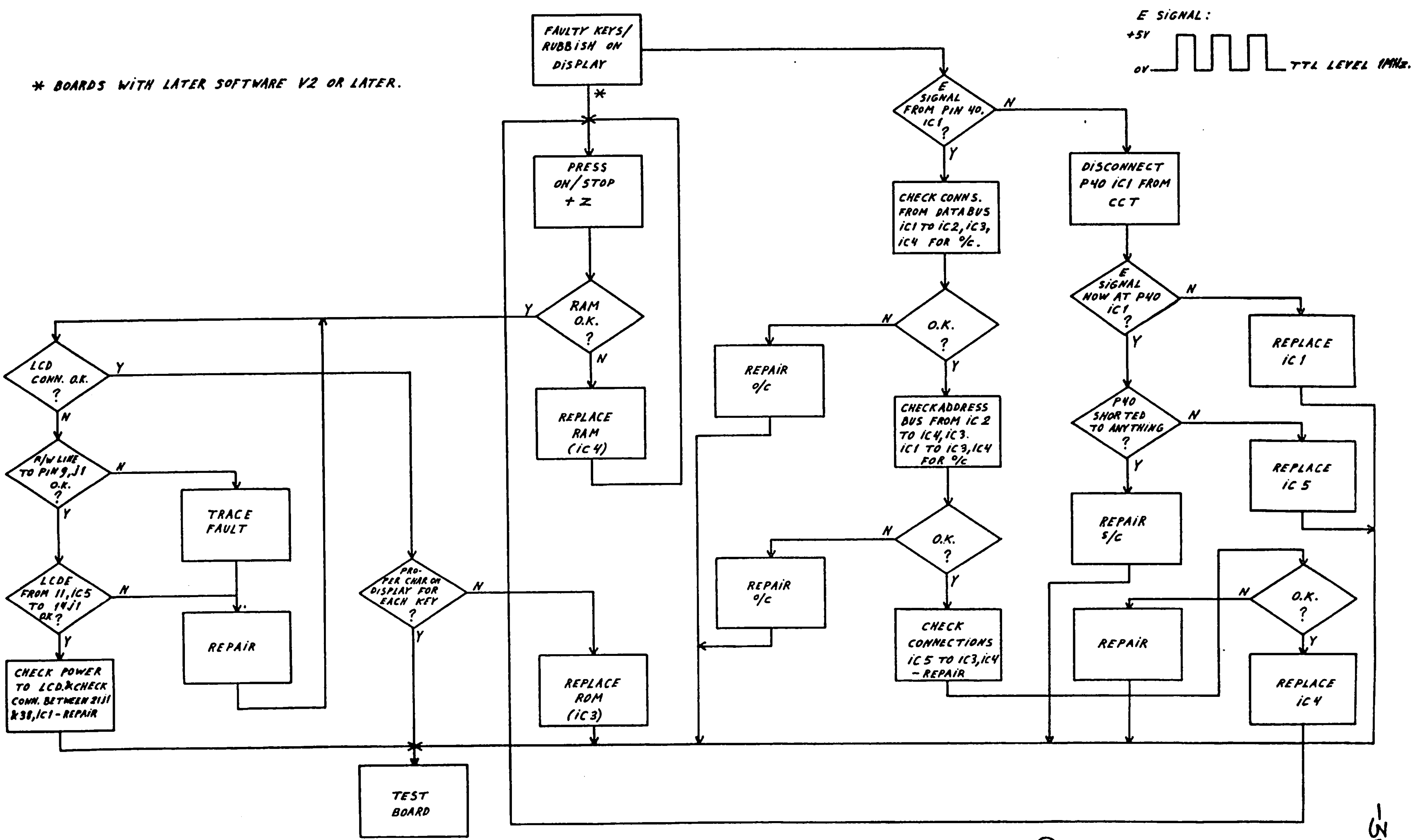
(2) LOGIC BOARD REPAIR PROCEDURE.



③ LOGIC BOARD REPAIR PROCEDURE.



(4) LOGIC BOARD REPAIR PROCEDURE.



(5) LOGIC BOARD REPAIR PROCEDURE.

DIGITAL FAULT REPAIR

Faults in the digital side of the circuit are much more difficult with which to cope. Such problems are recogniseable by the resultant rubbish that appears on the display, either in the form of a complete black or blank display, or random characters anywhere on the display. Because all the individual parts of the digital cct. are inter-linked, such a symptom could indicate a fault with any one, or more of these parts. Therefore, some strategy needs to be adopted that will pin-point the actual fault.

Basic essentials should first be examined.
First, press ON/STOP.
NOTE : Certain types of faults will cause the circuit to turn itself off, immediately after it is turned on. This can be a nuiscance when trying to trace signals on a scope. To overcome this problem, it is a good idea to seperate the power off signal of the MPU, from the rest of the circuit (e.g. cut pin 10, IC1). But, do not forget to make good this connection after the main fault has been repaired.

With an oscilloscope, check each IC for Vcc and GND. If they are not present on any IC, then there is a power supply problem. Check the power lines leading to the relevant IC, for short or open circuits. Once these are established, check the MPU, (IC1),for the following signals :

MPU pin no.	signal	description
2,3	XTL	Crystal signal i/p : 4MHz sine wave
6	RESET	2.5 - 5V
4	NMI	5V
7	STBY	5V
5	IRQ	5V
40	E	1MHz TTL square wave.
39	SC1	1MHz (0.3uS 5V, 0.7uS 0V) see diagram 4.3.2

If these signals are ok, the MPU can be presumed to be in working order. If the signals on pins 2 and 3 are not correct, check for these signals at the crystal terminals. If not present try replacing the crystal.
If the signals on pins 4,5 and 7 are not present, check the connection between these pins and Vcc. If the RESET pin 6 is not a constant voltage level between 2.5 and 5 V, then there is a fault with the reset circuit on the hybrid, and this must be replaced.

Look now at the keyboad enable pin (pin 19),on the MPU. It should be a TTL level signal, with a low level pulse of 0.4 msec, every 65 ms (see diagram 4.3.3). If this signal is present, it is more than likely, that IC's 1,2,3,4,5 are ok, and there is a fault with the interface to the LCD module (LCM). Another indication that the program is working, and that these IC's are ok, is if there is a beep everytime a key is pressed, and the unit turns itself off after 50 sec.

Check that there is no fault with the 32 pin connector, J1. Using a circuit schematic, trace and check that the same signals for the LCM on the logic board are present at the pins of J2 connector on the keyboard PCB. If not, there is probably a faulty connection at J1, i.e. dry or open solder joint.

The operation of the decoder, (IC5), should now be checked. The following features are characteristic of a working decoder :

a. Signal on pin 40 of (IC1) should also appear on pin 6 of IC5. If not, check for open circuit.
b. No two o/p's (pins 7,9,10,11,12,13,14,15) should be low at the same time.
c. O/p's Y1, Y3, Y5, Y7, (pins 14, 12, 10, 7) should never be low.
d. No o/p should be low when E signal (pin 6), is low.
e. When C i/p, (pin 3), is high, Y0, and Y2, (pins 15 and 13), will never be low.

