STORNO RADIOCOMMUNICATION

**POCKET
RADIOTELEPHONE
MODEL
STORNOPHONE 500
TYPE CQP511
TYPE CQP512
146...174 Mc/s**

Storno

POCKET RADIOTELEPHONE MODEL STORNOPHONE 500 TYPE CQP511 TYPE CQP512 146...174 Mc/s

GENERAL SPECIFICATIONS

Frequency Range	146-174 Mc/s	
Antenna Impedance	50 Ω nominal	
Minimum Channel Spacing	CQP511: 50 kc/s	CQP512: 25 kc/s
Frequency Stability -15°C to +50°C	Better than ±5 kc/s	Better than ±3 kc/s
Max. Frequency Deviation	±15 kc/s	±5 kc/s
Max. total Bandwidth	1400 kc/s	
Number of RF-Channels	Max. 3	
Overall dimensions, cabinet	196 x 72 x 33 mm	
Weight	750 grams	

TRANSMITTER SPECIFICATIONS

RF-Output Power	500 mW nominal
Modulation	Phase modulation 300 ... 3000 c/s
Modulation Response	6 dB/octave pre-emphasis 300 ... 3000 c/s +1, -3 dB
Spurious and Harmonic Radiation	Less than 2×10^{-7} W
Quartz Crystal TX	Storno type 98-8, spec. S-98-8
Transistors and Diodes	OC306/2, AF106, AF121, AF124, AF126, 2N1142, 2N1693, BSY39, BZY61 and OA200

RECEIVER SPECIFICATIONS

Sensitivity (1/2 emf)	0, 5 uV at 12 dB signal-to-noise ratio (EIA)
Squelch	Electronic, adjustable, opens at less than 0. 3uV 1/2 emf
Adjacent Channel Selectivity	80 dB (EIA two-signal method)
Spurious Radiation	Less than 2×10^{-9} W
Intermodulation	Attenuated more than 60/80 dB (EIA)
Quartz Crystal RX	Storno type 98-9, spec. S-98-9
AF-Output Power	200 mW
Transistors and Diodes	AF106, AF126, AC127, AC132, BCZ13, AA119, BZY57

BATTERY SPECIFICATIONS

Type	Storage battery NiCd, Storno BU501	
Capacity	10 cells, 12, 4 V nominal, 225 mAh	
Current Consumption	Stand-by	8, 5 mA
	Open squelch	9. . . 40 mA
	Transmitting	120 mA

CHAPTER I. GENERAL DESCRIPTION AND OPERATING INSTRUCTIONS

A. Model STORNOPHONE 500

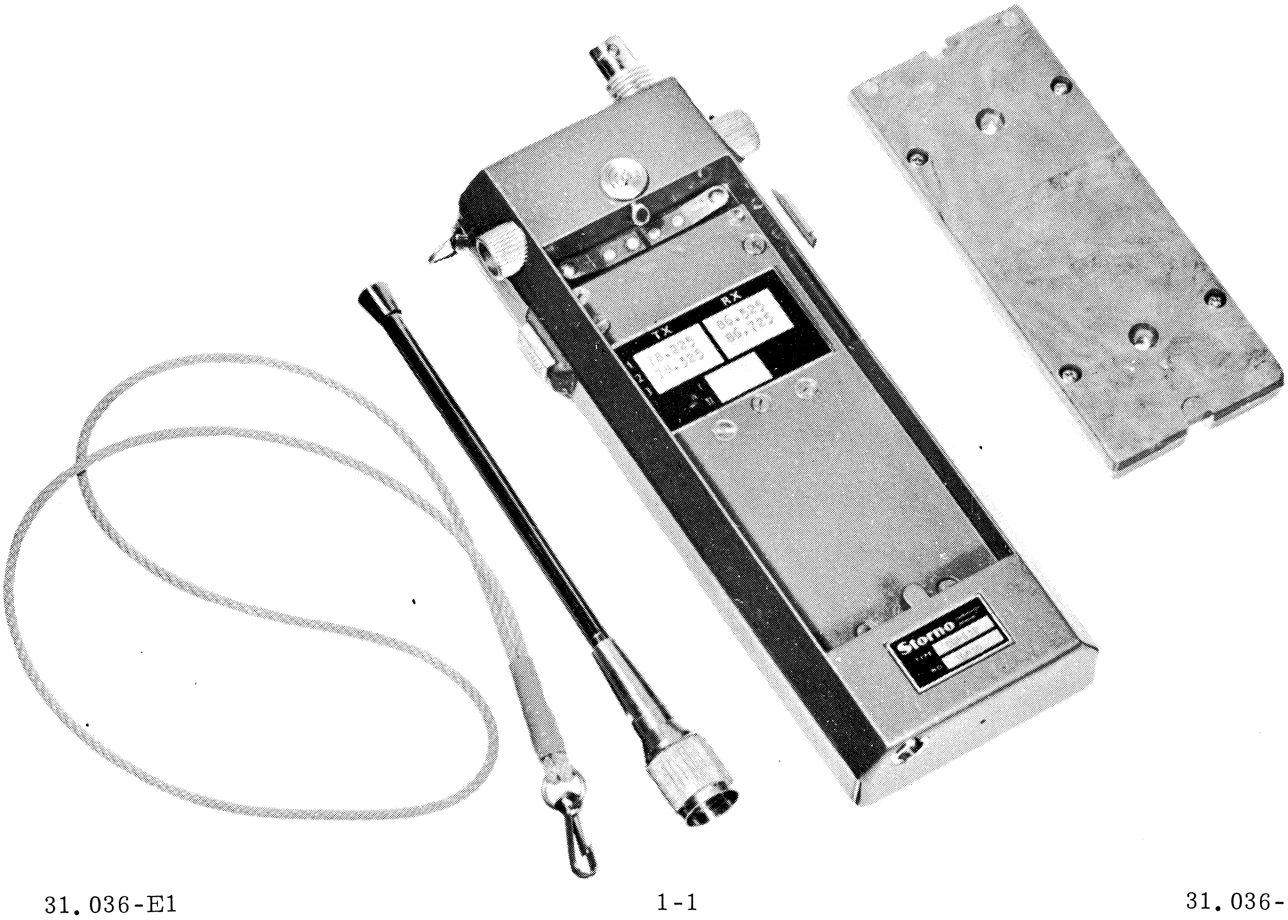
Introduction

The STORNOPHONE 500 portable radiotelephone - type CQP511 and type CQP512 - is a transmitter/receiver for VHF FM radio communication on fixed crystal-controlled channels in the frequency range 146 ... 174 Mc/s.

The complete radiotelephone comprises a transmitter/receiver cabinet containing a speaker-microphone, a nickel-cadmium storage battery, transmitter and receiver circuits, and control knobs. A telescoping antenna and a short sling are also supplied. Standard accessories for special applications, such as whip antenna, lapel microphone, carrying case, tone transmitter, etc. are available. Also available are different types of charging units for nickel-cadmium storage batteries.

Both the radiotelephone and the various types of standard accessories are described in detail in this technical manual. If a special version of the radiotelephone has been supplied, descriptions and circuit diagrams of the modifications in question will be found inserted at the end of this manual or in a separate manual.

We at STORNO are constantly processing the experience we acquire during the production and operation of our radiotelephones. Minor modifications will therefore be made continually, and all information given in this manual must therefore be subject to the reservations that are a necessary consequence of this policy. However, any corrections and modifications that may be made will - as far as is practically possible - be printed on a special supplement and amendment sheet which will be inserted as the last page of this manual.



 Storno

Chapter I. General Description

STORNOPHONE 500 radiotelephones meet the technical specifications which the telecommunication departments of a number of countries have made a condition for type approval of VHF radio equipment, and this portable radiotelephone may therefore be used in conjunction with existing VHF FM radio systems.

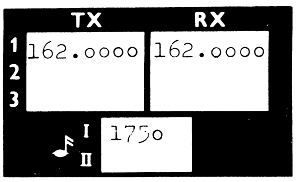
Standard versions of the STORNOPHONE 500 are tabulated below:

Type	Frequency Range	Channel Sep.
CQP511	146 .. 160/156 .. 174 Mc/s	50 kc/s
CQP512	146 .. 160/156 .. 174 Mc/s	25 kc/s
CQP531	68 .. 78/77 .. 88 Mc/s	50 kc/s
CQP532	68 .. 78/77 .. 88 Mc/s	25 kc/s

This technical manual covers only the two first-mentioned types.

The type plate at the bottom of the rear wall of the radiotelephone states its type designation and serial number. These should always be quoted in all communications to STORNO concerning the radiotelephone in question. A type plate with type designation and serial number is shown below.

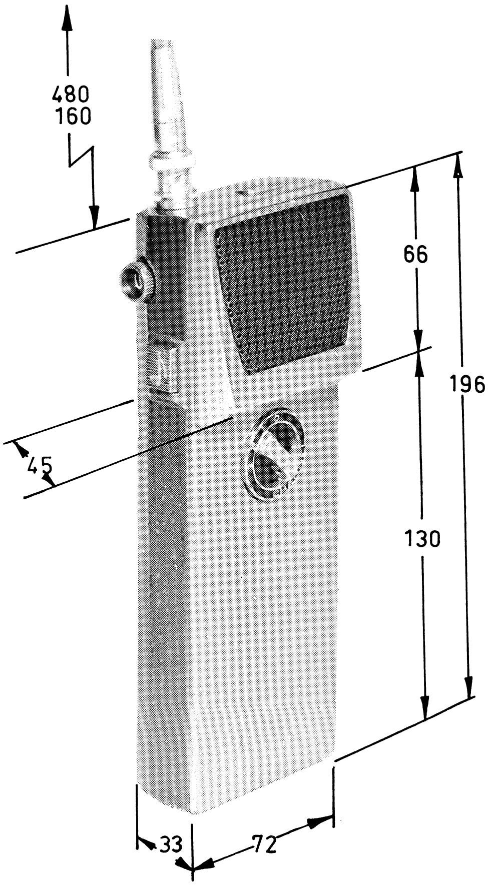
A frequency chart carrying the frequency specifications of the transmitter and the receiver is affixed to the bottom of the battery receptacle. For each channel provided in the radiotelephone, two frequencies are listed - a transmitting frequency and a receiving frequency. The frequency chart also has a space in which the tone frequencies of a built-in tone transmitter may be specified. For single-tone transmitters, the "I" space will be filled in whilst for double-tone transmitters both the "I" space and the "II" space will be filled in. A typical frequency chart is shown below.



Construction

The radiotelephone cabinet proper is of pressure-diecast light-alloy metal. This reduces weight to a minimum with no sacrifice of ruggedness - an important point as portable equipment must be capable of withstanding fairly robust handling. The metal cabinet also provides efficient shielding from electrical interference. This feature is very valuable in cases where the radiotelephone is used in localities with powerful electrical fields (industrial areas etc.).

The radio circuits are built on small printed-wiring boards which are mounted in small metal cans to facilitate service and provide best possible mutual shielding. Miniaturization and the modular type of construction employed mean rational space utilization and an exceedingly high order of ruggedness. However, it is obvious that there are limits to how robust handling a STORNOPHONE 500 can take. In practice it should be treated like a camera. Its resistance to impacts and robust treatment will be appreciably higher if it is placed in the carrying case.



The cabinet is designed so that it can be carried in the usual type of uniform breast pocket. The antenna is placed on the cabinet in such a manner that it will be most convenient to carry the radiotelephone in the left breast pocket. The radiotelephone will then be removed from the pocket with the right hand whereupon it is immediately ready for operation; besides, the antenna will cause no inconvenience to the operator when placed in this manner. However, the radiotelephone may also be fastened to a belt, in which case it will be carried in a special leather case.

The radiotelephone cabinet is splashproof and dustproof, and the relatively modest amount of heat generated by the transistors is dissipated through the metal surface of the cabinet. The radiotelephone is splashproof even with the battery removed. This means that battery replacement may be performed anywhere - also in rainy weather - and without use of tools.

STORNOPHONE 500, Standard Version

The standard version of the STORNOPHONE 500 consists of these components:

Transmitter/receiver cabinet, equipped with from one to three channels	CQP5xx
Telescoping antenna (90.132) with matching network (41.146)	AN511
Short sling with snap hook	49.096
Nickel-cadmium battery, 10 cells, 12,4 V, 225 mAh	BU501

B. Accessories

Standard Accessories

The following items and standard accessories may be supplied on special order:

Whip antenna (90.145) with matching network (41.146)	AN512
Nickel-cadmium battery, 10 cells, 12.4V, 225 mAh	BU501
Earphone with headband, cord, and plug, for use in cases where reception through microphone-speaker is undesirable (police) or impossible due to high ambient noise level	HP501
Lapel microphone for use in cases where it is not desirable to remove the STORNOPHONE 500 from the carrying case or breast pocket for every transmission	MC501
Single-tone transmitter unit for installation in the radio cabinet	TT501
Screw-on pocket clip for mounting on the radio cabinet to protect the radiotelephone from falling out of the pocket ([illegible])	49.105 00 00 ~~49.094~~
Case of black leather with sling and straps for attachment to belt, and with a case for the telescoping antenna	49.100
Charging unit for max. 10 battery outlets	CU501
Charging unit for max. 10 battery outlets and with automatic timer to permit the batteries connected to it to be charged for a predetermined number of hours	CU502
Charging unit for max. 2 battery outlets	CU503
Battery outlets for CU501 and CU503	15.001
Battery outlets for CU502	15.002

Tone receivers or additional selective tone equipment cannot be installed in the cabinet, but will be supplied in a separate cassette, which connects to the radio cabinet via a multi-conductor cable. Such special-purpose tone equipment will normally be described in a separate technical manual.

Service

The organization of a preventive maintenance procedure is of material importance in securing that the radiotelephone will be capable of peak performance under all conditions. Chapter IV contains a detailed description of maintenance and repairs of the radiotelephone. The correct procedure in making adjustments is described in detail in chapter V.

The consistent miniaturization of the circuits of this radiotelephone makes it absolutely necessary for service technicians to study and follow the directions given in this technical manual if satisfactory results are to be obtained.

When ordering spare parts, all pertinent information about the spare part desired should be written on the order form, which will preclude mistakes on the part of the staff. Orders for spare parts should therefore normally state: STORNO code number, diagram designation, size, type designation of module unit, and type designation and serial number of the radiotelephone.

C. Operation

Operating Instructions

Operation of the STORNOPHONE 500 portable radiotelephone is simple. Nevertheless, the user is advised to devote a few minutes to a study of the correct operating procedure.

Receiving

1. Pull the telescoping whip out to full length.
2. Turn the SQUELCH knob all the way to the left (counter-clockwise).
3. Set the CHANNEL selector to the desired channel.
4. Set the VOLUME knob to a convenient speaker volume, judging by the hiss, or by traffic (if any) on the channel.
5. Find the correct setting of the SQUELCH control with no traffic on the channel. Carefully turn the knob to the right (clockwise) until the hiss only just disappears.

Because the receiver is very sensitive it will under favourable conditions be possible to receive signals with the telescoping antenna fully collapsed. However, the telescoping antenna should always be pulled out to full length while transmitting.

Transmitting

1. Pull the telescoping antenna out to full length.
2. Set the CHANNEL selector to the desired channel.
3. The pocket radiotelephone is now ready to transmit, and if the receiver has been adjusted as explained above it will be possible to hear if there is traffic on the channel selected. Do not begin to transmit until existing traffic has ceased.
4. Press the TRANSMIT button whilst holding the pocket radiotelephone 5 - 10 cm from the mouth, with the antenna vertical. Speak distinctly at ordinary voice intensity. Be sure to release the TRANSMIT button when you want to receive.
5. If the pocket radiotelephone is equipped with a tone transmitter, a calling tone will be transmitted automatically when the TRANSMIT and TONE buttons are depressed at the same time.

CAUTION: Do not key the transmitter unless the antenna is in its place and pulled out to full length.

To switch off the station after use, set the CHANNEL selector to the 0 position.

Battery

A nickel-cadmium can be charged at least 500 times without appreciable reduction of its capacity. Ambient temperature, on the other hand, very markedly affects the capacity, which decreases with decreasing temperature. However, the battery may be used at temperatures as low as -25°C, but its capacity will then be only about half of what it is at room temperature.

If reception is weak and unsatisfactory, and the reason is not poor conditions of reception, the state of charge of the battery should be checked. This is done by depressing the TONE button only, thereby cutting in the charge indicator lamp at the bottom of the cabinet. If the brightness of the lamp decreases during a period of 20 to 30 seconds, or if it does not show light at all, the battery may be assumed to be almost discharged, and it should then be charged or replaced by a charged battery.

To remove the battery from the cabinet, press the slide button on the rear of the cabinet upwards, whereupon the battery can be tipped outwards. The battery can be inserted in one way only.

The recommended charging current is the current that will discharge the battery in 10 hours - approx. 23 mA for this battery type. However, approx. 14 hours will be required for charging a fully discharged battery, due to the fact that the efficiency when charging is approximately 70 per cent. Overcharging the battery should obviously be avoided, but the battery will not normally be permanently damaged by being charged for up to twice the prescribed charging time. Thus, a fully charged battery will not be permanently damaged by being charged for an additional 14 hours even though repeated overcharging will reduce its capacity and shorten its usable life.

The discharge time obviously depends on the particular nature of service for which the pocket radiotelephone is employed, but the percentagewise distribution tabulated below should serve as a guide for the great majority of cases:

10 % transmitting at 130 mA
80 % standby at 8 mA
10 % Squelch open, average 16 mA.

Consequently, average power consumption per working hour will be approx. 21 milliampere-hours, corresponding to a total working time of $\frac{225}{21}$ hours = 10.7 hours with a fully charged battery.

While receiving, the battery voltage will keep faily constant until the battery is almost discharged, when the voltage drops quite suddenly. However, when exposed to heavy loads, as will be the case while transmitting, the battery voltage will decrease somewhat during the last hours of the discharge period.

The Ni-Cd battery are charged in a type CU50x charging units, which is manufactured in different versions. These are described in detail in Chapter III of this technical manual. It should also be kept in mind that a certain amount of self-discharge occurs in the batteries.

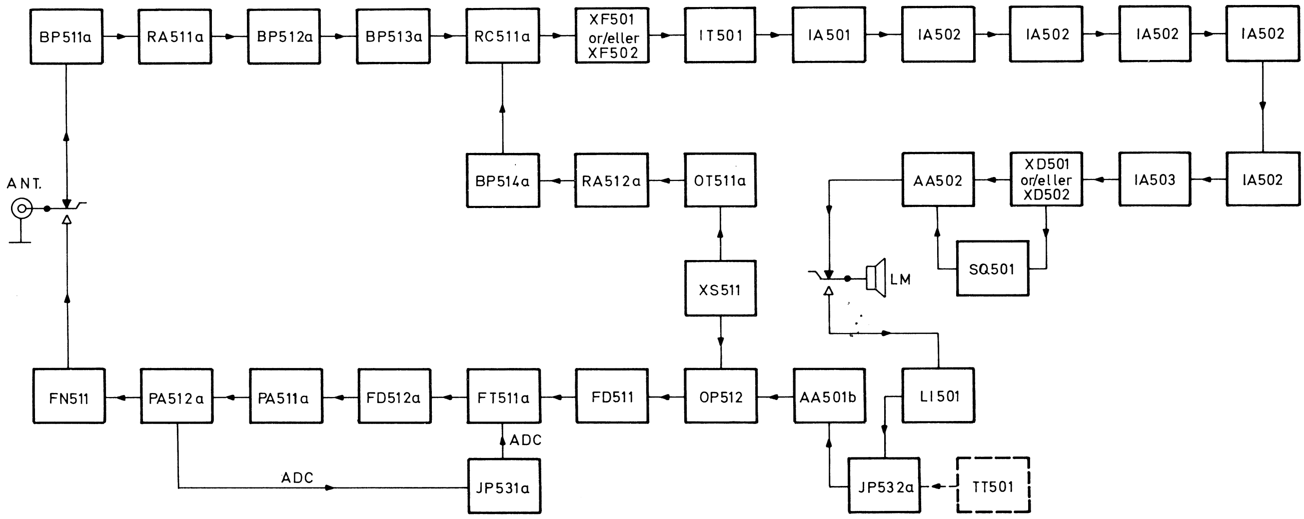
Communication

Due to the missing ground plane the antenna of the pocket radiotelephone is not so efficient as a comparable mobile antenna. However, this slight disadvantage can be offset by choosing a suitable site. Note also that it is important that the antenna be held vertical.

Range in practice depends materially on the nature of the surrounding terrain and on whether communication is to be with another pocket station, a mobile station, or a base station. Also, extended range will be obtained with the pocket radiotelephone placed on, say, the roof of a car, which will improve the effectiveness of the antenna.

In practice, the best sites have been found to be hilltops and high locations in general; near windows in buildings; in street intersections; and in cars, where the antenna can be put out of the window. Reduced range will be obtained from basements; ferro-concrete buildings; iron-frame bridges; dense woods; narrow streets; etc.

CHAPTER II. THEORETICAL CIRCUIT ANALYSIS



A. Transmitter Section

Construction

The transmitter section consists of the following standard modular units:

LI501	Limiter unit consisting of two transistor stages.
AA501b	Filter/amplifier unit for audio signals, consisting of a filter and two transistor stages.
OP512	Oscillator/phase-modulator unit.
FD511	Frequency doubler unit containing a transistor multiplier stage.
FT511a	Frequency tripler unit containing a transistor multiplier stage.
FD512a	Frequency doubler unit, containing a transistor multiplier stage.
PA511a	Driver stage, containing a transistorized straight amplifier.
PA512a	RF output stage consisting of a transistorized power amplifier stage.
FN511	Transmitter filter consisting of a band-pass filter for suppressing undesired radiation.
ADC	Automatic drive control to protect the RF output transistors against overload.

The individual transmitter modules are described in detail in the following pages. Complete circuit diagrams of the pocket radiotelephone and a sketch of the location of components on the printed wiring boards will be found on the last pages of this manual together with complete parts lists.

Coverage of the full frequency range requires minor alterations of coils and capacitors in the tuned circuits of some of the modular units. Such units have a letter added to their type designations, either H (high sub-band) or L (low sub-band). This division corresponds, in terms of output frequency, to 146 ... 160 Mc/s (L) and 156 ... 174 Mc/s (H).

