CARDIETTE ®

SERVICE MANUAL

START 100

H&C Medical Devices S.p.A.
via Pisa 250
20099 SESTO S.G. (MI) ITALY

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INDEX

FOREWORD AND SPECIAL REMARKS

This apparatus is a multilingual, class I (first) and CF type portable electrocardiograph with 3/6 printing channels and dual power supply (mains/battery).
The apparatus uses 130 mm wide rolls of thermosensitive paper, provided with grid.
It is supplied in two different models:

START 100 P **110 ÷ 120 Vac** **220 ÷ 240 Vac**

This model, in addition to recording the ECG, grants the possibility of:
- calculating the main electrocardiographic parameters with either brief or extended report;
- recording in both manual and automatic mode, with copy possibility in printing mode 3 and/or 6 channels;
- selecting the language (Italian - English - German - French -Spanish - Russian);
- selecting the 50 -55 - 60 Hz filters;
- automatically numbering the pages by either terns or six lines groups, 1 or 2;
- inserting the user name.

START 100 H **110 ÷ 120 Vac** **220 ÷ 240 Vac**

This model differs from the previous one in that it features the implementation of the interpreting program instead of the parameters calculation.

INSTALLATION PROGRAM

The access to the programming menus can be achieved in two steps.
The first one takes place by depressing the STOP key within 3 seconds after switching the apparatus on. If the procedure has been correctly performed, all the leds relevant to the velocity, amplitude and filters keys will blink.
In such condition the AUTO - STOP - SPEED keys shall be depressed in sequence.
The menu activation is very clearly guided on the print-outs.
For more detailed information, please refer to the “installation instructions”.

REGISTER NUMBER

The label with the apparatus identification data is placed on the movable bottom (Table T3).

The label is subdivided into three parts:
1 - The upper part gives the seller’s data and the apparatus trademark.

2 - The middle part gives:
The model _____
the characteristics of the power supply in Volt _____
The code number _____ the frequency in Hz. _____
The serial number _____ the absorption in Amperes _____
CE mark _____

3 - The lower part gives:
the language (or langages) _____
the manufacturer's identification data _____

NOTE:
Always use the series code and the apparatus code when communicating with the Seller or with the Assistance Service.

CE MARKING

The CE marking identification label is placed on the movable bottom and defines the type of apparatus conformity.
CE Marking only

CE

it defines conformity to European Community Directive 89/336 relative to electromagnetic compatibility.
CE Marking 0470

CE 0470

it defines conformity to European Community Directive 93/42 relative to the safety of medical devices.
The number 0470 indicates the homology number of the Nemko Certified Body.

AIM OF THE MANUAL

The aim of this manual is the following:
a) to give a description of how the unit operates;
b) to give a description of the procedures necessary to carry out a complete test of the apparatus;
c) to give a description of the procedures necessary to carry out the safety tests according to the IEC safety regulations;
d) to identify and isolate blocks of operational breakdowns;
e) to describe the maintenance interventions necessary for a correct and long-lasting operation of the apparatus;
f) to supply a list of spare parts.

REFERENCE STANDARDS

The safety characteristics of the electromedical class apparatus are in accordance with the regulations:

EN 60601-1: (1990)	General regulations for the safety of electromedical equipments
EN 60601-1: (1990/A1-1993)	
EN 60601-1: (1990/A2-1995)	
EN 60601-1-2: (1993)	Regulations about the electromagnetic compatibility of electromedical equipments
IEC 601-2-25: (1993)	Special safety regulations for electrocardiographs
IEC 62D(CO)6: (1978)	Special regulations about the performance of the electrocardiographs

SPECIAL REMARKS

a) Please remember that, by following the instructions outlined in this manual, the apparatus and its accessories will be correctly and efficiently maintained and consequently will be safer and will last longer.

b) Please remember that this service manual is only addressed to technically competent persons.

c) Please remember that all the instrumentation described or indicated in this service manual is necessary to correctly carry out tests, calibrations and controls of the safety characteristics of the apparatus.

d) Please remember that whenever the apparatus is opened for inspection or assistance, a complete control of the safety characteristics, as described in chapter 5, must be carried out before the apparatus is returned.

e) Please remember that this apparatus has been designed using CMOS technology.
Most of the electronic components belongs to the **ELECTROSTATIC SENSITIVE DEVICES (ESD).**family.
Therefore, it is necessary to follow specific working procedures.
Appendix A describes the special procedures required in the treatment of electrostatic sensitive devices (ESD.).
The manufacturer refuses all responsibility for any damage undergone by the apparatus caused by inadequate or non existent working procedure necessary in treating with ESD devices
NOTE:
Transportation and packaging of the apparatus not in its original packaging or an incorrectly packaged apparatus, frees the manufacturers of any responsibility with regard to damages to the apparatus and its accessories thus resulting in the annulment of the warranty.

f) **H&C MEDICAL DEVICES S.p.A. reserves to itself the right to modify at any time, and without any advance notice, the product or this manual.**

g) **Before starting the assistance service, please ready the entire content of this manual.**

1. TECHNICAL CHARACTERISTICS

Power supply from mains	Class I (first) 110..120 V~ ± 10% 50..60 Hz 220..240 V~ ± 10% 50..60 Hz
Max input	0.28 A at 110 ÷ 120V~ ± 10% 014 A at 220 ÷ 240V~ ± 10%
Mains power supply protection	T 0.315 A - 250 V (5x20 mm.) fuse at 110..120 V~ T 0.16 A - 250 V (5 x 20 mm) fuse at 220..240 V~
Built-in power supply	Built-in lead rechargeable battery 12V 0.8 Ah
Battery protection	T 2 A - 250V (5x20mm) fuse
Applied part	CF type
Protection from defibrillation	Inside the apparatus
Input dynamics	± 300 mV @ 0 Hz ± 6.4 mV in the passing through band
Input impedance	> 100 MΩ on each electrode
Common rejection	95 dB
Frequency response	0.05..150 Hz (-3dB) without filters
Time constant	> 3.3 sec
Acquisition	12 bits 1000 samples/sec/printing channel and filters 500 samples /sec/channel during calculation phase 3.125 μV/bit resolution
Leads	12 STANDARD leads, out of which: 8 acquired - 4 reconstructed (III - aVR - aVL - aVF)
Signal memory	10 s for each lead in self-isochronous mode
Sensitivity:	
manual	5 - 10 - 20 mm/mV ± 5%
automatic	**3 channels printing** 10 mm/mV for 0.3 ÷ 3 mV signals 5 mm/mV for signals > 3 mV 20 mm/mV for signals < 0.3 mV **6 channels printing** 10 mm/mV for 0.15 ÷ 1.5 mV signals 5 mm/mV for signals > 1.5 mV 20 mm/mV for signals < 0.15 mV
Printing system	Thermal printing unit 8 dot/mm Printing useful height 108 mm
Printing channels	3 - 6
Paper driving speed	5 mm/s ± 10% 25 - 50 mm/s ± 5%
Thermo-sensitive paper	DOT-CARD® 130 mm in 25 metres rolls
Filters	Mains disturbancies: modified 50 - 55 - 60 Hz notch digital filter Anti drift : 0.5 Hz, pass high and linear phase digital filter
Keyboard	Membrane type, with 8 functional and numerical keys
Led	9 Function indicators
Interpreting Program	HES ECG program developed by
(START 100 H)	Medizinische Hochschule Hannover - Germany
Parameters calculation	Developed by “Istituto di Fisiologia Clinica (C.N.R.)” in Pisa Italy
(START 100 P)	
Operating mode	Manual (real time acquisition) Automatic (isochronous)
Usage mode	Continuous operation
Autonomy	Built-in battery: 30 minutes in the 3 channel mode 10 mm/mV 25 mm/sec. 10 Hz p.v.
Recharging time	Built-in battery: 4 h 80% 12 h 100%
Caovering protection degree	IP20

Environmental conditions:	
operation	Ambient temperature: +10℃ to +40℃ Relative humidity: 25% to 95% (without condensation) Atmospheric pressure: 700 hPa to 1060 hPa
Transport and storage	Ambient temperature: -10℃ to +40℃ Relative humidity: 10% to 95% (without condensation) Atmospheric pressure :500 hPa to 1060 hPa
Dimensions	247 x 69 x 262 mm. (width x height x depth)
Weight	2.4 Kg
Compliance with standards	**EN 60601-1: (1990)** **EN 60601-1: (1990/A1-1993)** **EN 60601-1: (1990/A2-1995)** General standards for the electromedical equipment safety **EN 60601-1-2: (1993)** Standards related to the electromagnetic compatibility of electromedical equipment **IEC 601-2-25: (1993)** Special safety standards for electrocardiographs **IEC 62D(CO)6: (1978)** Special performance standards for electrocardiographs

NOTE REGARDING THE PROTECTION:
The maximum applicable voltage to inputs and outputs is the maximum value causing no damage to the apparatus.

2. APPARATUS DESCRIPTION

The apparatus consists of the following main components:
- case, internally painted with conductive and shielding paint, complete with paper lid, plate, keyboard and serigraphs;
- sealed lead battery;
- main electronic card, hereinafter called “mother board”;
- keyboard card;
- paper sensors card;
- printer mechanical group complete with thermal head;
- mechanical group of the paper driving device

2.1 CASE

The case consists of two parts:
- the upper housing, made of polycarbonate Lexan 940, colour RAL 7035;
- the lower housing, made of ABS, colour RAL 7025.

Both parts are internally painted with conductive and shielding paint. Such lining is highly conductive and works as a shielding both against the radio disturbances generated by the apparatus and those externally produced, which could cause malfunctions.
The fastening columns of cards and mechanical components, as well as the PVC insulating plates, are an integral part of the case.

SAFETY NOTE
The mentioned insulations are strictly required to guarantee the safety features of the apparatus. If they are removed during an inspection or repair of the apparatus, they must be exactly restored as foreseen by the design.

2.2 BATTERY

The battery is a lead sealed type accumulator having the following characteristics:
- voltage: 12 V;
- capacity: 0.8 Ah;
- dimensions: 96 x 62 x 25 mm (width - depth - height);
- weight: 350 g;
- recommended make: FIAMM-GS FG20086.

SAFETY NOTE
The battery can only be replaced with the recommended type or an equivalent one, as to both the electic characteristics and the mechanical ones.

2.3 MOTHER BOARD

The mother board is a multilayer printed circuit card (six layers) in “fine-line” technology for the assembly of SMD components (Surface Mounting Devices).
It houses most of the apparatus electronic circuits and may be divided in the following sections, with reference to the electrical block diagram file name: Blok - 100.

