Cardiovit AT-10 ECG and Spirometry Unit

Service Handbook

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AT-10 Service Handbook

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Associated Documents

Guide to SCHILLER Interpretation and Measurement Program E / D / F	Article No.	2.510179
SCHILLER AT-10 USER GUIDE - English	Article No.	2.510127
SCHILLER AT-10 USER GUIDE - German	Article No.	2.510126
SCHILLER AT-10 USER GUIDE - French	Article No.	2.510128

CE 0123 93/42/EEC Medical Devices: 0123 `Notified Body` TÜV P. S.

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Warranty

Disclaimer

The Information in this guide has been carefully checked for reliability; however no guarantee is given as to the correctness of the contents and SCHILLER makes no representations or warranties regarding the contents of this manual. We reserve the right to revise this document and make changes in the specification of the product described within at any time without obligation to notify any person of such revision or change.

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Terms of Warranty

The SCHILLER AT-10 is warranted against defects in material and manufacture for the duration of one year (as from date of purchase). Excluded from this guarantee is damage caused by an accident or as a result of improper handling. The warranty entitles free replacement of the defective part. Any liability for subsequent damage is excluded. The warranty is void if unauthorized or unqualified persons attempt to make repairs.

In case of a defect, send the apparatus to your dealer or directly to the manufacturer.

The manufacturer can only be held responsible for the safety, reliability, and performance of the apparatus if:

° assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by him, and

° the unit and approved attached equipment is used in accordance with the manufacturers instructions.

THERE ARE NO EXPRESS OR IMPLIED WARRANTIES WHICH EXTEND BEYOND THE WARRANTIES HEREINABOVE SET FORTH. SCHILLER MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCT OR PARTS THEREOF.

Safety Notices

TO PREVENT ELECTRIC SHOCK DO NOT DISASSEMBLE THE UNIT. NO SERVICEABLE PARTS INSIDE. REFER SERVICING TO QUALIFIED PERSONNEL ONLY.

DO NOT USE THIS UNIT IN AREAS WHERE THERE IS ANY DANGER OF EXPLOSION OR THE PRESENCE OF FLAMMABLE GASES SUCH AS ANAESTHETIC AGENTS.

IF THE DISPLAY IS DAMAGED, A LEAKAGE OF FLUID MAY OCCUR. DO NOT INHALE THE VAPOUR FROM THIS FLUID AND AVOID CONTACT WITH MOUTH AND SKIN. IF CONTACT IS MADE, CLEAN CONTAMINATED AREA IMMEDIATELY WITH FRESH WATER.

THIS PRODUCT IS NOT DESIGNED FOR STERILE USE.

SWITCH THE UNIT OFF BEFORE CLEANING AND DISCONNECT FROM THE MAINS.

DO NOT, UNDER ANY CIRCUMSTANCES, IMMERSE THE UNIT OR CABLE ASSEMBLIES IN LIQUID.

DO NOT OPERATE THE UNIT IF THE EARTH CONNECTION IS SUSPECT OR IF THE MAINS LEAD IS DAMAGED OR SUSPECTED OF BEING DAMAGED.

DO NOT USE HIGH TEMPERATURE STERILISATION PROCESSES (SUCH AS AUTOCLAVING). DO NOT USE E-BEAM OR GAMMA RADIATION STERILISATION.

DO NOT USE SOLVENT CLEANERS

USE ONLY ACCESSORIES AND OTHER PARTS RECOMMENDED OR SUPPLIED BY SCHILLER AG. USE OF OTHER THAN RECOMMENDED OR SUPPLIED PARTS MAY RESULT IN INJURY INACCURATE INFORMATION AND/ OR DAMAGE TO THE UNIT.

THE AT-10 COMPLIES WITH EMC REGULATIONS FOR MEDICAL PRODUCTS WHICH AFFORDS PROTECTION AGAINST EMISSIONS AND ELECTRICAL INTERFERENCE. HOWEVER SPECIAL CARE MUST BE EXERCISED WHEN THE AT-4 IS USED WITH HIGH FREQUENCY EQUIPMENT.

IT MUST BE ENSURED THAT NEITHER THE PATIENT NOR THE ELECTRODES (INCLUDING THE NEUTRAL ELECTRODE) COME INTO CONTACT WITH OTHER PERSONS OR CONDUCTING OBJECTS (EVEN IF THESE ARE EARTHED).

THERE IS NO DANGER WHEN USING THE ECG UNIT FOR A PACEMAKER PATIENT OR WITH SIMULTANEOUS USE OF OTHER ELECTRICAL STIMULATION EQUIPMENT. HOWEVER, THE STIMULATION UNITS SHOULD ONLY BE USED AT A SUFFICIENT DISTANCE FROM THE ELECTRODES. IN CASE OF DOUBT, THE PATIENT SHOULD BE DISCONNECTED FROM THE RECORDER.

Safety Notices

THIS UNIT IS CF CLASSIFIED ACCORDING TO IEC 601-1. THIS MEANS THAT THE PATIENT CONNECTION IS FULLY ISOLATED AND DEFIBRILLATION PROTECTED. SCHILLER CAN ONLY GUARANTEE PROTECTION AGAINST DEFIBRILLATION VOLTAGE, HOWEVER, WHEN THE ORIGINAL SCHILLER PATIENT CABLE IS USED.

WHEN NON-MEDICAL DEVICES ARE CONNECTED TO THE RS-232 INTERFACE ENSURE THAT BOTH UNITS ARE SECURELY CONNECTED TO THE SAME EARTH POTENTIAL.

WHEN OPERATING THE UNIT ON BATTERY AND SIMULTANEOUSLY USING NON-MEDICAL DEVICES, THE RS-232 INTERFACE MUST BE FULLY ISOLATED.

BEFORE USING THE UNIT, ENSURE THAT AN INTRODUCTION REGARDING THE UNIT FUNCTIONS AND THE SAFETY PRECAUTIONS HAS BEEN PROVIDED BY A SCHILLER REPRESENTATIVE.

THE GUIDELINES FOR PATIENT ELECTRODE PLACEMENT ARE PROVIDED AS ON OVERVIEW ONLY. THEY ARE NOT A SUBSTITUTE FOR MEDICAL EXPERTISE.

THE AT-10 ECG UNIT IS PROVIDED FOR THE EXCLUSIVE USE OF QUALIFIED PHYSICIANS OR PERSONNEL UNDER THEIR DIRECT SUPERVISION. THE NUMERICAL AND GRAPHICAL RESULTS AND ANY INTERPRETATION DERIVED FROM A RECORDING MUST BE EXAMINED WITH RESPECT TO THE PATIENTS OVERALL CLINICAL CONDITION. THE RECORDING PREPARATION QUALITY AND THE GENERAL RECORDED DATA QUALITY, WHICH COULD EFFECT THE REPORT DATA ACCURACY, MUST ALSO BE TAKEN INTO ACCOUNT.

IT IS THE PHYSICIANS RESPONSIBILITY TO MAKE THE DIAGNOSIS OR TO OBTAIN EXPERT OPINION ON THE RESULTS, AND TO INSTITUTE CORRECT TREATMENT IF INDICATED.

What´s in this Book

THE SERVICE PHILOSOPHY FOR ALL SCHILLER UNITS IS FAULT FINDING TO MODULE LEVEL. THE PURPOSE OF THIS BOOK IS TO PROVIDE ALL THE INFORMATION NECESSARY TO ENABLE THE SERVICE ENGINEER TO EFFICIENTLY LOCATE AND REPLACE A FAULTY MODULE. THIS BOOK ASSUMES NO DETAILED KNOWLEDGE OF THE AT-10 BUT DOES REQUIRE THAT THE SERVICE ENGINEER IS FAMILIAR WITH STANDARD WORKSHOP PRACTICES.

The book is divided into the following chapters:

Chapter 1 - Operating Elements

The purpose of this chapter is to provide an easy reference for all the main operator functions and to give a basic introduction to the AT-10. This chapter gives details of the operator controls with the operation and function of each key briefly explained. The information in this chapter provides a background to the operating functions only. Complete operating information is provided in the SCHILLER AT-10 Operating Manual.

Chapter 2 - Functional Overview

This chapter provides a functional overview of the AT-10 The functional description is supported by functional block diagrams.

Chapter 3 - Fault Diagnosis

This chapter provides a guide to locate a fault to module level. The diagnostics are presented in a logical sequence of fault finding algorithms and procedures. Illustrations are provided to support the text where needed.

Chapter 4 - Physical Overview & Module Replacement

This chapter gives an overview of the physical construction of the AT-10 with the main physical attributes of the unit briefly described. The physical description is supported by illustrations showing the internal location of all modules. Removal and Replacement instructions for all replaceable modules are also provided in this chapter. Each procedure is autonomous with details of tools, jumper settings, adjustments, and settings or special requirements that are required before and after replacement. Functional checks that must be carried out after replacing a new module are also provided.

Chapter 5 - Functional Checks & Adjustments

This chapter provides all adjustments and settings. Also detailed in this chapter are basic functional test procedures that can be performed to check the functioning of the unit.

Chapter 6 - Spare Parts

This Chapter provides the part numbers and reordering information for all replaceable modules. Also included in this chapter are details of any special test equipment or special tools required for adjustment or fault finding procedures.

Chapter 7 - Technical Data

The full technical specification of the AT-10 is given in this chapter.

Chapter 8 - Glossary

This Chapter explains all the acronyms and signal titles used in this book and in the AT-10 circuit diagrams.

What´s in this Book

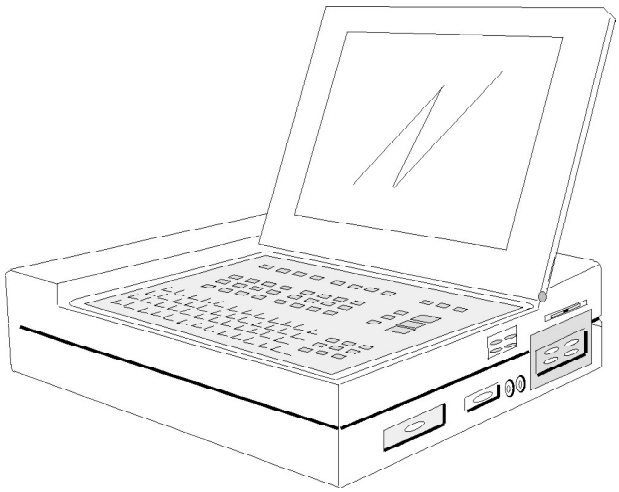
Circuit Diagrams & Board Layouts

The circuit diagrams and component layouts are provided for all boards. These details are provided for information only.

Chapter 1
Operating Elements

Contents

Introduction



The Schiller Cardiovit AT-10

The CARDIOVIT AT-10 is a sophisticated compact work-station for cardiological diagnosis. It has the facility to carry out both resting and exercise ECGs with the test results displayed on the integral LCD and recorded on the built-in thermal printer.

Three RS-232 interfaces and one RS-422 interface are provided for the connection of digitally controlled exercise test equipment, blood pressure equipment, and for data transmission/reception. The unit also has facilities for connection of an external video monitor, experimental DC inputs, and analog controlled exercise equipment.

With ECG program options, the AT-10 can be upgraded to provide ECG interpretation, exercise test evaluation, pacemaker measurement and Frank vector loops. A Spirometry option enables Spirometry tests to be performed and pulmonary function diagnosis to be carried out.

The AT-10 can also be connected to the Schiller PC-based data management program (designated SEMA-200), for the validation and archiving of recorded data.

Introduction (cont.)

The main operating and connection modules of the Cardiovit AT-10 are as follows:

- Keyboard — The keyboard is divided into three functional areas. The top area comprises the unit ON/OFF keys, the paper tray key and other general function keys. The central area contains dedicated control and function keys, and the bottom area contains the alpha-numeric keys and other general function keys.
- LCD Screen — The LCD screen displays the real-time ECG traces and certain operating and status information. Under operator control the display also gives menu options and displays operator entered data. The display is folded down when not in use.
- Thermal Printer — The printer provides hard copy of test results.
- Right-hand Side Panel — The side panel contains dc input connectors, the ECG patient connector, the Spirometry connector and RS serial connectors. When the floppy disk storage option is installed, the disk drive is installed on this side panel.
- Left-hand Side Panel — This panel contains the paper tray and (below the paper tray) the program pack.
- Rear Panel — The rear panel contains the data input/output connector, the external video monitor and the ERGO connector. The rear panel also contains the mains connector with on/off switch, voltage selector and mains fuse. When the LAN option is installed the LAN connector is mounted on the back panel

The Keyboard

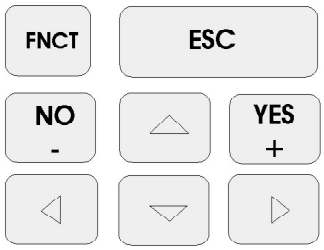
Alpha Numeric Keypad

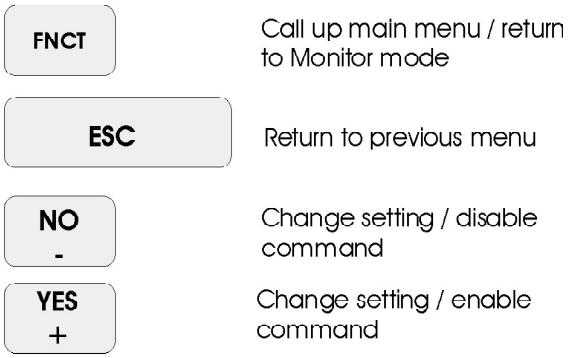
The functions of the dual purpose keys on the alphanumeric keyboard are as follows:

DUAL PURPOSE KEYS	
KEY	**FUNCTION**
'1' to '7'	Printout Speed Selection 2.5, 5, 10, 12.5, 25, 50, or 100 mm/s
'8' to `_	Printout Sensitivity Selection 2.5, 5, 10, or 20 mm/mV

General Purpose Keys

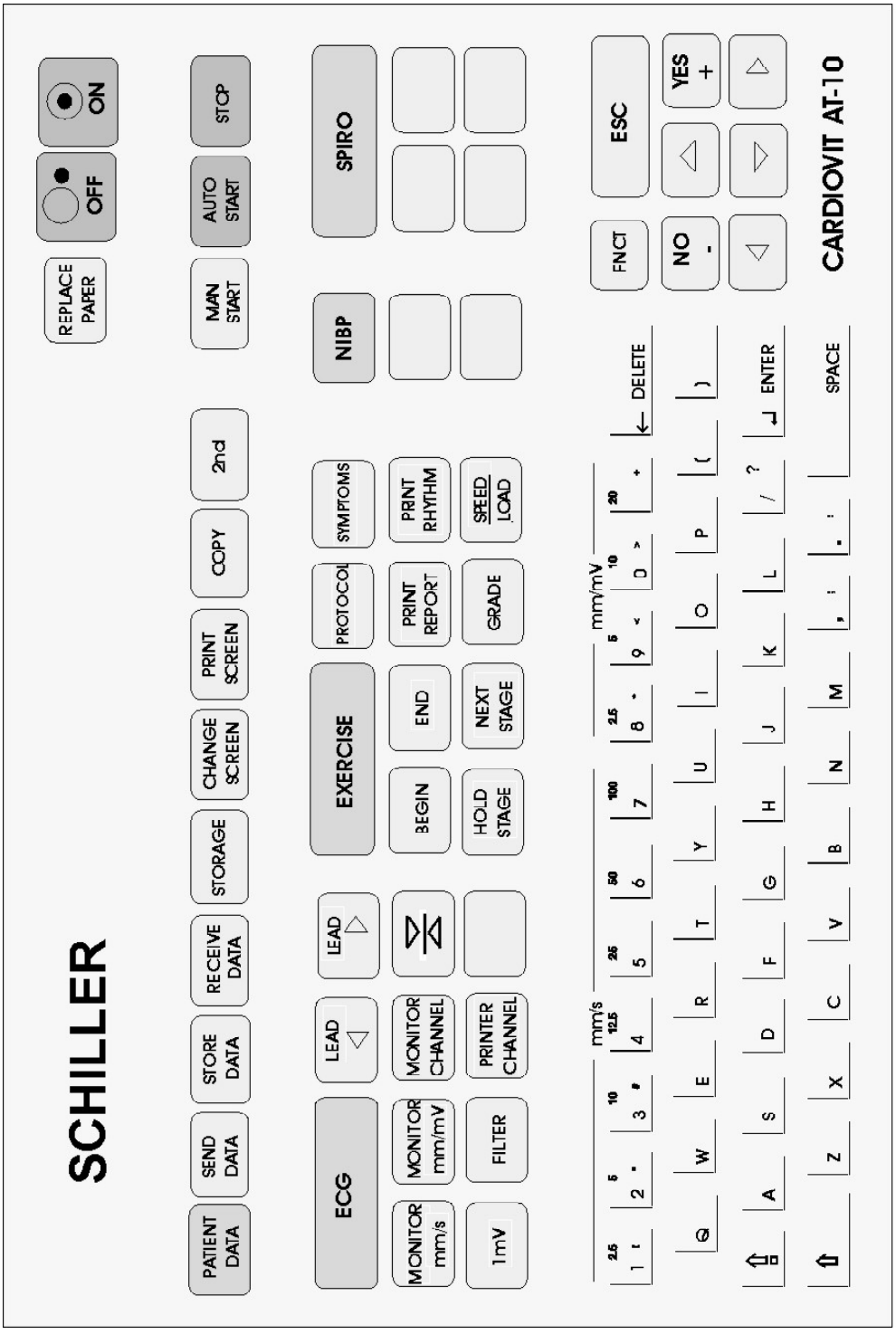
The general purpose keys to the right of the alpha-numeric keypad, are as follows:





The direction keys are used to move the cursor in order to make menu selections

The Keyboard (cont.)



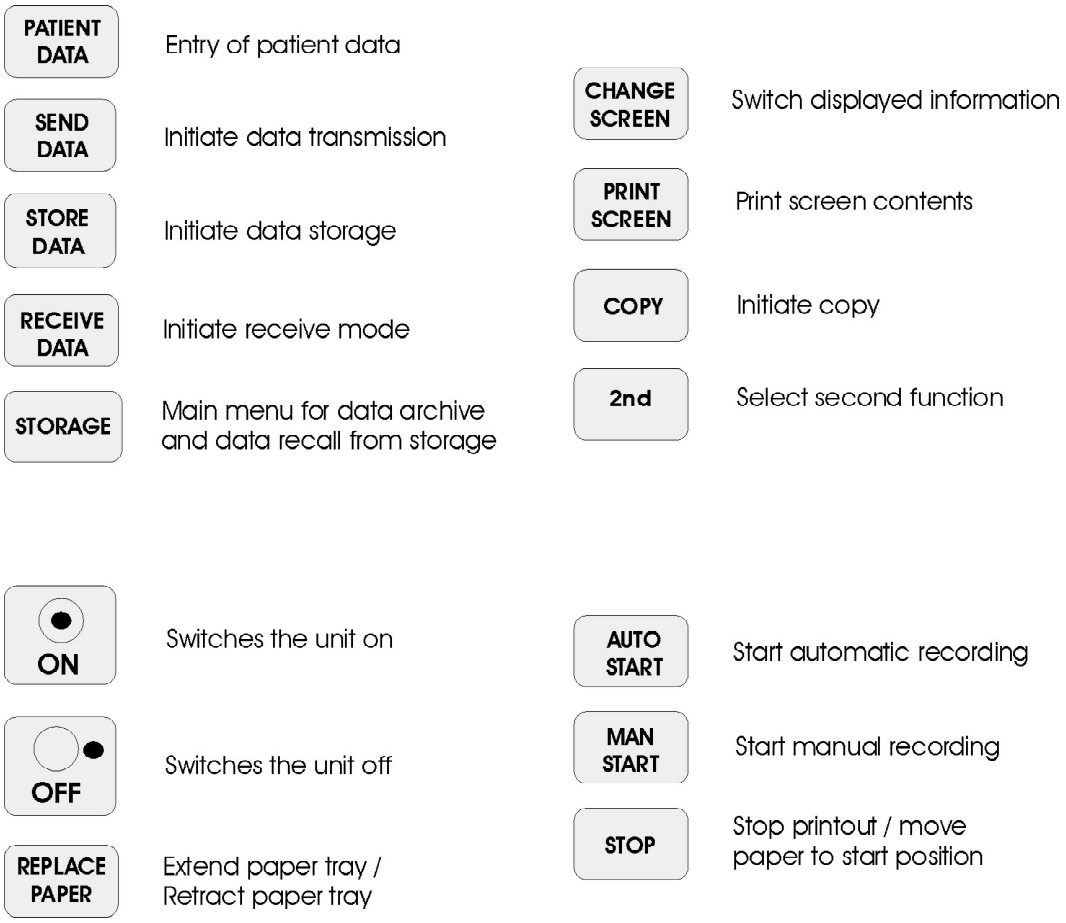
The AT-10 Keyboard

The top line of the keyboard is dual purpose and when the unit is in the ECG mode, these keys double as control for the direct setting of speed and sensitivity for manual printout. Otherwise, the alphanumeric keyboard serves as a normal keyboard for data input.

The Keyboard (cont.)

Control Keys

The Control keys are situated at the top of the keyboard and contain the function keys which are common to all function modules. The control keys are as follows:



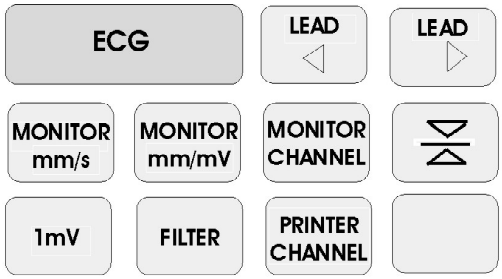
Note: Slight functional differences may exist in different modes

The Keyboard (cont.)

Function Keys

The function keys are arranged in a group in the middle of the keyboard. The left part of the group comprises keys for the resting ECG recording functions. The middle part comprises keys for the Exercise ECG functions. On the right hand side is the **SPIRO** key for the optional pulmonary function testing program. The following is a summary of the keys and their functions:

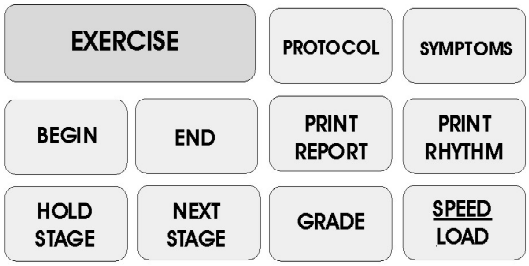
Resting ECG Function Keys



ECG	Select resting ECG menu	MONITOR CHANNEL	Channel selection for display, 3, 6 or 8
LEAD ▷	Lead selection, forwards	▽△	Signal centering
LEAD ◁	Lead selection, backwards	PRINTER CHANNEL	Channel selection for printout, 3, 4 (5) or 6 or user programmed
MONITOR mm/s	Selection of display speed, 25 or 50 mm/s	FILTER	Myogram filter on / off (150 Hz = off)
MONITOR mm/mV	Selection of display sensitivity, normal or half amplitude	1mV	Manual 1 mV pulse

The Keyboard (cont.)

Exercise Function Keys



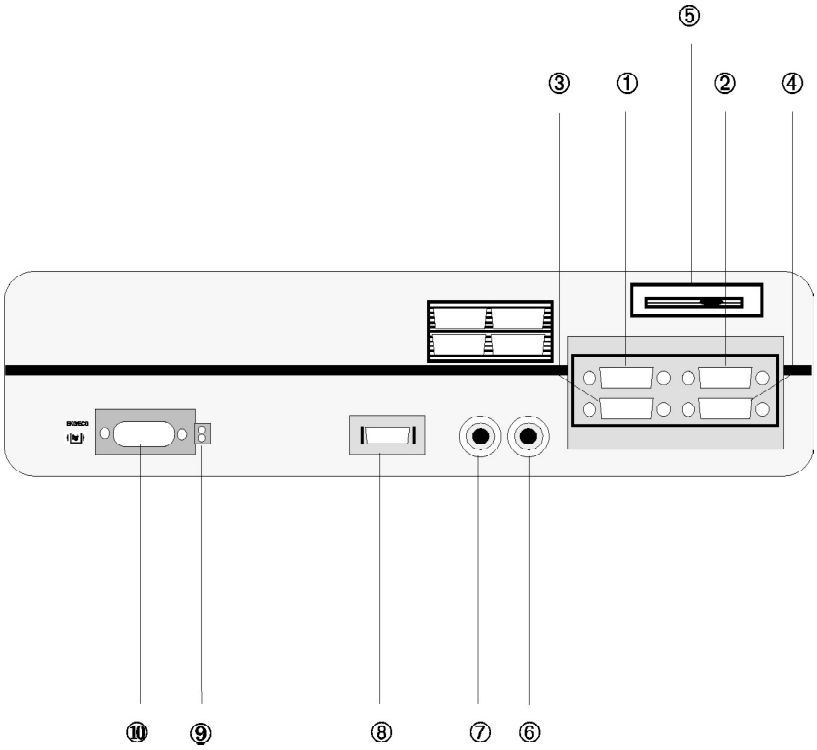
EXERCISE	Select exercise test menu	PRINT RHYTHM	Print out rhythm lead
PROTOCOL	Display / select protocol	HOLD STAGE	Hold current load stage
SYMPTOMS	Manual input of symptoms	NEXT STAGE	Initiate next load stage
BEGIN	Start exercise test	GRADE	Increase / decrease treadmill elevation *
END	Stop load	SPEED LOAD	Increase / decrease speed (treadmill) or load (bicycle) *
PRINT REPORT	Print out final report	NIBP	Select menu for non- invasive blood pressure measurement

* The grade increases when pressed in conjunction with the YES (+) key and decreases when pressed in conjunction with the NO (-) key.

The Speed/Load increases when pressed in conjunction with the YES (+) key and decreases when pressed in conjunction with the NO (-) key.

Connector Panels

Side Panel



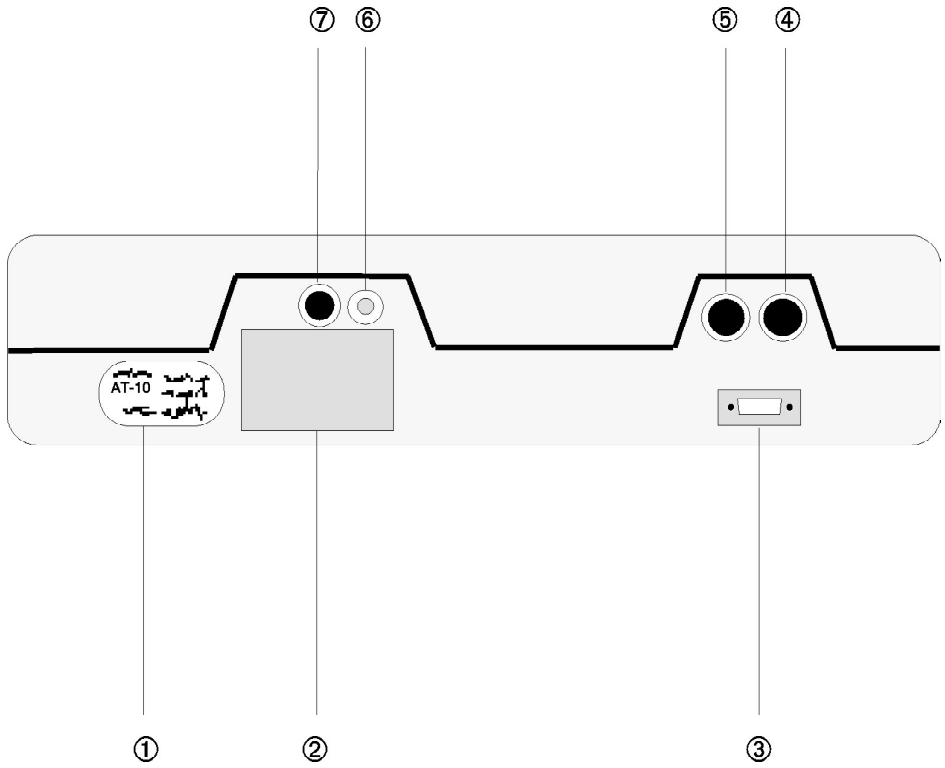
The following are located on the side panel:

1. 1 X RS-232C interface for connection of a bicycle with blood pressure measuring device (Port 1)
2. 1 X RS-232C interface for connection of an ergometer (bicycle or treadmill) (Port 2)
3. 1 X RS-232C interface for data transfer (Port 3)
4. 1 X RS-422 interface for data transfer
5. LCD contrast control
6. DC inputs: DC2 0.5V/cm
7. DC inputs: DC1 0.5V/cm
8. Connection for SP-20, SP-150, SP-110 or SP-110/R flow sensor for lung function measurements (Option)
9. Test socket for electrode leads with control light
10. EKG / ECG Socket for patient cable

Note: The socket is CF rated ie fully floating and isolated, defibrillation protected, suitable for intra-cardiac application.

Connector Panels (cont.)

Back Panel

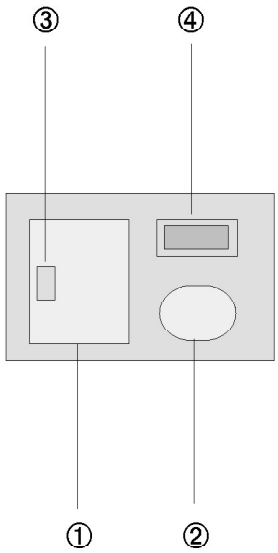


The following connectors are located on the back panel:

1. Identification Plate
2. Mains Module
3. Connector for external video
4. Exercise (stress) test connection for analogue ergometers (bicycle or treadmill)
5. Data I/O socket for connection of foot-switch, QRS trigger, treadmill elevation control
6. Potential equalisation (ground) connection
7. Local area network Connector (Option)

Connector Panels (cont.)

Mains Panel



The following are located on the mains panel:

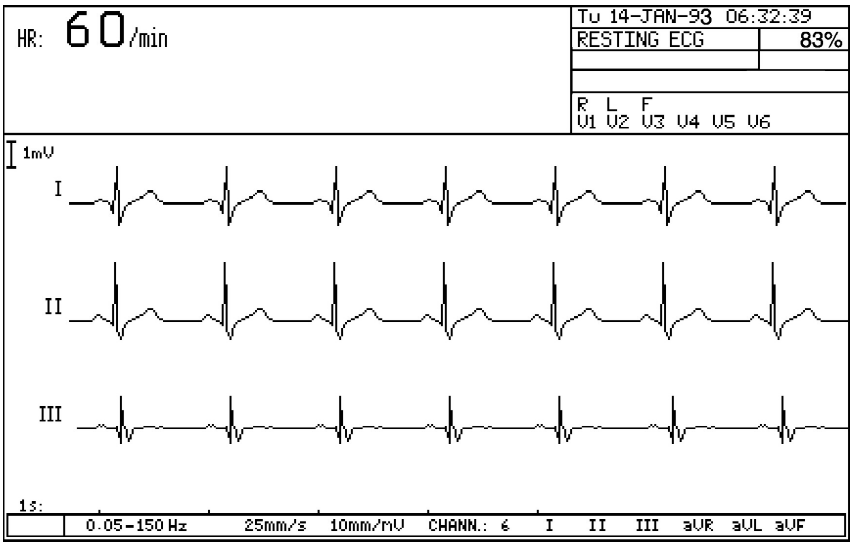
1. Mains fuse (200 mA slow) and voltage selector
2. Mains connection
3. Voltage indicator (mains)
4. Power on / off switch

Liquid Crystal Display

The liquid crystal display (LCD) performs both as a real-time monitor and as an alphanumeric display for menu selection, data input and the provision of important information.

The display can be folded down when not in use. The contrast can be adjusted by means of the LCD control located on the side panel of the unit.

A typical display of an ECG recording (with patient simulator connected) is as follows:



Depending on the function, the displayed information will vary but the screen is normally divided into three general area as follows:

- The top of the screen gives status and operating information. These are permanently displayed.
- The central part of the screen is taken up with the measured waveform (ie ECG trace, Lung function curve, etc) with the lead identifications or measurement units on the left-hand side.
- The bottom of the screen displays the time interval of the recording, indicated in seconds. The very bottom line gives, from left to right:
    - Selected Baseline and Myogram filter settings
    - Speed, sensitivity and the number of channels (for direct (manual) print-out)
    - The leads that are selected for the printout (for direct (manual) print-out)

Calibration

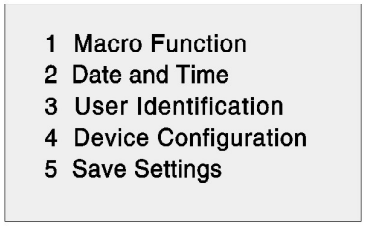
At any time during the ECG recording, a 1mV calibration signal can be manually produced by pressing the <1mV> key on the keyboard. This 1mV square wave signal is indicated both on the display and on the printout.

Manual Baseline Reset

Pressing the manual baseline recentre key  resets the displayed traces to the optimal position. Use this key to centre the real-time ECG traces, when `drifting´ occurs.

System Setup

There are several general settings for the AT-10. Press the <FNCT> key to call up the initial menu. Two options are presented. Option 1 is for entry of the operator information - MTA (Medical technical Assistant). The second menu item is the set-up option. Press <2> and the System Setup menu is displayed as follows:



When the menu is entered, the cursor is always located on the first item. There are two ways to select a particular menu item as follows:

- press the number indicated to the left, or
- use the direction keys to move the cursor to the item required and press the <ENTER> key.

Most of the options are self explanatory in the set-up menu, however the macro function and the save setup options are detailed here.