Audio Section (LI501 and AA501b)

The audio section of the transmitter consists of an LI501 speech limiter unit and an AA501b filter/amplifier unit. The primary function of these units is to amplify the microphone output voltages to a suitable level and to limit that level at loud microphone signals so that the maximum permissible frequency swing will not be exceeded. Also, the audio section serves the purpose of shaping the frequency re-

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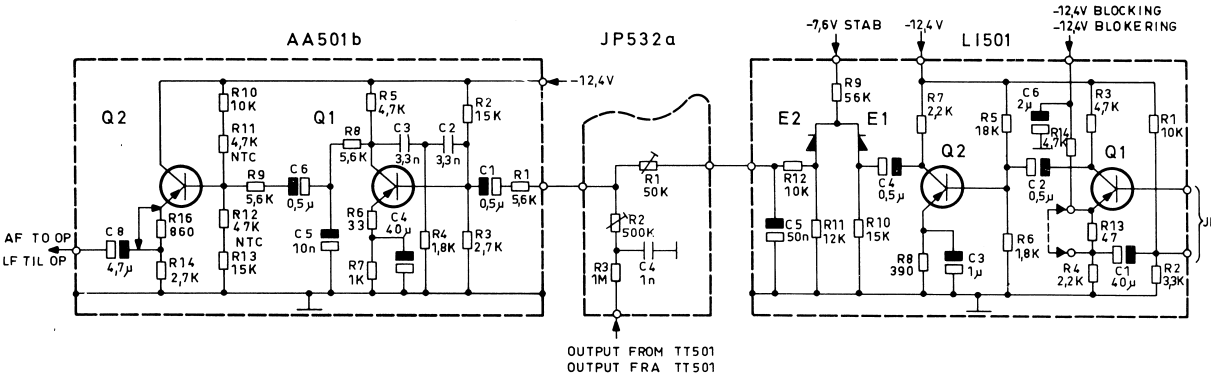


sponse so that undesired frequencies - frequencies below 300 c/s and frequencies above 3000 c/s - are properly attenuated.

The LI501 speech limiter module contains two amplifier stages (Q1 and Q2) and a diode clipper (E1 and E2). The first stage (Q1) of the unit is a conventional amplifier stage in a common-emitter circuit with the microphone signal applied between the base and a section of the emitter resistor (R13).

The second amplifier stage (Q2) is a grounded-emitter amplifier stage which feeds into a diode limiter (E1 and E2). The electrolytic bypass capacitor of the emitter of the second amplifier stage (C3) is relatively small so that only partial bypassing is obtained, thereby providing a lower degree of negative feedback at increasing frequencies (pre-emphasis of 6 dB per octave).

The diode clipper consists of two diodes which are biased in the conductive direction. The bias voltages applied to the diodes have been chosen so that symmetrical clipping is obtained. The clipper circuit is followed by an integrating circuit (R12 - C5) causing 6 dB attenuation per octave (de-emphasis).

Briefly, the introduction of pre-emphasis (differentiation), clipping, and de-emphasis (integration) can be explained as follows:

The output voltage from the microphone (speaker) is differentiated (pre-emphasized), causing the resulting voltage to be proportional to the modulating frequency. This is followed by limiting of signal peaks, and the signal voltage is thereafter integrated (de-emphasized) so that the voltage is once more proportional to the microphone output signal - assuming that the level was so low that no limiting took place. Finally, the signal is passed to the phase modulator of the transmitter.

It will be seen from the above that the input and output signals are proportional to the phase swing. The voltage after differentiation (pre-emphasis) is therefore proportional to

phase swing x modulating frequency = frequency swing

and the limiter consequently causes limiting of the frequency swing of the transmitter. This is necessary in order to prevent the transmitter from causing interference to adjacent channels when speaking into the microphone at high voice levels.

Between LI501 and AA501b is inserted a potentiometer (R1 in junction panel JP532a) for adjustment of the maximum frequency swing (clipping level). This potentiometer is adjusted at the factory and normally need not be touched.

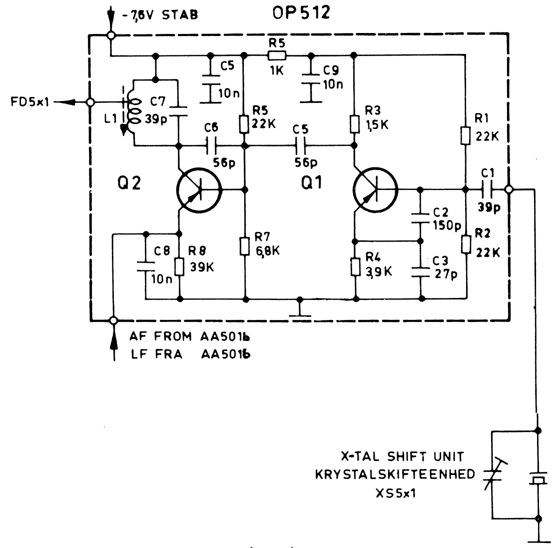
In certain cases it may be desirable to increase the sensitivity of the input circuit. A 6-dB sensitivity increase may be obtained by inserting a strap across the emitter resistor (R13) of the first stage (Q1), thereby reducing the negative feedback.

The AA501b filter/amplifier unit amplifies the limited audio signal and, in so doing, attenuates frequencies above 3000 c/s (splatter filter). The first amplifier stage (Q1) is a grounded-emitter amplifier operating as a splatter filter in that it provides the desired frequency characteristic in conjunction with the feedback circuit consisting of C3, C2, and R4, and the RC network R8 - C5.

The resistor R16 in the emitter of the transistor C2 is strapped in 50 kc/s equipments (CQP511) whilst the strap is omitted in 25 kc/s equipments (CQP512). However, fine adjustment of the frequency swing is carried out with potentiometer R1 in junction panel JP532a.

The second amplifier stage (Q2) operates in an emitter-follower circuit in order to provide a low value of output impedance. The base voltage divider includes two NTC resistors (R11 and R12) which serve the purpose of compensating for the gain reduction that would otherwise be caused by low temperatures.

Oscillator / Phase Modulator (OP512)



The oscillator stage (Q1) operates in a Pierce-Colpitts circuit, the output signals being taken off across a resistor (R3) in the collector circuit. The two capacitors C2 and C3 between base and emitter serve the dual purpose of providing a part of the load capacitance for the crystal and a voltage divider for the feedback.

Fine adjustment of the oscillator frequencies is performed with trimmer capacitors (C1, C2, and C3 in crystal shift unit XS511) connected in parallel with the crystals in XS511, which is the crystal shift unit common to both transmitter and receiver.

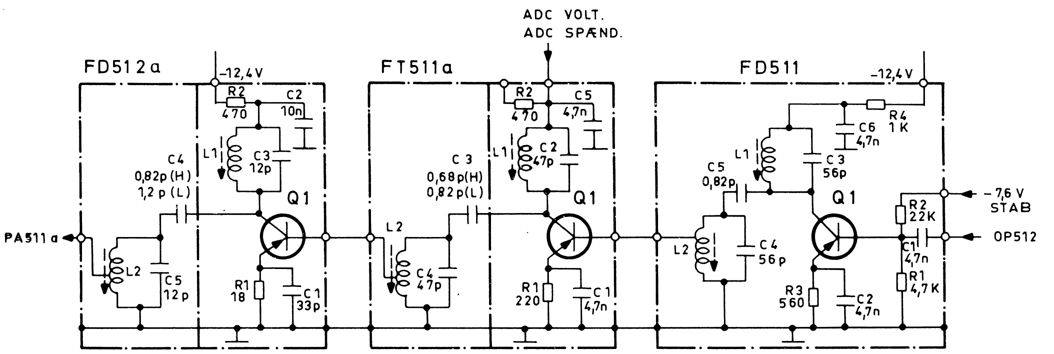
The oscillator signal is applied directly to the phase modulator (Q2) through capacitor C5. The crystal frequency range is 12.16 Mc/s - 14.50 Mc/s.

A capacitor (C6) provides feedback from the collector to the base of the phase modulator stage (Q2). Modulation is produced by the audio voltage which is applied to the emitter circuit from AA501b, thereby varying the mutual conductance of the transistor.

Multiplier Chain (FD511, FT511a, FD512a)

The multiplier chain of the transmitter consists of a frequency doubler FD511; a frequency tripler, FT511a; and an additional frequency doubler, FD512a. Thus the total multiplication of the crystal frequency is 12. FD511 operates as first multiplier stage: a grounded-emitter frequency doubler with double-tuned circuits inserted in the collector circuit. The stage is operated in Class A, and bias is applied from a stabilized 7.6 V DC source (junction panel JP531a). The advantage of this arrangement is that the input impedance is virtually independent of battery voltage and that the output level varies only slightly with battery voltage.

The selective elements of the stage (L1 - C3 and L2 - C4 and coupling capacitor C5) constitute a capacitance-coupled band-pass filter. The input frequency of frequency trip-



ler FT511a is twice the crystal frequency. Accordingly, the output frequency of the stage is six times the crystal frequency. The stage operates as a grounded-emitter frequency tripler without fixed base bias, which is possible due to the relatively high input voltage (approx. 1, 5 V). This provides good DC stability and high efficiency.

Double-tuned circuits are used in the collector configuration (L1 - C2 and L2 - C4 and coupling capacitor C3) with capacitive coupling between the hot ends of the two coils and a tap on the inductance of the output circuit (L2).

The input frequency of frequency doubler FD512a is six times the crystal frequency. The output frequency of the stage is twice the input frequency.

The FD512a unit contains a Class C transistor stage with two circuits coupled together via a small capacitance. The emitter resistor R1 is bypassed by C8, which provides a short circuit for harmonics. This arrangement suppresses radiation of signals at undesired frequencies.

RF-Output Stage (PA511a, PA512a and FN511)

The transmitter output section consists of driver PA511a, power amplifier PA512a, and antenna filter FN511.

PA511a operates at the output frequency. It comprises a straight amplifier, Q1; and a driver stage, Q2.

Input signal is applied to Q1 via C1 which, aided by choke coil L3, provides suppression of undesired frequencies. The collector is tuned by a single circuit, L1-C3. The emitter resistor, R1, provides a means of measuring the current through Q1.

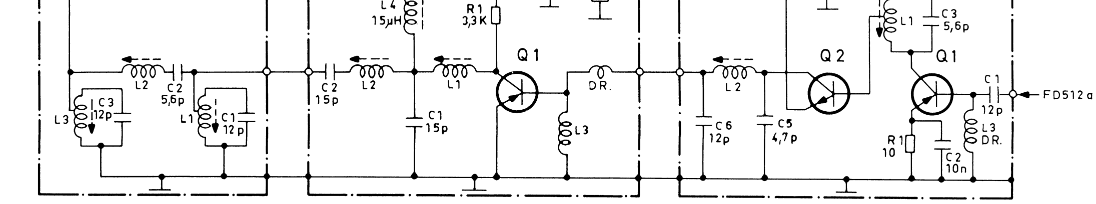
Driver transistor Q2 is an NPN-type with its supply voltage applied to the emitter. The base goes directly to a tap on L1, which provides a DC path. The collector is tuned by a pi-network (L2-C5-C6), which provides good mathcing and good efficiency.

Power amplifier unit PA512a is operated in Class BC without an emitter resistor in order to obtain maximum power amplification. This unit require a nominal input level of approx. 100 mW, corresponding to a nominal output level of approx. 500 mW, allowing for losses in antenna filter and antenna switch.

The collector circuit is a π -network (the output capacitance of Q1 and L1 and C1) which is followed by a series-tuned circuit (L2 and C2). These two circuits combine to provide a tunable output transformer. By adjustment of L1 and L2 a match is obtained between transistor and load, as well as proper suppression of harmonic frequencies.

Filter FN511 is a band-pass filter providing a high order of suppression of spurious and harmonic radiation from the transmitter section. The filter is of the π -type, consisting of three circuits (L1 - C1, L2-C2 and L3-C3), both L1, L2, and L3 being adjustable. The module can is provided with two internal shields to reduce coupling between coils.

The insertion loss is less than 0. 4 dB. Maximum power-handling capability is 2 watts.



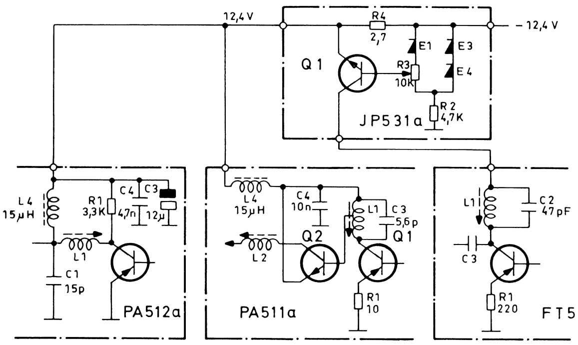
ADC (Automatic Drive Control)

The ADC circuit serves the purpose of protecting the RF output transistor (Q1 in PA512a) against overload caused by mismatching such as may occur if the transmitter is keyed without the telescoping antenna mounted and pulled out. Besides, the ADC circuit minimizes output power variations due to variations in voltage and temperature.

A small 2.7-ohm resistor (R4) has been inserted in the collector lead of the power amplifier transistor in PA512a. Physically, the resistor is located in junction panel JP531a. The voltage drop across R4 is used to control the NPN transistor Q1 in JP531a, which is seriesconnected in a DC-connection with transistor Q1 in FT511a, causing the current through that stage and hence the drive applied to it to be reduced when the collector current of PA512a increases. This in turn causes the drive applied to the driver stage (PA511a) and the output stage (PA512a) to be reduced so that a possible increase of the collector current of PA512a will be neutralized.

Silicon diodes E3 and E4 in JP531a operate as a voltage stabilizer in that the voltage drop (approx. 0.5 V) across a diode is virtually independent of the current and hence also of the voltage. These diodes and E1 also serve to temperature compensate the regulator transistor Q1.

When adjusting the base current of Q1 in JP531a, which is performed with potentiometer R3, the ADC circuit may be adjusted to a condition of balance where the power output is constant at 500 mV.



B. Receiver Section

Construction

The receiver section consists of the following standard modules:

BP511a	Receiver input band-pass filter. Cascode RF amplifier for amplification of signals.
RA511a	Cascode RF amplifier for amplification of signals.
BP512a, -3a	Band-pass filters to provide RF selectivity.
RC511a	Mixer unit for signal frequency and local oscillator frequency.
OT511a	Oscillator tripler, consisting of an oscillator stage with associated tripler circuit.
RA512a	Amplifier unit for amplification of local oscillator signals.
BP514a	Band-pass filter serving as impedance transformer.
XF501, -2	Crystal filters for 50 kc/s channel separation (CQP511) and 25 kc/s channel separation (CQP512), respectively.
IT501	Impedance transformer for providing a match between the crystal filter and the intermediate-frequency amplifier chain.
IA501	First intermediate-frequency amplifier unit.
IA502	Five identical intermediate-frequency units.
IA503	Last intermediate-frequency amplifier unit and limiter.
XD501, -2	Crystal discriminator for 50 kc/s channel separation (CQP511) and 25 kc/s channel separation (CQP512), respectively. The discriminator also contains two transistors to provide impedance matching.
AA502	Audio amplifier unit consisting of a driver stage and a push-pull audio output stage.
SQ501	Squelch unit with electronic control of the audio output amplifier, AA502.

Full coverage of the frequency range requires minor alterations of coils and capacitors in the tuned circuits of some of the modular units. Such units have a letter added to their type designations, either H (high sub-band) or L (low sub-band). This division corresponds, in terms of output frequency, to 156 ... 174 Mc/s (H) and 146 ... 160 Mc/s (L).

RF-Amplifier (BP511a, RA511a, BP512a, BP513a and RC511a)

The RF amplifier chain consists of antenna circuit BP511a, cascode amplifier unit RA511a, band-pass filter circuits BP512a and BP513a, and mixer unit RC511a.

Band-pass filter BP511a operates as antenna input circuit for the receiver section but also functions as impedance matching network between the antenna and RF amplifier unit RA511a. Impedance matching is accomplished by using a tap on coil L1 on the antenna side and a capacitive tap (C1 - C2) on the receiver side.

RF amplifier unit RA511a amplifies the signals coming from the antenna before they are passed through the two band-pass filters (BP512a and BP513a) to the mixer unit (RC511a). The amplifier unit is a cascode amplifier which minimizes feedback from output to input and has high gain.

The coil L1 connecting the collector of Q1 to the emitter of Q2 operates as a wideband circuit tuned by the series connection of the collector to chassis capacitance and the emitter to chassis capacitance. The two transistors are in series as far as DC is concerned so that either of them receives about half the full battery voltage.

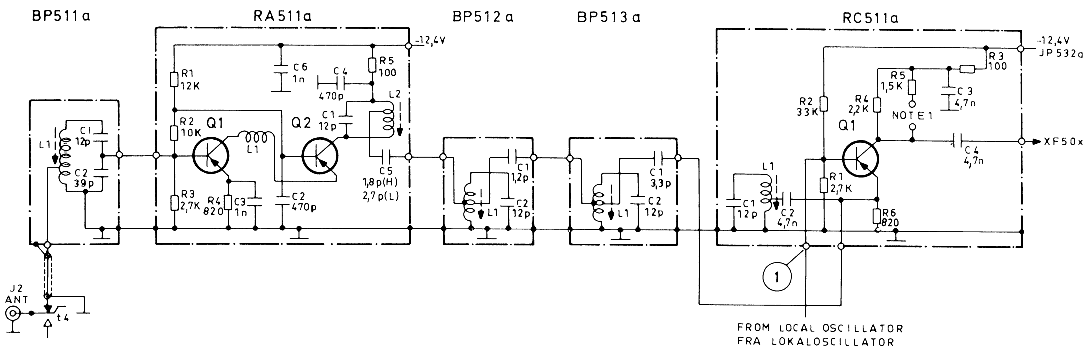
In order to increase RF selectivity still further, three band-pass filters are inserted between RA511a and mixer unit RC511a. Two of these are separate modular units, designated BP512a and BP513a, while the third circuit forms part of the succeeding mixer unit RC511a.

Frequency mixer unit RC511a receives the signal frequency from the antenna as well as the local oscillator frequency.

The signal frequency from the band-pass filter BP513a is coupled to a parallel-circuit (L1 - C1), and from a tap on the coil the signal is passed to the emitter of the mixer stage (Q1). A small impedance at the intermediate frequency and a good stability are obtained by using an inductive tap and a relative large coupling capacitor (C2).

The local oscillator signal is taken off from coil L1 in filter unit BP514a and applied to the base of mixer transistor Q1. Here, too, a low value of impedance to the intermediate frequency has been provided.

Because of the succeeding crystal filter, which may be for either 50 kc/s channel separation (XF501) or for 25 kc/s channel separation (XF502) it must be possible to alter the mixer output impedance. This is performed by means of a strapping arrangement which permits R4 to be shunted by R5 in 25 kc/s equipments only.



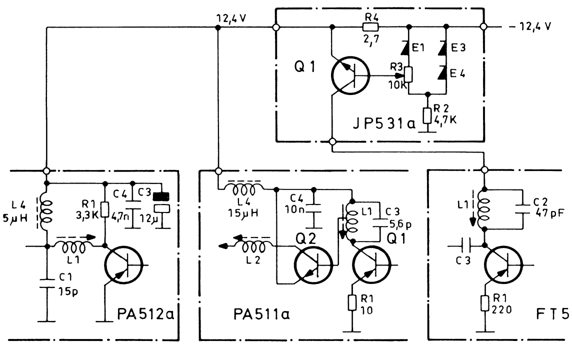
ADC (Automatic Drive Control)

The ADC circuit serves the purpose of protecting the RF output transistor (Q1 in PA512a) against overload caused by mismatching such as may occur if the transmitter is keyed without the telescoping antenna mounted and pulled out. Besides, the ADC circuit minimizes output power variations due to variations in voltage and temperature.

A small 2.7-ohm resistor (R4) has been inserted in the collector lead of the power amplifier transistor in PA512a. Physically, the resistor is located in junction panel JP531a. The voltage drop across R4 is used to control the NPN transistor Q1 in JP531a, which is seriesconnected in a DC-connection with transistor Q1 in FT511a, causing the current through that stage and hence the drive applied to it to be reduced when the collector current of PA512a increases. This in turn causes the drive applied to the driver stage (PA511a) and the output stage (PA512a) to be reduced so that a possible increase of the collector current of PA512a will be neutralized.

Silicon diodes E3 and E4 in JP531a operate as a voltage stabilizer in that the voltage drop (approx. 0.5 V) across a diode is virtually independent of the current and hence also of the voltage. These diodes and E1 also serve to temperature compensate the regulator transistor Q1.

When adjusting the base current of Q1 in JP531a, which is performed with potentiometer R3, the ADC circuit may be adjusted to a condition of balance where the power output is constant at 500 mV.



B. Receiver Section

Construction

The receiver section consists of the following standard modules:

BP511a	Receiver input band-pass filter. Cascode RF amplifier for amplification of signals.
RA511a	Cascode RF amplifier for amplification of signals.
BP512a, -3a	Band-pass filters to provide RF selectivity.
RC511a	Mixer unit for signal frequency and local oscillator frequency.
OT511a	Oscillator tripler, consisting of an oscillator stage with associated tripler circuit.
RA512a	Amplifier unit for amplification of local oscillator signals.
BP514a	Band-pass filter serving as impedance transformer.
XF501, -2	Crystal filters for 50 kc/s channel separation (CQP511) and 25 kc/s channel separation (CQP512), respectively.
IT501	Impedance transformer for providing a match between the crystal filter and the intermediate-frequency amplifier chain.
IA501	First intermediate-frequency amplifier unit.
IA502	Five identical intermediate-frequency units.
IA503	Last intermediate-frequency amplifier unit and limiter.
XD501, -2	Crystal discriminator for 50 kc/s channel separation (CQP511) and 25 kc/s channel separation (CQP512), respectively. The discriminator also contains two transistors to provide impedance matching.
AA502	Audio amplifier unit consisting of a driver stage and a push-pull audio output stage.
SQ501	Squelch unit with electronic control of the audio output amplifier, AA502.