2.3.1 POWER SUPPLY FROM MAINS

The power supply from mains is a Class I type, therefore it assures the apparatus electrical safety only if the protection earthing (yellow/green wire of the power supply cable) is connected to a system realized in compliance with the laws in force.

The section consists of the following parts:
- separable three-wire mains cable;
- three-pin mains plug with built-in extractable fuses (table T 2);
- protection devices (VDR and PTC) and disturbances filtering devices;
- mains transformer complying with medical standards, code ET 69701082 (table T 6);
- rectifying, filtering and voltage adjustment circuits with current limiter for the recharge of the built-in battery. Such circuits do not allow operating the apparatus without the battery;
- connection socket with earthing functions and equipotential connection (table T 2).

The equipotential connection must be carried out according to the instructions and using the materials listed hereunder.

Required material:
- cylindrical head, M5X10 mm type screw;
- 5 mm internal diameter washer;
- 5 mm internal diameter cable terminal;
- wire with overall resistance lower than 0.1 Ohm and 1.5 cm^2 minimum section.

Instructions:
- prepare and solder the wire to the cable terminal;
- insert the washer and the cable terminal in the screw;
- fix and adequately tighten the screw in the equipotential threaded bushing.

SAFETY NOTE
The replacement of the components belonging to the mains power supply section may only be carried out using identical components to the original ones, homologated by the manufacturer, or else the safety features of the apparatus will be lost.

2.3.2. POWER SUPPLY TO INTERMEDIATE CIRCUITS

This section consists of a DC/DC converter and a high frequency transformer generating the following voltages:
- 5 V to supply the control logic;
- 24 V to supply the printer thermal head;
- ± 5 V to supply the insulated part.

2.3.3. INTERMEDIATE CIRCUITS FOR CONTROL AND INTERFACING

This section includes the microprocessor system controlling the operation of the whole apparatus and the external interfaces of the mother board, such as the keyboard and the serial interface RS232, the analog inputs and outputs, the remote control and the auxiliary power supply, if provided.

SAFETY NOTE
The connection to the intermediate circuits, for instance through the serial interface RS232, may be realized only and exclusively towards other medical apparatus, according to IEC 601-1-1 standard relating to the medical systems safety. Should any doubt exist about the compliance to the medical standards of the apparatus connected to the intermediate circuits (e.g. a Personal Computer), make use of a galvanic de-coupling device, that may be provided by request.

2.3.4. INSULATED PREAMPLIFIER

This section consists of a 12 channels ECG preamplifier with active control of the reference electrode, complete with protection from the effects of defibrillation and 12 bit analog/digital conversion circuit.
The galvanic de-coupling is performed by means of a guard zone on the printed circuit (4 mm minimum insulation) and photo-couplers (2500V rms minimum for 1 minute insulation).

SAFETY NOTE
We strongly advise against any intervention on the components assuring the patient insulation, such as the photo-couplers and the insulation transformer of the DC/DC converter generating the intermediate and insulated power supplies. In case of failure replace the mother board.

2.4 KEYBOARD

This card houses only the keys and leds required for the operation of the apparatus.

2.5 PAPER SENSORS BOARD

This card houses the sensors signalling the paper presence and the paging black notch.

2.6 PRINTER MECHANICAL GROUP COMPLETE WITH THERMAL HEAD

This group consists of the supporting plate for the printer thermal head and the mechanical components required for its correct positioning.
A complete sparee group is provided.

2.7 MECHANICAL GROUP OF THE PAPER DRIVING SYSTEM

The group consists of the driving motor complete with support and gears.
A complete spare group is provided.

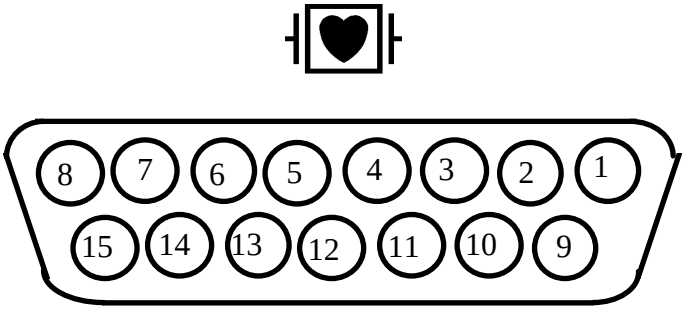
2.8 PROTECTION FROM DEFIBRILLATION

The apparatus has a built-in protection from the defibrillator discharges.
Therefore this apparatus allows the use of patient cables not protected from defibrillation and supplied by the manufacturer.

3. INPUTS AND OUTPUTS

START 100 does not allow any connection to other external apparatus.

3.1 CONNECTION TO THE PATIENT INPUT SOCKET (table T2)



Socket seen from the connection side

Pin 1	=	IN	C2	(C2 electrode)
Pin 2	=	IN	C3	(C3 electrode)
Pin 3	=	IN	C4	(C4 electrode)
Pin 4	=	IN	C5	(C5 electrode)
Pin 5	=	IN	C6	(C6 electrode)
Pin 6	=	IAGND		
Pin 7	=	NC		(not connected)
Pin 8	=	NC		(not connected)
Pin 9	=	IN	R	(R electrode)
Pin 10	=	IN	L	(L electrode)
Pin 11	=	IN	F	(F electrode)
Pin 12	=	IN	C1	(C1 electrode)
Pin 13	=	NC		(not connected)
Pin 14	=	IN	N	(N electrode)
Pin 15	=	NC		(not connected)

The inputs have the following characteristics:
a) Sensitivity: 1 mV/5 - 10 - 20 mm depending on the selected sensitivity;
b) Input impedance higher than 100 MOhm for each electrode;
c) Input dynamic:+/- 300 mV.at 0 Hz.
+/- 6.4 mV in the passing through band;
d) The inputs are protected from defibrillation.

4. SAFETY CHARACTERISTICS CONTROL

The safety regulation expects two important tests:

a) The applied voltage test:
it verifies the insulating efficiency of the power supply circuits and those relative to the patient connections.

b) The leakage current test**:**
it measures the value of the leakage currents in relation to patient safety.

NOTE:
All safety tests should be performed according to IEC 601-1 regulations(paragraphs 19-20).

4.1 NECESSARY INSTRUMENTS

a) Insulating strength analyser:
model "U28 M" Elektrotechn. Laboratorium D - 7015 Korntal Germany or its equivalent;

b) Leakage current analyser:
model “AMPLAID ST 10“ - Amplifon Division S.p.A. Italy, or
model METRON QA 80” Electrical Safety Analyser, or
model “BIO-TEK 601-PRO” Amplisim Division srl - Italy or its equivalents

4.2 APPLIED VOLTAGE TEST

The test should be carried out in a suitable location in accordance with safety regulations by using the instrument 4.1 a).
This test must be carried out only in those apparatuses in which components with special insulating characteristics have been substituted:
a) power supply transformers;
b) transformer on the TR1 voltage converter;
c) optoinsulators: FC1...FC7 of the mother board;
d) entire mother board.

4.2.1 INSULATING TEST TOWARDS MAINS POWER SUPPLY

Perform this test with the mains switch inserted (Table T2).

a) Apply the test voltage between the pins with the exclusion of the central pin in the apparatus mains plug (Table T2) and the equipotential outlet which is connected to the frame (ground) of the apparatus (Table T2).

b) How the performance test is carried out:
(class I electrocardiograph (first).

Apply for 10 seconds a voltage equal to 0.750 KVac, then raise it to 1.5 KVac and hold it at this value for 1 minute.

4.2.2 DECOUPLING TRANSFORMER AND OPTOINSULATOR TEST.

(CF type electrocardiograph defined by this symbol )

Perform this test with the apparatus turned off.

a) Apply the test voltage between all the Pins of the patient input outlet connector (Table T2) and the equipotential outlet (Table T2);

b) Apply for 10 seconds a voltage equal to 1.25KVac then raise it to 2.5KVac and hold it at this value for 1 minute.

4.2.3 IN BOTH TESTS (4.2.1 - 4.2.2)

Verify that during the test there are neither superficial nor destructive discharges.
Moderate discharges due to the back effect can be ignored, as long as they stop when the test voltage is temporarily lowered to a lower value, which nevertheless must remain greater than the reference voltage U (250V), as long as the discharges do not result in test voltage drops.

4.3 LEAKAGE CURRENT TEST

THIS TEST TO BE MADE AFTER EACH OPENING FOR INSPECTION AND/OR REPAIR USING TOOL 4.1 B AND IN ANY CASE EVERY TWO YEAR PERIOD.

Proceed as follows:

4.3.1 Connect the electrocardiograph to the measuring instrument according to the instructions given in its user's manual and remember that:

a) The leakage current towards ground, is measured between the mains power supply circuits and the ground point of the equipotential outlet (Table T2).

b) The leakage current towards the case, is measured between the mains power supply circuits(Table T2), the equipotential outlet (Table T2) and a metallic sheet not greater than 20 x 10 cm in size which should be pressed against the case, if composed of insulating material.

c) The leakage current in the patient, is measured between the mains (Table T2) and the applied part (Table T2).
The same patient cable can be used for the connection with the applied part.

d) The leakage current in the patient with mains voltage directly on the applied part (first fault condition), is measured between the equipotential connection (Table T2) and the applied part (Table T2).

e) The auxiliary current in the patient, is measured individually on each electrode (with the exclusion of the black one) with respect to all the other electrodes connected together.

4.3.2 Program the instrument according to the electrocardiograph type (CF) and class I (first).

4.3.3 Perform the measurement according to the instructions given in the user's manual of the instrument itself and verify that the values of the leakage currents measured are less than or equal to those reported in Table IV.

Table IV
Permanent admissible values for the leakage currents and for the auxiliary currents in the patient in **mA**.

