HYDROGEN MASER
FREQUENCY STANDARD

EFOS

part 2

maintenance and repair manual

february 1983

C O N T E N T S

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F I G U R E S

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TROUBLESHOOTINGS

T A B L E S

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LJ/IM/CMH
NEUCHATEL, MARCH 1983

4. THEORY OF OPERATION, DESCRIPTION

The general theory of the hydrogen maser is described in the literature

KLEPPNER, GOLDENBERG, RAMSEY,

Theory of the Hydrogen Maser,
Physical Review 126, No 2 (1962)

KLEPPNER ET AL,

Hydrogen-Maser Principles and Techniques,
Physical Review 138, No 4A (1965)

AUDOIN, C (in english)

The Hydrogen Maser as a Frequency Standard
Laboratoire de l'Horloge Atomic,
Equipe de Recherche du CNRS,
Bât. 221, Université de Paris-Sud,
91405 Orsay / FRANCE

and will not be repeated in detail here. Certain aspects of the maser functioning will be covered in this manual as a basis for understading the measurement and setting of the various operating parameters.

4.1 MASER PHYSICS

The maser uses several physical atomic phenomena for its action and characteristics :

- H atoms in the ground state possess several quantized energy states (levels) which can be separated by the application of a weak magnetic field (hyperfine splitting)
- if a population of atoms in a preferred energy state can be selected and suitably isolated they can be stimulated change from their present energy state to another (allowed) energy state by a quantum transition, and in the process give up or absorbe energy.

- a photon is the unit of energy associated with the process of release or absorption accompanying the transition from one energy level to another. The energy levels are quantized and the photon frequency corresponding to a given transition is precisely related to that transition, and is the same for all the atoms in that state

- if an interaction volume contains a large majority of atoms in a chosen state, the radiation (or absorption) of photons will be at a coherent frequency. The degree of coherence is determined by the length of time the atoms remain in the interaction volume. This dwelling or storage time for atoms usually used in atomic resonators is from a few milliseconds to a second or more. The hydrogen maser storage time is about one second.

- when a photon emission of an atom occurs and irradiates another atom in the corresponding energy state, that atom can change state and in the process emit a coherent photon which in turn will be available to stimulate another atom, and so on.

- when the density of atoms in a volume is sufficient, and when they can exist during their storage time sufficiently unperturbed, the total coherent energy available due to the stimulation will build up until the whole population of atoms in the volume will be participating in the process.

  The process can be sustained by replenishing the volume with atoms in the preferred state, and allowing the atoms having experienced transition to escape.

- the number of the emitted photon is higher than is necessary to <u>stimulate</u> the transition (here emission), and in this way the total coherent photon energy exceeds that necessary to sustain the stimulation of emission. This excess will eventually be dissipated in the surroundings of the interaction volume. If the enclosure is properly arranged, the excess of energy may be removed and detected by a suitable receiver.

This process of energy generation at a coherent frequency is called Microwave Amplification by Stimulated Emission of Radiation (MASER), and depending upon the atom chosen will occur at a precise frequency.

For the Hydrogen Maser, this unperturbed frequency is

$$f_H = 1\ 420\ 405\ 751.768 \pm 0.002 \text{ Hz}$$

In practice, this frequency is perturbed by interaction of the hydrogen atoms with the walls of the interaction volume container, doppler effects, interactions between the atoms themselves, etc. The resulting frequency for the EFOS Maser is taken to be

$$f_o = 1\ 420\ 405\ 751.689 \text{ Hz}$$

Separation of the atoms in the preferred state is accomplished by a weak magnetic field which also perturbs the hydrogen frequency by a factor :

$$2750\ H^2$$

where H is in Oersteds. Thus the expected operating frequency of the maser may be defined as

$$f_o = 1\ 420\ 405\ 751.689 + 2750\ H^2$$

(f_o in Hz
H in Oersted)

As part of the hyperfine splitting of the ground state, the population of atoms may also be stimulated to make a transition at a low frequency. This frequency is directly proportional the magnetic field (Zeeman frequency) and is given by

$$f_Z = 1.42 \times 10^6\ H$$

(f_Z in Hz
H in Oersted)

4.1.1 Maser elements

To achieve the conditions necessary for MASER action, the following elements must be provided :

- a high vacuum which allows the atoms to move freely in the confined space
- a generator of atoms and state selector
- an interaction volume for containing the atoms during their transition
- an electromagnetic structure (resonator) of sufficiently low loss for extracting the energy

Refer to Fig. 4.1-1 for a mechanical schematic of the EFOS maser.

4.2 MASER CONSTRUCTION DESCRIPTION

The EFOS Hydrogen maser consists of the following elements.

Refer to Fig. 4.1-1.

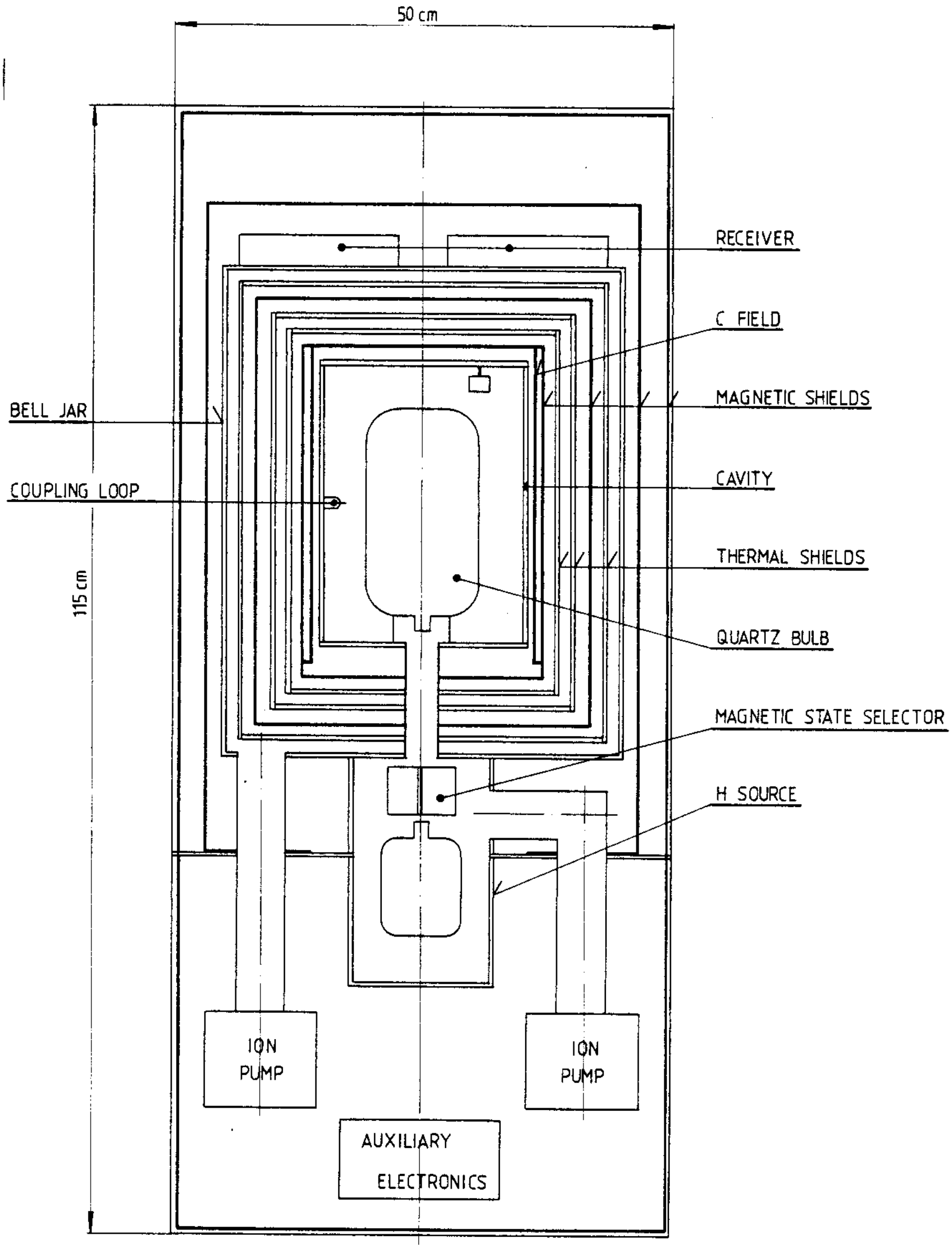


Fig. 4.1-1 : MASER MECHANICAL SCHEMATIC

4.2.1 Dissociator, Fig. 4.2-1

Hydrogen, as found in its natural state, is a molecule of two atoms (H_2) which must be separated by some means in order present the H atom in the microwave cavity. This breaking down of the H_2 molecule into two atoms is accomplished in the dissociator where, in fact, the generation of H atoms is part of an ionization process produced by a high intensity RF signal. The plasma discharge thus formed is dependent upon several important parameters (values for EFOS maser) :

a) pressure (0.1 to 0.2 TORR)

b) size of physical container (Ø 6 cm x 8 cm)

c) level of RF excitation (6 to 10 watts)

d) collision effects between atoms, ions, walls of the container, atomic cross-sections, etc.

The physical container for the discharge is a cylindrial glass bulb one end of which is necked to form a collimator for the hydrogen atoms escaping the container (Fig. 4.2-1)

The glass bulb is in turn contained within a helix which is an integral part of a resonator formed with the dissociator housing. The plasma discharge is formed and maintained by a RF power oscillator (100 to 150 MHz) coupled to the helical resonator via a tuned loop.

RF power oscillator

The RF power oscillator is a Clapp configuration chosen for this application because of its ability to oscillate and adapt to a varying load impedance and the fact that circuit component values and impedance levels are well suited for the frequency range 100 to 150 MHz. The combination of oscillator and resonator makes it possible for the discharge to be initiated without auxiliary means.

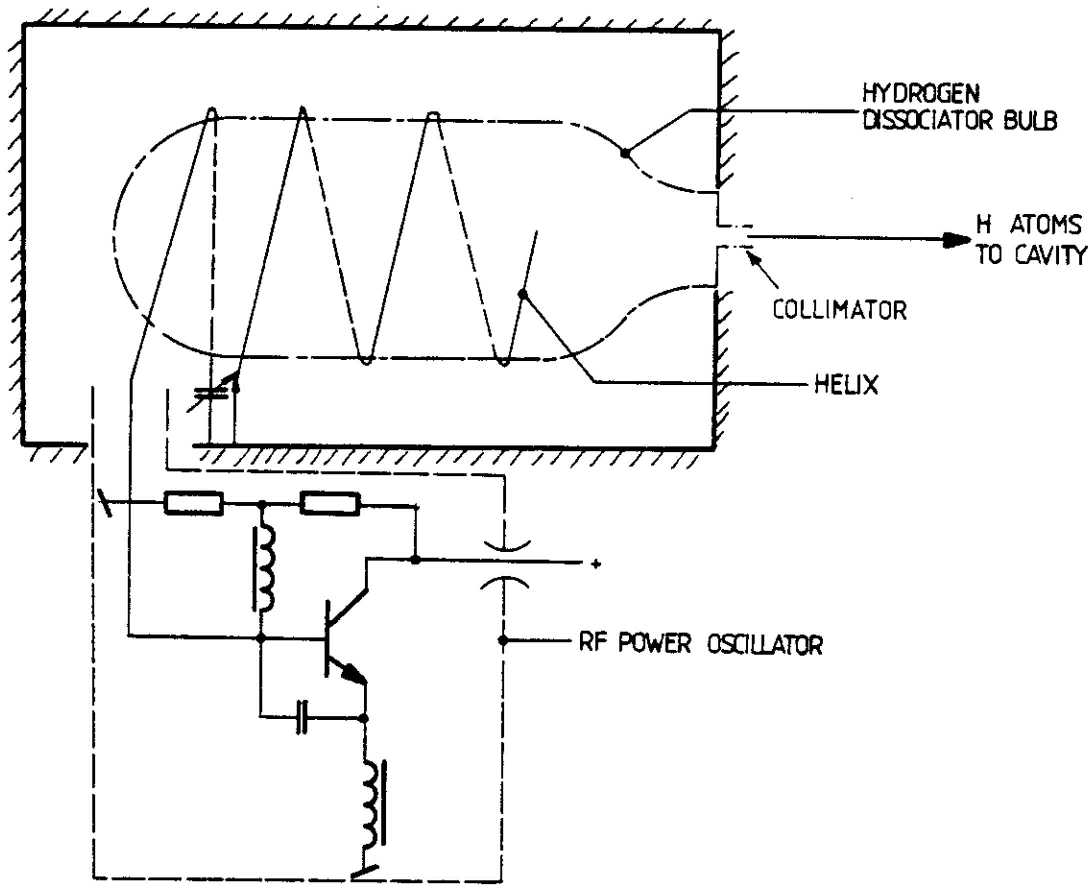


Fig. 4.2-1 : DISSOCIATOR SCHEMATIC

4.2.2 State selector magnet

The state selector located between dissociator and storage bulb is a quadrapole magnet of usual design.

4.2.3 The quartz bulb

The quartz bulb of about 4.5 liters volume is cylindrical in shape with hemispherical ends. This inside of this bulb is coated with a thin layer of teflon to minimize the interaction of Hydrogen atoms with the bulb walls.

4.2.4 A resonant RF cavity

A resonant RF cavity contains the quartz bulb. The cavity is made of aluminium and has an adjustable end disc for setting the cavity resonant frequency to within a few kHz of the Hydrogen atomic resonant frequency (1, 420, 405, 751 Hz). Fine tuning of cavity frequency is accomplished by temperature setting (~ +49°C) and eventually electrically by means of a voltage controlled varactor.

A single coupling loop mounted on the cavity wall couples the maser energy to the receiver. Coupling factor is chosen as a compromise for power output and load isolation.

4.2.5 The aligning magnetic solenoidal field (C-field)

The aligning magnetic solenoidal field consists of 320 turns of fine copper wire wound on an aluminium cylinder enclosing the cavity. A current of 1 μA produces 8.2 μ Oersteds. Nominal operating C-field for the EFOS maser is in the range of 300 μOersteds to 1 m Oersted.

4.2.6 Heater system

Seven heating systems are used in the EFOS maser, to stabilize the microwave cavity, regulate the hydrogen pressure for the dissociator, stabilize temperature of the RF electronics.

The temperature sensing element for each thermal system is a thermistor and wheatstone bridge. A preamplifier and power amplifier amplify the bridge unbalance to provide a heating power necessary to reduce the bridge unbalance to zero and thus stabilize the operating point at the thermister value prescribed. These proportional control systems function on DC signals throughout; operational amplifier offsets and drifts are of sufficiently low values as not to affect the required thermal stability.

Final heating power control is obtained from a pass-transistor biased to regulate the heater current, except for the two outer heaters (LO, UO). These heaters use power amplifiers which provide an output derived from an AC duty-cycle control proportional to the DC input to the power amplifier. This mode of operation is more efficient and requires less dissipative capacity in the transistor and mechanical structure.

Refering to figure 4.1-1 heaters are disposed as follows :

(1)	Lower - outer heater	on the bell-jar	(LO)
(2)	Upper - outer heater		(UO)
(3)	Lower - inner heater	on the external thermal shield	(LI)
(4)	Upper - inner heater		(UI)
(5)	Cavity heater		(CAV)
(6)	Upper vacuum feedthrough heater (coax output of maser)		(DALLE)
(7)	Palladium pressure control heater		

All heaters are provided with a proportional control.

Besides the heaters, temperature control is achieved in two ways :

a) thermal shields, Fig. 4.1-1

b) an external vacuum system, § 4.2.2 below

4.2.7 Magnetic shields

Shielding the maser cavity interaction space from external magnetic fields is important for maser operation. The EFOS maser has 4 magnetic shields, Fig. 4.1-1. Three of these shields are cylindric and concentric to the C-field. An additional outer shield is provided which also serves as the maser housing. The shields are constructed of molypermalloy.

A demagnetization (de-gaussing) system is built into the maser. This system allows passing a high axial current through the C-field aluminium cylinder, and is only necessary during the initial construction of the maser, or after an important change in external magnetic field (after shipping and installing the maser, for ex.).

4.2.8 Vacuum chamber and pumping system

The maser vacuum system consists of two chambers :

1) an outer vacuum envelope formed by the bell-jar and containing all thermal shields inner heating systems and RF cavity, Fig. 4.2-2
2) an inner vacuum system which includes the dissociator and the quartz storage bulb, Fig. 4.2-3

Vacuum for the two systems is maintained by two independent VAC-ION pumps of 20 liters/second capacity.

This technique has several advantages :

a) high thermal isolation of the aluminium cavity from the ambient temperature (thermal gain $\geqslant$ 10000)
b) long thermal time constants for the elements within the vacuum envelope thus filtering rapid ambient temperature changes. The time constant is of the order of 24 hours
c) maser cavity is essentially independent of ambient pressure

The pumping system also provides for external pumping of inner and outer chambers and changing of ION pump without losing vacuum, Fig. 4.2-2.

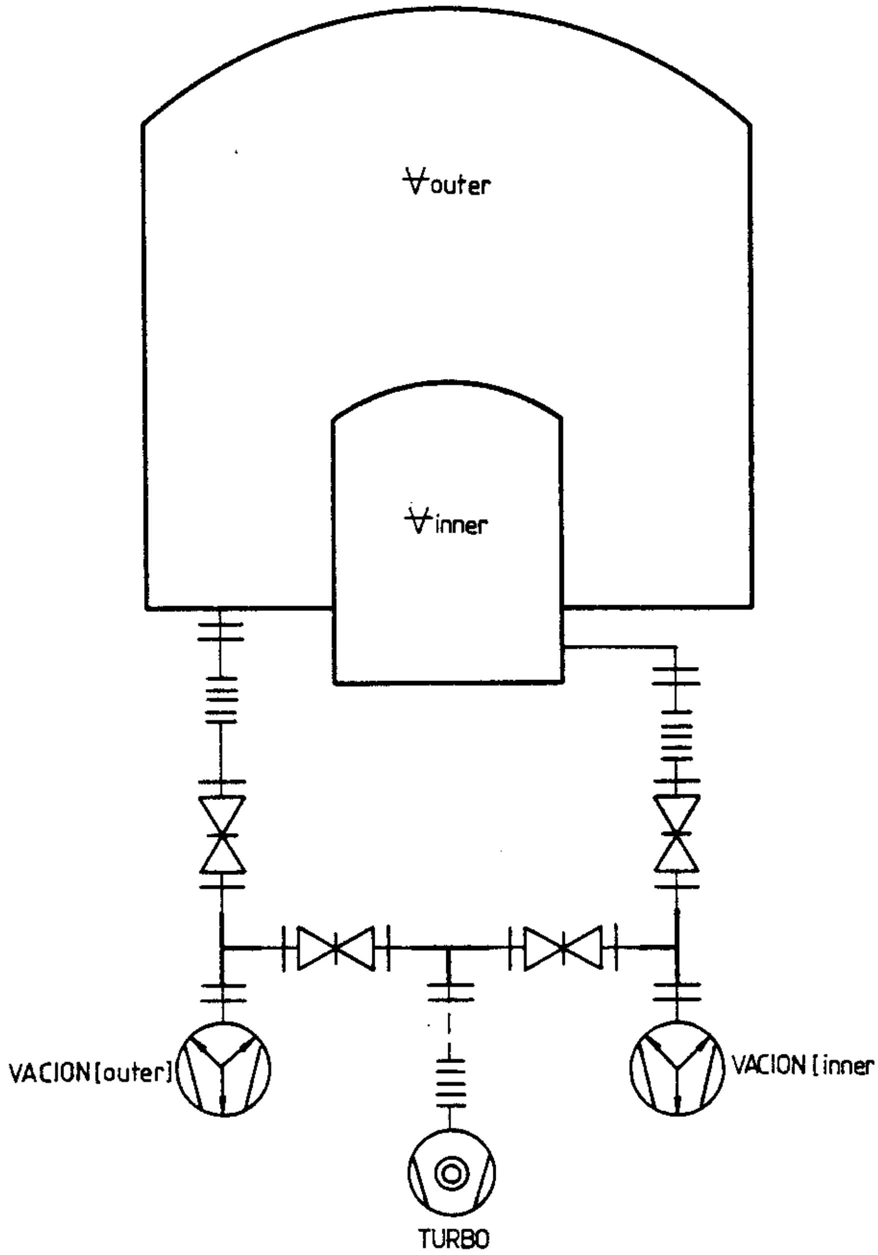


Fig. 4.2-2 : VACUUM SYSTEM OF HYDROGEN MASER

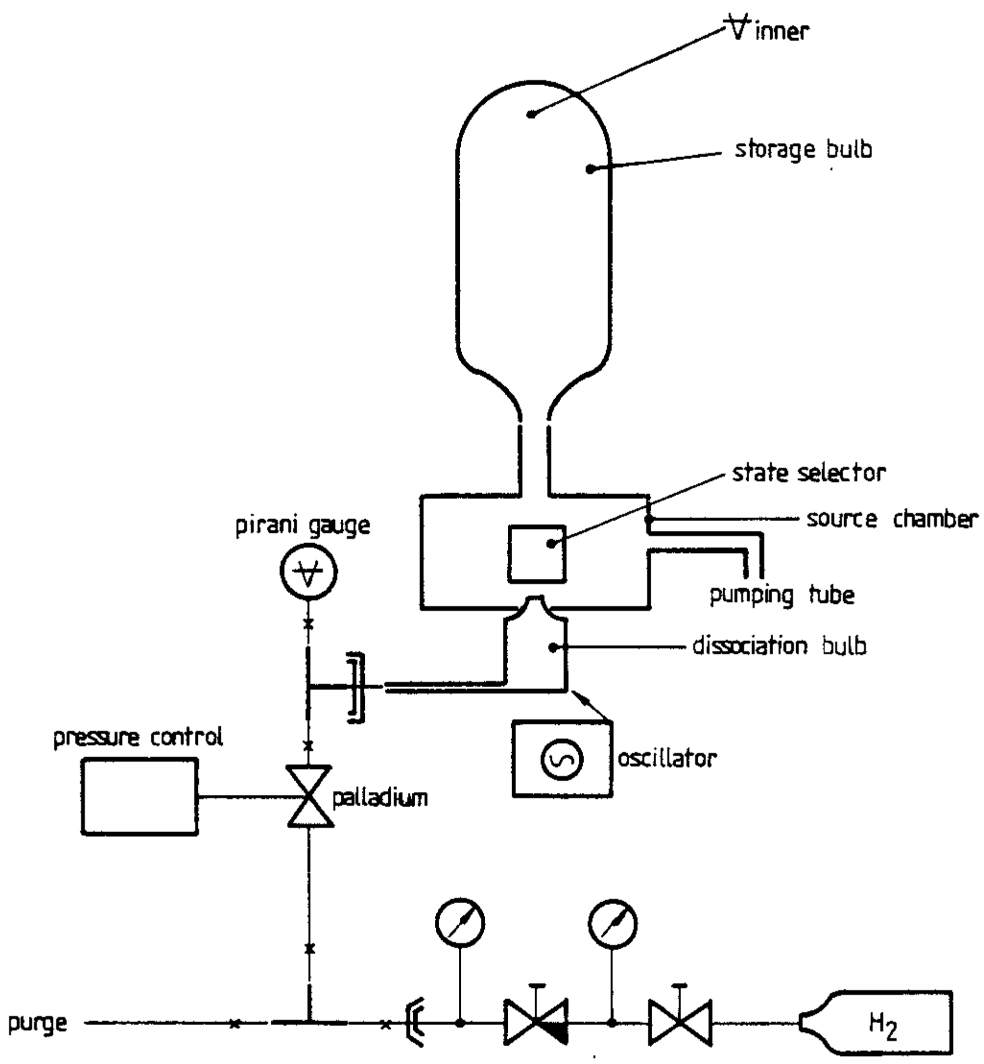


Fig. 4.2-3 : HYDROGEN INTERNAL VACUUM

4.2.8.1 Ion pump operation

Ion pumps operate by ionizing gas in a magnetically-confined cold-cathode discharge. The mechanisms which combine to pump virtually all gases encountered in a vaccum system are :

1) trapping of electrons in orbits by a magnetic field
2) ionization of gas by collision with electrons
3) sputtering of titanium by ion bombardment
4) gettering of active gases by titanium
5) diffuction of hydrogen and helium into titanium
6) dissociation of complex molecules into simple ones for easy pumping (for example, CH_4 is broken down into C and H_2). Hydrogen is pumped separately and carbon resides in solid form, no longer part of the residual gas.

The pumping action is accomplished by an array of cylindrical elements connected as the anode between two cathodes made of titanium vanes. The pump wall forms a third electrode and is at the same potential as the anode, Fig. 4.2.8-1. The entire assembly is contained within a transverse magnetic field, and as such is call a Triode (Noble) pump.

- pumping speed is dependent upon pressure, Fig. 4.2.8-2, and the gas being pumped, Table 4.2.8-1

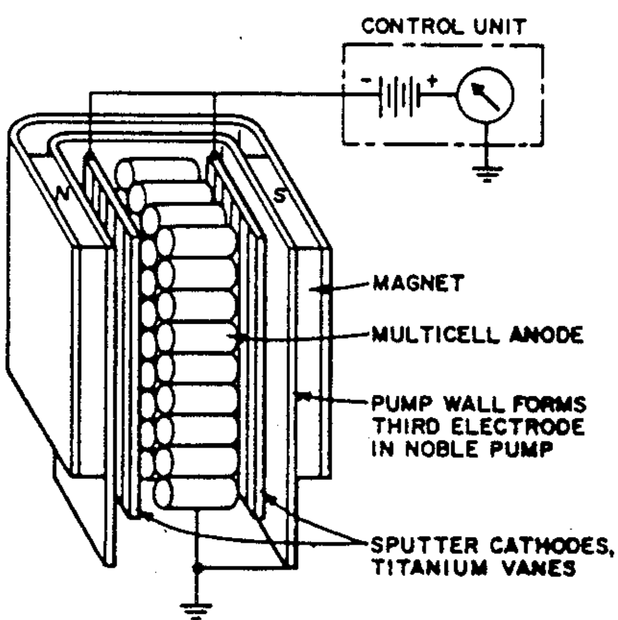


Fig. 4.2.8-1 : TRIODE (NOBLE) PUMP

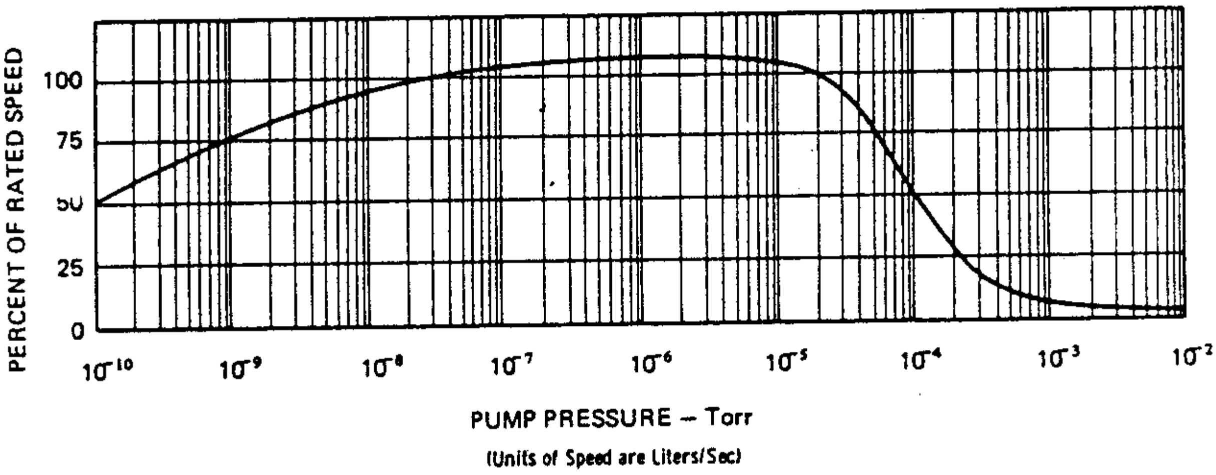


Fig. 4.2.8-2 : PUMPING SPEED VS PRESSURE

PUMPING SPEEDS FOR COMMON GASES RELATIVE TO THAT FOR AIR	
AIR	100%
NITROGEN	100%
WATER VAPOR	100%
ARGON	24%
HELIUM	30%

TABLE 4.2.8-1

- vacuum system pressure should be below 1×10^{-3} TORR for the best ion pump starting capability.

  Use of a turbomolecular pump is recommended for start-up operation in order to avoid contamination by oil.

  The time for the pump to start and pump-down will depend upon several factors :

  condition of electrodes because of exposure to air or moisture, leaks, outgassing, presence of foreign material in the pump, and hydrogen absorption into the titanium. The latter characteristic is of importance in the maser because of the predominance of hydrogen in the pumping of the internal vacuum system.

- pump-down time required will generally increse with age of the pump. During start-up, pump heating causes release of water vapor (if present) and some previously pumped hydrogen which lengthen starting time.

4.2.8.2 Vacuum system valves

There are four valves in the maser which allow two vacuum system manipulations :

1) attach an external turbomolecular pump to either inner or outer vacuum system, or both simultaneously

2) close the internal or external vacuum system in the maser during ion pump replacement

These valves do not have to retain vacuum during their actuation, and therefore are of the "gate-valve"type. The valve mechanical structure is designed so that the closing diaphragm is translated across the vacuum line, and then by means of a cam and roller mechanism moved axially against the valve seat. The mechanical linkage continues its travel for a short distance, creating a locking action in the mechanism.

The action of passing the center-lock position is felt in turning the knob on the valve.

4.2.9 Hydrogen pressure regulator system

The hydrogen pressure regulating system uses two basic elements to establish the desired pressure :

1) PIRANI PRESSURE GAUGE

2) PALLADIUM VALVE

Pirani pressure gauge

Two physical principles are used in the operation of the PIRANI gauge.

1) a metal wire increases in electrical resistivity when heated

2) the thermal conductivity of a gas is a function of the pressure

Between two bodies heat may be echanged by radiation when a vacuum exists between them, or by radiation and conduction when a gas exists between them. In the PIRANI gauge used in the EFOS Maser a resistive element is surrounded by an enclosure which is heated to a constant temperature. The heat transfered to the resistive element, and therefore its resistance, will depend on the conduction between the heated envelope and the resistance element. In this way, the resistance is an effective indication of pressure.

Palladium valve

Palladium has the special property that when at an elevated temperature it becames porous to hydrogen. The porousity depends upon temperature, and in this manner the palladium can control the flow of hydrogen in the system.

Pressure regulator

By using the resistance element in the PIRANI gauge to control the heat in the palladium valve, a simple pressure regulating system can be realized, Fig. 4.2-4.

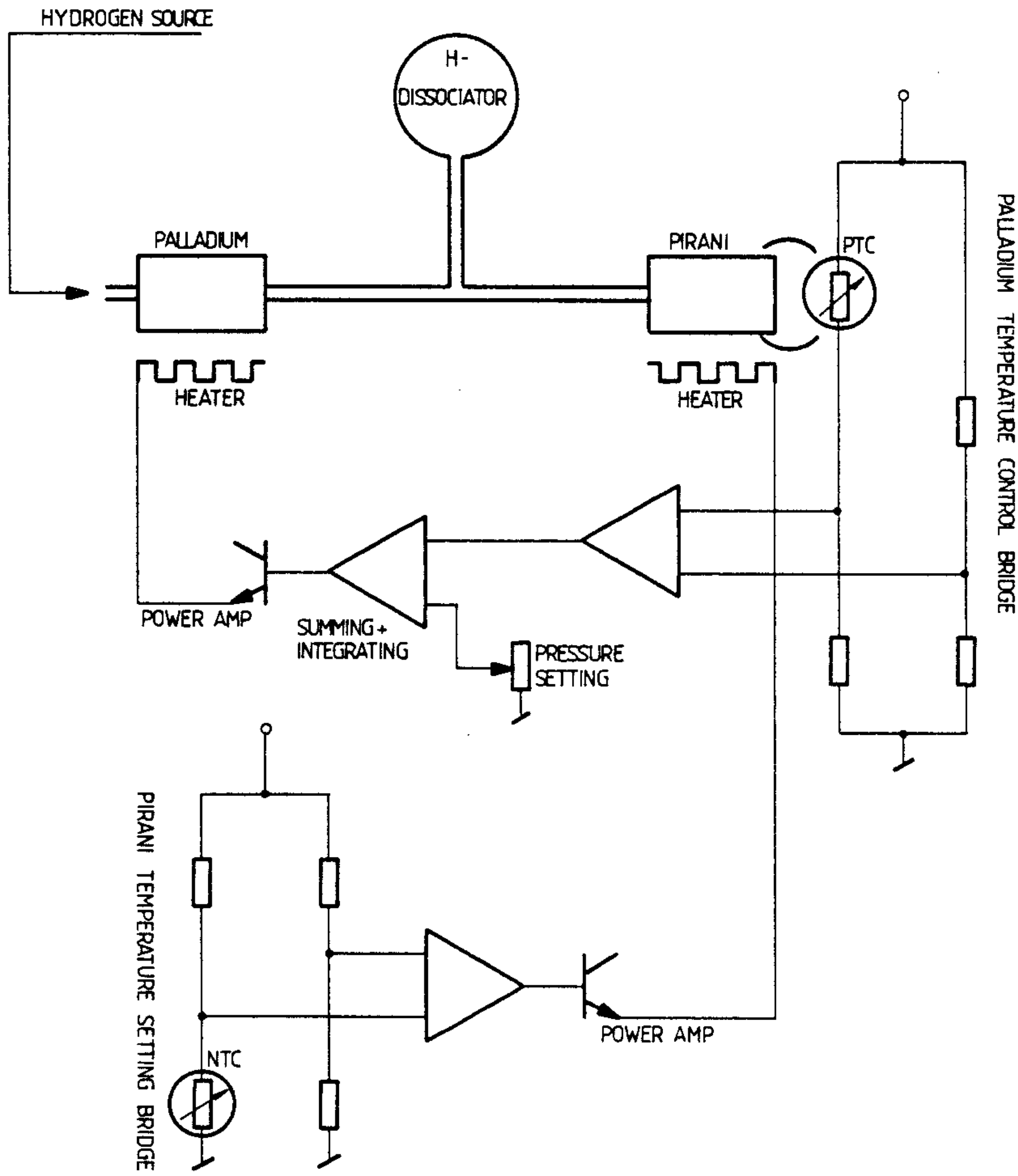


Fig. 4.2-4 : H - SYSTEM PRESSURE REGULATOR

4.2.10 Magnetic field controller

The magnetic field (C-field) controller, Fig. 7.11, is supplied from a regulated power supply of 15 V ahd consists of a stable zener reference and voltage - to current converter.

4.2.11 RF output signal isolator

The output signal isolator of the maser is a circulator providing 30 dB isolation to the maser output. Access to one of the circulator ports makes it possible to measure the maser cavity frequency, coupling factor, and Q with negligible load change on the maser. The cavity varactor voltage tuning characteristics can be readily determined as well as the cavity pulling factor. All of these parameters are useful in evaluating the performance characteristics of the maser.

4.3 RF OUTPUT

RF output from the EFOS maser is provided at the hydrogen frequency 1 420 405 751 Hz through a temperature stabilized circulator, see § 4.2.11 above. Maser output level is a nominal -106 dBm depending on the particular operating point of the maser (C-field, dissociator pressure, magnetic homogeneity, etc.).

4.4 RECEIVER SYSTEM, Fig. 4.4-1

The EFOS receiver has been designed and constructed with emphasis on low phase noise performance. This is necessary in order to exploit to the maximum the maser oscillator characteristics. Refer to figure 4.4-1 for the receiver system block diagram.

The low noise amplifier at 1.46 GHz is acommercial AVANTEK (N.F. = 2.8 dB). The multiplier is built at OSCILLOQUARTZ SA and has typical characteristics :

$$\frac{\Delta \varphi}{\Delta \Theta} \leqslant 1 \text{ RAD/°C}$$

and

$$S_\varphi = 10^{13} f^{-1} + 10^{-15} f^{0}$$

measured at 1.4 GHz and referred to 5 MHz.

The multiplier is put in the temperature stabilized maser head (thermal gain > 100) in order to avoid frequency change associated with temperature dependent phase changes.

The frequency synthesis at 5.7 kHz has a noise at least one order of magnitude below the measured performance of the maser. Finally the 5 MHz isolation amplifier has

$$\frac{\Delta f}{\Delta \Theta} < 0.1 \text{ RAD/°C}$$

and is also housed in the maser head for thermal stability.

Frequency stability

Theoretical equation for maser frequency stability (see for example REF 1) is given by the following asymptotic equation :

$$\sigma_y(\tau) = \left[\frac{1}{2\pi \nu o} \quad \frac{4\ kT}{P_{IN}} \left(1 + \frac{F-1}{\beta}\right) 3\ f_c \times \tau^{-2} + \frac{k\ T}{2\ P_{IN}\ Q_\ell^2} \times \tau^{-1} \right]^{1/2}$$

where :

$\sigma_y(\tau)$: two sample ALLAN VARIANCE corrected for dead time of the measuring system (see REF 2)

			EFOS PARAMETERS
ν_o	:	H frequency	
K	:	1.38×10^{-23}	
T	:	Absolute bulb and cavity temperature	315°K
P_{IN}	:	Power present inside the cavity	2.1×10^{-13} W
β	:	Coupling factor	0.15
βP_{IN}	=	Pout -105 dBm =	3.16×10^{-14} W
F	=	Noise figure of the RF amplifier	2.8 dB
f_c	=	Cut-off frequency of the measuring system	1 Hz
Q_ℓ	=	H line Q_ℓ	$> 2 \times 10^9$

REF 1) P. Lesage, C. Audoin and M. Têtu, Porced. of FCS 515-535 (1979)

REF 2) NBS Monograph 140
Time and Frequency Theory and Fundamentals, p 166 - 190

Receiver, phase-lock system

The receiver/phase-lock system is designed to synchronize a 5 MHz crystal oscillator to the maser output-signal. Since the hydrogen atomic frequency is not a direct multiple of 5 MHz, some method of synthesis must be used to accomplish the phase-lock. The EFOS Maser system is illustrated in figure 4.4-1 and consists of the following elements which are described below :

1) RF section
2) Receiver section
3) Synthesizer
4) Phase detector and integrator
5) Frequency multiplier
6) Voltage controlled quartz oscillator
7) Buffer amplifiers

4.4.1 RF section

The RF section contains the maser output feeding the circulator. By terminating the circulator third arm in 50 Ω load, the circulator functions as an isolator protecting the maser output from the effects of load impedance variation. Alternatively, the third arm can be use for interrogating the maser cavity either to determine cavity frequency or aid in maser evaluation.

The maser signal from the circulator is amplified in a broadband amplifier (about 30 dB). Then passed through a narrowband filter to the first mixer-preamplifier. The narrowband filter serves to suppress noise from the image frequency presented to the first mixer. A 1440 MHz, 1 mW local oscillator signal from the frequency multiplier is applied to the mixer which then outputs a 19.594 MHz IF to the receiver section via an IF preamplifier. For a maser signal of -105 dBm the 19.594 MHz level is about -60 dBm.

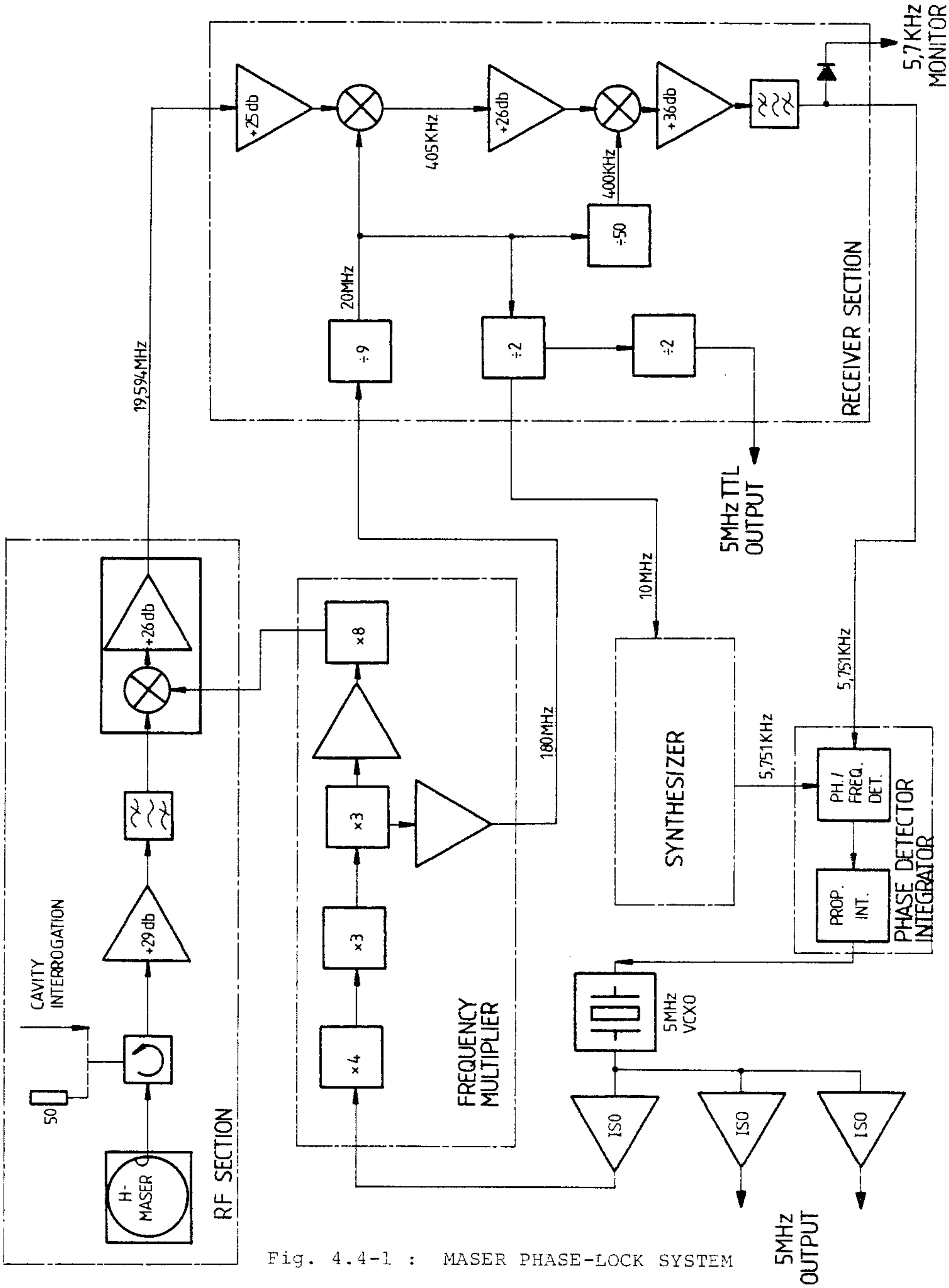


Fig. 4.4-1 : MASER PHASE-LOCK SYSTEM

4.4.2 Receiver section

The receiver section serves four functions.

1) down converts the 19.594 MHz IF to the 5.751 kHz PLL comparison signal
2) provides a 10 MHz reference signal to the synthesizer
3) provides a 5 MHz TTL output signal from the maser
4) provides a 5.751 kHz receiver monitoring output

The 180 MHz signal from the frequency multiplier is divided by 9 to 20 MHz and mixed with the 19.594 MHz input from the RF section, Fig. 4.1... The resultant 405 kHz signal is amplified and again mixed with a 400 kHz signal divided again (by 50) from 20 MHz. After amplifying and filtering. The derived 5.7 kHz signal is fed to the phase detector.

The 20 MHz signal is divided by 2 and fed to the frequency synthesizer; this 10 MHz signal is further divided by 2 to provide 5 MHz buffered TTL from the maser.

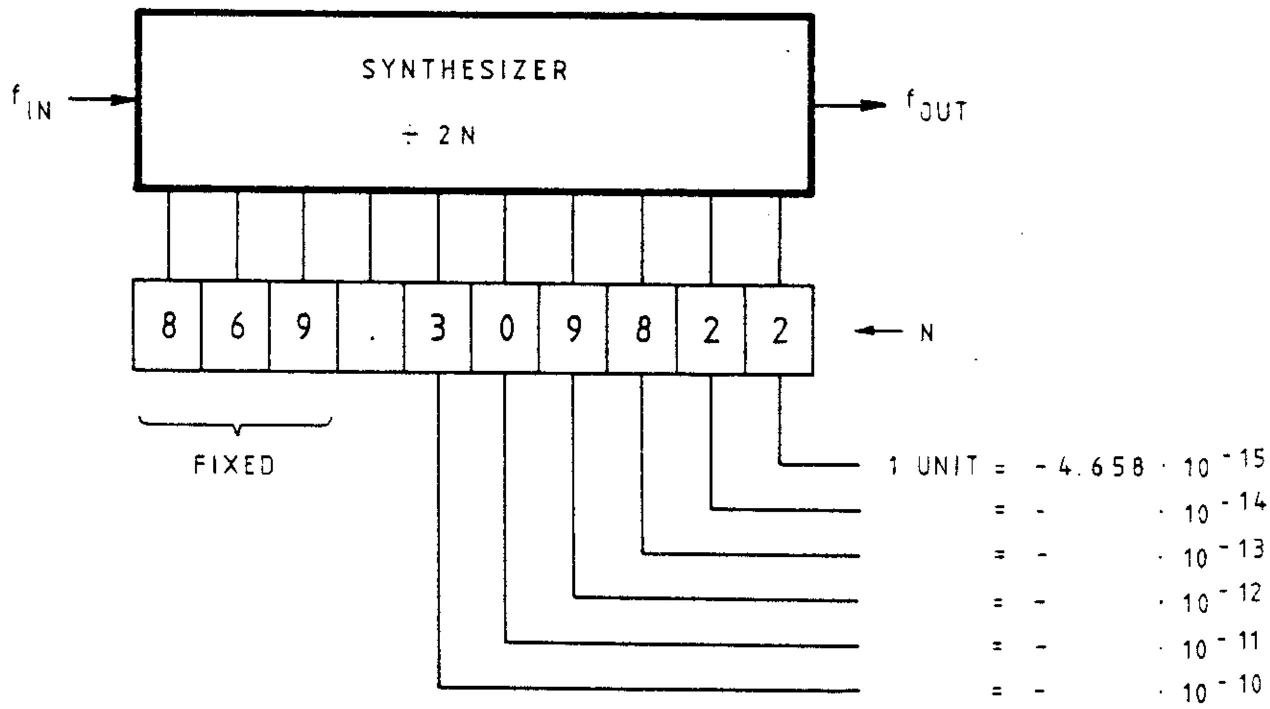
A 5.7 kHz envelope detector provides the receiver monitoring output.

4.4.3 Synthesizer

The synthesizer is a 9-digit dividing logic system which divides the 10 MHz reference to produce the 5.751 kHz phase lock loop comparison signal. The last 6 digits of the divider are variable by means of a remote digital switch. The first three digits of the divider are fixed. One unit change in the last digit of the synthesizer changes the maser frequency by 4.7×10^{-15} parts, Fig. 4.4-2 gives details of the dividing factors.

4.4.4 Phase/frequency detector and integrator

The PLL uses a digital phase/frequency detector. The frequency descriminating characteristics of this type detector are desireable because initial conditions can result in a 5.7 kHz beat frequency which may be 100 Hz, or so, from the nominal value. The frequency discriminator action of the detector will steer the oscillator frequency to obtain a phase-lock acquisition.



Synthesizer $f_{out} = \frac{fin}{2N}$

$$\Delta f_{out} = - \frac{fin}{2N^2} \times \Delta N \text{ (for small } \Delta N)$$

$$\frac{\Delta f_{out}}{f_H} = - \frac{fin}{2N^2 f_H} \times \Delta N$$

f_H = hydrogen maser frequency = 1420405751, 6893 Hz

f_{IN} = 10^7 Hz

N = 869.309822

ΔN = 10^{-6} (last digit)

$\frac{\Delta f}{f_H}$ = -4.658×10^{-15} for one unit in last digit

Fig. 4.4-2 : SYNTHESIZER DIGITAL FREQUENCY CONTROL

At lock, zero phase and frequency difference exist between reference and oscillator frequency. The digital sequential logic circuitry responds to transitions in the two input waveforms, therefore phase error is independent of input waveform duty cycle or amplitude variations.

The integrator following phase detection provides the DC gain and filtering characteristics necessary for the PLL response characteristics desired.

An auxiliary circuit uses the phase detector output to provide a phase-lock indication signal which is diaplayed as green (lock) or red (unlock) on the monitor receiver panel.

4.4.5 Frequency multiplier

The frequency multiplier multiplies the 5 MHz VCXO output to the 1440 MHz used as local oscillator in the RF section mixer/pre-amplifier. The multiplication (x288) is accomplished in two sections.

1st Section	:	5 MHz to 180 MHz (x36) by three stages of balanced transistor multipliers x 4, x 3, x 3. These stages use the balanced transistor configuration in order to aid harmonic rejection at the multiplier stage output. Selected low-noise transistors and emitter degeneration are used to obtain low 1/f noise performance.
2nd Section	:	180 MHz to 1440 MHz by means of a step-recovery diode. The diode is self-biased and produces 0 to +10 dBm output power. A bandpass filter at 1440 MHz output provides suppression of 180 MHz frequency components.

An auxiliary 180 MHz output signal is derived from the 1st section as pilot for the receiver down-converting system.

4.4.6 Voltage controlled quartz oscillator

The voltage controlled quartz oscillator is a standard model B-5400 manufactured by OSCILLOQUARTZ SA. Output is a 5 MHz with low phase noise. The oscillator output, within the PLL passband frequency is determined by the characteristics of the maser output and the frequency multiplier.

4.4.7 Output buffer amplifier

The 5 MHz buffer amplifiers consist of an cascode stage and a emmitter follower complementary pair output amplifier. These amplifiers are untuned in order to minimize phase variations with temperature and provide the best phase tracking characteristics.

4.5 MONITORING TRANSMITTER

Remote monitoring of 30 maser parameters is provided by a digital data transmitting system, Fig. 4.5-1, monitoring transmitter block diagram.

A voltage analog is derived at each test point in the maser which represents the measured value converted to a scale factor (for example, the 200 μA C-field full scale current is represented by a 4 V signal to the monitoring transmitter). Figure 4.5-2 contains a summary of full scale monitored values and scale factors.

The normalizing filter output is led to a digital multiplexer which is sequencially scanned by a clock input. Multiplexer output is then converted to BCD data and serial output for transmitting to the remote monitoring receiver via an opto-coupler and line-driver for eventual de-coding and presentation in the monitor receiver.

The clock sequency signal is also transmitted to the remote receiver via an opto-coupler and line-driver for eventual use in de-coding in the monitor.

Time for a complete data channel scam is about 320 μs, Fig. 4.5-3.

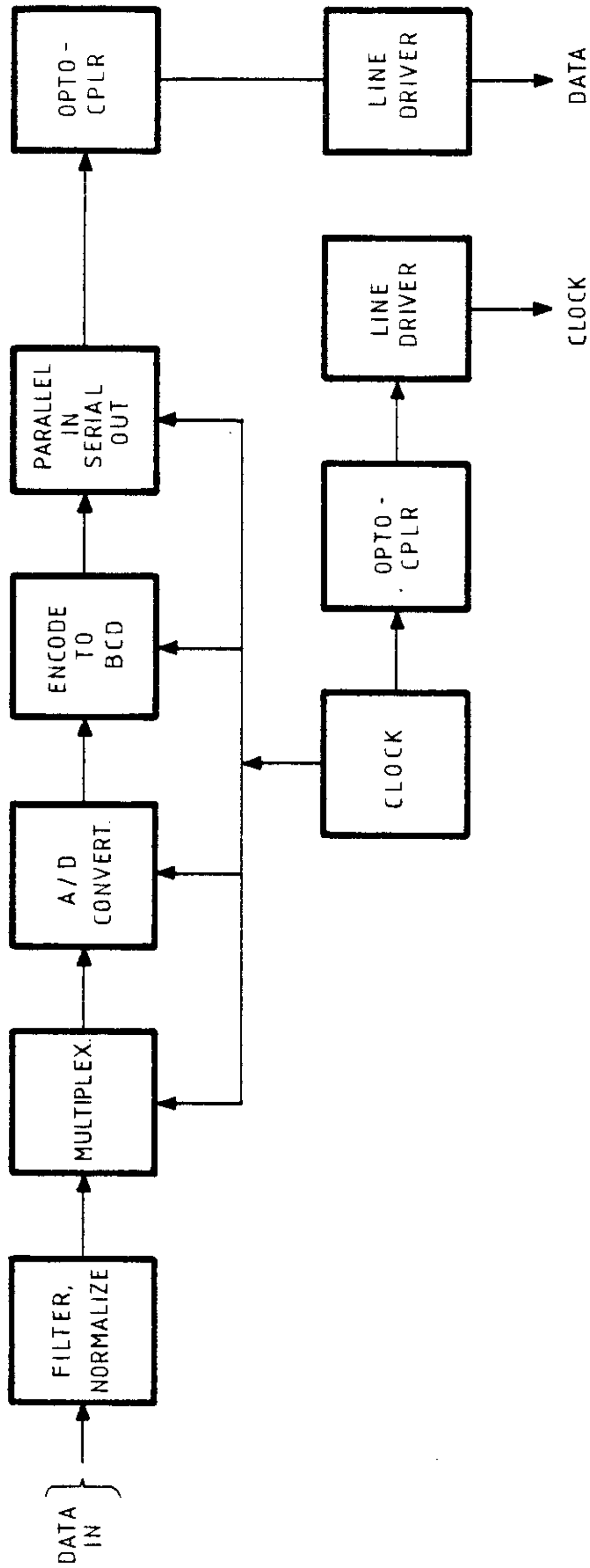


Fig. 4.5-1 : MONITORING TRANSMITTER BLOCK DIAGRAM

ADRESSE		FS	IN-FILTER	GAIN (R1-R2)	DIN 41612	AMP/BLOC	FILTER
00	Ubat A	24V	4V	1/100K	30c	A8-3	16K/100nF
1	I bat A	10A	4V	1/1M	29a	A8-2	"
2	UbatB	24V	4V	1/100K	31c	A6-3	"
3	I batB	10A	4V	1/1M	30a	A6-2	"
4				1/100K	31a	A3-2	"
5				1/100K	24a	A6-1	"
6	H-pressure control	10V	10V	150K/100K	32c	A3-3	"
7	H-pressure measure	10V	10V	150K/100K	25c	A8-4	"
10	LO	20V	20V	120K/30K	21c	A5-3	"
1	UO	20V	20V	"	21a	A5-2	"
2	DALLE	20V	20V	"	20a	A7-2	"
3	LI	20V	20V	"	20c	A7-3	"
4	UI	20V	20V	"	23a	A3-1	"
5	CAVITY	20V	20V	"	23c	A3-4	"
6	T-CAV	2°C	4V	1/100K	25a	A8-1	"
7	T-AMB	10°C	4V	1/100K	24c	A6-4	"
20	CAV-VAR	10V	10V	150K/100K	22c	A2-3	"
1	XTAL-VAR	10V	10V	150K/100K	22a	A2-2	"
2	AMPL. 5,7KHz	10V	10V	68K-56K//240K	13a	A7-1	"
3	C-FIELD	200µA	4V	1/100K	13c	A7-4	"
4	U } VAC ION INT	5KV	6,34V	43K/68K	12a	A5-1	"
5	I	-2mA	4V	2/100K×3	12c	A5-4	"
6	U } VAC ION EXT	-5KV	6,34V	43K/68K	11a	A2-1	"
7	I	2mA	4V	2/100K×3	11c	A2-4	"
30	U } RF SOURCE	24V	24V	75K/15K	9c	A4-3	"
1	I	1A	-1V	120K/30K	10a	A1-2	"
2	+24V	+24V	24V	75K/15K	9a	A4-2	"
3	+15V	+15V	15V	91K-33K	10c	A1-3	"
4	-15V	-15V	15V	91K-33K	7c	A4-1	"
5	+5V	+5V	5V	30K-120K	7a	A4-4	"
6	+15V	+15V	15V	91K-33K	6a	A1-1	"
7	-15V	-15V	15V	91K-33K	6c	A1-4	"

FILTERS (MONITORING TRX)
8002-30-22-

14.12.82

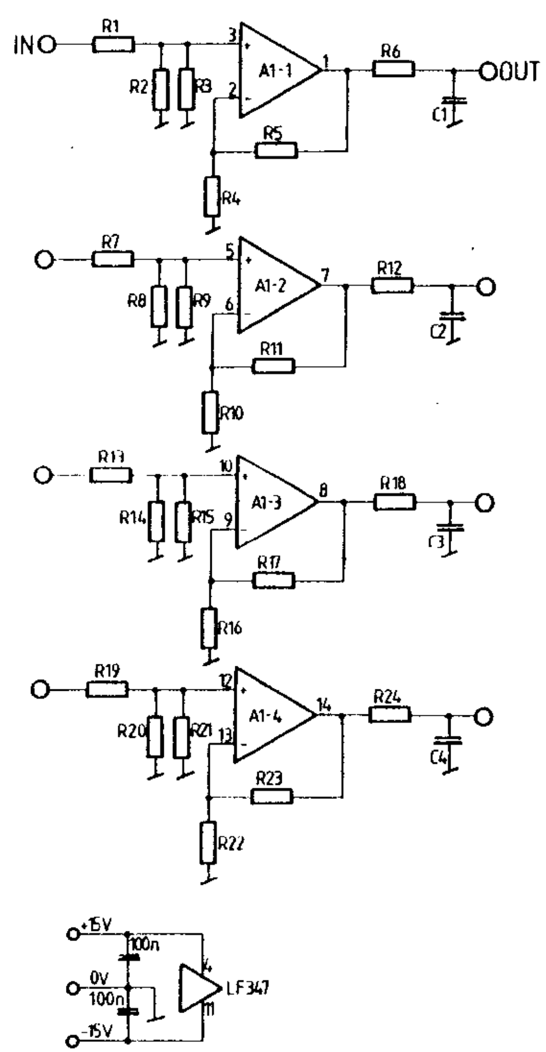


Fig. 4.5-2 : MONITORING TRANSMITTER
NORMALIZING AMPLIFIER / FILTER

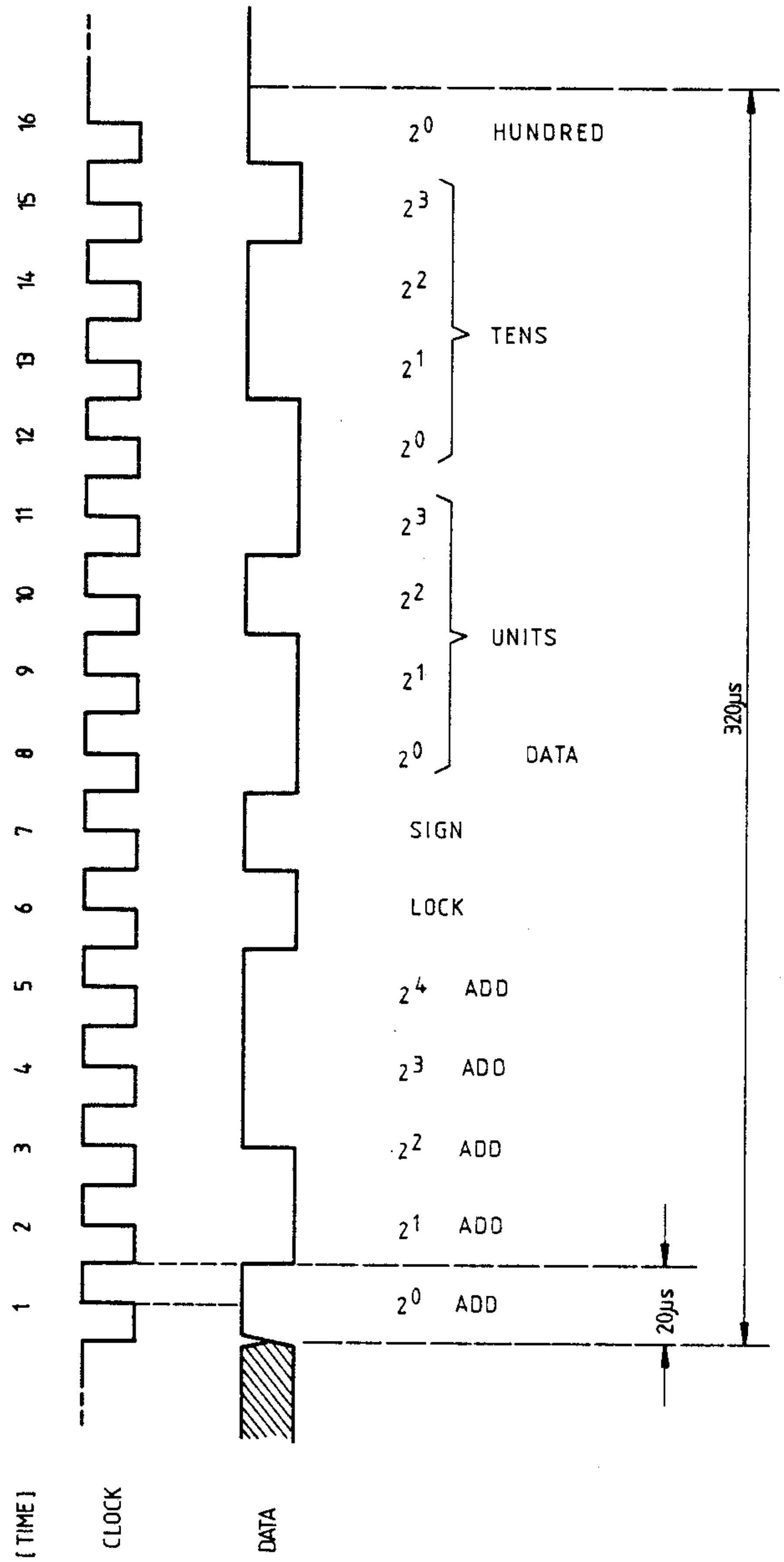


Fig. 4.5-3 : MONITORING TRANSMITTER OUTPUT SIGNALS

4.6 MASER ELECTRICAL SYSTEM BLOCK DIAGRAM

The maser electrical system block diagram is shown in figure 4.6-1 .

