ap radiotelefon

SERVICE MANUAL

Nordic Mobile Telephone

AP3533

Stock number: 296-300

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ACCESSORIES

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General information

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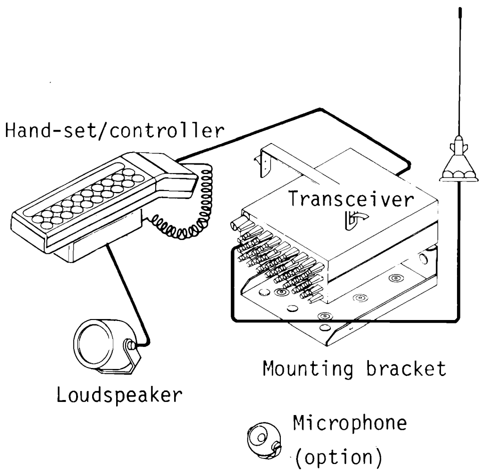
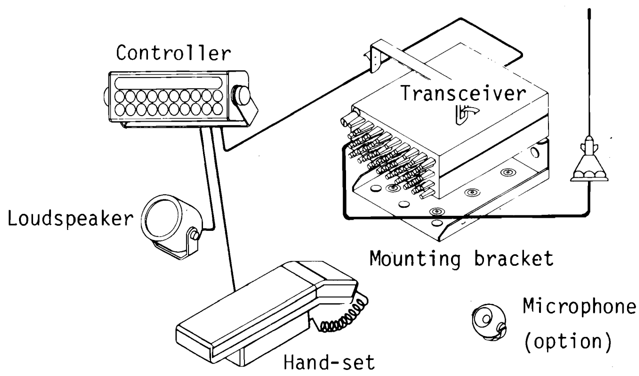
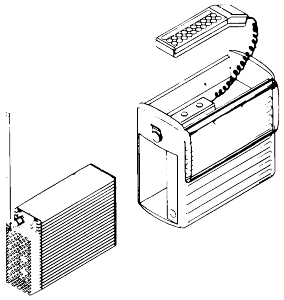


B. Mobile installation with separate controller.



C. Portaphone



The mobile telephone AP3533 is designed for maximum operating convenience. Thereby the operator can concentrate on the driving. To increase driving safety further, the mobile installation can be provided with an optional microphone for hands-free operation. Push-to-talk (PTT) is then done with an external switch mounted on e.g. the steering wheel. When lifting the hand-set, the hands-free mode is automatically switched off. Going back to hands-free mode is done by pushing the appropriate button on the controller.

A portaphone kit, which contains the carrying case and the antenna (see fig.C), is available. Switching from mobile to totally portable operation is easy as the transceiver is fixed to the mounting bracket with a snap-lock.
Connections are made with one multipin plug and a BNC connector for the antenna. In addition the handset/controller can also be unplugged and moved to the portaphone. The portaphone has built-in battery and charger.

Despite the small size of the transceiver it has a built-in duplex filter. The transceiver is built up with modules, either directly plugged to a mother board or via plug terminated cables. Thereby service, if needed, is simplified.

When a separate controller is used (see fig. B) an optional dual control box can be used. Two hand-sets can then be operated in parallel. A relay box for external calling indication is another option. This box has relay outputs (low voltage/2A) for music muting and for a calling indicator.

2. Technical data

A. General

Frequency range	: Transmitter	: 453.000MHz to 457.500MHz
	Receiver	: 463.000MHz to 467.500MHz
Principle		: Digital frequency synthesizer
RF - Bandwidth		: Max. 4.5MHz
Channel spacing		: 180 channels/25kHz. spacing
Channel switching time		: 40ms for 180 channels
Mode of operation		: Duplex, internal filter.
Duplex separation		: 10MHz with 4.5MHz RF - bandwidth.
Supply voltage		: 12V DC chassis neg. nom. 13.2V
Supply voltage variations		: 10.8 to 15.6V
Operation temperature		: -25°C to +55°C -30°C to +60°C but specifications not guaranteed.
Frequency stability		: Better than ±5ppm for the above specified temperature and supply voltage variations.
Vibration test		: According to the IEC publication 68-2-6.

B. For "hands free" operation

Loudspeaker	: external 4Ω
Audio output (regulated from control unit)	: Max. 3.5W at 5% distortion, 13.2V supply voltage.
Microphone	: 1kΩ condenser microphone.
Input level	: 2mV RMS for ±3kHz dev. at 1kHz tone.

C. For "handset" operation

Output from handset receiver (25Ω with built in amplifier and filter)	: Max. 115dB above $2x10^{-5}$ Pascal at 1kHz tone ±3kHz deviation. Nominal 90dB above $2x10^{-5}$ Pascal at 1kHz tone ±3kHz deviation.
Vol. requlated from control unit (nominal level adjusted internal in radio)	: -10dB and +15dB from nominal level.
Line level from radio unit	: 200mV RMS at 1kHz tone ±3kHz deviation. 560mV RMS at max. vol.

