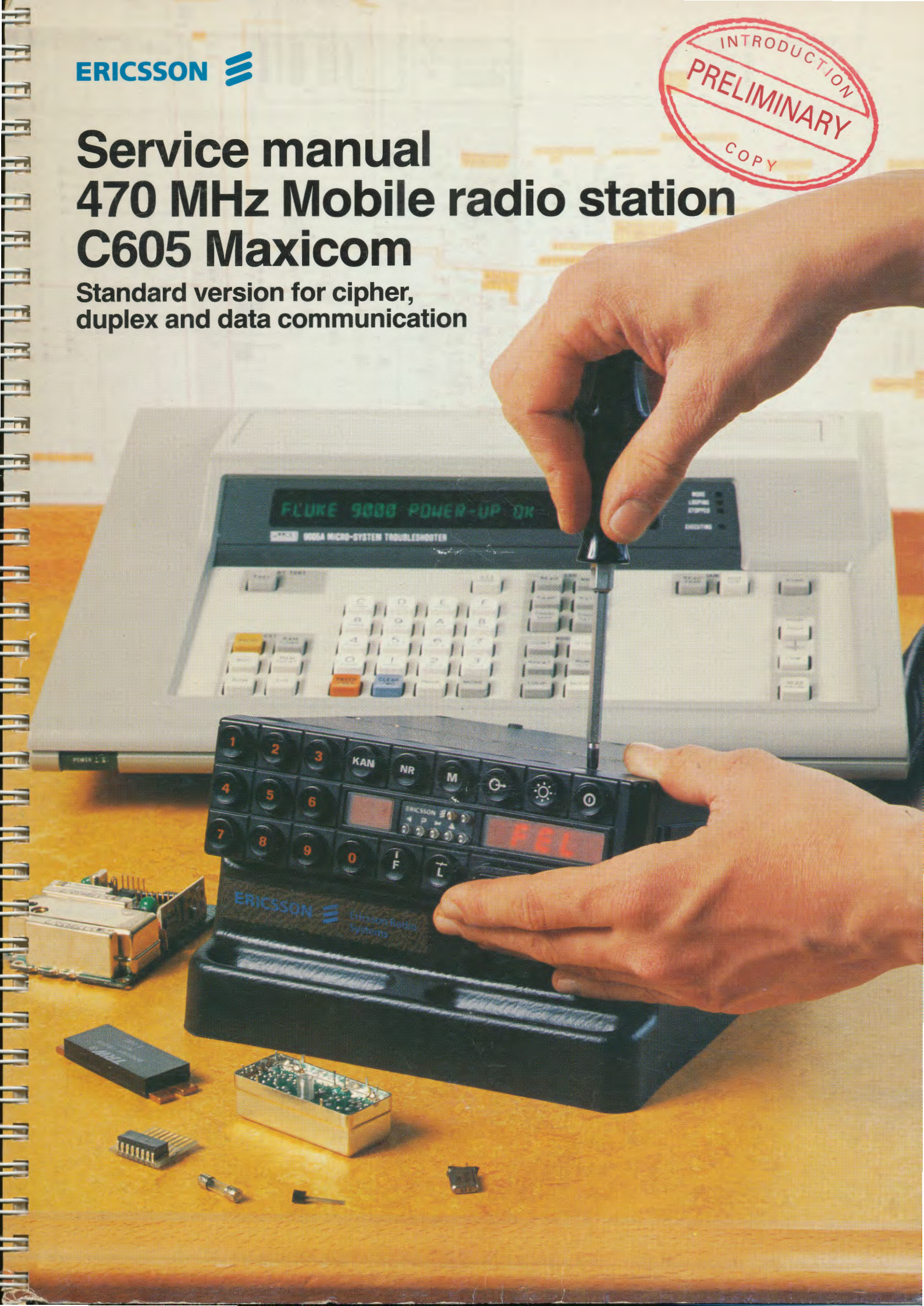
ERICSSON

INTRODUCTION
PRELIMINARY
COPY

Service manual
470 MHz Mobile radio station
C605 Maxicom

Standard version for cipher, duplex and data communication



Contents

List of figures

List of tables

1. Introduction

General

C605 Maxicom is a 470 MHz mobile radio station with cipher, duplex and data communication facilities.
In its standard version, C605 Maxicom has functions for individual calls and group calls, full number calls, automatic calls, semiautomatic calls, emergency calls and programming of automatic calls.
Further standard functions are open monitoring, external alarm and retransmission to another station.
In addition to showing channel number and call number, the display tells you if somebody has called you while you were away, if the channel you want to use is engaged, and also indicates incorrect operation. Optional functions in C605 Maxicom include "Who has called" and status reporting.
All these functions are included in this manual. Your station, however, may not have been programmed to incorporate them all.
Accessories to C605 Maxicom include carrying case and desk-top console.

2. Technical data

General

Frequency range:	*380... 470 MHz.*
Mode of operation:	*Simplex and duplex.*
Modulation:	*FM.*
Number of channels:	*10, 20 or 100.*
Channel spacing:	*12.5 or 25 kHz.*
Frequency stability:	*± 5 ppm.*
Antenna impedance:	*50 Ω.*
Power supply:	*12 or 24V.*
Power consumption	
transmission:	*4.5A.*
reception:	*0.5A.*
Ambient temperature	
specified data:	*-25°C... +55°C.*
operational:	*-40°C... +70°C.*
storage:	*-55°C... +85°C.*
Weight:	*1.9 kg.*
Dimensions:	*180 x 212 x 54 mm.*

Transmitter

Number of partial bands:	*3.*
Bandwidth within each partial band.	
12.5 kHz channel separation:	*1.75 MHz.*
25 kHz channel separation:	*3.5 MHz.*
Output power:	*10 or 20 W ±1 dB.*
Hum and noise:	*-40 dB.*
Unwanted radiation:	*< 0.25 uW.*
Attenuation of modulation products in adjacent channel.	
12.5 kHz channel spacing:	*60 dB.*
25 kHz channel spacing:	*60 dB.*
Audio response	
12.5 kHz channel spacing:	*300... 2550 Hz, tolerance +1... -3 dB rel. 6 dB/octave.*
25 kHz channel spacing:	*300... 3000 hZ, tolerance +1... -3 dB rel. 6 dB/octave.*

Reciver

Number of partial bands:	*1.*
Bandwidth within each partial band.	
12.5 kHz channel separation:	*1.75 MHz.*
25 kHz channel separation:	*3.0 MHz.*
Sensitivity (1/2 EMF at 12 dB SINAD).	
12.5 kHz channel spacing:	*0.45 uV.*
25 kHz channel spacing:	*0.35 uV.*
Hum and noise:	*-40 dB.*
Selectivity	
12.5 kHz channel spacing:	*65 dB.*
25 kHz channel spacing:	*70 dB.*
Intermodulation attenuation:	*70 dB.*
AF power to loudspeaker:	*4 W.*
Spurious response attenuation:	*80 dB.*
Spurious emission:	*< 2 nW.*
Distortion:	*< 10%.*
Audio response.	
12.5 kHz channel spacing:	*300... 2550 Hz, tolerance +1... -3 dB rel. 6 dB/octave.*
25 kHz channel spacing:	*300... 3000 Hz, tolerance +1... -3 dB rel. 6 dB/octave.*

Regulator

Supply voltage:	*12 V.*
Regulated voltage:	*9.3 V.*
Voltage tolerance:	*± 0.1 V.*
Maximum current load (at the regulated voltage of 9.3 V):	≈ 250 mA.

Tone reciver and transmitter

CCIR:	*5 tone and 5 and 7 tone.*
ZVEI:	*5 tone.*
No. of selectable combinations:	*100 000.*
No. of coded calls:	*11.*
No. of codes, tone receivers:	*4.*

Cipher

Traffic type:	*Duplex.*
Speech digitizing method:	*ADM (adaptive delta modulation).*
Data rate:	*14.4 kbit/s.*
Data modulation:	*NRZ (non return to zero).*
Data bandwidth:	*14-8500 Hz.*
Radio bandwidth − 60 dB:	*55 kHz.*
Radio bandwidth − 70 dB:	*70 kHz.*
Temperature range:	*-10°C... +55°C.*
Number of key combinations:	*2^{72} (4.7×10^{21}).*

Life of back-up battery for cipher key:	*5 years.*
Level to modulator	
Cipher mode:	*1.7 V_{p-p}.*
Plain text mode:	*Nom 360 mV, 1.7 V_{p-p} max increasing 6 dB/ /octave within 300... 2500 Hz.*
Level from discriminator	
Cipher mode:	*470 mV_{p-p}.*
Plain text mode:	*Nom 100 mV, 470 mV_{p-p} max increasing 6 dB/ /octave within 300... 2500 Hz.*
AF level to the radio's loudspeaker amplifier	
Cipher mode:	*Nom 200 mV at 1 kHz increasing 6 dB /octave within 300... 2100 Hz.*
Plain text mode:	*Nom 100 mV at 1 kHz increasing 6 dB/ /octave within 300... 2500 Hz.*
Digital squelch	
Cipher reception:	*Grounded.*
Plain text reception:	*Open.*
Cipher transmission:	*Grounded.*
Plain text transmisssion:	*Open.*
Link:	*Grounded.*
Non-link:	*Open.*
AF in at link:	*Nom 100 mV, 470 mV_{p-p} max increasing 6 dB/ /octave within 300... 3000 Hz.*
Microphone input:	*Nom 40 mV.*
Data out:	*7 V_{p-p}, 14.4 kbit/s.*
Data in at link:	*7V – 15 V_{p-p} 14.4 kbit/s.*
Clock output:	*7 V_{p-p}, 14.4 kbit/s.*
Key loading:	*300 bit/s ASCII, Logic 0=7V, Logic 1=0V.*
Supply voltage:	*10... 16V.*
Current consumption:	*30 mA.*

3. Installation

General

A complete mobile radio station C605 with cipher, duplex and data facilities consists of radio with radio cassette, cipher unit with cipher cassette, handset with holder, antenna, duplexfilter, cables for interconnection of the parts, a connector unit, mounting plate for the cassettes, housings, covers, 4 wire interface for the data communication and antenna.

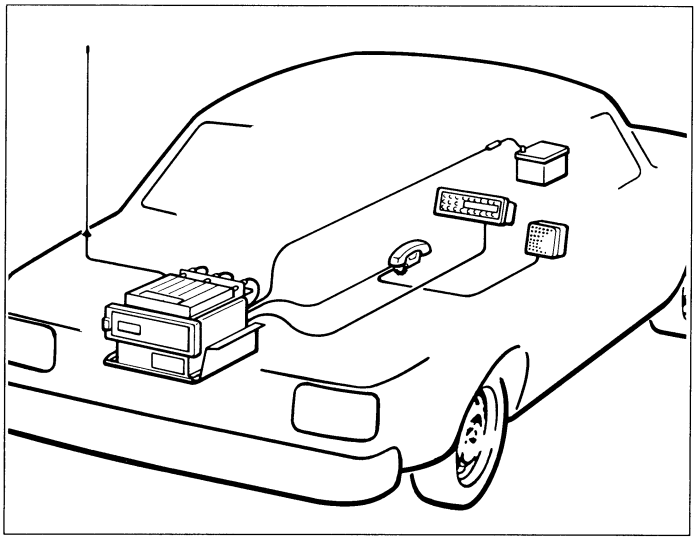


Fig. 3.1. The location of the control unit and the radio, logic and cipher units in the car.

Divided installation

Divided mounting means that the station's front panel, display board, control board and code board is put in a plastic housing to form a control unit and then installed in the car's dashboard.
The radio with the logic, cipher and duplex filter is installed in the luggage compartment of the car.

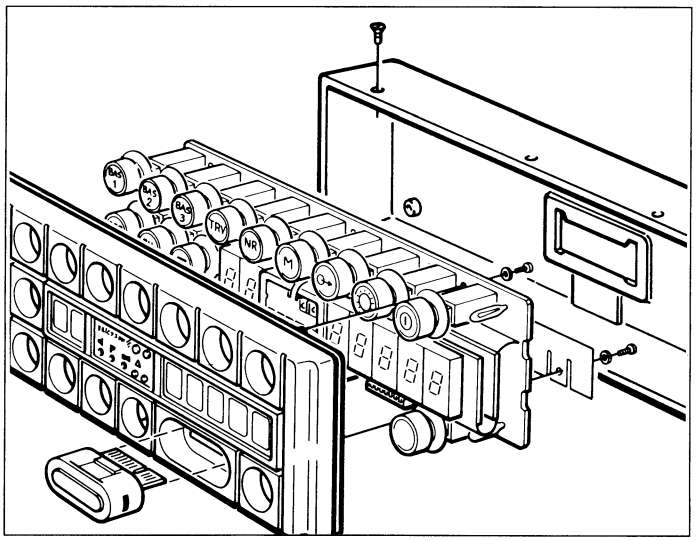


Fig 3.2. The front panel, the control board, the display board is put together in a housing to form the control unit.

Installation of the control unit

The control unit is put in an installation housing and mounted to the dashboard of the car, and connected via a flat cable to the radiostation in the luggage compartment.

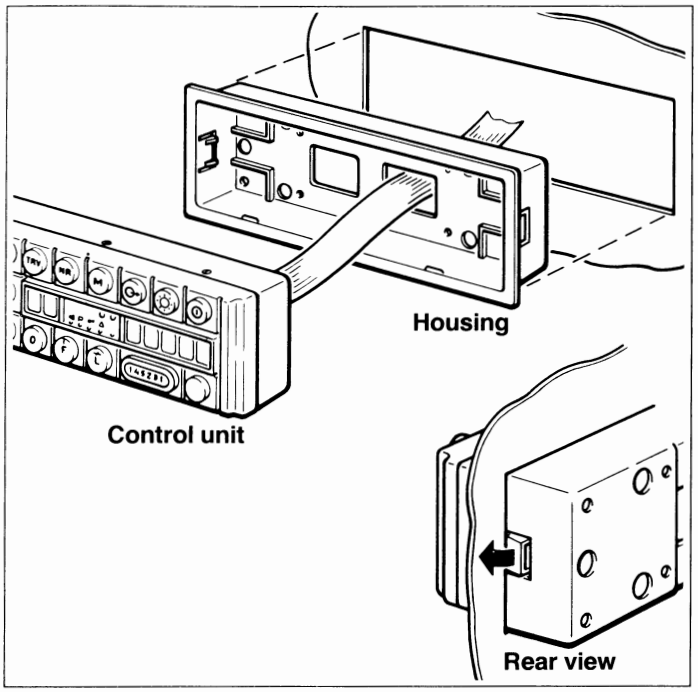


Fig 3.3. The control unit is installed in plastic housing and installed into the dashboard of the car and connected to the radiostation via a flat cable.

Installation of the radio and cipher

The radio and cipher cassette is mounted together on a case with fast lock facilities and locked to a mounting plate fixed to the floor of the luggage compartment.

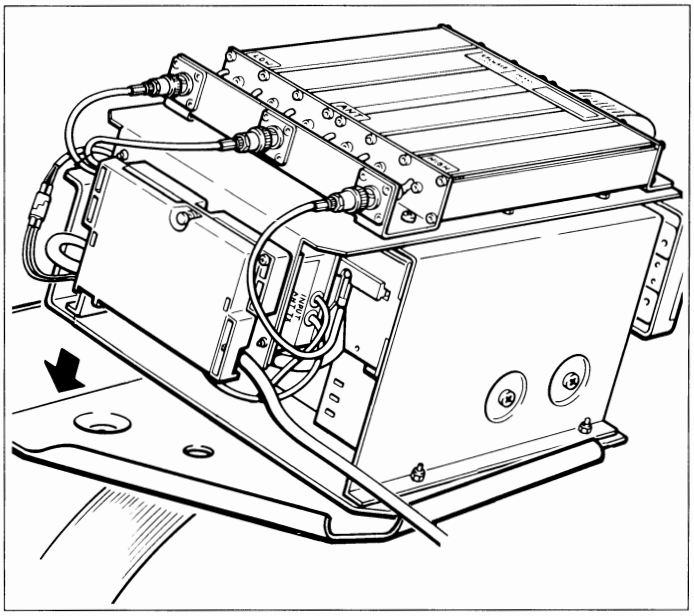


Fig 3.4. The installation of the radio and cipher cassettes and the location of the duplex filter and data interface.

The duplex filter is fixed to the top of the radio cassette, antenna filter and data interface are fixed to the rear end of the radio cassette. The radio parts are connected to the control unit via a flat cable.

Installation of handset with holder

The handset is a modified "Diavox" handset for telephone traffic.
The holder has controls for power on, cipher on with lamp, volume control and disconnection of call. The handset has a T/R switch.

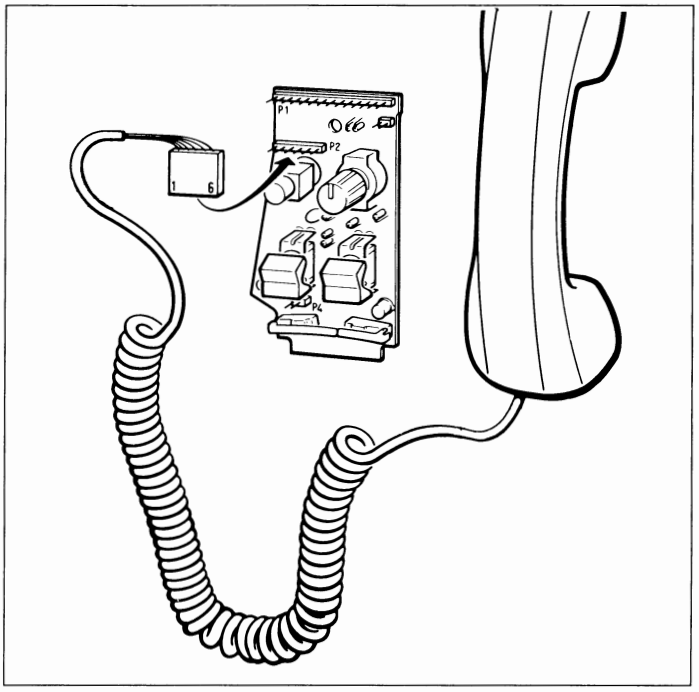


Fig 3.5. The connection of the handset to the circuit board of the handset holder.

The handset is connected to the holder via a 6 wire cable and the holder is connected to the connector unit via a 14 wire cable.

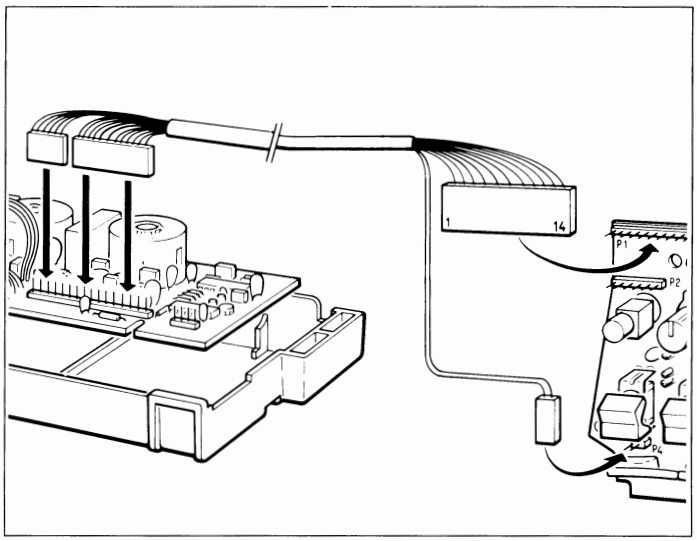


Fig 3.6. The connection of the holder's circuit board to the connection unit.

Installation of loudspeaker

The loudspeaker has 60 ohms impedance and is connected to the circuit board of the handset holder by a 2 wire cable.

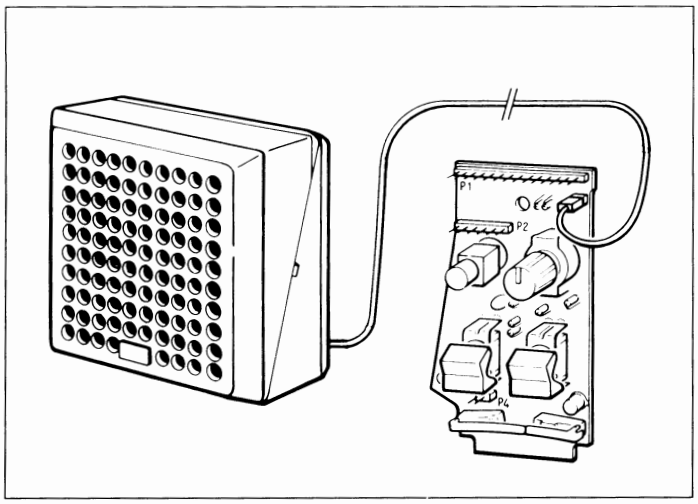


Fig 3.7. The connection of the loudspeaker to the holder's circuit board.

DC power connection

The station is connected to the battery by a 2 wire cable, and a 1 pole fuse holder.

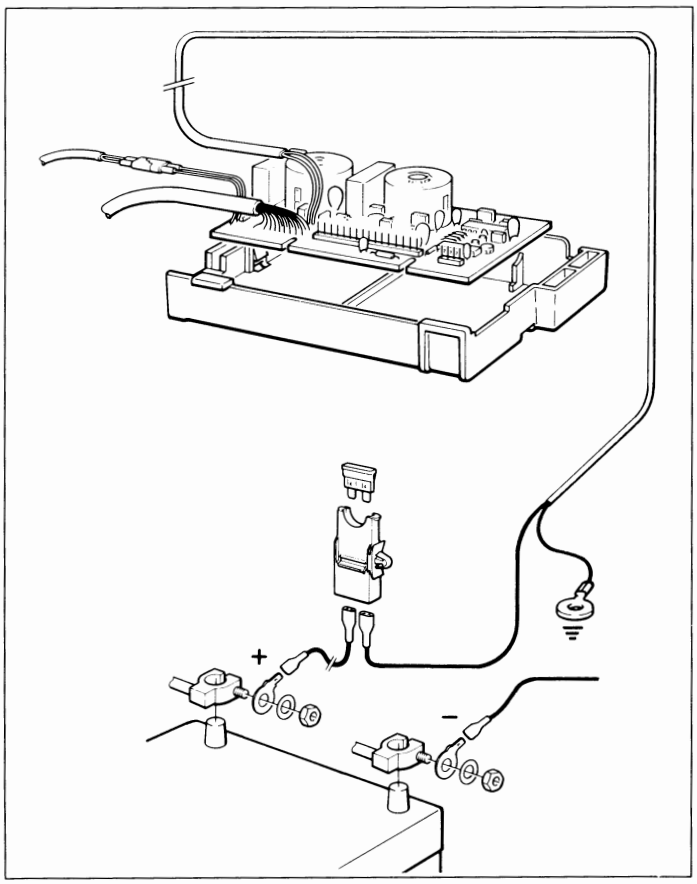


Fig 3.8. The connection of the station to the car's battery.

The earth pole of the cable is grounded to the chassie of the car, the plus pole of the cable is connected to the plus pole of the battery. The other end of the cable is connected to the connector unit.

External alarm relay

The external alarm relay unit is connected to the connector unit via a 2 wire cable.
The other two terminals of the relay can be connected to the horn of the car, the headlights or other source of alarm.

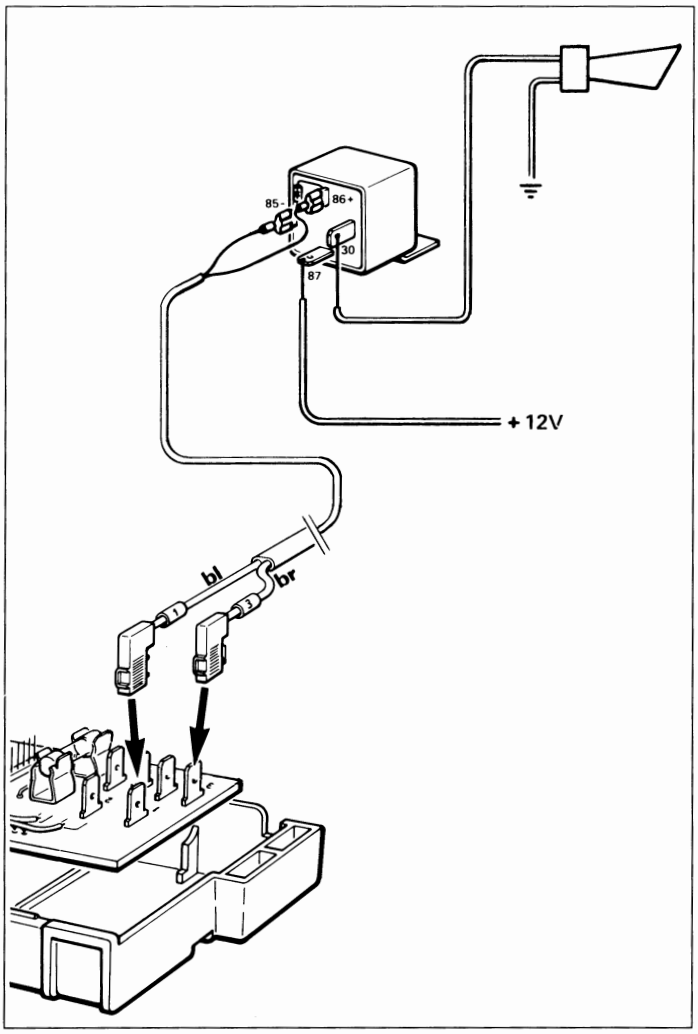


Fig 3.9. The connection of the external alarm relay to the connection unit.

Antenna installation

The antenna is fixed to the car and connected to the antenna filter at the rear of the radio cassette by a coaxial cable with a fast connector.

4. Operating instructions

General

The C605 MAXICOM consists of a control unit placed in the dashboard of the car and radio, logic and cipher units placed in cassettes in the trunk of the car. The duplex filter is mounted at the top of the radio cassette.

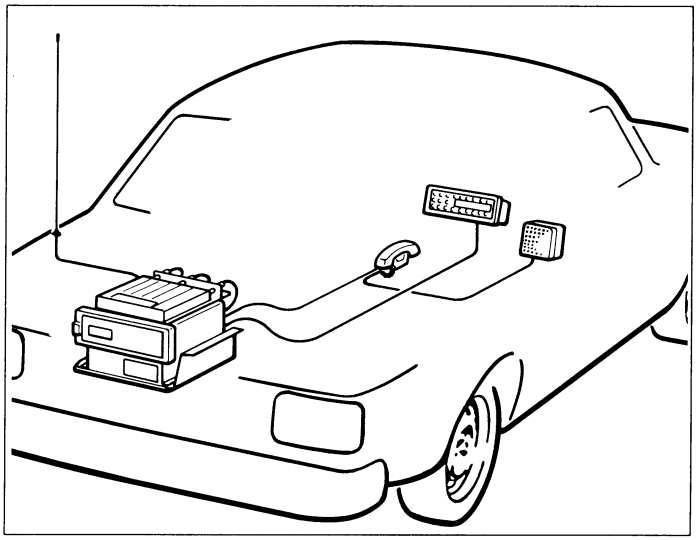


Fig 4.1. The station consists of a control unit, radio and logic units, cipher unit and duplex filter, radio and cipher cassettes.

Controls and indicators

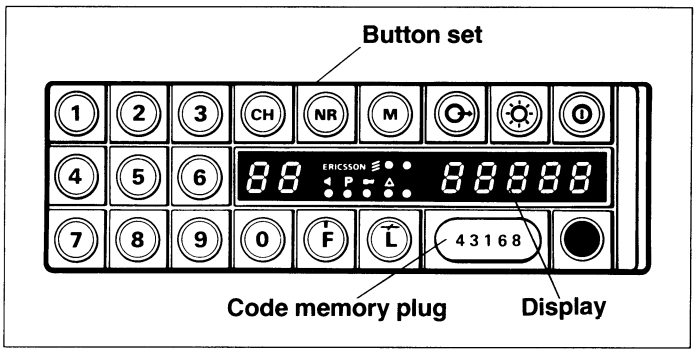


Fig 4.2. The control unit and the code memory plug in board.

Display
Display with two-digit channel indicator and five-digit number indicator and indicator lamps for transmission, incoming call, open monitoring, retrans- mission external alarm and automatic functions dis- connected

Button set
For selection of channel, call number and other functions.

Code memory plug
Replaceable code memory plug which contains all individual information about the station, e.g. its own call number.

Handset
Handset off answers an incoming call. Handset on disconnects an ongoing call.

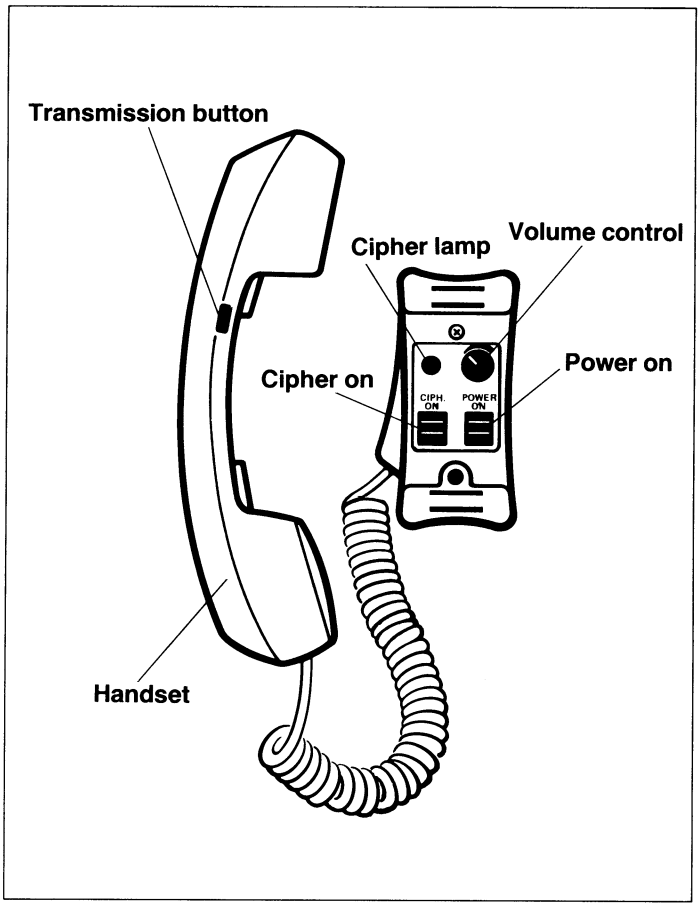


Fig 4.3. The handset and its holder with controls and indicators.

Transmission button
Placed on the handset. For switching from reception to transmission. Press to transmit, release to receive.

Power on
Placed on the holder. Turns on power to the station.

Cipher on
Placed on the holder. Turns on cipher function.

Cipher lamp
Placed on the holder. Lamp on indicates that cipher function is on.

Volume control
Placed on the handset. Turn the knob clock-wise to increase the volume.

Button set

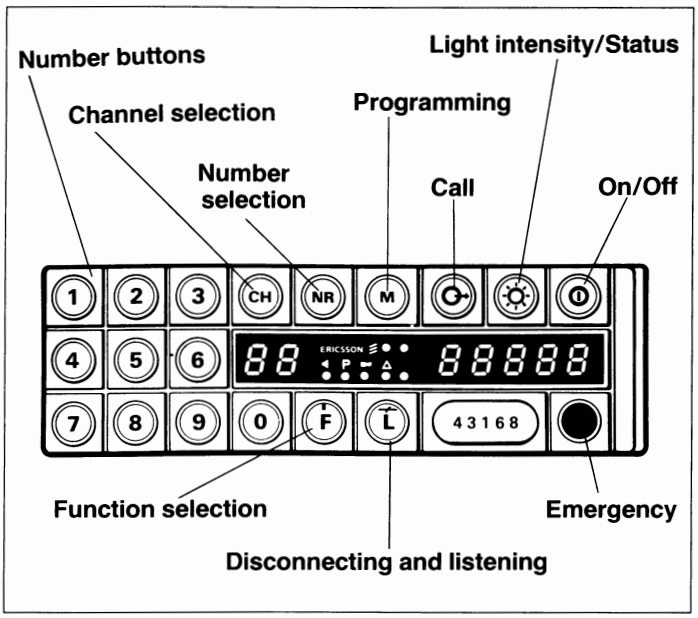


Fig 4.4. The button set includes number buttons for entering digits and function selection buttons for selecting different functions.

Number buttons
The number buttons 0 to 9 are used for entering digits in automatic calls, semi-automatic calls, full number calls and channel selection. The buttons 0, 7, 9 may have a double function, 0 as WHC button, 7 for status reporting and 9 for retransmission.

Channel selection button
The channel selection button CH is used when selecting the channel for an outgoing call or for open monitoring. It is also used for reset after incorrect operation.

Number selection button
The number selection button NR is used when selecting the call number for an outgoing call, or in own programming of automatic calls. It is also used for reset after incorrect operation.

Programming button
The programming button M is used for programming automatic call numbers and for displaying automatic calls numbers.

Call button
The call button is used to transmit a manual full number call, a WHC recall, or a status call.

Light intensity/Status button
The button is used to show the display contents with high light intensity. With the station in stand-by and the display extinguished, this button will display the last mobile number. In systems with status reporting, the button is used to display the current status. When entering digits, this button gives entry of the entry symbol "-".

On/Off
The button is used for power on/off.

Function selection button
The function selection button F is used to select open monitoring, external alarm, retransmission to another station and automatic functions disconnected. During a call, the button has a squelch on/off function.

Disconnecting and listening button
The disconnecting and listening button is used for disconnecting the station after a call and for temporary listening in on a selected channel. The button may also be used to restore the function lamps.

Emergency button
The red button is used to transmit an emergency call.

Display

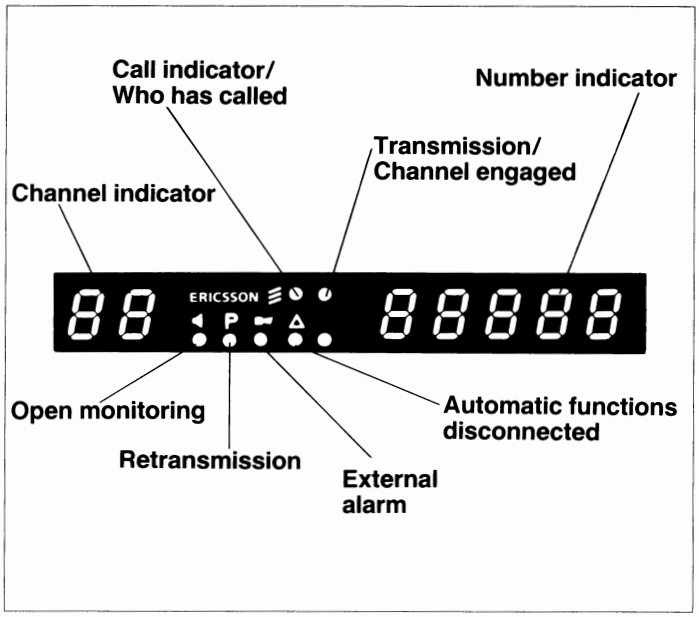


Fig 4.5. The station's display with channel indicator, number indicator and function lamps.

Channel indicator
The two-digit channel indicator shows the channel in use. Flashing digits indicate that somebody has called you on that channel while you were away. In stations with extra functions, channel selection 00 means that the station will select a free channel automatically.

Number indicator
The five-digit channel indicator shows the selected call number. In stations with WHC, the number indicator also shows the number of the calling station. In stations with status reporting, the status code is shown here. Incorrect operation, e.g. selection of a channel which does not exist, will bring up the word Error in the number indicator.

Call indicator/"Who has called"
The yellow lamp is lit with steady light during a connected call. It flashes to indicate unanswered incoming call.

Transmission/Channel engaged
The red lamp lights with steady light to indicate that the selected channel is engaged. An attempt to make a call on an engaged channel will result in busy tone and disconnection. During an outgoing call, the lamp is lit with steady light, but flashes when the transmission button is pressed down.

Open monitoring
The lamp by the symbol ◀ lights up when the station is in open monitoring mode.

Retransmission
The lamp by the symbol **P** lights up to indicate retransmission on.

External alarm
The lamp by the symbol ◣ lights up to indicate external alarm on.

Automatic functions disconnected
The lamp by the symbol △ lights up when automatic functions are disconnected (= the station is locked on the selected channel).