Current path	CF type	
	N.C. (+)	S.F.C.(++)
Leakage current towards ground	0.5	1
Leakage current in the case	0.1	0.5
Leakage current in the patient	0.01	0.05
Leakage current in the patient with mains voltage in the applied part	-----	0.05
Auxiliary current in the patient	0.01	0.05
(+) N.C. = Usual condition (++) S.F.C. = First fault condition		

5. CONTROL OF THE APPARATUS MAIN TECHNICAL CHARACTERISTICS

5.1 REQUIRED INSTRUMENTS:

The instrumentation required includes:

a) mV impulse generator with the following minimum characteristics:
- impulse width: 1mV ± 3%;
- impulse repetition rate: 1 Hz;
- tolerance rate: ± 1%;
- max. impulse rise time: 1 ms

b) low frequency sinusoidal wave generator.

c) accessory ECG simulator

5.2 SENSITIVITY TEST

Proceed as follows:

a) prearrange the apparatus for the recording of 3 signals with leads V1...V3 and sensitivity of 20 mm/mV.;

b) connect the patient cable to the apparatus;

c) connect the C1...C6 terminals of the patient cable connected to the apparatus to the positive pole of the instrument **5.1 a)**;

d) connect all the other terminals of the cable to the negative pole of the instrument **5.1 a)**;

e) carry out a recording for a few seconds;

f) check that the width of the recorded signal is equal to 20mm. ± 5% over all the channels (Reference: IEC 62 D(CO)6 Regulations);

g) repeat the test with leads V4...V6.

5.3 ECG LEAD TEST

Proceed as follows:

a) turn on the apparatus;

b) connect the patient cable to the apparatus;

c) connect the patient cable red terminal to the positive pole of the instrument **5.1 a),** and the remaining ones to the negative pole.
Start recording and check that the signal width in mm and its polarity (positive or negative) agrees with the values given in Table 5.3.

d) repeat the measurement in succession with all the remaining active terminals G - V - C1 - C2 - C3 - C4 - C5 - C6 of the patient cable in the same manner as in c) and check that the values correspond to those reported in Table 5.3.

LEADS AND PATIENT CABLE TEST

CONNECTIONS FOR TESTING

INSTRUMENT PART		PATIENT CABLE LINK
Connector	Patient cable terminal	N. 1 Terminal on positive (black excepted)
+ ◎	1	N. 4 Terminals on negative with 5 wires cable
- ◎	2 3 4 5 6 7 8 9 10	N. 9 Terminals on negative with 10 wires cable
Square wave signal: 1 Hz ± 1% 1 mVpp ± 3%		Electrocardiograph : 1mV/10 mm amlificaiton recorded signal in mm 5%

TABLE OF VALUES

Terminal on positive	LEADS AND PULSE VALUES											
	I°	II°	III°	aVR	aVL	aVF	V1	V2	V3	V4	V5	V6
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
R	- 10	- 10	0	+ 10	- 5	- 5	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3
G	+ 10	0	- 10	- 5	+ 10	- 5	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3
V	0	+ 10	+ 10	- 5	- 5	+ 10	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3	- 3,3
C1	0	0	0	0	0	0	+ 10	0	0	0	0	0
C2	0	0	0	0	0	0	0	+ 10	0	0	0	0
C3	0	0	0	0	0	0	0	0	+ 10	0	0	0
C4	0	0	0	0	0	0	0	0	0	+ 10	0	0
C5	0	0	0	0	0	0	0	0	0	0	+ 10	0
C6	0	0	0	0	0	0	0	0	0	0	0	+ 10

Table 5.3

5.4 CHECK OF THE PAPER DRIVING SYSTEM

Proceed in the following manner:

a) turn on the apparatus and connect the patient cable;
b) connect the C1...C6 terminals of the patient cable to the positive pole of the instrument **5.1 a)**;
c) all the other terminals should be connected to the negative pole of the instrument **5.1 a)**;
d) using the instrument with a 1Hz square wave of 1 mVpp width;
e) record the signal on the leads V1...V6;
f) measure the length of the wave period recorded on the paper.

It should come out to be:
Period = 25 mm ± 5% for 25 mm/s speed;
Period = 50 mm ± 5% for 50 mm/s speed;
Period = 5 mm ± 10% for 5 mm/s speed.

NOTE:
It's not necessary to calibrate the paper feed rate, because this control is automatically managed by the microprocessor.

5.5 CHECK OF THE FREQUENCY RESPONSE

Proceed as follows:

a) turn on the apparatus and connect the patient cable;
b) connect the C1...C6 terminals of the patient cable to the positive pole of the instrument **5.1 b)**;
c) all the other connectors should be connected to the negative pole of the instrument **5.1 b)**;
d) prearrange the generator on a 10Hz sinusoidal wave with about 1 mVpp width
e) select V1...V6 leads and 10 mm/mV sensitivity;
f) carry out a recording and set the generator width in such a way as to obtain a 10 mm swing in the recorded signal;
h) vary the generator frequency from 0.5Hz to 100Hz keeping the width constant;
g) check that the frequency response is in agreement with Table 5.5.

FILTERS	FREQUENCY PARAMETERS (Hz)	WIDTH (mm)
none	0.5-60	min. 9.0 - max. 10.5
none	75	min. 7.0 - max 10.5
none	100	max. 9.0
35Hz	0.5-20	min. 9.0 - max. 10.5
35Hz	30	min. 7.0
35Hz	40	max. 7.2
35Hz	70	min. 3.0 - max. 4.5
50Hz (60)	0.5-20	min. 8.0 - max. 10.0
50Hz (60)	50 (60)	max. 0.5
50Hz (60)	60-100 (70-100)	max. 2.0

TABLE 5.5

5.6 CHECK OF POWER SUPPLY AND BATTERY RECHARGE

Proceed as follows:

a) open the apparatus as mentioned in chapter 7.2, supply it through the mains, paying attention to keep the live parts duly insulated;
b) **checking the supplied voltage:**
- replace the battery with a 1 KOhm, 0.25 W resistor and measure the voltage at its terminals: it must correspond to 13,65 V ± 5%;

c) **checking the supplied current:**
- replace the battery with a load ranging from 0 Ohm to 30 Ohm 15 W and measure the supplied voltage and current;
- check that with a 12 Vdc voltage the current is 0.9 A ± 10%;

d) **check the discharged battery indication:**
- still meeting the polarities, replace the battery with a power supply capable of supplying 5A with a voltage ranging from 0 to 15 Vdc;
- switch the apparatus on and check that the yellow led indicating a "discharged battery" condition lights up with 10.75Vdc ±2%.

5.7 TECHNICAL SELF-TEST

The self-test function can be activated by depressing the COPY key within 3 seconds from the apparatus start-up.
The apparatus prints out a triangular wave to check the efficiency or detect failed dots of the printer head, if any, the alphanumeric types available in the memory and some 'step' signals to check the 3 velocities.
Then it prints out a page reporting the result of the RAM test, the total number of pages printed so far, the code and the software revision and a warning to remind proceeding with the keys test.
Depressing the keys in sequence lights the related led up as follows:

key	*led*
MAN	50 mm/sec.
AUTO	25 mm/sec.C
COPY	10 mm/mV
VELOCITY	5 mm/mV
AMPLIFICATION	50 Hz filter
FILTERS	ADF filter
STOP	saturation

This configuration can be abandoned by depressing the STOP key, that lights up the orange led and brings the apparatus back to the normal "ready for use" status.

6. DETECTION OF THE DAMAGED CIRCUITS AND ANALYSIS OF THE MAIN MALFUNCTIONS

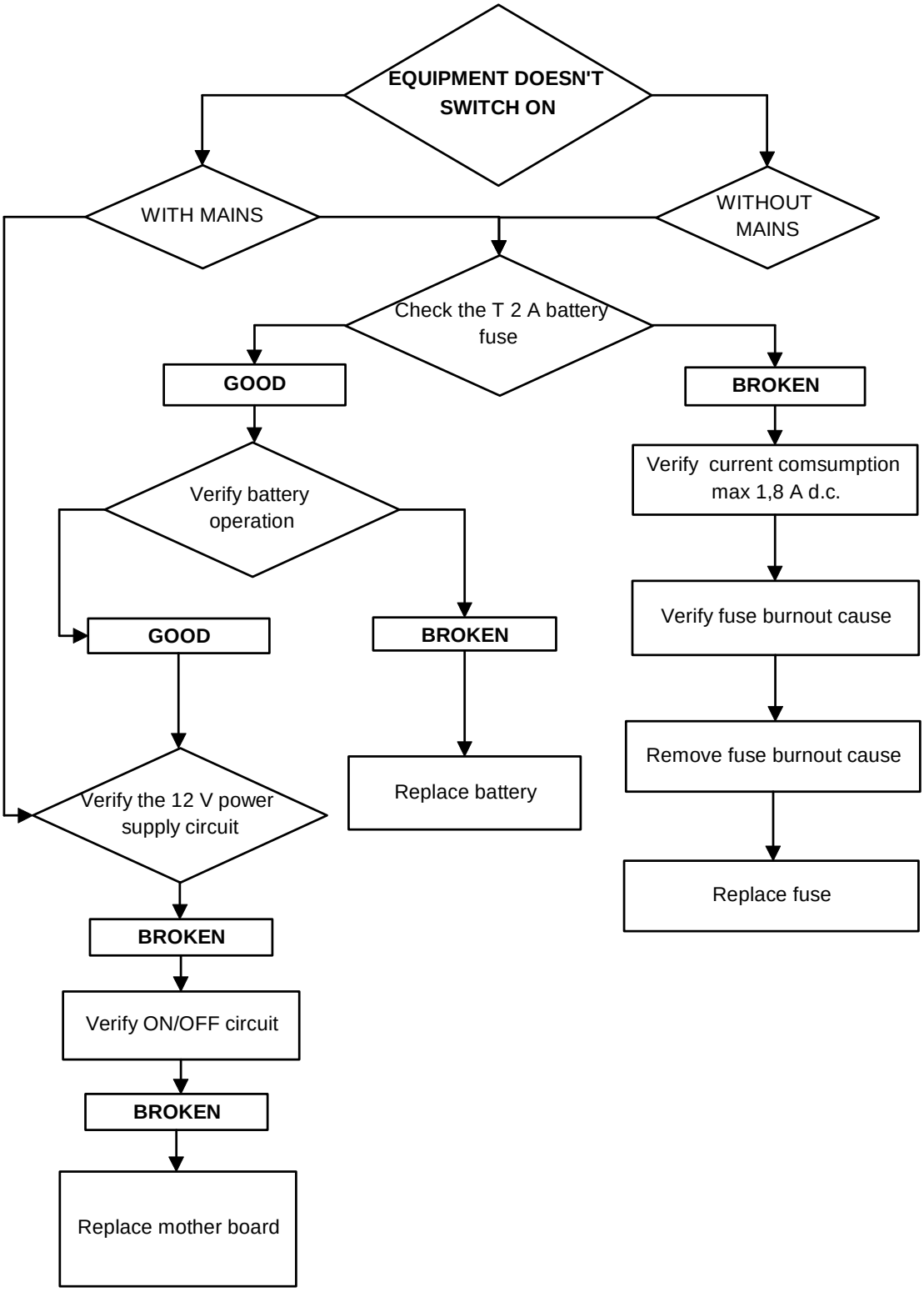
6.1 INTRODUCTION

After the introduction of SMT technology (Surface Mounting Technology) and of “fine line” multilayer printed circuits, singling out and repairing the damage have become extremely difficult even with adequate equipment and tools.
Therefore it is advisable not to attempt the repair of single cards, whereas their replacement is suggested. Quite often an inadequate intervention prevents any possibility of further repair once the apparatus is sent back to the factory.