Full coverage of the frequency range requires minor alterations of coils and capacitors in the tuned circuits of some of the modular units. Such units have a letter added to their type designations, either H (high sub-band) or L (low sub-band). This division corresponds, in terms of output frequency, to 156 ... 174 Mc/s (H) and 146 ... 160 Mc/s (L).

RF-Amplifier (BP511a, RA511a, BP512a, BP513a and RC511a)

The RF amplifier chain consists of antenna circuit BP511a, cascode amplifier unit RA511a, band-pass filter circuits BP512a and BP513a, and mixer unit RC511a.

Band-pass filter BP511a operates as antenna input circuit for the receiver section but also functions as impedance matching network between the antenna and RF amplifier unit RA511a. Impedance matching is accomplished by using a tap on coil L1 on the antenna side and a capacitive tap (C1 - C2) on the receiver side.

RF amplifier unit RA511a amplifies the signals coming from the antenna before they are passed through the two band-pass filters (BP512a and BP513a) to the mixer unit (RC511a). The amplifier unit is a cascode amplifier which minimizes feedback from output to input and has high gain.

The coil L1 connecting the collector of Q1 to the emitter of Q2 operates as a wideband circuit tuned by the series connection of the collector to chassis capacitance and the emitter to chassis capacitance. The two transistors are in series as far as DC is concerned so that either of them receives about half the full battery voltage.

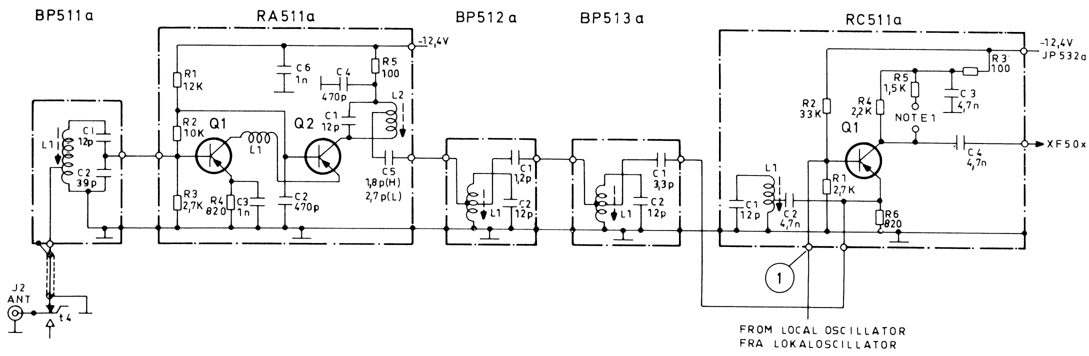
In order to increase RF selectivity still further, three band-pass filters are inserted between RA511a and mixer unit RC511a. Two of these are separate modular units, designated BP512a and BP513a, while the third circuit forms part of the succeeding mixer unit RC511a.

Frequency mixer unit RC511a receives the signal frequency from the antenna as well as the local oscillator frequency.

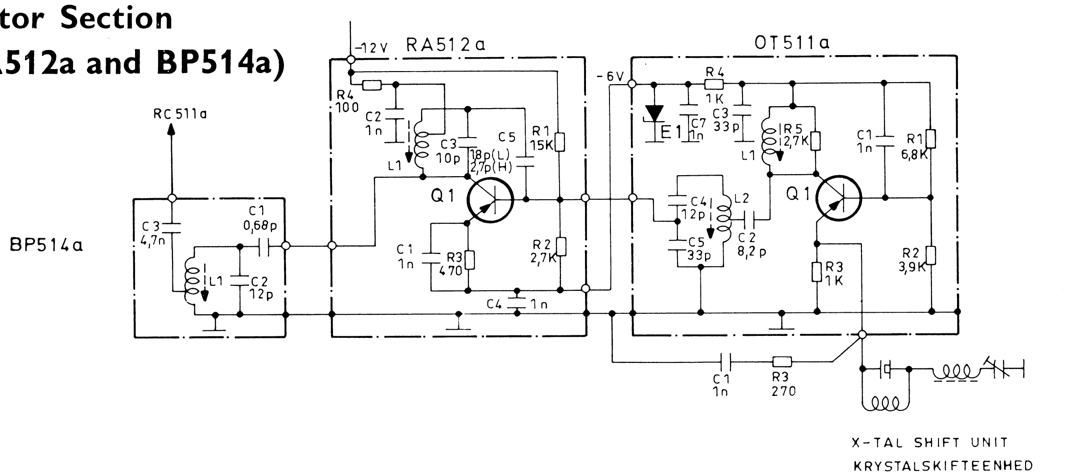
The signal frequency from the band-pass filter BP513a is coupled to a parallel-circuit (L1 - C1), and from a tap on the coil the signal is passed to the emitter of the mixer stage (Q1). A small impedance at the intermediate frequency and a good stability are obtained by using an inductive tap and a relative large coupling capacitor (C2).

The local oscillator signal is taken off from coil L1 in filter unit BP514a and applied to the base of mixer transistor Q1. Here, too, a low value of impedance to the intermediate frequency has been provided.

Because of the succeeding crystal filter, which may be for either 50 kc/s channel separation (XF501) or for 25 kc/s channel separation (XF502) it must be possible to alter the mixer output impedance. This is performed by means of a strapping arrangement which permits R4 to be shunted by R5 in 25 kc/s equipments only.



Local Oscillator Section (OT511a, RA512a and BP514a)



The local oscillator section is composed of an oscillator/tripler unit, OT511a, an RF amplifier unit, RA512a; and a band-pass filter,BP514a.

The oscillator/tripler unit contains a third-overtone crystal oscillator the output frequency of which three times the oscillator frequency. Basically, the oscillator is a Colpitts oscillator with the crystal in series with the emitter of the oscillator transistor. The oscillator will therefore operate at the frequency of minimum crystal impedance - the series resonant frequency of the crystal - provided the collector circuit is tuned to approximately that frequency.

The receiver crystals (maximum three crystals) are inserted in sockets in a separate crystal shift unit, XS511, in which the transmitter crystals too are inserted. In series with each receiver crystal is a series resonant circuit (L1 - C4, L2 - C5, or L3 - C6) in which, by means of the trimmer capacitor, the oscillator frequency can be pulled without affecting the phase angle of the series circuit. The oscillator frequency will change in such a manner that the phase change of the crystal impedance counteracts the phase change of the circuit.

The pi-section in the collector circuit (L1 - C2 - C3) has been made so wide that frequency pulling has no appreciable influence on its impedance. The third harmonic of the oscillator frequency is selected in the parallel-resonant circuit L2 - C4 - C5. From the capacitive tap of the circuit, the local-oscillator frequency is fed to the succeeding RF amplifier unit, RA512a. The oscillator/tripler unit is in series with the succeeding amplifier stage as far as DC is concerned, and either stage therefore operates at only approximately half battery voltage.

Amplifier unit RA512a amplifies the local oscillator signal to a power level that is adequate for mixer unit RC511a.

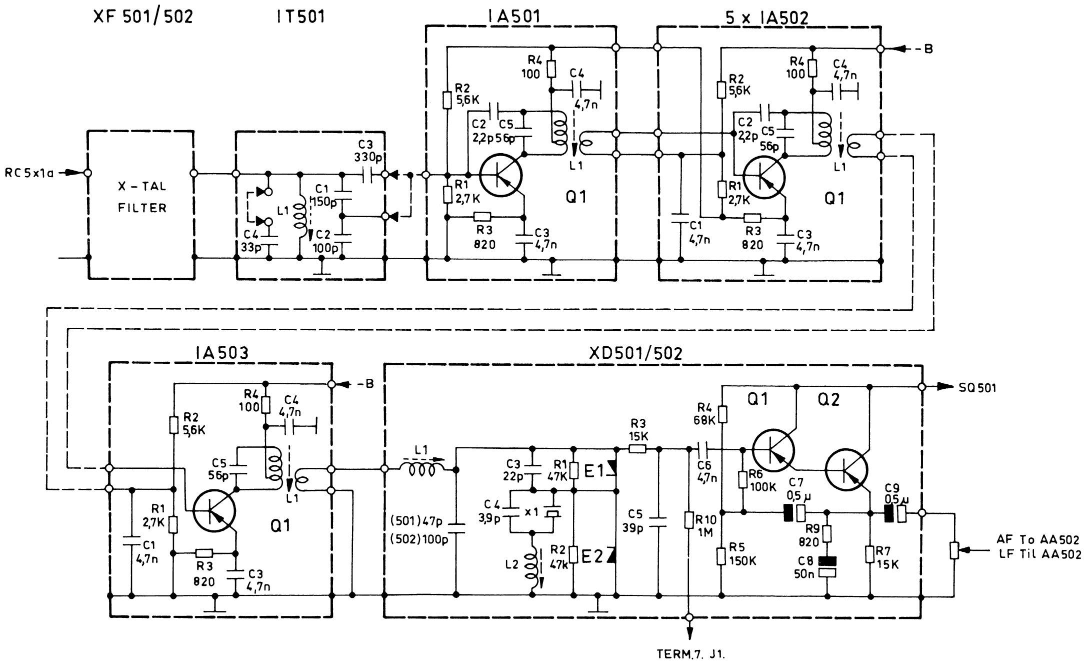
Under normal conditions of operation, the amplifier stage is driven so hard that limiting of the output signal occurs. This limiting has been introduced intentionally in order to compensate for variations in the output of the oscillator unit. The collector circuit (L1 - C3) is tuned to three times the local oscillator frequency (just like L2 - C4 - C5 in OT511a)

Between the RF amplifier unit and the mixer unit is inserted a band-pass filter BP514a, which has for its object to reduce spurious responses and to function as an impedance matching transformer. In the interests of stability it is desirable that the output impedance of the band-pass filter should be low with respect to the intermediate frequency, 10.7 Mc/s. For this reason coil L1 has an inductive tap, and coupling capacitor C3 is relatively large.

IF-Chain (XF501,-2, IT501, IA501, IA502, IA503, and XD501,-2)

The intermediate-frequency chain consists of a crystal filter, XF501 (50 kc/s channel separation) or XF502 (25 kc/s channel separation); impedance transformer IT501; first intermediate-frequency stage IA501; five identical intermediate-frequency stages, IA502; last intermediate-frequency stage IA503; and a crystal discriminator, XD501 (50 kc/s channel separation) or XD502 (25 kc/s channel separation).

Chapter II. Circuit Analysis



Crystal filter XF501 or XF502 is mounted in a hermetically sealed shield can which cannot be opened for inspection or service. However, the filter requires no kind of adjustment whatsoever.

The impedance transformer unit IT501 provides an impedance match between the crystal filter unit and first intermediate-frequency unit IA501. In equipments using 25 kc/s channel separation the signal for intermediate-frequency unit IA501 is taken off via C3·in equipments using 50 kc/s channel separation the signal take-off point is the junction of C1 and C2, and C4 is connected across the circuit for tuning purposes.

First intermediate-frequency unit IA501 and the succeeding five IA502 intermediate-frequency units and last intermediate-frequency unit IA503 are virtually identical except for the input circuits. IA503 uses the coupling coil of the preceeding unit to provide a DC path between voltage divider and base, and the neutralization (C2) has been omitted.

The intermediate-frequency amplifier chain is divided into two groups which are connected in series as far as DC supply voltage is concerned, so that each of the first four IF units receives a supply voltage equal to one-fourth of the battery voltage whereas each of the last three IF units receives one-third of the battery voltage.

The IF units have so high overall gain that noise limiting occurs in the last stages of the chain (fifth IA502 and IA503). Units IA501 and IA502 are neutralized.

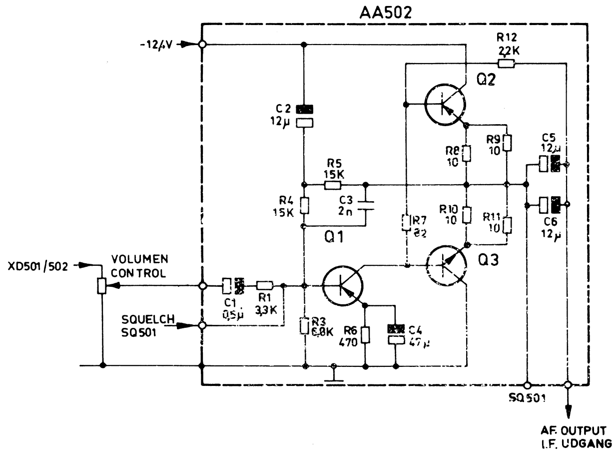
The centre frequency of the IF chain is 10.7 Mc/s, and the IF curves of the individual units are so wide that minor deviations from these will not affect the overall selectivity. In any case, virtually the whole of the selectivity is concentrated in the crystal filter.

The discriminator unit includes a quartz crystal whose points of parallel and series resonance are adjusted by means of coil L2 in conjunction with the two capacitors C3 and C4. The parallel resonant frequency of the crystal (30 pF) is in the vicinity of 10.715 Mc/s. The symmetry of the S-curve may be adjusted with L1.

This discriminator circuit requires a very high order of input impedance whereas the input impedance of the succeeding audio unit AA502 must be low. For this reason the discriminator unit incorporates a two-stage impedance converter - a so-called Darlington amplifier - the most characteristic properties of which are its high input impedance and low output impedance. This unit has no voltage gain.

Audio Section (AA502)

The audio section of the receiver consists of a driver stage (Q1) and a push-pull output



stage (Q2 and Q3) with transformerless coupling to a microphone-speaker.

The driver stage (Q1) is a grounded-emitter amplifier using frequency-dependent negative feedback. Input signal from the crystal discriminator is applied to the base through a 5 k ohm potentiometer (VOLUME control) mounted inside the cabinet.

The push-pull stage (Q2 and Q3) uses two complementary transistors (PNP and NPN). These two transistors are matched and normally should not be replaced individually. They are operated in Class B in a common-collector circuit. The output circuit, which is transformerless, operates into a 40-ohm speaker.

Squelch Unit (SQ501)

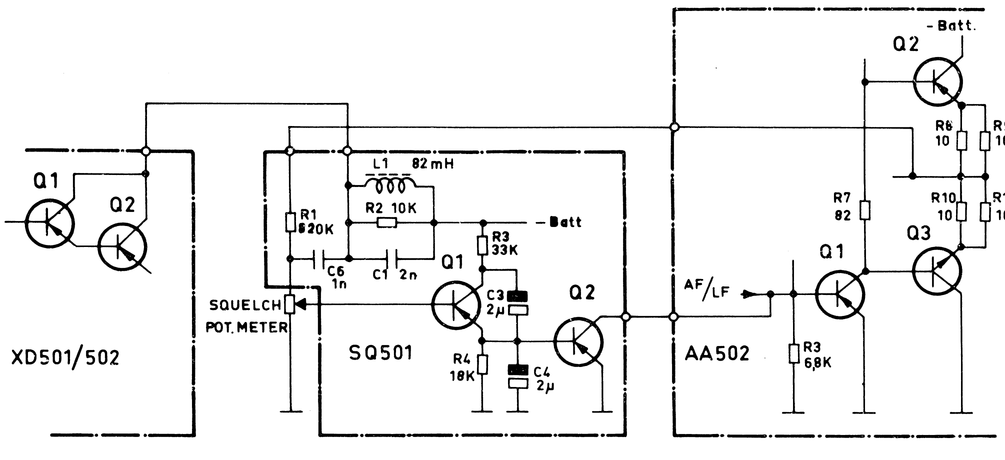
The squelch unit is used for suppressing noise (hiss) and reducing power consumption during no-signal periods (standby). The operation of the squelch system is based on noise changes in the output of discriminator unit XD50x.

The squelch unit contains a squelch filter (L1 - C1), a detector stage (Q1), and a DC amplifier (Q2) performing a relay function.

The collectors of Q1 and Q2 of the Darlington amplifier in crystal discriminator unit XD50x connect directly to a parallel-resonant circuit in SQ501 consisting of coil L1 and capacitor C1. This circuit is tuned to 12 kc/s, and the noise amplified by the Darlington amplifier is selected by the circuit and fed back to the squelch potentiometer together with a feedback DC voltage from AA502, whereafter the composite signal is applied to the base of Q1, which operates as a detector. A DC voltage builds up across the RC circuit R4 and C4, roughly equal to the peak voltage of the base signal. This DC voltage is applied directly to the base of relay transistor Q2. When this DC voltages reaches a certain level (approx. -0.5V), the internal resistance of the transistor will become very low, and its collector voltage potential approaches ground potential.

Because the collector of the relay transistor (Q2) connects directly to the base of the driver transistor (Q1) of the audio amplifier (AA502), the bias of the latter transistor will be very nearly short-circuited.

The voltage at the junction of R8, R9, R10, and R11 of AA502 approaches the full battery voltage owing to the fact that the base of Q1 in AA502 is approximately short-circuited. This negative voltage is feed back to the base of Q1 in SQ501 through R1 and the squelch potentiometer. This produces an increasing amount of feedback which shuts off the output amplifier AA502 even more effectively.



When a signal is being received, the noise components will be partly suppressed, and the noise signal from the Squelch filter (L1 - C1) to the base of the detector stage (Q1) drops below 0.5 V, causing relay transistor Q2 to begin to be less conductive. The result of this is that Q1 in AA502 again receives a small amount of base bias, and the voltage at the junction of R8, R9, R10, and R11 will then begin to decrease towards one-half of full voltage. This voltage, as described above, is fed back to the detector stage (Q1), causing it to become less conductive, as a result of which the voltage across relay transistor Q2 becomes still more negative - that is, the driver transistor of the output stage is becoming even more negative; in other words: the driver transistor of the output stage changes quickly from a non-conductive to a conductive condition.

C. Common Functions

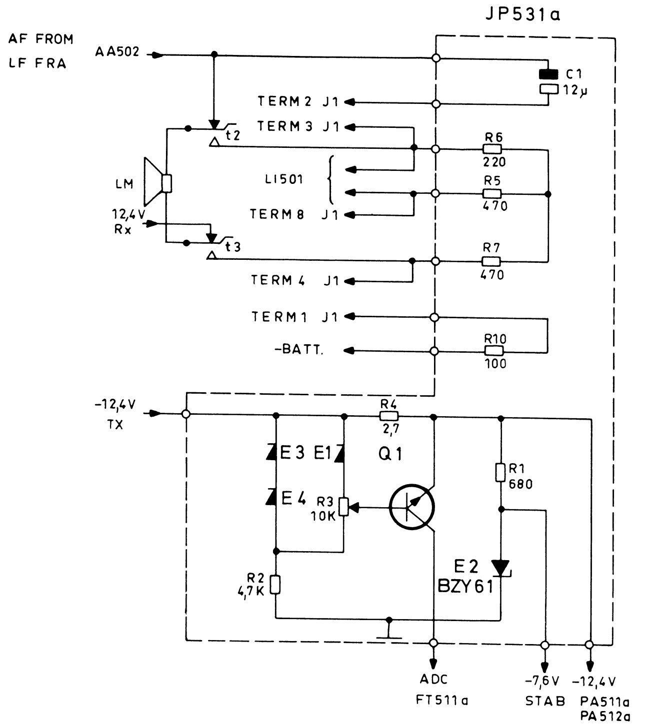
The common functions of the pocket radiotelephone are handled by the following modular units and circuits:

JP531a	Junction panel containing a voltage stabilization circuit and circuits for the speaker-microphone and ADC.
JP532a	Junction panel containing circuits for adjusting the audio level of the transmitter, and filters for the operating voltages of some of the receiver modules.
XS511	Crystal shift unit, common to transmitter and receiver, containing sockets and circuits for three transmitter and three receiver crystals (three channels).
BU501	Nickel-cadmium battery.
LM	Speaker-microphone.
J1	Multi-wire connector for check measurements and for connection of external accessories.

Junction Panels (JP531a and JP532a)

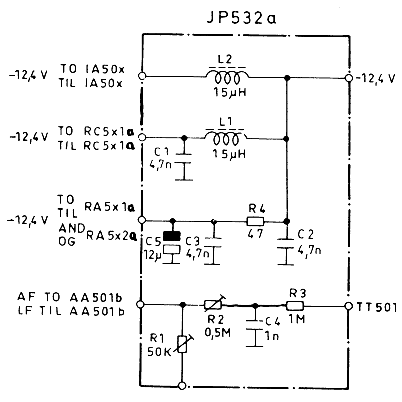
Junction Panel JP531a contains the ADC circuit (Automatic Drive Control) which has been introduced to protect the RF output transistors of the transmitter section. This system is described in detail in Section A. The panel moreover carries a Zener circuit which supplies a -7.6 V stabilized voltage to LI501, OP512 and FD511.

Lastly, the panel carries various resistors and capacitors associated with the external connector



J1. These components perform a number of bypassing and DC functions.

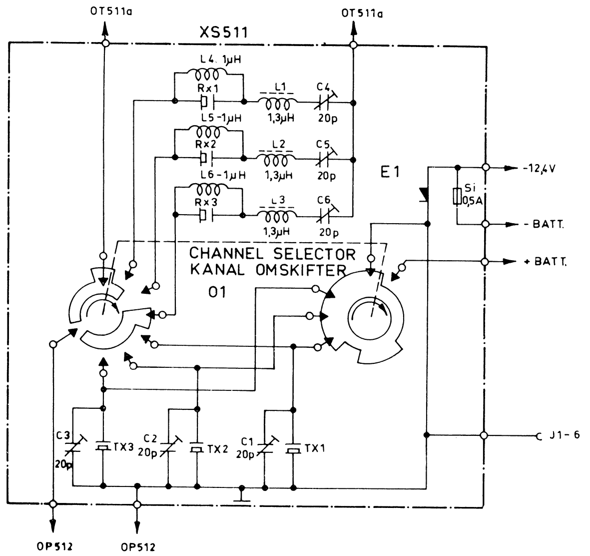
Junction panel JP532a contains supply-voltage filters for units RA511a, RA512a, OT511a (C2 - R4 - C3 - C5) and RC511a (C2 - L1 - C1). Both



filters are capacitor-input π-filters. Furthermore the panel houses a filter choke (L2) for filtering of the supply voltage to the IF-stages.