4.7 HYDROGEN MASER PHYSICAL PARAMETERS

The following summarizes the hydrogen maser parameters associated with the EFOS.

-1. Frequency of oscillation

$fo = 1420405751.689$ Hz

-2. Magnetic field dependence

$fh = fo + 2750\ H^2$ f in Hz, H in Oersteds

$fo = 1420405751.689$ Hz

-3. Zeeman frequency

$fz = 1.4$ Hz / μ Oersted

-4. C-field calibration

$H = 8.2\ \mu$ Oersted / μ A

$= 16.4\ \mu$ Oersted / monitor digital unit

-5. Wall shift

$$\frac{\Delta f}{f} < 2 \times 10^{-11}$$

-6. Cavity pulling factor $\frac{Qc}{QH}$

Where : Qc = Cavity quality factor
QH = Maser line Q

$$1 \times 10^{-5} \leq \frac{Qc}{QH} < 2 \times 10^{-5}$$

where Qc = 32 k for EFOS and QH depends upon hydrogen pressure.

-7. Cavity temperature coefficient

$\Delta fc_{/fc} = -2.5 \times 10^{-5}/+1°C$

-8. Dependence upon external magnetic field perturbation

$$\frac{\Delta fm}{fm} = \frac{5500}{fm} H \times \Delta H$$

$\Delta Hm = \Delta H ext \times$ magnetic attenuation

Attenuation factor ≃ 5000
fm = maser frequency
H is in Oersteds

-9. Oscillation threshold : < 100 μOersted

-10. Residual magnetic field : < 20 μOersted

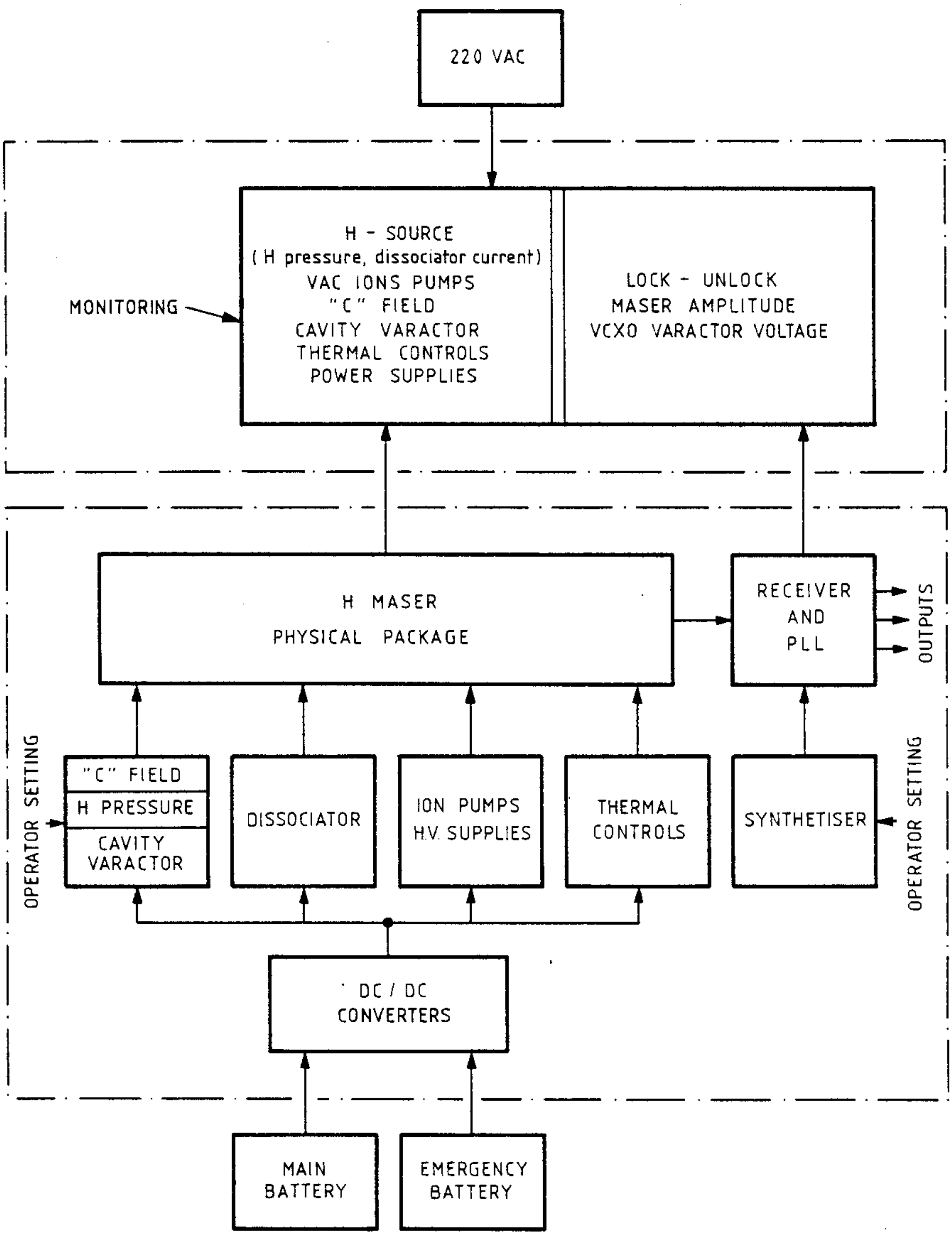


Fig. 4.6-1 : MASER SYSTEM BLOCK DIAGRAM

5. PERFORMANCE CHECK PROCEDURE

5.1 INTRODUCTION

Operating performance checks on the maser involve two aspects :

- output frequency stability (short term and long term)
- internal operating parameters

1) Output frequency can only be checked by using other frequency standards of adequate stability and precision. Such measurements and their necessary auxiliary equipment are outside the scope of this manual, except as described in the operators instruction section (spin exchange tuning).

2) Internal operating parameters are readily checked by the maser monitoring system, except for the hydrogen bottle pressure. Under normal operating conditions, the following parameters may be expected to change with time :

   a) hydrogen bottle pressure due to utilization hydrogen

   b) ion pump current due to pump aging

   c) VCXO control voltage due to quartz crystal aging

   Other parameters may be expected to change according to the ambient temperature :

   - all heater voltages

5.2 OPERATING CHECKS

Operation of the maser should be checked periodically by using the monitoring system. Reading should be noted in the log-book.

For those parameters which are expected to change with time as mentioned above :

a) <u>Hydrogen bottle pressure</u>

The hydrogen bottle pressure for normal maser use will decrease about 10 atmospheres per year. Bottle pressure can be checked by removing the rear cover of the vacuum manifold compartment, Fig. 1.1 ②; 2.1; 2.2 ⑥.

After the maser is transported, it is recommended that the hydrogen system leak test described in § 2.4.2.b) be performed.

b) <u>PLL VCXO control voltage</u>

The B-5400 quartz oscillator has a nominal aging rate $< 3 \times 10^{-8}$ per year. The nominal range of voltage control for the oscillator is $\pm 1 \times 10^{-7}$, therefore about three years operation should be possible before the voltage control range is exceeded. Bias voltage on the oscillator control is 5 Volts and when monitoring indicates a 1 Volt departure from this value the oscillator coarse frequency control should be adjusted.

c) <u>Ion pump</u>

The expected life of the ion pump is 2 to 3 years at the pressures existing in the maser. Furthermore, the pump current of the internal vacuum system depends on the pressure of the hydrogen system. From some initial value $< 600\ \mu A$ the pump current will gradually decrease until a steady value of some 100 μA is reached. Pump failure will be noted by an increase in pump current and a loss of vacuum in the maser.

6. ADJUSTMENTS AND MEASUREMENTS

Measurements of the various parameters of the maser can be divided into two categories :

a) basic measurements of the physics or electronics elements which do not change with time or the replacement of another components.

Example : the cavity frequency vs temperature coefficient.

b) those measurements which must be repeated when some parameter or element of the maser is changed.

Example : receiver output vs input

This section covers measurements and adjustments which must be made when certain modules are changed.

6.1 RESUME OF MEASURED PARAMETERS

The maser log book contains the following data :

-1 nominal operating values read out on monitor and control panel

-2 receiver calibration

-3 maser output vs C-field, threshold

-4 Zeeman frequency

-5 line Q (Q_ℓ)

-6 cavity Q (Qc)

-7 cavity coupling factor, β

-8 test point voltages on heater pre-amp

-9 heater test point reading at cavity temperature setting

-10 cavity pulling factor

-11 dissociator pressure setting

-12 cavity thermistor temperature coefficient

-13 cavity tuning voltage - frequency calibration curve

-14 spin exchange tuning data

-15 inner vacuum system minimum pressure (ion pump current minimum)

Certain of the measurements depend upon the physical construction of the maser and will not vary with time, or as a function of other parameters. They are :

-6 cavity Q

-7 cavity coupling factor

-12 cavity thermistor temperature coefficient

6.2 TROUBLESHOOTING, REPAIR OF MASER

The test data summarized in § 6.1 is useful in troubleshooting the maser. In addition, certain tests and adjustments must be re-done and noted in the log book when repairs of replacement of modules is made. They are :

Replacement of receiver

Receiver calibration, see § 6.2.1

Demagnetization

a) maser output vs C-field threshold measurement, see § 6.2.2

b) Zeeman frequency, see § 3.11

Replacement of heater preamplifier module -

a) LO, UO, LI, UI, DALLE heaters. Test point voltages on heater preamp, see § 6.2.3

b) for cavity temperature setting

- heater test point reading at cavity temperature setting
- cavity thermistor temperature coefficient, see § 6.2.3-2

c) cavity frequency setting

- spin exchange tuning, § 3.11.5

For adjustment of cavity tuning see § 6.2.3

Replacement of dissociator

- maser output vs C-field, see § 6.2.2
- dissociator pressure setting
- inner vacuum system minimum pressure, see § 7.2.5-4

6.2.1 Receiver calibration

The receiver should be calibrated in the maser and at the operating temperature of the maser head electronics compartment. Proceed as follows :

-1. install the receiver, § 7.3.5.3-2, Fig. 7.4

-2. disconnect the maser output coax (3) , Fig. 7.4, at the maser

-3. connect a 10 dB attenuator on the coax (3) , going to the circulator and an external coax going to the signal generator, Fig. 6.2.1-1. This coax should be lend through the demagnetizing access holes on the electronic compartment and cover of the maser head (2) , (3) , Fig. 7.2. Place the insulation also in order to keep the thermal environment the same. It will not be necessary to close the upper cover and magnetic shield panel (3) , Fig. 7.1

-4. wait for the compartment temperature to stabilize (1 hour). Connect an oscilloscope to the 5.7 kHz coax output, Fig. 7.4, and a digital voltmeter (10 V F.S.) to the control panel (11), Fig. 1.3, 5.7 kHz output

-5. set the signal generator to the maser frequency and level, Fig. 6.2.1-1, and record 5.7 kHz outputs for signal generator power levels from -80 dBm to 110 dBm

N O T E

> The attenuation of the cable and attenuator should be calibrated by making a separate measurement using a power meter.

6.2.2 <u>Maser output vs C-field, threshold</u>

Connect a digital voltmeter to "C-field" current measure (14), Fig. 1.3, and to "AMP 5.751" (11), Fig. 1.3. Use voltmeter full-scale at least 5 V.

Vary C-field from zero to max (250 μA) and measure measer signal, record, and make a plot.

Near a C-field current of 0, oscillations will cease. Determine this threshold as follows :

- reduce C-field current slowly or in small steps (e.g. 5 μ A) until maser output signal rapidly drops to zero. Note C-field current.

- increase the C-field in small increments, and wait several minutes at each step. Note C-field current when oscillations are re-established.

The threshold of oscillations is between these two C-field current values, and should be less than 20 μ A. If the threshold is greater than 50 μ A, the demagnetization cycle should be repeated.

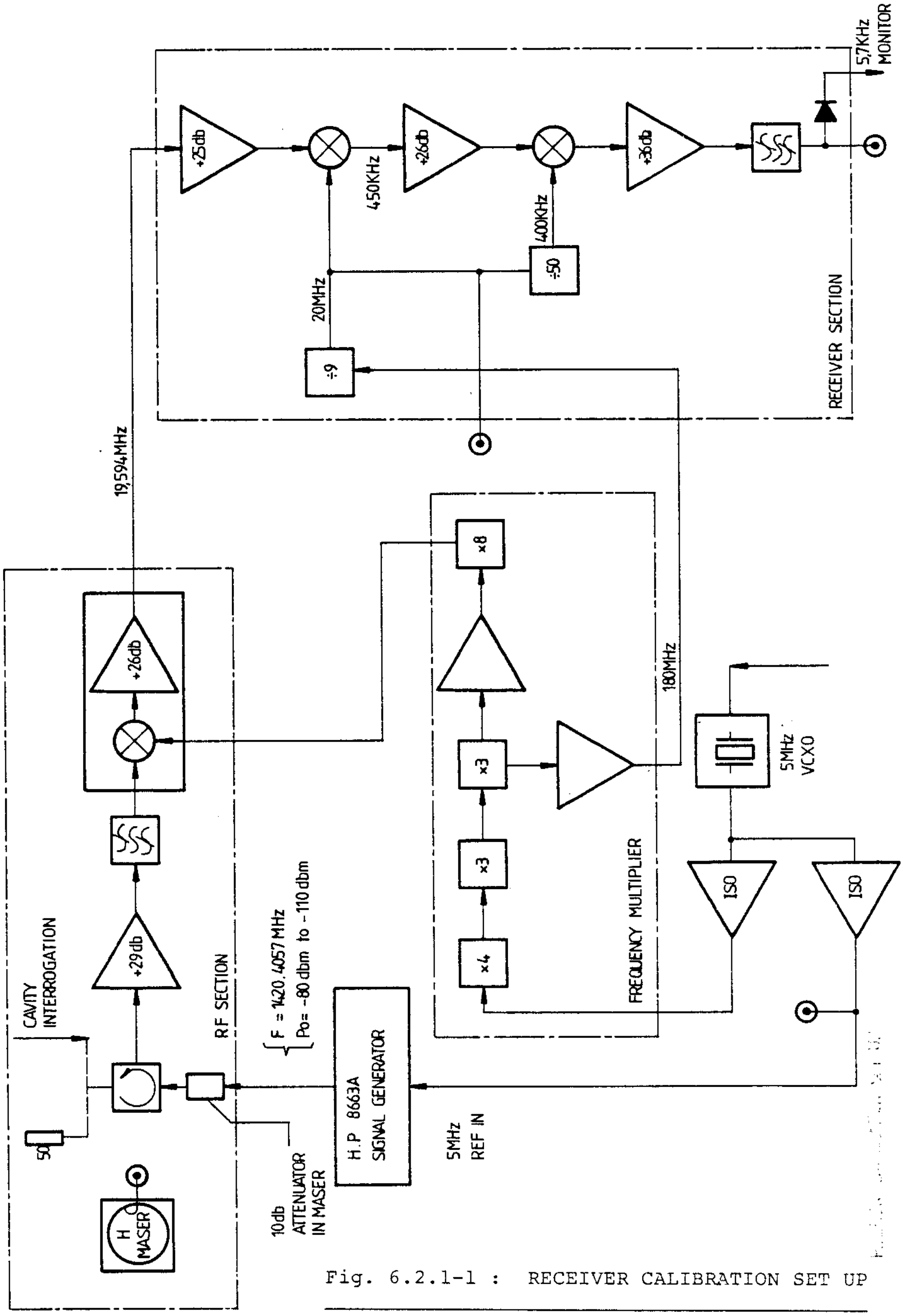


Fig. 6.2.1-1 : RECEIVER CALIBRATION SET UP

6.2.3 Temperature setting

Replacement of the heater preamplifier circuit card will necessitate setting the operating point temperatures according to the values already established.

-1. Outer heaters operating point setting

LO, UO, LI, UI and DALLE temperature proceed as follows :

a) energize circuit card with input power control switch on position "HEATERS" (2), Fig. 1.3

b) measure, with a high impedance voltmeter, the voltage on preamp test points (Dwg 8002-30-24-1152) and set values noted in log book :

TPI - LO

TP2 - UO

TP3 - LI

TP4 - UI

TP5 - CAVITY
(NOTE : further adjustments of cavity will be needed, see -2. below)

TP6 - DALLE

c) check heater voltages on monitor to assure that heating systems are working. Wait until all heating systems are regulating before proceeding (this may take from several hours to several days depending on the initial temperature of the cavity).

-2. Cavity temperature / frequency setting

After heaters are turned on, monitor cavity heater voltage "ADDRESS-15 CAV" on monitor display

a) wait until heater regulates and is stable

b) connect a digital voltmeter to the "TEMP CAV" coax on control panel (10), Fig. 1.3. This point will be used in subsequent adjustments to determine cavity temperature

c) connect a voltmeter as indicated in 6.2.3-1 (b) above to TP5-CAVITY on the heater preamplifier circuit card (1), Fig. 7.6, Dwg 8002-30-24-1152

d) voltage measured on "TEMP CAV" test point should be 0 ± 40 mV (voltage/temperature coefficient = 4 V per °C) or in other words, cavity temperature must be within ± 0.01° of set value

e) obtain temperature - voltage coefficient from the logbook for setting voltage on TP5, and correct this voltage in the sense to cause the cavity temperature voltage indication to approach zero. Make small increments in pot setting (a few millivolts each time) and wait at least one hour or until assured that the set value is stabilized on cavity temperature.

f) check the cavity temperature operating point by making a spin exchange tuning, § 3.11.5. Cavity varactor voltage for frequency set point should be 3 ± 1 V.

g) if cavity varactor voltage for spin exchange tuning is not within the range (f), use voltage, frequeny and temperature coefficients as a guide to changing cavity temperature to obtain the required spin exchange tuning point.

h) record final values :
TP5, cavity varactor voltage, temperature monitor readings in the log book

6.2.4 Dissociator RF oscillator adjustment

This is a one-time adjustment and should be made when the RF-oscillator module is replaced or when the dissociator is changed and the RF oscillator module is not changed. The procedure is slightly different in the two cases; however, the maser must be operating in either case.

-1. Oscillator module replacement

a) set dissociator pressure to normal value specified in log-book

b) disconnect the "RF" cable on the interconnecting cable panel (8), Fig. 7.13, in the electronic / control module (module must be slid out of maser housing)

c) connect an adaptor (two wires) from the cable connector to a D.C. power supply 0 - 30 V adjustable, 1 A current limit in order to energize the oscillator from this external supply

d) the front panel on the vacuum manifold compartment will normally be removed for changing the RF oscillator module thus giving access to the oscillator tuning control (capacitor) on the mounting plate of the oscillator. This capacitor should be located by reference to the D.C. feed-throughs so that its relative position is known after installation and that it can be readily engaged by the tuning screwdriver.
(Dwg 8002 - 40 - 22 - 1197)

e) set power supply DC to zero, turn on, then slowly increase the D.C. applied to the dissociator RF oscillator. Observe current and voltage.

f) at a supply voltage of about 10 V the current will sharply increase indicating oscillation. Continue increasing the voltage.

g) at a voltage between 12 and 20 volts the hydrogen discharge should start

h) connect voltmeter to 5.7 kHz maser signal and wait until maser oscillates

i) reduce maser C-field until 5.7 kHz starts to decrease

j) tune oscillator for maximum signal

k) reduce D.C. to zero and repeat turn on cycle. IF discharge does not start, turn oscillator tuning in a clockwise direction (one turn) reduce supply voltage to zero and repeat the process until the discharge will start when the supply voltage is brought up

-2. Dissociator replacement

The process is essentially the same as -1 above, except that the initial discharge obtained may not be satifactory for full maser operation. In this case, after discharge is initiated, wait until the rich pink glow is obtained before proceeding as above. This may take several days depending on the "burn in" time required by the replacement dissociator.

6.2.5 Cavity pulling factor, line Q (Q_ℓ)

Cavity pulling factor is defined :

Maser freq. change =

pulling factor x cavity freq. change

For a known pulling factor, the maser line Q (Q_ℓ) may be determined from the relation :

$$\text{pulling factor } (k) = \frac{Qc}{Q_\ell} \quad \text{where}$$

$$Qc = \text{cavity Q.}$$

$$\text{Thus} \quad Q_\ell = \frac{Qc}{k}.$$

Cavity Q (Qc) is recorded in the maser log-book (as is Q_ℓ for the initial maser measurements).

To measure k or determine Q_ℓ, make frequency pulling test as described for spin exchange tuning, § 3.11.5 keeping dissociator pressure constant.

Cavity frequency change is determined from calibration curve in the log book, maser frequency change is measured; k and Q_ℓ may be calculated.

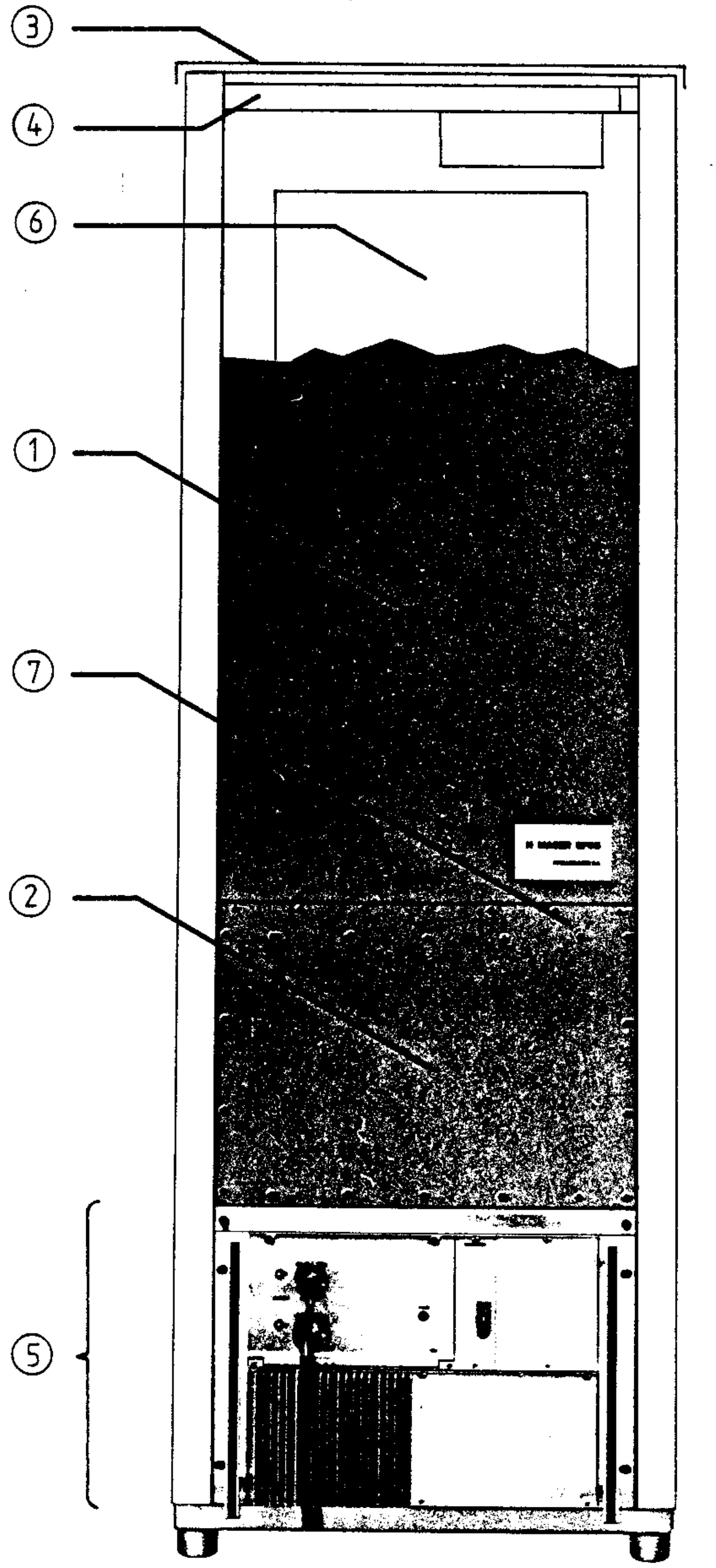


Fig. 7.1 : E F O S HYDROGEN MASER

① MASER PHYSICS COMPARTMENT

② VACUUM MANIFOLD COMPARTMENT

③ UPPER COVER AND MAGNETIC SHIELD

④ UPPER FRAME PLL SECTION

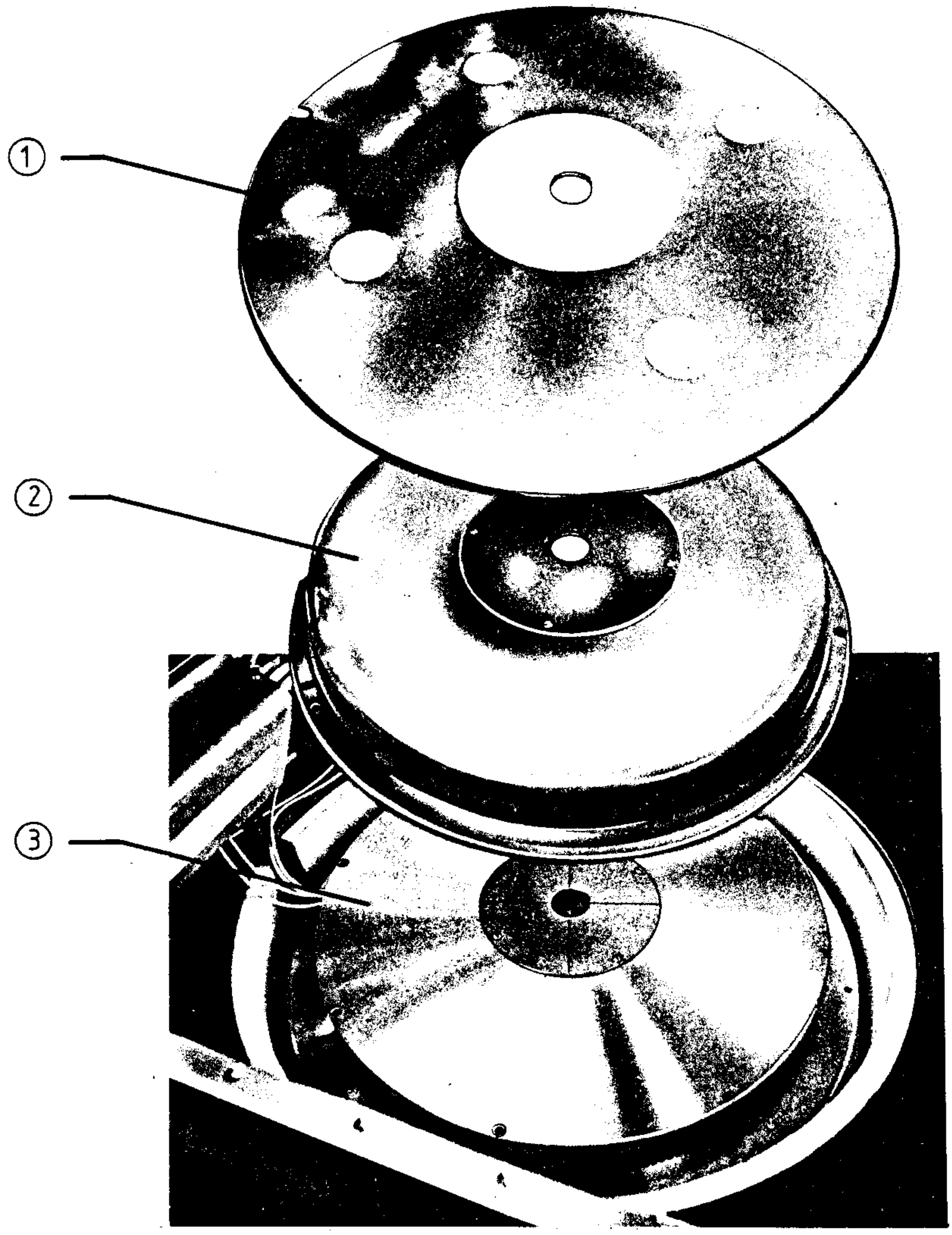
⑤ ELECTRONICS / CONTROL UNIT

⑥ MASER HEAD

⑦ DISSOCIATOR LIGHT PIPE

Fig. 7.1 : E F O S HYDROGEN MASER

(CONTINUED)



① OUTER MAGNETIC SHIELD
② MASER HEAD COVER
③ ELECTRONICS COMPARTMENT COVER

Fig. 7.2 : MASER HEAD :
ACCESS TO ELECTRONICS COMPARTMENT

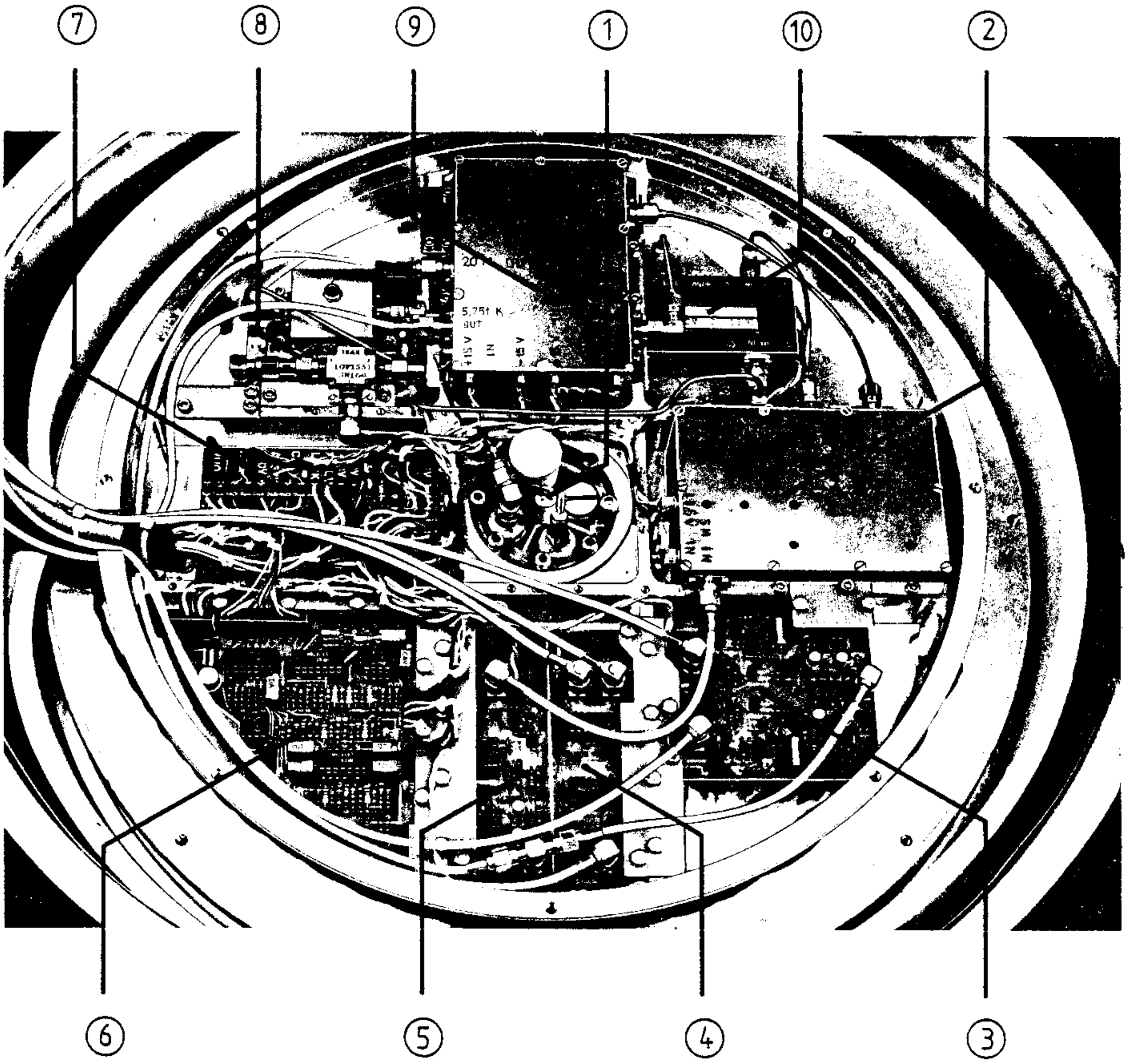


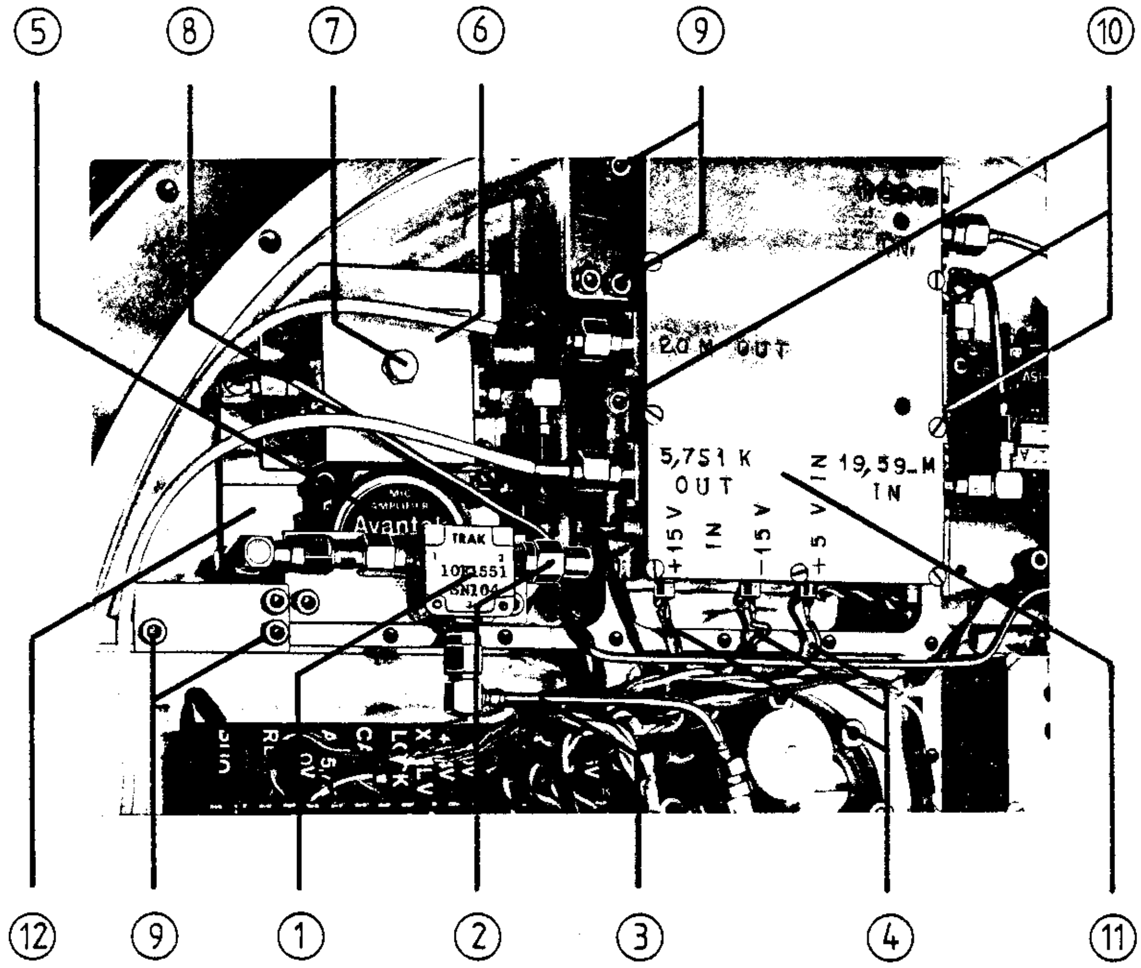
Fig. 7.3 : MASER HEAD GENERAL ASSEMBLY

1. CENTER SECTION "DALLE" *
2. FREQUENCY MULTIPLIER
3. 5 MHz OUTPUT BUFFER AMPLIFIERS
4. DIVIDE FROM 20 MHz, 10 MHz,
   TTL BUFFERED OUTPUT
5. MULTIPLIER 5 MHz BUFFER AMPLIFIER
6. HEATER PREAMPLIFIERS
7. INPUT CONNECTING BOARD
8. RF PREAMPLIFIER SECTION
9. RECEIVER SECTION
10. 1st MIXER / PREAMP SECTION

* "DALLE" is a french word which could be literally translated in this case as "throat" or "mouth"

Fig. 7.3 : MASER HEAD GENERAL ASSEMBLY

(CONTINUED)



(1)	CIRCULATOR
(2)	CIRCULATOR 50Ω TERMINATION
(3)	MASER OUTPUT COAX
(4)	DC CONNECTIONS
(5)	RF PREAMPLIFIER
(6)	RF FILTER
(7)	FILTER TUNING ADJUSTMENT
(8)	RF COAX TO FIRST MIXER PREAMPLIFIER MODULE
(9)	RF PREAMPLIFIER SECTION MOUNTING PLATE AND ATTACHMENT SCREWS
(10)	RECEIVER MODULE ATTACHMENT SCREWS
(11)	RECEIVER MODULE
(12)	RF PREAMPLIFIER, FILTER MOUNTING PLATE

Fig. 7.4 : MASER HEAD :
RF PREAMPLIFIER / RECEIVER INSTALLATION

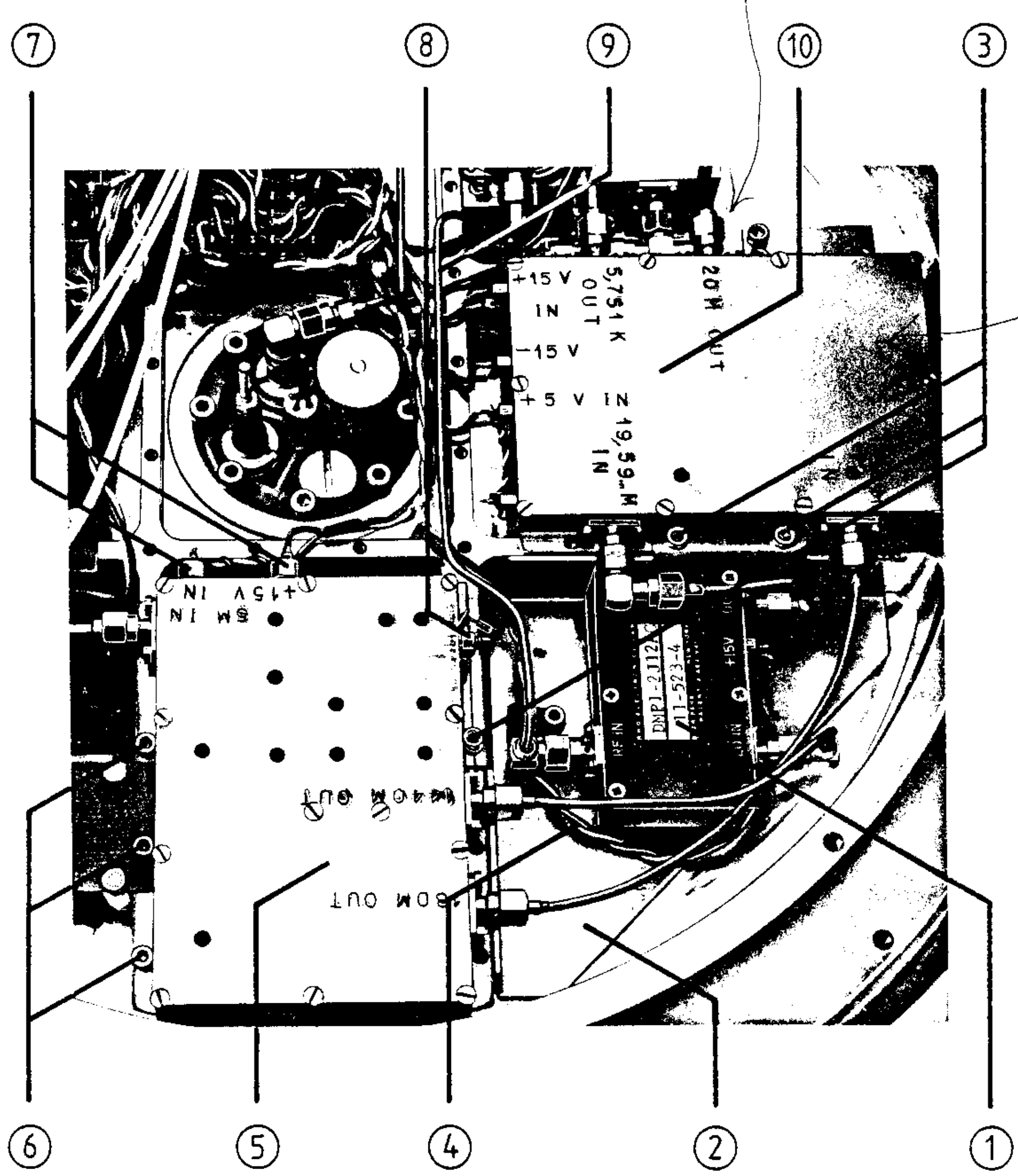


Fig. 7.5 : MASER HEAD : 1st MIXER
PREAMPLIFIER + FREQUENCY MULTIPLIER INSTALLATION

1. 1st MIXER / PREAMP MODULE
2. MIXER / PREAMP MODULE MOUNTING PLATE
3. MOUNTING PLATE ATTACHMENT SCREWS
4. DC CONNECTING WIRES
5. FREQUENCY MULTIPLIER MODULE
6. MULTIPLIER / ISOLATION AMPLIFIER MODULE ATTACHMENT
7. DC CONNECTIONS TO FREQUENCY MULTIPLIER
8. STEP RECOVERY DIODE BIASING RESISTOR
9. MASER SIGNAL COAX FROM RF PREAMP
10. RECEIVER MODULE

Fig. 7.5 : MASER HEAD : 1st MIXER / PREAMPLIFIER + FREQUENCY MULTIPLIER INSTALLATION

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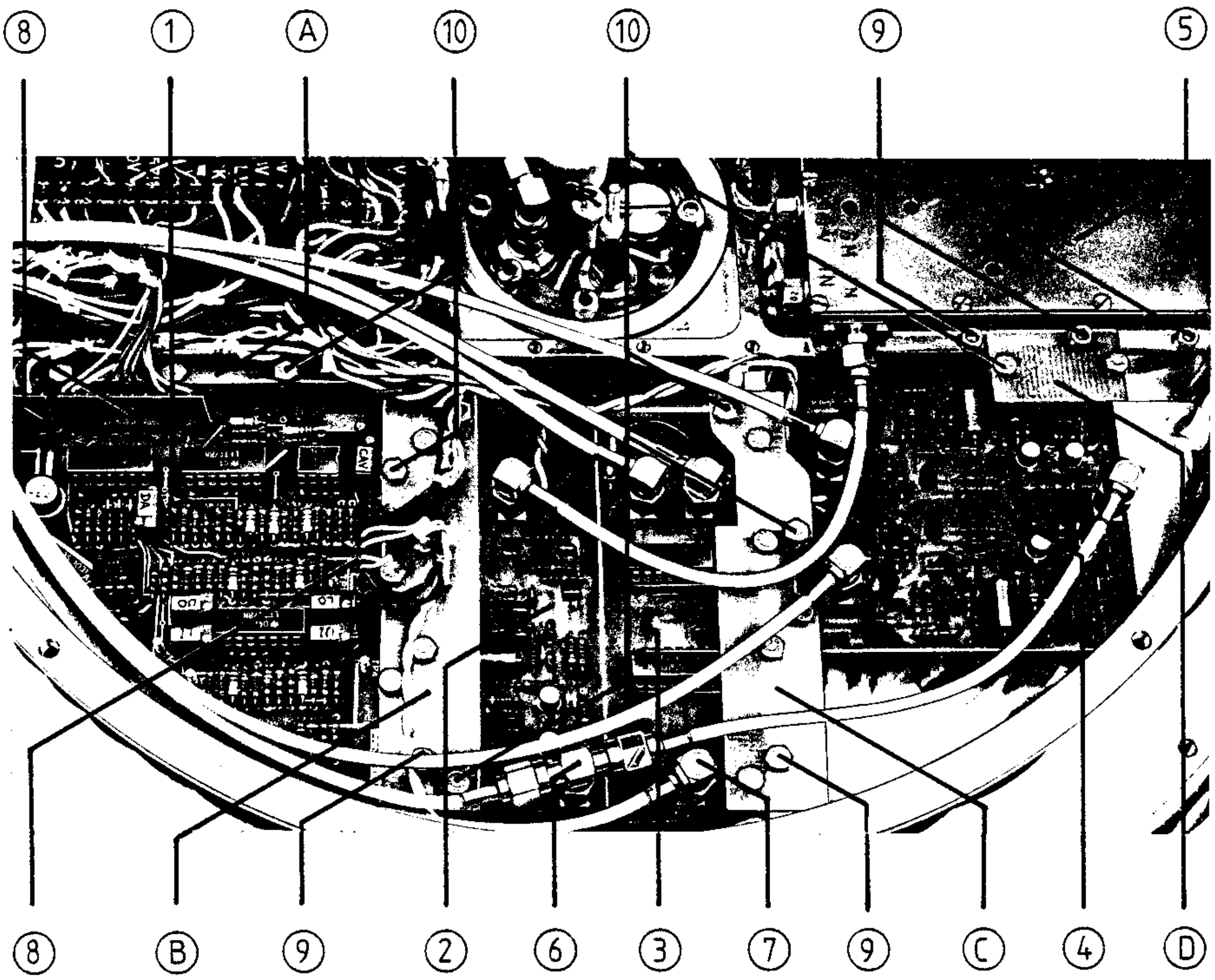


Fig. 7.6 : MASER HEAD :
HEATER PREAMPLIFIER,
BUFFER AMPLIFIER INSTALLATION

(1) HEATER PREAMPLIFIER BOARD

(2) 5 MHz FREQUENCY MULTIPLIER BUFFER AMPLIFIER

(3) 20 MHz TO 5 MHz + 10 MHz DIVIDER BOARD

(4) 5 MHz OUTPUT BUFFER AMPLIFIER BOARD

(5) FREQUENCY MULTIPLIER

(6) 5 MHz FROM VCXO

(7) 20 MHz FROM RECEIVER SECTION

(8) HEATER PREAMPLIFIER BOARD CONNECTORS

(9) MOUNTING PLATE ATTACHMENT SCREWS

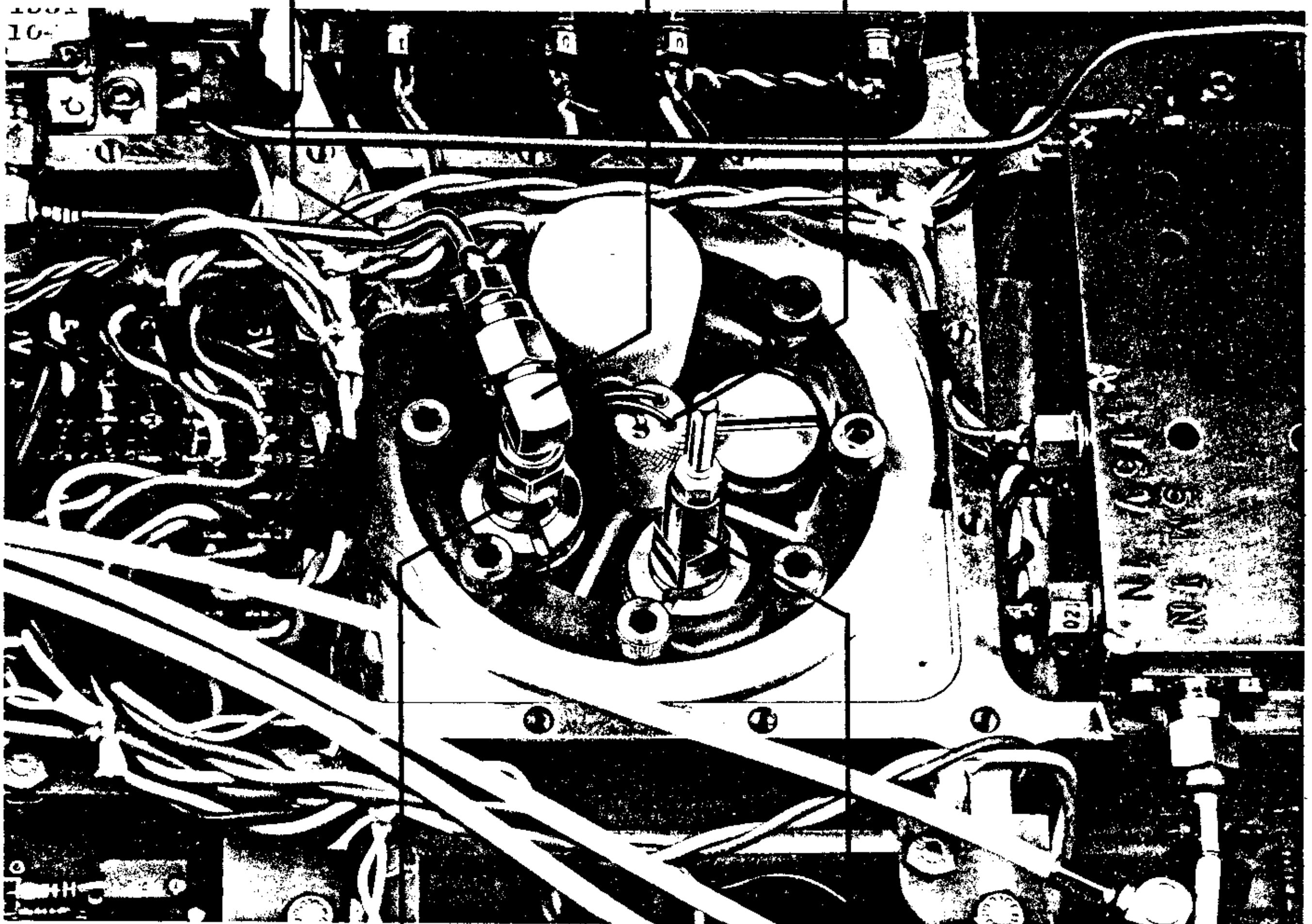
(10) CIRCUIT BOARD MOUNTING STANDOFF

(A), (B), (C), (D) } CIRCUIT BOARD MOUNTING PLATE

Fig. 7.6 : MASER HEAD :
HEATER PREAMPLIFIER,
BUFFER AMPLIFIER INSTALLATION

(CONTINUED)

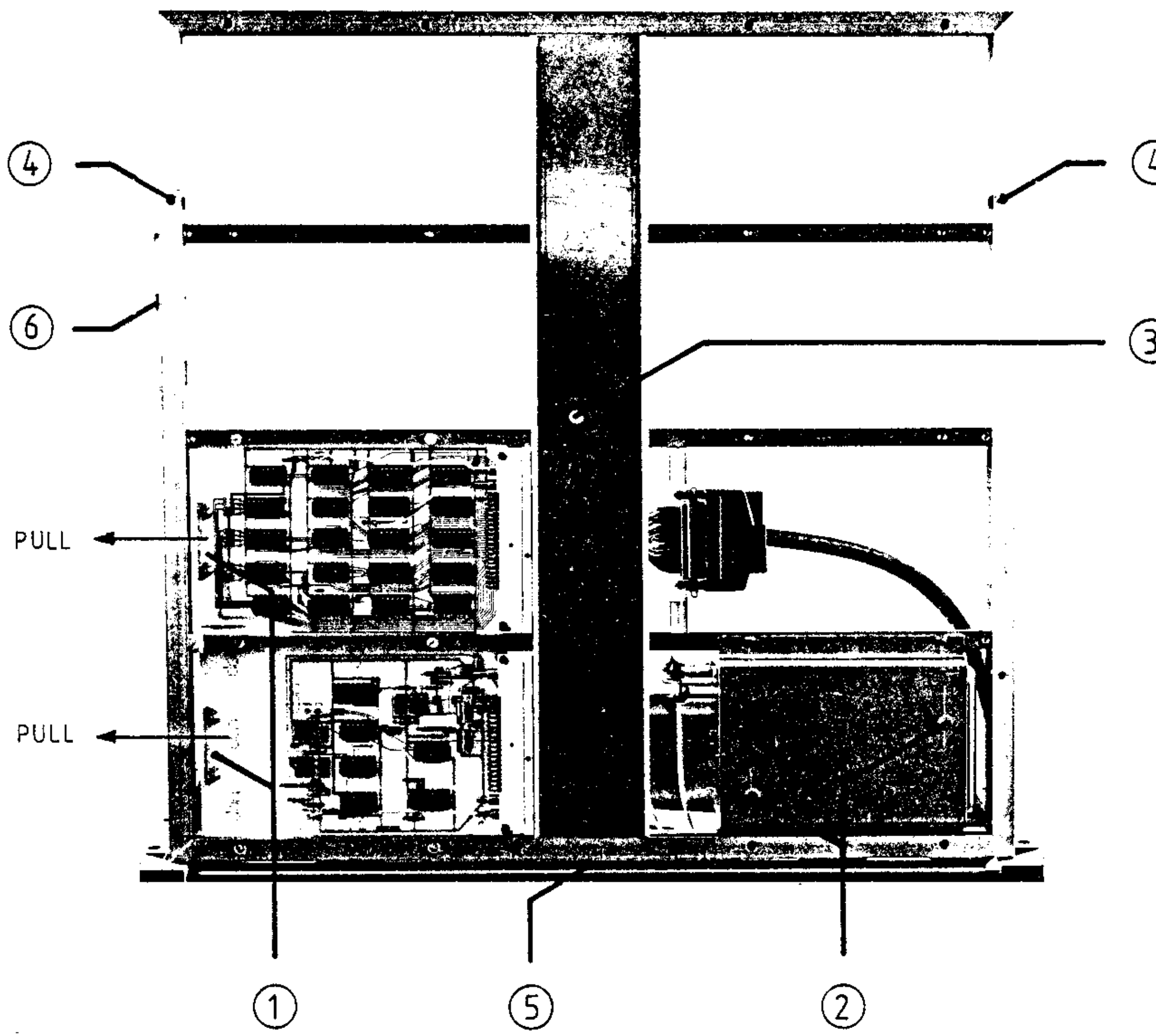
③ ② ⑤



① ④

① MASER OUTPUT COAX (SMA MALE)
② 90° SMA ADAPTOR
③ COAXIAL OUTPUT CABLE TO CIRCULATOR
④ DEMAGNETIZING ELECTRODE
⑤ "DALLE" HEATER CONNECTIONS

Fig. 7.7 : CENTER "DALLE" SECTION



1 PULLS FOR CIRCUIT CARD REMOVAL

2 OSCILLATOR MOUNTING SCREWS

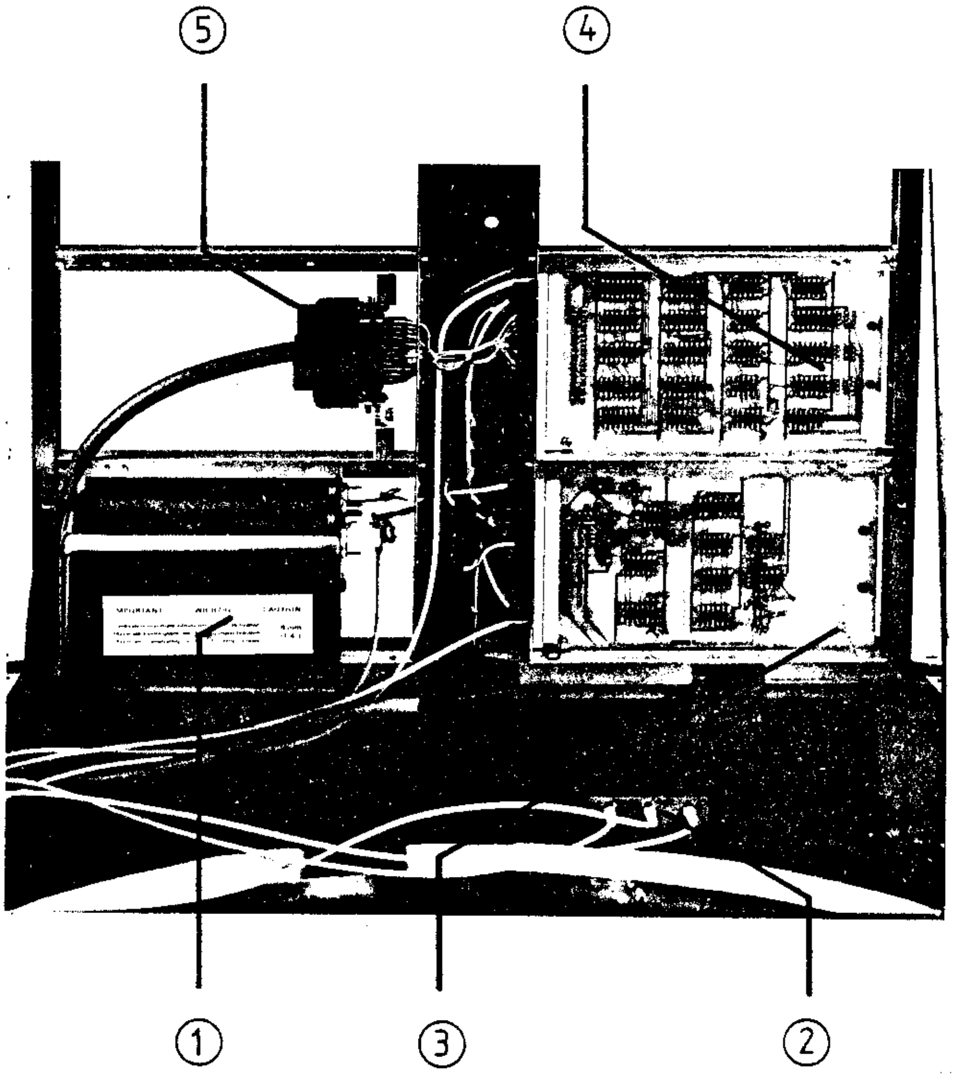
3 DEMAGNETIZING ELECTRODE PASSAGE

4 PLL FRAME HOLD-DOWN SCREWS

5 HINGE

6 SUPPORT BAR LUG

Fig. 7.8 : UPPER FRAME PLL SECTION, OUTSIDE VIEW



① QUARTZ OSCILLATOR VCXO (B-5400)