6.2 PURPOSE

This chapter provides the repairman with useful information in order to single out the failed card and/or group.
For that purpose, the analysis of the possible malfunctions or failures is synthesized in flow diagrams, and subsequently developed in detail according to the circuit logic reported in the general block diagram of the apparatus and mother board.

6.3 THE APPARATUS DOES NOT SWITCH ON, FLOW ANALYSIS AND TECHNICAL DESCRIPTION
(refer to electrical diagram, file name ACCU 12 V)



6.3.1 Protective fuse of the battery type T 2 A missing or melted

- Check that the power absorbed by the apparatus is lower than 1.8 A d.c.. If the value is higher, search for the cause.
- Once the cause has been eliminated, replace the fuse with an equivalent type.

6.3.2 Damaged battery

- The battery emitted some acid
- It is swallen
- Cannot be recharged

Replace it with an equivalent one as to type, voltage and capacity.

6.3.3 Battery check

To check the efficiency of a battery having plate data 12 V 0.7 - 0.8 Ah proceed as follows:

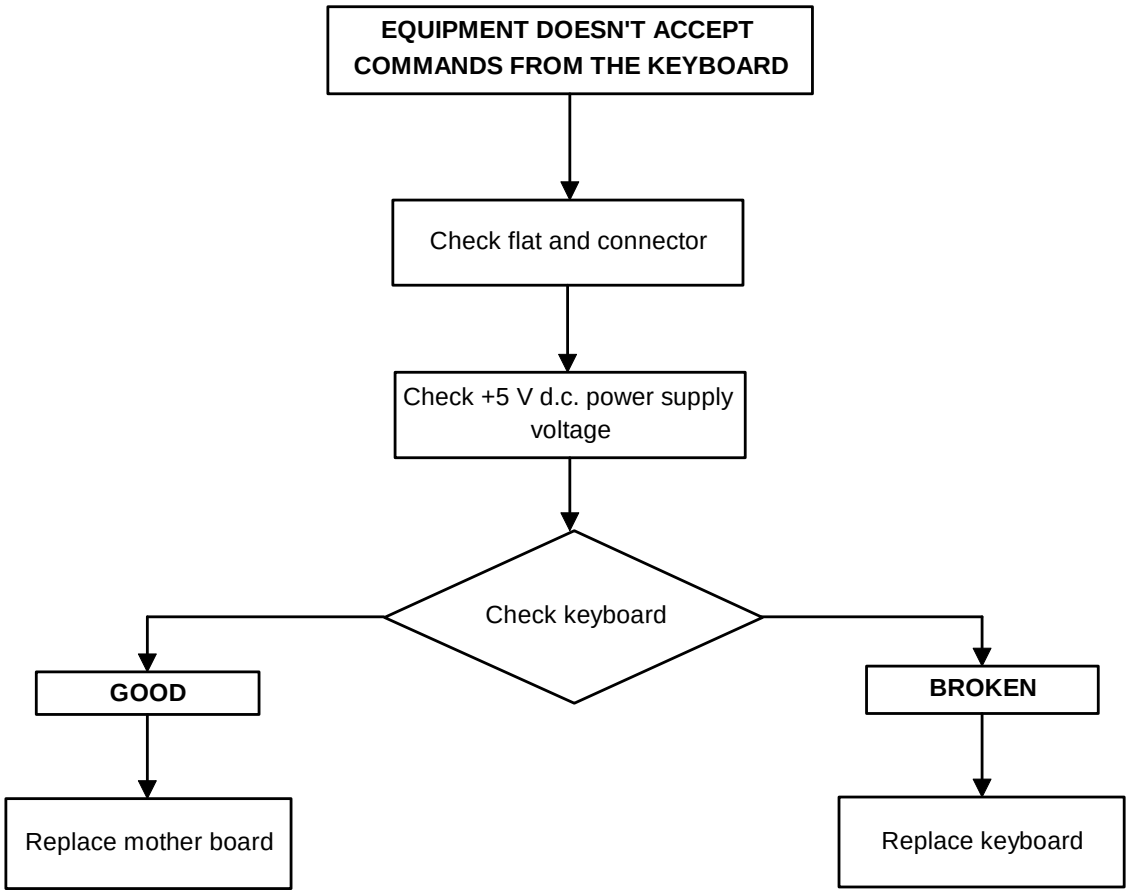
- Take it out from the case as described in chapter 7.4.
- Power it with an external 13.65 V voltage power supply, checking whether it absorbs any current. Such current depends on the charge conditions.
- After recharging it for 15 hours, discharge it through a resistance with a 0.7 - 0.8 Ah current.

If the voltage remains higher than 11 Volt for about 30 minutes the battery may be still considered to be efficient, if not its charging capacity is very limited and its replacement is advisable.

6.3.4 Battery recharge failed due to the 12 V power supply, check:

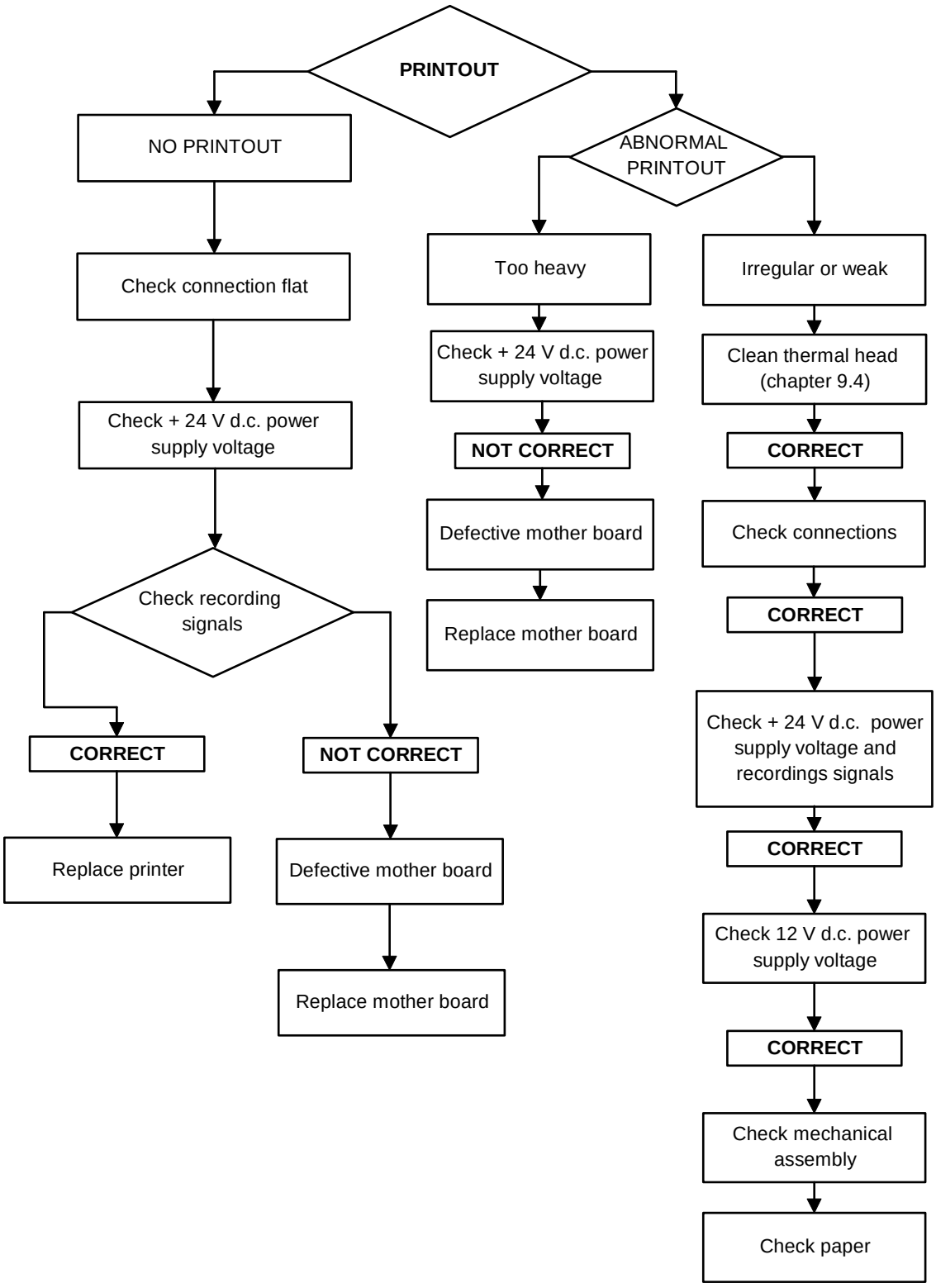
- Refer to chapter 5.6
- Supply circuit from mains
- Transformer 230/22 V - 115/22 V
- Outlet bridge 30 Vdc ± 5% on pin 4 of the switching IC29 controller.
- Presence of about 14 V ± 0.5 measured on R4, anode side of diode D54. The correct value of such voltage indicates a regular operation of the switching IC29 controller.
- ON/OFF circuit, check whether depressing the ON/OFF key of the keyboard, with the stand-by switch closed, a 13.65 V voltage appear on Q8 drain. If not, the mother board is to be considered damaged.

6.4 THE APPARATUS DOES NOT CORRECTLY ACCEPT THE KEYBOARD COMMANDS, FLOW ANALYSIS AND TECHNICAL DESCRIPTION (refer to electrical diagram, file name TAS START)



- When a failure occurs, It is a good practice checking the efficiency of all the connections (flat - wires - terminals); if they are damaged, replace them with an equivalent type provided in the spare kit.
- Check the presence of + 5 V voltage
- Check the operation of keys and leds with a tester.
- If the mentioned circuits are repairable and operating and the apparatus still does not accept any command, it is advisable to replace the mother board.