The Deemphasis is located in the radio unit.

Handset microphone sensivity (1kHz condenser microphone with amplifier and filter)	: 94dB above $2x10^{-5}$ Pascal free field sound pressure at 1kHz will produce a Tx deviation between ±3 and ±4.5kHz.
Line level from handset	: 100mV RMS at 1kHz tone ±3kHz deviation on transm.

The preemphasis is located in the radio unit.
A 5Ω loudspeaker is located in the handset.

Antenna impedance	: 50Ω
Power consumption for NMT	: Standby: 13.2V 0.7A for E-Prom version 0.55A for mask programmed. Tx 15W: 13.2V 5A.

D. Receiver

Sensitivity		: Typ 0.3µV (½EMF) for 20dB sinad psophometric.
Squelch level internal adjusted		: 0.4µV (½EMF)
Co-channel rejection	: Cept method	: -7.5dB
	NMT method	: -6.5dB
Adjacent channel rej.	: Cept method	: 72dB normal test conditions
	NMT method	: 74dB normal test conditions

Spurious and image rej.	: Cept method	:	>70dB in duplex. Image 90dB
	NMT method	:	>70dB in duplex. Image 90dB
Intermodulation rej.	: Cept method	:	>70dB
	NMT method	:	>67dB
Blocking	: Cept method	:	>100dB
	NMT method	:	>100dB
Spurious emissions	: Antenna	:	<2nW
	Cabinet	:	<2nW
Deemphasis		:	Following 6dB per octave curve from 0.3 to 3kHz within +1-3dB relative level at 1kHz.
Harmonic distortion		:	NMT method: 2%

Audio frequency

Intermodulation	:	NMT method: -25dB
Hum and noise	:	Cept method: -50dB RMS Psophometric NMT method: -50dB RMS Psophometric NMT method: -30dB Peak
AM suppression	:	NMT method: 34dB
Function of limiter	:	NMT method: <0,5dB

E. Transmitter

Power output		:	15W ±1dB from -25^{o}C to +55^{o}C between 10.8 and 15.6V.
Power reduction for NMT		:	Power reduced to 1.5W ±3dB.
Carrier rise time		:	<1ms
Carrier fall time		:	<1ms
Spurious emissions:	Antenna	:	<0.25µW
	Cabinet	:	<2.5µW

Adjecent channel power	:	76dB below carrier power at ±25kHz.
Frequency deviation	:	Max. ±4.7kHz. (supervisory ±300Hz)
Preemphasis	:	Following 6dB per octave curve from 0.3 to 3kHz within +1-3dB relative level at 1kHz.
Harmonic distortion	:	2% at ±3kHz deviation and 1kHz mod. frequency
Audio intermodulation: NMT method	:	-24dB
Hum and noise in "handset" operation		
(residual mod.): CEPT method	:	-48dB RMS psophometric
: NMT method	:	-48dB RMS psophometric
: NMT method	:	-24dB Peak

3. Description of the simplified block diagram

The radio contains a full duplex transmitter/receiver, a data modem and a CPU. The CPU communicates with the base station via the modem which converts digital information to an FFSK (Fast Frequency Shift Keying) signal and reverse. It also communicates with a µP in the handset/control unit (HS/CU) and with circuits in the radio.

In the manual the designation "active handset" is used for a handset with a keyboard and a display built in. The "passive handset" does not have the keyboard and the display. In this case these functions have been moved to a separate "control unit". Functionally there is no basic difference between the two cases.

When a call has been established the base station transmits a 4kHz supervisory (pilot) signal together with the speech. The tone is looped back by the mobile radio. At the base station (BS) the received tone is evaluated. A poor signal/noise ratio gives automatic switching to a more close BS or in the worst case disconnection of the call.