Note : It is useful to use signal on pin 40, IC1, as oscilloscope trigger, while making these observations.
If these conditions are met, we can assume that the decoder is ok.
If not, try replacing the decoder.

Now, with an oscilloscope, check the signals on the pins of the RAM (IC4), bearing in mind the following.

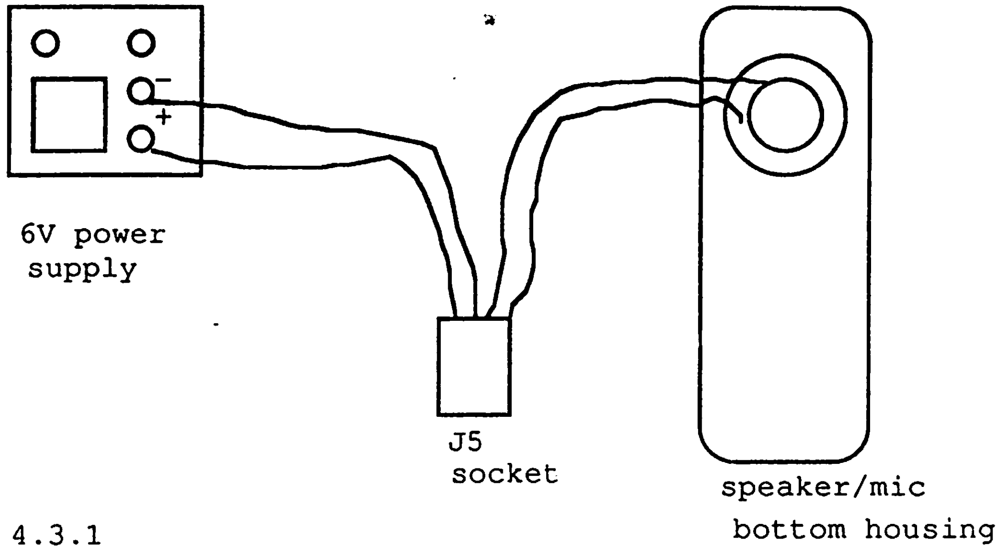
a. These signals are connected to the MPU (IC1), the ROM (IC3), and the LATCH (IC2).
b. The DATA and lower ADDRESS BUSES are multiplexed.

Firstly, the signals on pins 26,27 IC4, should be the same as those on pins 16,38 IC1, respectively. If not, check for open circuit.
Also, signal on pin 26, IC4, should be high.
Looking at the other pins, what will be seen will be difficult to analise, but after a while a definite pattern will be identified.
What should be looked for here are two or more signals, which either appear the exact same, or, which contain definite voltage levels, (not including transitions), which are not TTL.
If found, then the pins with these signals should be examined with an ohmeter, for short circuits.

If a short circuit is found, the shorted tracks should be followed where they lie next to each other, and closely examined. It might be that a stray blob of solder got lodged on the PCB. It is also possible that there may be a short on an IC. If an IC is suspected, try replacing it.
Also, look for pins, which do not appear to have any signal on them, (i.e. open circuited). If such a signal looks suspect, it can be quickly compared with the corresponding signal on either of the other three IC's.

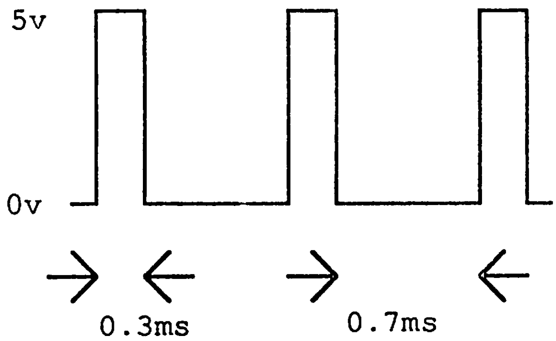
If there appears to be no activity on any of the lower address lines, (pins 3 to 10), it is possible that the LATCH, (IC2), is faulty. Check that pin 11, IC2, has the same signal as pin 40, IC1. If the i/p signals on IC2 appear valid, but there is no o/p, seperate one of the o/p signals from the remainder of the circuit, (e.g. cut the pin). If there is now still no valid o/p, then IC2 is faulty, and must be replaced.

If the board is still faulty, then it must be the MPU that is faulty. Replace, and check again.



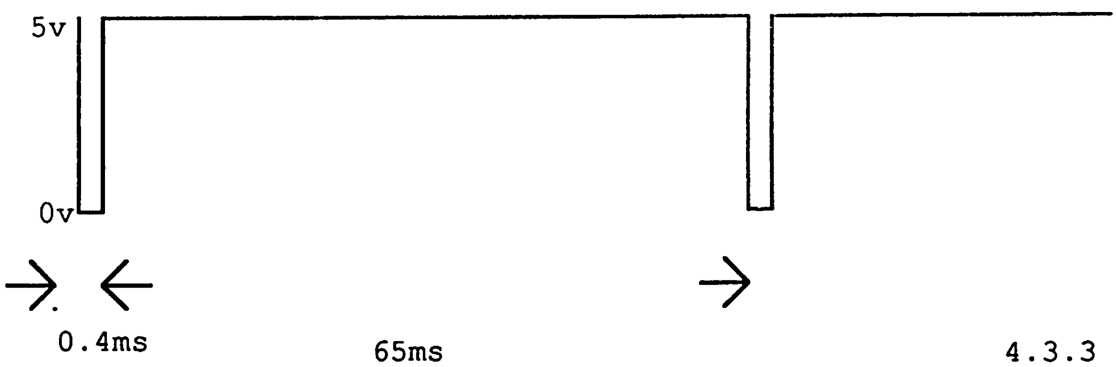
6V power supply
J5 socket
speaker/mic bottom housing

4.3.1



5v
0v
0.3ms
0.7ms

4.3.2



5v
0v
0.4ms
65ms

4.3.3

CHAPTER 5

APPLICATIONS

5.1 C-MAIL

C-MAIL is the name given to an Electronic Mail System, developed by West Tec. Ltd., and which is designed for use by small to medium sized companies. Its purpose is to enable members of the company to be always able to communicate with each other, even if in different time zones, etc.
It consists of a central mini-computer, which can transmit and receive text, to and from the PX1000, via the telephone system. The computer contains software which enables users of the system to leave messages for other users, and also collect messages that have been left for him. To set up the system, one needs an IBM or compatible PC, with a minimum of 64 kB memory, and minimum of 360 kB disk drive capability. Also neccessary is an RS232C Serial Interface board. A modem capable of operating at CCITT Standard V.23, mode 1, connects the PC to the telephone line, via the RS232C port. Optionally, a printer with Centronics interface can be connected, to get hard copies of messages, etc. If this is required, it is neccessary to have a parallel printer board on the PC.
Communication with the system involves calling the telephone number and sending a PX message, headed by a certain command. This command indicates to the system what type of operation you want to carry out. After the message has been sent, the PX is put into receive, and the reply is sent by the system. On later models of the PX a special C-MAIL function automatically puts the PX into receive mode, after sending the message. On older models this must be carried out manually.
Full details of how to set up and operate the system, and also the system software, are available from West Tec Ltd.