Defining Macro Functions

With the AT-10 you can create your own macro functions and assign them to one of the first six numerical keys on the alphanumeric keyboard. Up to 30 keystrokes can be stored for one macro enabling you to call up a particular sub-menu or to carry out a particular programming sequence by pressing only two keys.

Note: Before starting to program a macro, it is advisable to carry out the sequence making a note of the order of the key strokes for reference.

In the System Setup menu, press key <1> to call up the Macro function input menu. To start the programming sequence, press key <I> , then the number key which you wish to program and then carry out the required sequence.

Once the sequence is completed, press the <2nd> key followed by the <ESC> key and storage of the keystroke sequence is confirmed by an audible tone.

To initiate a programmed Macro sequence, press the <2nd> key and then the programmed number key on the alphanumeric keyboard. The sequence will remain stored until a new sequence overwrites the existing macro programmed for that key.

System Setup (cont.)

Save Settings

Programmable parameters can be stored as base settings. These stored settings are not erased when the unit is switched off. To call up this function, select the last item in the System Setup menu and the Save Settings menu is displayed as follows:

See the AT-10 Operating Manual for full explanation. By pressing <ENTER>, the actual configuration will be permanently stored and confirmation is given with the message:

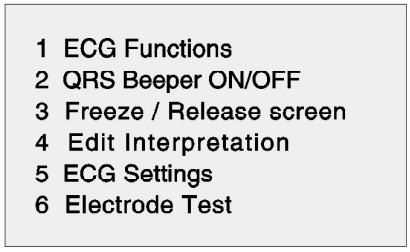
*** Settings memorized! ***.

By pressing key "X" the factory default settings are activated. Press <ENTER> and these settings are stored and confirmed through the message:

*** Settings memorized! ***.

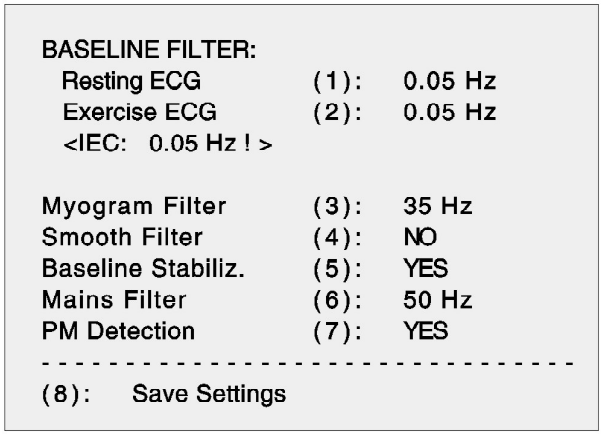
ECG Menu

To call up the menu for any of the main functions, simply press the respective function key (eg <ECG> for resting ECG, <EXERCISE> for exercise ECG, etc). To return from any menu directly to the Monitor mode, press the <FNCT> key. To return from any menu to the previous menu, press the ESC key. To call up the main restingECG menu, press the ECG key.



Filters

There are five filters which can be set before starting the recording of an ECG. To call up the menu for these filters, press the <ECG> key, then select option `ECG Settings´ followed by 'Filters´. The following menu is displayed:



Baseline Filter

A digital baseline filter has been designed in order to suppress excessive baseline drifts. By pressing key <1> (for resting ECGs) or key <2> (for exercise ECGs), the setting can be altered to one of the following values: 0.50, 0.25, 0.12 or 0.05 Hz. The value set is the lower limit of the frequency range and is normally set to 0.05Hz (IEC recommendation), i.e. a frequency range of 0.05 to 150Hz.

The settings 0.12, 0.25 and 0.50Hz should only be used when absolutely necessary as the possibility exists that they could affect the original ECG signal, especially the ST segments.

Pressing key <4>, <5> or <7> toggles the smooth filter, the baseline stabilisation or the pacemaker detection circuit on or off.

The current baseline filter setting is indicated at the bottom of the screen. Once the setting has been changed, firstly press the <FILTER> key in order to reset this indication.

Myogram Filter

The myogram filter suppresses disturbances caused by strong muscle tremor. This filter can be switched on and off by pressing the <FILTER> key. When set to off, the displayed setting will be 150Hz. When set to on, the selected cut-off frequency (25 or 35Hz) will be indicated.

To alter the setting for the filter, press key <3> and the cut-off frequency can be set to either 25 or 35Hz. The current Myogram filter setting is indicated at the bottom of the screen to the right of the baseline filter setting. Once the setting has been changed, press the <FILTER> key in order to reset this indication.

The stored ECG can be printed either with or without passing the myogram filter.

Note: Using the myogram filter causes wave amplitudes on the printout to be reduced by as much as 20%. Average cycles and measurement values however are not affected by this filter.

Mains Filter

The mains filter is an adaptive 50Hz / 60Hz digital interference filter designed to suppress ac interference without attenuating or distorting the ECG. By pressing key <6>, the filter can be set according to country requirements to either 50Hz (for most European countries) or 60Hz (for the USA) or switched off.

Number of Printed Copies

The number of copies to be printed out can be pre-selected. To do this, press the <ECG> key, select the ECG Settings / Further Settings menu option and then select "Number of copies" (1).

Press key <1> several times to select the required number of copies (either 1, 2, 3, 4 or none).

The unit will now produce the specified number of ECG copies whenever the <AUTO START> or <COPY> key is pressed.

Lead Sequence

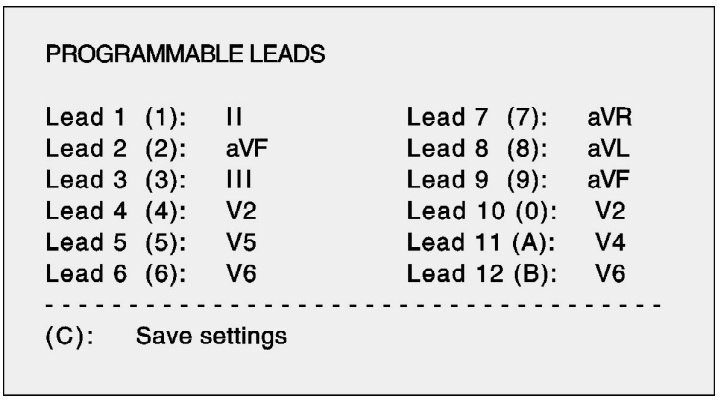
The lead sequence can be set to either Standard or Cabrera. The sequence required can be selected by pressing the <ECG> key, selecting the ECG Settings / Further Settings menu option and then selecting "12 Lead Sequence" (2).

Press key <2> to toggle between Standard and Cabrera leads.

Lead Groups							
Standard				***Cabrera***			
I	VI	II	V4	aVL	V1	II	V4
II	V2	aVF	V5	I	V2	aVF	V5
III	V3	III	V6	-aVR	V3	III	V6
aVR	V4	V2	V7	II	V4	V2	V7
aVL	V5	V4	V8	aVF	V5	V4	V8
aVF	V6	V5	V9	III	V6	V5	V9

User-programmable Lead Group

The user-programmable group comprises 12 leads which can be individually programmed. To program these leads, press the <ECG >key, select the ECG Settings menu option and then select "Programmable Leads" (5). The following table is then displayed:



The display shows the leads currently programmed. The numbers 1 to 12 symbolise the order of the leads and the actual lead identifications show which lead is in which position in the group.

To program your own lead group, simply enter the code number of the lead you require and press it several times to select the lead that you want. As an example, to select lead V1 as the first lead, press key <1> several times until lead V1 is displayed. All leads can be programmed in this way.

Programmable channels for Printout

The number of channels for the printout can be set to either 3, 4 (5,7), 6 or a user-defined number. To set this user-defined number, press the <ECG> key, select the ECG Settings / Further Settings menu option and then select "Programmable Channels" (3).

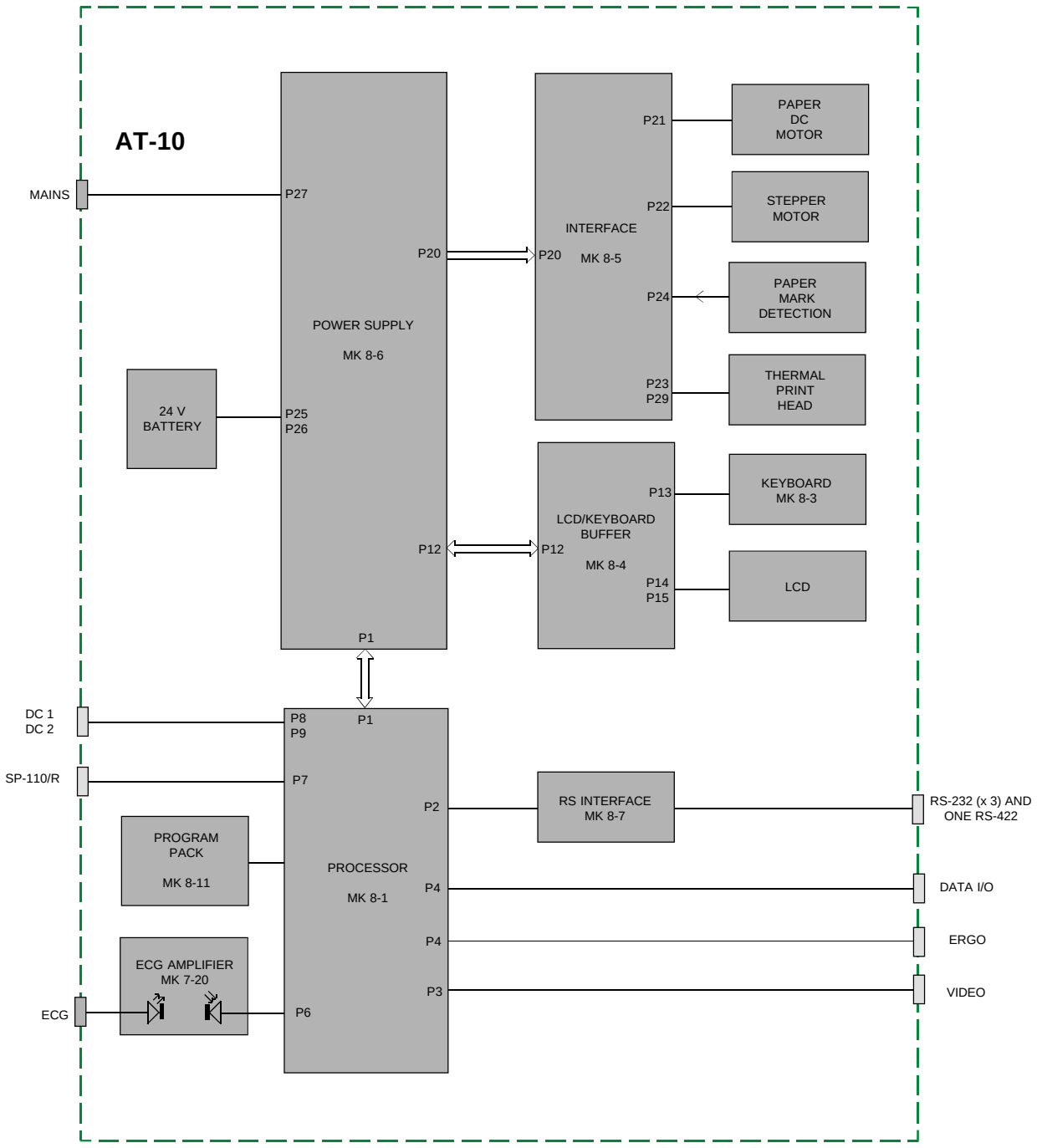
Press key <3>, several times to select the required number of channels (ie, 4, 5 or 7). This setting is particularly useful when, for example, additional Doppler or Phono waveforms are to be recorded through the experimental inputs.

Note: Selection of the number of channels (ie, 3, 4 or 6) is performed by pressing the <PRINTER CHANNEL> key and the current selection is indicated at the bottom of the screen.

Chapter 2
Functional Overview

Contents

Block Diagram



AT-10 Basic Block and Interconnection Diagram

Brief Description

The AT-10 comprises the following boards and major functional areas:

Power Supply

The power supply rectifies the mains input and generates all the required voltages for the AT-10 electronics. Two rechargeable 12V batteries, connected in series, provide the power for the printer and enable the AT-10 to operate for about one hour when mains is not present.

Processor Board

The Processor Board is the master control for all peripherals and contains the main CPU, system timing circuits and the unit RAM memory. This board also contains the following:

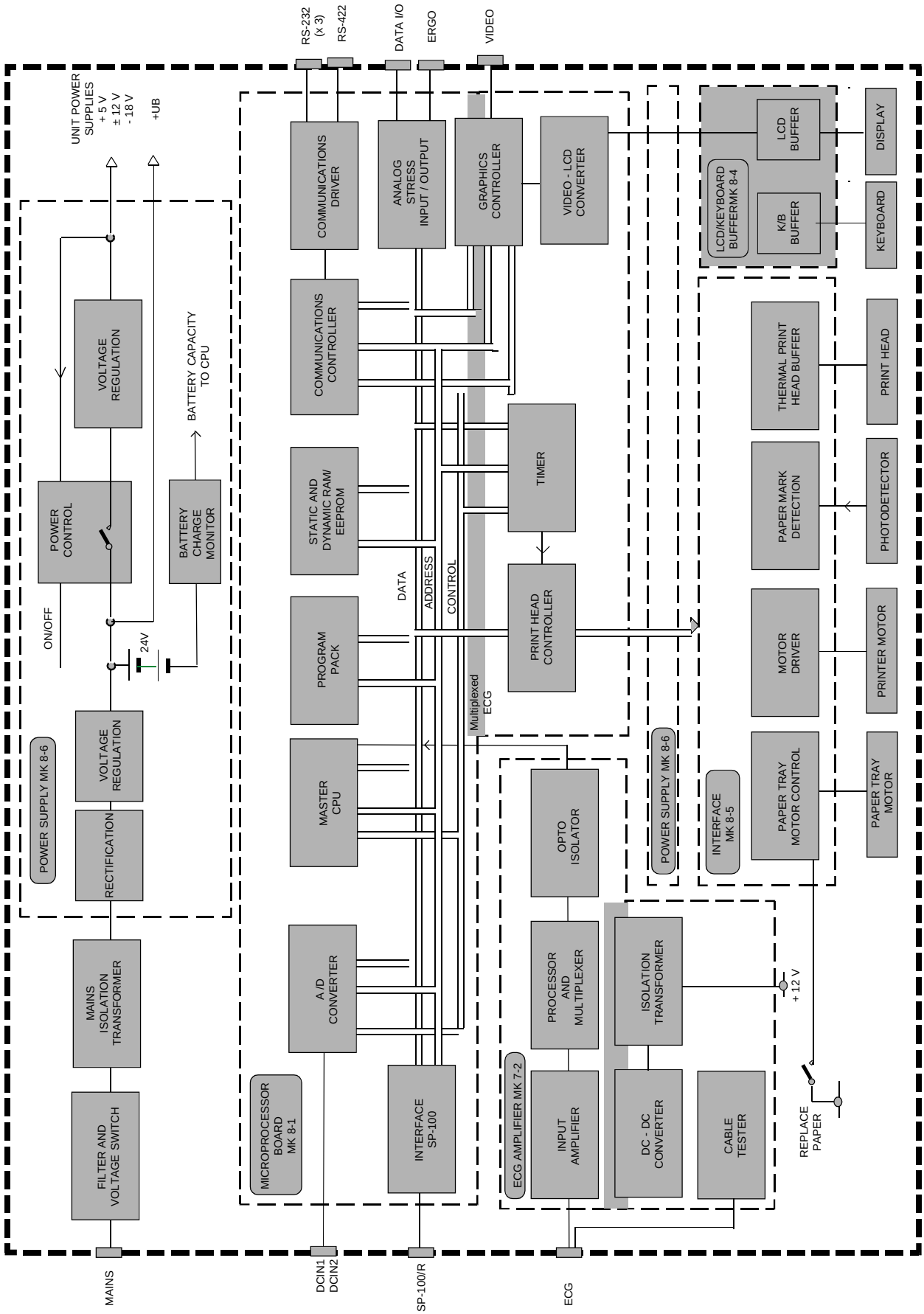
- Video signal generation circuits and the video/LCD conversion circuit for the LCD
- Program Pack containing the unit software
- Print control, keyboard timing, and graphics control circuits

The Processor Board communicates externally over the following connectors:

- Serial RS-232 and RS-422 interfaces for connection of RS controlled treadmills and blood pressure measuring equipment. A port is also available for data transmission to other ECG equipment or to an external computer for data evaluation and storage.
- ERGO connector which provides an analog output to control the speed of a treadmill or the load on a bicycle ergometer. An analog signal is returned from a treadmill to indicate the current elevation and speed.
- Data I/O connector which is used for the following:
  - a foot-switch input
  - QRS trigger output for BP-200
  - control signal for treadmill elevation
- Video connector for connection of an external monochrome VGA standard monitor. The digital video signal reflects the current LCD display.
- Spirometry connector for connection of a spirometer (SP-20, SP110, SP-150).
- DC connectors (DC1, DC2) which are used for experimental analog input signals.

Brief Description (cont.)

ECG Amplifier Board	This board amplifies and carries out some signal processing on the incoming ECG signals. To ensure absolute safety of the patient, all incoming/outgoing data is via opto-isolators.
Interface Board	The Interface board contains the following: • Paper mark detection circuit • Thermal print head data buffers • Stepper motor control circuit • Control circuit for the paper tray dc motor
LCD/Keyboard Buffer Board	This board buffers the LCD and keyboard data and contains the high voltage circuit for the LCD.



AT-10 Functional Block Diagram

Overall Functional Description

Power Supply

Mains is applied to the power supply via a mains filter, on/off switch and a voltage selection switch. The voltage selection switch connects the supply to the relevant winding of the mains isolation transformer. The ac voltage is then rectified to produce a resultant dc voltage of approximately +27V. This voltage is applied to regulator circuits which generate all of the dc power supplies required by the AT-10 electronics.

The power on/off control circuit switches the supply voltage to the regulators. The power on/off is controlled by the following conditions:

- On signal from the keyboard
- Off signal from the Microprocessor (Off key pressed on keyboard, Reset pressed, Batt Down (5V supply below 4.75V))
- Overcurrent condition on the +12V rail

Two 12V batteries, connected in series, directly provide the power for the thermal printer, and provide power for the switching regulators when mains is not connected. The charge state of the battery is monitored by a battery charge monitor circuit.

Processor and Memory

The AT-10 is controlled by a high speed, CMOS 68000 processor with a 16-bit data bus and 23-bit address bus. The clock speed is 16.7 MHz. The processor works in conjunction with a dedicated gate array which is custom programmed to perform specific tasks. The working RAM memory comprises 256 kByte of static RAM and 2MByte of dynamic RAM. The dynamic RAM holds the ECG (or spirometry) data and other variables and an EEPROM holds the operator selectable parameters. The unit software comprises 256kBytes of EPROM contained on the program pack. A digital signal processing chip, also situated on the program pack, is used for real-time processing of ECG data.

ECG

The ECG signal from the patient is low pass filtered, amplified and applied to the processor and multiplexer circuit. The ECG Amplifier board carries out the following:

- Analog to digital conversion of the ECG signal at a sampling rate of 4kHz
- Reduction of the sampling rate to 1kHz
- Detection of pacemaker signals and
- Determination of the pulse width of a pacemaker signal
- Transmission of the processed ECG (and PM measurements and status signals) over the opto-isolators

Overall Functional Description (cont.)

The serial input/output is transmitted to the master CPU at 2.5 MBaud and commands are received from the master CPU at 38.4 kBaud. To ensure absolute patient safety, an isolation transformer galvanically isolates the AT-10 power supply from the patient.

A cable tester circuit is also incorporated on this board which allows open circuit testing of the electrode leads. It is automatically activated when a patient lead is connected to the test point.

Keyboard

The keyboard is a matrix style circuit which is periodically scanned by the processor via the Keyboard Interface circuit. When a key is pressed, the key information is clocked to the Processor board for interpretation by the master CPU.

Printer Control

The Thermal Print Head is controlled by the print head controller circuit and the timer circuit. The print head controller serialises the parallel data written by the CPU into a 16-bit FIFO register. The timer circuit controls how long current is applied to the head, and thus the intensity of the print-out.

The printer motor speed is controlled by the master CPU via the timer circuit.

Graphics Control

The display data is generated in the graphics processor circuit under the control of the master CPU. The graphics processor outputs a VGA standard serial video signal. The video signal is converted to an LCD signal by the Video - LCD circuit.

Miscellaneous Inputs/Outputs

Spirometry

The serial input signal from the spirometer is connected to the interface circuit. The serial data is clocked into a shift register in the interface circuit and, when enabled the data is presented in parallel on the data bus for interpretation by the master CPU.

DC Inputs

The dc input connectors allow analog signals, for example from an ultra sound device or a phono / pulse recording unit, to be input to the AT-10. The analog inputs are converted to a digital level and presented on the data bus. The maximum input voltage is 2.5 V p-p.

Video Connector

The video connector outputs the serial video signal generated by the graphics processor. The video connector reflects the same data as that displayed on the LCD.

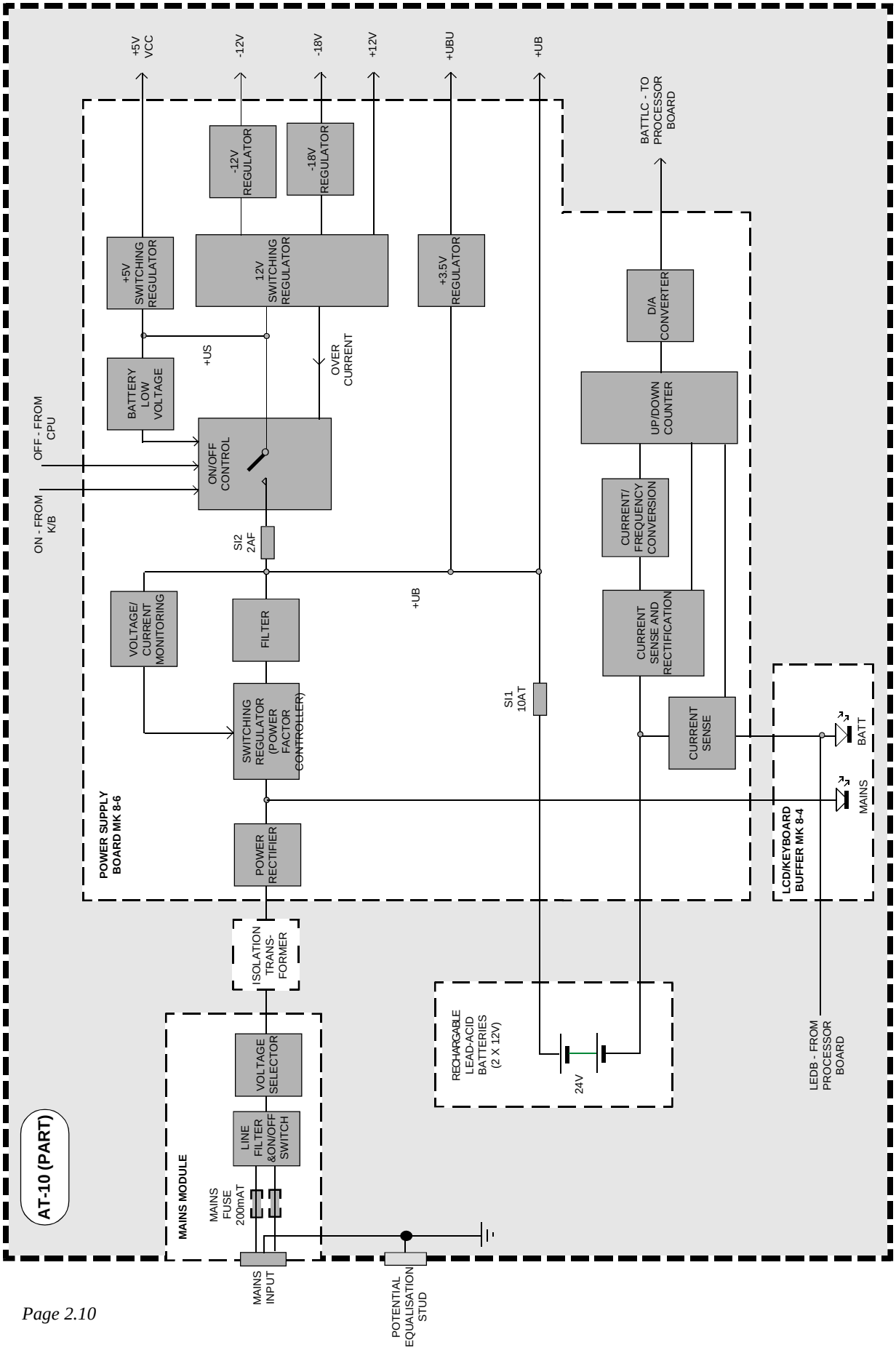
Overall Functional Description (cont.)

ERGO

The analog stress I/O circuit contains a digital to analog converter that converts load or speed control data to an analog voltage. The elevation and speed of the treadmill is returned as an analog value and converted to digital data for interpretation by the main CPU. When a bicycle is connected an analog signal representing the load is sent and received.

Serial Ports

The communications controller contains USARTS which generate serial signals for the transmission and reception of data. The communications driver circuit contains interface circuits to ensure signal level compatibility with RS-232. The RS-422 connector is used when high data rates are required or when longer cable lengths are used.



Power Supply - Functional Block Diagram

Power Supply

Mains is applied to the line filter via the on/off switch and two 200 mA, slow-blow fuses. The line filter incorporates a temperature variable resistor to ensure that the current is limited at initial switch-on. After a few seconds the resistor warms, the resistance drops and normal power is supplied. The voltage switch ensures that the correct primary winding of the isolation transformer is used for the mains voltage applied.

The transformed ac input is full-wave rectified by a bridge rectifier to produce a dc voltage of approximately +22V. The rectified voltage is used by a switching regulator and filter circuit to generate the +UB supply .

The switching regulator comprises a power factor controller chip (U1) and associated components. The switching regulator controls a power MOS FET (Q1) which acts as a switch to regulate the current flow in loading coil T1. Thus, via diode D4 and output filter (C89, C13 etc), the voltage of +UB is regulated to +27V.

The pulse width set by U1, is determined by a zero current detection circuit incorporated in U1 (tapping from loading coil T1), the feedback on the current sense (via Q1 power FET), (and the voltage feedback from +UB (via VR1) when mains is connected (Q3 is switched on). The frequency of the switching can be between 40kHz and 500kHz.

An overvoltage protection circuit monitors +UB when the unit is operating form the mains and cuts the voltage to the power supply if +UB exceeds +35V. The overvoltage protection circuit is formed by Q30 and associated components and monitors +UB via Q3 (which is only switched on when mains is connected to the unit). When an overvoltage is detected, the dc input voltage to the +UB switching regulator is cut by switching off Q5.

A short circuit protection circuit formed by Q4, C3 and associated components, monitors for undervoltage which indicates high current and a possible short circuit. If an undervoltage is detected Q5 is switched off.

On/Off Control and Low Battery Voltage Monitoring

The supply for the +5 and ±12V regulators is controlled by an on/off control circuit. The switch of the on/off control circuit is Q11. It is initially switched on by the ON signal from the keyboard, and then latched by the Vcc (+5V) supply. When the OFF signal from the processor goes low, Q11 is switched off, the power to the switching regulators is cut, and the unit is switched off.

The voltage of the battery is monitored by comparator U6C (monitoring the +US power rail). If the voltage drops below 18.8V (battery voltage low) Q11 is switched off. In the same manner if an overcurrent or overvoltage (+12V) is detected, Q11 is switched off via U7B.

Power Supply (cont.)

+5V and ±12V Switching Regulators

The 5V and 12V step down switching regulators both function in the same manner. The description given here is for the 12V regulator.

Power FETs Q9 and Q10 form a push-pull circuit which switches the supply to loading coil T2. The power FET control circuit is formed by U6A which monitors the ac feedback (via C24) and dc feedback (via R47) to control the switching oscillator (U5B, C17). A gate booster for the power FETs is provided by U4 and associated components.

Secondary windings of T2 provide voltages of 13V and 25V. These are used by linear voltage regulators to produce the regulated -12V and -18V supplies respectively.

The power supply distribution is given on the following table.

POWER SUPPLY DISTRIBUTION						
Boards	**Power Supplies**					
	+ 5 V (VCC)	+ 12 V	- 12 V	-18V	+UBU Backup	+ UB
Processor Board	3	3	3		3	
LCD/Keyboard Buffer	3	3	3	3		
ECG Amplifier	3	3				
Interface Board	3					3

Battery Controller

The battery controller circuit measures the charge/discharge current of the battery to enable the CPU to calculate the capacity of the battery. The battery controller circuit also controls the battery LED to give a visual indication when the battery is charging and when the unit is using battery power.

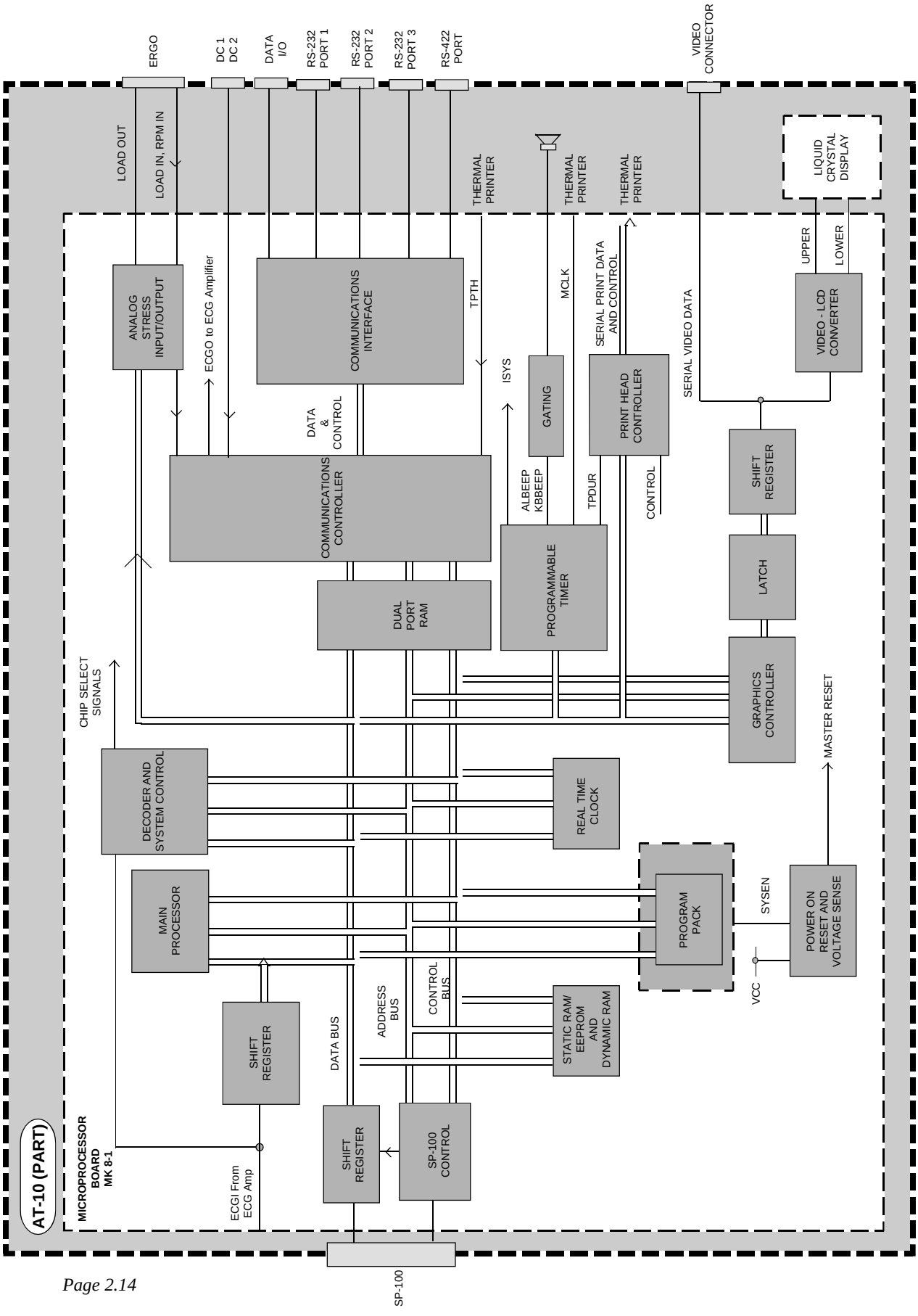
The negative side of the battery is connected to a current sense circuit. Operational amplifier U15B gives an indication to the counter of the current direction ie charging or discharging. Operational amplifiers U15C and U15A form a current rectification and measurement circuit the output of which is fed to a current frequency converter circuit. The current/frequency converter provides a frequency output that is directly proportional to the battery charge or discharge current. The output of the current/frequency converter clocks an up/down counter which is used to indicate the charge/ discharge current and charge/discharge time of the battery, and thus the actual capacity of the battery.

Power Supply (cont.)

The frequency of the current/frequency converter at a charge or discharge rate of 1A is approximately 31.3Hz.

The counter counts up when the battery is discharging and down when the battery is charging. The count is converted to an analog value by D/A converter U13 for use by the CPU in determining the charge state of the battery. When the battery is fully charged ie counter all `1´s, the DAC output is 0V.

The counter is preset when the battery is fully charged. This is carried out by a comparator U14C which acts as a current sense and goes high when the charging rate of the battery is less than 10mA. Via Q23, the PRESET signal goes low and the counter is preset to all `1´s. This circuit is also used (via Q24) to light the battery LED when the battery is charging.