6.5 MALFUNCTIONS DURING PRINTING PROCESS, FLOW ANALYSIS AND TECHNICAL DESCRIPTION (refer to electrical diagram, file name POW-SUP and XILINX)



6.5.1 There is no print-out

- Check the efficiency of the connection between thermal head and mother board (flexstrip).
- Check, while the printing process is active, the power supply to the thermal head Vset, 25 V d.c. ± 1 measured on either drain Q7 or pin 1 of J4 (depending on the type of signal being printed) during the printing process.
- Check the existence of either an electrocardiographic or instrumental signal.
- If above points check, activate the printing function of the apparatus and check on connector J4:
  a) The presence of a 1.5 Mhz clock on pin 5, see Fig. 1;
  b) The presence of logic signals on the lines BDIP on pin 7 (data) and -LAPT on pin 6, see Fig. 1;
  c) The presence of a square strobe wave signal on pin 4 with a frequency of 1 Khz, see Fig. 1.
  If there is still no print-out when such signals are present as per Figure 1, replace the thermal head group.
  If, on the contrary, the signals do not correspond to Figures 1, the failure is located in the mother board which needs being replaced.

6.5.2 Anomalous print-out

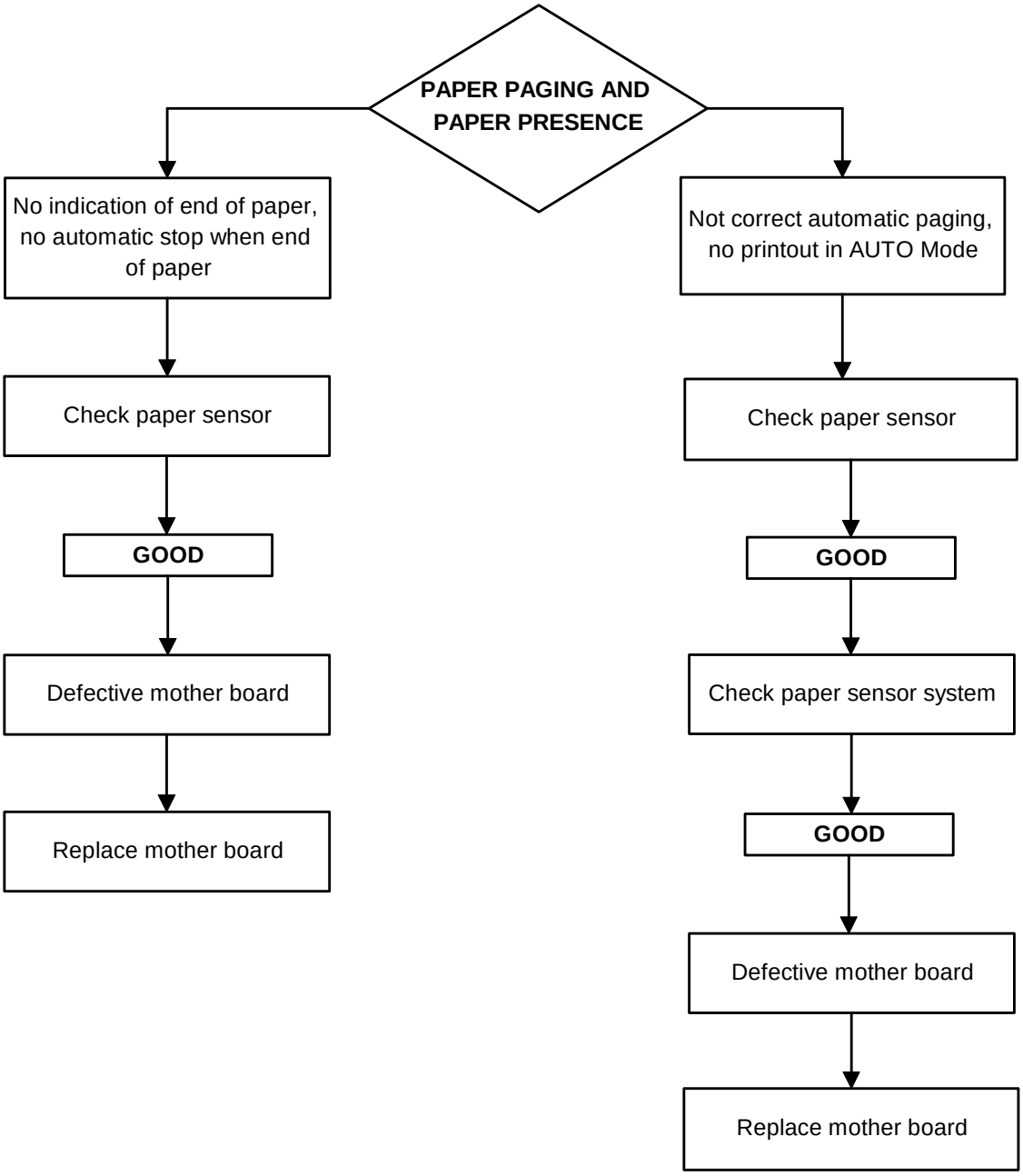
Electrical check

- If the prin-out is too intense at any velocity, check that Vset on pin 1 of J4 is not higher than 28 Vdc (maximum supply voltage of the thermal head); if Vset is higher, the control circuit is damaged (see Q2 - Q3 - Q4 - Q7).
- If the duration of the strobe impulse on pin 4 of J4 is higher than approximately 700 msec., see Fig. 2, the mother board is damaged and needs being replaced.
- If the apparatus regularly operates and the print-out disappears, check the correct operation of the battery.

Mechanical check

- If the pressure among the thermal head, paper and driving platen is insufficient, check fixing of the printer on the case and pay attention, when tightening the two screws, to keep the thermal head group well and homogeneously forward pressed against the box containing the paper. If the printer is fixed in an inclined position the writing is irregular.
- Check that the paper driving platen does not rotate eccentrically; if this happens, replace the paper lid.

6.6 MALFUNCTIONS DURING PAGING AND PAPER PRESENCE SIGNALLING, FLOW ANALYSIS AND TECHNICAL DESCRIPTION (refer to electrical diagram, file name M-SPEED)



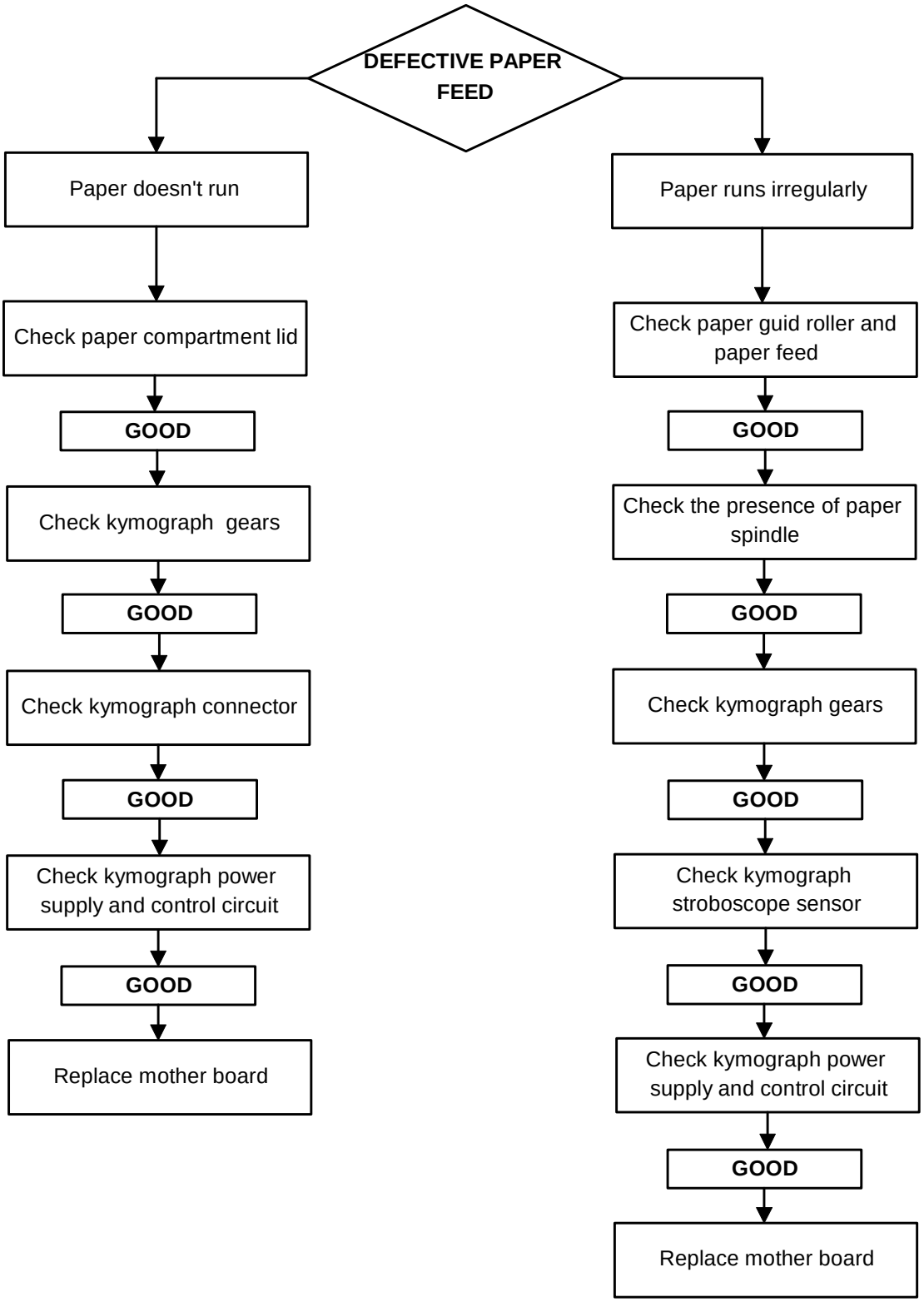
6.6.1 The failed control of “paper over” condition may depend on:

- FC1 sensor is dirty, clean with a cloth the slide above it.
- Faulty connection between keyboard card and mother board. Check the flexstrip.
- The calibration voltage of the sensor is not correct as per chapter 8.2.
- Damaged sensor. Replace the sensors card as per chapter 7.8.
- If the above conditions do not apply, the mother board is damaged.