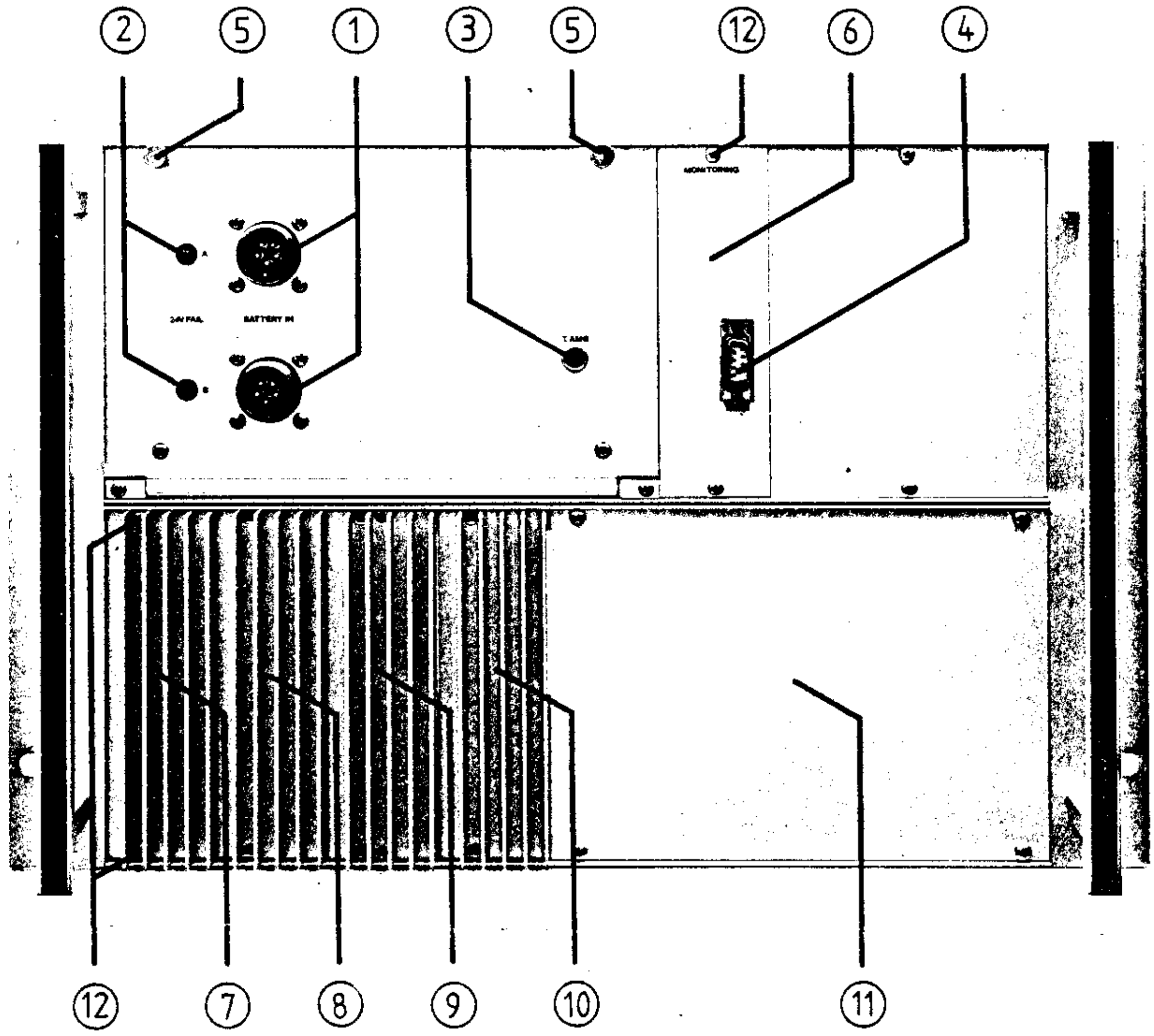
② MASER OUTPUT COAXIAL CONNECTORS

③ PHASE LOCK COMMAND

④ SYNTHESIZER DIGITAL SYSTEM

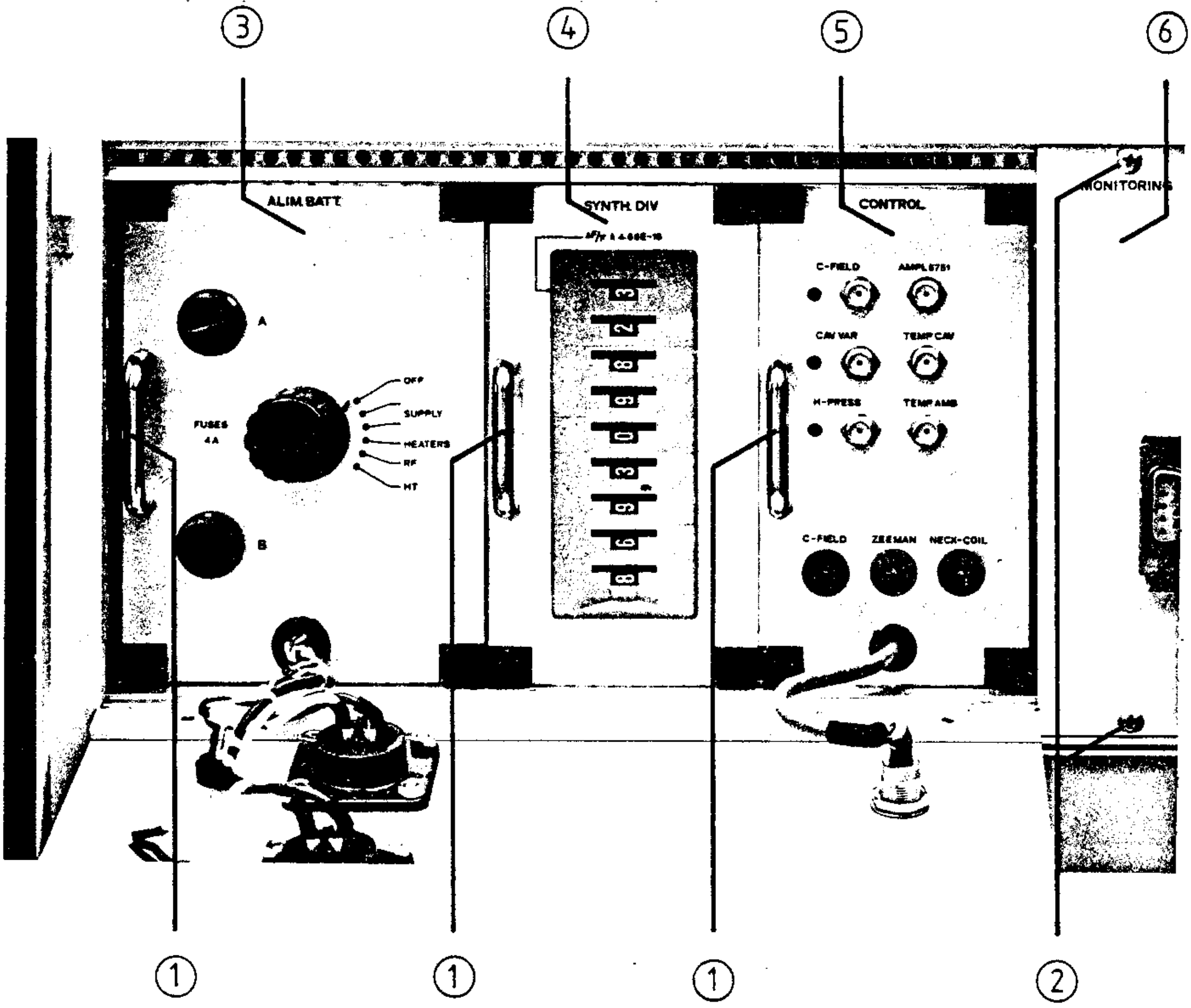
⑤ CONNECTOR CABLE TO SYNTHESIZER DIGITAL SWITCH

Fig. 7.9 : UPPER FRAME PLL SECTION, INSIDE VIEW



1. INPUT POWER CONNECTORS
   (see Fig. 1.6 for connections)
2. POWER ON SIGNAL LIGHTS
3. AMBIENT TEMPERATURE PROBE CONNECTOR
   (see Fig. 1.6 for connections)
4. MONITORING CONNECTOR
   (see Fig 1.6 for connections)
5. FRONT PANEL RETAINING THUMB SCREWS
6. MONITOR TRANSMITTER MODULE
7. 24 V DISSOCIATOR POWER SUPPLY
8. 24 V REGULATED POWER SUPPLY
9. 5 V, ±15 VOLT POWER SUPPLY
10. ±15 VOLT POWER SUPPLY
11. PUMP HIGH-VOLTAGE POWER SUPPLY COMPARTMENT
12. MODULE RETAINING SCREWS

Fig. 7.10 : FRONT VIEW ELECTRONICS AND CONTROL UNIT



① MODULE PULL HANDLES

② MONITOR MODULE RETAINING SCREWS

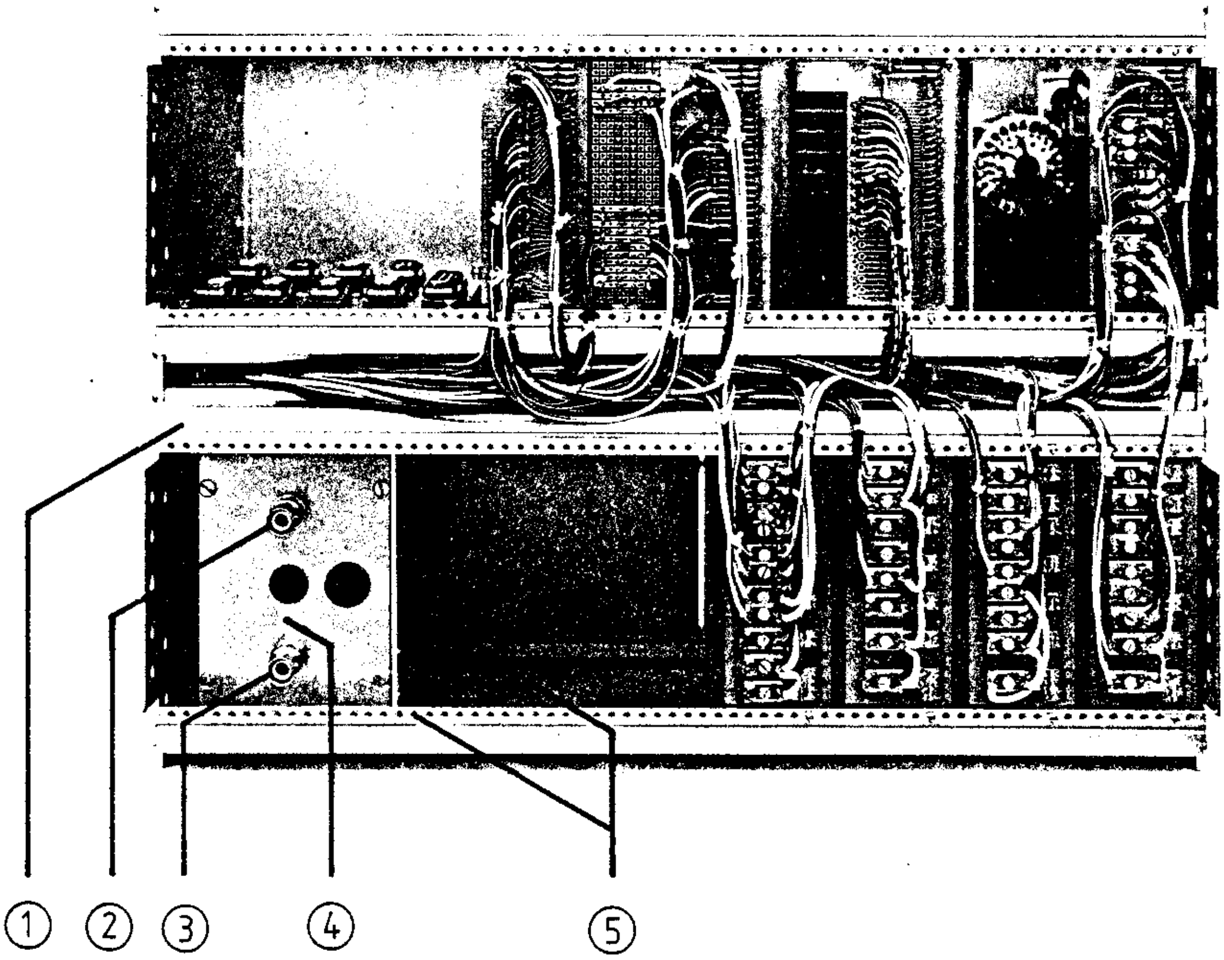
③ INPUT POWER CONTROL MODULE

④ SYNTHESIZER DIGITAL SWITCH MODULE

⑤ CONTROL MODULE

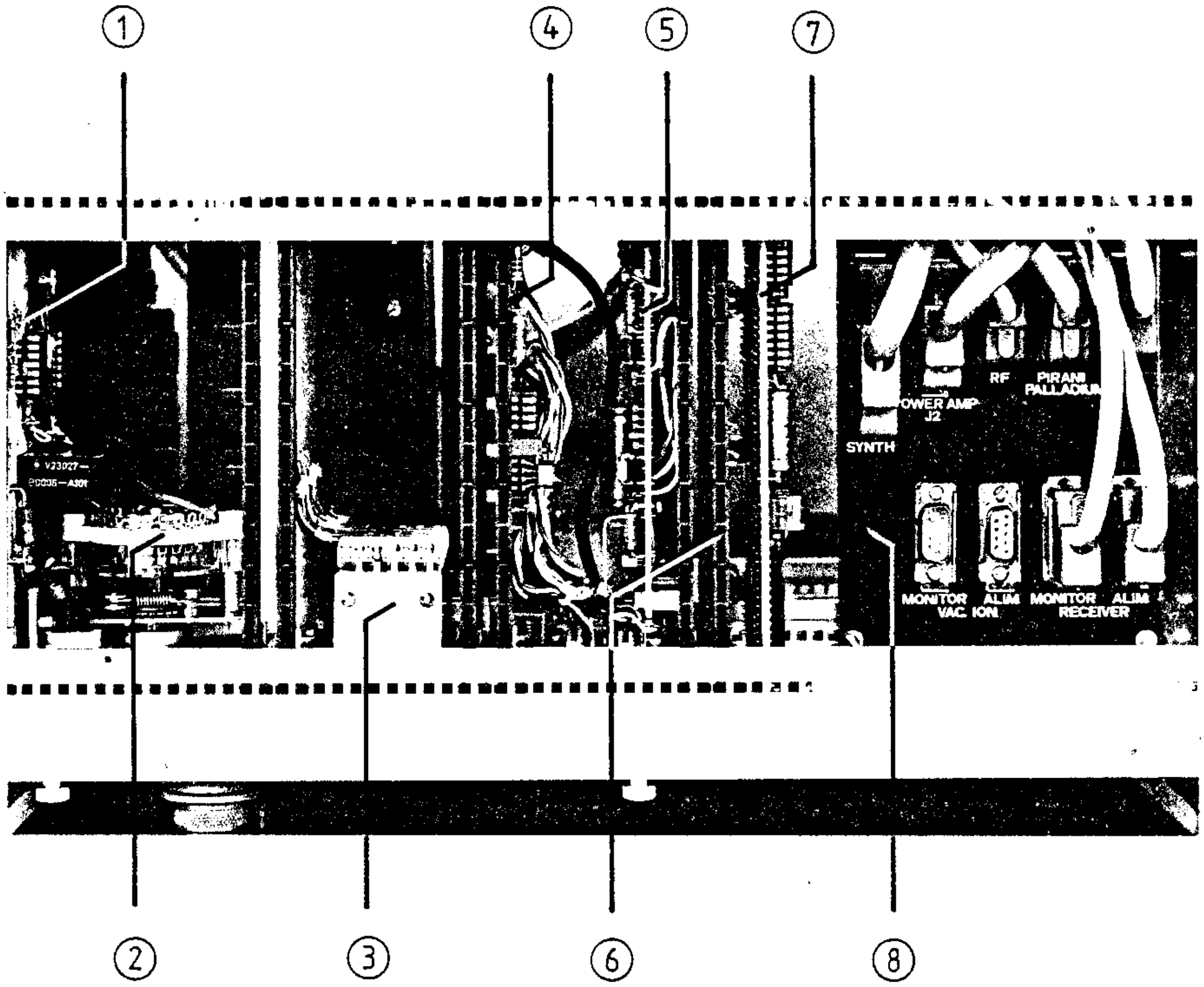
⑥ MONITORING TRANSMITTER MODULE

Fig. 7.11 : CONTROL PANEL, MONITORING UNIT



1. ELECTRONICS AND CONTROL UNIT
2. COAXIAL CONNECTOR TO INTERNAL VACUUM SYSTEM PUMP
3. COAXIAL CONNECTOR TO EXTERNAL VACUUM SYSTEM PUMP
4. ION PUMP H.V. POWER SUPPLY MODULE
5. POWER SUPPLY MODULE RETAINING SCREWS

Fig. 7.12 : ELECTRONICS / CONTROL UNIT, REAR VIEW



(1) INPUT POWER MONITORING / CONTROL BOARD
(2) POWER CONTROL SWITCH
(3) SYNTHESIZER DIGITAL SWITCH
(4) MASER CONTROL
(5) PRESSURE CONTROL
(6) MONITORING TRANSMITTER FILTERS
(7) MONITORING MULTIPLEXER / TRANSMITTER
(8) INTERCONNECTING CABLE PANEL

Fig. 7.13 : ELECTRONICS / CONTROL UNIT, TOP VIEW

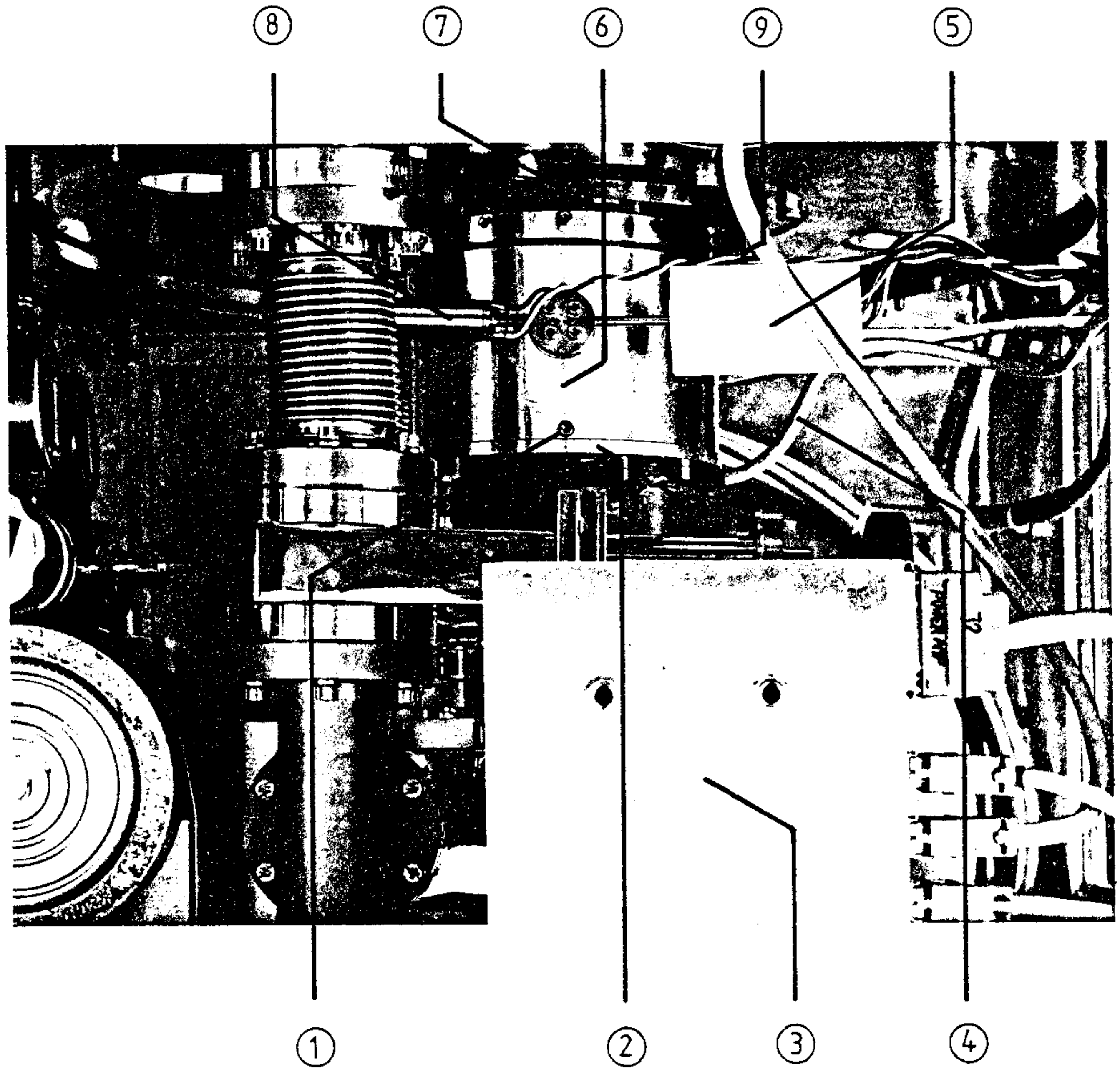
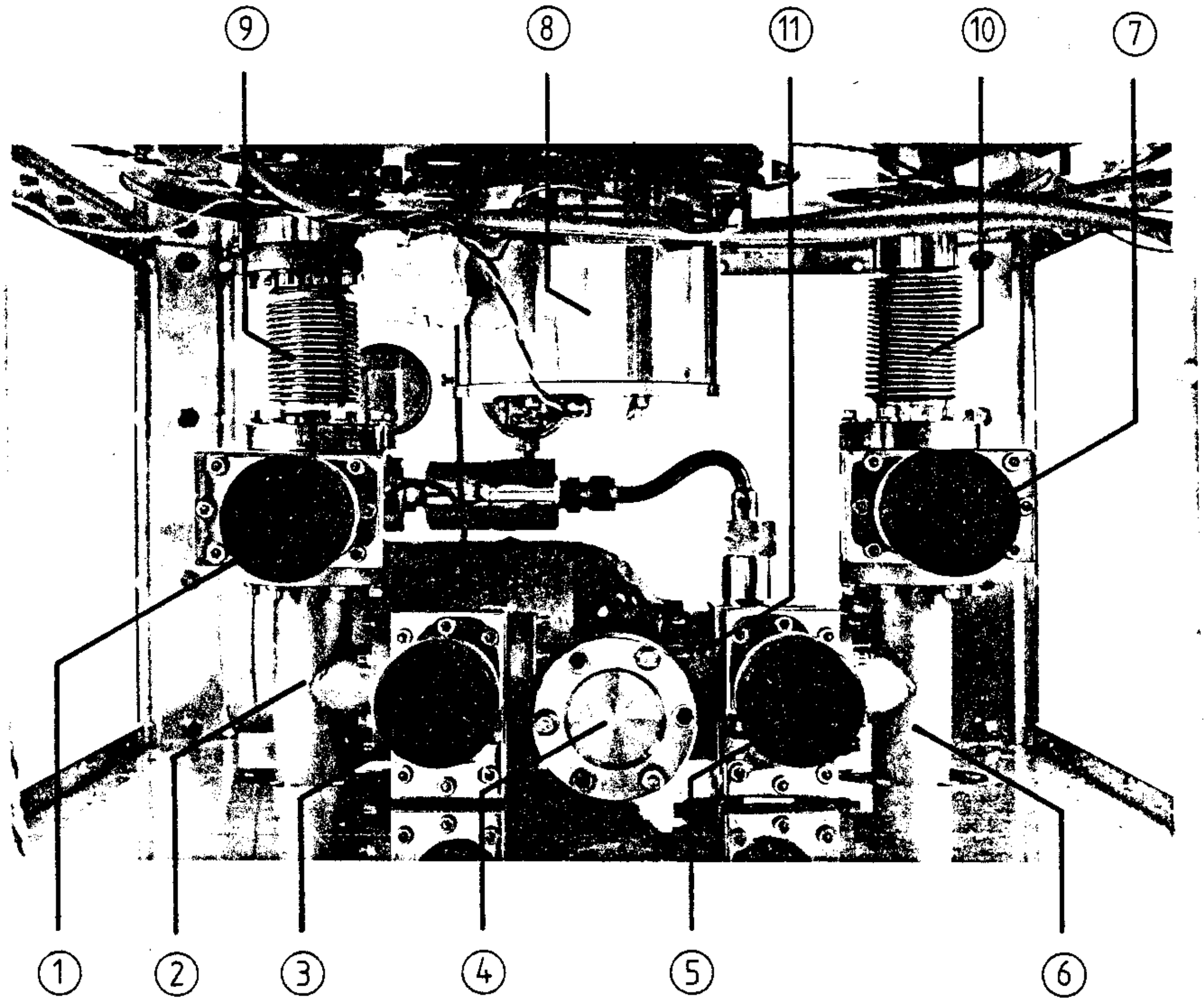


Fig. 7.14 : VACUUM MANIFOLD COMPARTMENT,
RIGHT SIDE,
DISSOCIATOR AND
HEATER POWER AMPLIFIER INSTALLATION

1. DISSOCIATOR OSCILLATOR MODULE RETAINING SCREW (x3)
2. DISSOCIATOR OSCILLATOR MODULE
3. HEATER POWER AMPLIFIER MODULE
4. DISSOCIATOR OSCILLATOR POWER SUPPLY CABLE
5. PIRANI PRESSURE GAUGE ASSEMBLY
6. DISSOCIATOR HOUSING
7. DISSOCIATOR ORIENTATING FLANGE
8. PALLADIUM VALVE
9. DISSOCIATOR ORIENTING SCREW (x3)

Fig. 7.14 : VACUUM MANIFOLD COMPARTMENT,
RIGHT SIDE,
DISSOCIATOR AND
HEATER POWER AMPLIFIER INSTALLATION

(CONTINUED)



(1)	INTERNAL VACUUM SYSTEM, INTERNAL VALVE [V1]
(2)	INTERNAL VACUUM SYSTEM T-COUPLING
(3)	INTERNAL VACUUM SYSTEM, EXTERNAL VALVE [V2]
(4)	EXTERNAL PUMP ATTACHMENT, PINCH-OFF
(5)	EXTERNAL VACUUM SYSTEM, EXTERNAL VALVE [V3]
(6)	EXTERNAL VACUUM SYSTEM T-COUPLING
(7)	EXTERNAL VACUUM SYSTEM, INTERNAL VALVE [V4]
(8)	HYDROGEN DISSOCIATOR
(9)	BELLOWS, INTERNAL VACUUM SYSTEM
(10)	BELLOWS, EXTERNAL VACUUM SYSTEM
(11)	EXTERNAL T-COUPLING

Fig. 7.15 : VACUUM MANIFOLD COMPARTMENT, FRONT SIDE

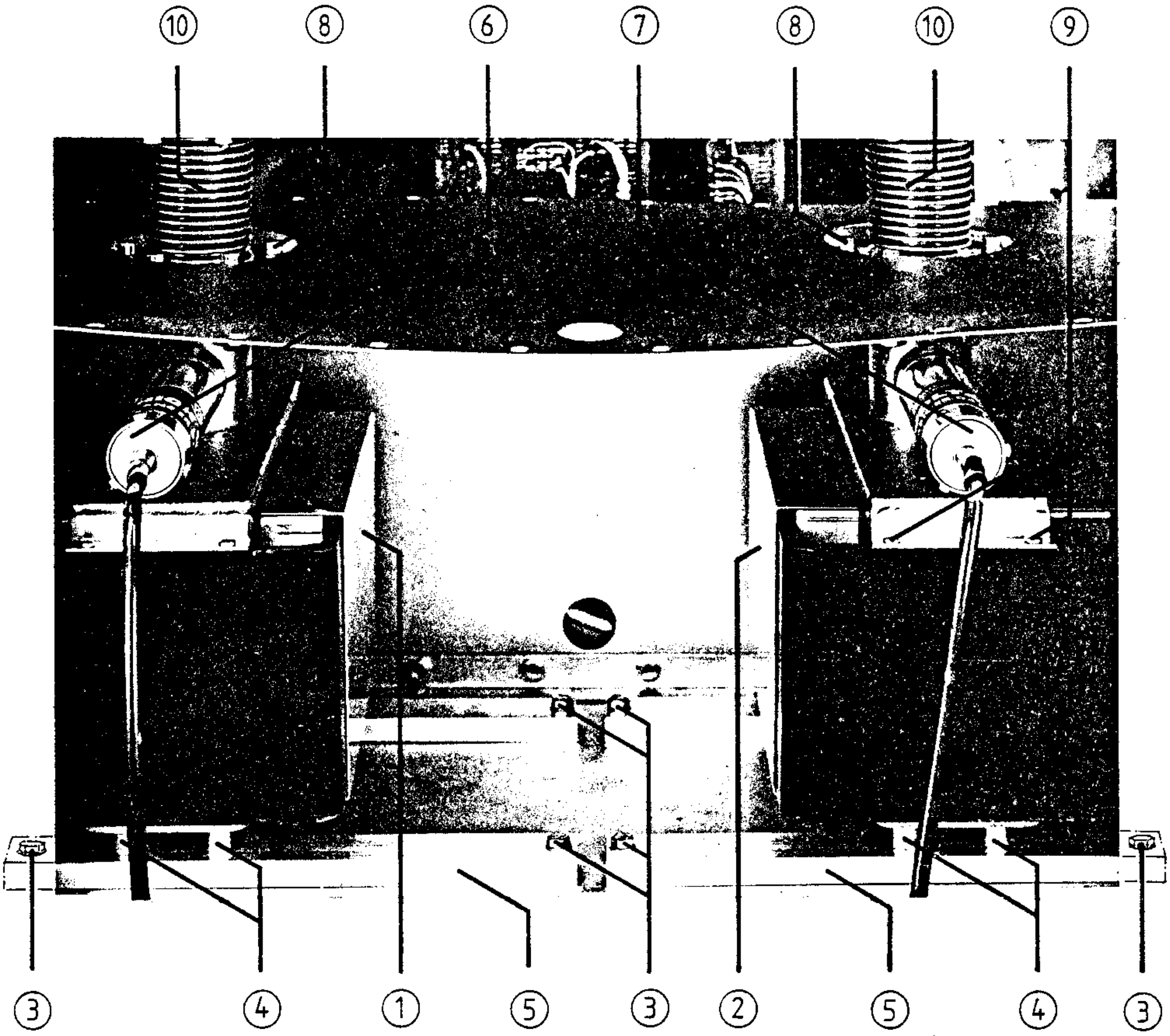
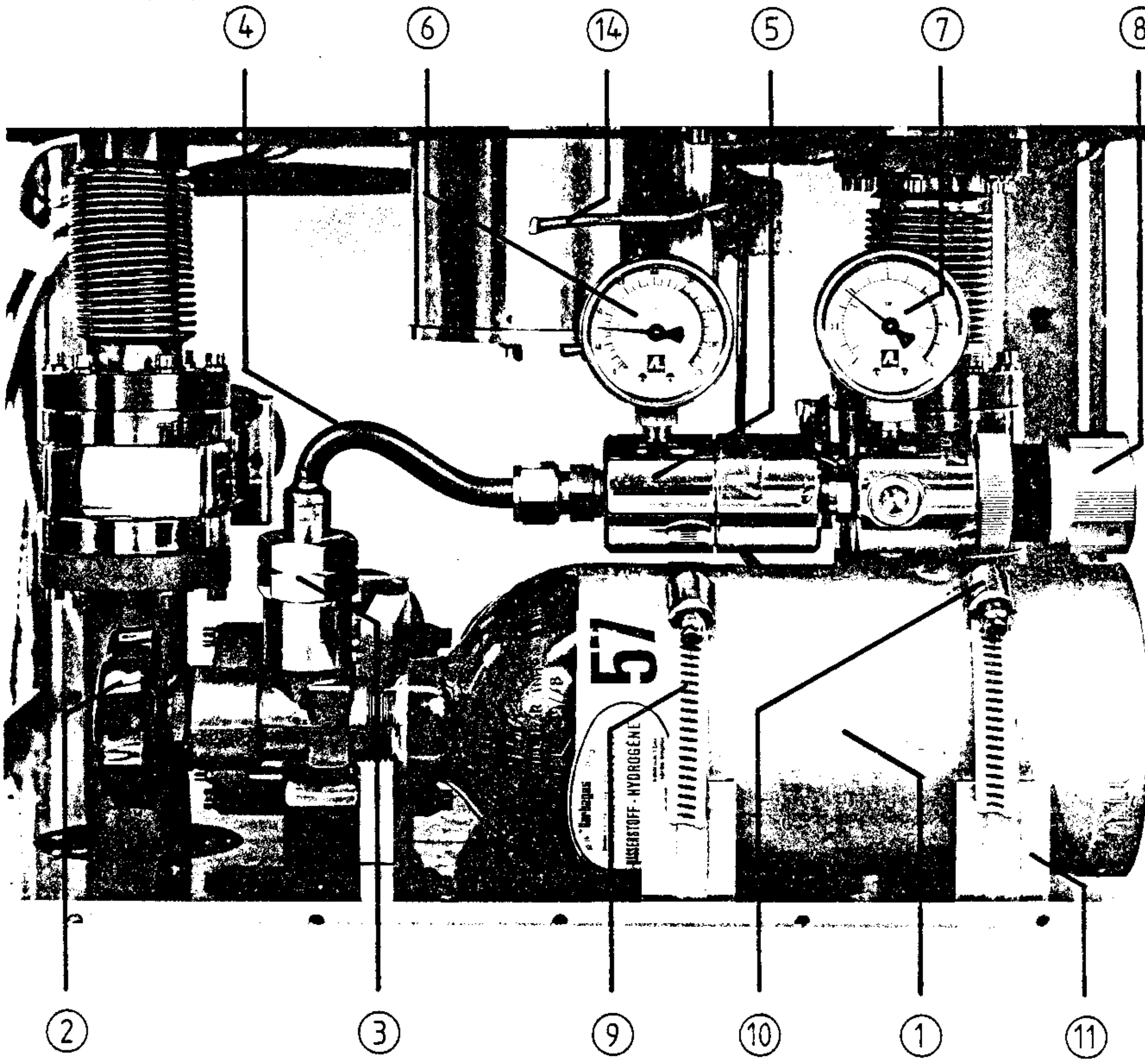


Fig. 7.16 : ION PUMP INSTALLATION

1. EXTERNAL VACUUM SYSTEM ION PUMP
2. INTERNAL VACUUM SYSTEM ION PUMP
3. ION PUMP MOUNTING RAIL RETAINING SCREWS (x4)
4. ION PUMP MOUNTING SPACERS (x4)
5. ION PUMP MOUNTING RAIL
6. EXTERNAL VACUUM PUMP H.V. CONNECTOR
7. INTERNAL VACUUM PUMP H.V. CONNECTOR
8. VACUUM FLANGE CONNECTIONS
9. PUMP ELEMENT MOUNTING SCREWS (x4)
10. BELLOWS

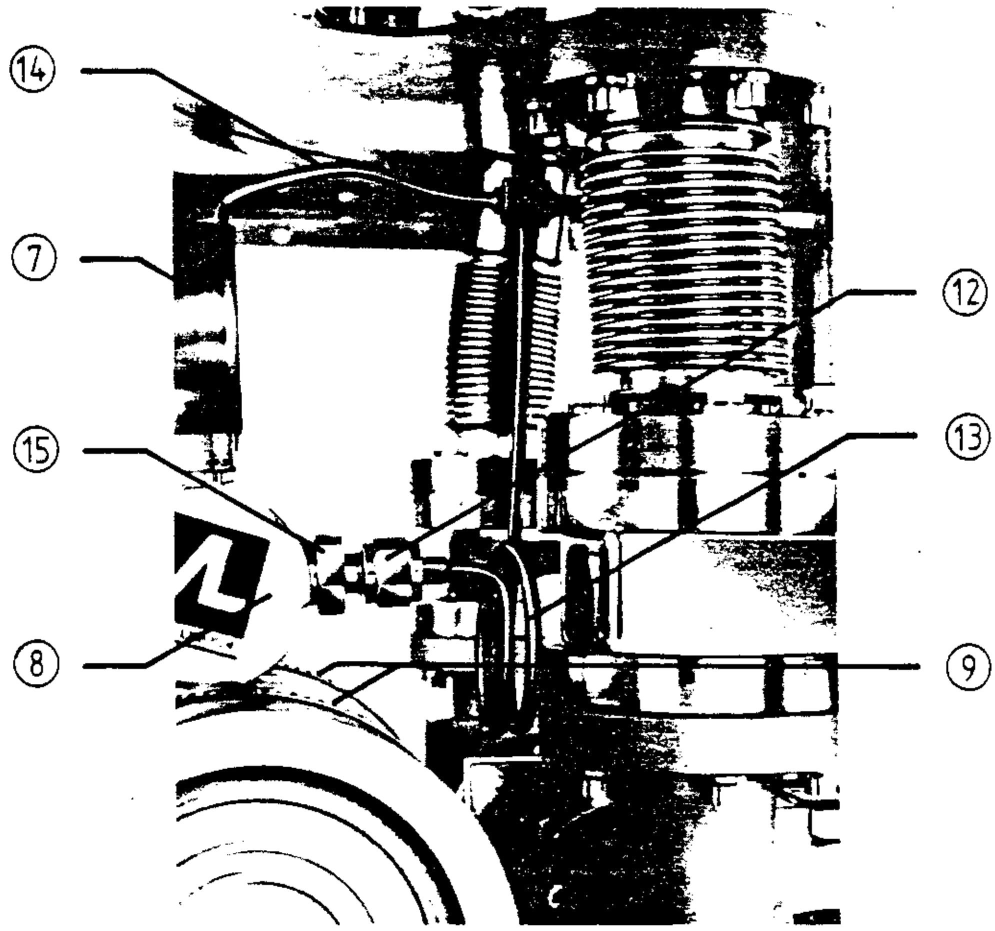
Fig. 7.16 : ION PUMP INSTALLATION

(CONTINUED)



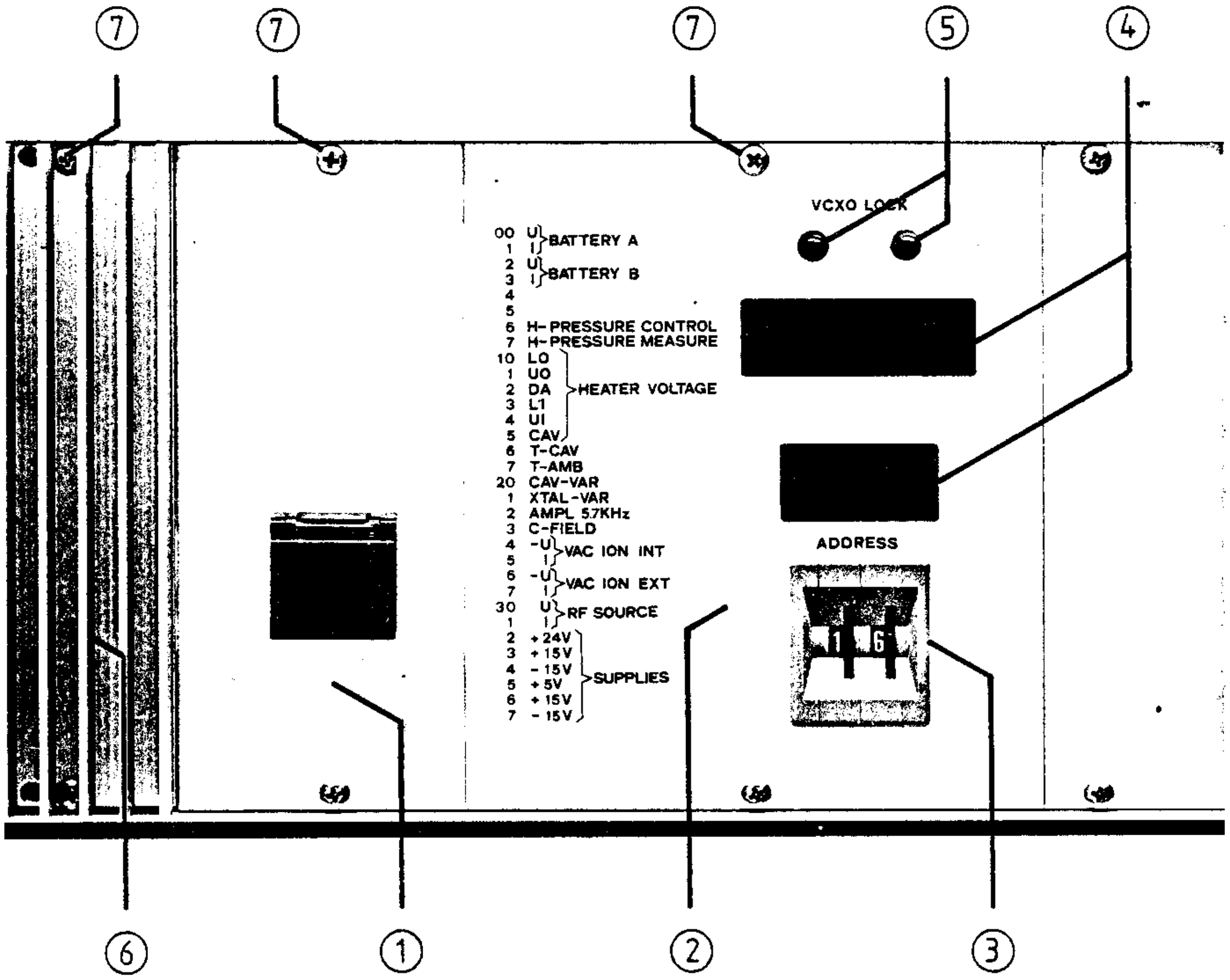
1 HYDROGEN BOTTLE
2 HYDROGEN BOTTLE SHUT-OFF VALVE
3 BOTTLE OUTPUT CONNECTOR
4 HIGH PRESSURE OUTPUT TUBE
5 PRESSURE REDUCING SYSTEM
6 HYDROGEN BOTTLE PRESSURE GAUGE
7 HYDROGEN OUTPUT PRESSURE GAUGE (MASER DISSOCIATOR)
8 HYDROGEN SYSTEM PRESSURE ADJUSTMENT
9 MOUNTING STRAP
10 STRAP RETAINING SCREW
11 BOTTLE MOUNTING CRADLE
14 HYDROGEN SUPPLY TUBE PURGE PINCH-OFF

Fig. 7.17 : VACUUM MANIFOLD COMPARTMENT, BACK SIDE



(7) PRESSURE GAGE
(8) HYDROGEN SYSTEM PRESSURE ADJUSTMENT
(9) MOUNTING STRAP
(10) STRAP RETAINING SCREW (see Fig. 7.17)
(11) BOTTLE MOUNTING CRADLE (see Fig. 7.17)
(12) HYDROGEN SUPPLY TUBE COUPLING
(13) HYDROGEN SUPPLY TUBE TO DISSOCIATOR
(14) HYDROGEN SUPPLY TUBE PURGE PINCH-OFF
(15) PRESSURE REDUCER OUTPUT FITTING

Fig. 7.18 : HYDROGEN BOTTLE INSTALLATION, END VIEW



1 POWER INPUT CONTROL MODULE

2 MONITOR RECEIVER MODULE

3 CHANNEL SELECT DIGITAL SWITCH "ADDRESS"

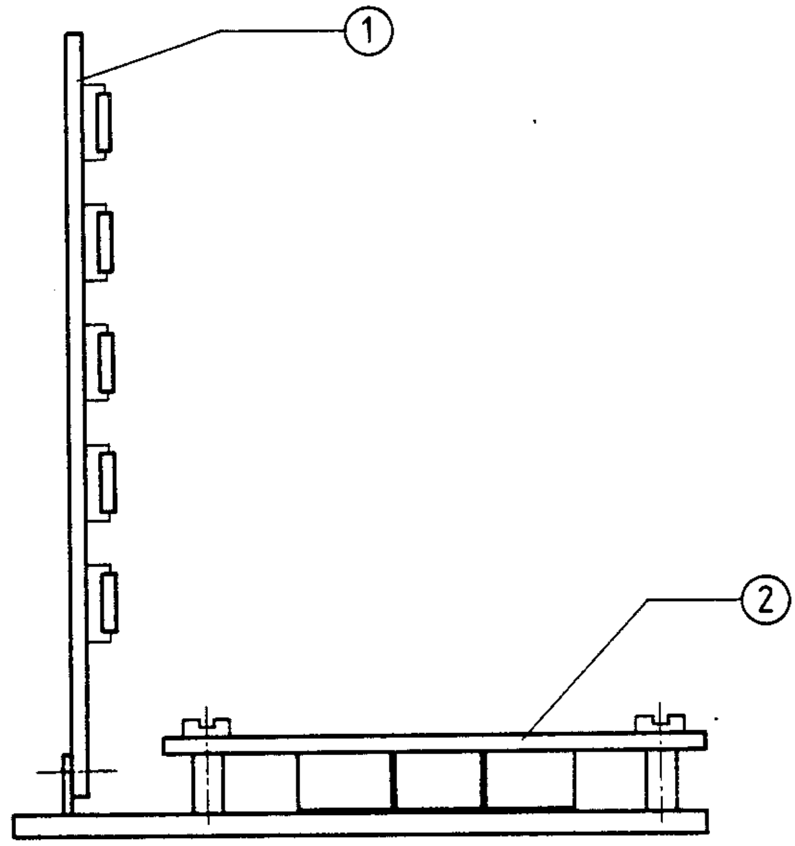
4 PARAMETER VALUE READOUT

5 MASER PHASE LOCK INDICATOR LIGHTS

6 POWER SUPPLY MODULE

7 MODULE RETAINING SCREWS

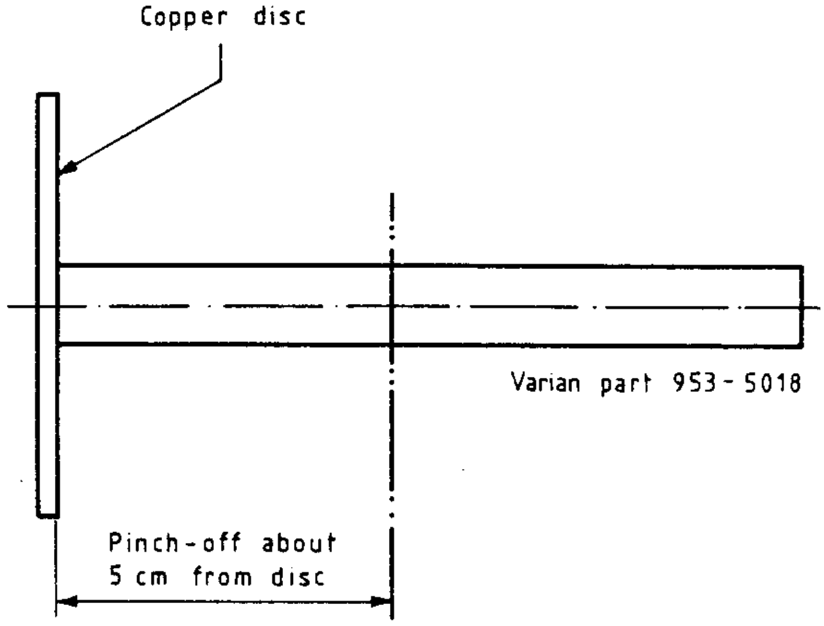
Fig. 7.19 : MONITOR DISPLAY RECEIVER FRONT PANEL



(1) MONITOR RECEIVER LOGIC

(2) MONITOR RECEIVER READ-OUT

Fig. 7.20 : MONITOR RECEIVER MODULE, TOP VIEW



PINCH - OFF TUBE

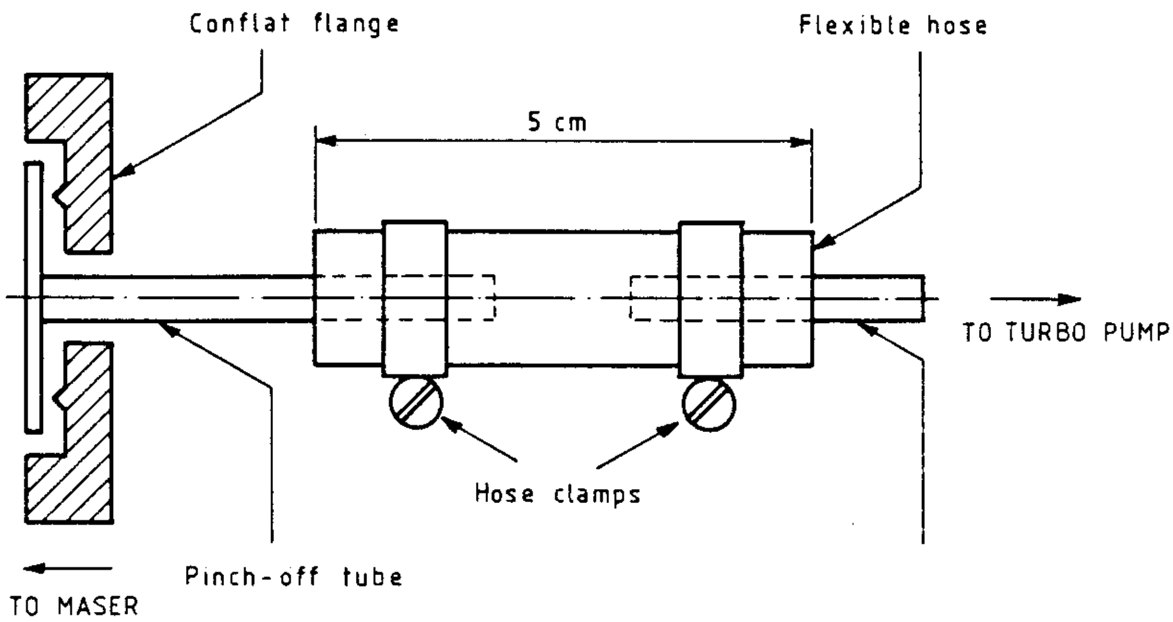


Fig. 7.21 : PINCH - OFF ASSEMBLY

7. MAINTENANCE PROCEDURE

7.1 GENERAL

The basic troubleshooting procedure uses the maser monitoring system to trace the difficulty to a particular subsystem and module in the maser. Operation is restored by replacing the defective module. Any analysis of abnormal operation of the maser must therefore start with the monitoring readings.

Monitor readings should be recorded at regular intervals which should be more frequent when the instrument is installed in order to check any change in performance due to moving and transport.

Table 7.1 summarizes the general effects of deviation from normal functioning of the maser element in question. The indications are not exhaustive, and do not cover all possible effects from simultaneous malfunctioning of more than one element.

7.1.1 Preventive maintenance

Preventive maintenance basically consists of the routine surveillance of the monitor readings in order to detect any gradual or sudden change not otherwise observed in normal use of the maser.

"ADDRESS"	MEASURED PARAMETERS	ELEMENT AFFECTED	MASER PARAMETERS AFFECTED
0 0 0 1 0 2 0 3	U I Battery A U I Battery B	Indicates power supply available and power consumption	
0 4 0 5 0 6 0 7	H-pressure control H-pressure measure	PIRANI/Palladium system	Maser signal level
1 0	L 0	Lower - outer heater	Thermal isolation
1 1 1 2	U 0	Upper - outer heater "DALLE" heater	Thermal isolation of maser and maser head electronics
1 3 1 4	L I U I	Lower - inner heater Upper - inner heater	Frequency / Frequency stability
1 5	CAV	Cavity heater	Cavity tuning Maser frequency
1 6	T - CAV	Cavity temp.	Maser frequeny
1 7	T - AMB		Maser frequency
2 0	CAV - VAR	Cavity varactor	Cavity tuning Maser frequency
2 1	XTAL - VAR	Quartz oscillator frequency	oscillator aging

TABLE 7.1 : MONITOR READING ANALYSIS, TROUBELSHOOTING

"ADDRESS"	MEASURED PARAMETERS	ELEMENT AFFECTED	MASER PARAMETERS AFFECTED
2 2	AMPL 5.7 kHz	Indicates state of operation of the maser	
2 3	C-Field	Magnetic field	Frequency maser signal amplitude maser oscillation
2 4 2 5	-U I	Ion pump voltage Ion pump current	Vacuum (internal system pressure)
2 6 2 7	-U I	Ion pump voltage Ion pump current	Vacuum (external system pressure)
3 0 3 1	U I	Dissociator oscillator Dissociator oscillator	Maser signal Maser signal
3 2	+24V	PIRANI/Palladium system Cavity Heat	Maser operation - vacuum - oscillation
3 3 3 4	± 15 V	Pump H.V. Heater P.A. Control	Maser operation
3 5 3 6 3 7	± 15 V 5 V	Monitoring trans-mitter Receiver Synthesizer	Output of maser Monitoring

TABLE 7.1 : MONITOR READING ANALYSIS, TROUBELSHOOTING

(CONTINUED)

7.2 TROUBLESHOOTING

Three troubleshooting charts are included which are based on the maser output signal indications. The actual maser output level is about -105 dBm. This signal is amplified and, by heterodyning, is translated to a base band frequency of about 5.7 kHz. It is the 5.7 kHz signal level available in the monitor which indicates maser output. The troubleshooting charts are :

CHART 1	:	No 5.7 kHz output signal no lock
CHART 2	:	5.7 kHz signal level decreases
CHART 3	:	5.7 kHz signal but no phase lock

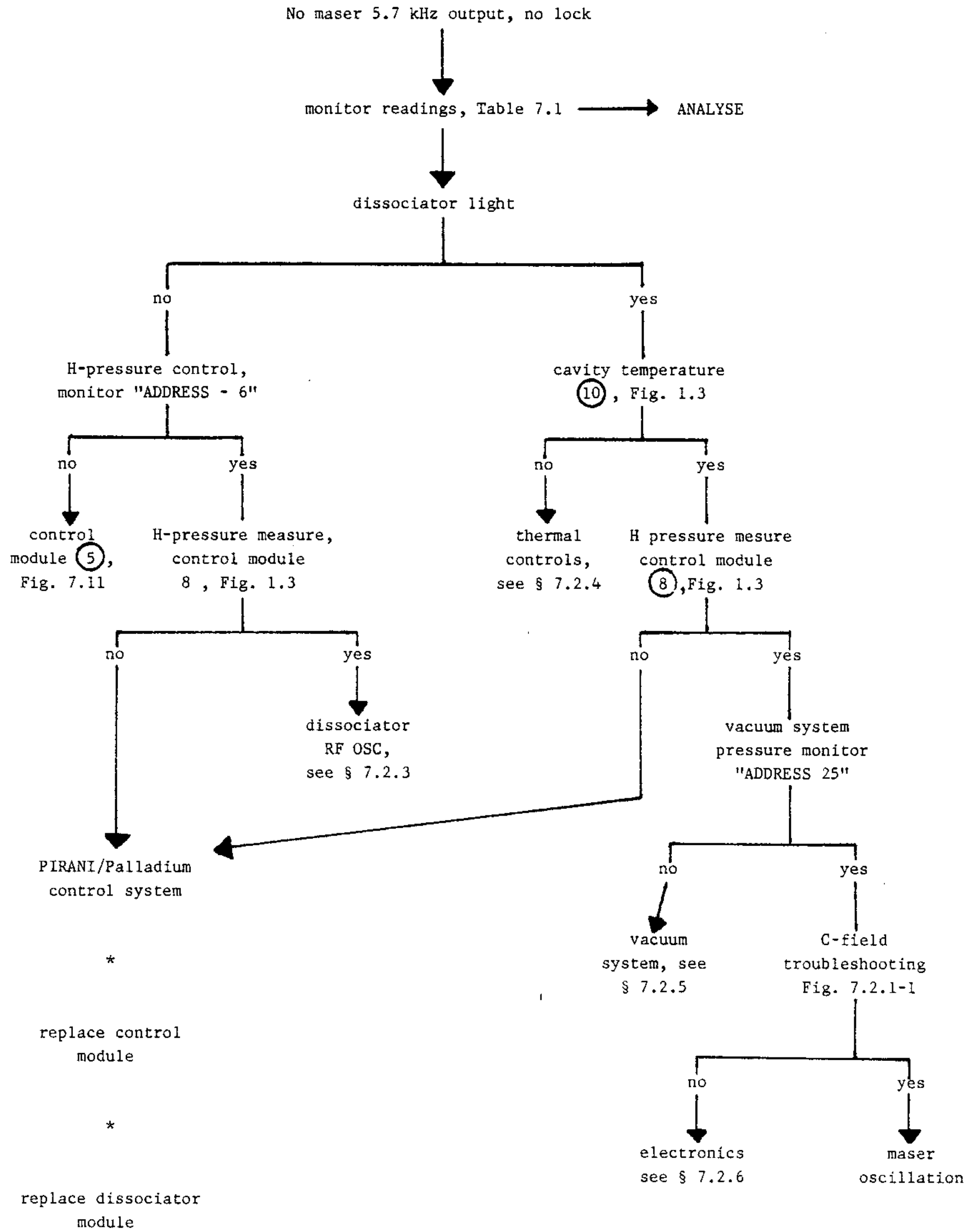
The following paragraphes cover specific tests or measurements designed to aid in localizing troubles in the maser. Consult § 7.3 for precautions to be taken during opening of the maser compartments and manipulation controls and modules. Paragraphe 7.3 also covers replacement of modules access, etc.

