KEITH PARKER

LIFEPULSE 10

OPERATING AND SERVICE MANUAL

PART NO. 910 008

Covering the following models:
LP10 and LP10/B

CE
0120

Model No:
Serial No:

Issue: 12
Date: February 2000

QUALITY, RELIABILITY AND SAFETY

This equipment has been manufactured using quality components and designed to operate safely and reliably. HME Limited can accept responsibility only if the following conditions are observed.

1. The equipment is used in accordance with the instructions for use provided by HME Limited.

2. The equipment is used in a building whose electrical installations conform to the standards specified by the country in which the building is situated.

3. If the integrity of the protective earth conductor arrangement is in doubt, the equipment should be operated from its internal electrical power source.

4 All modifications and repairs to the equipment are carried out by service engineers, agents or hospital technicians authorised by HME Limited.

CE MARKING

This equipment carries a CE mark but this is only fully valid if it is used in conjunction with cables and other accessories approved by HME Ltd.

Your local HME agent is:

Manufactured in England by
HME Limited,
Arlingham House
St Albans Road,
South Mimms
Hertfordshire,
EN6 3PH
United Kingdom.

Telephone: +44 (0) 1707 601300
Fax: +44 (0) 1707 646250
Email:- service@hme.ltd.uk

Cautions

Note	The following are descriptions of general hazards and unsafe practices that could result in death, severe injury or product damage. Specific warnings and cautions not appearing in this section are found throughout the manual.
Possible Fire or Explosion	A possible explosion hazard exists if used in the presence of flammable anaesthetics. Explosion or fire can result.
Possible Safety Hazard	Do not mount the equipment directly above the patient. Place the equipment in a location where it cannot harm the patient should it fall from its shelf or other mount.
Possible Electrical Hazard	Do not operate the equipment using damaged cables and wires, or loose snap fittings, which may cause interference or loss of signal. Perform frequent electrical and visual inspections on cables and wires.
Possible Shock or Fire Hazard	Do not immerse any portion of the instrument in water.
Possible Equipment Damage	Do not sterilise this product. Sterilisation environments can cause severe damage. Do not autoclave or gas sterilise accessories unless manufacturer instructions clearly approve it.
Possible Safety Risk	Do not substitute accessories. Use only recommended accessories listed in this manual. Substitution may cause the instrument to work improperly. The correct accessories are shielded to prevent conductive parts of the electrodes contacting other conductive parts or earth. No action should be taken which permits this to happen.
Warning	When several equipments of various origins are interconnected, the summation of leakage currents may constitute a hazard.
Warning	The accuracy of the readings obtained from this equipment may be affected by the presence of a pacemaker or by cardiac arrhythmia.

PORTABLE SINGLE TRACE CARDIAC MONITOR
LIFEPULSE 10

OPERATING MANUAL

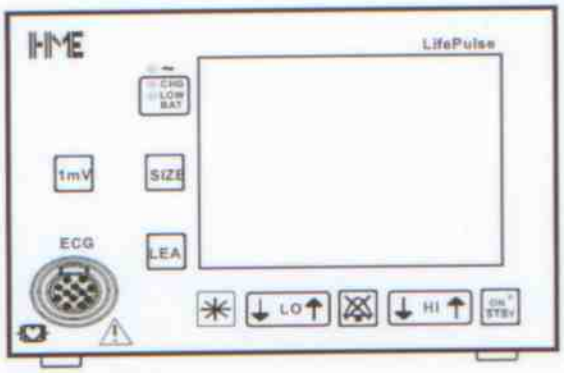
CONTENTS

1. INTRODUCTION

The LifePulse 10 is a portable lightweight single trace cardiac monitor, powered directly from the mains supply or by the optional built in rechargeable battery pack (LP10/B). The monitor provides display of heart rate, QRS indication, low and high heart rate alarm levels, lead selected and trace size displayed on the tube face. Pacemaker and lead off indication will be displayed if the appropriate condition occurs.
Protection is provided to prevent patient burning when this equipment is used with high frequency surgical equipment.

The patient input is fully isolated, ECG pickup is obtained via conventional electrodes and a standard 3 way patient cable, or optional 5 way patient cable (LP10/5L).

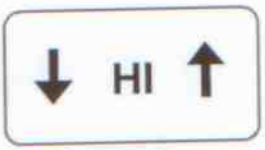
1.1 Front Panel



1.2 Front Panel Operated Controls

1.2.1 Monitor Section

- 1mV calibration pulse
- 3 position amplitude
- 3 way lead selector or optional 5 lead selector
- ECG waveform freeze
- Set low alarm levels



☜Set high alarm levels

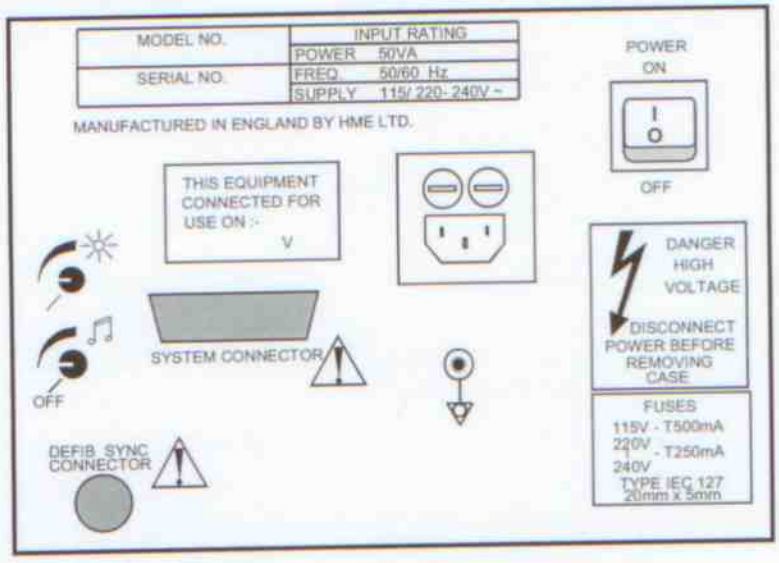
☜Alarms on/off

☜Unit on/standby

Front panel indicators

Green "~" ON Indicates mains power connected.
Yellow "CHG" ON Indicates that the internal battery is charging.
Red "LOW BAT" ON Indicates the internal battery is LOW and requires charging.

1.2.2 Rear Panel Controls



☜Brilliance

☜QRS bleep on/off, volume

☜Mains power ON **I** / OFF **0**

2. PRELIMINARY CHECKS

Delivery Inspection

HME Limited takes every precaution to ensure that their goods reach you in perfect condition. However, accidental damage can occur in transit and storage. For this reason we recommend that a thorough visual inspection is made prior to installation. Should any damage be evident or any parts missing, ensure that HME is informed at once.

Storage

Should the unit not be required for immediate use, it should be re-sealed in its original packing, after carrying out the initial delivery inspection, and stored under covered conditions at a temperature between -10 and 50 degrees C, and relative humidity of 0 -99% (non-condensing).

2.1 Installation

LifePulse monitors are supplied with a 3 core plug-in mains lead, which must be fitted with a corresponding 3 pin mains plug. The cores are coloured in the European colour code

Brown	Live
Blue	Neutral
Green/Yellow	Earth

Fit the mains plug to the cable taking care that the wires have correct lengths, so that in the event of extreme strain, the earth wire will be the last to break. Make sure that the cable clamp secures the outer sheathing so that there is no direct strain on any individual wires at the terminals.

Where the plug is fused, a 5 amp fuse should be fitted.

2.2 Line Power Operation

Check that the factory set voltage setting (see input rating panel on rear of unit) matches the local mains power supply. If this needs to be changed the unit has an internal voltage selector switch which can be adjusted for either 115 Volts or 230 Volts (for 240V set the selector to 230V).

Connect the equipotential earth terminal to a potential equalisation conductor where provided or mandatory. Connect the power cable to the line power socket.

2.3 Fuses

Fuses are fitted in both the power live and neutral lines. The correctly rated fuses for the operating voltage selected must be fitted.

Type IEC 127 20mm x 5mm

115V	T.500mA	250V
220V- 240V	T.250mA	250V

2.4 Battery Operation (LP10/B)

A fully charged battery provides approximately 2 hours continuous use. A low battery indicator light illuminates when battery power is low (sufficient power for 15 minutes operation). The battery is charged when the LP10/B is connected to the mains and the main power switch (back panel) is in the 'ON' position.

3. Technical Specification

Equipment classification

Type of protection against electric shock.	Class 1 and Internally powered equipment
Degree of protection against electric shock	Type CF - equipment with an applied part, intended for direct electrical connection to the heart. This equipment is defibrillator discharge protected.
Mode of operation.	Continuous
Degree of protection against harmful ingress of water.	IPX0
Degree of safety of application in the presence of a FLAMMABLE ANAESTHETIC	Equipment not suitable for use in the presence of a FLAMMABLE ANAESTHETIC MIXTURE WITH AIR or WITH OXYGEN OR NITROUS OXIDE

General

Supply voltage	115 or 220-240V 50/60Hz.
Power input	50 VA
Screen	80mm x 100mm non-fade CRT display
Sensitivity	Selectable .5, 1 and 2cm/mV. Sensitivity selected indicated on tube face.
1mV calibration	By pressing and releasing the calibration button a 1mV step is displayed.
Trace speed	25mm per second
Freeze	Front panel button freezes trace, QRS indication and heart rate display remain active.
Lead selector	Leads I, II and III, and aVR, aVL, aVF, V, STD with 5 lead option (LP10/5L). Lead selected is displayed on tube face.
Lead off indicator	Lead off or electrode fault indicated on tube face by flashing "lead off", and if the alarms are enabled, an intermittent audible tone.
Pacemaker	Indication on tube face "P". Pacemaker pulses suppressed from heart rate counter and reconstituted as negative spike (2cm amplitude) on ECG waveform.
Heart rate display	The heart rate is digitally displayed on the tube face. Range 15 - 250 BPM.
Accuracy	±1% ±1 digit
QRS indicator	Visual indication on tube face with audible bleep (volume adjustment and audio on/off switch on rear panel)

Heart rate alarm	The low and high alarm levels selected are displayed on the tube face. Low range 30 to 100 BPM High range 60 to 250 BPM
Asystole alarm	If within 4 seconds of last R wave no further R wave is detected, "asystole" will be displayed on the tube face. If alarms are selected a continuous bleep will sound. Normal rhythm cancels asystole alarm.
Input impedance	Greater than 20M Ohm per lead
Frequency response	0.1 to 30Hz
Patient input leakage current	Less than 10uA at 240V 50Hz
Battery (LP10/B)	Rechargeable. With mains power connected and mains switch in on position battery is being charged. From a fully charged battery the unit will run for approximately 2 hours. When the battery low indicator is illuminated approximately 15 minutes monitoring remains. Battery recharge time 14 hours.
Outputs	All standard outputs are available from the optional rear mounted 25 way "D" connector. Separate socket for defibrillator synchronisation.
Equipotential earth	Terminal fitted to rear panel.
Electro-surgery immunity	The input is protected and screened against RF interference from electro-surgery equipment. The ECG trace is normally interference free. NOTE Severe RF levels and bad electrode placement may cause trace disturbance.
Defibrillator protection	The input is protected against defibrillation.
Size	192mm (7.6 inches) wide 155mm (6.1 inches) high, 262mm (10.3 inches) deep.
Weight	3.6Kg (7.9 lbs), 4.5Kg (10.lbs) with battery fitted.

Environmental

Operating	
Temperature range	10°C - 40°C
Relative Humidity	30% - 90% (non condensing)
Pressure	860mb - 1060mb
Storage	
Temperature range	-10°C - 50°C
Relative Humidity	0% - 99% (non condensing)
Pressure	860mb - 1060mb

Equipment Markings and Classification

The following is an explanation of the markings that may be found on the equipment.

Signifies the presence of high voltages during use.

Type CF equipment, and the inputs are protected against defibrillation damage.

Off (power disconnected from supply)

On (power connected to supply)

Protective earth (ground)

Equipotentiality

Alternating current

Attention - Consult accompanying documents

Standard Accessories

Mains input lead UK	XC0019
Mains input lead Continental	XC0015
3 way patient cable (complete with fly leads with pinch clip ends)	XC0033
5 way patient cable (LP10/5L only) Complete with electrodes	XC0007
Operators manual	910 007

General Accessories

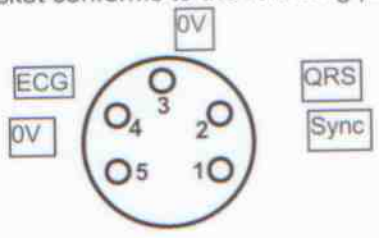
Rechargeable battery pack (LP10/B only)	810 034
Rechargeable battery pack including fixing hardware	010 360
This Maintenance Manual	910 008
Patient cable - no fly leads	XC0041
Fly lead press stud end - red	XC0027
Fly lead press stud end - green	XC0028
Fly lead press stud end - yellow	XC0029
Fly lead press stud end - black	XC0030
Fly lead press stud end - white	XC0031
Fly lead pinch clip end - red	XC0036
Fly lead pinch clip end - green	XC0037
Fly lead pinch clip end - yellow	XC0038
Fly lead pinch clip end - black	XC0039
Fly lead pinch clip end - white	XC0040
Adult single use pre-gelled electrodes	EA0001
Paediatric single use pre-gelled electrodes	EA0002

Defibrillator Sync Connector

Socket: 5 way DIN 45322 socket (60 degree type)

Pin	Function	Level	(Max)
1	Sync in	0-5V (>5mS)	(0-12V)
2	QRS out	8V (180mS)	(+12V)
3	0V common	0V	(0V)
4	ECG out	1V/mV	(+5V)
5	0V common	0V	(0V)

The sync socket conforms to the following pin view connection.



System Connector (optional)

25 Way "D" Type	Description	Signal Level	(Max)
1	Digital GND		
2	TxD	+8V	(+12V)
3	RxD	+8V	(+12V)
4	RTS	+8V	(+12V)
5	CTS	+8V	(+12V)
7	Digital GND	0V	(0V)
9	* Gamma camera sync (Option)	+5V	
10	Analogue GND	0V	(0V)
11	Delayed ECG	+/- 4V	
12	ECG	1V/mV	(+5V)
19	Heart Rate	2V/100 BPM	(+5V)
20	ALM off	Active low	(+15V)
21	QRS	Active high +8V	(+10V)
22	ALM alarm	Active low	(+15V)
25	Unit on	Active high +5V	(+5V)

NOTE: System Connector, Defibrillator Sync Socket

Connection should be made only to equipment tested to comply with BS5724 Part I or equivalent. The LifePulse 10 must be separately earthed.

4. OPERATING INSTRUCTIONS

4.1 Using the LifePulse 10 Cardiac Monitor

Power supply - connect unit to local mains supply using the mains input lead supplied. Switch rear mounted I-O (on/off) switch to I (on). The green ~ LED on the front panel will now be illuminated.

The LifePulse LP10/B is fitted with a rechargeable battery pack. If this pack is fitted then the amber, CHG, LED on the front panel will be illuminated showing battery pack is charging. Once the above conditions are met, the unit is ready for use.

Switch on - depress on/standby button on front panel to switch unit on. When on the adjacent amber LED will be illuminated, a short bleep will be heard and a trace will appear on the tube within 10 seconds.

Certain default or initial control settings are displayed on the tube. They are as follows:

Lead Selected	Lead 1
Sensitivity	1cm/mV
Alarm condition	Off

The above initial settings can now be altered if desired by using the following controls. With the exception of 1mV cal button, a short bleep indicates changed function when control button is depressed.

Lead selection

- By depressing the "lead" push button the lead selected for monitoring the ECG will change to Lead II. Further operations of this push button will select the leads available and the standardise ⎍ position. When standardise is selected, all alarms are inoperative.
Note When the 3 way patient cable (Part No. XC0033) is used, only Leads I, II, III and STD are available. When the 5 way patient cable (Part No. XC0007) is connected, Leads I, II, III, avR, avL, avf, V and STD are available.

Sensitivity

By depressing the sensitivity push button the sensitivity will change to 2cm/mV. Depressing this button again will give a sensitivity of 1/2cm/mV. Further operation of this button will select 1cm/mV again.

Calibration

Should a cal signal be required, pressing and releasing the 

control will display a 1mV step. For clarity of measurement the lead button can be pressed to reach the standardise position ⎍

Alarms

If alarms are required, depressing the  button will activate the alarms and display pre-set limits on the tube face.
Low heart rate alarm level : 50
High heart rate alarm level : 150
If alternative alarm levels are desired they may be changed as

follows.

Continuous pressure on the ↓ LO button will decrease the low alarm limit. Once the required level is reached, remove pressure from the button.

The low alarm limit can be raised by carrying out the same operation on the LO ↑ button. Identical operations can be carried out on the ↓ HI ↑ high alarm limits until both the low and high alarm levels are set to the values required.

If alarms are no longer required, they can be de-activated by re depressing the button. The pre-set limits will be removed and alarm off indicator " " will be displayed on the tube.

Freeze

By depressing the ✳ button the ECG trace is frozen. The QRS indicator and heart rate are not affected.

Press ✳ again to un "freeze" the trace.

4.2 ECG Monitoring

Apply appropriate electrodes to patient as shown below, and attach to either 3 way patient cable (Part No. XC0033) or 5 way patient cable (Part No. XC0007). Connect input plug to ECG input socket on front panel.

ECG electrode application - There are several acceptable arrangements for positioning ECG electrodes. Optimum sites may vary with the patient's particular physiological characteristics and conditions. In most cases, ECG signal deficiencies may be improved by repositioning one or more of the electrodes.

For the best monitoring results, chest placement of the electrodes is preferred because there are fewer skeletal muscles to cause artefact. Fig. 1 shows typical electrode positions for 3 lead ECG monitoring (Leads I, II, III).

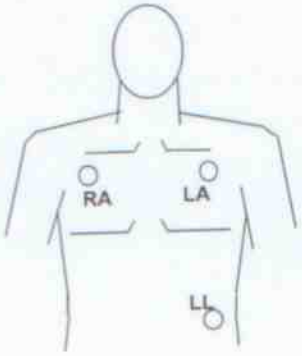


Fig 1

Under certain conditions it may be preferred to place the electrodes on the limbs. This electrode configuration would normally be used only on a short term basis or to monitor an

anaesthetised patient during surgery. It is not recommended for continuous long term monitoring because of excessive muscle artefact caused by movement of the limbs.

Use the following steps to apply ECG electrodes:

1. If necessary, shave the area where the electrode is to be placed.
2. The skin should be abraded slightly with a gauze pad or, alternatively, commercially available electrode preparation solutions may be used in place of abrasion.
3. Clean the area with an alcohol pad to remove all abrading residues and baby oils (not necessary with prep solutions).
4. Dry the skin.
5. Snap the ECG lead wire to the electrodes prior to placement on the patient's chest.
6. If reusable or non-gelled electrodes are used, apply gel to the electrodes. If pre-gelled disposable electrodes are used, peel the backing from the electrode adhesive and apply the electrodes.

4.2.1 Heart Rate Indication

The patient's heart rate will be displayed between the low and high alarm levels. Each QRS detected will cause a ♥ to be seen adjacent to the heart rate display.

4.2.2 Pacemaker indication

If the patient connected to the LifePulse 10 Cardiac Monitor is fitted with a pacemaker which is working, the ECG display will show a 2cm negative spike superimposed on the ECG waveform. The symbol adjacent to the heart rate display will change to a letter "P" for each pacemaker pulse detected.

4.2.3 Warning Messages

MESSAGE	CAUSE
LEAD OFF	A lead has fallen off, is faulty or has bad contact.
INOP	Generally as a result of a defibrillator discharge the monitor electronics may be briefly saturated and the trace is unreliable until the message disappears, usually after a few seconds. Alternatively if the warning persists it may be caused by an incorrect type of electrode or a faulty lead or connection.
ASYSTOLE	No heart activity is detected.

4.2.4 Battery State

When the unit is fitted with its rechargeable battery pack and both mains power "~" (green indicator) and "CHG" (amber indicator) are illuminated, the battery is being charged.

If no mains is applied the unit will automatically run from the battery pack. From a fully charged battery the unit will run for approximately 2.0 hours,. When approximately 15 minutes of battery life remains the "low" (red indicator) will be illuminated. When the mains is restored the battery will be charged and the red indicator will be extinguished.

4.3 Rear Panel Controls

4.3.1 QRS bleep on/off and volume

Turning this control clockwise the audible QRS bleep is turned on, further clockwise rotation will increase the volume of the bleep

4.3.2 Brilliance

Should the brilliance of the display require changing, clockwise rotation of the control will increase brilliance and anti-clockwise rotation will decrease brilliance. In order to prolong the life of the tube display the brilliance level should be set to give a clear trace without being too bright.

4.4 Operator First Line Trouble Shooting

This section gives some of the more common problems encountered during use and possible causes. If the operator cannot locate the problem after consulting the tables in this section, the monitor should be switched off, disconnected from mains power source and a qualified technician should be consulted.

Before attempting trouble shooting verify that the power cable is properly connected to both the monitor and mains power source.

SYMPTOM	POSSIBLE CAUSE
Green power indicator not illuminated	1. Power cable not connected to live power source 2. Rear panel AC power switch in OFF position 3. Defective power cable 4. Mains input fuses blown
Amber unit "ON" indicator not illuminated	1. Unit not switched on
Green power indicator and amber unit "ON" indicator illuminated but no display present	1. Rear panel brilliance control set too low
No signal on trace	1. Defective patient cable
Excessively noisy trace	1. Electrode site not properly prepared 2. Poor electrode contact 3. Defective patient cable
No heart rate display or flashing heart symbol	1. Patient electrodes incorrectly sited. Try repositioning the electrodes
No QRS bleep	1. Switch on rear panel in OFF position or volume set too low
No alarm digits displayed	1. Alarms switched off
Continuous alarm indications. No ECG signal on display ("lead off" displayed)	1. Defective patient cable 2. Electrode or lead off

4.5 Cleaning and Maintenance by the User

4.5.1 Cleaning

The unit and patient lead should be kept clean and free from electrode gel. It is recommended that they are wiped clean with a cloth or tissue dampened with water and detergent. Repeated cleaning with hot water and detergent should remove even heavy soiling. Do not autoclave the unit or patient cable.

Cleaning (weekly)

The unit and power lead should be kept clean and checked for signs of damage. It is recommended that they be wiped clean with a cloth or tissue dampened with water and detergent.

Check mains power connections weekly and examine outer sheath of power lead for signs of damage.

Note Electrical connectors must not be immersed in any fluid.

4.5.2 Battery (LP10/B only)

If the unit is not in constant use the state of battery charge should be checked periodically and recharged if necessary.

Recharging a flat battery will take approximately 14 hours and is achieved by connecting the unit to the mains power and switching the rear power switch to I (on). Observe that the green ~ indicator and amber "CHG" are illuminated.

Note: The monitor does not have to be in operation for battery charging.

4.5.3 Further Maintenance

HME recommend that preventative maintenance checks are carried out on the unit 6 monthly under a HME Service Contract. Alternatively, the maintenance may be carried out by suitably qualified personnel. Details of the procedures are provided in this maintenance manual. Further technical information is available from HME Limited upon request.

5. PRINCIPLES OF OPERATION

5.1 ECG Amplifier

Patient ECG signals via the patient socket first pass through a defibrillator protection and diathermy suppression circuit, consisting of a resistor, capacitor and diode network to the unity gain buffer amplifiers and the resistive weighting network (used for the 5 lead option), and thence to the lead selector where the appropriate lead selection is made. The selected ECG lead is then passed to a X10 instrumentation amplifier to give a gain of 10mV/mV at this point.

To maintain a high degree of patient isolation, this part of the ECG amplifier is galvanically isolated from earth by sending power and ECG signals via transformer coupling across the isolation barrier. Control signals for "lead select", "lead off" etc. are via opto isolators.

The non isolated ECG signals are first de-modulated and filtered to remove the 62.5KHz carrier, and passed to a X2 amplifier where any gain adjustment, if necessary, is made. The signal then goes to a summing amplifier where the baseline correction signal, derived by integration of the output signal, is added. This is followed by pacemaker detection and removal.

The signal then passes to the main X25 ECG amplifier to give a gain of 500mV/mV and then to a 50/60Hz notch filter to remove any mains frequency interference which may be present.

The final amplification stage consists of a programmable amplifier to give three gain settings of 0.5/1/2V/mV at its output.

The ECG amplifier includes a diode DC offset sensing circuit which, if the output exceeds a pre-determined value, the time constant of the baseline integrator is greatly reduced, thereby reducing the output to an acceptable level.

A baseline reset circuit is also included which automatically operates under software control whenever a different lead is selected to allow the baseline to cater for differing electrode potentials which may be present.