6.6.2 The failed control of the black notch on the paper and the related malfunctions in automatic mode may depend on:

- FC2 sensor is dirty, clean with a cloth the slide above it.
- Faulty connection between keyboard card and mother board. Check the flexstrip.
- The calibration voltage of the sensor is not correct as per chapter 8.2.
- Damaged sensor. Replace the sensors card as per chapter 7.8.
- If the above conditions do not apply, the mother board is damaged.

6.7 MALFUNCTIONS CAUSED BY DEFECTIVE PAPER DRIVING, FLOW ANALYSIS AND TECHNICAL DESCRIPTION (refer to electrical diagram, file name M-SPEED)



6.7.1 The paper does not run

The main causes are due to:

- Paper lid badly closed, correctly insert it.
- The teeth of either the paper lid or the motor group gear are damaged (crushed), replace either paper lid or motor group.
- Stroboscopic disc either warped or damaged, replace motor group.
- Check the connection motor - mother board, if damaged replace the kymograph.
- Check the motor power supply and control system, proceeding as follows:
  With reference to the electrical diagram, file name M-SPEED:
  - check the presence of 12 Vdc on the emitter of Q1;
  - check the presence of 7.5 Vdc on pin 9 of IC3;
  - check the logic status of the ACV - BCV controls according to the table reported in the electrical diagram;
  - if correct values are noticed, check the working condition of the stroboscopic sensor by manually turning the stroboscopic disc and checking on IC31 the presence of a sinusoidal/trapezoidal signal with variable frequency as per Fig. 2 (it depends on the set velocity);
  - if no signal is noticed the stroboscopic sensor is damaged, therefore replace the kymograph. If, on the contrary, a +/- 0.6 V signal is noticed as per Fig. 2, replace the mother board.

6.7.2 The paper runs irregularly (refer to electrical diagram of the mother board, file name M-SPEED)

The faulty driving of paper also causes some mulfunctions during the printing process and the notch checking process.

The main causes are due to:

- Perform all the mechanical checks described in above chapter 6.7.1.
- If the motor does not control the speed any longer and takes to spin along, then either the stroboscopic control is missing or Q1 transistor is short-circuited.
  - In the first case, check the signal on pin 1 of IC31. If the stroboscopic sensor is damaged no signal will be noticed, therefore replace the motor group.
  - In the second case, Q1 transistor is short-circuited; replace it with an equivalent one.
- If the paper velocity is irregular, check:
  - The efficiency of AR3 calibration potentiometer (refer to chapter 8.3, relevant to velocity calibration); should it show any false contact, replace either the potentiometer itself or the mother board.
  - The efficiency of the motor control circuit as described in above paragraphs 6.7.1 and 6.7.2; if the circuit is found damaged, replace the mother board.

6.8 ILLUSTRATION OF THE POWER SUPPLY VOLTAGE, FLOW ANALYSIS AND TECHNICAL DESCRIPTION (refer to electrical diagram, file name POW-SUP and ACCU - 12 V)

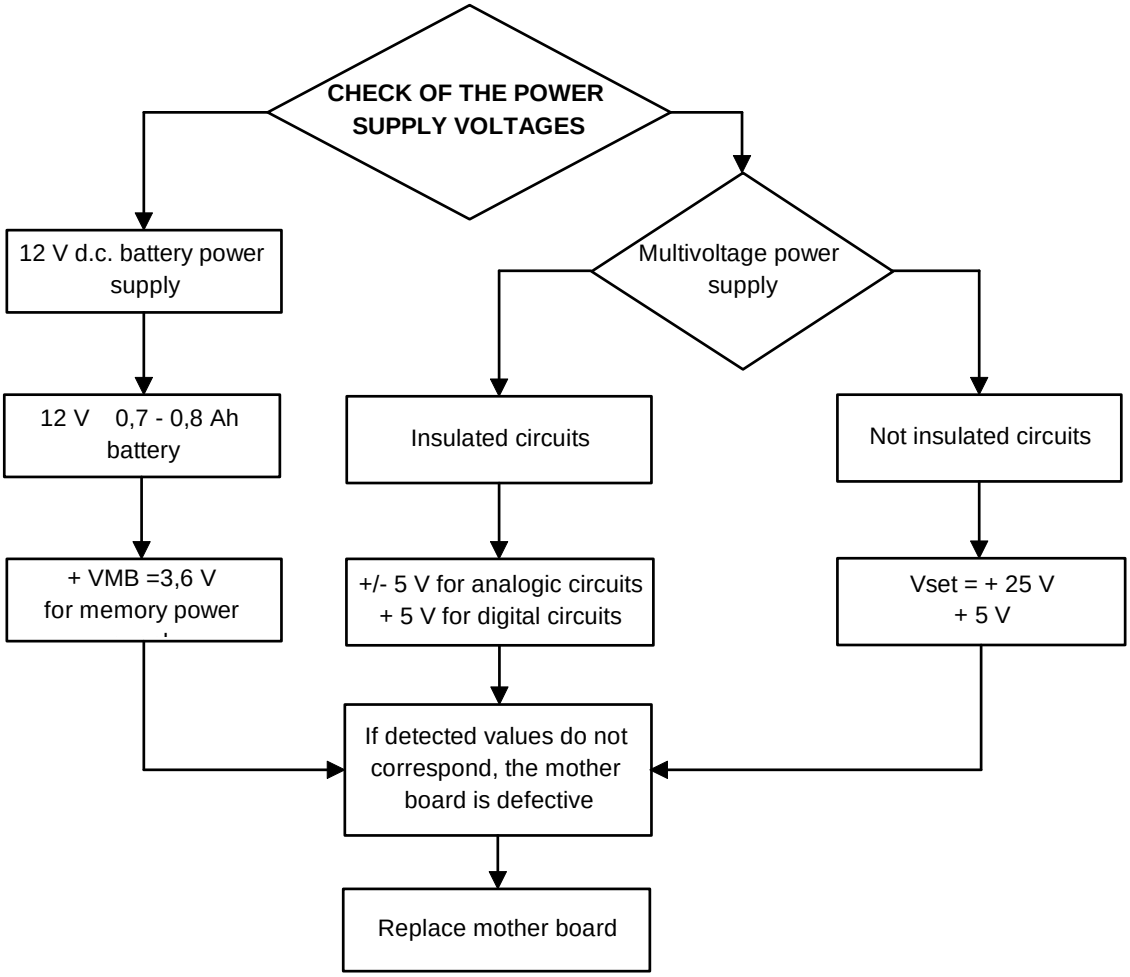


Illustration of the functions relevant to the power supply voltages.

- The section relevant to the power supply and battery recharge has already been illustrated in chapter 6.3.
- The voltage +VBM = 3.6 V is supplied to the static RAM's through IC33 regulator in order to keep the data when the apparatus is off.
- Following supply voltages are obtained from TR1 multivoltage transformer:
  - + 5 V through IC90 regulator to supply the digital logic;
  - + 25 V Vset to supply the thermal head illustrated in chapter 6.5;
  - ± 5 Volt, respectively stabilized by IC38 - IC39, to supply the analogic circuits on the insulated part.
  - Should all of the power supplies be missing, check and/or replace the 4A F1 pico-fuse type SLO BLO SMD foreseen in the spare parts list.
  - Should the values measured during the checks be wrong, it is advisable to replace the mother board.

7. DISASSEMBLING AND REASSEMBLING THE APPARATUS

7.1 FOREWORD

Before opening the unit all necessary precautions shall be taken to avoid possible errors or incorrect operating procedures.

In particular:

a) always follow the directions given in appendix A of this manual, regarding the operating procedures, the tools needed and the precautions to be taken when working on E.S.D. components.;

b) before reassembling the unit the required calibrations as described in chapter 8 of this manual shall be performed;

c) before closing the apparatus it is necessary to check that all subassemblies and connections are properly installed;

d) before closing the apparatus check the proper assembly and positioning of the insulating plates located as follows:
- on patient input connector;
- under the mother board, stuck to the bottom of the case (table T4).

NOTE:
The safety characteristics (see chapter 4) shall be checked after every opening and/or repairing of the apparatus, as well as before its redelivery to the client.

7.2 OPENING AND CLOSING THE APPARATUS (table T 5)

The following procedure is recommeded:

a) put the equipment on a soft working bench keeping the case removable bottom upward; unscrew and remove the eight TSP 2.5mm x 8mm screws (table T3, ref.1);

b) lift upward and disconnect the mobile bottom of the case.

NOTE:
In case the apparatus is power supplied while open, please remind that the inside is conductive. Therefore pay special attention to the uncovered points where the primary mains voltage and the secondary voltage of the cards supplying circuits exist, in order to avoid causing permanent damages.

To close the equipment again follow the above directions in the opposite direction.

7.3 DISASSEMBLING THE MOTHER BOARD (table T 5)

a) proceed as mentioned at chapter 7.2 (opening the apparatus);

b) unscrew and remove the six M4 x 6 x 3.25 brass nuts (table T 5).
Lift the card above the paper box by 1 cm and interpose through that spacing an insulating sheet along the whole conductive case.
Once released the card in such area, by exerting an upward pressure on the power supply plug and the patient connector contemporaneously, lift it up again by a few centimeters and unthread the socket of the wire connected to the battery.
After this operation it becomes possible to rotate the card itself by 180° by means of the hinge along the paper holding box, bringing it to an horizontal position.

At the end of the rotation it is advisable to lean the part overhanging from the case on a suitable insulated rest, so as to avoid any traction on the connected cables and flats.

Under these conditions it is already possible to perform some preliminary checks without power supply.

c) In order to achieve a more adequate functional position, from the position reached, rotate the case by 90° towards the card, leaving it in a vertical rest along the paper outlet side.

d) In case of checks performed with mains power supply, pay particular attention not to come into contact with live parts not insulated.

e) To either disassemble or replace the mother board completely, disconnect as follows:
- the flat of the keyboard card;
- the flat of the sensors card;
- the flat of the thermal head;
- the connector with the connecting wires to the motor group;
- the faston with the yellow/green wire of the printer earthing connection;

Always remember to perform all the operations, as well as handling the card, only after earthing yourselves with a suitable protected armlet.

Remember that the inside of the case is conductive.

Remember to put the card on insulated parts, in order to avoid that residual voltages on the condensers may discharge on components or groups of components causing permanent damage.

e) Proceed in the opposite direction to reassemble the mother board, paying attention to insert the mains plug vertically in the dedicated slots, so that its fixing wings correctly lock on the internal wall of the case.

NOTE

When the insulations and auxiliary fixing elements are not restored or restored wrongly, the safety characteristics of the apparatus fail and the producer is released from whatsoever responsibility.

g) The mother board replacement requires the calibration of the paper sliding speed and the calibration of the two paper and notch presence sensors.