7.2.1 C-field

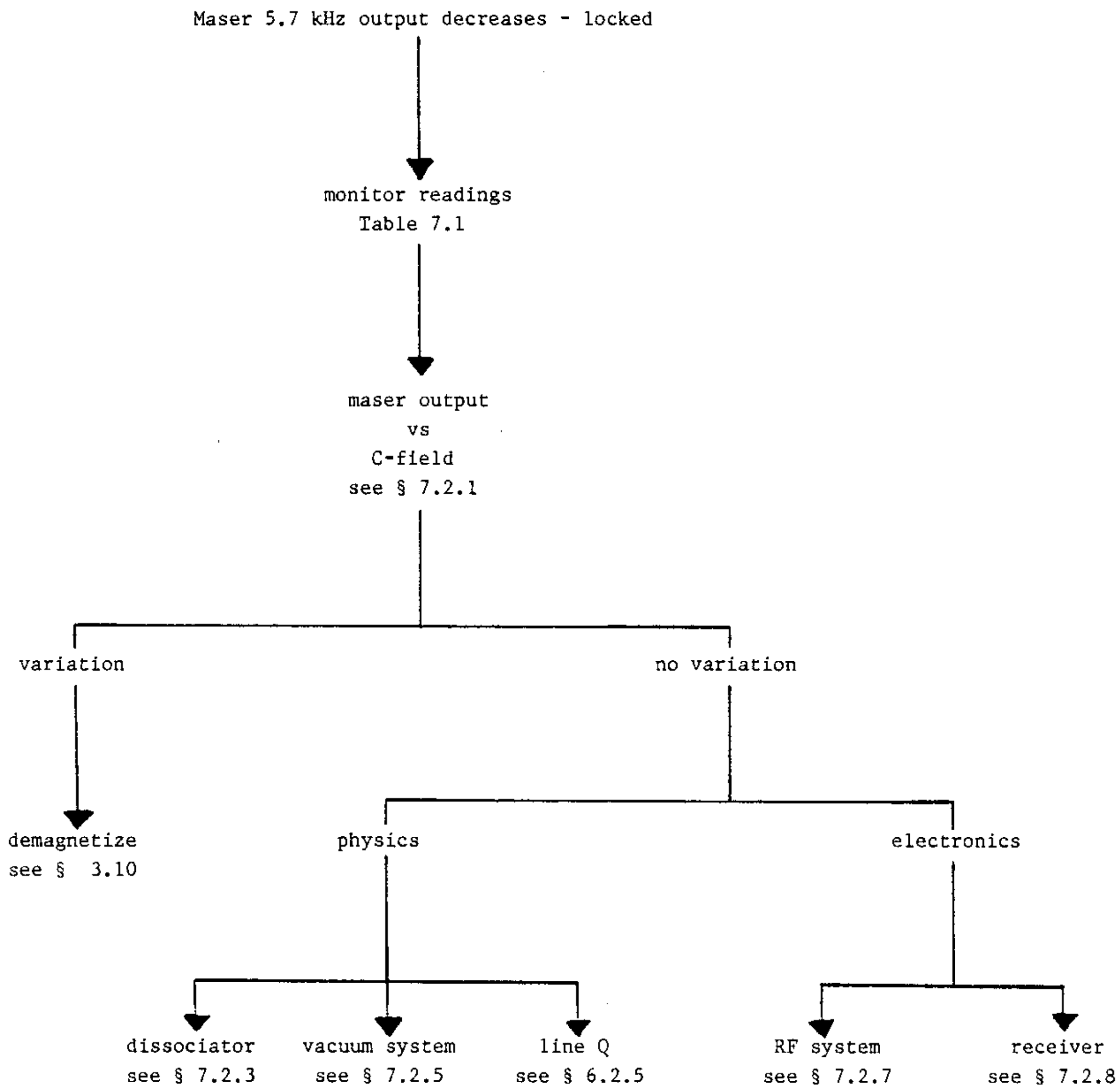
The C-field is an integral and necessary part of maser operation. The effect of the C-field in the operation of the maser has two general aspects :

-1. Determinant

A weak field must exist for the necessary orientation of atoms to produce the coherent radiation which constitutes maser output. Thus, if there is no maser output the C-field may be zero, see figure 7.2.1-1 for troubleshooting guide.



TROUBLESHOOTING : C H A R T 1



TROUBLESHOOTING : C H A R T 2

Maser 5.7 kHz signal - no lock

↓

monitor readings
Table 7.1

↓

electronics
see § 7.2.6

TROUBLESHOOTING : C H A R T 3

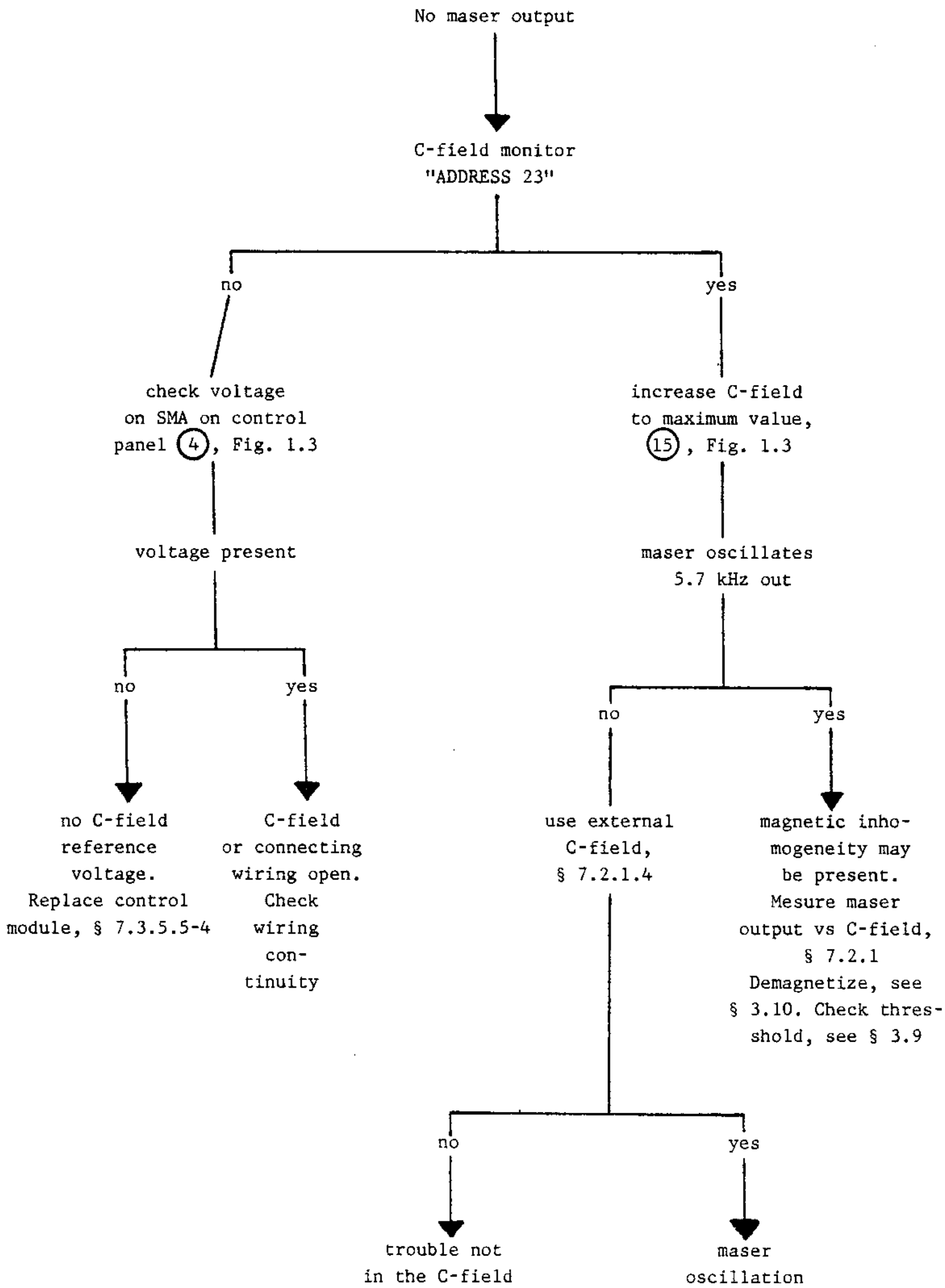


Fig. 7.2.1-1 : C-FIELD TROUBLESHOOTING

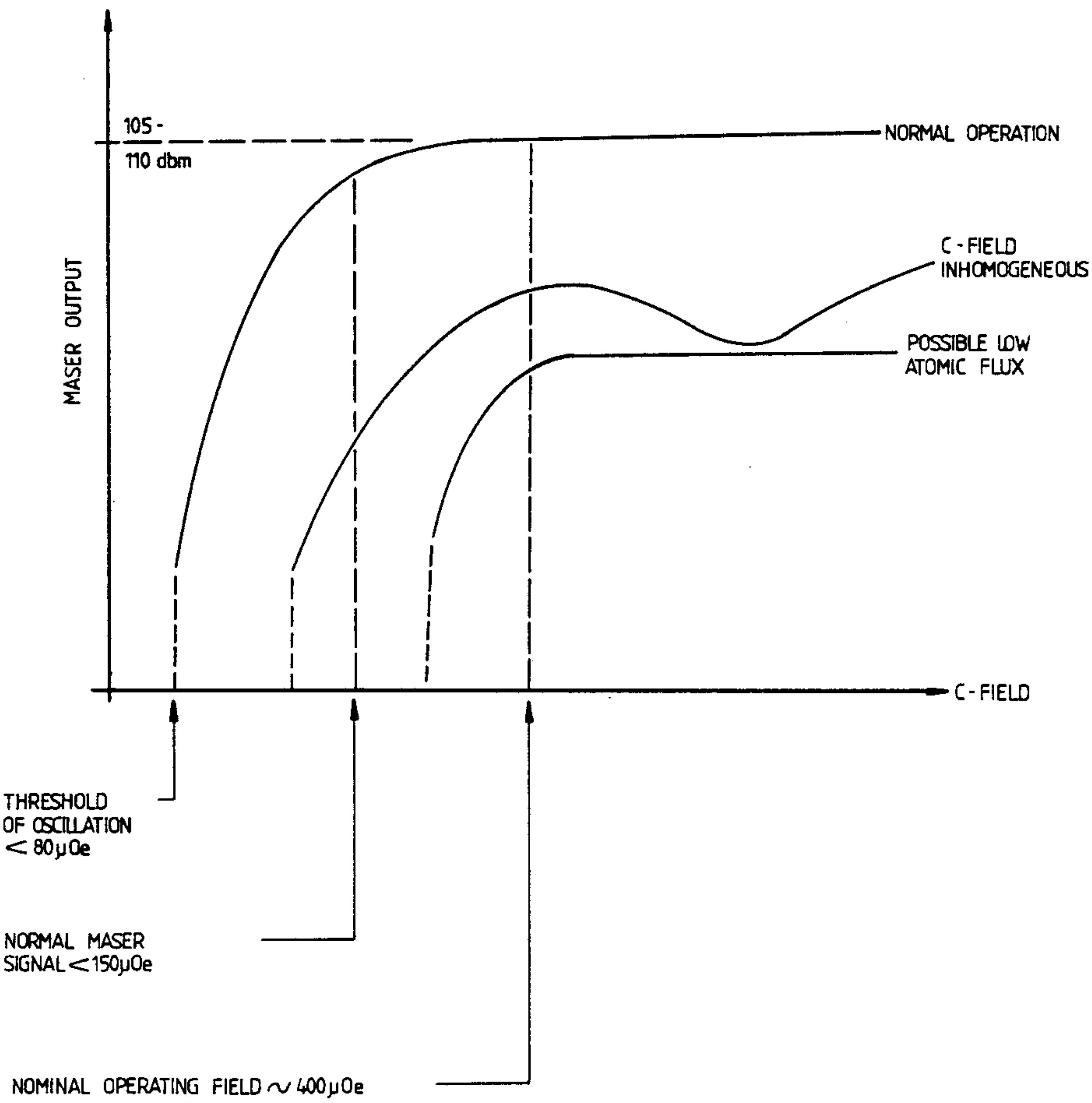


Fig. 7.2.1-2 : MASER OUTPUT VS C-FIELD CURRENT

-2. Qualitative

Maser operation requires the magnetic field in the atom interaction volume to be parallel to the axis of the cavity. Perturbations to this co-linearity may be resolved into magnetic fields having components in the radial direction of the cavity, and these components produce atomic trnasitions other than that used in the maser oscillations. Thus atoms are lost to contributing to the maser output, and in fact if the perturbations are large enough the maser may not oscillate at all even though all other conditions are fulfilled. The general idea is illustrated in figure 7.2.1-2.

-3. Low signal output

As illustrated, maser output will generally be less than the normal value when magnetic field is perturbed. However, a low flux of atoms also results in low output. The two conditions may usually be distinguished by the difference in response to the C-field, Fig. 7.2.1-2.

-4. External C-field

This paragraph describes the use of an external C-field current generator which is required when Maser oscillation does not start in the C-field current range (0 - 250 μA) provided by the internal generator.

A variable DC power supply (0 to 30 Volt) with limiting serie resistor of few kΩ can be used. The maximum C-field current should be limited to 5 mA max.

In order to use the external C-field power supply, the following steps are required :

a) reduce the internal C-field current to zero ("ADDRESS 23") by turning the C-field current adjust potentiometer (15), Fig. 1.3, fully counter-clockwise

b) connect the external generator to C-field winding SMA connector (4), Fig. 1.3, monitoring the current through a milliamperometer

c) adjust the voltage in order to obtain the desired current increasing gradually the voltage from zero

d) the maximum current to be used is approximately 5 mA (corresponding to 0.04 Oersted).

If the maser oscillation does not start in the range 0.2 to 5 mA, the trouble is not the magnetic inhomogeneity.

7.2.2 Hydrogen quartz bulb

The quartz bulb retains the hydrogen atoms within the desired interaction region of the cavity. Should the bulb be broken, the maser will stop oscillating. To test for broken bulb proceed as follows :

-1. set monitor address to "25 VAC ION INT" pump current

-2. set H-pressure control ⑦ , Fig. 1.3, to 0 (full conter clockwise)

-3. monitor internal vacuum system pump current; should descend to the minimum value attainable in the internal system of about 10 µA (4×10^{-8} TORR). This value is noted in the EFOS maser logbook.

-4. if internal vacuum system pump current does not descend, as above, and the two pump currents, internal and external remain equal, there is a connection between the two vacuum systems, possibly caused by a rupture of the quartz bulb.

7.2.3 Dissociator

Troubleshooting the dissociator is comprised of determining the correct operation of three essential elements necessary, Fig. 7.2.3-1 :

1) hydrogen atoms in the discharge volume

2) correct pressure, vacuum

3) sufficient RF power to initiate and maintain the atomic plasma of the dissociation

The fourth element for which there is no direct way of determining the function is the state selecting magnet system.

> **N O T E**
>
> Assure that the maser vacuum system is operating correctly before troubleshooting the dissociator.

-1. RF power oscillator

The particular monitor readings of RF oscillator V, I under normal operating conditions are noted in the maser log books. These values should be used as guide in troubleshooting the oscillator.

Two ranges of values of V, I are normal, depending upon whether there is a discharge or not.

a) 0.6 to 0.8 amp with limit of 15 Watts input when no discharge is taking place

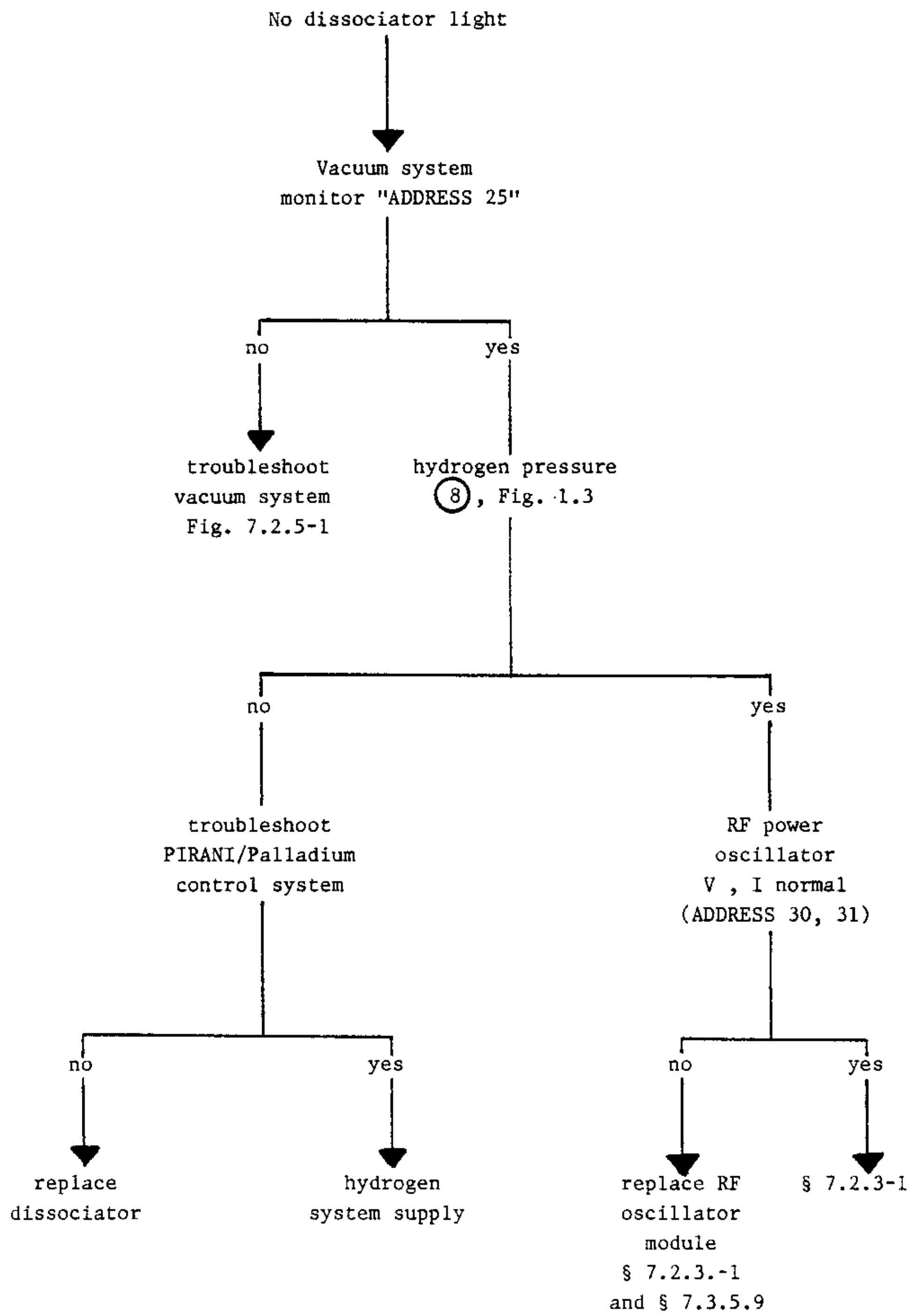


Fig. 7.2.3.-1 : DISSOCIATOR TROUBLESHOOTING

b) 0.3 to 0.5 amp with 8 - 10 Watts input when discharge is on

If the power transistor is short-circuited, the oscillator system will consume the maximum permitted in a) above, so it is not possible to dtermine (on the basis of V, I) whether there is no discharge because of transistor failure by short circuit, on lack of H atoms.

Two methods are available to check the transistor, or oscillator power in the discharge.

a) measure D.C. response of the transistor

b) detect presence of RF in the dissociator

DC response

Slide the electronics / control unit out, § 7.3.5.5.-6. From the top deconnect the "RF" connector on the interconnecting cable panel ⑧, Fig. 7.13 which an adaptor connect a variable power supply DC 0 - 24 V, 1A to the interconnecting cable by means of wires connected to pins 1 (+24 V) and 2 (GND). Set the supply to 0 volts, then increase the voltage manually, and measure current at the same time. This current will normally remain small until voltage on the transistor is about 10 V, at which time it will jump to a higher value (0.1 - 0.2 A). This is the point at which the transistor oscillates.

If the transistor current rises immediately and follows supply voltage, the transistor is defective and should be replaced - or the RF module replaced.

RF response

Connect a D.C. (0 - 500) microammeter to the detector diode output on the oscillator plate ②, Fig. 7.14, (DWG 8002 - 1197). With normal power applied to the transistor check for detector current. No current indicates that RF oscillator is not oscillating.

If results above are negative, replace the RF oscillator module, § 7.3.5.9.

7.2.4 Thermal controls

All thermal control circuits are designed to operate within their control range for an ambient temperature 20° - 30°C. Therefore, full heater voltage or no heater voltage indicate the possibility of :

a) the maser ambient temperature is at the extreme of range

b) the particular heating element has cooled and is demanding full heating power (this might occur if power to the maser is interrupted)

c) some defect in the heating system turns the system full-on or full-off

For the first condition, a) can be checked by observing the ambient temperature on monitor ADDRESS "17 : T-AMB".

Conditions b) and c) can be evaluated only with a sufficiently long observation time. The criteria of proper thermal system functioning is the cavity temperature.

The inner, outer and "DALLE" heating systems will respond to large transients (such as turn-off and turn-on of the maser) within about 4 hours. Therefore, if within four hours, the particular heating system is not regulating, troubleshooting should be pursued as indiacted in § -1. below.

The cavity heating system has a much longer time constant, and after the outer heating systems are regulating may take up to 12 hours or more before any significant temperature change is observed on cavity temperature monitor.

For troubleshooting the cavity heating system refer to § -2. and -3. below.

-1. Outer heaters troubleshooting

Open right hand side of vacuum manifold compartment, § 7.3.5.6 (③ , Fig. 7.14). The heater systems may be checked from this module. Connections between the power amplifier module and the maser heaters are via J3 and J4. Connections to the heater preamplifier in the maser head are via J1. Power supply connections and monitoring connections are via J2 to the electronics control module.

-2. Cavity heating system analysis

Connect a ± 15 V D.C. voltmeter to the cavity temperature monitor (10) , Fig. 1.3. Full scale voltage corresponds (linearly) to ± 3° of cavity temperature. Set monitor to "ADD-RESS - 15 CAV HEATER VOLTAGE". Observe heater voltage and temperature as follows (allow sufficient time for the temperature to change).

I F CAVITY HEAT	CAVITY TEMP.	TEMP. CHANGE	INTERPRETATION / ACTION
FULL ON	+	+	Troubleshoot system
	-	+	Heating, wait until cavity temp. → 0
OFF	-	-	Troubleshoot system
	+	-	Heat off, wait until cavity temp. → 0

-3. Cavity heating system troubleshooting

The maser head must be opened to troubleshoot the cavity heater system, § 7.3.5.1, .2, .5.

7.2.5 Vaccum system

There are three things which can result in degradation or loss of the vacuum in the maser.

a) PUMP POWER SUPPLY FAILURE

b) PUMP FAILURE / AGING

c) VACUUM SYSTEM LEAK

The state of maser vacuum is usually indiacted by the ion pump current, higher pump current being associated with higher pressures. However, this simple observation should be regarded cautiously because the aging characteristics of ion pumps pumping hydrogen have not been systematically observed, and therefore pump current cannot be taken as the absolute measure of vacuum system pressure.

-1. Pump power supply failure

Power supply failure is more or less readily observed by monitoring power supply voltage and current

-2. Pump failure

Pump failure, also, is most generally characterized by a low resistance or near short-circuit on the high voltage terminal

-3. Vaccum system leak

Unless very large, vacuum system leak is more difficult to detect

The leaks most likely to occur in the maser vacuum systems would result in a pump current slightly higher than "normal" pump current obtained without leak.

In the external vacuum system this is tolerable, to a certain extent, because the importance of the external vacuum system rests in the thermal isolation it provides for the inner physics of the maser. Thus the most important factor is that the pressure is within the limits of the maser ion pump power supply. Leak rate is not expected to change with time, so that aging characteristics of the pump - whatever they are - would also be independent of the "leak".

The internal vacuum system is not the same. In this system, a leak however small will allow molecules from the atmosphere to enter the active part of the maser itself.

Presence of these molecules will result in collisions and interactions with hydrogen atoms, and may ultimately reduce the maser oscillating power, or extinguish oscillations altogether. The pump current in the inner vacuum system is largely determined by the flux of hydrogen atoms leaving the dissociator. Turning off the hydrogen supply makes it possible to determine the basic system pressure - hence by comparison with the system known H-off pressure - determine if there is a leak.

-4. Internal vacuum system leak test

Consult the maser log-book for the internal vacuum system empty pressure (pump current), then :

a) turn-off the hydrogen source pressure with the pressure control (7), Fig. 1.3

b) monitor internal pump current (ADDRESS 15 : I-VAC ION INT) until it descends no further. This may take several hours. Compare this value of current with the value recorded in the log-book.

This value should not be more than three times the log-book value.

Consult figure 7.2.5.-1 for a troubleshooting guide to the vacuum system.

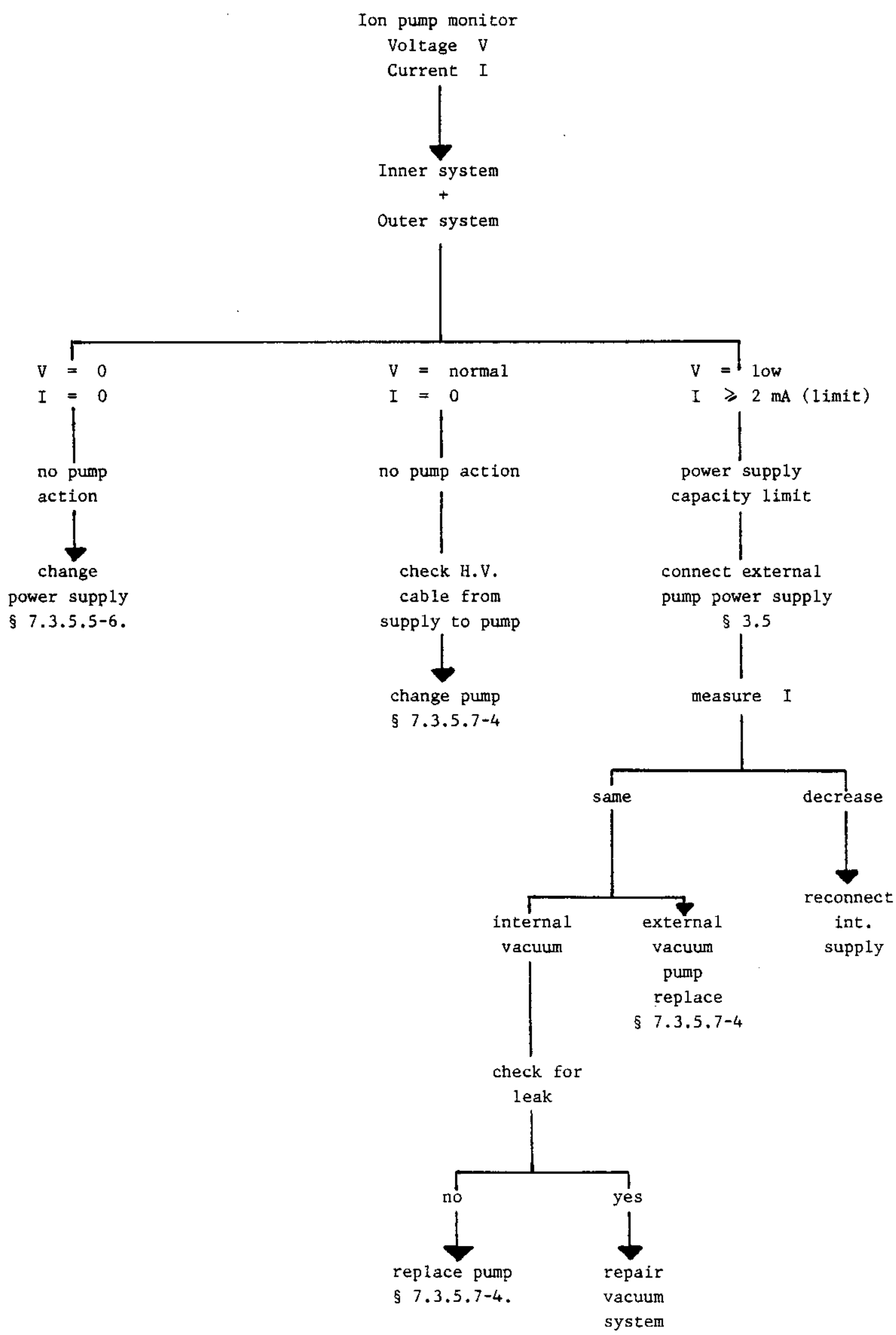


Fig. 7.2.5.-1 : VACUUM SYSTEM TROUBLESHOOTING

7.2.6 Low frequency electronic

1. The electronics covered in this section of the troubleshooting guide consists of :

   a) SYNTHESIZER

   b) PLL ELECTRONICS

   c) 20 MHz DIVIDER TO 10 MHz + 5 MHz TTL OUTPUT

   d) 5 MHz OUTPUT BUFFER AMPLIFIERS

   All these elements are in the upper part (4), Fig. 7.1, or in the head (6), Fig. 7.1 of the maser. § 7.3.4 and 7.3.5 give certain informations for access to the modules for the tests described.

   Refer to figures 7.2.6-1, -2, -3 and -4 for the general guide to troubleshooting. As a general rule, check D.C. power supply inputs to the module prior to troubleshooting and signal tracing.

   Guide to troubleshooting the RF system is in § 7.2.7, to the receiver is in § 7.2.8, to the frequency multiplier is in § 7.2.9

2. PLL circuit card

   Troubleshooting the phase-lock-loop circuit consists of the following checks :

   a) the two 5.7 kHz signals are present at the phase detector input

   b) state of logic indicating lock corresponds to the VCXO control voltage (see d below)

   c) the same 5.7 kHz signal to the two phase detector inputs results in the nominal equilibrium VCXO control voltage (see e below)

      For the troubleshooting analysis it will be helpful if a DC ± 15 V voltmeter is connected to the VCXO control voltage terminal on the 5 MHz oscillator 1 , Fig. 7.9. The VCXO voltage is derived from an integrator, sufficient time must be allowed for integrator to respond to any change in signal inputs to the phase detector. This may be several minutes.

d) the following chart is useful for trouble-shooting the alarm system as indicated in b) above

e) the check of c) above is accomplished as follows :

-1. disconnect 5.7 kHz maser output on receiver module

-2. connect a jumper wire between the two coaxial connections "5.7 kHz filtre" and "5.7 kHz TTL" on the PPL circuit card, see circuit drawing 8002-30-24-1159

-3. for normal operation VCXO control voltage stabilzes around the nominal 5 V bias

Figure 7.2.6-2. is a guide to troubleshooting the phase detector.

7.2.7 RF system

The noise in the RF system is used as a check to proper operation, and troubleshooting the RF system is usually under taken after correct operation of receiver section is assured. To pin point defects not detectable by the noise response of the system, a signal generator and spectrum analyser must be available, see list of test equipment, Table 7.2.

Refer to figure 7.2.7.-1. for RF system trouble-shooting guide.

VCXO VOLTAGE	"LOCK" STATE (PIN 16)	MONITOR PHASE LOCK INDICATION	ANALYSIS
5 V ± 5 V	A C T I V E	RED	Normal
5 V ± 4 V	0	GREEN	Normal
5 V ± 5 V	0	GREEN	Defective alarm logic
5 V ± 4 V	A C T I V E	RED	Defective alarm logic
5 V ± 5 V	A C T I V E	GREEN	Monitoring system defective
5 V ± 4 V	0	RED	Monitoring system defective

7.2.8 **Receiver system**

As with the RF system, the RF noise at the input to the receiver is used as a troubleshooting guide. An oscilloscope with high impedance input should be used for the 5.7 kHz output monitor during the tests.

The 180 MHz input to the receiver may be measured with high frequency scope 50 Ω input, see list of test equipment, Table 7.2.

Refer to figure 7.2.8.-1. for the receiver trouble shooting guide.

7.2.9 **Frequency multiplier**

The frequency multiplier furnishes 180 MHz to the receiver and 1440 MHz L.O. signal to the 1st mixer.

Normal power levels of the frequency multiplier are as follows.

a) input requirement 5 MHz : +7 dBm ± 2 dB

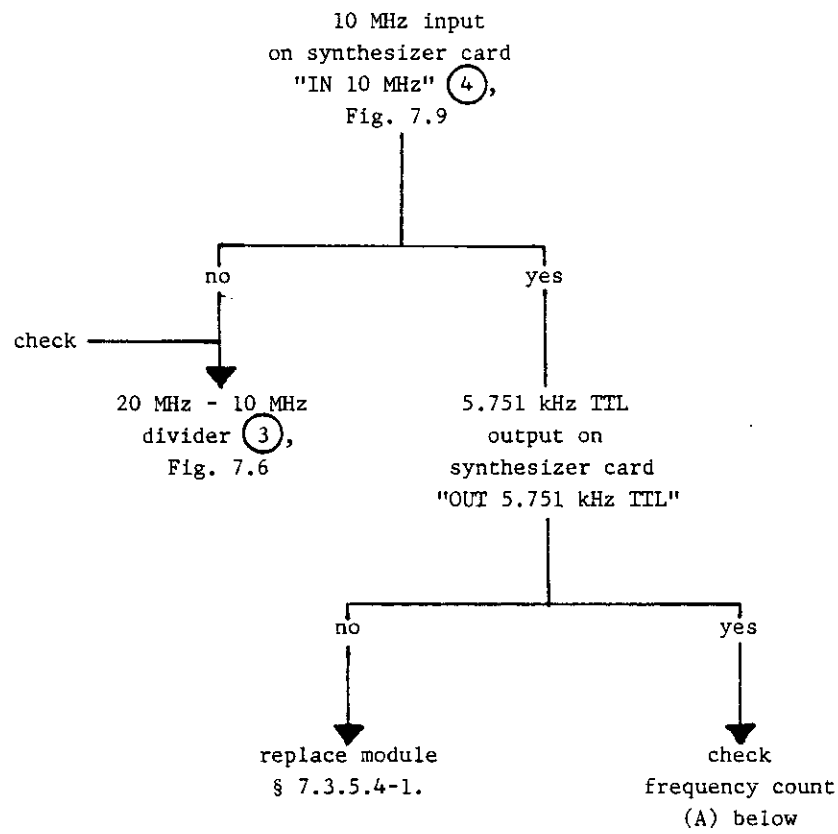
b) 1440 MHz output : nominal 10 dBm

An attenuator is used between the multiplier and 1st mixer to set level on the mixer to 0 dBm. Level should also be checked at output of this attenuator.

c) 180 MHz output : 0 dBm

Requirement for the frequency divider in the receiver is minimum 400 mV p-p. This value may be checked on a scope with 50 Ω input impedance.

Refer to figure 7.2.9.-1. for troubleshooting guide.



(A) The frequency count of the synthesizer may be checked as follows :

-1. connect input A on the HP 5328A counter to "5.751 kHz OUT" on the synthesizer card (4), Fig. 7.9

-2. connect input B on the HP 5328A to the "5 MHz TTL" output on the maser front panel (6), Fig. 1.1

-3. set counter to "RATIO B/A" and "N" to 10^5 or 10^6. The counter will display the number set on the synthesizer digital switch (3), Fig. 1.3. The last two digits displayed may not correspond because of the counter characteristics. "HOLD" and "RESET" may be used if 10^6 or greater N. is chosen because of the counting time required

-4. the synthesizer digital switch may be checked by changing setting and observe corresponding count

Fig. 7.2.6-1 : SYNTHESIZER TROUBLESHOOTING

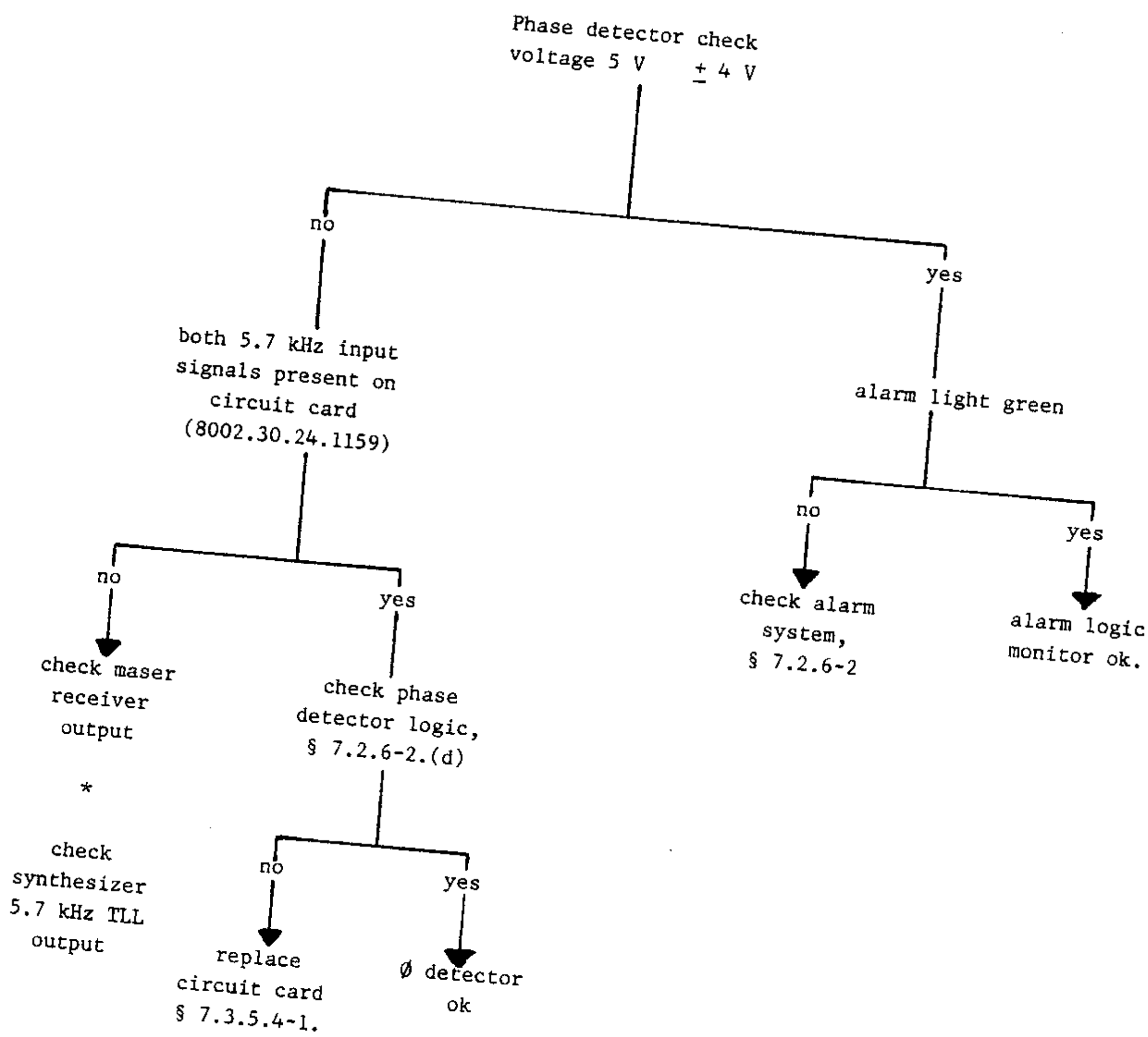


Fig. 7.2.6-2. : PLL ELECTRONICS TROUBLESHOOTING

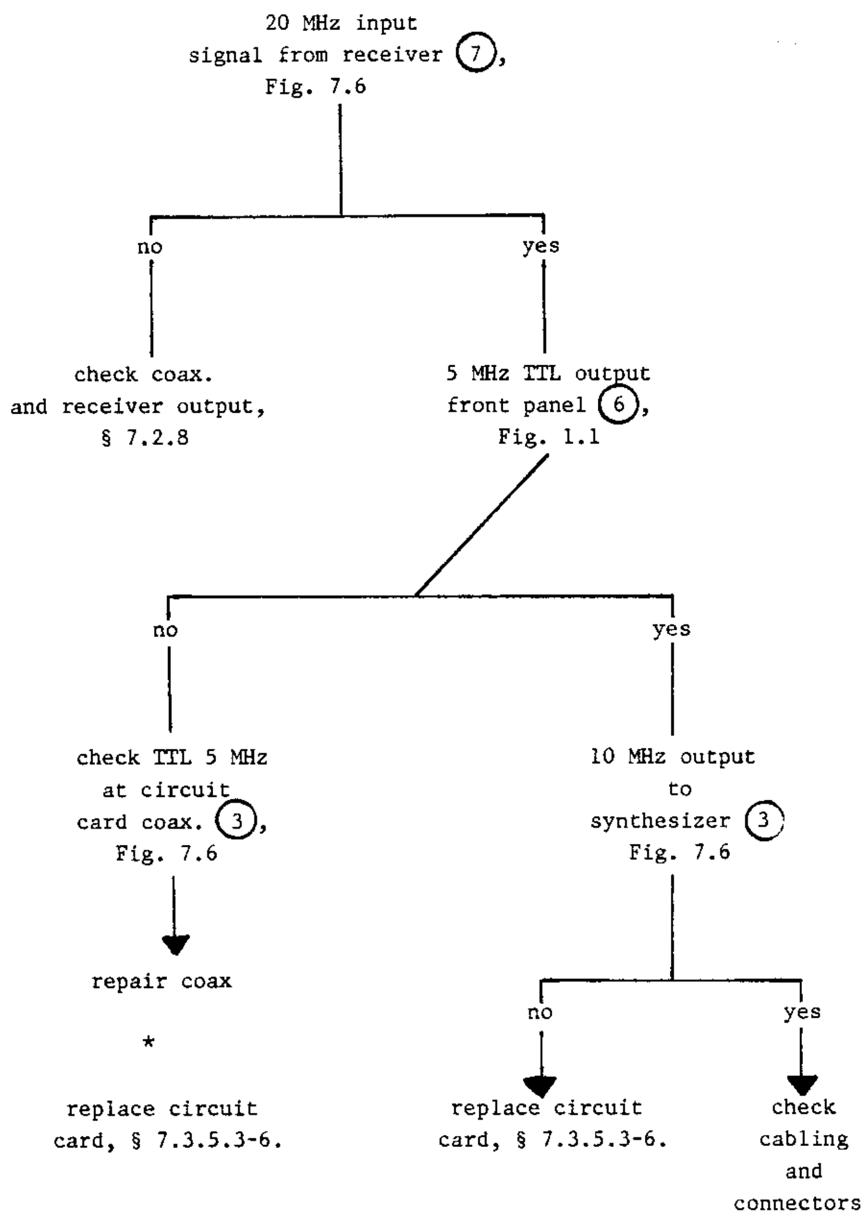


Fig. 7.2.6-3. : 20 MHz DIVIDER TROUBLESHOOTING

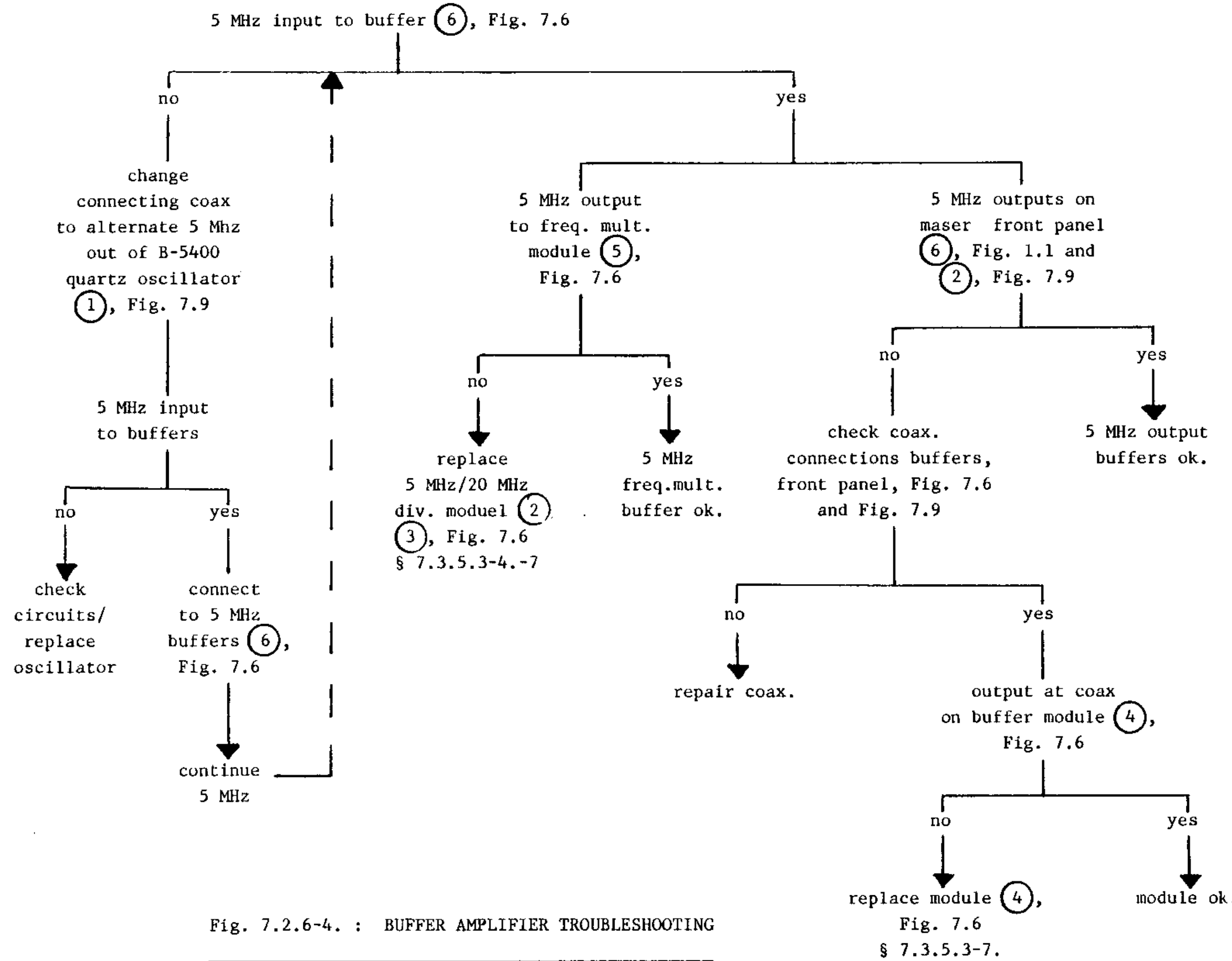


Fig. 7.2.6-4. : BUFFER AMPLIFIER TROUBLESHOOTING

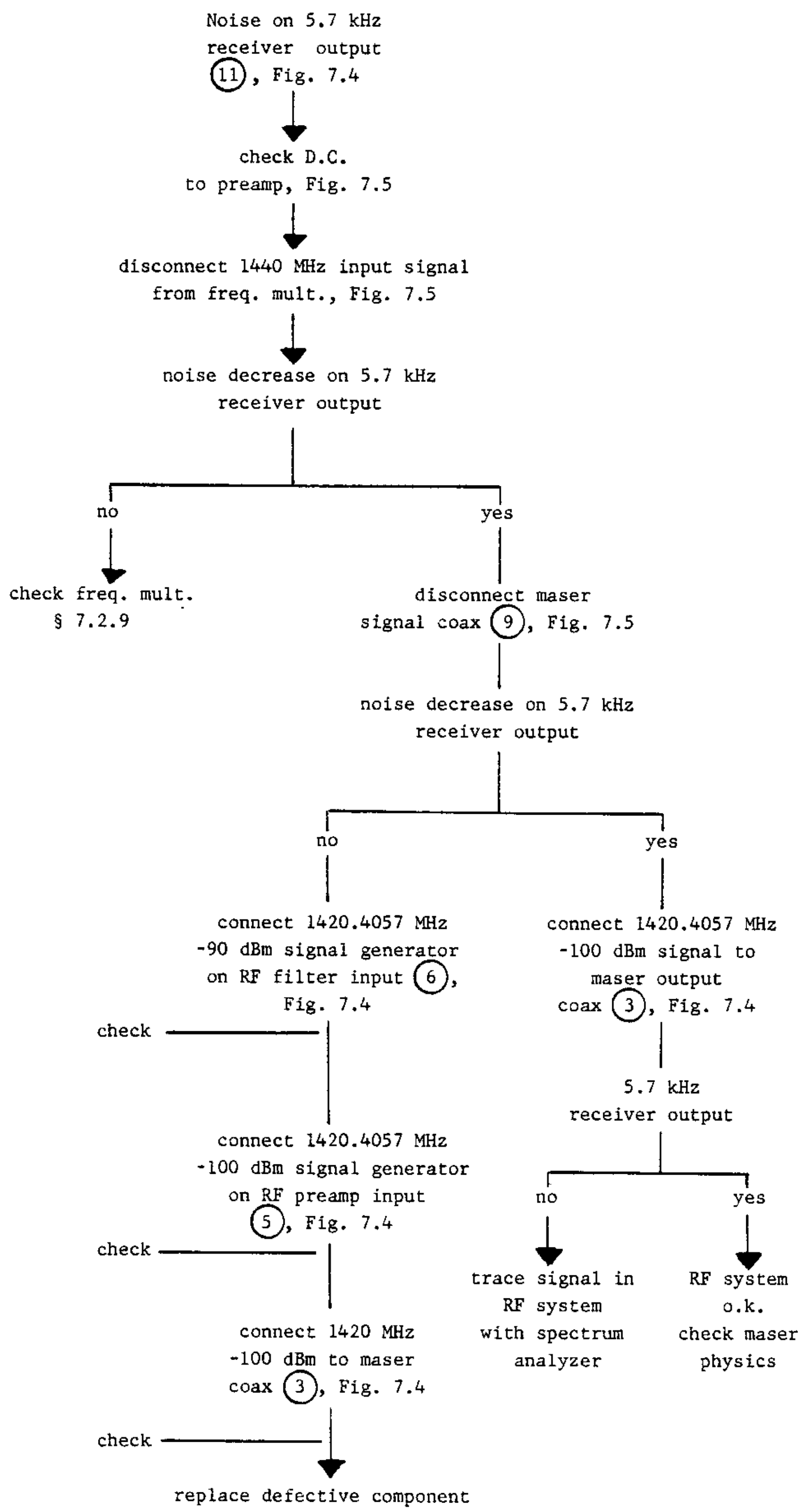


Fig. 7.2.7-1 : RF SYSTEM TROUBLESHOOTING

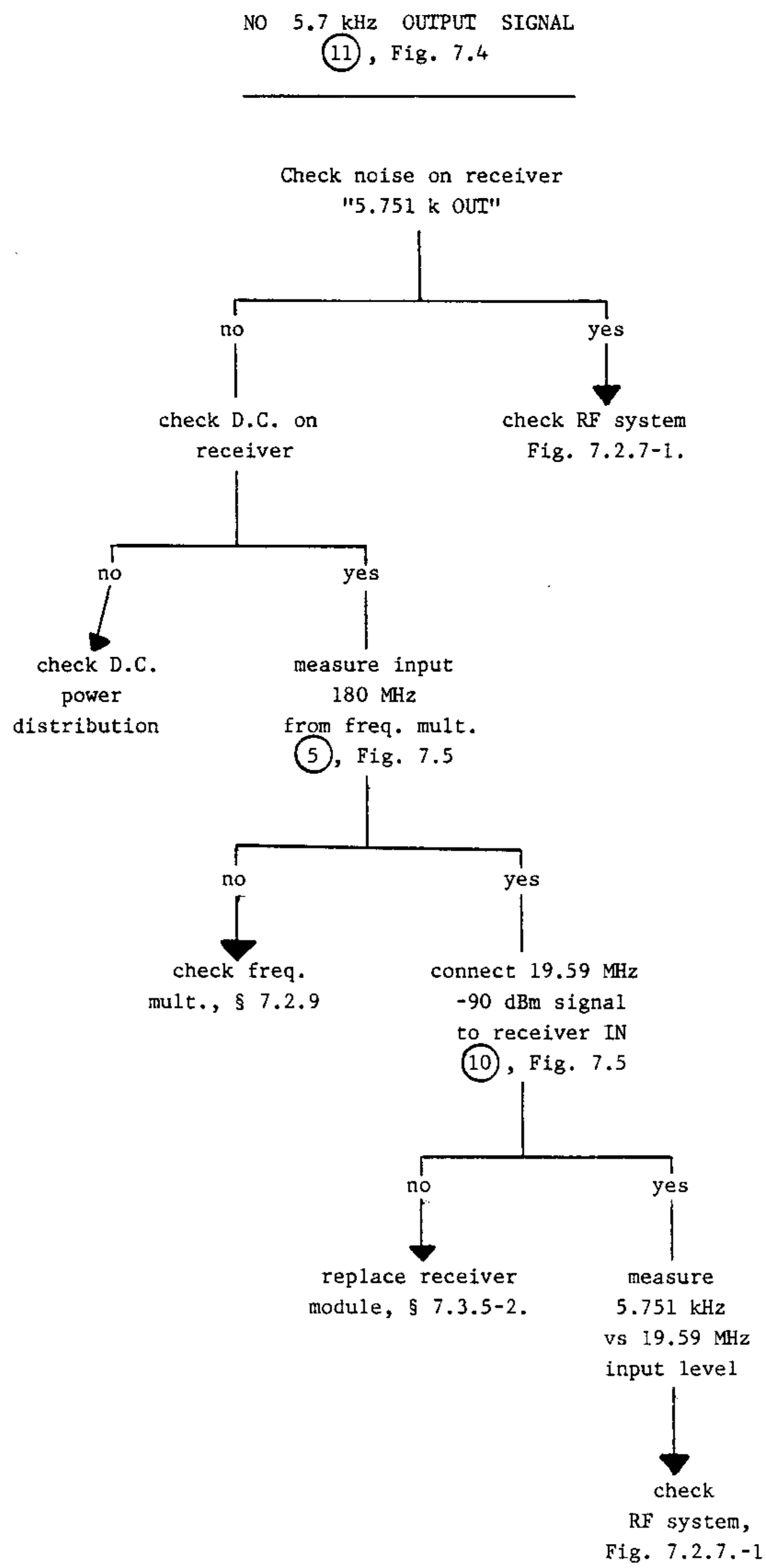


Fig. 7.2.8-1. : RECEIVER TROUBLESHOOTING

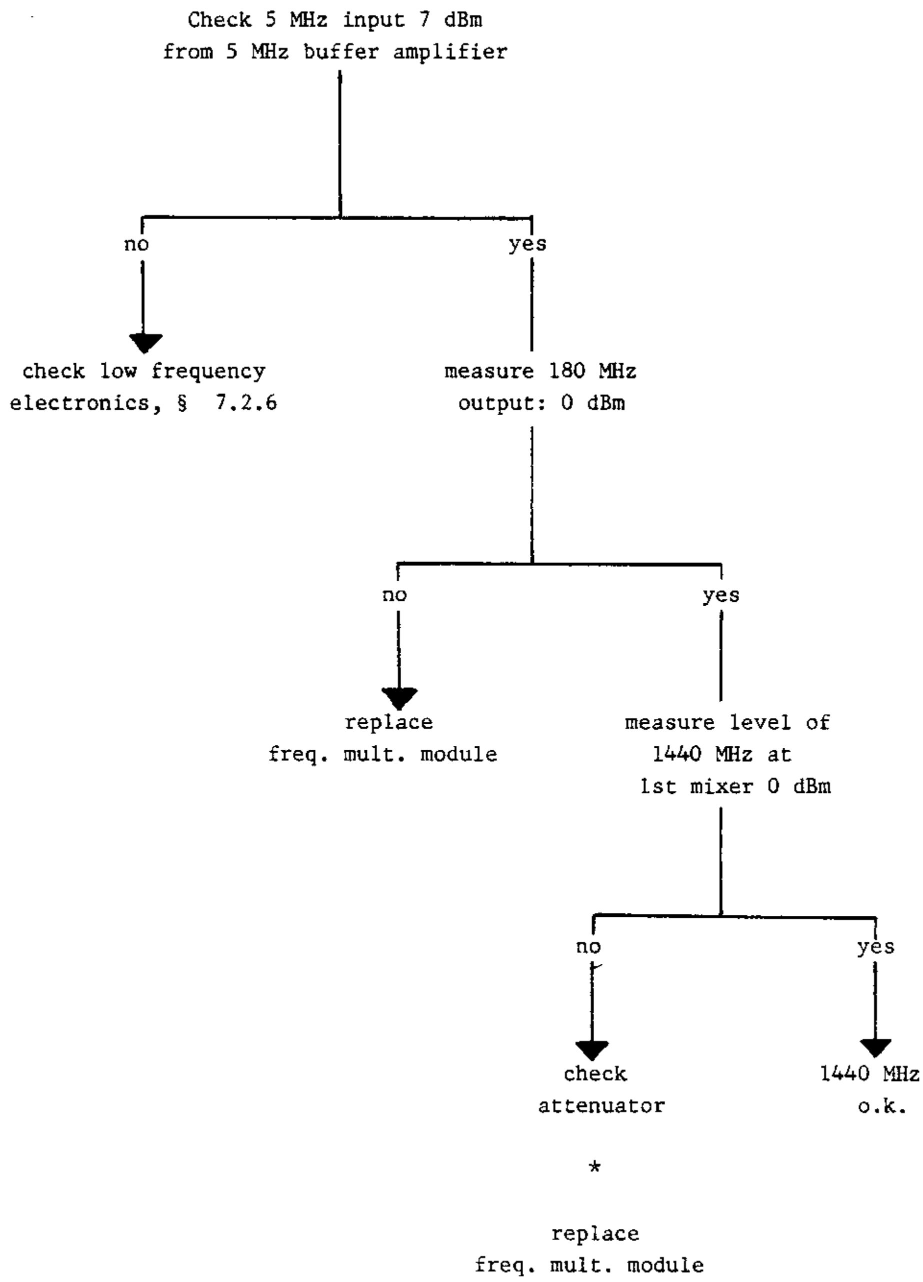


Fig. 7.2.9-1. : FREQUENCY MULTIPLIER TROUBLESHOOTING

PARA.	DESCRIPTION
7.3	GENERAL - Open-end/box-end wrenches; metric series M4 (4 mm) to M15 (15 mm) in 1 mm steps - Screw drivers; metric series M3 (3 mm) to M8 (8 mm) in 1 mm steps - DC voltmeter, 50 kΩ / volt (0 - 30 V) - Digital multimeter - 4 digits
2.4 + 7.3.5.10	HYDROGEN BOTTLE INSTALLATION/REMOVAL - Wrenches M7, M8 and M15, 9/16", 11/16" open-end - Screw drivers M3 and M6 - Pinch-off tool : ERMA LTD. Wembley / ENGLAND Cat. No 2903 or THE TEAM COMPANY 233 Harvard St. Brooklin MA 02146 USA - Leak detector liquid : "AIR-TEC" AMERICAN GAS& CHEMICAL 511E 72nd St. New York, 10021
3.5.1	CONNECTION OF PUMP EXTERNAL POWER SUPPLY - Pump H.V. adaptor cable ASULAB Part No 8002 - 1150/1 (2 req'd) - Pump control unit (H.V. supply) VARIAN model 911-5030 (2 req'd)

Auxiliary equipment and tools required for servicing of EFOS HYDROGEN MASER

T A B L E 7.2

PARA.	DESCRIPTION
3.5.3	EXTERNAL PUMP CONNECTION
	- Pinch-off tube VARIAN part 935-5018
	- 5 cm length of flexible hose + 2 hose clamps
+	- Turbo-molecular vacuum pump PFEIFFER (Germany) type TSU 118, 40 litres/second
	- PIRANI-cold cathode gauge control, BALZERS model PKG 020 with probe IKR 010
	- PIRANI vacuum gauge, BALZERS model TPG 060 with probe TPR 010
	- Flexible tube for maser-to-pump connection (according to turbo), max length 1 meter
7.3.5.7	- Pinch-off tool : see TABLE 7.2 above
3.10	DEMAGNETIZING PROCEDURE
	- Clip-on ammeter (AC) 0-30 A
	- VARIAC 250 VA
	- AC arc welder 100 A or current transformer
	- RHEOSTAT, 0 to 1 kΩ, 1 A
	- Demagnetizer 30 A. OSA Model 3098 A
	- Low current demagnetizer, OSA Model 3098
3.11.2	ZEEMAN FREQUENCY MEASUREMENT
	Synthesizer 0 to 10 kHz / HP model 3325 A
	DC voltmeter, high impedance 0 to 5 V

Auxiliary equipment and tools required for servicing of EFOS HYDROGEN MASER

T A B L E 7.2

(CONTINUED)

PARA.	DESCRIPTION
3.11.5	CAVITY SPIN-EXCHANGE TUNING
	- Reference oscillator : hydrogen maser or oscillator 1×10^{-14} in 10 minutes interval
+	- Dual Mixer Time difference frequency measurement system (NBS)
	- Digital voltmeter (4 digits) x 2
	- Synthesizer HP model 3325 A
	- Frequency counter HP model 5328 A
7.2.6	- SMA-to-voltmeter adapter cable
7.2.7	MULTIPLIER AND RF SYSTEM
	- Signal generator HP, Model 8663 A
	- Spectrum analyser TEKTRONICS, Model T.L.12
	- High frequency oscilloscope TEKTRONICS, Model 7A19 plug-in
	- Power meter HP Model
	- Torque wrench SUHNER, Model 742-0-0-21

Auxiliary equipment and tools required for servicing of EFOS HYDROGEN MASER

T A B L E 7.2

(CONTINUED)

7.3 CORRECTIVE MAINTENANCE

7.3.1 Introduction

The corrective maintenance on the EFOS maser consists of module replacement. The trouble-shooting guide is designed to localize malfunctioning to a module, allowing the defective module to be replaced immediately and then repaired later. As a general rule, the maser will take about 10 minutes to stabilize per one minute shut-down. With full heat applied to the maser, cavity temperature will increase about 0.1° per hour. Thus from a cold start, it may take 1 to 2 weeks for the maser to achieve the specified stability. Repairs requiring shut-down of the maser heating system should be made as rapidly as possible.