5.2 QRS Detector

The QRS detector uses the 500mV/mV level ECG signal, and first full wave rectifies it to produce positive only signals. This signal is then band pass filtered to remove baseline wander, T waves and possible muscle artifact. This is followed by peak detecting the filtered signal and comparing a percentage (66%) of this with the original filtered signal. The output of this comparison is "AND" gated with a minimum threshold comparator which is set to operate at ECG signals exceeding 250uV."QRS" signals which meet the detection criteria trigger a monostable set to about 180mS to produce the QRS output. The QRS monostable is non-retriggerable during this time and is thus prevented from double triggering on abnormal complexes.

5.3 CRT Display

The display of ECG and characters is on a 13cm diagonal, magnetically deflected CRT. The display consists of a series of frames, 50 a second, in which the electron beam traces an oblong across the width of the screen, moving from the bottom left hand corner drawing a vertical raster for the digit display to the bottom right hand side. The beam is then re-positioned to the centre right hand side and then traces the waveform display from right to left. At the end of this period the trace is re-positioned to the bottom left hand side and the operation is repeated for the next frame.

At the conventional ECG writing speed of 25mm/sec, all CRT phosphors exhibit considerable fading. For this reason, a refreshed display system is used. The ECG signals are sampled at a rate of 250 per second, A-D converted and stored in digital form in a RAM (random access memory). Samples are serially D-A converted, and displayed on the CRT in a 10.9 mSec scan. The stored samples taken at 250/sec corresponds to 4.1 seconds of ECG display. The scan is repeated at a rate of 50 scans per second which is above the flicker rate perceptible to the human eye.

The LP10 uses rolling mode display in which the trace appears to move across the screen at 25mm/sec, the information displayed is updated at an appropriate rate to achieve this.

For a "frozen" display (after the stop button has been pressed) the information in the RAM is not updated. The same information is re-processed and displayed and the display is therefore static.

5.4 Microprocessor Control

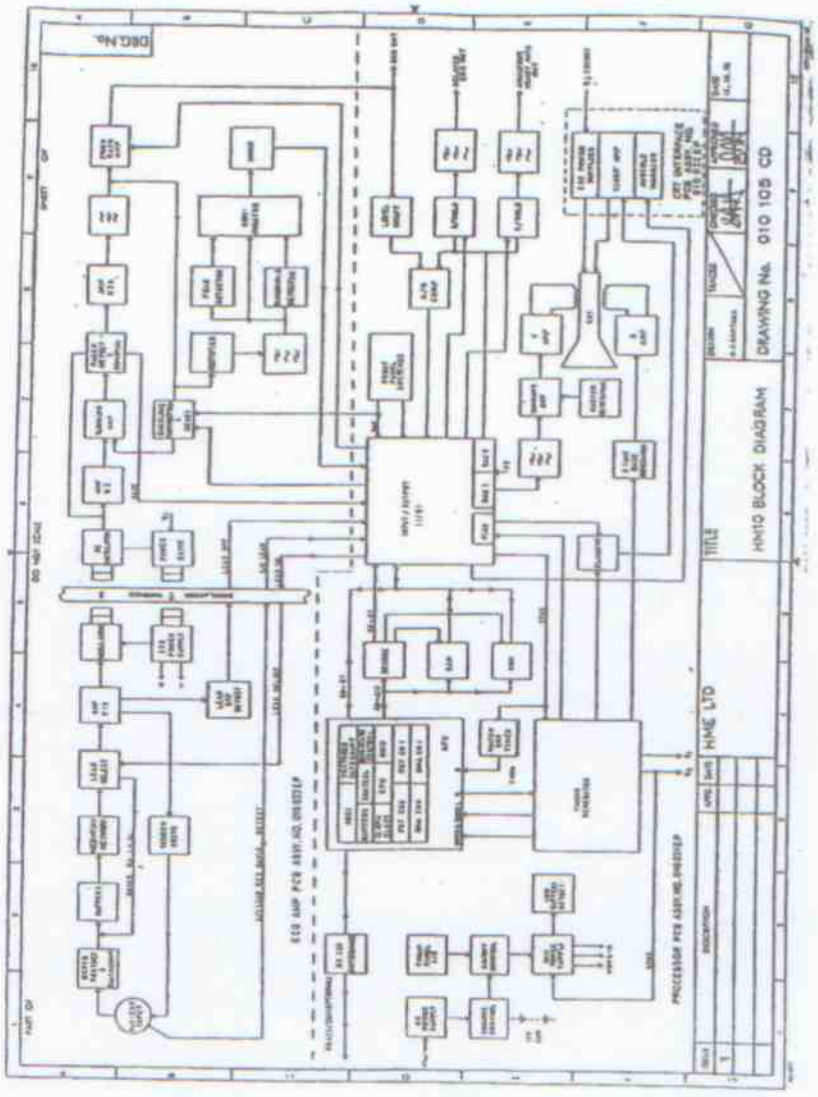
The monitor function and display are controlled by a microprocessor, the programme for which is stored in an Eprom.

The tasks carried out by the microprocessor are listed below:

Sampling and A-D conversion of the ECG by successive approximation.
Control and display of the stored ECG waveform.
Control of the delayed ECG waveform.
Interrogation of the front panel switches.
Generation of the ECG amplifier control signals.
Generation of the characters displayed on the CRT.
Calculation of the heart rate from the detected QRS.
Generation of timing signals for the CRT display.
Generation of all alarm functions.

5.5 System Block Diagram

Drawing 010-105 shows a complete block diagram of the LP10 monitor section. All major function blocks are show, together with the signal paths and major connections.



LP10 and LP10/B 5-3

6. CIRCUIT DESCRIPTIONS

Processor Board (Drg. 010 101 - 4 sheets)

6.1 DC Power Supply Circuit

(Drg 010-101/1)
The A/C is fed to bridge rectifier BR1. The DC voltage produced is smoothed by C1 to produce about 19V. This voltage is fed to a fixed +5V regulator IC1.

The +16V required is produced by maintaining a fixed +5V across R23 which forms the top half of a divider chain, the other half of which is formed by R24 VR2. A voltage V set (16 - 5V) is maintained at IC1 pin 5. Should this voltage fall more current will be drawn from IC3 "com" terminal via TR1 turning IC3 "ON" more, and thus restoring the set output voltage.

6.1.1 Battery Charger & Detector Circuit

(Drg 010-101/1)
The LP10 battery (if fitted) is charged at all times when A/C power is applied to the unit. A 12V, 2.2AH Ni-cad type is used and is charged using a quasi constant source, operating as follows:

A fixed voltage (16V) is fed to the battery via D3 and the current limiting posistor PTC1. During charge the battery terminal voltage is very nearly constant and therefore the voltage across PTC1, due to the charging current, will also be constant. PTC1 is chosen to allow currents of up to 350mA to flow at 25C. Currents in excess of this will cause the resistance of the device to increase, thus reducing the charging current. Fail safe control of the charging current is thus provided in the event of either charger or battery failure. D3 prevents battery discharge into the charging circuit.

Charge indication operation is as follows:

When charge current flows through PTH1 a voltage will develop across it. This will cause the voltage at comparator IC1 pin 3 to fall relative to pin 2, which is fed via divider RN2 and D4 from the 16V supply.

The voltage at IC1 pin 3 is set to be slightly higher with no battery charging current set at pin 2.

The output of IC1A will be off preventing base current to TR10 flowing via R71. When charging current flows IC1A output will be low. TR10 will be "on" and the "charge" LED will be on.

6.1.2 On/Off Circuit

(Drg 010-101/1)
The on/off circuit controls the power for the operation of the unit via RL1 and is powered up at all times when a battery is present and/or mains power is applied to the unit.

The principle of operation is that when power is first applied to the circuit C4 will be discharged. The voltage on the bases of TR3, TR4 will start to rise, but since the voltage on TR3 base will rise slower than TR4 base, due to C4, TR4 turns "on" holding TR3 "off" by setting its base to approximately 0V. C5 will also be discharged via RN1 (3-4). As TR3 is "off" very little voltage will be developed across RN2 (5-6) and, therefore, TR2 and RL1 will be off. As C5 is discharged, pressing the front panel I/O button will connect TR4 base to

0V. TR4 then turns off. TR3 turns "on" and the voltage across C5 rises to about 0.6V. TR2 also turns "on" energising RL1 to apply power to the unit.

To turn the unit "off" the front panel I/O switch is again pressed. C5, which is charged to the TR3 Vbe voltage, is then applied to TR4 base via the switch TR4 turns "on" TR3 turns "off". TR4 is held "on" via RN1 (5-6). TR2 turns "off" de-energising RL1.

6.1.3 +5V +8V Power Supplies

(Drg 010-101/1)
The flyback mode converter providing these supply voltages is designed around a switched mode power supply controller IC4, which is synchronised by a 31.25 KHz square wave 02 from IC8 pin 6.

IC4 output delivers a train of pulse width modulated, positive going pulses, which are fed to buffer IC5 to provide sufficient drive capability to TR5 gate.

TR5 is in series with the primary winding of T1 supplied from the main +12V line. During positive pulses at TR5 gate, the FET conducts and current rises linearly in T1 primary. When at the end of a positive pulse IC4 gate is driven to 0V, the FET is cut off and primary current ceases. The collapsing magnetic flux induces current flow in T1 secondary through diodes D5, D6, D7 charging up the reservoir capacitors C8-12 in the +5V, ö+ò8V supply lines, thereby transferring the magnetic energy stored in the transformer core during the "on" period into stored electrical energy.

The voltage developed across R14, which is connected in series with TR5 is fed to IC4 via R12, C15 as an over current trip, thereby preventing damage to TR5 in the event of a short circuit in the output lines. R12, C15 remove spikes due to leakage inductance which might otherwise cause mis-operation.

The +5V line is sampled by divider chain R18, R20, VR1 and fed to the internal error amplifier of IC4. Deviations from the output voltage set by VR1 with respect to the internal reference voltage results in a change of the pulse width of subsequent controller output pulses, the magnetic energy stored in subsequent cycles thereby correcting the output voltage.

6.1.4 Low Battery Indication Circuit

(Drg 010-101/1)
This consists of a comparator IC2, whereby the +5V logic supply voltage is compared with a fraction of the supply voltage set by R25, R27 to produce a high or low output on IC2. R26, R76 act to provide hysteresis to prevent indeterminate operation at voltages near the low battery threshold. R77 limits the drive current to the "low batt" LED.

6.2 Microprocessor Control Section

(Drg 010-101/2)
IC6 (64180) is a high integration MPU which combines a high performance CPU core with the following function blocks:

1. Clock generator-
2. Bus state controller
3. Interrupt controller
4. Memory management unit
5. 2 channel DMA controller
6. 2 channel ASCI interface
7. 2 channel PRT (timers)

8. CSI/O (not used)

The function of the microprocessor (MPU) is determined by IC9, the (Eprom), in which the programme for the LP10 is stored. Tasks are carried out sequentially, subject to interrupts.

The MPU is connected to an 8 line data bus which is common to the MPU, the Eprom IC9, the data memory (RAM) IC10 and the I/O devices.

6.3 Memory and I/O Decoder

(Drg 010-101/2)
The MPU address line A15 and the ME strobe are decoded by IC23A, IC24A, D to map the program memory IC9 into the lower 32K and the data memory IC10 into the upper 32K.

All external I/O is mapped into 16 byte blocks and uses A7 and IOE as enables to the I/O decoder IC20. Further decoding is provided by IC22. The MPU internal I/O (used by DMA, timers etc.) is mapped into the lower 128 bytes of the I/O address space by software.

Decoder outputs B0-B7 are used to enable the following:

BO Used in conjunction with A0 to select IC19 2 channel D/A.
Channel 0 is used in

A/D conversion
Delayed ECG out
Analogue heart rate out

Channel 1 used for

Waveform out
Digit vertical position

B1 Enables IC18 (input) not used in LP10.
B2¦-
Enables IC16 (input). Reads front panel keyboard as follows:

Pin	Bit	Function
9	0	Gain
8	1	Lead no.
7	2	Hi limit
6	3	Hi limit
5	4	Mute alarm
4	5	Lo limit
3	6	Lo limit
2	7	Freeze

All input active low

B3 Enables IC15 (output). Writes data to the ECG amplifier and sample hold switches as follows:

Pin	Bit	Function
12	0	Delayed ECG S/H
9	1	Heart rate S/H
15	2	(Bres) ECG baseline reset
6	3	LA0) see isolated ECG
16	4	LA1) amp section for
5	5	LA2) codes
19	6	GA0) see non isolated ECG
2	7	GA1) section for codes

B4 Enables IC14 (output) controlling the following

Pin	Bit	Function
12	0	X time base control
9	1	X time base control
15	2	Alarm off
6	3	Alarm
16	4	Z blanking control
5	5	(TRES) Timing reset
19	6	Not used
2	7	Not used

B5 Enables IC13 (output). Parallel in serial out shift register used to produce the digit raster "dot" information (see timing text for operation).

B7 Enables IC17 (input). Reads status data from the ECG amplifier, defib sync input and A/D conversion circuits as follows:

Pin	Bit	Function
2	0	ECG A/D comp input
3	1	Not used
4	2	Not used
9	3	5 lead ECG flag
8	4	Lead off flag
7	5	Pacer flag
6	6	QRS flag
5	7	Defib sync flag

6.3.1 Oscillator and Watch Dog Timer Circuits

(Drg 010-101/2)
The MPU IC6 has a self contained oscillator circuit and only requires the frequency setting components C28, C29 and the 12MHz ceramic resonator X1. The basic oscillator frequency is divided by 2 internally before use by the MPU and is available for use by the timing circuits on pin 64 at 6mhz.

A watchdog timer IC37 is included which operates as follows. The IC is connected to act as a free running oscillator in its normal mode of operation. In this application timing reset pulses (TRES) generated by software are fed via IC26A inverter and C34 to TR9. TR9 turns "on" at each successive positive edge due to C34. This action resets the timing capacitor C31 preventing astable operation and the output P3 resetting the MPU. In the

event of a software failure the correct timing at TP7 will not be present and the MPU will be reset. (See timing diagram for correct timing).

6.4 Timing Generator

(Drg 010-101/2)
The purpose of these circuits is to generate the desired frequencies and timing used by the waveform and digit displays. The timing generator may be separated into the following parts:

Frequency generation
Waveform display timing
Digit display timing
Reset

Frequency generation. Used to provide 62.5KHz to drive the isolated ECG amplifier and demodulation of the ECG signal (see ECG amplifier section). Generation of 31.25 KHz is used to drive the EHT generator (see CRT interface board section).
The circuit uses the system 6MHz (O) to counter IC7 divide by 12 IC, to provide 500KHz at pin 8. This signal is used by IC8A to further divide by 8 to give the required 62.5KHz (01) at pin 5, and divide again by 2 to give the 31.25KHz (O2) at pin 6.

Waveform display timing. The purpose of this timing is to control the rate at which waveform data is fetched from memory for display. The LP10 uses the MPU built in DMA unit. The DMA is programmed to operate in the memory to memory mapped I/O block transfer mode using DREQO on the MPU (pin 54) to time the transfers of any byte at a time under software control. This timing input is programmed to be negative edge sensed. By this method it is only necessary to control the rate at which data is required for display. The length of the data block is entirely defined by software. This method also allows the normal MPU processing to continue between byte transfers.

The 6MHz system clock is divided by 2 by IC11A, then 16 by IC8B, and a further 2 by IC38 to give a 6MHz/64=93.75KHz. This equates to a line period T of 10.67uS at IC38 pin 12. This signal is inverted by IC25C to feed the DREQO input on the MPU giving a total waveform display of 1024 bytes x 10.67uS=10.92uS.

Digit display timing. The digit display is organised as a vertical raster system of 2 bytes per column of N columns. N can be set by software to be 128 in the basic unit.

A special area within the data memory (RAM) IC10 is reserved for screen digit data. The data is accessed in the same way as for the waveform data using a timed DMA block transfer method via DREQ1, programmed to be negative edge sensitive as before. In this mode, however, the data is sent from memory to IC13, a double buffered parallel in, serial out shift register. Double buffering is necessary because as data is shifted out serially it is necessary to pre-fetch the next data byte ready for loading and shifting without causing any discontinuity at the byte boundaries.

During line reset it is necessary to blank the Z mod line for this period. This is done automatically by making the shift out period for the last byte in any line longer. This is done by the timing so that data on the serial input IC13 pin 14, which is always zero, gets shifted out after the last data byte (see timing diagram for exact timing).

The required DREQI timing is produced as follows. The 6mHz system clock is divided by 32 by IC11A and IC8B to give 187.5KHz at IC38 pin14. This is further divided by IC38.

IC38 is a divide by 10 counter. The asymmetrical waveform on pin 9 is first inverted by IC25A, the output of which forms the DREQ1 input to the MPU. This gives an average block transfer for 256 bytes, i.e. (128 times of 2 bytes) of 26.67 uS/byte x 256 bytes=6.83uS.

Line flyback pulses are generated by taking IC38 QD (pin 11), and shifting it by one half a shift clock pulse width in IC11B (see timing diagram). The output of IC11B is fed directly to the digit ramp generator circuit.

Timing reset. At the end of each block transfer, be it waveform or digit information, timing reset is generated under software control.
This reset is necessary to ensure that all counters start from the same point relative to the X time base ramp generator (IC27, IC31B) which is entirely under software control. The reset (TRES) is issued with the X ramp commands at IC14 outputs. This output is inverted by IC26A and used as a watchdog prompt signal (see timing diagram.

Z mod timing. Digit data loaded into IC13 (see digit display timing) is output at QH (pin 9) after transfer from the internal buffer by the SLD clock (see timing diagram), which is generated by detecting count zero in IC38 by nor gate IC26B, the output of which is fed to nand gate IC25D for gating with SCK to produce SLD. SCK is the serial shift clock.

Digit data appearing on QH (IC13) is fed to IC24 where it is "or"ed with the Z control line (software generated). This line is low during waveform display, i.e. continuous "bright up". The output of IC24B feeds IC23B where waveform end (flyback) blanking is "and"ed to the signal to form the composite Z mod. IC23C inverts this signal which is then directed to the video amplifier (Drg. 010 102 DD) via J10 pin 7.

6.4.1 X Time Base Generator

(Drg 010-101/4)
This consists of integrator IC31B and analogue switch IC27, which connects the integrator input to the required functions to either ramp up, down, hold present value or return to the reset position.
Control of the X time base generator is set by codes emitted by software on IC14 pins 9, 12 as follows:

Pin 9	Pin 12	Function (IC31B Output
0	0	Hold present value (+2.5V)
1	0	Ramp down (waveform display)
0	1	Ramp up (digit display)
1	1	Reset (-2.5V)

The codes are implemented as follows. Pin 10 is set to be -2.5V via divider R74, R75 from the -5V reference voltage at IC31A. For reset C32 will be short circuit via IC27, causing IC31 output to equal the non-inverting input voltage of -2.5V. For ramp up the short on C32 is removed and the non-inverting input of IC31B is connected to -5V via R28, VR4 to cause C32 to charge positively in a linear fashion, maintaining the non-inverting input of IC31B at -2.5V.

Ramp down operates in exactly the same way as ramp up, except R29, VR5 are used as the integrating resistors and are connected to the +5V reference instead to give a ramp down. Hold present value is achieved by open circuiting all switches within IC27. C32 then acts as a hold capacitor to maintain a constant output value, normally +2.5V, when set correctly (see timing diagram for waveform at IC31B).

6.4.2 Digit Raster Generator and Waveform Display Circuits

(Drg 010-101/4)
The digit raster generator consists of integrator IC31C, R 54, C35, ramp reset switch IC24C where "or"ing of the signal and the X time base control signal to produce a continuous reset during waveform display and ramp reset pulses from IC11B during digit display.

During a ramp reset C35 is short circuit causing IC31C output to be OV. When switch IC28A is open C35 charges positively due to R54. Repeated reset pulses to IC28 gives the digit display raster. The output of this circuit is fed to the summing network RN5, R70 IC31D, where it is combined with the time scaled ECG waveform output signal from IC30D. During digit display a DC level is fed from IC30D. This DC level is set by software and controls the vertical position of the digit display.

6.4.3 Waveform Display Circuits

Waveform data to be displayed on the CRT is loaded from memory by DMA transfer to the dual A/D converter IC19, one half of which is used for waveform display. Data is converted to be a voltage output by IC30B and then fed to IC30D, which with its attendant components acts as a combined level shift and low pass filter circuit to produce a bi-polar time scales ECG waveform. The filter acts as a dot joining circuit to improve the visual display. The gain of this stage is 1.0, giving a full scale output of $\pm$ 2.5V.
This output is then fed to the summing network R70, RN5, IC31D prior to amplification by the Y deflection amplifier.

6.4.4 A/D Conversion Circuit

(Drg 010-101/3)
A/D conversion of the analogue ECG signal is carried out using a software implemented technique utilising a D/A converter and comparator.
High level ECG signals on J7 pin 1 are fed to the differential amplifier and level shifter IC21B where the signal is referenced to the ECG amp "local" earth via J7 pin 2. Level shifting is done to convert the bi-polar signal to the uni-polar 0-5V FS used by the A/D converter.

The MPU IC6 sends 8 bits of data to the DAC IC19. The output of DAC is compared to the ECG input by IC21B. The result of the comparison (1 if lower, 0 if higher) goes back to the MPU via port IC17 pin 2 for handling. This allows the software routine to estimate the proper digital representation of the analogue input by first outputting the MSB, and keeping it if the input says "too low still", or dropping it if the input says "too high now". From there each bit in order of significance is tried and either kept or discarded. By this method, therefore, it takes 8 tries to produce a complete conversion of the ECG input.

This process is repeated at approximately 4uS intervals to produce a 250Hz sampling rate. After conversion, the result is stored in successive locations in memory, each new conversion over-writing the oldest data in a 1K block of memory. It follows, therefore, that at 250Hz sampling each data point will be updated in 1024/250 4-1 seconds corresponding to the trace time on the CRT display. The sampled ECG data is also used by other routines within the unit and are discussed separately where used.

6.4.5 Delayed ECG Output Circuit

(Drg 010-101/4)
The delayed ECG is implemented using a separate 5K/byte block of memory for data storage. New data is entered at the same time data is entered for the waveform display. However, immediately prior to writing this data the oldest data which will be at the same memory address is loaded into the DAC IC19. A strobe is then generated by software via

port IC15 pin 12 to the sample and hold circuit IC28B, C23 and buffer IC32C. This signal is then fed to the level shift and low pass filter IC32 to produce a bi-polar output equivalent in amplitude to the real time ECG output, but delayed by about 20.5 seconds.

6.4.6 Analogue Heart Rate Output

(Drg 010-101/4)
Heart rate is derived from the QRS by software and, therefore, only exists in digital form. To produce the analogue output required a binary equivalent of the displayed heart rate is loaded into the DAC IC19. A strobe is then generated by software via port IC15 pin 9 to the sample and hold circuit IC28A, C22 and buffer IC32A. This level is then fed to a low pass filter IC32D to smooth out step changes due to differing heart rates.

6.4.7 CRT Deflection Amplifier Circuits

(Drg 010-101/4)
Y scan amplifier circuit
The Y signal from the summing amplifier IC31D are fed to divider network VR6, R45, the height control. The output of VR6 is fed to a high power op amp IC34. The Y deflection coil fed with current from the output of IC34 is shunted by R42 to limit ringing. A voltage proportional to the deflection current is developed across R43 in the Y coil circuit. This voltage is fed back to the inverting input of IC34, thus determining the amplifier transconductance.

X scan amplifier circuit
The X signal from IC31B is fed to "T" network, consisting of R33, 34, 35 and D10, 11 in the input port of the X deflection amplifier, gain determining network to provide "S" correction necessary for the large deflection angles used.

The X deflection amplifier IC33, a high power op amp, feeds the X deflection coil with current. This current is sensed by R40 and a voltage proportional to the deflection current produced. A divider network VR3, R41 allows for a proportion of this voltage to be fed back to the input via feedback resistor R36 to control the gain. R42 across the X deflection coil is used to prevent ringing in the circuit.

6.5 Isolated ECG Amplifier

(Drg 010-103/1)
ECG signals originating via the patient socket are fed to the defibrillator protection circuits R1-R4 and resistor network RN-1 to IC4, whose input protection diodes complete the circuit. This circuit also forms part of the diathermy protection network with the addition of C1-C8 to produce a low pass filter to all inputs.IC1 acts as a unity gain buffer between the ECG input and the weighting network RN-2, RN-3 used in the "augmented" leads (5 lead option only).

IC2, 3, 4 select the appropriate inputs to IC5 for amplification in accordance with the following table.