7.4 DISASSEMBLING THE BATTERY (table T 6)

To replace the battery (table T 6) proceed as follows:

a) Open the equipment as mentioned at chapter 7.2;

b) Follow the directions of chapter 7.3 points a) - b), relevant to the movement of the card, to reach the battery.

Removing the card completely is unnecessary; if desired, proceed as per point e).

c) Remove the two fixing rods of the battery, lifting them upwards, after unscrewing the respective fixing screws;

d) Install in the same position a new 12 V - 0.8 Ah lead battery, equivalent as to dimensions and power to the original one.

e) In reverse sequence:
- reassemble and fix the two battery fixing rods;
- reposition and fix the mother board, taking care to connect it first to the battery power socket in the correct polarity. Pay attention to correctly position the insulating plate located on the patient connector;
- reinstall and fix the mobile bottom.

7.5 DISASSEMBLING THE KEYBOARD

To disassemble the keyboard it is necessary to proceed as follows:

a) Proceed as per chapter 7.3, points a) - b) - e), to open and remove the mother board of the apparatus.
b) Unscrew the 6 fixing screws and remove the keyboard lifting it upward.
c) Proceed in the opposite direction to reassemble the board and close the apparatus.

7.6 DISASSEMBLING THE PAPER DRIVING MOTOR GROUP (table T 6)

Proceed as follows:
a) Take off the paper lid and the paper roll of the apparatus.
b) Proceed as per chapter 7.3, points a) - b) - e), to open and remove the mother board.
c) Take off the 2 fixing screws and lift the motor group up.
d) The replacement of the motor requires calibrating the paper sliding speed.
e) Proceed in the opposite direction to reassemble the motor group and close the apparatus.

7.7 DISASSEMBLING THE PRINTER GROUP (table T 6)

Proceed as follows:
a) Follow the directions of chapter 7.3, points a) - b) - e), to open and remove the mother board. of the apparatus, and those of chapter 7.6 for the removal of the motor group.
b) Take off the 2 fixing screws of the printer group and remove it from its housing, paying attention not to damege the thermel head dots with hard items.
c) Proceed in the opposite direction to install the printer group, paying particular attention to positioning all mechanical items, such as screws, washers, etc.; besides, remember to carry out the earthing connection under the fixing screw of the frame supporting the thermal head with the mother board, and during the fastening keep the group forced against the paper holding box.
d) In order to achieve a long life of the thermal head, it is advisable to exclusively use the thermo-sensitive paper DOT-CARD®, recommended by the manufacturer, in 130 mm high rolls. The ordering code is stamped on the bottom edge of the paper itself.
e) The thermal head is highly sensitive to electrostatic potentials; therefore the operational procedures described in appendix A shall be followed in any case.
f) The replacement of the printing group requires no calibration.

7.8 DISASSEMBLING THE PAPER AND NOTCH SENSORS BOARD (table T 6)

Proceed as follows:
a) Follow the directions given in chapter 7.3, points a) - b) - e), to open the apparatus and remove the mother board.
b) To remove the sensors card, force it upward with a suitable tool. The card is stuck in its housing inside the upper case.
c) To replace the card it is necessary cleaning its housing, correctly positioning it inside its housing, with the flat outlet facing the paper holder, and sticking it by means of an instantaneous adhesive.
d) To close the apparatus follow the reverse operations.
e) After replacement, the sensors card requires calibration to be carried out on the mother board.

7.9 DISASSEMBLING THE PAPER LID (table T 1)

The paper lid system is a mechanical device, located in the case and accessible from the outside, which is actuated by the apparatus motor and lets the thermo-sensitive paper slide.
It is housed above the paper box and covers the latter entirely.
To remove this particular part, proceed as follows:

a) Exert a pressure on the dedicated release hook, located in the middle of the case front where the paper comes out from, and extract it by inclining it upwards.

b) Disassembly ot this group is necessary before inserting a new paper roll, when cleaning the roller and, in any case, before replacement or disassembly of the thermal head.

c) To reassemble the device it is sufficient to let it slide into its housing, keeping the rubber roller towards the apparatus inside and holding it lifted up from the opposite end.
As soon as inserted, exert a slight pressure downwards on the lifted end, so as to make it click.
NOTE:
If the roller is not clean and the paper lid is either badly inserted or badly fixed, the paper driving will be difficult and an apparatus malfunction will occur.

7.10 DISASSEMBLING AND REPLACING THE KEYBOARD MEMBRANE (table T 1)

The keyboard membrane is an elastic membrane located above the keyboard card which allows depressing the control keys of the latter.
This self-adhesive plate is stuck on the front side of the apparatus.
To replace it in case of wear, lift it up on one corner by means of a thin blade tool and tear it away from the case.
If any adhesive remains on the case, remove it using the finger-tips.
To install a new membrane, centre its corners inside the housing and exert a slight pressure on the whole surface.

7.11 MAINS FUSES

The mains fuses can be reached from the outside as they are positioned below the power supply plug on the rear part of the apparatus (table T2).
In order to replace them, exert a pressure on the two plastic wings of its container using a pair of tweezers. The protection fuses are T 0.16 A with 220 - 240V~ power supply and T 0.315 A with 110 - 120 V~ power supply.

NOTE:
Use standard fuses. Those selected by the manufacturer are the recommended ones (see the spare parts list, chapter 10).

NOTE:
FUSES MELTING MAY BE DUE TO EXCESSIVE POWER INPUT, AS WELL AS TO A WRONG USE OF, OR POWER SUPPLY TO THE APPARATUS. IN ANY CASE CHECK THE APPARATUS TO IDENTIFY THE REASON FOR SUCH FAILURE.
WARNING: ALWAYS REPLACE THE FUSES KEEPING THE MAINS CABLE DISCONNECTED FROM THE APPARATUS POWER PLUG.

8. CALIBRATIONS

8.1 GENERAL INFORMATION

- This apparatus has an automatic calibration system.
  The only calibrations required after disassembling the apparatus for checks or repairs, and related to the mother board exclusively, are those for the sensors of paper presence, notch detection and paper sliding speed.
- START 100 electrocardiograph is supplied duly calibrated from the factory; during the installation at the user's, some non-volatile data (i.e., those data saved in the RAM even when the apparatus is off) can be set, e.g.: user's data, patient's data - language - printing channels - number of automatically printed pages - analysis type - filter type, and functions programmable by the installation technician as described in the "guide to installation" manual.
- The equipment is delivered to the distributor without the d.c. protection fuse which can be reached from the case bottom, in order to avoid a damaging discharge of the battery after a long period of storage or inactivity.
  In such condition, at the **first** start-up proceed according to the following sequence:
  1. Install the fuse;
  2. Perform the apparatus self-test by depressing in sequence the ON key and, within 3 seconds, the MAN key with mains power supply. The self-test operation automatically performs the apparatus reset and the configuration set up in the English language.
  3. Carry out the desired programming.
  4. After leaving step 3, the apparatus is ready for use.

  NOTE:
  The sequence described above shall be performed:
  1. At the **FIRST INSTALLATION** start-up and/or eproms replacement.
  2. After installing and/or replacing the power supply fuse, if any data stored in the memory have been lost.
  3. After replacing the battery or else after a long interruption of the internal d.c. power supply to the memories, such to cause loosing the stored data, even if partially.
  4. In case of loss of data stored in the memory, even if partial, occurred after switching the apparatus off.

  NOTE:
  The two sensors (S1 notch passage and S2 paper presence) can be seen extracting the paper lid of the paper housing (table T1); dust or whatsoever material on the protecting glass alter the sensors sensitivity.
  A good procedure recommends to check and, if necessary, clean the glass surface using alcohol soaked cotton before calibrating the sensors.
  A strong light directed to the apparatus may influence the sensor.

8.2 CALIBRATING THE SENSITIVITY OF THE PAPER AND NOTCH PRESENCE SENSORS (refer to electrical diagram, file name M-SPEED)

Required instrumentation: d.c. voltmeter.

Proceed as follows:
a) disconnect the apparatus from the mains;
b) open the apparatus as described at chapter 7.3 a) - b) - c) - e) keeping all connections active. Pay attention to keep the card isolated from the conductive inside of the case;
c) connect the battery supply.

Calibration of the paper presence sensor:
a) connect the negative pole of the voltmeter to the DGND earth;
b) connect the positive pole of the voltmeter to either pin 3 of the integrated circuit IC36 or the dedicated J39 contact;
c) remove the paper, if inserted, and install the paper lid**;**
d) switch the apparatus on and adjust the AR1 trimmer to obtain a 4 Vdc +/- 0.3 Volt voltage (table T 6, ref. 2);
e) insert the paper, close the lid and check that the voltage is 1 Vdc - 0 Volt + 0.3 Volt; if necessary, fine tune the trimmer and repeat the item (d) test without inserting the paper.

Calibrating the notch presence sensor:
a) connect the negative pole of the voltmeter to the DGND earth;
b) connect the positive pole of the voltmeter to either pin 5 of the integrated circuit IC36 or the dedicated IC40 contact;
c) remove the paper, if inserted, and close the lid;
d) switch the apparatus on and adjust AR2 trimmer to obtain 4 Vdc +/- 0.3 V voltage (table T 6, ref. 3);
e) insert the paper, close the lid and check that when the paper is **NOT** present the voltage is 1 Vdc - 0 Volt +0.3 Volt; if necessary, fine tune the trimmer and repeat the test of item (d) without the paper.

8.3 CALIBRATING THE PAPER SPEED (refer to electrical diagram, file name M-SPEED)

The calibration of the paper speed must be carried out with 12 Volt power supply from battery, as described in chaoter 5.4.
Start recording a 1 impulse/sec frequency signal at 25 mm/sec and calibrate it by means of AR3 potentiometer (Table T 6, ref. 1) as accurately as possible (tolerance ± 5%).
Then start another recording at 50 mm/sec speed and check that it is in the ± 5% tolerance too; if not, fine tune the calibration by means of the AR3 potentiometer and check again at 25 mm/sec.
The velocity must be steady with slow voltage variations in the range 13.5 ÷ 10.5 Vd.c.