Similarly, the time that the ion pump are shut down should be limited in order to avoid exceeding the capacity of the pump power supplies for start-up.

If suitable precautions are taken, certain modules may be replaced without denergizing the heating system or exceeding the pump internal power supply capacity, see § 7.3.2 for precautions, and table 7.3 for the maser replaceable modules.

7.3.2 Precautions

The following precautions should be observed when changing modules : when power is left on the maser.

- for unsoldering a module which is energized use insulated tweezers and a soldering iron which is not grounded

- have all necessary tools, instruments, etc. available so that the time during which the maser enclosure is open is a minimum. This will minimize thermal transients and gradients eventually affecting the re-stabilizing time of the maser

FIGURE + INDEX No	DESCRIPTION	PART NUMBER	SUPPLIER
7.3 - 2	Frequency multiplier	8002 - 1196	OSCILLOQUARTZ SA
- 3	5 MHz output buffer amplifiers	8002 - 1215	"
- 4	20 MHz divider buffer	8002 - 1166	"
- 5	Isolation amplifier	8002 - 1166	"
- 6	Heater preamplifiers	8002 - 1152	"
- 8	RF preamplifier	AMT-2014M	AVANTEK
- 9	Receiver section	8002 - 1197	OSCILLOQUARTZ SA
- 10	1st mixer / preamplifier	DMP1 - 2J12AC	RHG ELECTRONICS
7.4 - 1	Circulator	HOA131	TRAK
- 5	RF preamplifier	AMT-2014M	AVANTEK
- 6	RF filter	8002 - 1194	OSCILLOQUARTZ SA
- 11	Receiver section	8002 - 1195	"
7.5 - 1	1st mixer / preamplifier module	DMP1 - 2J12AC	RHG ELECTRONICS
- 5	Frequency multiplier	8002 - 1196	OSCILLOQUARTZ SA
- 10	Receiver	8002 - 1195	"

TABLE 7.3 : REPLACEABLE MODULES

FIGURE + INDEX No	DESCRIPTION	PART NUMBER	SUPPLIER
7.6 - 1	Heater preamplifier board	8002 - 1152	OSCILLOQUARTZ SA
- 2	Frequency multiplier buffer amp	8002 - 1166	"
- 3	Divider / buffer	8002 - 1166	"
- 4	5 MHz output buffer amplifiers		
- 5	Frequency multiplier	8002 - 1196	"
7.9 - 1	Quartz oscillator 5 MHz VCXO	B-5400	OSCILLOQUARTZ SA
- 3	Phase detector and filter	8002 - 1159	"
- 4	5.751 kHz frequency synthesizer	8002 - 1157	"
7.10 - 6	Monitor transmitter module	8002 - 1155	OSCILLOQUARTZ SA
- 7	24 V dissociator power supply	E30 B24	POLYAMP
- 8	24 V regulated supply	E30 B24	"
- 9	5 V, ± 15 V power supply	E30 B5S-15-15	"
- 10	± 15 V power supply	E30 B15-15	"

TABLE 7.3 : REPLACEABLE MODULES

(CONTINUED)

FIGURE + INDEX No	D E S C R I P T I O N	PART NUMBER	SUPPLIER
7.11 - 3	D.C. input command / control	8002 - 1161	OSCILLOQUARTZ SA
- 4	Synthesizer digital switch	8002 - 1163	"
- 5	Control module		"
- 6	Monitoring transmitter module	8002 - 1155	"
7.12 - 4	Ion pump H.V. power supply	8002 - 1150	OSCILLOQUARTZ SA
7.13 - 1	Input power control	-	OSCILLOQUARTZ SA
- 2	Power control switch	8002 - 1161	"
- 3	Synthesizer digital switch	8002 - 1163	"
- 4	Maser control	8002 - 1162	"
- 5	Pressure control	8002 - 1153	"
- 6	Monitor transmitter filters	8002 - 1156	"
- 7	Monitor transmitter	8002 - 1155	"

TABLE 7.3 : REPLACEABLE MODULES

(CONTINUED)

FIGURE + INDEX No	D E S C R I P T I O N	PART NUMBER	SUPPLIER
7.14 - 2	Dissocator oscillator module	8002 - 1197	OSCILLOQUARTZ SA
- 3	Heater power amplifier	8002 - 1036	"
- 6	Dissociator (less oscillator)	8002 - 1122	"
7.15 - 1	Vacuum gate valve	GVA - 150	HUNTINGTON
- 2	T-coupling	8002 - 1171	OSCILLOQUARTZ SA
- 3	Vacuum gate valve	GVA - 150	HUNTINGTON
- 4	Pinch-off	953 - 5018	VARIAN
- 5	Vacuum gate valve	GVA - 150	HUNTINGTON
- 6	T-coupling	8002 - 1171	OSCILLOQUARTZ SA
- 7	Vacuum gate valve	GVA - 150	HUNTINGTON
- 8	Dissociator + power oscillator (see Fig. 7.14)		OSCILLOQUARTZ SA
- 9	Bellows, internal vacuum system	8002 - 1170	"
- 10	Bellows, external vacuum system	8002 - 1169	"
- 11	External T-coupling	8001 - 0996	"

TABLE 7.3 : REPLACEABLE MODULES

(CONTINUED)

FIGURE + INDEX No	DESCRIPTION	PART NUMBER	SUPPLIER
7.16 - 1	Ion pump, external vacuum system (201/s)	911 - 5030	VARIAN
- 2	Ion pump, internal vacuum system	911 - 5030	"
- 3	Ion pump mounting rail retaining screws (x4)	952 - 5054	"
-	Copper gasket (13)	953 - 5015	"
-	Stainless-steel nuts + bolts	953 - 5027	"
-	Stainless-steel nuts + bolts for gate valves	953 - 5011	"
7.17 - 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8	Maser hydrogen supply	8001 - 0999	OSCILLOQUARTZ SA
-	Nylon gasket, high pressure	8002 - 1213	"
-	Nylon gasket, low pressure	8002 - 1214	"

TABLE 7.3 : REPLACEABLE MODULES

(CONTINUED)

FIGURE + INDEX No	DESCRIPTION	PART NUMBER	SUPPLIER
7.19 - 1	Power control module	8002 - 1198	OSCILLOQUARTZ SA
- 2	Monitor receiver module		
- 6	Power supply module	E30 B5S-15-15	POLYAMP
7.20 - 1	Monitor receiver logic	8002 - 1193	OSCILLOQUARTZ SA
- 2	Monitor receiver readout	8002 - 1154	"
7.21	Pinch-off tube	953 - 5018	VARIAN

TABLE 7.3 : REPLACEABLE MODULES

(CONTINUED)

- all screws and fasteners in the maser are non-magnetic stainless steel and should never be replaced by iron or stell fasteners

- avoid introducing magnetized materials or tools into close proximity of the maser

- avoid short-circuitry power supplies, pulses of current can possibly affect magnetic homogeneity of the magnetic structure. The most sensitive elements to this effect are C-field and Zeeman coils.

When power must be turned off to change a module, the following precautions should be observed :

- insofar possible, energize the heating circuits intermittently to retain temperature as close to operating values as possible

- if ion pump power supplies are turned off, again cycle the maser power on to the power supplies if this is possible, at least every one hour. During this time, the hydrogen pressure should be set to zero in order to prevent pressure rise in the internal vacuum system.

- if the internal H.V. supplies to the ion pumps are to be turned off for more than one hour, external supplies should be connected, see § 7.3.5.7.

- an oil diffusion vacuum pump is never to be used for external vacuum system pump-down on the maser. The vacuum system pollution usually produced by this sort of pump will make the maser inoperative.

- if the maser vacuum system(s) must be let up to air pressure (e.g. change of hydrogen dissociator) this should be accomplished only with dry air (or any dry inert gas). This may be assured by using a dessicator on the turbo molecular pump connected to the external pumping system and proper manipulation of vacuum system valves.

CAUTION

> The pressure differential between internal vacuum and external vacuum system should be the smallest possible to avoid possible breakage of the H quartz bottle.

7.3.3 Tools and equipment necessary

All mechanical fasteners (except vacuum system components fabricated in the USA) are in the metric system of dimensions and threads. A set of appropriate metric tools should be on hand when effecting repairs and dismounting of elements and modules, see table 7.2 for a guide to sizes.

Table 7.2 also contains a list of auxiliary equipment necessary for repair and maintenance of the maser.

7.3.4 General maser layout

The replaceable modules are accessible in four compartments in the maser structure, Fig. 7.1

- (2) VACUUM MANIFOLD COMPARTMENT
- (4) UPPER FRAME PLL SECTION
- (5) ELECTRONICS / CONTROL UNIT
- (6) MASER HEAD

7.3.5 Replacement procedure

The following descriptions are appropriate for removal of the particular module. The reverse procedure should be followed to re-install the module.

7.3.5.1 Maser head access

Access to the maser head electronics is gained by removing the upper cover and magnetic shield (3), Fig. 7.1, moving up the upper frame PLL section (4), Fig. 7.1, and removing the three maser head cover elements (6), Fig. 7.1, proceed as follows :

a) remove the demagnetizer electrode insulated plug (4), Fig. 3.5, and note that the demagnetizer electrode in the maser is slightly off-center (4), Fig. 7.7. This requires all access covers to be correctly oriented in order to have access to the demagnetizing electrode.

b) note the orientation as prescribed above and remove the upper cover (4 corner screws) and magnetic shield (28 screws) (3), Fig. 7.1.

c) remove the outer shield by lifting around the edges (1), Fig. 7.2. noting orientation as before. The shield is retained by a sliding fit.

d) remove the screws (8) on the periphery of the maser head cover (2), Fig. 7.2 (note orientation, and remove the cover.

e) remove the screws (8) retaining the electronics compartment cover (3), Fig. 7.2, and remove cover. The maser head electronics is now accessible, Fig. 7.3

7.3.5.2 Maser head general assembly

There are nine compartments in the maser head, Fig. 7.3. The center compartement (1), Fig. 7.3, call the "DALLE", Fig. 7.7, is temperature controlled, and is an integral part of the maser physics. It contains the maser output coax (2), Fig. 7.7, and the demagnetizing electrode (4), Fig. 7.7. These two connections pass directly into the external vacuum system of the maser, and are sealed by fittings at the base of the element. Extreme care must be excercised in manipulating the connections to these elements so that the seals are not damaged.

The other eight compartments contain the electronic elements. The separating walls of the compartments contain a series of tapped holes, and it is by this means, and stand-offs, that the electronic modules are mounted in the maser head.

7.3.5.3 Component removal

Before proceeding with component removal, check the maser operating condition for that module. All coaxial connectors should be tightened by the proper torgue wrench, Table 7.2.

-1. RF section, Fig. 7.4

Comprising circulator (1), RF preamplifier (5) and bandpass filter (6). This section may be removed in its entirety by :

a) disconnecting the coaxial cables to the maser (3), to the lst mixer/preamp (8) and the receiver module "20 M out", "5.751 K out"

b) unfastening the retaining screws (9) holding the module mounting plate to the compartment wall

c) lifting the section up and insoldering the D.C. connections to the RF preamp (5)

Alternatively the individual modules may be removed as follows :

d) Circulator (1)

Disconnect coax from maser (3). Loosen coax connector leading to preamp (5). Rotable the circulator on its 1 - 2 port axis so that it clears the positioning pins on the circulator mounting plate, disconnect completely the coax to the preamp.

e) RF pre amplifier (5)

Remove circulator as in d) above, then the circulator mounting plate by removing the fasteners on the mounting plate stand-offs. Disconnect the coax to the band pass filter (6), then the two screws holding the amplifier to the mounting plate (12). Unsolder the D.C. leads to the amplifier.

f) Bandpass filter (6)

Disconnect coax from preamplifier and coax (8) to lst mixer. Remove retaining screws on diagonal corners of the filter, and lift out.

-2. Receiver module (11), Fig. 7.4

Screws retaining the receiver module also serve to retain the RF section and lst mixer/preamplifier module (9), (10) Fig. 7.4, (3) Fig. 7.5

a) disconnect coaxial connectors to the receiver module :

" 5.751 K OUT"

" 20 M OUT"

" 19.59 M IN"

"180 M IN"

b) Unsolder D.C. connections

c) remove retaining and stand-off screws on RF section (9) , Fig. 7.4 and retaining screws (10) , Fig. 7.4, (3) , Fig. 7.5

d) slide the 1st mixer/preamp module aside to free the mounting rail of the receiver module (10) , Fig. 7.5, and lift module out.

-3. <u>1st mixer/preamp module</u>, Fig. 7.5

Disconnect to coax between the multiplier "1440 M OUT" and "L.O. IN" on 1st mixer/preamp module (1) .

a) disconnect coax from "IF OUT" to +19.59 M IN" on receiver module

b) remove retaining screws (3) and unsolder D.C. connections to preamp module. Detach D.C. wiring harness retaining clip and remove module (and its mounting plate).

The module is attached to the mounting base plate from the under side.

-4. <u>Frequency multiplier module</u>, Fig. 7.5

This module can be removed only after the 1st mixer/preamp module is loosend and slide aside as described in § 7.3.5.3.2.c), d) above, when this is accomplished :

a) disconnect coax cables from the multiplier :

" 5 M IN"

"1440 M OUT"

" 180 M OUT"

b) remove retaining screws ⑥ and the stand-off attaching screws of the 5 MHz output buffer amplifier board, ⑩ , Ⓓ , ④ Fig. 7.6

c) unsolder D.C. connections and remove the module ⑤ , Fig. 7.5

-5. <u>Heater preamp circuit card</u> ① , Fig. 7.6

a) disconnect D.C. connectors from the circuit card ⑧

b) remove stand-off retaining screws ⑩ on circuit board mounting plate Ⓐ

c) remove the circuit board retaining screws ⑨ on mounting plate Ⓑ and the stand-off screws ⑩ on the same plate. The circuit board may now be lifted up and removed.

-6. <u>20 MHz divider and TTL buffer</u> ② , ③ Fig.7.6

a) disconnect the 5 coaxial connectors and unsolder the D.C. connections

b) remove the stand-off screws ⑩ on circuit board mounting plate Ⓑ

c) remove the stand-off screws ⑩ on mounting plate Ⓒ which support the 5 MHz output buffer amplifier ④

d) remove the 4 retaining screws ⑨ on mounting plate Ⓒ

e) tilt the board up on the side Ⓒ and remove

-7. <u>5 MHz output buffer amplifier</u> ④ , Fig. 7.6

a) disconnect the ③ coaxial calbes on the circuit board ④ . Unsolder D.C. connection.

b) remove stand-off restaining screws ⑩ on circuit mounting plate Ⓒ

c) remove retaining screws ⑨ on mounting plate Ⓓ

d) tilt the circuit board ④ and remove

7.3.5.4 Upper frame PLL section, Fig. 7.8 and 7.9

The synthesizer digital circuit card (4), Fig. 7.9 and phase lock command circuit card (3), Fig. 7.9 may be removed without raising the mounting frame. It is necessary to raise the frame to remove the quartz oscillator (1), Fig. 7.9

-1. Synthesizer; phase lock command cards (3), (4) (Fig. 7.9)

Using the finger grips mounted on the outer edge of the circuit card (1), Fig. 7.8, pull the card out of the connector.

-2. Quartz oscillator (2), Fig. 7.8, (1), Fig.7.9

a) loosen the captive thumb screws (4), Fig. 7.8 holding the frame in position

b) raise the frame on its hinge and engage the support far into the lug (6), Fig. 7.8 on the side of the frame

c) disconnect the oscillator by pulling the connectors on the end of the connecting wire free. Observe polarity markings on the oscillator for future reference.

d) loosen the oscillator mounting screws (2) Fig. 7.8 while at the same time holding the oscillator so that it cannot fall

7.3.5.5 Electronics and control unit, Fig. 7.10 and 7.11

Before replacing modules in this unit check the guide in Table 7.1

-1. Power supply modules, Fig. 7.10

Remove the module retaining screws (2) (12) on the desired module (7), (8), (9), (10) and remove the module by pulling on the radiating fin structure.

-2. Input power control module (3), Fig. 7.11

Remove by pulling the module pull handle (1)

-3. <u>Synthesizer digital switch module</u> (4) (Fig. 7.11)

Remove by pulling the module pull handle

-4. <u>Control module</u> (5), Fig. 7.11

Remove by pulling the module pull handle

-5. <u>Monitor transmitter module</u> (6), Fig. 7.11

This module is removed by releasing the module restraining screws (2), Fig. 7.11

-6. <u>Pump H.V. supply module</u> (4), Fig. 7.12

Remove the front panel of the H.V. supply compartment (11), Fig. 7.10

a) release the electronics and control (5), Fig. 7.11, retaining screws (6), Fig. 1.2, and pull the unit out of the maser

b) check to be sure that input power switch (2), Fig. 1.3, is on another position than "H.T."

WARNING

The ion pump H.V. supply must be de-energized before disconnecting the High Voltage cables. Dangerous voltages are present in these supplies.

c) disconnect the pump H.V. cables (2), (3), Fig. 7.12

d) disconnect the D.C. input and the monitoring cables on the interconnecting cable panel (8), Fig. 7.13

e) remove the four module retaining screws (5), Fig. 7.12 and remove the power supply module

7.3.5.6 Heater power amplifier module (3), Fig. 7.14

The heater power amplifier module is located on the right side to the vacuum manifold compartment (2), Fig. 7.1

a) remove the magnetic shield panel on the right side of the vacuum manifold compartment (25 screws)

b) remove the four connectors from the right side of the power amplifier module (3)

c) release the module mounting screws at the base of the module, and remove

7.3.5.7 Vacuum system components

Vacuum system components require special care in handling in order to safeguard the internal cleanliness and avoid damage to mating surfaces of flanges. Furthermore, a thorough analysis of the vacuum system difficulties should be made by experts before undertaking component replacement (other than possibly the ion pump or hydrogen bottle) to avoid possible contamination of the vacuum system.

-1. Precautions

Some general precautions apply to vacuum system components in general.

a) components should always be retained in plastic containers which are dust proof. Without this protection, the component should have covers on the flanges (usually plastic), or be covered with aluminum foil. Measures should always be taken to avoid introducing contaminants, dust, or foreign objects into internal surfaces of the vacuum system.

b) copper gaskets should never be reused. A new OFHC annealed copper gasket must be used each time a joint is changed

c) when a joint is separated, the gasket may remain in one of the flanges and not be removeable with the fingers. In this case, a screw-driver or similar tool may be judiciously employed to engage the edge of the gasket to pry it out. Extreme care should be taken not to scratch the flange surface or damage the knife edge of the flange. These surfaces should always be carefully checked before making connections

d) mating surfaces should be cleaned with a lint-free cloth and a solution of acetone. Oil, grease or similar materials on vacuum surfaces should be scrupulously avoided, as well as lint, hair and other such fine particles.

-2. Valve operation

To close the valve, turn in the clockwise direction from the open (counter clockwise) position. Near to end of travel the torque necessary to turn the valve will increase, then decrease again. This is the center-lock action, and the valve is now closed. Turning beyond this point will bring the mechanism to an abrupt stop. Do not turn against the valve stop, this is unecessary and may damage the mechanism.

To open the valve, turn in a counter-clockwise direction. On opening, when the valve mechanism passes the center-lock position there will be a pronounced "clack" sound in the valve. It is now open, and further turning is unecessary.

The pressure on the two sides of the valve should be equal before opening the valve.

-3. Vacuum joints and component replacement

The vacuum manifold system is "suspended" between the ion pumps and the maser physics by bellows in the vacuum lines, Fig. 7.15 and 7.16. This flexibility simplifies the alignment of the vacuum lines and flange faces when installing or removing a component. Before making the joint observe precautions § 7.3.5.7.1.

The vacuum tight joint is formed by placing an unused annealed copper disc between the flanges, installing and tightening the bolts in the mounting flange to hand-tight. While tightening by hand it is well to keep the flange faces as nearly parallel as possible. Then, with the 1/4 inch box-end wrench tighten each bolt successively around the flange by 1/4 turn always keeping the two faces parallel until the faces are in contact. In this manner the knife edge of the flange is pressed into the soft annealed copper assuring a hermetic seal.

-4. Ion pump replacement, Fig. 7.14

Procedure for replacement of the internal or external vacuum system ion pumps is essentially the same. The procedure for replacing the internal vacuum system pump is described below.

The same vacuum system manipulations will apply to changing the external system pump.

a) remove the front panel of the vacuum manifold compartment ②, Fig. 7.1. Remove the rear panel of the electronics/control unit ⑤, Fig. 7.1, then the magnetic shield in the ion pump enclosure. Similarly, remove the right and left panels and pump magetic shield panels on the electronic control compartment. The ion pumps are now accessible ①, ② Fig. 7.16.

WARNING

Ion pumps are energized with 5 KV with a current capacity up to a hundred mA. Contact with these high voltage elements can be lethal and must be avoided. Always check that the pump H.V. supplies are OFF before manipulation the connecting cables.

b) turn off the H.V. to the pumps by placing the power control switch ②, Fig. 1.3, to position "RF"

If it is desired to continue pumping with the external system pump, slide the electronics / control unit out and disconnect the internal system pump cable according to § 7.3.5.5..6 c) above.

High voltage may then be turned on the external system pump.

c) close the internal vacuum system valves (1) (3), Fig. 7.15

d) disconnect the pump from the vacuum manifold by unbolting the flange on the pump (8), Fig. 7.16

e) remove the pump and its rail mounting assembly (5), (4), (1), Fig. 7.16 by removing the retaining screws (4) (3)

f) the pump is attached to the rail assembly by four stand-offs (4)

g) replace the pump and reinstall the pump/rail assembly in the maser (5), Fig. 7.16

h) connect the pump to the vacuum manifold as described in § 7.3.5.7.3 above. Before the high voltage is connected, the pressure must be reduce to less than about 10^{-5} TORR.

-5. Ion pumps star-up

Connect the turbo molecular pump to the external pump flange (4), Fig. 7.15 and § 7.3.5.7.3 using a flexible vacuum line (1/4 inch min. drain). Before this connection is made, assure that the pinch-off fitting is available (VARIAN part No 953-5018), Fig. 7.2.1.

a) turn on the turbo pump and keep the valves closed until pressure in the line from the turbo to the maser vacuum manifold has descended to 1×10^{-5} TORR

b) open valve [V2] (3), Fig. 7.15 (maser internal vacuum system). Continue to pump with the turbo in this configuration until system pressure has descended to 10^{-5} TORR

c) open valve [V1] ①, Fig. 7.15 (internal valve), and continue pumping to a pressure 10^{-5} TORR. Then open valve [V3] ⑤, Fig. 7.15, and subsequently valve [V4] ⑦, Fig. 7.15. Pump to 10^{-5} TORR

d) while turbo is pumping down the system, set up the monitoring receiver to check pump voltage, and current, § 2.3.2 and 1.2.3. Set monitor "ADDRESS" to "25", "VAC ION INT" current, or "27" as appropriated

e) connect the H.V. cable to the pump ⑥, Fig. 7.16, and after checking that the power control switch is not on "H.T.- position", connect the H.V. cable to the pump power supply, § 7.3.5.4 b) above

f) set power control switch to "H.T." and check pump current on monitor "ADDRESS" 25. and 27. The pump should start and indicate a current $<$ 2 mA.

Leave H.T. on and continue pumping with turbo and ion pump until current less than about 500 μA is obtained.

g) close the two external valves [V2] ③ and [V3] ⑤. Check that ion pumps are pumping normally by checking pump voltage and current on the monitor.

6. <u>External pump close-off</u>

The pinch-off disc which was removed to connect the turbo pump may not be reused. A replacement piece (VARIAN part No 953-5018) must first be connected to the turbo by means of a short length of rubber tube as shown in figure 7.21

The pinch-off disc and tube are of annealed oxygen-free (OFHC) copper. Bolt the disc to the maser manifold flange using the original flange rings and bolts, and the method indicated above.

a) connect the turbo pump in the same fashion and pump down the system to lower than 10^{-5} TORR. Valves [V2] and [V3] must remain closed during this attachment and pump-down.

b) when turbo pressure is below 10^{-5} TORR., make the pinch-off (see Table 7.2). Assure that a continuous pressure is applied to the pinch-off tool to the point that the copper tube separates.

C A U T I O N

> The edge formed on the copper pieces in the pinch-off process are extremely sharp so that care should be exercised in order not to be injured by accidental contact with these pieces. Epoxy or silicone cement should be applied to the pinch-off edge

c) open valve [V3] (maser exterior vacuum system) of the maser. Leave[V2] (maser internal vacuum system) closed. Observe pump current monitor "ADDRESS" 27 to assure that the seal to the turbo flange is good. Close valve [V3].

7.3.5.8 Dissociator replacement, Fig. 7.14 and 7.15

The dissociator assembly contains the RF discharge bulb, PIRANI/palladium elements for hydrogen pressure control, and the state selecting magnets.

General

Sixteen bolts retain the source structure in the maser, and are not visible from outside the maser housing. They are accessible through 14 mm dia. holes on the periphery of the dissociator orienting flange (7) , Fig. 7.14. Three dissocator orienting screws are accessible and visible on the periphery of the orienting flange also. These screws need not be touched during the replacement of the dissociator.

The maser heating system need not be shut off during the dissociator replacement.

-1. remove the vacuum compartment outer panels (4), (2) Fig. 7.1

-2. disconnect the PIRANI/Palladium and RF oscillator connectors on the interconnecting cable panel (8), Fig. 7.13

unsolder the electrical connections to the PIRANI /palladium assembly and the RF oscillator module

-3. close valve [V2] (3), Fig. 7.15. Connect the turbo pump to the vacuum manifold, § 7.3.5.7. Be sure that the turbo is equiped with a dessicator in good condition.

-4. close the hydrogen bottle shut-off valve (2), Fig. 7.17 (clockwise), and the hydrogen system pressure adjustment (8), Fig. 7.17 (counter-clockwise).

-5. disconnect the hydrogen supply tube coupling (12), Fig. 7.18. Use a wrench to retain the pressure reducer output fitting (15), Fig. 7.18, immobile while turning the coupling (12)

-6. turn off H.V. to ion pumps with power control switch, Fig. 7.11

-7. turn on turbo pump and pump down external vacuum line to 10^{-4} TORR. (remember that valves [V2] and [V3] are closed). When this pressure is obtained, open the valves [V2] and [V3], then shut off the turbo pump. The inner and outer vacuum systems will come up to atmospheric pressure through the turbo dessicator.

I M P O R T A N T

> Pressure difference between inner and outer vacuum system should always be the minimum possible because the cavity quartz bulb forms part of the separation between the two vacuum systems.

Wait about three hours before proceeding in order to allow the dry air time to fill the maser vacuum spaces.

-8. Pass an allen wrench through the holes in the orientation flange and loosen the 16 mounting bolts slightly. Leave two diametrically opposed bolts in place (to retain the dissociator) and remove the other 14 bolts.

While supporting the assembly with one hand, loosen the two remaining bolts alternatively until they are free, and the assembly may be lowered and removed.

Be sure that the copper gasket cames out with the assembly.

Place the assembly immediately in a plastic dust-free container.

NOTE

> Every precaution should be taken to maintain a clean and dust-free atmosphere around the maser during installation of the source. Avoid air currents, and allow only the minimum number of personnel in the area.

-9. Installation

Proceed as follows :

a) open the packaging of the replacement source as close to the maser as possible. Be sure that a new copper gasket is in place. Then holding the dissociator housing (6), Fig. 7.14, in one hand with the state selecting magnet structure upward, orient the assembly in the sense of installation.

Place as close to the source installed position, and remove the cover on the state selector. Immediately slip the assembly into the opening and raise it up until the mounting flange bottom on the maser structure.

b) place a mounting bolt on the allen wrench, slide into bolt hole in the mounting flange and rotate the assembly to engage the mounting bolt. Screw in the bolt several turns. Then install a second bolt diametrically opposite and tighten finger tight. Install the other 14 bolts finger tight.

c) with the allen wrench tighten the bolts successively about 1/8 turn each bolt until the turning torque reaches the limit of the allen wrench. Note that, by contrast with the vacuum system flanges, there is no way to see the flange faces during the tightening sequence.

d) install the RF power oscillator, § 7.10

-10. Follow the sequence of manipulations in reverse sequence as noted above :

a) connect the hydrogen supply tube.

b) turn on the turbo pump

c) solder the connecting wires to the PIRANI / palladium and RF oscillator module

d) reconnect the PIRANI/Palladium control and RF oscillator connectors on the interconnecting cable panel (8), Fig. 7.13

-11. Purge the hydrogen supply system according to § 7.3.5.10-1.

-12. Pump-down, and pinch-off according to procedures in § 7.3.5.7-5 and 7.3.5.7-6

A new dissociator may take a week or so of operation after installation before normal-stable conditions are obtained.

7.3.5.9 Dissociator power oscillator replacement, Fig.7.14

The RF oscillator module (2) , Fig. 7.14, is retained in the dissociator housing (6) , by three retaining screws (1) . Proceed as follows :

-1. unscrew retaining screw and slide the module downward taking care not to rotate the assembly

-2. disconnect the RF cable (8) , Fig. 7.13, unsolder the D.C. connections on the RF oscillator

To install replacement, observe carefully the index marks on the dissociator housing and the RF oscillator module mounting plate. It is important that these marks be aligned before the helix is engaged on the dissociator bulb. Regular mis-alignment can damage the connecting tube to the dissociator bulb.

-3. reverse steps 2 and 1 above.

7.3.5.10 HYDROGEN BOTTLE INSTALLATION AND REMOVAL

(see Fig. 2.1 for location)

The hydrogen bottle and associated pressure reducing system (1) , (2) , (3) , (4) , (6) , (7) and (8) , Fig. 2.2 and 2.3 is removed or installed as a unit. Replacement of the hydrogen bottle is covered in paragraph 2.4.

I M P O R T A N T

Whenever the hydrogen bottle is to be removed or installed assure the following :

1) The hydrogen bottle valve (2) , Fig. 2.2, is firmly closed

2) The palladium pressure regulating valve is set to zero with the control potentiometer full counter clockwise (7) , Fig. 1.3, on the control panel

3) The hydrogen pressure regulator is set for zero pressure by turning the valve counter clockwise (8) Fig. 2.2

4) A pinch-off tool is available, see table 2.1

-1. <u>Installation</u>

Before the bottle is installed and connected, it is convenient to open the maser supply tube (14), Fig. 2.3, to allow later purging of the hydrogen supply to the palladium valve. This can be accomplished by filing a notch near the pinch-off end of the tube then breaking, or using side-cutting pliers and being sure that there is an opening at the end of the pinch-off tube.

- loosen the mounting strap restraining screw and strap (10), (9) Fig. 2.2, to allow placing the bottle in the mounting cradle (11)

- install the bottle in the cradle with the reducing valve and pressure gage above the bottle, (5), (6) Fig. 2.2, and tighten the strap restraining screws (10)

- connect the output of the pressure reducer (8), Fig. 2.3, to the maser hydrogen supply system via the coupling, (12) Fig. 2.3. The pressure reducer output fitting, (15) Fig. 2.3, should be held immobile with a wrench while the coupling (12) is being turned (either tightened or loosened). First examine the tubing end and ferrules of the coupling (12) to be sure that they are clean and undamaged. Then insert the tubing with its ferrules into the fitting body (15) and tighten (12) to a hand-tight condition. Second, with a wrench tighten the coupling nut (12), while at the same time retaining (15) immobile as mentioned above, until a sharp rise in torgue is felt, then simply snug. This takes about 1/4 turn.

- open the hydrogen bottle shut-off valve slowly about 1/4 turn, (2) Fig. 2.2, counter clockwise direction. The bottle pressure gage should read between 20 and 200 atmospheres (6), Fig. 2.2. Pressure reading on the reducer output should be 0, (7) Fig. 2.2 if valve (8) is closed (counter clockwise rotation).

- before admitting hydrogen to the maser system via the pressure regulator valve (8), Fig. 2.2 have ready the pinch-off tool

- open the pressure regulator valve (8) by turning clockwise about 1/4 turn. An output pressure of 1 atmosphere will be shown on the pressure gage (7), Fig. 2.2.

- allow hydrogen to purge the maser supply tube via the open pinch-off tube (14), Fig. 2.3 for about 1 minute.

I M P O R T A N T

> Failure to purge the maser supply system which has been opened to air will result in improper operation and possible damage of the palladium valve.

- pinch-off the tube (14) near its open end by applying a steady pressure to the pinch-off tool until the copper tube separates. Cover the exposed edge with epoxy or other means to protect the edge.

- turn the hydrogen bottle shut-off valve (2), Fig. 2.2, to the full open position (full counter clockwise rotation). Assure that maser hydrogen system pressure, (7) Fig. 2.2, is between 1 and 2 atmospheres and adjust (8) as necessary.

-2. <u>Leak test</u>

The hydrogen system is tested for leaks by two methods:

a) a leak detector liquid applied to the couplings and joints

b) observing the hydrogen system pressure change. This test is made after maser is operating.

Proceed as follows :

a) use a leak detector liquid such as "air-tec" manufactured by AMERICAN GAS AND CHEMICAL, INC. 511E. 72nd Str. New York, 10021.

With a syringe or eye-dropper apply a drop of liquid on each joint in the system, Fig. 2.2 and 2.3, including the joints on the bottle-to-valve tube. Presence of any growing bubbles in the joints indicates a leak and should be corrected by tightening the joint, or in some cases replacing the washer or ferrules in the joint. (See the maintenance manual for complete replacement instructions).

b) refer to § 3.11.3 and set the dissociator pressure to about 0.2 Torr. Close hydrogen bottle shut-off valve (2), Fig. 2.2. Observe pressure reading on hydrogen bottle pressure gauge (6), Fig. 2.2. The pressure will diminish about 10 atmospheres per week for normal hydrogen consumption. If it is significantly greater than this, consult the maintenance and repair manual.

When tests are completed, open the bottle shut-off valve (2).

-3. <u>Hydrogen bottle removal</u>

The hydrogen bottle will normally be removed for :

1) Shipping the maser
(according to the transport regulations)

2) Removal of the bottle is essentially the reverse of installation. Detail of manipulations are contained in § 2.4.1 above

To remove the bottle, these steps are carried out :

1) Turn-off palladium valve in maser hydrogen system

2) Close pressure reducer by turning the pressure reducer valve counter-clockwise

3) Close hydrogen bottle shut-off
(clockwise rotation)

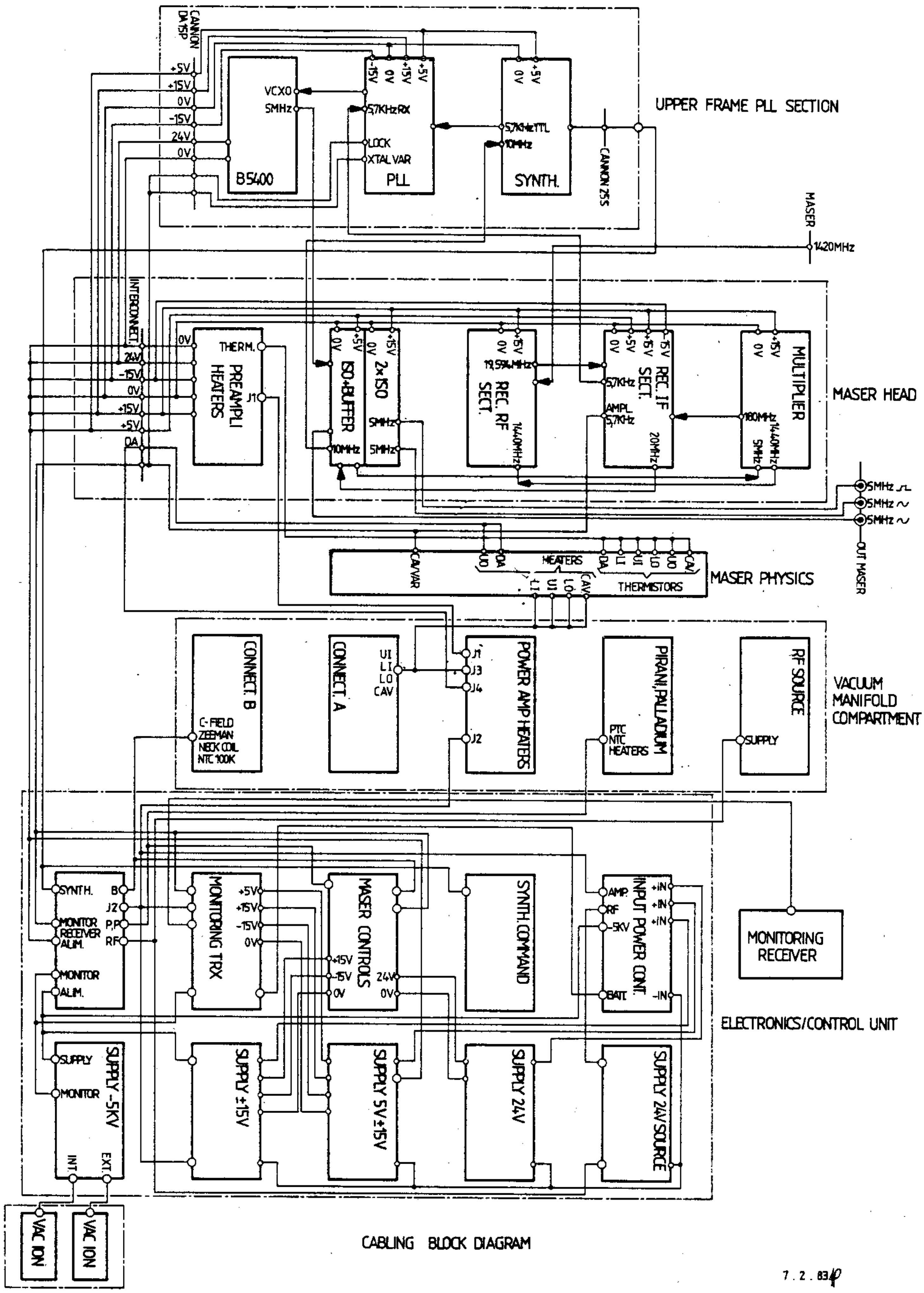
4) Disconnect maser hydrogen system from the pressure reducer via coupling nut

5) Loosen retaining strap screws

6) Remove bottle

8. DRAWINGS

8.1 INDEX OF DRAWINGS



CABLING BLOCK DIAGRAM

7.2.83

Groupe	Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
POWERAMP J2	1	2	Connecteur "D" Cannon		DA 15P	KONTAKT SYSTEME
	2	2	Capot plastic		DA 512 -1	" "
	3	2	Paquet de vis		D 530 18-V	" "
	4	1	Câble bl. 16 x 0,25 qm		526920 / Long. 112 cm	AUMANN
	5					
MONITOR VAC ION	6	1	Connecteur "D" Cannon		DE 9S	KONTAKT SYSTEME
	7	1	Capot plastic		DE 51218-1	" "
	8	1	Paquet de vis		D 530 18-V	" "
	9	1	Câble bl. 8 x 0,14 qm		52 59 20 / Long. 62 cm	AUMANN
	10					
ALIM VAC ION Réf.	11	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
	12	1	Capot plastic		DE 512 18-1	" "
	13	1	Paquet de vis		D 530 18-V	" "
	14	1	Câble bl. 5 x 0,40 qm		/ Long. 62 cm	
	15					
	16	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
	17	1	Capot plastic		DE 512 18-1	" "
	18	1	Paquet de vis		D 530 18-V	" "
	19	1	Câble bl. 5 x 0,40 qm		/ Long. 150 cm	
	20					
PIRANI, PALLADIUM	21	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
	22	1	Capot plastic		DE 512 18-1	" "
	23	1	Paquet de vis		D 530 18-V	" "
	24	1	Câble bl. 8 x 0,40 qm		/ Long. 130 cm	
	25					
MONITOR RECEIVER	26	1	Connecteur "D" Cannon		DE 9S	KONTAKT SYSTEME
	27	1	Capot plastic		DE 512 18-1	" "
	28	1	Paquet de vis		D 530 18-V	" "
	29	1	Câble bl. 8 x 0,14 qm		52 59 20 / Long. 220 cm	AUMANN
	30					
	31	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
	32	1	Capot plastic		DE 512 18-1	" "
	33	1	Paquet de vis		D 530 18-V	" "
	34	1	Câble bl. 8 x 0,40 qm		/ Long. 220 cm	
	35					
B	36	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
	37	1	Capot plastic		DE 512 18-1	" "
	38	1	Paquet de vis		D 530 18-V	" "
	39	1	Câble bl. 8 x 0,40 qm		/ Long. 120 cm	
	40					
	41					
	42					
	43					
	44					

Modifications

liste de pièces

CABLAGE DU MASER

Ecrit : 7.1.83 P

Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL

DEPARTEMENT TECHNIQUE

.40.02.

Réf.	Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
SYNTH.	46	1	Connecteur "D" Cannon		DB 25S	KONTAKT SYSTEME
SYNTH.	47	1	" " "		DB 25P	" "
SYNTH.	48	2	Capot plastic		DB 51212-1	" "
SYNTH.	49	2	Paquet de vis		D 53018-V	" "
SYNTH.	50	1	Câble bl. 27x0,14 qm		52 6060 / Long. 250cm	AUMANN
	51					
PLL	52	1	Connecteur "D" Cannon		DA 15S	KONTAKT SYSTEME
PLL	53	1	Capot plastic 90°			" "
PLL	54	1	Paquet de vis		D 53018-V	" "
PLL	55	1	Câble bl. 8x0,40 qm		/ Long. 73cm	
	56					
J1 [POWER AMP]	57	1	Connecteur "D" Cannon		DE 9P	KONTAKT SYSTEME
J1 [POWER AMP]	58	1	Capot plastic		DE 51218-1	" "
J1 [POWER AMP]	59	1	Paquet de vis		D 53018-V	" "
J1 [POWER AMP]	60	1	Câble bl. 8x0,14 qm		525920 / Long. 210cm	AUMANN
	61					
J3 [POWER AMP]	62	1	Connecteur "D" Cannon		DE 9S	KONTAKT SYSTEME
J3 [POWER AMP]	63	1	Capot plastic		DE 51218-1	" "
J3 [POWER AMP]	64	1	Paquet de vis		D 53018-V	" "
J3 [POWER AMP]	65	1	Câble bl. 8x0,40 qm		/ Long. 50cm	
	66					
J4 [POWER AMP]	67	1	Connecteur "D" Cannon		DE 9S	KONTAKT SYSTEME
J4 [POWER AMP]	68	1	Capot plastic		DE 51218-1	" "
J4 [POWER AMP]	69	1	Paquet de vis		D 53018-V	" "
J4 [POWER AMP]	70	1	Câble bl. 5x0,40 qm		/ Long. 210 cm	

Modifications

liste de pièces

CABLAGE DU MASER

Ecrit : 7.1.83

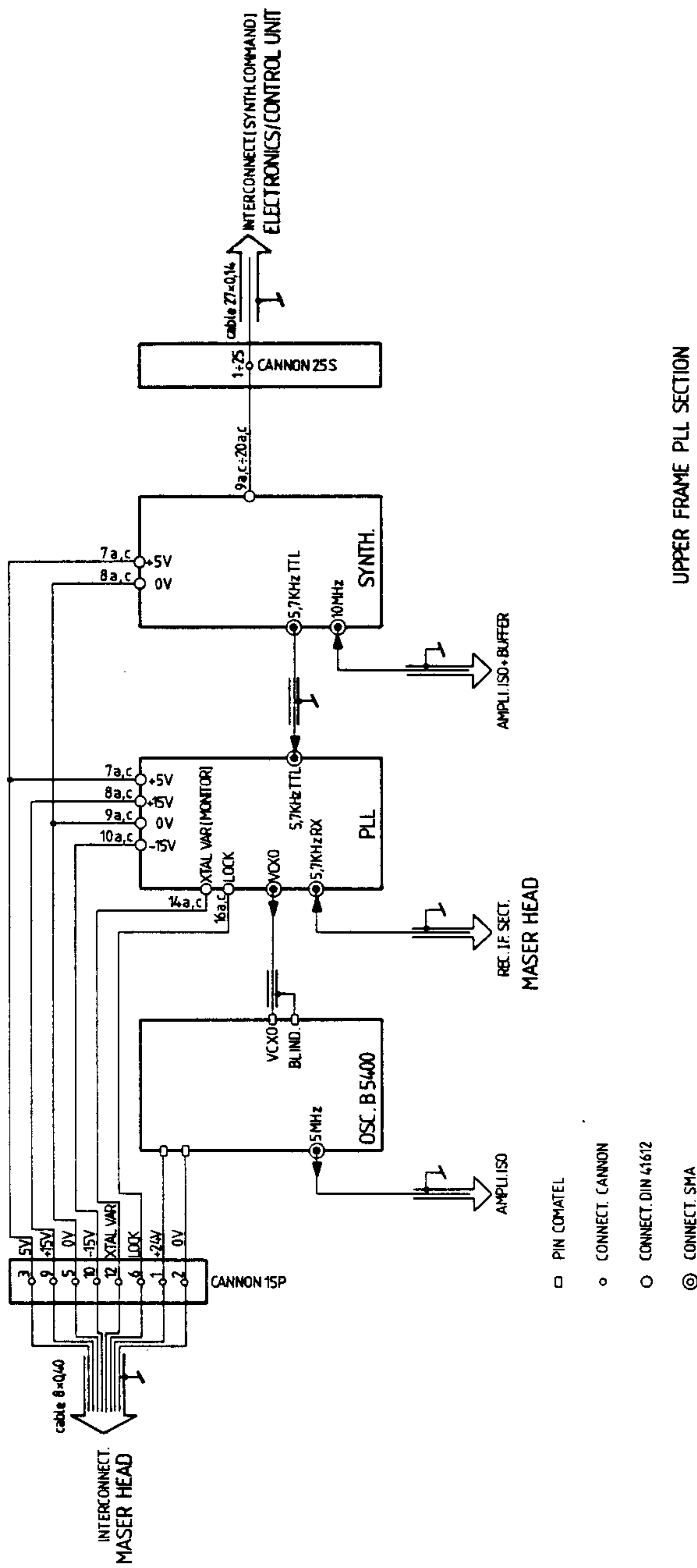
Contrôlé

Original du

Remplace le No

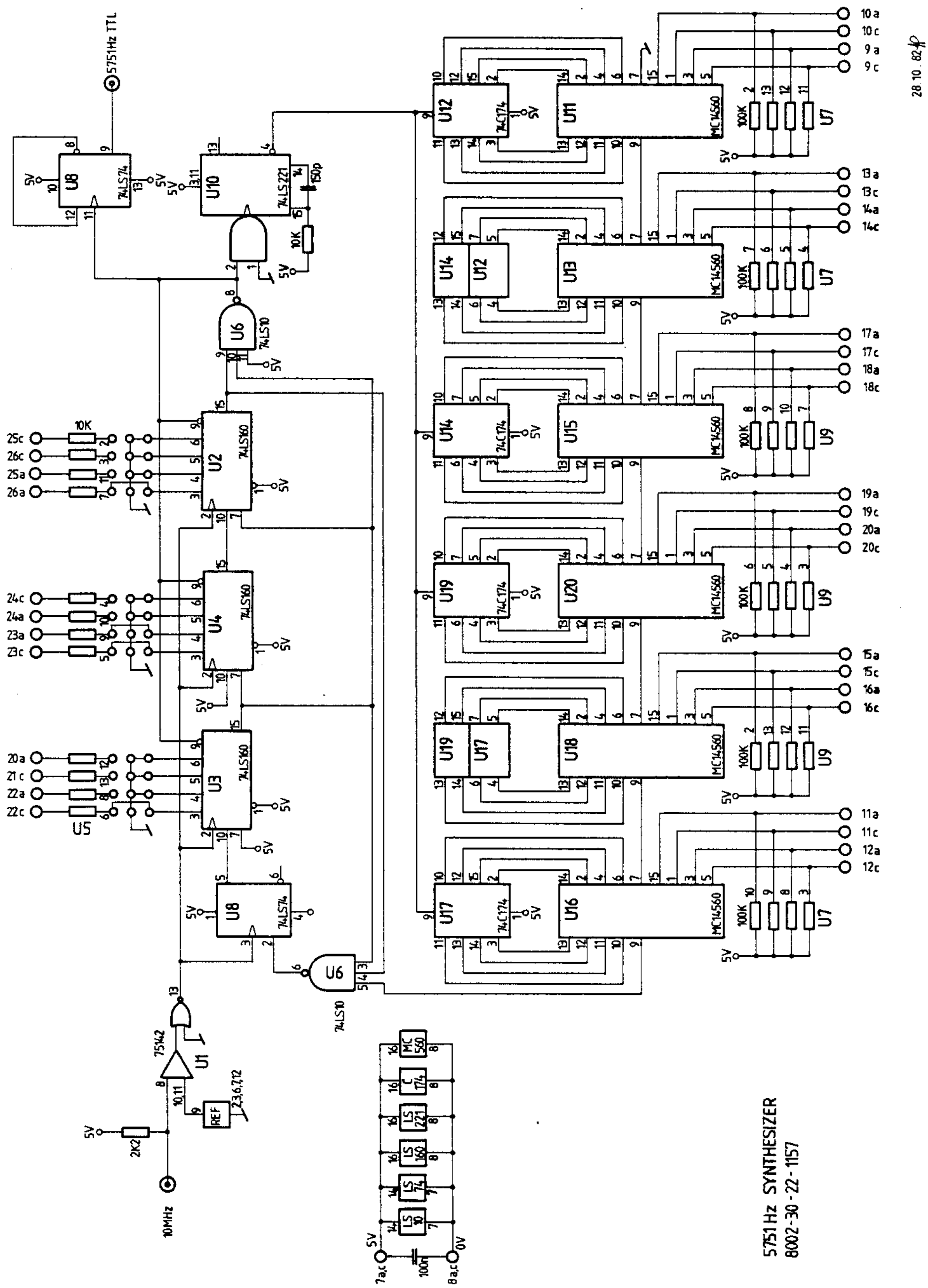
EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

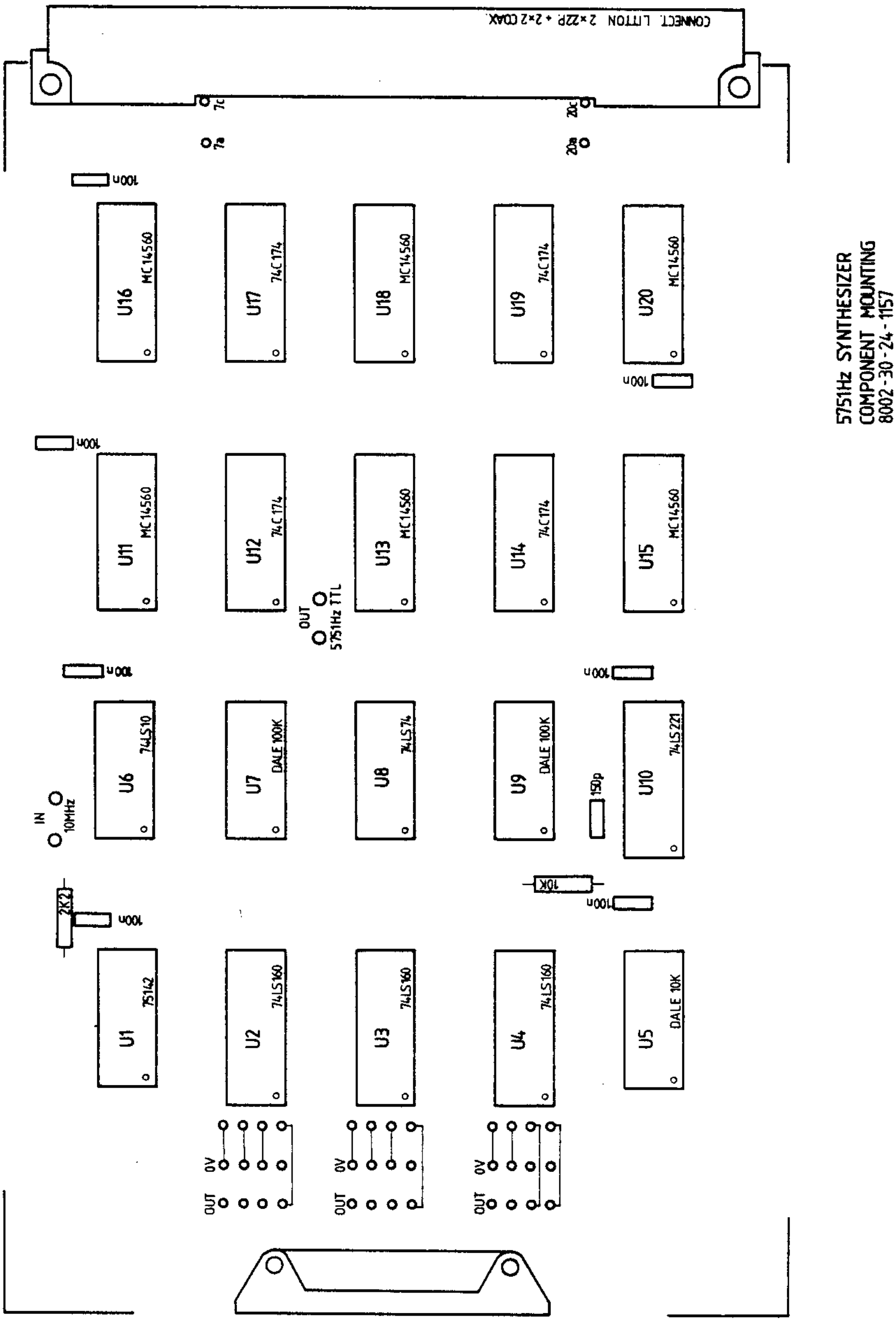
.40.02.



UPPER FRAME PLL SECTION
CABLAGE

2.2.83


5751 Hz SYNTHESIZER
8002-30-22-1157
28.10.82
5751Hz TTL
10MHz


CONNECT. LITTON 2×22P + 2×2 COAX.
5751Hz SYNTHESIZER
COMPONENT MOUNTING
8002-30-24-1157
28.10.82
U16 MC14560
U17 74C174
U18 MC14560
U19 74C174
U20 MC14560
U11 MC14560
U12 74C174
U13 MC14560
U14 74C174
U15 MC14560
OUT 5751Hz TTL
U6 74LS10
U7 DALE 100K
U8 74LS74
U9 DALE 100K
U10 74LS221
IN 10MHz
150p
10K
2K2
U1 75142
U2 74LS160
U3 74LS160
U4 74LS160
U5 DALE 10K
100n
0V
OUT
7c
7a
20c
20a

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1157	PRINTELEC
2	1	Triple nand 3-input		SN74LS10N	FABRIMEX
3	1	Flip-Flop D		DM74LS74N	"
4	3	Synchronus 4-bit counters		SN74LS160N	"
5	1	Dual monostable		SN74LS221N	"
6	1	Counter/Latch/Decoder/Driver		SN75142N	"
7	4	Hex D flip-flop		MM74C174BCN	FENNER
8	6	BCD ADDER		MC14560BCP	MOTOROLA
9	1	Résistance MDP 1401 Dale		31287/10K	ESD/ITT
10	2	" " " "		31293/100K	" "
11	6	Socle 14 pattes		ICT-143-ST	MEGEX
12	14	" 16 "		ICT-163-ST	"
13	1	Résistance 2K2		MR25/2322 151 52202	PHILIPS
14	1	" 10K		" " " 51003	"
15	1	Cond. céramique 150pF		2222 650 70151	"
16	7	Cond. " 100nF			ASU COMPONENT
17	1	Connecteur			LITTON
18	1				

Réf.