LA2	LA1	LA0	LEAD
0	0	0	V
0	0	1	aVF
0	1	0	aVL

0	1	1	aVR
1	0	0	III
1	0	1	II
1	1	0	I
1	1	1	STD

It should be noted that the I, II, III connections shown differ for a 3 and 5 lead input, i.e. as OP5 and its driver re not installed. Reference should be made to the following table for the actual connections.

Lead Position	-	+	Ref.	
I	R	L	N	5 lead patient cable
II	R	F	N	
II	L	F	N	
aVR	(L&F)/2	R	N	
aVL	(R+F)/2	L	N	
aVF	(L+R+F)/3	F	N	
V		C	N	
I	R	L	F	3 lead patient cable
II	R	F	L	
II	L	F	R	
STD	SC	SC	SC	3 & 5 lead patient cable

For a 3 lead cable input, a link is provided in the patient plug to connect SEL7-SEL8 together. This enables IC4 via Pin 6 to give a reference to RA, LA, LL as appropriate (see table).

IC5A, C, D forms a conventional instrumentation amplifier with a fixed gain of 10 set by RN-4, R14, R91. VR1 is used to maximise the CMRR by balancing the differential input gain appearing at the input. C9, C10 reduces the high frequency response of the amplifier. The output is then fed via R50 to the synchronise modulator IC6. IC6 is an analogue switch fed by a 62.5KHz square wave from T1 via R16. IC6 is then on or off such that any DC on the output of IC5C will produce a corresponding amplitude modulated signal on T2.

6.5.1 Lead Selection

As previously described in the Isolated ECG Amplifier Section, the actual selection is made by IC2, 3, 4 which are controlled by software to give selection codes LAO, LA1, LA2 via port IC15 Pins 6, 16, 5. These signals are then fed via J7 to the ECG amplifier PCB. LA0, LA1, LA2 are presented to inverting buffers IC17 Pins 3, 5, 2 which are used to drive opto isolators OP3, OP4, OP5, the outputs of which then directly control IC2, 3, 4 to give the desired selection.

6.5.2 Isolated Power Supplies

A 62.5KHz square wave from the processor PCB is presented to IC17 Pin 7 which converts the 5V logic level to an 8V logic level. This is then fed to analogue switch IC11B to convert to a +8V logic level used to drive TR1, TR2 to give a 62.5KHz 15V PP square wave on the primary of T1. This waveform appears on the secondary and is half wave rectified by D12, D13 to give a +7.5V. C11-14 are used for smoothing. D11 prevents the isolated power supply voltage from rising above +9V under defibrillation pulse conditions.

6.5.3 Lead Off Detection

Lead off detection of any lead in use is detected by pulling each input up via a very high value resistor (R7-R10) to a value greater than about 2V set by R18, RN-5. In the event of a "lead off" either Pin 1 or 14 of IC5 will go high. D9, 10 are used to "OR" these outputs to give a voltage greater than the threshold at IC5B Pin 5. IC5B output then goes high to turn opto isolator OP2 "ON" via R19. This causes its output to go "LOW" on J1 Pin 12 which connects via J7 on the processor board to "PORT" IC17 Pin 8 for further processing by software and subsequent display and warning.

6.6 Non-Isolated ECG Amplifier

(Drg 010-103/2)

Amplitude modulated ECG signals from the isolated section appear on T2 secondary, and are synchronously modulated by analogue switch IC11A. This signal is then smoothed by C34, 35 and resistor network RN-8 to remove any of the 62.5KHz carrier frequency. IC8A acts as a buffer to prevent loading and subsequent gain errors from the de-modulator. IC8A has a nominal gain of x2 set by VR5, and used to calibrate the final output voltage gain. At this point (IC8 Pin 1) the gain is 20mV/mV. The ECG signal is then passed to a unity gain differential amplifier IC8B used to "sum" the baseline signal from integrator IC15B. IC8B output is fed via the pacemaker reject sample hold circuit IC11C to the ECG amplifier IC8C which has a fixed gain of 25 set by R39, 40 to give an overall gain of 0.5V/mV. C5 reduces the high frequency roll- off to about 90Hz.

The ECG signal is now fed via the line frequency notch filter, a conventional twin-tee circuit comprising R36-R38, and C29-C32. VR4 sets the final notch frequency value allowing for tolerance changes in the components used. IC8D is a unity gain buffer, the output of which is fed to the final amplification stage IC15A.C15A gain is controlled by GAO and GA1 under software control via IC17 Pin 4,Pin 1 to control analogue switches IC16A, B which directly control the gain of IC15A to give x1, x2, x4 in accordance with the following table.

GA1	GA0	GAIN
0	1	0.5cm/mV
1	0	1.0cm/mV
1	1	2.0cm/mV

Overall DC stabilisation of the ECG amplifier is provided by integrator IC15B fed at the 0.5V/mV level from Pin 2 IC15A. The integration components R32, C24 are chosen to give a low frequency cut off of 0.1Hz. If the ECG amplifier output goes outside the voltage set by R53, R54, D20, or D21 will start to conduct, greatly reducing the integrator time constant, thus restoring the output to the correct operating region. The circuit is designed to cope with the offsets referred to the input of $>\pm 300$mV.

6.6.1 Baseline Reset

When a lead is selected, a pulse appears on BRE generated by software which, via IC17, Pin 6 buffer, triggers monostable IC14A to generate a 40mS pulse. This is used to close analogue switch IC16C connected directly across R32, the main integration resistor controlling the time constant. This has the effect of rapidly returning the ECG amplifier output to zero, minimising any effects caused by DC artefacts at the input on different lead configurations.

6.6.2 1mV Calibration

The 1mV calibration signal is fed to the non-inverting input of the integrator IC15B to artificially shift the zero reference point. As IC8B is a differential amplifier the calibration signal must be of the same equivalent amplitude as the ECG signal at this point, i.e. 10mV/mV at IC8A Pin 1. Therefore, for this reason the 1mV calibration signal at IC15 Pin 5 must also be 10mV/mV.

This is done as follows. Depressing the 1mV button causes the voltage at J1 Pin 16 set by R48 RN-12 to go low. Current through R48 then increases the base emitter voltage on TR3 turning it "on". Current then flows through R33, R31, VR3. The voltage developed across R31, VR3 and fed to IC153 is 10mV as required.

6.6.3 Pacer section

It is important to remove any pacemaker pulses from the ECG signal in order to prevent false triggering of the QRS detector.

Pacemaker pulses appearing at IC11A are directed to + threshold comparators IC9A, B via C36. The threshold limits are set by R42 and resistor network RN-6.

When a pacer pulse is detected IC9 output goes low to trigger IC10A. This acts to "turn off" analogue switch IC11C. C28 acts as a sample hold capacitor during IC11C "off time".

Monostable IC10B operates in conjunction with IC10A to produce a pacer refractory period of about 200mS. This output is also fed to the processor via J1 Pin 10 to port IC17 on the processor board where, under software, the pacer is re-constituted with the ECG waveform to indicate the pacer position relative to the ECG complex. This signal is also used by other software routines concerned with QRS display and ratemeter operation.

6.6.4 QRS detector

(Drg 010-103/2)
The high level ECG signal from IC8D is first fed to full wave rectifier IC12D and IC12A which converts all signals to + ve going. This signal is then fed to low pass filter IC12C and then to IC12B high pass filter. IC12C and IC12B together form a low Q band pass filter to remove baseline T waves and muscle artefact, making the R wave the predominant signal.

The signal is then fed to the peak detector IC13C. A percentage of the peak obtained set by R25 and R24 (approx. 69%) is fed to comparator IC13D which compares this peak with the filtered ECG signal so that provided the R wave is larger than 69% of the previous, it is deemed to be good and a pulse is produced on IC13D output.

A second comparator IC13B is used to inhibit this output if the signal level is below a predetermined threshold set by R27, thus preventing triggering on noise.

The QRS output is applied to the following:-

a) The processor via port IC17 Pin 5 (Drg 010 101 Sht 3 of 4) to produce under software control the QRS symbol on the CRT display;

b) The QRS bleep control (Drg 010 102) via VR1 bleep volume and TR7 driver transistor;

c) The defib sync socket and system connector.

6.7 CRT Interface Board

(Drg 010-102)

The CRT interface board consists of the following essentially separate circuits.

EHT generator

Video amplifier

Audible circuits

6.7.1 EHT generator

The circuit operates as a driven pulse width modulated flyback converter with feedback of the "flyback" voltage via an error integrator and reference voltage to control the pulse width, and hence output voltage.

A 31.25KHz 5V logic level square wave is fed to TR2 from J1 Pin 4 and is converted to a 12V logic level. This signal is differentiated by C2, R3 to reduce its pulse width, and presented to monostable IC1 Pin 2. IC1 is then triggered on each negative going pulse to produce a 0-12V output pulse on Pin 3, the width of which is controlled by R4, C3 and the control voltage on Pin 4. This pulse is presented to the gate of FET driver transistor TR1, turning it "hard on". Current now starts to build up linearly within T1 primary winding, causing energy to be stored. At the end of the pulse, TR1 switches "off" and the voltage across all the windings in T1 reverse and the energy stored is transferred to the load via D1, D2, or directly into the EHT multiplier MLT-1.

The flyback voltage generated and hence the EHT and other control voltages, are set by taking the peak drain voltage on TR1 detected by D1, C6 and taking a proportion set by R13, R16 and VR3 and comparing this to a reference (+5V) produced by IC3, at IC2B.

IC2B acts as an integrator to the error voltage due to C10, R13. This error is fed to the control input of IC1 to increase or decrease the output pulse width as required to maintain the set output voltage.

As a safety feature, a current mode of operation is provided by IC2A and R9, and operates as follows:

As current builds up in T1 primary, the voltage across R9 also increases. This is fed to IC2A via R8, C7 which removes spikes due to leakage inductance transients. The voltage developed across R9 is compared by IC2A to a reference voltage of about 0.5V set by R10, 11 from the 5V reference IC3. Should the voltage across R9 exceed this reference voltage IC2A output goes "low" resetting monostable IC1 and thus preventing any further increase in current and possible damage.

6.7.2 Video amplifier

5V logic level video signals from the processor are presented to TR5 base via biasing resistors R22, R23, necessary to prevent TR5 from being "turned off" on a logic 0 level, with consequent reduction in performance due to charge storage.

About 30V of video drive is required to fully modulate the CRT display. Therefore, 40V supplies are used, derived from a tap on the secondary winding on T1 via D2 rectifier and C12 smoothing capacitor.

The gain of TR5 is controlled by pull up resistors R24 and R20, which provide the necessary negative feedback. The values of R20, R24 are chosen to maximise the video output voltage without saturating TR5 which would also degrade performance.

The video signal on TR5 collector is passed via decoupling capacitor C11 to the CRT cathode biasing circuit TR6, R18, 19 and brilliance control VR4. This biasing circuit is essentially a constant current source set by the brilliance control VR4 to control the voltage across R19 and hence the collector current of TR6, which directly controls the CRT beam current via R17, J2 to the cathode. The maximum beam current is set to be 20uA, i.e. (5-0.6V)/220K.

The writing speed of the waveform display is different from that of the digit display, which would cause differences in brilliance, and for this reason it is necessary to modify the video gain for each mode of display. This is effected by turning TR4 "on" under software control to attenuate the logic level input signal via R21 and hence the video gain.

6.7.3 Audible warning

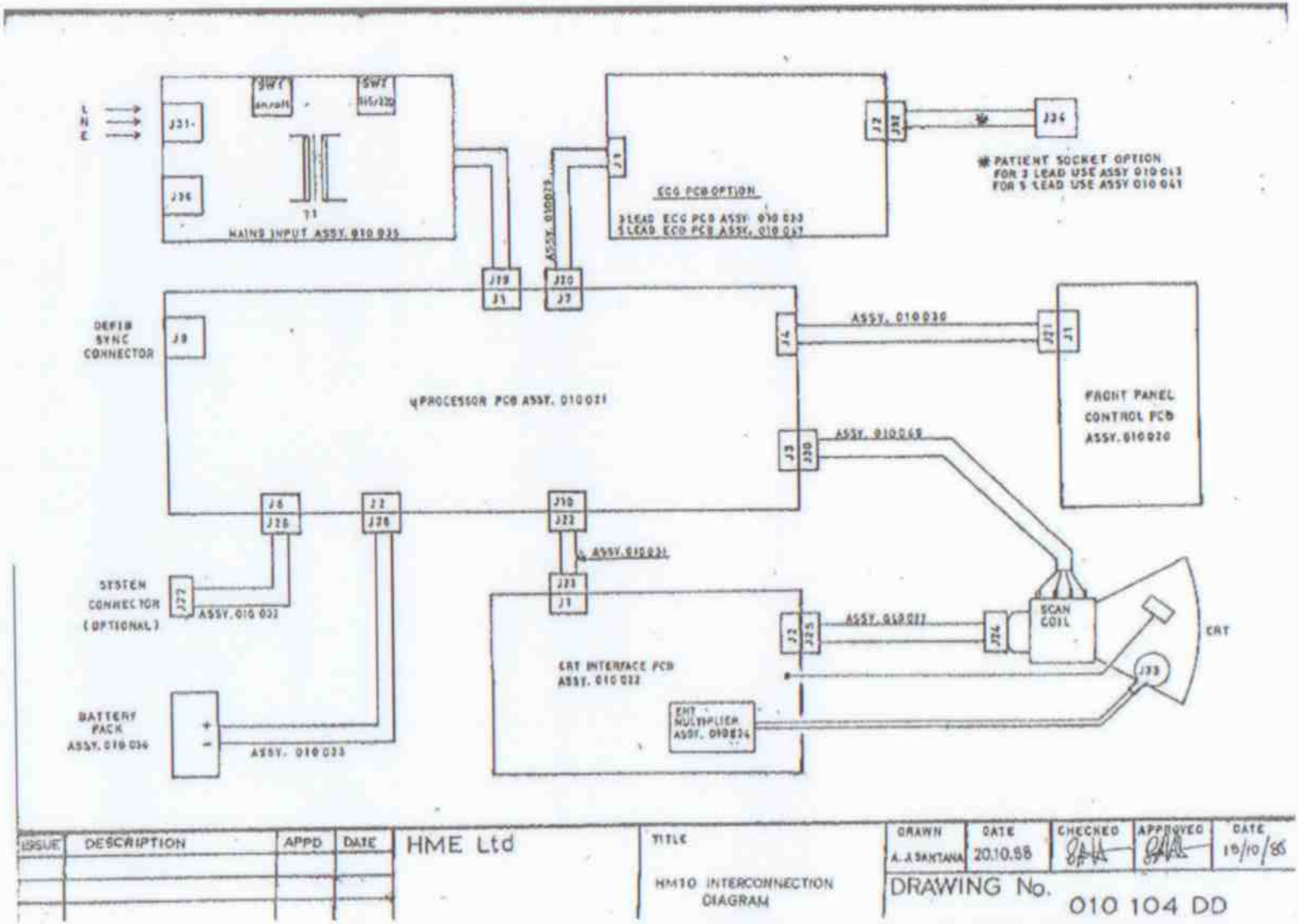
This utilises a self-contained piezo-ceramic oscillator SP1 to implement the audible alarm, QRS and the "pip" when the front panel buttons are depressed.

Activation in the alarm and "pip" mode is implemented under software control at J1 Pin 6 from "PORT" IC14 Pin 6. When this point goes high TR3 is turned "on" to apply the full +12V supply across SP1. C1 is used to reduce the attack and decay times to produce a more acceptable sound.

In the QRS bleep mode, the QRS is applied at J1 Pin 1 directly from the QRS detector circuit. When J1 Pin 1 goes high TR7 is turned "on". If the QRS volume control VR1 is in the "on" position, SP1 will bleep with a volume dependant on the VR1 position. R1 converts the essentially constant current characteristic of SP1 to a voltage dependant one to increase the effective volume setting range for various VR1 settings.

7. CIRCUIT DIAGRAMS

Title		Drawing Number
Interconnection Diagram		010 104
ECG	- Isolated Amplifier	010 103
	- Instrumentation Amplifier	010 103
	- Pacer Detect	010 103
	- QRS Detect	010 103
Processor	- Power Supplies	010 101-1
	- MPU & Timing	010 101-2
	- Input Output	010 101-3
	- Timing Base & Deflection	010 101-4
CRT Interface	- EHT generator	010 102
	- Video Amplifier	010 102
	- Audible Warning	010 102
Mains Input	- Circuit Diagram	010 106
	- Wiring Detail	020 324
Front Panel	- Circuit Diagram	010 100



ISSUE	DESCRIPTION	APPD	DATE

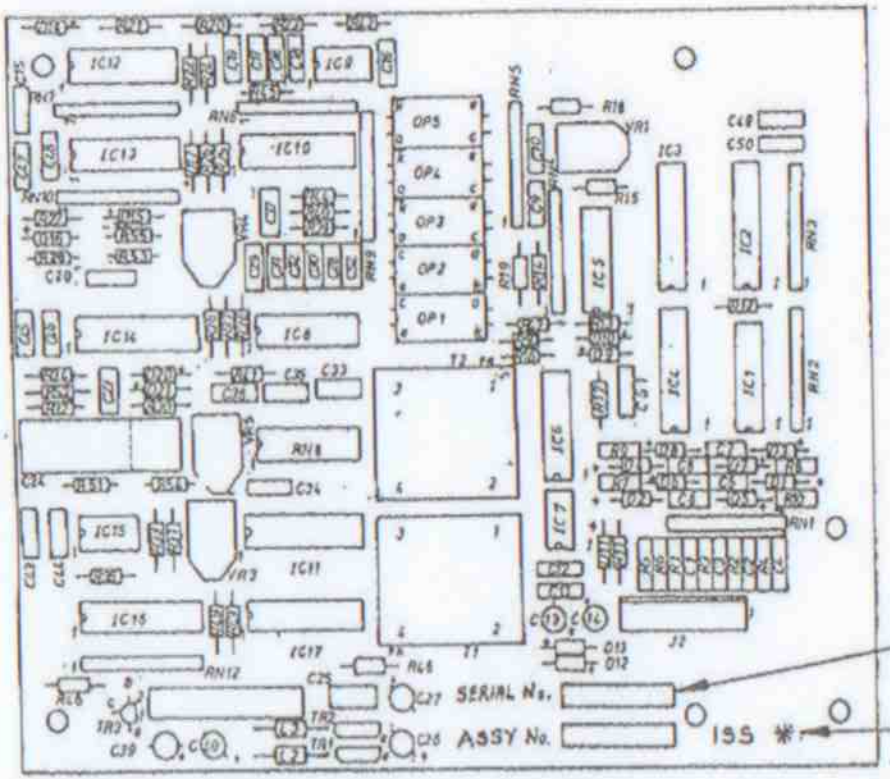
HME Ltd

TITLE

HM10 INTERCONNECTION DIAGRAM

DRAWN	DATE	CHECKED	APPROVED	DATE
A. J. SANTANA	20.10.88			19/10/88

DRAWING No. 010 104 DD



NOTES:-
1. INDELIBLY MARK SERIAL No. IN APPROXIMATE POSITION SHOWN.
2. INDELIBLY MARK ASSEMBLY No. AND ISSUE IN APPROXIMATE POSITION SHOWN.

ISS	ECO No.	DAY	MTH	YEAR	SIC
4	95882	01	02	95	B.E.B.
3	-	15	05	95	B.E.B
2	-	18	02	94	S.A.H.
1	1st ISS	17	05	93	S.A.H.

DATE

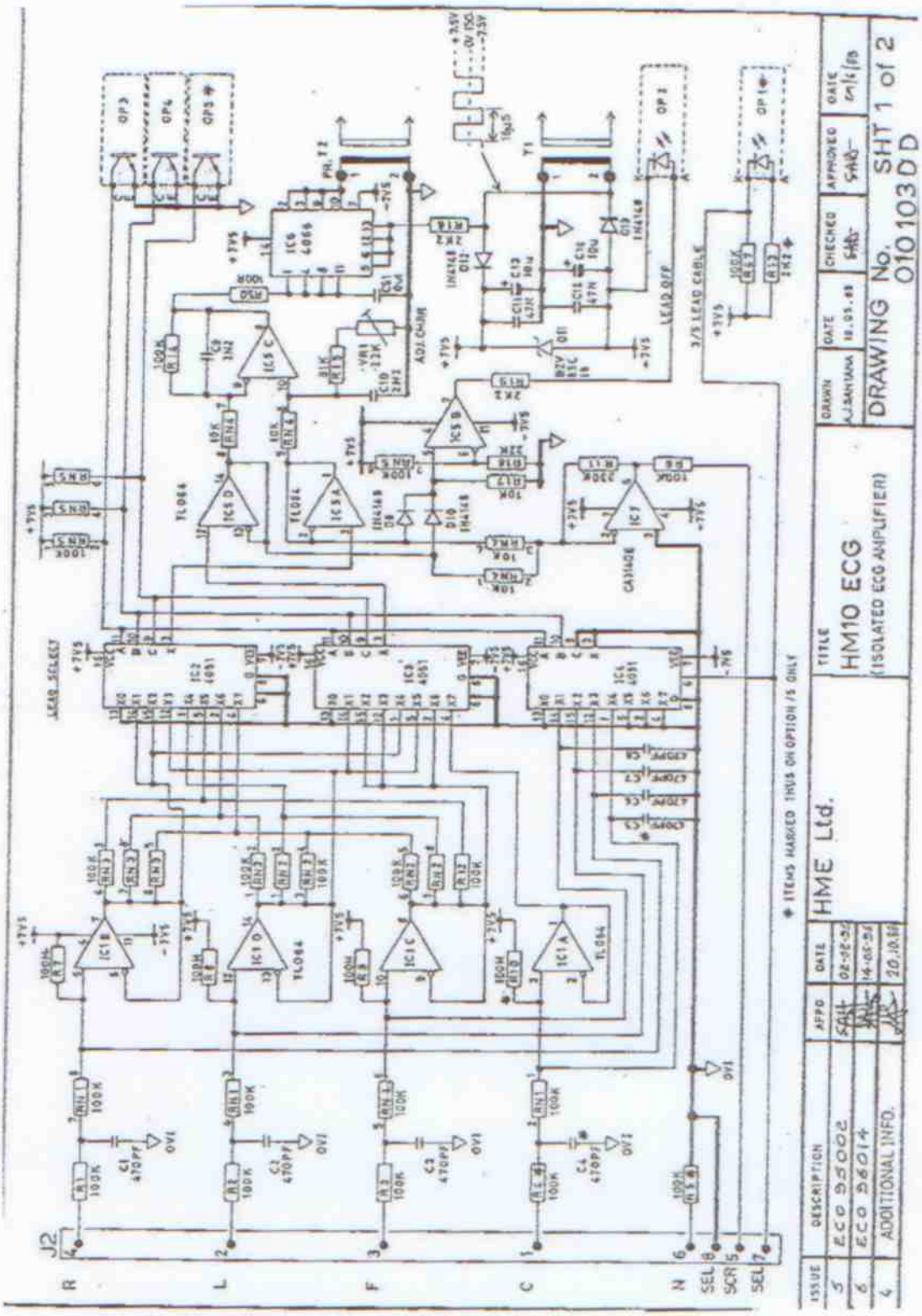
MATERIAL: SEE PARTS LIST
FINISH:
PLATNESS TOLERANCE
DO NOT SCALE DRAWING
65308
USED ON: LP10
SCALE: 1/1
DRAWN: S.A.HODGKISS.
CHD
APPR

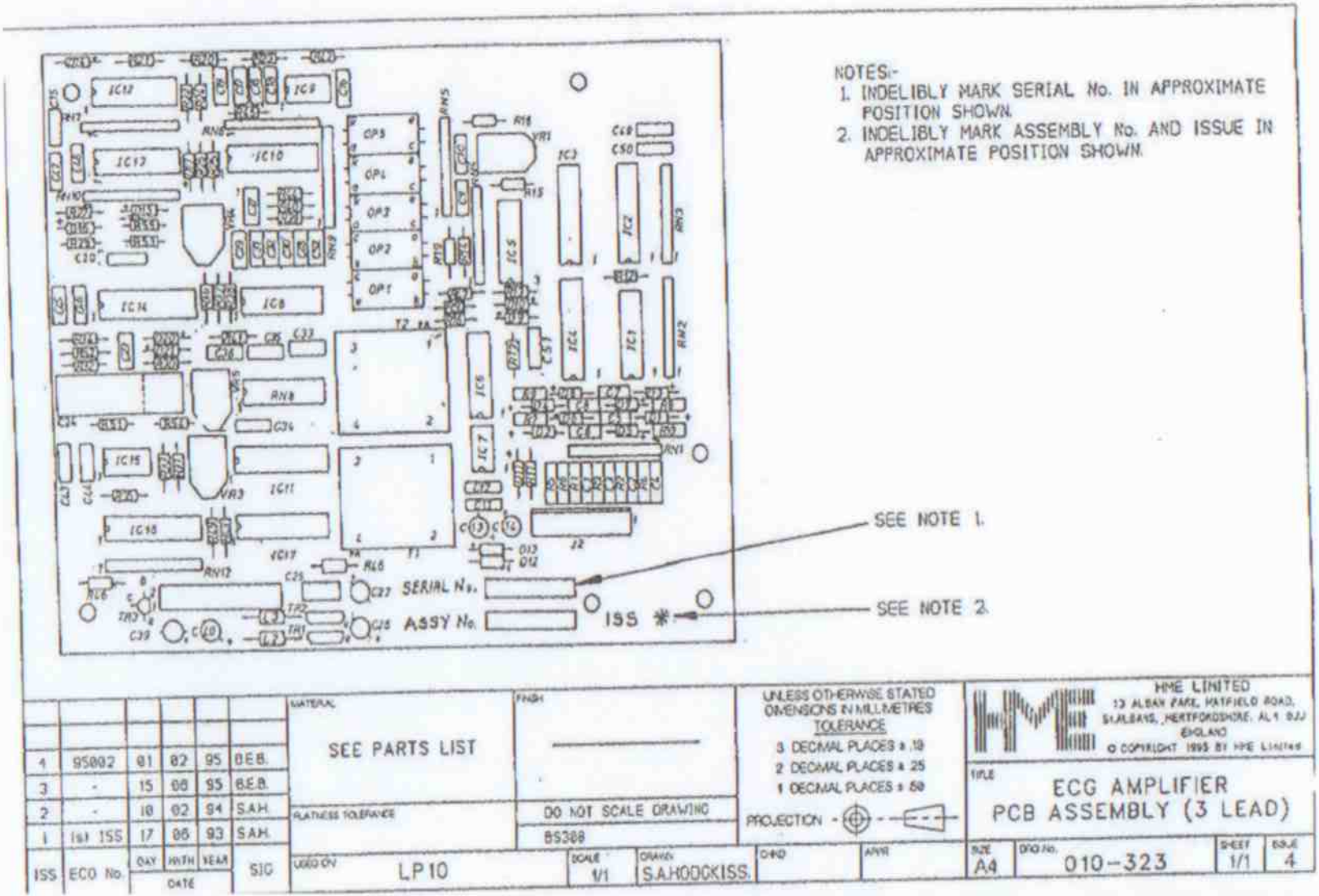
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCE
3 DECIMAL PLACES ± .13
2 DECIMAL PLACES ± .25
1 DECIMAL PLACES ± .50
PROJECTION

HME LIMITED
13 ALBAN PARK, HATFIELD ROAD, ST.ALBANS, HERTFORDSHIRE. AL1 9JJ ENGLAND

TITLE: ECG AMPLIFIER PCB ASSEMBLY (3 LEAD)

SIZE: A4 | DRG NO: 010-323 | SHEET: 1/1 | ISSUE: 4


HME Ltd.
HM10 ECG
(ISOLATED ECG AMPLIFIER)
DRAWING No. 010103DD
SHT 1 of 2
ECO 95002
ECO 96014
ADDITIONAL INFO.
J2
R
L
F
C
N
SEL B
SCR E
SEL T



ISS	ECO No.	DAY	MTH	YEAR	SIG
4	95002	01	02	95	B.E.B.
3	-	15	08	95	B.E.B.
2	-	10	02	94	S.A.H.
1	(s) ISS	17	06	93	S.A.H.