Junction panel JP532a moreover carries a potentiometer for adjusting the level of the maximum frequency swing (R1) and a potentiometer (R2) and filter (C4 - R3) for adjusting the tone level from the built-in tone transmitter (if provided).

Crystal Shift Unit (XS511)



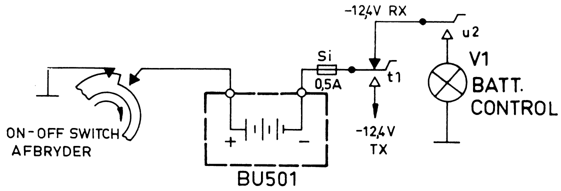
The crystal shift unit contains sockets for three receiver crystals and three transmitter crystals. The maximum number of channels with which the radiotelephone may be equipped is therefore three.

The receiver crystals are overtone crystals oscillating on their series resonant frequency (near the third harmonic). In series with each crystal is a series-resonant circuit consisting of a coil and a trimmer capacitor. By means of the variable capacitance, the frequency may be pulled to exactly the nominal frequency of the crystal.

The channel selector has four positions three of which are used for switching between the three channels. In the fourth position, the radiotelephone is switched off. The switch sections are so designed that unused receiver crystals are disconnected whilst unused transmitter crystals are short-circuited to chassis potential.

The crystal shift unit moreover contains a main fuse through which flows the entire amount of current consumed by the pocket radiotelephone, and a protective diode which assures correct polarization of the battery voltage.

Battery (BU501)



The replaceable nickel-cadmium battery BU501 supplies the operating voltage required by the pocket radiotelephone (nominal voltage 12.4 V).

In normal operation of the pocket radiotelephone, the battery may be used for approx. 10 hours before charging is necessary (see also Chapter I, Sector C, Operation).

The state of charge of the battery is checked by means of the lamp (V1) at the bottom of the radiotelephone cabinet. The current drain of the lamp approximately equals that of the transmitter. An extra pair of contacts on the tone button U (u2) close the current through the lamp, and its brightness should be observed for 20 - 30 seconds. Constant brightness throughout that period indicates that the battery is sufficiently charged whilst a decrease in brightness during the period indicates that the battery should be charged.

If the lamp does not glow at all, the battery is fully discharged - or the lamp has burned out. It is a characteristic feature of a nickel-cadmium battery that its voltage on completion of the charging process drops fairly rapidly during use to its nominal voltage, which then remains relatively constant during the period of discharge, thereafter to fall off very rapidly immediately before the battery is fully discharged.

Speaker-Microphone Circuit

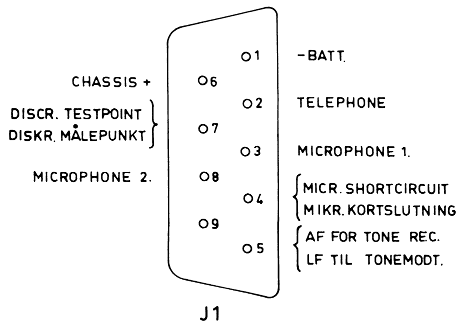
The speaker LM performs the dual function of speaker during reception and microphone during transmission. Transmit button performs the necessary switching.

When transmit button T is not depressed (receive position), the speaker is connected to the common emitter point of the push-pull output transistors in audio amplifier AA502 through make contacts t3, the speaker, make contacts t2, and C5 - C6.

The third pair of contacts (t1) in their neutral position close the connection between the battery and the receiver units whilst the fourth pair of contacts (t4) connect the receiver input to the antenna connector and hence the antenna.

On pressing transmit button T, contact pairs t3 and t2 connect the speaker to the input of limiter unit LI501, thereby permitting it to function as a microphone. At the same time a circuit is closed from the battery to the transmitter units through contact pair t1, and supply voltage is removed from the receiver units. Contact pair t4 switches the antenna from the receiver input to the transmitter output.

Multi-wire Connector J1



The multi-wire connector J1 at the top of the pocket radiotelephone is used for making a few important check measurements on the equipment and for connecting various extra accessories such as tone receiver, lapel microphone, earphone, etc.

The multi-wire connector contains nine conductors. The table below specifies the point in the radiotelephone to which the individual conductors are connected as well as the functions performed by them.

Pin	
1	Battery voltage, negative with respect to chassis (pin 6)
2	Connection for earphone etc.
3	Connection for external microphone (between pins 3 and 8)
4	Short-circuits the speaker-microphone to pin 3 when an external microphone is connected.
5	Audio for an external tone receiver (if provided), which is taken off after the discriminator unit but ahead of the volume control.
6	Chassis (connects directly to the positive battery terminal when the equipment is switched on).
7	Discriminator test point, connected to test point 6 through a 1 megohm resistor.
8	Connection for external microphone (between pins 3 and 8).
9	Available for special-purpose accessories.

D. Supplementary Technical Specifications

Reference is also made to the general data tabulated on the first pages of this manual. Technical data of accessories such as charging units, external microphones and speakers, selective tone equipment, etc. are listed in Chapter III under the detailled description of the individual accessories.

Transmitter Section

Speech Limiter LI501

Nominal Input Level

Approx. 1 mV with strap, approx. 2 mV without strap, at $\Delta f = 2/3\ \Delta f_{max.}$ and fm = 1000 c/s.

Distortion

Less than 4 % at input level of 2 mV at 1000 c/s.

Frequency Response Characteristic

A straight line +1 -3 dB from 300 to 3000 c/s in conjunction with filter/amplifier AA501b.

Transistor Complement

Q1	OC306/2	First amplifier stage
Q2	OC306/2	Second amplifier stage
E1-2	OA200	Diode clipper

Filter-Amplifier AA501b

Frequency Limiting

Above 3000 c/s not less than -18 dB/octave.

Input Voltage

Approx. 10 mV at $\Delta f = 2/3\ \Delta f_{max.}$ and fm = 1000 c/s.

Transistor Complement

Q1	AF126	Amplifier stage ($\beta > 130$)
Q2	OC306/2	Emitter follower.

Oscillator/Phase Modulator OP512

Frequency Range

12.16 ... 14.50 Mc/s.

Calculation of the crystal frequency

$$fx = \frac{fs}{12}\ \text{Mc/s}$$

where fx = quartz crystal frequency in Mc/s.
fs = RF output frequency in Mc/s.

Crystal Specification

Storno Type 98-8, spec. S-98-8.

Crystal Power Rating

Max. 1 mW.

Frequency Stability

Better than 1.8 kc/s.

Frequency Adjustment

Crystal trimmers can pull the oscillator frequency not less than $+20 \times 10^{-6}$.

Transistor Complement

Q1	AF121	Oscillator
Q2	AF124	Phase modulator.

Frequency Doubler FD511

Output Frequency

24.333 ... 29.000 Mc/s Approx.

Input Voltage

Min. 90 mV for correct functioning.

Transistor Complement

Q1	AF106	Frequency doubler.

Frequency Tripler FT511a

Output Frequency Range

FT511aL: 73 ... 80 Mc/s
FT511aH: 78 ... 87 Mc/s.

Input Voltage

Nominal value approx. 1.5 V.

Transistor Complement

Q1	AF106	Frequency tripler.

Frequency Doubler FD512a

Output Frequency Range

FD512aL: 146 ... 160 Mc/s
FD512aH: 156 ... 174 Mc/s.

Input Voltage

Nominal value approx. 900 mV.

Transistor Complement

Q1 AF202 Frequency doubler.

Driver Stage PA511a

Input Voltage

Nominal value approx. 1.4V.

Transistor Complement

Q1 AF202 Straight amplifier
Q2 BSX19 " "

RF-Output Stage PA512a

Input Voltage

Approx. 3.5V (corresponds to approx. 100mW).

Output Level

500 mW into 50 ohms.

Load Impedance

50 ohms.

Transistor Complement

Q1 2N1692 Power amplifier.

Antenna Filter FN511

Pass Band

146 ... 174 Mc/s.

3 dB Attenuation Points

124 Mc/s and 190 Mc/s.

Insertion Loss

Max. 0.4 dB as measured between PA stage PA512a and50-ohm load in the range 146 ... 174 Mc/s.

Attenuation

More than 20 dB at 87 Mc/s.

More than 30 dB at 292 Mc/s.
Both values to be measured between 50-ohm generator and 50-ohm load.

Permissible RF Power

2 watts max.

B. Receiver Section

Band-pass Filter BP511a

Frequency Ranges

BP511aL: 146 ... 160 Mc/s
BP511aH: 156 ... 174 Mc/s.

Input Impedance

Nominal value 50 ohms.

RF Amplifier RA511a

Frequency Range

RA511aL: 146 ... 160 Mc/s
RA511aH: 156 ... 174 Mc/s.

Gain

Voltage gain is approx. 35 dB.

Transistor Complement

Q1/Q2 AF106 Cascode amplifier.

Band-pass Filters BP512a and BP513a

Frequency Ranges

BP512aL and BP513aL: 146 ... 160 Mc/s
BP512aH and BP513aH: 156 ... 174 Mc/s.

Mixer Stage RC511a

Frequency Ranges

RC511a: 146 ... 174 Mc/s.

Voltage Gain

CQP511: approx. 12 dB.
CQP512: approx. 9 dB.

Intermediate Frequency

10.7 Mc/s.

Transistor Complement

Q1 AF106 Mixer.

Oscillator/Tripler OT511a

Crystal Frequency Ranges

OT511aL: 52.2 ... 56.9 Mc/s
OT511aH: 48.4 ... 54.4 Mc/s.

Output Frequency Ranges

OT511L: 156.6 ... 170.7 Mc/s
OT511H: 145.2 ... 168.2 Mc/s.

Calculation of the crystal frequency

Low sub-band 146-160 Mc/s:

$$fx = \frac{fs + 10,7}{3} \text{ Mc/s}$$

High sub-band 156-174 Mc/s:

$$fx = \frac{fs - 10,7}{3} \text{ Mc/s}$$

where fx = quartz crystal frequency in Mc/s.
fs = receiver input frequency in Mc/s.

Crystal Specification

STORNO Type 98-9, spec. s-98-9.

Crystal Power Rating

Approx. 0.1 mW.

Frequency Stability

Better than $\pm 2 \times 10^{-6}$ at 23°C and a voltage variation of ±20 %.

Frequency Adjustment

The crystal trimmer permits pulling the crystal frequency not less than $\pm 25 \times 10^{-6}$.

Power Output

Approx. 200 uW.

Transistor Complement

Q1 AF106 Oscillator/Tripler
E1 BZY57 Zenerdiode.

Amplifier Unit RA512a

Frequency Ranges

RA512aL: 156 ... 171 Mc/s
RA512aH: 145 ... 163 Mc/s.

Power Gain

Approx. 8 dB (signal intensities below clipping level).

Transistor Complement

Q1 AF106 RF Amplifier.

Band-pass Filter BP514a

Frequency Ranges

BP514aL: 156 ... 171 Mc/s
BP514aH: 145 ... 163.5 Mc/s.

Crystal Filters XF501 and XF502

Type	XF501	XF502
Type of equipment	CQP511	CQP512
Max. attenuation	5 dB	5 dB
Max. 6 dB attenuation at	±15 kc/s	±7.5 kc/s
Min. 80 dB attenuation at	±40 kc/s	±20 kc/s
Operating impedance	820Ω=25pF	2 kΩ=25pF

Impedance Transformer IT501

Frequency Range

10,7 Mc/s ±0.2 Mc/s.

Insertion Loss

6 dB ±2 dB.

IF-stages IA501, IA502 and IA503

Gain

19 dB ±4 dB per stage.

Bandwidth

350 ... 400 kc/s.

Frequency Response Curve

1 dB bandwidth: ±75 kc/s
3 dB bandwidth: ±170 kc/s
6 dB bandwidth: ±300 kc/s.

Transistor Complement

Q1 AF126 Intermediate-frequency amplifier stage.

Crystal Discriminators XD 501 and XD502

Bandwidth

XD501 (CQP511): ±25 kc/s
XD502 (CQP512): ±12 kc/s.

Centre Frequency

10.7 Mc/s.

Output Voltage

XD501: At 1000 c/s and Δf = ±10 kc/s: approx. 500 mV.
XD502: At 1000 c/s and Δf = 3.3 kc/s: approx. 350 mV.

Distortion

XD501: Δf = ±10 kc/s: 3.5 %
XD502: Δf = ±3.3 kc/s: 3.5 %.

Transistor Complement

Q1, Q2,	BCZ13	Darlington amplifier
E1, E2,	AA119	Discriminator diodes.

Audio Amplifier AA502

AF Power Output

Nominal value 200 mW into 40 ohms.

Input Voltage

Nominal value 200 mV at 1 kc/s and full power output.

Frequency Response Characteristic

With reference to 1 kc/s and -6 dB/octave, tolerance is +2 dB to -8 dB.

Distortion

Less than 5 % at 1 kc/s and 200 mW power output.

AF Noise Level

Attenuated more than 40 dB at nominal input voltage.

Transistor Complement

Q1	AF126	AF driver
Q2	AC132	AF push-pull stage
Q3	AC127	AF push-pull stage

Storno

CHAPTER III. ACCESSORIES

A. Charging Units

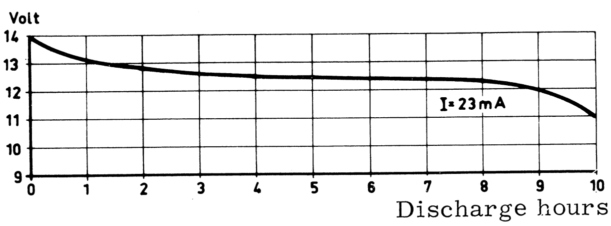
General

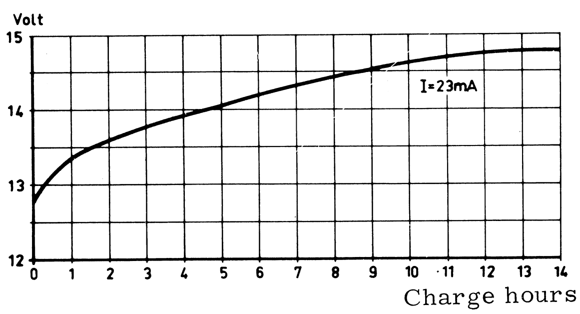
Additional nickel-cadmium batteries and three types of charging units are available as standard accessories.

- BU501 10-cell nickel-cadmium battery, 225mAh.
- CU501 Charging unit with provision for connection of up to 10 charging outlets.
- CU502 Charging unit with provision for connection of up to 10 charging outlets and with built-in timer.
- CU503 Charging unit with provision for connection of up to 2 charging outlets.

BU501 Battery

As mentioned in Chapter I, the battery may be charged more than 500 times without appreciable reduction of its capacity. However, it should not be overcharged repeatedly as this will reduce its capacity.



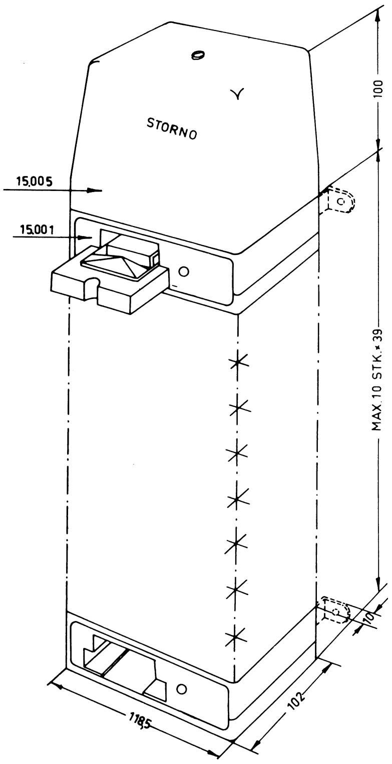


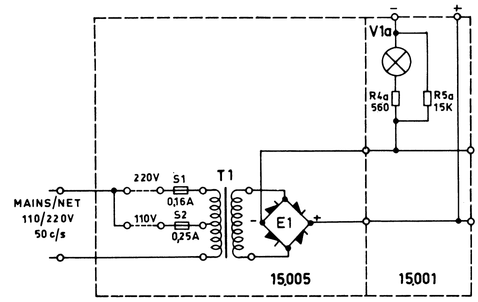
As shown in the illustration, the discharge curve is essentially straight-lined at a discharge current of 23 mA. When the voltage has dropped to approx. 11 volts, in practice corresponding to approximately 10 hours of operation, the voltage curve drops fairly sharply, and if the voltage across the battery goes below approx. 10 volts there will be a risk of re-polarization of one or more cells, which may then be ruined the next time the battery is charged. Strong polarity reversal of one or more cells will be evidenced by somewhat lower voltage for a normally charged (not overcharged) battery.

In cases where one pocket radiotelephone is used by several persons or where other factors make it impossible to keep a check on the operating time so that the charging time cannot be predetermined with certainty, there are two methods of solving this problem. One method consists in always operating the pocket radiotelephone until the built-in pilot lamp shows that the battery is discharged, then replacing the discharged battery with a fully charged spare battery. This can easily be carried in a pocket, thanks to its small size. The other method consists in discharging the battery before charging it. However, the discharge current should not exceed 115 mA, which means that the shorting resistor employed should not be smaller than 110 ohms and be rated at not less than 3 watts. Discharge should not be allowed to continue past the point where the battery terminal voltage has dropped to approx. 11 volts.

CU501 Charging Unit

The CU501 charging unit consists of a power supply (15.005) to which a maximum of 10 identical charging outlets (15.001) may be connected. A built-in switch permits switching the power line input between 110 volts AC and 220 volts AC. The output from the secondary of the power transformer (T1) is rectified by a bridge rectifier (E1) and fed to the charging outlets. In each outlet, the charging current for the battery flows through a resistor (R4) and a filament lamp (V1) which operates both as a current regulator and a pilot lamp.

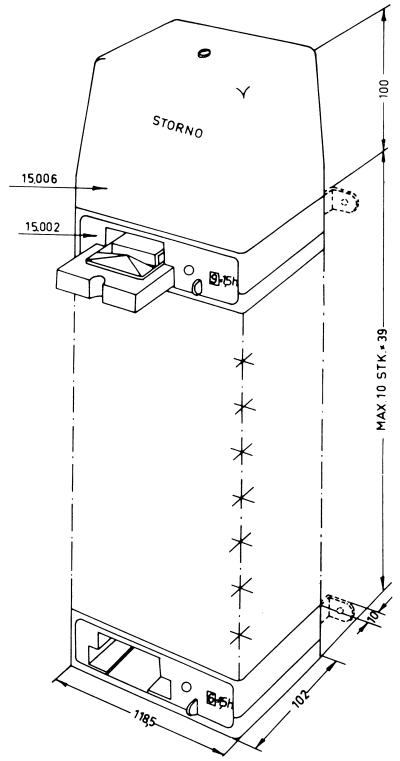


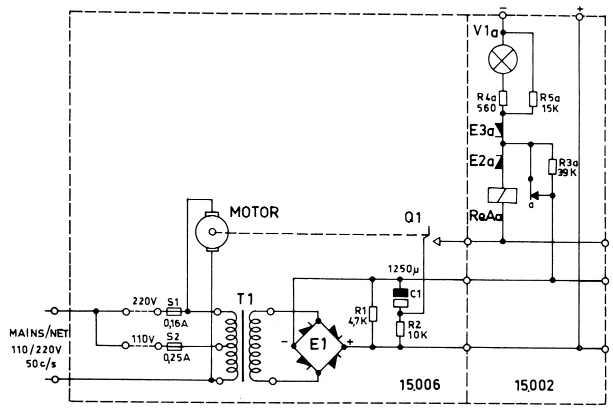


Normal charging current for each charging outlet is approx. 25 mA, and the time normally required for charging a discharged battery is 14 hours.

CU502 Charging Unit

The CU502 charging unit consists of a power supply (15. 006) to which a maximum of 10 identical charging outlets (15. 002) may be connected. Besides a bridge rectifier (E1), the power supply section contains a synchronous motor the friving shaft of which makes one-sixth revolution per hour, thanks to a gear reduction system. Each charging outlet moreover has a built-in counter which may be set for charging the battery for any desired number of periods between 1 and 9. Each charging period lasts one hour and a half, corresponding to approximately one hour's normal operation of the pocket radiotelephone.



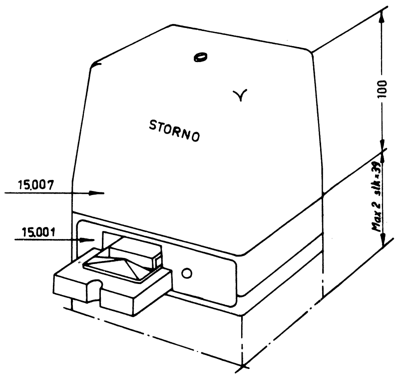


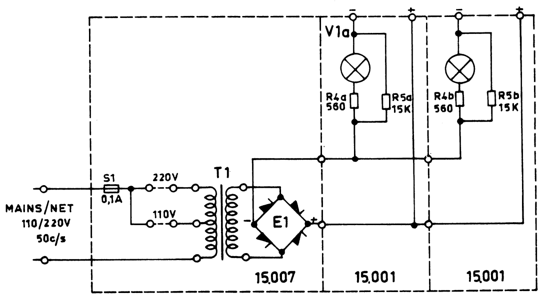
The cam wheel of the synchronous motor sees to it that contacts 01 make once every one and one-half hours, thereby causing electrolytic capacitor C1 to discharge through contacts 01, counter coil A, rectifier E2, and relay contacts a. This causes counter relay A to move backwards by one digit, and when digit 0 has been reached, the counter relay operates, causing contacts a to break the battery charging circuit. However, a very low value of charging current (approx. 0. 6 mA) flows through a resistor (R3) to compensate for self-discharge.

When contacts a of the counter relay are open, rectifier E2 will prevent charging current from flowing through the counter coil to the other charging outlets. Similarly, rectifier E3 will prevent the battery from discharging through the counter relay coil and the other charging outlets. Lamp V1 operates both as a current regulator and a pilot lamp.

Contacts a of the counter relay remain open until the counter of the outlet is once more set for charge.