5.2 COMPANY MESSAGE CENTER

The Company Message Center is a system developed by West Tec Ltd., which enables small to medium sized companies to have messages, sent from the PX1000 from any location where there is a telephone, printed on a printer at a central place, e.g. the company base.
The system consists of a printer with Centronics type interface, which is connected to the telephone line, via a CCITT Standard V.23 Mode 1 compatible modem with auto answer capability, and the TEXT TELL Message Center interface unit.
To operate the system, the center is called and the message is sent from the PX in the normal way. The interface unit processes the message before sending it to the printer. It will also send a reply giving details of the reception quality, and the time and date.
Full details of the operation of the system, as well as information on the the interface unit is available from West Tec Ltd.

5.3 CONNECTION TO MOVING MESSAGE DISPLAYS

Although not originally designed for the purpose, the PX1000 can be used to program TEXT LITE's Moving Message displays. Programming is done serially from the PX1000 serial output port, to the display's serial input. A cable with a connection from the PX output pin to the display's input pin is all that is required. To use the PX1000 to program a display, first enter the required text into the PX, keeping the following points in mind :

1. Any margin can be used when creating the text, but a margin of 13 should be used when sending the text to the display. This way the first character sent to the unit is a carriage return, which is what the display will expect (this changes the display from run mode to edit mode).

2. The first four characters of the message should be "0"'s, i.e. the right-shifted zero on the PX. This is neccessary to give a delay while the display is echoing the carriage return mentioned in 1 above.

3. All characters typed should be upper-case, as the displays use only upper-case, and lower-case codes are used for commands. Also, only characters used on the displays should be used.

4. To enter a command in the message use the lower case letter corresponding to the particular command. These letters are listed in table 5.3.2. The position where the commands are entered in relation to the text is the same as that described in the Display operating manual. Note that, otherwise, the actual letters have no direct bearing to the particular command.

5. Sixteen spaces must be entered at the end of the message.

6. The text must be limited to 2000 characters, as this is the maximum memory area of the displays.

7. It is not possible to view the message in running mode as it would run on the display.

8. No carriage return should be inserted in the message. This is because the carriage return will change the display into run mode and all text after the carriage return will be lost. (After the message has been sent the PX will send a carriage return as it normally does. This will set the display to run mode.)

When the mesage is created, connect the PX to the display, and send at the high speed from the PX, (1200 Bd), to program.
The old display series operate at 300 Bd with echo. Because of the echo, it is not possible to program the old series with the PX.
The later version series operates at 1200 Bd, without echo.

CHAPTER 6

ACCESSORIES

6.1 STANDARD

The unit is delivered with a Mains Adaptor, for recharging the battery pack, a Serial Cable for serial communications, an audio cable for use with a tape recorder, an operator's manual, and soft case.

6.2 OPTIONAL

PXP40 printer

The PXP40 is a portable 40 column printer developed especially for use with the PX1000. This unit is described in detail in the second half of this manual.

Serial Adapter

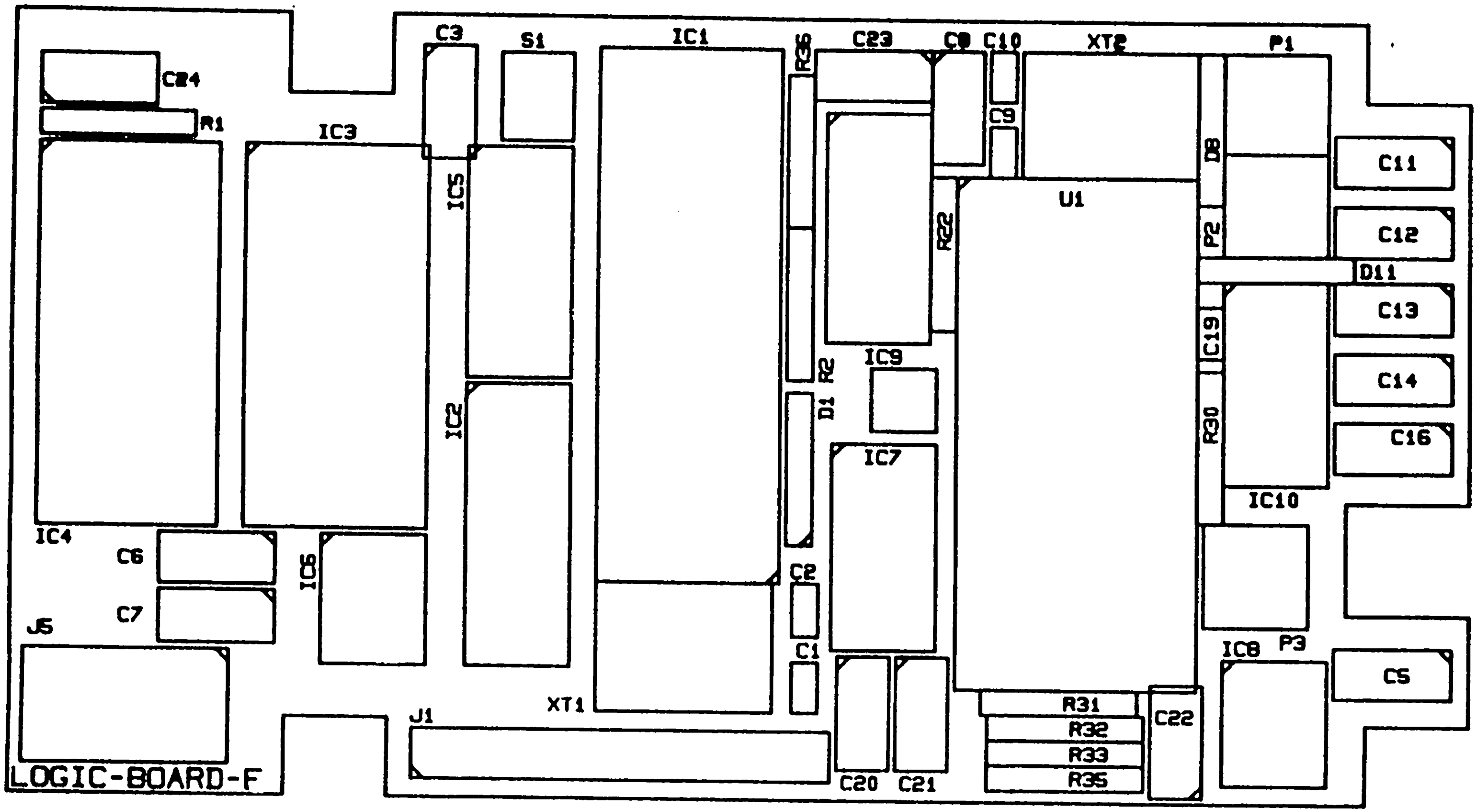
This is an interface cable which can be used to enable serial communication between the unit and almost any other other computer, terminal, printer or data epuipment with serial interface. This cable comes with a booklet giving the neccessary hardware settings for communication with the most popular makes of equipment.