Incoming calls

Individual calls
- A call signal is heard over the loudspeaker, the channel indicator flashes and the yellow lamp lights up.
- Take the handset and answer. Press the transmission button on the handset to talk, release it to listen. Flashing red lamp verifies own transmission.
- Disconnect the call by replacing the handset or by pressing the disconnecting button [t].

Group calls
- The yellow lamp lights up.
- Listen to the group message. If you need to answer, pick up the handset and press the transmission button. Flashing red lamp verifies own transmission. Do not replace the handset until the entire group call is finished.
- The call is automatically disconnected.

Outgoing calls

Full number calls
- Press the channel selection button [CH].
- Enter the channel number with the number buttons [0] to [9]. The selected channel number appears in the channel indicator.
- Press the number selection button [NR].
- Enter the call number with the number buttons [0] to [9]. The selected call number appears in the number indicator.
- Press the call button [⟳] to transmit the call.
- A reply tone confirms that your call has been connected. Take the handset and make your call.
- Disconnect the call by replacing the handset or pressing the disconnecting button [t].

Memory
The station will remember the last number you entered, even when
the display is extinguished or the station switched off.
To repeat this call, press the button [⚙] (the number is now displayed) and then the call button [t].

Automatic calls
Automatic call means making a complete call with channel number and call number simply by pressing one number button, on which all the necessary information has been pre-programmed.
- Press the appropriate number button [0] to [9]. The pre-programmed channel and call number appear in the channel indicator and number indicator.
- A reply tone confirms that your call has been connected. Take the handset and make your call.
- Disconnect the call by replacing the handset or pressing the disconnecting button [t].

Semi-automatic calls
Semi-automatic call means that part of the call number has been programmed in advance, and that you must enter one or several digits to complete the call number.
- Press the number button [0] to [9]. The display shows the pre-programmed digits followed by dashes in the positions where you must enter a digit.
- Enter the remaining digits of the call number with the number buttons [0] to [9].
- A reply tone confirms that your call has been connected. Take the handset and make your call.
- Disconnect the call by replacing the handset or pressing the disconnecting button [t].

Programming automatic calls
Programming an automatic call means storing a call, complete with channel number and call number, on one of the number buttons.
- Press the channel selection button [CH].
- Enter the channel number with the number buttons [0] to [9]. The selected channel number appears in the channel indicator.
- Press the number selection button [NR].
- Enter the call number with the number buttons [0] to [9]. The selected call number appears in the number indicator.
- Press the programming button [M].

– Press the number button 0 to 9 on which you want the call stored. You have now stored an automatic call for convenient access simply by pressing the chosen number button.

You may check what call numbers are pre-programmed on the different number buttons by pressing the programming button M and then one of the number buttons. The display will show the automatic call number.

Other functions

Temporary listening
By pressing the listening button t you can listen in on ongoing conversations on the selected channel for twenty seconds, whereafter the station returns to stand-by mode.

Open monitoring
Select the channel you want to listen to by pressing the channel selection button CH and then enter the channel number with the number buttons 0 to 9. Press the function selection button F until the lamp by the symbol for open monitoring ◀ lights up.
To return to stand-by mode, press the function selection button F until all the function lamps are extinguished.

External alarm
With the external alarm function, a special tone for incoming calls is heard. Via a relay, this tone can activate the vehicle horn.
To select external alarm, press the function selection button F until the lamp by the external alarm symbol ◣ lights up.
To return to stand-by mode, press the function selection button F until all the function lamps are extinguished.

Retransmission to another station
Preset channel and call number in the same way as when programming an automatic call and store on number button 9.
To retransmit calls, press the function selection button F until the lamp by the symbol for retransmission P lights up.
To return to stand-by mode, press the function selection button F until all the function lamps are extinguished.

Automatic functions disconnected
Automatic functions disconnected means that the station is locked on the set channel and will not receive calls on other channels.
To disconnect automatic functions, press the function selection button F until the lamp by the symbol for automatic functions disconnected △ lights up.
To return to stand-by mode, press the function selection button F until all the function lamps are extinguished.

Error indication
Incorrect operation will bring up the word Error in the display. Start from the beginning.
If you have selected the wrong channel number or call number, press the channel selection button CH or the number selection button NR respectively, and enter the correct number.

Time limits
The station may be programmed with various time limits, e.g. automatic disconnection if the station neither transmits or receives carrier wave during a longer time period.

Transmission limit
This means that during a call you may transmit only for a limited time. After this time, the station will automatically change to receiving mode. To continue transmission you must release the transmission button on the handset and then press it again.

Who has called?

Unanswered call
If a call is not answered the caller may request a recall by pressing the number button 0. When contact has been established the station will disconnects automatically and the yellow call lamp goes out.

Recall
Upon your return after an absence, your station may display a channel number and call number. This tells you who has called while you were away.
To recall the displayed number, press the call button ⟳.

Queue function
The station can store up to fifteen unanswered calls. The last call is shown in the channel and number indicator of the display. The digits in the channel indicator and the yellow call lamp flash.
To check who has called, you may step back in the queue by repeated pressings of number button 0 until you reach stand-by mode.
Pressing once more will bring up the latest call again. You can also step back in the queue with the button t, but it will at the same time erase the previous call in the queue.
To call the number shown in the display, press the call button ⟳.
The entire queue is erased when the station is switched off.

Status reporting

Status reporting means that instead of personally making a call you transmit a two-digit code with a meaning earlier agreed upon.

– Press the status button S. The first two digits in the five-digit number indicator show the latest selected status code.
– Enter a new status code with the number buttons 0 to 9. The new status code appears in the last two position of the number indicator. When the entry is complete, the new code will replace the old one in the first two positions of the number indicator.

- Transmit the status call by pressing number button 7 and the call button ⟳.
- An acknowledgement tone confirms that the call has been received.

Accessories

Desk-top console
C605 Maxicom can be used as a base station, for instance in an office. It can be suitably located as a desk-top console with built-in connections for antenna and power supply. When the station is supplied as a base station it is called B605 Maxicom.

Carrying case
The carrying case makes it possible to carry your C605 Maxicom station with you on site. It can also receive and retransmit emergency alarms for example from a portable pocket-size alarm transmitter.

5. Circuit description of radio parts

Regulator

Refer to fig. 11.1., 11.2 and 11.3.
Regulation is accomplished by series element V1, a transistor. The output voltage of the series element is sensed by comparing the voltage dropped across resistor R5 of the voltage divider consisting of R6, R7 and R5 with a reference voltage of 4.7V. The difference in voltage controls the series element.
Be feeding in a logic "1" or a logic "0" into input "S/R" (pin P1:6) the 9V output voltages, +9T and +9R, can be controlled. If a logic "1" is fed in, then +9V will be fed out on output "+9R" (pin P1:5), while +9V will be fed out on output "+9T" (pin P1:7) if a logic "0" is fed in.
The +9V can be adjusted using test resistor R7.

Reciver

Refer to fig. 11.1., 11.32 and 11.33.
The receiver is a double superheterodyne which obtains its local oscillator signal from an external frequency generator. The voltage value of logical "1" is +9, of logical "0", 0V. The voltage +9 VT is present during transmission and the voltage +9 VR is present during reception.

RF section and first IF section
The local oscillator signal from the frequency generator is at a frequency that is bellow the receiving frequency, at a distance equal to the first intermediate frequency.
Following first mixer U8, the difference between the L0 signal and the RF signal from the aerial is obtained. The difference frequency is the first intermediate frequency and is 21.4 MHz.

Second IF section
The frequency of the second oscillator may be above or below the first IF, at a distance equal to the second intermediate frequency, which is 455 kHz.
Following the second mixer the difference frequency between the output signal of the second oscillator and the first IF signal is obtained. This difference frequency is the second intermediate frequency.

Squelch and AF sections
The squelch circuit filters of the noise in the AF signal at frequencies greater than 15 kHz. When there is noise, a logic "1" is fed out from the squelch circuit (pin Z3:5). When there is no noise, that is when the carrier is being received, the output of the squelch circuit will be at logic "0".
The blocking of the AF path through the AF amplifier in case of noise in dependent on external circuits.
Volume is controlled by external components in all types of receivers.

Duplex transmitter

Refer to fig 11.1., 11.30 and 11.31.
The transmitter has three main functions:
- Generation of the carrier signal
- Control of the VCO
- Power amplifications of the signal

The carrier signal is generated using the output signals from the frequency generator, the VCO and a crystal-controlled, frequency-modulated oscillator (FMO). The VCO is controlled by a DC voltage generated with the aid of a detector circuit and a transmitter loop circuit. The output signal from the VCO is amplified in a power amplifier.
The voltage value of logic "1" is +9V, of logic "0", 0V.
The voltage +9 VT is present during transmission.

Generation of the carrier

The carrier is the output signal of the VCO. To permit the adjustment of the carrier frequency (f1) to the correct frequency distance form the output signal of the frequency generator (f2), these two signals are mixed in mixer Z4. When the VCO is oscillating at the correct frequency, the output of the mixer (the difference frequency f1-f2 will be of a certain frequency). This signal is compared in the detector circuit, Z1, with the signal from the FMO, f3, (the FMO is designated U2:V2, V1) which is the reference signal.

Controlling the VCO

The VCO is controlled in the following way. The two signals, f1-f2 and f3, are compared in the detector circuit Z1. When the radiotelephone is turned on, the difference between these two signals is large. The detector circuit feeds out a DC voltage that differs from 7V.
The transmitter loop circuit senses that the voltage differs from 7V and turns off the transmitter by closing the electronic switch on the transmitter loop circuit's upper output, generates a control sweep that is fed out on the lower output of the transmitter loop circuit Tp7 and blocks the integrator built into the transmitter loop circuit
The control sweep alters the frequency of the VCO until the difference frequency, f1-f2, is exactly 11.4 MHz. The detector circuit senses that the f1-f2 and f3 frequencies are the same and feeds out 7V DC.
The transmitter loop circuit senses that 7V is fed in on its input and locks the control sweep to the control voltagethat has just set the VCO to the correct frequency. The transmitter loop is now locked on.
The VCO can now vary so much in frequency that the DC output voltage decreases as much as to 1V or as increases as much as to 8V without causing the loop to lose lockon (i.e., the holding range is 1-8V). The transmitter loop circuit will immediately change the value of the control voltage to return the VCO to the correct frequency any time it varies.
However, if the VCO should deviate so greately in frequency that the detector circuit produces a voltage lower than 1V or greater than 8V, the loop will be broken and the lockon procedure will start over from the beginning.

The AF signal from the handset is continually superimposed on the DC voltage fed out from the detector circuit. When the loop is locked on, the transmitter loop circuit acts as an integrator and the variations of the AF signal result in a varying control voltage which changes the frequency of the VCO. In this way modulated carrier is obtained and then transmitted.

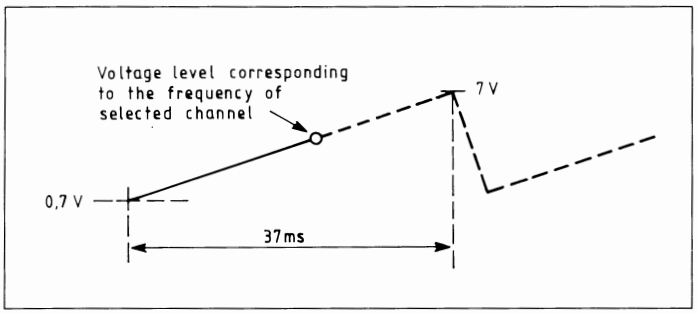


Fig 5.1. The control sweep during lock-on, measured at test point Tp7.

Power amplification

The output signal from the VCO receives its final amplification in the power amplifier. The power out may be regulated by varying the output voltage from the voltage control circuit consisting of V5-V9. The desired power out can be adjusted using potentiometer R25.
If a logic "1" is fed in on pin P1:2, "Power control", the power output will be decreased to approximately half. Unless both of the voltage control circuit's input conditions are satisfied, the power amplifier will be shut off.

Frequency generator

Refer to fig 11.1, 11.28 and 11.29.
The Frequency Generator is of the digital synthesizer type. The carrier is generated in a free-running, voltage controlled oscillator (VCO) which oscillates directly at the radio frequency by means of a phaselocked feedback loop.
The various channels are selected by means of a binary number, the divisor N, sent to the control circuits of the Frequency Generator. Each divisor corresponds directly to a channel frequency.
The output signal from the VCO can be used as

- local oscillator signal from the receiver
- transmitter signal during simplex operation
- oscillator signal to a transmission loop during duplex operation (the transmission loop consists of a transmitter that generates a transmitter signal at the proper duplex distance from the receiver signal).

The frequency generator has two main functions:

- Generating the carrier signal
- Controlling the VCO

The carrier signal is generated by the VCO and a channel oscillator. The output signal from the VCO serves as the output signal of the frequency generator, while the channel oscillator is used to provide an intermediate frequency, which after division is compared with a reference signal.
The VCO is controlled by a DC voltage generated in a loop filter. The magnitude of the control voltage is determined by the factor by which the intermediate frequency is divided (the divisor , N). When the VCO commences oscillating, an error signal will result from the comparision mentioned above and be used to change the control voltage, and thus the frequency of the VCO, until the error signal is zero.
The voltage value of logical "1" is +9, of logical "0", 0 V. The voltage +9 VT is present during transmission and the voltage +9 VR is present during reception.

Generation of the carrier

The output frequency of the VCO (f_1) is used as the transmitter signal during simplex operation, as the local oscillator signal for the receiver and as the input signal to a transmitter loop, which in turn generates the transmitter signal at the proper duplex distance from the receiver frequency during duplex operation. (The transmitter loop is not included in the frequency generator.) The VCO is modulated directly by the AF signal from the handset preamplifier.
The VCO can be made to operate on up to three partial bands, since the channel oscillator Z8 is equipped with three crystal oscillators. The desired frequency band is selected by feeding in logical "1" on the appropriate input, P1:4. If no logical "1" is fed in, the oscillator shown lowest on the functional diagram is connected up.
This position is normally used to generate the transmitter signal in simplex (and both the transmitter signal and the local oscillator signal in duplex).
The three oscillators in the channel oscillator are fully compatible.
One of the oscillators is connected by feeding a current into one of inputs Z8:2/6 via resistors R12 and R14. These are the bias resistors for the oscillators.
The output signal from the channel oscillator (f_2) is mixed with the output signal from the VCO (f_1). The difference frequency is filtered out and an intermediate frequency is obtained. This intermediate frequency is divided by means of a programmable divider, Z3, to obtain a frequency of 25 kHz. The divider is programmed with a binary number, the divisor N. This number corresponds directly to a channel. The divider is clocked by the difference signal f_1-f_2 and counts from the number N down to 0, at which time the output pulse is generated.
The output signal from the VCO is composed according to the following formula:

$$f_1 = f_2 + N0.025$$

where f_1 = the output freqeuncy of the VCO (MHz)
f_2 = the output frequency of the channel oscillator (MHz)
N = the divisor

It is apparent from the formula that the divisor corresponds directly to a channel freqeuncy and that the difference frequency, f_1-f_2, also corresponds directly to a channel frequency. The divisor may assume values between 50 and 190 and the difference frequency may assume values between 1.25 and 4.75 MHz. The VCO has a bandwidth of 3.0 MHz.

Generation of the control voltage

The output signal at 25 MHz, which is obtained from divider Z3, is compared in phase detector Z1 with the signal from crystal oscillator Z2b. The signal from the crystal oscillator is divided (within the phase detector) to obtain a signal at the frequency of
25 kHz and then a comparison is made of the phases (φ) of the two input signals.
If the phase angle (φA) of the divided signal from the VCO is less than the phase angle of the reference signal (φB) (the divided signal from the VCO leads the reference signal) the phase detector feeds out a positive pulse train. This pulse train is integrated in loop filter Z6 and converted to a control voltage which is a DC voltage between 2 and 4.5 V that sets the VCO to operate at the desired frequency. The control voltage affects the capacitance diodes in the oscillator circuit of the VCO. Each channel frequency corresponds to a specific value of the voltage.
If the phase (φA) of the divided signal from the VCO is greater than the phase angle of the reference signal (φB) (the divided signal from the VCO lags the reference signal) the phase detector feeds out a negative pulse train. In this case the control voltage will be between 4.5 and 8.3 V.
Loop filter Z6 is an active filter consisting primarily of an integrator. The integrator comprises operation amplifier Z6:Z1, capacitor C4 and resistors R3 and R16. The characteristics of the integrator must be adapted to the various operating conditions by connecting and disconnecting the various resistors in the resistance network which provides the bias for the operation amp.

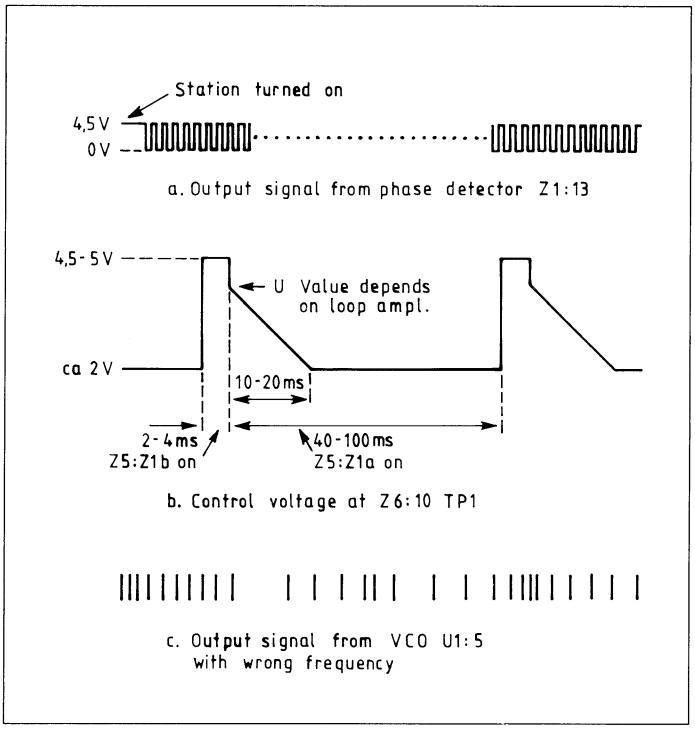


Fig 5.2. Control voltage at TPI when φA > φB and the VCO is not locked.

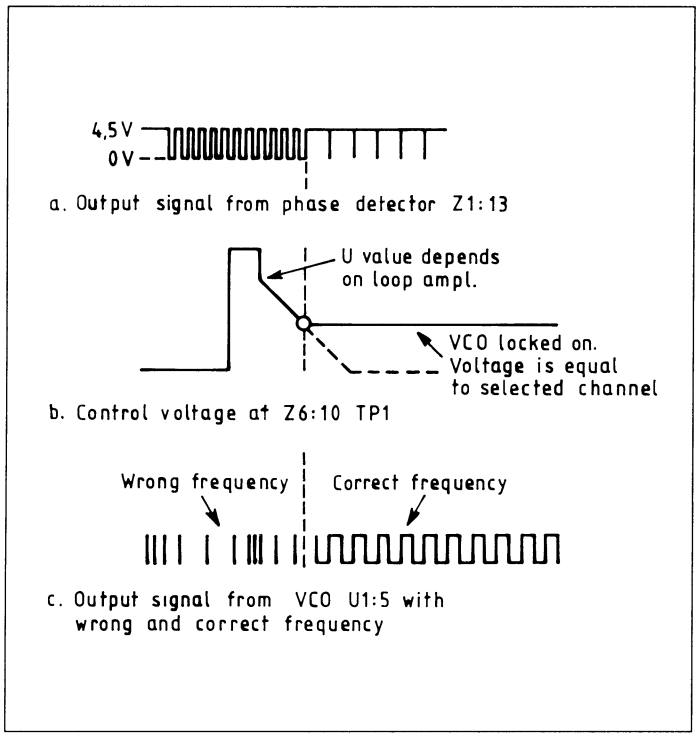


Fig 5.3. Control voltage at TPI when VCO is locked and φA=φB from φA › φB.

Acquisition sequence

When there is a large error (for example when the unit is first turned on) it is necessary to ascertain that the VCO operates within the range of regulation. This is accomplished as follows. When the error is great the phase detector provides a pulse train from output 12. The pulse train is integrated and shaped in the fast acquisition circuit Z5 and triggers a monostable multivibrator Z1b, which is also part of the fast acquisition circuit.

The monostable multivibrator closes electronic switch Z5:Z2a, which in turn shorts the integrating capacitor, C4, of integrator Z6:Z1. The integrator will now operate as an amplifier with unity gain and its output voltage will be 4.5 V which is approximately in the centre of the range of regulation.

After 2 to 4 ms monstable multivibrator Z1b triggers monostable multivibrator Z1 a to prevent Z1b from being triggered again. At this point of time the shorting of the integrator Z6:Z1 ceases. If the output signal on Z1:13 of the phase detector is a negative pulse train, the control voltage will fall sharply to a value U depending on the amplification in the phaselocked loop. Then the control voltage drops according to a curve determined by the characteristics of the integrator.

As the control voltage drops, the frequency of the VCO is changed and when the frequency has dropped so far that is corresponds to the frequency of the channel that has been selected (by means of the divisor N used to programme the divider Z3) the VCO will be locked on to the frequency of the channel and the loop filter will provide a voltage that is proportional to the channel frequency.

If the output signal from Z1:13 is a positive pulse train, the process will be identical except that the voltage will rise sharply to a certain value U when monostable multivibrator Z5:Z1b is reset. As in the above case, the voltage U is determined by the amplification in the loop. If the VCO does not lock on, the above sweeping process will be repeated when monostable multivibrator Z5:Z1a is reset.

To ascertain that the loop filter has the appropriate characteristics during the locking-in phase, electronic switch Z5:Z2d is blocked and diode V3 conducts during the locking in, causing the resistor network that determines the bias to the loop filter's integrator to be switched. The diode conducts during the locking in because the phase detector feeds out narrow positive "spikes", sufficient to keep the diode open, from output Z1:13 at the same time as the negative pulse train is produced (if A› B). When the frequency has locked in, that is when A= B, a positive voltage of 4.5 V is fed out and is sufficiently low (and has no positive spikes) to keep the diode blocked. The diode blocks and opens at about 5 V.

Diode V4 in fast acquisition circuit Z5 is opened in the same manner as diode V3 by the positive spikes from output 13 of the phase detector. Diode V4 is an extra input for triggering monostable multivibrator Z5:Z1b, which is normally triggered from output 12 of the phase detector.

During the entire acquisition period the radio trans- mitter is blocked by electronic switch Z5:V3 which is kept closed by Schmitt trigger Z5:V2/Z2e.

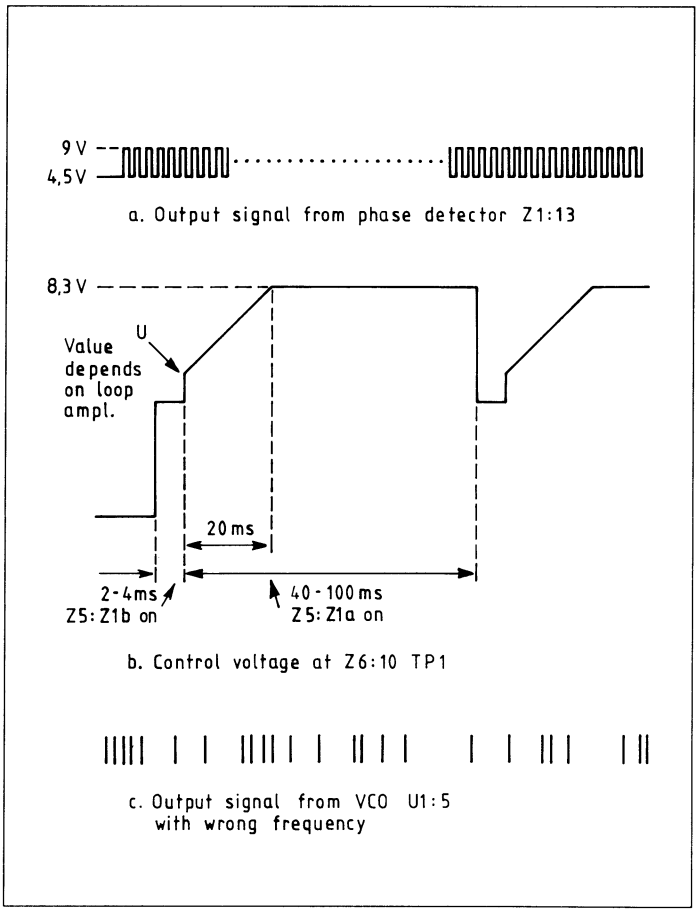


Fig 5.4 Control voltage at TPI when φA ‹φB and the VCO is not locked.

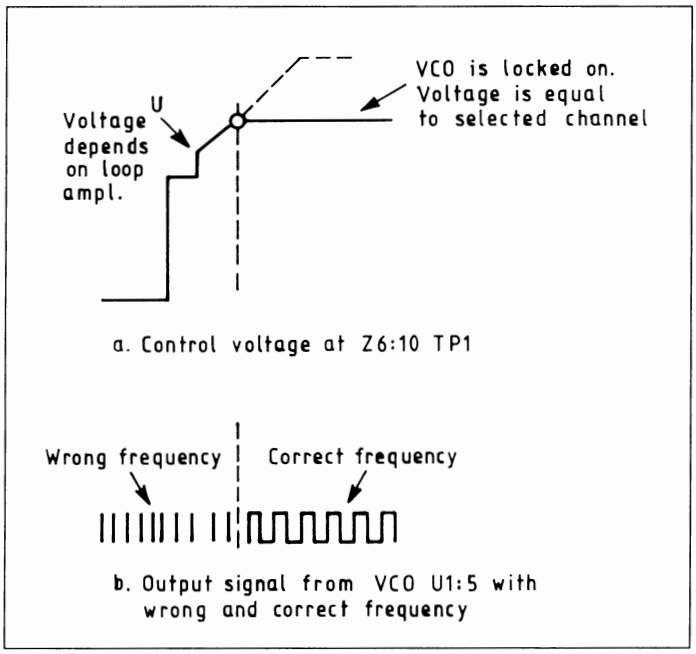


Fig 5.5 Control voltage at TPI when VCO is locked an φA=φB from φA <φB.

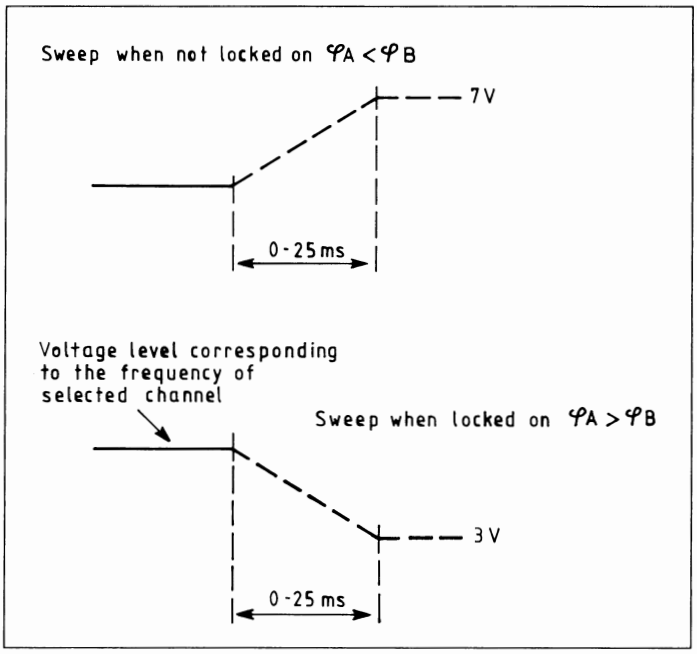


Fig 5.7 Control sweep when the VCO locked in reception mode.

Control sweep when the VCO is locked on

The characteristics of the sweeping for transmission and reception must be somewhat different. For transmission e.g., the VCO must not react to rapidly, for that would counteract modulation!

Fig 5.6 and fig 5.7, shows the appearance of the sweep for reception and transmission. The differences in characteristics between transmission and reception are accomplished by using electronic switch Z5:Z2b.

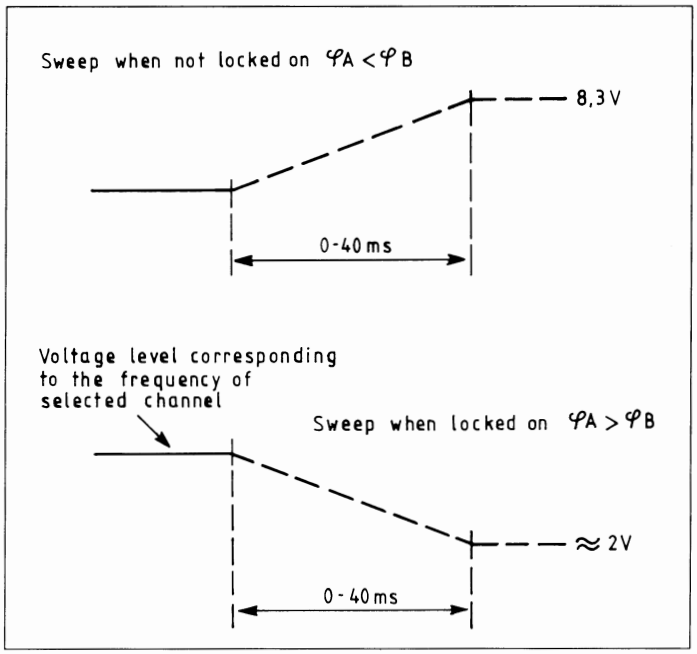


Fig 5.6 Control sweep when the VCO locked in transmission mode.

Divisor and control voltage

The characteristics of the loop filter must be changed for large divisors, that is for divisors larger than 128. This is done with electronic switch Z5:Z2c. This switch is closed when the most significant bit (128) of the binary divisor N is 1. As mentioned above each divisor corresponds to a certain control voltage. Table 5.1 shows the voltage corresponding to certain divisors.

Divisor N	Control voltage V
50	3
130	4
170	4.5 – 5
220	6

Table 5.1 Divisors and control voltages.

6. Description of the logic parts

Block diagram description of the micro computer

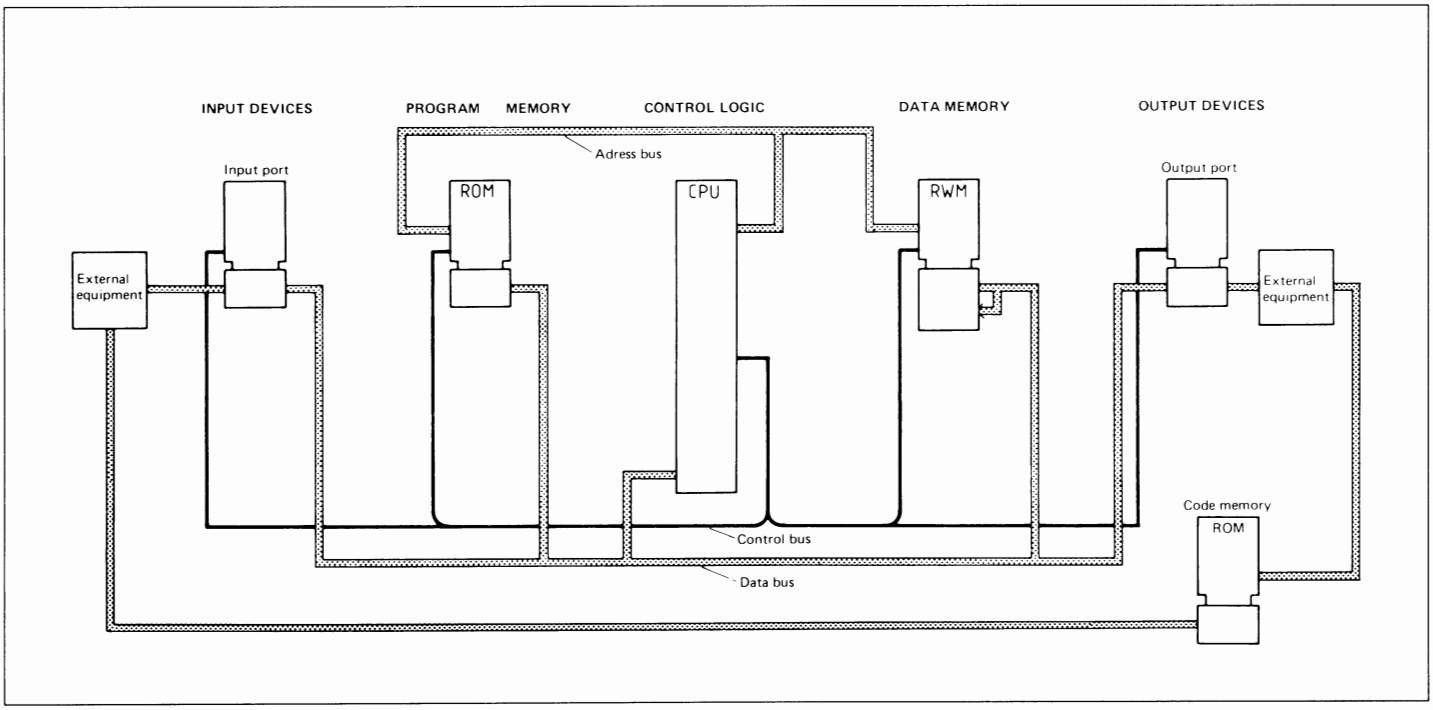


Fig 6.1 Block diagram of the logic parts.

General

The logic parts consists of a micro computer, a control unit and a code memory.

The micro computer has in- and output gates, program and data memory and control logic.

Those parts are connected to each other via the address bus, the data bus and the control bus.

The input and output devices of the microcomputer form the interface between the computer and the external environment. The input devices may be a keyboard or input ports for signals from other units in the system. The output devices may be a display or output ports for signals to other units in the system.

The program memory is a read-only memory, i.e. a memory containing permanently programmed information. The memory contains the program which controls the microcomputer. The control logic reads this program, instruction by instruction, and controls the other units accordingly.

The data memory is used to store the data required by the program. It may be a read-only memory or a read/write memory.

The control logic addresses, through the address bus, the memory cell to or from which the data is to be communicated. The address signal which consists of a binary number in parallel form, is fed from the control logic to the other units of the microcomputer. This address signal points out the corresponding unit.

Data and instructions are transmitted through the data bus between the control logic, the memories and the input and output devices. Data is passed between the units which are addressed in the form of binary numbers in parallel form.

Reset synchronizing signals and data direction signals are passed through the control bus. Synchronization and data direction signals indicate the direction in which data is to be fed through the data bus and they clock the data from the bus into memories and registers.

The control logic carries out the program instructions in two stages. First, an instruction is fetched from the program memory, the control logic then carries out the instruction. The control logic then fetches the next instruction and so on.

The control logic fetches an instruction by passing the address through the address bus to the appropriate memory cell in the program memory. At the same time, the control logic feeds an output signal on to the control bus, which indicates that data is to be passed from the data memory to the control logic. In this way, data is fed from the addressed memory cell to the control logic through the data bus.

If, for example, the instruction that is fetched requires that data should be fed from an input device to the data memory, the control logic addresses the correct input port and memory cell through the address bus. At the same time, the control logic feeds an output signal in to the control bus to indicate that data is to be fed from the input port to the data memory. Data which is carried through the data bus is clocked into the indicated memory position in the data memory by one of the signals on the control bus.

Microcomputer program

The microcomputer is controlled by the instructions in the program as follows: the control logic reads an instruction, carries out the instruction, then reads the next instruction and so on.

The instructions may be of the following types:

- supply output data to memory or output device
- supply input data from memory or input device
- process previously entered data
- jump to another place in the program
- call for a sub-routine

Processing of previously entered data may include, inversion, shifting, adding etc. A jump to antoher place in the program may be a conditional jump such as "Jump if the value 0 is obtained", or unconditional.
A call to a sub-routine is used when the same operation is to be performed on a number of occasions in the program. The instruction causes a jump to a sub-routine; the sub-routine ends by a jump back to the place from which the initial jump to the sub-routine was made.
A jump to a sub-routine may also be initiated by a logic signal to the control logic. This signal, called an "Interrupt" (INT) is used when a unit in the system requires immediate attention. When the signal is activated, the control logic interrupts the program and jumps to a special "Interrupt routine". This routine finishes by returning to the interrupted program; running of the program is resumed from the point at which the interrupt signal was received.

General program description of the 100-channel standard program

The program description is intended to explain how the set works together with its program. The program of the set has two main functions: to handle radio traffic and to control the set internally.

Code memory

In order to operate the set must be provided with a code memory. The code memory consists of a read-only memory which contains 512 words, 4 bits wide. This memory contains information about for example: Channels and radio frequencies, monitoring of incomming calls, what actions are to be carried out when an incoming call has been accepted, what call number that will be sent when a direct dialling key is pressed.