Processor - Functional Block Diagram

Processor Board

CPU

Overall control and coordination of all circuits and all peripherals (with the exception of the paper tray carriage motor), is by the CPU (U46) situated on the Microprocessor Board. The CPU used is the 68000 and it works in conjunction with a dedicated gate array IC (U47). The main functions of the gate array circuit are as follows:

- To decode the address bus (A17 to A23) and generate the chip select (CS) signals for the memory and the peripherals.
- To generate interrupt priority signals (IPL0, IPL1, IPL2) for the main processor - the highest priority interrupt is `7´ the lowest `1´.
- To generate the row address strobe (RAS), column address strobe (CAS) and address multiplex control signals for the dynamic RAM.
- To synchronize the clock of the (asynchronous) ECG input signal.

Program Pack

The Program Pack comprises two EPROM chips and a DSP (digital signal processor). The DSP is used for real time processing of the ECG signal as follows:

- QRS detection
- Filtering (Myogram, Mains, Baseline)
- Lead calculation (I, II .. etc)

A 20 MHz oscillator provides the clock input for the DSP. Communication between the main CPU and the DSP is via a 16-bit parallel port integral in the DSP.

The EPROM chips contains the AT-10 software. The EPROMs each have 256 or 512 kByte of memory which is addressed by address lines A0 to A20 and enabled by the EPROM CS signal.

Memory

Dynamic RAM

The Dynamic RAM comprises four 1 Mbyte RAM modules. The RAM control signals are generated by the gate array (U47). The RAM data is transparently refreshed via CAS before RAS control protocol at approximately 1kHz. The dynamic RAM stores the following data:

- Printer pixel pattern
- Printer text data
- Stress test ECG data
- Rhythm ECG data

Static RAM and EEPROM

The two 128k RAM chips (U25 & U26) are addressed via address lines A0 to A19; they are enabled by the CSSRAM signal. The static RAMs use the back-up power supply so that the stored data is not lost when the unit is switched off.

Processor Board (cont.)

The static RAM stores the following:

- Last 10 seconds of ECG data
- Patient data

The AT-10 EEPROM memory stores some user defined parameter settings and comprises a single 64k EEPROM chip (U27). It shares an enable signal (CSRTCC) with the real time clock (U30).

Communications Controller

The Communications Controller carries out the following functions:

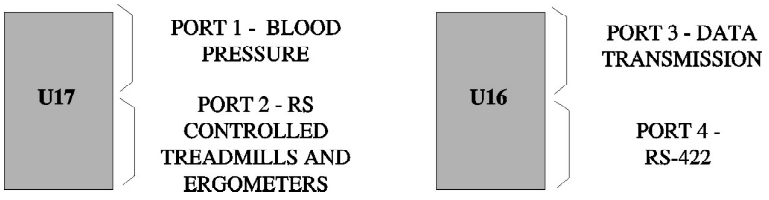
- Controls the serial ports
- Converts the incoming analog values from the ERGO connector to digital and vice versa.
- Provides synchronization of the peripheral devices with the CPU

The communications controller comprises a single chip processor (U14) with built in RAM and ROM to control the serial interfaces and Data I/O ports. Data between the Communications Controller and the CPU, is via a dual port RAM (U13) which acts as a data buffer. It is selected by the CSCC signal.

The inputs to the A/D converter of the communications controller processor are as follows:

- Speed/load (LOADIN)
- Elevation/RPM (RPMIN)
- Temperature signal from the thermal print head.

Communication over the RS ports is via two dual communication interface controllers. Each of the controllers monitor two RS ports as follows:



The enable signals for the communication controllers are generated by U14 via a binary to octal converter (U15).

U14 also outputs the TREADMILL UP and TREADMILL DOWN signals (TMUP, TMDN) to control treadmill elevation via the Data I/O port.

Processor Board (cont.)

Stress Analog Input/Output

The analog input/output circuit comprises a digital/analog converter circuit and buffer circuits that carry out the following functions:

- Converts the control commands for an exercise equipment (ergometer or treadmill), to the required analog command signal - a 12-bit DAC (U40) produces the LOAD OUT signal (ERGO 0). The output is 1V per 100 W.
- Buffers and scales the returned analog responses from the ergometer or treadmill. The returned signals are:
  - LOAD IN (ERGO 1) (also used for the treadmill speed input). The load signal is 100W = 1V,
  - RPM IN (ERGO 2) (also used for the treadmill elevation input). The RPM signal scaling is 1V = 100 RPM, the elevation angle scaling is 1V = 12°

  These signals, are converted to a digital signal by the A/D converter in the Communications Controller.

Thermal Print Head Controller

The thermal print head controller circuit comprises programmable generic array logic (GAL) chips and latch buffers. Data to be printed is presented on the data bus and strobed through first in, first out (FIFO) memories (U60 and U61) in two bytes (lower - D0 to D7, upper D8 to D15). The 10 input, 8 output GALs are programmed to serialise data from the FIFOs memories and send it in the required format for the printer. To ensure a superior quality print the print head data is `cycled´ so that each pulse is repeated eight times. This is carried out by FIFO memory U59.

TPD is the print head serial data signal, TPS0 and TPS1 are printer strobes, and TP clock is the 4 MHz serial data clock. The output to the printer is synchronized with the 1.9kHz clock. The temperature control for the print head is set by the TPDUR signal (thermal print duration from the programmable timer), which is strobed by signal TGATE (6kHz).

Programmable Printer Timer and Beeper

The timer circuit comprises U28 and U29 which decode the timing instructions from the CPU encoded on the data bus. The timers are accessed by the CSEE signal. The timing signals produced are as follows:

- MCLK — The printer motor clock. The faster the speed of the motor the faster the paper feed
- ISYS — A general purpose timing clock of 2 kHz, used as system interrupt (determines sampling rate, printing rate etc.)
- TPDUR — The duration that the print head is heated. This is calculated by the CPU, from the resistance of the print head and the measured ambient temperature of the print head.
- ALBEEP, KBBEEP — Audio signals for the alarm and keyboard beeper.

The timers are addressed by address lines A1 and A2 to select the required timing. The frequency of the master clock input is 5 MHz.

Processor Board (cont.)

Graphics Controller

A VGA standard signal (480 rows with 640 pixels/row with a horizontal sync of approximately 31.8 kHz and a vertical sync of 60 Hz), is generated by a graphics processor chip (U39) and associated components. The video controller also generates all the necessary protocol signals (HSYNC, VSYNC etc).

The parallel data output of the video controller is fed to two 8-bit shift registers (U33 and U34) which together convert the 16-bit parallel output from the video controller to the required serial video output. Two RAM chips (U31 and U32) form a latch circuit for the pixel memory and allow picture freeze when required. The video signal to the Video/LCD Converter is gated with signal SCINV which inverts the screen image (changes the LCD to white on black image), when set.

Certain control and enable signals from the video controller are further decoded by GAL U38.

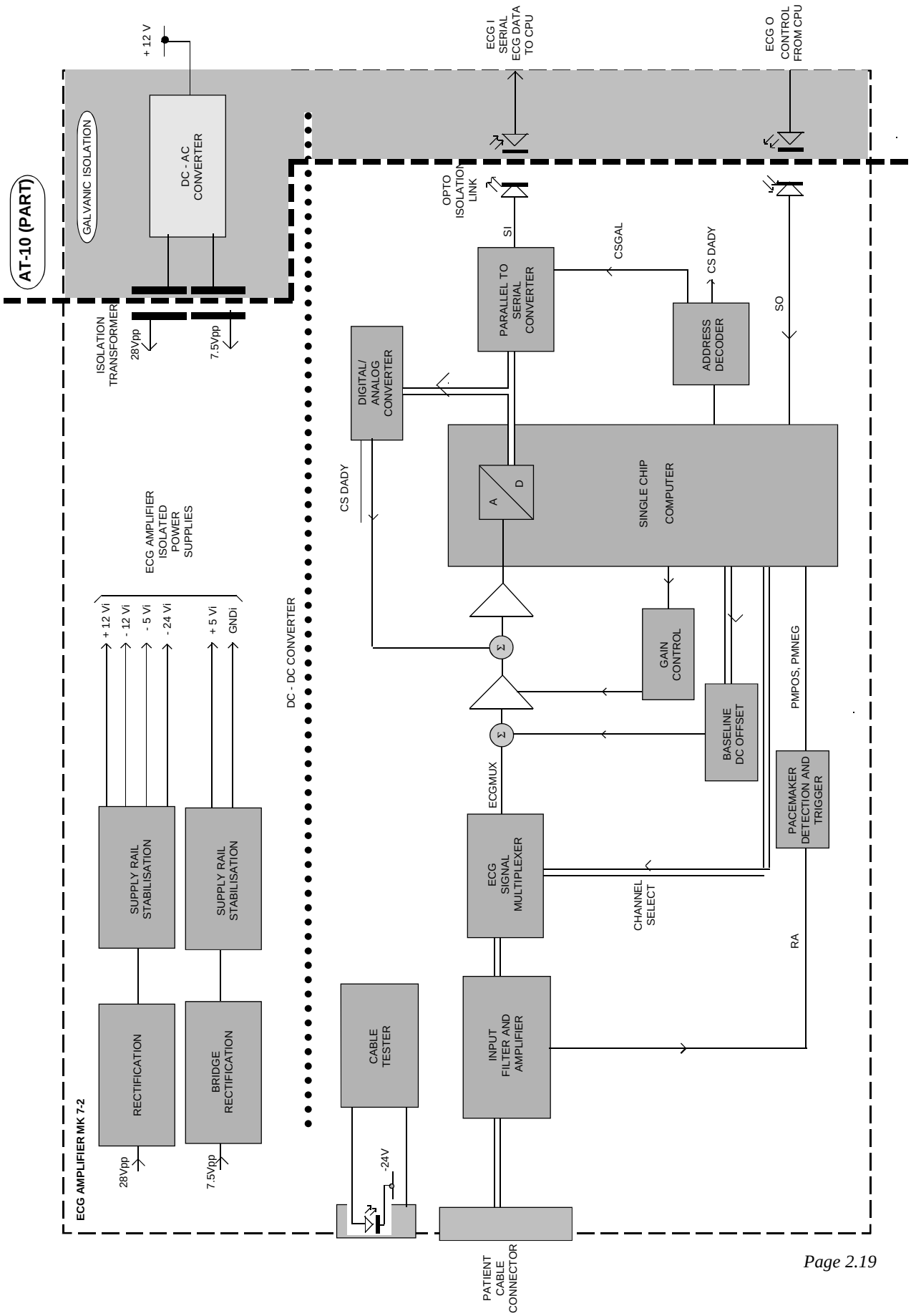
Video - LCD Converter

The video/LCD converter chip (U74) generates all the timing and strobe signals required by the LCD and converts the serial video signal into the correct format for display. Four upper and four lower control and data signals are output to the LCD along with two clock signals. A working memory for the converter chip is provided (U75).

Power On Reset

The Power on reset circuit is formed by U54 and associated components. The circuit controls the master reset of the CPU. This circuit has three functions as follows:

- Provides a delay on initial switch on to ensure that the power supply is fully stabilized and to give the 200ms reset time required by the 68000 processor
- Ensures that the system is inoperative and in reset mode when the SYSEN indicates that the Program Pack is not present
- Disables the unit if the +5V rail drops below +4.75V



ECG Amplifier - Functional Block Diagram

ECG Amplifier

ECG Isolated Power Supplies

The DC/DC converter circuit produces all the isolated power voltages required by the ECG Amplifier circuit. The +12V rail from Power Supply MK 8-6 is applied to isolation transformer U2 via a pulsing circuit. The pulsing circuit comprises a 125kHz oscillator divided by two, which via Schmitt triggers switches MOS FETs Q3 and Q4. This gives a pulsed, 180° phase shifted input on the two primary windings of the isolation transformer.

The two secondary windings of the isolation transformer produce 28Vpp and 7.5Vpp respectively. A Schotky diode and capacitor network produce the +12V, -12V and -24V isolated supplies. A linear regulator (U5) generates the -5V supply from the isolated -12V supply.

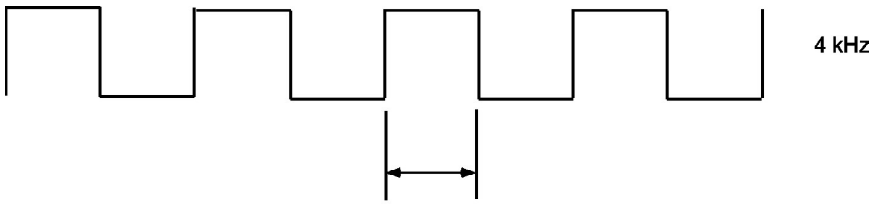
The +5V isolated supply is generated from the 7.5Vpp secondary winding. A bridge rectifier produces approximately +7V which is applied to a FET. The FET is controlled by an operational-amp and transistor circuit so that it acts as a variable resistor to stabilise and produce a +5V supply.

Servicing Note: When taking measurements always ensure that the isolated ground is used for reference.

ECG Signal

The incoming ECG signals RA, LA, and C1 to C9 are 41kHz low-pass filtered and applied to non-inverting operational-amps giving a gain of 11. The signals are further low pass filtered (1.6kHz) and amplified by 3 before being applied to the multiplexer.

The multiplexer enable signal is 4kHz with the output duration of each sampled lead approximately 20 microseconds.



ALL LEADS SAMPLED,
EACH APPROX 20
MICROSECONDS

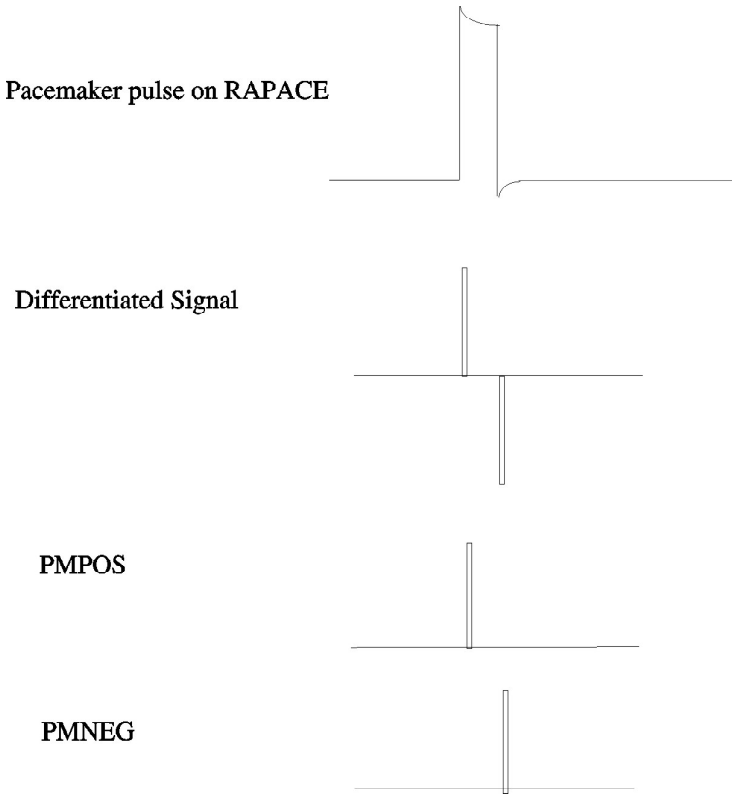
The multiplexed ECG signal is base line compensated. The base line compensation is set by the ECG processor and converted to an analog signal by a DAC (U20). The maximum compensation is ± 300 mV. A gain control is also incorporated for the multiplexed ECG signal, and set by the processor. This gain is selectable to 2.5, 5, or 10.

The signal is then passed to a summing circuit where the last sample value from the D/A converter (U21) is subtracted from the present sample value. The resultant is the difference of the actual sample and the previous sample. The resulting voltage is analog to digital converted by the ECG processor and output to the CPU via a multiplexer and GAL circuit (U23, U26) and opto isolators.

ECG Amplifier (cont.)

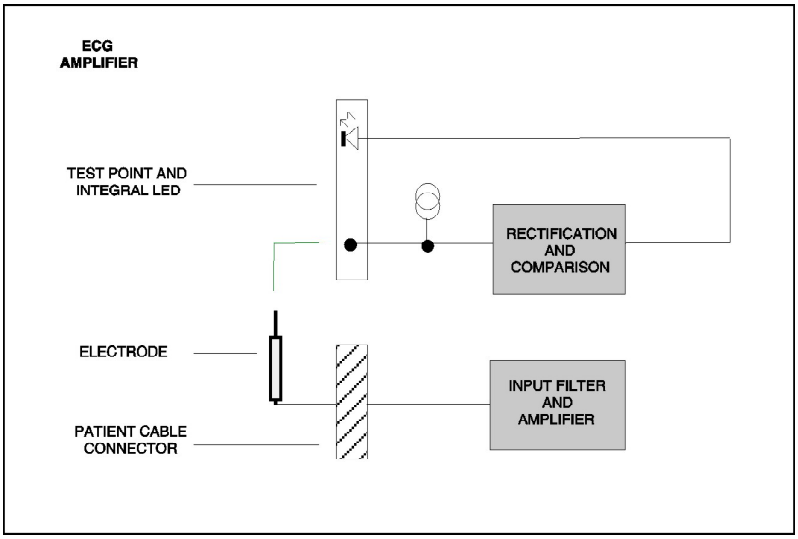
Pacemaker Trigger

The RA lead is fed, before it is filtered, to the pacemaker detection circuit. The RAPACE signal from the patient is differentiated and fed to the ECG processor. The negative pulses (PMNEG), and the positive pulses (PMPOS) indicate the start and end slope of the pacemaker pulse. From the signals the CPU can calculate the timing of the pacemaker pulse for display (software option).



ECG Amplifier (cont.)

Cable Tester

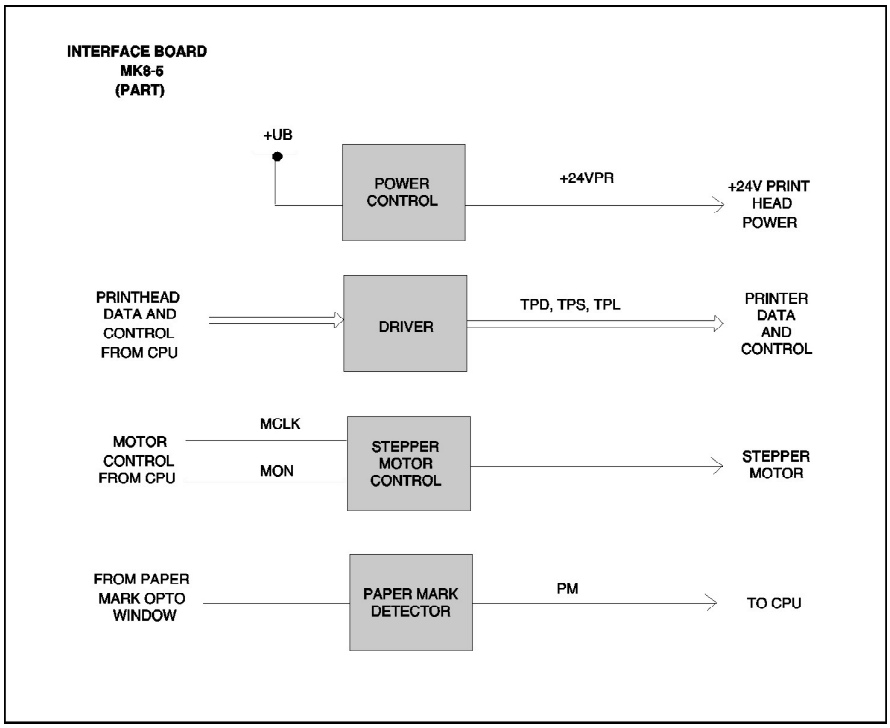


The cable tester circuit checks the resistance of an individual lead in the patient cable. The resistance of the lead must be between 10KOhms and 1MOhms.

The cable tester comprises a 3.3kHz oscillator and comparator circuit. The oscillator is connected to the test point and when a lead is connected to the test point, the potential on the lead (from the input filter and amplifier circuit) alters the waveform. The waveform is rectified and, via a comparator (U1B) lights the LED. The comparison voltage at U1B is 1.45V and the generated waveform is at a base level of approximately -17V with an oscillation of 5V.

Interface Board

Thermal Printer Control

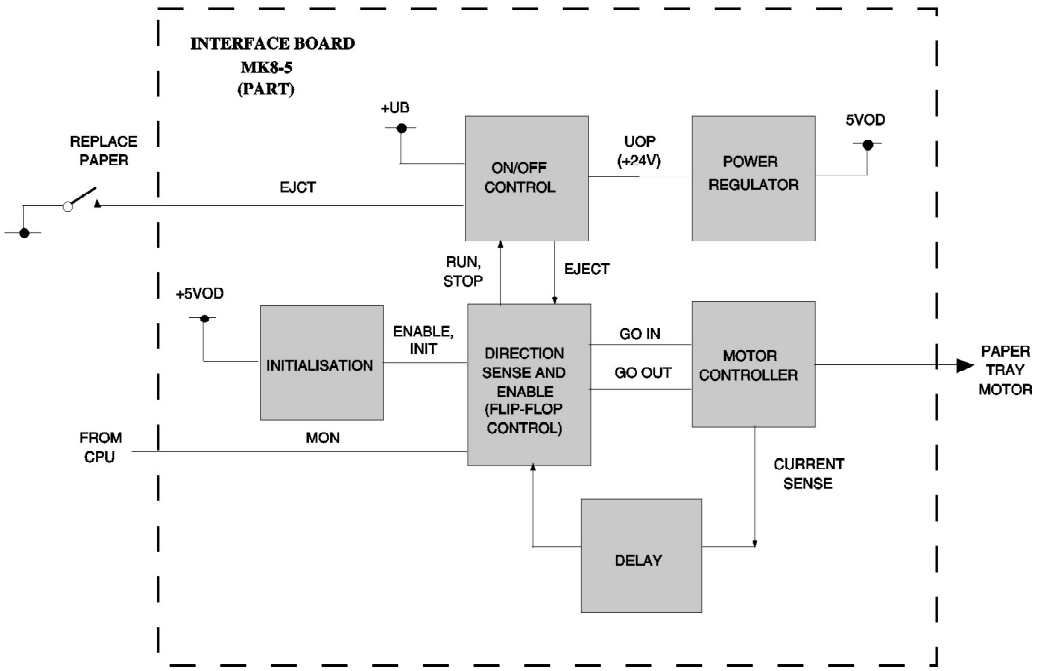


The Thermal Printer stepper motor is controlled by stepper motor controller U1. The MON signal from the processor is the enable signal for the controller and the MCLK signal sets the speed; 209Hz gives a paper speed of 2.5 mm/s, 2.09kHz gives a paper speed of 25 mm/s. The driver circuit incorporates a current sense circuit. The current of the motor is approximately 100mA, depending on the step rate set.

The printer data, the strobe and the clock signals are buffered by U5. The strobe frequencies (TPS0 and TPS1) are 2kHz, the clock (TPCLCK) is 4MHz, and the latch frequency (TPL) is 2kHz.

Because of the high power peaks drawn by the TPH, reservoir capacitors on the +24V rail ensure a stable supply to the thermal print head (via the controller).

The paper mark detector is an opto sense circuit. The output from the detector is fed to an operational amplifier (U4) to set the PM signal when a paper mark is detected. The input from the optocoupler is 0.4V to 0.6V for white paper and 3.5V to 4V for black paper ie paper mark. The PM output signal is logic 0 when a paper mark is detected.


INTERFACE BOARD
MK8-5
(PART)
+UB
REPLACE PAPER
EJCT
ON/OFF CONTROL
UOP (+24V)
POWER REGULATOR
5VOD
RUN, STOP
EJECT
+5VOD
INITIALISATION
ENABLE, INIT
DIRECTION SENSE AND ENABLE (FLIP-FLOP CONTROL)
GO IN
GO OUT
MOTOR CONTROLLER
PAPER TRAY MOTOR
FROM CPU
MON
CURRENT SENSE
DELAY

Interface Board (cont.)

Paper Carriage Control

The paper tray carriage motor control circuit works independently from the CPU and has its own power supply. The power supply is enabled as follows:

- AT-10 switched on — Vcc (+5V) latches transistor Q9 on which latches Q7 on to switch +UB and generate +Uop.
- AT-10 switched off — pressing the REPLACE PAPER key sets signal EJCT to GND and switches transistor Q7 on to generate +Uop from the +UB supply. Q7 is latched on by Q9 which is switched on by the DIR.IN signal high. When the tray has returned, the DIR.IN signal goes to ground which switches Q9 and Q7 off. This cuts the +Uop rail and switches off the power supply.

  Note that when the AT-10 is switched on the power supply remains on via Q9 held on from Vcc.

+Uop is regulated by U4C to generate the +5V supply for the paper carriage motor control circuit (5Vpd).

Extend Paper Tray

The 5Vpd voltage initially sets a delay and timing circuit formed by U6C, U6D and associated components. This sets the ENABLE and INIT signals to flip-flops U7A and U7B so that the circuit is in a known state. Pressing the REPLACE PAPER key sets the EJECT signal to the flip-flops, via Q8. The flip-flops enable the motor control chip U8 and set the direction of the 24V dual polarity motor (GO IN, GO OUT signals). The motor controller incorporates an `H´ bridge current sense circuit to detect when the paper tray is fully extended. When the paper tray is fully extended the current increases, the motor controller detects this and sets the sense line which, via comparator U4D is fed back via a delay circuit, resets the flip-flops and stops the motor. A delay circuit (C34) prevents the motor being stopped prematurely during the power surge when the motor is initially activated.

Retract Paper Tray

When the paper tray is extended, pressing the REPLACE PAPER key switches off transistor Q8 and activates the EJECT signal. This produces a clock input to the flip-flops and activates the GO IN signal to the motor controller. In the same manner as when the paper tray is being extended, the current sense circuit stops the motor when the paper tray has fully returned.

The flip-flop control circuit monitors the printer motor via the MON signal, and the paper tray motor via the Stop signal (paper tray motor active). This ensures that the circuit is disabled if the REPLACE PAPER key is pressed when either the printer motor, or paper tray motors are active.

Chapter 3
Fault Diagnosis

Contents

Introduction

The purpose of this chapter is to provide fault-finding procedures that will quickly and efficiently identify a fault on an AT-10 to a specific module. The fault-finding procedures are designed so that test equipment is kept to a minimum.

An initial fault diagnosis chart is provided detailing all the general fault indications that may occur. When this is followed it will indicate the module where the fault lies or specify a further fault-finding procedure. When more than one module is stated, the first module given is the one most likely to contain the fault. If the fault is not found on the first module, the other modules should be checked in the order given.

If the initial fault-finding chart does not indicate the area where the fault exists, re-check all the settings and parameters that have been entered (for the particular task that fails). If these are correct, check the software. If this is correct suspect external connections.

If a key operation or menu selection is required when carrying out the functional checks after replacement, the key sequence required is given in parenthesis '<>´. The character(s) given in parenthesis is the actual character(s) printed on the key. When a key sequence is provided it must be followed in the order given. For example the key sequence to give the Macro screen is:

<FNCT> <2> <ENTER>

This requires that the Function key on the keypad is pressed, followed by the `2´ key followed by the Return (or Enter) key.

Test Equipment

The following proprietary and dedicated test equipment is the minimum that is required to fault find and carry out any board checks and adjustments, on the AT-10.

The list of proprietary equipment is not comprehensive. Recommendations of suitable proprietary test equipment can be obtained from the Schiller Service Department.

Dedicated Test Equipment

- RS Test Cable Assembly required for the RS self test

In addition to the above a Schiller patient cable (Schiller Number 2.400011) is required when carrying out simulated ECG tests.

Proprietary Test Equipment/Tools

- ECG Emulator, eg Phantom 320*
- Oscilloscope
- Digital Multimeter*
- Stabilised Power Supply
- Standard tool kit with a selection of cross-bladed, flat-bladed and posi-drive screwdrivers, Pliers and general tools*
- Soldering Iron
- VGA Monitor

* Indicates Essential Equipment for basic AT-10 fault finding

Special Tools / Equipment

The following table lists all the special tools and equipment that may be required when fault finding or carrying out certain maintenance procedures on the AT-10.

DESCRIPTION	PART NUMBER
RS TEST CABLE ASSEMBLY 3-WAY CONNECTORS	2. 310 042
2MM HEXAGONAL KEY FOR THE REMOVAL /REPLACEMENT OF TIIE PROGRAM PACK	STANDARD TOOL AVAILABLE ON THE MARKET
HEXAGONAL CROSS-BLADED SCREWDRIVER USED FOR THE REMOVAL AND REPLACEMENT OF THE PRINT HEAD	SCHILLER NUMBER 4.950074. MANUFACTURED BY WERA, NUMBER - WERA 367 TX 210180

Fault Diagnosis

Use the fault finding charts and procedures on the following pages to indicate a faulty area or module. In most cases the fault finding charts should indicate the most likely faulty area.

When a possible faulty module is indicated by the fault finding charts, the module must be replaced. When a module has been replaced specific test parameters and setting-up of the module may be applicable. The removal and replacement instructions for all replaceable modules, along with any set-up or check procedures required, are given in Chapter 4.