DATE

MATERIAL: SEE PARTS LIST

FINISH: —

FLATNESS TOLERANCE

DO NOT SCALE DRAWING

BS308

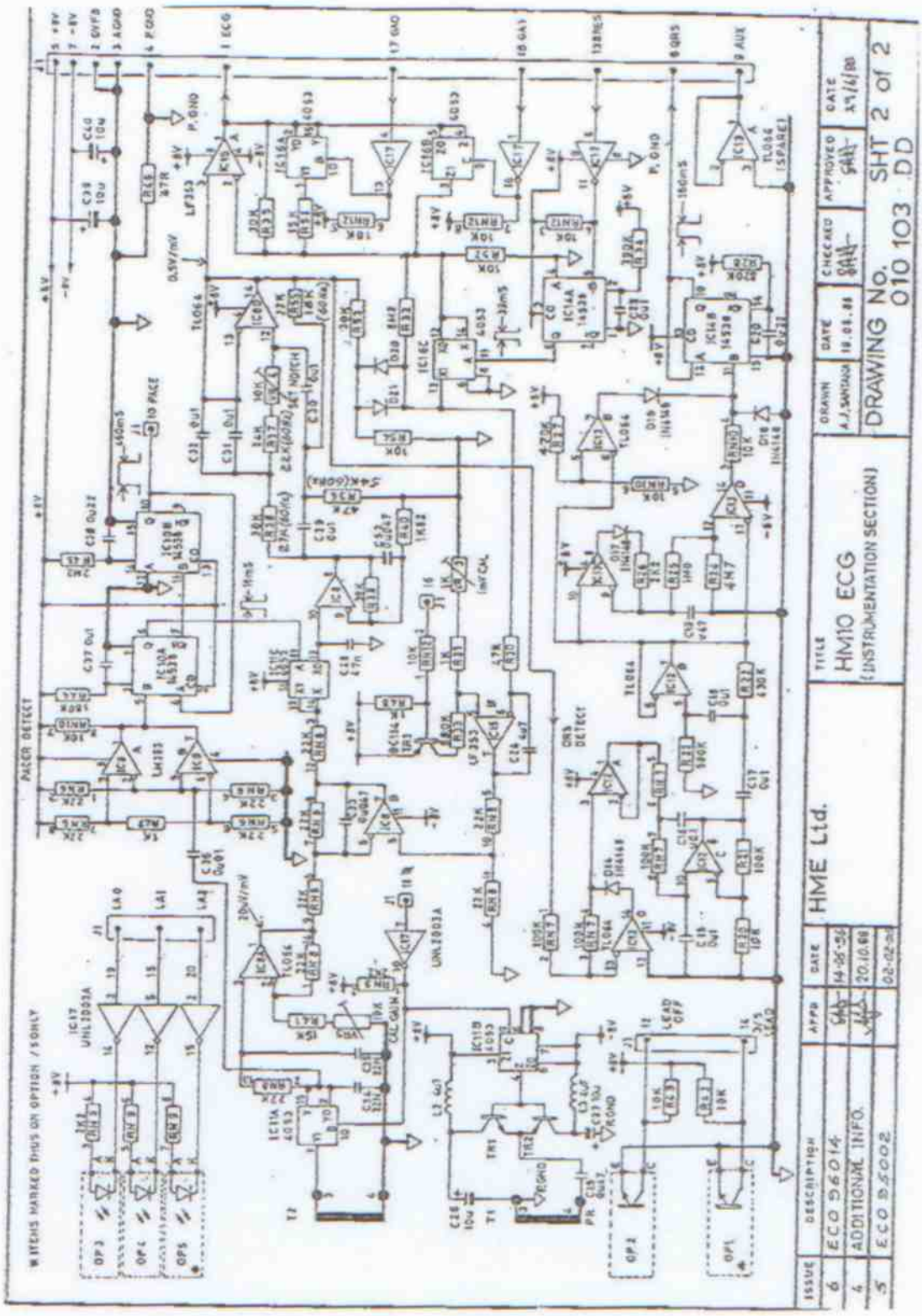
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCE
3 DECIMAL PLACES ± .10
2 DECIMAL PLACES ± .25
1 DECIMAL PLACES ± .50

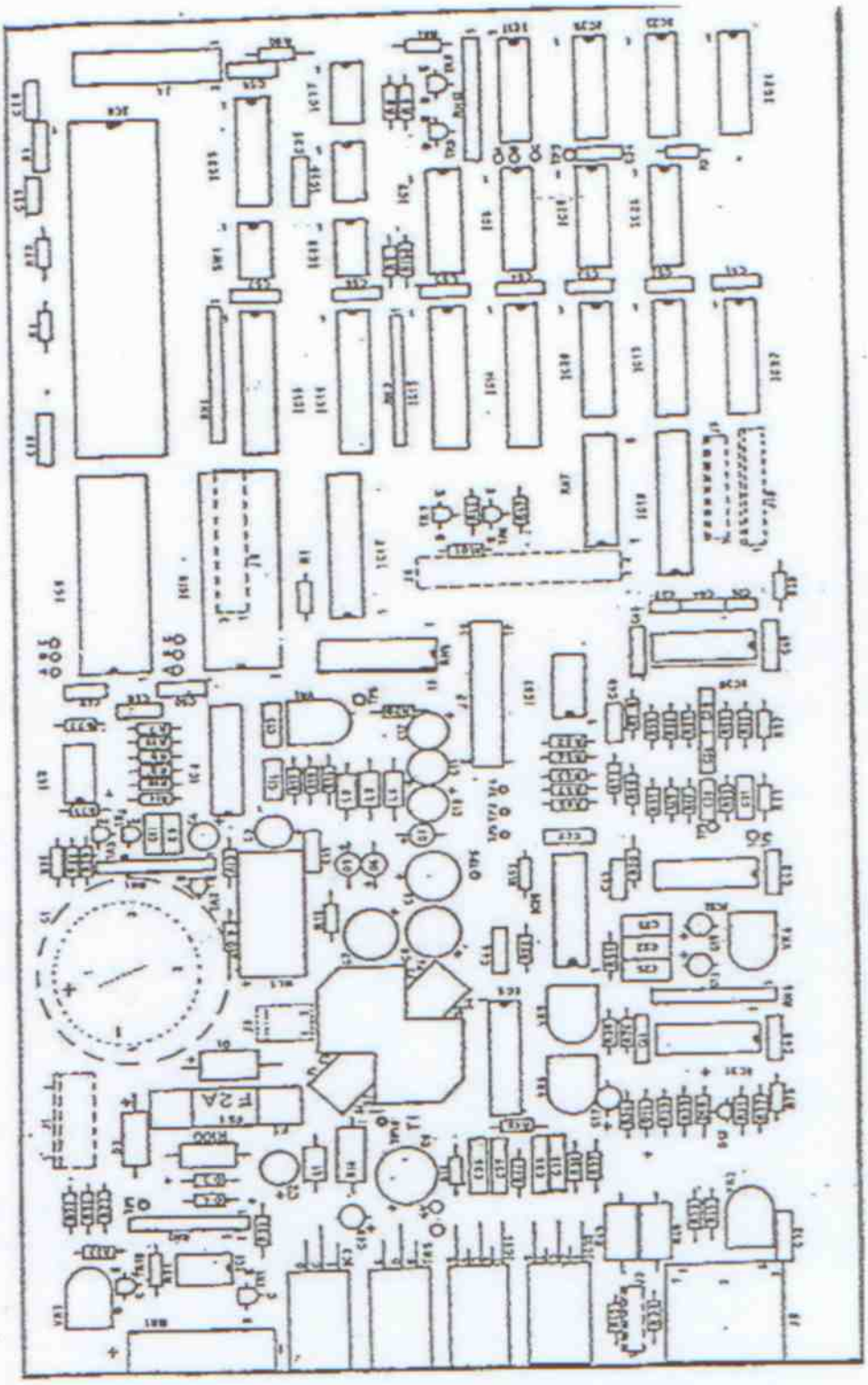
PROJECTION

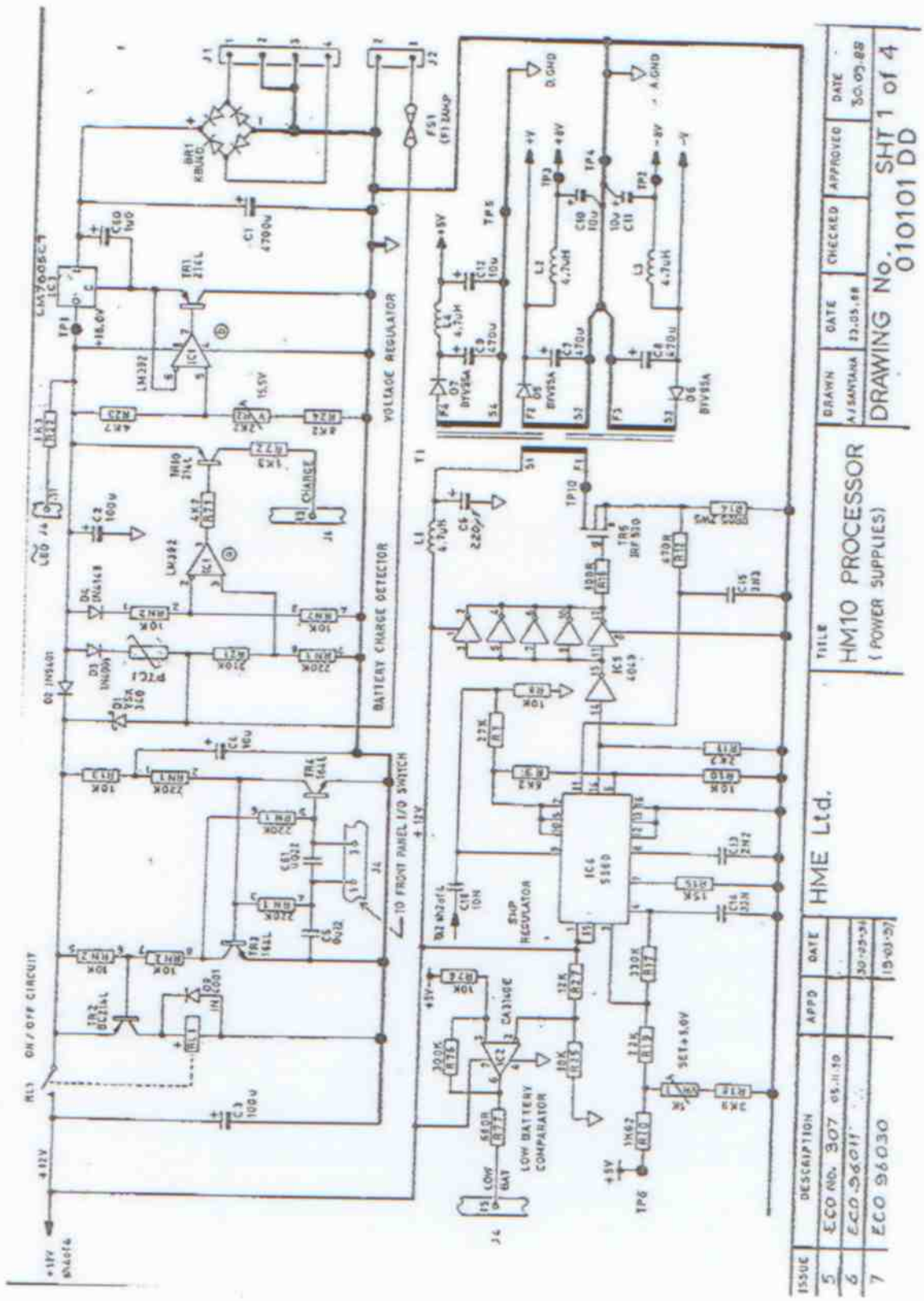
HME LIMITED
13 ALBAN PARK, HATFIELD ROAD, ST.ALBANS, HERTFORDSHIRE. AL1 4JJ ENGLAND

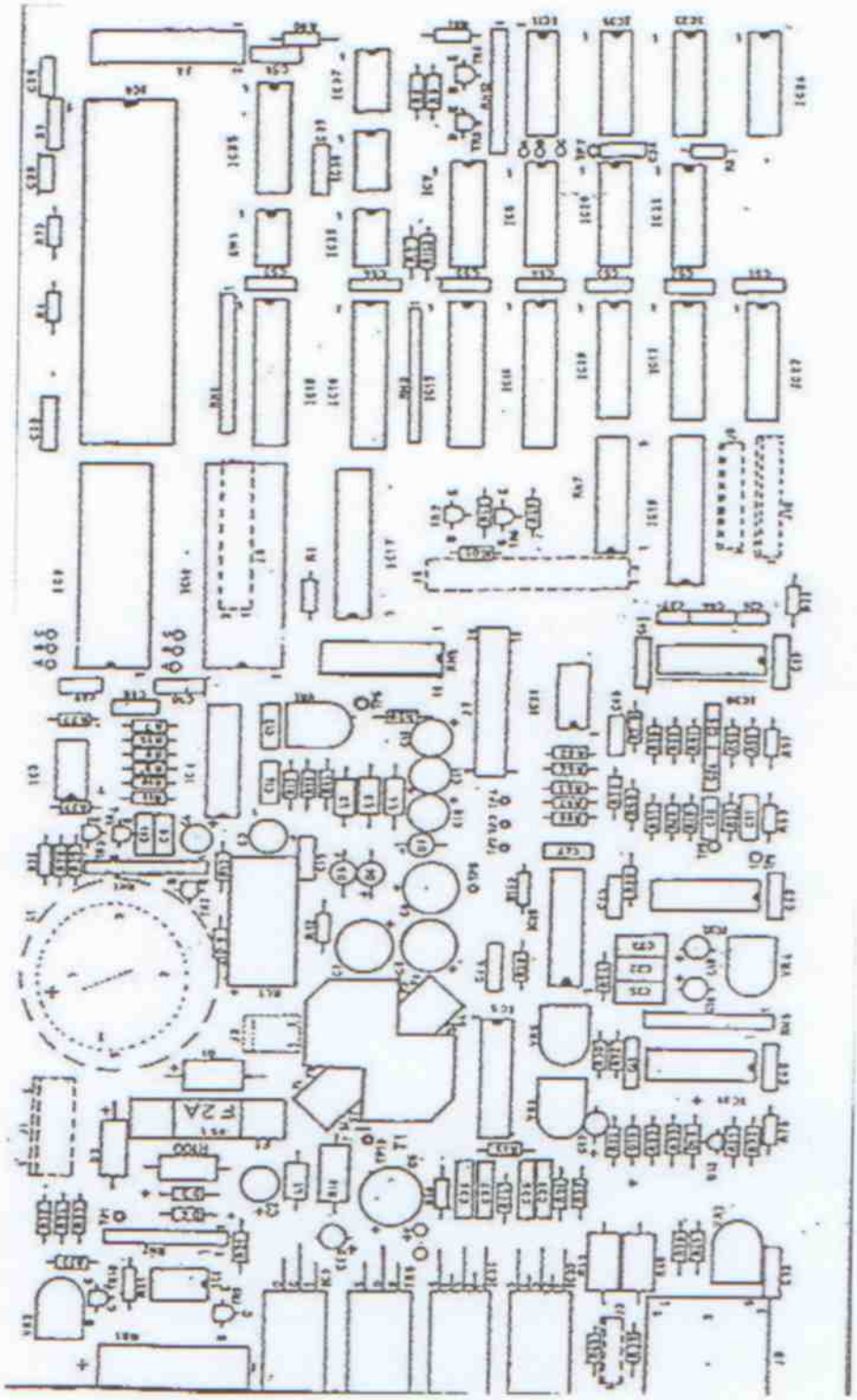
TITLE: ECG AMPLIFIER PCB ASSEMBLY (3 LEAD)

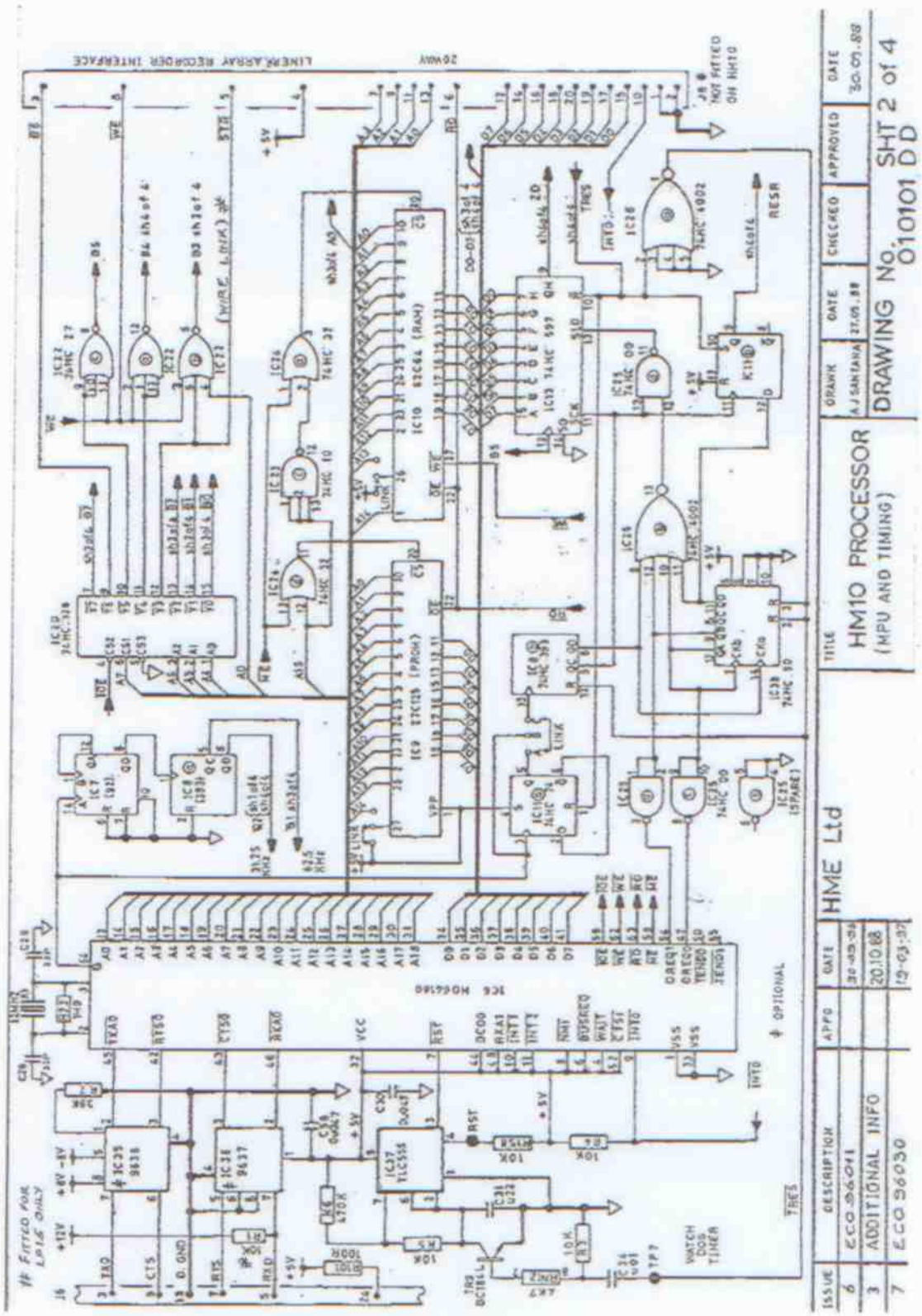
USED ON	SCALE	DRAWN	CHKD	APVD	SIZE	DRG No.	SHEET	ISSUE
LP10	1/1	S.A.HODGKISS			A4	010-323	1/1	4