Start, on-switching

When the switch-on key is pressed certain initialising routines are performed in order to check the code memory.
The channel which was on the display immediately before the set was switched off is still stored in a certain memory. At on-switching a check is made to see if this channel is still defined in the code memory.

Operation

When operating the set the content of the display is showed with strong light intensity during a certain time after each key-pressing. This time is 5 or 10 seconds. The short time is used when showing a direct selection channel and at those states where normally no more key is expected to be pressed. The long time is used at those cases where key-pressing is to be expected.
Any incorrect operation of the set causes "Error" to appear on the display during 2 seconds. After the 2 seconds the display shows the same content as before the incorrect operation.

Incoming calls, monitoring models

Channel changing is carried out in accordance with the definition contained in the code memory, where a maximum 21 channels can be defined. For each channel there is specified if open monitoring, carrier wave monitoring, tone monitoring and auto-channel monitoring are permitted. When the station is switched on, channel changing starts at the first channel followed by the next and so on until the last channel is reached, and then begins again at the first channel.

Open monitoring. This mode can be selected manually by the mode selector or automatically after channel selection if the channel has been defined for this in the code memory. In this mode carrier wave monitoring is carried out on the display channel and on those channels which have been defined for this in the code memory.

Carrier wave monitoring is only carried out when the "open monitoring mode" has been selected. Carrier wave monitoring always takes place on the display channel and on the channels which are defined for carrier wave monitoring in the code memory.
When a carrier wave is found, the channel selector stops on the channel in question and the channel number is shown on the display with the engaged lamp lit. When a carrier wave has been detected, the channel selector remains on the channel until the carrier wave has been disappeared for 5 seconds. This delay time is to prevent the channel selector from moving on when minor interruptions occur on a channel.
If the T/R key is pressed when the channel selector has stopped on a channel, connection of call will be made on this channel.

Tone monitoring. The set can monitor up to 4 different types of tone calls on a maximum of 21 channels. The channels which are to be tone monitored are defined in the code memory. The display channel is always tone monitored.
Before commencing monitoring, the set notices which channel is display channel. A search is then made in the code memory for information about this channel. Using this information, the frequency generator is adjusted for reception on the channel concerned. There is also included in the code memory which 4 tone calls that are to be monitored. Notice that these 4 tone calls are identical for all 21 channels. The set now searches in the code memory for the first of these calls and there finds the first tone in this call. With this information, the station now sets out to detect the first tone in the first call; the actual tone monitoring now begins.
The set now tries to receive the first tone in the first call. If a tone is not received or the received tone does not agree with the first tone, the set tries to recieve the first tone in the second type of tone call. The four types of tone call on the first channel are monitored followed by a change to the second channel. This channel is monitored in the same way, followed by the monitoring on the third channel and so on. When the final channel has been monitored for tones, the procedure starts again from the beginning.

Automaticity disconnected. In this mode, the channel selector is locked on to the display channel. Tone monitoring and carrier wave monitoring is carried out continously on this channel, Incomming calls are connected as normal. After disconnection, the set remains locked on to the display channel.
There is no maximum time for the channel selector to remain on a continous carrier wave.
Pressing the T/R key gives connection of call.

Outgoing calls
Direct selection. If a direct selection is to be transmitted one of the keys which is intended for direct selection, a direct dialling key, is pressed. The set then reads the information stored in the code memory for the key that has been pressed. If the channel number is correct, a tone call which is specified in the memory for direct selection, is transmitted. If there is any error, e.g. the channel number in the memory for direct calling is incorrect, the set continues monitoring on the selected mode.

Relay. In the code memory information is stored, if relaying of incoming calls is to be carried out and in that case, which direct selection that will be transmitted.
When an incoming call has been accepted this agress with a certain call-memory area in the code memory. This area contains information about relaying. Here it is specified which direct selection that will be transmitted. In other words the set sends on an incoming call in the form of a direct selection.

Auto-channel monitoring. This monitoring always take place, provided that auto selection channels are defined in the code memoring.
During the monitoring, the first unoccupied autoselection channel is given. If this channel is engaged, then the next unoccupied autoselection channel is given. This means that the autoselection channels are monitored for a longer time interval to give greater certainty that a particular channel is genuinely available.
When transmitting on autoselection channel, channel 00 shall be entered.

Handshaking procedure
Radio traffic between mobile and control centre is preceded by the handshaking procedure. When a mobile calls the control centre the call consists of the ordinary 5-tone call number followed by a special number called the identity number (ID). When the control centre receives the 5-tone call number and the ID number it sends back the ID number to the mobile as a call acknowledgement. By doing this the mobile knows if the transmission has been succesful or not. After the mobile has received a correct ID connection of call can be made.

Alarm traffic
When the alarm call key is pressed, attempts are made to establish contact with the alarm centre. If the alarm traffic operates with alarm repetition with ID-transmission procedure 1 takes place, if not the set continues with procedure 2.

1. Handshake attempts are made first on all free channels which are defined for alarm traffic in the code memory. If the handshaking fails, the first busy channel is set and a handshaking attempt is made on the channel in order to "break in". If handshaking fails here too, the next busy channel is set and the shaking attempt is repeated on all busy channels and then back to free channels again, and so on.

If any of the handshaking attempts succeeds, the set switches to the conversation state and a conversation can take place.

2. In this case there is only one channel where alarm transmission takes place. No carrier wave test is carried out before transmission.

Time limits
Transmission time limit. This time limit is intended to prevent unintentional locking of the T/R key in the transmission position.
When the time limit is reached, the set changes over automatically from transmission to reception, as if the T/R key had been released. In order to again move into the transmission mode, the T/R key must first be released and then pressed again to restart the transmitter.
A new time limit is initiated each time the T/R key is pressed.

No activity time. This time limit concerns the time when a mobile has been connected but neither has transmitted nor received any carrier wave. At a certain maximum time automatic disconnection of the call take place. However when dealing with alarm traffic this time limit is inoperative.

Listen time limit. This time limit corresponds to a "no-activity time" which is independent of incoming carrier wave. If the mobile misses a disconnection tone then a new call on the same channel shall not be able to keep the mobile connected on this channel longer than the listen time limit. When this time is reached automatic disconnection of the call take place, however not when dealing with alarm traffic.
A new time limit is initiated each time the T/R key is pressed.

Disconnection
A call is terminated by disconnection, either automatically or manually. After disconnection monitoring is started.

Automatic disconnection. The following cases cause automatic disconnection:

- Incoming disconnection tone
- Time limit for "no activity" reached
- Time limit for "listen time limit" reached

Automatic disconnection is not accompanied by transmission of disconnection tone. In the case of alarm calls, automatic disconnection is inoperative.

Manual disconnection.
The following cases cause manual disconnection:

- Operation of the L key
- Change of channel while in voice mode
- Return of handset to holder

Transmission of disconnection tone.
For transmission of disconnection tone, the first station must be an A-subscriber. In addition, the code memory must allow transmission of disconnection tone.

Telephone mode
The telephone mode operates as special kind of direct selection. A call is initiated by pressing the telephone button on the set. The system will then automatically select a free channel and connect a line circuit to a PABX or public network. A dialling tone will then be heard in the receiver. The user can now dial any number or combination of numbers up to 16 digits on the keyset. The call is now only limited by those limits existing in the telephone network.

7. Description of the cipher circuits

General

In the ciphering unit enciphering of transmitted signals and deciphering of received signals take place simultaneously. The electronic circuitry of the ciphering unit is mostly contained in five hybrid circuits placed on two circuit boards U1 and U2: see fig 11.16 to 11.19.

- A modem circuit Z2
- A delta modulator Z1
- A delta demodulator Z3
- A transmit (Tx) cipher circuit Z1 (on U2)
- A receive (Rx) cipher circuit Z6

The delta modulator/demodulator circuits are identical as well as the ciphering circuits. Their function is determined by the logic level on the mode-select inputs of the circuits. Processing of analog signals, for both transmission and reception, is carried out by the modem circuit. It also digitizes all received signals for further processing by the Rx-ciphering circuit.
Analog-to-digital conversion of transmission signals is carried out in the delta modulator. The circuit also contains an analog noise generator. Digital-to-analog conversion of reception signals is carried out in the delta demodulator.
The Tx ciphering circuit enciphers the handset signal or the linked data signal before it is transmitted. The Rx ciphering circuit deciphers the received cipher signal.
The ciphering unit is intended for NRZ coded signals with a data rate of 14.4 kbit/s.
On the U2 board there is also a circuit for generation of a data clock by which the deciphered (plain) data signal is clocked out into the B ciphering unit at link traffic.
A voltage supervisor circuit on the U2 board shuts off the ciphering circuits if the battery voltage is too low, in order to avoid incorrect ciphering.

Mechanical design

The Ciphering Unit is housed in a plug-in type metal case which is placed in the cipher compartment of an A station unit.
Connectors for connection to the radio and the key programmer are located on the rear side of the case, see fig. 7.1.
The case is disassembled by unscrewing four screws. The two printed circuit boards inside are joined by a multipole connector.

Automaticity disconnected. In this mode, the channel selector is locked on to the display channel. Tone monitoring and carrier wave monitoring is carried out continously on this channel, Incomming calls are connected as normal. After disconnection, the set remains locked on to the display channel.
There is no maximum time for the channel selector to remain on a continous carrier wave.
Pressing the T/R key gives connection of call.

Outgoing calls
Direct selection. If a direct selection is to be transmitted one of the keys which is intended for direct selection, a direct dialling key, is pressed. The set then reads the information stored in the code memory for the key that has been pressed. If the channel number is correct, a tone call which is specified in the memory for direct selection, is transmitted. If there is any error, e.g. the channel number in the memory for direct calling is incorrect, the set continues monitoring on the selected mode.

Relay. In the code memory information is stored, if relaying of incoming calls is to be carried out and in that case, which direct selection that will be transmitted.
When an incoming call has been accepted this agress with a certain call-memory area in the code memory. This area contains information about relaying. Here it is specified which direct selection that will be transmitted. In other words the set sends on an incoming call in the form of a direct selection.

Auto-channel monitoring. This monitoring always take place, provided that auto selection channels are defined in the code memoring.
During the monitoring, the first unoccupied autoselection channel is given. If this channel is engaged, then the next unoccupied autoselection channel is given. This means that the autoselection channels are monitored for a longer time interval to give greater certainty that a particular channel is genuinely available.
When transmitting on autoselection channel, channel 00 shall be entered.

Handshaking procedure
Radio traffic between mobile and control centre is preceded by the handshaking procedure. When a mobile calls the control centre the call consists of the ordinary 5-tone call number followed by a special number called the identity number (ID). When the control centre receives the 5-tone call number and the ID number it sends back the ID number to the mobile as a call acknowledgement. By doing this the mobile knows if the transmission has been succesful or not. After the mobile has received a correct ID connection of call can be made.

Alarm traffic
When the alarm call key is pressed, attempts are made to establish contact with the alarm centre. If the alarm traffic operates with alarm repetition with ID-transmission procedure 1 takes place, if not the set continues with procedure 2.

1. Handshake attempts are made first on all free channels which are defined for alarm traffic in the code memory. If the handshaking fails, the first busy channel is set and a handshaking attempt is made on the channel in order to "break in". If handshaking fails here too, the next busy channel is set and the shaking attempt is repeated on all busy channels and then back to free channels again, and so on.

If any of the handshaking attempts succeeds, the set switches to the conversation state and a conversation can take place.

2. In this case there is only one channel where alarm transmission takes place. No carrier wave test is carried out before transmission.

Time limits
Transmission time limit. This time limit is intended to prevent unintentional locking of the T/R key in the transmission position.
When the time limit is reached, the set changes over automatically from transmission to reception, as if the T/R key had been released. In order to again move into the transmission mode, the T/R key must first be released and then pressed again to restart the transmitter.
A new time limit is initiated each time the T/R key is pressed.

No activity time. This time limit concerns the time when a mobile has been connected but neither has transmitted nor received any carrier wave. At a certain maximum time automatic disconnection of the call take place. However when dealing with alarm traffic this time limit is inoperative.

Listen time limit. This time limit corresponds to a "no-activity time" which is independent of incoming carrier wave. If the mobile misses a disconnection tone then a new call on the same channel shall not be able to keep the mobile connected on this channel longer than the listen time limit. When this time is reached automatic disconnection of the call take place, however not when dealing with alarm traffic.
A new time limit is initiated each time the T/R key is pressed.

Disconnection
A call is terminated by disconnection, either automatically or manually. After disconnection monitoring is started.

Automatic disconnection. The following cases cause automatic disconnection:

- Incoming disconnection tone
- Time limit for "no activity" reached
- Time limit for "listen time limit" reached

Automatic disconnection is not accompanied by transmission of disconnection tone. In the case of alarm calls, automatic disconnection is inoperative.

Manual disconnection.
The following cases cause manual disconnection:

- Operation of the L key
- Change of channel while in voice mode
- Return of handset to holder

Transmission of disconnection tone.
For transmission of disconnection tone, the first station must be an A-subscriber. In addition, the code memory must allow transmission of disconnection tone.

Telephone mode
The telephone mode operates as special kind of direct selection. A call is initiated by pressing the telephone button on the set. The system will then automatically select a free channel and connect a line circuit to a PABX or public network. A dialling tone will then be heard in the receiver. The user can now dial any number or combination of numbers up to 16 digits on the keyset. The call is now only limited by those limits existing in the telephone network.

7. Description of the cipher circuits

General

In the ciphering unit enciphering of transmitted signals and deciphering of received signals take place simultaneously. The electronic circuitry of the ciphering unit is mostly contained in five hybrid circuits placed on two circuit boards U1 and U2: see fig 11.16 to 11.19.

- A modem circuit Z2
- A delta modulator Z1
- A delta demodulator Z3
- A transmit (Tx) cipher circuit Z1 (on U2)
- A receive (Rx) cipher circuit Z6

The delta modulator/demodulator circuits are identical as well as the ciphering circuits. Their function is determined by the logic level on the mode-select inputs of the circuits. Processing of analog signals, for both transmission and reception, is carried out by the modem circuit. It also digitizes all received signals for further processing by the Rx-ciphering circuit.
Analog-to-digital conversion of transmission signals is carried out in the delta modulator. The circuit also contains an analog noise generator. Digital-to-analog conversion of reception signals is carried out in the delta demodulator.
The Tx ciphering circuit enciphers the handset signal or the linked data signal before it is transmitted. The Rx ciphering circuit deciphers the received cipher signal.
The ciphering unit is intended for NRZ coded signals with a data rate of 14.4 kbit/s.
On the U2 board there is also a circuit for generation of a data clock by which the deciphered (plain) data signal is clocked out into the B ciphering unit at link traffic.
A voltage supervisor circuit on the U2 board shuts off the ciphering circuits if the battery voltage is too low, in order to avoid incorrect ciphering.

Mechanical design

The Ciphering Unit is housed in a plug-in type metal case which is placed in the cipher compartment of an A station unit.
Connectors for connection to the radio and the key programmer are located on the rear side of the case, see fig. 7.1. The case is disassembled by unscrewing four screws. The two printed circuit boards inside are joined by a multipole connector.

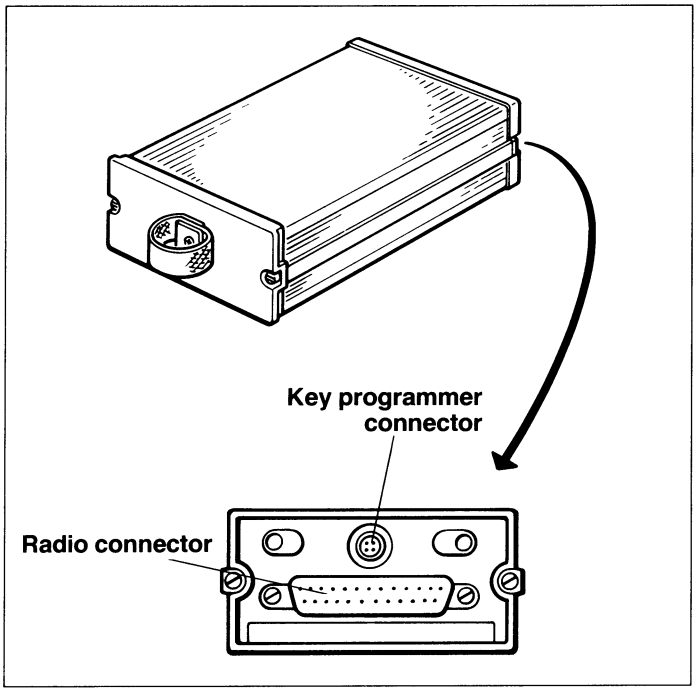


Fig. 7.1. The ciphering unit.

Transmission of plain text

Transmission in plain text or cipher is selected by use of the CIPHER switch on the handset holder. The switch is set for plain text when it is in the OFF position. In this position, a logic 0 on pin P1:18 (plain) operates a selector in the modem circuit through pin 19 and another selector in the Tx ciphering circuit clock regenerator through pin 42.
The signal from the handset is fed via P1:21 to the modem where it is amplified, pre-emphasized and amplitude-limited. After further amplification, the signal is fed through a selector from the modem via pin 22, and through a selector in the Tx cipher clock regenerator, back to the modem. After amplification and low-pass filtration, the signal is fed through pin P1:23 to the modulator in the radio station.

Transmission of enciphered message

Processing of enciphered signals consists, in the main, of the following steps:

- Addition of noise to the analog speech signal
- Digitizing of speech signal in a delta modulator
- Addition of data bits from a pseudo-random generator to the digital speech signal. The start value of the generator is determined by a cipher key which has been entered and is common to both the transmitter and receiver.
- Synchronization of the pseudo-random generators in the transmitter and receiver by periodical restart of the generators.
- Digital low-pass filtration of the enciphered pulse trains before transmission.

The speech signal is processed in the modem in the same way as during transmission of plain text, but the signal is also de-emphasized in order to obtain the straight frequency characteristic that is required by the subsequent circuits.
The signal is fed through pin 25 to the delta modulator, which operates as an analog-to-digital converter. Noise from a noise generator is added to the speech signal on pin 14 of the A/D converter input.
The purpose of the noise signal is to mask the pauses in speech which would otherwise give rise to a periodic output signal (01010...) from the A/D converter.
In principle, delta modulation means that the fluctuation slope of the analog speech signal is converted into a fluctuating density of logic "ones" and "zeroes" in the outgoing pulse sequence. Logic "ones" predominate in the positive-going portions of the speech signal, while logic zeroes predominate in the negative-going portions of the signal.
The output signal from the delta modulator is fed through a selector Z5 into the Tx ciphering circuit through pin 52 (PD).

The Tx (and Rx) ciphering circuits include the following:

- A pseudo-random circuit
- A restart circuit
- A clock regenerator
- A microcomputer of conventional type with a CPU and associated memories (ROM and RWM).

A 3V back-up battery on board U2 retains information in the RWM; it is connected through pin 14 of the ciphering circuits when the ciphering unit is not supplied with power from an external source.
Zero setting of the ciphering circuits (but not of the key memories) is carried out by pin 18 (CLEAR) being kept low for 35-65 ms after switch-on of the power supply. A time delay is obtained from a circuit controlled by a voltage supervisor on U2 (comparator Z5) which sets the ciphering circuits to zero if the supply voltage should be less than 6V. This is to prevent incorrect functioning of the cipher system.
The main purpose of the CPU is to handle the cipher key. This may either be a key which is permanently programmed into the ROM, or a key which is obtained from a key programmer. The latter key is fed into the CPU through pin P2:1 (KEY IN).
When key loading is commenced, KEY REQ (Pin P2:2) is at logic 1. If a check total at the end of the key loading is correct, then KEY REQ is again at logic 0.

The following data information is obtained from the key programmer:

Key	9x8 bits
Selector word	2x8 bits
Restart word	2x8 bits
Check word	1x8 bits

The information is stored in the RWM.

The check word identifies the key information. If the CPU does not recognise the check word, the internal key (also selector word and restart word) is used.
The data bits in the key and the restart word may be optionally selected. The selector word must contain eight logic "zeroes" and eight logic "ones". The check word is fixed (i.e. always the same eight bits).
The digital speech signal PD is fed into the pseudo-random generator. This generates a number of pseudo-random sequences, starting from a value which is determined by the cipher key that has been entered through the data bus. The pseudo-random sequences are used to produce a superimposition series which is added, modulus 2, to the digital speech signal. The result is an enciphered signal KD which is fed to the restart circuit.
The restart circuit is programmed by the CPU with a selector word and a restart word which are placed in the 16-bit shift register. Each data bit in the enciphered pulse train is clocked into another 16-bit shift register, the contents of which is compared, after each data bit, with the contents in the restart word register. Because of the selector register, attention is paid only to the results of eight bit comparisons. When there is agreement between the contents of the registers, a restart order, PEOS, is passed to the random generator and the CPU, which again enters the ciper key into the random generator. The restart order is supplied at an average of each 256th data bit.
The enciphered data signal DATA OS from the restart circuit is fed through a digital low-pass filter which reshapes the steep pulse edges into approximate sinusoidal forms as required by the radio unit. The filter consists of an 8-bit shift register (in the clock regenerator) and weighted resistor network. The data signal is clocked into the shift register at a speed of 8 times the data clock CB. The output signals Q0 to Q7 of the shift register are fed to the weighted resistor network.
The output signal from the resistor network is fed through the selector in the clock regenerator to the modem, where the signal is amplified and low-pass filtered; this removes the steps in the sinusoidal pulse transitions. The signal is then fed to the modulator in the radio unit, for transmission.
The necessary clock signals are generated by a crystal-controlled oscillator in the clock regenerator. The oscillator frequency, divided by two, is used as the CPU clock.
The CP clock (921.6 kHz) is used to clock the registers in the restart unit.
The CB clock (14.4 kHz) is the data clock resulting from the CP clock and has a fixed frequency.
The significance of the other signals of the microcomputer is given in the data book of the microprocessor CDP 1802.

8. Checking and adjusting

General

Before any adjusting is done in the radio circuits always check the dc levels of the regulator. If all radio parts is to be adjusted start with the frequency generator and end with the receiver.

Test equipment

Standard equipment

- Voltmeter ± 2% accuracy
- Frequency counter 10mV sensitivity
- Deviation meter
- Low frequency generator
- High frequency generator
- Power meter with attenuator
- Dc power supply +13.2V

Special equipment

- Ericsson control unit SS-791/363
- Ericsson logic eliminator SS-8205/469

Test set up

General

The control unit and the logic unit must be removed from the radio unit before any adjustments are made.

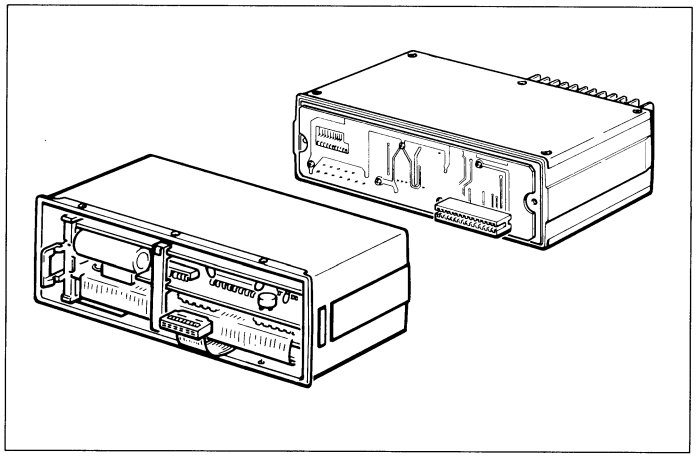


Fig 8.1. Removing the logic unit from the radio unit.

The logic unit of the station is replaced by the logic eliminator SS-791/363 and the control unit by control unit SS-8205/469.

- Set the dc supply to 13.2V and connect it to the control unit.
- Connect the power meter to the control unit.

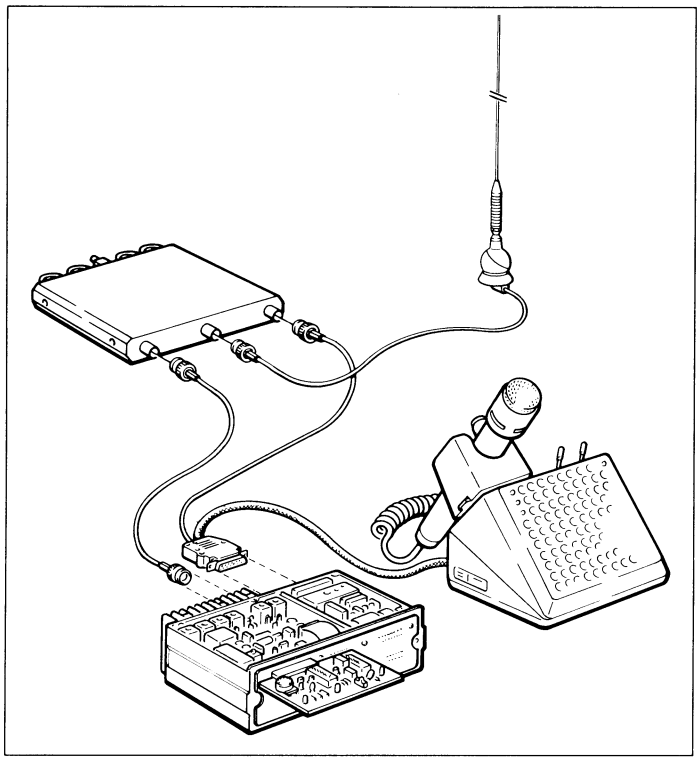


Fig 8.2. Connecting the logic eleminator and the control unit and the duplex filter to the stations radio unit.

Checking the regulator

– Set the radio to transmission mode and check the dc levels by means of the voltmeter in accordance with table 8.1.

Voltmeter	connection		Measured voltage			
Test	Test point	Ref.	Min V	Nom. V	Max V	Tolerance in V
+12V, batt	+12V, batt	Batt	12.0	13.2	14.5	± 0.2
+12V	R15/K1	Earth	10.0	13.2	14.5	–
+ 9V	R1 /C2	Earth	9.1	9.1	9.1	± 0.5
+ 9VR	V7, coll	Earth	9.1	9.1	9.1	± 0.5
+ 9VT	V8, coll.	Earth	8.7	8.7	8.7	± 0.1

Table 8.1. Dc levels of the regulator board.

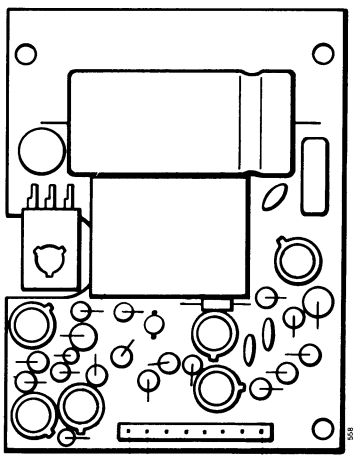


Fig 8.3. Regulator's testpoints.

Checking and adjusting the frequency generator

Checking the dc levels

– Set the logic eliminator to "ON"
– Check the dc levels by means of the voltmeter in accordance with table 8.2.
– Set the logic eliminator to division factor 128
– Check that the logic level at pin 8 of connector P2 is "1" and levels at pins 1 to 7 is "0"
– Connect the voltmeter to TPI
– Adjust C4 to 5V ± 0.5V

Testpoint Connector P1	Measured Voltage, V	Remarks
Pin 1	9	Not in transmission mode
Pin 2	9	Only transmission mode
Pin 5	9	Constant level

Table 8.2. Dc levels at connector P1

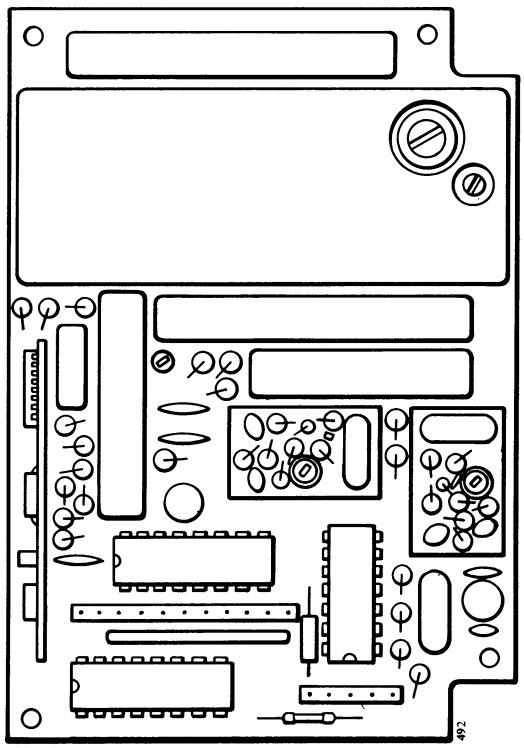


Fig 8.4. Frequency generator's testpoints and trimmers.

High band tuning of the frequency generator

– Set the logic eleminator to "0" and the division factor N to 128
– Note the frequency of the X-tal on board U3 as printed on the housing of the X-tal.
– Connect the pick-up loop of the frequency counter to the X-tal and check that it oscillates at the noted frequency.
– Set the oscilloscope to dc and connect it to TPI.
– Adjust trimmer C4 until frequency generator locks. Oscilloscope read-out should be +5.0V.
– Calculate the VCO frequency in accordance with formula $F_{VCO} = 128 \times 0.025 + 6 \times F^*_{X\text{-tal}}$. Note the result of the calculation.
– Connect the counter's pick-up loop into the VCO.
– Adjust the VCO frequency by means of trimmer coil on U3 to the calculated frequency.

* As printed on the housing of the X-tal.

Low band tuning of frequency generator
This adjustment is relevant only for frequency generators with 2 X-tals.
- Set logic eliminator to "1" and division factor N to 128.
- Note the frequency of the X-tal on board U2 as printed on the housing of the X-tal.
- Connect the counter's pick-up loop to the X-tal and check that it oscillates at the noted frequency.
- Set the oscilloscope to dc and connect it to TPI.
- Adjust trimmer C3 until oscilloscope read-out becomes +5V.
- Calculate the VCO frequency in accordance with formula $F_{VCO} = 128 \times 0.025 + 6 \times F^*_{X\text{-tal}}$. Note the result of the calculation.
- Connect the counter's pick-up loop into the VCO.
- Adjust the VCO frequency by means of trimmer coil on U2 to the calculated frequency.

Checking the control sweep of the VCO
- Set the logic eliminator to division factor 30.
- Connect the oscilloscope to TPI of the frequency generator board.
- Observe the oscilloscope and check that the sweep locks, this is indicated by constant dc level on the oscilloscope.
- Set the logic eliminator to division factor 210.
- Check that the sweep locks.

Checking and adjusting the 1 band reciver

Test set up
- Connect the signal generator to the antenna input of the radio.
- Connect a pick-up loop from the frequency generator to any of the two holes for the trimmer capacitors on board U1.
- Set the logic eliminator to division factor 128.
- Open the squelch by setting trimmer potentiometer R43 on the receiver board fully clockwise.
- Note the read-out of the frequency counter.

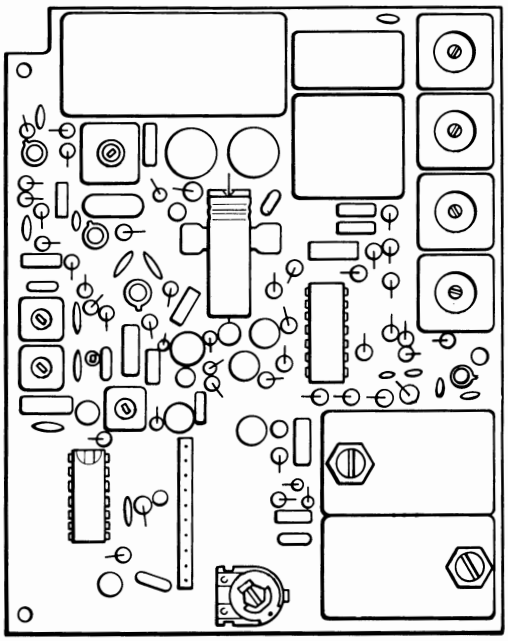


Fig 8.5. 1 band receiver board's testspoints and trimmers.

HF and MF circuits adjusting
- Set the signal generator to the sum of the noted read-out of the frequency counter and 21.4 MHz.
- Set the oscilloscope to 30mV AC and connect it to TP5 on the receiver board.
- Increase the amplitude of the input signal from the signal generator until oscilloscope read out becomes 15-20mV or a tone is heard from the loudspeaker.
- Adjust HF trimmer capacitors C1, C2, C6, C9, C11 and C14 to max oscilloscope read-out.
- Adjust MF trimmer coils U4, U5 and U6 to max oscilloscope read-out.

LF circuits adjusting
- Connect the oscilloscope to pin 9 of connector P1.
- Observe the oscilloscope and adjust the trimmer coil in U7 to max amplitude and min distortion.
- Turn squelch potentiometer R43 to the cut-off point and observe the hysteresis on the oscilloscope.

Checking and adjusting the duplex transmitter

Test set up
Before any adjustment is done check that the control sweep locks. See frequency generator adjusting.
Connect the power meter to the control unit.

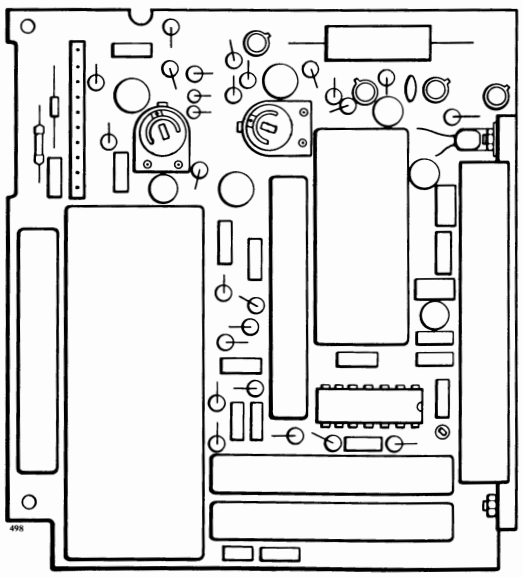


Fig 8.6. Duplex transmitter's testpoints and trimmers.

Checking the control sweep of the VCO at high band

- Set the logic eliminator to division factor 128 and X="0".
- Connect the oscilloscope to TP1 of the transmitter board.
- Check that oscilloscope read-out is +5V, adjust trimmer C4 if necessary.
- Set the logic eliminator to division factor 30.
- Observe the oscilloscope and check that the sweep locks. This is indicated by constant dc level on the oscilloscope.
- Set the logic eliminator to division factor 210.
- Check that the sweep locks.

Checking the control sweep of the VCO at low band.

- Set the logic eliminator to division factor 128 and X="1"
- Connect the oscilloscope to TPI of the transmitter board.
- Check that oscilloscope read-out is +5V, adjust trimmer C3 if necessary.
- Set the logic eliminator to division factor 30.
- Observe the oscilloscope and check that the sweep locks. This is indicated by constant dc level on the oscilloscope.
- Set the logic eliminator to 210.
- Check that the sweep locks.

Setting the duplex frequency

- Set the logic eliminator to division factor 128.
- Connect a pick-up loop from the frequency counter to the output stage of the transmitter.
- Note the channel frequency as printed on the housing of the radio.
- Observe the frequency counter read-out and check that the read-out is the same as the channel frequency. If necessary adjust trimmer inductance on board U2 FMO.

Adjusting the temperature limiter

- Set the radio to transmission mode.
- Observe the power meter and turn trimming potentiometer R25 slowly clockwise.
  Stop when further adjusting of R25 does not increase the read-out of the watt meter.
- Check the setting by adjusting R25 slowly clockwise respectively anti clockwise while watching the read-out of the power meter.

Setting the deviation

- Connect the deviation meter via an attenuator to the antenna output.
- Set the LF generator to 25mV and 300 Hz and connect it to pin 1 of connector P1.
- Observe the deviation meter and adjust trimming potentiometer R7 to ±4.5 kHz read-out at the deviation meter.
- Speak into the mic. and check that measured deviation is approx. ±4 kHz.

9. Trouble shooting

Trouble shooting on unit level in the car.

Error 1.
DC power failure, station lamp is off.

- Check battery fuse to the connection unit and the fuse in the connection unit.
- Remove radio and check 12V supply in the cassette.

Error 2.
No transmission

- Connect a Wattmeter to the duplex filter and check output power and standing wave ratio. If not correct check antenna and cables.
- Change cipher unit.
- Check handset.
- Check radio station in test bench.