CU503 Charging Unit





The CU503 charging unit consists of a power supply (15. 007) to which a maximum of 2 identical charging outlets (15. 001) may be connected. The power transformer (T1) has taps for both 110 volts AC and 220 volts AC. The fuse should be replaced with another of suitable rating when the charging unit is rewired for operation from another line voltage. The output from the secondary of the power transformer (T1) is rectified by a bridge rectifier (E1) and fed to the charging outlets. In each outlet, the charging current for the battery flows through a resistor (R4) and a filament lamp (V1) which operates both as a current regulator and a pilot lamp.

Common Specifications

Supply Voltage

110 volts or 220 volts AC, 50 c/s.

Charging Current

When battery is discharged: 22 ... 27 mA.
When battery is fully charged: 20 ... 25 mA (except as specified for CU502).

No-load Voltage

40 volts DC.

B. Selective Tone Equipment

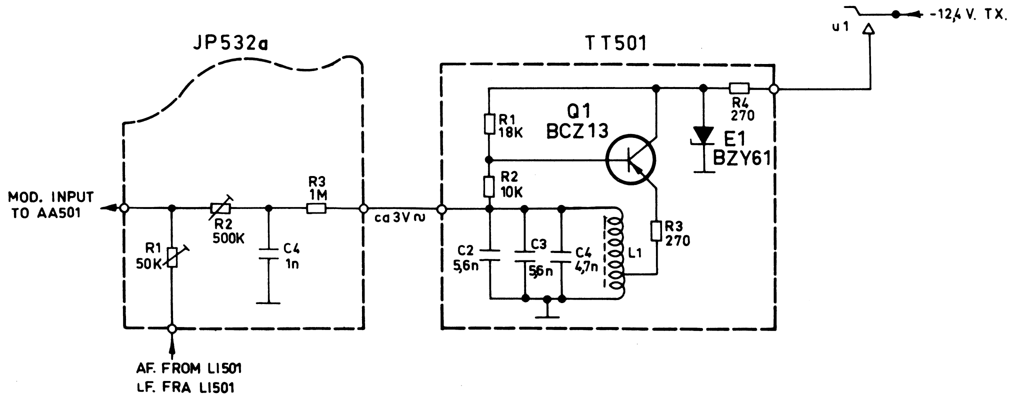
General

A TT501 single-frequency calling tone generator, described below, is a standard accessory specifically designed for installation in the pocket radiotelephone. Additional tone equipment can be provided but only for special applications and only installed in a separate box external to the pocket radiotelephone. Circuit diagrams and technical information (if available) concerning such special equipment will be contained in a separate technical manual or be inserted at the back of this manual.

TT501 Tone Generator

The TT501 calling tone generator employs a Hartley-type oscillator (Q1) with feedback between emitter and base. The tuning coil (L1) is wound on a miniature ferroxcube core with air gap and has a ferrite tuning slug for accurate adjustment of the oscillator frequency.

The total tuning capacitance comprises three parallel-connected capacitors (C2, C3, and C4) of the type with a very small temperature coefficient. The DC supply voltage for the oscillator is zener stabilized (E1) in order to



make the output voltage and operating frequency independent of the supply voltage.

Technical Specifications

Supply Voltage

Nominal: 12.4 volts; minimum: 10 volts; maximum: 14 volts.

Current Drain

Nominal: 20 mA at 12.4 volts.

Frequency Stability

±1 %.

Harmonic Distortion

Maximum: 6 %.

Output Voltage

3 volts ±1 dB (with 1-megohm load).

CHAPTER IV. SERVICE

A. General

Before leaving the factory, the STORNOPHONE 500 pocket radiotelephone has been aligned to the specified operating frequencies and tested for satisfactory performance. The results of this performance check have been entered on a special Final Test Report sheet which is enclosed with each radiotelephone. The Final Test Report should be kept because comparisons with the Test Report values during subsequent service work will facilitate maintenance. Also, in cases of complaints, and when repairs are to be made at the factory, the Final Test Report should be sent to the factory with the defective radiotelephone if at all possible.

As is the case with other lasting consumers' goods, the pocket radiotelephone can only be kept at the top of its performance if subjected to preventive service inspections at regular intervals. The frequency of such service inspections will depend on actual use of the pocket radiotelephone, but intervals between service inspections should not exceed six months.

The readings listed on the Test Report and the typical voltage values stated in the main circuit diagrams are important aids in systematic fault-finding and repair work. A further aid will be obtained if a log is kept of the test-point readings obtained in each service inspection since checking the readings obtained in one service inspection against those obtained in the succeeding one may provide an indication as to whether realignment is necessary; also, defective modules, if any, may be shown up by such checks.

Alignment of the radiotelephone and repairs of mechanical or electrical defects outside the module cans may be performed by any skilled radio technician who has the necessary tools and measuring equipment at his disposal and has acquainted himself with the operation of the radiotelephone through a study of this manual.

However, attempts to repair circuits inside individual module cans should NOT be made - circuits in the module cans are quite critical, and the average service shop does not have the facilities required for a satisfactory result; besides, because of the replacement service now practised it will in most cases be cheaper to replace a module can than to repair it.

B. Final Test Report

In the absence of agreements to the contrary, a Final Test Report will be enclosed in the special enclosed in which the pocket radiotelephone is shipped. The meaning of the various spaces will be explained in brief below.

The space in the top right-hand corner contains the number under which the order was processed and shipped from Storno. This is followed, in order from left to right, by the type designation of the pocket radiotelephone; a space available for particulars about tone

Stornophone 500

B-order

MÅLEBLAD - FINAL TEST REPORT - MESSBLATT

Type		No.	= 12,4 Volt

equipment or other special features; the serial number; and the battery working voltage. Any communication to Storno concerning a pocket radiotelephone should quote this information in order to ensure quick processing and prevent mistakes.

SENDER - TRANSMITTER - SENDER

	(antenna) MHz Mc/s	(crystal) kHz kc/s
1	–	–
2	–	–
3	–	–

MODTAGER - RECEIVER - EMPFÄNGER

	(antenna) MHz Mc/s	(crystal) MHz Mc/s
1	–	–
2	–	–
3	–	–

The maximum number of channels that can be provided in a radiotelephone is three. The spaces illustrated above list the aligned channels provided in the radiotelephone as supplied from Storno. The spaces headed by the antenna symbol list the radiotelephone's transmitting and receiving frequencies whilst the spaces headed by the crystal symbol list the frequencies marked on the crystal holders. Unless otherwise specified, measurements and alignment have been performed at the lowest (lower) frequency.

Følsomhed for 12 dB SINAD (½ emk) Sensitivity for 12 dB SINAD (½ EMF)	µV
TX udgangseffekt TX output power	mW
Forvrængning ved 200 mW LF ud Distortion at 200 mW AF out	%
Min. batterispænding for squelch lukning Min. battery voltage for squelch closing	Volt

(tone) I =	Hz c/s	(tone) II =	Hz c/s
Strømforbrug Consumption Verbrauch	Stand-by		mA
	Modtagning Reception	200 mW LF ud AF out	mA
	Sending Transmission		mA

The two spaces at the top list tone frequencies, if the radiotelephone was supplied with a built-in tone transmitter. If only the left space has been filled in, the tone transmitter is a single-tone generator. If both spaces have been filled in, the tone transmitter is a two-tone generator. The power consumption was measured on Stand-by (no signal - speaker muted by squelch), on Receive, and on Transmit (key down).

Receiver sensitivity is stated in terms of half EMF for 12 dB signal-to-noise ratio as measured at the antenna connector. Transmitter power output is stated in milliwatts, likewise measured at the antenna connector. The distortion measurement was made with the volume control set for 200 milliwatts of audio output signal at 1000 c/s. The minimum battery voltage at which the electronic squelch mutes the receiver was found by reducing the power-supply voltage.

The main circuit diagrams show a number of test points at which typical values may be measured for use when checking the condition of the radiotelephone. The completed Final Test Report lists the readings obtained in the final test at the factory. These readings may only be compared with readings obtained in subsequent tests if these are carried out under identical conditions. The supply voltage for the pocket station during the measurements should be exactly 12.4 volts, and the measuring instruments used should conform to the specifications listed in the Final Test Report and in the text below.

Transmitter Test Points

TX	Unit Enhed Einheit	Målingstype Type of measuring	Måling Measuring Messungen
7	OP5xx	Sonde A	µA
8	OP5xx	Sonde A	µA
10	FD5x1	Sonde B	Volt
12	FT5x1	Sonde B	Volt
13	FD5x2	Sonde B	Volt
13A	FD5x2	Sonde B	Volt
14	PA5x1	Sonde C	Volt
15	PA5x2	Sonde D	Volt
16	FN5x1	Sonde D	Volt

The above measurements were made with an RF probe (Storno type 95.059) in conjunction with instruments of the types specified below:

Sonde A: Probe and 0-50 uA meter (R_i = 1000 ohms)

Sonde B: Probe and 0-2.5 V meter (20 k ohms/V)

Sonde C: Probe and 0-10 V meter (20 k ohms/V)

Sonde D: Probe + 0-25 V meter (20 k ohms/V)

E	LI501	LF	★	mV
F	AA501	LF	★	mV
G	AA501	LF	★	mV
H	TT50x	LF		Volt

An audio vacuum-tube voltmeter was used for measurements at the test points indicated above. Readings at the test points marked by ★ were obtained at a terminal voltage of 2 mV at 1000 c/s between pin 3/4 and pin 8 of multi-wire connector J1.

Receiver Test Points

RX	Unit Enhed Einheit	Målingstype Type of measuring	Måling Measuring Messungen	
1	RA5x2 BP5x4	Sonde B		Volt
2	OT511 OD531	Sonde A		μA
A	BP5x1,2,3 RA5x1	Sonde A	●	mV
B	RC5x1 XF50x IT501	Sonde A	●	mV
4	IA50x	Sonde A	●	μA
5	IA50x	Sonde B	■	Volt

The above measurements were made with an RF probe (Storno type 95.059) in conjunction with instruments of the types specified below:

Sonde A: Probe and 0 - 50 uA meter (Ri = 1000 ohms)

Sonde B: Probe and 0-2.5 V meter (20 k ohms/V).

Readings listed in the spaces marked by ● were obtained by noting the antenna signal (EMF) required for a 10 uA reading on the probe meter. The reading listed in the space marked ■ was obtained with no antenna signal applied.

C	XD50x	LF	■	mV
D	SQ501	LF	■	Volt

Readings listed in the spaces shown above were obtained with an audio vacuum-tube voltmeter and with no signal applied through the antenna connector.

The location of individual test points is shown on the main circuit diagrams and on the layout sketch indicating the location of components on the printed wiring boards.

C. Fault Finding and Repair

Fault-finding

The locating of faults in the pocket radiotelephone should only be entrusted to skilled personnel who possess the required service aids and equipment and have already studied the operation of the radiotelephone.

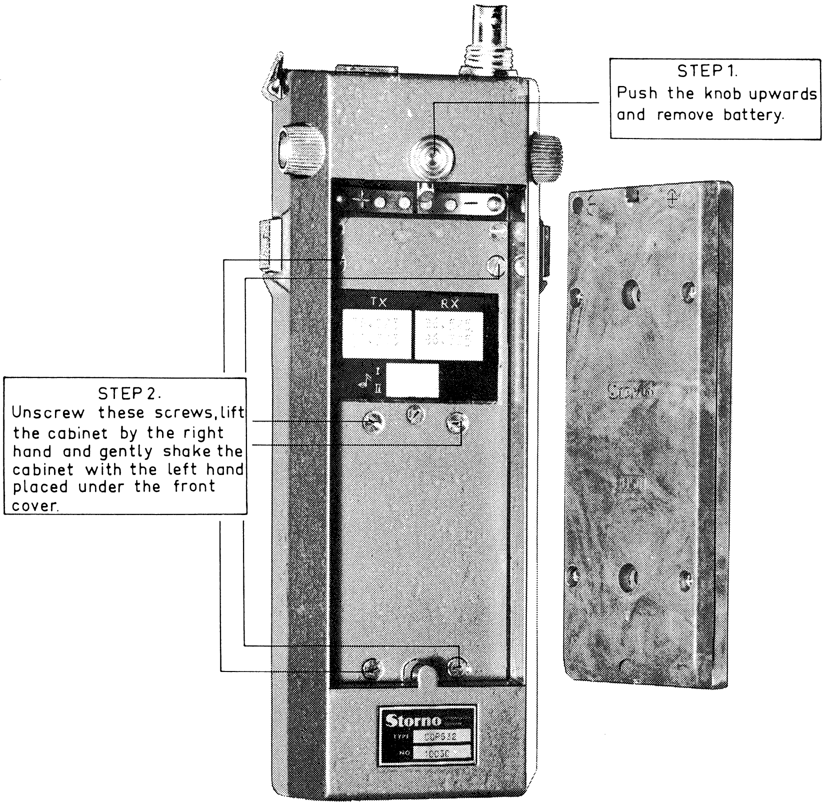
Any fault-finding job should begin with a check whether the fault is in the accessories, in the cabling, in the transmitter section, or in the receiver section.

The accessories can be checked simply and in a minimum of time by connecting them to a radiotelephone that is known to be in perfect order.

If the fault is not traced to the accessories, the radiotelephone cabinet should be opened by sliding the knob on the rear of the cabinet upwards. The battery may now be tipped out. Then remove the six screws indicated in the drawing below, and the radiotelephone may now be shaken carefully out into the hand.

A visual inspection should now be made of the accessible control knobs, the crystal shift feature, and the cabling. Broken wires and leads should be soldered into position or replaced if necessary. This job should be performed carefully - reference is made to the section on soldering elsewhere in this chapter.

Chapter IV. Service



A communication test with another pocket radiotelephone on the same frequency will quickly disclose whether the fault should be looked for in the transmitter section or in the receiver section. In order to be able to locate the defective module it is necessary to have: a signal generator covering the particular frequency range; an audio vacuum-tube voltmeter; a 0-50 uA meter (Ri = 1000 ohms); and a multimeter (such as an AVOmeter with 20 k ohms/V ranges). The special Storno SI501 probe is also required.

The main circuit diagrams list a number of typical voltages. While these are intended only as a guide, they will provide a fairly clear picture of the present condition of the radiotelephone they are compared with the Final Test Report readings and with entries in the log (if one is kept).

To trace faults in the transmitter, a 50-ohm 1-watt dummy load should be connected across the antenna connector of the radiotelephone, whereupon the transmitter key should be depressed. Then check each individual test point with an SI501 probe and a multimeter which has been set at the measuring range specified in the Final Test Report. Begin at test point (16) at the transmitter output circuit, then working backwards through all the test points at the transmitter section.

Also check, by means of the multimeter, the typical voltages stated in the circuit diagrams.

To trace faults in the receiver section, connect the signal generator to the antenna connector and apply a signal of convenient level to the receiver input. In this case, test measurements should begin a test point (A) and continue from there through all test points of the receiver section, ending up at test point (C) in the discriminator output circuit. In the receiver section, too, the typical voltages may conveniently be checked with the multimeter.

The gain of each IF stage should be approximately 19 dB. The simplest way of checking this is to measure the input signal and note the signal-generator attenuator setting. Then transfer the meter to the output circuit of the stage and adjust the signal-generator attenuator for the same meter reading as before. The gain then equals the difference between the two attenuator settings.

When the defective module has been traced by means of test measurements, replacement should not be resorted to immediately as there may be a chance of correcting the defect through adjustment. Reference is made to the alignment procedure described in Chapter V.

Replacing Modules

The replacement of module cans will not normally cause difficulties if the job is done with care and common sense. For instance, care should be taken that no adjacent cans will be damaged while removing and replacing the defective can.

First unsolder all leads from the defective module. It may be a good plan to make a few notes on the connections first, so that the cabling will be exactly the same after the replacement job.

To ensure best possible chassis connections between module cans, all cans carry small solder lugs which are soldered to the lugs of the adjacent cans. One side should be unsoldered at a time. To do this, push a small knife down between the cans during the heating process, and the can to be replaced may then be worked loose with the knife while the solder is still liquid.

When the can is free, it should be pulled out carefully. Before inserting the new module can, the solder lugs of the adjacent modules should be cleaned of excess solder. The new module should now be pushed into place and the lugs soldered together carefully. At last, solder the leads from the cabling into place.

If the module which as been replaced contains adjustable stages, it as well as the adjacent modules should be aligned in accordance with the directions given in Chapter V.

Soldering

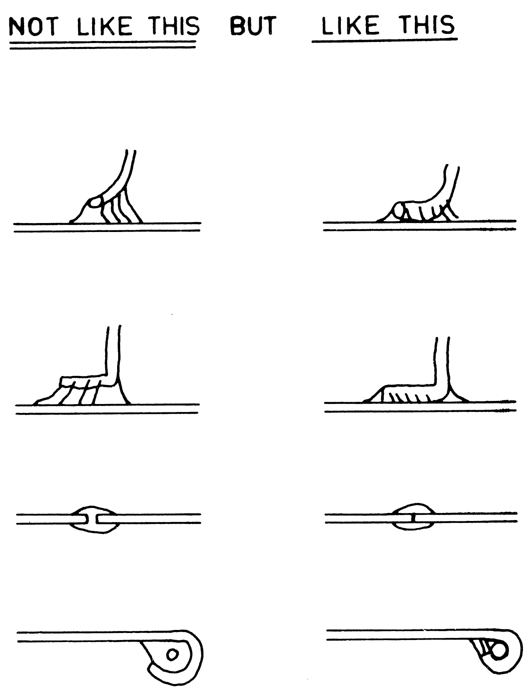
As mentioned previously, a certain amount of care is required when soldering in connection with printed wiring boards in the module cans. For soldering directly on the printed wiring boards a 6-volt iron of approx. 15-watt rating is recommended while a 220-volt iron of approx. 30-watt rating may be used for unsoldering leads from module cans.

When soldering on, or close to printed wiring boards, the iron should not be applied for more than three seconds. The wiring boards are made of a glass fiber material that is quite capable of standing up against heat for short periods at a time, but while heat is applied there is a risk that the copper foil may detach itself from the wiring board; moreover, components on the wiring board may be damaged, or they may fall away from the board and down into the can.

Correct soldering temperature is 270°C. The tip of the iron should preferably have a diameter of not more than three or four millimetres. The tip should be shaped like a chisel or screwdriver.

Conventional 60/40 soft solder may be used, but solder with a flux content of approx. 0.5 per cent is better suited. Conventional solder has a flux content of approx. 3.5 %.

Removal of excess flux is to be performed with isopropyl alcohol; however, this solvent must not get into contact with components.



Repairing Modules

Repairs of circuits inside module cans should only be undertaken in very special cases. The greatest care should be exercised in order to avoid impairing the performance and specifications of the radiotelephone.

When the module can has been taken out, the can should be placed in some sort of holder that will grip the can in a horisontal position without squeezing it so much that the can itself will be damaged. Now, using a sharp scalpel-type knife, twist loose the wiring board whilst heating, with a soldering iron, the places where the can makes its chassis connection to the copper foil of the circuit board. By carefully prying all four sides of the circuit board loose from the can (using the knife), the board may ultimately be pulled out. Work will be facilitated if some simple device is available by means of which the liquid solder can be removed while the sides are being heated (for instance using a hypodermic syringe on similar device as a suction pump).

Replacement of components in the circuit requires a very high degree of care and accuracy since it is extremely important that wiring and component layout should not be changed. It goes without saying that defective components should be replaced by components which conform to the exact specifications of the components which were removed.

When the defect has been corrected, the wiring board should be put back in the shield can. Because of the miniaturization techniques employed, space in the can has been fully utilized, for which reason great care should be taken that bare wires do not have, or can have, contact with the bare metal surface of the shield can. If the shield can was damaged when the circuit board was being removed, a new shield can should be used.

When the wiring board is in place, a soldered connection should be made between the shield can and the chassis connection of the shield can.

On completion of the repair job and insertion of the module, complete realignment of the radio section in question will be necessary.

CHAPTER V. ALIGNMENT PROCEDURE

A. General

Introduction

The directions given in this chapter are intended as an aid in aligning a CQP511 or CQP512 radiotelephone, and the procedure described should therefore not be regarded as the only correct one. Certain adjustments can with advantage be performed differently if a wider range of measuring equipment is available. However, departures from the directions given here should only be made in cases where the radio technician can be absolutely certain that different alignment procedures will not impair the specifications or render subsequent sections of the alignment process difficult.

Only such skilled radio technicians as have already studied the operation of the radiotelephone should perform adjustments and service.

Each radiotelephone is checked and tested before shipment from the factory. Unless special arrangements have been made, the testing department has:

(1) Inserted quartz crystals for the channels specified in the customer's order;

(2) Aligned the complete radiotelephone so that both transmitter and receiver frequencies are correct with an accuracy better than 3×10^{-6};

(3) Adjusted the receiver power output and the speech limiter clipper level to conform with the specifications;

(4) Adjusted and tested built-in tone equipment (if provided).

As received from Storno, therefore, the radiotelephone is aligned for maximum performance and in satisfaction of the specifications in question.

CAUTION!

The greatest care should be shown when measuring voltages, currents etc. in the circuits of the radiotelephone. Even brief short-circuits such as may be caused by the test prods of a measuring instrument can result in permanent damage to a transistor.

STORNOPHONE 500

These directions have been drawn up for use in connection with these radiotelephones:

CQP511 (146-174 Mc/s), 50 kc/s channel separation.
CQP512 (146-174 Mc/s), 25 kc/s channel separation.

Measuring Equipment

While adjustments are being performed, the radiotelephone should be connected to an external power supply delivering a variable voltage between 9 and 15 volts at 300 mA and having low internal resistance (considerably below 2 ohms).

Alignment should be performed at nominal voltage (12.4 V) unless otherwise specified. The channel selector should be set to the lowest-frequency channel unless otherwise specified.

The shields provided in the radiotelephone should be in place during all adjustments.

The first paragraph of each section of these directions specifies the types of measuring instruments required for correct and adequate performance of the adjustment or check in question.