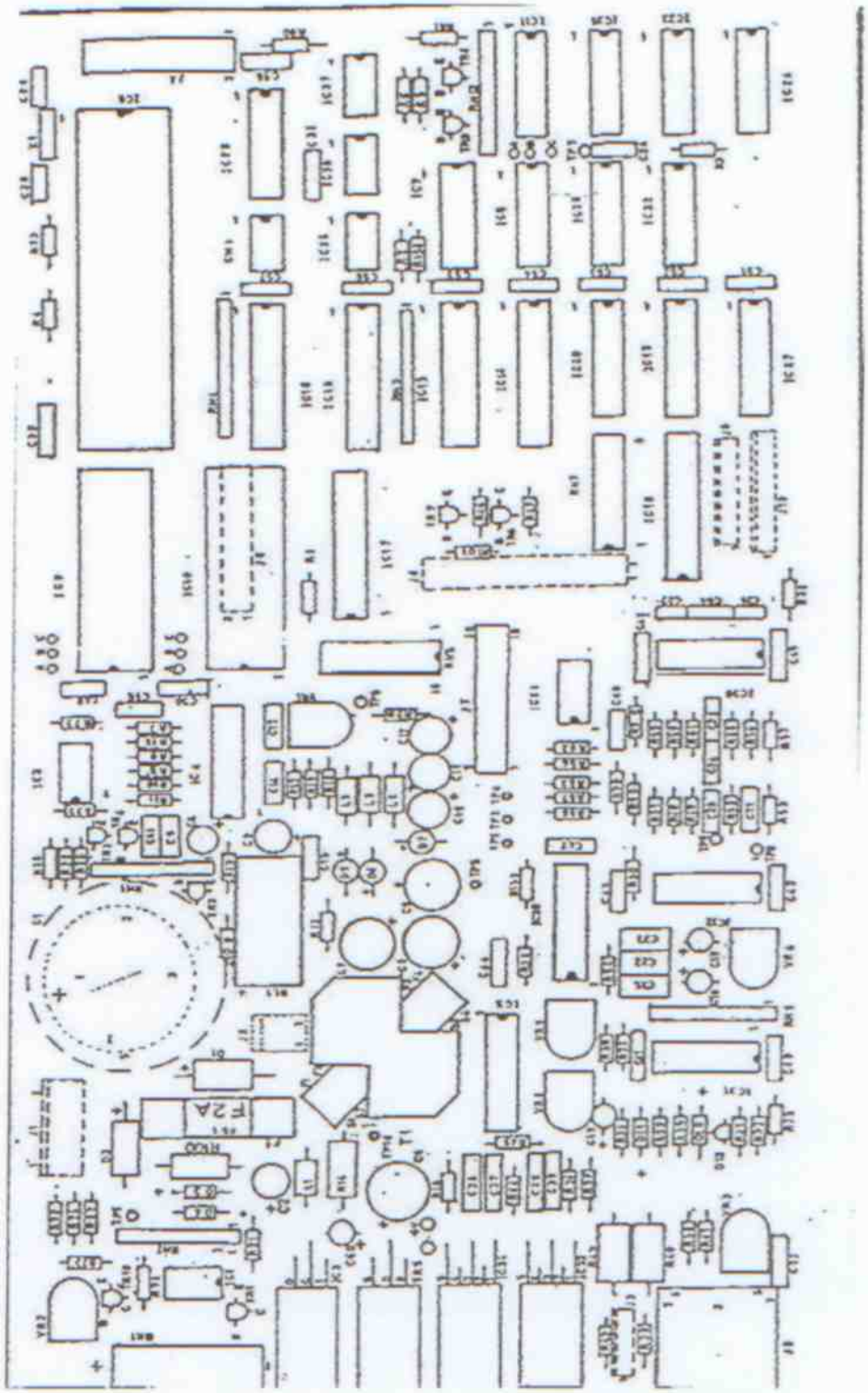

HME Ltd.
HM10 ECG
(INSTRUMENTATION SECTION)
DRAWING No.
010 103 DD
SHT 2 of 2
PACER DETECT
ISSUE
DESCRIPTION
DATE
ECO 96014
ADDITIONAL INFO.
ECO 85002

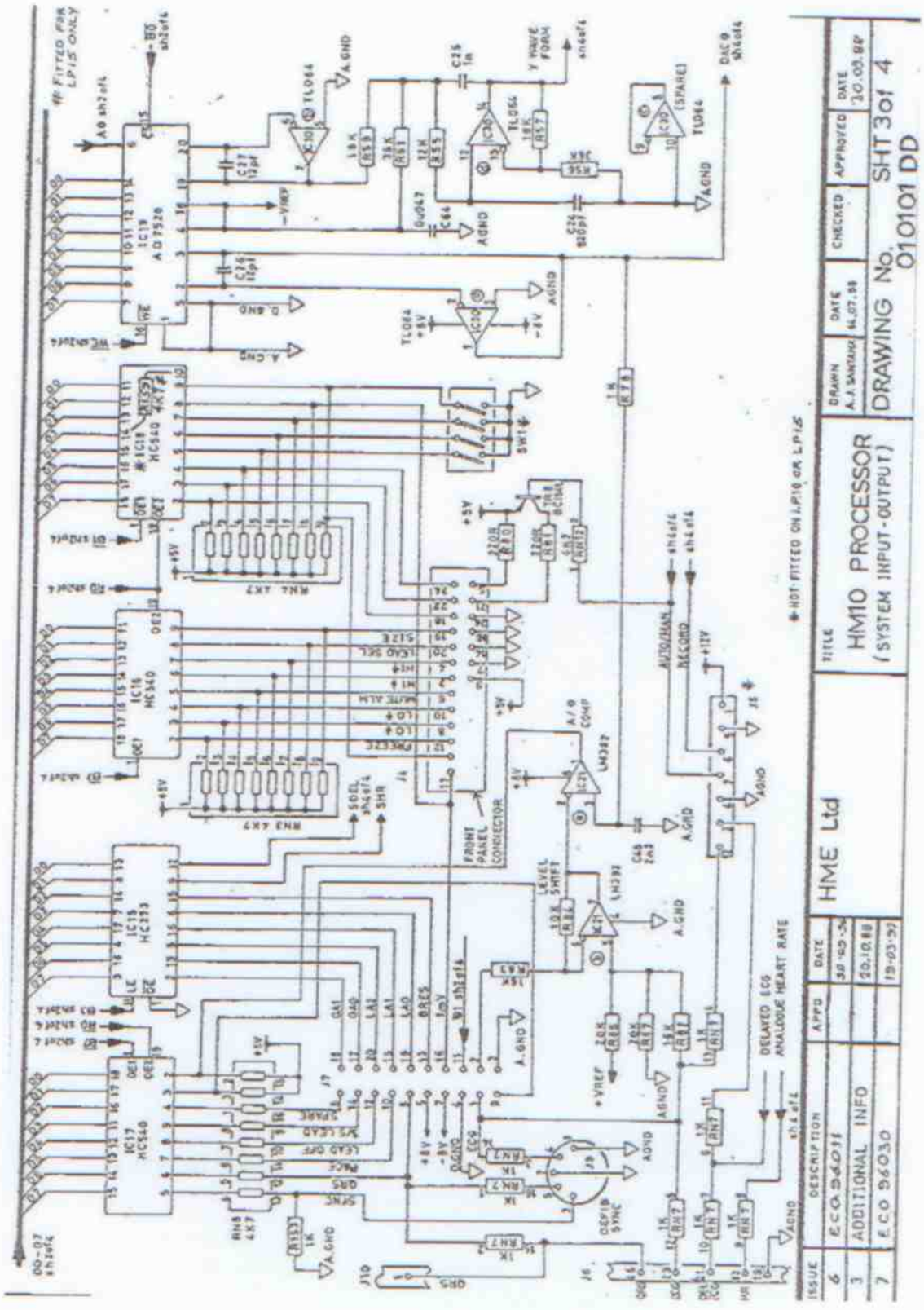


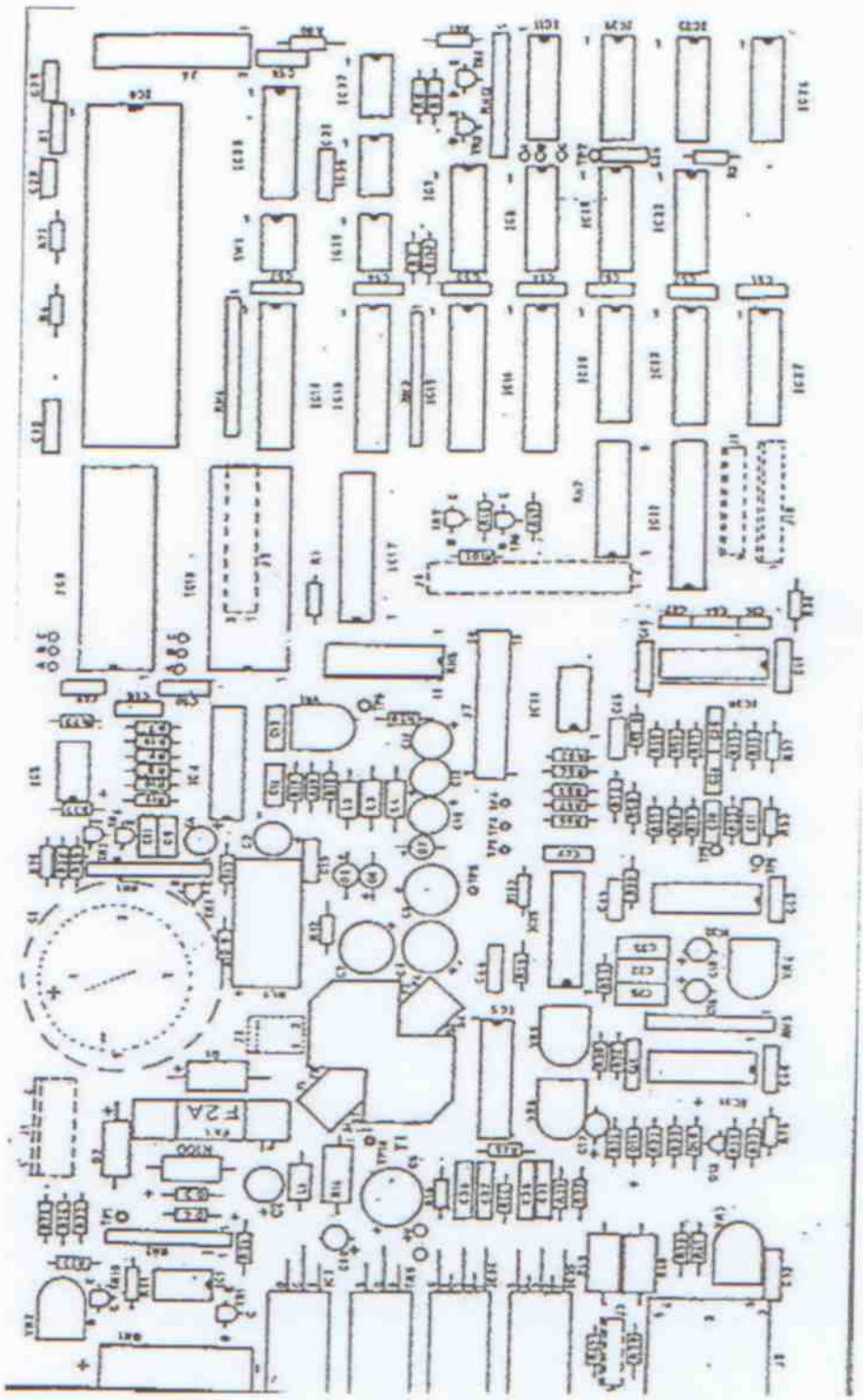

HME Ltd.
HM10 PROCESSOR
(POWER SUPPLIES)
DRAWING No. 010101 DD
SHT 1 of 4
DRAWN A J SANTANA
DATE 23.05.88
CHECKED
APPROVED
DATE 30.05.88
ISSUE
5 ECO No. 307 05.11.90
6 ECO 96011 30-03-93
7 ECO 96030 15-03-97
BATTERY CHARGE DETECTOR
VOLTAGE REGULATOR
ON / OFF CIRCUIT
TO FRONT PANEL I/O SWITCH
LOW BATTERY COMPARATOR
SMPS REGULATOR
+12V
+5V
+8V
-8V
-5V
D.GND
A.GND

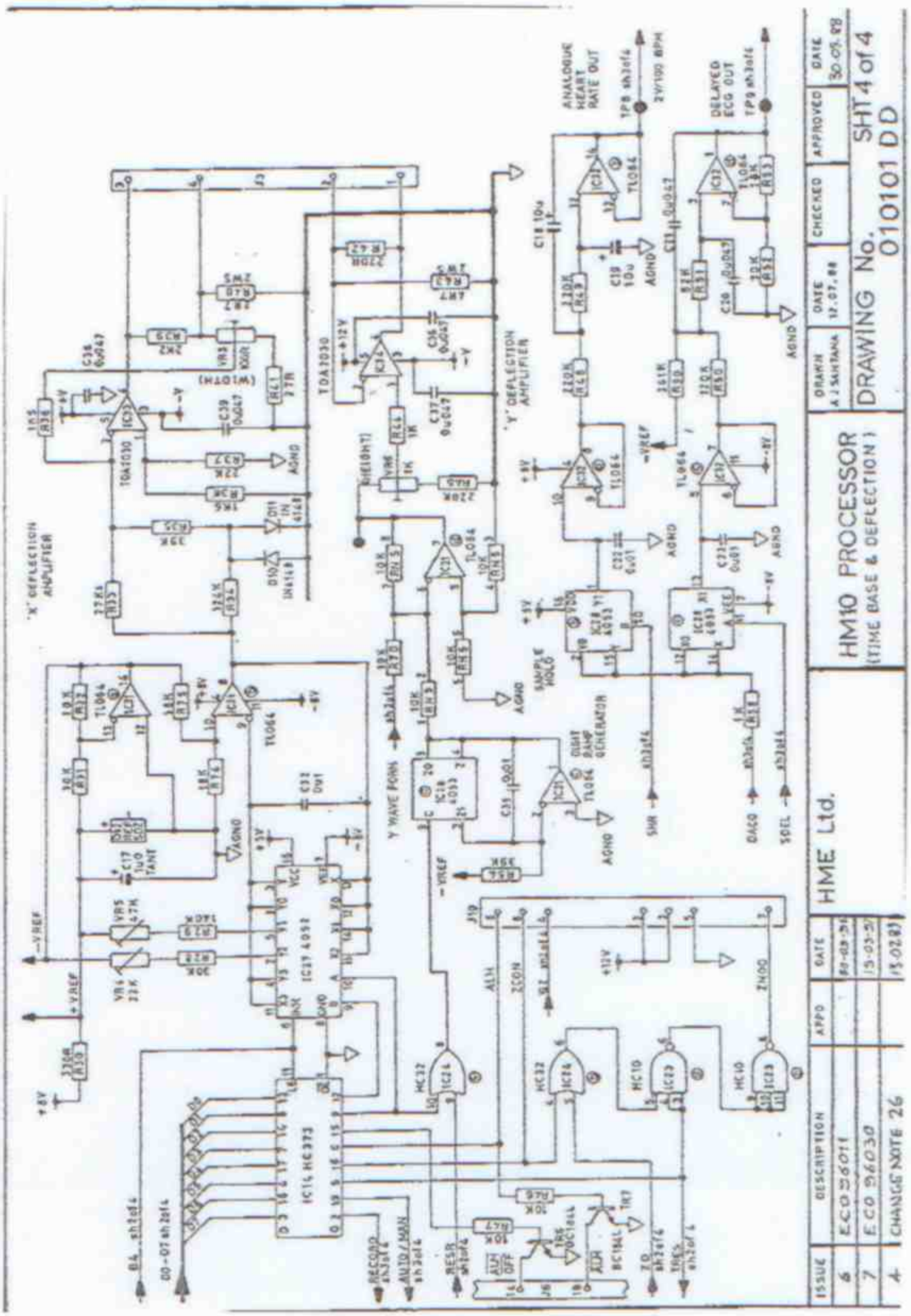


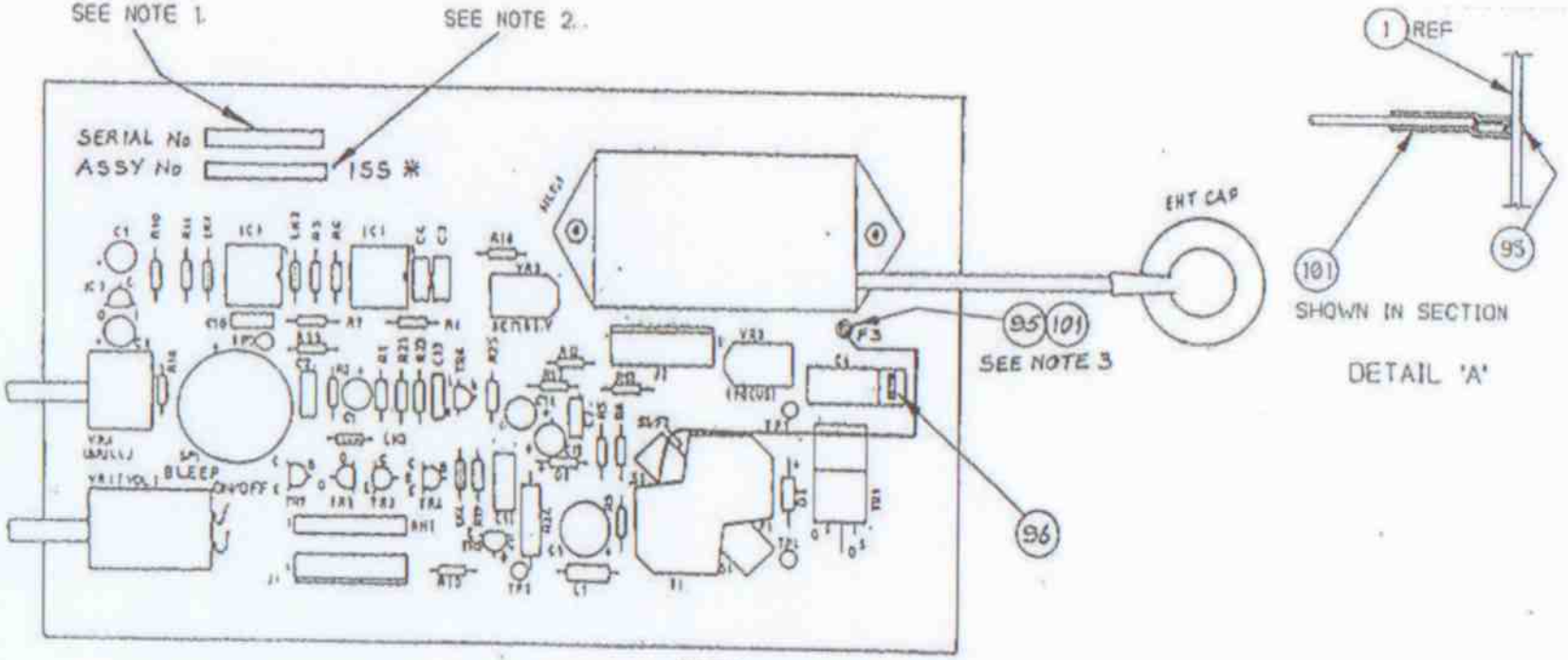

HME Ltd
HM10 PROCESSOR
(MPU AND TIMING)
DRAWING No. 010101 DD
SHT 2 of 4
ISSUE
DESCRIPTION
APPD
DATE
ECO 36041
ADDITIONAL INFO
ECO 36030




HME Ltd
HM10 PROCESSOR
(SYSTEM INPUT-OUTPUT)
DRAWING No. 010101 DD
SHT 3 of 4
DRAWN A.J. SANDANO 4.07.88
CHECKED
APPROVED
DATE 30.09.88
ISSUE 6 ECO 96011 30-09-88
3 ADDITIONAL INFO 20.10.88
7 ECO 96030 19-03-91
* NOT FITTED ON LP10 OR LP15
* FITTED FOR LP15 ONLY
FRONT PANEL CONNECTOR
DELAYED ECG
ANALOGUE HEART RATE
DEFIB SYNC
LEVEL SHIFT
A/D COMP
AUTO/MAN
RECORD
Y WAVE FORM
(SPARE)
DAC 0
RNA 4X7
RNB 4X7




HME Ltd.
HM10 PROCESSOR
(TIME BASE & DEFLECTION)
DRAWING No. 010101 DD
SHT 4 of 4
'X' DEFLECTION AMPLIFIER
'Y' DEFLECTION AMPLIFIER
ANALOGUE HEART RATE OUT
DELAYED ECG OUT
SAMPLE HOLD
DIGIT RAMP GENERATOR
Y WAVE FORM



NOTES:-

1. INDELIBLY MARK SERIAL No. IN APPROXIMATE POSITION SHOWN.
2. INDELIBLY MARK ASSEMBLY No. AND ISSUE IN APPROXIMATE POSITION SHOWN.
3. CUT SLEEVING ITEM 101 TO A 20mm LONG LENGTH AND SHRINK OVER SOLDERED JOINT ON SOLDER PIN ITEM 95 (SEE DETAIL 'A').

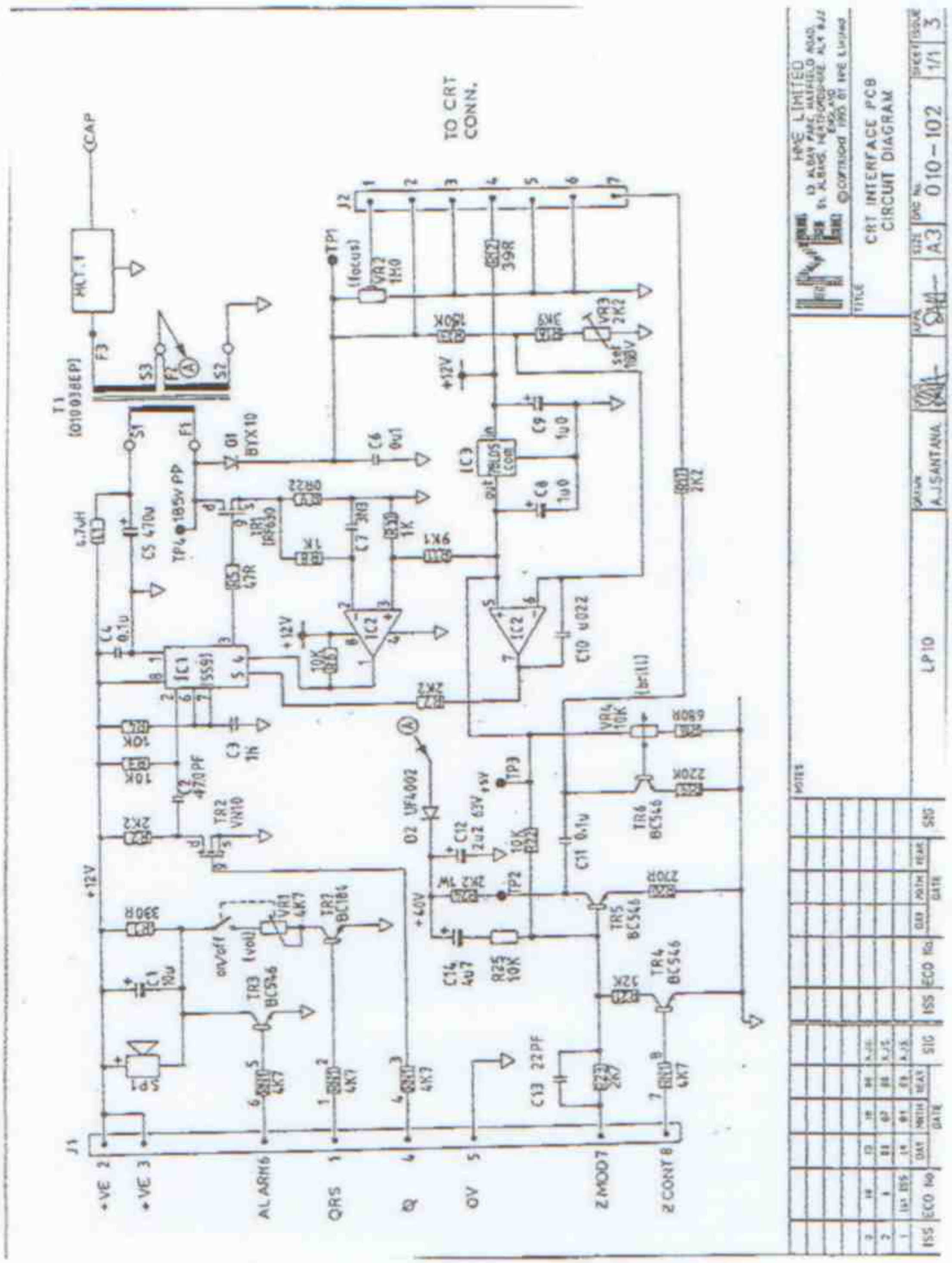
ISS	ECO No.	DATE DAY	MONTH	YEAR	SIG
4	96008	10	05	96	B.E.B.
3	95003	24	01	95	B.E.B.
2A	95009	15	05	95	B.E.B.
2	–	06	10	93	S.A.H.
1	1st ISS	24	09	88	A.J.S.