Error 3.
No modulation

- Remove cipher unit and check if audio can pass through the bridgin unit.
- Check the handset.

Error 4.
Only noise in cipher transmission mode.

- Check that the correct cipher key is used.

Error 5.
No audio in the loudspeaker.

- Check if there is audio in the handset, if so, check loudspeaker white cable and switch S1 in handset holder.

Error 6.
No audio in the loudspeaker nor in the handset.

- Remove cipher unit.
- Change handset.
- Check radiostation in test bench.

Error 7.
No, or noisy audio in cipher reception mode.

- Check that correct cipher key is used.
- Replace the cipher unit.

Central service

For repairs, circuit board and unit swapping is our central service always ready to serve you.
Fast delivery at fixed prices. For more info and price list call or write us.
Mail: Ericsson radio systems AB, Landmobile radio,
Dept. F/RTR
Torshamnsgatan 27–31,
163 80 Stockholm, Sweden.
Telephone: 08-757 00 00. Ask for Central service or department F/RTR.
Telex: 13545 ERICRA.
Telefax: 08-752 80 56.
Please state dept. F/RTR on all messages.

10. Spare parts

Duplex transmitter

Capacitors

Pos	Order number	Description			
C1	NE 765871-5100	Plastic foil	10nF	20%	100V
C2	NG 663716-1470	Dipped tantalum	4.7uF	20%	16V
C3	NF 775656-5220	Met. polyester foil	22nF	20%	63V
C4	NF 775656-5470	Met. polyester foil	47nF	20%	63V
C5	NE 765871-5100	Plastic foil	10nF	20%	100V
C6	NE 765871-5100	Plastic foil	10nF	20%	100V
C7	NE 765871-5100	Plastic foil	10nF	20%	100V
C8	NE 765871-5100	Plastic foil	10nF	20%	100V
C14	NG 663735-1100	Dipped tantalum	1.0uF	20%	35V
C15	NE 765871-5100	Plastic foil	10nF	20%	100V
C16	NG 663735-1100	Dipped tantalum	1.0uF	20%	35V
C17	NA 158456-4100	Ceramic	1nF	10%	63V
C18	NE 765871-5100	Plastic foil	10nF	20%	100V
C20	NA 158456-3470	Ceramic	470pF	10%	63V
C21	NE 765871-4220	Plastic foil	2.2nF	20%	100V
C24	NG 663735-0150	Dipped tantalum	0.15uF	20%	35V
C25	NG 663716-1470	Dipped tantalum	4.7uF	20%	16V
C26	NG 663735-0330	Dipped tantalum	330nF	20%	35V
C27	NA 158456-3470	Ceramic	470pF	10%	63V
C29	NF 775371-5330	Metal. polyester	33nF	20%	100V
C30	NG 663735-1100	Dipped tantalum	1.0uF	20%	35V

Resistors

Pos	Order number	Description			
R1	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R2	OD 106555-4560	Carbon film	5.6 kohm	5%	0.125W
R3	OD 106555-5470	Carbon film	47 kohm	5%	0.125W
R5	OD 106555-4330	Carbon film	3.3 kohm	5%	0.125W
R6	OD 106555-3470	Carbon film	470 ohm	5%	0.125W
R7	OP 500877-4470	Cermet Pot.	4.7 kohm	20%	0.75W
R8	OB 751366-0220	Wire wound	0.22 ohm	10%	4W
R9	OD 901744-5470	Metal oxide	47 kohm	2%	0.125W
R10	OD 901744-5470	Metal oxide	47 kohm	2%	0.125W
R11	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R12	OD 901744-5100	Metal oxide	10 kohm	2%	0.125W
R13	OD 106555-2560	Carbon film	56 ohm	5%	0.125W
R14	OD 901744-5120	Metal oxide	12 kohm	2%	0.125W
R15	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R16	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R17	OD 106555-4220	Carbon film	2.2 kohm	5%	0.125W
R18	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R19	OD 106555-4180	Carbon film	1.8 kohm	5%	0.125W
R20	OD 106555-4150	Carbon film	1.5 kohm	5%	0.125W
R21	OD 106555-4470	Carbon film	4.7 kohm	5%	0.125W
R24	OD 106555-4150	Carbon film	1.5 kohm	5%	0.125W
R25	OP 500877-4470	Cermet Pot.	4.7 kohm	20%	0.75W
R26	OD 106555-3330	Carbon film	330 ohm	5%	0.125W
R27	OD 106555-3100	Carbon film	100 kohm	5%	0.125W
R28	OH 900000-2470	Termistor	47 ohm		
R30	OD 106555-4330	Carbon film	3.3 kohm	5%	0.125W
R31	OD 106555-2470	Carbon film	47 kohm	5%	0.125W
R33	OD 106555-2330	Carbon film	33 ohm	5%	0.125W
R34	OD 106555-3390	Carbon film	390 ohm	5%	0.125W
R37	OD 901744-5220	Metal oxide	22 kohm	2%	0.125W
R38	OD 106555-3330	Carbon film	330 ohm	5%	0.125W
R39	OD 106555-2150	Carbon film	15 ohm	5%	0.125W
R40	OD 106555-3180	Carbon film	180 ohm	5%	0.125W
R45	OD 106555-4820	Carbon film	8.2 kohm	5%	0.125W

Semiconductors

Pos	Order number	Description	
V1	VC 602362-0001	Silicon planar	1N4148
V2	VC 602362-0001	Silicon planar	1N4148
V3	VC 602362-0001	Silicon planar	1N4148
V4	XYD400017-0002	Silicon PNP	BC 307A, BC 557A
V5	XYD405049-0003	Silicon NPN	BC237A, BC547A
V6	VC 602362-0001	Silicon planar	1N4148
V7	VC 602362-0001	Silicon planar	1N4148
V8	XYD400017-0002	Silicon PNP	BC 307A, BC557A
V9	XYE400012-0001	Silicon PNP	BD 436
V10	VC 602362-0001	Silicon planar	1N4148
V11	XYD405049-0003	Silicon NPN	BC237A, BC547A
V12	XYD400017-0002	Silicon PNP	BC307A, BC557A
Z1	TA 503013-2120	FM IF amp	TBA120

Hybride circuits

Pos	Order number	Description
Z3	RR-1789502	Wideband Amplifier
Z4	RR-1789503	Transmitter Mixer
Z5	RR-1789504	Transmitter Loop
Z6	RR-1789505	Microphone amplifier

Inductances

Pos	Order number	Description	
L2	RR-11188410	Choke	C20-Series
L3	RR-11188410	Choke	C20-Series
L4	PB 105003-0033	Choke Fe core	47uH, 10%

Miscellaneous

Pos	Order number	Description	
P1	BP 500103-0003	Terminal strip	10 poles
1	BA 203004-0001	Terminal stud	E 413
3	BC 111003-0001	Connector Jack	1-pol

1 band reciver

Capacitors

Pos	Order number	Description
C1	NK 100021-2470	47 pF 10% 50V NP0 ceramic chip
C2	NK 150001-3470	470 pF 10% 50V ceramic chip
C3	NK 100021-2120	12pF 0.5 pF 50V NP0 ceramic chip
C4	NK 150001-3470	470 pF 10% 50V ceramic chip
C5	NA 158456-3470	470 pF 10% 63V ceramic
C6, C9	NS 156002-0003	3.5-18 pF adjustable
C7	NE 765871-4220	2.2 nF 20% 100V plastic foil
C8	NE 765871-4100	1 nF 20% 100V plastic foil
C11,C14	NS 156002-0003	3.5-18 pF adjustable
C15	NA 109256-1270	2.7 pF $\pm$0.25 pF 63V NP0 ceramic
C16	NA 158456-4100	1 nF 10% 63V ceramic
C17,C18	NE 765871-5100	10 nF 20% 100V plastic foil
C19	NA 109356-2330	33 pF 2% 63V N150 ceramic
C20,C23	NE 765871-5100	10 nF 20% 100V plastic foil
C22,C24	NA 158456-4100	1 nF 10% 63V ceramic
C25,C27	NE 765871-5100	10 nF 20% 100V plastic foil
C26	NA 109256-1470	4.7 pF $\pm$0.25 pF 63V NP0 ceramic
C28,C32	NF 775371-5680	68 nF 20% 100V met. polyester
C29	NE 765871-4100	1 nF 20% 100V plastic foil

C31	NG 663735-0100	0.1 uF 20% 35V dipped tantalum
C34,C42	NG 663735-0220	0.22 uF 20% 35V dipped tantalum
C35	NA 10906-3150	150 pF 2% 63V N750 ceramic
C39	NF 775656-5470	47 nF 20% 63V met. polyester
C44,C49	NG 104325-2470	47 uF -10+100% 25V al. electrolytic
C45	NG 103516-3220	220 uF -10+100% 16V al. electrolytic
C46	NE 765871-4100	1 nF 20% 100V plastic foil
C47	NE 765871-4470	4.7 nF 20% 100V plastic foil
C48	NG 663735-0470	0.47 uF 20% 35V dipped tantalum
C50	NE 765871-5100	10 nF 20% 100V plastic foil
C51	NG 663703-2470	47 uF 20% 3V dipped tantalum
C52	NE 765871-4100	1 nF 20% 100V plastic foil
C53	NA 109356-2560	56 pF 2% 63V N150 ceramic
C54	NA 109356-2680	68 pF 2% 63V N150 ceramic
C55,C56	NE 165386-3680	680 pF 2.5% 680V polypropylene
C57	NE 165386-3680	680 pF 2.5% 680V polypropylene
C58,C59	NE 765871-4470	4.7 nF 20% 100V plastic foil
C60	NF 775371-5470	47 nF 20% 100V met. polyester
C61	NF 775371-5220	22 nF 20% 100V met. polyester
C62	NA 109356-2470	47 pF 2% 63V n150 ceramic
C63	NG 663735-0220	0.22 uF 20% 35V dipped tantalum
C65	NE 765871-4330	3.3 nF 20% 100V plastic foil
C66,C67	NA 109356-3120	120 pF 2% 63V N150 ceramic
C68	NE 165386-3680	680 pF 2.5% 680V polypropylene
C82	NE 765871-5100	10 nF 20% 100V plastic foil
C83	NA 109056-3150	150 pF 63V N750 ceramic
C85	NG 663735-0220	0.22 uF 20% 35V dipped tantalum
C88	NE 765871-5150	15 nF 20% 100V plastic foil
C89	NG 664235-0220	0.22 uF 35 V dipped tantalum

Resistors

Pos	Order number	Description
R1	OD 106555-3820	820 ohm 5% 0.125W carbon film
R2	OD 106555-3560	560 ohm 5% 0.125W carbon film
R3	OD 106555-3470	470 ohm 5% 0.125W carbon film
R4, R9	OD 106555-4680	6.8 kohm 5% 0.125W carbon film
R5	OD 106555-5220	22 kohm 5% 0.125W carbon film
R6	OD 106555-4150	1.5 kohm 5% 0.125W carbon film
R7	OD 106555-1820	8.2 kohm 5% 0.125W carbon film
R8	OD 106555-3330	330 ohm 5% 0.125W carbon film
R10,R11	OD 106555-4100	1 kohm 5% 0.125W carbon film
R12	OD 106555-4220	2.2 kohm 5% 0.125W carbon film
R13	OD 106555-3100	100 ohm 5% 0.125W carbon film
R14	OD 106555-4150	1.5 kohm 5% 0.125W carbon film
R15	OD 106555-5220	22 kohm 5% 0.125W carbon film
R16	OD 106555-4100	1 kohm 5% 0.125W carbon film
R17,R19	OD 106555-4390	3.9 kohm 5% 0.125W carbon film
R18	OD 106555-4100	1 kohm 5% 0.125W carbon film
R20	OD 106555-4100	1 kohm 5% 0.125W carbon film
R21	OD 106555-4330	3.3 kohm 5% 0.125W carbon film
R23	OD 106555-3150	150 ohm 5% 0.125W carbon film
R28	OD 106555-5100	10 kohm 5% 0.125W carbon film
R29	OD 106555-5150	15 kohm 5% 0.125W carbon film
R30	OD 106555-3330	330 ohm 5% 0.125W carbon film
R31	OD 106555-4120	1.2 kohm 5% 0.125W carbon film
R32	OD 106555-3100	100 ohm 5% 0.125W carbon film
R33	OD 106555-4270	2.7 kohm 5% 0.125W carbon film
R34	OD 106555-1100	1 ohm 5% 0.125W carbon film
R35	OD 106555-2220	22 ohm 5% 0.125W carbon film
R41	OD 106555-6120	120 kohm 5% 0.125W carbon film
R42	OD 106555-4180	1.8 kohm 5% 0.125W carbon film
R43	OP 500877-5100	10 kohm 20% 0.75 cermet trimmer
R44	OD 106555-4820	8.2 kohm 5% 0.125W carbon film
R45	OD 106555-5180	18 kohm 5% 0.125W carbon film
R46	OD 106555-5330	33 kohm 5% 0.125W carbon film
R49	OD 106555-4150	1.5 kohm 5% 0.125W carbon film
R50	OD 106555-4150	1.5 kohm 5% 0.125W carbon film
R51	OD 106555-6100	100 kohm 5% 0.125W carbon film
R52	OD 106555-4220	2.2 kohm 5% 0.125W carbon film
R53	OD 106555-6220	220 kohm 5% 0.125W carbon film
R54	OD 106555-5470	47 kohm 5% 0.125W carbon film
R55	OD 106555-6330	330 kohm 5% 0.125W carbon film
R56	OD 106555-5270	27 kohm 5% 0.125W carbon film
R57	OD 106555-6470	470 kohm 5% 0.125W carbon film
R58	OD 106555-3120	120 ohm 5% 0.125W carbon film
R60	OD 106555-3100	100 ohm 5% 0.125W carbon film
R61	OD 106555-5470	47 kohm 5% 0.125W carbon film
R63	OD 106555-3470	470 ohm 5% 0.125W carbon film
R64	OD 106555-4120	1.2 kohm 5% 0.125W carbon film
R65	OD 106555-3220	220 ohm 5% 0.125W carbon film
R66	OD 106555-5270	27 kohm 5% 0.125W carbon film
R67	OD 106555-5820	82 kohm 5% 0.125W carbon film
R68	OD 106555-5150	15 kohm 5% 0.125W carbon film

Semiconductors

Pos	Order number	Description
V1	YD 405074-0001	BFR91 NPN silicon
V2	YD 405004-0001	BF115 NPN silicon
V11	YD 405004-0001	BF115 NPN silicon
V12	YD 405004-0001	BF115 NPN silicon
V13	YD 405004-0001	BF115 NPN silicon
V24	YA 405000-0003	BC107B NPN silicon
V15	VC 602362-0001	1N4148 silicon planar
V16	VC 602362-0001	1N4148 silicon planar
Z1	TA 503013-3120	TBA120S, FM IF amplifier
Z2	TA 503011-4810	TBA810S, AF-Power amplifier
Z3	TA 503017-2301	3301/3401, Quad OP.-amplifier
U8	SJ 1000001-0001	Double balanced mixer

Inductances

Pos	Order number	Description
L1	PB 105003-0003	0.15 uH 10% with phenol corea
L2	PB 105003-0017	2.2 uH 10% with iron core
L3	PB 105003-0007	0.33 uH 10% with phenol core
U1	RR-180260	Helical filter
U4	RR-163200/168	
U5	PC 550000-0002	1300 uH
U6	PC 550000-0002	1300 uH
U7	PC 550000-0001	170 uH

Miscellaneous

Pos	Order number	Description
P1	BP 500103-0003	10-pol.connector for circuit board
X1	SB 700018-0001	Crystal filter 21.4 MHz, B=±7.5 kHz
Y1	PP464-20,94500	Crystal 20.94500 MHz
Y1	PP464-21,85500	Crystal 21.855 MHz
	RR-170024	Isolator for C6, C9, C11, C14
	CH 221003-0001	Screen box for C6, C9, C11, C14
	BC 111004-0001	Connector socketfor Y1
	RR-161594	Cover for Y1
	RR-184295	Screen box
	PJ 764004-0032	Core for U4

Frequency generator

Capacitors

Pos	Order number	Description			
C3	NA 156140-3470	Ceramic	470 pF	-20+80%	40V
C4	NF 775356-6330	Met. polyester	330 nF	20%	63V
C7	NG 663710-3100	Dipped tantalum	100 uF	20%	10V
C9	NG 663725-2100	Dipped tantalum	10 uF	20%	35V
C10	NA 109356-2120	Ceramic N 150	12 pF	2%	63V
C11	NA 109356-2680	Ceramic N150	68 pF	2%	63V
C12	NK 150011-5100	Chip ceramic	10 nF	20%	50V
C13	NK 150011-5100	Chip ceramic	10 nF	20%	50V
C15	NK 150011-5100	Chip ceramic	10 nF	20%	50V
C16	NA 156140-4220	Ceramic	2.2 nF	-20+80%	40V
C17	NA 156140-3470	Ceramic	470 pF	-20+80%	40V

Resistors

Pos	Order number	Description			
R4	OD 106555-5680	Carbon film	68 kohm	5%	0.125W
R5	OD 106555-5820	Carbon film	82 kohm	5%	0.125W
R6	OD 106555-3100	Carbon film	100 ohm	5%	0.125W
R8	OD 106555-4330	Carbon film	3.3 kohm	5%	0.125W
R10	OD 106555-6390	Carbon film	390 kohm	5%	0.125W
R11	OD 106555-6390	Carbon film	390 kohm	5%	0.125W
R7	OD 106555-5180	Carbon film	18 kohm	5%	0.125W
R16	OD 106555-5180	Carbon film	18 kohm	5%	0.125W
R9	OD 106555-6330	Carbon film	330 kohm	5%	0.125W
R12	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R21	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R14	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R15	OD 106555-6100	Carbon film	100 kohm	5%	0.125W
R17	OD 106555-4180	Carbon film	1.8 kohm	5%	0.125W
R18	OD 106555-3220	Carbon film	220 ohm	5%	0.125W
R20	OD 106555-5330	Carbon film	33 kohm	5%	0.125W
Z9	OL 150066-6100	Res. Net. w.	8x100 kohm	10%	

Semiconductors

Pos	Order number	Description	
V3	VC 602362-0001	Silicon diode	1N4148
Z1	XTA160005-2068	Integrated circuit	14568
Z2	TA 160008-2069	Integrated circuit	4069 B
Z3	XTA160005-2069	Integrated circuit	14569

Hybrid circuits

Pos	Order number	Description
Z5	RR-184908	Function block start circuit
Z6	RR-178951/2	Loop filter
Z7	RR-178950/7	Mixer
Z8	RR-178951/3	Channel oscillator

Inductances

Pos	Order number	Description		
L1	PB 105003-0001	Choke with phenolic core	0.1 uH	10%
L3	PB 105003-0013	Choke with phelolic core	1.0 uH	10%
L4	PB 105003-0037	Choke with ferrite core	100 uH	10%
L2	PB 105003-0021	Choke with iron core	4.7 uH	10%

Miscellaneous

Pos	Order number	Description	
P1	BP 500103-0001	Terminal strip	5 poles
P2	BP 500103-0004	Terminal strip	11 poles
Y1	PP403-3200,000	Crystal unit	
	BA 203004-0001	Terminal stud	
	RR-165916	Teflon washer	

Regulator

Capacitors

Pos	Order number	Description			
C1	NG 103525-4100	Electrolytic, al.	1000 uF	-10+50%	25V
C2	NG 661925-1100	Dipped tantalum	1 uF	-20+50%	25V
C3	NG 663716-2150	Dipped tantalum	15 uF	20%	16V
C4	NA 158456-4100	Ceramic	1 nF	10%	63V
C5	NA 158456-4100	Ceramic	1 nF	10%	63V
C6	NA 158456-4100	Ceramic	1 nF	10%	63V
C7	NF 775371-5680	Met. poly.	68 nF	20%	100V
C8	NA 158456-3470	Ceramic,	470 pF	10%	63V

Resistors

Pos	Order number	Description			
R1	OD 106555-4100	Carbon film	1.0 kohm	5%	0.125W
R2	OD 105355-3820	Carbon film	820 ohm	5%	0.125W
R3	OD 106555-3470	Carbon film	470 ohm	5%	0.125W
R4	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R5	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R6	OD 106555-5120	Carbon film	12 kohm	5%	0.125W
R7	Selected	Carbon film	27-100 kΩ	5%	0.125W
R8	OD 106555-5220	Carbon film	22 kohm	5%	0.125W
R9	OD 106555-4470	Carbon film	4.7 kohm	5%	0.125W
R11	OD 105355-3330	Carbon film	330 ohm	5%	0.5W
R10	OD 106555-4180	Carbon film	1.8 kohm	5%	0.125W
R12	OD 106555-4180	Carbon film	1.8 kohm	5%	0.125W
R13	OD 106555-4100	Carbon film	1.0 kohm	5%	0.125W
R14	OD 106555-6100	Carbon film	100 kohm	5%	0.125W
R15	OD 106555-5100	Carbon film	10 kohm	5%	0.125W
R16	OD 106555-5390	Carbon film	39 kohm	5%	0.125W

Semiconductors

Pos	Order number	Description	
V1	XYE400012-0001	PNP	BD 436
V2	YD 400014-0012	Silicon PNP	BC178B
V6	YD 400014-0012	Silicon PNP	BC178B
V7	YD 400014-0012	Silicon PNP	BC178B
V3	YA 405000-0004	Silicon NPN	BC 108B
V4	YA 405000-0004	Silicon NPN	BC 108B
V8	YD 400015-0051	Silicon PNP	2N2907A
V5	VL 100604-0002	Zener diode	1N750A
V9	VC 602362-0001	Silicon	1N4148
V10	VC 602362-0001	Silicon	1N4148

Miscellaneous

Pos	Order number	Description	
K1	HR 105018-0012	Relay	
P1	BP 500103-0010	Terminal strip for p.c.board	8 poles
	BA 203004-0001	Terminal stud	E 413

Logic board

Capacitors

Pos	Order number		Description
C1	NG 663716-2100	10 uF	±20% 16 V tantalum
C2	NG 663735-0330	0,33 uF	±20% 35 V tantalum
C3	NG 663716-1470	4,7 uF	±20% 16 V tantalum
C4	NG 663716-1470	4,7 uF	±20% 16 V tantalum
C12	XNF775656-6100	100 nF	±20% 63 V polyester
C13	XNF775656-6100	100 nF	±20% 63 V polyester
C15	NA 109356-2470	47 pF N150	±2% 63 V ceramic
C22	NG 663710-2330	33 uF	±20% 10 V tantalum
C24	NG 663716-1470	4,7 uF	±20% 16 V tantalum
C25	NG 663735-0330	0,33 uF	±20% 35 V tantalum
C27	NG 663735-1100	1 uF	±20% 35 V tantalum
C28	NE 165377-4390	3,9 nF	±2,5% 160 V polyprop.
C29	NG 663735-0330	0,33 uF	±20% 35 V tantalum
C30	NE 165377-4150	1,5 nF	±2,5% 160 V polyprop.
C31	NG 663716-2330	33 uF	±20% 10 V tantalum
C32	NE 165377-4220	2,2 nF	±2,5% 160 V polyprop.
C34	NE 765871-5150	15 nF	±20% 100 V polyester f.
C35	NE 765871-4680	6,8 nF	±20% 100 polyester f.
C36	NG 103516-3220	220 uF	-10+100% 16 V el.lyte
C37	NG 663735-0330	0,33 uF	±20% 35 V tantalum

Resistors

Pos	Order number		Description
R1	OD 106555-1680	6,8 ohm	±5% 0,125 W carb f.
R2	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R3	OD 106555-4470	4,7 kohm	±5% 0,125 W carb f.
R4	OF 401166-7100	1 Mohm	±10% 0,25 W comp
R5	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R6	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R11	OD 106555-3820	820 ohm	±5% 0,125 W carb f.
R24	OD 106555-4470	4,7 kohm	±5% 0,125 W carb f.
R25	OD 106555-5330	33 kohm	±5% 0,125 W carb f.
R27	OD 106555-5220	22 kohm	±5% 0,125 W carb f.
R28	OD 106555-5150	15 kohm	±5% 0,125 W carb f.
R29	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R30	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R31	OD 106555-4220	2,2 kohm	±5% 0,125 W carb f.
R32	OD 106555-4100	1 kohm	±5% 0,125 W carb f.
R33	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R34	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R35	OD 106555-4470	4,7 kohm	±5% 0,125 W carb f.
R36	OD 501033-4562	5.62 kohm	±1% 0,4 W metal film
R37	OD 106555-4470	4,7 kohm	±5% 0,125 W carb f.
R38	OD 106555-4470	4,7 kohm	±5% 0,125 W carb f.
R39	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R40	OD 501033-5178	17,8 kohm	±1% 0,125 W metal film
R41	OD 106555-5220	22 kohm	±5% 0,125 W carb f.
R42	OD 106555-5120	12 kohm	±5% 0,125 W carb f.
R43	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R44	OD 106555-6330	330 kohm	±5% 0,125 W carb f.
R46	OD 106555-5330	33 kohm	±5% 0,125 W carb f.
R47	OD 106555-6220	220 kohm	±5% 0,125 W carb f.
R48	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R49	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R50	OD 106555-5220	22 kohm	±5% 0,125 W carb f.
R51	OD 106555-6180	180 kohm	±5% 0,125 W carb f.
R52	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R53	OD 106555-6180	180 kohm	±5% 0,125 W carb f.
R54	OD 106555-5470	47 kohm	±5% 0,125 W carb f.
R55	OD 106555-6680	680 kohm	±5% 0,125 W carb f.
R56	OJ 130003-3330	330 ohm	20% Thermistor
R57	OD 106555-3270	270 kohm	±5% 0,125 W carb f.
R58	OD 106555-5270	22 kohm	±5% 0,125 W carb f.
Z3	OL 150066-5470	8x47 kohm	±10% 0,125 W 9-pin SIL
Z13	OL 150066-5220	8x22 kohm	±10% 0,125 W 9-pin SIL
Z30	OL 150066-5220	8x22 kohm	±10% 0,125 W 9-pin SIL

Semiconductors

Pos	Order number		Description
Z1	TA 350002-2852	CDP1852	1/0-port
Z2	TA 160008-2053	4053 BE	Multiplexer
Z4	TA 160008-2050	4050 B	Buffer/converter
Z5	TA 160008-2050	4050 B	Buffer/converter
Z6	TA 509005-2004	2004	Buffer inv
Z7	TA 160008-2011	4011 B	Nand gates
Z8	TA 160008-2069	4069	Inv
Z9	TA 350002-2802	CDP1802	CPU
Z10	TA 262002-2823	CDP 1823	ROM
Z11	TA 350002-2852	CDP1852	1/0 port
Z12	TA 160008-2103	40103 B	Counter
Z14	TA 160008-2109	40109 B	Volt level shift
Z15	TA 160008-2099	4099 B	Addressable latch
Z16	TA 262002-2823	CDP 1823	ROM
Z17	TA 160008-2099	4099 B	Addressable latch
Z20	TA 160008-2007	CD4007 B	Complementary pair
Z21	TA 160008-2066	4066 B	Bilateral switch
Z22	TA 500010-2324	LM 324	OP-amplifier
Z23	TA 160008-2069	CD4069 B	Inverter
Z24	TA 160008-2011	4011 B	Nand gates
Z31	TA 160008-2081	4081 B	AND gates
Z32	TA 160008-2081	4081 B	AND gates
V1	VC 602362-0001	1N4148	0,115 W silicon
V2	VC 602362-0001	1N4148	0,115 W silicon
V10	VL 103704-0002	BZX 55C4V7	4,7 V zener Diode
V23	VC 602362-0001	1N4148	0,115 W silicon
V24	VC 602362-0001	1N4148	0,115 W silicon
V25	VC 602362-0001	1N4148	0,115 W silicon

Miscellaneous

Pos	Order number		Description
X1	RA 120012-0001	3,6 V	Ackumulator-kit
Y1	PP471-4194,304	4,194304 Mhz	Chrystal
	RR-174123	End Block	
	RR-174124	Support	
	RR-186897	Cable	
	HH 340001-0018	40-PIN	DIL Holder
	HH 340001-0013	16-PIN	DIL Holder

Control board

Capacitors

Pos	Order number		Description
C1	NG 103516-3220	220 uF	-10 + 100% 16 V El.lyte
C2	NG 103516-3220	220 uF	-10 + 100% 16 V El.lyte
C4	NG 663716-1470	4,7 uF	±20% 16 V tantalum
C15	NA 158456-4100	1 nF	±10% 63 V ceramic

Resistors

Pos	Order number		Description
R1	OD 106555-2100	10 ohm	±5% 0,125 W carb f.
R3	OD 106555-3390	390 ohm	±5% 0,125 W carb f.
R6	OD 106555-3270	270 ohm	±5% 0,125 W carb f.
R7	OD 106555-5220	22 kohm	±5% 0,125 W carb f.

Semiconductors

Pos	Order number	Description	
V7	YA 504000-0003	BC 107B	TO18 0,3 W npn silicon
V3	VL 100609-0001	1N757A	Zener
V12	VC 602362-0001	1N4148	0,115 W silicon
V13	VC 602362-0001	1N4148	0,115 W silicon
V14	VC 602362-0001	1N4148	0,115 W silicon
V15	VL 103705-0002	BZX55C-5V6	Zener
Z1	TA 509005-2004	2004 A	Buffer inv.
Z2	TA 160008-2051	CD 4051B	Multiplexer
Z3	TA 160008-2050	CD 4050B	Buffer/convert
Z4	TA 160008-2050	CD 4050B	Buffer/convert

Miscellaneous

Pos	Order number	Description
RR-186975	Light shielding Gasket	
	RR-186898/3	Insulating sheet
J1	HB 100032-0002	Code Memory Holder 16-poles connector
S1-S19	RMD 94312/01	2-pole, non-locking switch
V1,2,4, 5,6,8,11	RC 170003-0002	5 V 60 mA lamp

PROM board

Capacitors

Pos	Order number		Description
C1	NA 155412-6100	0,1 uF	-20+80% 12 V ceram.
C2	NG 663716-2100	10 uF	±20% 16 V tantalum
C3	NG 663716-1470	4,7 uF	±20% 16 V tantalum
C4	NG 661935-1100	1 uF	-20+50% 35V tantal.
C5	NA 157671-3470	470 pF	±10% 100V ceramic

Resistors

Pos	Order number		Description
R1	OD 106555-5100	10 kohm	±5% 0,125 W carb f.
R2	OD 106555-2100	10 ohm	±5% 0,125 W carb f.
R3	OD 106555-2100	10 ohm	±5% 0,125 W carb f.

Diodes

Pos	Order number		Description
V1	VC 602362-0001	1N4148	0,115 W silicon
V2	VC 602362-0001	1N4148	0,115 W silicon
V3	VC 602362-0001	1N4148	0,115 W silicon
Z3	TA 505002-2109	LM 309H	OP-amp
Z4	TA 350002-2852	CDP1852	1/0 Gate
Z5	TA 160008-2049	CD4049B	Inv buffer/conv.
Z6	TA 160008-2050	CD4050B	Buffer/converter
Z7	TA 160008-2109	CD40109B	Volt level shift
Z8	TA 160008-2109	CD40109B	Volt level shift
Z9	TA 160008-2050	CD4050B	Buffer/converter
Z81	**	PROM	
Z82	**	PROM	

**) State no of E order

Miscellaneous

	Order number	Description	
	HH 340001-0015	DIL Holder, 24-pin	for PROM
	BF 100000-0002	Flexcable, 12-w.	L=64
	BF 100000-0004	Flexcable, 12-w.	L=76
	AH 190102-0002	Spacer TO5	for pos Z3

Display board

Capacitors

Pos	Order number		Description
C7-C14	XNA158371-4470	4,7 nF	-20+50% 100 V ceramic

Resistors

Pos	Order number		Description
R9-R15	OD 106555-2820	82 ohm	±5% 0,125 W carb f.
R16	OD 106555-2470	47 ohm	±5% 0,125 W carb f.
R17-R24	OD 106555-4120	1.2 kohm	±5% 0,125 W carb f.