Telephone Adapter

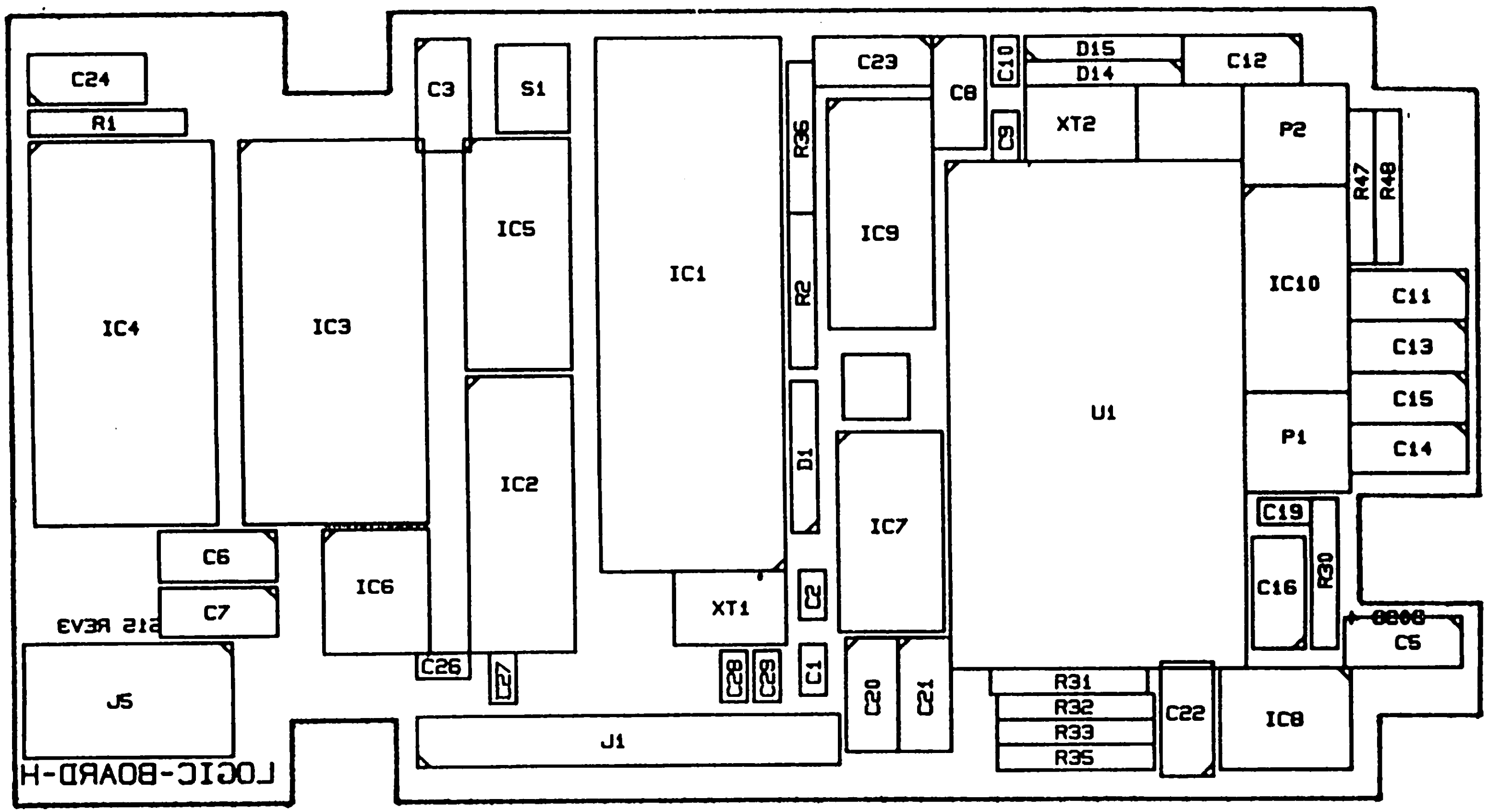
This is a unit which enables the pocket telex to be directly connected to the telephone line, eliminating the environmental noise interference problems associated with accoustical coupling, and thus ensuring error-free communication. Use of this unit is restricted to those countries where-in it is approved by the telephone company.

7.1 PX1000 MODULE LIST

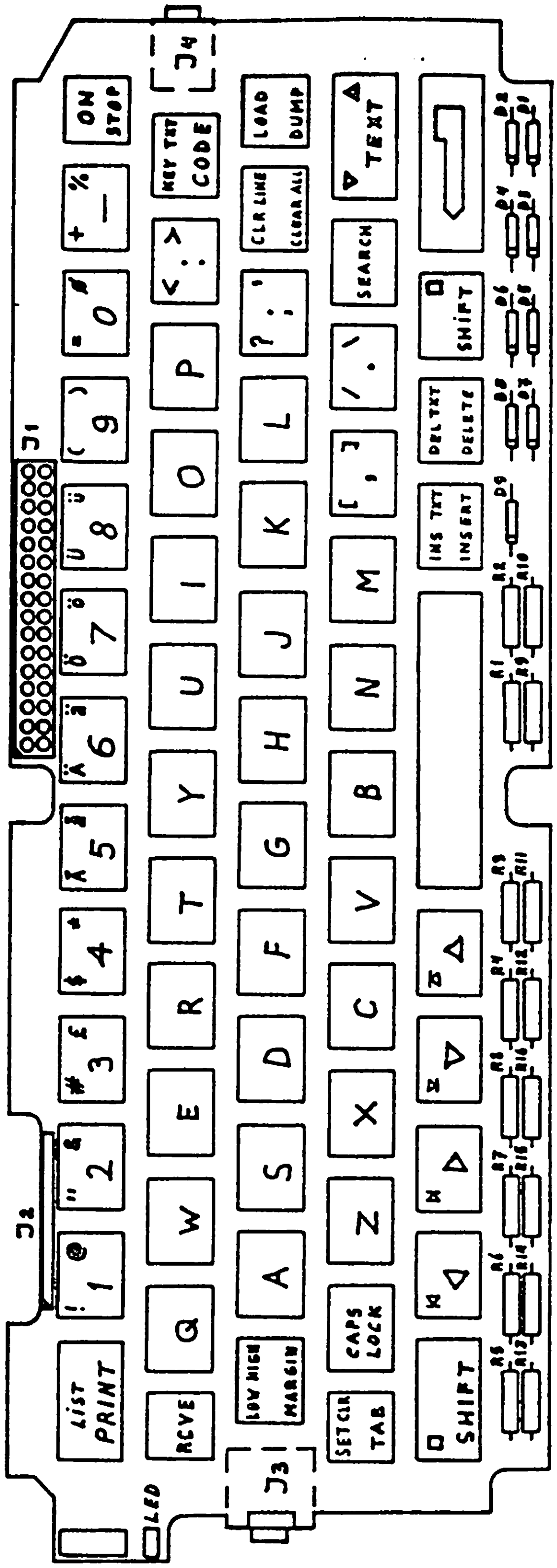
MODULE NO.	MODULE NAME	DESCRIPTION
PX-1	LCD MODULE	LCD PCB with LCD, glass, and driver circuit
PX-2	KEYBOARD	Keyboard PCB, with rubber pad, keys, upper casing, LED, and flexi-cable
PX-3	LOGIC BOARD	PCB main circuit
PX-4	BATTERY PACK	Battery pack of five cells with solder tabs
PX-5	BOTTOM HOUSING	Bottom part of unit.
PX-6	LCD COVER	Cover for LCD, with transparent screen
PX-7	AUDIO TRANSDUCER	Speaker/Microphone
PX-8	OTHERS	a. set of stickers (3 pcs) (state country) b. LCD screws , 9 pcs c. case screws, 6pcs d. rubber feet, 4 pcs e. insulation sheet, 1 pc f. flexible PCB, 1 pc g. 4-way J5 connector, with wires h. accoustic sealing ring
PX-9	PACKAGE	a. Soft case b. cardboard box & sleeve c. foam d. audio & serial cables e. manual (state country)
PX-10	ADAPTER	12V DC adapter (state country)