Reference is made to various types of measuring equipment specially developed by STORNO for service and alignment of STORNO radio equipment. This measuring equipment includes STORNO's type SI501 service instrument, consisting of an RF probe and a 50-0-50 microammeter with proper series resistors. However, a volt-ohm-milliammeter may be used instead of the microammeter in conjunction with the probe if it:

(1) contains a 0-50 uamp. moving coil DC meter (Ri = 1000 ohms);

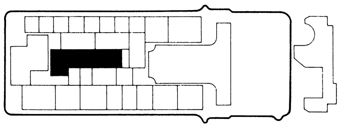
(2) has a sensitivity of 20 k ohms per DC volt; and

(3) has ranges of 0-50 uamp., 0-2,5 V, 0-10 V, and 0-25 V.

Moreover, in all other cases where reference is made to STORNO's own measuring equipment it applies that other equipment of comparable or better specifications may of course be used.

B. Receiver Section

Multiplier-chain Alignment OT511a, RA512a and BP514a



Instruments

Service instrument (Storno type SI501) consisting of:

RF probe (Storno type 95.059), see Fig. 1.
50-0-50 uamp. meter (Ri = 1000 ohms) with series resistors.
One 39 k ohm 0.5 W resistor.

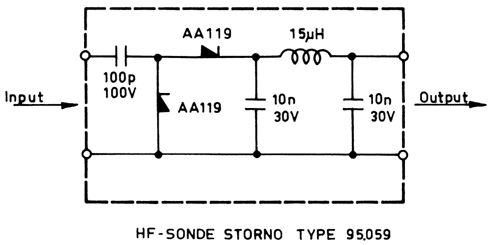


fig. 1

Setup (see Fig. 2)

For readings at test point (2), the meter should be connected through the RF probe. For readings at test point (1), it should moreover be connected through a 39 k ohm series resistor.

Procedure (see Fig. 2)

(a) Connect the microammeter at test point (2) in OT511a through the RF probe.

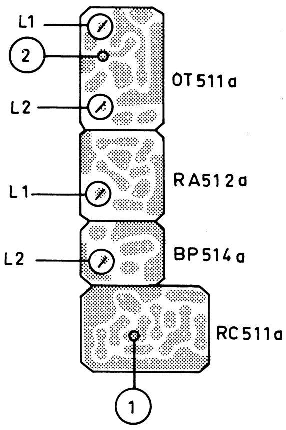


fig. 2

(b) Tune coil L1 in OT511a for minimum meter reading.

(c) Connect the microammeter, through the RF probe and a 39 k ohm series resistor, at test point (1) in RC511a.

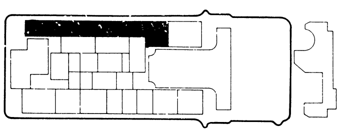
(d) Tune coil L1 in BP514a for maximum meter reading.

(e) Tune coil L1 in RA512a for maximum meter reading (approx. 12 uamp.).

(f) Tune coil L1 and L2 in OT511a for maximum meter reading.

(g) Select other channels (frequencies) - if provided - and check that readings are approx. 12 microamp. in these cases too.

IF-Chain and Discriminator Alignment IT501, IA501, IA502, IA503 and XD501 or XD502



Chapter V. Alignment Procedure

Service instrument (Storno type SI501)

RF probe (Storno type 95. 059), see Fig. 1.
50-0-50 microammeter (Ri = 1000 ohms) with series resistors.
One 39-k ohm 0. 5 W resistor.
10. 7 Mc/s signal generator
DC oscilloscope or DC vacuum-tube voltmeter.

Setup (see Fig. 3)

Set the signal generator to 10. 7 Mc/s and connect it inductively to L1 in IT501. To do this, place the signal cable terminating in a coupling loop close to L1 in IT501.

Connect the microammeter, through the RF probe, at test point ④ of the fourth IA502.

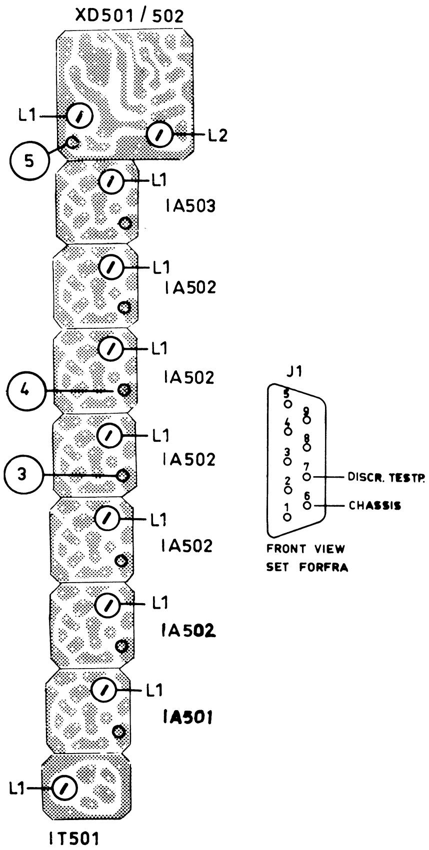
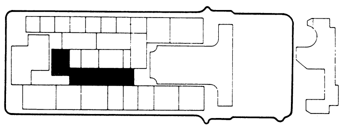


fig. 3

Procedure (see Fig. 3)

(a) Tune coil L1 in IA501 for maximum meter reading.
(b) Tune coil L1 in the first IA502 for maximum meter reading.
(c) Tune coil L1 in the second IA502 for maximum meter reading.
(d) Tune coil L1 in the third IA502 for maximum meter reading.
(e) Connect the microammeter, through the RF probe and a 39 k ohm resistor, at the input of the fifth IA502.
(f) Tune coil L1 in the fourth IA502 for maximum meter reading.
(g) Connect the microammeter through the RF probe and a 39 k ohm resistor, at the input of IA503.
(h) Tune coil L1 in the fifth IA502 for maximum meter reading.
(i) Connect the microammeter, through the RF probe and a 39 k ohm resistor, at test point ⑤ in XD501/502.
(j) Tune coil L1 in IA503 for maximum meter reading.
(k) Connect the DC oscilloscope or DC vacuum-tube voltmeter between pins 6 and 7 of connector J1.
(l) Tune coil L2 in XD50x for zero indication on the vacuum tube voltmeter or oscilloscope.

Front-end Alignment BP511a, RA511a, BP512a, BP513a and RC511a



Instruments

Service Instrument (Storno type SI501) consisting of:

RF probe (Storno type 95. 059), see Fig. 1.
50-0-50 microammeter (Ri = 1000 ohms) with series resistors.

Signal generator (146-174 Mc/s)

One 15-kohm 0, 5 W resistor.

Setup

Set the signal generator to the receiving frequency and connect it to antenna connector J2. Connect the microammeter, through the RF probe, at test point ③ in the third IA502 (see Fig. 3).

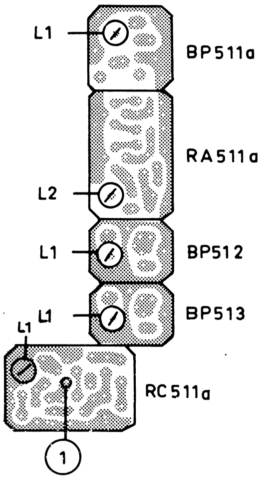
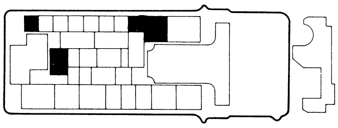


fig. 4

Procedure (see Fig. 4).

(a) Tune coil L1 in BP511a for maximum meter reading.
(b) Tune coil L2 in RA511a for maximum meter reading.
(c) Tune coil L1 in BP512a for maximum meter reading.
(d) Tune coil L1 in BP513a for maximum meter reading.
(e) Tune coil L1 in RC511a for maximum meter reading.

Discriminator Alignment XD 501/502



Instruments

Signal generator (146-174 Mc/s)

Audio vacuum-tube voltmeter.
Distortion meter.
One 15 kohm 0,5 W resistor.

Setup (see Fig. 5)

Set the signal generator to the receiving frequency and connect it to antenna connector J2.

Modulate the signal generator as follows:

For CQP511: ±10 kc/s frequency swing at a modulating frequency of 1000 c/s.

For CQP512: ±3.3 kc/s frequency swing at a modulating frequency of 1000 c/s.

Connect the vacuum-tube voltmeter to test point (6) through a 15-k ohm resistor.

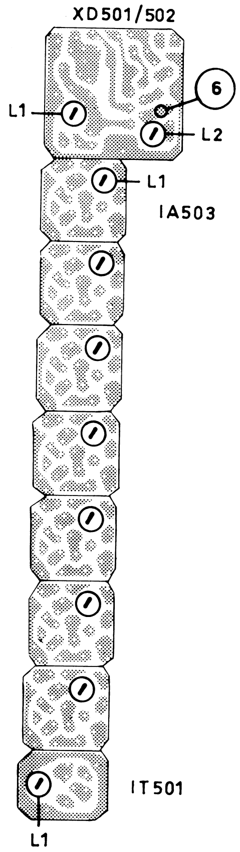


fig. 5

Procedure (see fig. 5)

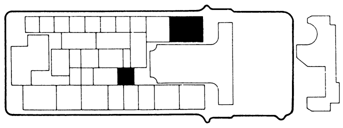
(a) Connect the distortionsmeter and the audio vacuum-tube voltmeter at test point (6) through a 15 k ohm resistor.
(b) Tune coil L1 in IA503 for maximum audio voltage reading.
(c) Tune coil L1 in XD501/502 for minimum distortion. Audio voltage reading, with the distortion meter disconnected, should not be less than:

  500 mV for XD501 (in CQP511)
  350 mV for XD502 (in CQP512)

(d) Tune coil L1 in IT501 for minimum distortion.

The distortion should be less than 4 %.

Checking the Audio Output Amplifier AA 502



Instruments

Audio vacuum tube voltmeter.
Distortion meter.
DC vacuum-tube voltmeter.
One 40-ohm 0.5 W resistor.

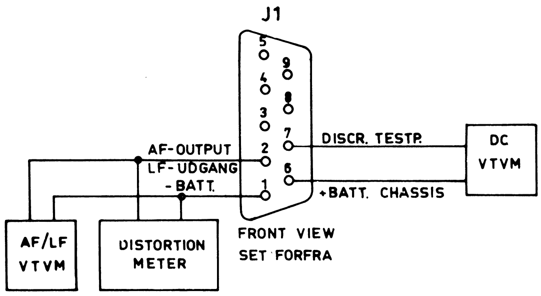


fig. 6

Setup (see Fig. 6)

Connect the signal generator to antenna connector J2. Connect the DC vacuum-tube voltmeter between pins 6 and 7 of connector J1. Connect a 40-ohm load across the output instead of the speaker, which should be unsoldered.

Connect the audio vacuum-tube voltmeter and the distortion meter in parallel across the output (connector J1).

Set the signal generator to the receiving frequency (for zero reading on the DC vacuum-tube voltmeter) and adjust it to deliver a signal strength that will provide adequate noise suppression (approx. 10 uV).

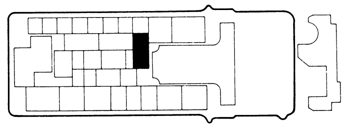
Apply modulation to the signal generator so that the resulting frequency swing is two-thirds the maximum permissible swing, in other words,

for CQP511: ±10 kc/s at a modulating frequency of 1000 c/s.
for CQP512: ±3.3 kc/s at a modulating frequency of 1000 c/s.

Procedure

(a) Set the volume control for 200 mW power output (2.8 V across 40 ohms ±1 dB).
(b) Check the distortion. It should be less than 5%.
(c) With no signal at the antenna input, note the noise level in terms of dB (to be read on the vacuum-tube voltmeter).
(d) Set the signal generator output voltage at a level where the vacuum-tube voltmeter reading is 12 dB below the level that was measured with no signal at the antenna input. Sensitivity should be better than 0.6 uV EMF.
(e) Tune coil L1 in BP511a for best signal-to-noise ratio (see Fig. 4).

Checking the Squelch Circuit SQ 501



Instruments

Signal generator (146-174 Mc/s)

Squelch Function

Turn the supply voltage down to 9 V and check, by rotating the squelch potentiometer back and forth, if the squelch circuit will cut off the receiver when no RF signal is being received.

Minimum Squelch Sensitivity

(a) Set the signal generator to the receiving frequency and connect it to antenna connector J2.
(b) Increase supply voltage to 12.4 V.
(c) Turn the squelch potentiometer all the way to the right.
(d) Increase the signal generator output level until the squelch circuit will pass signals through the receiver.

Minimum sensitivity: less than 2 uV EMF.

Maximum Squelch Sensitivity

(a) Set the signal generator to the receiving frequency and connect it to antenna connector J2.

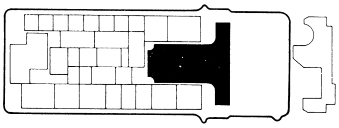
(b) Adjust supply voltage to 12.4 V.

(c) With no RF signal at the receiver input, adjust the squelch potentiometer until the audio output has been reduced by not less than 40 dB.

(d) Increase the signal generator output level until the squelch circuit will pass signals through the receiver.

Maximum sensitivity: less than 0.8 uV EMF.

Crystal Frequency Adjustment XS511



Instruments

Frequency counter.

Signal generator (146-174 Mc/s).

One T-section network (matching not critical).

DC vacuum-tube voltmeter.

Setup (see Fig. 7)

Connect the signal generator, the counter, and antenna connector J2 together through the T-section network. Adjust, by means of the counter, the signal generator to the desired signal frequency.

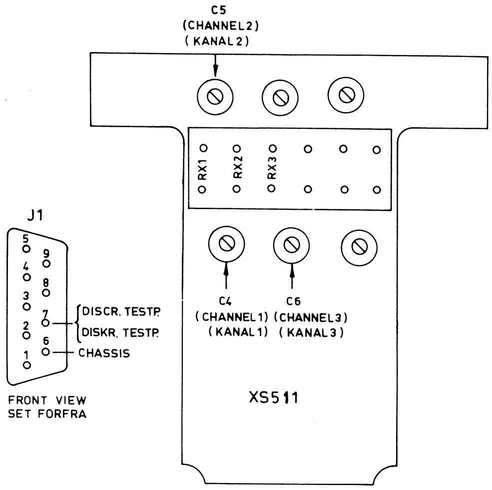


fig. 7

Connect the DC vacuum-tube voltmeter between pins 6 and 7 of connector J1.

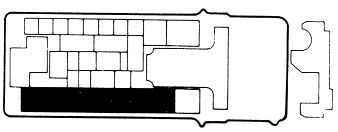
Procedure (see Fig. 7)

Adjust the trimmer capacitor for the channel selected (C4, C5, or C6, located in XS531) for zero DC vacuum-tube voltmeter reading.

The frequency accuracy must be better than $\pm 3 \times 10^{-6}$ (with the lid in place).

C. Transmitter Section

Multiplier-chain Alignment OP512, FD511, FT511a, FD512a PA511a, PA512a and FN511



Instruments

A DC instrument covering the following ranges:

0-2,5V, 0-10V, and 0-25V (20 kΩ/V)
0-50 uA (Ri = 1000 Ω).

An RF wattmeter having a 0 - 1 Watt range.
RF probe (Storno type 95.059), see fig. 1.

Setup (see fig. 8)

Apply an operating voltage of 12.4 V to the pocket station. Turn the ADC potentiometer (R3 in JP531a) fully counterclockwise. The transmitter should be keyed for all adjustments referred to below. The voltages stated only refer to the approximate meter-readings and must not be regarded as maximum or minimum readings. The spread in transistors

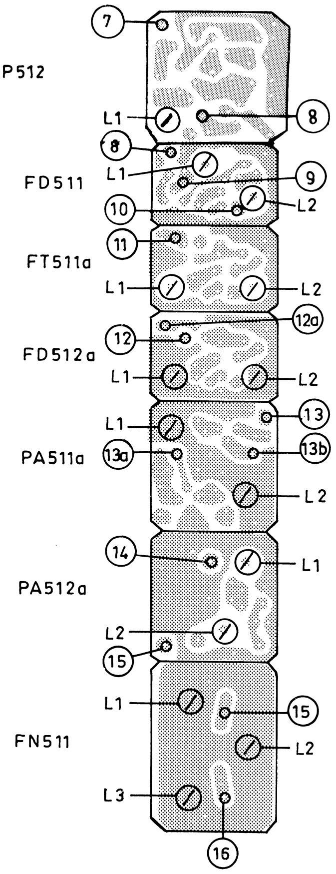


fig. 8

and dependance of frequency may cause a deviation up to 100% at nominal output power.

Procedure (see fig. 8)

a) Connect the DC instrument (0-2, 5V range) at test point (9) in FD511. Tune coil L1 in OP512 for maximum reading. It should be approx. 1V.

b) Connect the DC instrument (0-2, 5 V range) at test point (11) in FT511a. Tune coil L2 in FD511 for maximum reading. Tune coil L1 in FT511a for maximum reading. It should be approx. 0, 5V.

c) Connect the DC instrument (0-50 uA range) at test point (12a). Tune coil L2 in FT511a for maximum reading. Tune coil L1 in FD512a for maximum reading. It should be approx. 30 uA. If the reading is more than 50 uA, then it should be adjusted by the ADC potentiometer (R3 in JP531a) until a reading of approx. 30 uA is obtained.

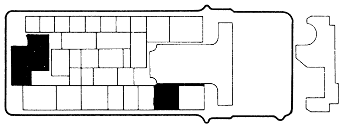
d) Now measure the output power and tune the following coils for maximum output power: Coil L1 and L2 in PA511a, coil L1 and L2 in PA512a, coil L1, L2 and L3 in FN511. During the tuning the ADC potentiometer is adjusted all the time so a 500 mW output power is not exceeded.

e) Repeat section d) until 500 mW output power is obtained with the ADC potentiometer tuned as far counterclockwise as possible.

f) Connect the DC instrument (0-10 V range) at test point (11a). Tune the coils L1 and L2 in FT511a and L1 in FD512a for minimum reading. It should be approx. 5-10 V.

At fault finding an RF probe is used in conjunction with a 50 uA or DC instrument, and the readings are compared with those stated in the final test report.

Modulation Adjustment
LI501, JP532a, AA501b



Instruments

300 - 3000 c/s tone generator
Audio vacuum-tube voltmeter
Deviation meter
Distortion meter
Matching transformer (Storno type 60. 5100), see Fig. 9.
One 750 usec. de-emphasis network.

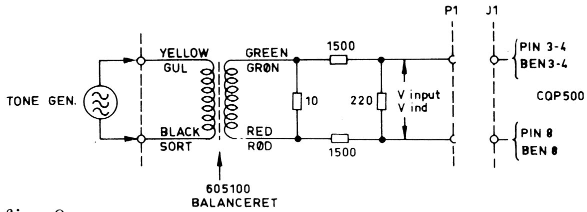


fig. 9

Setup (see Fig. 9)

Connect the tone generator, through the matching transformer, between pins 3/4 and 8 of connector J1.

Connect the deviation meter to the transmitter output of CQP51x (connector J2) through a proper attenuation network.

The transmitter should be keyed for the adjustments described below.

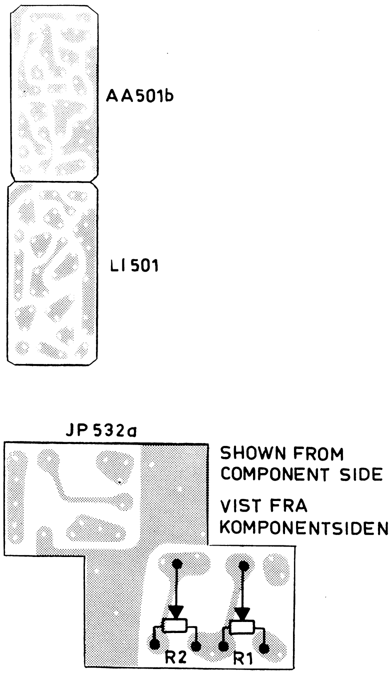


fig. 10

Procedure (see Fig. 10)

(a) Set the input voltage from the tone generator at 10 mV at a frequency between 700 and 800 c/s (NOTE: the vacuum-tube voltmeter should not be connected to the connector pins during the measurements described below due to possible hum voltages).

(b) Adjust potentiometer R1 in JP532a for maximum permissible frequency swing as indicated by the deviation meter.

For CQP512, Δf max. = 5 kc/s
For CQP511, Δf max. = 15 kc/s.

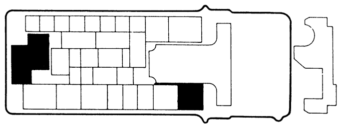
(c) Reduce the input voltage to two-thirds the maximum permissible frequency swing at a modulating frequency of 1000 c/s. Sensitivity should be better than 2 mV, cf. item (a).

(d) Connect the distortion meter to the audio terminals of the deviation meter through a 750 usec. de-emphasis network.

(e) Tune coil L1 in OP512 for minimum harmonic distortion.
Maximum harmonic distortion: 7%.

(f) Remove connector P1 from the input (J1). Test the speaker, using it as a microphone.

Tone Level Adjustment TT501, JP532a



Instruments

Deviation meter.

Setup

Connect the deviation meter to the transmitter output of CQP51X through a proper attenuation network. Both the transmitter and the tone transmitter should be keyed for the adjustments described below.

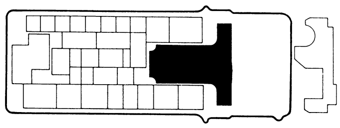
Procedure

Adjust, with potentiometer R2 in JP532a, the tone level to two-thirds the maximum permissible frequency swing (see Fig. 10).

For CQP512, two-thirds Δf max. = 3.3 kc/s
For CQP511, two-thirds Δf max. = 10 kc/s.

The frequency of the tone transmitter is adjusted by means of coil L1 in TT501. This requires the use of a frequency counter as the frequency accuracy must be better than 5 parts in a thousand.

Crystal Frequency Adjustment XS511



Instruments

Frequency counter (frequency range 68-88 Mc/s).

Setup

The counter should be connected to antenna connector J2 through a proper attenuating network.

Procedure (see Fig. 11)

With the transmitter keyed, adjust the trimmer capacitor for the channel selected (C1, C2, or

C3, located in XS511) for correct output frequency.