Semiconductors

Pos	Order number		Description
V12-V19	XYD 405049-0001	BC 238B	T092 0,3 W npn silicon
V20-V24	XVM100012-0001	ESBR 3401	L E D Red
V25	XVM100013-0001	SPY 3431	L E D Yellow
V26	XVM100012-0001	ESBR 3401	L E D Red
Z5-Z11	TM 100006-0001	5082-7613	7-segm., Red, display

Miscellaneous

Pos	Order number	Description
	RR-184277	Light shield
	RR-184141	Holder for terminal strip P1
P1	BP 500102-0002	Terminal strip, 20-poles, male connector

Bridgin board

Capacitors

Pos	Order number	Description		
C1	NF 775371-5470	Metallized polyester	47nF	20% 100V
C2	NF 775371-5470	Metallized polyester	47nF	20% 100V
C3, C7	NG 663716-1470	Dipped tantalum	4.7uF	20% 16V
C4, C9	NF 775356-6220	Metallized polyester	220nF	20% 63V
C5	NF 775371-6100	Metallized polyester	100nF	20% 100V
C6	NG 663716-2100	Dipped tantalum	10uF	20% 16V
C8	NE 765871-4100	Polyester foil	1 nF	20% 100V

Resistors

Pos	Order Number	Description			
R1, R17	OD 106555-6100	Carbon film	100kohm	5%	0.125W
R2	OD 106555-5120	Carbon film	12kohm	5%	0.125W
R3, R7	OD 106555-5820	Carbon film	82kohm	5%	0.125W
R4, R15,	OD 106555-4470	Carbon film	4.7kohm	5%	0.125W
R16	OD 106555-4470	Carbon film	4.7kohm	5%	0.125W
R5	OD 106555-3390	Carbon film	390 ohm	5%	0.125W
R6	OD 106555-5330	Carbon film	33kohm	5%	0.125W
R8	OD 106555-3180	Carbon film	180 ohm	5%	0.125W
R9	OD 106555-3100	Carbon film	100 ohm	5%	0.125W
R10	OD 106555-4560	Carbon film	5.6kohm	5%	0.125W
R11	OD 106555-4220	Carbon film	2.2kohm	5%	0.125W
R13, R23	OD 106555-4100	Carbon film	1.0kohm	5%	0.125W
R14	OD 106555-3220	Carbon film	220 ohm	5%	0.125W
R18	Selected	Carb.film,	220-330 Ω	5%	0.125W
R19	OD 106555-4270	Carbon film	2.7kohm	5%	0.125W
R22	OD 106555-5330	Carbon film	33kohm	5%	0.125W
R20	OP 500877-4470	Cermet pot.	4.7kohm	20%	0.75W

Semiconductors

Pos	Order number	Description
Z1	TA 160008-2011	401B (CMOS 4000B-Series)
Z2	TA 160008-2011	4011B
Z3	TA 160008-2053	4053B
Z5	RR-178950/5	Microphone amplifier
Z6	XTA505003-1808	uA 7808
Z7	TA 505004-4741	uA 741,Op. Amp.
V2	YA 405000-0004	Transistor BC 108B, NPN silicon

Connectors

Pos	Order number	Description
P1	BP 500100-0002	P.C Terminal block 16-poles

Interconnection unit for cipher

Pos	Order number	Description
J1	XHB100040-0116	Connector socket, 16 poles
R1	OD 106555-4150	Resistor, 1.5 kohm 5% carbon film
R2	OD 106555-3120	Resistor, 120 ohm 5% carbon film
R3	OD 106555-5680	Resistor, 68 kohm 5% carbon film
R4	OD 106555-5680	Resistor, 68 kohm 5% carbon film
Z1	TA 160008-2011	Integrated Circuit, 4011B
10	HB 900014-0001	Connector with cable

Connection unit

Pos	Order number	Description
F1	RD 100006-0001	Fuse 6.3A Super rapid action 5x20 mm
P1	BP 500103-0003	Terminal strip for PC board, 10 poles
P2	BP 500103-0008	Terminal strip for PC board, 3 poles
P3	BP 500103-0009	Terminal strip for PC board, 6 poles
V1	VL 104818-0001	Diode PFZ 18A Tranzil
	RR-187013/4	Cover
	CL 110007-0002	Snap lock CAP
	CL 110007-0012	Snap lock PLUG
	HH 700015-0001	Fuse holder
		Two-piece type for PC-board
	RR-187013/3	Cover (2 holes)

Interconnection unit

Pos	Order number	Description
J1	HB 100032-0004	Edge connector 2x17 poles
P1	BP 500103-0003	Terminal strip 10 poles
P2	BP 500103-0010	Terminal strip 8 poles
	RR-182872	Flex cable w. 8 pol. connector
	RR-177396	Spacer
	RR-181482	Flex cable w. 10 pol. connector
	RR-181486	Flex cable w. 5 pol. connector
	RR-181486/2	Flex cable w. 11 pol. connector
	RR-181484	Flex cable w. 10 pol. connector

Microtelephone with holder

Order number	Description
RR-193299	Micro telephone, with cable
RMD 94301	Switch
RLD 51814 R2A	Telephone receiver
8606077/010	Cover
RR-209322	Telephone cable
CA 123502-0008	Tie Strap
RR-193325/2	Microphone Holder, complete
RR-190275/2	Cover, beige colour
RR-190063	Bottom
RR-195844/2	Speaker Cable
RR-193401/2	Connector unit cable

Interface board

Resistors

Pos	Order number	Description
R1	OD 106555-3680	680 ohm, 0.125W 5% Carbon film
R10	OD 106555-6330	330 kohm, 0.125W 5% Carbon film
R11	OD 106555-4470	4.7 kohm
R12	OD 106555-4100	1.0 kohm
R15	OD 106555-6100	100 kohm
R16	OD 106555-5470	47 kohm
R17	OD 106555-5470	47 kohm
R18	OD 106555-5120	12 kohm
R19	OD 106555-5220	22 kohm
R2	OP 502066-3200	--
R20	OD 106555-6220	220 kohm
R22	OP 502066-5100	Variable 10 kohm, 10%, Linear
R23	OP 502066-5100	Variable 10 kohm, 10%, Linear
R24	OD 106555-5220	22 kohm
R25	OD 106555-5470	47 kohm
R26	OD 106555-4470	4.7 kohm
R27	OD 106555-3150	150 kohm
R28	OD 106555-5220	22 kohm
R29	OD 106555-6100	100 kohm
R30	OD 106555-4100	1.0 kohm
R31	OD 106555-4470	4.7 kohm
R32	OD 106555-5120	12 kohm
R33	OD 106555-5120	12 kohm
R34	OD 106555-6330	330 kohm, 0.125W 5% Carbon film
R4	OD 106555-5120	12 kohm
R6	OP 502066-4500	Variable 5 kohm, 10%, Linear
R7	OD 106555-5470	47 kohm
R8	OD 106555-5470	47 kohm
R9	OD 106555-5120	12 kohm

Capacitors

Pos	Order number	Description
C1	NF 775071-7220	2.2uF, 20%, 100V, Met.plast.foil
C10	NF 775071-7220	2.2uF, 20%, 100V, Met.plast.foil
C11	NF 775656-6470	470nF,20%, 63V, Met.poly.foil
C12	NG 663716-2680	68uF, 20%, 16V, Tant.elec.
C13	NF 775656-6100	100nF, 20%, 63V, Met.plast.foil
C14	NF 775656-6100	100nF, 20%, 63V, Met.plast.foil
C15	NG 663735-2150	15uF, 20%, 35V, Tantalum
C16	NG 663710-2100	10uF, 20%, 10V, Tantalum
C17	NG 663710-2100	10uF, 20%, 10V, Tantalum
C18	NF 775656-6100	100nF, 20%, 63V, Met.plat.foil
C19	NG 663735-1100	100nF, 20%, 63V, Met.plat.foil
C2	NF 775656-6100	100nF, 20%, 63V, Met.plat.foil
C3	NF 775656-6100	100nF, 20%, 63V, Met.plat.foil
C4	NG 663710-3100	100uF, 20%, 10V, Tantalum
C5	NG 663735-1100	1.0uF, 20%, 35V, Tantalum
C6	NF 775656-6100	100nF, 20%, 63V, Met.plat.foil
C7	NG 663710-3100	100uF, 20%, 10V, Tantalum
C8	NG 663710-2100	10uF, 20%, 10V, Tantalum
C9	NG 663735-1100	1.0uF, 20%, 35V, Tantalum

Semiconductors

Pos	Order number	Description
V2	XYD405049	--
V3	VC 602362-0001	1N4148 Silicon
V4	VC 602362-0001	1N4148 Silicon
V5	BC338	Transistor
Z1	TA 500010-2324	LM324
Z2	TA 500010-2324	LM324
Z3	TA 160008-2066	CD4066B
Z4	XTA505007-2808	LM78L08

Miscellaneous

Pos	Order number	Description
	RD 196001-0001	Fuse
	HH 777004-0001	Fuse holder
J11	RR-208059	4-wire
J31	RR-208060	For taperecorder
J61	RR-208058	Cable
P1	BP 500103-0020	4-pole for circuit board
P2A	BP 500103-0003	10-pole for circuit board
P2B	BP 500103-0009	6-pole for circuit board
P3	BP 500103-0020	4-pole for circuit board
P41	RR-208108	Cable
T1	RR-127670/20	Ferrite
T2	RR-127670/20	Ferrite

Complete units

Order number	Description
RR-181700/3	Loudspeaker
RR-193408	Mounting plate
RB 100317-0001	Antenna
RR-193289	Antenna cable
RR-193286	Microtelephone with holder
RR-193400	Connection unit with cable
RR-193380	Interconnection unit for cipher
RR-193390	Bridging unit
RR-184604	Display board
RR-184922	Frequency generator board
RR-178154	VCO
RR-193271	Crystal unit
RR-193266	Transmitter board

11. Block diagram, circuit diagrams and component layouts

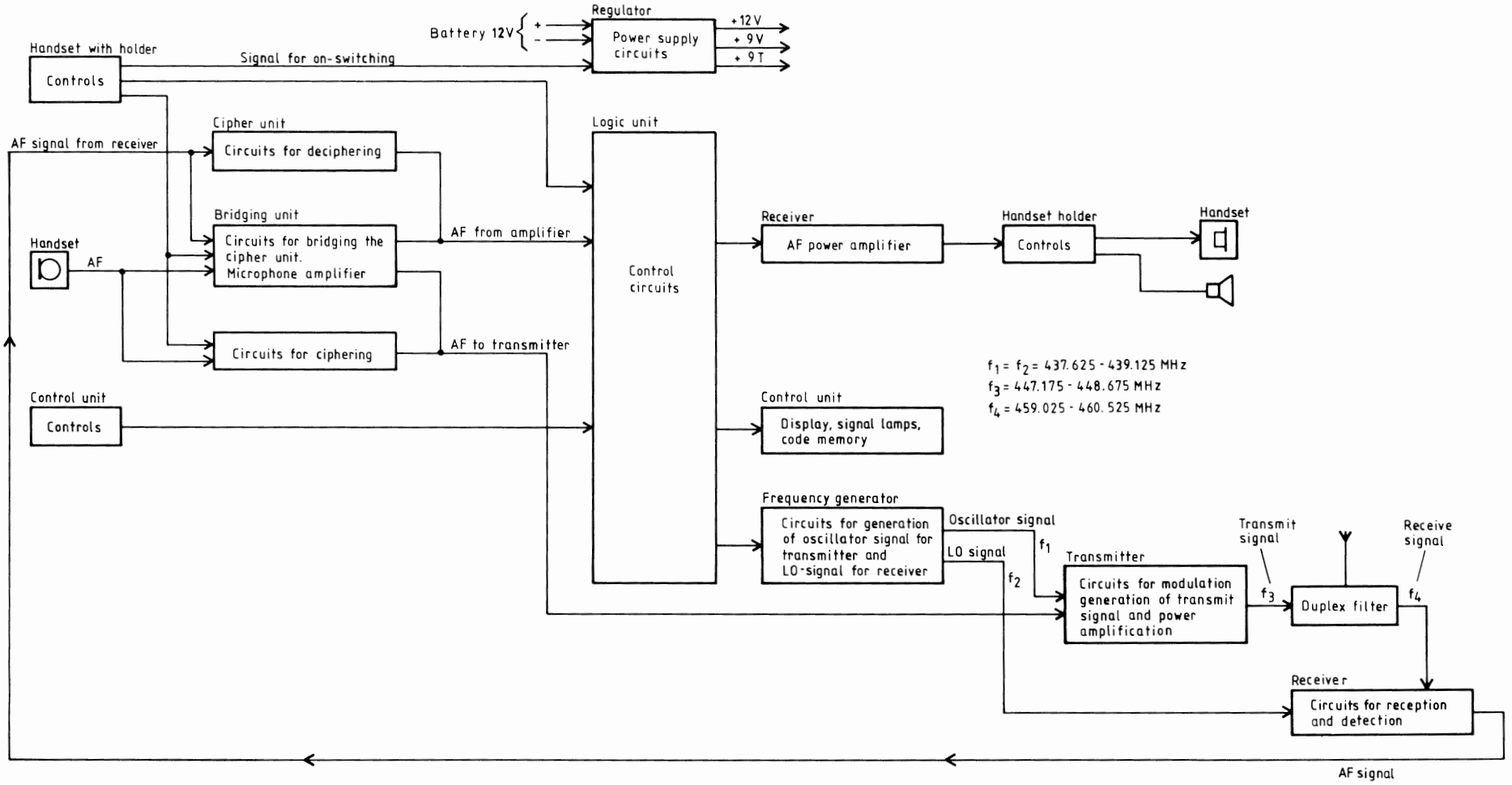


Fig 11.1. Block diagram

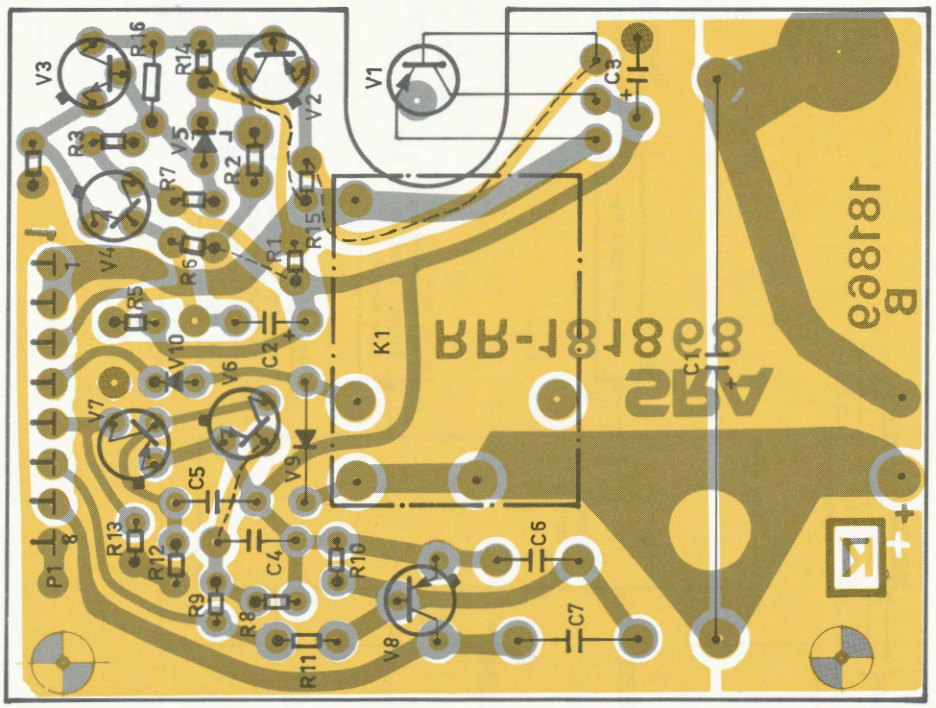


Fig 11.2. Regulator, component layout

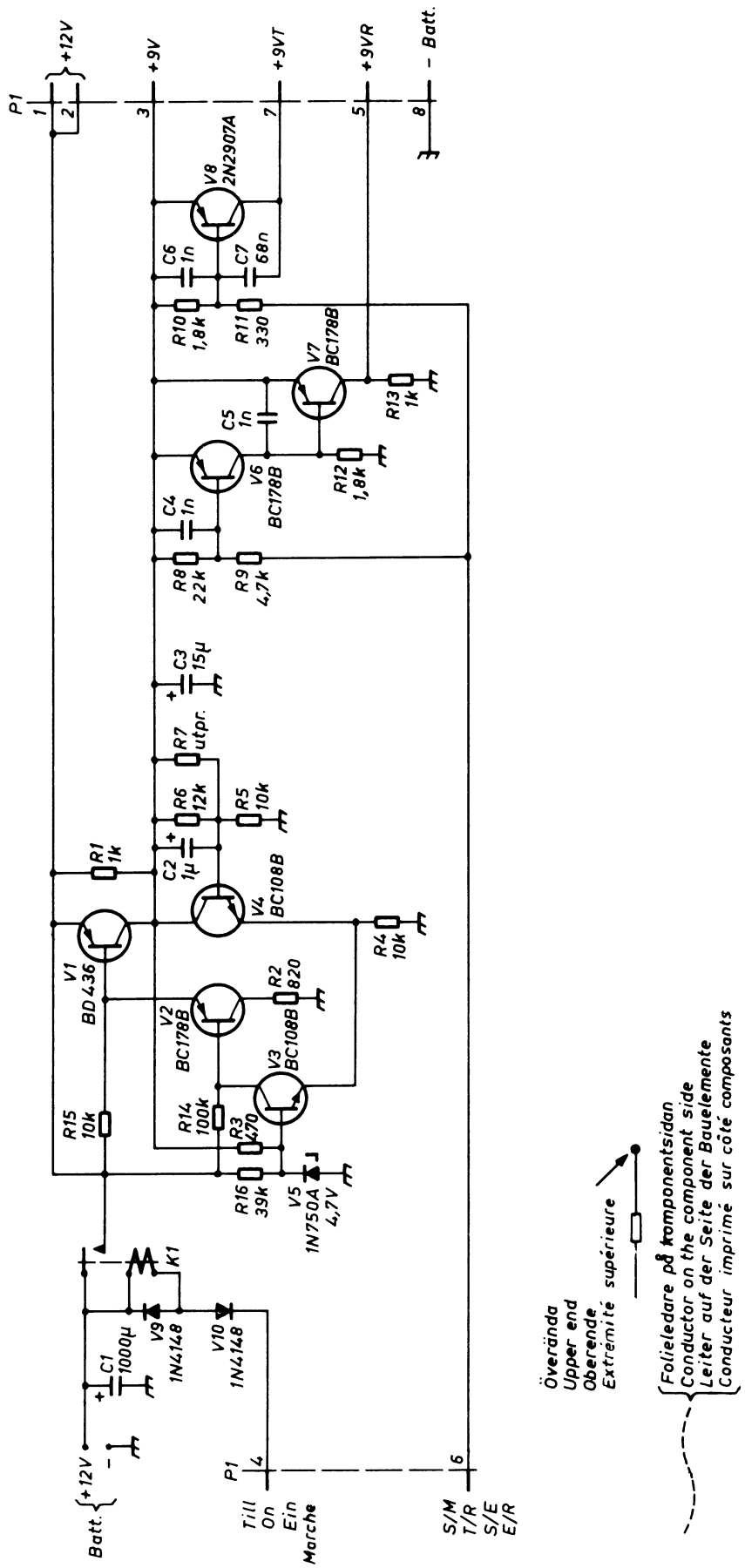


Fig 11.3. Regulator, circuit diagram

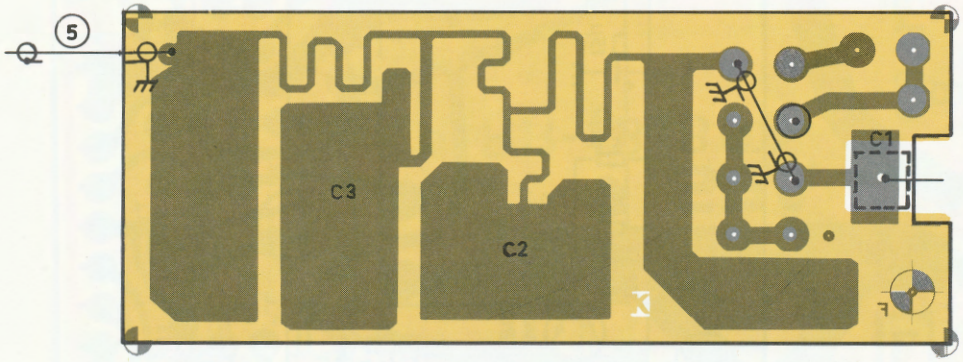


Fig 11.4. Antenna filter, component layout

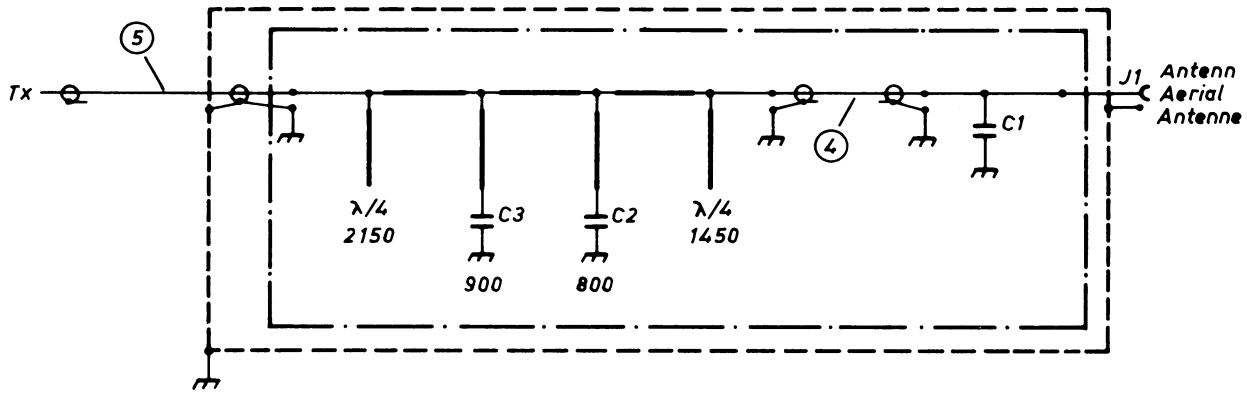


Fig 11.5. Antenna filter, circuit diagram

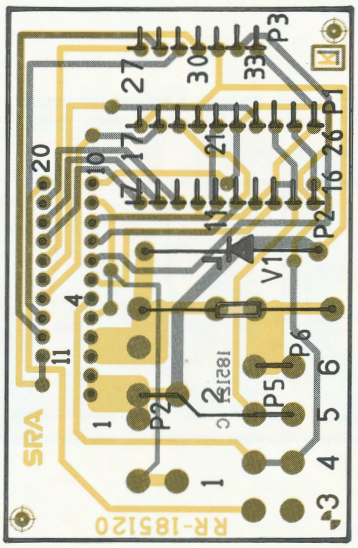


Fig 11.6. Connector board for dc and radio, component layout

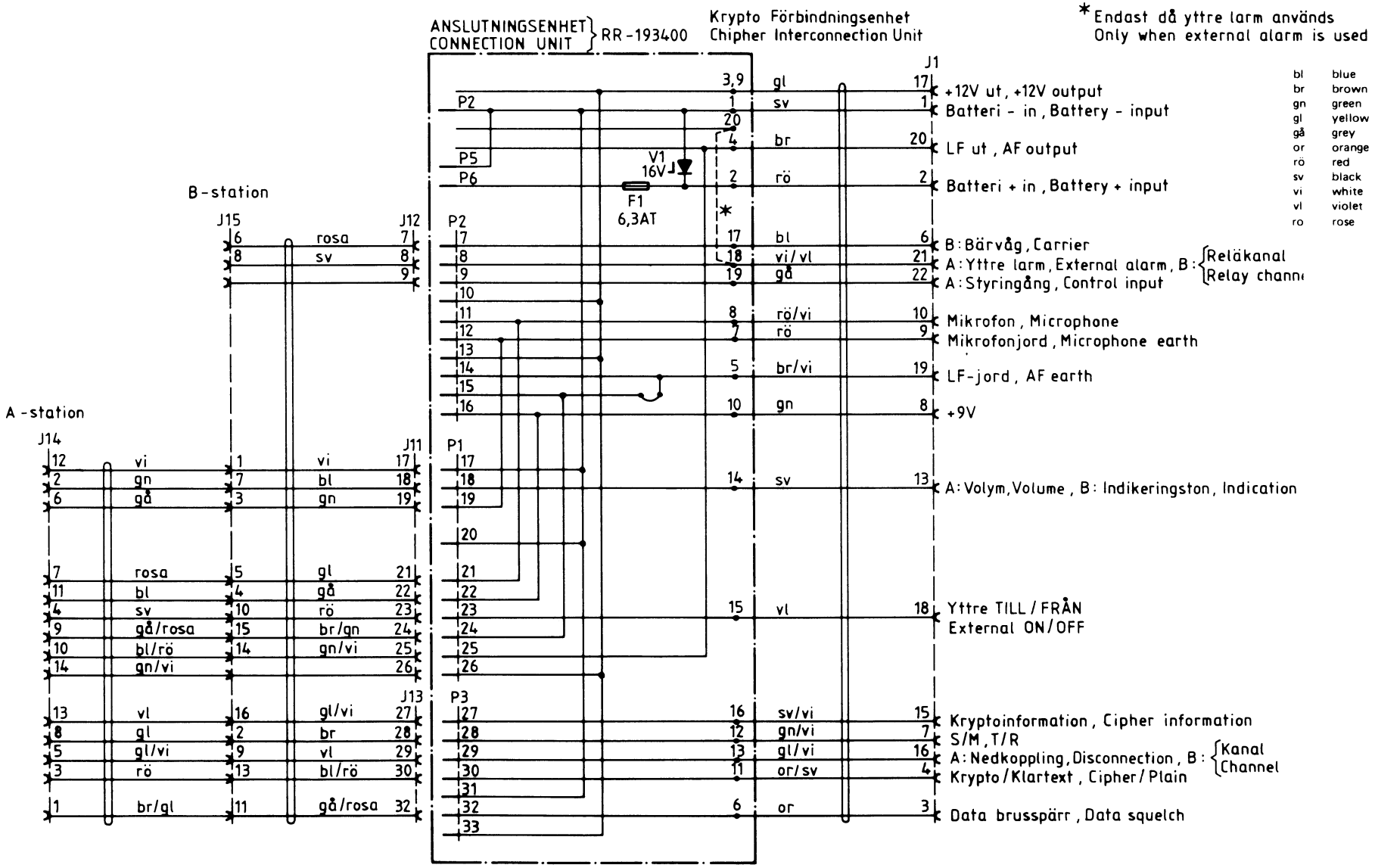


Fig 11.7. Connector board for dc and radio, circuit diagram

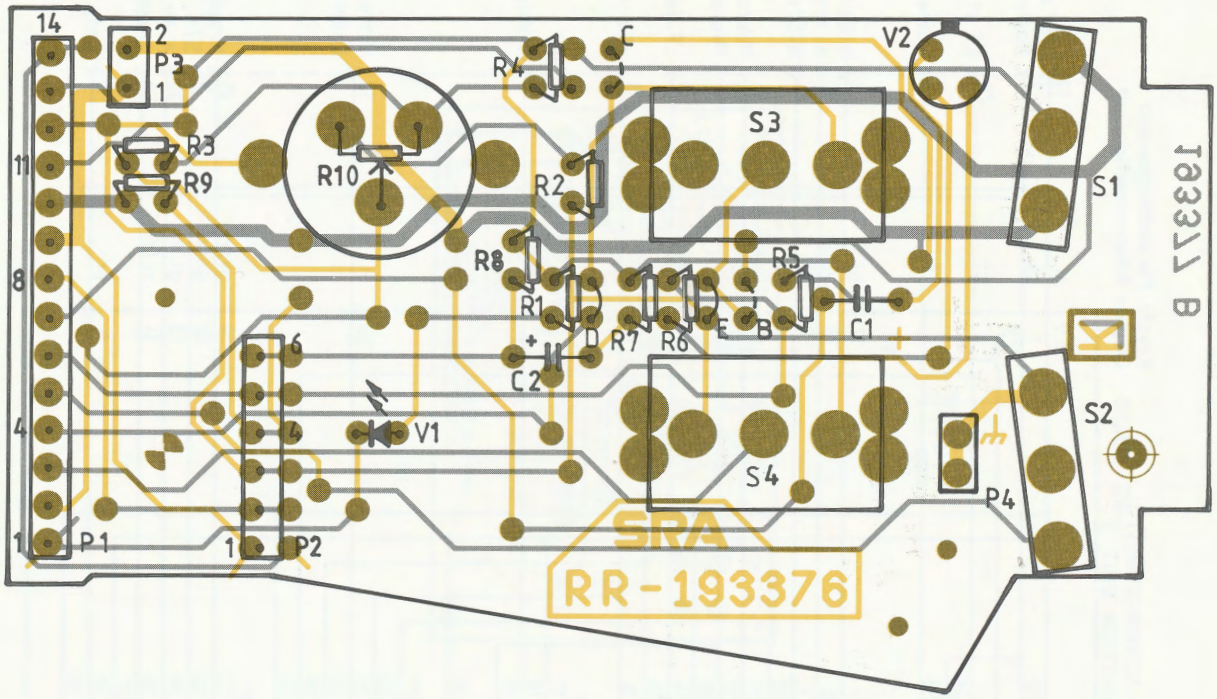
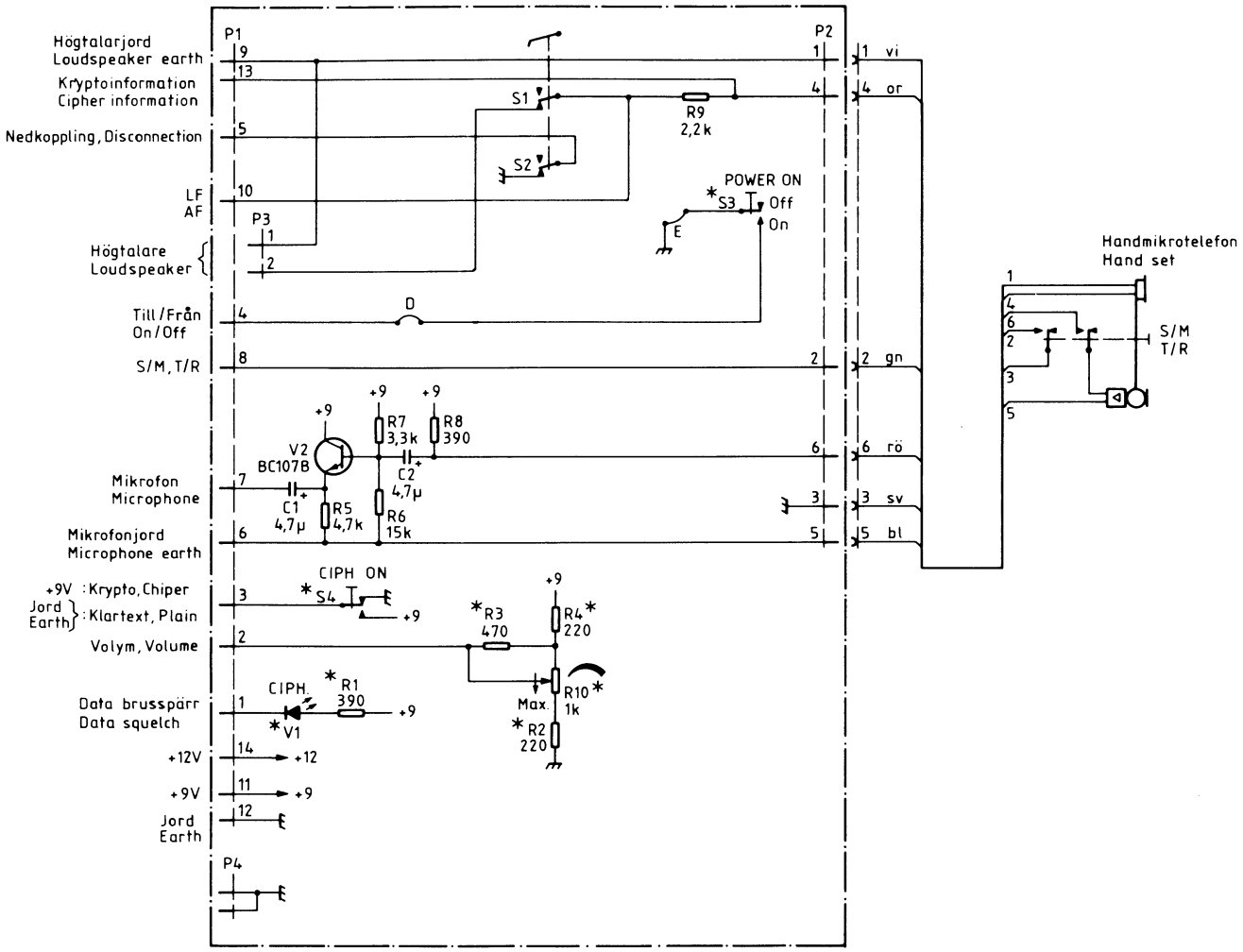


Fig 11.8. *Connector board for loudspeaker and handset, component layout*



* {Endast för C-605 A / Only for C-605 A

C-605 A : D, E
C-605 A/B : D, E

bl	blue
br	brown
gn	green
gl	yellow
gå	grey
or	orange
ro	red
sv	black
vi	white
vl	violet
ro	rose