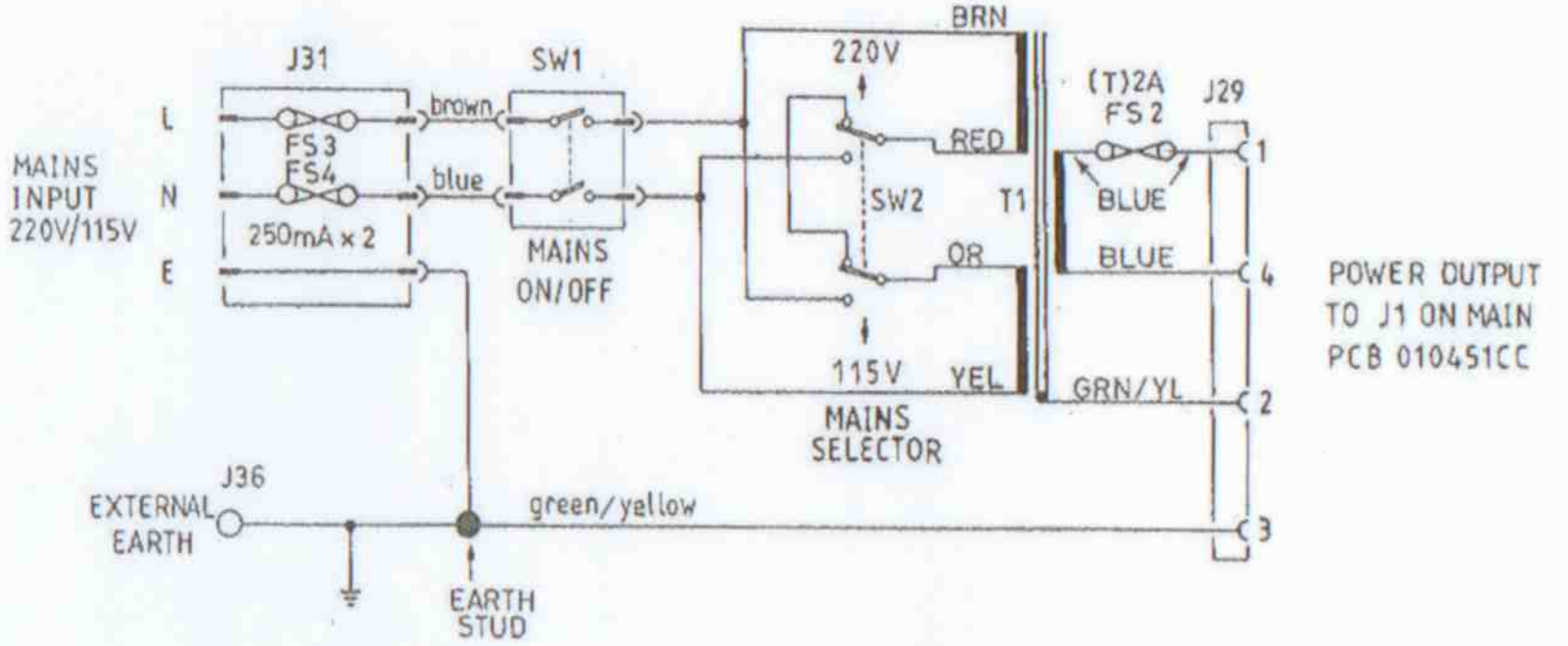
MATERIAL: SEE PARTS LIST
FINISH: —
FLATNESS TOLERANCE:
DO NOT SCALE DRAWING
BS308
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCE
3 DECIMAL PLACES ± 10
2 DECIMAL PLACES ± 25
1 DECIMAL PLACES ± 50
PROJECTION -

HME LIMITED
13 ALBAN PARK, HATFIELD ROAD
ST ALBANS, HERTFORDSHIRE, AL4 0JJ
ENGLAND

TITLE: CRT INTERFACE PCB ASSEMBLY

USED ON	SCALE	DRAWN	CHKD	APPD	SIZE	DWG No.	SHEET	ISS
LP10	1/1	A.J.SANTANA	SAH	SAH	A4	010-322	1/1	4


HPE LIMITED
CRT INTERFACE PCB
CIRCUIT DIAGRAM
A.J.SANTANA
LP10
A3
010-102
1/1
3
TO CRT
CONN.
+VE 2
+VE 3
ALARM6
QRS 1
Q 4
0V 5
Z MOD7
Z CONT 8



ISS	ECO No.	DAY	MTH	YEAR	SIG
2	12	-	-	-	A.J.S.
1	1st ISS	-	-	-	A.J.S.

DATE

NOTES

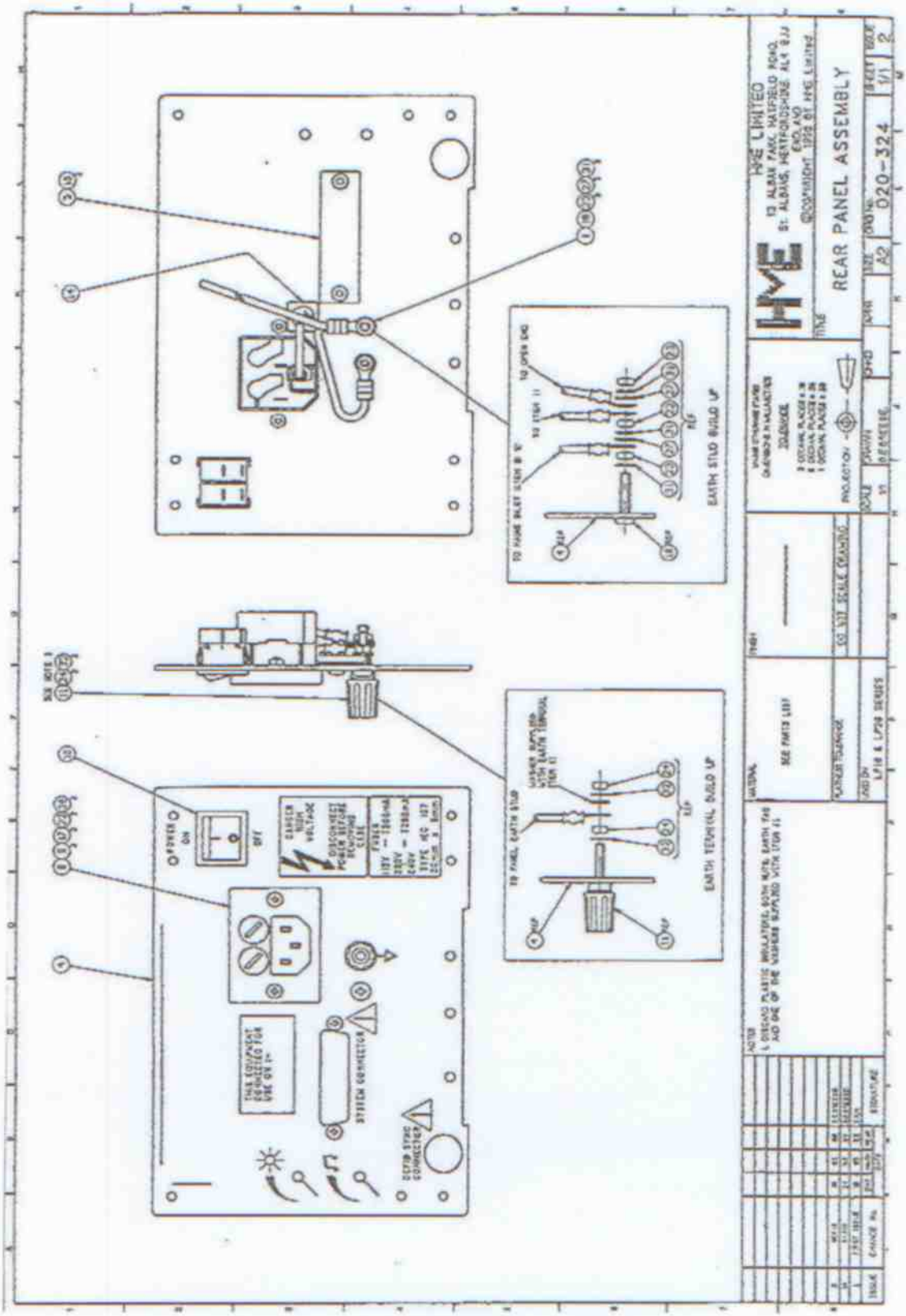
LP10

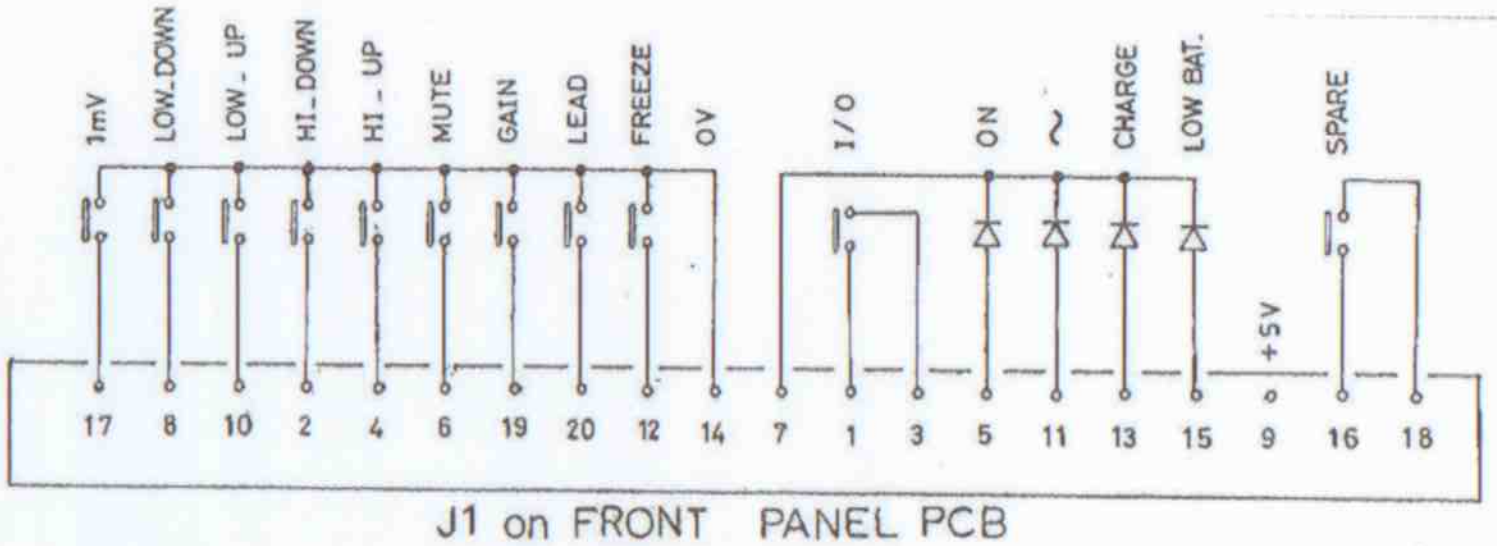
DRAWN B.E.BREESE. CHD SAH APPD SAH

HME LIMITED
82 ALBAN PARK, HATFIELD ROAD,
ST.ALBANS, HERTFORDSHIRE. AL1 4JJ
ENGLAND

TITLE
CIRCUIT DIAGRAM
MAINS INPUT

SIZE A4 | DWG No. 010-106 | SHEET 1/1 | ISS 2


REAR PANEL ASSEMBLY
020-324



J1 on FRONT PANEL PCB

DRAWN. AJS		CHECKED.				TITLE			
DATE. 07.07.88		DATE				HM10 FRONT PANEL CONTROL CIRCUIT DIAGRAM			ISSUE 1
ISSUE	2								
DATE	20/2/8								
CHANGE NO.	—								
NAME	AJS						DRG. NO. 010 100 ED		SHT 1 OF 1

8. MAINTENANCE

8.1 User Maintenance

Operator first line trouble shooting and cleaning is described in Section 4.4 and 4.5 of this Manual, and should be referred to first in the event of a fault.

HME recommend that preventative maintenance checks are carried out on the unit at 6 monthly intervals under an HME Service Contract. Alternatively, the maintenance may be carried out by suitably qualified personnel.

8.1.1 Mechanical assembly and access

The instrument is housed in an aluminium case. Internally the unit consists of a aluminium back panel and a PCB which forms the front panel containing the touch sensitive membrane switches and LED indicators. The front and rear panels are secured on the side of a steel U section box which also acts as the ECG amplifier screening box. A steel plate on the opposite side provides for rigidity and support for PCB's.

8.1.2 Case removal and replacement

Place the unit upside down and unscrew the 2, M4 screws securing the case to the rear heat sink. Carefully slide the unit out of the rear of the case.

Case replacement is a reversal of the above. However, it is important to check that the star washers on the fixing screws are fitted, ensuring an adequate case earth.

8.1.3 Battery removal/replacement

To remove or replace the battery (if fitted), remove the instrument from the case as described in section 8.1.2 above. The battery box is located at the top rear of the unit. Remove the 4 off M3x6 fixing screws. Lift off the battery box top cover exposing the batteries. Lift out the battery complete with tray, taking care not to strain the connector. The battery may now be removed from the tray to complete the procedure.

Fitting batteries is a reverse procedure of the above. Care should be taken, however, to ensure correct polarity of the battery connector. The red battery lead should be towards the rear of the unit.

8.1.4 Changing the mains tapping

The voltage tapping is normally set to be correct for the country in which it is intended for use. However, if it is necessary to change it the following procedure should be used:

a) Remove unit from the case as described in 8.1.2 above.

b) The voltage selector is located on top of the transformer screening box on the left hand side of the instrument, and should be set as follows:

For 115V	set 115V
For 220-240V	set 230V

The mains input fuses located in the mains input socket may also need changing and are as follows:

Setting 115V	Fuse T500mA	250V	20x5mm	IEC127
Setting 220V	Fuse T250mA	250V	20x5mm	IEC127

The transformer secondary fuse located next to the voltage selector is a T2A fuse 20x5mm IEC127 for all values of mains input.

8.1.5 Access to PCB's

All PCB's within the LP10 are accessible without the use of extenders and, therefore, most fault finding can be done in situ. If it is necessary to remove the PCB's the following procedure should be used.

Access to main PCB - located at the bottom of the unit.

a) Disconnect battery (8.1.3) if fitted.
b) Disconnect J22,J29, J30 Drg. 010 337/1
c) Disconnect J20, J21 Drg. 010 337/3
d) Unscrew the 3 screws securing the PCB rear heat sink to the back panel heat sink. Drg. 010 337/3
e) Remove the two M3x6 edge fixing screws Drg. 010 337/3
f) Gently lift and pull the PCB sideways from the side edge to clear the PCB card guide. Once clear remove PCB rearwards to remove.

Installation is a reverse procedure of the above. However, reference should be made to the assembly drawings, number 010 337(sht 1-4) for correct screw and washer location.

Access to ECG amplifier PCB - located in the side screening box.

a) Disconnect J2 Drg. 010 353
b) Disconnect J20 on main board, Drg. No. 010 337/3
c) Using small flat nose pliers, unscrew the 4X M3 PCB retaining nuts complete with fibre washers. (Drg 010 337/2 item 3) Lift the rear of the PCB clear. C24 may be used as a support for this operation, if necessary, then lift the PCB clear.

Installation is a reverse of the above procedure.

Access to CRT interface PCB - located on the right hand side of the unit.

a) Remove the brilliance and bleep volume control knobs by lifting the control knob caps with a knife blade and then unscrewing the collet to loosen the knob.

b) Remove the four M3 fixing screws and PCB insulator.

c) Gently lift the front end of the PCB out and slide to release the brilliance and bleep volume control shafts. Disconnect the EHT cap, J23, and J25 to completely remove.

Installation is a reverse of the above procedure. It is, however, very important to ensure that the PCB insulator is re- fitted to ensure adequate insulation to the case.

8.2 Setting up procedure - Monitor

The following is a complete setting up procedure in correct order. It will be evident from first reading which parts are relevant after a component replacement.

Disconnect CRT interface and ECG amplifier PCB connections.

8.2.1 Voltage checks

Use the junction of R41, R42 as ground reference.

a) Turn brilliance to minimum.

b) Apply power and turn rear power switch "on", on main board (bottom board). Set VR1 to give 16.0V on FS1.

c) Turn front panel I/O switch "on". Adjust VR2 to give +5.0V at TP5.

d) On Processor PCB Drg 010-101 sheet 1
e) Check +8V +10% at IC31 Pin 4
f) Check -8V +10% at IC31 Pin 11
g) Check +12V at +10% at D6 cathode
h) Check +22V +10% at TR6 drain

a) Check waveform at TR5 drain to be as in Fig 8.06

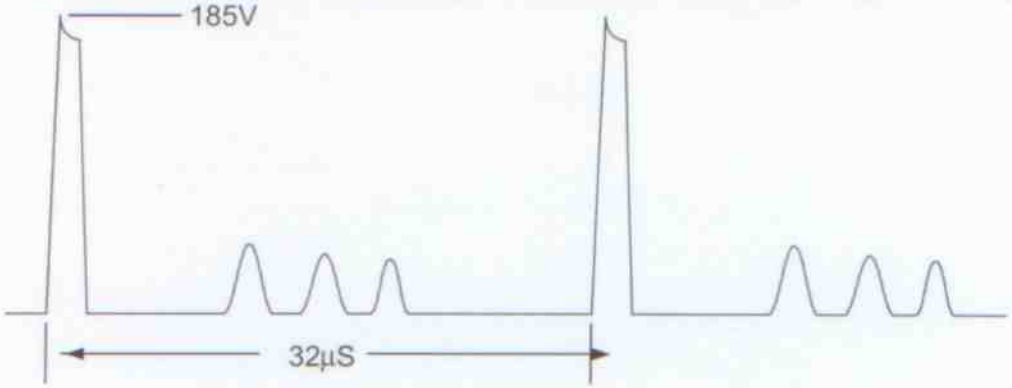
8.2.2 X Time Base Set Up

A correctly set up time base should conform to the waveform shown in Fig 8.05 at IC31 Pin 8.

Adjust VR10 to give a "ramp up" peak of +2.5V at IC31 pin 14.
Adjust VR8 to give "ramp down" of -2.5V at IC31 Pin 14 as shown in the timing diagram Fig 8.04

Check Y waveform drive at IC31 Pin 1 to be as in Fig 8.05.
Switch off

Re-connect CRT and ECG PCB'S. Connect oscilloscope to TP4 on CRT board (PCB 010 452) and adjust VR3 (CRT board) to give the following waveform (i.e. adjust to 185 peak).



Observe CRT display. Increase brilliance. Adjust scan coil orientation and VR3 (width) on main board to give a full screen width picture.

Adjust VR6 to give approximately the correct height display, i.e. digits approximately 1cm from bottom and top of screen.

Turn brilliance to maximum. Adjust VR2 (CRT board) to give best focus on digit display. Re-adjust brilliance for normal viewing.

Check operation of ALL front panel controls for correct operation.

Switch off and disconnect mains. Connect an adjustable 8- 15V (1A minimum) power supply to the battery connector (J2) on main board. Ensure correct polarity +VE nearest to front of unit and switch unit "on".

Turn power supply voltage down slowly and observe "low battery" LED. Determine point at which it illuminates. Check power supply voltage to be +11.5V +100mV. Disconnect and re-connect mains power.

8.2.3 ECG Amplifier Set Up

CMRR set up - connect, R,L together, use F as reference and apply a 3V PP 10Hz signal. Set "gain" to 2cm/mV, and adjust VR1 (ECG board) to give minimum signal. Re-adjust VR1 to give a signal that just clips the signal on the CRT. Adjust VR3 (main board) to give a full scale to just fill the screen, i.e. 80mm height. Re-adjust VR1 (ECG amp) from minimum signal. Check amplitude <1ccm PP on CRT.

Cal Gain

Connect L, F together and use as reference. Apply a 1mV calibrated square wave to R. Adjust VR3 (ECG amp PCB) to give 2cm on X2 gain. Check that X1 gives 1cm and X0.5 gives 0.5cm on the CRT.

1mV Cal

Select STD, and X2 gain. Depress 1mV button and adjust VR3 (ECG amp PCB) to give 2cm pulse.

50Hz Notch Cal

Select Lead I, X2 gain, apply 50Hz 1mV sine wave. Adjust VR4 (ECG amp PCB) to give a null signal on the CRT.

Lead Select Test

Connect a calibrated ECG simulator to the patient input. Set to 1mV 60 BPM. Observe correct waveform in all leads (see waveform sheet).

8.2.4 Ratemeter and Alarm Checks

Ensure heart rate reads 60BPM. Change to 120 BPM and check reading agrees. Set to 1/2mV and check ratemeter operates correctly.

Switch off simulator. Check asystole indication operates in 4 seconds.

Switch simulator back on. Check QRS bleep control operates correctly.

Check LO and HI limit alarms operate after delay of 8 seconds when heart rate is outside set limits. Check for intermittent warning sound. Asystole continuous warning sound.

8.2.5 X Time Base Calibration

Set simulator to 60 BPM. Allow trace to stabilise for >4 seconds. Press freeze.

Adjust VR3 (width) to give 25mm spacing between QRS complexes. When adjusted the trace should just fill the CRT display and be central. Slight shift adjustments may be necessary using the deflection yolk ring magnets or by VR4.

8.2.6 Pacemaker Rejection Checks

Connect a combined ECG and pacemaker simulator and check for proper ratemeter operation in the presence of pacemaker pulses.

Pacemaker pulses should be displayed as 2cm negative going pulses on the CRT. Check that for pacer only pulses the heart rate reads zero and the asystole alarm operates.

Check for correct operation of ratemeter and pacer display for +V and -VE combinations of both at ECG amplitudes from 0.25mV-2.5mV and pacer pulses from 50mV-750mV, 0.2mS-2mS.

8.2.7 Defib Sync Operation

Connect the QRS out to the sync in connections on the rear "DIN" socket together. Connect a simulator at 1mV 60BPM and observe the modified QRS waveform on the CRT (i.e. differentiated looking QRS).

8.2.8 Delayed ECG output

Connect an oscilloscope to pin 11 on the system connector. Connect an ECG simulator to the patient input and switch on. Observe a 0V signal for the first 20.5 seconds followed by an exact replica of the real time ECG output present on pin 12. Switch off simulator and observe signal for 20.5 seconds.

8.2.9 Analogue Heart Rate Output

Connect an oscilloscope or voltmeter to the system connector pin 19. Connect an ECG simulator to the input. Set to 60 BPM. Check that the voltage at pin 19 settles to 1.2V +10%. Set the simulator to 120 BPM. Check that the output voltage now settles to 2.4V +10%.

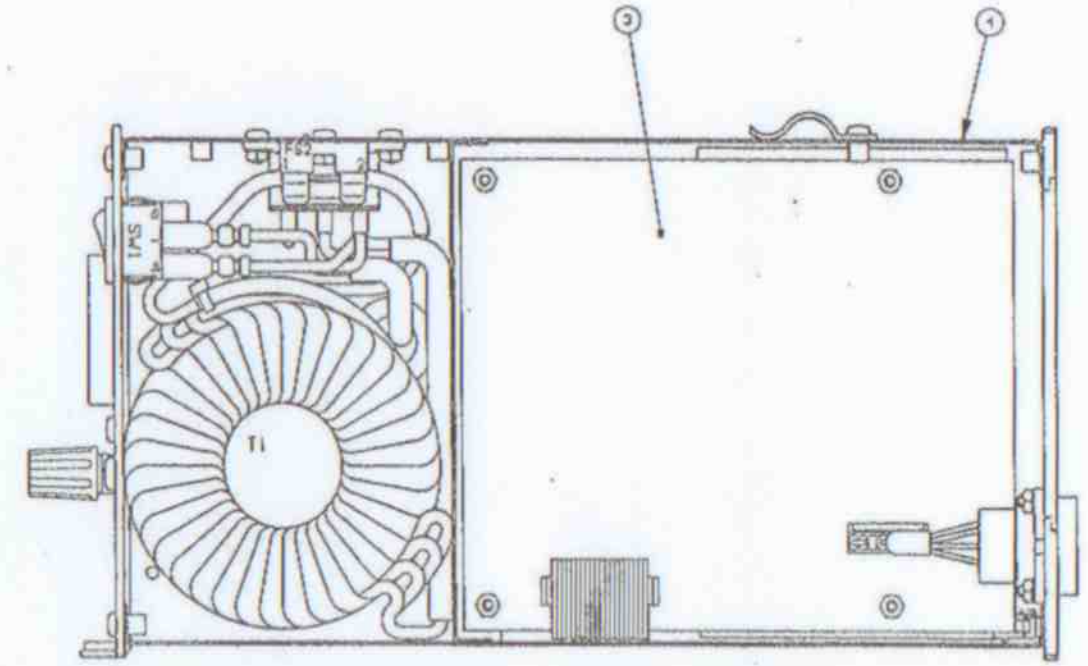
8.2.10 Lead Off

For 3 lead options, select Lead I. Connect an ECG simulator. Remove each lead, one at a time (i.e. R,L,F) and check "lead off" is displayed in each case.

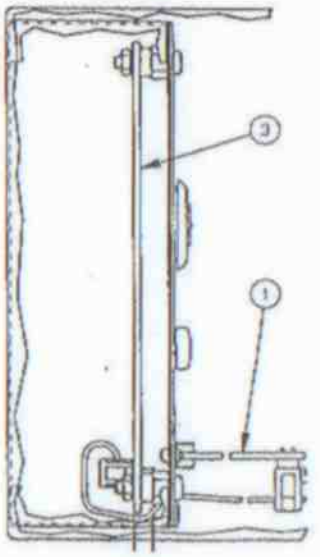
For 5 lead versions, select the "V" lead and remove each lead in turn (i.e. II, II, III, aVF, V) and observe the "lead off" is displayed in each case.