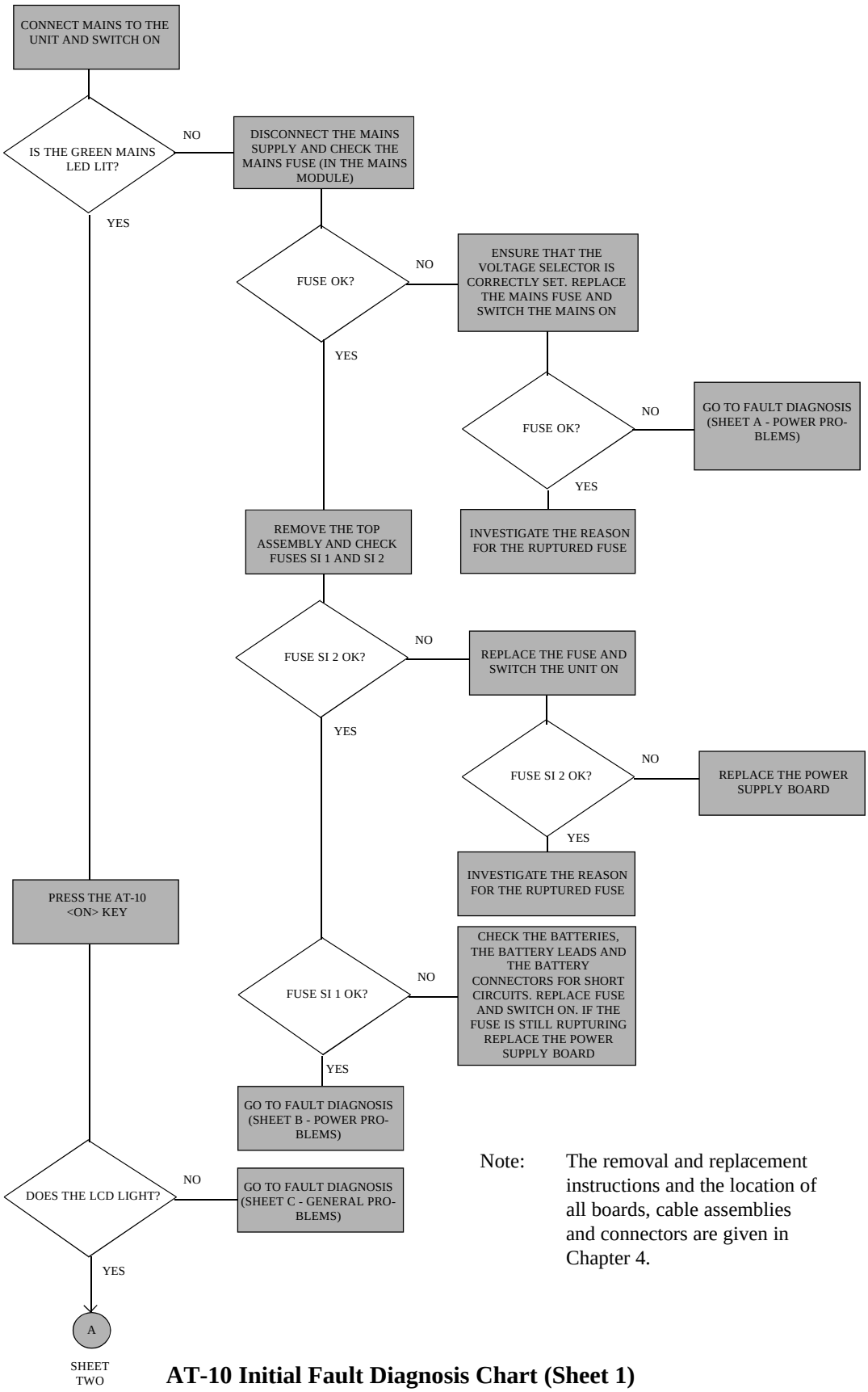
WARNINGS

MAINS POWER IS PRESENT WHEN THE UNIT COVER IS REMOVED. CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED AND MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

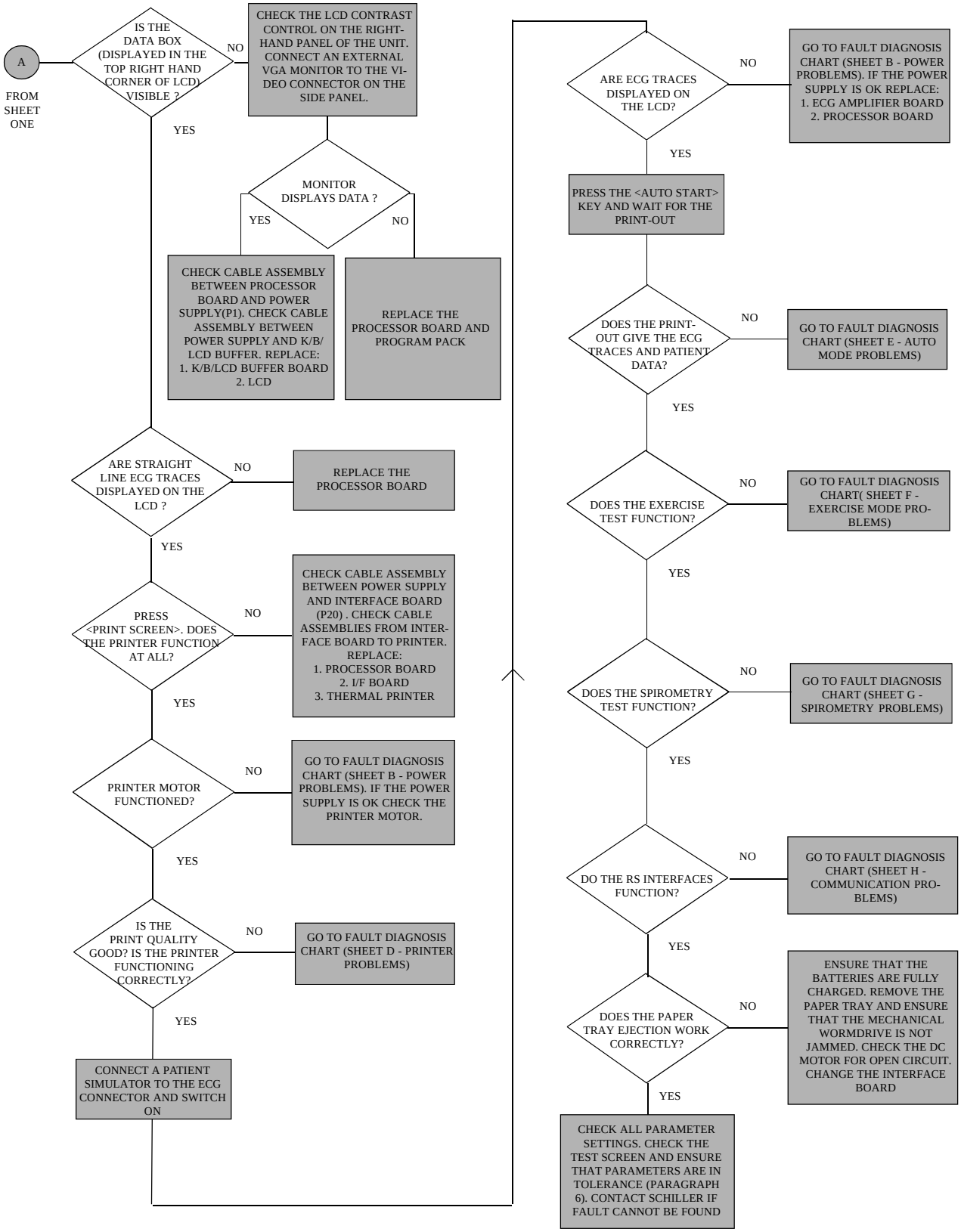
THE AT-10 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS. ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES. PERSONNEL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS. ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

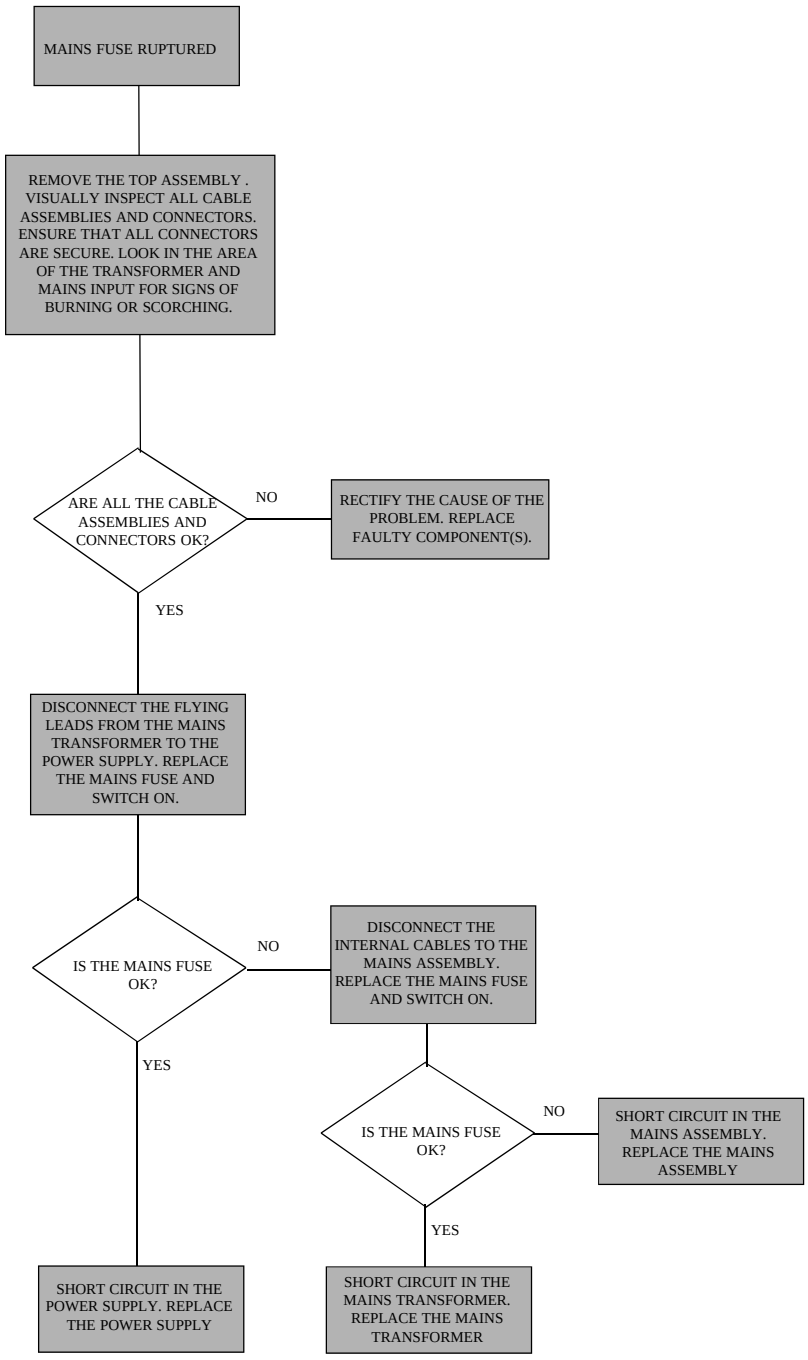


Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Initial Fault Diagnosis Chart (Sheet 1)

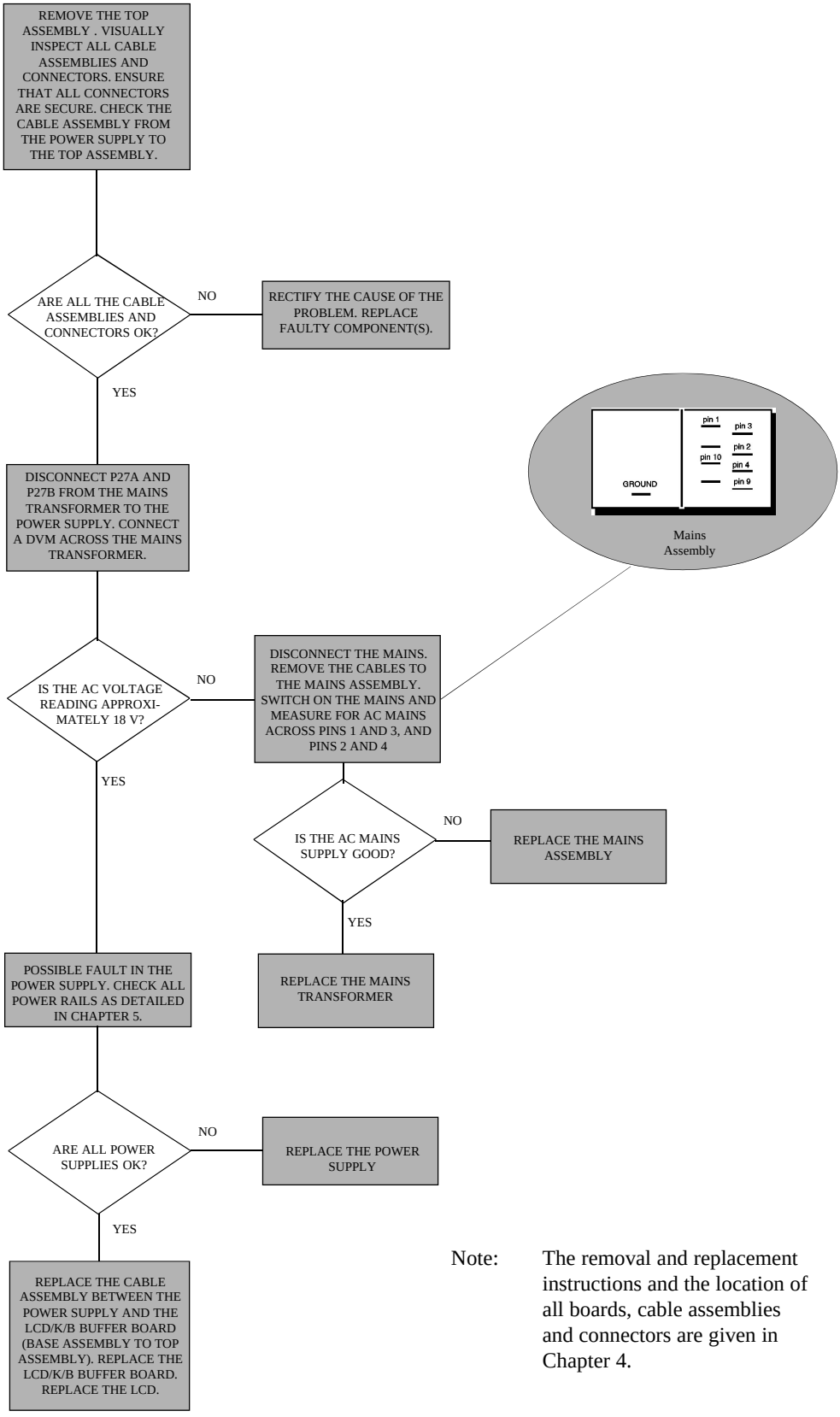


AT-10 Initial Fault Diagnosis Chart (Sheet 2)



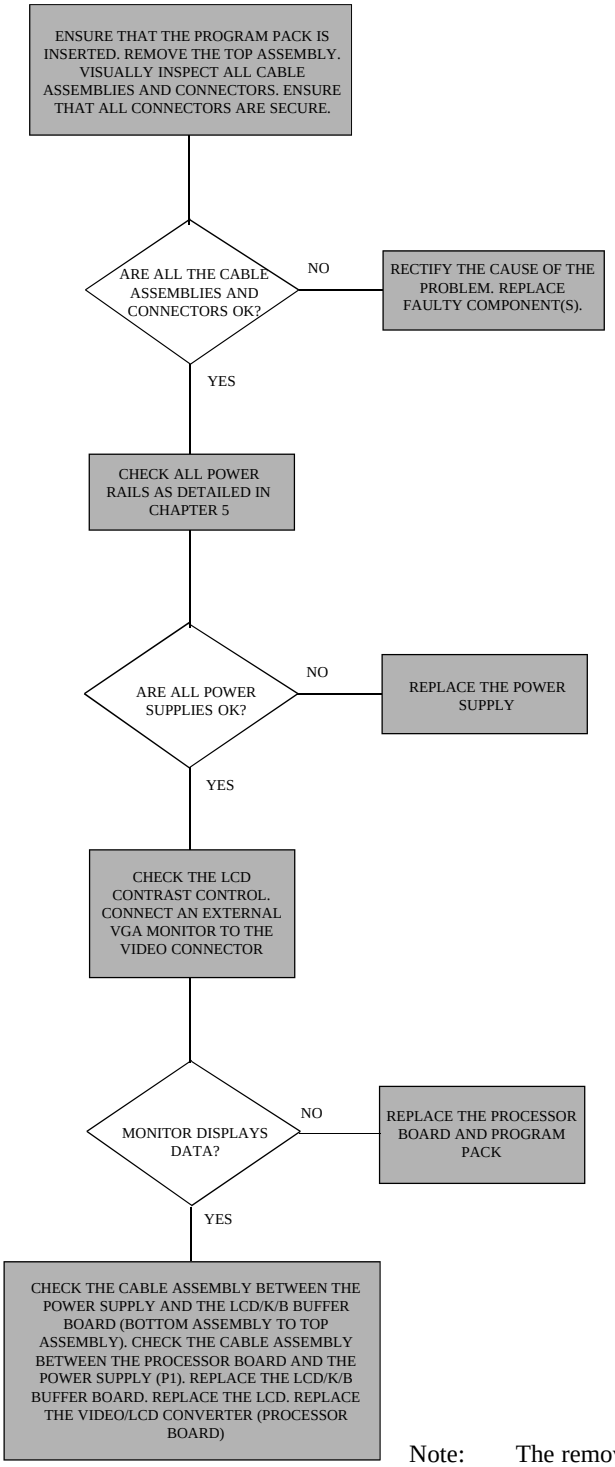
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Fault Diagnosis Chart (Sheet A - Power Problems)



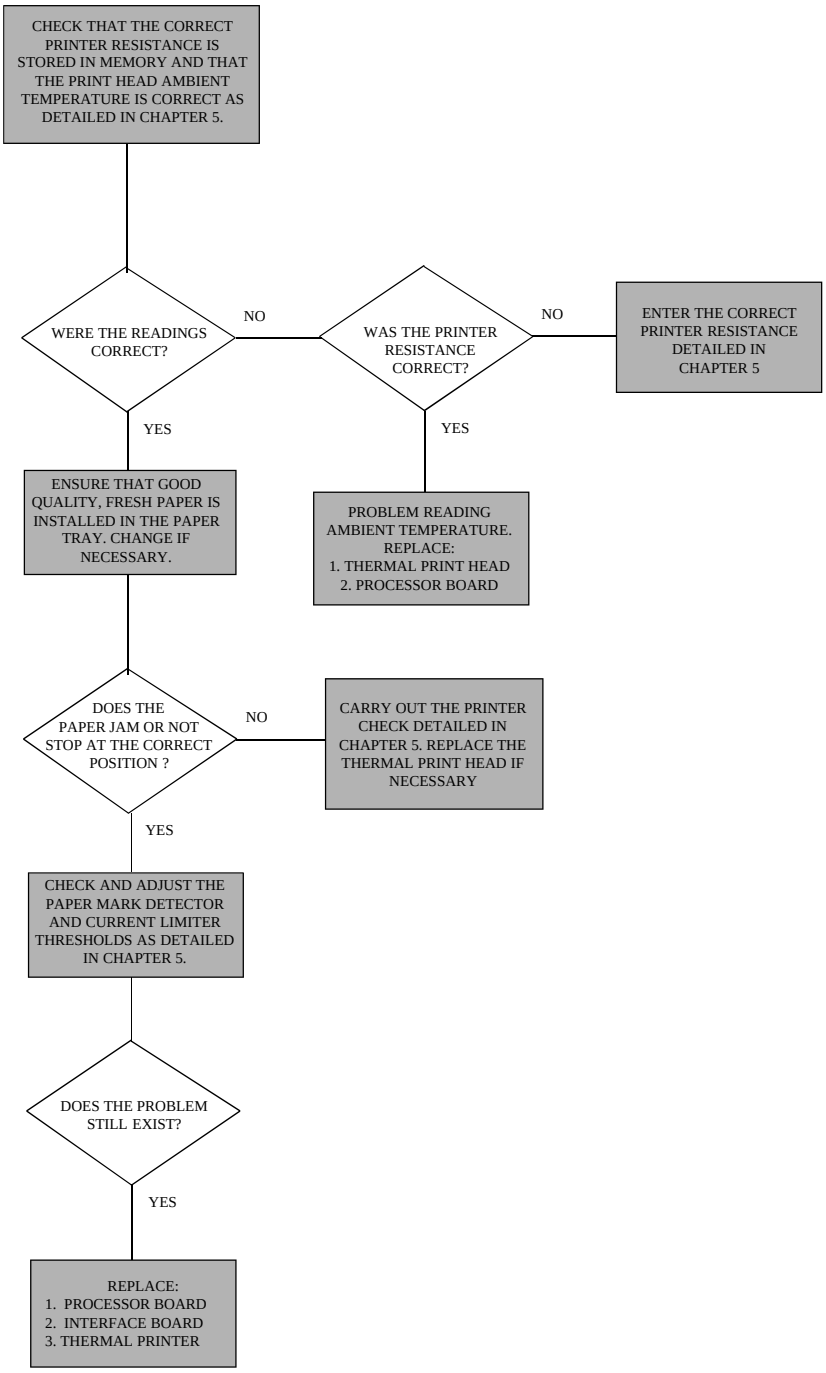
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Fault Diagnosis Chart (Sheet B - Power Problems)



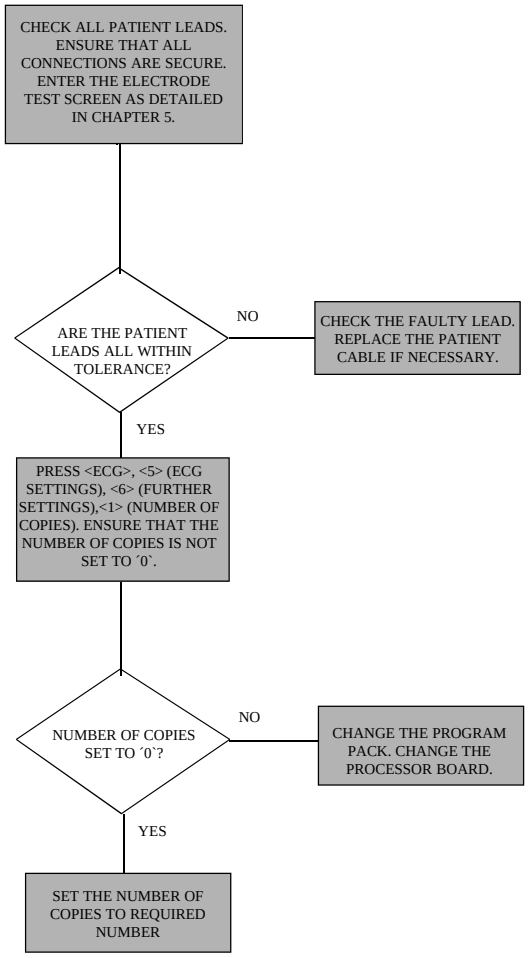
Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Fault Diagnosis Chart (Sheet C - General Problems)

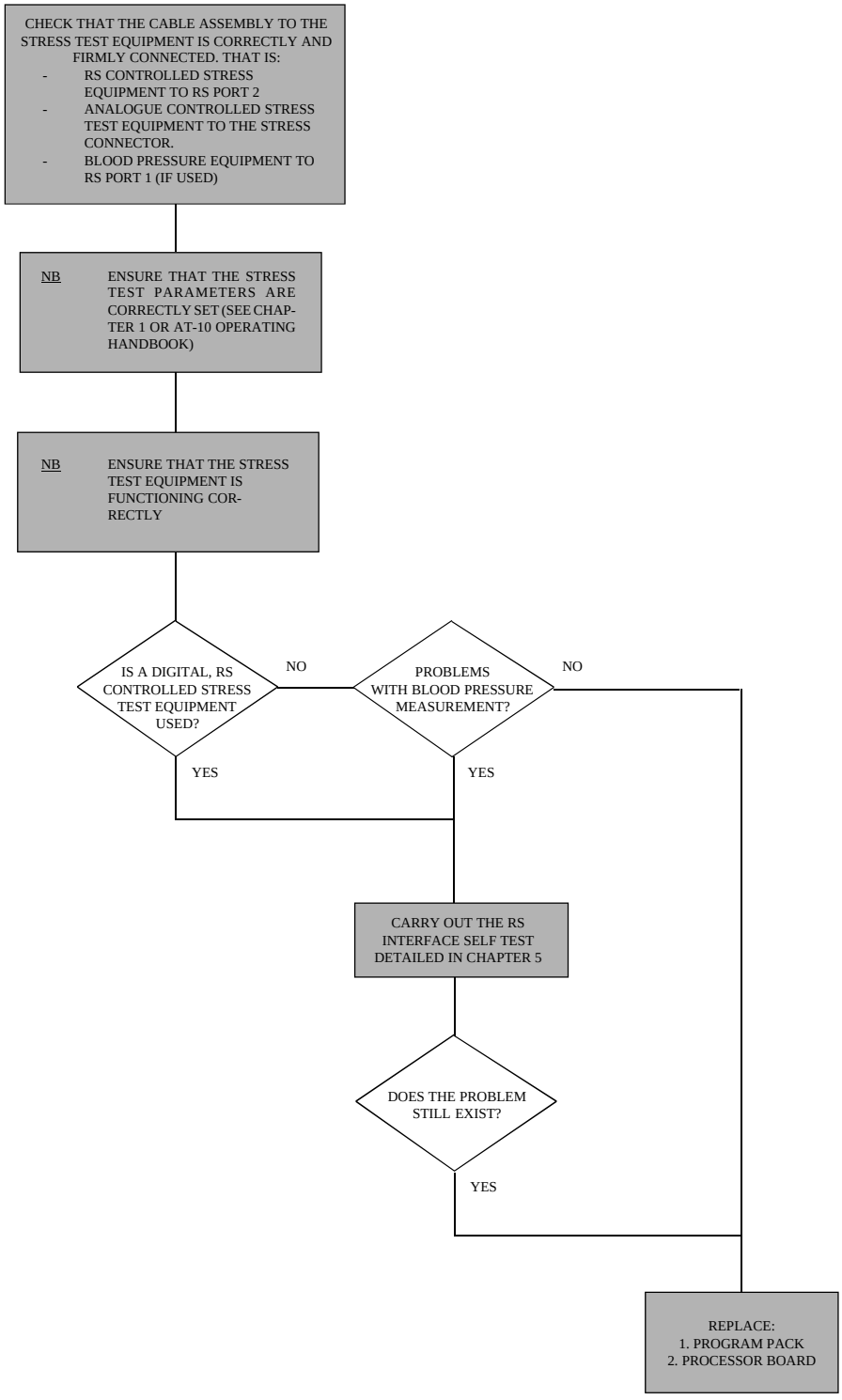


Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

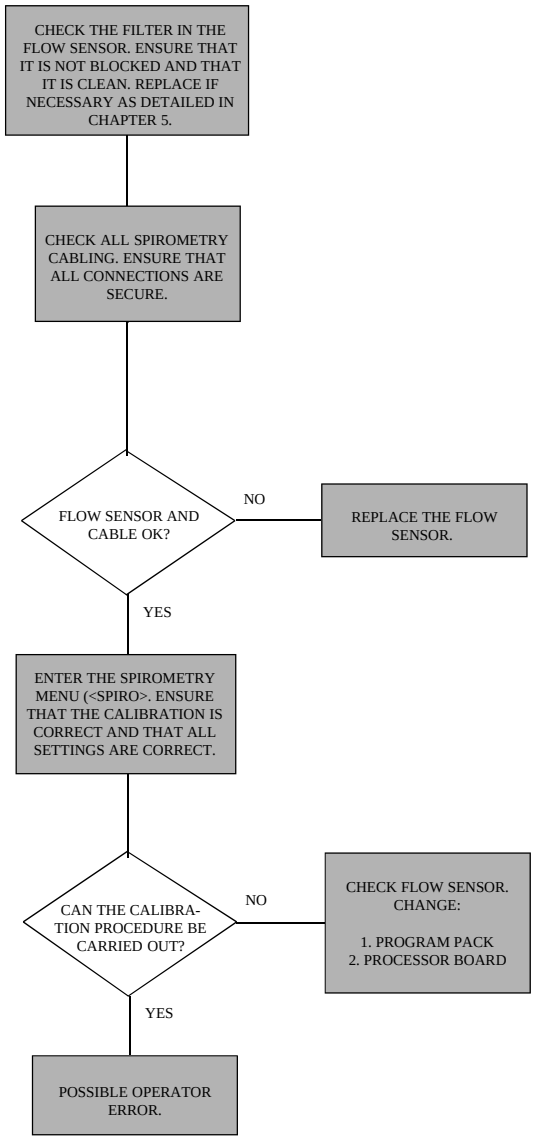
AT-10 Fault Diagnosis Chart (Sheet D - Printer Problems)



AT-10 Fault Diagnosis Chart (Sheet E - Auto Mode Problems)

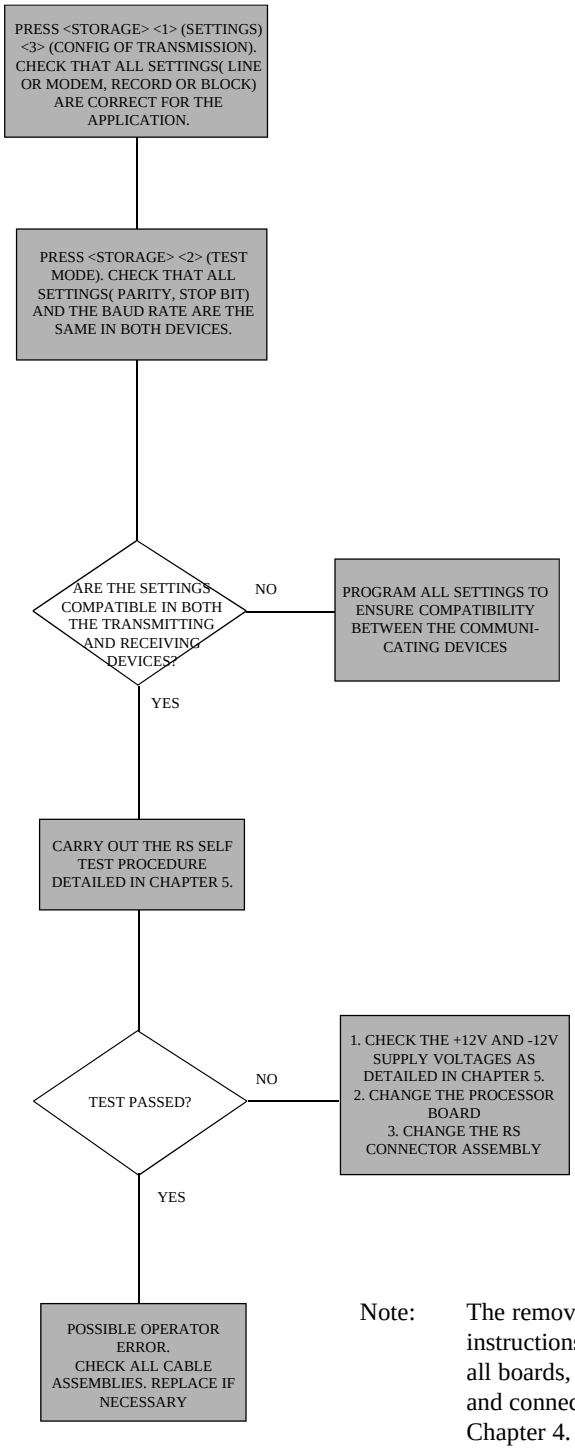


AT-10 Fault Diagnosis Chart (Sheet F - Exercise Mode Problems)



Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Fault Diagnosis Chart (Sheet G - Spirometry Problems)



Note: The removal and replacement instructions and the location of all boards, cable assemblies and connectors are given in Chapter 4.

AT-10 Fault Diagnosis Chart (Sheet H - Communication (RS) Problems)

Chapter 4
Physical Overview & Module Replacement

Contents

Introduction

The AT-10 comprises two main assemblies as follows:

- The Base Assembly
- The Top Assembly

The Base Assembly contains most of the AT-10 electronics, and all external connectors. The Top Assembly houses the keyboard and the LCD display. The two assemblies are moulded to fit together and are secured with captive screws. Electrical connection between the two assemblies is achieved with a ribbon cable assembly.

Because of the plastic construction, threaded metal inserts are used for all screw fixings in the unit.

Base Assembly

The base assembly comprises a moulded plastic tray onto which is mounted the following:

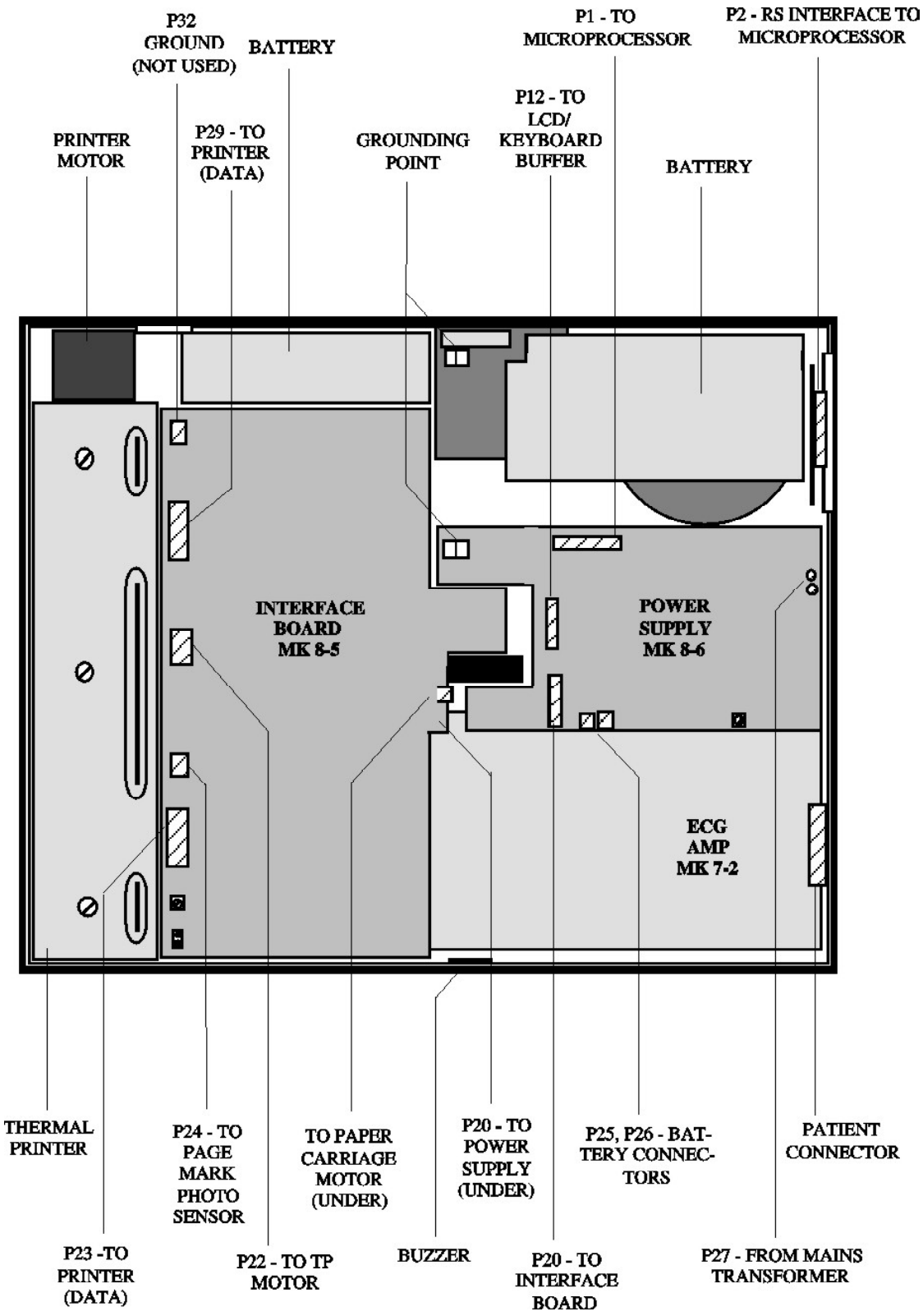
- Mains Isolation Transformer
- Two Lead-Acid Batteries
- Power Supply PCB MK 8-6
- ECG Amplifier PCB MK 7-2
- Interface Board MK 8-5
- Microprocessor Board MK 8-1
- Program Pack MK 8-11
- Thermal Printer
- Paper Tray Assembly with Carriage Motor

The Microprocessor board and the ECG Amplifier are secured to moulded supports on the bottom of tray. The Power Supply is mounted on four spacers above the Microprocessor board and the Interface board and the thermal printer are mounted on the metal paper tray framework. Electrical connection between all boards is achieved with ribbon cable assemblies or with flying leads.