COMPONENT LAYOUT : LOGIC BOARD F



COMPONENT LAYOUT : LOGIC BOARD H



	west-tec
20-3-'84 RVA	
KEYBOARD COMPONENT LAY-OUT PX1000.	

7.3 COMPONENT LISTING

PX-1000 LOGIC BOARD   VERSION F

P/N	Type No.	Description	Comp. No.	Qty per unit
201	HD6303	microprocessor	IC 1	1
252	74HC373(507)	octal latch	IC 2	1
213	27C64	EPROM	IC 3	1
210	HM6264LP-15	8K x 8 RAM	IC 4	1
251	74HC138(506)	1-8 decoder	IC 5	1
321	ICL7660CPA	voltage converter	IC 6	1
250	74HC00 (505)	quad NAND gate	IC 7	1
320	ICL7665CPA	dual voltage sensor	IC 8	1*
280	TCM3101JD (512)	modem	IC 9	1
509	M51304L	input amplifier	IC10	1
	TH528	customised hybrid	U1	1
1405	1N4148	diode	D1, D11	2
1450	1N4001	diode	D8	1
1005	27pF	ceramic cap.	C1,2,9,10	4
1105	6,8nF	ceramic cap.	C19	1
1301	0,1uF	35V dipped tantalum cap.	C11,12,23,25	4
1315	4,7uF	10V dipped tantalum cap.	C3,5,6,7,8,13,16, 20,21,22,24	11
529	0,22uF	dipped tantalum cap.	C14	1
535	22 Ohm	resistor 1/4 W	R30	1
615	120 Ohm	resistor 1/4 W	R33, R37	2*
617	180 Ohm	resistor 1/4 W	R31,32,35	3
626	1K Ohm	resistor 1/4 W	R22,36	2
630	2K2 Ohm	resistor 1/4 W	R2	1
638	10K Ohm	resistor 1/4 W	R1	2
541	22K Ohm	resistor 1/4 W	R39	1
542	3M Ohm	resistor 1/4 W	R38	1
910	100K Ohm	pot. meter	P1,2	2*
925	200K Ohm	pot. meter	P3	
2610	4.000 MHz	ceramic resonator	XT1	1
2611	4.433 MHz	ceramic resonator	XT2	1
2002	D101632C	32-way socket	J1a	1
2003	custom	4-pin header	J5	1
3501	HKW0269-01-010	reset switch	S1	1
515		PCB/F-version		1

HYBRID (TYPE TH528) ON LOGIC BOARD F

Type	Component No.	
transistor	T1 - T9	9
diode	D2 - D7, D9, D10	8
resistor	R3 - R21, R23 - R29 R34, R40	27
capacitor	C4, 15, 17, 18	4

* parts deleted : S1, IC8
parts inserted : R37

KEYBOARD A160-3

P/N	Type No.	Description	Comp. No.	Qty per unit
1405	1N4148	diode	D1 - D9	9
		LED	D10	1
646	4K7 Ohm	resistor	R1 - R16	16
2001	D101631C	32-way plug	J1	1
2011	HSJ0861-01-240	socket 3.5 mm stereo	J3	1
2013	HSJ0838	socket 2.5 mm mono	J4	1

LOGIC BOARD VERSION H

P/N	Type No.	Description	Comp. No.	Qty per unit
201	HD6303	microprocessor	IC 1	1
252	74HC373(507)	octal latch	IC 2	1
213	27C64	EPROM	IC 3	1
210	HM6264LP-15	8K x 8 RAM	IC 4	1
251	74HC138(506)	1-8 decoder	IC 5	1
321	ICL7660CPA	voltage converter	IC 6	1
250	74HC00 (505)	quad NAND gate	IC 7	1
320	ICL7665CPA	dual voltage sensor	IC 8	1
280	TCM3101JD (512)	modem	IC 9	1
203	TA7330P	input amplifier	IC10	1
	TH536 (513)	customised hybrid	U1	1
1405	1N4148	diode	D1	1
1450	AA119	diode	D14,15	2
1005	27pF	ceramic cap.	C1,2,9,10	4
1020	560pF	ceramic cap.	C19,28,29	3
1105	6,8nF	ceramic cap.	C26,27	2
1301	0,1uF	35V dipped tantalum cap.	C11,12,23	3
1312	1uF	35V dipped tantalum cap.	C14,15	2
1315	4,7uF	10V dipped tantalum cap.	C3,5,6,7,8,13,16, 20,21,22,24	11
615	120 Ohm	resistor 1/4 W	R33	1
617	180 Ohm	resistor 1/4 W	R31,32,35	3
626	1K Ohm	resistor 1/4 W	R30,36	2
630	2K2 Ohm	resistor 1/4 W	R2	1
638	10K Ohm	resistor 1/4 W	R1,47	2
650	100K Ohm	resistor 1/4 W	R48	1
	not used	resistor	R29	
910	100K Ohm	pot. meter	P22	
925	250K Ohm	pot. meter	P11	
2610	4.000 MHz	ceramic resonator	XT1	1
2611	4.433 MHz	ceramic resonator	XT2	1
2002	D101632C	32-way socket	J1a	1
2003	custom	4-pin header	J5	1
3501	HKW0269-01-010	reset switch	S1	1
2		PCB/H-version		1

HYBRID (TYPE TH536) ON LOGIC BOARD H

Component	Type	Number	Qnty on Hybrid
transistor	NPN	T1 - T3,T8,T10	5
transistor	PNP	T4 - T7,T9,T11 - T13	8
diode		D2 - D13	12
zener diode		Z1,2	2
capacitor	1 uF	C4,17	2
	3.3nF	C18	1
	0.1uF	C25	1
resistor	13 Ohm	R37	1
	800 Ohm	R22	1
	1 K Ohm	R8,18,34	3
	3 K Ohm	R46	1
	3.3K Ohm	R26,28	2
	4.7K Ohm	R42	1
	10 K Ohm	R19,20,21,23,24, 25,27,40	8
	22 K Ohm	R39,41	2
	30 K Ohm	R15	1
	45 K Ohm	R10	1
	53 K Ohm	R13	1
	68 K Ohm	R45	1
	70 K Ohm	R16	1
	82 K Ohm	R17	1
	90 K Ohm	R11	1
	100K Ohm	R3,5,6,7,9	5
	150K Ohm	R4	1
	180K Ohm	R14	1
	470K Ohm	R44	1
	600K Ohm	R12	1
	750K Ohm	R43	1
	3 M Ohm	R38	1