8.3 Unit Assembly

Item No.	Description	Stock No.
01	Processor PCB Assembly	010-321
02	ECG Amplifier PCB Assembly	010-323
03	CRT Interface PCB Assembly	010-322
04	Front Panel Assy (LP10)	010-320
05	Scan Coil Assy	010-328
06	Cable Assy (CRT to CRT I/F PCB)	010-367
07	Cable Assy (CRT I/F PCB to Proc)	010-331
09	Cable Assy (Nicolay Skt 3 Lead)	010-343
10	CRT Conn PCB Assy	001-310
14	LP10 Program Code (Firmware)	010-600
18	Side Screen Box	010-202
19	Side Panel	010-203
20	Rear Panel Silk Screened	020-206
21	CRT Support Bracket	010-205
24	Front Panel Overlay LP10	010-405
27	CRT M13-125W	DC0003
28	Transformer Mains	WT0036
29	Mains Inlet 250V AC (CEE22 Type)	KP0109
30	Switch Mains 2 Pole 250V AC	LR0021
31	Voltage Selector	LS0020
32	Fuse 250mA (20 x 5) Time Lag	FA0052
33	Fuse 2A (T) 250Vac 20 x 5	FA0063
34	Fuse Holder (Chassis Mounting)	FB0001
35	Terminal Earth	KT0070
36	Knob	HK0002
37	Knob Cap	HK0005
38	Tension Clip	HF0432



LEFT SIDE VIEW (WITH CASE REMOVED)



PART SECTION FRONT VIEW

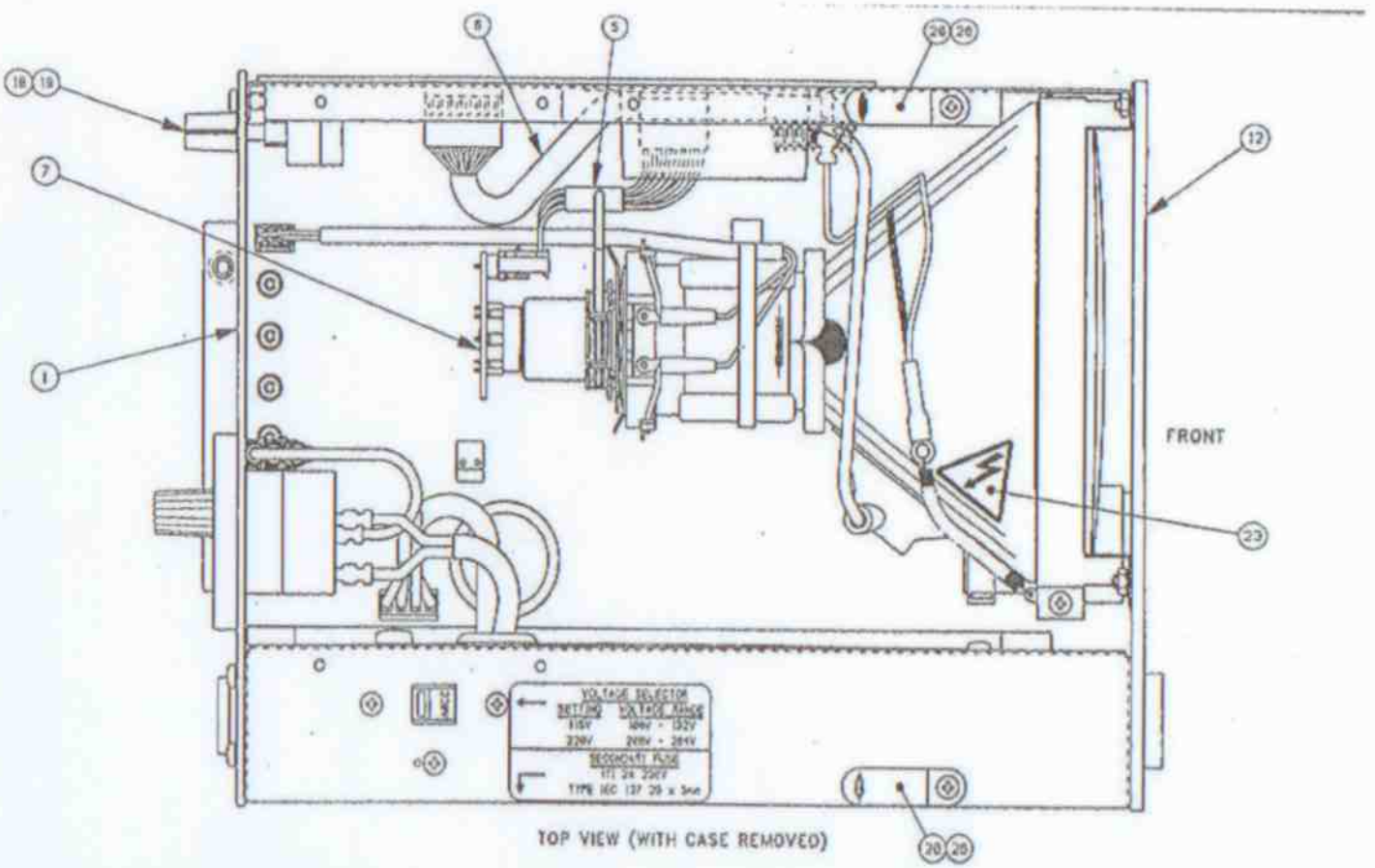
ISSUE	CHANGE No.	DAY	MONTH	YEAR	SIGNATURE
6	85268	23	05	95	B.E.BREESE
5A	84218	28	03	94	B.E.BREESE
5	UPDATED	05	04	93	S.MCCOSKISS
4	UPDATED	26	10	88	A.J.SANTANA
3	CHASSIS MODEL VERSION	11	11	88	A.J.SANTANA
2	TEXAS 50,60 ADDED	31	03	88	A.J.SANTANA
1	65001	08	03	88	B.E.BREESE

MATERIAL: SEE PARTS LIST
FINISH:
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCE
3 DECIMAL PLACES ± .13
2 DECIMAL PLACES ± .25
1 DECIMAL PLACES ± .50
PROJECTION
FLATNESS TOLERANCE
DO NOT SCALE DRAWING
65268
USED ON

HME LIMITED
13 ALBAN PARK, HATFIELD ROAD, ST. ALBANS, HERTFORDSHIRE, AL4 0JA ENGLAND
©COPYRIGHT 1995 BY HME LIMITED

TITLE: ELECTRONIC ASSEMBLY LP10

SCALE	DRAWN	CHD	APPD	SIZE	DRG No.	SHEET	ISS.
1/1	B.E.BREESE	SA/A	SA/A	A3	010-337	2/4	7

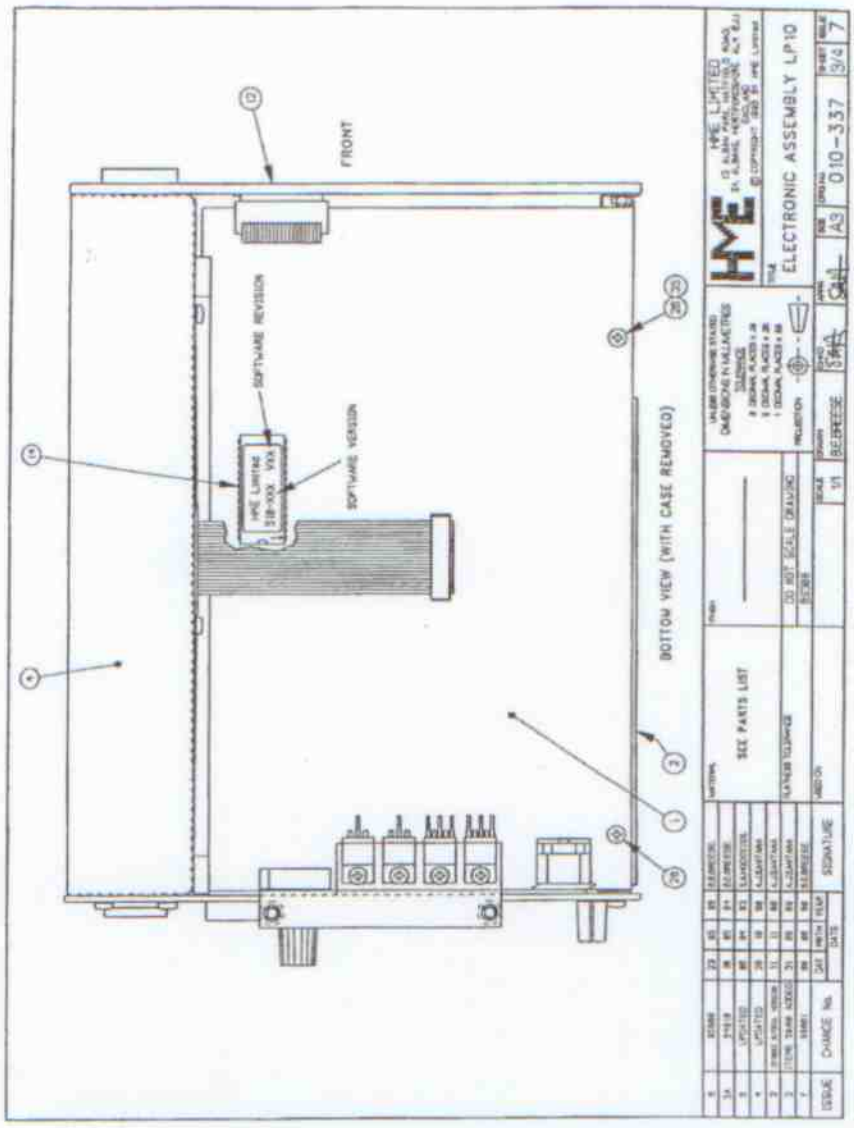


ISSUE	CHANGE No.	DATE DAY	DATE MTH	DATE YEAR	SIGNATURE
6	57309	23	05	95	B.E.BREESE.
5A	54018	18	05	94	B.E.BREESE.
5	UPDATED	06	04	93	RAMDOOSS.
4	UPDATED	28	10	88	A.J.SANTANA
3	[illegible]	11	11	88	A.J.SANTANA
2	ITEMS 5028 ADDED	31	08	88	A.J.SANTANA
1	54031	17	06	86	B.E.BREESE.

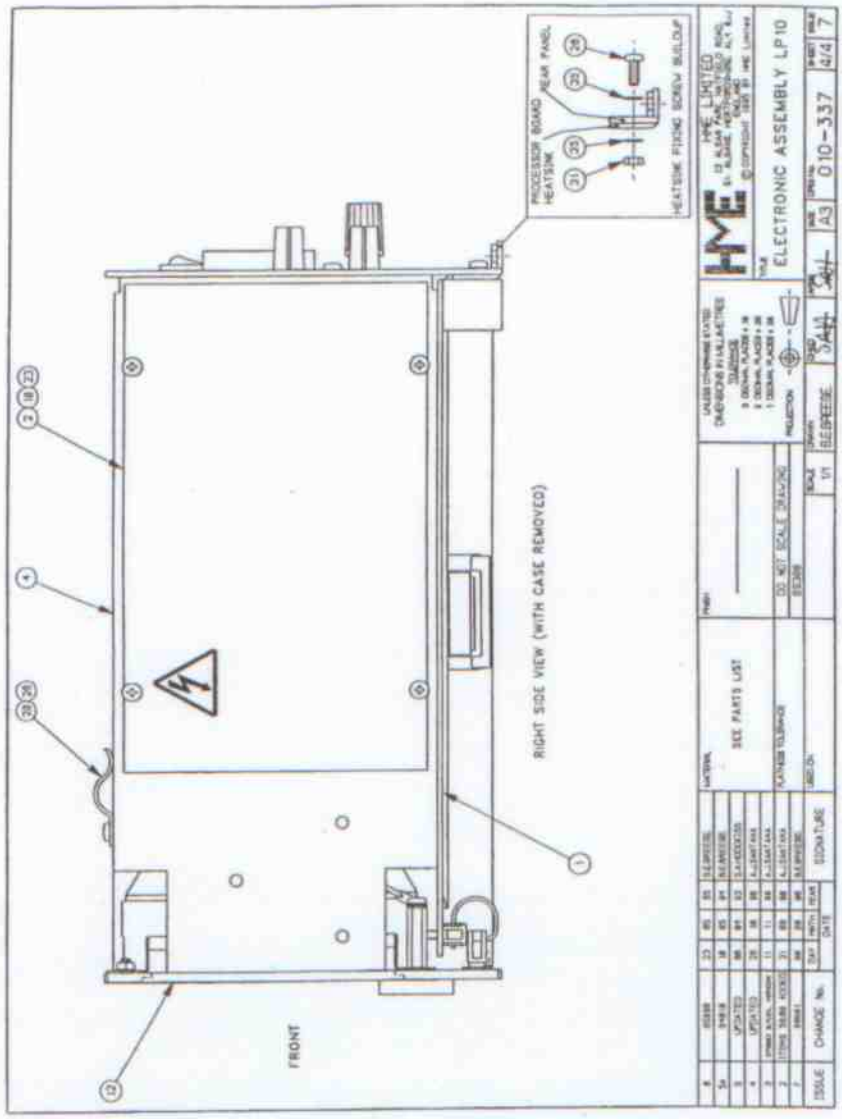
MATERIAL: SEE PARTS LIST
FINISH: —
UNLESS OTHERWISE STATED DIMENSIONS IN MILLIMETRES
TOLERANCE: 3 DECIMAL PLACES ± .10; 2 DECIMAL PLACES ± .05; 1 DECIMAL PLACES ± .02
PLATENESS TOLERANCE
DO NOT SCALE DRAWING
PROJECTION
USED ON
SCALE 1/1
DRAWN B.E.BREESE. DATE
CHKD SAM DATE
APPD SAM DATE
SIZE A3
DRG No. 010-337
SHEET 1/4
ISSUE 7

HME LIMITED
13 ALBAN PARK, HATFIELD ROAD, St. ALBANS, HERTFORDSHIRE AL4 0JJ ENGLAND

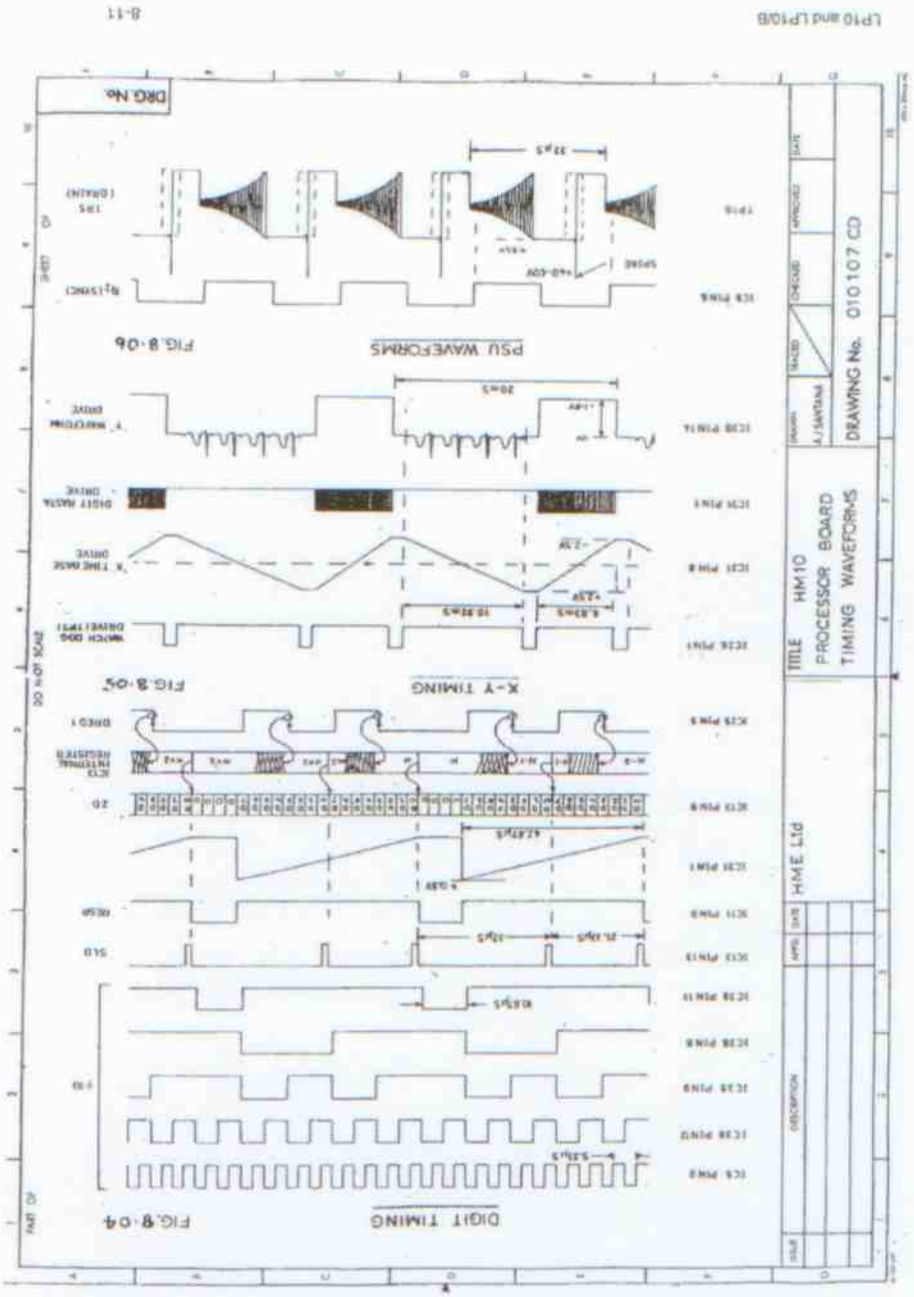
TITLE: ELECTRONIC ASSEMBLY LP10

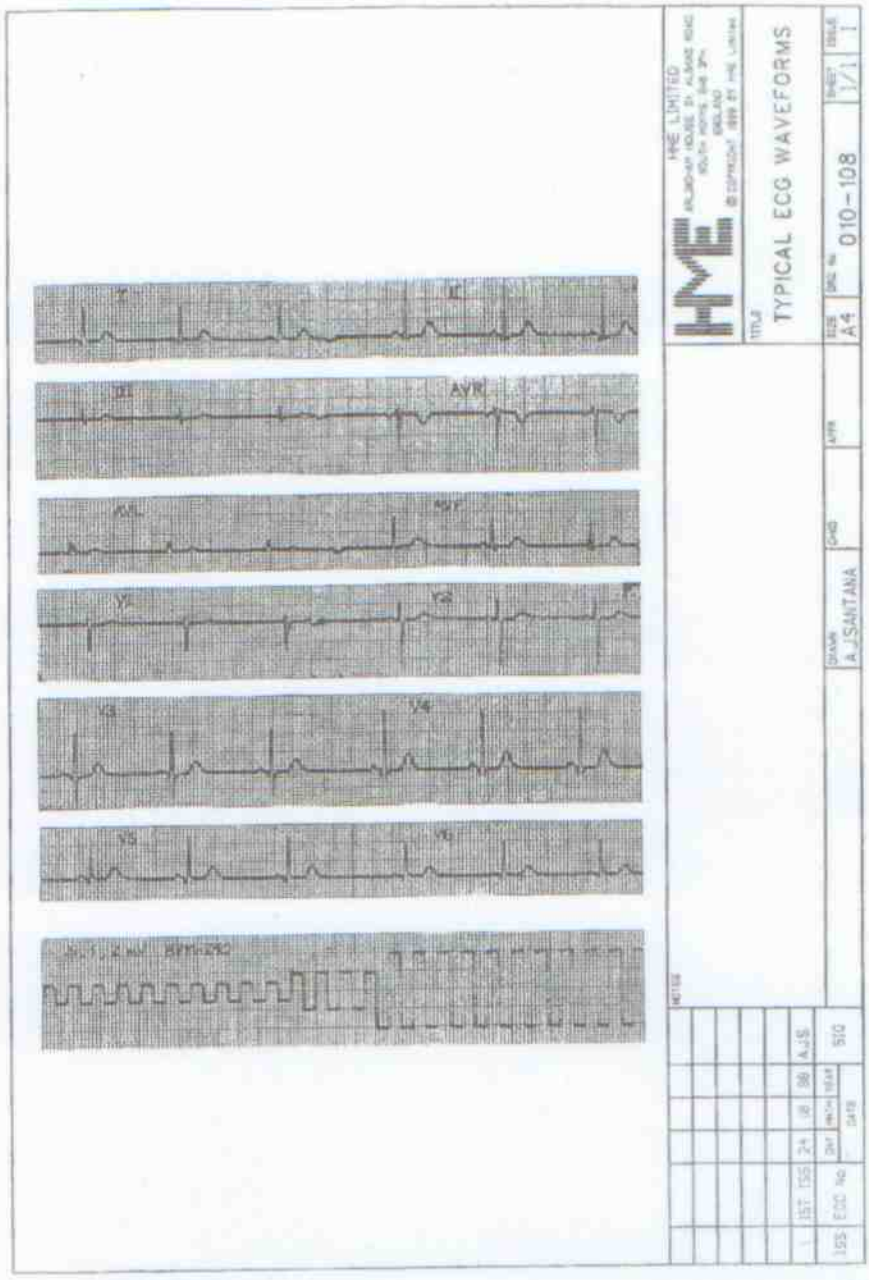


LP10 and LP10/B 8-9



LP10 and LP10/B 8-10


LP10 and LP10/B
8-11
DRG. No.
FIG. 8-06
PSU WAVEFORMS
FIG. 8-05
X-Y TIMING
FIG. 8-04
DIGIT TIMING
TITLE HM10
PROCESSOR BOARD
TIMING WAVEFORMS
DRAWING No. 010107 CD
A.J.SANTANA
HME Ltd


HME LIMITED
TYPICAL ECG WAVEFORMS
010-108
A4
A.J.SANTANA

Replace with 010-108

9. Recommended Spare Parts

9.1 Electronic and Electro-Mechanical Spares

Certain items have a long shelf life but a limited life in use. Items in this category are mains power leads, patient input cables, which are subject to physical damage in use, and fuses.

9.1.1 Ordering Spare Parts

Due to developments improving the product, over the years certain spare parts may not be readily interchangeable between early and late production units. Always quote the serial number of the unit and date of purchase, if known. This information is in addition to the circuit reference and the reference number and issue of the PCB required.

Items returned for replacement under guarantee should be labelled with the unit type, serial number, date of purchase, if known, and written details of the symptoms or fault found.

Orders for spare parts may be sent by post, telex, fax or telephoned to HME or approved agents or distributors.