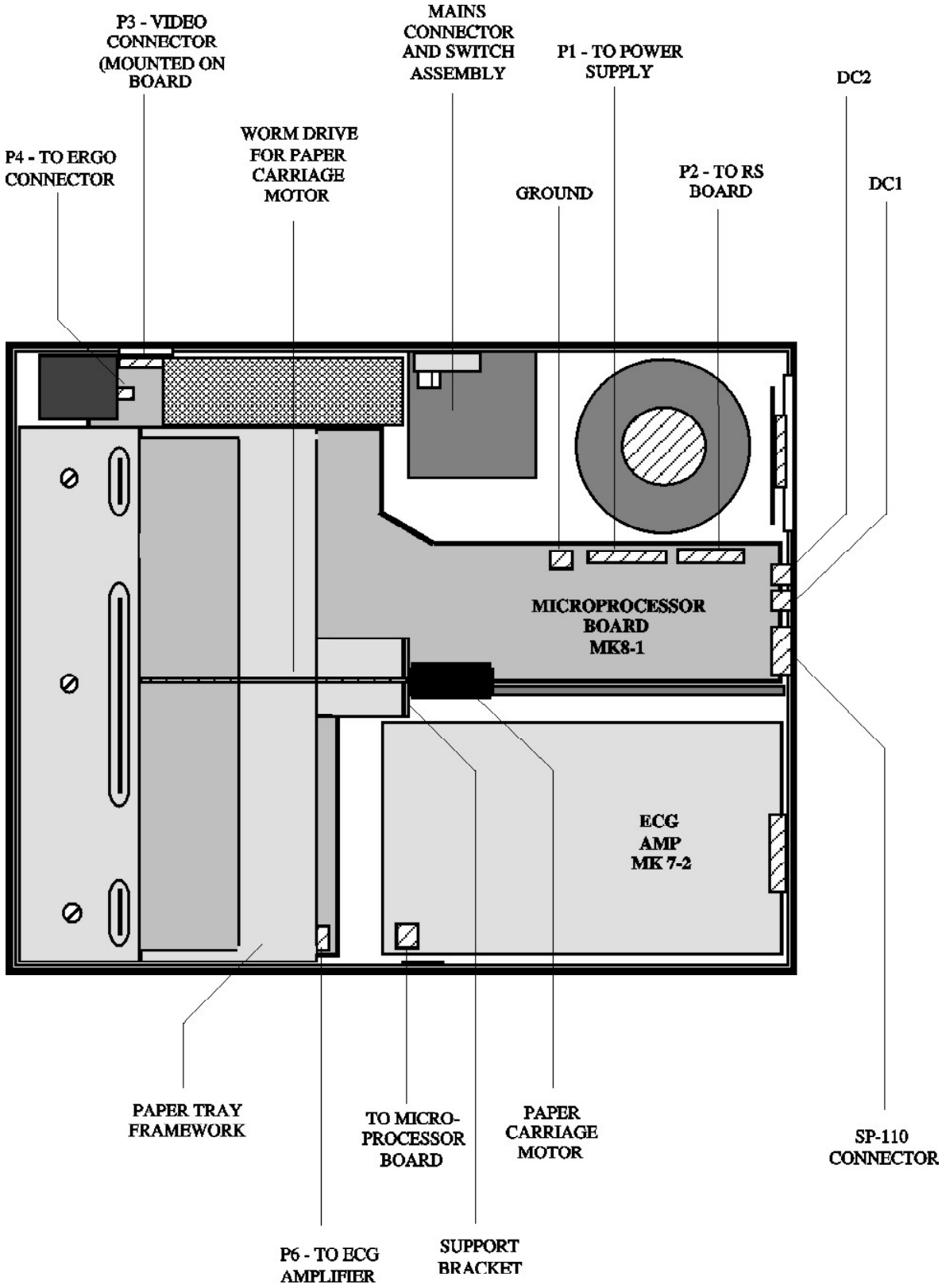
The Mains Connector and Switch assembly is secured to the Back Panel with spring loaded clips. The Mains Transformer is secured to the tray with a centre screw. Electrical connection between the Power Supply board, the Transformer, the Batteries, and the Mains Connector and Switch assembly, is achieved by flying leads.

The Program Pack is inserted via a cut-out in the side panel under the paper tray. It is mounted in slides and connects directly with the Processor Board. One captive screw secures the Program Pack in position.

Cut-outs in the back and side panels are provided for external connectors. The Video, DC1, DC2, and the Spiro (SP-110) connectors are all mounted directly on the Microprocessor board. The Patient connector is mounted directly on the ECG Amplifier. All other connectors are mounted on dedicated mounting plates.



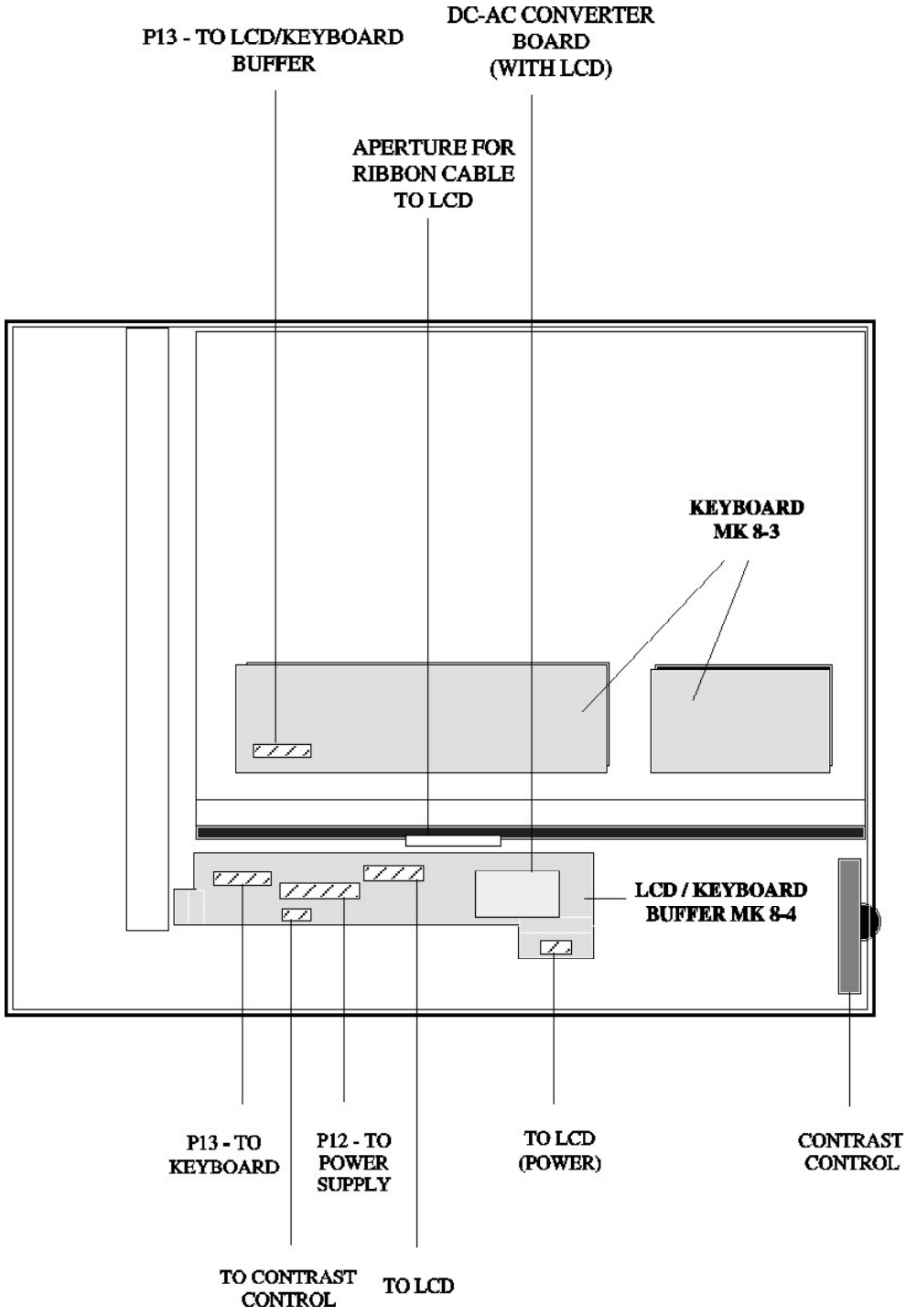
Base Assembly - Top Assembly Removed



Base Assembly - Paper Carriage extended and Power Supply Board, Interface Board and Battery Removed

Base Assembly (cont.)

The metal paper tray framework allows the paper tray to be withdrawn. The dual rotation paper carriage motor turns a worm drive to slide the paper tray in or out.

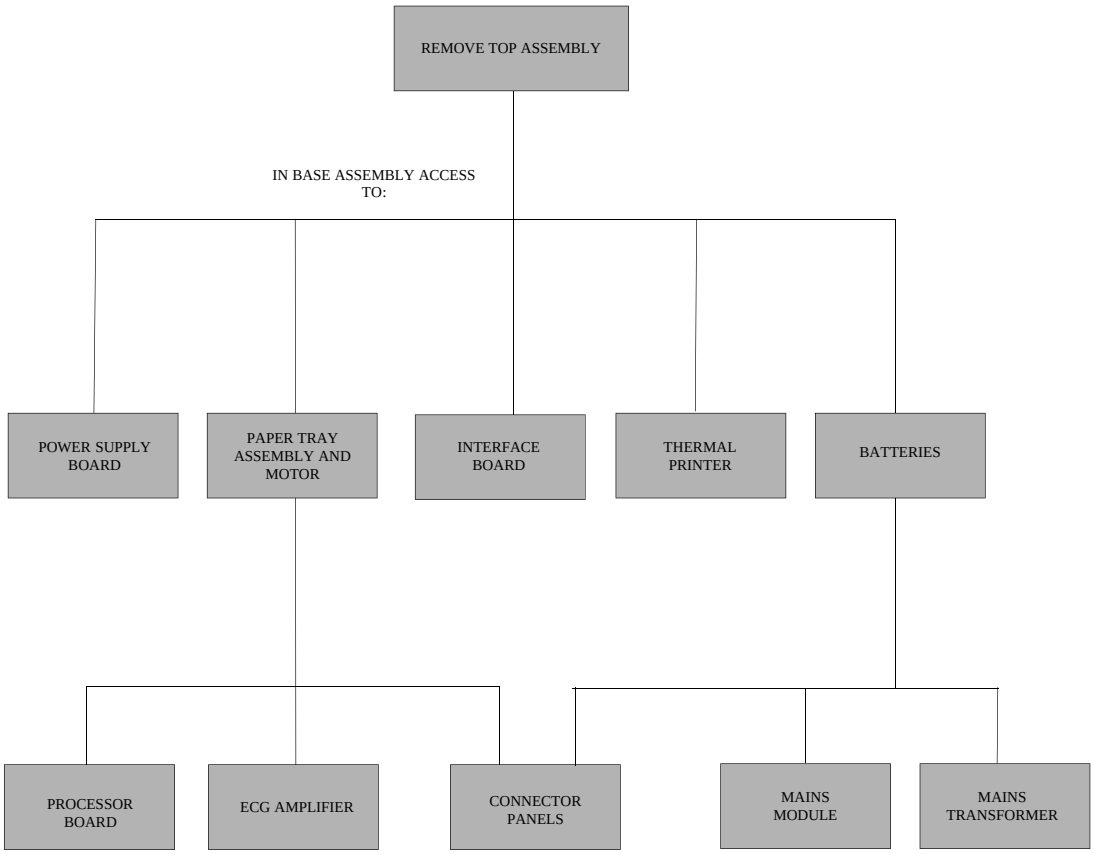


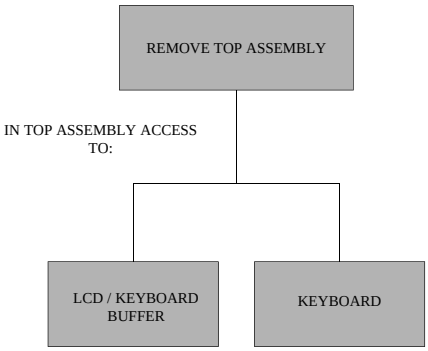
LCD / Keyboard Assembly

Top Assembly

The Top Assembly is manufactured from moulded plastic and comprises a Main Housing with a hinged LCD Assembly.

Secured in the Main Housing is the LCD / Keyboard Buffer MK8-4 and the Keyboard MK 8-3. Both of these boards are secured with double sided tape. Electrical connection between the modules is achieved with ribbon cable assemblies or with flying leads.





Note: Access to the Program Pack is gained via the left-hand Side Panel under the paper tray
Access to the mains fuse and the voltage selector is from the back panel (Mains Module).

Removal and Replacement

Introduction

This Chapter provides the procedures required to carry out the removal and replacement of all modules that are spared at service level. The instructions given in this chapter are autonomous, with each module containing the following:

- The pre-requisites that must be fulfilled before removal of the module
- Tools and equipment that are required to remove and replace the module and to carry out the functional checks and adjustments.
- Removal Procedures
- Replacement Procedures
- Checks and Tests that must be carried out after replacement.

Any adjustments, jumper settings, special checks or functional procedures that are required during a procedure, are detailed in the relevant step.

In-text diagrams support the text where required and provide location details of connectors, test points and adjustment potentiometers.

Specific warnings and cautions are given where applicable. Warnings indicate potential danger could cause personal injury. Cautions indicate areas that could cause damage to the equipment .

If a key operation or menu selection is required, the key sequence required is given in parenthesis `<>´. The character (or character string) given in parenthesis is the actual character that is printed on the key. When a key sequence is provided it must be followed in the order given. For example the key sequence to display the macro screen is as follows:

<FNCT> <2> <ENTER>

This requires that the function key on the keypad is pressed, followed by the 2 key, followed by the return key (Enter).

Safety Notes

WARNINGS

BEFORE COMMENCING ANY REMOVAL OR REPLACEMENT PROCEDURES ENSURE THAT THE MAINS POWER SUPPLY IS SWITCHED OFF AND THAT THE MAINS CABLE IS REMOVED.

CERTAIN CHECKS AND ADJUSTMENTS CAN ONLY BE CARRIED OUT WITH THE TOP ASSEMBLY REMOVED AND WITH MAINS CONNECTED. WHEN CARRYING OUT THESE PROCEDURES BEWARE THAT POTENTIALLY LETHAL VOLTAGES ARE PRESENT.

CAUTIONS

THE AT-10 CONTAINS STATIC SENSITIVE CMOS COMPONENTS; OBSERVE ANTI-STATIC PRECAUTIONS:

- WHEN CARRYING OUT ANY MAINTENANCE PROCEDURES ALWAYS PLACE THE UNIT ON AN EARTHED ANTI-STATIC MAT.

- PERSONAL MUST BE EARTHED WHEN HANDLING ANY BOARDS OR COMPONENTS

- ALWAYS USE AN ANTI-STATIC BAG WHEN TRANSPORTING BOARDS OR COMPONENTS

THE UNIT IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING, ALWAYS PLACE THE UNIT ON A SOFT, NON-ABRASIVE CLOTH WHEN CARRYING OUT MAINTENANCE PROCEDURES

TAKE CARE NOT TO PLACE ANY STRAIN ON THE CONNECTING RIBBON CABLE WHEN REMOVING THE TOP ASSEMBLY . ENSURE THAT THE CABLE ASSEMBLY IS NOT CRIMPED OR TWISTED AND THAT THE TOP ASSEMBLY IS NOT PLACED ON THE CABLE ASSEMBLY.

CARE MUST BE TAKEN WHEN REMOVING AND REPLACING CONNECTORS. NEVER USE FORCE. NEVER STRAIN THE CABLE ASSEMBLIES.

THE PROCEDURAL STEPS GIVEN FOR EACH MODULE MUST BE FOLLOWED IN THE ORDER GIVEN.

Opening the Case

Pre-requisites

- The unit must be placed on an anti-static mat and anti-static precautions observed when any maintenance is carried out on the AT-10. The room temperature should be between 18 and 28 degrees.
- Mains supply is required to carry out the unit functional test after assembly.
- THE WARNINGS AND CAUTIONS AT THE BEGINNING OF THE CHAPTER MUST BE OBSERVED.

Tools

- Posi-drive screwdriver

Test Equipment

The following test equipment is required to carry out the functional test after unit assembly

- Schiller Patient Cable
- Patient Simulator eg phantom 320.
- RS Test Cable (supplied by Schiller)

Top Assembly Removal

The Top Assembly is mounted on the Base Assembly and is secured to the Base Assembly with four screws and washers; access to the screws is gained from the underside of the unit. To remove the Top Assembly, proceed as follows:

1. Remove all cable assemblies connected to the side and rear panels. Ensure that the mains cable is removed.
2. Taking care to secure the hinged LCD module so that it cannot swing open, turn the unit up-side-down and rest on a soft cloth.
3. Unscrew the six retaining screws and washers situated in the extreme corners and edges of the unit, indicated by an arrow.
4. Grasping the top and bottom of the unit to ensure that the two assemblies cannot part, carefully return the unit to the standing position.
5. Gently lift the Top Assembly sufficiently to gain access to the interconnecting cable, and disconnect the connector from the Power Supply Board.
6. Gently lift the Top Assembly away from the Base Assembly and place on a soft cloth.

Opening the Case (cont.)

Top Assembly Replacement

To replace the Top Assembly proceed as follows:

1. Check that all boards and components are firmly secured. Check for loose screws. Ensure that no screws or foreign bodies are loose in the bottom of the case.
2. Inspect all the internal cable assemblies and ensure that they are in good condition and that no visible damage can be seen. Ensure that no cable assemblies are strained, crushed or caught.
3. Ensure that all connectors are firmly home.
4. Position the Top Assembly adjacent to the Base Assembly and without straining the ribbon cable, plug in the interconnecting cable from the Top Assembly to the Power Supply (P12).

   Note: It may be necessary to tilt the Top Assembly for the cable assemblies to reach.

5. Carefully position the Top Assembly on the Base Assembly.
6. Grasping the two assemblies to ensure that they cannot part, carefully turn the unit up-side-down and replace the six securing screws and washers in the extreme corners and edges of the unit. Return the unit to the upright position.

Functional Check After Assembling the AT-10

The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test but is intended to identify any faults that may be present after the unit has been reassembled. If any check fails go to Fault Diagnosis Chapter 4. To carry out the general confidence check proceed as follows:

1. Ensure that the voltage selector on the back panel is set for the required voltage and connect mains to the unit. Switch on the mains and ensure that the green mains LED on the hinged LCD Assembly, lights.
2. Switch the unit on by pressing the <ON> key on the Keyboard. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.
3. Press <FNCT> <2> <2> and enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen.
4. Connect the ECG phantom to the ECG connector on the side panel and switch the phantom on. Ensure that a good ECG trace is displayed on the screen.
5. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality. Press <MAN START> and ensure that the print-out is accurate and of good quality.
6. Press the <AUTO START> key and wait approximately 10 seconds for the print-out to commence. Ensure that the print-out is accurate and of good quality.
7. Connect the RS test cable to RS-232 ports 1, 2 and 3 on the back panel and carry out the RS transmission test as detailed in Chapter 5.

Opening the Case (cont.)

8. Press the <PATIENT DATA> key and systematically press the keys:

   <QWERTZUIOP>, <ENTER>, <1234567890>

   Ensure that the entered data is presented on the screen as entered. Press <ESC> to exit from the patient data display.

9. Press the <BEGIN> key and ensure that the AT-10 indicates that an exercise test has commenced. Press the <STOP> key and ensure that a print-out is given.

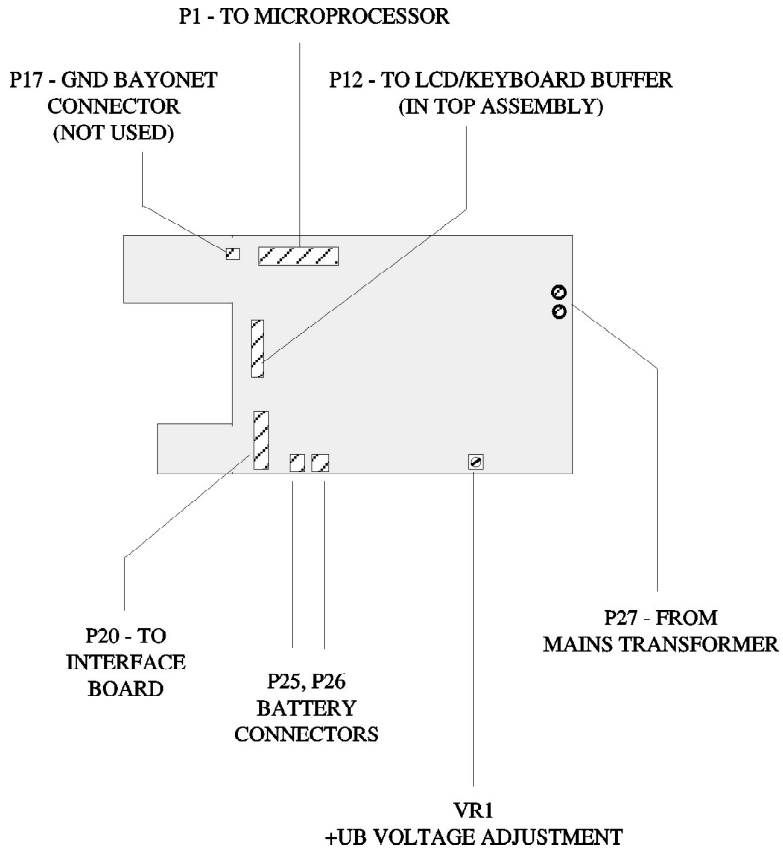
10. Enter the required static parameter values. Store the entered parameter values by pressing

    <FNCT <2> <5>.

    Note: Details of all parameters and parameter values are provided in the AT-10 Operating Manual.

11. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out). Switch the unit off and leave connected to the mains supply for 15 hours to fully charge the battery. Ensure that the Battery LED is extinguished when the battery is fully charged.

12. Disconnect the mains power supply and leave the unit for 24 hours. Switch the unit on and check that the battery LED lights. Ensure that all static parameters have been remembered. Leave the unit switched on for 45 minutes (without using the printer) and check that the battery LED does not start to flash in that time.



Power Supply Board MK 8-6

Power Supply Board MK 8-6

The Power Supply board is positioned on four spacers above the Processor board.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.

Tools and Equipment

- Cross-Bladed screwdriver
- Small flat-bladed screwdriver
- Digital Voltmeter

In addition if the Power Supply board is checked in isolation, a Power Supply capable of supplying up to 30V, is required.

Parts

- Power Supply MK 8-6. Part number as detailed in Chapter 6.

Power Supply Board Removal

WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

To remove the Power Supply board proceed as follows:

1. Disconnect the flying leads to the mains transformer and to the batteries. Disconnect P20 to the Interface board, P1 to the Microprocessor and the GND guard P17. (P12 to the LCD/ Keyboard Buffer MK 8-4 will already be removed).
2. Unscrew the four screws securing the board to the spacers and remove the board

Power Supply Board Replacement

To replace the Power Supply proceed as follows:

1. Position the board on the spacers and secure with the four securing screws.
2. Connect the Mains Transformer leads and the battery leads. Connect P1, P20 and P17 (GND).

Checks and Tests after Power Supply Board Replacement

After assembly, connect the mains supply to the unit and ensure that the green mains supply LED is lit. Switch the unit on and ensure that the LCD is lit and that meaningful data is displayed. Press the <PRINT SCREEN> key. Ensure that the printer functions.

Power Supply Board MK 8-6 (cont.)

Check that the battery charge monitor circuit is functioning as follows:

1. Switch the unit off but leave the mains connected. Leave the battery to charge for 10 hours. Check that the battery light flashes when the battery is charging and extinguishes when the battery is fully charged (after a maximum time of 15 hours).

2. Disconnect the mains and run the unit on battery power for 60 minutes (without using the printer). Check that:

   - the battery LED lights when running on battery power
   - the battery LED flashes when the battery capacity is low
   - the unit switches off when the battery capacity falls below a preset value

Note: Control of the Battery LED is from the CPU which uses the counter signal (BATTLC) to calculate the charge state of the battery. If the Battery LED is not giving the expected indications, the fault may lie on the Processor board (or P1 connector). The signal to control the battery LED is LEDB.

The nominal battery capacity at which the Battery Low is active (LED flashing) is 25%. The nominal voltage at which the Battery down signal is active and the unit switches off, is 21V.

Checking the Power Supplies

The power supply voltages can be checked without the AT-10 being assembled. However the Power Supply board is easily accessible and it is usually easier to check the power supplies with the unit assembled and the Top Assembly positioned by the side. If the board is to be checked in isolation a latch circuit must be manually set to switch on the power supply (equivalent to pressing the <ON> key).

Test points are provided on the Power Supply board for measurement of all power rails.

Individual adjustment is not possible for any of the voltage rails except +UB (from which all other supplies are generated and the batteries are charged). Note that +UB can only be adjusted with mains connected.

On Signal Simulation

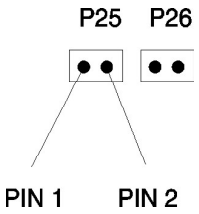
If the Power Supply board is checked in isolation the on line must be connected to GND to latch the power supply on. To simulate the on signal, proceed as follows:

Note: The on simulation signal is only required when the ON key on the keypad, cannot be used to switch the power supply on, that is when P12 to the Top Assembly is disconnected.

1. Connect power to the Power Supply board as follows:

   - If the unit is assembled, use either mains (via the mains transformer) or two fully charged batteries connected to the battery connectors
   - If the unit is not assembled, connect a power supply to the battery connectors on the Power Supply board. Connect the positive to pin 1 of plug P25, and the negative to pin 2 of plug P26. Set the Power Supply to 24V.

Power Supply Board MK 8-6 (cont.)



2. Using a suitable lead, connect GND to Plug P12 pin 25, and hold for 2 seconds. The power supply will now be latched on and all generated power supplies can be checked for the correct voltage.

Note: To switch the power supply off, connect 0V to P1 pin 50.

+UB Adjustment

This adjustment sets the voltage supplied from the switching regulator on the mains power factor controller circuit. To adjust this voltage the unit must be assembled and mains connected.

WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THE POWER SUPPLY. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENTS.

To check and adjust +UB supply proceed as follows:

1. Connect mains power to the unit and switch on by pressing the <ON> key on the keyboard.

2. Measure the voltage at P25 pin 1. Adjust VR1 to achieve a voltage of +27V ±200mV.

Power Rail Measurement

No adjustment is possible for any of the power rails. To check the power rail voltages go on the relevant test point (component layout given at the end of this book) and measure with a DVM. If any of the values are out of tolerance first ensure that +UB voltage is correct. If this is correct the power supply must be changed.

Lead-acid Batteries

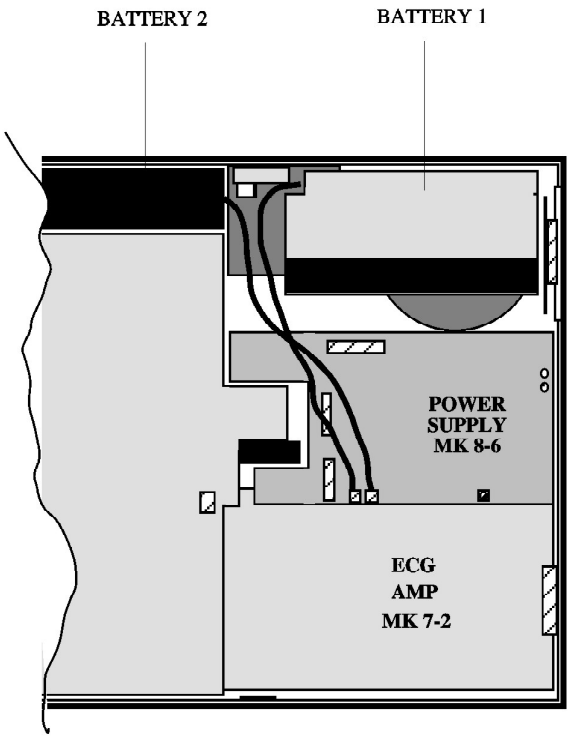
Two batteries are installed in the AT-10. They are self contained with integral leads and connectors.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.

Parts

The part numbers of all replaceable items are given in Chapter 6.



Battery Removal

WARNING

THE MAINS SUPPLY MUST BE DISCONNECTED DURING THIS PROCEDURE

To remove the battery proceed as follows:

1. Ensure that the unit is switched off and that the mains is disconnected. Remove all cable assemblies connected to the front and rear panels.
2. Disconnect the battery connectors from the Power Supply board and remove the batteries.

Lead-acid Batteries (cont.)

Battery Replacement

To replace the battery position the battery and connect the leads to the battery connector on the Power Supply.

Note: Red lead is the + battery terminal

Black lead is the - battery terminal

Checks and Tests After Battery Replacement

To ensure that the battery and the battery recharging circuit are functioning after battery replacement, proceed as follows:

1. Connect mains to the unit and ensure that the green mains and the yellow battery indicators, next to the display, are lit. Charge the battery for approximately 15 hours.
2. Ensure that the Battery indicator is extinguished after 15 hours (battery fully charged).
3. So that the capacity of the newly installed battery is calculated correctly by the processor, run the unit on battery power until the battery is fully discharged and the unit switches off. Repeat this process two times. This ensures that the correct capacity of the battery is registered by the processor. The calculated value of the battery capacity can be seen by pressing:

   <ECG> <6> (electrode test) <ENTER> <ENTER>

   The B CAPACITY indication displays the calculated battery capacity. See Chapter 5 for further details.
4. Program all static settings, for example time and date, which will have been lost when the battery was disconnected.

Interface Board MK 8-5

Pre-requisites

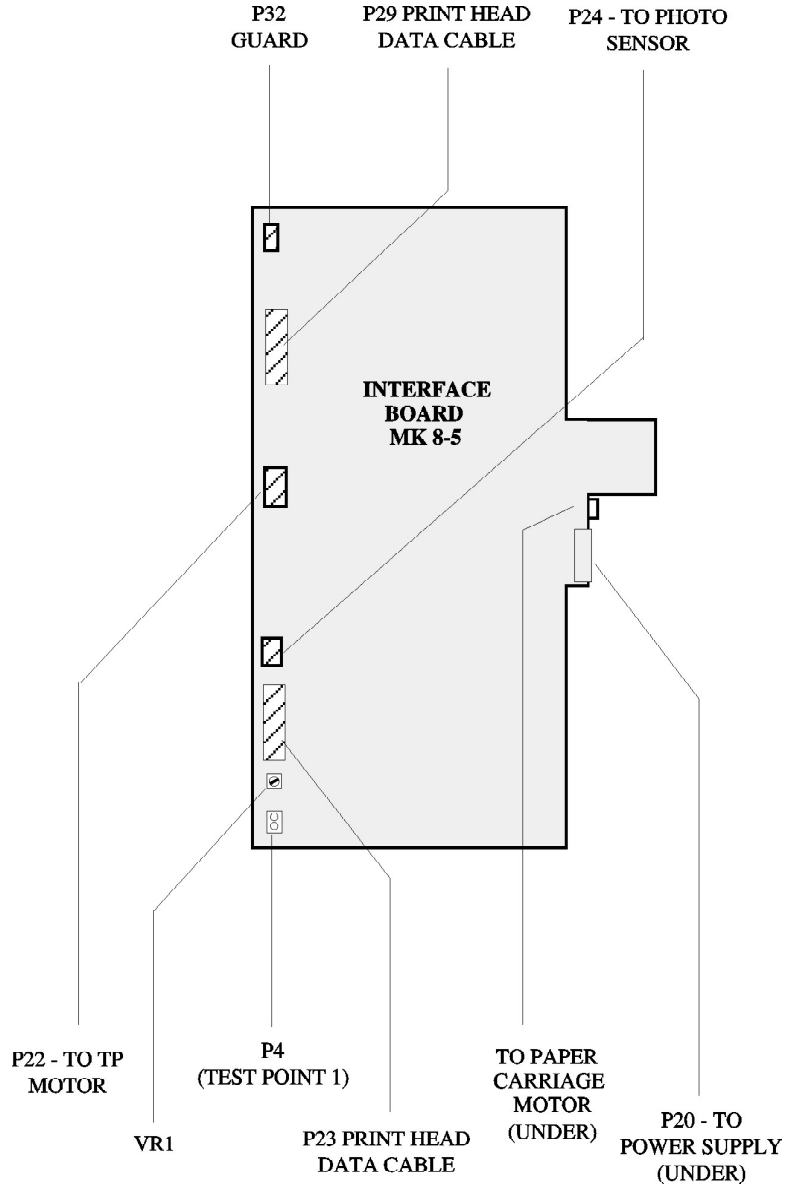
- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.

Tools

- Cross-bladed screwdriver
- Small flat-bladed screwdriver

Parts

- Interface Board MK 8-5. Part number as detailed in Chapter 6.



Interface Board MK 8-5 (cont.)

Interface Board Removal

To remove the Interface Board disconnect all connectors, unscrew the four screws securing the board to the Paper Tray Assembly, and lift the board away from the Paper Tray Assembly.

Interface Board Replacement

The replace the Bus Interface position the board on the Paper Tray Assembly and secure using the four captive screws. Reconnect all connectors to the Thermal Printer and the Power Supply.

Checks and Tests After Interface Board Replacement

The paper mark detection offset must be checked. To set the paper mark threshold proceed as follows:

1. Connect a digital voltmeter across the P4 connector (test point 1).

2. Switch the unit on and adjust VR1 to obtain a reading as follows:
   - > 3.5V when the black paper mark is under the paper mark detector
   - 0.4 to 0.5V when there is no paper mark under the detector ie white paper

NB IF THE DETECTION DOES NOT RECOGNISE THE PAPER MARK AFTER ADJUSTMENT, ENSURE THAT THE PAPER MARK WINDOW IS CLEAN.

3. Carry out the printer check to ensure that the board is functioning correctly . Enter the following key sequence:

   <ECG> <6> (electrode test) <P>

   A print-out of a series of diagonal lines will be given. Examine the print-out and ensure that all the lines are even and uninterrupted. Ensure that the complete paper is covered with close diagonal lines and that no blocks of plain paper are present. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print.

   Note: Unevenness of print or faulty individual pixels indicates a problem with the printer or printer alignment. If a complete block is left unprinted it additionally indicates that the Interface board could be faulty or the fault lies with the printer data control circuits on the Processor board.