9. GENERAL DIRECTIONS FOR MAINTENANCE

9.1 FOREWORD

START 100 P - H electrocardiograph has been designed to grant a high reliability and maintainability of the product during the whole operating life.
However it is always necessary to scrupulously follow the directions of both this manual and the **user manual** during the whole operating life of the apparatus.
START 100 P - H electrocardiograph is provided with a computer aided automatic system capable of controlling and managing all the functions of the apparatus.
Any wrong use or anomalous working condition is indicated by blinking green leds, by the lighting of orange leds or by messages printed on paper.
The programming phase is guided by the relevant print-out.

9.2 MESSAGES

Led	Signalling of the operating status
Orange led	Battery discharged
Orange led	Inputs saturation
Velocity green leds blinking	Paper lacking and/or open lid
All leds alight but the discharged battery one	- Switching on phase - Last phase of self-test
Green leds alight, either one by one or in pairs	Programming phase
Messages on paper	- Self-test print-out - Guide to programming - The memory does not contain the electrocardiographic tracing since the last recording was manually carried out or the apparatus was not switched off correctly .
Sensitivity leds blinking	Acquisition phase completed
Leds out in isochronous print - velocity - sensitivity - filters	Parameters calculation or analysis phase

9.3 INSPECTION FREQUENCY

Periodical inspections and checks of both the apparatus and its accessories are required to assure a safe and long duration.
Table 9.3 indicates the type required and the scheduling of the check operations for the standard use of the recorder (about 4000 ECG recordings/year).

SAFETY CHECK

Type of intervention	Frequency
If the apparatus is used as an electrocardiograph only - check of the dispersion currents	every 2 years
If the apparatus is used for intracardiac applications - check of the dispersion currents **NOTE:** This periodic check must be carried out according to the directions of the National safety standards of the State where the apparatus works. However it is advisable to perform the tests relevant to the dispersion currents at least once per year.	every year

FUNCTIONAL CONTROL

Type of intervention	Frequency
- printing head dot check and cleaning	**every 3 months**
- paper driving roller check and cleaning	every 3 months
- apparatus power supply plug check	every 3 months
- power supply cable check	every 3 months
- paper sliding speed check	once per year
- keys and keyboard check	once per year
- keyboard plate check	once per year
- cleaning of paper housing and check of paper/notch presence sensors	once per year
- check of patient cables and electrodes	once per year
- battery check	once per year
- calibration	once per year

9.4 CLEANING THE THERMAL HEAD

9.4.1 FOREWORD

The periodic cleaning of the thermal head, to be carried out when the apparatus is switched off, is required as indicated at table 9.3. The correct periodic cleaning of the thermal printing head grants a true and precise reproduction of the E.C.G: tracing and a long life of the printing system.

9.4.2 TOOLS NEEDED

a) THERMAL HEAD cleaning marker code 66020004.

9.4.3 CLEANING PROCEDURE

Proceed as follows:

a) open the lid of the printing unit;

b) pass the special tool on the dots of the thermal head **paying attention to avoid touching the head with the hands or other tools.**

NOTE:
The thermal printing head is highly sensitive to electrostatic potentials.
Therefore it is recommended not to touch it for any reason whatsoever!
In case of need, handle it after earthing yourselves through a suitable protected strap or armlet.

10. LIST OF SPARE PARTS

10.1 GENERAL INFORMATION

Tables 10.1, 10.2, 10.3 and 10.4 report the code number of the spare parts.
When ordering a spare part please refer to the table corresponding to the apparatus.

List of spare parts for START 100 P 220 ÷ 240V code 60500052

Code	Description	
69700528	12V - 0.8 Ah battery	
69701065	Kymograph	
69700077	T 0.16 A fuse	(10 pieces)
69700197	T 2 A fuse	(10 pieces)
69701070	4 A fuse SLO-BLO-SMD	(10 pieces)
69701071	Paper feed, complete	
69701072	ON/OFF switch	
69701083	Internal cables kit	
69701073	EPROM parameters 1st series kit	
69701086	EPROM parameters 2nd series kit	
69701074	Insulating membrane kit	
69701027	SMD led (8 green pcs + 2 yellow pcs)	(10 pieces)
69701075	Lower case, complete	
69701076	Upper case, complete	
69700162	Paper spindle 3 C	
69701077	CPU/acquisition board START 100 P 220 V - hardware	
69701078	Sensors board	
69701079	Keyboard	
69701080	Printer, complete	
69701099	Keyboard membrane	
69700932	Key for the keyboard	(10 pieces)
69701082	14 VA 230/22 V transformer	

Table 10.1

List of spare parts for START 100 P 110 ÷ 120V code 60500059

Code	Description	
69700528	12V - 0.8 Ah battery	
69701065	Kymograph	
69700197	T 2 A fuse	(10 pieces)
69701070	4 A fuse SLO-BLO-SMD	(10 pieces)
69700331	T 0.315 A fuse	(10 pieces)
69701071	Paper feed, complete	
69701072	ON/OFF switch	
69701083	Internal cables kit	
69701086	EPROM parameters 2nd series kit	
69701074	Insulating membrane kit	
69701027	SMD led (8 green pcs + 2 yellow pcs)	(10 pieces)
69701075	Lower case, complete	
69701076	Upper case, complete	
69700162	Paper spindle 3 C	
69701096	CPU/acquisition board START 100 P 120 V - hardware	
69701078	Sensors board	
69701079	Keyboard	
69701080	Printer, complete	
69701099	Keyboard membrane	
69700932	Key for the keyboard	(10 pieces)
69701082	14 VA 230/22 V transformer	

Table 10.2

List of spare parts for START 100 H 220 ÷ 240V code 60500060

Code	Description	
69700528	12V - 0.8 Ah battery	
69701065	Kymograph	
69700077	T 0.16 A fuse	(10 pieces)
69700197	T 2 A fuse	(10 pieces)
69701070	4 A fuse SLO-BLO-SMD	(10 pieces)
69701071	Paper feed, complete	
69701072	ON/OFF switch	
69701083	Internal cables kit	
69701097	Interpreting EPROM kit	
69701074	Insulating membrane kit	
69701027	SMD led (8 green pcs + 2 yellow pcs)	(10 pieces)
69701075	Lower case, complete	
69701076	Upper case, complete	
69700162	Paper spindle 3 C	
69701098	CPU/acquisition board START 100 H 220 V - hardware	
69701078	Sensors board	
69701079	Keyboard	
69701080	Printer, complete	
69701099	Keyboard membrane	
69700932	Key for the keyboard	(10 pieces)
69701082	14 VA 230/22 V transformer	

Table 10.3

List of spare parts for START 100 H 110 ÷ 120V code 60500062

Code	Description	
69700528	12V - 0.8 Ah battery	
69701065	Kymograph	
69700197	T 2 A fuse	(10 pieces)
69701070	4 A fuse SLO-BLO-SMD	(10 pieces)
69700331	T 0.315 A fuse	(10 pieces)
69701071	Paper feed, complete	
69701072	ON/OFF switch	
69701083	Internal cables kit	
69701097	Interpreting EPROM kit	
69701074	Insulating membrane kit	
69701027	SMD led (8 green pcs + 2 yellow pcs)	(10 pieces)
69701075	Lower case, complete	
69701076	Upper case, complete	
69700162	Paper spindle 3 C	
69701104	CPU/acquisition card START 100 H 120 V - hardware	
69701078	Sensors board	
69701079	Keyboard card	
69701080	Printer, complete	
69701099	Keyboard membrane	
69700932	Key for the keyboard	(10 pieces)
69701082	14 VA 230/22 V transformer	

Table 10.4

SPECIAL NOTE
When ordering spare parts for mother board and software, keep in mind the following:

a) Apparatus **START 100 P 220 ÷ 240 V first series**

No. 50 ECG START 100 code 60500052 Lot No. 00099
From number: **LHIF 001** to number: **LHIF002**
From number: **LHZM 001** to number: **LHZM046**
From number: **LHLA 001** to number: **LHLA002**

On these apparatus it is possible replacing the first series EPROM kit code 69701073 or else
replacing the CPU/acquisition mother board second series code 69701077 with EPROM START 100 kit second series code 69701086.

b) **Other apparatus START 100 P - H**
On these apparatus it is possible replacing indipendently the CPU/acquisition mother board and the EPROM kit foreseen in the respective spare parts list.

c) Never replace EPROM kits in the apparatus with a revision status lower than the installed one.

APPENDIX A

1. PROCEDURES FOR THE HANDLING AND STORAGE OF ELECTRONIC COMPONENTS SENSITIVE TO ELECTROSTATIC DISCHARGES (ESD)

1.1 GENERAL INFORMATION

All modern electronic components, and in particular those based on CMOS technology, can be irreparably damaged by even modest electrostatic discharges.
When handling and working with electronic components sensitive to electrostatic discharges, precautions must be taken against electrostatic discharges: ELECTROSTATIC SENSITIVE DEVICE (ESD).

2. PROCEDURE

2.1 WORKING AREA PROTECTION

2.1.1 INDIVIDUAL PROTECTION SYSTEM

The personnel dealing with control, storage, transportation and installation procedures should be connected to ground by means of the special conductive bracelet in accordance with safety regulations. Should it not be possible to use this procedure, the operator must use appropriate antistatic shoes.

2.1.2 PROTECTION OF THE WORKING EQUIPMENT AND INSTRUMENTS

All working equipment should be grounded.
Tables, working benches and other surfaces on which the components are handled should be covered with conductive material and should be grounded.
All tables and working benches should be covered with a layer of conductive material and should be grounded.
The repair man himself should be connected to ground with the special bracelet in accordance with safety regulations.

2.2 PACKAGING AND TRANSPORT

The material should be held in special antistatic bags or containers and should be labelled according to MIL STD 129J. The containers should guarantee adequate protection from shocks and handling during transportation.

2.3 STORAGE

All ESD components should be stored in their original boxes and placed in special metallic containers.
During warehouse storage, the electronic components should be kept in the original packaging.
Possible containers should be exclusively metallic material and/or conductive material. In the event of direct handling, the personnel should adopt all those precautions described in 2.1.1.

2.4 TRANSPORT OF THE ELECTRONIC COMPONENT CARDS

During transportation phases, the cards should be deposited in the special antistatic containers.

2.5 ESD COMPONENT IDENTIFICATION

Each component sensitive to electrostatic discharges is identified with the ESD initials.
In the Warehouse area, the containers are labelled with the appropriate symbol.

2.6 WARNINGS AND RESPONSIBILITY

Please follow all the instructions given in this procedure when dealing with ESD components.

The manufacturer is not responsible for any damage to the apparatus caused by insufficient or inadequate treatment, handling or working methods.

ILLUSTRATED TABLES