References

1. Teleteknik, 1982, No. 1
2. NMT DOC. 1-4

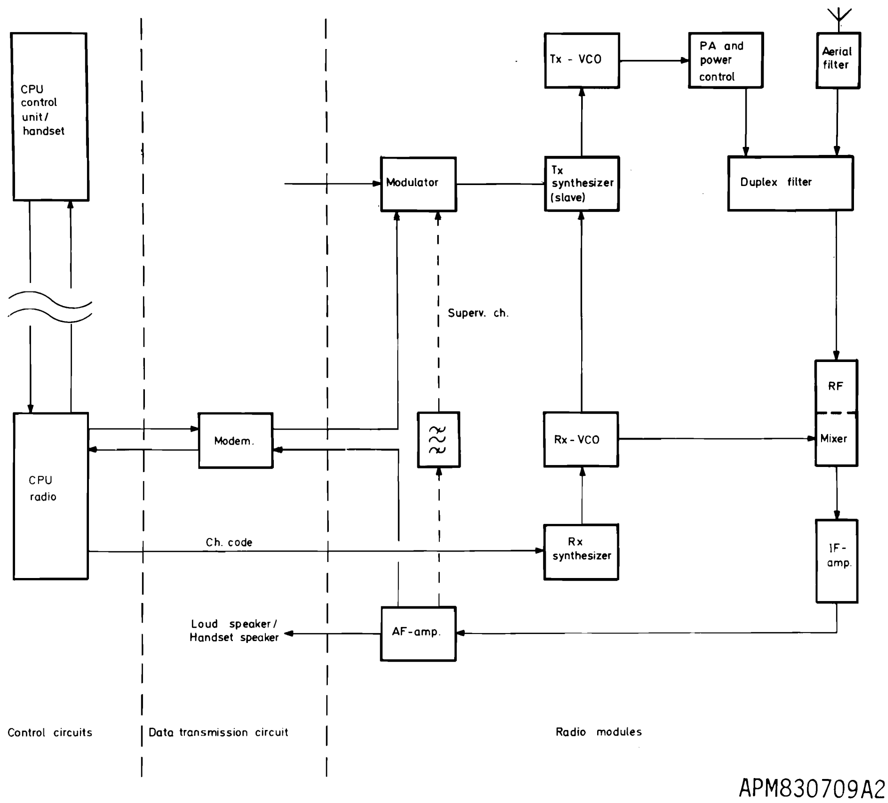
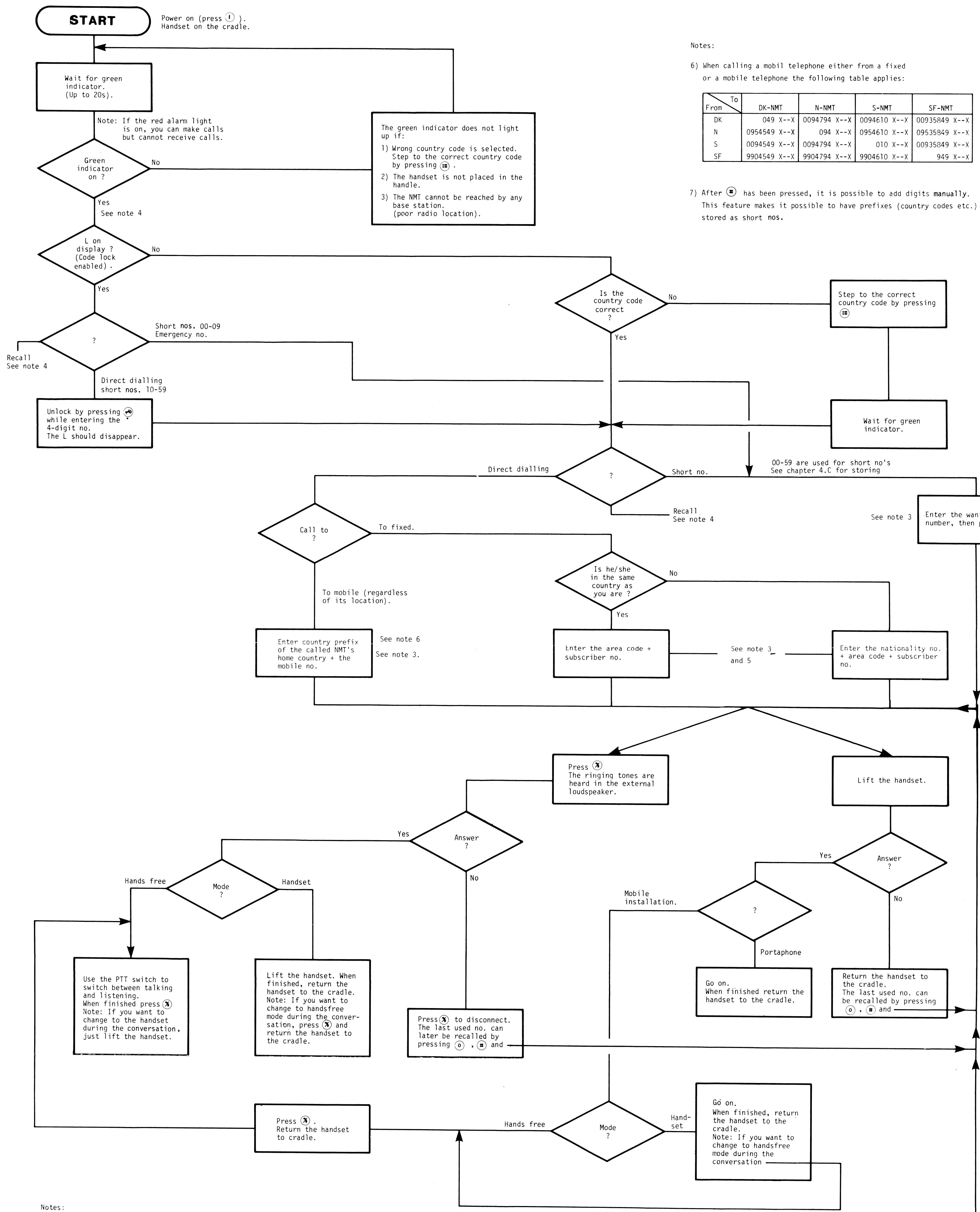