The frequency accuracy must be better than 3×10^{-6} (with the lid in place).

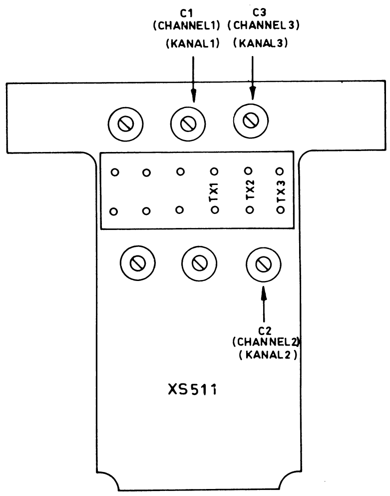


fig. 11

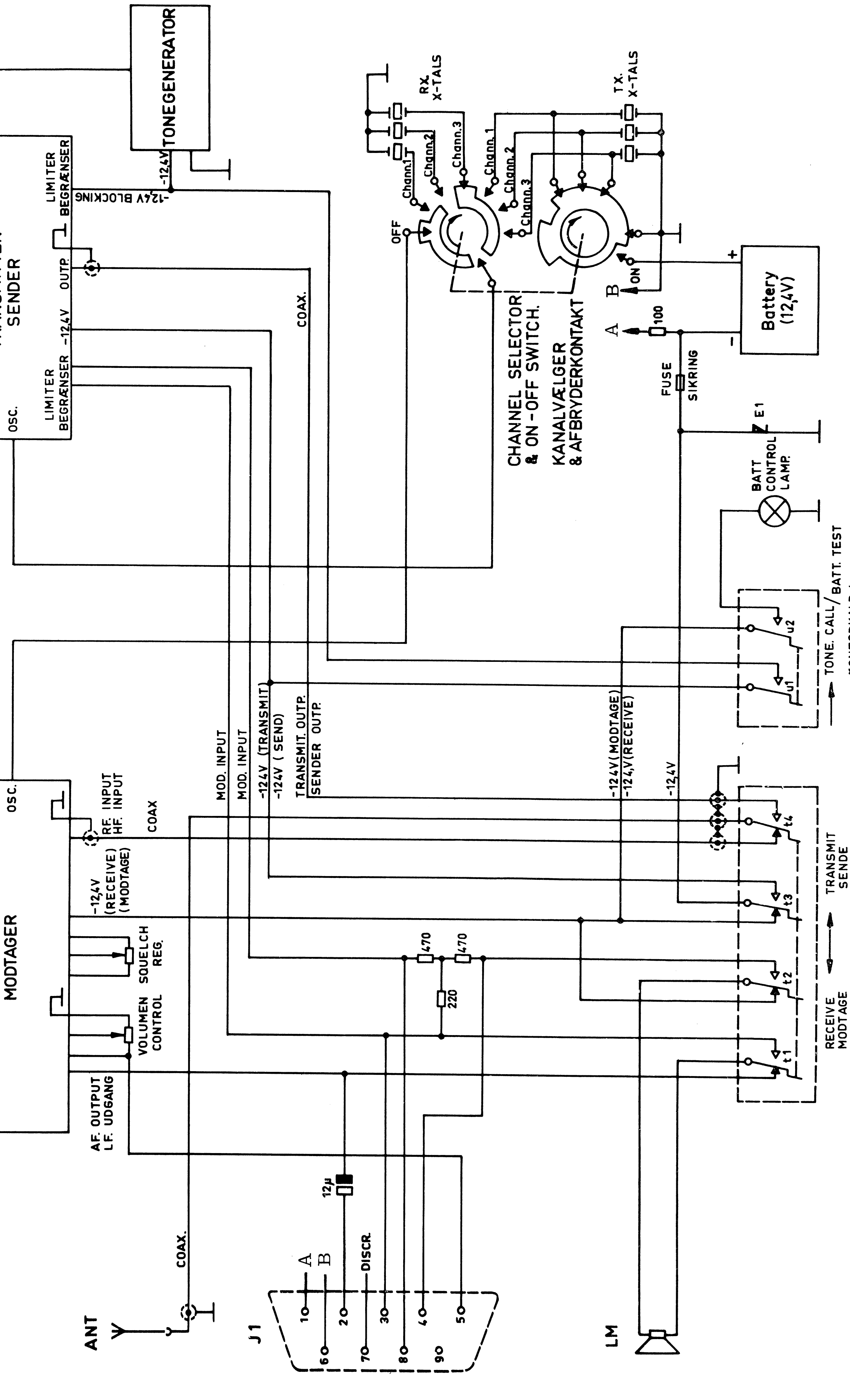
Storno

CHAPTER VI. DIAGRAMS AND PART LISTS

The diagrams and schematics of the pocket radiotelephone station, model STORNOPHONE 500, are to be found on the pages following.

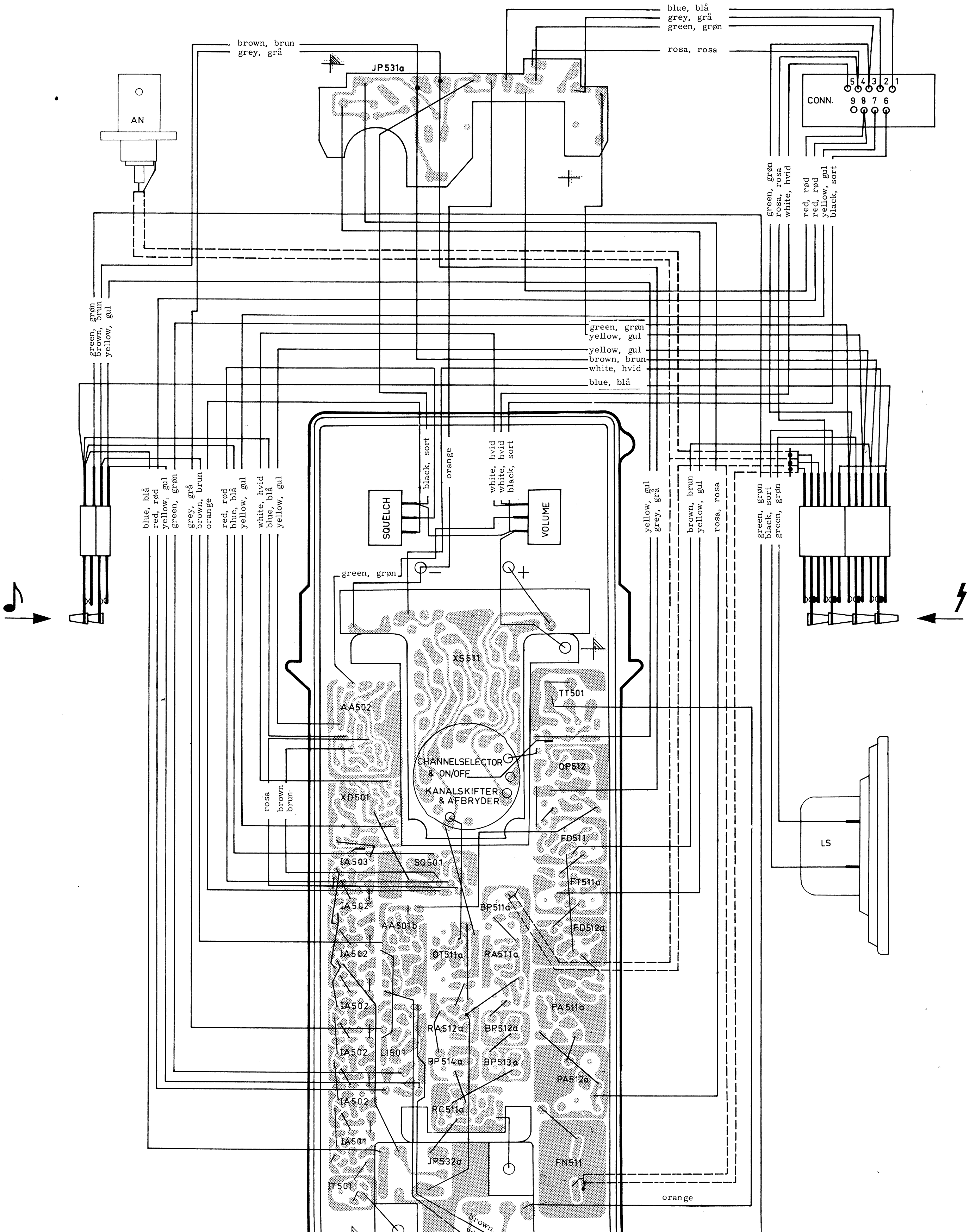
The component designation in each modular unit starts at R1, C1, L1, etc., for what reason special care should be devoted in filling out the spare part order blanket. All information concerning each component in question can be found in the part lists and should be stated together with the type designation of the modular unit. Furthermore - specification of equipment type and possible production number will ease the handling of the order at Storno and minimize the risk of erroneous delivery.

The last page in this manual contains alterations and modifications of the equipment.

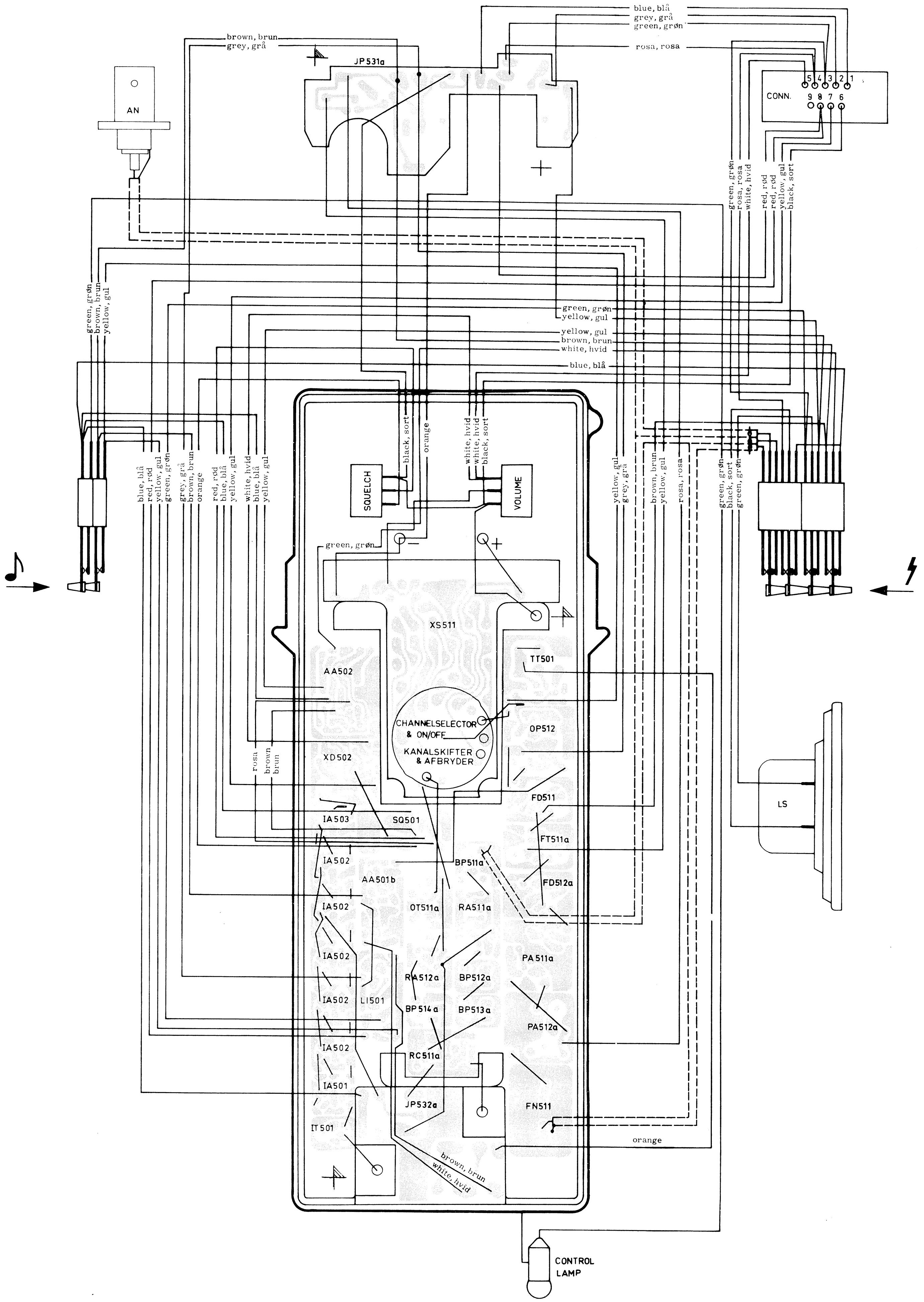


OPERATION LAY-OUT
FUNKTIONSDIAGRAM

CQP500

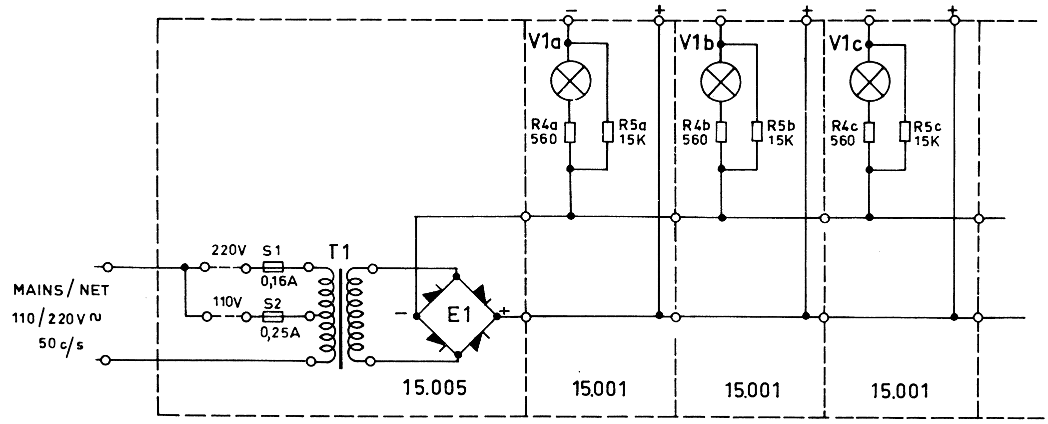


CABLEFORM
KABLINGSDIAGRAM CQP511

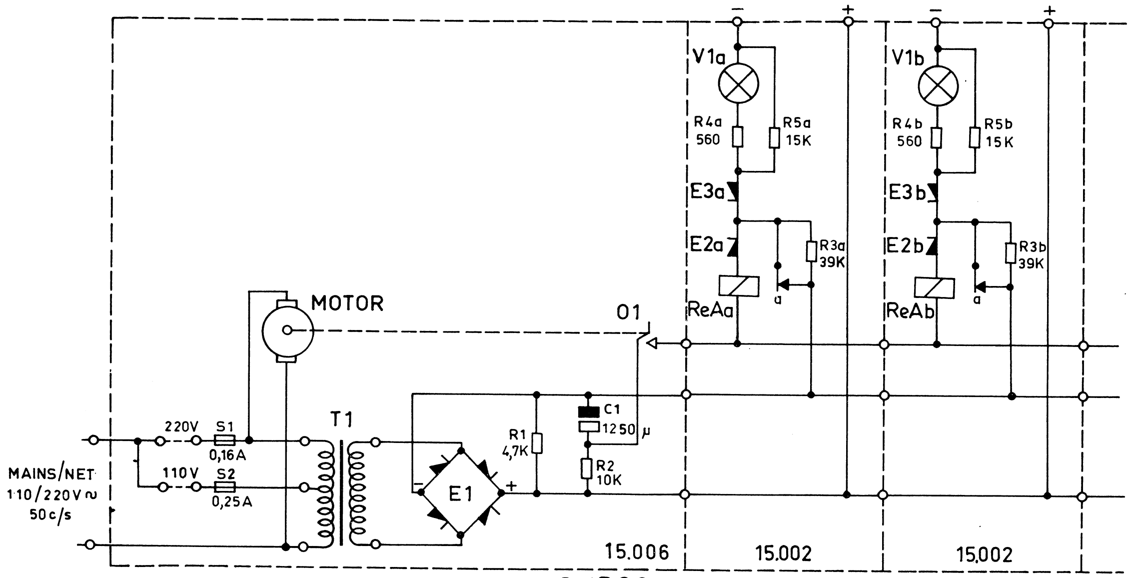


CABLEFORM
KABLINGSDIAGRAM

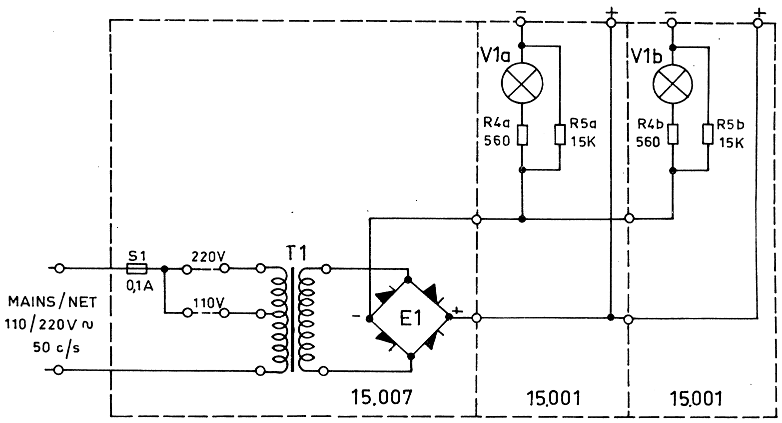
CQP512



CU501



CU502



CU503

CHARGING UNIT
LADEAGGREGAT **CU501, CU502, CU503**

CU501

CHARGING RECTIFIER LADEENSRETTER 15.005			BATTERY OUTLETS LADEKASETTER 15.001		
no.	code	data	no.	code	data
E1	94. 5016	Rectifier/Ensretter B60C500	R4	81. 5046	560Ω carbon film ±5% 0, 5W
			R5	80. 5463	15kΩ " " ±5% 0, 25W
T1	60. 5125	Transformer/Transformator			
			V1	92. 5003	Lamp/Lampe 24V, 25mA
S1	92. 5027	Fuse/Sikring 160mA			
S2	92. 5029	Fuse/Sikring 250mA			

CU502

CHARGING RECTIFIER LADEENSRETTER 15.006			BATTERY OUTLETS LADEKASETTER 15.002		
no.	code	data	no.	code	data
C1	73. 5099	1250u Elco	R3	80. 5468	39kΩ carbon film ±5% 0, 25W
			R4	81. 5046	560Ω " " ±5% 0, 5W
R1	82. 5057	4, 7kΩ carbon film ±5% 2W	R5	80. 5463	15kΩ " " ±5% 0, 25W
R2	81. 5061	10kΩ " " ±5% 0, 5W			
			E2	94. 5002	Diode E60C130
E1	94. 5016	Rectifier/Ensretter B60C500	E3	94. 5002	Diode E60C130
O1	47. 301	Contact set/Kontaktsæt	ReA	58. 5048	Counter/Tæller
T1	60. 5125	Transformer/Transformator	V1	92. 5003	Lamp/Lampe 24V, 25mA
S1	92. 5027	Fuse/Sikring 160mA			
S2	92. 5029	Fuse/Sikring 250mA			
Motor	93. 5003	Synchronous motor with gear Synkronmotor med gear			

CU503

CHARGING RECTIFIER LADEENSRETTER 15.007			BATTERY OUTLETS LADEKASETTER 15.001		
no.	code	data	no.	code	data
E1	94. 5006	Rectifier/Ensretter B60C160	R4	81. 5046	560Ω carbon film ±5% 0, 5W
			R5	80. 5463	15kΩ " " ±5% 0, 25W
T1	60. 5126	Transformer/Transformator			
			V1	92. 5003	Lamp/Lampe 24V, 25mA
S1	92. 5025	Fuse/Sikring 100 mA			

AA501b

Type	no	code	Data	
	C1	73.5073	0,5uF tantal ±10%	10V
	C2	76.5060	3,3nF polyest. ±10%	50V
	C3	76.5060	3,3nF " ±10%	50V
	C4	73.5075	40uF tantal -20/+70%	3V
	C5	73.5078	10nF " ±10%	15V
	C6	73.5073	0,5uF " ±10%	10V
	C8	73.5080	4,7uF " ±20%	10V
	R1	80.5058	5,6kΩ carbon film 5%	0,1W
	R2	80.5063	15 kΩ " " 5%	0,1W
	R3	80.5054	2,7kΩ " " 5%	0,1W
	R4	80.5052	1,8kΩ " " 5%	0,1W
	R5	80.5057	4,7kΩ " " 5%	0,1W
	R6	80.5030	27Ω " " 5%	0,1W
	R7	80.5049	1 kΩ " " 5%	0,1W
	R8	80.5058	5,6kΩ " " 5%	0,1W
	R9	80.5058	5,6kΩ " " 5%	0,1W
	R10	80.5061	10 kΩ " " 5%	0,1W
	R11	89.5009	4,7kΩ NTC, 5%	
	R12	89.5009	4,7kΩ NTC, 5%	
	R13	80.5063	15 kΩ carbon film 5%	0,1W
	R14	80.5052	1,8kΩ " " 5%	0,1W
	R16	80.5084	820kΩ " " 10%	0,1W
	Q1	99.5062	transistor AF126	
	Q2	99.5019	transistor OC306/2	

AA502

Type	no	code	Data	
	C1	73.5073	0,5uF Tantal ±10%	10V
	C2	73.5074	12uF Tantal -20/+75%	15V
	C3	77.5020	2 nF MP ±10%	150V
	C4	73.5029	47uF Tantal -20/+50%	6 V
	C5	73.5074	12uF " -20/+75%	15V
	C6	73.5074	12uF " -20/+75%	15V
	R1	80.5055	3,3kΩ carbon film ±5%	0,1W
	R3	80.5059	6,8kΩ " " ±5%	0,1W
	R4	80.5063	15kΩ " " ±5%	0,1W
	R5	80.5063	15kΩ " " ±5%	0,1W
	R6	80.5045	470Ω " " ±5%	0,1W
	R7	80.5036	82Ω " " ±5%	0,1W
	R8	80.5025	10Ω " " ±5%	0,1W
	R9	80.5025	10Ω " " ±5%	0,1W
	R10	80.5025	10Ω " " ±5%	0,1W
	R11	80.5025	10Ω " " ±5%	0,1W
	R12	80.5053	2,2kΩ " " ±5%	0,1W
	Q1	99.5062	Transistor AF126	
	Q2	99.5068	Transistor AC132	
	Q3		Transistor AC127	