Modifications	liste de pièces SYNTHESE	Ecrit :
		Contrôlé
		Original du
		Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1157

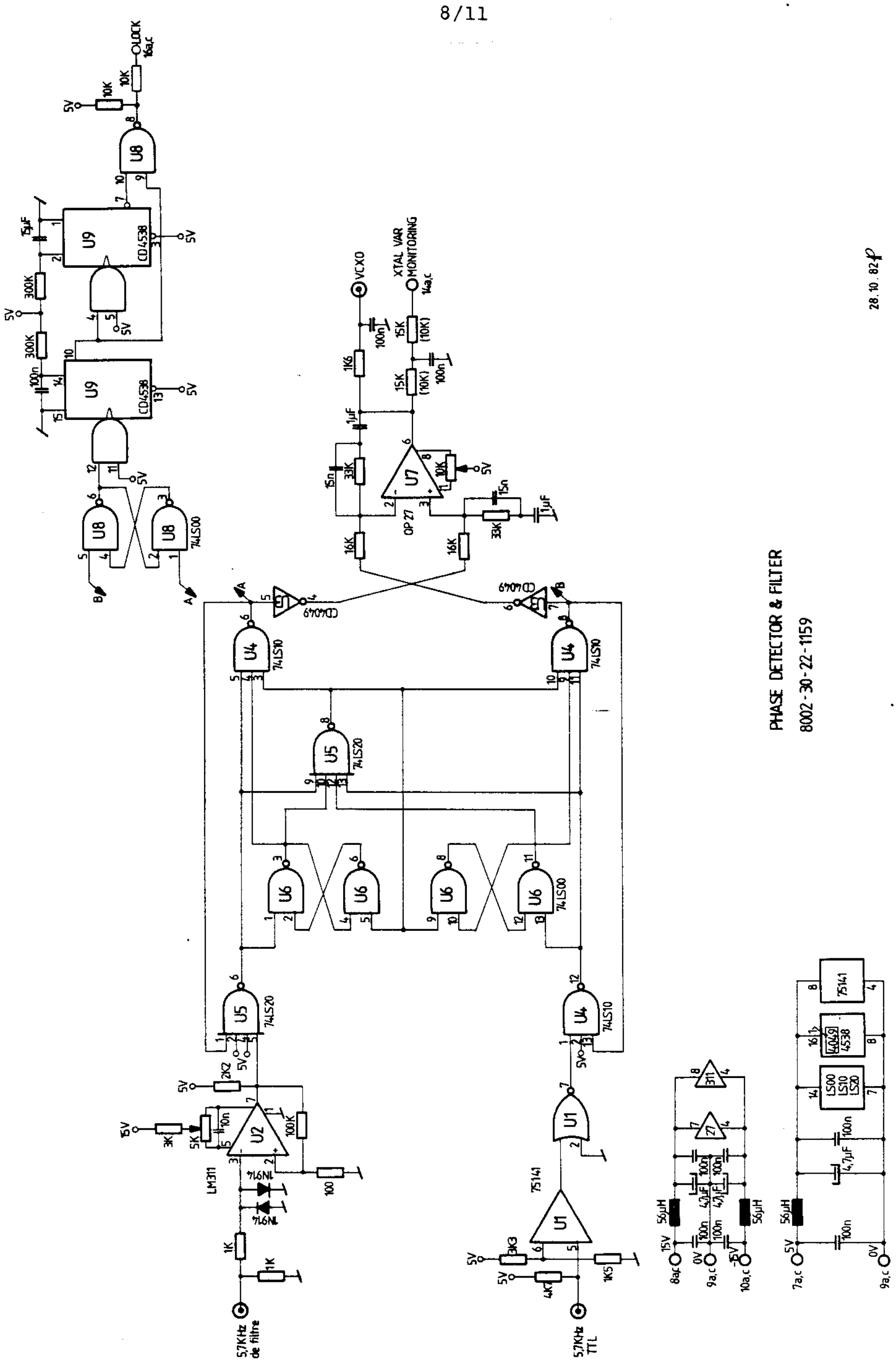
C A B L I N G   D E T A I L

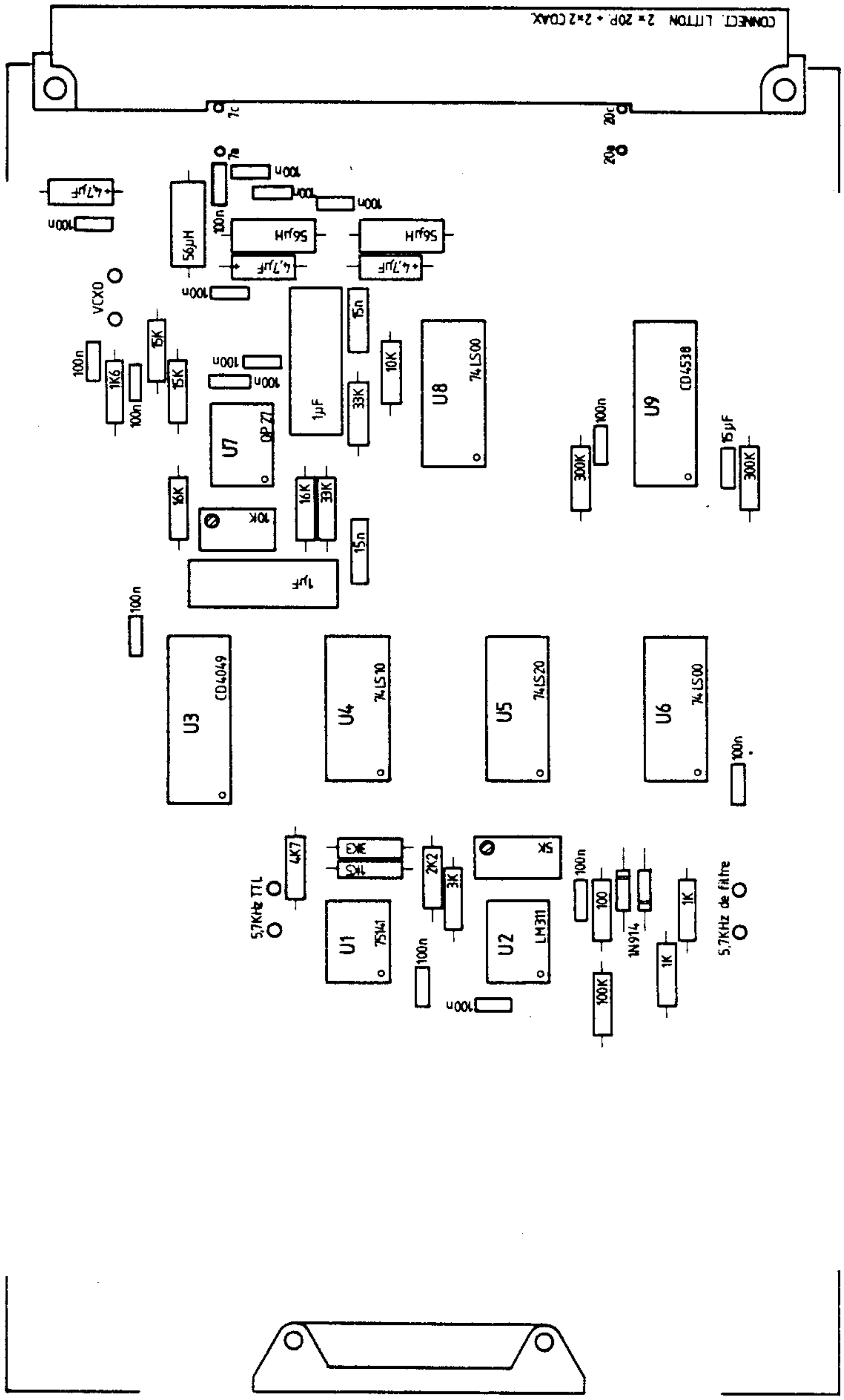
C O N N E C T I O N   O F   S Y N T H E S I Z E R

****

			UPPER FRAME PLL SECTION PRINTED CIRCUIT SYNTH.	ELECTRONICS/CONTROL UNIT PRINTED CIRCUIT SYNTH.COMMAND
CANNON DB 25S	FIL COLOR	ASSIGNATION	CONNECT. DIN 41612	CONNECT. DIN 41612
PIN No 1	YELLOW	COMMON	PIN No 8a	PIN No 2a, c
14	RED	8 LSD [U11]	9c	5c
2	BROWN	4 LSD [U11]	9a	5a
15	GREEN	2 LSD [U11]	10c	6c
3	ROSE	1 LSD [U11]	10a	6a
16	PURPLE	8 [U13]	14c	7c
4	BLUE	4 [U13]	14a	7a
17	WHITE	2 [U13]	13c	8c
5	GREY	1 [U13]	13a	8a
18	WHITE/RED	8 [U15]	18c	9c
6	BLACK	4 [U15]	18a	9a
19	WHITE/ROSE	2 [U15]	17c	10c
7	WHITE/YELLOW	1 [U15]	17a	10a
20	WHITE/BLUE	8 [U20]	20c	11c
8	WHITE/GREEN	4 [U20]	20a	11a
21	WHITE/BLACK	2 [U20]	19c	12c
9	WHITE/GREY	1 [U20]	19a	12a
22	BROWN/GREEN	8 [U18]	16c	13c
10	BROWN/RED	4 [U18]	16a	13a
23	BROWN/BLACK	2 [U18]	15c	14c
11	BROWN/BLUE	1 [U18]	15a	14a
24	GREY/ROSE	8 MSD [U16]	12c	15c
12	GREY/BROWN	4 MSD [U16]	12a	15a
25	BLUE/RED	2 MSD [U16]	11c	16c
13	GREY/GREEN	1 MSD [U16]	11a	16a

CABLE 27 x 0.14 / No 521060 DISTRELEC


PHASE DETECTOR & FILTER
8002-30-22-1159
28.10.82
LOCK 16a,c
VCXO
XTAL VAR MONITORING 14a,c
U1
U2
U4
U5
U6
U7
U8
U9
CD4538
74LS00
74LS10
74LS20
CD4049
OP 27
LM311
75141
1N914
5,7KHz de filtre
5,7KHz TTL
15V
5V
0V
-15V
8a,c
9a,c
10a,c
7a,c
56µH
4,7µF
100n
15µF
1µF
15n
10n
300K
100K
33K
16K
15K
(10K)
10K
5K
3K3
3K
2K2
1K6
1K5
1K
4K7
100
311
27
LS00
LS10
LS20
4049
4538



29.10.82

PHASE DETECTOR & FILTER
COMPONENT MOUNTING
8002-30-24-1159

Pos.	Nb	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1159	PRINTELEC
2	2	Nand 2-input		SN 74LS00N	FABRIMEX
3	1	" 3-input		SN 74LS10N	"
4	1	" 4-input		SN 74LS20N	"
5	1	Hex inverter		CD 4049CN	FENNER
6	1	Dual monostable		CD 4538	"
7	1	Dual line receiver		SN 75141	
8	1	Comparator		LM 311N	FENNER
9	1	Op amp.		OP 27 GZ	
10	3	Socle 8 pattes		ICT-083-ST	MEGEX
11	4	" 14 "		ICT-143-ST	"
12	2	" 16 "		ICT-163-ST	"
13	1	Résistance 100		MR25/2322-151-51001	PHILIPS
14	2	" 1K		" " " 51002	"
15	1	" 1K5		" " " 51502	"
16	1	" 1K6		" " " 51602	"
17	1	" 2K2		" " " 52202	"
18	1	" 3K		" " " 53002	"
19	1	" 3K3		" " " 53302	"
20	1	" 4K7		" " " 54702	"
21	1	" 10K		" " " 51003	"
22	2	" 15K		" " " 51503	"
23	2	" 16K		" " " 51603	"
24	2	" 33K		" " " 53303	"
25	1	" 100K		" " " 51004	"
26	2	" 300K		" " " 53004	"
27	1	Cond. céramique 15pF		2222 650 10159	PHILIPS
28	2	" " 15nF		MKS	KURT HIRT
29	16	" " 100nF			ASU COMPONENT
30	2	" " 1µF			KURT HIRT
31	1	Cond. tantale 4,7µF/10V			SPRAGUE/
32	2	" " " /35V			"
33	3	Self Delavan 56µH			STOLZ
34	6	Plot à fourche		537.24	JAEGER
35	1	Connecteur Litton			EGLI FISCHER
36	3	Contact			
37	1	Poignée			ELMA
38	1	Potentiomètre 5K			CONTELEC
39	1	" 10K			"
40	2	Vis tête cylind. fendue		M2,5x10mm/nickelée	BOSSARD
41	2	Ecrou		M2,5mm	"
42		Câble 1cond. blindé		/25cm	

Réf.

Modifications

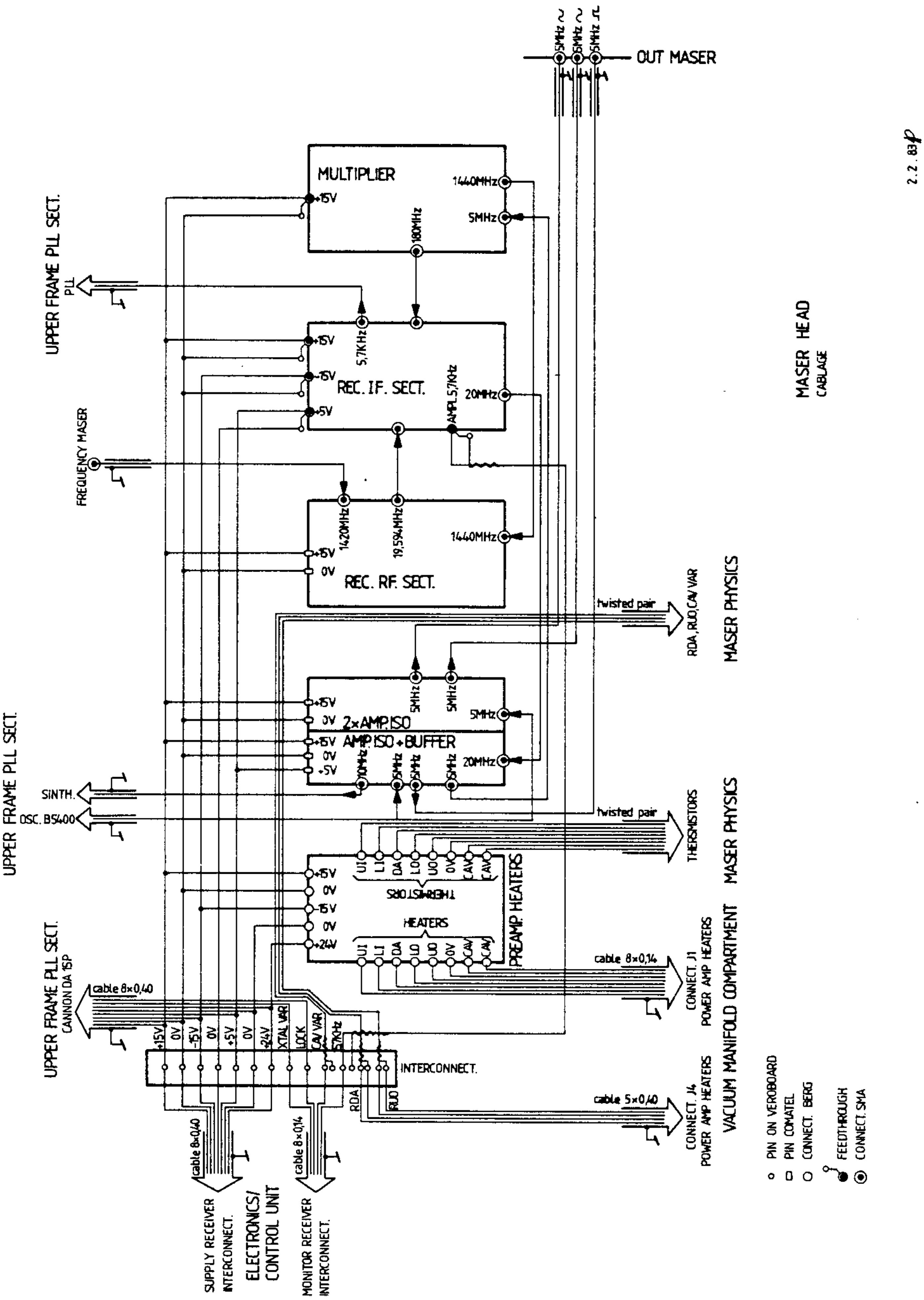
liste de pièces

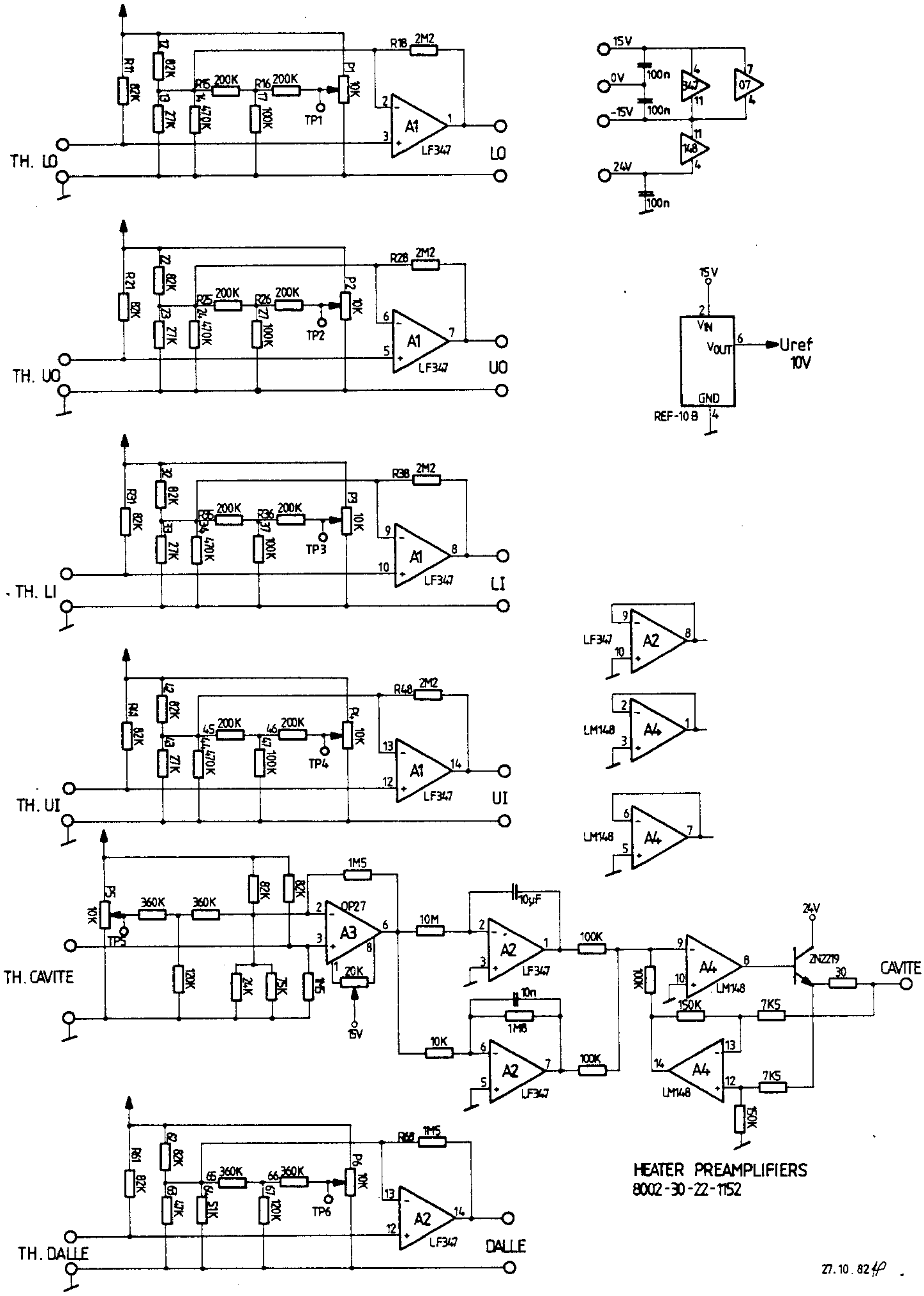
DECTECTEUR φ-F + FILTRE P-I

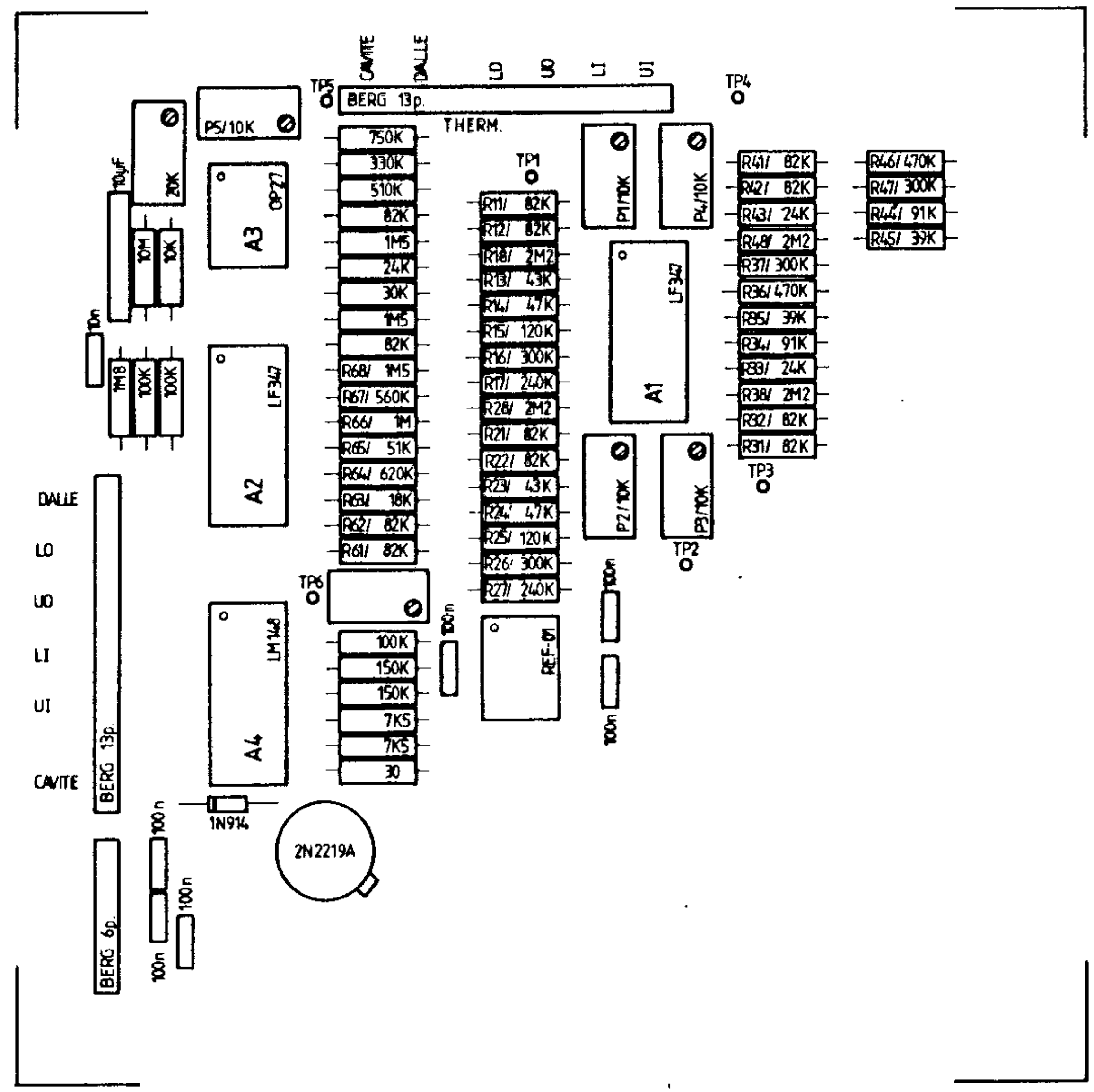
Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02.1159


OUT MASER
5MHz
5MHz
5MHz
MULTIPLIER
+15V
1440MHz
5MHz
180MHz
UPPER FRAME PLL SECT.
PLL
5,7KHz
+15V
-15V
REC. I.F. SECT.
+5V
AMPL.5,7KHz
20MHz
FREQUENCY MASER
1420MHz
19,594MHz
1440MHz
+15V
0V
REC. RF. SECT.
twisted pair
RDA, RUO, CAV VAR
MASER PHYSICS
5MHz
5MHz
+15V
0V
2×AMP.ISO
5MHz
AMP.ISO+BUFFER
+15V
0V
+5V
10MHz
5MHz
5MHz
5MHz
20MHz
UPPER FRAME PLL SECT.
SINTH.
OSC. B5400
twisted pair
THERMISTORS
MASER PHYSICS
+15V
0V
-15V
0V
+24V
U1
L1
DA
LO
UO
0V
CAV
CAV
THERMISTORS
HEATERS
PREAMP. HEATERS
cable 8×0,14
CONNECT. J1
POWER AMP HEATERS
VACUUM MANIFOLD COMPARTMENT
UPPER FRAME PLL SECT.
CANNON DA 15P
cable 8×0,40
+15V
0V
-15V
0V
+5V
0V
+24V
XTAL VAR
LOCK
CAV VAR
5,7KHz
INTERCONNECT.
RDA
RUO
cable 5×0,40
CONNECT. J4
POWER AMP HEATERS
cable 8×0,40
SUPPLY RECEIVER
INTERCONNECT.
ELECTRONICS/
CONTROL UNIT
cable 8×0,14
MONITOR RECEIVER
INTERCONNECT.
MASER HEAD
CABLAGE
2.2.83
PIN ON VEROBOARD
PIN COMATEL
CONNECT. BERG
FEEDTHROUGH
CONNECT. SMA


TH. LO
LO
TH. UO
UO
TH. LI
LI
TH. UI
UI
TH. CAVITE
CAVITE
TH. DALLE
DALLE
Uref
10V
REF-10 B
HEATER PREAMPLIFIERS
8002-30-22-1152
27.10.82



HEATER PREAMPLIFIERS
COMPONENT MOUNTING

8002-30-24-1152

27.10.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1152	PRINTELEC
2	6	Plot test		537.16	JAEGER
3	1	Broche droite 1x36		75160-105/06012 12[illegible]	BERG/LEITGEB
4	1	Boîtier à ver. 1x36		65039-001/06012 210	" "
5	29	Mini PV		47712/06012 250	" "
6	3	Broche de codage		65307-001/06012 220	" "
7					
8	2	Socle 8 pins		ICT-083-ST	MEGEX
9	3	" 14 "		ICT-143-ST	"
10	1	VOLTAGE REF		REF-01 HP	PMI/BOURNS
11	1	SINGLE OPAMP		OP-27 FZ	"
12	1	QUAD " "		LM 148 J	NS/FENNER
13	2	" " "		LF 347B	"
14	1	BJT NPN		2N 2219 A	MOT/OMNI RAY
15	1	Diode		1N 4148	FAIRCHILD/MOOR
16					
17	1	Résistance 30		MR25/ 2322 151 53009	PHILIPS
18	2	" 7K5		" " " 57502	"
19	1	" 18K		" " " 51803	"
20	3	" 24K		" " " 52403	"
21	1	" 30K		" " " 53003	"
22	2	" 39K		" " " 53903	"
23	2	" 43K		" " " 54303	"
24	2	" 47K		" " " 54703	"
25	1	" 51K		" " " 55103	"
26	11	" 82K		" " " 58203	"
27	2	" 91K		" " " 59103	"
28	1	" 100K		" " " 51004	"
29	2	" 120K		" " " 51204	"
30	2	" 150K		" " " 51504	"
31	2	" 240K		" " " 52404	"
32	4	" 300K		" " " 53004	"
33	1	" 330K		" " " 53304	"
34	2	" 470K		" " " 54704	"
35	1	" 510K		" " " 55104	"
36	1	" 560K		" " " 56004	"
37	1	" 620K		" " " 56204	"
38	1	" 750K		" " " 57504	"
39	1	" 1M		" " " 51005	"
40	3	" 1M5		VR25/	"
41	4	" 2M2		"	"

Réf.

Modifications

liste de pièces

PREAMPLI THERMOSTATS

Ecrit :

Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .**40.02.** 1152/1

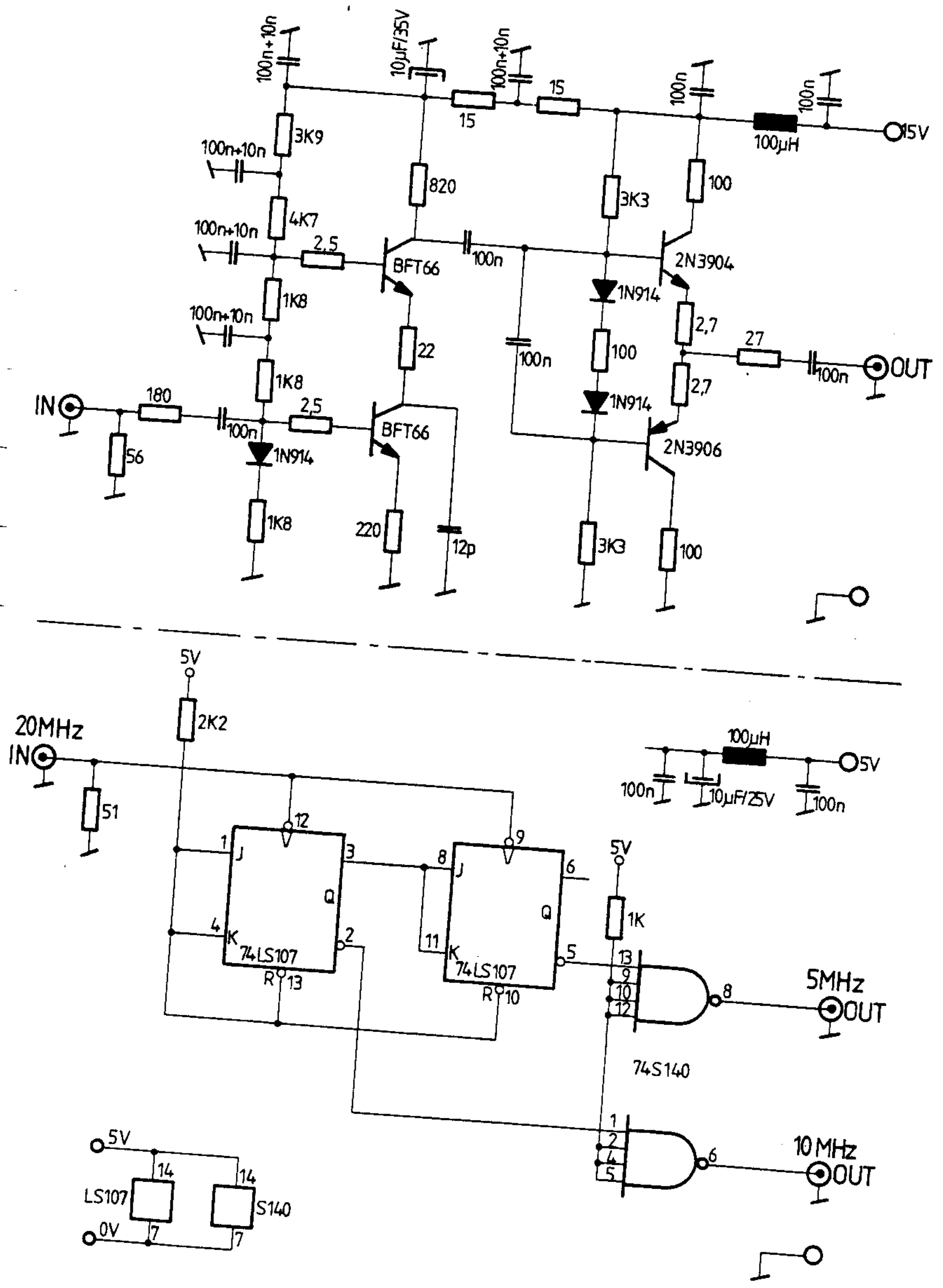
Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
45	1	Cond. céramique 10nF			ASU COMPONENT
46	6	" " 100nF			" "
47	1	" polycarbonate 10µF			ADVALM/ROTIMA
48					
49	6	Potentiomètre 10K		183W	CONTELEC
50	1	" 20K		183W	"

Réf.

Modifications	liste de pièces	Ecrit :
	PREAMPLI THERMOSTATS	Contrôlé
		Original du
		Remplace le No

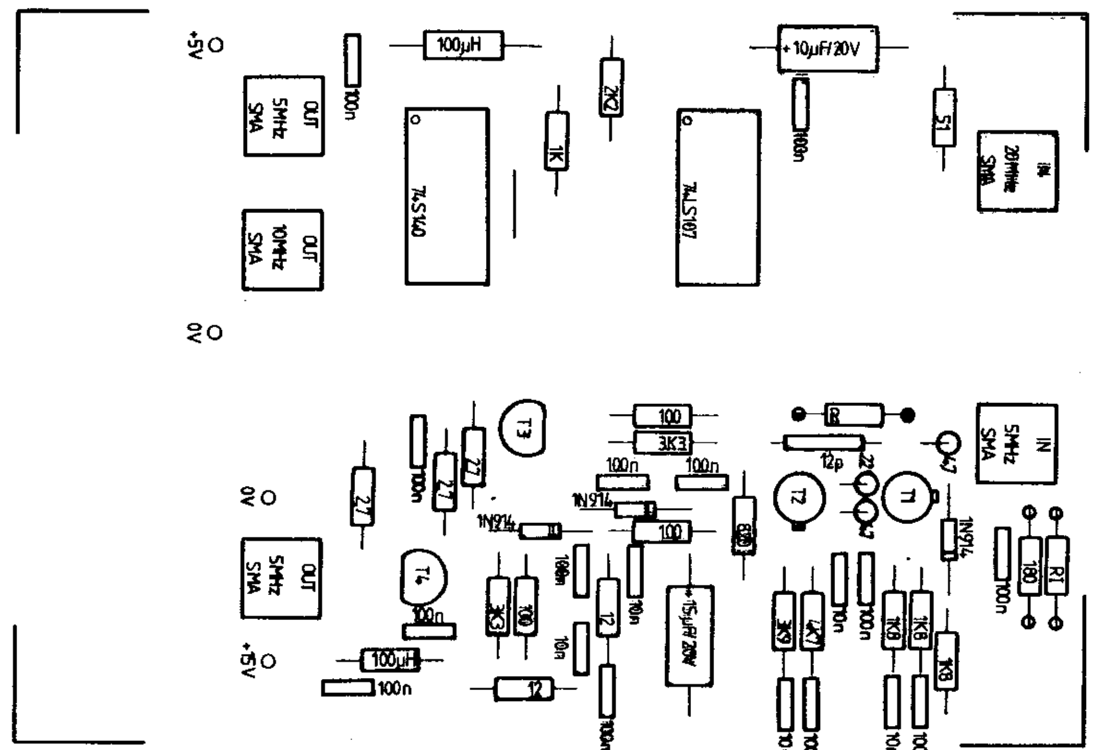
EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1152/2



ISO AMPLIFIER & BUFFER
8002 - 40 - 22 - 1166

18. 11. 82



T1,T2 = BFT66 "TRIE"
T3 = 2N3906 "TRIE"
T4 = 2N3904 "TRIE"

ISOLATION AMPLIFIER & BUFFER
COMPONENT MOUNTING
8002-30-24-1166

10.2.83

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-40-25-1166	PRINTELEC
2					
3	1			74LS 107	TEXAS/FABRIMEX
4	1			74S 140	" "
5	2	Socle 14 pins		ICT-143-ST	MEGEX
6	1	Résistance 22		MR25/2322 151 52509	PHILIPS
7	2	Résistance 2,7Ω		MR25/2322 151 52709	PHILIPS
8	2	" 15		" " " 51509	"
9	1	" 51		" " " 55109	"
10	1	" 27		" " " 52709	"
11	3	" 100		" " " 51001	"
12	1	" 180		" " " 51801	"
13	1	" 390		" " " 53901	"
14	1	" 820		" " " 58201	"
15	1	" 1K		" " " 51002	"
16	3	" 1K8		" " " 51802	"
17	1	" 2K2		" " " 52202	"
18	2	" 3K3		" " " 53302	"
19	1	" 3K9		" " " 53902	"
20	1	" 4K7		" " " 54702	"
21	1	" 22Ω		" " " 52209	"
22	3	Diode		1N4148	FAIRCHILD/MOOR
23	1	Cond. verre 12p		CY10C 120K CGW	CORNING GLASS
24	5	Cond. céramique 10nF			ASU COMPONENT
25	13	" " 100nF			" "
26	1	" tantale 10µF/20V		150D 106X0020B2	SPRAGUE
27	1	" tantale 15µF/20V		150D 156X0020B2	SPRAGUE
28					
29	1	Self Delevan 100µH		1537-76	STOLZ
30	1	" " "		1025	"
31	2	Transistor [trié au bruit]		BFT 66	SIEMENS
32	1	" "		2N3904	FABRIMEX
33	1	" "		2N3906	"
34					
35	5	Connecteur		82 SMA-50-0-1	SUHNER
36	4	Plot à fourche		537.24	JAEGER
37	4	Cosse à souder		1001 DO	VOGT

Réf.

Modifications	liste de pièces	Ecrit :
	AMPLI D'ISO + BUFFER	Contrôlé
		Original du
		Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1166

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		Ampli d'iso	PRINTELEC
2					
3	4	Résistance 27		MR25/2322 1515 2708	PHILIPS
4	4	" 15		" " " 1509	"
5	2	" 22		" " " 2209	"
6	2	" 27		" " " 2709	"
7	4	" 47		" " " 4709	"
8	7	" 100		" " " 1001	"
9	2	" 180		" " " 1801	"
10	2	" 240		" " " 2401	"
11	2	" 820		" " " 8201	"
12	6	" 1K8		" " " 1802	"
13	4	" 3K3		" " " 3302	"
14	2	" 3K9		" " " 3902	"
15	2	" 4K7		" " " 4702	"
16					
17	6	Diode		1N4148	FAIRCHILD / MOOR
18	2	Cond. verre 12p		CY10C 120K CGW	CORNING GLASS
19	10	" céramique 10nF			
20	22	" " 100nF			
21	2	" tantale 15µF/20V		150D 156X0020 B2	SPRAGUE
22					
23	2	Self Delevan 100µH		1025	STOLZ
24					
25	4	Transistor "trié I/F"		BFT 66	SIEMENS
26	2	"		2N3904	FABRIMEX
27	2	"		2N3906	"
28					
29	3	Connecteur		82 SMA-50-0-1	SUHNER
30					
31	6	Plot à fourche		537.24	JAEGER

Réf.

Modifications

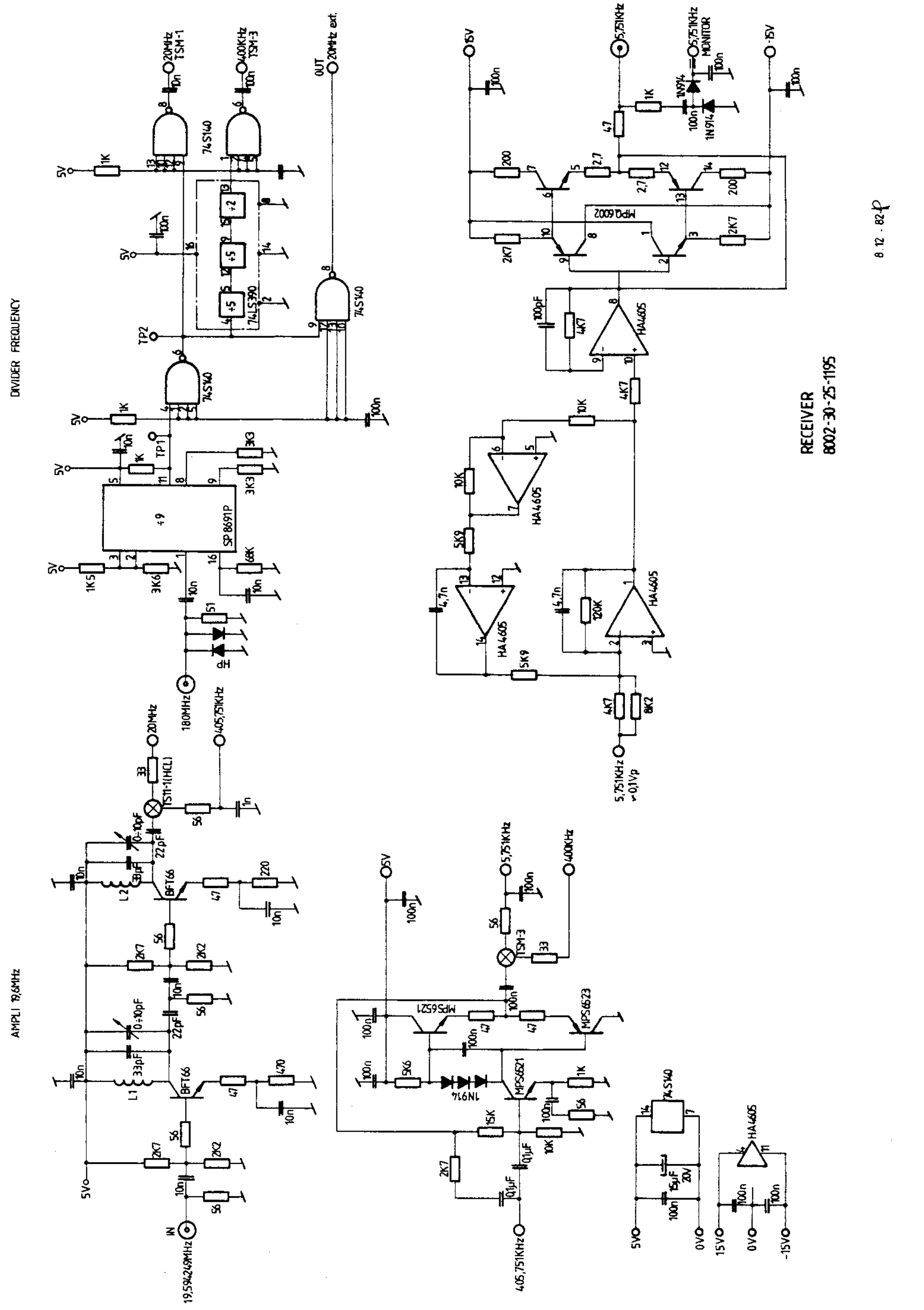
liste de pièces

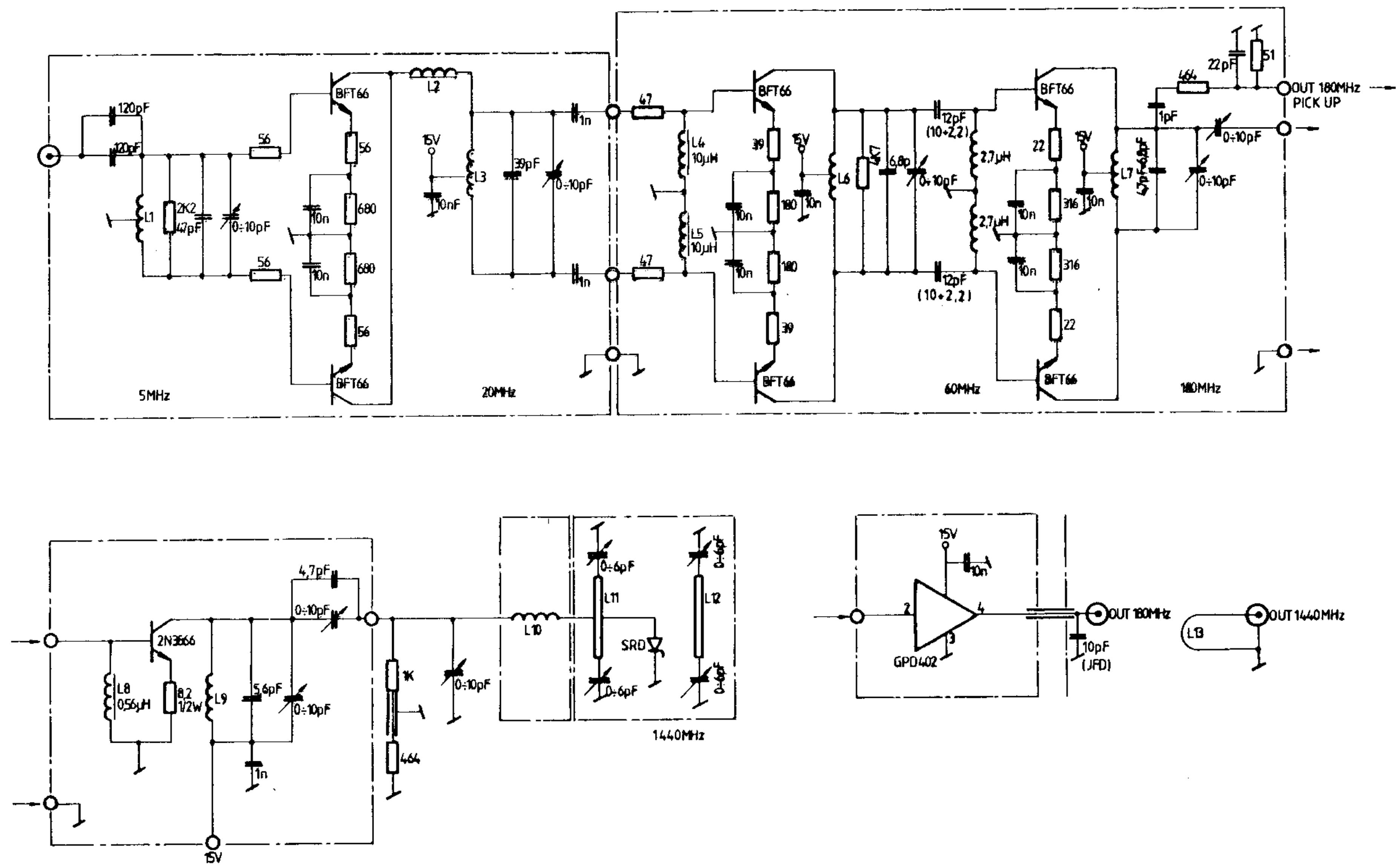
DOUBLE AMPLI D'ISO

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

.40.02.


DIVIDER FREQUENCY
AMPLI 19,6MHz
RECEIVER
8002-30-25-1195
8.12.82
IN
19,59424MHz
5V
L1
L2
BFT66
33pF
22pF
0÷10pF
2K7
2K2
56
47
470
220
10n
TSM-1(HCL)
33
20MHz
405,751KHz
1n
180MHz
51
SP8691P
÷9
1K5
3K6
68K
3K3
1K
TP1
TP2
74S140
74LS390
÷5
÷2
100n
20MHz TSM-1
400KHz TSM-3
OUT 20MHz ext.
5,751KHz ≈0,1Vp
4K7
8K2
5K9
4,7n
120K
HA4605
10K
100pF
MPQ6002
200
2,7
15V
-15V
5,751KHz
1N914
5,751KHz MONITOR
MPS6521
MPS6523
5K6
15K
0,1µF
405,751KHz
400KHz
TSM-3
15µF 20V
5V
0V
15V
-15V



FREQUENCY MULTIPLIER 5MHz ÷ 1440MHz
8002-30-22-1196

4.12.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		5 ÷ 20 MHz	
2					
3	4	Résistance 56,2		NK3	CORNING
4	2	" 681		"	"
5	1	" 2K2		MR25/2322 151 52202	PHILIPS
6					
7	1	Cond. 39pF		CY 10C 390K CGW	CORNING
8	1	" 47pF		CY 10C 470K CGW	"
9	1	" 220pF		CY 10C 221K CGW	"
10	1	" 330pF		CY 15C 331K CGW	"
11	2	" céramique 1nF			ASU COMPONENT
12	3	" " 10nF			" "
13					
14	2	Cond. variable 0,8÷10pF		5751	JOHANSON
15					
16	2	Transistor		BFT 66 [sélectioné]	SIEMENS
17					
18	2	Torre Stycast		16×6×6mm	
19					
20	1	Fil Cu isolé		⌀ 0,27 [1,5m]	
21	1	" " "		⌀ 0,4 [1m]	
22					
23	2	Perle att. HF 3B 3,7×3,5×1,2		4322 020 34400	PHILIPS
24					
25	7	Plot à souder		2000 053	COMATEL

Réf.

Modifications

liste de pièces

MULTIPLICATEUR 5-20 MHz

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1196/1

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
	2	Résistance	21,5 Ω	Film métallique NK3	Corning
	2		38,3 Ω	"	"
	2		46,4 Ω	"	"
	1		51 Ω	Film métallique MR16	Philips.
	2		178 Ω	NK3	Corning
	2		316 Ω	"	"
	1		464 Ω	"	"
	1		4k7	Film métallique MR25	Philips.
	1	Condo HF 1pF		JFD.	
	1	Condo HF 4,7pF		JFD	
	2	Condo HF 6,8pF		JFD	
	2	HF (2,2+10)pF		JFD	
	1	HF 22pF			
	3	Condo var. 0,8÷10pF		Johanson 5751	
	6	Condo céram. 10nF			
	2	Transistor (sélect.) BFT 66			Siemens
	2	Self 2,7 µH		Delevan 1025	
	2	Self 10 µH		Delevan 1025	
	1	Torre Stycast 16x6x6 mm			
	1	Fil Cu isolé ⌀ 0,8 (0,5m)			
	1	Fil Cu ⌀ 1,3 (0,2m)			
	12	Plots à souder		Comatel 20 00 053	
	1	Ecran laiton 27x8x0,6 mm.			

Réf.

Modifications

liste de pièces

Multiplicateur 20 MHz - 180 MHz

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1176/2.

Pos.	Nb.	Désignation	Valeur	Type et №	Fournisseur
1	1	Circuit imprimé		180 MHz	
2					
3	1	Résistance 8,2		MR25/2322 151 58209	PHILIPS
4					
5	1	Cond. HF 4,7pF			JFD
6	1	" céramique 1nF			ASU COMPONENT
7					
8	2	Cond. variable 0,8÷10pF		5751	JOHANSON
9					
10	1	Transistor		2N3866 [sélectionné]	
11					
12	1	Self Delavan 56µH			STOLZ
13					
14	1	Fil Cu		φ1,3 [0,1m]	
15					
16	5	Plot à souder		2000 053	COMATEL

Réf.

Modifications

liste de pièces

AMPLI 180MHz [PUISSANCE]

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

2002 .40.02. 1196.3

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
	1	condo céram 1nF			
	1	C. I. GPD-402		Avantek	
	2	Plots à souder		Cmatel 20 00 05[illegible]	
	1	Elément de fixation Alu			

Réf.

Modifications				

liste de pièces

Ampli 180MHz/

Ecrit :	
Contrôlé	
Original du	
Remplace le No	

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1195/4

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1					
2					
3	1	Résistance 1K		MR25/2322 151 51002	PHILIPS
4	1	" 464		NK3	CORNING
5					
6	5	Cond. variable 0,8÷10pF		5750	JOHANSON
7	1	" passage Spectrum Control		54-790-001-501 2	EMSA
8	2	" " " "		51-719-021	"
9					
10	1	Diode SRD HP		5082-0803 [OUTLINE 66]	HP
11					
12	3	Connecteur		23 SMA 50-0-11	HUBER & SUHNER
13	1	"		25 SMA 50-3-25	" "
14					
15	1	Ecrou six pans		4-40 UNC-2B	EMSA
16	2	" " "		13-32 UNEF-2A	"
17	2	Rondelle dentée argentée		Spectrum Control	"
18	4	" ressort "		" "	"
19	2	Cosse à souder		NV 2010	VOGT
20	3	" "		NV 2038	"
21	23	Vis tête cylindrique fendue		M2x5mm / Laiton	BOSSARD
22	4	" " " "		M2x6 mm "	"
23	12	" " " "		M2x8 mm "	"
24	2	" " " "		M2,5x4 mm "	"
25	3	" " " "		M2,5x5 mm "	"
26	3	" " " "		M2,5x8mm "	"
27	4	Vis tête cônique fendue		M2x6mm "	"
28	4	" " " "		M2x10mm "	"
29	3	Ecrou		M2,5 "	"
30					
31	1	Câble		RG 196 A/U 7x0,1	HUBER & SUHNER
32					
33	1	Fil Cu		⌀1,3 L=26	
34	1	" "		⌀2,3 L=26	

Réf.

Modifications

liste de pièces

MULTIPLICATEUR 180 MHz ÷ 1440 MHz

Ecrit :

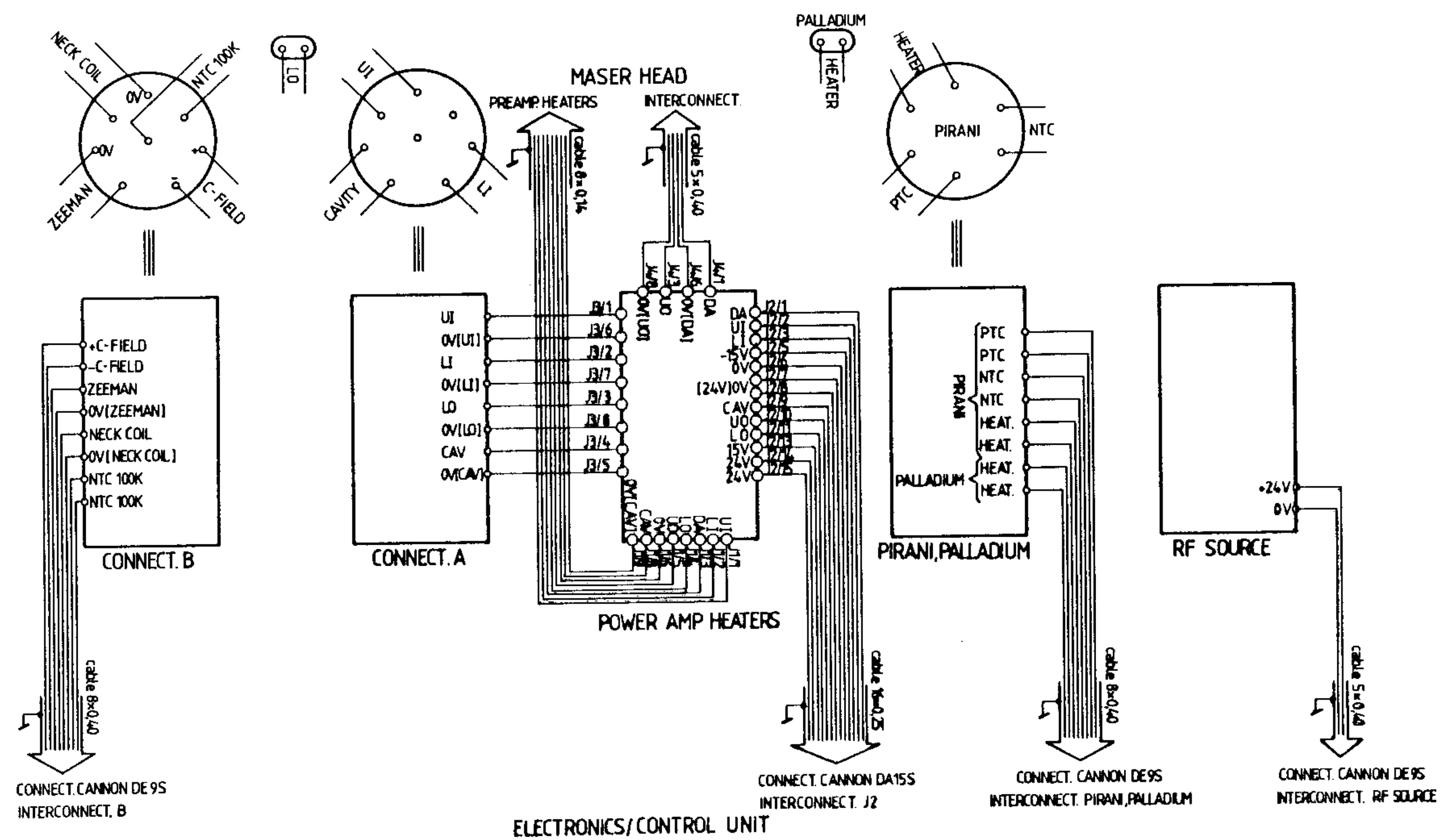
Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1196/5

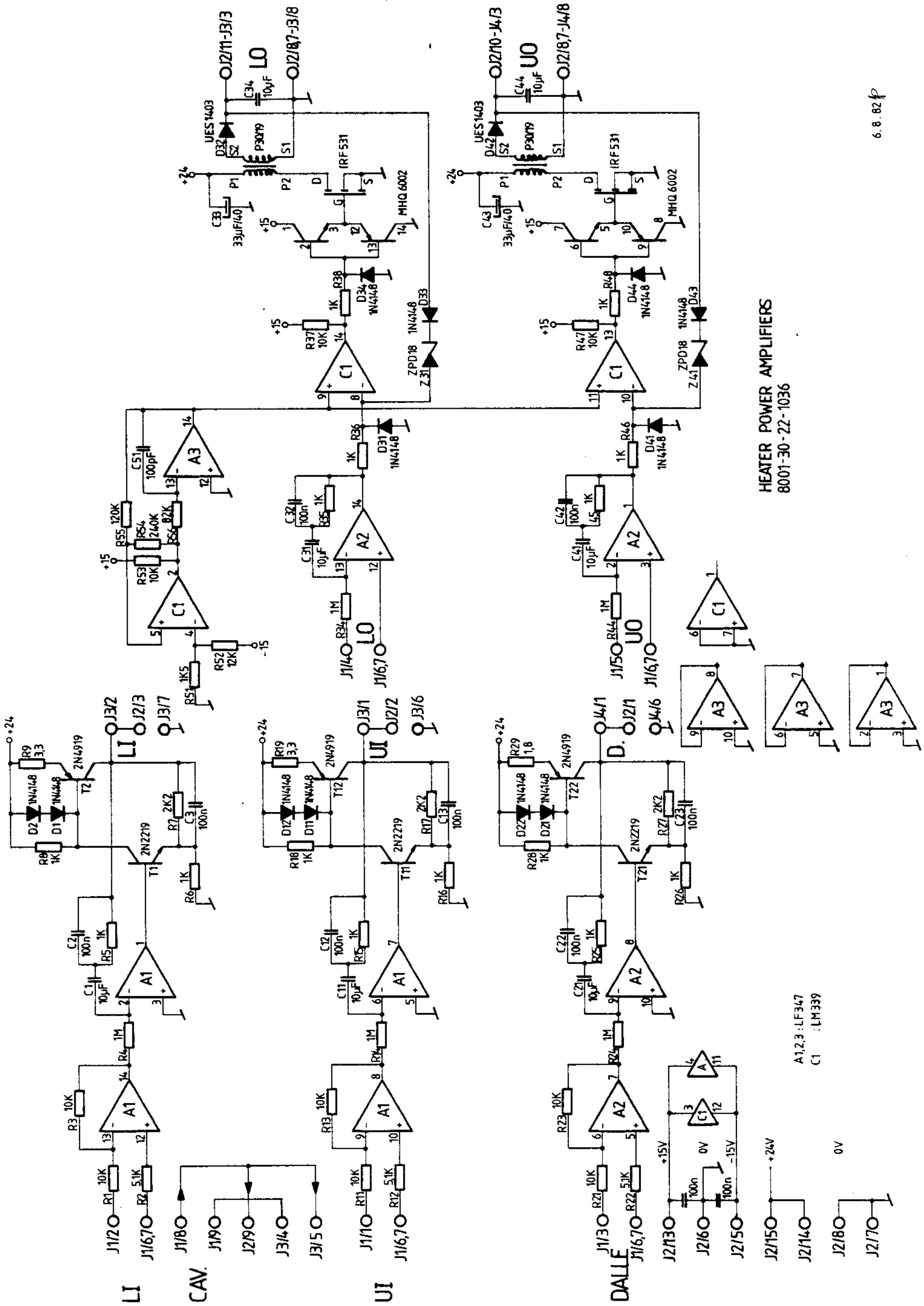


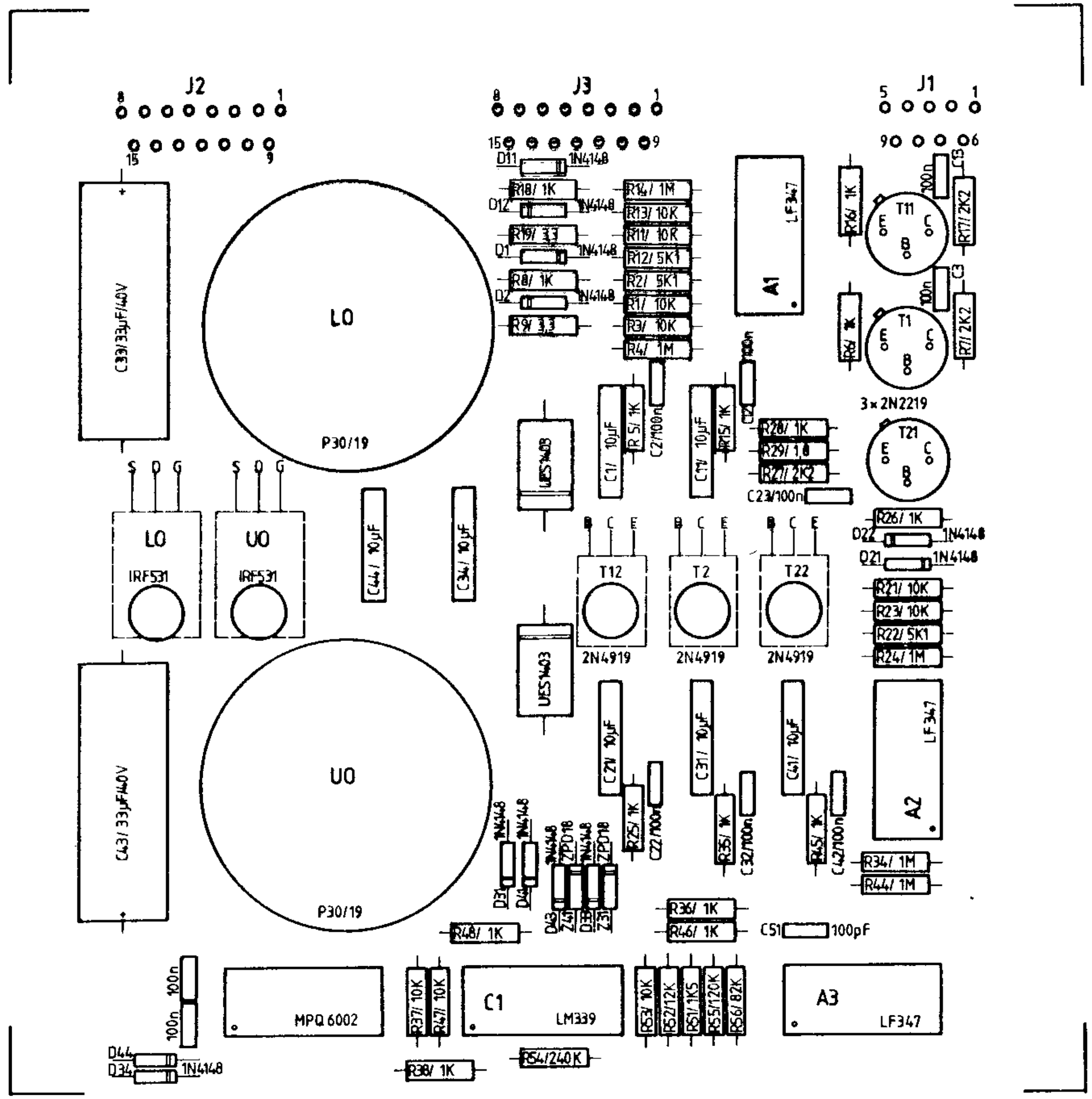
o SOLDERING

O POWER AMP HEATERS : J1/CONNECT. CANNON DE9P (CABLE 8×0,14)
J2/CONNECT. CANNON DA15P (CABLE 16×0,25)
J3/CONNECT. CANNON DE9S (CABLE 8×0,40)
J4/CONNECT. CANNON DE9S (CABLE 5×0,40)

VACUUM MANIFOLD COMPARTMENT
CABLAGE

2.2.83


HEATER POWER AMPLIFIERS
8001-30-22-1036
6.8.82
A1,2,3 : LF347
C1 : LM339
LI
CAV.
UI
DALLE
LO
UO
IRF 531
MHQ 6002
2N4919
2N2219
+15V
0V
-15V
+24V
0V



HEATER POWER AMPLIFIERS
COMPONENT MOUNTING
8001-30-24-1036

9.6.82

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Plaque frontale		8001-40-12-1036/1	
2	1	" arrière		" /1	
3	1	" supérieure		" /2	
4	1	Radiateur		" /3	
5	2	Plaque latérale		" /4	
6	4	Entretoise		" /4	
7	1	Support de diodes		" /5	
8	2	Entretoise Pot.		" /5	
9	16	Vis tête cônique fendue		M3x8mm /Nickelée	BOSSARD
10	2	" " " "		M3x6mm "	"
11	2	" " cylindrique "		M3x8mm "	"
12	6	" " " "		M3x6mm "	"
13	5	Vis imbus		M3x6mm	
14	2	Canon isolant Di=3,1		V5359/650312	/DISTRELEC
15	2	Connecteur "D" Cannon		DE9P	KONTAKT SYSTEME
16	1	Connecteur "D" Cannon		DE9S	KONTAKT SYSTEME
17	1	" " "		DA15S	" "
18	3	Verrouillage		DE 51224-1	" "
19	1	"		DE 51220-1	" "

Modifications

liste de pièces

POWER AMP THERMOSTATS

Ecrit :

Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL

DEPARTEMENT TECHNIQUE

8001 .40.02.1036/1

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8001-30-25-1036	PRINTELEC
2	1			MPQ 6002	FABRIMEX
3	1	QUAD COMPARATOR		LM339	NS/FENNER
4	3	" OP AMP		LF 347B	" "
5	5	Socle 14 pins		ICT-143-ST	MEGEX
6					
7	1	Résistance 1,8		MR25/2322 151 51809	PHILIPS
8	2	" 3,3		" " " 53309	"
9	15	" 1K		" " " 51002	"
10	1	" 1K5		" " " 51502	"
11	3	" 2K2		" " " 52202	"
12	3	" 5K1		" " " 55102	"
13	9	" 10K		" " " 51003	"
14	1	" 12K		" " " 51203	"
15	1	" 82K		" " " 58203	"
16	1	" 120K		" " " 51204	"
17	1	" 240K		" " " 52404	"
18	5	" 1M		" " " 51005	"
19					
20	1	Cond. céramique 100pF			PHILIPS
21	10	" " 100nF			ASU COMPONENT
22	7	" " 10µF			" "
23	2	" électrolytique 33µF/40V			PHILIPS
24					
25	12	Diode		1N4148	FAIRCHILD/MOOR
26	2	" Zéner ZPD 18V			
27	2	Diode		UES 1403	UNITRODE/STOLZ
28					
29	3	Transistor		2N2219	FABRIMEX
30	3	"		2N4919	"
31	2	"		IRF 531	INT. RECTIFIER
32					
33	2	Pot.			