Fig. 3-1 Simplified block diagram

4. Directions for use

A. Call from mobile telephone

Call from mobile telephone



Notes:

6) When calling a mobil telephone either from a fixed or a mobile telephone the following table applies:

From \ To	DK-NMT	N-NMT	S-NMT	SF-NMT
DK	049 X--X	0094794 X--X	0094610 X--X	00935849 X--X
N	0954549 X--X	094 X--X	0954610 X--X	09535849 X--X
S	0094549 X--X	0094794 X--X	010 X--X	00935849 X--X
SF	9904549 X--X	9904794 X--X	9904610 X--X	949 X--X

7) After ■ has been pressed, it is possible to add digits manually. This feature makes it possible to have prefixes (country codes etc.) stored as short nos.

Notes:

1) Locking can be done when the handset is on the cradle and with blank display.
Press ⊸ three times. When locked the 10 first short nos. (00-09), emergency nos. and last used no. (see note 4) can still be used and calls can be received.
2) Your telecommunication administtation offers services not covered by this flow-chart e.g. re-routing of calls.
3) Number entered by mistake can be deleted by pressing ■ twice.
4) The last used no. can be recalled by pressing ⓞ, ■ and ⟶
5) The same number as when a fixed telephone is used.

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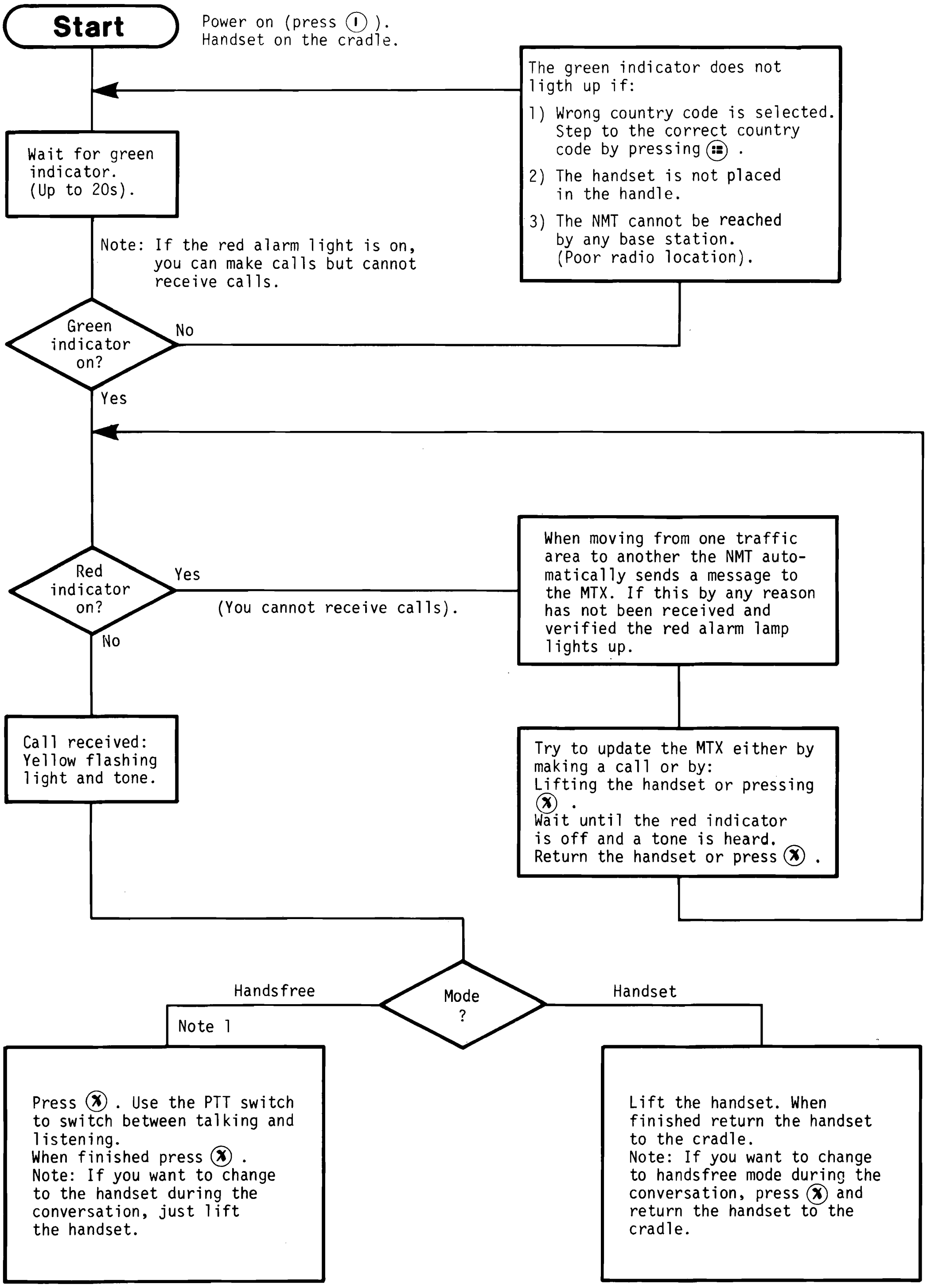
Fig. 4-1 Call from mobile telephone