BP511a

Type	no	code	Data	
	C1	74.5141	12pF ceram. ±0,5pF	250V
	C2	74.5117	39pF " 2%	250V
H	L1	61.922	RF-coil/HF-spole (156-174 Mc/s)	
L	L1	61.917	RF-coil/HF-spole (146-160 Mc/s)	

BP512a

Type	no	code	Data	
	C1	74.5124	1,2pF ceram. ±0,25pF	250V
	C2	74.5141	12 pF " ±0,5 pF	250V
H.	L1	61.924	RF-coil/HF-spole (156-174 Mc/s)	
L.	L1	61.918	RF-coil/HF-spole (146-160 Mc/s)	

BP513a

Type	no	code	Data	
	C1	74.5129	3,3pF ceram. ±0,25pF	250V
	C2	74.5141	12pF " ±0,5pF	250V
H	L1	61.924	RF-coil/HF-spole (156-174 Mc/s)	
L	L1	61.918	RF-coil/HF-spole (146-160 Mc/s)	

BP514a

Type	no	code	Data	
	C1	74.5121	0.68pF ceram. ±0,1pF	250V
	C2	74.5141	12 pF " ±0,5pF	250V
	C3	74.5108	4,7nF " -20/+80%	20V
H	L1	61.925	RF-coil/HF-spole (145-168 Mc/s)	
L	L1	61.919	RF-coil/HF-spole (156,7-170,7 Mc/s)	

CA501

Type	no	code	Data
	C1	74.5112	1nF ceram. -20/+80% 20V
	C2	74.5142	18pF " 0,5pF 250V
	R1	86.003	Volumen pot. meter 5 kΩ
	R2	86.002	Squelch pot. meter 50 kΩ
	R3	80.5042	270Ω carbon film 5% 0,1W
	J1	41.5077	Connector (male/han)
	J2	41.144	Antenna connector
	LM.	97.5011	Loudspeaker-microphone
	V1	92.5013	Lamp/lampe 12V 130mA
	t1-t4	47.277	Spring contact set fjederkontakt sæt
	u1-u2	47.278	Spring contact set fjederkontakt sæt

FD511

Type	no	code	Data	
	C1	74.5108	4,7nF ceram. -20/+80%	20V
	C2	74.5108	4,7nF " -20/+80%	20V
	C3	74.5111	56 pF " 2%	250V
	C4	74.5111	56 pF " 2%	250V
	C5	74.5122	0,82pF " ±0,1pF	500V
	C6	74.5108	4,7nF " -20/+80%	20V
	R1	80.5057	4,7kΩ carbon film 5%	0,1W
	R2	80.5065	22kΩ " " 5%	0,1W
	R3	80.5046	560Ω " " 5%	0,1W
	R4	80.5049	1 kΩ " " 5%	0,1W
	L1	61.744	RF-coil/HF-spole (24,3-29Mc/s)	
	L2	61.745	RF-coil/HF-spole (24,3-29Mc/s)	
	Q1	99.5067	Transistor AF106	

FD512a

Type	no	code	Data
	C1	74.5116	33pF ceram. ±2% 250V
	C2	74.5109	10nF " -20/+80% 20V
	C3	74.5141	12pF " 0,5pF 250V
H.	C4	74.5122	0,82pF " 0,1pF 250V
L.	C4	74.5124	1,2pF " 0,25pF 250V
	C5	74.5141	12pF " 0,5pF 250V
	R1	80.5028	18Ω carbon film 5% 0,1W
	R2	80.5045	470Ω " " 5% 0,1W
H.	L1	61.907	RF-coil/HF-spole 156-174 Mc/s
L.	L1	61.905	RF-coil/HF-spole 146-156 Mc/s
H.	L2	61.903	RF-coil/HF-spole 156-174 Mc/s
L.	L2	61.904	RF-coil/HF-spole 146-156 Mc/s
	Q1	99.5169	Transistor AF202S

FN511

Type	no	code	Data
	C1	74.5136	12pF ceram. 5% 125V
	C2	74.5132	5,6pF " ±0,25pF 125V
	C3	74.5136	12 pF " 5% 125V
	L1	61.753	RF-coil/HF-spole (146-174 Mc/s)
	L2	61.754	RF-coil/HF-spole (146-174 Mc/s)
	L3	61.753	RF-coil/HF-spole (146-174 Mc/s)

FT511a

Type	no	code	Data
	C1	74.5108	4,7nF ceram. -20/+80% 20V
	C2	74.5118	47pF " ±2% 250V
H.	C3	74.5121	0,68pF " ±0,1pF 250V
L.	C3	74.5122	0,82pF " ±0,1pF 250V
	C4	74.5118	47pF " ±2% 250V
	C5	74.5108	4,7nF " -20/+80% 20V
	R1	80.5041	220Ω carbon film 5% 0,1W
	R2	80.5045	470Ω " " 5% 0,1W
	L1	61.905	RF-coil/HF-spole 73-89Mc/s
H.	L2	61.909	RF-coil/HF-spole 78-89Mc/s
L.	L2	61.908	RF-coil/HF-spole 73-78Mc/s
	Q1	99.5067	Transistor AF106

IA501 IA502 IA503

Type	no	code	Data
502 503	C1	74.5108	4,7nF ceram. -20/+80% 20V
501 502	C2	74.5127	2,2pF " ±0,25pF 500V
	C3	76.5061	4,7nF polyest. ±10% 50V
	C4	76.5061	4,7nF polyest. ±10% 50V
	C5	74.5111	56pF ceram. ±2% 250V
	R1	80.5054	2,7kΩ carbon film ±5% 0,1W
	R2	80.5058	5,6kΩ " " ±5% 0,1W
	R3	80.5048	820Ω " " ±5% 0,1W
	R4	80.5037	100Ω " " ±5% 0,1W
501 502	L1	61.545	IF-coil/MF-spole 10,7 Mc/s
503	L1	61.773	IF-coil/MF-spole 10,7 Mc/s
	Q1	99.5062	Transistor AF126

IT501

Type	no	code	Data
	C1	76.5103	150pF polystyren 2,5% 30V
	C2	76.5102	100pF " 2,5% 30V
	C3	76.5105	330pF " 2,5% 30V
	C4	74.5116	33 pF ceram. NO75TB 2% 250V
	L1	61.785	Coil/Spole 10,7 Mc/s

JP531a

Type	no	code	Data
	C1	73.5074	12uF tantal -20/+75% 15V
	R1	80.5047	680Ω carbon film ±5% 0,1W
	R2	80.5057	4,7 kΩ " " ±5% 0,1W
	R3	86.5037	10kΩ pot. meter lin. 0,05W
	R4	89.5021	2,7Ω metall 1/16W
	R5	80.5045	470Ω carbon film ±5% 0,1W
	R6	80.5041	220Ω " " ±5% 0,1W
	R7	80.5045	470Ω " " ±5% 0,1W
	R10	89.5022	100Ω metaloxyd ±20% 0,25W
	E1	99.5028	Diode OA200
	E2	99.5075	Zenerdiode Si BZY61
	E3	99.5028	Diode OA200
	E4	99.5028	Diode OA200
	Q1	99.5076	Transistor BSY39

JP532a

Type	no	code	Data
	C1	74.5108	4,7 nF ceram. -20/+80% 20V
	C2	74.5108	4,7 nF " -20/+80% 20V
	C3	74.5108	4,7 nF " -20/+80% 20V
	C4	76.5109	1 nF polyestyr. 2,5% 30V
	C5	73.5074	12uF tantal -20/+75% 15V
	R1	86.5036	50kΩ pot. meter carbon 0,05W
	R2	86.5038	0,5 MΩ pot. meter " 0,05W
	R3	80.5085	1 MΩ carbon film ±10% 0,1W
	R4	80.5033	47Ω " " ±5% 0,1W
	L1	63.5007	15uH filtercoil/drossel ±10%
	L2	63.5007	15uH filtercoil/drossel ±10%

LI501

Type	no.	code	Data
	C1	73.5075	40uF tantal -20/+75% 3 V
	C2	73.5073	0,5uF tantal ±10% 10V
	C3	73.5076	1 uF tantal ±10% 3 V
	C4	73.5073	0,5uF tantal ±10% 10V
	C5	73.5077	50nF tantal ±10% 10V
	C6	73.5098	2uF tantal -20/+50% 15V
	R1	80.5061	10kΩ carbon film ±5% 0,1W
	R2	80.5055	3,3kΩ " " ±5% 0,1W
	R3	80.5057	4,7 kΩ " " ±5% 0,1W
	R4	80.5053	2,2kΩ " " ±5% 0,1W
	R5	80.5064	18kΩ " " ±5% 0,1W
	R6	80.5052	1,8kΩ " " ±5% 0,1W
	R7	80.5053	2,2kΩ " " ±5% 0,1W
	R8	80.5044	390Ω " " ±5% 0,1W
	R9	80.5070	56 kΩ " " ±5% 0,1W
	R10	80.5062	12 kΩ " " ±5% 0,1W
	R11	80.5063	15 kΩ " " ±5% 0,1W
	R12	80.5061	10 kΩ " " ±5% 0,1W
	R13	80.5033	47 Ω " " ±5% 0,1W
	R14	80.5057	4,7 kΩ " " ±5% 0,1W
	E1	99.5028	Diode OA200
	E2	99.5028	Diode OA200
	Q1	99.5019	Transistor OC306/2
	Q2	99.5019	Transistor OC306/2

OT511a

Type	no	code	Data
	C1	76.5109	1nF polyester 2,5% 30V
	C2	74.5160	8,2pF ceram. ±0,5pF 250V
	C3	74.5116	33pF " 2% 250V
	C4	74.5141	12pF " ±0,5pF 250V
	C5	74.5116	33pF " 2% 250V
	C7	74.5112	1nF " -20/+80% 20V
	R1	80.5059	6,8kΩ carbon film 5% 0,1W
	R2	80.5056	3,9kΩ " " 5% 0,1W
	R3	80.5049	1kΩ " " 5% 0,1W
	R4	80.5049	1kΩ " " 5% 0,1W
	R5	80.5054	2,7kΩ " " 5% 0,1W
H.	L1	61.763	RF-coil/HF-spole(48,43-54,43 Mc/s)
L.	L1	61.788	RF-coil/HF-spole (52,23 - 56,9 Mc/s)
H.	L2	61.765	RF-coil/HF-spole (145,3 - 163,3 Mc/s)
L.	L2	61.764	RF-coil/HF-spole (156,7 - 170,7 Mc/s)
	E1	99.5114	Zenerdiode BZY57
	Q1	99.5067	Transistor AF106

PA512a

Type	no	code	Data
	C1	74.5137	15pF ceram. 5% 125V
	C2	74.5137	15pF ceram. 5% 125V
	C3	73.5074	12uF tantal -20/+75% 15V
	C4	74.5708	4,7nF ceram. -20/+80% 20V
	R1	80.5055	3,3kΩ carbon film 5% 0,1W
H.	L1	61.899	RF-coil/HF-spole 156-176 Mc/s
L.	L1	61.905	RF-coil/HF-spole 146-156 Mc/s
H.	L2	61.897	RF-coil/HF-spole 156-176 Mc/s
L.	L2	61.896	RF-coil/HF-spole 146-156 Mc/s
	L3	62.651	Filtercoil/Drosselspole
	L4	63.5007	Filtercoil/Drosselspole 15 uH 10% 500 mA
	Q1	99.5069	Transistor 2N1692

OP512

Type	no	code	Data
	C1	74.5117	39pF ceram. ±2% 250V
	C2	76.5103	150pF polyest. ±2,5% 30V
	C3	74.5156	27pF ceram. ±2% 250V
	C4	74.5109	10 nF " -20/+80% 20V
	C5	74.5111	56 pF " ±2% 250V
	C6	74.5111	56 pF " ±2% 250V
	C7	74.5117	39 pF " ±2% 250V
	C8	74.5109	10 nF " -20/+80% 20V
	C9	74.5109	10 nF " -20/+80% 20V
	R1	80.5065	22 kΩ carbon film ±5% 0,1W
	R2	80.5065	22 kΩ " " ±5% 0,1W
	R3	80.5051	1,5kΩ " " ±5% 0,1W
	R4	80.5056	3,9kΩ " " ±5% 0,1W
	R5	80.5049	1 kΩ " " ±5% 0,1W
	R6	80.5065	22 kΩ " " ±5% 0,1W
	R7	80.5059	6,8kΩ " " ±5% 0,1W
	R8	80.5056	3,9kΩ " " ±5% 0,1W
	L1	61.783	Modulator coil/spole 11,3-14,6 Mc/s
	Q1	99.5066	Transistor AF121
	Q2	99.5073	Transistor AF124

RA511a

Type	no	code	Data
	C1	74.5141	12pF ceram. ±0,5pF 250V
	C2	74.5161	470pF " ±20% 125V
	C3	74.5112	1 nF " -20/+80% 20V
	C4	74.5161	470pF " ±20% 125V
H	C5	74.5126	1.8pF " ±0,25pF 250V
L	C5	74.5128	2.7pF " ±0,25pF 250V
	C6	74.5112	1 nF " -20/+80% 20V
	R1	80.5062	12kΩ carbon film 5% 0,1W
	R2	80.5061	10kΩ " " 5% 0,1W
	R3	80.5054	2.7kΩ " " 5% 0,1W
	R4	80.5048	820Ω " " 5% 0,1W
	R5	80.5037	100Ω " " 5% 0,1W
	L1	62.614	Coil/spole (146-174 Mc/s)
H	L2	61.923	RF-coil/HF-spole(156-174Mc/s)
L	L2	61.916	RF-coil/HF-spole(146-160Mc/s)
	Q1	99.5067	Transistor AF106
	Q2	99.5067	Transistor AF106

PA511a

Type	no	code	Data
	C1	74.5136	12pF ceram. 5% 125V
	C2	74.5109	10nF " -20/+80% 20V
	C3	74.5132	5,6pF " 0,25pF 250V
	C4	74.5109	10nF " -20/+80% 20V
	C5	74.5131	4,7pF " 0,25pF 250V
	C6	74.5137	15pF " 5% 125V
	R1	80.5025	10Ω carbon film 5% 0,1W
H.	L1	61.906	RF-coil/HF-spole
L.	L1	61.901	RF-coil/HF-spole
H.	L2	61.902	RF-coil/HF-spole
L.	L2	61.900	RF-coil/HF-spole
	L3	62.651	Filtercoil/Drosselspole
	L4	63.5007	Filtercoil/Drosselspole 15uH 10% 500mA
	Q1	99.5169	Transistor AF202S
	Q2	99.5139	Transistor BSX19

RA512a

Type	no	code	Data
	C1	74.5112	1nF ceram. -20/+80% 20V
	C2	74.5112	1nF " -20/+80% 20V
	C3	74.5110	10pF " ±0,5pF 250V
	C4	74.5112	1nF " -20/+80% 20V
H	C5	74.5128	2,7pF " ±0,25pF 250V
L	C5	74.5126	1.8pF " ±0,25pF 250V
	R1	80.5063	15kΩ carbon film 5% 0,1W
	R2	80.5054	2,7kΩ " " 5% 0,1W
	R3	80.5054	470Ω " " 5% 0,1W
	R4	80.5037	100Ω " " 5% 0,1W
H	L1	61.926	RF-coil/HF-spole (145-168 Mc/s)
L	L1	61.916	RF-coil/HF-spole (156-170 Mc/s)
	Q1	99.5067	Transistor AF 106

RC511a

Type	no	code	Data
	C1	74.5141	12pF ceram. 0,5pF 250V
	C2	74.5108	4,7nF " -20/+80% 20V
	C3	76.5061	4,7nF polyester 10% 50V
	C4	76.5061	4,7nF polyester 10% 50V
	R1	80.5054	2,7kΩ carbon film 5% 0,1W
	R2	80.5067	33 kΩ " " 5% 0,1W
	R3	80.5037	100Ω " " 5% 0,1W
	R4	80.5053	2,2kΩ " " 5% 0,1W
	R5	80.5051	1,5kΩ " " 5% 0,1W
	R6	80.5048	820Ω " " 5% 0,1W
	L1	61.912	RF-coil/HF-spole
	Q1	99.5067	Transistor AF106

SQ501

Type	no	code	Data
	C1	77.5020	2nF MP ±5% 150V
	C3	73.5098	2 uF tantal -20/+50% 15V
	C4	73.5098	2 uF tantal -20/+50% 15V
	C5	73.5082	0,5uF tantal -20/+150% 15V
	C6	74.5155	1 nF ceram. ±20% 125V
	R1	80.5084	820 kΩ carbon film ±5% 0,1W
	R2	80.5061	10 kΩ " " ±5% 0,1W
	R3	80.5067	33 kΩ " " ±5% 0,1W
	R4	80.5064	18 kΩ " " ±5% 0,1W
	R5	80.5049	1 kΩ " " ±5% 0,1W
	L1	61.577	Coil/spole 82 mH
	Q1	99.5043	Transistor BCZ13
	Q2	99.5043	Transistor BCZ13

TT501

Type	no.	code	Data
	R1	80.5064	18kΩ carbon film ±5% 0,1W
	R2	80.5061	10kΩ " " ±5% 0,1W
	R3	80.5042	270Ω " " ±5% 0,1W
	R4	80.5042	270 Ω " " ±5% 0,1W
	R5	80.5041	220 Ω " " ±5% 0,1W
	C2	76.5051	5,6nF polyest. ±2,5% 25V
	C3	76.5051	5,6nF " ±2,5% 25V
	C4	76.5050	4,7nF " ±2,5% 25V
	L1	61.624	AF-coil/LF-spole
	E1	99.5075	Zenerdiode BZY61
	Q1	99.5043	Transistor BCZ13

XD501 XD502

Type	no.	code	Data
501	C1	74.5118	47pF ceram. ±2% 250V
502	C1	76.5102	100pF polyest. ±2% 30V
	C2	74.5112	1nF ceram. -20/+80% 20V
	C3	74.5106	22pF " ±0,5pF 250V
	C4	74.5130	3,9pF " ±0,25pF 500V
	C5	74.5117	39pF " ±2% 250V
	C6	74.5108	4,7nF " -20/+80% 20V
	C7	73.5073	0,5uF tantal ±20% 10V
	C8	73.5077	5nF tantal ±20% 10V
	C9	73.5073	0,5uF tantal ±20% 10V
	R1	80.5069	47kΩ carbon film ±5% 0,1W
	R2	80.5069	47kΩ " " ±5% 0,1W
	R3	80.5063	15kΩ " " ±5% 0,1W
	R4	80.5071	68kΩ " " ±5% 0,1W
	R5	80.5075	150kΩ " " ±5% 0,1W
	R6	80.5073	100kΩ " " ±5% 0,1W
	R7	80.5063	15kΩ " " ±5% 0,1W
	R9	80.5048	820Ω " " ±5% 0,1W
	R10	80.5085	1 MΩ " " ±5% 0,1W
	E1	99.5074	Diode AA119
	E2	99.5074	Diode AA119
501	L1	61.594	Coil/spole 10,7 Mc/s
502	L1	61.614	Coil/spole 10,7 Mc/s
	L2	61.595	Coil/spole 10,7 Mc/s
	Q1	99.5043	Transistor BCZ13
	Q2	99.5043	Transistor BCZ13
	X1	98.5003	Crystal type 98-7

XF501 XF502

Type	no	code	Data
511	XF501	69.5002	X-talfilter 50 kc/s
512	XF502	69.5001	X-talfilter 25 kc/s

XS511

Type	no	code	Data
	C1	78.5026	
	C2	78.5026	
	C3	78.5026	4,5 - 20pF ceram.
	C4	78.5026	trimmer 160V
	C5	78.5026	
	C6	78.5026	
	L1	61.777	coil/spole 1.25 uH
	L2	61.777	coil/spole 1.25 uH
	L3	61.777	coil/spole 1.25 uH
	L4	62.652	filtercoil/drosselspole
	L5	62.652	" "
	L6	62.652	" "
	E1	99.5028	diode OA200
	01	47.257	channel selector kanalomskifter
	Si	92.	fuse/sikring 0,5 Amp.

Note 1. The resistor R4 (1, 5k) is inserted as shown.
Modstand R4 (1, 5k) er indskudt som vist.

Note 2. The capacitor C4 (33pF) is omitted as shown.
Kondensator C4 (33pF) er udeladt som vist.

Note 3. When the resistor R13 (47Ω) is short-circuited the input sensitivity is increased by 6 dB.
Når modstanden R13 (47Ω) kortsluttes, forøges indgangsfølsomheden 6 dB.

←---||---→ Capacitors inserted in the low frequency band (146-160 Mc/s).

←---||---→ Kondensatorer indskudt i det lave frekvensområde (146-160 MHz).

Storno

PORTABLE RADIOTELEPHONE
BÆRBAR RADIOTELEFON

CQP512

D400.610/2

Note 1. The resistor R4 (1, 5k) is omitted as shown.
Modstand R4 (1, 5k) er udeladt som vist.

Note 2. The capacitor C4 (33pF) is inserted as shown..
Kondensator C4 (33pF) er indskudt som vist.

Note 3. When the resistor R13 (47Ω) is short-circuited the input sensitivity is increased by 6 dB.
Når modstanden R13 (47Ω) kortsluttes, forøges indgangsfølsomheden 6 dB.

Note 4. The resistor R16 (820Ω) in AA501b is short-circuited.
Modstanden R16 (820Ω) i AA501b er kortsluttet.

←----||----→ Capacitors inserted in the low frequency band (146-160 Mc/s)

←----||----→ Kondensatorer indskudt i det lave frekvensbånd (146-160 MHz).

Storno

PORTABLE RADIOTELEPHONE
BÆRBAR RADIOTELEFON
CQP511

D400588/4