Modifications

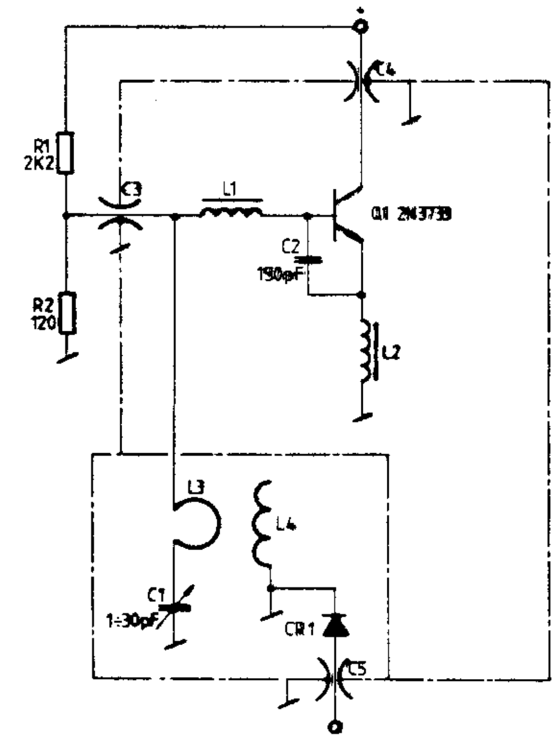
liste de pièces

POWER AMP THERMOSTATS

Ecrit :
Contrôlé
Original du
Remplace le No

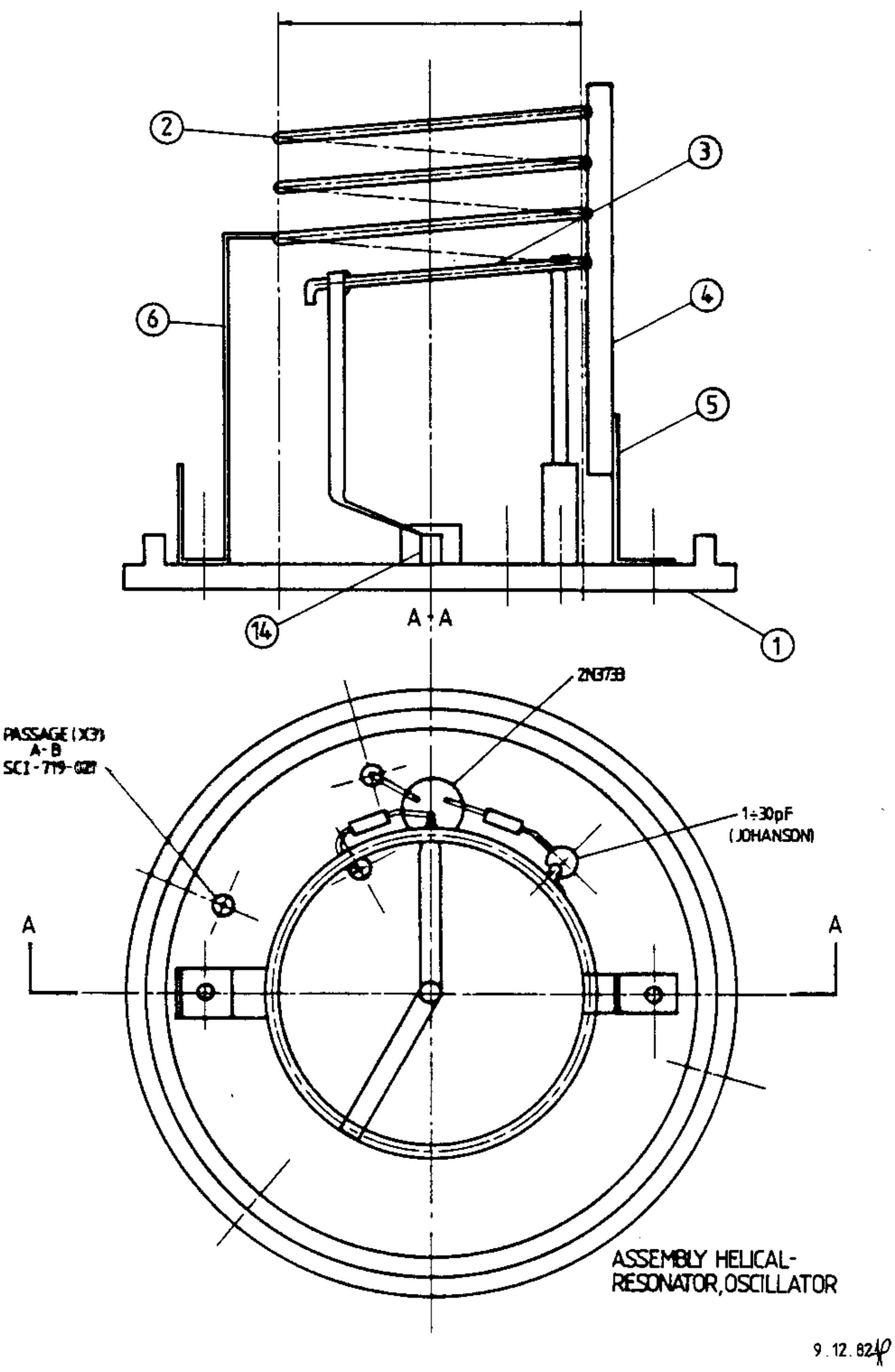
EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8001 .40.02. 1036/2



SCHEMATIC
DISSOCIATOR OSCILLATOR
8002-40-22-1197

8.12.82



2
3
4
5
6
14
1
A - A
2N3733
PASSAGE (X3)
A - B
SCI - 719 - 027
1÷30pF
(JOHANSON)
A
A
ASSEMBLY HELICAL-
RESONATOR, OSCILLATOR
9.12.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Transistor		2N 3733	RCA/BAERLOCHER
2					
3	1	Résistance 120		MR25/2322 151 51201	PHILIPS
4	1	" 2K2		" " " 52202	"
5					
6	1	cond. variable 1÷30pF		VMC 3908	JOHANSON/
7	1	" céramique 150pF		VY 03151	JFD/
8					
9	1	Feedthrough cap		SCI 719-021	ALLEN-BRADLEY
10	1	" "		or SMFB-A2	"
11	1	" "		"	"
12					
13	1	RF CHOKE 1,5µH		1537-16	DELAVAN/STOLZ
14	1	" " "		"	" "
15	1	Coupling loop			
16	1	R-F COIL			
17					
18	1	Diode, Detector		5082-2800	HP/BAERLOCHER
19					
20	1	STAND OFF		526.30	JAEGER

Réf.

Modifications

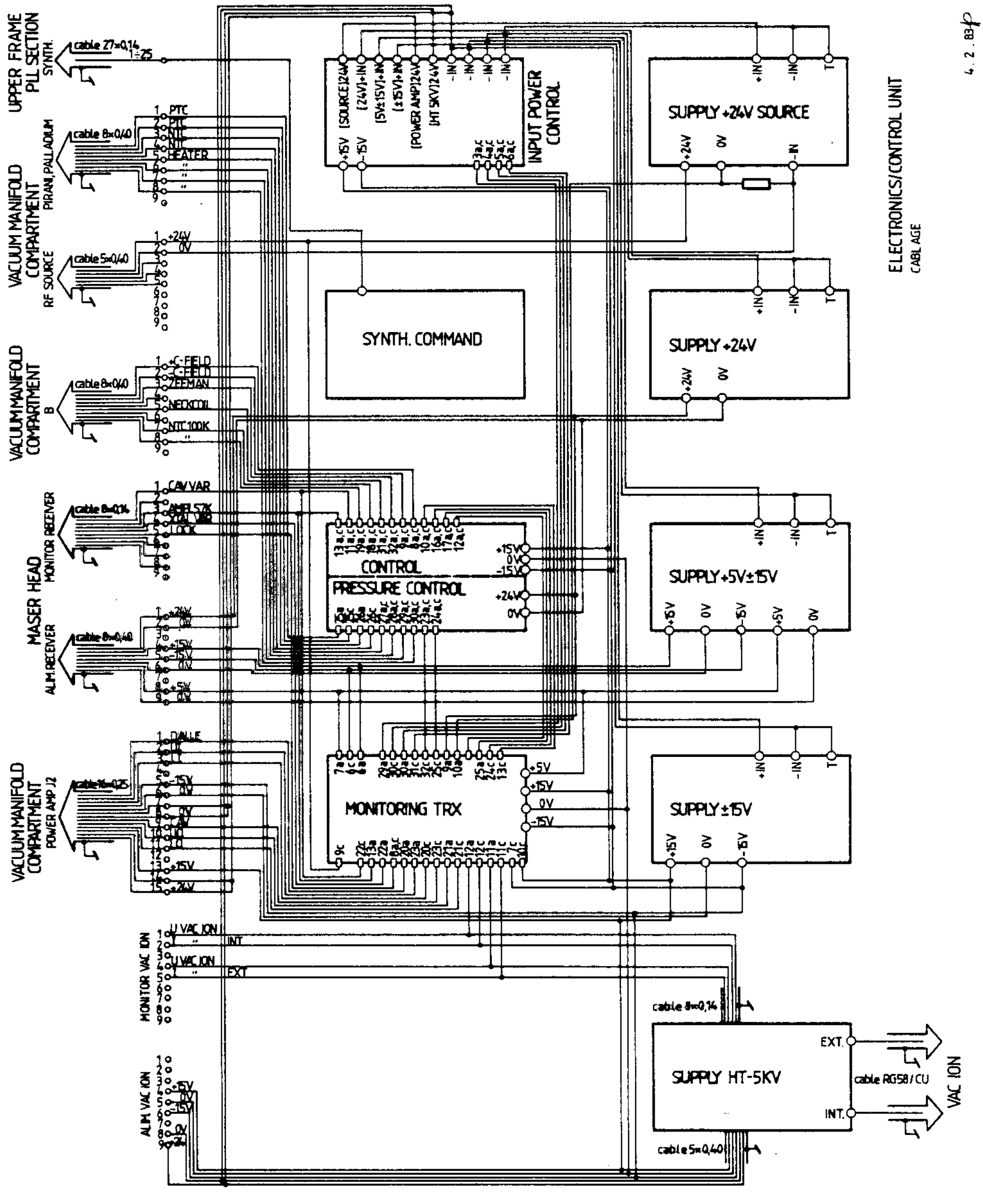
liste de pièces

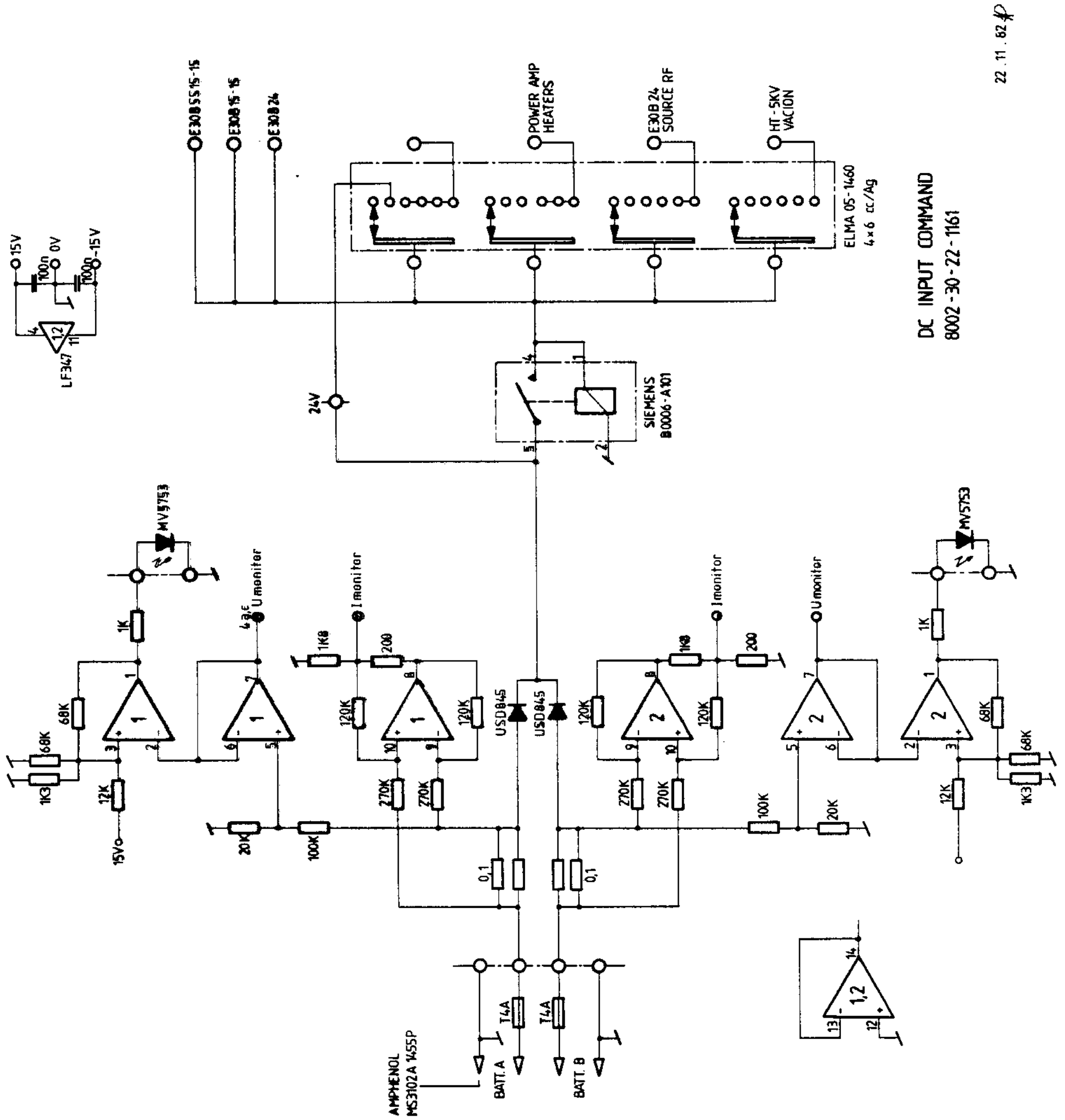
DISSOCIATOR OSCILLATOR

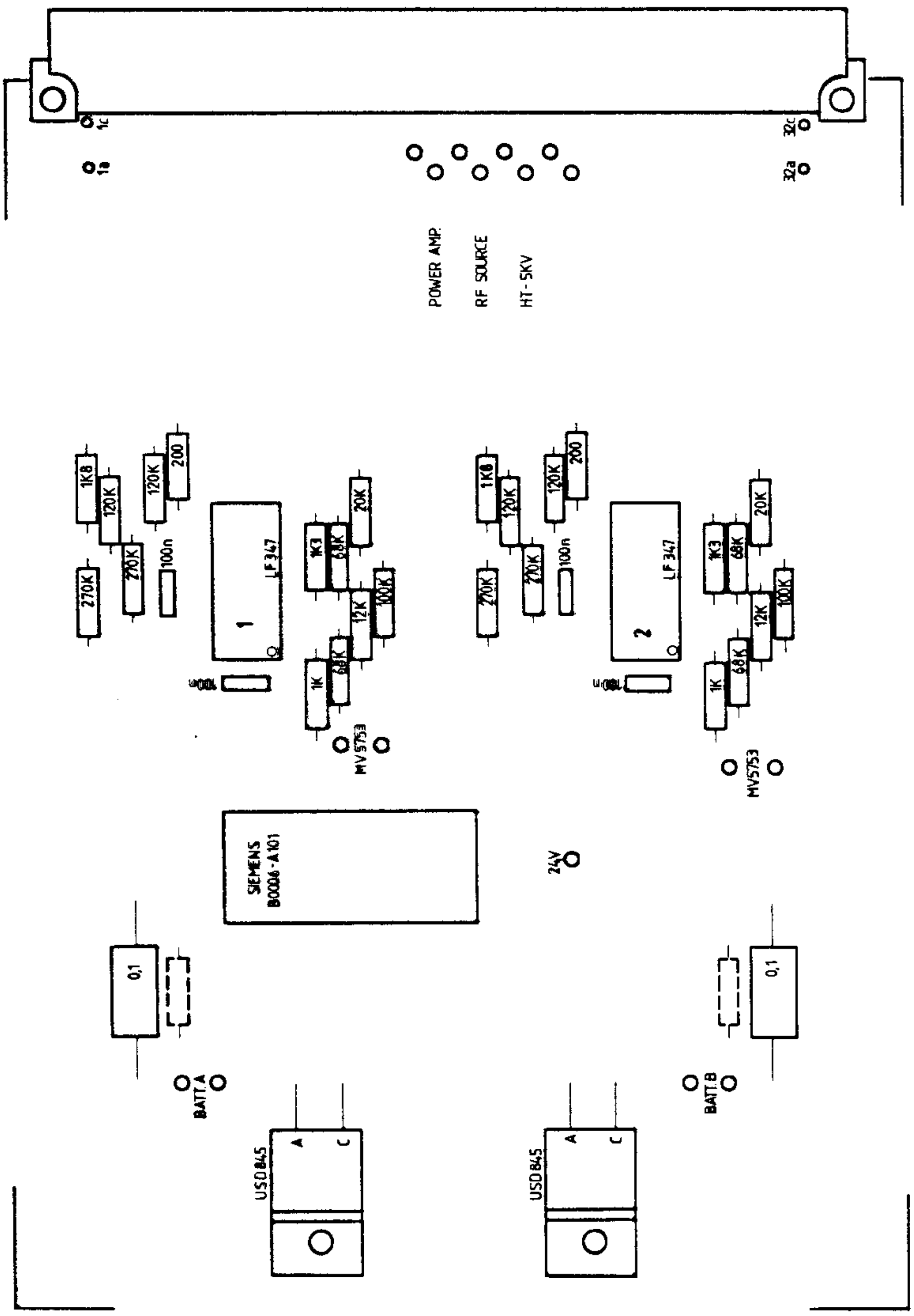
Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

.40.02. 1197


ELECTRONICS/CONTROL UNIT
CABLAGE
4.2.83
UPPER FRAME
PLL SECTION
SYNTH.
cable 27×0,14
VACUUM MANIFOLD
COMPARTMENT
PIRANI, PALLADIUM
RF SOURCE
cable 8×0,40
cable 5×0,40
PTC
NTC
HEATER
+24V
0V
VACUUM MANIFOLD
COMPARTMENT
B
C-FIELD
ZEEMAN
NECKCOIL
NTC 100K
MASER HEAD
MONITOR RECEIVER
ALIM RECEIVER
cable 8×0,14
CAV VAR
AMPL 5,7K
XTAL VAR
LOCK
+15V
-15V
+5V
VACUUM MANIFOLD
COMPARTMENT
POWER AMP J2
cable 16×0,25
MONITOR VAC ION
U VAC ION
INT
EXT
ALIM VAC ION
INPUT POWER
CONTROL
(SOURCE)24V
(24V)+IN
(5V±15V)+IN
(±15V)+IN
(POWER AMP)24V
(HT 5KV)24V
-IN
SYNTH. COMMAND
CONTROL
PRESSURE CONTROL
MONITORING TRX
SUPPLY +24V SOURCE
SUPPLY +24V
SUPPLY +5V±15V
SUPPLY ±15V
+IN
-IN
T
SUPPLY HT-5KV
EXT.
INT.
cable 8×0,14
cable 5×0,40
cable RG58/CU
VAC ION


DC INPUT COMMAND
8002-30-22-1161
22.11.82
E30BSS15-15
E30B15-15
E30B24
POWER AMP HEATERS
E30B24 SOURCE RF
HT-5KV VACION
ELMA 05-1460
4×6 cc/Ag
SIEMENS
B0006-A101
24V
15V
0V
-15V
100n
LF347
MV5753
U monitor
I monitor
1K
68K
1K3
12K
15V
20K
100K
1K8
200
120K
270K
USD845
0,1
T4A
AMPHENOL
MS3102A 14S5P
BATT. A
BATT. B



DC INPUT COMMAND
COMPONENT MOUNTING
8002-30-24-1161

22.11.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Panneau frontal		8002-40-12-1161/1	
2	1	Poignée		9511.67	ELMA
3	4	Vis tête cylindrique		M3 x 8 mm	BOSSARD
4	4	Rondelle ressort		M3	"
5	1	Radiateur [Diodes]		8002-40-12-1161/2	
6	1	Isolation 20x70		[1673]	CHOMERICS/SICOVEND
7	2	" TO 220		60-11-8302-1673	" "
8	2	Diode		USD 845	UNITRODE/STOLZ
9	2	Canon isolant Di = 3,1 mm		V5359/650312	/DISTRELEC
10	2	Porte-fusible		FEP 031.1201	SCHURTER
11	2	Fusible T4A Φ5 x 20 mm		FST 034.3123	"
12	1	Commutateur 4x6		05-1460	ELMA
13	1	Bouton "A" Φ21		020-4420/260576	ELMA/DISTRELEC
14	1	Disque à flèche		041-4030/260733	" "
15	1	Capuchon		040-4030/260703	" "
16	1	Entretoise		8002-40-12-1161/4	
17	1	Clavette		" " " "	
18	1	Passe-fil		570.6	JAEGER
19					
20	1	Carte Alim. Batterie		8002-40-02-1161/2	
21	1	" support		8002-40-12-1161/3	
22	4	Vis tête cylindrique fendue		M2,5x6 mm / Nickelée	BOSSARD
23	4	Rondelle ressort		M2,5	"

Réf.

Modifications

liste de pièces

ALIM. BATTERIES

Ecrit :

Contrôlé

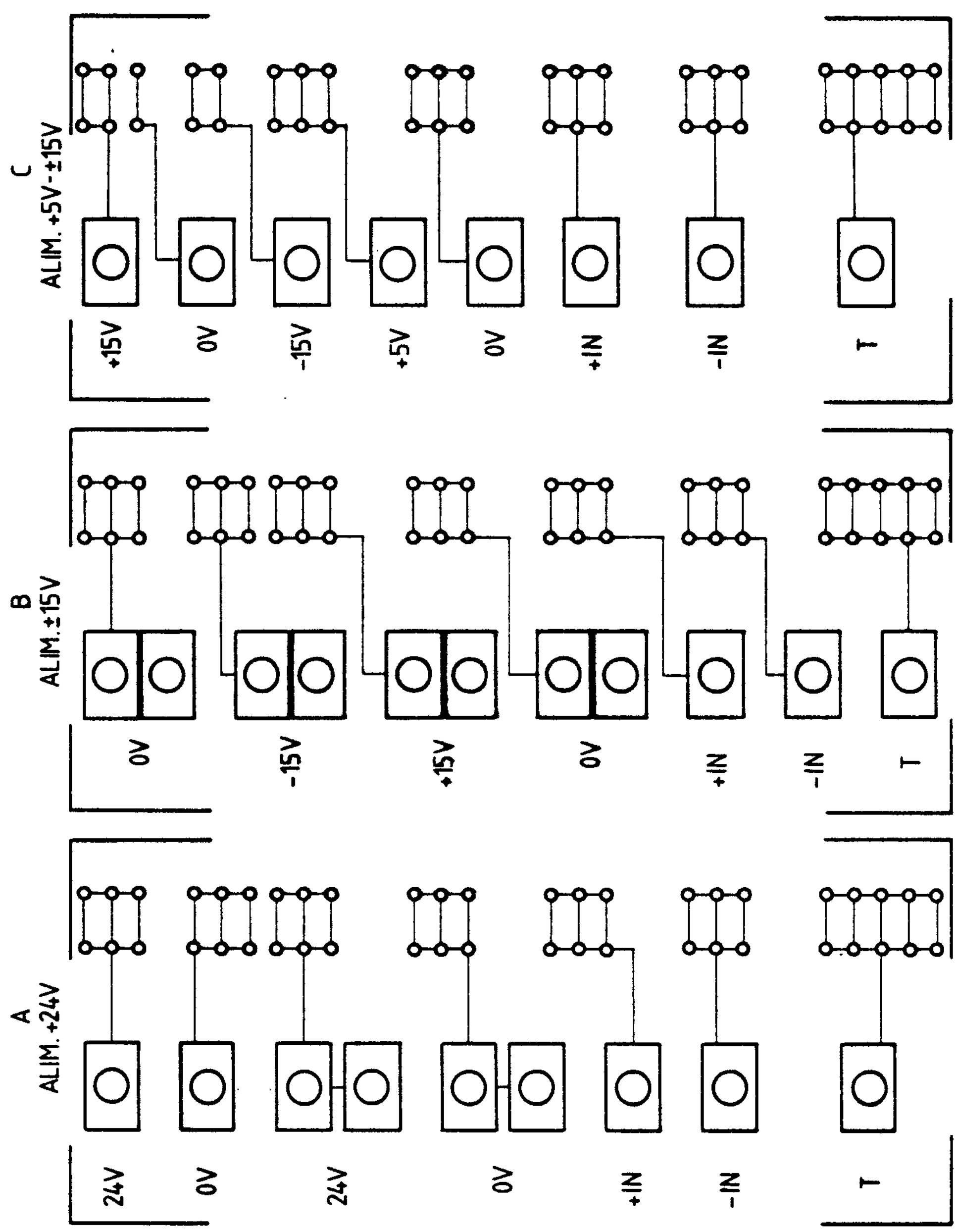
Original du

Remplace le No

EBAUCHES SA NEUCHATEL

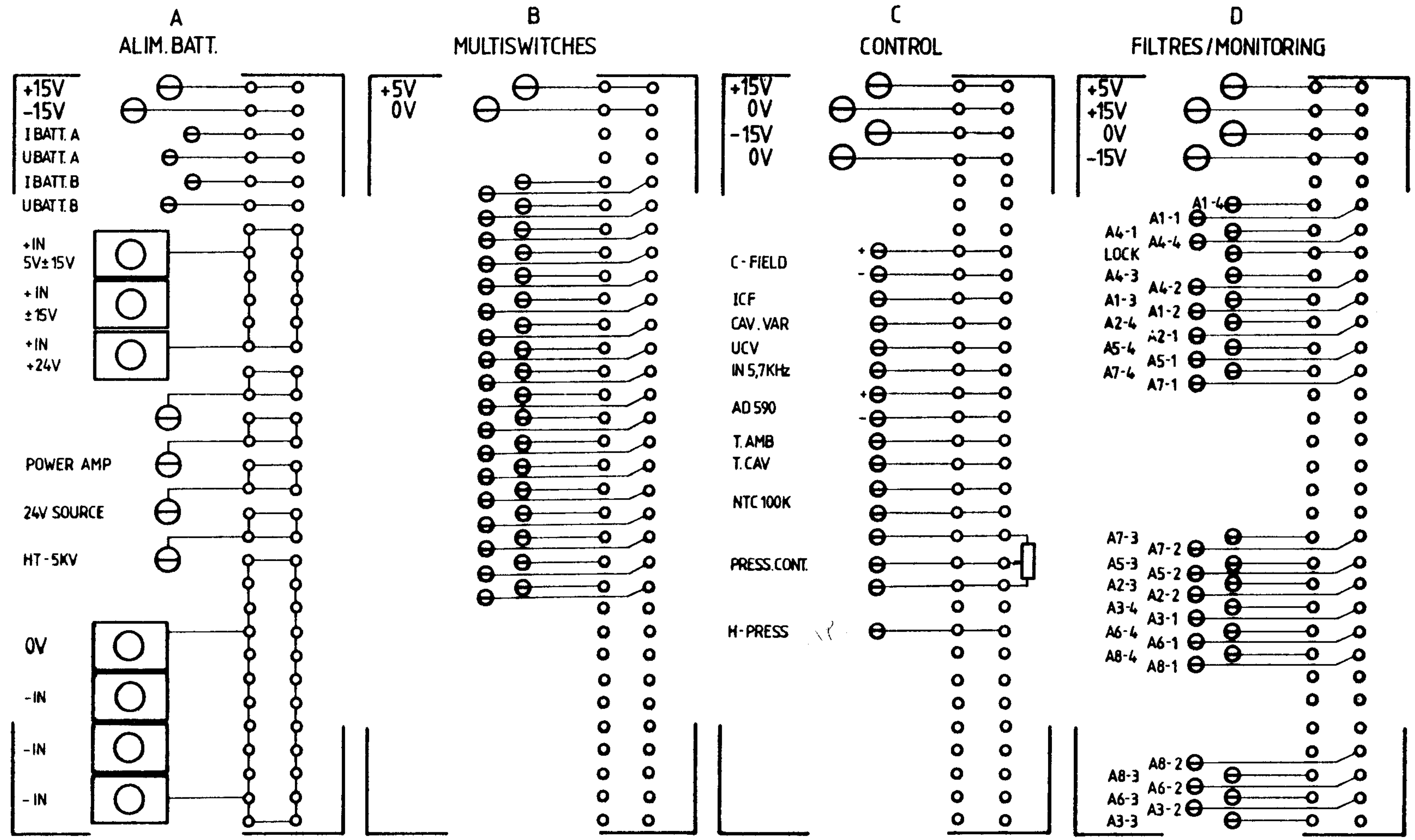
DEPARTEMENT TECHNIQUE

8002 .40.02. 1161/1



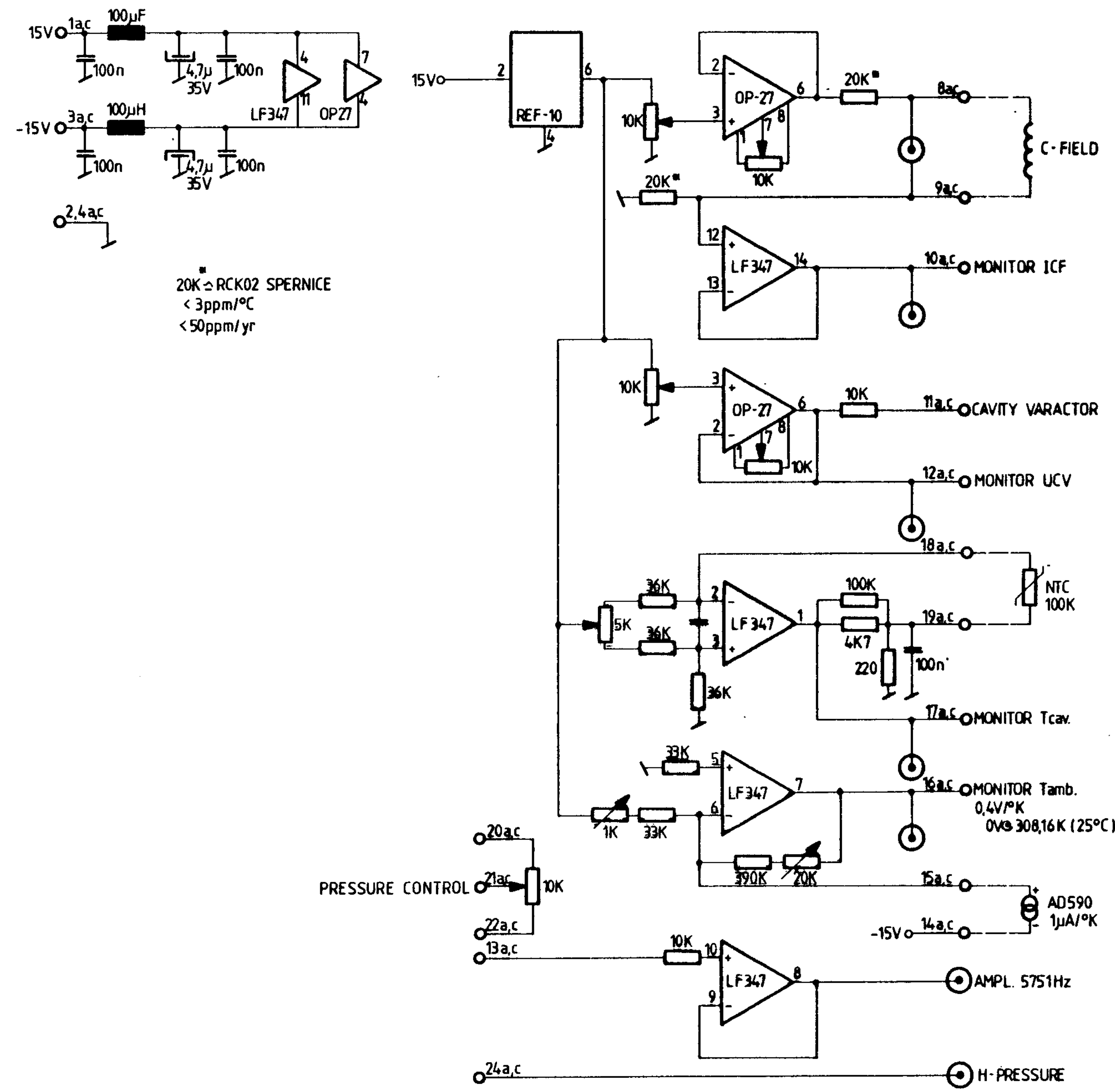
POWER SUPPLY CONNECTIONS
8002-30-22/24-1164 A,B,C

23.11.82



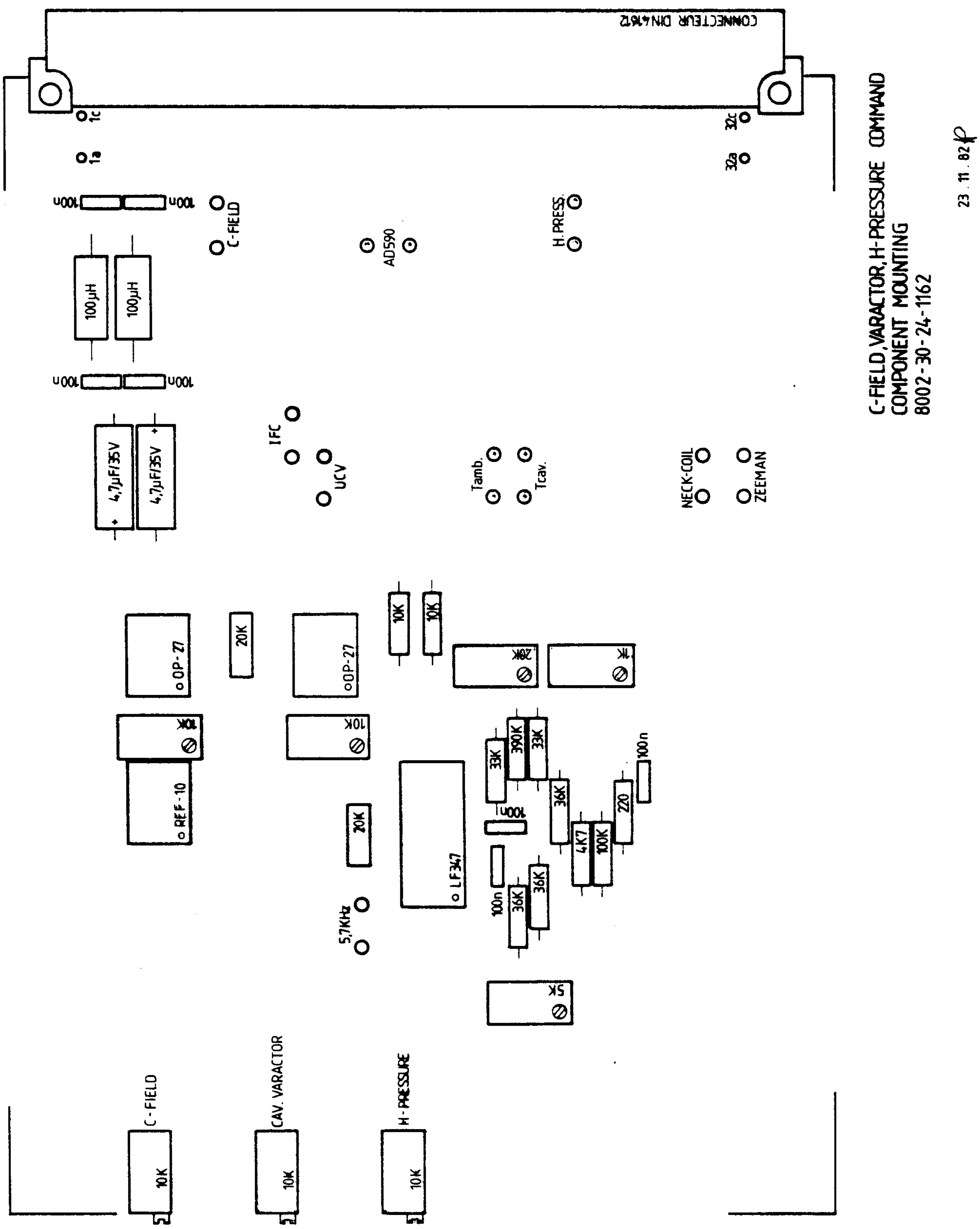
CONTROL MODULE CONNECTIONS
8002-30-22/24-1165 A,B,C,D

25.11.82



C-FIELD, VARACTOR, H-PRESSURE COMMAND
8002-30-22-1162

22.11.82


C-FIELD, VARACTOR, H-PRESSURE COMMAND
COMPONENT MOUNTING
8002-30-24-1162
23.11.82
CONNECTEUR DIN41612
1c
1a
32c
32a
100n
100µH
4,7µF/35V
C-FIELD
AD590
H.PRESS.
IFC
UCV
Tamb.
Tcav.
NECK-COIL
ZEEMAN
OP-27
20K
10K
1K
REF-10
LF347
33K
390K
36K
4K7
100K
220
5,7KHz
5K
CAV. VARACTOR
H-PRESSURE

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Panneau frontal		8002-40-12-1162	
2	1	Poignée		9511.67	JAEGER
3	2	Vis tête cylindrique		M3x8mm	BOSSARD
4	9	Connecteur		22SMA 50-0-4	HUBER & SUHNER
5	9	Cosse à souder		2067 Ag	VOGT
6	1	Passe-fil		570.1	JAEGER
7	4	Vis tête cylindrique fendue		M2,5x6mm / Nickelée	BOSSARD
8	4	Rondelle ressort		M2,5	"
9					
10	1	Carte Control		8002-40-02-1162/2	
11	1	" Pressure Control		8002-40-02-1153	

Réf.

Modifications

liste de pièces

CONTROL

Ecrit :

Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL

DEPARTEMENT TECHNIQUE

8002 .40.02.1162/1

Pos.	Nb.	Désignation	Valeur 8/52	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1162	PRINTELEC
2	1	Connecteur DIN 41612		96P-6033-0523-0	LITTON
3	2	Vis tête cylindrique fendue		M2.5×6mm / Nickelée	BOSSARD
4	2	Rondelle ressort		M2,5	"
5	2	Ecrou		M2,5	"
6	20	Plot à fourche		537.24	JAEGER
7	3	Socle 8pins		ICT-083-ST	MEGEX
8	1	" 14pins		ICT-143-ST	"
9					
10	1	Voltage reference IC		REF-10B	PMI/BOURNS
11	2	OP AMP		OP 27 FZ	"
12	1	Quad OP AMP		LF 347B	NS/FENNER
13					
14	1	Résistance 220		MR25/2322 151 52201	PHILIPS
15	1	" 4K7		" " " 54702	"
16	2	" 10K		" " " 51003	"
17	2	" 33K		" " " 53303	"
18	3	" 36K		" " " 53603	"
19	1	" 100K		" " " 51004	"
20	1	" 390K		" " " 53904	"
21	2	Résist. "HIGH STAB" 20K-1%		RCK02	SFERNICE/KONTRON
22					
23	1	Potentiomètre 1K		183W	CONTELEC
24	1	" 5K		183W	"
25	2	" 10K		183W	"
26	3	" 10K		183X	"
27	1	" 20K		183W	"
28					
29	7	Cond. céramique 100nF			ASU COMPONENT
30	2	" tantale 4.7µF/35V			SPRAGUE/
31					
32	2	Self Delavan 100µH		1537-76	STOLZ

Réf.

Modifications

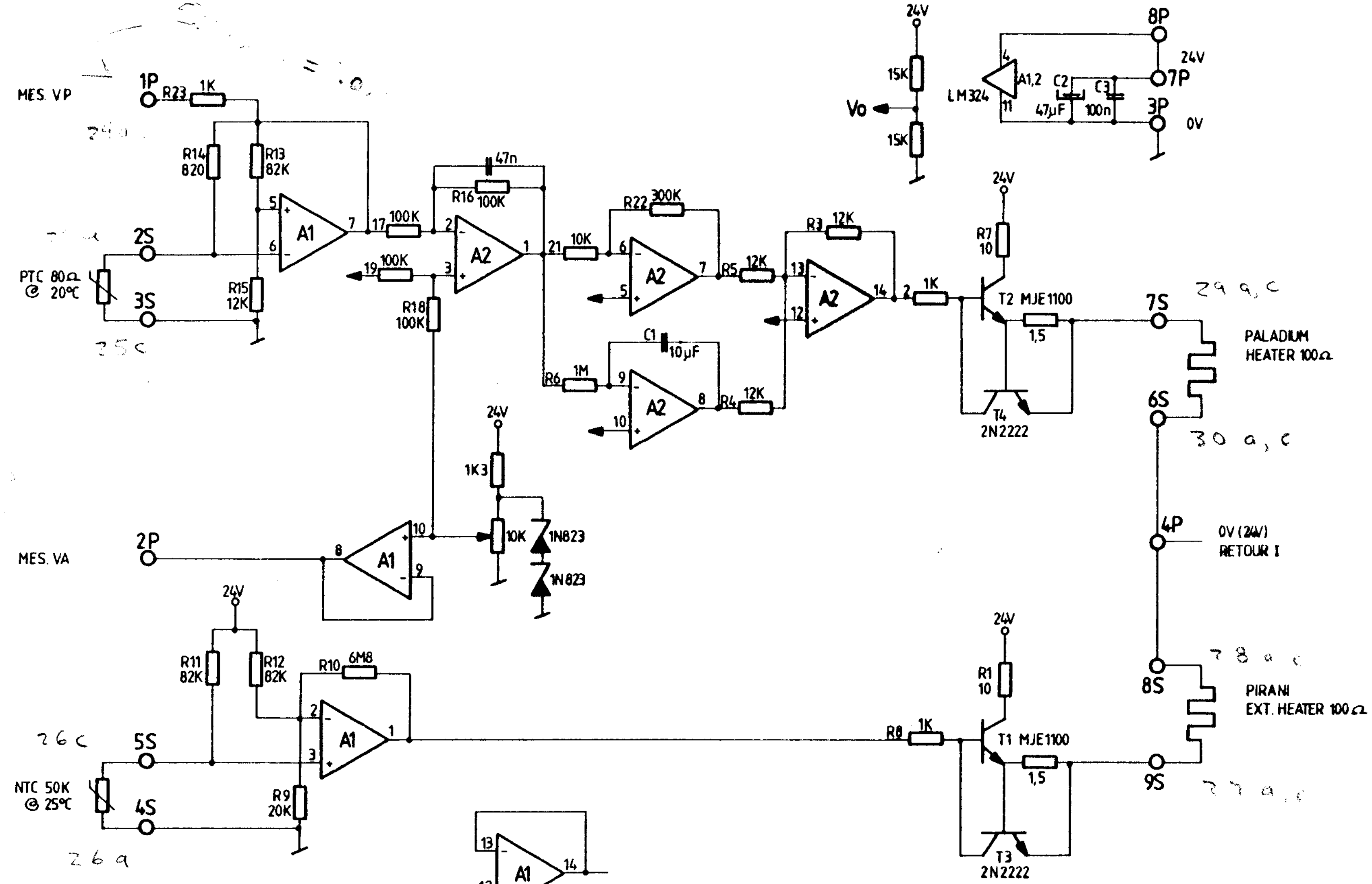
liste de pièces

CARTE CONTROL

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

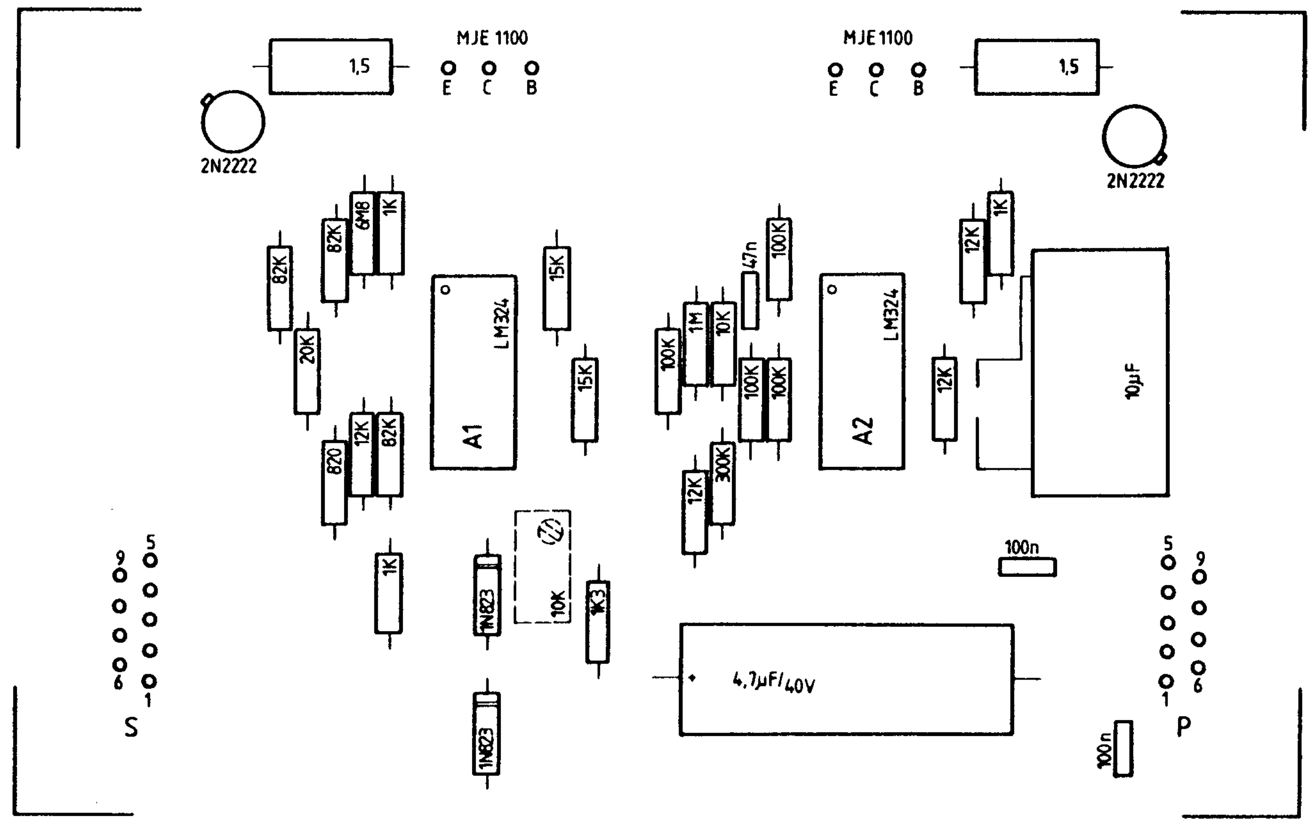
8002 .40.02.1162/2



PRESSURE REGULATOR
8002-30-22-1153

P= cannon m. 9p.
S= cannon f. 9p.

26.10.82



PRESSURE REGULATOR
COMPONENT MOUNTING
8002-30-24-1153

26.10.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1153	PRINTELEC
2	2	Socle 14 pins		ICT-143-ST	MEGEX
3	2	Quad OPAMP		LM 324	FENNER
4					
5	2	Transistor		2N2222	MOT/OMNI RAY
6	2	"		MJE 1100	" "
7					
8	2	Diode zéner		1N823A	MOT/OMNI RAY
9					
10	2	Résistance 1,5Ω/3W		C3A-S13.104	CGS/EGLI FISCHER
11	1	" 820		MR25/2322-151-58201	PHILIPS
12	3	" 1K		" " " 51002	"
13	1	" 1K3		" " " 51302	"
14	1	" 10K		" " " 51003	"
15	4	" 12K		" " " 51203	"
16	2	" 15K		" " " 51503	"
17	1	" 20K		" " " 52003	"
18	3	" 82K		" " " 58203	"
19	4	" 100K		" " " 51004	"
20	1	" 300K		" " " 53004	"
21	1	" 1M		" " " 51005	"
22	1	" 6M8		VR25	"
23					
24	2	Cond. céramique 100nF			ASU COMPONENT
25	1	" Polycarbonate 10µF			FILMCAP-ROTIMA
26	1	" Electrolytique 4,7µF/40V			PHILIPS
27					
28	1	Radiateur		8002-40-12-1153	
29	4	Entretoise		Φ6/Φ3x10 Alu	
30	6	Ecrou Kalei		M3	BOSSARD
31	4	Vis tête cylindrique fendue		M3x16mm/Nickelée	"
32	4	Rondelle		M3	"
33	4	" ressort		M3	"
34	2	Vis tête cylindrique		M3x8mm	"
35					
36	1	Connecteur DIN 41612		96P-6033-C523-0	LITTON
37	2	Vis tête cylindrique fendue		M2,5x16mm/Nickelée	BOSSARD
38	2	Rondelle ressort		M2,5	"
39	2	Ecrou		M2,5	"
40	2	Entretoise		Φ5/Φ2,6x2,5 Alu	

8155

Réf.

Modifications

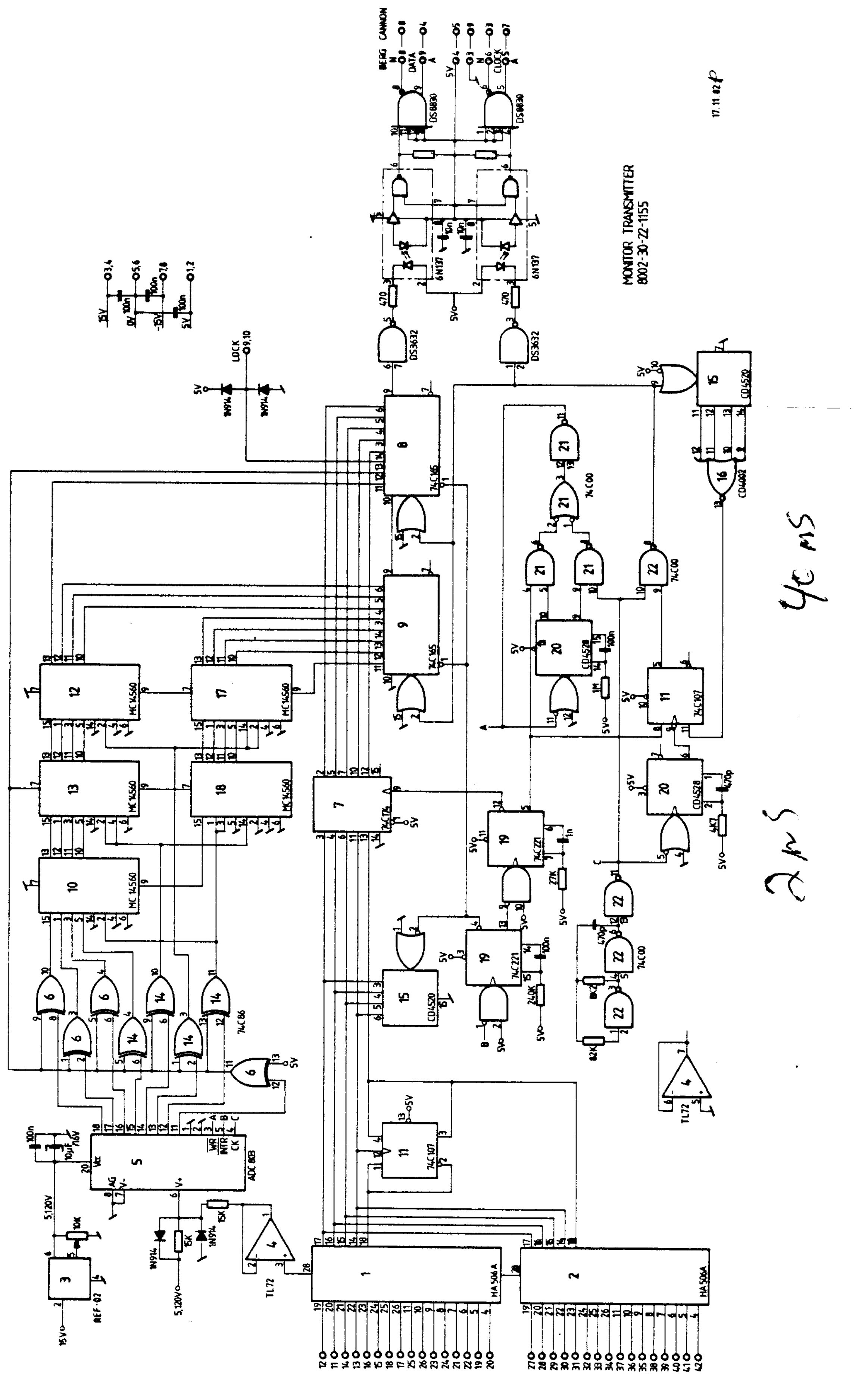
liste de pièces

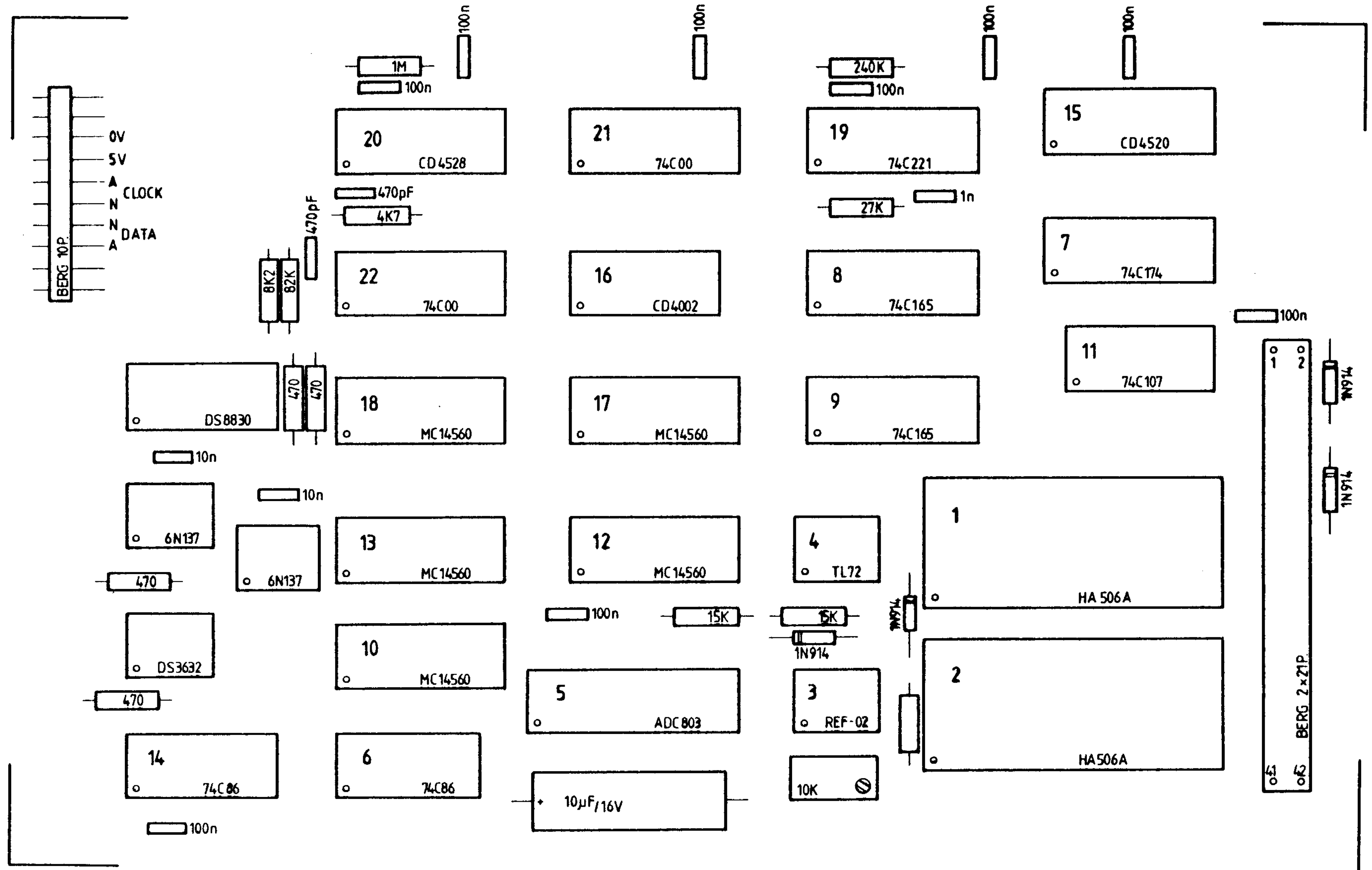
CARTE PRESSURE CONTROL

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1153


MONITOR TRANSMITTER
8002-30-Z2-1155
17.11.82



MONITOR TRANSMITTER
COMPONENT MOUNTING
8002-30-24-1155

17.11.82

8/58

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Panneau frontal		8002-40-12-1155/2	
2	4	Vis tête cylindrique fendue		M2,5x6mm/Nickelée	BOSSARD
3	4	Rondelle ressort		M2,5	"
4					
5	1	Connecteur "D" Cannon		DE 9S	KONTAKTSYSTEME
6	1	Verrouillage		DE 51224-1	" "
7					
8	1	Circuit imprimé		8002-30-85-1155	PRINTELEC
9	1	Connecteur PCB 2x21		75212-121/06012 522	BERG/LEITGEB
10	1	Broche 90° 1x10		75168-113/06012 160	" "
11	1	Boîtier à ver. 1x10		65039-027/06012 201	" "
12	6	Mini PV		47712 /06012 250	" "
13	5	Socle 8pins		ICT-083-ST	MEGEX
14	7	" 14 "		ICT-143-ST	"
15	11	" 16 "		ICT-163-ST	"
16	1	" 20 "		ICT-203-ST	"
17	2	" 28 "		ICT-283-ST	"
18	2	MUX ANALOG 16 INPUTS		HI-0506A-5	HARRIS/STOLZ
19	1	Référence 5,12V		REF-02 HP	PMI/BOURNS
20	1	DUAL OP AMP		TL 072	TEXAS/FABRIMEX
21	1	A/D CONVERTER		ADC 803 LCN	NS/FENNER
22	2	QUAD 2-INPUTS XOR		74C86	"
23	1	HEX D F-F		74C174	"
24	2	OCTAL PISO		74C165	"
25	5	DEC ADDER		MC 14560	MOT/OMNI RAY
26	1	DUAL JK F-F		74C107	NS/FENNER
27	1	DUAL HEXA COUNTER		CD 4520	"
28	1	DUAL 4-INPUT NOR		CD 4002	"
29	1	DUAL MONOSTABLE		74C221	"
30	1	" "		CD 4528	"
31	2	QUAD 2-INPUT NAND		74C00	"
32	1	DUAL PERIPHERAL DRIVER		DS 3632	"
33	1	" DIFF. LINE DRIVER		DS 8830	"
34	2	OPTO-COUPLER		6N137	HP/BAERLOCHER
35	4	Diode		1N4148	FAIRCHILD/MOOR
36	4	Résistance 470		MR25/2322 151 54701	PHILIPS
37	1	" 4K7		" " " 54702	"
38	1	" 7K5		" " " 57502	"
39	1	" 8K2		" " " 58202	"
40	2	" 15K		" " " 51503	"
41	1	" 27K		" " " 52703	"
42	1	" 82K		" " " 58203	"
43	1	" 240K		" " " 52404	"
44	1	" 1M		" " " 51005	"

Modifications

liste de pièces

MONITORING TRX

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1155/1

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
45	1	Cond. céramique 470pF			PHILIPS
46	1	" " 1nF			"
47	1	" " 4n7			"
48	2	" " 10nF			ASU COMPONENT
49	9	" " 100nF			" "
50	1	" tantale 10µF/16V			SPAGUE/
51					
52	1	Potentiomètre 10K		183 W	CONTELEC

Réf.