Spare Parts Recommended as Essential

Number of units to be maintained	Stock No	1	5	10
Patient cable 3 way	XC0041	1	2	3
Patient cable 5 way (LP10/5L only)	XC0042	1	2	3
Flying leads Pinch clip - red	XC0036	1	2	3
Flying leads - green	XC0037	1	2	3
Flying leads - yellow	XC0038	1	2	3
Flying leads - black (LP10/5L only)	XC0039	1	2	3
Flying leads - white (LP10/5L only)	XC0040	1	2	3
Mains lead - UK only	XC0019	1	2	3
Mains lead - Continental only	XC0015	1	2	3
Mains fuses - 200-260V T250mA	FA0052	4	6	10
Mains fuses - 100-132V T500mA	FA0056	4	6	10
LT fuses T2A	FA0063	2	3	5
LT fuses F2A	FA0019	2	3	5

Spare Parts Recommended as Desirable

Number of units to be maintained	Stock No	1	5	10
Battery pack	810 334	-	1	2
Mains switch	LR0021	-	1	1
Cathode ray tube	DC0004	-	1	1
Processor assembly	010-321	-	1	2
ECG amplifier assembly	010-323	-	1	2
CRT interface assembly	010-322	-	1	2

10. LP10 PARTS LISTS

10.1 ECG Amplifier PCB Assy (3 LEAD)

Part No 010-347

Resistors

Part No.	Description	Qty	Cct/Eng Ref
RM0039	MF RES 0.25W 1% 100R	1	R50
RM0031	MF RES 0.25W 1% 47R	1	R46
RM0063	MF RES 0.25W 1% 1K	3	R31,42,48
RM0369	MF RES 0.25W 1% 1K62	1	R40
RM0071	MF RES 0.25W 1% 2K2	3	R16,19,26
RM0087	MF RES 0.25W 1% 10K	6	R17,20,43,49,52,54
RM0091	MF RES 0.25W 1% 15K	2	R41,51
RM0095	MF RES 0.25W 1% 22K	2	R18,55
RM0097	MF RES 0.25W 1% 27K	1	R37
RM0098	MF RES 0.25W 1% 30K	2	R35,53
RM0566	MF RES 0.25W 1% 31K6	1	R38
RM0101	MF RES 0.25W 1% 39K	1	R39
RM0103	MF RES 0.25W 1% 47K	1	R30
RM0598	MF RES 0.25W 1% 57K6	1	R36
RM0110	MF RES 0.25W 1% 91K	1	R15
RM0111	MF RES 0.25W 1% 100K	4	R12,14,21,47
RM0117	MF RES 0.25W 1% 180K	1	R44
RM0126	MF RES 0.25W 1% 680K	1	R33
RM0123	MF RES 0.25W 1% 390K	1	R34
RM0659	MF RES 0.25W 1% 210K	1	R22
RM0677	MF RES 0.25W 1% 430K	1	R23
RM0124	MF RES 0.25W 1% 470K	1	R27
RM0127	MF RES 0.25W 1% 820K	2	R28,45
RM0128	MF RES 0.25W 1% 1M0	2	R11,25
RM0178	MF RES 0.25W 1% 4M7	1	R24
RM0175	MF RES 0.25W 1% 2M7	1	R32
RC0220	RES CARBON FILM 100K	4	R1,2,3,6
RT0008	RES THICK FILM .25W 5% 100M	3	R7,8,9

Resistor Networks

Part No.	Description	Qty	Cct/Eng Ref
RN0013	RES NET SIL 2K2X4 2%	1	RN9
RN0017	RES NET SIL 10KX4 2%	3	RN4,10,12
RN0019	RES NET SIL 22KX4 2%	1	RN6
RN0023	RES NET SIL 100KX4 2%	5	RN1,2,3,5,7
RN0120	RES NET DIL 22KX7 2%	1	RN8

Potentiometers

Part No.	Description	Qty	Cct/Eng Ref
RV0020	MINIATURE HORIZ POT 1K	1	VR3
RV0023	MINIATURE HORIZ POT 10K	2	VR4,5
RV0024	MINIATURE HORIZ POT 22K	1	VR1

Capacitors

Part No.	Description	Qty	Cct/Eng Ref
CE0394	CAP ELECTR. RADIAL 100uF 35V	1	C53 (NEXT TO C44)
CE0387	CAP ELECTR. RADIAL 10uF 50V	6	C13,14,26,27,39,40
CC0489	CAP CERAM PLATE (LOW-K) 470pF	3	C6,7,8
CC0220	CAP HV DISC CERAM 470pF 1KV	3	C1,2,3
CC0207	CAP DISC CERAM 0.047uF 63V	11	49,50,52

Part No.	Description	Qty	Cct/Eng Ref
CP0092	CAP POLYESTER MMP 2200pF 63V	2	C9,10
CP0099	CAP POLYESTER MMP 0.022uF 63V	2	C34,35
CP0101	CAP POLYESTER MMP 0.047uF 63V	2	C28,33
CP0097	CAP POLYESTER MMP 0.01uF 63V	2	C16,36
CP0103	CAP POLYESTER MMP 0.1uF 63V	9	C15,17,18,29,30,31, 32,37,51
CP0105	CAP POLYESTER MMP 0.22uF 63V	3	C20,23,38
CP0107	CAP POLYESTER MMP 0.47uF 63V	2	C19,25
CP0042	CAP POLYCARB 3.3uF 63V	1	C24

Diodes

Part No.	Description	Qty	Cct/Eng Ref
SD0001	DIODE IN4148	8	D9,10,12,13,14,15,16 ,17
SD0025	DIODE FDH333	2	D20,21
SZ0209	Z.DIODE BZV85C18	1	D11

Transistors

Part No.	Description	Qty	Cct/Eng Ref
ST0074	TRANSISTOR ZTX651	1	TR1
ST0075	TRANSISTOR ZTX751	1	TR2
ST0072	TRANSISTOR BC214L	1	TR3

Integrated Circuits

Part No.	Description	Qty	Cct/Eng Ref
SC2086	IC DUAL OP AMP LF353N	1	IC15
SC2469	IC QUAD OP AMP TL064 - TEXAS	5	IC1,5,8,12,13
SC0048	IC 8 CH. MULTIPLEXER 4051	3	IC2,3,4
SC0050	IC TRIPLE CH MULTI 4053	2	IC11,16
SC0057	IC QUAD SW MULTI 4066	1	IC6
SC0112	IC DUAL MONOSTABLE 4538	2	IC10,14
SC2264	IC DUAL COMPARATOR LM393	1	IC9
SC2511	IC DARLINGTON DRIVER ULN2003	1	IC17

Opto isolators

Part No.	Description	Qty	Cct/Eng Ref
DE0002	OPTO ISOLATOR OPI1264A	3	OP2,3,4

Miscellaneous

Part No.	Description	Qty	Cct/Eng Ref
010-329	ECG TO MAIN PCB CABLE ASSY	1	
WC0004	CHOKE 4.7uH	2	L2,3
WT0035	SCHAFFNER TRANSFORMER IT239	2	T1,2
KP0008	MOLEX 6410 8 PIN HEADER	1	J2

10.2 CRT Interface PCB Assembly

Part No 010-322

Resistors

Reference		Description			Part No.
R1	1K	0.25W	Metal Film	1%	RM0063
R2	2K2	0.25W	Metal Film	1%	RM0071
R3	10K	0.25W	Metal Film	1%	RM0087
R4	10K	0.25W	Metal Film	1%	RM0087
R5	147R	0.25W	Metal Film	1%	RM0031
R6	10K	0.25W	Metal Film	1%	RM0087
R7	2K2	0.25W	Metal Film	1%	RM0071

Reference		Description			Part No.
R8	1K	0.25W	Metal Film	1%	RM0063
R9	0R22	0.25W	Metal Film	1%	RM0201
R10	1K	0.25W	Metal Film	1%	RM0063
R11	9K1	0.25W	Metal Film	1%	RM0086
R12	39R	0.25W	Metal Film	1%	RM0223
R13	150K	0.25W	Metal Film	1%	RM0115
R16	3K9	0.25W	Metal Film	1%	RM0077
R17	2K2	0.25W	Metal Film	1%	RM0071
R18	680R	0.25W	Metal Film	1%	RM0059
R19	220K	0.25W	Metal Film	1%	RM0119
R20	270R	0.25W	Metal Film	1%	RM0049
R21	12K	0.25W	Metal Film	1%	RM0089
R22	10K	0.25W	Metal Film	1%	RM0087
R23	2K7	0.25W	Metal Film	1%	RM0073
R24	2K2	1W	Carbon Film	5%	RC0186
R25	10K	0.25W	Metal Film	1%	RM0087

Resistor Networks

Reference		Description			Part No.
RN1	4K7 x 4	0.125W	SIL 8 Pin	2%	RN0015

Potentiometers

Reference		Description		Part No.
VR1	4K7	Carbon Film (Log)	20%	RV0128
VR2	1M	0.15W Carbon Film (Trimming)	20%	RV0029
VR3	2K2	0.15W Carbon Film (Trimming)	20%	RV0021
VR4	10K	Carbon Film (Lin)	20%	RV0127

Capacitors

Reference		Description			Part No.
C1	10uF	50V	Electrolytic (Sub-Min)	20%	CE0387
C2	470pF	100V	Ceramic Plate 683 Series	2%	CC0489
C3	1000pF	100V	Polycarbonate	10%	CP0090
C4	0.1uF	63V	Metallised Polyester	10%	CP0103
C5	330uF	16V	Electrolytic (High Temp)	20%	CE0172
C6	0.1uF	250V	Metallised Polyester	10%	CP0015
C7	3300pF	100V	Polycarbonate	10%	CP0093
C8	1uF	50V	Electrolytic (Sub-Min)	20%	CE0381
C9	1uF	50V	Electrolytic (Sub-Min)	20%	CE0381
C10	0.022uF	63V	Metallised Polyester	10%	CP0099
C11	0.1uF	250V	Metallised Polyester	10%	CP0015
C12	2.2uF	50V	Electrolytic (Sub-Min)	20%	CE0383
C13	100pF	100V	Polycarbonate	10%	CP0084
C14	4.7uF	50V	Electrolytic (Sub-Min)	20%	CE0385

Diodes

Reference		Description		Part No.
D1	BYX10	1.6KV	High Voltage	SD0025
D2	UF4003	200V	Fast Recovery	SD0029

Transistors

Reference		Description		Part No.
TR1	IRF630	NPN	Power MOSFET	ST0028
TR2	VN10KM	NPN	Low Power MOSFET	ST0036
TR3	BC546	NPN	Low Power Bipolar	ST0073
TR4	BC546	NPN	Low Power Bipolar	ST0073
TR5	BC546	NPN	Low Power Bipolar	ST0073
TR6	BC546	NPN	Low Power Bipolar	ST0073
TR7	BC546	NPN	Low Power Bipolar	ST0073

Integrated Circuits

Reference		Description	Part No.
IC1	NE555	Timer	SC2273
IC2	LM392N	Amplifier/Voltage Comparator	SC2262
IC3	78L05	Voltage Regulator 3-Terminal Positive	SR0010

Miscellaneous

Reference	Description	Part No.
J1	Header 8 Way Molex 6410 Series	KP0008
J2	Header 7 Way Molex 6410 Series	KP0007
L1	Choke 4.7uH ±10%	WC0004
T1	CRT HV Transformer	WT0042
SP1	Piezo Electric Sounder	TS0006
MLT1	EHT Multiplier	010-325

10.3 Processor Board

Part No 010-321

Resistors

Reference		Description	Part No.
R1		Deleted	
R2	1K	0.25W 1%	RM0063
R3	10K	0.25W 1%	RM0087
R4	10K	0.25W 1%	RM0087
R5	10K	0.25W 1%	RM0087
R6	2M2	0.25W 1%	RM0174
R7	27K	0.25W 1%	RM0097
R8	10K	0.25W 1%	RM0087
R9	8K2	0.25W 1%	RM0085
R10	10K	0.25W 1%	RM0087
R11	2K2	0.25W 1%	RM0071
R12	470R	0.25W 1%	RM0055
R13	10K	0.25W 1%	RM0087
R14	0R05	2W5 10%	RW0000
R15	15K	0.25W 1%	RM0091
R16	100R	0.25W 1%	RM0039
R17	330K	0.25W 1%	RM0122
R18	3K3	0.25W 1%	RM0075
R19	22K	0.25W 1%	RM0095
R20	1K62	0.25W 1%	RM0369
R21	210K	0.25W 1%	RM0659
R22	1K3	0.25W 1%	RM0359
R23	9K1	0.25W 1%	RM0079
R24	8K2	0.25W 1%	RM0086
R25	10K	0.25W 1%	RM087
R26	10K	0.25W 1%	RM0087
R27	12K4	0.25W 1%	RM0521
R28	30K	0.25W 1%	RM0098
R29	140K	0.25W 1%	RM0640
R30	330R	0.25W 1%	RM0051
R31	10K	0.25W 1%	RM0087
R32	10K	0.25W 1%	RM0087
R33	27K4	0.25W 1%	RM0559
R34	124K	0.25W 1%	RM0635
R35	39K	0.25W 1%	RM0101
R36	2K2	0.25W 1%	RM0071
R37	22K	0.25W 1%	RM0095
R38	1K5	0.25W 1%	RM0067
R39	2K2	0.25W 1%	RM0071
R40	2R7	2W5 10%	240 035
R41	27R	0.25W 1%	RM0219
R42	270R	0.25W 1%	RM0049
R43	4R7	2W5 10%	RW0041
R44	1K	0.25W 1%	RM0063
R45	220R	0.25W 1%	RM0047
R46	10K	0.25W 1%	RM0087
R47	10K	0.25W 1%	RM0087
R48	220K	0.25W 1%	RM0119
R49	220K	0.25W 1%	RM0119
R50	120K	0.25W 1%	RM0113
R51	82K	0.25W 1%	RM0109
R52	30K	0.25W 1%	RM0098
R53	18K	0.25W 1%	RM0093
R54	27K	0.25W 1%	RM0097

Reference		Description	Part No.
R55	12K	0.25W 1%	RM0089
R56	36K	0.25W 1%	RM0100
R57	18K	0.25W 1%	RM0093
R58	1K	0.25W 1%	RM0063
R59	18K	0.25W 1%	RM0093
R61	36K	0.25W 1%	RM0100
R70	6K8	0.25W 1%	RM0083
R71	4K7	0.25W 1%	RM0071
R72	1K3	0.25W 1%	RM0359
R73		Not now used	
R74	18K	0.25W 1%	RM0093
R75	18K	0.25W 1%	RM0093
R76	300K	0.25W 1%	RM0673
R77	680R	0.25W 1%	RM0059
R78	330R	0.25W 1%	RM0051
R80	220R	0.25W 1%	RM0047
R81	220R	0.25W 1%	RM0047
R82	16K	0.25W 1%	RM0532
R83	16K	0.25W 1%	RM0532
R84	10K	0.25W 1%	RM0087
R86	20K	0.25W 1%	RM0094
R87	20K	0.25W 1%	RM0094
R90	261K	0.25W 1%	RM0670
R101	100R	0.25W 1%	RM0039
R153	1K	0.25W 1%	RM0063
R158	10K	0.25W 1%	RM0087

Thermistors

Reference	Description	Part No.
R100	350mA	TC0001

Resistor networks

Reference	Description	Part No.
RN1	4 X 220K 2% SIL	RN0025
RN2	4 X 10K 2% SIL	RN0017
RN3	8 X 4K7 2% SIL	RN0074
RN4	8 X 4K7 2% SIL	RN0074
RN5	4 X 10K 2% SIL	RN0017
RN7	8 X 1K 2% DIL	RN0095
RN8	8 X 4K7 2% DIL	RN0097
RN12	4 X 4K7 2% SIL	RN0015

Potentiometers

Reference	Description		Part No.
VR1	1K	Horiz. mounting	RV0020
VR2	2K2	Horiz. mounting	RV0021
VR3	100R	Horiz. mounting	RV0017
VR4	22K	Horiz. mounting	RV0024
VR5	47K	Horiz. mounting	RV0025
VR6	1K	Horiz. mounting	RV0020

Capacitors

Reference	Description		Part No.
C1	4700uF	40V Electrolytic	CE0212
C2	100uF	25V Electrolytic	CE0116
C3	10uF	50V Electrolytic	CE0387
C4	10uF	50V Electrolytic	CE0387
C5	0.22uF	63V Polyester	CP0105

Reference	Description		Part No.
C6	10uF	25V Electrolytic	CT0039
C7	330uF	16V Electrolytic	CE0172
C8	330uF	16V Electrolytic	CE0172
C9	330uF	16V Electrolytic	CE0172
C10	220uF	50V Electrolytic	CE0351
C11	220uF	50V Electrolytic	CE0351
C12	220uF	50V Electrolytic	CE0351
C13	2200pF	63V Polycarbonate	CP0092
C14	0.033uF	63V Polyester	CP0100
C15	3300pF	63V Polycarbonate	CP0093
C16	0.0luF	63V Polyester	CP0097
C17		Not now used	
C18	10uF	50V Electrolytic	CE0387
C19	10uF	50V Electrolytic	CE0387
C20	0.047uF	63V Polyester	CP0101
CRM	0.047uF	63V Polyester	CP0101
C22	0.0luF	63V Polyester	CP0097
C23	0.0luF	63V Polyester	CP0097
C24	820pF	100V Ceramic (Med-K)	CC0417
C25	1000pF	63V Polycarbonate	CP0090
C26	12pF	100V Ceramic (Low-K)	CC0450
C27	12pF	100V Ceramic (Low-K)	CC0450
C28	33pF	100V Ceramic (Low-K)	CC0460
C29	33pF	100V Ceramic (Low-K)	CC0460
C30	0.047uF	63V Ceramic Disc	CC0207
C31	0.22uF	63V Polyester	CP0105
C32	0.1uF	63V Polyester	CP0103
C34	0.0luF	63V Polyester	CP0097
C35	0.0luF	63V Polyester	CP0097
C36	0.047uF	63V Ceramic Disc	CC0207
C37	0.047uF	63V Ceramic Disc	CC0207
C38	0.047uF	63V Ceramic Disc	CC0207
C39	0.047uF	63V Ceramic Disc	CC0207
C40	0.047uF	63V Ceramic Disc	CC0207
C41	0.047uF	63V Ceramic Disc	CC0207
C42	0.047uF	63V Ceramic Disc	CC0207
C43	0.047uF	63V Ceramic Disc	CC0207
C44	0.047uF	63V Ceramic Disc	CC0207
C45	0.047uF	63V Ceramic Disc	CC0207
C46	0.047uF	63V Ceramic Disc	CC0207
C47	0.047uF	63V Ceramic Disc	CC0207
C48	2200pF	63V Polycarbonate	CP0092
C49	0.047uF	63V Ceramic Disc	CC0207
C50	0.047uF	63V Ceramic Disc	CC0207
C51	0.047uF	63V Ceramic Disc	CC0207
C52	0.047uF	63V Ceramic Disc	CC0207
C53	0.047uF	63V Ceramic Disc	CC0207
C54	0.047uF	63V Ceramic Disc	CC0207
C55	0.047uF	63V Ceramic Disc	CC0207
C56	0.047uF	63V Ceramic Disc	CC0207
C57	0.047uF	63V Ceramic Disc	CC0207
C58	0.047uF	63V Ceramic Disc	CC0207
C60	1uF	35V Tantalum	CT0049
C61	0.022uF	63V Polyester	CP0099
C64	0.047uF	63V Ceramic Disc	CC0207

Diodes

Reference	Description		Part No.
D1	VSK340	40V Schottky	SD0027

Reference	Description		Part No.
D2	IN5401	100V Standard Recovery	SD0015
D3	IN4001	50V Standard Recovery	SD0002
D4	IN4148	75V Signal	SD0001
D5	UF4003	200V Fast Recovery	SD0029
D6	UF4003	200V Fast Recovery	SD0029
D7	UF4003	200V Fast Recovery	SD0029
D9	IN4001	50V Standard Recovery	SD0002
D10	IN4148	75V Signal	SD0001
D11	IN4148	75V Signal	SD0001
D12	ZNREF50Z	5V Ref	SZ0253
BR1	KBU4D	200V Bridge Rectifier	SS0003

Transistors

Reference	Description		Part No.
TR1	BC214L	PNP	ST0072
TR2	BC214L	PNP	ST0072
TR3	BC184L	NPN	ST0071
TR4	BC184L	NPN	ST0071
TR5	IRF530	FET 100V	ST0026
TR6	BC184L	NPN	ST0071
TR7	BC184L	NPN	ST0071
TR8	BC184L	NPN	ST0071
TR9	BC184L	NPN	ST0071
TR10	BC214L	PNP	ST0072

Integrated circuits

Reference	Description		Part No.
IC1	LM392	OP Amp	SC2262
IC2	CA3140E	FET OP Amp	SC2022
IC3	L78S05CV	Regulator 5V	SR0041
IC4	NE5560N	Dual Timer	SC2422
IC5	4049	Hex Inverting Buffer	SC0046
IC6	Z8018006PSC	8-Bit High Integration CPU	SC3504
IC7	74LS92	Divide by 12 Counter	SC0574
IC8	74HC393	Dual 4 Stage Counter	SC1726
IC9	EPROM	Programme Memory	517-100 (std)
IC10	HM6264P-15	RAM (150ns)	SC3300
IC11	74HC74	Dual D Type Flip Flop	SC1561
IC13	74HC597	Shift Register	SC1766
IC14	74HC373	Octal 3 State Latch	SC1716
IC15	74HC373	Octal 3 State Latch	SC1716
IC16	74HC540	Octal 3 Driver/Receiver	SC1743
IC17	74HC540	Octal 3 Driver/Receiver	SC1743
IC19	TLC7528	D to A Converter (Dual)	SC3006
IC20	74HC138	1 of 8 Decoder	SC1602
IC21	LM392	OP Amp	SC2262
IC22	74HC27	Triple 3 I/P Nor	SC1526
IC23	74HC10	Triple 3 I/P Nand	SC1510
IC24	74HC32	Quad 2 I/P Nor	SC1530
IC25	74HC00	Quad 2 I/P Nand	SC1500
IC26	74HC4002	Dual 4 I/P Nor	SC1917
IC27	4052	Dual 4 I/P Mux	SC0049
IC28	4053	Triple 2 I/P Mux	SC0050
IC30	TL064CN	Low Power OP Amp	SC2469
IC31	TL064CN	Low Power OP Amp	SC2469
IC32	TL064CN	Low Power OP Amp	SC2469
IC33	TDA2030H	Power OP Amp	SC2458
IC34	TDA2030H	Power OP Amp	SC2458

Reference	Description		Part No.
IC37	LMC555CN	Timer	SC2065
IC38	74LS90	Counter	SC0572

Miscellaneous

Reference	Description	Part No.
J1	4 pin Molex 2391 series (Header)	KP0058
J2	2 pin Molex 2391 series (Header)	KP0056
J3	4 pin Molex 6410 series (Header)	KP0004
J6	2 x 13 way straight header	KD0157
J7	2 x 10 way straight header	KD0158
J8	2 x 10 way straight header	KD0158
J9	5 way DIN socket (PCB Mounting)	KS0001
J10	8 pin Molex 6410 series (Header)	KP0008
L1	4.7uH choke	WC0004
L2	4.7uH choke	WC0004
L3	4.7uH choke	WC0004
L4	4.7uH choke	WC0004
T1	SMP transformer	WT0043
F1	Fuse holder	FB0012
RL1	Relay 12V G6B-1114P	WR0008
X1	Crystal 12.288MHz	SX0037

10.4 Front Panel PCB Assembly

Description	Qty	Part No.
3 Lead ECG Socket Assembly	1	010-343
LED Green	1	DA0000
LED Yellow	2	DA0001
LED Red	1	DA0002
Header 10 x 2 way Straight	1	KD0150
Front panel overlay	1	010-405

11. Equipment Changes

Date	Change

12. Warranty

HME Limited ('the Company') guarantees such equipment against defects (normal wear and tear exempted) in materials and workmanship for one year from the date of delivery PROVIDED that this guarantee shall not be inoperative nor shall the Company be under any liability to the customer:-

1. unless the customer notifies the Company in writing of the defect not more than [two days] after the defect first becomes apparent to the customer;

2. unless the defective equipment is returned (as a unit) to the Company works, freight prepaid within fourteen days after the defect first becomes apparent;

3. in the event of any improper use or mishandling of the equipment, removal of the date, serial number, stamps or markings from the equipment or it's component parts or the repair or replacement of any parts or the repair or replacement of any parts thereof by unauthorised persons;

4. if the equipment is used at any time after the discovery of the defect;

5. if the equipment is sold by the customer

6. if the equipment is sold pursuant to an international supply contract as defined by S.26 of the Unfair Contract Terms Act, 1977;

7. in respect of any consequential or special loss or damage sustained by the customer howsoever caused.

The Company's liability under this guarantee shall be limited at its option to the repair or replacement of the equipment or damages not exceeding the invoice price of the equipment. Delay in installation beyond the control of the Company will not extend the starting date for this guarantee more than one month from the receipt of the equipment at the customer's location.

The Company does not exclude or restrict its reliability for death or personal injury resulting from negligence of itself or its servants or agents (but not independent contractors) while acting in the course of their employment or agency of the Company; or for breach of any undertaking as to the title implied by S.12 of the Sale Of Goods Act, 1893. Save as aforesaid, this Guarantee is in substitution for and shall replace all conditions and warranties on the part of the Company implied by statute common law or otherwise all of which are expressly excluded.

Spare Parts

The Company guarantees spare parts against defects (normal wear and tear excepted) in materials and workmanship for 30 days from delivery and otherwise on the same terms as the guarantee in respect of serial numbered medical equipment.

Electrical Safety

The Company considers that the equipment has been designed, constructed and tested so as to comply with the requirements of BS5724 Part One, 'Specification for Safety of Medical Electrical Equipment'.

The Company considers itself responsible for the effects of safety, reliability and performance of this equipment only if:

installation, preventative maintenance, re-adjustments modifications or repairs are carried out by persons authorised by the Company.

Authorised persons are:

the Company, its employees, the Company's approved agents or distributors and their employees.

The electrical installation in the relevant room complies with the current regulations of the country in which the equipment is used. The standard for the United Kingdom is 'Regulations for the Electrical Equipment of Buildings' published by the Institution of Electrical Engineers.

The equipment is used in accordance with the operating instructions.

Service Agreements

Periodic inspection and preventative maintenance are essential to ensure continued effective operation. Contact the Company or its approved agents or distributors for further information on service contracts.

Operating and maintenance Manuals

Although every care has been taken to ensure that the information in this manual is accurate, continuous development may result in equipment changes. The Company reserves the right to make such changes without prior notification, and resulting manual inaccuracies may occur. This manual and any changes are protected by copyright.

In order to maintain or improve standards of manufacture and reliability, HME products are continuously reviewed. For this reason the contents of this publication are subject to change without notice.

PN 910-008