KEYBOARD A160-4D

P/N	Type No.	Description	Comp. No.	Qty per unit
1405	1N4148	diode	D1 - D9	9
		LED	D10	1
646	4K7 Ohm	resistor	R1 - R16	16
	22uH	RF-choke	L1 - L6	6
1020	560pF	ceramic cap.	C1 - C4	4
2001	D101631C	32-way plug	J1	1
2011	HSJ0861-01-240	socket 3.5 mm stereo	J3	1
2013	HSJ0838	socket 2.5 mm mono	J4	1

MISCELANEOUS

1901	M4031	LCD module		1
3		flexible PCB	J2	1
7001		driver (speaker/microphone)		1
2402	70515	battery package	B1	1

SECTION B: PXP40

CONTENTS

CHAPTER 1

GENERAL

1.1 PRODUCT DESCRIPTION

The TEXT TELL PXP40 is a compact, 40 column, dot matrix, thermal transfer, printer, developed mainly for use with the PX1000 pocket telex.
Printing is onto a roll of thermal sensitive paper, which can be cut after each print-out by means on an in-built paper cutter.
The character font is made up of 7 x 5 dot.
The unit is fully portable and operates from an internal, rechargeable battery pack.
The housing includes two sping clips to enable the unit to be firmaly attached to the PX1000.
Data transfer to the printer is serial.
The PXP has two terminals, one for the 12V DC adapter, and one which serves two functions; as a serial port, and as a 12V ouput for charging the PX1000.

1.2 SPECIFICATIONS

General

Dimensions	Lenght	: 187 mm
	Weight	: 110 mm
	Height	: 55 mm
Weight		: 500 g

Technical

Power Supply		: internal battery pack rechargeable from external 12V DC adapter.
Power consumption	Standby	: 20 mA
	Printing	: 400 mA average
		: 1400 mA peak
Battery charge current		: 50 mA
Battery use after full charge		: ^{3}1 hr. printing
Buffer memory capacity		: 2 kB
Printing speed		: 25 characters/sec

Serial Port

Baud rate		: 1200 Bd
Data format		: 1 start-bit, 7 data-bits, LSB first, 1 check-bit, 2 stop-bits
Parity		: even
Voltage levels	input	: MARK -3V to -15V
		SPACE +3V to +15V
	output	: MARK 0V
		SPACE 11.3V (adapter connected)
		4.3V (no adapter connected)

CHAPTER 2

THEORY OF OPERATION

POWER SUPPLY

The PXP derives its power from a rechargeable battery pack, consisting of six 1.2V cells, connected in series, giving a nominal voltage of 7.2V, at the battery terminals.
This volatage is applied to the remainder of the circuit via ON/OFF switch, S1. When the switch is in the ON position, two regulator circuits are powered up.
The first involves IC5, a LM2931Z 5.0V regulator, and transistors T6, and T7. The output from this circuit, Vb, is used to drive the printer motor. T6, a TIP32A, provides the high current needed by the motor.
The second regulator circuit involves IC6, also a LM2931. This regualator IC provides the 5V Va, to power all other IC's. Also connected to this IC are transistors T8 and T9. This circuit acts as a battery low voltage indicator to the microprocessor. When the difference between the input and output voltage of IC6 becomes less than 0.7V, transistor T8 turns off, in turn switching transistor T9, which is connected to port DB7 of the MPU. This occurs when the battery voltage is approximately 6.2V.
The battery pack is recharged when the 12V DC adapter is inserted in connector 4. The charge circuit consists of blocking diode D7 and resistor R16, which is 56 Ohms, giving a charge current of approximately 50 mA.

MPU

The microproccessor, or MPU, IC1 (80C49), controls the operation of the printer. The IC has mask ROM on board which contains the program. The MPU derives its clock from crystal CR1, which is either 6 MHz or 11 MHz, depending on the PCB version. The crystal frequency is divided down inside, so that the actual system clock is somewhat lower. The MPU reset circuit consists of RC network R30 and C4, and diode D1, which is connected directly to Va. Thus the reset circuit is activated immediately the unit is turned on.

SERIAL INPUT

The serial input for data consists of transistor T4, diode D3, and resistor R7, R9 and R10. T4 and R7 inverts data appearing on the input pin of connector 3 before entering the MPU. The circuit will also limit RS232 voltage levels to TTL levels, via R9, R10 and D3.

SERIAL OUTPUT

The serial output circuit consists of transistors T2, T3, T5 and T11. This circuit has four functions. First it must be able to provide a BUSY/READY signal to the PX1000 when printing. Secondly it must give a READY signal to the PX1000 when the printer is off. Thirdly it must be able to provide charge current for the PX1000. And, lastly, it must be short-circuit protected because of the nature of connector 3, which shorts the terminals when the plug is inserted.
The BUSY/READY state is controlled from the MPU output port P23. This port turns on or off transistor T5 and T11. When they are on, T3 is on, and T2 is off. Therefore the BUSY signal is low (active). When P23 is brought low, T5 and T11 are off, T2 is on and the BUSY signal is not active.
When the printer is off, this cicuit presents a high impedence output to the PX1000. The PX1000 has a pull-up resistor on its serial input, so the high impedance output of the PXP40 will cause it to see a READY state. (This is neccessary to be able to operate the PX1000 while still connected to the PXP40 which is turned off; each time ²CR³ is pressed, the PX1000 will not hang waiting for a READY signal from the printer).
When the PX1000 is connected to the PXP40 while the recharge adapter is inserted, power to this circuit is provided via diode D6. T2 is biased on via resistors R11 and R26. As long as the PXP is not busy, then charge current for the PX1000 is provided via R8, T2, and D10.
This circuit is also short-cicruit protected, with D10 and R3.

BUFFER

Valid data which appears on the serial input pin of the MPU, pin 6, is stored in the RAM IC, IC2 which has a capacity of 2kB. When printing, the MPU fetches the next byte and feeds it to the printer drive circuit. The outputs of the IC are pulled down via resistor network, RN1. This ensures a steady input to Latch IC3, when the RAM IC is disabled.

PRINTER HEAD DRIVE CIRCUIT

The printer drive circuit consists of IC4, and the two circuits involving transistors T1 and T10.
IC4 is a dot driver IC (LB1256), which drives the seven thermal dots of the printer head directly. These dots can be represented by resistors.
When the MPU wants to send data to the head driver, it first reads the ASCII byte stored in RAM. Then it calculates from the byte the make up of each 7 bit data block it will send to the driver, to make up the 7 x 5 dot character font. This block of data is first latched into IC3, then fed through IC4 which acts as a buffer for the print head.
Because the method of printing is thermal transfer, the lenght of time for each dot determines the darkness of the print. This is controlled by the circuit around T10, a mono stable, whose ouput enables the latch output, which in turn feeds the dot driver IC. The width of the output pulse from the mono-stable is controlled by two factors. One is potentiometer P1, which varies the time constant of the RC network. This is calibrated at the factory to suit the characteristics of the particular print head. The input to the circuit comes from the circuit involving T1. This circuit converts the sine wave of the motor tacho feedback signal to TTL level. If for any reason the motor speed deviates from the norm, e.g. when the batteries are low, or when the paper roll is full, then the time spent for each dot will be decreased, so that the print contrast is constant.
The mono-stable also provides a safety feature for the printer, in that if the motor stops for any reason, e.g. paper gets stuck, the monostable will time out, thus disabling the latch outputs, and consequently disabling the dot driver output.
The TTL converted signal from the tacho of the motor is fed also to the MPU, pin 1, so that it can monitor the position of the motor.