Paper Tray Assembly

The Paper Tray Assembly comprises a metal framework onto which is mounted the paper tray and motor, the thermal printer and the interface board. It is positioned above the Processor board and is mounted on four spacers.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.

Tools

- Cross-Bladed Screwdriver
- Flat-Bladed Screwdriver

Parts

- The part number for the Paper Tray Assembly, complete with the DC motor is given in Chapter 6.

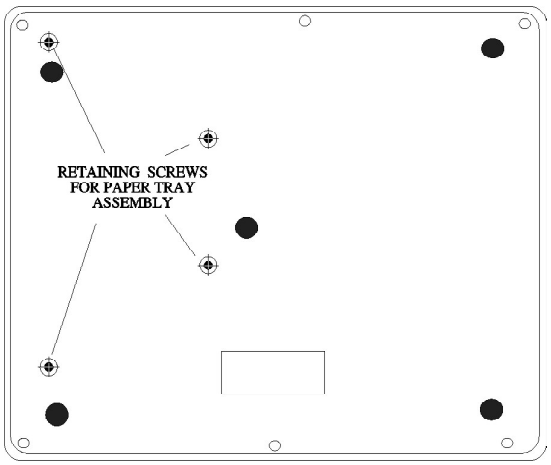
WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Paper Tray Removal

To remove the Paper Tray Assembly proceed as follows:

1. Remove P20 on the Power Supply.
2. Carefully turn the unit upside down and rest it on a soft cloth. Remove the four screws retaining the paper tray assembly.
3. Hold the two parts together and turn them right side up. Watch for screws falling out !
4. Taking care not to damage the printer motor gently ease the complete Paper Tray Assembly away from the unit.



Paper Tray Assembly (cont.)

Paper Tray Replacement

To replace the Paper Tray Assembly proceed as follow:

1. Gently ease the assembly in position on the four spacers above the Processor board.
2. Hold the two parts firmly together and turn upside down. Secure the four screws retaining the Paper Tray Assembly to the Base Assembly.
3. Turn right side up and replace P20 on the Power Supply.
4. Replace the Top Assembly as detailed earlier.

Checks and Tests after Paper Tray Assembly Replacement

After assembly connect mains to the unit and ensure that the green power LED lights. Press the <REPLACE PAPER> key and ensure that the paper tray retracts smoothly. Check the printer by entering enter the following key sequence:

<ECG> <6> (electrode test) <P>

A series of diagonal line will be printed. Ensure that the print-out is even.

Microprocessor Board

Pre-requisites

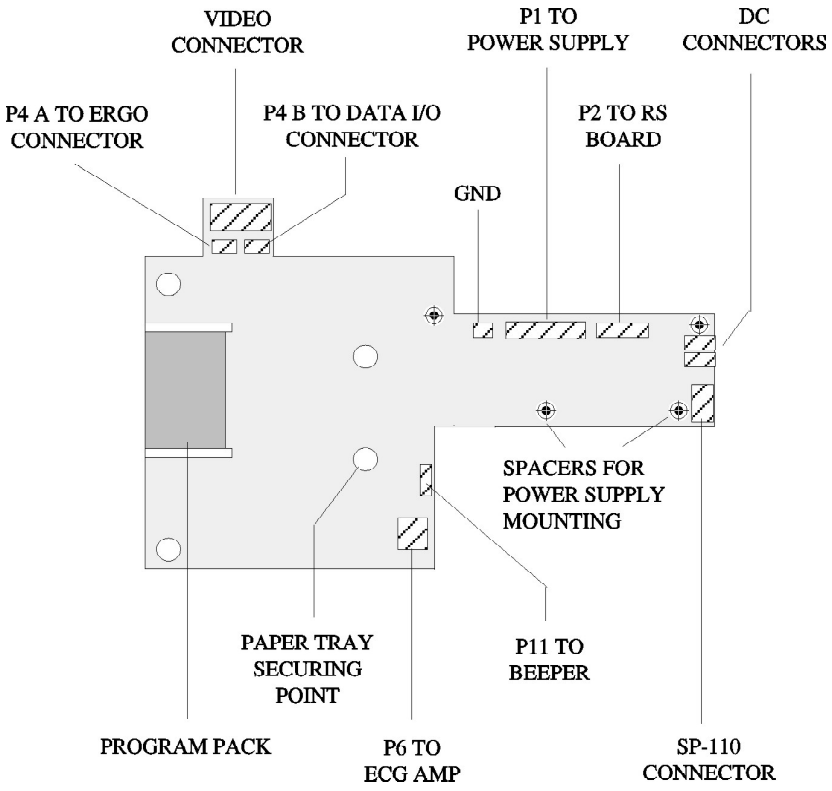
- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.
- The Power Supply board and the paper tray assembly must be removed before removing the Processor board.

Tools

- Cross-Bladed screwdriver

Parts

- Microprocessor Board MK 8-1. Part number as detailed in Chapter 6.



Microprocessor Board (cont.)

Microprocessor Board Removal

The Microprocessor board is secured to the Base Assembly with screws. To remove the Microprocessor Board proceed as follows:

CAUTION

THE MICROPROCESSOR BOARD CONTAINS CMOS COMPONENTS. ANTI-STATIC PRECAUTIONS MUST BE OBSERVED AT ALL TIMES.

1. Remove the Top Assembly as detailed above.
2. Remove the Power Supply board
3. Remove the Paper Tray Assembly as detailed above.
4. Remove the Program Pack
5. Disconnect the following connectors from the Microprocessor board:
   - P4 A and B to the ERGO and DATA I/O connectors on the back panel
   - P6 to the ECG Amplifier
   - P2 to the RS connectors on the Back Panel
   - P11 to the Beeper Connector
   - GND
6. Unscrew and remove the six Microprocessor board securing screws (one under the program pack) and the four spacers for the Power Supply board and remove the Microprocessor Board.

Note: The Program Pack is mounted in slides on the Microprocessor board and connects directly with it. Removal and replacement instructions for the Program Pack are provided in Paragraph 8.

Microprocessor Board Replacement

To replace the Microprocessor board proceed as follows:

1. Position the Microprocessor board in the Base Assembly and secure with the ten securing screws.
2. Reconnect the following connectors to the Microprocessor board:
   - P4 A and B to the ERGO and DATA I/O connectors on the back panel
   - P6 to the ECG Amplifier
   - P2 to the RS connectors on the Back Panel
   - P11 to the Beeper Connector
   - GND

Microprocessor Board (cont.)

3. Slide in, and secure the Program Pack as detailed below
4. Replace the Paper Tray Assembly as detailed above.
5. Replace the Power Supply board as detailed above.
6. Replace the Top Assembly.

Checks and Tests After Microprocessor Board Replacement

When the unit is reassembled after Microprocessor board replacement, the functional check detailed on page 14 must be carried out to ensure the integrity of the assembled unit.

The capacity of the battery is calculated and stored by the processor for reference. To recalculate and store the correct battery capacity proceed as follows:

1. Fully charge the battery by leaving the unit connected to the mains for 15 hours.
2. Run the unit on battery power until the battery is fully discharged and the unit switches off.
3. Repeat this process two times.

The value of the battery capacity calculated (and stored) by the processor, can be seen by pressing:

<ECG> <6> (electrode test) <ENTER> <ENTER>

The B CAPACITY indication displays the calculated battery capacity. See Chapter 5 for further details.

Program all static settings.

Program Pack and Software Modules

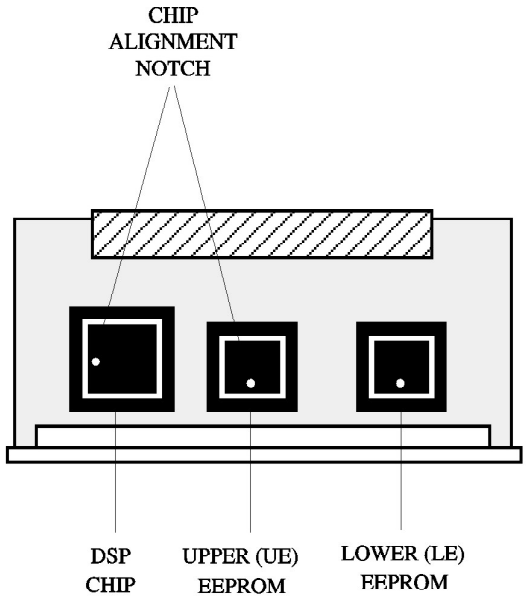
Pre-requisites

Tools

- Cross-Bladed screwdriver
- Special chip removal tool type AMP.

Parts

- Program Pack with the correct software installed, or the software EEPROM or DSP modules. Part numbers as detailed in Chapter 6.



Note: The EEPROM software is available in various languages indicated by the label on the EEPROM. The second letter in brackets indicates the language as follows:

E - English

D - German

S - Swedish

I - Italian

F - French

P - Spanish

Program Pack and Software Modules (cont.)

Program Pack (and program EEPROM and DSP) Removal

The Program Pack is mounted in slides secured on the Processor board. Access to the Program Pack is gained from the side panel under the Paper Tray.

CAUTION

THE PROGRAM PACK CONTAINS STATIC SENSITIVE CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.

Use the attached handle to gently ease the Program Pack away from the connector.

To remove an EEPROM or DSP chip from the board, use the special chip removal tool to gently and evenly ease the chip away from the socket.

Program Pack (and program EEPROM and DSP) Replacement

Note: The software version of a program EEPROM or DSP chip is written on the label attached to the chip. Before replacing a program chip ensure that it is the correct software version for the application.

To replace an EEPROM or DSP chip, position it above the socket so that the chip alignment notch is matched with the socket alignment notch. Gently and firmly push home until retained by the connector.

To replace the Program Pack, slide the pack in the board guides and gently and firmly push home.

Checks and Tests After Program Replacement

1. Switch the unit on by pressing the <ON> key on the Keyboard for approximately a second. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.

2. Switch the unit on and check that the correct software version, as stated on the label is installed. To do this press the key sequence:

   <ECG> <6> (electrode test) <.> (period)

   The software version is displayed on the LCD. (See Chapter 5 for software details).

3. Carry out the AT-10 functional check detailed on page 14.

ECG Amplifier Board

The ECG Amplifier is mounted next to the Processor board and is secured to the Base Assembly with four screws.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.
- The Power Supply board must be removed as detailed in Paragraph 3.
- The Paper Tray Assembly must be removed as detailed in Paragraph 6.

Tools and Test Equipment

- Cross-Bladed screwdriver
- Flat-bladed screwdriver

Parts

- ECG Amplifier board. Part number as detailed in Chapter 6.

ECG Amplifier Board Removal

CAUTION

THE ECG AMPLIFIER CONTAINS STATIC SENSITIVE CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.

To remove the ECG Amplifier proceed as follows:

1. Disconnect the cable assembly to the Processor board (P6).
2. Unscrew the four corner securing screws (the two inner screws also secure the end connector) and remove the board.

ECG Amplifier Board Replacement

Secure the ECG Amplifier board in position with the four retaining screws. Connect the cable to the Processor board and replace:

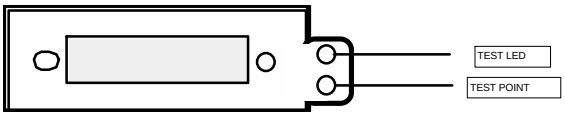
- Paper Tray Assembly
- Power Supply board
- Top Assembly

ECG Amplifier Board (cont.)

Checks and Tests after Replacement

To prove the integrity of the replaced board carry out the following functional check procedure:

1. Switch on the unit and connect a Schiller patient cable to the ECG connector. Carry out a cable test by inserting each lead in turn into the lead test point. Ensure that the green test LED lights when a patient lead is inserted.



2. Connect a suitable patient simulator to the ECG connector and carry out a resting ECG. Ensure that all the leads can be displayed on the LCD.

Note: The procedure to carry out an ECG test is given in the AT-10 operating manual

Mains Assembly

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.
- The batteries must be removed.

Tools

- Narrow, blunt instrument for unlatching the assembly catches.
- Small flat-bladed screwdriver

Parts

- Mains Assembly. Part number as detailed in Chapter 6.

WARNING

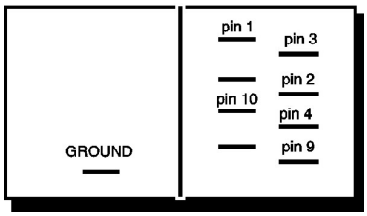
ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Mains Assembly Removal

To remove the assembly proceed as follows:

1. Disconnect the crimped flying lead connectors on the back of the assembly.
2. Using a narrow blunt instrument, unlatch the two bottom retaining catches. Unlatch the top catch and remove the assembly from the Mains Assembly securing bracket on the Base Assembly.

   Note: The Mains Assembly is retained in position with three tensioned catches. Access to the two bottom catches is gained from the bottom of the Base Assembly via two access holes.



Mains Assembly (cont.)

Mains Assembly Replacement

1. Ensure that the mains voltage selector is set to the correct voltage for the application as indicated by an arrow in the selector and fuse sub-assembly. If the voltage is not set for the required voltage, proceed as follows:

   - Using a small flat-bladed screwdriver gently prise the selector and fuse sub-assembly away from the main assembly.
   - Lift the retaining clip securing the voltage plate and remove the plate.

     Note: The plate has contacts which are pushed into tensioned connectors; a small screwdriver may be required to prise the plate away from the connectors.
   - Replace the voltage plate by pushing fully home. Ensure that the correct voltage is displayed in the front and top `voltage windows´.
   - Click the sub-assembly back in place in the Mains Assembly.

Note: The fuse sub-assembly containing the mains fuses, is positioned under the voltage plate and is removed and replaced in the same way as above.

CAUTION

IT IS POSSIBLE TO INSERT THE MAINS ASSEMBLY UPSIDE DOWN. WHEN REPLACING THE ASSEMBLY ENSURE THAT THE MAINS ON/OFF SWITCH IS UPPERMOST WITH THE MAINS CONNECTOR UNDER THE ON/OFF SWITCH.

2. Push the Mains Assembly into the Base Assembly until the catches engage with the bracket. Ensure that the assembly is firmly in position.
3. Reconnect the crimped cables.

Checks and Tests after Replacement

After assembly connect mains to the unit and ensure that the green power LED lights.

Mains Transformer

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed in Paragraph 2 and all external cable assemblies disconnected.
- Battery 1 and the EMC shield covering the transformer must be removed.

Tools

- Flat-Bladed screwdriver

Parts

- Mains Transformer. Part number as detailed in Chapter 6.

WARNING

ENSURE THAT THE MAINS CABLE IS DISCONNECTED BEFORE COMMENCING

Mains Transformer Removal

To remove the Mains Transformer proceed as follows:

1. Disconnect the two power supply bayonet connectors on the Power Supply board.
2. Disconnect the flying lead connectors to the Mains Assembly.
3. Unscrew the centre screw of the Mains Transformer, and remove from the Base Assembly.

Mains Transformer Replacement

To replace the mains transformer proceed as follow:

1. Position the Transformer and secure to the Base Assembly with the centre screw.
2. Connect the flying leads to the Power Supply and to the Mains Assembly. (See the Power Supply paragraph and Mains Assembly paragraph respectively, for the connector colours).

Checks and Tests after Replacement

After assembly connect mains to the unit and ensure that the green power LED lights.

LCD / Keyboard Buffer MK 8-4

The LCD/Keyboard Buffer board is situated in the Top Assembly adjacent to the Keyboard. It is secured in position with three retaining screws. The DC-AC Converter board (part of the LCD assembly) is soldered to the LCD/Keyboard Buffer board.

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed as detailed above and all external cable assemblies disconnected.

Tools

- Cross-bladed screwdriver

Parts

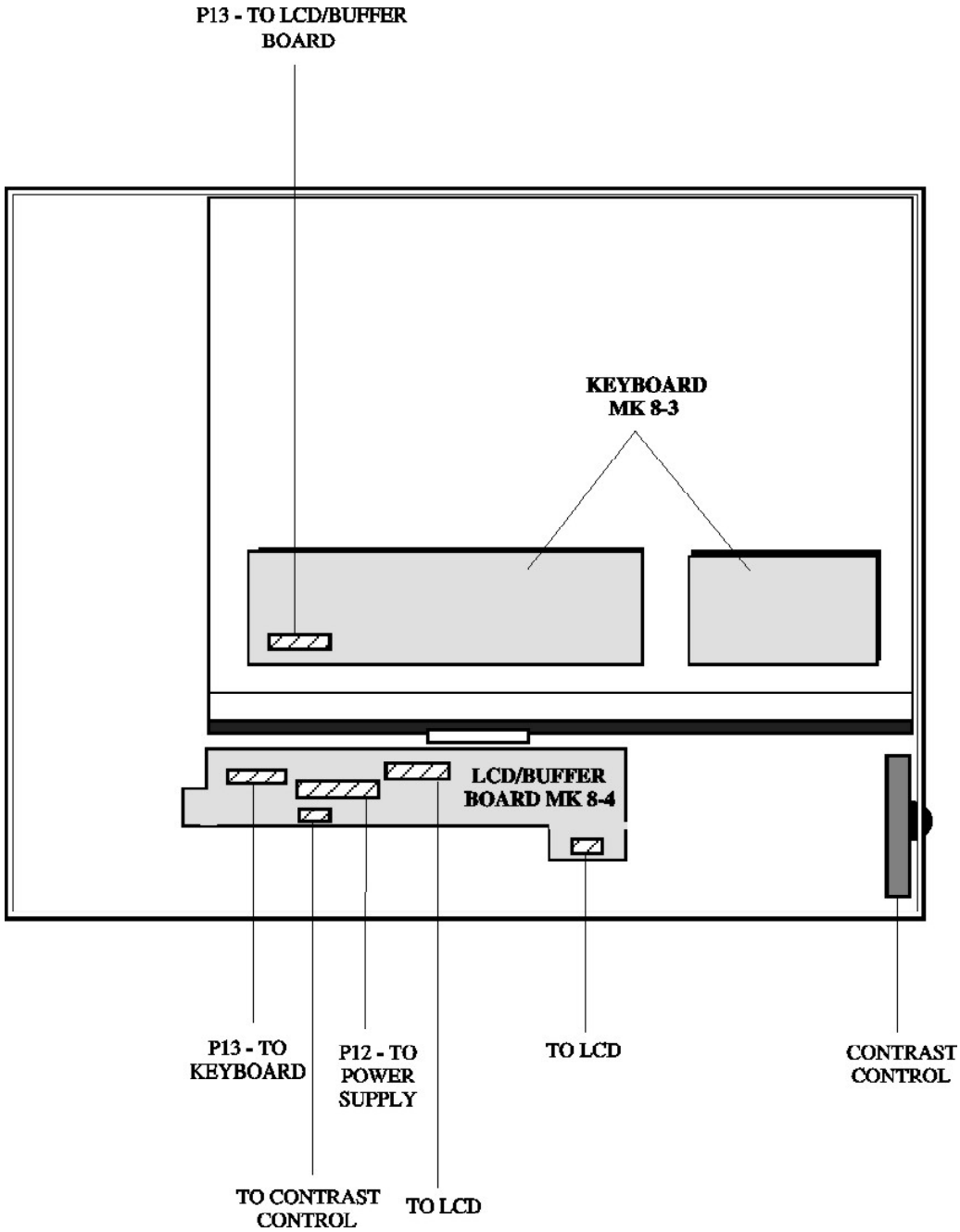
- The part number for the LCD/ Keyboard Buffer Board MK 8-4 are given in Chapter 6.

WARNING

HIGH VOLTAGES ARE GENERATED IN THE LCD. ENSURE THAT THE MAINS IS DISCONNECTED.

CAUTION

THE LCD/KEYBOARD BUFFER BOARD CONTAINS STATIC SENSITIVE CMOS COMPONENTS. OBSERVE ANTI-STATIC PRECAUTIONS.


P13 - TO LCD/BUFFER BOARD
KEYBOARD MK 8-3
LCD/BUFFER BOARD MK 8-4
P13 - TO KEYBOARD
P12 - TO POWER SUPPLY
TO LCD
CONTRAST CONTROL
TO CONTRAST CONTROL
TO LCD

LCD / Keyboard Buffer MK 8-4 (cont.)

LCD/Keyboard Buffer Removal

To remove the LCD/Keyboard Buffer proceed as follows:

1. Disconnect all connectors from the board.
2. Remove the three retaining screws and gently ease the board away from the case.

LCD/Keyboard Buffer Replacement

To replace the LCD/Keyboard Buffer board proceed as follows:

1. Position the board and secure with the three screws.
2. Connect all connectors.

Checks after Replacement

1. After assembly, connect mains to the unit and switch on. Ensure that the mains LED lights.
2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads. Ensure that the `information box´ in the top right hand corner of the display is clearly defined and that all characters are correctly formed.
3. Enter the patient data screen by pressing <PATIENT DATA> and systematically press each of the keyboard characters. Check the LCD and ensure that the correct characters are displayed as entered.

LCD

The LCD comprises the LCD screen, a contrast control and an DC/AC Converter PCB (mounted on the LCD/Keyboard Buffer). The LCD is secured in position with double sided tape.

Pre-requisites

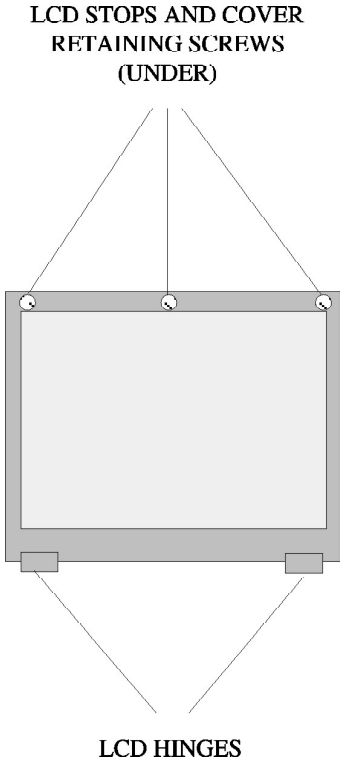
- The replacement of the LCD must be carried out under clean room conditions.
- The Warnings and Cautions at the beginning of the Chapter must be observed.

Tools and Disposables

- Cross-Bladed Screwdriver
- Long shafted cross-bladed screwdriver
- Flat-bladed blunt knife
- Anti-static cleaning fluid (alcohol based) and clean cleaning cloth

Parts

- The part number for the LCD assembly is given in Chapter 6.



LCD (cont.)

LCD Removal

To remove the LCD proceed as follows:

WARNING

HIGH VOLTAGES ARE GENERATED IN THE LCD. ENSURE THAT THE MAINS IS DISCONNECTED BEFORE REMOVING THE LCD HOUSING COVER.

1. Using a flat-bladed knife or a small screwdriver remove the three LCD stops on the top of the LCD to gain access to the screws securing the LCD housing cover.
2. Unscrew the three screws and gently ease the cover away from the LCD hinges at the bottom.

CAUTION

THE RIBBON CABLE TO THE LCD DOES NOT HAVE A CONVENTIONAL PLUG AND IS INSERTED DIRECTLY INTO THE SIDE OF THE CONNECTOR ON THE LCD. TAKE CARE NOT TO DAMAGE THE RIBBON CABLE CONTACTS WHEN REMOVING THE RIBBON CABLE. TAKE SPECIAL CARE WHEN REPLACING THE CABLE ASSEMBLY.

3. Lift the retaining tape from the LCD connector on the back of the LCD and remove the ribbon cable to the LCD/Buffer Board.
4. Very gently and evenly prise the LCD away from the case until it is free. Take care not to strain the ribbon cable.
5. On the LCD/keyboard buffer board remove the power connector and the connector to the contrast control. Remove the LCD.
6. Remove the two retaining screws securing the contrast control to the Top Assembly.

LCD Replacement

To replace the LCD proceed as follows:

1. Ensure that the LCD recess is clean and free from grease, dirt, and any traces of adhesive. Use a clean cloth and alcohol based cleaning agent to wipe the recess to ensure a good adhesion surface.
2. Position the LCD in the casing and thread the ribbon cable and the power cable through the aperture in the Top Assembly casing.
3. Join the connectors at the back of the LCD and carefully tape to the LCD.
4. Using a flat-bladed knife peel off the protective backing from the two sided tape on the LCD and secure the LCD Assembly in the LCD recess.

LCD (cont.)

5. Taking care not to touch the plastic screen, position the cover in the LCD bottom hinges and secure with the three retaining screws at the top. Replace the LCD stops in the screw recesses.
6. Secure the contrast control with the two retaining screws.
7. Replace the connectors to the LCD/Keyboard Buffer and secure the cable to the housing with the cable clips. Secure the ribbon cable with retaining tape.

Checks after LCD Replacement

1. After assembly, connect mains to the unit and switch on. Ensure that the mains LED lights.
2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads. Ensure that the `information box´ in the top right hand corner of the display is clearly defined and that all characters are correctly formed.
3. Enter the patient data screen by pressing <PATIENT DATA> and systematically press each of the keyboard characters. Check the LCD and ensure that the correct characters are displayed as entered.

Thermal Printer and Print Head

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.
- The Top Assembly must be removed. All external cable assemblies must be disconnected.

Tools

- Cross-Bladed Screwdriver
- Flat-Bladed Screwdriver
- Hexagonal screwdriver Torx TX10
- Flat ended pliers

Part Numbers

The part number for the Thermal Printer and print head is given in Chapter 6.

CAUTION

THE THERMAL PRINTER CONTAINS IS STATIC SENSITIVE; OBSERVE ANTI-STATIC PRECAUTIONS:

Thermal Printer Removal

To remove the Thermal Printer disconnect all connectors to the Interface board, unscrew the four corner printer securing screws, gently lift the printer and remove the complete assembly.

Print Head Removal

To remove the Thermal Print Head after the printer assembly has been removed from the Top Assembly , proceed as follows:

1. Slacken the three print head tensioning screws and remove the three springs and brass spacers.
2. Using the hexagonal screwdriver, slacken the hexagonal print head retaining screw and carefully remove the print head retaining rod with a pair of pliers
3. Gently ease the thermal print head away from the printer assembly.

Print Head Replacement

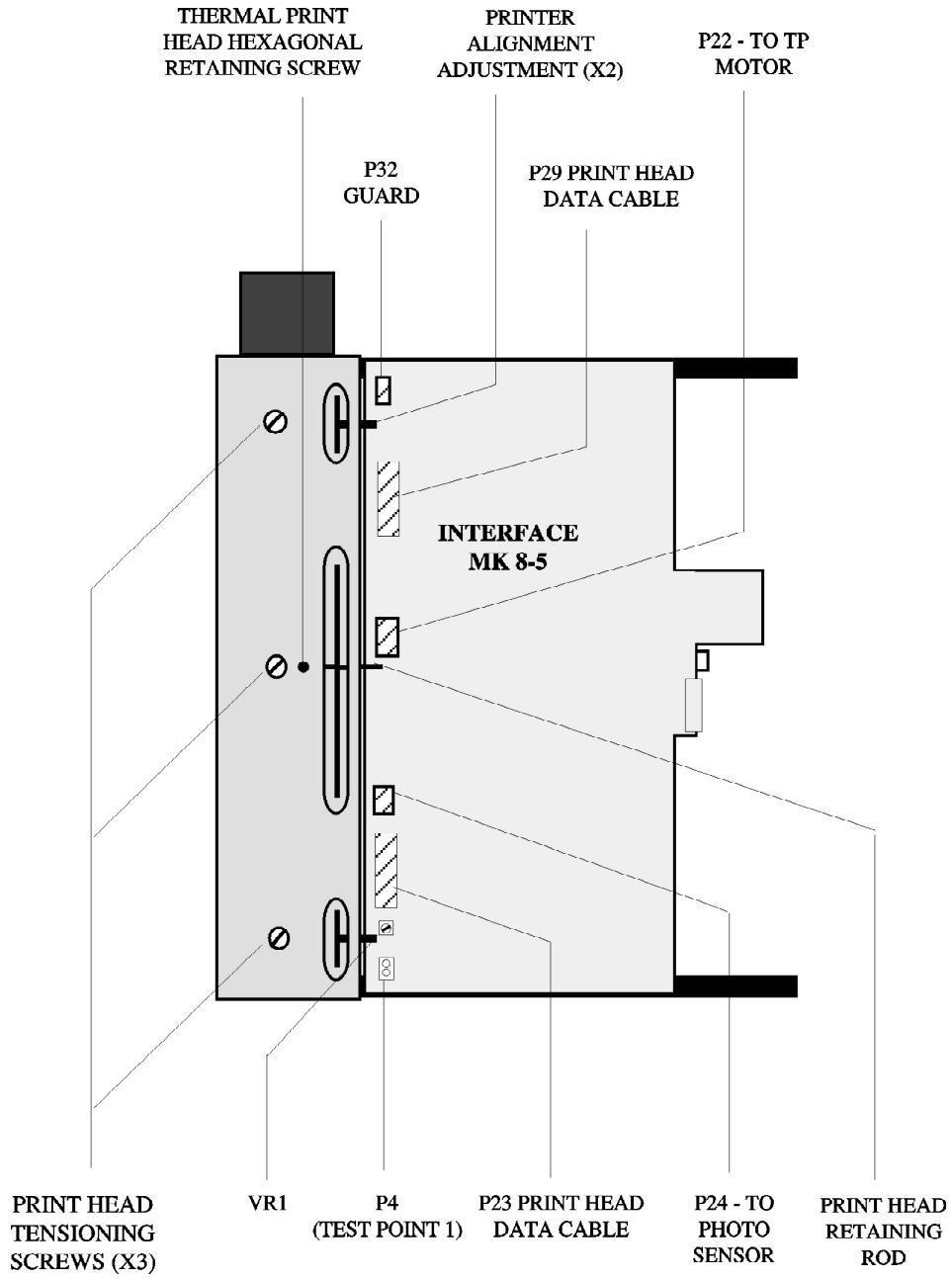
The Thermal Printer must be removed to replace the print head. The print head comes complete with the data cable assemblies connected (x2). To replace the print head in the printer assembly proceed as follows:

1. Remove the three print head tensioning screws. Assemble the three spring and brass spacers and insert the springs into the tensioning screws aperture so that the brass spacer adjoins the print head. Loosely fasten the three print head tensioning screws.

Thermal Printer and Print Head (cont.)

2. Carefully insert the print head retaining rod and secure with the hexagonal print head retaining screw.

3. Adjust the print head tensioning screws so that the head of the screws are indented and an even print head spring tension is achieved.



Thermal Printer and Print Head (cont.)

Thermal Printer Replacement

The resistance value of the printer is used as an off-set by the printer drive circuit and must be entered via the AT-10 menu structure, prior to operation. Before replacing the printer, make a note of the printer resistance. The resistance value is found written on a label on the printer.

To replace the Thermal Printer proceed as follows:

1. Position the Printer and secure with the four corner retaining screws. Ensure that the cable assemblies from the printer to the Interface PCB are not caught and are not strained.
2. Reconnect the connectors to the Interface board

Checks, Tests and Adjustments after Printer Replacement

Carry out the printer check as follows:

1. Check that the correct resistance of the printer is entered in the AT-10 memory as follows:

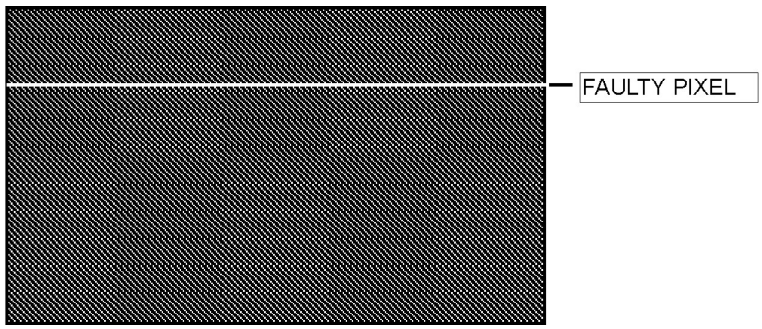
   Note: The printer resistance will be found on a label attached to the printer.

   - Enter the following key sequence <ECG> <6> (electrode test) <ENTER> <ENTER>
   - R TPH is the resistance of the printer. To enter a new resistance value press </>. The first figure of the resistance value is highlighted and the correct resistance value can be entered. Note that the AT-10 will only accept a resistance range of between 1000 and 1800 Ohms.

2. To check the printer and to ensure that every pixel is operational enter the test screen and press P. Enter the following key sequence:

   <ECG> <6> (electrode test) <P>

A print-out of a series of diagonal lines will be given. Carefully examine the print-out and ensure that all the lines are even and uninterrupted. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print. If the print intensity is uneven (for example darker at the top than the bottom), check the alignment of the printer and adjust the tension of the print head (print head tensioning screws) to obtain the best print-out.



Keyboard

Pre-requisites

- The Warnings and Cautions at the beginning of the Chapter must be observed.

- The Top Assembly must be removed as detailed in Paragraph 3 and all external cable assemblies disconnected.

Tools and Materials

- Wide, blunt instrument eg screwdriver handle (for applying an even pressure to the board during removal).
- Clean lint free cloth
- Cleaning agent such as alcohol or trichorethylene

Part Numbers

The part number for the keyboard PCB is given in Chapter 6.

Keyboard Removal

The Keyboard is secured in position with double side adhesive tape. To remove the keyboard proceed as follows:

1. Taking care to secure the hinged LCD module so that it cannot open, turn the Top Assembly up-side-down.

CAUTION

THE TOP ASSEMBLY IS SUSCEPTIBLE TO ABRASION DAMAGE. TO PREVENT SCRATCHING PLACE THE TOP ASSEMBLY ON A NON-ABRASIVE CLOTH WHEN UP-SIDE-DOWN.