Fig 11.9. Connector board for loudspeaker and handset, circuit diagram

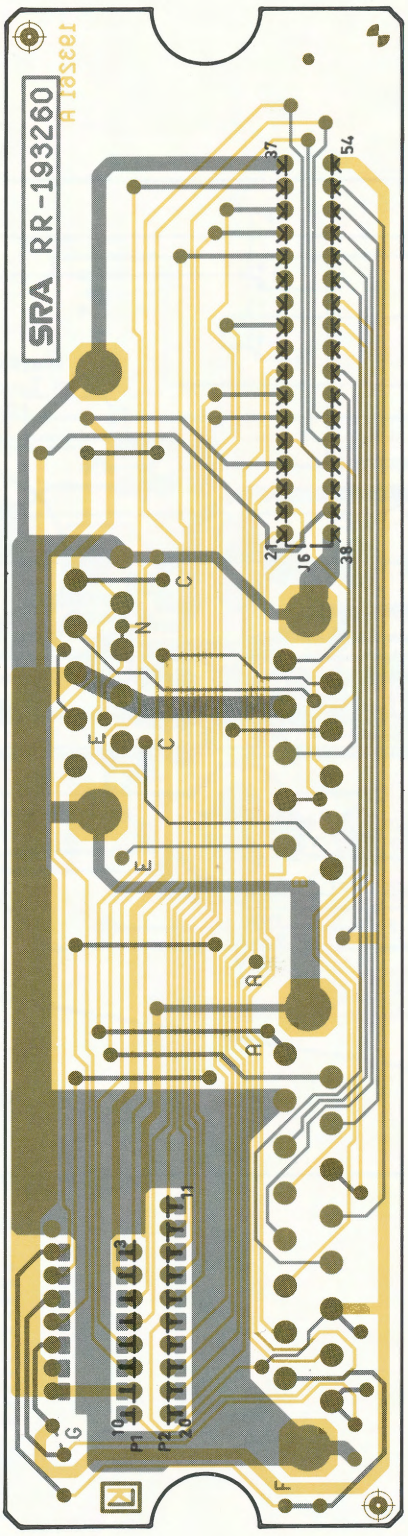


Fig 11.10. Connector board for radio and logic boards, component layout

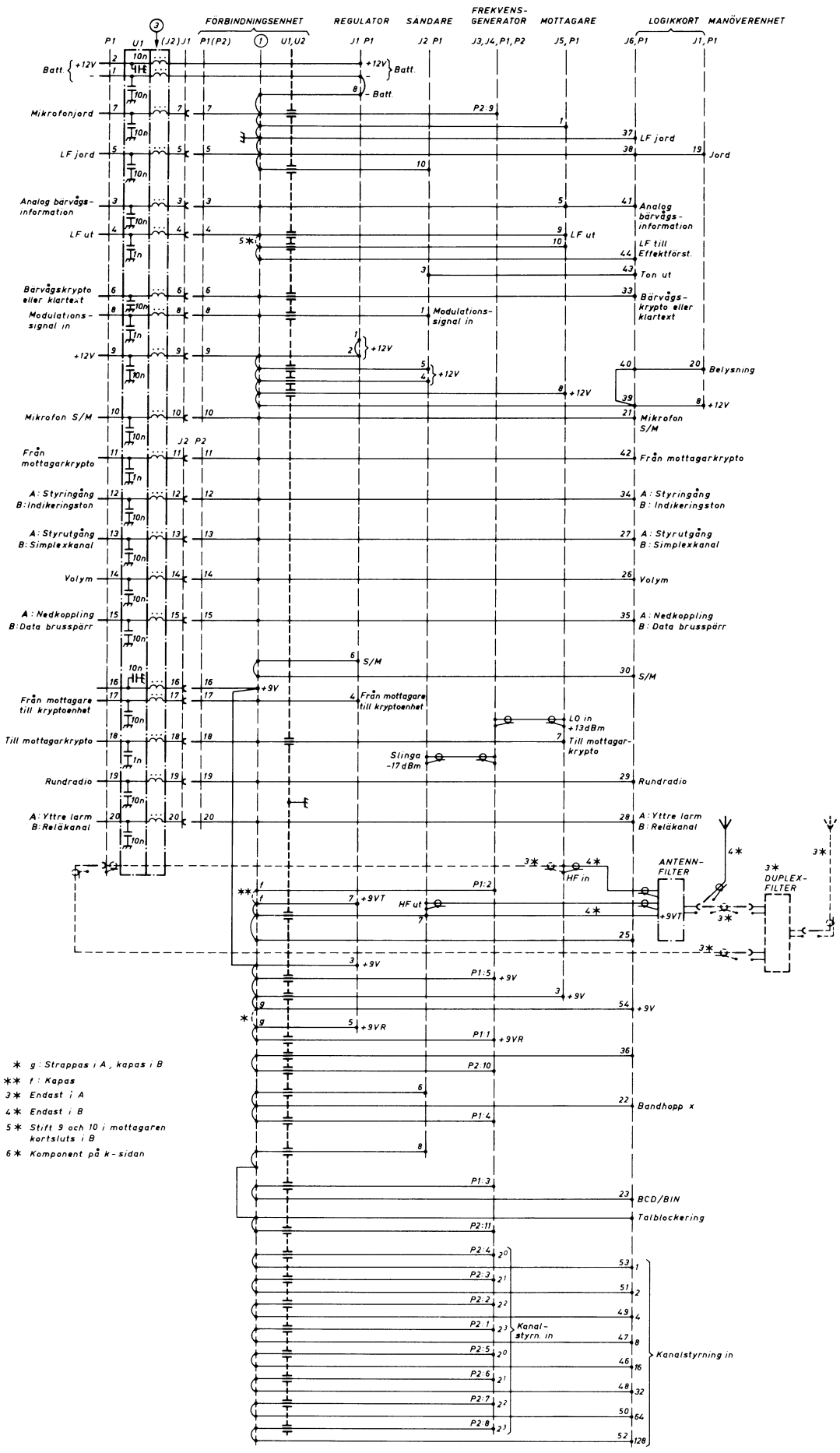


Fig 11.11. Connector board for radio and logic boards, circuit diagram

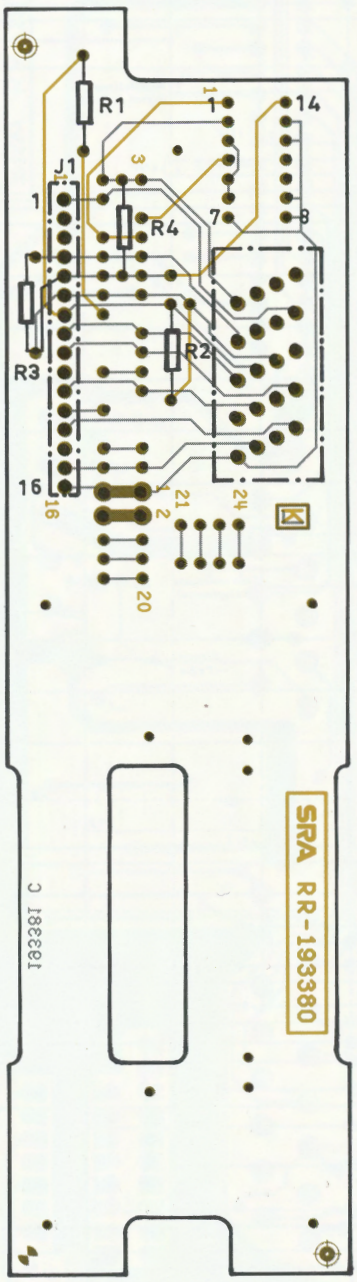


Fig 11.12. Connector board for cipher, component layout

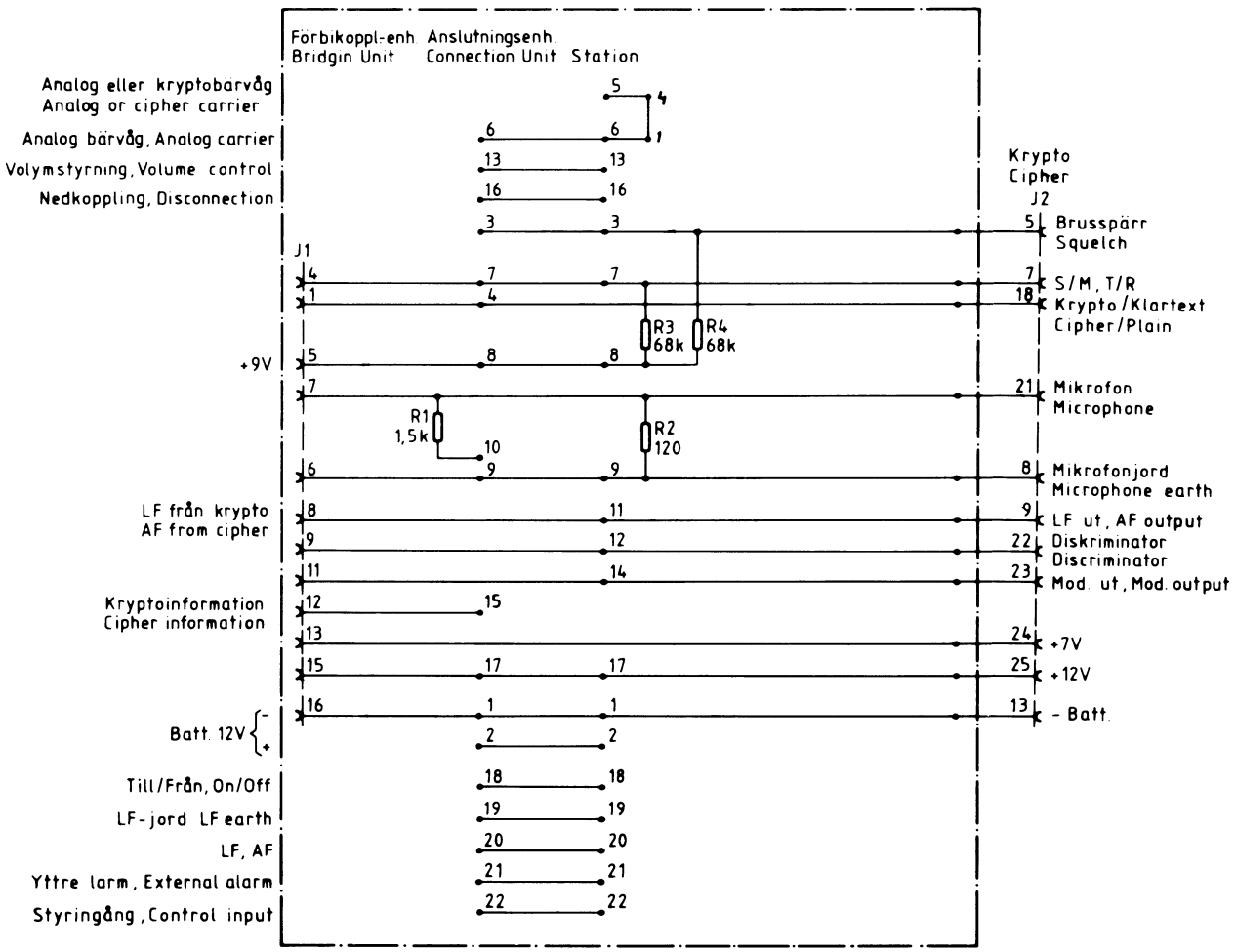


Fig 11.13. Connector board for cipher, circuit diagram

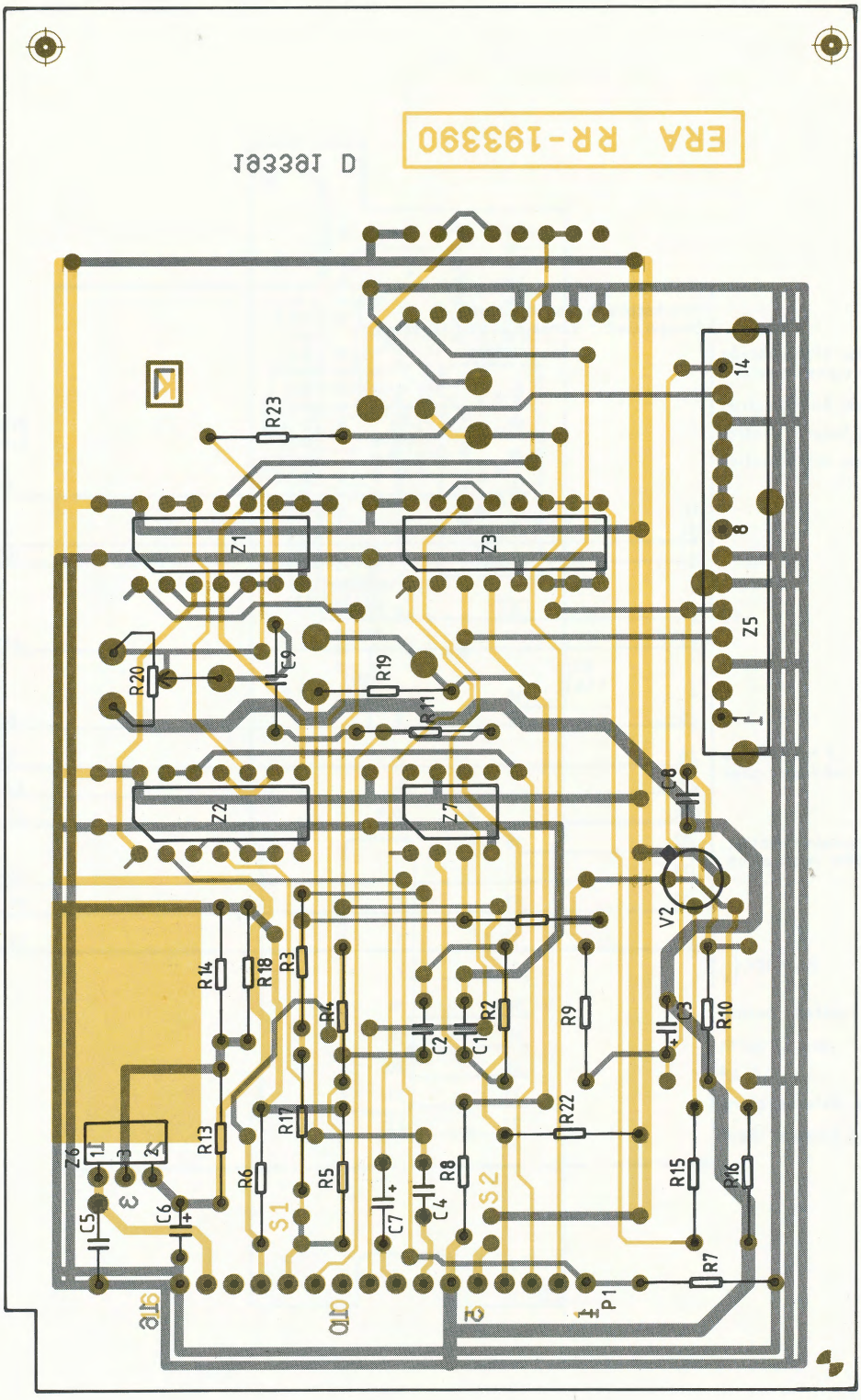


Fig 11.14. Bridgin board for cipher, component layout

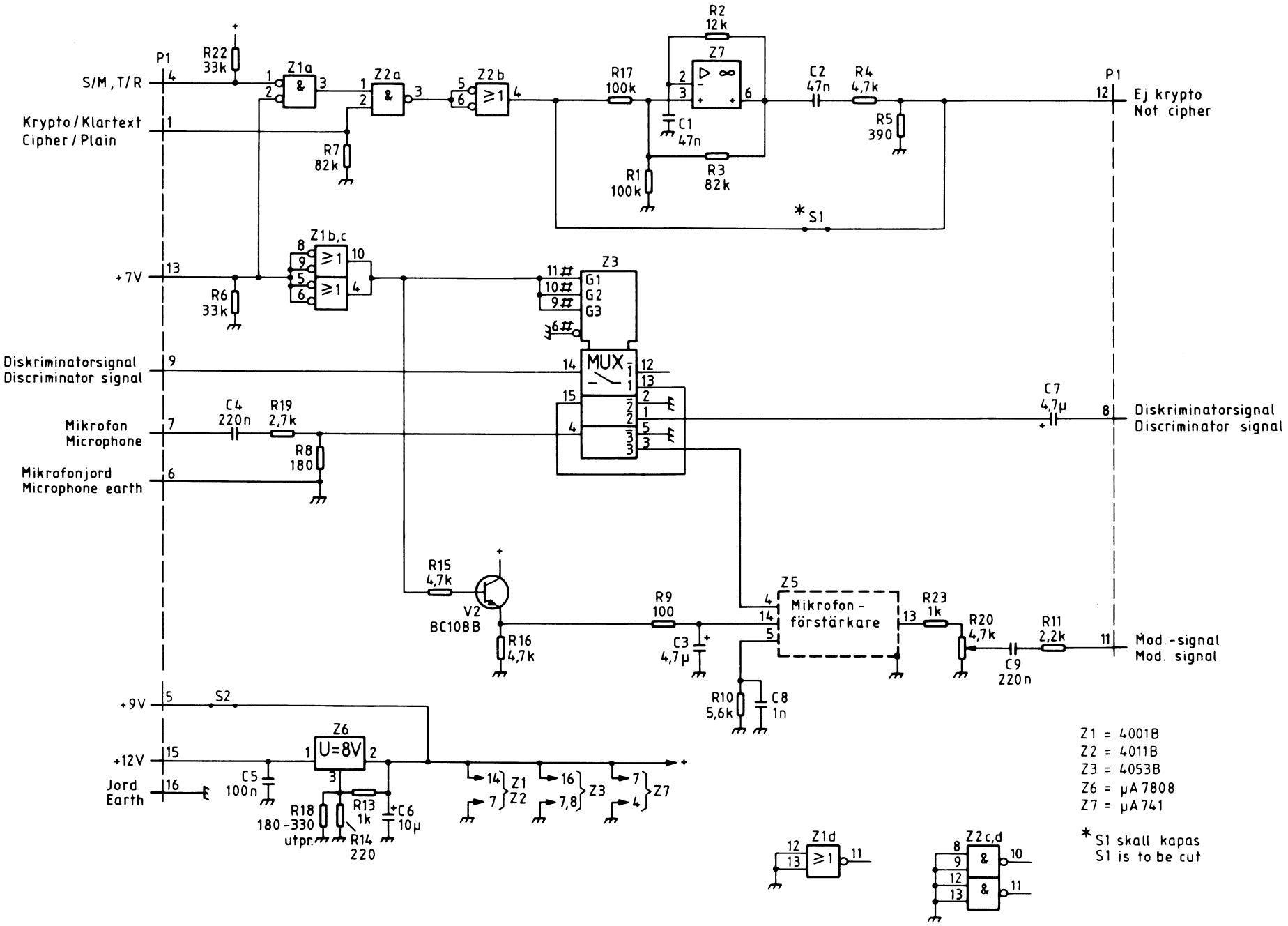


Fig 11.15. Bridgin board for cipher, circuit diagram

Bridging board for cipher

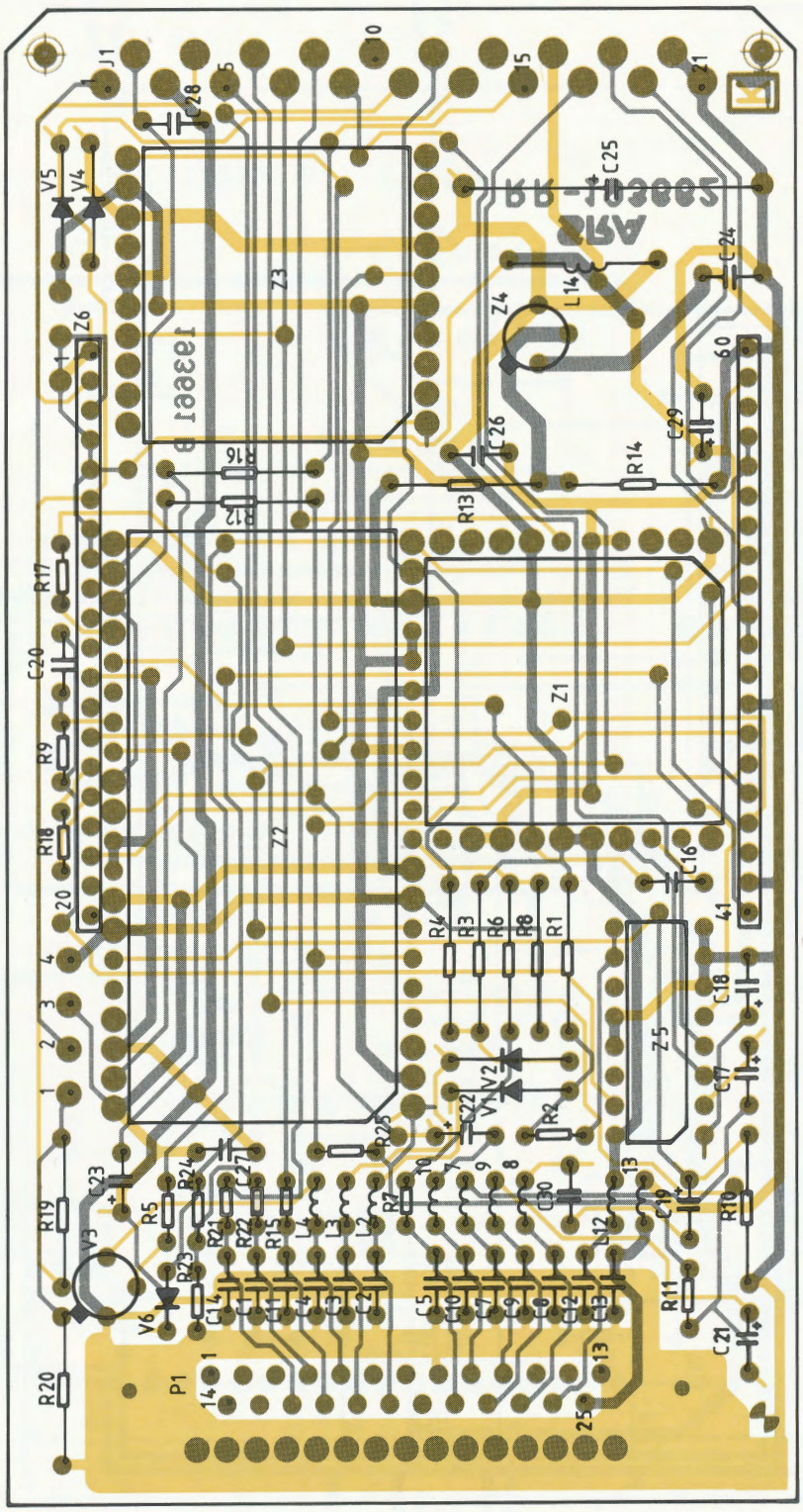


Fig 11.16. Cipher board 1, component layout

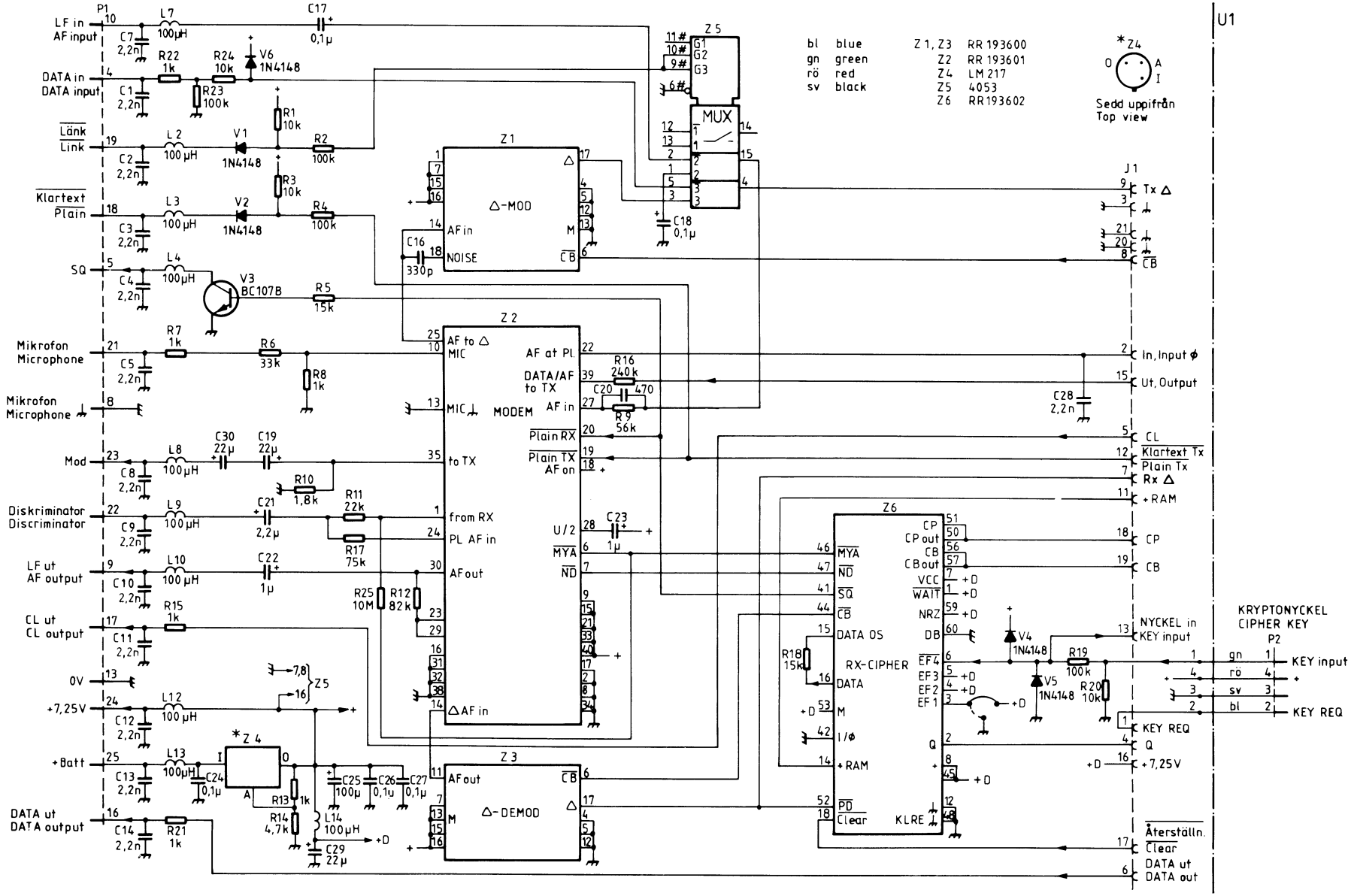


Fig 11.17. Cipher board 1, circuit diagram

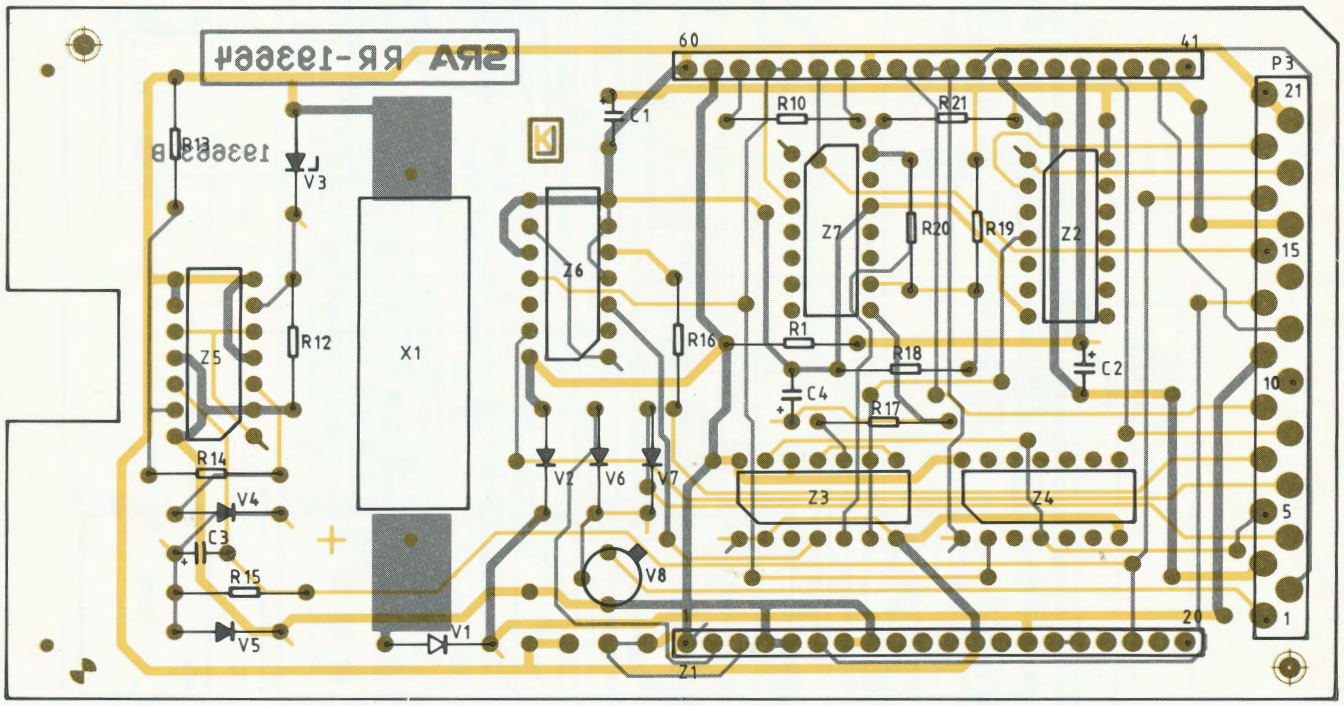


Fig 11.18. Cipher board 2, component layout

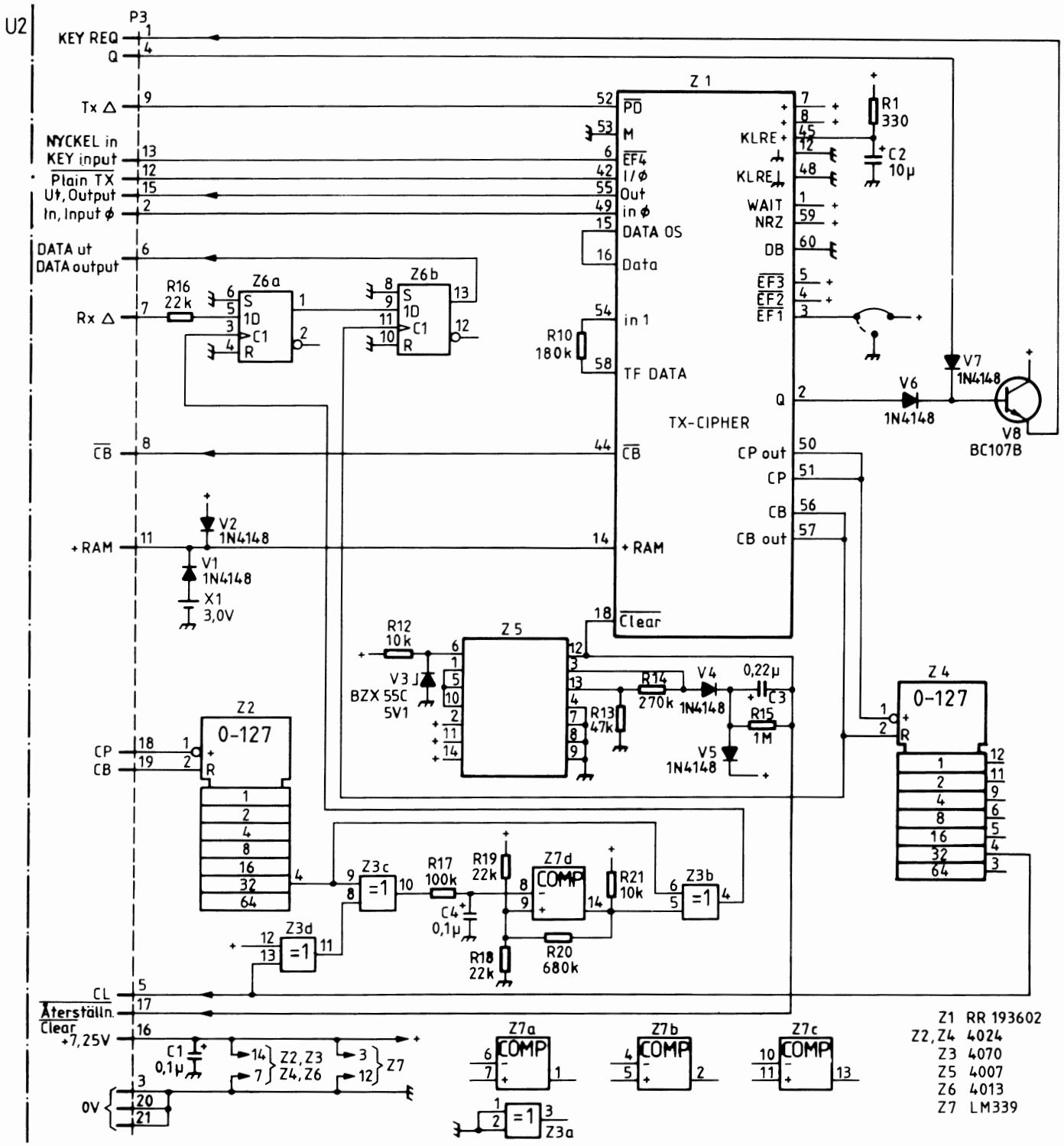


Fig 11.19. Cipher board 2, circuit diagram

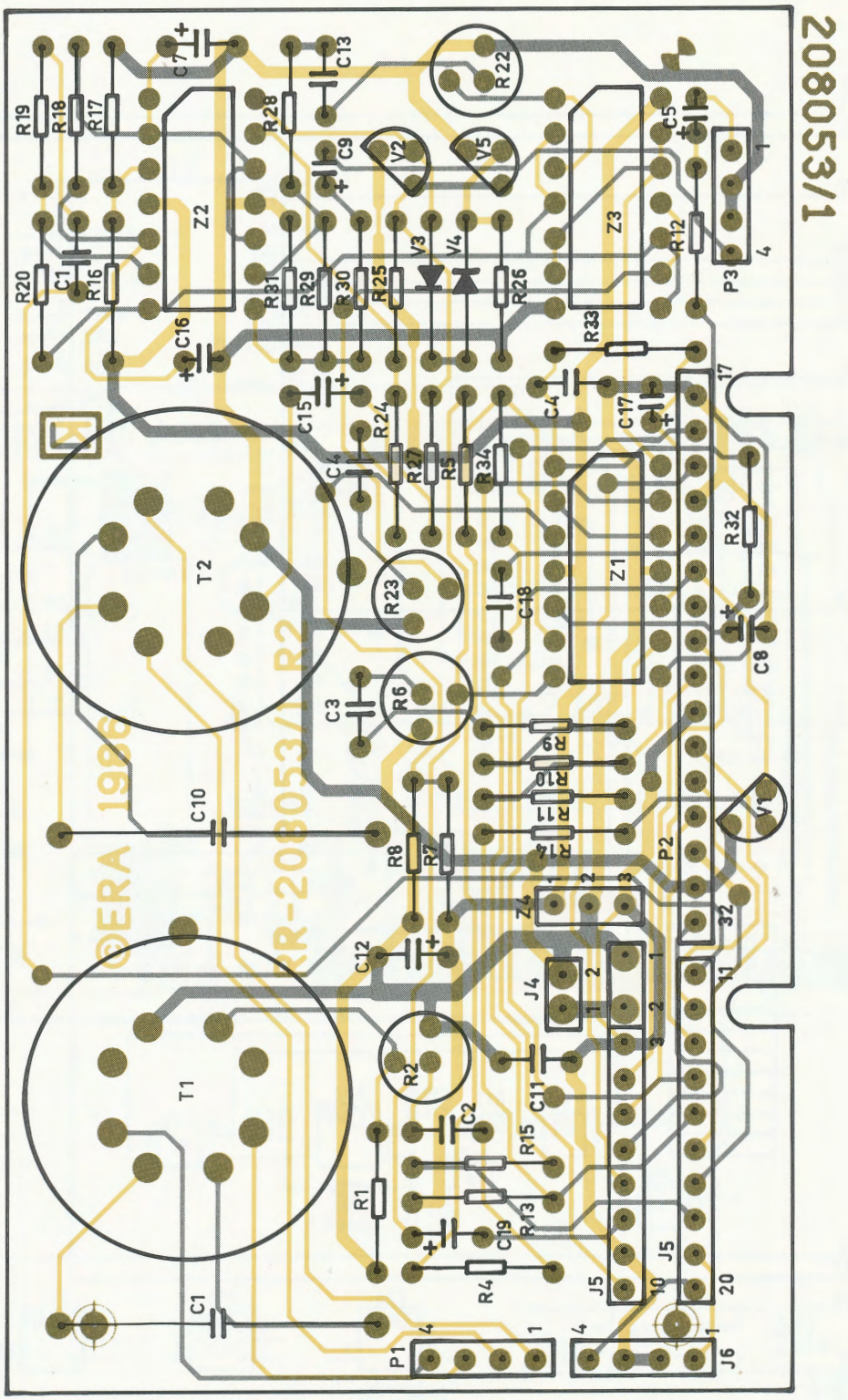


Fig 11.20. Interface board for data communication, component layout

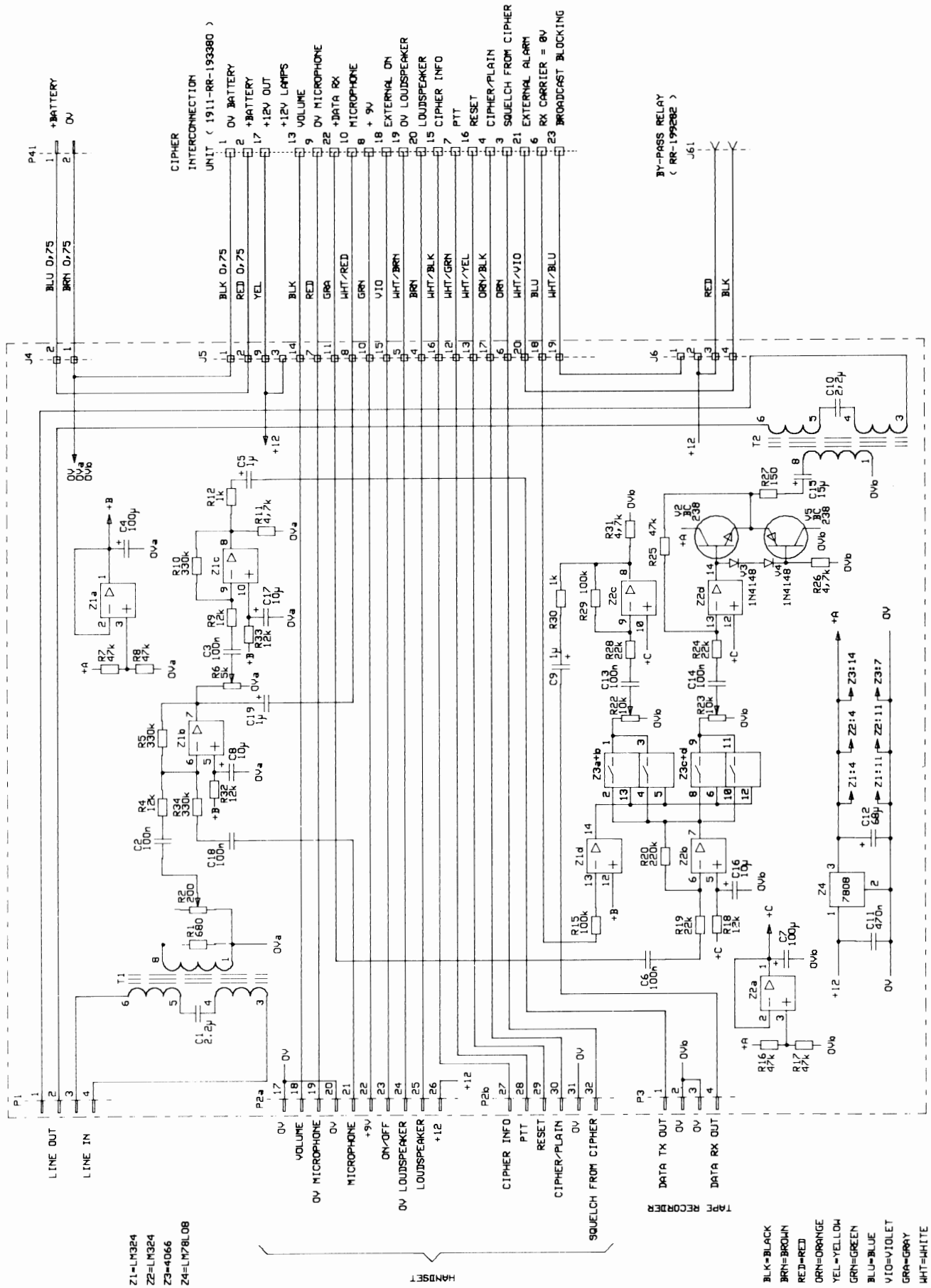


Fig 11.21. Interface board for data communication, circuit diagram

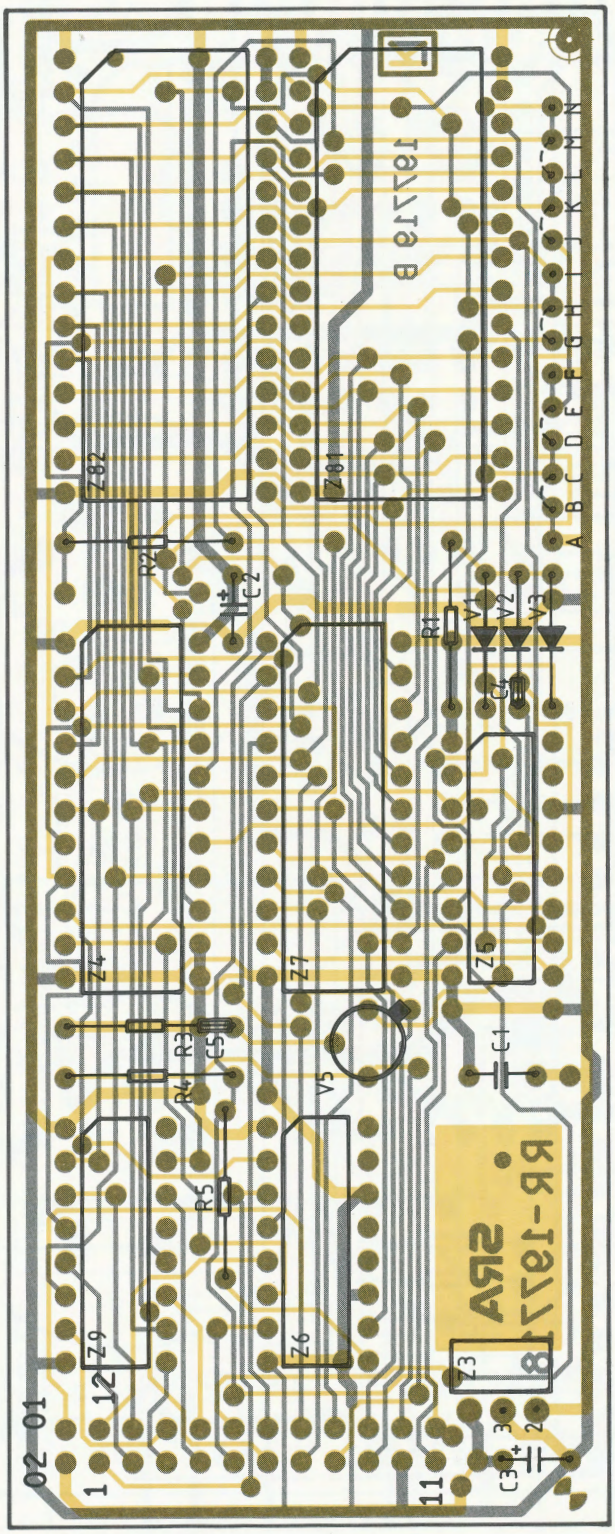


Fig 11.22. PROM board, component layout

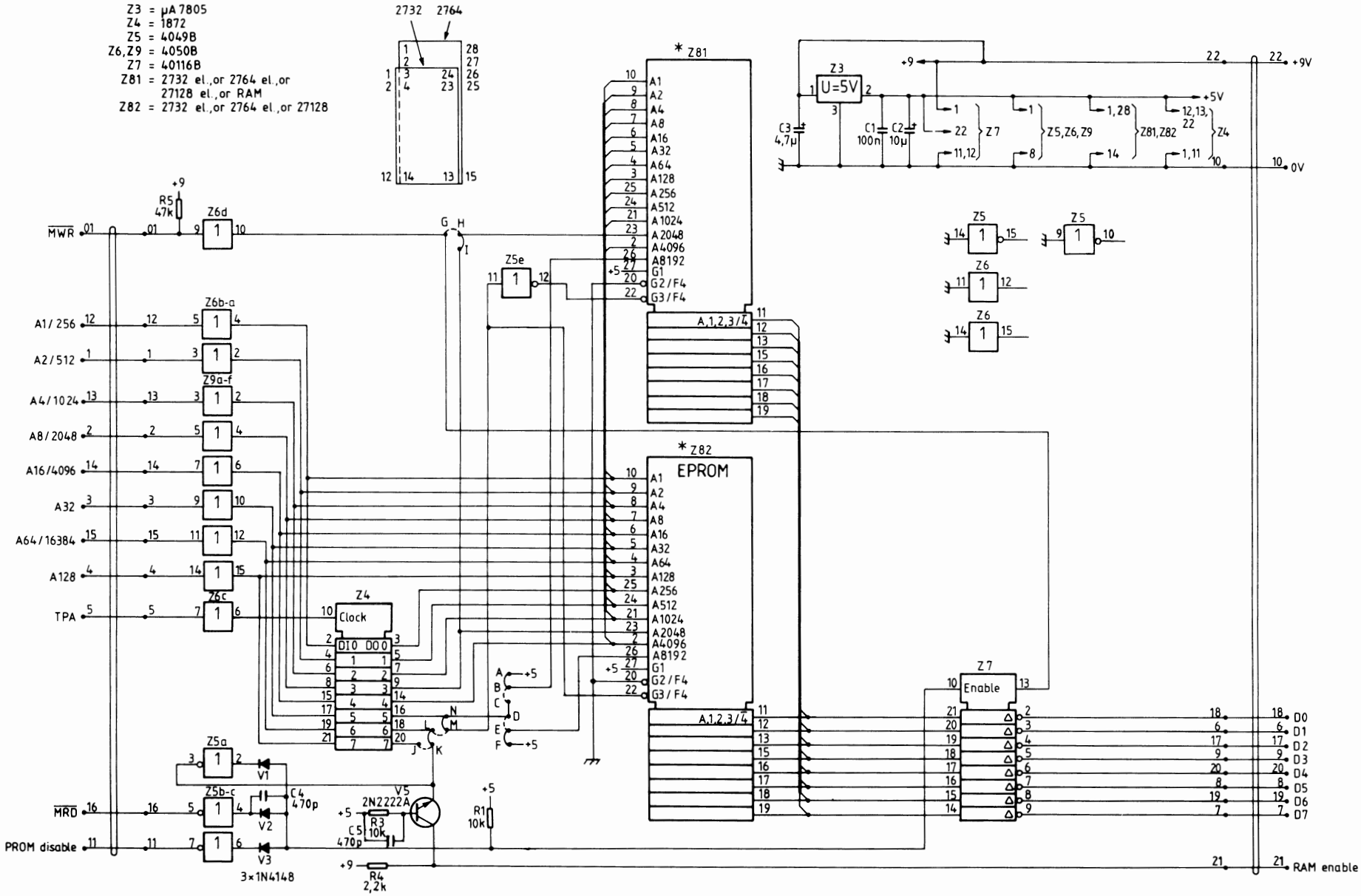


Fig 11.23. PROM board, circuit diagram

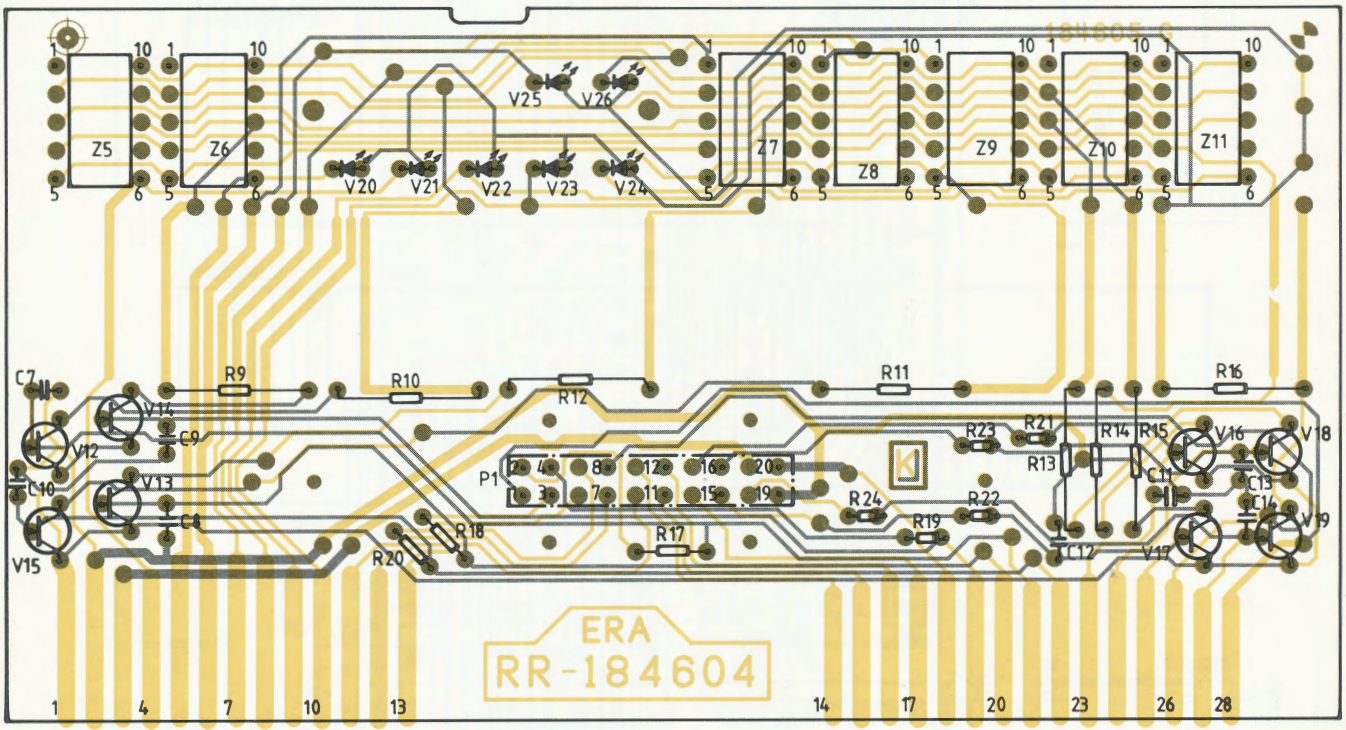
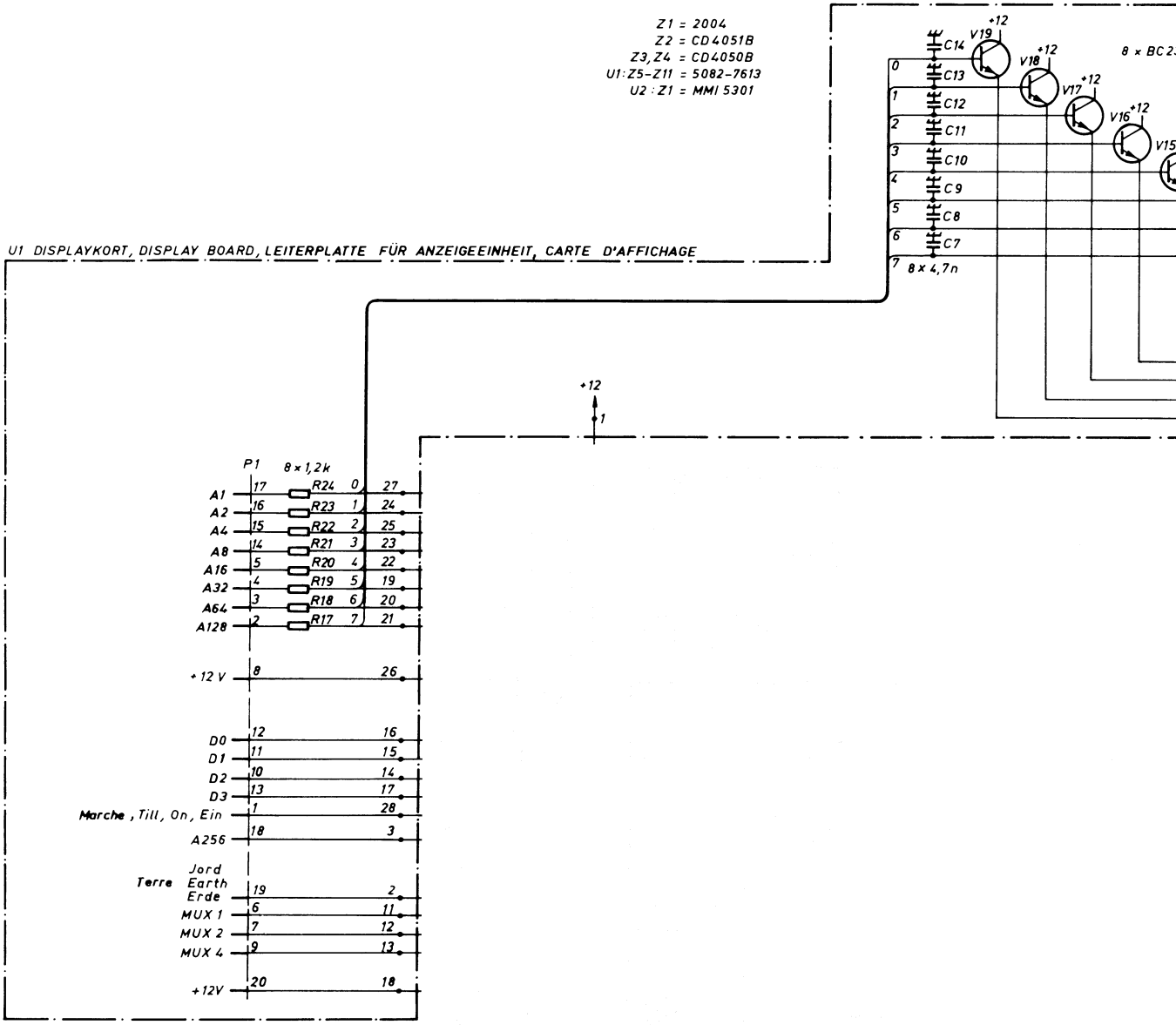
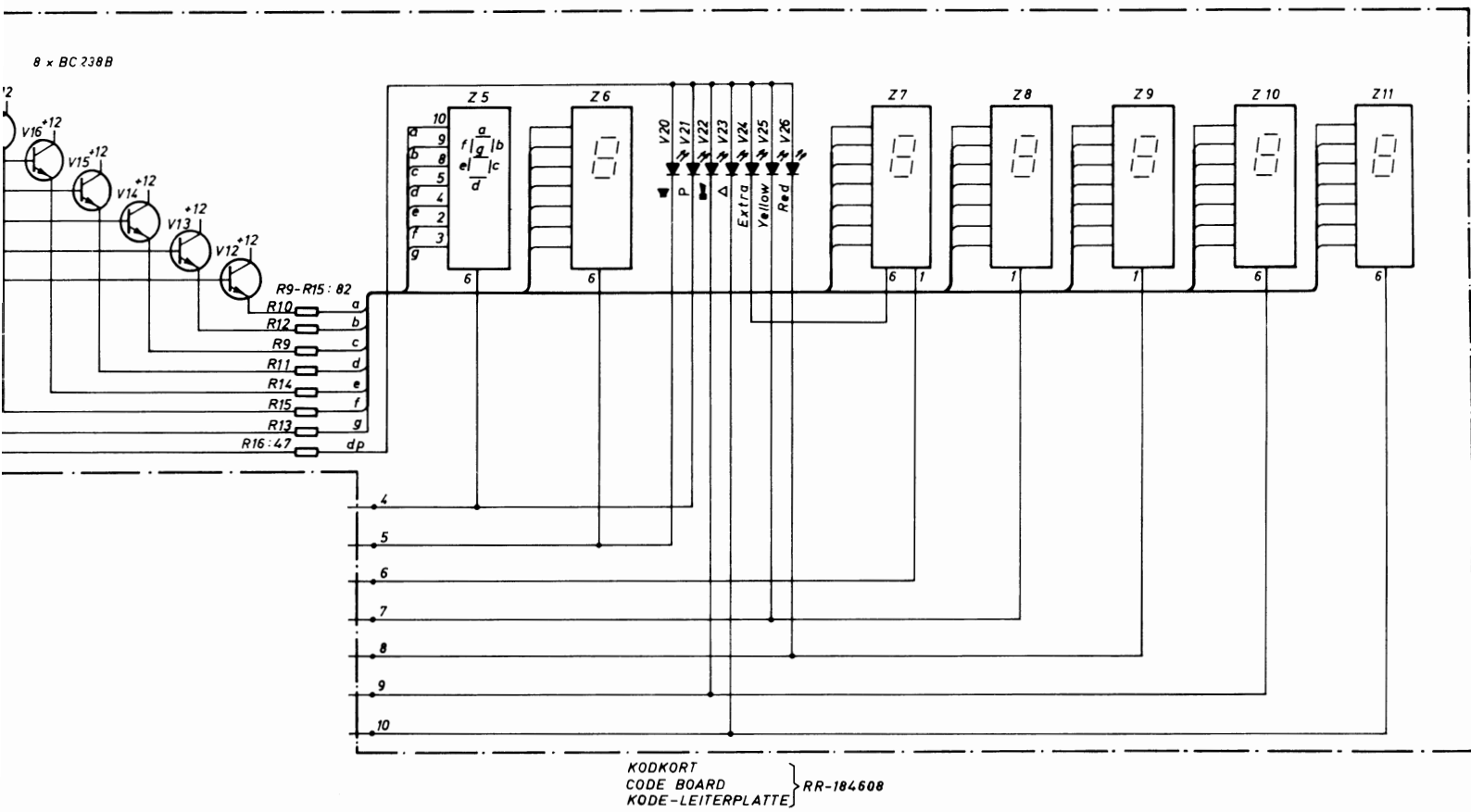
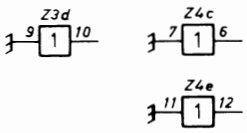


Fig 11.24. Display board, component layout


Z1 = 2004
Z2 = CD4051B
Z3, Z4 = CD4050B
U1: Z5–Z11 = 5082-7613
U2 : Z1 = MMI 5301
U1 DISPLAYKORT, DISPLAY BOARD, LEITERPLATTE FÜR ANZEIGEEINHEIT, CARTE D'AFFICHAGE
P1
8 x 1,2k
A1
A2
A4
A8
A16
A32
A64
A128
+12 V
D0
D1
D2
D3
Marche, Till, On, Ein
A256
Terre
Jord
Earth
Erde
MUX 1
MUX 2
MUX 4
+12V
R24
R23
R22
R21
R20
R19
R18
R17
+12
1
C14
C13
C12
C11
C10
C9
C8
C7
8 x 4,7n
V19
V18
V17
V16
8 x BC2





* När logikenheten har korr.-läge A-G flyttas bygel från (1) till (2).