PRINTER MOTOR INTERFACE

The printer drive motor is a DC motor driven from the 5V supply, Vb, which is connected directly to the positive terminal of the motor, M+. The motor is turned on and off under control of the MPU, via port P21 on IC1. This output controls whether Vb or GND appears at the motor negative terminal, M-. The motor TG signal from the motor is a sine wave tacho signal, and its use is described above. The home signal is the output from a micro switch, which momentarily shorts to GND, each time the motor reaches the left-most position. This gives the MPU an indication of the position of the motor after power on.

SOFTWARE

The control software for the printer operates as follows. On power on the MPU comes out of reset, and after approximately one second, is ready to receive data. The BUSY/READY line is held high to indicate printer READY. When a bit-stream is received by the MPU, it will set the BUSY/READY line low (BUSY), and test the data received. If the data is not valid, e.g. a parity error, or unknown character, then it is ignored.. If the data is valid, i.e. a printable character or carriage return, then it is stored in the 2k buffer. The printer is set READY again, and waits for new data. When 128 valid characters are received, the PXP goes BUSY, and starts printing one line. After the line is printed, it waits to receive another 128 characters. This way the printer receives data and prints seemingly at the same time.
If the RAM buffer is nearly full, the printer starts watching for carriage returns, and when one is received, data input is stopped (BUSY/READY line is put low), and the printer starts printing the contents of the buffer. If no carriage return is received, the printer will begin printing as soon as the buffer is full.
When data input stops, i.e. no data is seen at the input for a certain lenght of time, the remaining contents of the text in the RAM buffer are printed.
In order to prevent unwanted empty lines on the print-out, trailing spaces before a carriage return will be ignored.
The printer does not use Escape characters. Therefore if an escape character is received, this character is ignored, as is the following character. This way, text with embeded escape sequences for use with other printers, will be printed correctly on the PXP40.
When the battery voltage falls below approximately 6.2 V, the PXP prints the message " Batteries low, please recharge", and further input and printing is blocked until the unit is switched off, and the battery pack recharged.
If the paper roll jams, or the printer mechanism is blocked in some way, the motor is prevented from burning out by a timing device which will switch the motor off, if printing of one line takes too much time.

CHAPTER 3

SERVICE

3.1 DISASSEMBLY/ASSEMBLY

To disassemble the unit for calibration or repair purposes use the following procedure:

1. Remove the roll of paper, by tearing it where it enters the print mechanism.

2. Remove the five cross-head, self-tap screws on the bottom side of the unit. Turn the unit right-side up, and lift off the upper housing. There may have been adhesive used in the vicinity of the 3.5 mm plug. Care should be used when seperating the housings in this case.

3. The plastic paper cover can now be seperated from the unit.

4. Remove the battery pack froM the PCB by desoldering the terminal solder tags. When replacing the battery pack, ensure that the insulation paper is in place.

5. Remove the printer mechanism from the PCB by first removing the paper advance wheel. Desolder the flexible PCB from the component side of the main PCB. Desolder the five signal wires on the left-hand side from the printer mechanism PCB. Remove the three nuts and bolts holding the mechanism to the main PCB. Replacement is in reverse order.

6. Remove the printer head and flexi-PCB from the mechanism by first removing the retaining clip on the back of the printer head. Before doing this, the flexi-PCB must be separated from this clip by pulling it to the right. If glue has been used to keep it in place this can easily be freed. Now lift the clip out from the retaining lug at the base of the printer head. Hold the paper pressure bar back slightly, and with a tweezers, or similar small tool, slide the printer head up and free from the carriage. When it is free from the carriage, the head can be brought under the carriage bar, and away from the mechanism. Replacement is in the reverse order.

7. Remove the motor from the printer mechanism by first desoldering the four wires from the printer mechanism PCB. Remove the cross-head screws that fix the motor to the printer mechanism.
   Replacement is in the reverse order.

3.2 TEST PROCEDURE

Test the correct operation of the printer using the following procedure.
Charge the batteries on the PXP by inserting the 12V DC adapter and leaving it in for a minimum of 10 hours. The battery pack should now be fully charged, and should give 1 hour minimum continuous printing, or more than 2,000 lines of 40 characters.
Check that the battery pack has some charge, by turning on the unit. The printer head should travel to the end of the line, and back again. If it does not, then turn the unit off and on again. If it still does nothing, or prints "Batteries low, please recharge", then there is a problem either with the battery pack, or with the recharge circuit.
Create a text in a PX1000 of more than two thousand characters, i.e. more than 50 full lines of text.
Connect the PX to the PXP to be tested. Turn on the PXP. Press PRINT on the PX. The complete text as in the PX should be printed without error.
If some of the text is missing, or seems overwritten, then there is a problem either with the READY/BUSY signal, or the RAM buffer IC.
If the text appears either too dark, or very faint, then the setting of potentiometer P1 is incorrect.

3.3 REPAIR

The following is a description of procedure which should help in dealing with any faults that occur with the PXP40. Generally speaking, the unit is made to a very high quality standard, and should give little operational trouble.

1. UNIT IS DEAD

First check that the battery pack has not come free from the PCB. If it has, resolder and attach a piece of foam or sponge to the top of the battery pack, so that it is held firmly in place by the housing.
Check with a voltmeter that the battery pack is fully charged. There should be a minimum of 6.3 volts on its terminals. If after a 10 hour recharge, this is not so, check that the charge current is correct, by inserting a mili-ampmeter between the positive battery terminal, and the PCB.
If the charge current is not correct, check the value of R16.
If there is no charge current, check for open circuits.
If everything seems ok, check that there is no foreign object stuck in the mechanism, or that the battery pack is not pressing against the cogs and wheels of the motor drive. If there is nothing found, then replace the battery pack.
If the battery pack appears ok, then there is a problem with one of the voltage regulator circuits. Check that there is 5V at Va and Vb. If not check that there is 5V at the output of each regulator IC, IC5 and IC6. Replace if faulty.
If the regulators are ok check the by-pass transistors, T6, T7, and T8.
If the battery pack and charge circuit seem ok, but the unit still prints "Batteries low, please recharge", check the circuit around T9. With full batteries, pin 19 on the MPU, IC1, should be low. If this is not the case, check for open or short circuits. If not found, replace T9.