---

2. Remove the keyboard connector from the LCD/Keyboard Buffer PCB.

CAUTION

TO PREVENT DAMAGE TO THE TOP ASSEMBLY HOUSING, DO NOT ATTEMPT TO PRISE THE KEYBOARD FROM THE FRONT OF THE UNIT.

---

3. From the bottom of the assembly, through the housing aperture, apply pressure to the Keyboard with a blunt instrument, until the keyboard lifts.
4. When the keyboard has lifted, return the Top Assembly to the upright position and remove the Keyboard from the recess.
5. Using a clean cloth and a cleaning agent wipe the Keyboard recess to remove any traces of adhesive or dirt that may prevent good adhesion.

Keyboard (cont.)

Keyboard Replacement

The Keyboard comes complete with double sided adhesive tape for fixing the board in position. To replace a keyboard proceed as follows:

1. Ensure that the Keyboard recess is clean and free from grease, dirt, and any traces of adhesive. Use a clean cloth and a cleaning agent to wipe the keyboard recess to ensure a good adhesion surface.

2. Remove the protective backing from the adhesive tape, precisely position the board and gently place in position. When the Keyboard is correctly positioned, use a clean cloth to firmly press down on the keyboard to ensure good adhesion.

4. Turn the Top Assembly up-side-down and connect the keyboard connector to the LCD/ Keyboard Buffer board.

Checks after Replacement

1. After assembly, connect mains to the unit and switch on. Ensure that the mains LED lights.

2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads. Ensure that the `information box´ in the top right hand corner of the display is clearly defined and that all characters are correctly formed.

3. Enter the patient data screen by pressing <PATIENT DATA> and systematically press each of the keyboard characters. Check the LCD and ensure that the correct characters are displayed as entered.

Chapter 5
Functional Checks & Adjustments

Contents

Check and Adjustment Procedures

General Confidence Check

The procedure detailed here is a general confidence check in the unit after an internal module or board has been replaced. It is not a full functional test but is intended to identify any faults that may be present after the unit has been reassembled. To carry out the general confidence check of the AT-10 proceed as follows:

1. Ensure that the voltage selector on the back panel is set for the required voltage and connect mains to the unit. Switch on the mains and ensure that the green mains LED lights.

2. Switch the unit on by pressing the <ON> key on the keyboard. Ensure that the LCD lights and that for a few seconds the test screen is displayed at the bottom of the screen. When the test screen disappears, check that straight line traces are displayed for the selected leads and that the information box in the top right-hand corner of the display, is present.

3. Press <FNCT> <2> <2> and enter the time and date details. Press <ESC> when complete. Ensure that the correct date and time is displayed on the screen.

4. Connect the ECG phantom to the ECG connector on the side panel and switch the phantom on. Ensure that a good ECG trace is displayed on the screen.

5. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality. Press <MAN START> and ensure that the print-out is accurate and of good quality.

6. Press the <AUTO START> key and wait approximately 10 seconds for the printout to commence. Ensure that the print-out is accurate and of good quality.

7. Press the <PATIENT DATA> key and systematically press the keys:

   <QWERTY UIOP>, <ENTER>, <1234567890>

   Ensure that the entered data is correctly presented on the screen as entered. Press <ESC> to exit the patient data display.

8. Press the <BEGIN> key and ensure that the AT-10 indicates that an exercise test has commenced. Press <END> and <PRINT REPORT> and ensure that a print-out is given. Press <STOP>.

9. Enter the required static parameter values and store the values by pressing <FNCT> <2> <5>.

   Note: A brief overview of the programmable parameters is provided in Chapter One. A full description of the programmable parameters, the parameter values and the procedure to set them, is provided in the AT-10 Operating Manual.

10. If a module has been replaced carry out the checks and tests detailed in the relative Paragraph (if not already carried out). Switch the unit off and leave connected to the mains supply for 24 hours to fully charge the battery.

Check and Adjustment Procedures (cont.)

Power Supply

1. Connect mains to the unit and switch on. Ensure that the mains LED lights and the Battery LED lights. (Ensure that when the battery is fully charged - maximum 15 hours - the battery light is extinguished when mains is still connected).

2. Switch the unit on and ensure that the LCD lights and that straight line traces are displayed for the selected leads.

3. Press the <PRINT SCREEN> key and ensure that the print-out is accurate and of good quality.

   Note: If the print-out quality is poor and the printer has not been changed, the stored printer resistance data may have been lost from memory. To check the stored resistance setting see Paragraph 5 `Self Test Screens and Offset Adjustments´. If problems are experienced with paper mark detection or setting the printer speed it may be necessary to adjust the factory pre-sets on the Interface board.

4. Press any key and ensure that the buzzer beeps.

5. Check the ±12V supplies and communications interface by carrying out the RS test procedure detailed in Paragraph 4.4.

6. Disconnect the mains supply and ensure that the mains LED is extinguished and that the yellow battery LED lights.

If all these checks are satisfactory it indicates that the Power Supply board is functioning. If any of the checks fail, the individual power supplies must be checked.

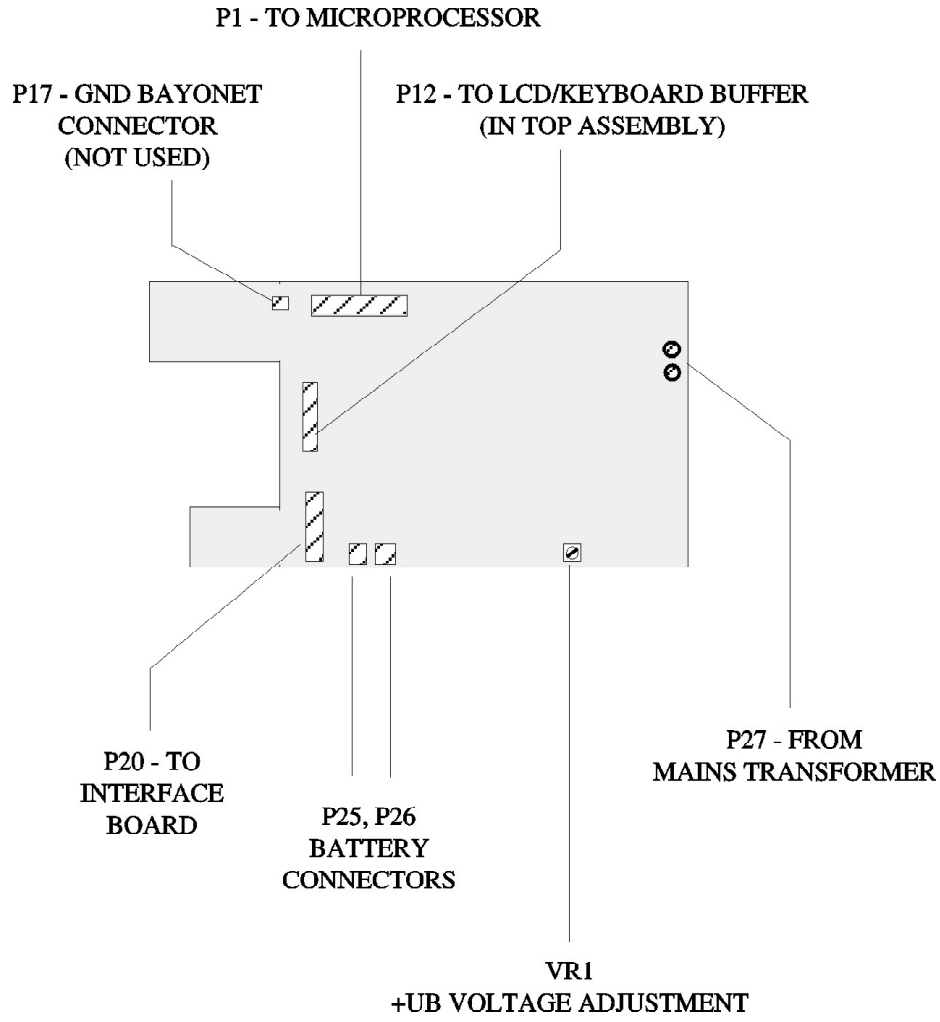
Power Rail Adjustment Procedure

The power supply voltages can be checked in isolation; it is not a requirement that the unit has to be assembled to check the power supplies. If the power supplies are checked when the Power Supply is connected to the Processor board however, a more accurate measurement may be achieved.

Test measuring points are provided on the Power Supply board for measurement of all power rails.

Individual adjustment is not possible for any of the voltage rails except +UB (from which all other supplies are generated and the batteries are charged).

Check and Adjustment Procedures (cont.)



Check and Adjustment Procedures (cont.)

WARNING

LETHAL VOLTAGES ARE PRESENT WHEN CHECKING AND ADJUSTING THE POWER SUPPLY. DO NOT LET CONCENTRATION LAPSE. EXERCISE GREAT CARE WHEN TAKING MEASUREMENTS.

On Signal Simulation

A latch circuit exists on the power supply. If the Power Supply board is checked in isolation the on signal must be connected to GND. To simulate the on signal, proceed as follows:

1. Connect mains to the unit and switch the mains on.
2. Using a suitable lead, connect GND to Plug P12 pin 25, and hold for 2 seconds. The power supply will now be latched on and all generated power supplies can be checked for the correct voltage.

Note: To switch the power supply off, connect GND to P1 pin 50.

+UB Adjustment

To check and adjust +UB supply proceed as follows:

1. Connect mains power to the unit and switch on. Latch the power supply on, as detailed above.
2. Measure the voltage at connector P25 pin 1. Adjust VR1 to achieve a voltage of +27V ±200mV.

   Note: The test point where measurement is taken is situated after the On/Off switch. If no voltage is present ensure that the on/off switch Q11, is switched on. To check the voltage before the On/Off switch measure the voltage on fuse SI2.

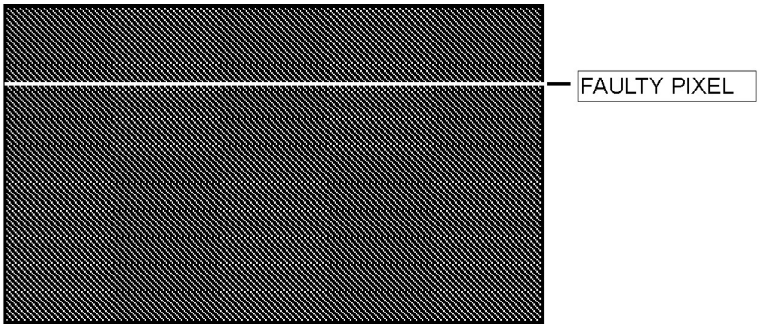
Power Rail Measurement

No adjustment is possible for any of the power rails. To check the power rail voltages go on the relevant connector pin and measure with a DVM. If any of the values are out of tolerance first ensure that +UB voltage is correct. If this is correct the power supply must be changed.

Printer

To check the printer and to ensure that every pixel is operational, a built-in printer test is provided. To carry out the printer check enter the following key sequence:

<ECG> <6> (Electrode test) <P>



A print-out of a series of diagonal lines will be given. Carefully examine the print-out and ensure that all the lines are even and uninterrupted. Any faulty print-head pixels will be seen as a horizontal white line. Examine the print-out for evenness of print.

If a faulty pixel is detected the printer must be replaced. If the print-out is uneven (for example darker at the top than the bottom), it indicates that the printer alignment is not correct. If the print-out is too faint or too dark, check that the correct resistance is entered in memory as detailed in Paragraph 4.3.1.

Printer Resistance

Check that the correct resistance of the printer is entered in the AT-10 memory as follows:

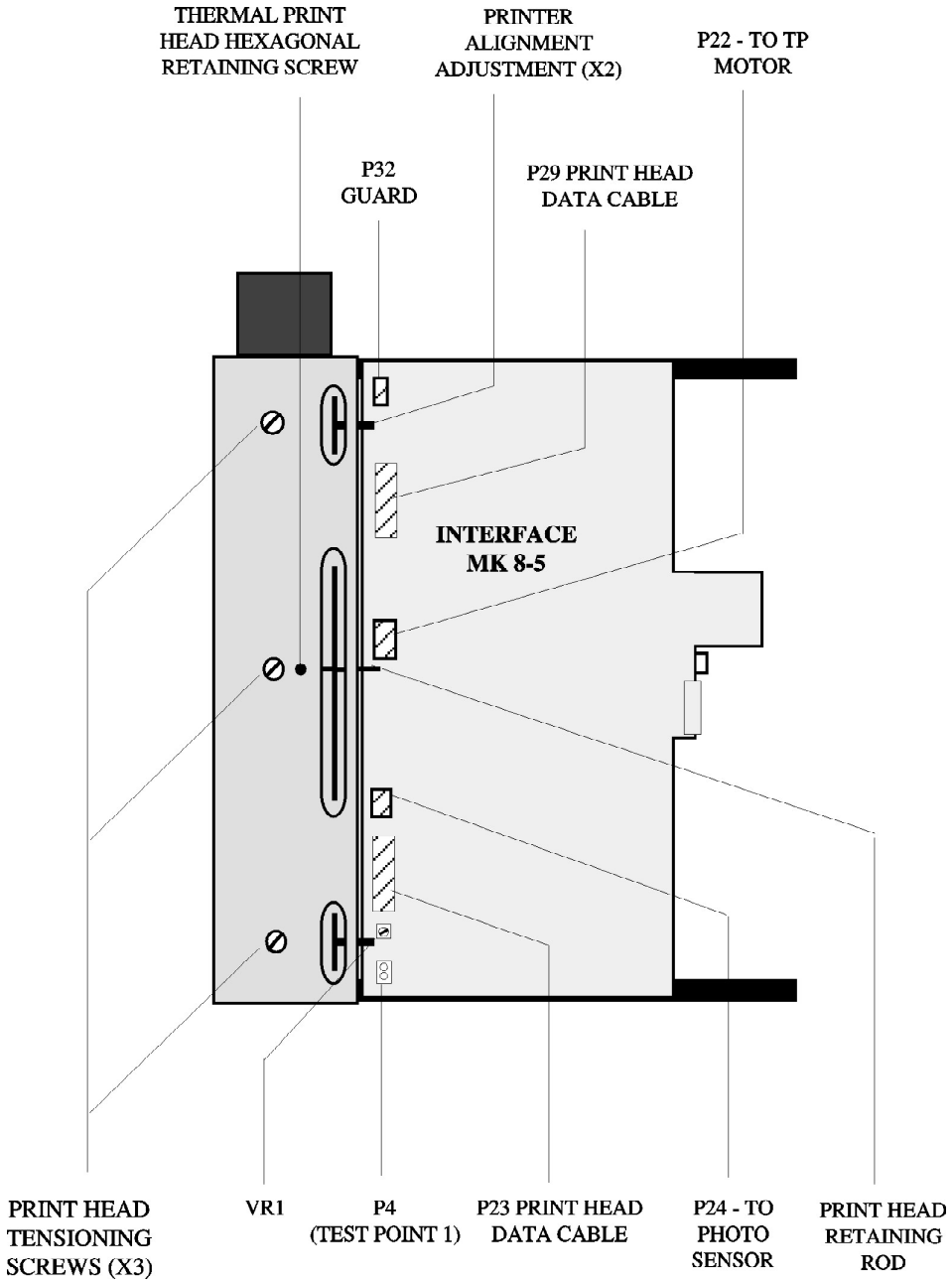
Note: The printer resistance will be found on a label attached to the printer.

1. Enter the following key sequence <ECG> <6> (Electrode test) < ENTER> <ENTER>
2. R TPH is the resistance of the printer. To enter a new resistance value press </>. The first figure of the resistance value is highlighted and the correct resistance value can be entered. When the correct resistance value has been entered, press <ENTER> to save the setting. Note that the AT-10 will only accept a resistance range of between 1000 and 1800 Ohms.

Printer (cont.)

Printer Head Alignment

Printer alignment is achieved with the three print head alignment (tensioning) screws. Adjust the screws so that they are slightly indented below the frame. Adjust to achieve the best quality print-out.



RS Interface Testing

RS Interface Error messages

The following error messages are associated with the RS Interface. If any of these error messages are displayed, carry out the checks suggested.

SERIAL LINK TIME-OUT

This indication appears if no signal is received from the remote unit (after approximately 30 seconds).

- Check that the remote unit is switched on and set to the correct parameters
- Check the correct set-up in both units (<STORAGE> key)
- Check that the connecting cable is correctly plugged in
- Check the integrity of the cable assemblies (at both units)
- If using a modem ensure that it is communicating with the remote modem

TRANSMISSION ERROR

This is a general fault indication

- Check that the remote unit is switched on and set to the correct parameters
- Check that the connecting cable is correctly plugged in
- Check the integrity of the cable assemblies (at both units)
- If using a modem, ensure that it is communicating with the remote modem

NO ECG IN MEMORY

An ECG transmission has been attempted, but no ECG is stored in the units´ memory. Store an ECG in the memory and attempt the transmission again. If the same message appears, change the Processor board.

RS Interface Testing (cont.)

RS Self Test

The RS interface self test ensures that the RS communication circuit on the Processor board is functioning. To carry out the RS self test proceed as follows:

1. Connect the RS test cable to RS ports 1, 2, and 3 as indicated on the RS plugs.
2. Switch the AT-10 on. Press the <STORAGE> key and then select the Test Mode option and self test with test plug.

The self test starts and a pass or fail message appears on the LCD. An audible indication is given that the test is complete.

Test Failure

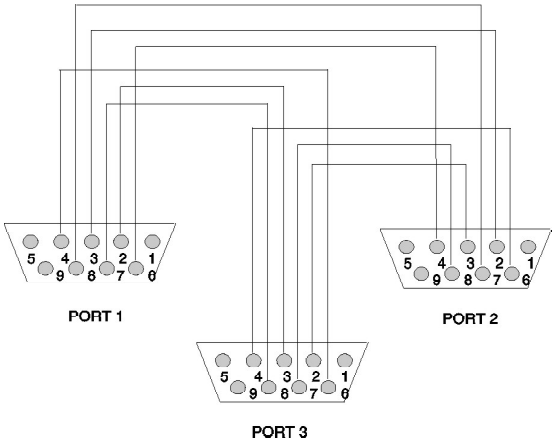
If this test fails ensure that the cable assembly is wired and connected correctly. If the test cable assembly is correct, a fault is indicated on the Processor Board or Power Supply.

Test Pass

When this test passes it indicates that the fault lies in the remote equipment, the transmission line or that the protocol of the two communicating devices are incompatible.

- Check that all settings (Parity, Stop bit) and the Baud rate are the same in both devices.
- Reset all settings to ensure compatibility between the communicating devices. Check that all settings (Line or Modem, Record or Block) are correct for the application. Are the settings compatible in both the transmitting and receiving devices?
- Check the integrity of all cable connections. Are all cables correctly connected to the programmed port?

RS Interface Testing (cont.)



RS Test Cable ART. No. 2. 310 042

RS 232 Pin Connections	
PIN	**SIGNAL**
3	Out (Data Output)
2	In (Input Data)
7	RTS1 (Output - Request to Send)
8	CTS1 (Input - Clear to Send)
6	DSR1 (Input - Receive Unit Ready)
4	DTR1 (Output - AT-60 Ready)
5	Ground

RS -232 Transmission/Reception Test

Test Input / Output

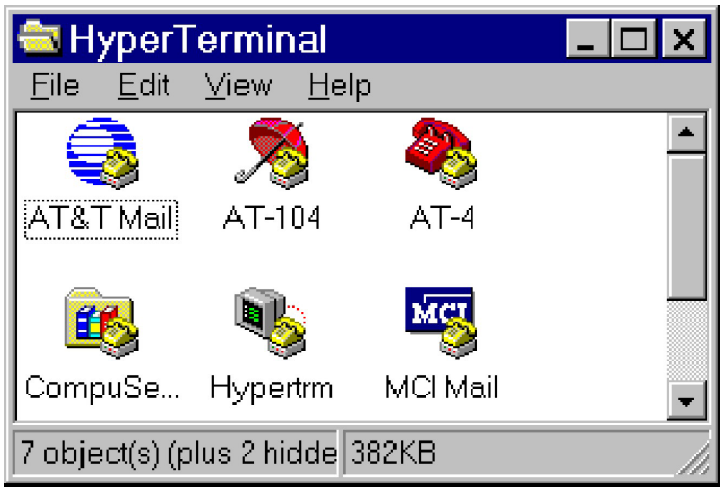
The test transmission / test reception options enables a test sequence to be generated and received. Use these test options to ensure that the receiving and transmitting units can communicate and that the cable assemblies, connectors etc. between the communicating units are good.

The test message generated is a string of all ASCII characters - ABCD.... 1234....abcd... etc. When the test transmission / reception option is selected, the string of characters sent by the transmitting unit are displayed on the LCD in the receiving unit. In the transmitting unit a message is displayed indicating that a test transmission is in progress.

To perform these tests, you will need a second AT-10 unit, or the AT-10 RS-232 (#3) interface has to be connected to an active terminal, for example the Hyperterminal, which is available under Windows 95™. The following equipment is needed:

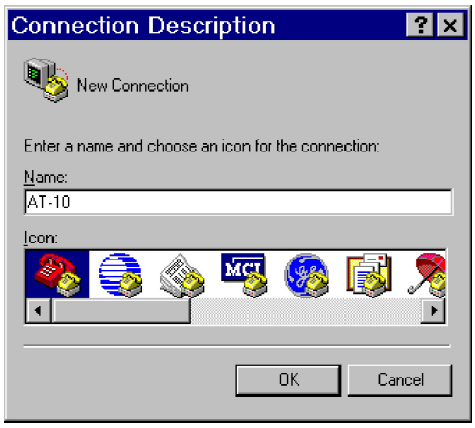
- A personal computer (PC) with Windows 95™ Hyperterminal installed.
- An RS-232 cable assembly, Art.No. 2.310 159, for connecting the RS-232 (#3) interface on the AT-10 with the COM port of the PC. This assembly consists of a cable, Art. No. 2. 310 094 and an adapter DB 9 / DB 25, Art. No. 2. 100 552.

1. Start from Windows 95 desktop. Click on START. Select Programs / Accessories / Hyperterminal.

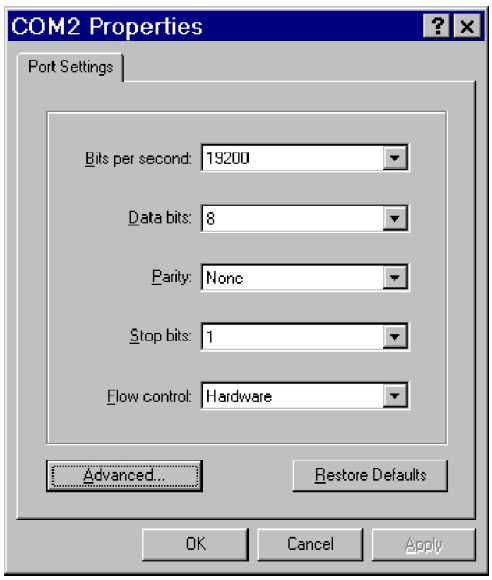


2. Double-click on Hypertrm(.exe). Enter the name AT-10 for the new connection and click on OK.

RS-232 Transmission/Reception Test (cont.)

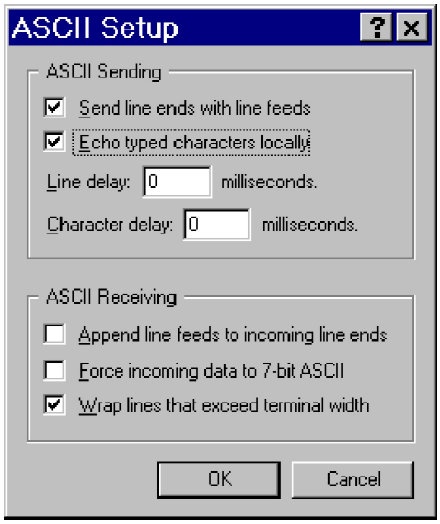


3. Set the direct connection to the proper COM-port and click OK.
4. Enter the port settings 19200, 8, N, 1, Hardware and confirm with OK..



5. You are now in the AT-10 Hyperterminal window. Click on File and select Properties.
6. Go to tab Settings and set Terminal keys, Auto detect and 500 buffer lines.
7. Click on ASCII Setup.

RS-232 Transmission/Reception Test (cont.)

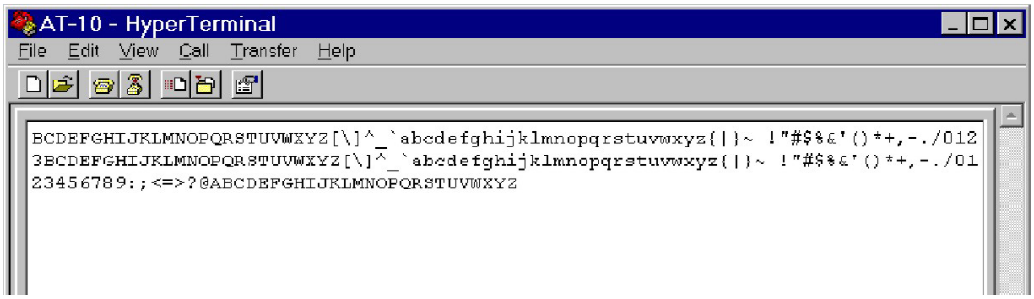


8. Check the boxes for "Send line ends with line feeds", "Echo typed characters locally" and "Wrap lines that exceed terminal width". Confirm with OK. Click once more on OK to get back to the open Hyperterminal window.

You are now ready to start the input and output tests.

Test Output

- On the AT-10, press the <STORAGE> key and select Test mode. Make sure that the settings are 19200 bps, parity N, stopbit 1. Set Channel No. 3.
- Press key <5> ´Test output on channel n´ on the AT-10.
- The AT-10 now sends a string of alphanumerical characters, which are echoed in the Hyperterminal window on the PC.

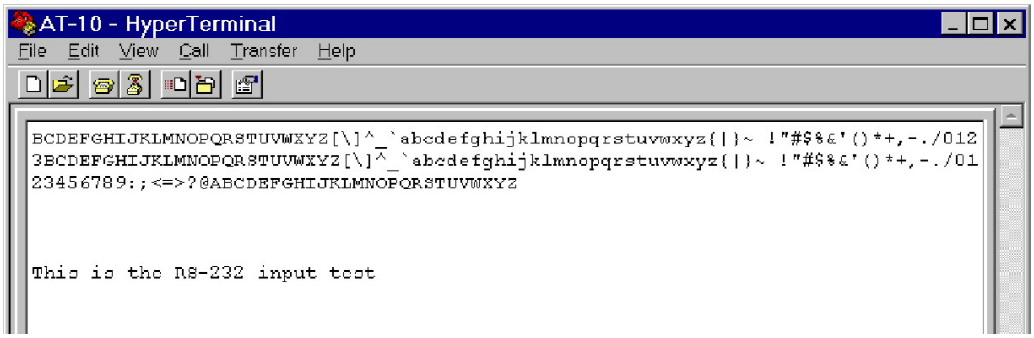


- Stop the test by pressing key <7> ´End of test input/output´.

RS-232 Transmission/Reception Test (cont.)

Test Input

- In the RS-232 test window, press the key <6> ´Test input on channel n´. The upper part of the RS-232 test window is erased to be able to display incoming messages.
- On the PC, type any characters and verify that they are echoed on the AT-10.



- Stop the test by pressing key <7>. Leave the RS-232 test window by pressing ESC.

Error Codes

The error codes shown at the bottom of the display have the following interpretations:

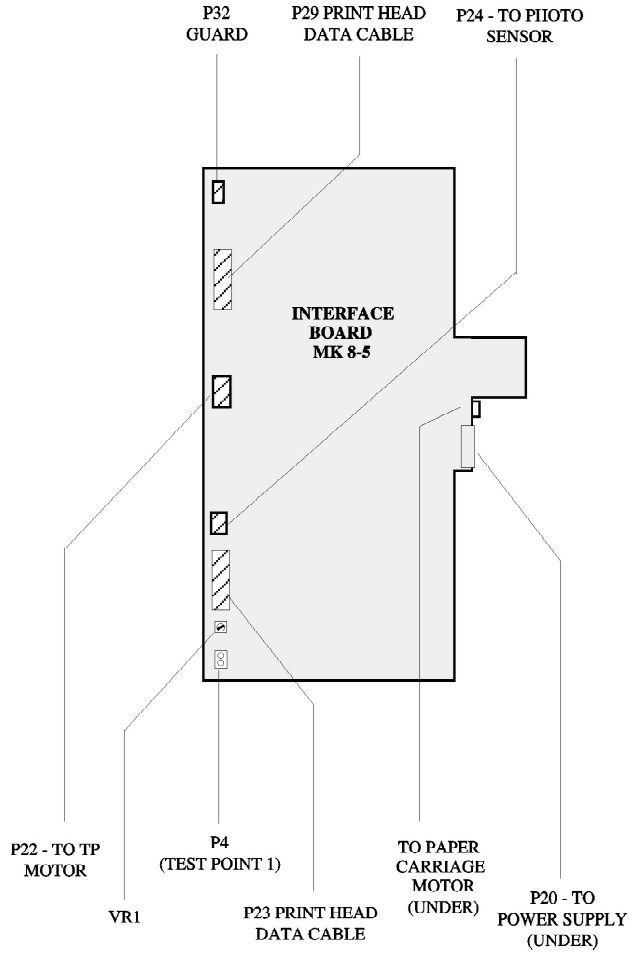
DSR	Data set ready
BD	Break detected
FE	Frame error
OE	Overrun error
PE	Parity error
TxE	Transmitter empty
RxR	Receiver ready
TxR	Transmitter ready

Interface Board Adjustments

One adjustment is possible on the Interface board - Paper Mark (VR1). This pre-set is used to adjust the paper mark detection circuit threshold so that the paper mark is recognised. The paper mark is used for calculation of print-out commencement position, paper detection, paper present etc.

Paper Jammed Indication

When the detection circuit does not recognise the paper mark, a paper jam error message may be displayed. Before carrying the paper mark adjustment procedure, ensure that the paper detector window is clean.



Paper Mark Adjustment

Set the paper mark threshold as follows:

1. Connect a digital voltmeter across the P4 connector (test point 1).
2. Switch the unit on and adjust VR1 to obtain a reading as follows:
   - > 3.0 V when the black paper mark is under the paper mark detector
   - 0.2 to 0.4 V when there is no paper mark under the detector ie white paper

NB IF THE DETECTION DOES NOT RECOGNISE THE PAPER MARK AFTER ADJUSTMENT, ENSURE THAT THE PAPER MARK WINDOW IS CLEAN.

Self Test Screens / Electrode Test Screen

There are three test screens built into the AT-10 for use by the service engineer. The first screen provides test information of the patient cable and electrode application. The second screen gives the value of certain reference voltages and important internal synchronisation measurements and the third screen gives variable settings and measurements. The first two screens are for information only, and no adjustment can be made to these values. Additional test equipment is required to carry out some of the settings on the third screen. The three test screens are as follows:

Electrode Test Screen	This screen indicates the electrode offset voltage and can indicate any faults in the patient cable or patient electrode.
Self Test Screen	This screen displays ECG internal reference voltages and internal measurements of synchronisation and other parameters.
Offset Settings Test Screen	This provides measurements and setting facilities for the analog offsets used for accurate control of exercise bikes and analog controlled treadmills. This screen also contains the thermal print head resistance setting option.

Electrode Test Screen

Use this screen to display the dc voltage between the left leg electrode and all other electrodes. The measurements obtained will indicate any cable short circuits or open circuits. To enter the electrode test screen proceed as follows:

1. Press <ECG> to display the main menu options.
2. Select option `Electrode Test´ to enter the electrode test screen. The following display will be shown:

El	<mV>
RA	0
LA	-3
C/V1	0
C/V2	0
C/V3	-3
C/V4	-3
C/V5	0
C/V6	0

The measured voltage value will depend on where the electrodes are connected. The voltage readings that can be expected are as follows:

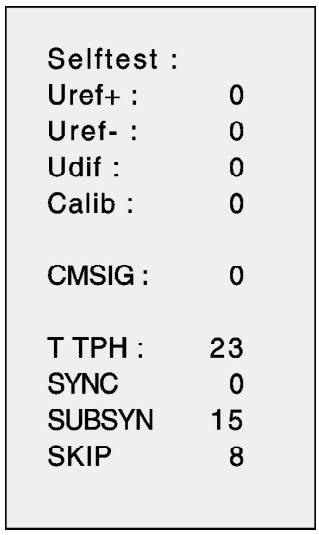
- With patient connected ± 100mV.
- With patient simulator connected ± 30 mV - this will depend on the patient simulator used and must be taken as a flexible measurement.
- With all electrodes shorted together: ± 20 mV.
- Patient lead not connected ie open circuit ± 50 mV.

Note: The readings obtained with this screen are necessarily arbitrary. Generally when the readings for all electrodes are the same, or vary by only a small percentage, it can be assumed that the patient cable and electrodes are within tolerances.

Self Test Screen

To enter the self test screen proceed as follows:

1. When in the Electrode test screen, press <ENTER>. The following display will be shown:



This screen gives the following data:

Uref +

This is the value of the reference voltage used in the multiplexer circuit on the ECG Amplifier. The value of the reference voltage is 2727 mV. However because the ECG amplifier has a floating ground, this figure is arbitrary and the measured voltage can give a great variance to the true value.

Uref -

This is a negative reference voltage used on the ECG Amplifier board. Because the ECG amplifier has a floating ground this figure is arbitrary.

Udif

This is the difference of the two reference values above (Uref + and Uref -).

Calib

This is the value of a signal generated by the CPU for calibration of the ECG signals.