When the logic unit has revision status A-G the connection is to be moved from (1) to (2).

Wenn die Logikeinheit Änderungslage A-G hat, Brücke (1) entfernen und (2) einlegen.

Lorsque l'unité logique a les lettres de révision A-G, le strap passe de (1) en (2).

Fig 11.25. Display board, circuit diag

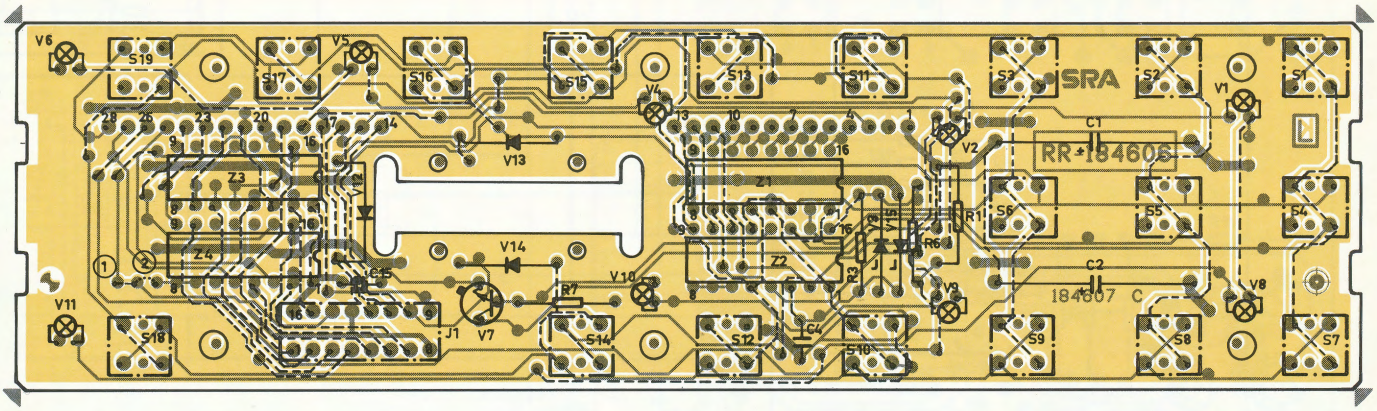
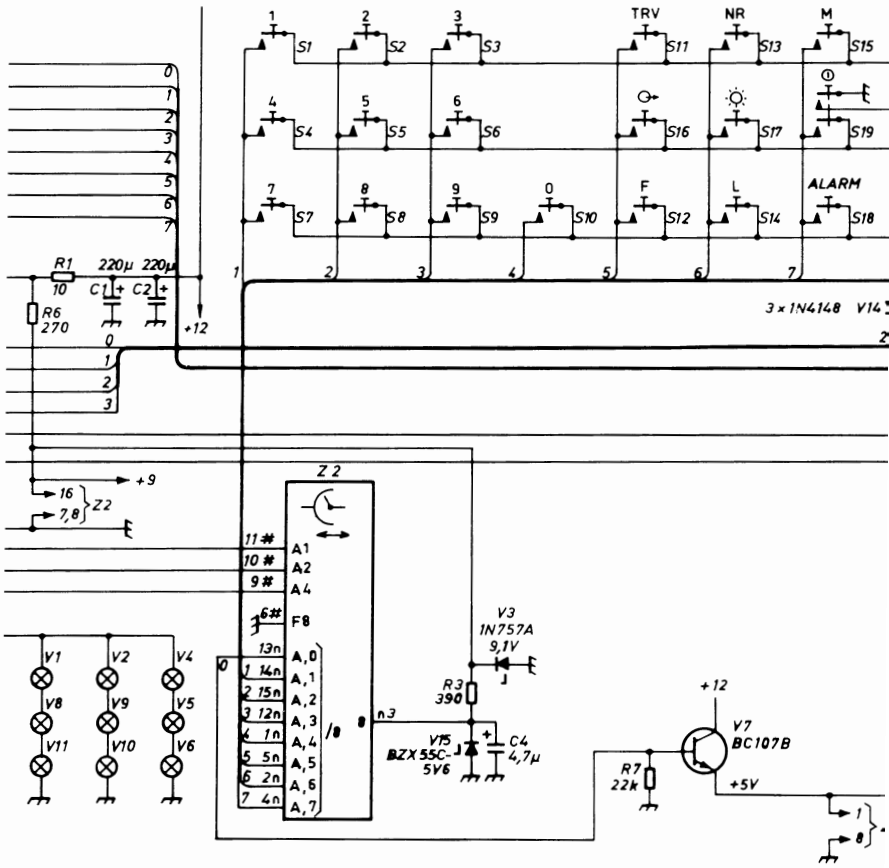
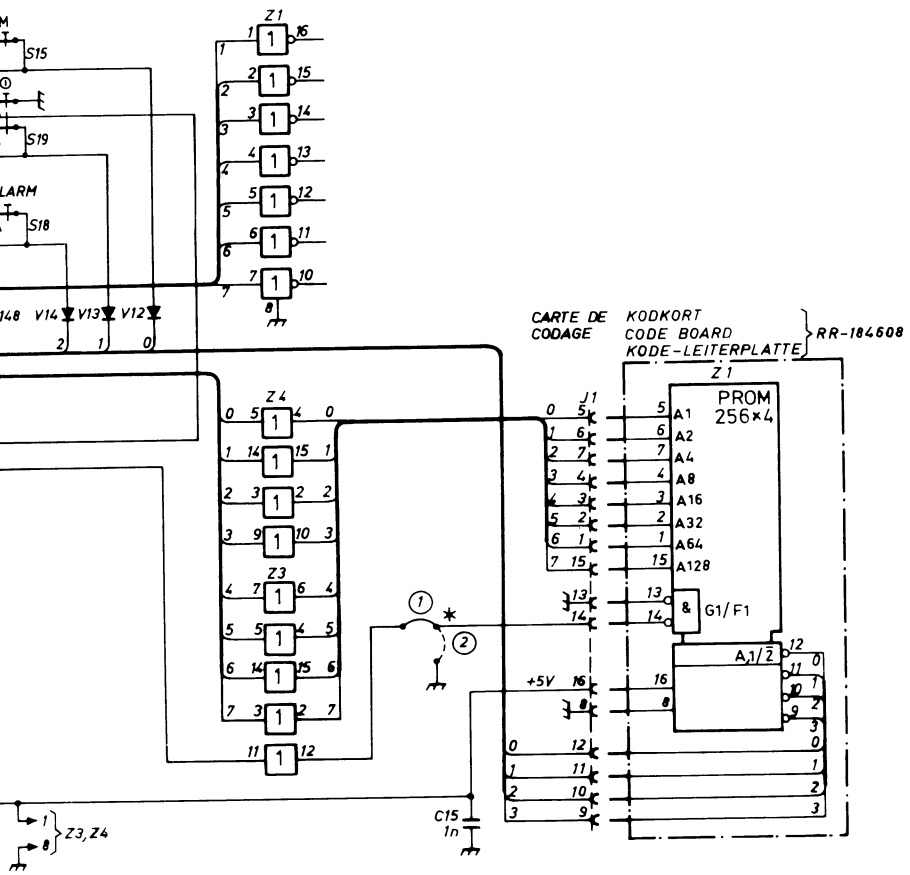


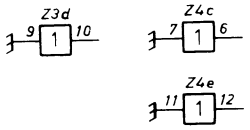
Fig 11.26. Control board and code board, component layout

Z1 = 2004
Z2 = CD4051B
Z3, Z4 = CD4050B
U1: Z5–Z11 = 5082-7613
U2 : Z1 = MMI 5301

U1 DISPLAYKORT, DISPLAY BOARD, LEITERPLATTE FÜR ANZEIGEEINHEIT, CARTE D'AFFICHAGE







* När logikenheten har korr.-läge A-G flyttas bygel från (1) till (2).

* When the logic unit has revision status A-G the connection is to be moved from (1) to (2).

* Wenn die Logikeinheit Änderungslage A-G hat, Brücke (1) entfernen und (2) einlegen.

* Lorsque l'unité logique a les lettres de révision A-G, le strap passe de (1) en (2).

Fig 11.27. Control board and code board, circuit diagra

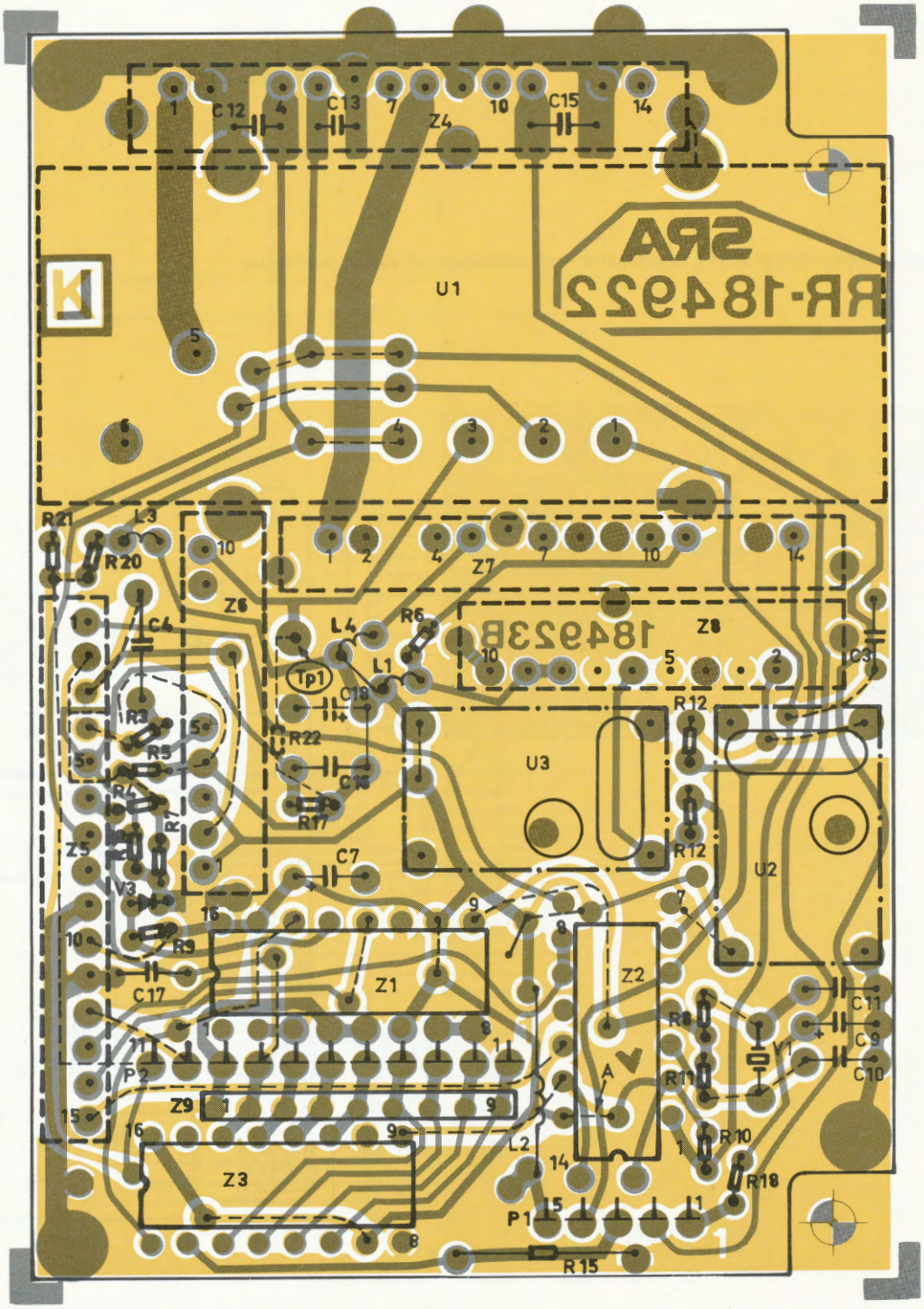
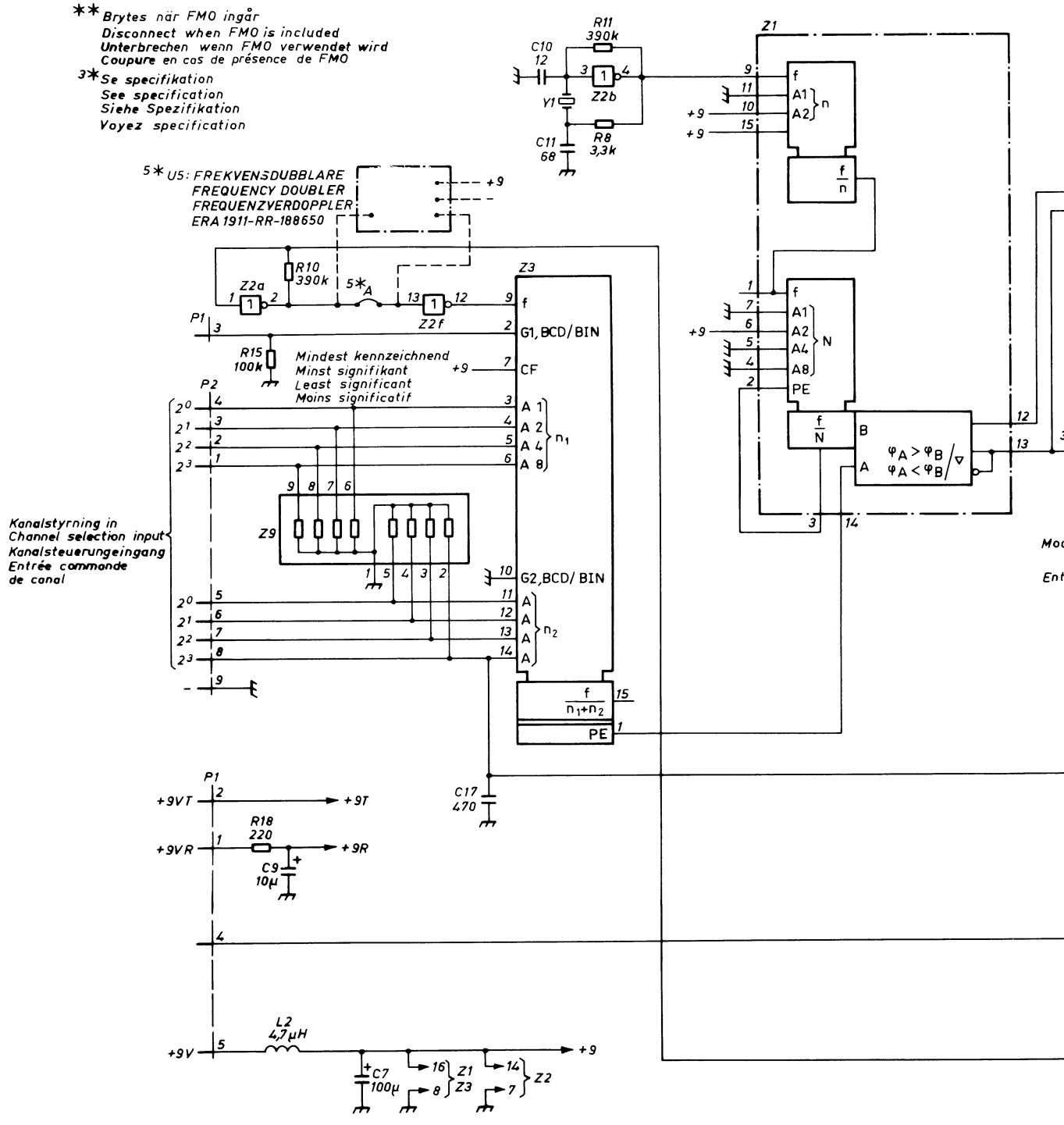


Fig 11.28. Frequency generator, component layout


** Brytes när FMO ingår
Disconnect when FMO is included
Unterbrechen wenn FMO verwendet wird
Coupure en cas de présence de FMO
3* Se specifikation
See specification
Siehe Spezifikation
Voyez specification
5* U5: FREKVENSDUBBLARE
FREQUENCY DOUBLER
FREQUENZVERDOPPLER
ERA 1911-RR-188650
R11 390k
C10 12
Y1
Z2b
C11 68
R8 3,3k
Z1
R10 390k
Z2a
Z2f
Z3
P1
P2
R15 100k
Mindest kennzeichnend
Minst signifikant
Least significant
Moins significatif
G1, BCD/BIN
G2, BCD/ BIN
CF
Z9
Kanalstyrning in
Channel selection input
Kanalsteuerungeingang
Entrée commande de canal
C17 470
+9VT
+9T
+9VR
R18 220
C9 10µ
+9R
L2 4,7µH
+9V
C7 100µ
Z1 = MC14568
Z2 = 4069
Z3 = MC14569
Z9 = 8 × 100k
Folieledare på komponentsidan
Conductor on the component side
Leiter auf der Seite der Bauelemente
Conducteur imprimé sur côte composants
Komponent på lödsidan
Component on the soldering side
Bauelemente auf der Lötseite
Composant sur côté soudures
Överända
Upper end
Oberende
Extrémité supérieure