2. UNIT PRINTS BUT PART OF MESSAGE IS NOT PRINTED

Check that the BUSY/READY signal from the printer is operational. This signal at the connector 3, should be low whenever the printer head is moving, and the printer is printing. If this is not the case, check that BUSY/READY control signal on the MPU, pin 24 is ok. This pin should be high when the pprinter is busy. If this output is ok, but the BUSY/READY at connector 3 is not, then there is a fault in the circuit involving T2, T3, T5 and T11.
When pin 24 IC1 is high, all transistors should be on. When this pin is low, only T2 should on. If this is not so, replace the the suspect transistor.
If the printer still loses some of the message, it might be that the RAM, IC2 is faulty. Replace this and check again.

3. NO PRINT

Check that data is entering the MPU, IC1 pin 6, when PRINT on the PX is pressed, and the printer is not busy.
If there is no data entering, but data is present at the input on connector 3, then check for open or short circuits between the connector and pin 6 IC1. If none found, replace T4.
Check the motor on/off signal from IC11, pin 23. When this pin is low, the motor should be on. If not, check the connections from the motor to the main PCB, and to pin 11 IC4.
If pin 11, IC4, does not follow pin 8, IC4, then replace IC4.
If pin 23 of IC1 does not go low when the unit is switched on, there is a problem with IC1. Check that the reset circuit is operational; pin 4 IC1 should be a constant DC level between 3V and 5V. If not, check for open circuit, or short circuit, and replace faulty component if neccessary.
Ensure that the crystal inputs are correct. A sine wave of the cyrstal frequency should be at pins 2 and 3 if IC1. Check that pin 5 is high, and pin 7 is low. If not check that the pull-up, and pull-down circuits are ok.
If these signals appear ok, and pin 23 still does not go low, then replace IC1.

Remember when replacing components on the PXP that there are two versions. Always check the correct component listing.

4. PRINT IS TOO DARK OR TOO FAINT

Check the setting of P1. Vary P1 until the desired print contrast is acheived.
If it is not possible to acheive correct contrast at any setting, replace T10.
If the contrast is still faulty, try replacing the print head.

4.1 COMPONENT LISTING PXP-40 (PRINT MASK VERSION PCB)

Type No.	Description	Comp. No.	Qty per unit
M80C49-172	microprocessor	IC1	1
uPD449C	2K RAM	IC2	1
74HC373	octal latch	IC3	1
LB1256	dot driver	IC4	1
LM2931Z	5.0V regulator	IC5,6	2
74HC00	quad 2 input NAND	IC7	1
6033Y	NPN transistor	T1,4,5,9,10,11	6
2SC2001	NPN transistor	T7	1
1153Z	PNP transistor	T2,3,8	3
2SA1069	PNP transistor	T6	1
1N4148	diode	D1 - D10	10
30pF	ceramic cap.	C7,8	2
470pF	ceramic cap.	C6	1
560pF	ceramic cap.	C20 (modification)	1
10nF	ceramic cap.	C19	1
100nF/50V	ceramic cap.	C5,17	2
1uF/16V	tant. cap.	C1,2,4,9,10	5
10uF/10V	tant. cap.	C3,13,18	3
22uF/10V	tant. cap.	C12,14,15	3
22uF/16V	tant. cap.	C11	1
	* NOT INCLUDED	C16	
3.3 Ohm	resistor 1/8W	R8	1
100 Ohm	resistor 1/8W	R2,15	2
270 Ohm	resistor 1/8W	R11	1
1K Ohm	resistor 1/8W	R17	1
2K2 Ohm	resistor 1/8W	R25	1
3K3 Ohm	resistor 1/8W	R9	1
3K9 Ohm	resistor 1/8W	R13	1
4K7 Ohm	resistor 1/8W	R1,5,10,14,18,23,28,29	8
10K Ohm	resistor 1/8W	R7,20	2
12K Ohm	resistor 1/8W	R12,26	2
27K Ohm	resistor 1/8W	R24	1
47K Ohm	resistor 1/8W	R6,27	2
82K Ohm	resistor 1/8W	R22	1
100K Ohm	resistor 1/8W	R19,21,30	3
180K Ohm	resistor 1/8W	R3,4	2
56 Ohm	resistor 1/4W	R16	1
100K Ohm	resistor network	RN1	1
22K Ohm	pot. meter	P1	1
6 MHz	ceramic resonator	CR1	1
SS-12ZA-06P	on/off switch	S1	1
	3.5mm stereo plug	CON3	1
HSJ0861-01-240	3.5mm stereo socket	CON4	1
MTP401-40AN	printer mechanism		1
	M2 metal bolt		3
	M2 metal nut		3
	PCB PXP-40		1

COMPONENT LISTING PXP-40 (NON PRINT MASK VERSION PCB)

Type No.	Description	Comp. No.	Qty per unit
TMP80C49AP -6601	microprocessor	IC1	1
TC5516	2K RAM	IC2	1
74HC373	octal latch	IC3	1
LB1256	dot driver	IC4	1
LM2931Z	5.0V regulator	IC5,6	2
74HC00	quad 2 input NAND	IC7	1
BC238B	NPN transistor	T1,4,5,9,10,11	6
BC338B	NPN transistor	T7	1
BC308B	PNP transistor	T2,3,8	3
TIP32A	PNP transistor	T6	1
1N4148	diode	D1 - D7, D11, D12	9
IN4001	diode	D9, 10	2
	* NOT INCLUDED	D8	
15pF	ceramic cap.	C7,8	2
470pF	ceramic cap.	C6	1
560pF	ceramic cap.	C20 (modification)	1
47nF	ceramic cap.	C16 *1	1
100nF/50V	ceramic cap.	C5,16 *2	2
1uF/20V	tant. cap.	C1,2,4,9,10	5
10uF/10V	tant. cap.	C3,13,18	3
22uF/10V	tant. cap.	C12,14,15	3
22uF/16V	tant. cap.	C11	1
*1 AND *2 ARE IN PARALLEL			
3.3 Ohm	resistor 1/8W	R8	1
100 Ohm	resistor 1/8W	R2,15	2
270 Ohm	resistor 1/8W	R11	1
1K Ohm	resistor 1/8W	R17	1
2K2 Ohm	resistor 1/8W	R25	1
3K3 Ohm	resistor 1/8W	R9	1
3K9 Ohm	resistor 1/8W	R13	1
4K7 Ohm	resistor 1/8W	R1,5,10,14,18,23,28,29	8
10K Ohm	resistor 1/8W	R7,20	2
12K Ohm	resistor 1/8W	R12,26	2
27K Ohm	resistor 1/8W	R24	1
47K Ohm	resistor 1/8W	R6,27	2
82K Ohm	resistor 1/8W	R22	1
100K Ohm	resistor 1/8W	R19,21,30	3
180K Ohm	resistor 1/8W	R3,4	2
56 Ohm	resistor 1/4W	R16	1
100K Ohm	resistor network	RN1	1
22K Ohm	pot. meter	P1	1
11 MHz	ceramic resonator	CR1	1
SS-12ZA-06P	on/off switch	S1	1
	3.5mm stereo plug	CON3	1
HSJ0861-01-240	3.5mm stereo socket	CON4	1
MTP401-40AN	printer mechanism		1
	M2 metal bolt		3
	M2 metal nut		3
	PCB PXP-40		1