B. Receiving calls



Note 1: When using the portaphone, you can only use the handsfree mode when waiting for answer or when contacting the weather report, news service etc. as the handset microphone cannot be used.

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Fig. 4-2 Receiving calls

C. Storing short numbers

It is possible to store up to 60 telephone numbers. They can thereafter be recalled by entering a short number (two digits 00-59). The design is such that the first ten numbers (00-09) can be used also if the code lock is enabled.

Storing of telephone numbers

- The display must be blank (unlocked dondition).
- Press (*). H is displayed.
- Enter the short number (00-59).
- Press (*). H xx H is displayed.
- Enter the telephone number (including eventual prefixes).
- Press (#) and then (*) (Blank display).

Deleting a stored telephone number

- The display must be blank (unlocked condition).
- Press (#).
- Enter the short number.
- Press (#) and then (*).

Checking of which number is stored

- Enter the short number.
- Press (#). The corresponding telephone number is shown.
- Press (#).

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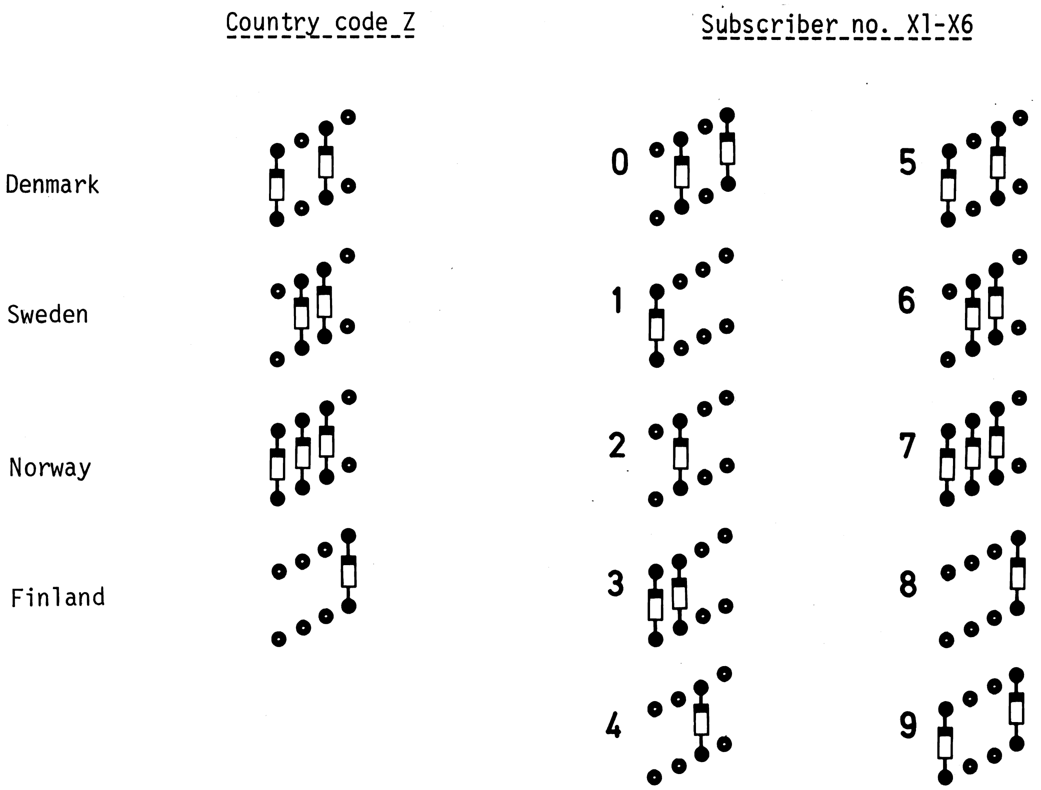
Configuration and installation

5. Configuration

A. Telephone number coding

The coding is done by cutting the correct diodes on the CPU-board N15, i.e. when delivered from the factory, diodes are mounted in all positions.
The telephone number is built up with 7 digits of which the 1st is the country code.
See fig. 5-1 for the location of the diodes.