CMSIG

This measurement gives an indication of the common mode noise. A high reading indicates high common mode noise and thus the quality of the ECG reading may not be as good as with a lower noise level. The measurement indicates the amplitude of the output signal of the right leg driver circuit.

Self Test Screen (cont.)

The patient must be connected to obtain a meaningful measurement. The range of the measurement is between 0 and 255. A high reading means that common mode noise is present and it may be necessary to move the unit to a less noisy environment. Sources of noise could include the following:

- bad electrode connection
- electric light
- electric motors, CRT monitors etc.

T TPH

This is the temperature of the print head heat sink. This measurement is used by the CPU to control the printer timing to obtain optimum print. The reading given here should be approximately the ambient temperature of the room. Note that if the printer has recently been active this reading may be higher than the room temperature.

SYNC

This value is a counter reading of the number of communication failures between the ECG Amplifier and the main CPU, since the unit was switched on. There should never be any communication failures and this value should be 0. If communication failures are occurring it indicates a problem with the ECG Amplifier board or the Processor board.

SUBSYNC

This counter gives the number of times that re-synchronisation of the data subvector has occurred. On initial switch on this counter could read 5 to 30. After initial synchronisation this figure should not increase. If re-synchronisation is occurring, check the optical link between the Processor board and the ECG Amplifier board.

SKIP

This counter gives the number of times re-synchronisation is necessary by skipping one ECG sample. On initial switch on this counter could read 5 to 10. Synchronisation is periodically required and over a 24 hour period the counter could be up to 100.

NOTE !!

For units using the ECG board MK 7-2 SW V 0.4, values are shown for Uref+ to CMSIG. For units with ECG board MK 7-20 SW V1.20, these values are all zero.

Offset Screen

This screen gives the value (and setting facility) for the thermal print head resistance and the value and setting option of various analog offsets for analog controlled stress test devices. A DVM is required to carry out the analog offset settings.

To enter the offset test screen proceed as follows:

From the electrode test screen press <ENTER> <ENTER>. The following display is shown:

DACOFFS :	3	R TPH :	1129
IN4OFFS :	3	AIN4 :	14
IN5OFFS :	2	AIN5 :	9
B TEMP		AIN6 :	0
BV	26,7	AIN0 :	4360
BCHARGE	40	AIN1 :	1201
B CAPACITY (%)	100		K

This screen gives the following data and adjustments:

R TPH

The value indicated here is the resistance of the thermal print head and must be set to the correct resistance to ensure a good quality print-out. The print head resistance is found on the printer and can be accessed by removing the printer cover plate.

To set the resistance of the thermal print head press </>. The first figure of the resistance value is now highlighted and the new resistance value can be entered. The entered value must be more than 1000 Ohms and less than 1800 Ohms. If a resistance value outside of these limits is entered, the user is prompted to enter the value again. When the resistance is set press <ENTER>.

DACOFFS

This is an indication of the offset value of the digital to analog converter used for load or speed conversion for bicycle ergometers and analog treadmills respectively. To set this value proceed as follows:

1. From monitor mode enter the exercise menu and select the bicycle option as follows:

   <EXERCISE> <3> (Exercise Settings) <4> (Treadmill / Bicycle setup) <1> <1>
   (Bicycle 1V/100W)

   Press >ENTER> and exit the exercise menu.

2. Commence an exercise test by pressing <BEGIN>. Press the <PROTOCOL> key, select <1> edit Protocol 1 and manually set the base load to 100 W.

3. Wait 30 seconds and press <NEXT STAGE>.

4. Measure the voltage at pin 5 of the Stress connector. Using the <YES> and <NO> keys, set the DACOFFS value to obtain a reading of 1.00V ±5mV.

IN4OFFS and AIN4

This offset ensures that the correct load input value is interpreted from a bicycle. The IN4OFFS gives the value (-32 to 31) of the offset and the AIN4 gives the actual value. To set this offset proceed as follows:

1. Connect a power supply, with an accuracy of at least 0.1%, to pin 4 of the stress connector. Set the power supply to 1.0V

Offset Screen (cont.)

2. Adjust IN4OFFS using the left and right cursor, until a reading of 1000 (mV) ±5 is obtained at AIN4.

IN5OFFS and AIN5

This offset ensures the correct reading for analog input of RPM (bicycle) or elevation (analog treadmill). The procedure to adjust this offset is the same as for IN4OFFS but the PSU must be connected to pin 1 of the stress connector and the <UP> and <DOWN> keys are used for adjusting the value.

B TEMP and AIN6

This displays the battery temperature, and the battery temperature in volts, received from the transducer.

BV and AIN0

BV indicates the voltage level of +US (that is the battery voltage, or the primary dc voltage generated by the power factor controller from the mains (and used for battery charging)). The actual voltage level of +US is calculated from the BATTV signal (sheet 5 of the power supply circuit diagram) and shown on this screen as AIN0. The value of BV is approximately 26.8V (nom +27V) when working from the mains, and between +24V and +21V when using battery power. The AIN0 indication (signal BATTV) is 4000mV±100 when working from the battery and 4400mV±100 when working from the mains

BCHARGE, AIN1 and B CAPACITY

AIN1 gives a voltage value indicating the loading control level of the battery (from the PSU - signal BATTLC). The voltage range is 0mV to 2500mV (0V indicates that the battery is fully charged, 2500mV indicates that the battery is fully discharged.

Because every battery varies, the processor initially calculates the capacity of the battery so that it knows when to generate the battery low signal - the B CAPACITY indication gives the calculated capacity of the installed battery. When a new battery installed, it must be fully charged and fully discharged a minimum of two times, so that the processor can accurately assess the capacity of the new battery.

The BCHARGE indication shows the remaining battery capacity and is calculated from BATTLC signal (AIN1 indication).

Note: The battery capacity displayed on the LCD information box is the actual remaining capacity of the battery and is calculated from B CAPACITY and AIN1. The remaining capacity displayed in the information box will not necessarily be the same as that shown for BCHARGE.

K

This character indicates the type of print head which is used. Two types are available:

K : Manufacturer Kyochera

R: Manufacturer Ricoh

Software and Options

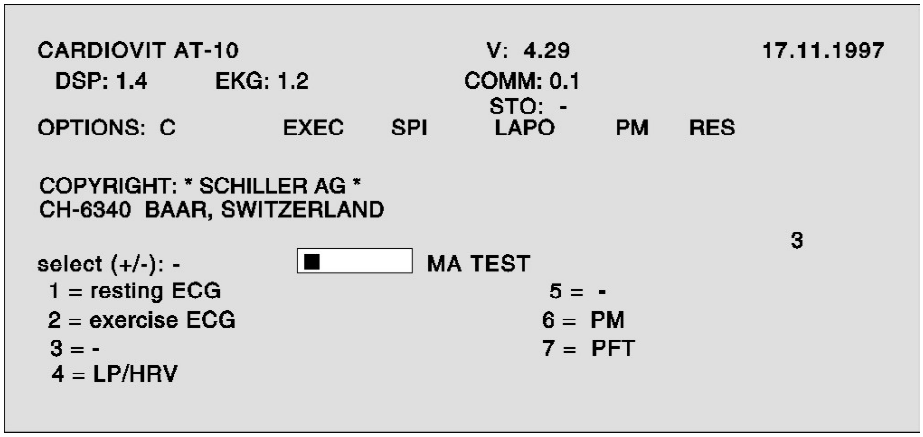
To check the software version of the unit and to display all the systems options that have been installed, proceed as follows:

Display the software option screen by pressing the key sequence:

<ECG> <6> (Electrode test) <.> (period)

Note: The actual key sequence may change slightly for different software versions.

The software version and the installed options are displayed on the LCD as follows:



- The top line gives the equipment name and the overall system software version of the unit; that is the software version of the EPROMs in the Program Pack. This is followed by a combination of characters to indicate the type of software (or basic options) that is installed. These are as follows:
  - C - Interpretation Program
  - V - Frank Vector Loops
  - S - Standard
  - M - Measurement

  The measurement program is integral to the interpretation program, thus when the interpretation program is installed, by default the measurement program is also installed. Full details of all the software versions are given in the AT-10 Operating Handbook.

Software and Options (cont.)

- The second and third line give the software version of all the software controlled peripherals in the AT-10. These are as follows:
  - DSP - the software version of the digital signal processor on the Program Pack.
  - EKG - the software version of the single chip processor on the ECG Amplifier Board
  - COMM - the software version of the communications controller on the Processor Board
  - STO - the software version of the optional disk controller
- Below the software version details is the options line. This details the options that are installed. These are as follows:
  - EXEC - analysis program for exercise ECGs
  - SPI - Spirometry
  - LAPO - Late Potential
  - PM - Pacemaker
  - RES - Lung Resistance
  - PFT - Pulmonary Functiuon Test
- The number below, and to the right of the Copyright notice, is a counter of the number of unauthorized attempts that have been made to incorporate extra options to the unit.

  Important - only 9 attempts are allowed and if this figure exceeds 9, no more upgrades are possible.
- The number immediately below the unauthorized attempts counter is the system serial number.
- The options on the bottom of the screen are the software updates that can be incorporated into the unit when the correct code is entered. To incorporate any of these software options the code must be entered, the option selected with the <+> and <-> keys and the <ENTER> key pressed. The code can be purchased from Schiller AG through your local dealer.

  LP Late potentials

  HRV Heart Rate Variability

  PM Pacemaker

  PFT Pulmonary Function Test

Replacing the Flow Sensor Filter

Spirometer SP-20 / SP-110 / SP-150

The filter is the only serviceable item on the flow meter. To replace the filter proceed as follows:

1. Remove and discard the mouthpiece.
2. Remove the rubber adapter by pulling it away from the inner tube.
3. Remove the inner tube of the flow sensor by pushing it out of the outer tube in the direction of the red location marks. Once the tube has been pushed half way it can be pulled out from the other side.
4. Unscrew the two halves of the inner tube and remove and discard the filter.
5. Clean and sterilize all parts of the inner tube, the rubber adapter and the inside of the outer tube with one of the following products:
   - Incidin GG
   - Amocid
   - Lysoformin
   - Alhydex
6. The cable and handle can be wiped with soapy water (do not dip into liquid!).

Replacing the Flow Sensor Filter (cont.)

7. Insert a new filter into the inner tube so that it sits on the inner lip of the half with the red location mark.
8. Carefully screw the two halves of the inner tube together making sure that the filter is not displaced.
9. Locate the end of the inner tube into the end of the outer tube and push it gently but firmly until the shoulder of the inner tube makes contact on the outside edge of the outer tube. The two red location marks must be in line.
10. Fit the rubber adapter by placing its wider end over the end of the inner tube with the red location mark.
11. Insert a new mouthpiece (max. 1.5cm) into the end of the rubber adapter.

Chapter 6
Spare Parts

Contents

Introduction

This Chapter gives the part numbers for modules that can be replaced by the service engineer. The part numbers for disposables, accessories and dedicated test equipment are also included.

When ordering state that the module required is for an AT-10 unit and provide the following:

- Part Title
- Part Number
- Software Version *
- Serial number of the unit *
- Your company address and a contact name

* The software version and the serial number of the unit are found on the software screen (details in Chapter 4). The serial number is especially necessary when ordering mechanical parts to ensure that the correct version is identified by the processing department.

Additionally if you are returning a faulty module the following information, in as much detail as possible, will speed repair:

- the exact nature of the fault
- the circumstances, and function being carried out, when the fault occurred

IT IS RECOMMENDED THAT RETURNED MODULES ARE SENT BY REGISTERED POST.

IMPORTANT

ALL BOARDS AND STATIC SENSITIVE MODULES MUST BE RETURNED IN A SEALED STATIC SHIELDING BAG. NO RESPONSIBILITY CAN BE ACCEPTED FOR MODULES NOT SENT IN THIS WAY

The address to send your order is:

Schiller AG

Sales Department (Order Processing)

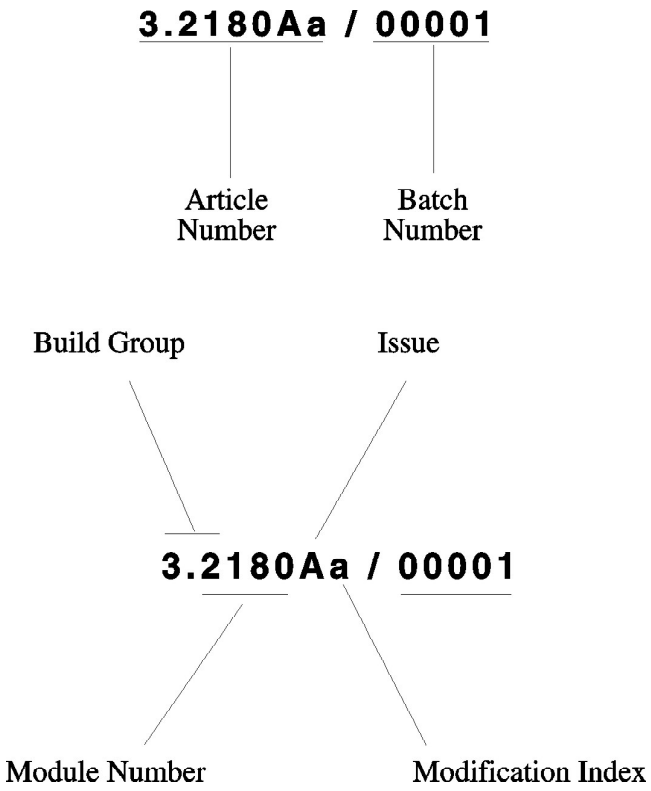
Altgasse 68

6340 Baar

Switzerland

Module Identification

Every module has a unique part number. The number is either stencilled on the module or printed on an attached label. The module numbers are arranged as follows:



When ordering a module, only the article number has to be stated (without the modification index). The Batch number is a manufacturing identification number and need not be stated unless a module is suspected of having a manufacturing fault.

The article number is divided as follows:

Build Group Number	This number identifies the type of module or module group, for example electrical (PCB), mechanical, component etc.
Module Number	The individual module number
Issue Letter	This is always an upper case letter and gives the issue state of the module
Modification Index	This lower case letter gives the modification or build state of the module. It is applicable only for the specific Issue

The documentation associated with a module, is identified by a letter in place of the module build group number. For example the processor board for the AT-60 ECG unit without the Spirometry option, has the article number **3.2180Ga.**

The Circuit Diagram is **S.2180Ga,**

The Block Diagram is **B.2180Ga**

The Component Layout is **D.2180Ga.**

The categories are as follows:

DOCUMENT	IDENTIFICATION LETTER
CIRCUIT DIAGRAM	S
BLOCK DIAGRAM	B
COMPONENT LAYOUT	D
TEST DOCUMENTATION	P
ASSEMBLY DOCUMENTATION	F

Note that the Test Documentation and Assembly Documentation is usually available for internal use only.

AT-10 Spare Modules

DESCRIPTION	NUMBER
KEYBOARD MK 8-3 ENGLISH	3. 2233FA
KEYBOARD MK 8-3 GERMAN	3. 2232FA
KEYBOARD MK 8-3 FRENCH	3. 2234FA
KEYBOARD MK 8-3 ITALIAN	3. 2235FA
ECG BOARD MK 7-2	3. 2181
MICROPROCESSOR BOARD MK 8-1D	3. 2230DB
MICROPROCESSOR BOARD MK 8-1 WITH LAN	3. 2228
PROGRAM PACK MK 8-11C	3. 2242CA
CONNECTORS RS 232/422 MK 8-7C	3. 2239CB
POWER SUPPLY BOARD MK 8-6E	3. 2238EF
INTERFACE BOARD MK 8-5E	3. 2237EA
LCD/KEYBOARD BUFFER MK 8-4C	3. 2236CB
PAPER TRAY DC MOTOR (COMPLETE)	3. 910 610
THERMAL PRINT HEAD	4. 140 113
THERMAL PRINTER MOTOR	3. 910 609
LCD 640 X 480	4. 600 051
LEAD ACID BATTERY	4. 350 020
MAINS MODULE (COMPLETE)	4. 270 004
MAINS TRANSFORMER	4. 320 085

Disposables

DESCRIPTION	PART NUMBER
PRINTER PAPER	2. 157 012
DISPOSABLE CARDBOARD MOUTHPIECES (FOR PNEUMOTACHO SENSOR SP-100)	2. 100 024
ELECTRODE GEL 100 mL	2. 158 005

Accessories

DESCRIPTION	PART NUMBER
GROUND CABLE	2. 310005
POWER CABLE	2. 300005
ELECTRODE SET COMPRISING FOUR EXTREMITY STAINLESS STEEL ELECTRODES WITH RUBBER STRAPS. SIX PRECORDIAL SUCTION ELECTRODES AND ELECTRODE GEL	2. 000041
PATIENT CABLE (CLIP)	2. 400048
PNEUMOTACHO SENSOR SP-110	2. 200510
NOSE CLIP	2. 100025
FILTERS (FOR SP-100)	2. 100026

Dedicated Test Equipment and special Tools

DESCRIPTION	PART NUMBER
RS TEST CABLE ASSEMBLY 3-WAY CONNECTORS	2. 310 042
2MM HEXAGONAL KEY FOR THE REMOVAL /REPLACEMENT OF THE PROGRAM PACK	STANDARD TOOL AVAILABLE ON THE MARKET
HEXAGONAL CROSS-BLADED SCREWDRIVER USED FOR THE REMOVAL AND REPLACEMENT OF THE PRINT HEAD	SCHILLER NUMBER 4.950074. MANUFACTURED BY WERA, NUMBER - WERA 367 TX 210180

Chapter 7
Technical Data

Contents

General Technical Data

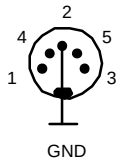
Dimensions (l/w/h):	320 x 264 x 74 mm
Weight:	approx. 4.7 kg
Power supply requirements:	110 / 130 / 220 / 240Vac, 50 / 60Hz
Power consumption:	13 to 30VA
Battery:	lead-acid, 2 x 12V
Printing process:	high-resolution thermal printhead, 8 dots per mm (amplitude axis), 40 dots per mm (time axis) @ 25mm/s
Paper speed:	2.5 / 5 / 10 / 12.5 / 25 / 50 / 100 mm/s
Sensitivities:	2.5 / 5 / 10 / 20mm/mV
Recording tracks:	3, 4, 5, 6 or 7 channels, positioned at optimal width on 200 mm, automatic baseline adjustment
Chart paper:	thermoreactive, Z-folded, perforation for A5 format
Liquid crystal display:	Backlighted liquid crystal display for ECG monitoring and alphanumeric information
	Resolution: 480 x 640 dots; viewing angle adjustable
Frequency range of the	
digital recorder:	0 Hz - 150 Hz (IEC); 0 Hz - 150 Hz (AHA)
Test socket for patient cable:	for testing of electrode cables for interruptions and short-circuit; control light indication
Patient input:	fully floating and isolated, defibrillation protected
Patient leakage current:	less than 5 µA
Safety standard:	CF according to IEC
Protection class:	I according to IEC
Environmental conditions:	temperature, operating: 10° to 40 °C temperature, storage: 0° to 50°C relative humidity: 15 to 85 % (non-condensing)
Keyboard:	splashproof keys
Leads:	Standard / Cabrera / Frank X Y Z / Nehb / V7, V8, V9 / further combinations can be programmed by the user
Automatic lead programs:	3, 4, 5, 6 or 7 channel representation on one or two pages A4 (25, 50, 100 mm/s)
	Versions M and C: average complexes of the 12 standard leads (25 or 50 mm/s) and 10s rhythm strip (1 or 3 leads); Vector loops from the standard leads

General Technical Data (cont.)

Data record:	Listing of ECG recording data, date and time of recording, patient data, etc.
	Versions M and C: ECG measurement results (intervals, amplitudes, electrical axes), average complexes with optional measurement reference markings
	Version C: ECG interpretation statements
Long-term rhythm recordings:	1 lead, 10 min / page
	1 lead, 5 min / page
	1 lead, 90 sec / page
Exercise ECGs with final report:	automatic control of bicycle ergometer and treadmill (user programmable)
	Final report showing trendplots of heart rate, load and blood pressure, physical working capacity (PWC 150, PWC 170, PWC max.)
	Versions M and C: QRS and ST measurements
ECG storage:	Output memory for 10s (12 ECG leads)
	Circular input memory for 10s (12 ECG leads): The last 10s ECG can be copied from input memory to output memory by pressing one key.
	An ECG can be copied from the output memory any number of times.
Myogram filter (muscle tremor filter):	adjustable at 25 or 35 Hz, only effective for printed ECG
Line frequency filter:	distortion-free suppression of superimposed 50 or 60 Hz sinusoidal interferences by means of adaptive digital filtering
ECG amplifier:	simultaneous, synchronous recording of all 10 active electrode signals (= 12 leads)
	sampling frequency: 4kHz
	digital resolution: 2.5 µV (min)
	dynamic range: ± 16 mV
	max. electrode potential: ± 300 mV
	frequency response: 0 to 350Hz (-3 dB)
	common mode rejection: > 100dB / 50 or 60 Hz
	input impedance: >100 MOhm
	pacemaker detection / measurement: - detection voltage range ± 1mV to ±500mV - measurement duration range 0.1 to 5ms

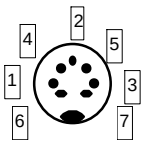
Connectors

ERGO Connector



Input impedance:	> 100 kOhm	
Pin Connections	Pin 1	RPM Input: 100 RPM/V
	Pin 2	GND
	Pin 4	Load input: 100 W/V
	Pin 5	Load output: 100 W/V

Data I/O Connector



TTL logic level:	5 Vdc Note: max. non-destructive voltage +15 Vdc, or -10 Vdc (2.5 kV static discharge)	
Pin Connections:	Pin 1	QRS trigger
	Pin 2	GND
	Pin 3	footswitch (contact to GND = START)
	Pin 4	TM DN
	Pin 5	TM UP

Connectors (cont.)

Video Connector

Type:	D sub, 15 pole, High-density, female:	
Resolution:	640 x 480 dots	
Input signals:	horizontal sync.:	TTL (positive)
	vertical sync.:	TTL (negative)
	video:	0 to 0.7V
Scanning frequency:	horizontal:	31.3 kHz
	vertical:	60 Hz
Pin Connections:	Pin 2	Video
	Pin 11	DISP
	Pin 5	Test
	Pin 13	H-SYNC
	Pin 7	Video GND
	Pin 14	V-SYNC
	Pin 9	D CLK
	Pin 10	Sync GND

Experimental Input Connectors DC1, DC2

Jack plug positive and negative

RS-232 (V24) Serial Interface (Interface numbers 1, 2 and 3)

Protocol:	Asynchronous
Baud Rate:	75 to 153600 Baud
Byte Format:	1 start bit, 8 data bits.
	0 or 1 parity bit (+ or -), programmable
	1 / 1.5 / 2 stop bits, programmable.
Transfer Control:	by means of DTR, DSR, CTS, RTS
Connection Socket:	3 x D subminiature (9 pole female), wired as DTE (Data Terminal Equipment).

Connectors (cont.)

Pin Connections:	Channel 1, 2, 3:	Pin 3	TXD1 0	(output data)
		Pin 2	RXD1 I	(input data)
		Pin 7	RTS1 0	(request for output)
		Pin 8	CTS1 I	(ready for output)
		Pin 6	DSR1 I	(transfer unit ready)
		Pin 4	DTR1 0	(AT-10 ready)
		Pin 5	GND	

RS-422 Serial Interface

Protocol:	Asynchronous	
Baud Rate:	75 to 153600 Baud	
Byte Format:	1 start bit, 8 data bits.	
	0 or 1 parity bit (+ or -), programmable	
	1 / 1.5 / 2 stop bits, programmable.	
Transfer Control:	None	
Connection Socket:	1 x D-sub, 9 pole	
Pin connections:	Pin 1	GND
	Pin 2	TXC +
	Pin 3	TXC -
	Pin 4	RXC +
	Pin 5	RXC -
	Pin 6	RXD +
	Pin 7	RXD -
	Pin 8	TXD +
	Pin 9	TXD -

Pulmonary Function SP-110

Method of Measurement:		pneumotachometer
Measurement Ranges:		Flow: 0 to ± 14 l/s;
Volume:		0 to ± 11 litres
Measurement Accuracy:		± 2%
Flow Impedance:		less than 0.5 mbar * s/l at 10 l/s
Measured Values:		VC, ERV, IRV, TV, FVC, $FEV_{0.5}$, $FEV_{1.0}$, $FEV_{3.0}$, $FEV_{0.5}$/VC, $FEV_{1.0}$/VC, $FEV_{3.0}$/VC, $FEF_{0.2 - 1.2}$ (litres), $FEF_{25-75\%}$, $FEF_{75-85\%}$, PEF, $MEF_{75\%}$, $MEF_{50\%}$, $MEF_{25\%}$, MV, MVV, FIVC, $FIV_{1.0}$, $FIV_{1.0}$/FIVC, $FIV_{1.0}$/FVC, PIF, $MIF_{50\%}$.
		Comparison pre/post medication possible.
Prediction Equation:	Adults:	ECCS / Berglund / Finnish / Indian / Morris / Crapo / Knudson
	Children:	Quanjer & Tammeling / Indian / Knudson

Accessories for Pulmonary Function Testing

Standard Accessories	Pneumotacho sensor SP-110 / SP-20 / SP-150
	Disposable cardboard mouthpieces
	Nose clips
	Filter
Optional Accessories	Calibration pump

Chapter 8
Glossary

Contents

Introduction

The following list provides a glossary of the important signals and acronyms used in the circuit diagrams for the SCHILLER instruments. They will not all apply to the AT-10.

Only abbreviations that are specific to SCHILLER equipment are included here. General electrical and electronic abbreviations are not included.

Acronyms

..OS	Offset signal (on the ECG amplifier)
A(1..n)	CPU Address Bus.
ALBEEP	Alarm beeper signal to the audio amplifier. The frequency of this signal is about 1000 Hz.
ANA1, ANA2	Analog input from the experimental inputs DC1 and DC2.
AS	Address strobe
BATT	Signal to CPU indicating battery operation
BATTLC	Analog signal to the processor giving the charge condition of the battery.
BATTV	Battery voltage - analog signal from the power supply used by the processor to assess battery or mains operation.
BLOW	Battery less than 11.3V. LCD flashes when this signal is active. When the battery voltage drops to below approximately 9.4V the unit is switched off. These values apply to equipment with 12 V battery. For other equipment the limits are different.
CHAD ..	ECG signal multiplexer control signals (on the ECG Amplifier)
CIF(0..16)	Communication interface. General control signals for the communication interface circuits.
CI(0..10)	RS interface control lines - input.
CO(0..10)	RS interface control lines - output.
CL1	19 kHz LCD latch pulse.
CL2	3.11 MHz LCD clock frequency.
CLK..	Clock Signal. The number following the CLK indicates the frequency. For example CLK 19 indicates a frequency of 19 MHz.
CS..	Chip select. The general format of the chip select signals is CS followed by some characters. The characters indicate the device to which the chip select signal appertains. For example CSRTC is the chip select signal for the real time clock and CSEPROM is the select signal fot the EPROM etc.
CTS	Clear to send. General signal used in data communication.
D (0..15)	Data Bus
DACWR	Digital / analog converter wire.
DIO..	Data input/output on the Data I/O connector
DMUX	Data multiplexer.
DRAM	Dynamic RAM
DRC(0..6)	Dynamic RAM control.
DS..	Data strobe.

Acronyms

DSP..	Digital signal processor (on program pack).
DTACK	Transfer data acknowledge. Bus signal to acknowledge transfer of data.
DTR	Outgoing serial data, turns modem on.
ECG1	ECG in - serial ECG data to the CPU sent over the optical interface.
ECGMUX	The multiplexed ECG signal from the ECG amplifier.
ECGO	ECG out - serial ECG amplifier control data from the CPU sent over the optical interface.
EF	Empty flag.
EJCT	Eject (paper tray).
EKGRES	Reset signal to the ECG Amplifier. This signal resets the ECG Amplifier to recenter the ECG image on the LCD.
FIFOR	First in first out read.
FLM	Control signal for frame synchronisation of the LCD.
FPIN	Input for floating point co-processor.
FWR	Flag read / write.
HREN	Output enable signal for thermal print head data (History enable).
HSYNC	Horizontal synchronisation (video / VGA output).
IPL0..2	Interrupt priority level (binary encoded).
IREG	Control signal from the current detector and limiter circuit on the power supply to regulate supply.
ISYS	Interrupt system (2 kHz).
KB..	Keyboard data in.
KBBEEP	Keyboard beep (to audio amplifier).
KBCLR	Keyboard clear.
KBCL1	Keyboard clock.
KBCL2	Keyboard clock.
KBIN..	Keyboard data in - serial data from the keyboard to the CPU.
KBS..	Keyboard Strobe.
KONV	Convert - this signal initiates the conversion of the incoming signal from the ECG Amplifier..
LA	Left Arm.
LCA	Liquid crystal address - enable.
LCDAS	LCD Address Strobe.

Acronyms

LCDKONT	LCD contrast - sets the -18 V voltage level (from which the LCD backlight power is generated) and thus the contrast of the screen.
LCDW	LCD Write.
LD1,2,3,4	Lower LCD data.
LDS	Lower data strobe.
LED (0..3)	Operate signals to the LED indicators on the keyboard.
LEDB	Battery LED.
LEDMAINS	Signal indicating mains connected - to operate LED indicator on the keyboard.
LOE	Lower output enable - control signal for static Ram.
LP	Line synchronisation.
LSRAM	Lower output enable - control signal for static RAM.
LWE	Lower Write Enable - control signal for Static Ram.
M	LCD control signal derived from FLM.
MCLK	Motor Clock - speed control for the printer motor.
MOD	Control signal from the battery charging circuit.
MOFF	Motor off.
MON	Motor On - Printer motor enable signal.
NWTZ	Mains supply.
NMI	Non-maskable interrupt - interrupt for U47 (Schiller gate array) activated by the reset button.
OFF	Off signal from the OFF key to switch off the power supply.
PDS	Control signal derived from FLM (unity waveform 1/2 FLM frequency).
PM	Paper mark signal.
PMARK	Paper mark detection signal.
PMPON	Pacemaker detection pulse.
PMNEG	Pacemaker negative - indicates the trailing edge of a pacemaker pulse.
PMPOS	Pacemaker positive - indicates the leading edge of a pacemaker pulse.
PWM	Pulse Width Modulation
QTRRG	QRS trigger - output signal.
RA	Right Arm.
RAS	Row address strobe.
RES	Reset.

Acronyms

RESLCD/	Resets / darkens the LCD.
RES/P	Error reset signal to inactivate the LCD.
RTS	Ready to send - ougoing serial data, handshake with CTS.
RXD	Receive data - incoming serial data.
R / W	Read / Write
SC(0..8)	System control bus - CPU control signals.
SCINV	Screen inversion.
SI	Serial in.
SO	Serial output from the CPU to the ECG amplifier via opto isolators.
SP..	Spirometry control and data signals.
SRAM	Static RAM memory.
STRB1/2	Timing signals for printer control.
SYSEN	System enable - active when the program pack is inserted. The CPU will not work if this signal is not active.
TGATE	Gate pulse for programmable timer. This signal sets the TPDUR signal.
TM	Thermal printer temperature - dc voltage from the print head, pulse width modulation of signal TPTH.
TPC	Thermal printer clock. This is not a continuous clock signal but is active when loading a line of printer data (into shift registers).
TPCLK	Thermal printer clock.
TPD	Thermal printer data - serial data for the printer.
TPDUR	Thermal printer duration - duration of the strobe pulse dependant on the ambient temperature of the print head and the resistance of the print head.
TPCSEL	Thermal printer controller select - control of thermal printer FIFO (input memory buffer).
TPL	Thermal printer latch - print strobe control and data latch signal.
TPRES	Thermal printer reset - FIFO reset for thermal printer controller.
TPS 0 & 1	Thermal Printer Strobe - master timing strobe enable signal.
TPTH	Thermal Printer temperature - dc voltage from the print head to ADC, approximately 3.7V at room temperature.
TS	Temperature sense (from battery).
TXD	Outgoing serial data.

Acronyms

µPOFF	Off control signal. Logic 1 keeps the unit switched on, Logic 0 switches the unit off . Note that the unit is initially switched on directly from the ON key on the keyboard.
U1,2,3,4	Upper LCD data.
+UB	Battery voltage.
UCAS	Upper column address strobe (for dynamic RAM).
UD1, UD2	Upper data strobe - used for generating UOE and UWE.
UDS	Upper Data Strobe - used on the SCHILLER gate array.
UOE, USRAM	Upper output enable - for static RAM.
+UP	Voltage rectified from the mains input and regulated to approximately + 15 V.
UWE	Upper Write Enable - for static RAM.
+U	Unregulated dc supply from mains (approximately 30 V).
+UBU	Back-up voltage for the real time clock and static RAM.
+UD	Unswitched regulated dc voltage used as power source for the switched supply +US. The voltage is 13.5V when mains is connected, or battery voltage when mains is not connected. When mains is connected, this supply charges the battery.
-ULCD	Contrast voltage to LCD.
+US	Switched dc voltage of 13.5V when mains is connected or battery voltage when working from the battery. Input voltage for all PSUs on the power supply board.
VCC	+5 V.
VMA	Valid memory address.
VPA	Valid peripheral address.
VSYNC	Vertical synchronisation - (video / VGA output).
WP0 and WP1	ECG In - the serial multiplexed ECG serial data to the CPU sent over the optical interface, from the ECG Amplifier.
XD0..XD3	Pixel information.
XSCL	Shift clock for XDn.
YD	Frame synchronisation.
YDIS/	LCD off.
ZEROSET	Baseline reset (on the ECG amplifier) from the processor.