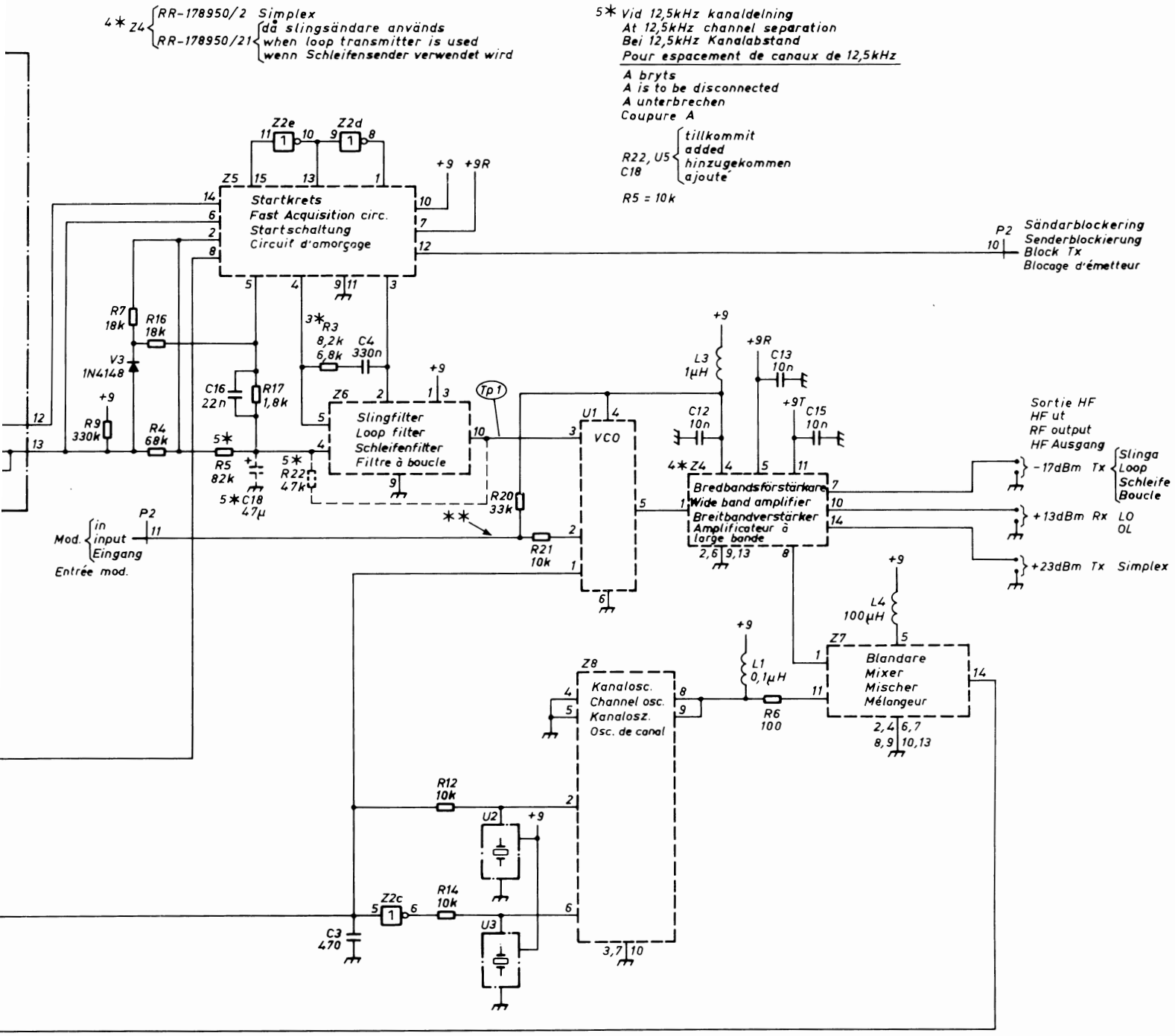


Fig 11.29. Frequency generator, circuit diag

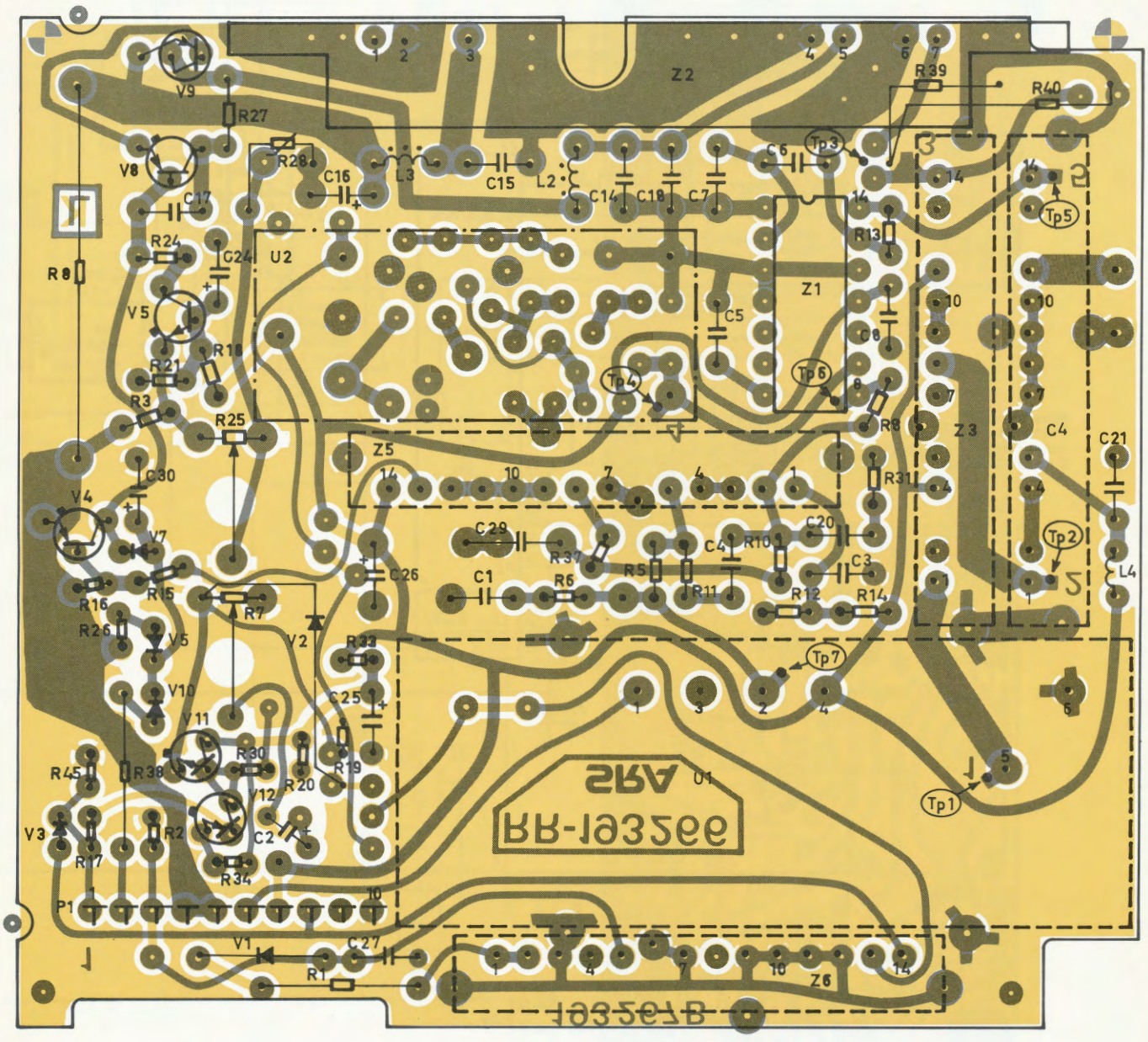
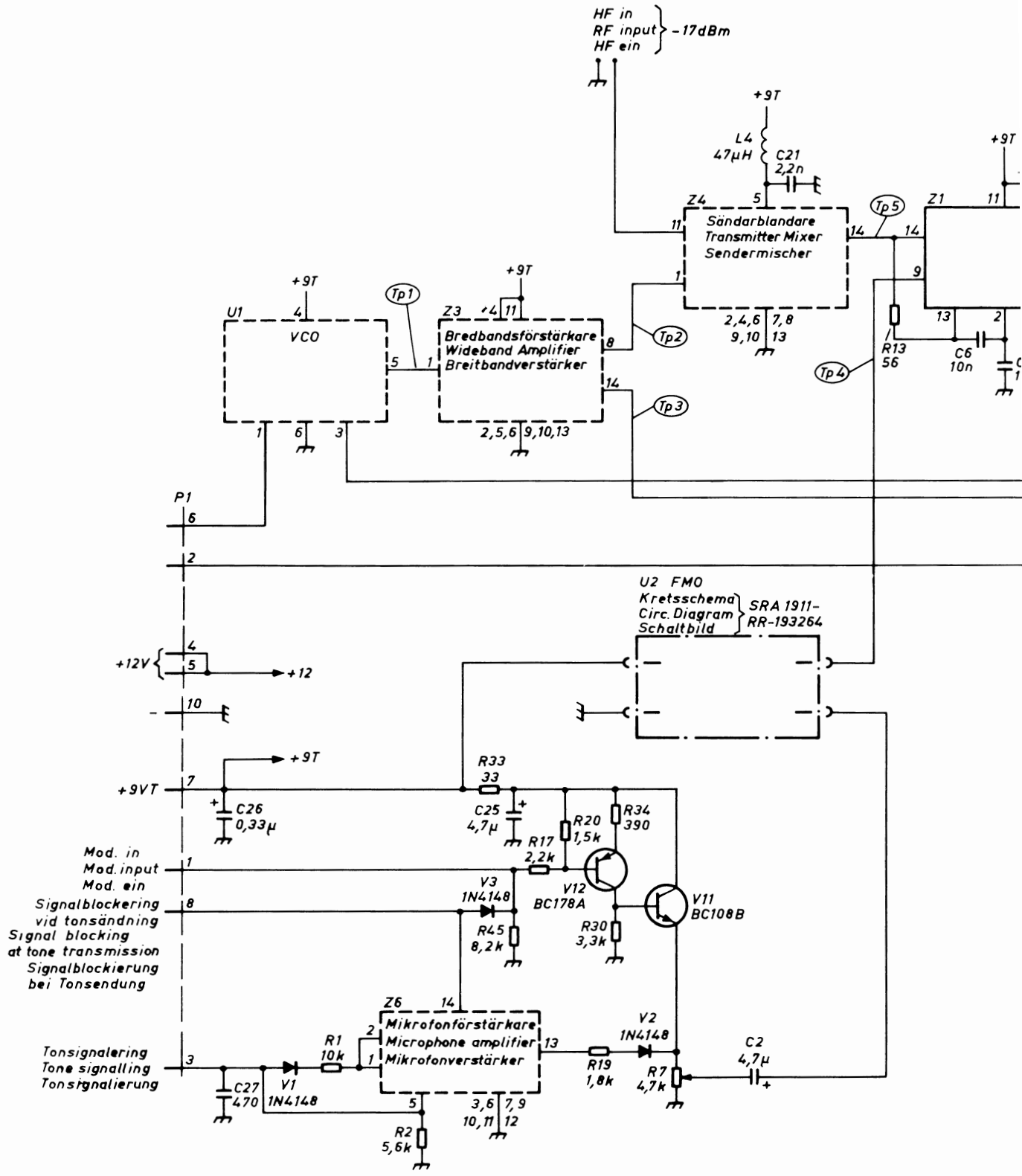
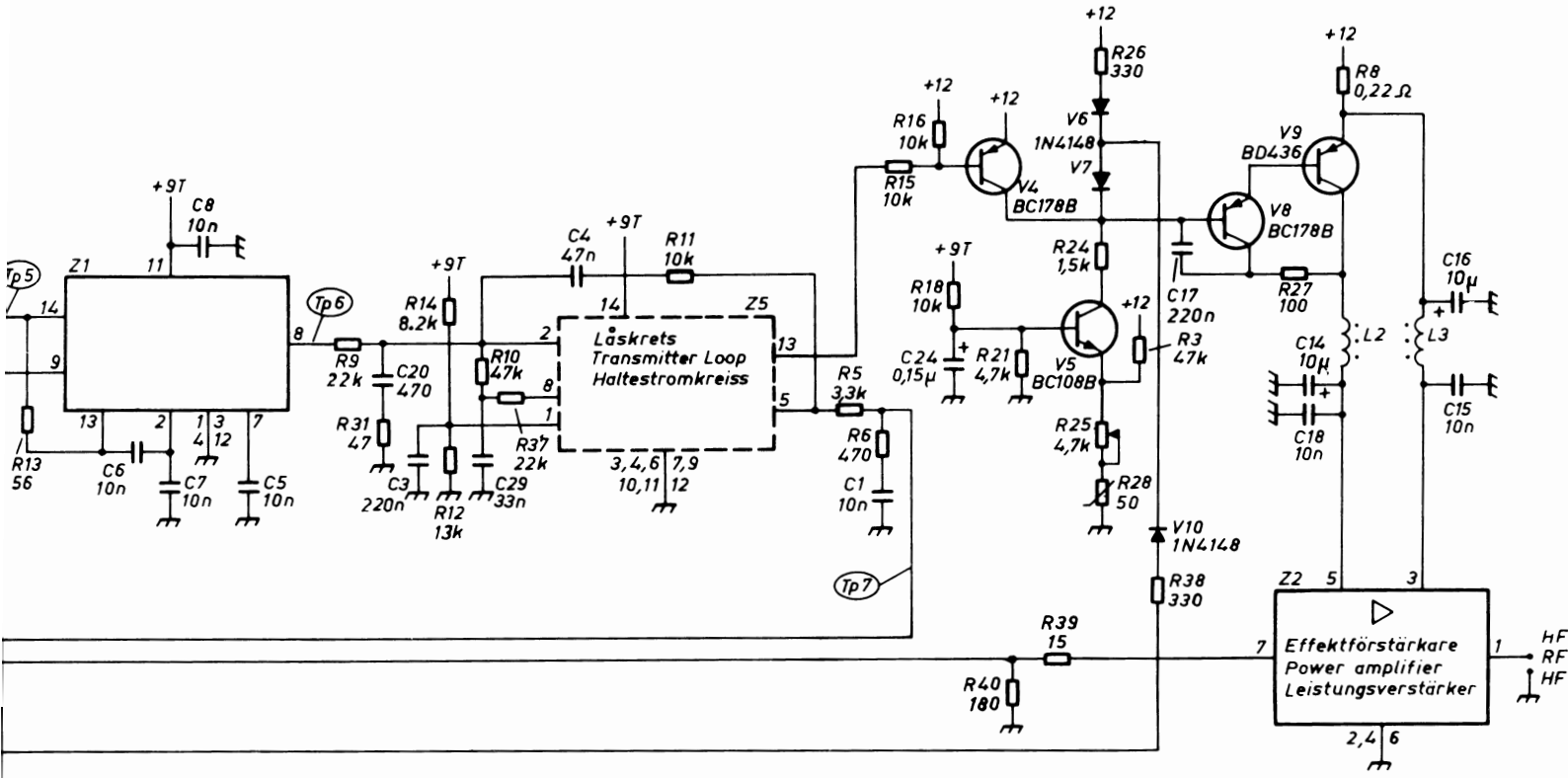


Fig 11.30. Duplex transmitter, component layout


HF in
RF input
HF ein
-17dBm
+9T
L4
47µH
C21
2,2n
Z4
Sändarblandare
Transmitter Mixer
Sendermischer
Tp5
Z1
U1
VCO
Tp1
Z3
Bredbandsförstärkare
Wideband Amplifier
Breitbandverstärker
Tp2
Tp3
Tp4
R13
56
C6
10n
2,4,6 7,8
9,10 13
2,5,6 9,10,13
P1
U2 FMO
Kretsschema
Circ. Diagram
Schaltbild
SRA 1911-
RR-193264
+12V
+12
+9VT
C26
0,33µ
R33
33
C25
4,7µ
R20
1,5k
R34
390
R17
2,2k
V12
BC178A
V11
BC108B
V3
1N4148
R45
8,2k
R30
3,3k
Mod. in
Mod. input
Mod. ein
Signalblockering
vid tonsändning
Signal blocking
at tone transmission
Signalblockierung
bei Tonsendung
Z6
Mikrofonförstärkare
Microphone amplifier
Mikrofonverstärker
R1
10k
V2
1N4148
R19
1,8k
R7
4,7k
C2
4,7µ
Tonsignalering
Tone signalling
Tonsignalierung
C27
470
V1
1N4148
R2
5,6k
3,6 7,9
10,11 12



Z1 = TBA 120
Z2 = MHV-710-2

* Komponent på lödsidan
Component on the soldering side
Bauelemente auf der Lötseite

Överända
Upper end
Oberende

Fig 11.31. Duplex transmitter, circ

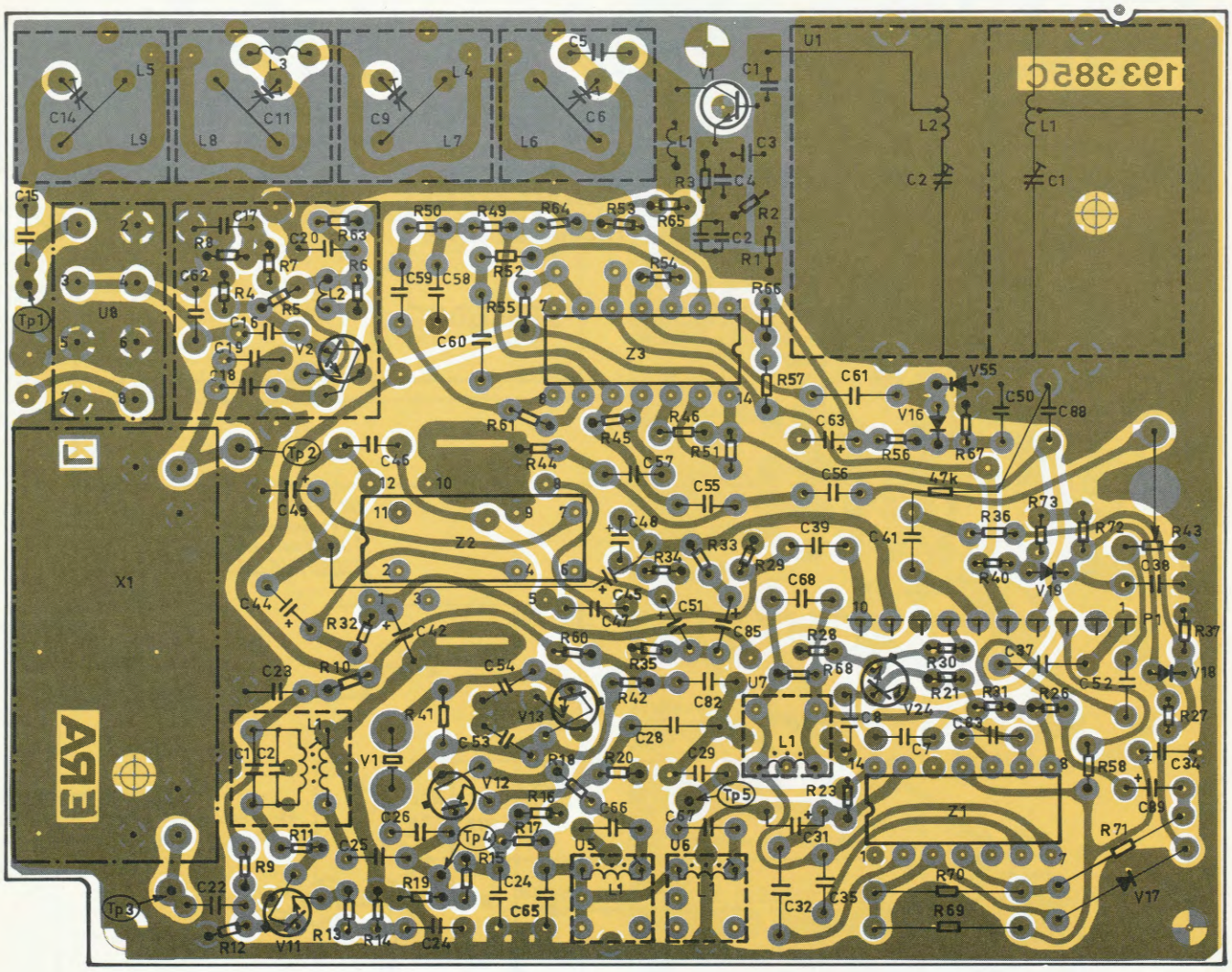
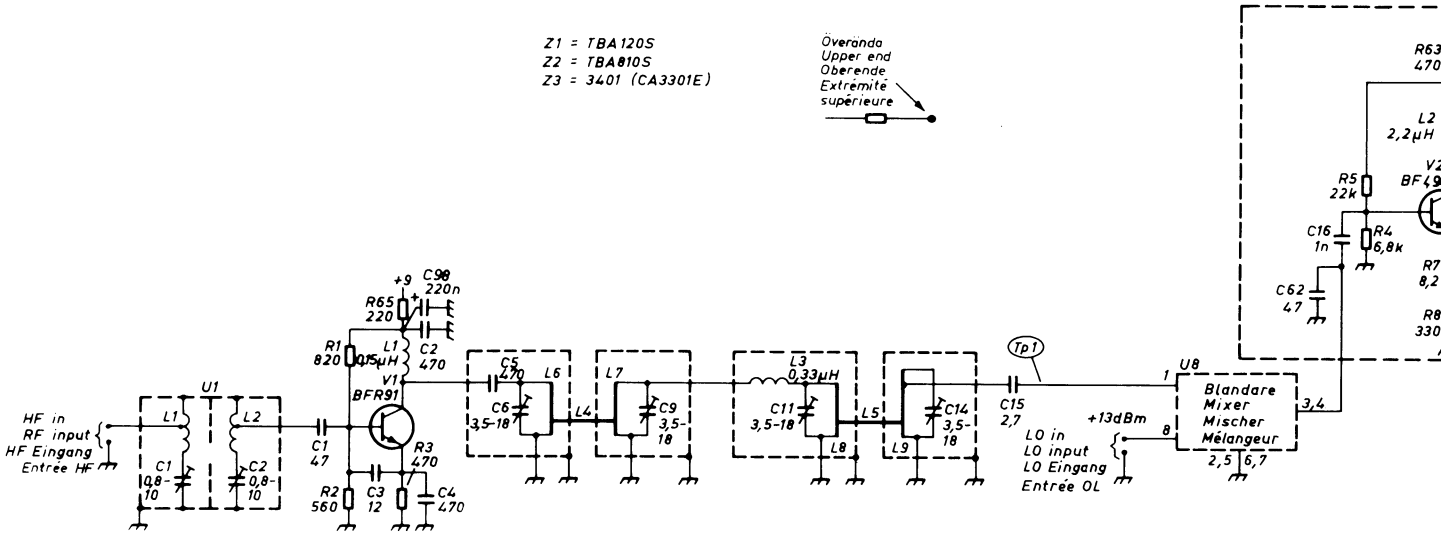


Fig 11.32. 1 band receiver, component layout


Z1 = TBA120S
Z2 = TBA810S
Z3 = 3401 (CA3301E)
Överända
Upper end
Oberende
Extrémité
supérieure
HF in
RF input
HF Eingang
Entrée HF
U1
L1
L2
C1
0,8-10
C2
0,8-10
C1
47
R1
820
L1
0,15µH
V1
BFR91
C2
470
+9
C98
220n
R65
220
R2
560
C3
12
R3
470
C4
470
C5
470
C6
3,5-18
L6
L4
L7
C9
3,5-18
L3
0,33µH
C11
3,5-18
L8
L5
L9
C14
3,5-18
C15
2,7
Tp1
+13dBm
LO in
LO input
LO Eingang
Entrée OL
U8
1
8
Blandare
Mixer
Mischer
Mélangeur
3,4
2,5
6,7
R5
22k
C16
1n
R4
6,8k
C62
47
L2
2,2µH
R63
470
R7
8,2
R8
330

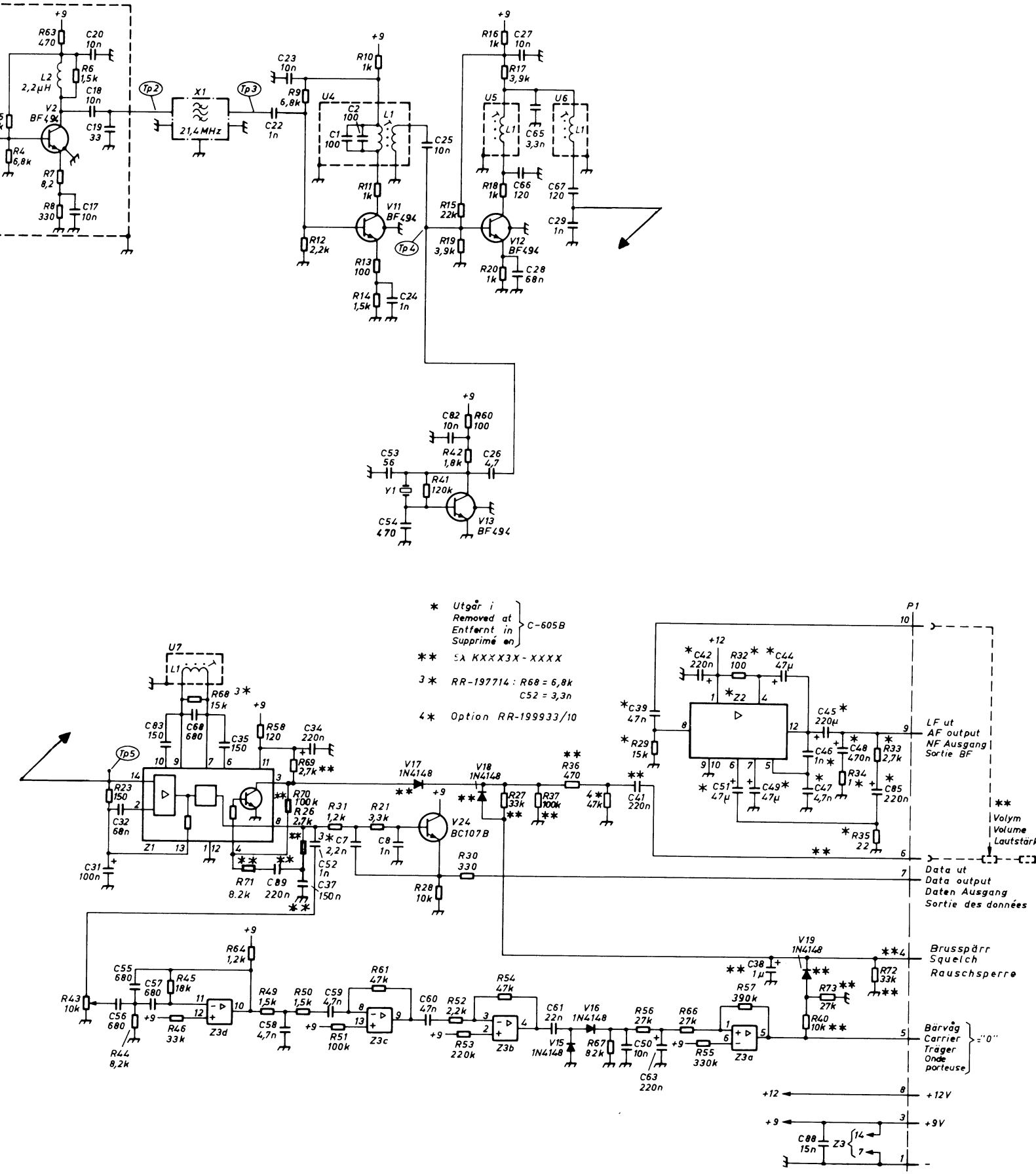


Fig 11.33. 1 band receiver, circuit diagra

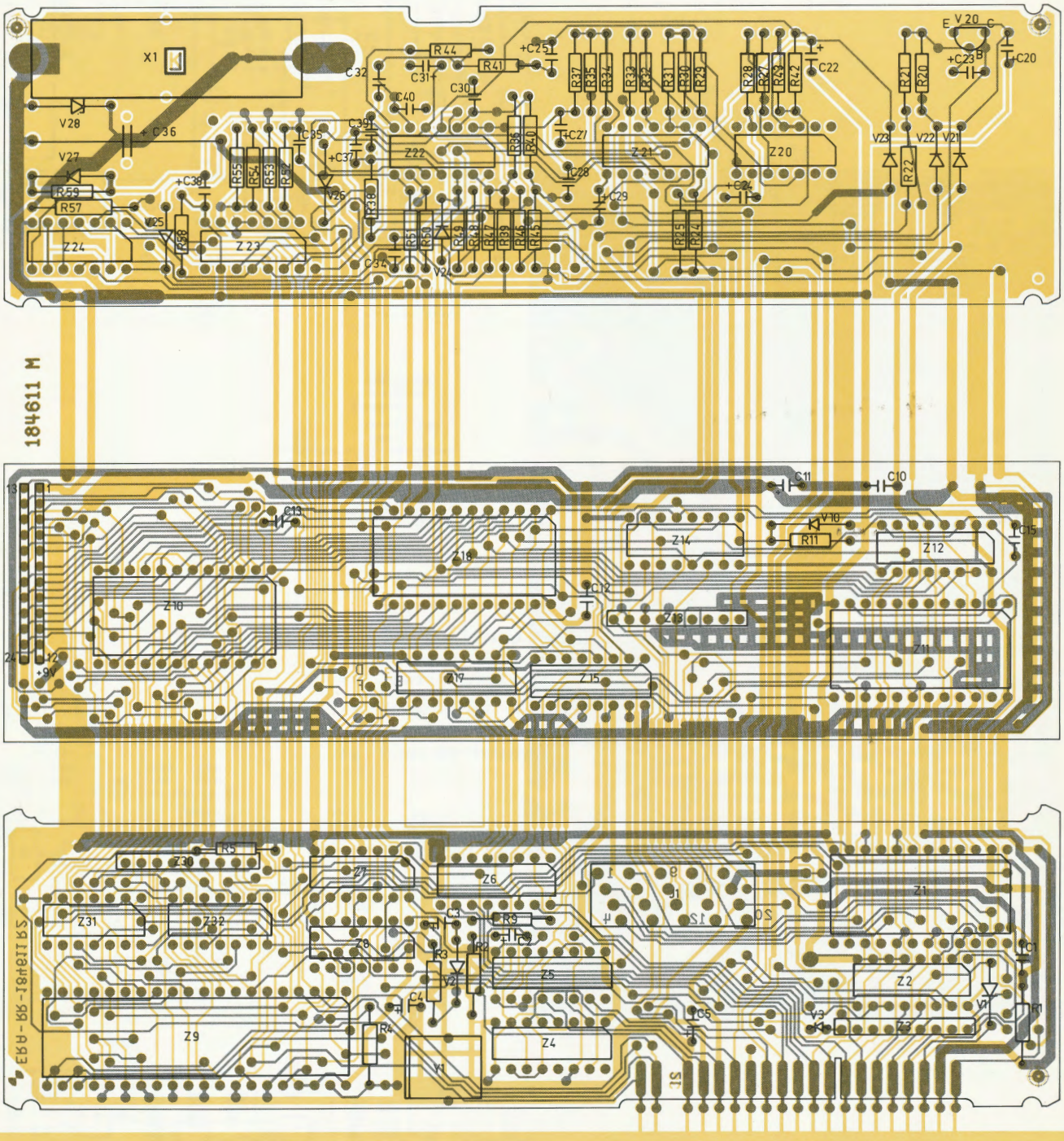
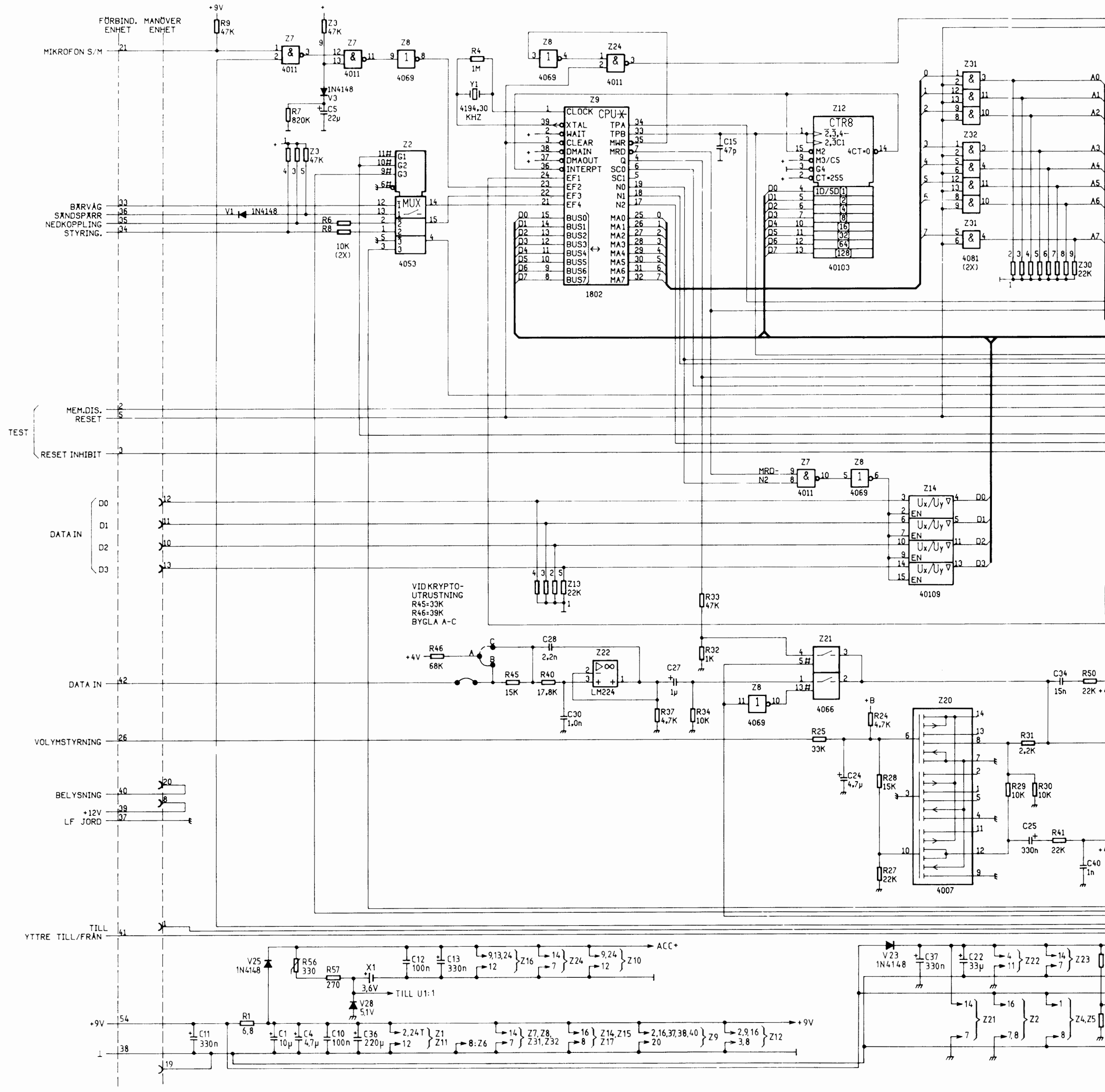


Fig 11.34. Basic logic, component layout



FÖRBIND. ENHET
MANÖVER ENHET
MIKROFON S/M
BÄRVÅG
SÄNDSPÄRR
NEDKOPPLING
STYRING.
TEST
MEM.DIS.
RESET
RESET INHIBIT
DATA IN
D0
D1
D2
D3
VID KRYPTO-UTRUSTNING
R45=33K
R46=39K
BYGLA A-C
DATA IN
VOLYMSTYRNING
BELYSNING
+12V
LF JORD
TILL
YTTRE TILL/FRÅN
+9V
ACC+
TILL U1:1
CPU
CLOCK
XTAL
WAIT
CLEAR
DMAIN
DMAOUT
INTERPT
EF1
EF2
EF3
EF4
TPA
TPB
MWR
MRD
SC0
SC1
N0
N1
N2
1802
CTR8
40103
40109
4053
4007
4066
LM224
4081
4011
4069
4194,30 KHZ
MRD-
N2

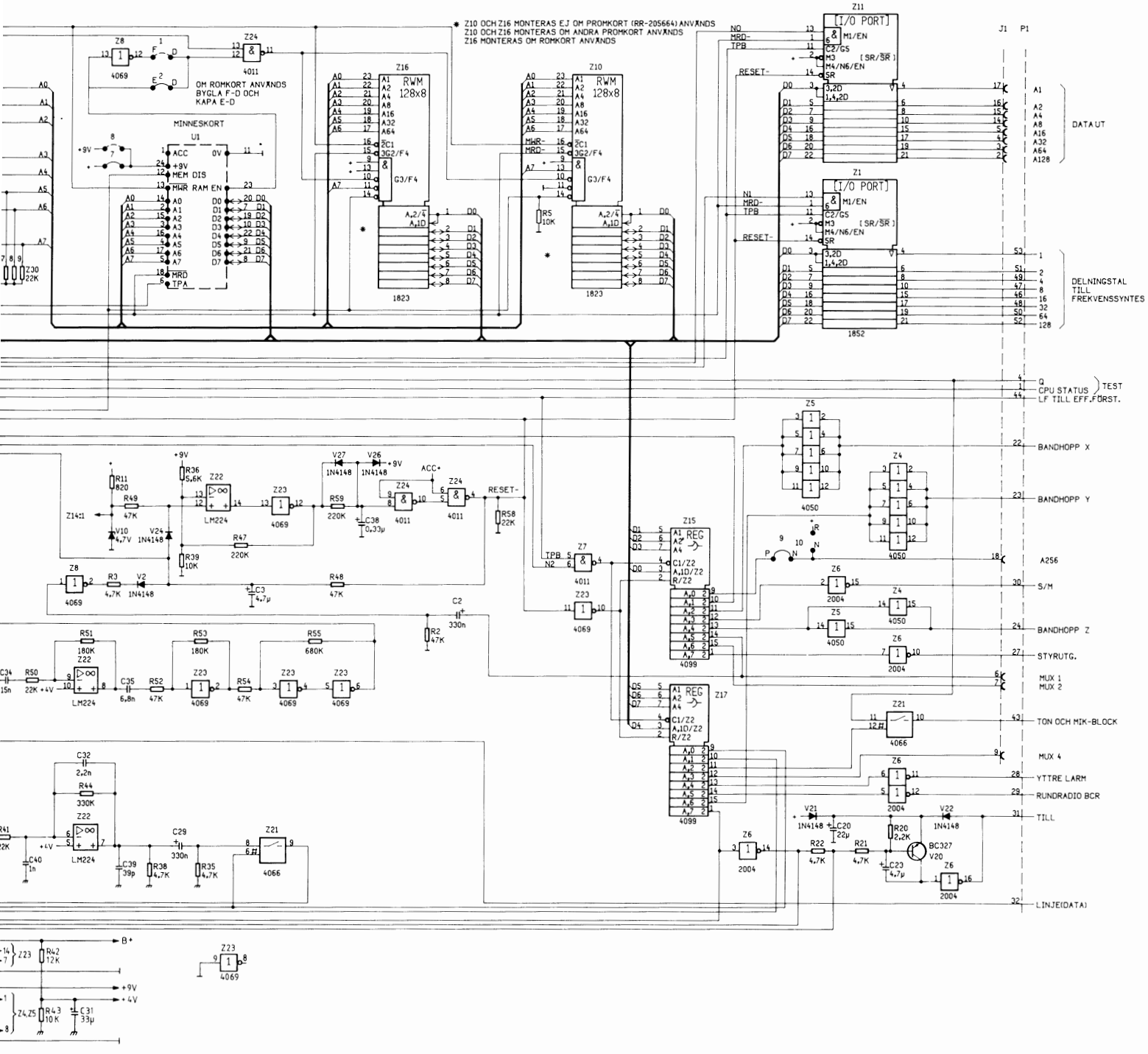


Fig 11.35. Basic logic, circuit diagram