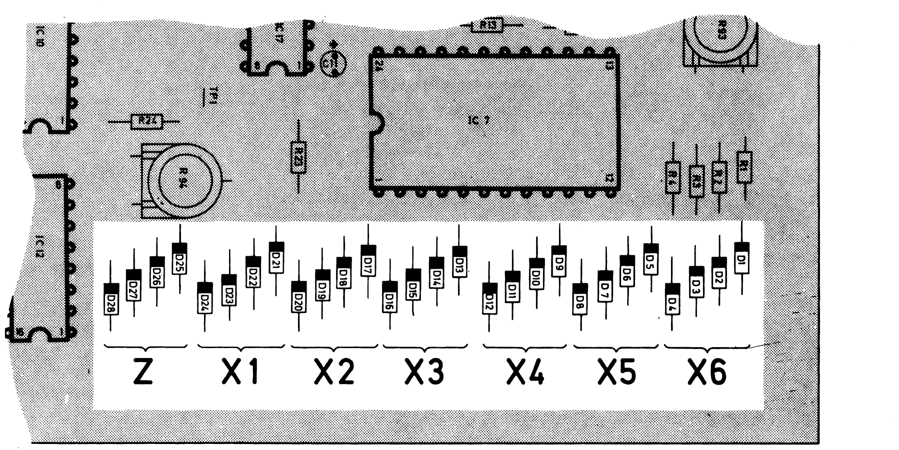


Fig. 5-1 Location of coding diodes for telephone number.

X1 = 7 vest for storbolt
- = 9 øst - -
X[illegible] [illegible] 2 [illegible]

B. Code lock

When delivered all NMT's have been given the code 1,2,3,4.
This can be changed according to customer requirements with the following procedure.