Modifications	

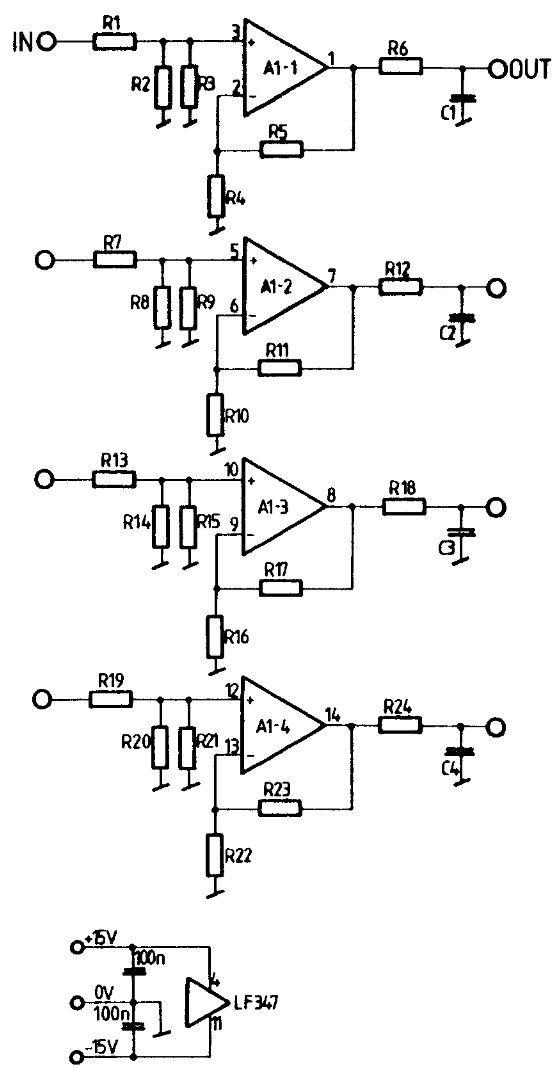
liste de pièces

MONITORING TRX

Ecrit :	
Contrôlé	
Original du	
Remplace le No	

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

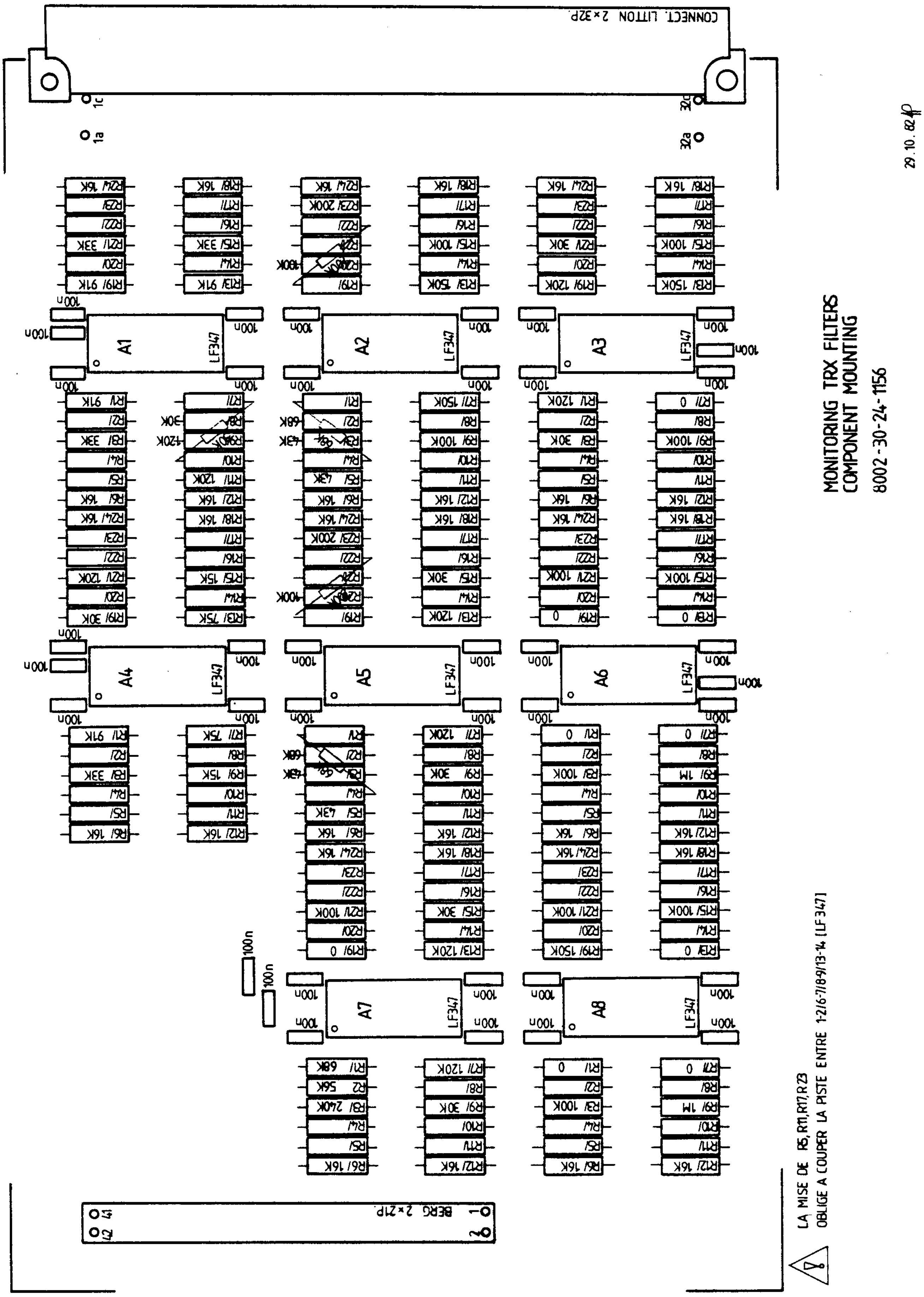
8002 .40.02. 1155/2



ADRESSE		FS	IN-FILTER	GAIN (R1–R2)	DIN 41612	AMP/BLOC	FILTER
00	UbatA	24V	4V	1/100K	30c	A8-3	16K/100nF
1	I batA	10A	4V	1/1M	29a	A8-2	"
2	UbatB	24V	4V	1/100K	31c	A6-3	"
3	I batB	10A	4V	1/1M	30a	A6-2	"
4				1/100K	31a	A3-2	"
5				1/100K	24a	A6-1	"
6	H-pressure control	10V	10V	150K/100K	32c	A3-3	"
7	H-pressure measure	10V	10V	150K/100K	25c	A8-4	"
10	LO	20V	20V	120K/30K	21c	A5-3	"
1	UO	20V	20V	"	21a	A5-2	"
2	DALLE	20V	20V	"	20a	A7-2	"
3	LI	20V	20V	"	20c	A7-3	"
4	UI	20V	20V	"	23a	A3-1	"
5	CAVITY	20V	20V	"	23c	A3-4	"
6	T-CAV	2°C	4V	1/100K	25a	A8-1	"
7	T-AMB	10°C	4V	1/100K	24c	A6-4	"
20	CAV-VAR	10V	10V	150K/100K	22c	A2-3	"
1	XTAL-VAR	10V	10V	150K/100K	22a	A2-2	"
2	AMPL. 5,7KHz	10V	10V	68K-56K//240K	13a	A7-1	"
3	C-FIELD	200µA	4V	1/100K	13c	A7-4	"
4	U } VAC ION INT	-5KV	6,34V	43K/68K	12a	A5-1	"
5	I }	-2mA	4V	2/100K×3	12c	A5-4	"
6	U } VAC ION EXT	-5KV	6,34V	43K/68K	11a	A2-1	"
7	I }	-2mA	4V	2/100K×3	11c	A2-4	"
30	U } RF SOURCE	24V	24V	75K/15K	9c	A4-3	"
1	I }	1A	-1V	120K/30K	10a	A1-2	"
2	+24V	+24V	24V	75K/15K	9a	A4-2	"
3	+15V	+15V	15V	91K-33K	10c	A1-3	"
4	-15V	-15V	15V	91K-33K	7c	A4-1	"
5	+5V	+5V	5V	30K-120K	7a	A4-4	"
6	+15V	+15V	15V	91K-33K	6a	A1-1	"
7	-15V	-15V	15V	91K-33K	6c	A1-4	"

FILTERS (MONITORING TRX)
8002-30-22-

14.12.82


CONNECT. LITTON 2×32P.
BERG 2×21P.
MONITORING TRX FILTERS
COMPONENT MOUNTING
8002-30-24-1156
LA MISE DE R5,R11,R17,R23
OBLIGE A COUPER LA PISTE ENTRE 1-2/6-7/8-9/13-14 [LF 347]
29.10.82

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1156	PRINTELEC
2	1	Broche droite 2x21		75844-118/06012 180	BERG/LEITGEB
3	1	Connecteur DIN 41612		96P-6033-0523-0	LITTON
4	2	Vis tête cylindrique fendue		M2,5x16mm /Nickelée	BOSSARD
5	2	Ecrou		M2,5	"
6	2	Entretoise		ϕ5/ϕ2,6x5 Alu	
7					
8	8	Socle 14 pins		ICT-143-ST	MEGEX
9	8	QUAD OP AMP		LF 347B	NS/FENNER
10					
11	4	Résistance 10K		MR25/2322 151 51003	PHILIPS
12	2	" 12K		" " " 51203	"
13	2	" 15K		" " " 51503	"
14	32	" 16K		" " " 51603	"
15	7	" 30K		" " " 53003	"
16	4	" 33K		" " " 53303	"
17	2	" 75K		" " " 57503	"
18	4	" 91K		" " " 59103	"
19	14	" 100K		" " " 51004	"
20	7	" 120K		" " " 51204	"
21	4	" 150K		" " " 51504	"
22	2	" 1M		" " " 51005	"
23					
24	38	Cond. céramique 100nF			ASU COMPONENT

Modifications

liste de pièces

FILTRES [MONITORING TRX]

Ecrit :

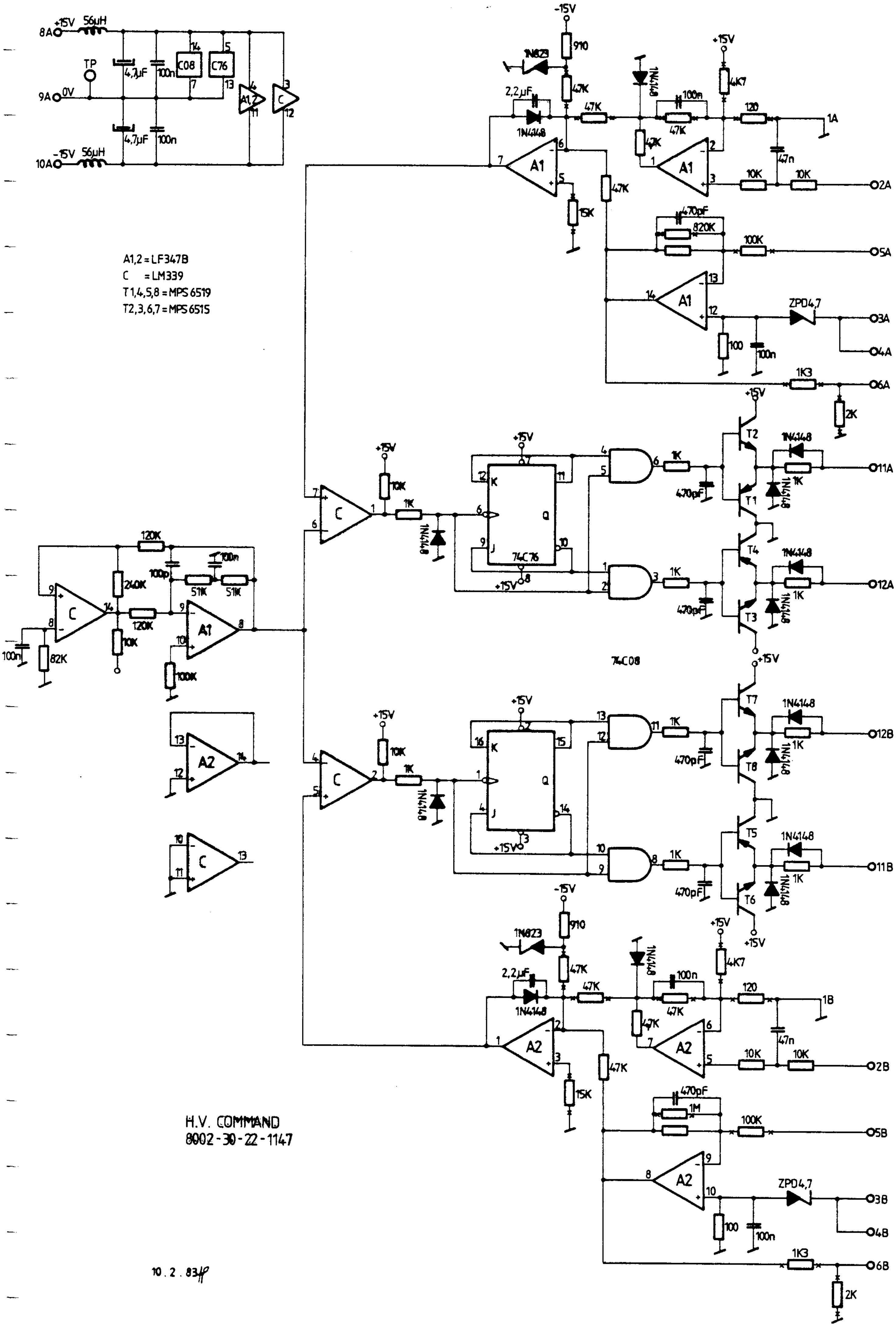
Contrôlé

Original du

Remplace le No

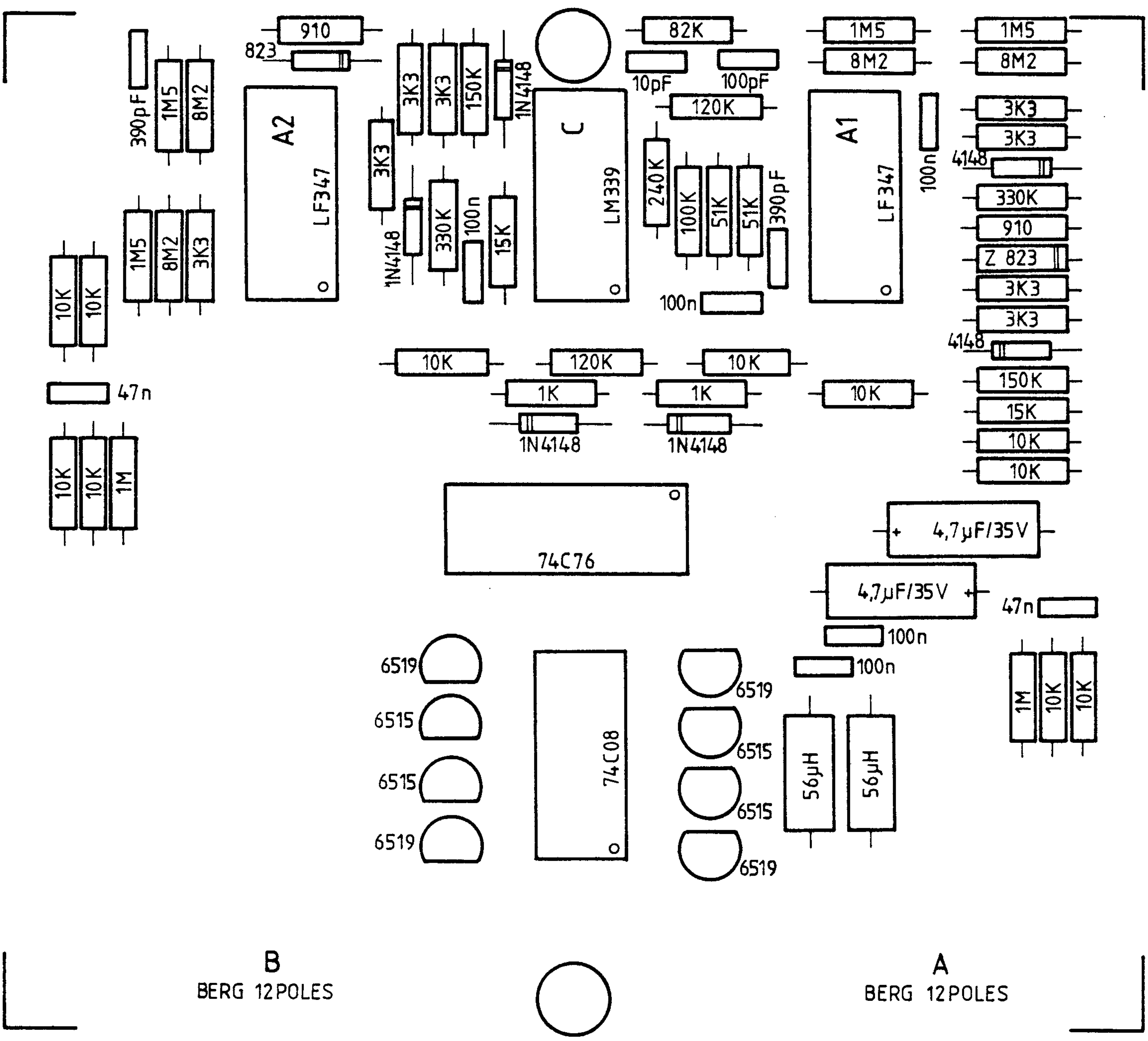
EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1156


A1,2 = LF347B
C = LM339
T1,4,5,8 = MPS 6519
T2,3,6,7 = MPS 6515
8A
9A
10A
TP
+15V
0V
-15V
56μH
4,7μF
100n
C08
C76
74C76
74C08
1N823
1N4148
ZPD4,7
1A
2A
5A
3A
4A
6A
11A
12A
12B
11B
1B
2B
5B
3B
4B
6B
H.V. COMMAND
8002-30-22-1147
10.2.83

4.8.82

H.V. COMMAND
COMPONENT MOUNTING
8002-40-24-1147



Pos.	Nb.	Désignation	Valeur	Type et №	Fournisseur
1	1	Circuit imprimé		8002-30-25-1147	PRINTELEC
2	1	Quad and gate		74C08	FENNER
3	1	Flip Flop JK		74C76	//
4	2	Op amp		LF 347B	//
5	1	Quad comparator		LM 339	//
6	4	Socle 14 pattes		ICT-143-ST	MEGEX
7	1	// 16 //		ICT-163-ST	//
8					
9	2	Résistance 100		MR25/2322 151 51001	PHILIPS
10	2	// 120		// // // 51201	//
11	2	// 910		// // // 59101	//
12	10	// 1K		// // // 51002	//
13	2	// 1K3		// // // 51302	//
14	2	// 2K		// // // 52002	//
15	4	// 4K7		// // // 54702	//
16	7	// 10K		// // // 51003	//
17	2	// 15K		// // // 51503	//
18	8	// 47K		// // // 54703	//
19	2	// 51K		// // // 55103	//
20	1	// 82K		// // // 58203	//
21	3	// 100K		// // // 51004	//
22	2	// 120K		// // // 51204	//
23	1	// 240K		// // // 52404	//
24	1	// 820K		// // // 58204	//
25	1	// 1M		// // // 51005	//
26					
27	1	Cond. céramique 100pF		2222 650 70101	PHILIPS
28	6	// // 470pF		9932 313 00162	//
29	2	// // 47nF		// // 00225	//
30	8	// // 100nF			ASU COMPONENT
31	2	// // 2,2µF		USCC/	CENTRALAB
32	2	Cond. tantale 4,7µF/35V			SPRAGUE/LEITGEB
33					
34	14	Diode		1N4148	ESD/ITT
35	2	Diode zéner		1N 823	MOT/CMNY RAY
36	2	Diode zéner		ZPD 4,7V	ESD/ITT
37					
38	2	Self 56µH			DELAVAN/STOLZ
39	4	Transistor		NPS 6515	FABRIMEX
40	4	//		NPS 6519	//
41	41	Pin			COMATEL
42	1	Barette Berg 36 contacts		75160-105	LEITGEB
43	1	Connecteur Berg 36 contacts		65039-001	//
44	24	Contacts femelle		MINI PV 47712	//

Modifications

liste de pièces

H.V. COMMAND

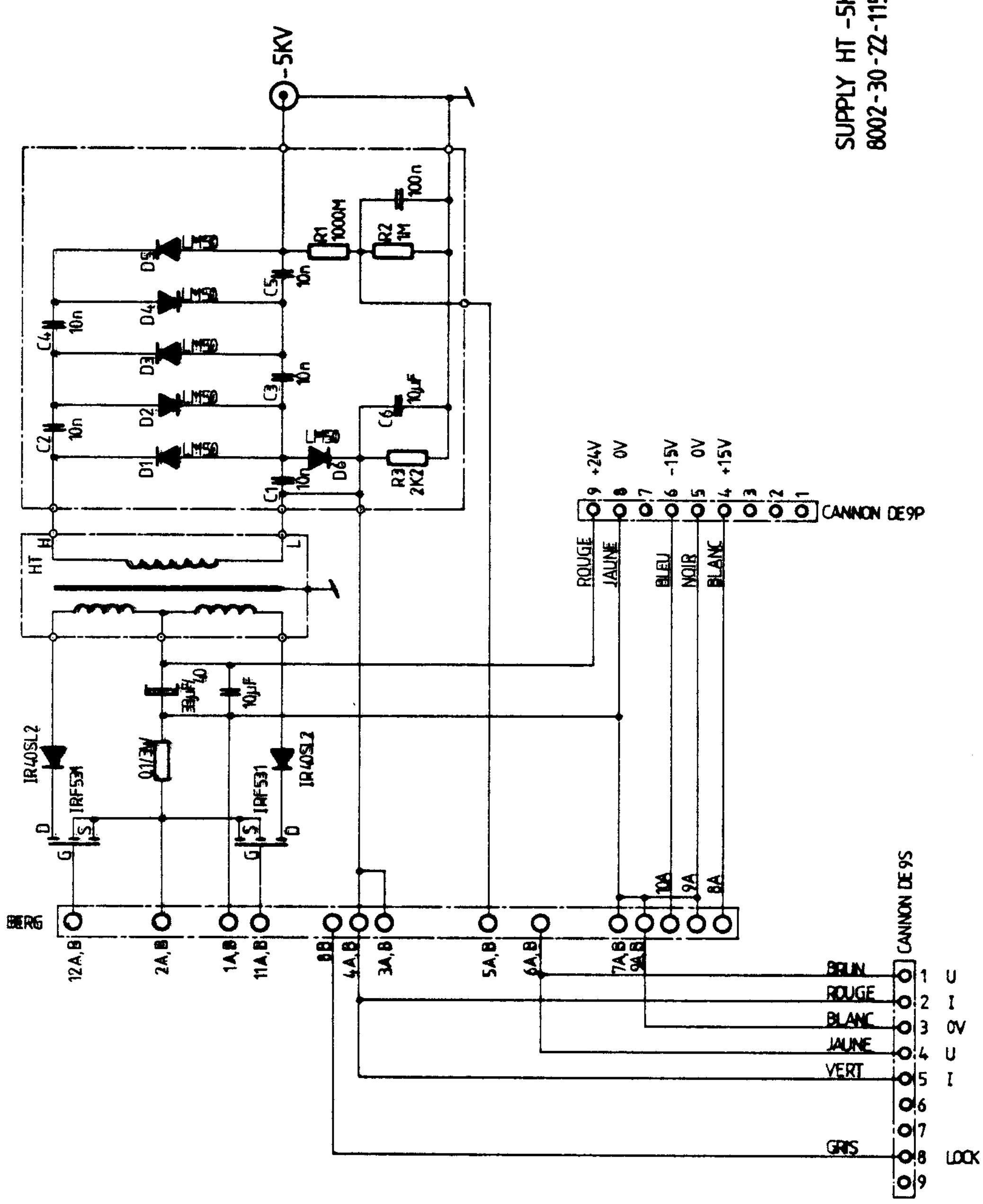
Ecrit : 11. 2. 83
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1147

7.2.83

SUPPLY HT -5KV
8002-30-22-1150



8/68

Pos.	Nb.	Désignation	Valeur	Type et №	Fournisseur
1	1	Plaque latérale		8002-40-12-1150/1	
2	2	" " support		" " " " /2	
3	1	" supérieure		" " " " /3	
4	1	" base		" " " " /4	
5	1	" avant		" " " " /5	
6	1	" arrière		" " " " /5	
7	3	Entretoise		" " " " /6	
8	2	"		" " " " /6	
9	2	"		" " " " /6	
10	2	"		" " " " /5	
11					
12	2	Vis tête cônique fendue		M3x10mm / nickelée	BOSSARD
13	4	Rondelle		M3	"
14	36	Vis tête cônique fendue		M3x8mm / nickelée	"
15	4	Rondelle ressort		M3	"
16	4	Ecrou		M3	"
17	4	Vis tête cônique fendue		M2x 6mm / nickelée	"
18	4	Rondelle ressort		M2	"
19	4	Ecrou		M2	"
20	6	Cosses		2055 Ms / argentée	VOGT
21	4	Entretoise plastic			DISTRELEC
22	4	Feuille Cho-therm		TO-220	
23					
24	4	Diode		1N4148	FAIRCHILD/MOOR
25	4	Varistor		S10K40	SIEMENS/DISTRELEC
26	2	Barette à souder		TS6-10/V34 529	POLAR/EGLI FISCHER
27	2	Transfo			
28	4	Transistor		IRF 531	I. RECTIFIER
29	4	Diode		IR 40SL2	FABRIMEX
30	2	Résistance 0,33Ω/3W		C3A/S13.124	CGS/EGLI FISCHER
31	2	Cond. céramique		10μF/50V	ASU COMPONENT
32	2	" électrolytique		33μF/40V	PHILIPS
33					
34	2	Support isolant+isolation		8002-40-12-1150/7	
35	15	Terminette		12100	HENRY & THOMAS/DAM
36	6	Diode HT		LM50	UNITRODE
37	5	Cond. céramique		10nF/5KV	SEMTECH
38	1	" "		10μF/50V	ASU COMPONENT
39	1	Résistance 1GΩ/5%		MOX-1	VICTOREEN/BAERLOCHER
40	1	" 1M		HR25/2322 151 51005	PHILIPS
41	1	" 1k		" " " 51002	"
42	10	" 10M		VR25/2322 214 13106	"
43	2	Cond. céramique 47nF/50V		9932 313 00225	"
44					

Modifications

liste de pièces

H.V. SUPPLY -5KV

Ecrit : 11.2.83
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02.1150/1

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
45	2	Connecteur BNC/HT 5KV		22SHV-50-0-2	HUBER & SUHNER
46					
47	1	Commande HT		8002-40-02-1147	
48	2	Entretoise isolante		⌀6/⌀8x5mm/Delrin	
49	2	Vis tête cylindrique fendue		M3x10 mm/Nickelée	BOSSARD
50	1	Passe-fil		570.6	JAEGER
51	1	" "		570.7	"
52	1	Câble Alim 50cm		blindé 5x0,40 qm	AUMANN
53	1	" Monitor "		" 8x0,14 qm	"

Réf.

Modifications

liste de pièces

H.V. SUPPLY - 5KV

Ecrit : 11.2.83

Contrôlé

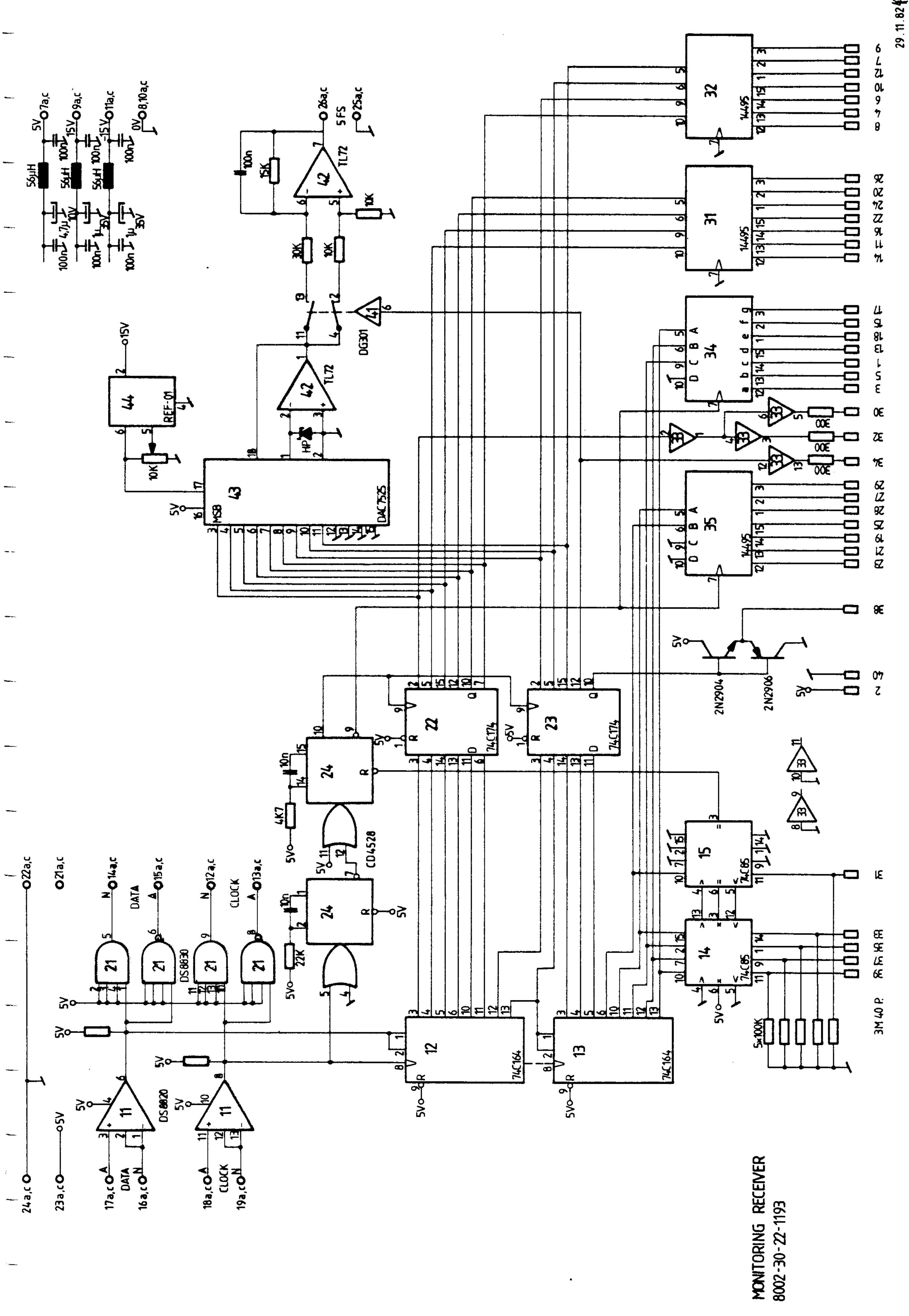
Original du

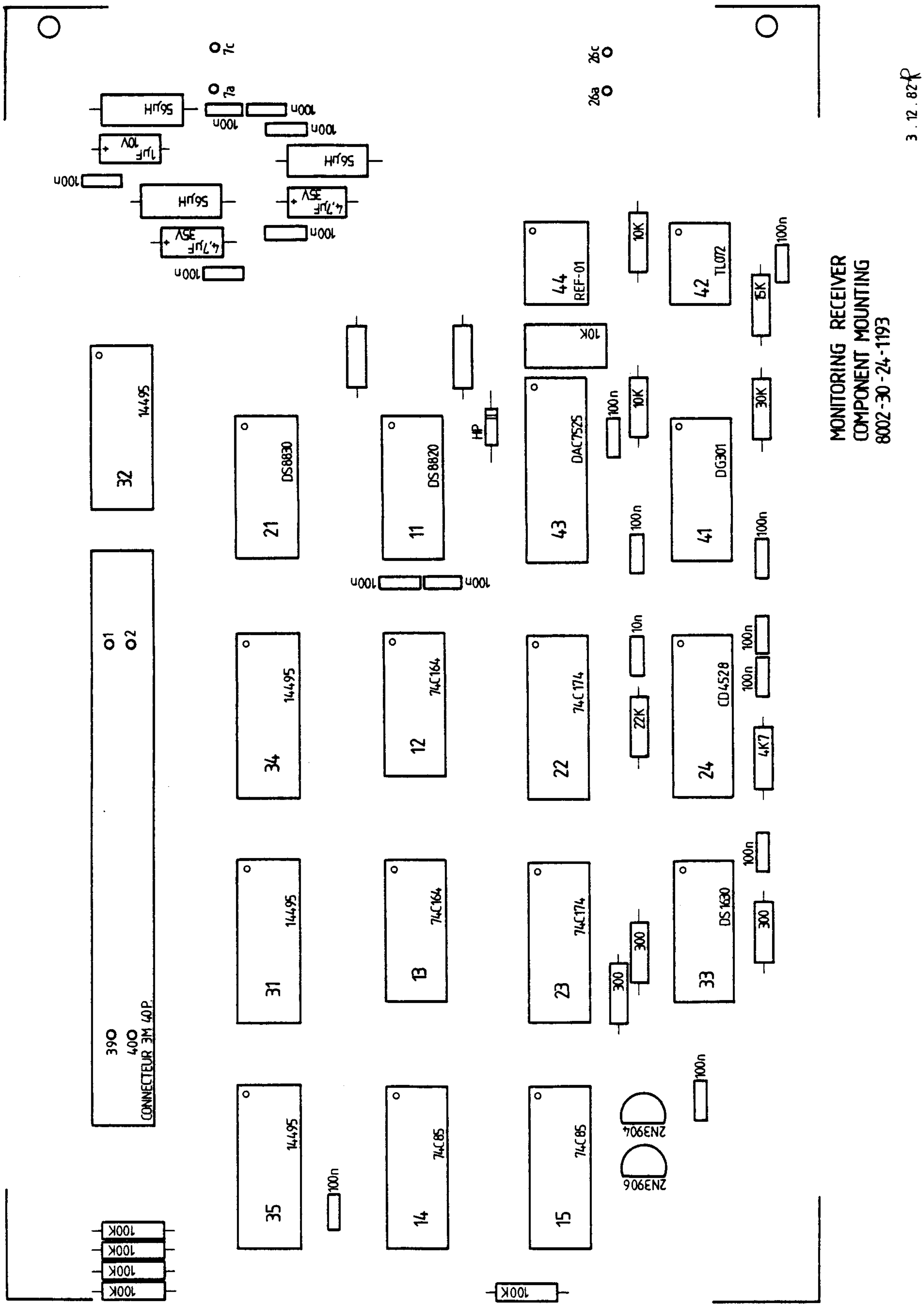
Remplace le No

EBAUCHES SA NEUCHATEL

DEPARTEMENT TECHNIQUE

8002 .40.02.1150/2


29.11.82
MONITORING RECEIVER
8002-30-22-1193
DAC7525
REF-01
TL72
DG301
14495
74C174
74C164
74C85
CD4528
DS8830
DS8820
2N2904
2N2906
DATA
CLOCK
5x100K
3M 40 P.


MONITORING RECEIVER
COMPONENT MOUNTING
8002-30-24-1193
3.12.82
CONNECTEUR 3M 40P.
14495
DS8830
DS8820
DAC7525
DG301
REF-01
TL072
74C164
74C174
CD4528
DS1630
74C85
2N3906
2N3904
56µH
1µF 10V
4,7µF 35V
100n
10n
10K
15K
30K
22K
4K7
300
100K
HP

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1193	PRINTELEC
2	2	4bit Magnitude Comparator		MM74C85N	FENNER
3	2	8bit Parallèle OUT		MM74C164N	"
4	2	Hex D Flip Flop		MM74C174 N	"
5	1	Dual monostable		CD 4528 BCN	"
6	1	Hex Buffer		DS 3630 N	"
7	1	Dual line receiver		DS 8820 N	"
8	1	Dual Differential		DS 8830 N	"
9	4	Decoder		MC 14495P	MOTOROLA
10	1	Switch		DG 301 CJ	SILICONIX
11	1	Convertisser		AD 7525 KN	ANALOG DEVICE
12	1			TL072CP	FABRIMEX
13	1	Voltage référence		REF-01	BOURNS
14	2	Socle 8 bottes		ICT-083-ST	MEGEX
15	6	" 14 "		ICT-143-ST	"
16	9	" 16 "		ICT-163-ST	"
17	1	" 18 "		ICT-183-ST	"
18	3	Résistance 300		MR25/2322 151 53001	PHILIPS
19	1	" 4K7		" " " 54702	"
20	2	" 10K		" " " 51003	"
21	1	" 15K		" " " 51503	"
22	1	" 22K		" " " 52203	"
23	1	" 30K		" " " 53003	"
24	5	" 100K		" " " 51004	"
25	1	Cond. céramique 10nF			ASU COMPONENT
26	17	" " 100nF			" "
27	1	Cond. tantale 1µF/10V			SIEMENS
28	2	" " µF/35V			"
29	3	Self Delavan 56µH			STOLZ
30	1	Diode HP			BAERLOCHER
31	1	Transistor. 2N 3904		2N3904	MOTOROLA
32	1	" 2N 3906		2N3906	"
33	1	Potentiomètre 10K			CONTELEC
34	1	Connecteur 3M 40 pôles			3M
35	1	" Litton 2x32 pôles			LITTON
36	2	Vis tête cylindrique fendue		M2,5 x 6mm/nickelée	BOSSARD

Modifications

liste de pièces

RECEPTEUR 'MONITORING'

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02.1193

Réf.

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Magasin à carte [81T]	Mod. 68T	11-160-31	ELMA
2	4	Bande taraudée M3	Mod. 68T	63-065	"
3	9	Connecteur DIN 41612		96S-6033-0522-3	LITTON
4	18	Vis tête cylindrique fendue		M2,5x6mm / Nickelée	BOSSARD
5	18	Rondelle ressort		M2,5	"
6	22	Guide carte		63-028	ELMA
7	10	Vis tête cylindrique en croix		M3x8mm	BOSSARD
8					
9	2	EURO CARD 24V	Con. a+c	E30B24	POLYAMP/ECG
10	1	" " ±15V	" "	E30B15-15	" "
11	1	" " 5V±15V	" "	E30B5S15-15	" "
12					
13	1	Alim. Battery		8002-40-02-1161	
14	1	Codeur		8002-40-02-1163	
15	1	Contrôl		8002-40-02-1162/1	
16	1	Monitoring		8002-40-02-1155	
17					
18	2	Circuit imprimé		8002-30-25-1164 A	
19	1	" "		" " " " B	
20	1	" "		" " " " C	
21	1	" "		8002-30-25-1165 A	
22	1	" "		" " " " B	
23	1	" "		" " " " C	
24	1	" "		" " " " D	
25					
26	93	Plot à fourche		537.24	JAEGER
27	37	Cosse AMP		V30.258	AMP/EGLI FISCHER
28					
29	1	Panneau frontal rabattable		8002-40-12-1189/1	
30	2	Led verte		MV 5253	GI/MOOR
31	2	Support led		MP52	"
32	2	Connecteur cyl. Série 97		MS3102A 14S5P	AMPHENOL/HIRT
33	8	Vis tête cylindrique en croix		M3x8mm	BOSSARD
34	8	Rondelle ressort		M3	"
35	8	Ecrou		M3	"
36					
37	1	Raccord		RGØB.303C.A222	LEMO
38	1	Sonde Tamb.		8002-40-02-1190	
39					
40	1	Plaque d'interconnection		8002-40-12-1189/2	
41	4	Entretoise		556.310	JAEGER
42	8	Vis tête cyl. en croix		M3x8	BOSSARD
43	8	Rondelle ressort		M3	"
44	4	Rondelle		M3	"

Modifications

liste de pièces

BOITIER ELECTRONIQUE

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1189/1

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
45	5	Connecteur "D" cannon		DE 9S	KONTAKTSYSTEME
46	2	" "		DE 9P	" "
47	7	Verrouillage		DE 51224-1	" "
48	1	Connecteur "D" Cannon		DA 15S	" "
49	1	Verrouillage		DA 51220-1	" "
50	1	Connecteur "D" Cannon		DB 25S	" "
51	1	Verrouillage		DB 51221-1	" "

Réf.

Modifications

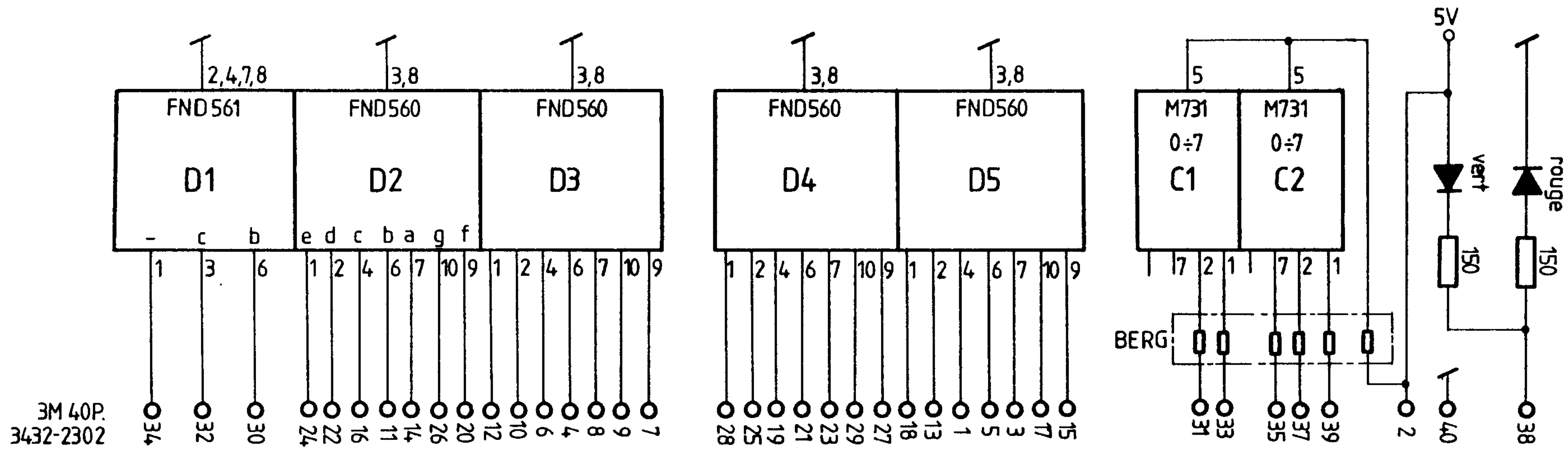
liste de pièces

BOITIER ELECTRONIQUE

Ecrit :
Contrôlé
Original du
Remplace le No

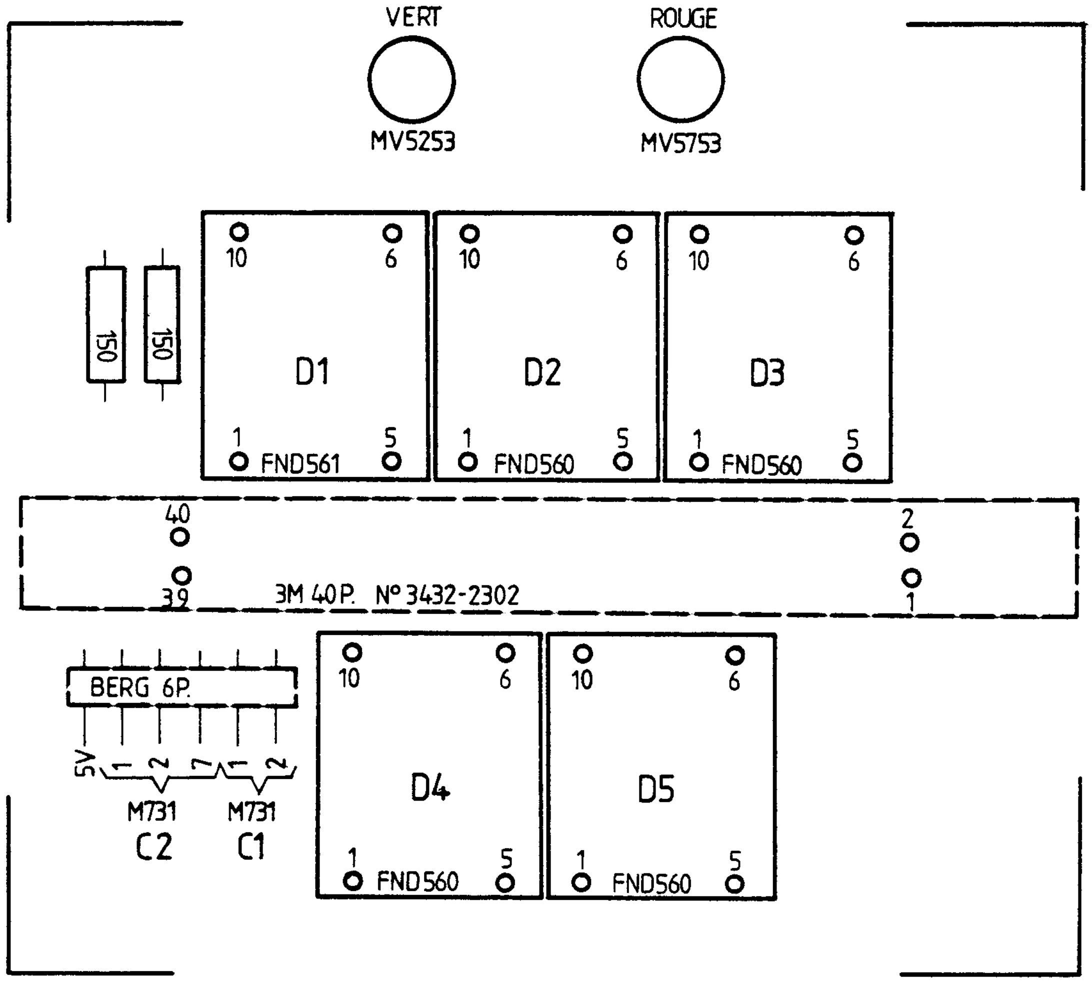
EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1189/2



RECEIVER READOUT
8002-40-22-1154

19.11.82



RECEIVER READOUT
COMPONENT MOUNTING
8002-40-24-1154

19.11.82

Pos.	Nb.	Désignation	Valeur	Type et Nº	Fournisseur
1	1	Circuit imprimé		8002-30-25-1154	PRINTELEC
2					
3	1	Display		FND 561	
4	4	"		FND 560	
5					
6	1	Connecteur 2x20		3432-2302	3M
7	1	Broche 90° 1x6		75168-113/06012 160	BERG/LEITGEB
8	1	Boîtier à ver. 1x6		65039-027/06212 201	" "
9	6	Mini PV		47712/06012 250	" "
10					
11	2	Résistance 150		MR25/2322 151 51501	PHILIPS

Réf.

Modifications				

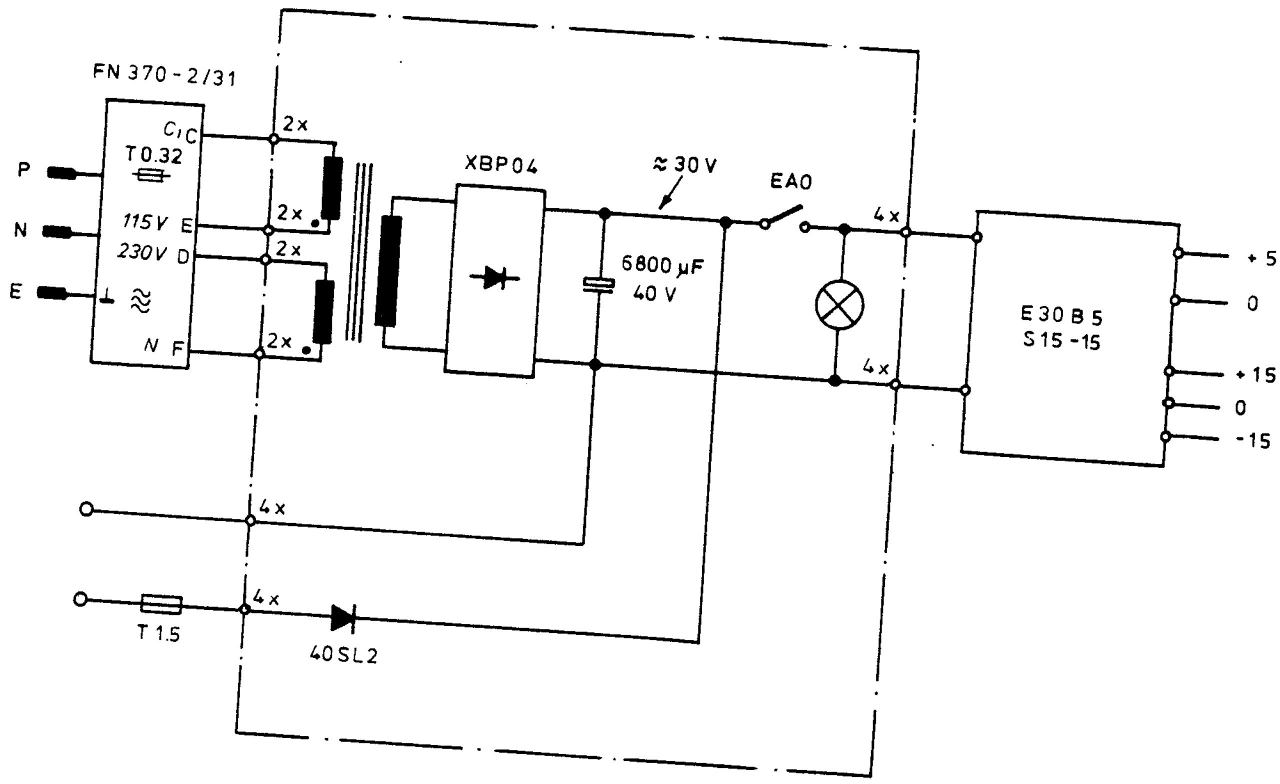
liste de pièces

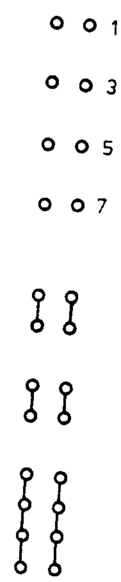
AFFICHAGE "RECEPTEUR"

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02. 1154





Supply monitoring

Pos.	Nb.	Désignation	Valeur	Type et №	Fournisseur
1	1	Carte VERO Europe			ITT/ESD
2	1	Transfo. toroidale			
3	1	Redresseur KBP04			
4	1	Cond. électrolytique 6800µF/40V			PHILIPS
5	1	Diode		40SL2	
6	1	Connecteur Litton 2x32pôles		96P-6033-0523-0	EGLI FISCHER
7					
8	1	Panneau			ELMA
9	1	Interrupteur EAO 01-261		22 0009	DISTRELEC
10	1	Calotte rouge EAO 01-901		22 0021	"
11	1	Lampe téléphone 24V		25 0014	"
12	1	Clapet pivotant		22 0085	"

Réf.

Modifications

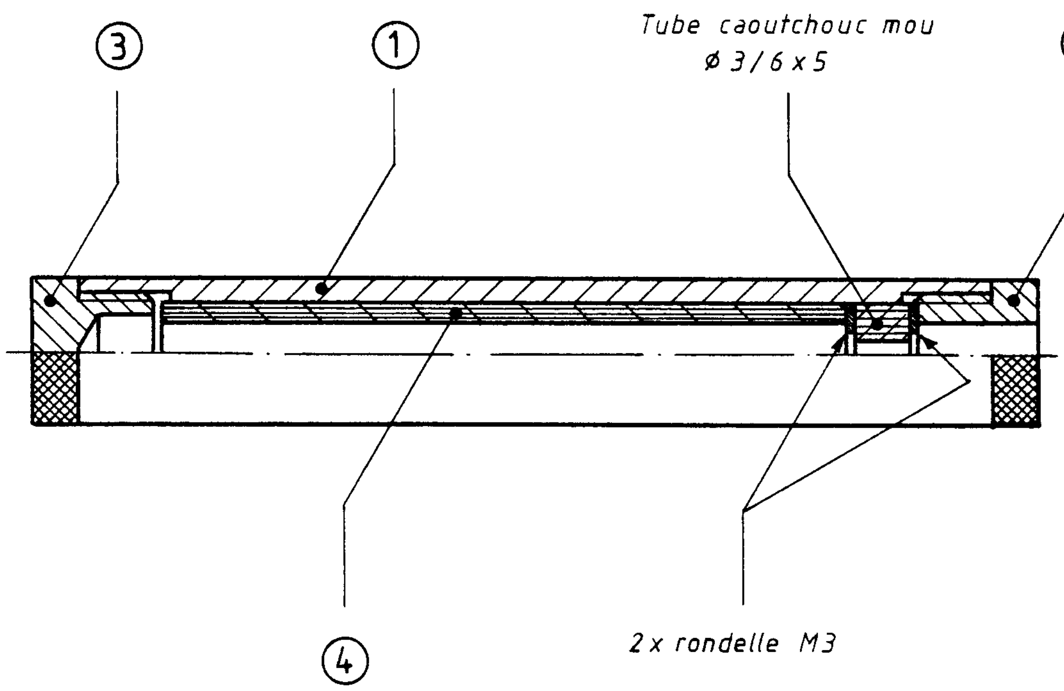
liste de pièces

CARTE TRANSFORMATEUR (MONITORING)

Ecrit :
Contrôlé
Original du
Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

.40.02.



2 : 1

Sonde Tamb. 8002-40-10-1190

Pos.	Nb.	Désignation	Valeur	Type et N°	Fournisseur
1	1	Boîtier			
2	1	Bouchon serre-joint		8002-40-12-1190/1	
3	1	"		" " " " /2	
4	1	Entretoise		" " " " /3	
5	1	Serre-joint		" " " " /4	
6	2	Rondelle		Caoutchouc mou ϕ6/ϕ3x5	
7				M3	BOSSARD
8	1	TEMP TRANCDUCER		AD 590 JH	ANALOG DEVICES
9	1	Câble 3m			
10	1	Fiche		FGØB. 303C. GØ25	LEMO

Réf.

Modifications

liste de pièces

SONDE DE TEMPERATURE

Ecrit :

Contrôlé

Original du

Remplace le No

EBAUCHES SA NEUCHATEL

DEPARTEMENT TECHNIQUE

8002 .40.02. 1190

C O N N E C T O R "SYNTH. DIV."
****

	MULTISWITCH M861S		
1a, c	NC		
2a, c	BLACK	COMMON	
5a	YELLOW	4	LSD
5c	GREY	8	
6a	BROWN	1	
6c	RED	2	
7a		4	
7c		8	
8a		1	
8c		2	
9a		4	
9c		8	
10a		1	
10c		2	
11a		4	
11c		8	
12a		1	
12c		2	
13a		4	
13c		8	
14a		2	
14c		1	
15a		4	MSD
15c		8	
16a		2	
16c		1	
17a	NC		
17c	"		
18a	"		
18c	"		
19a	"		
19c	"		
20a	"		
20c	"		
21a	"		
21c	"		
23a	"		
23c	"		

Pos.	Nb.	Désignation	Valeur	Type et N°	Fournisseur
1	1	Circuit imprimé		8002-30-25-1163	PRINTELEC
2	1	Connecteur DIN 41612		96P-6033-0523-0	LITTON
3	2	Vis tête cylindrique fendue		M2,5x10mm/Nickelée	BOSSARD
4	2	Écrou		M2,5	"
5					
6					
7					
8					
9					
10	1	Panneau frontal		8002-40-12-1163	
11	1	Poignée		9511.67	JAEGER
12	2	Vis tête cylindrique		M3x8mm	BOSSARD
13	4	Vis tête cylindrique fendue		M2,5x6mm/Nickelée	"
14	4	Rondelle ressort		M2,5	"
15					
16	6	Multiswitch		M861S	CONTRAVES
17	3	"		M000	"
18	1	Equerre latérale		MV5	"
19	1	" "		MW5	"
20	2	Tige filetée		M2x80mm	"
21	2	Écrou fendu		M2	"
22	3	Goupille de blocage		ϕ5x5 /PVC	

Réf.

Modifications

liste de pièces

CODEURS

Ecrit :
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Remplace le No

EBAUCHES SA NEUCHATEL
DEPARTEMENT TECHNIQUE

8002 .40.02.1163