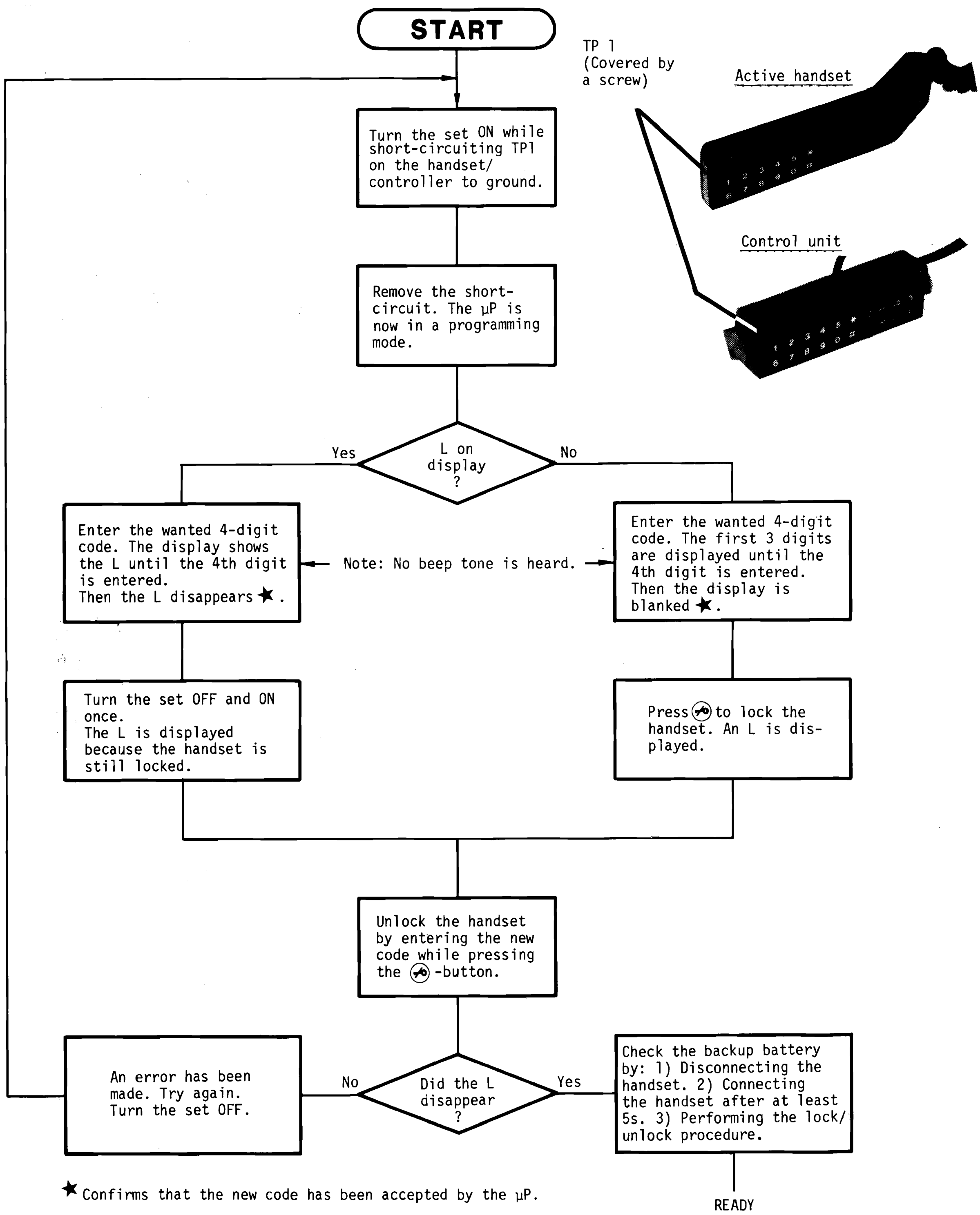


Fig. 5-2 Code lock programming.

6. Installation instructions

A. Active handset

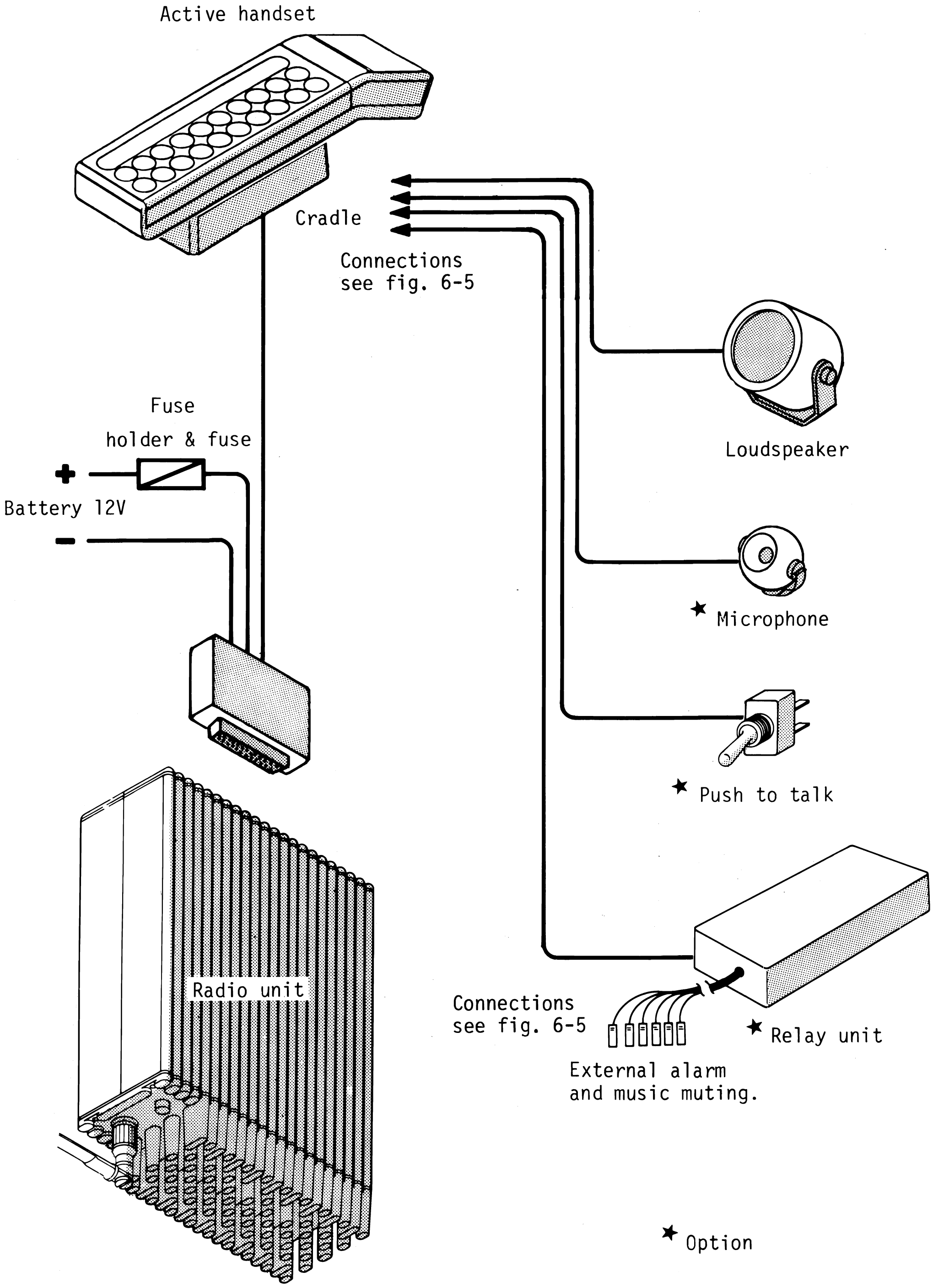


Fig. 6-1 Installation with active handset

B. Passive handset

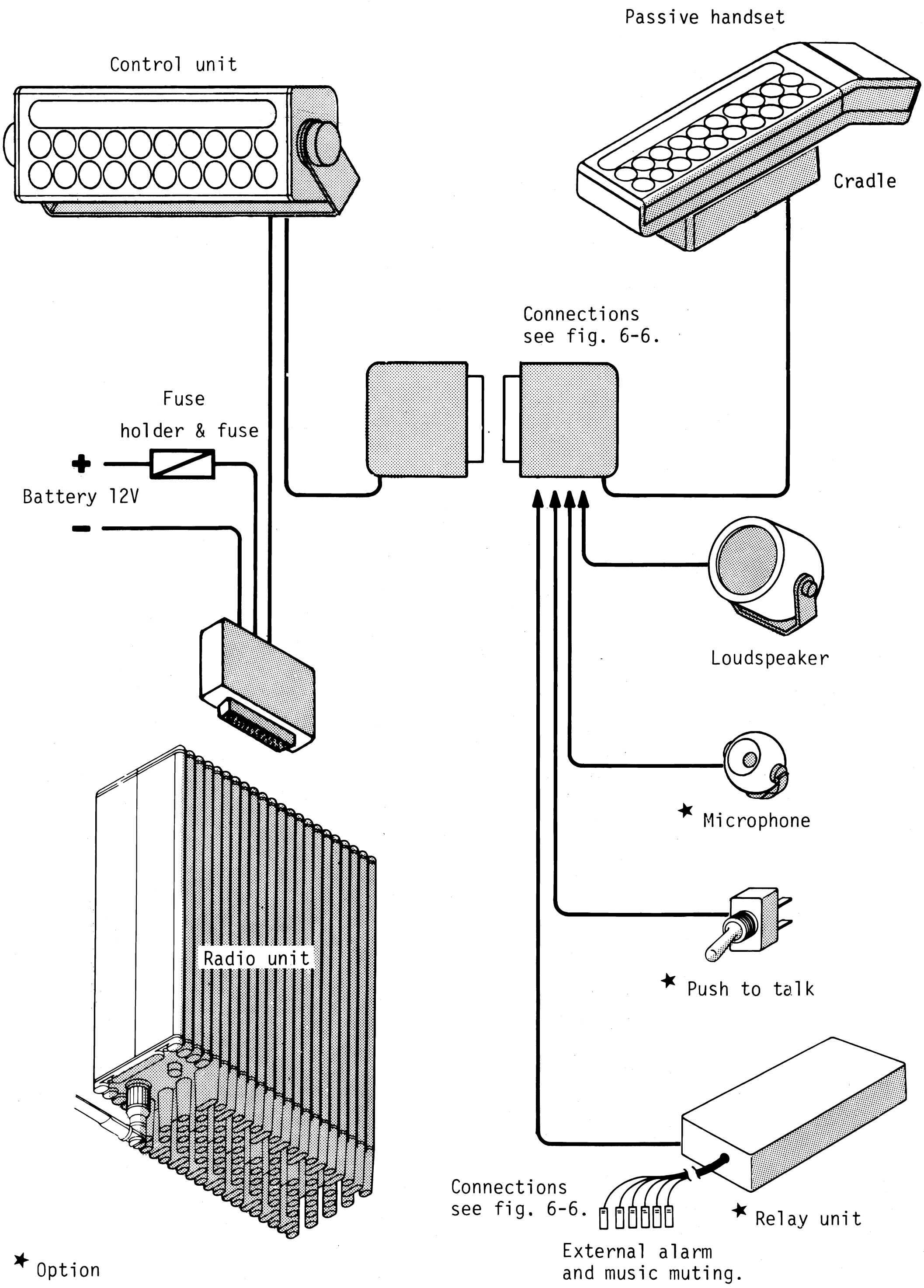


Fig. 6-2 Installation with passive handset

C. Ackerman handset (passive)

The connections are the same as in B.

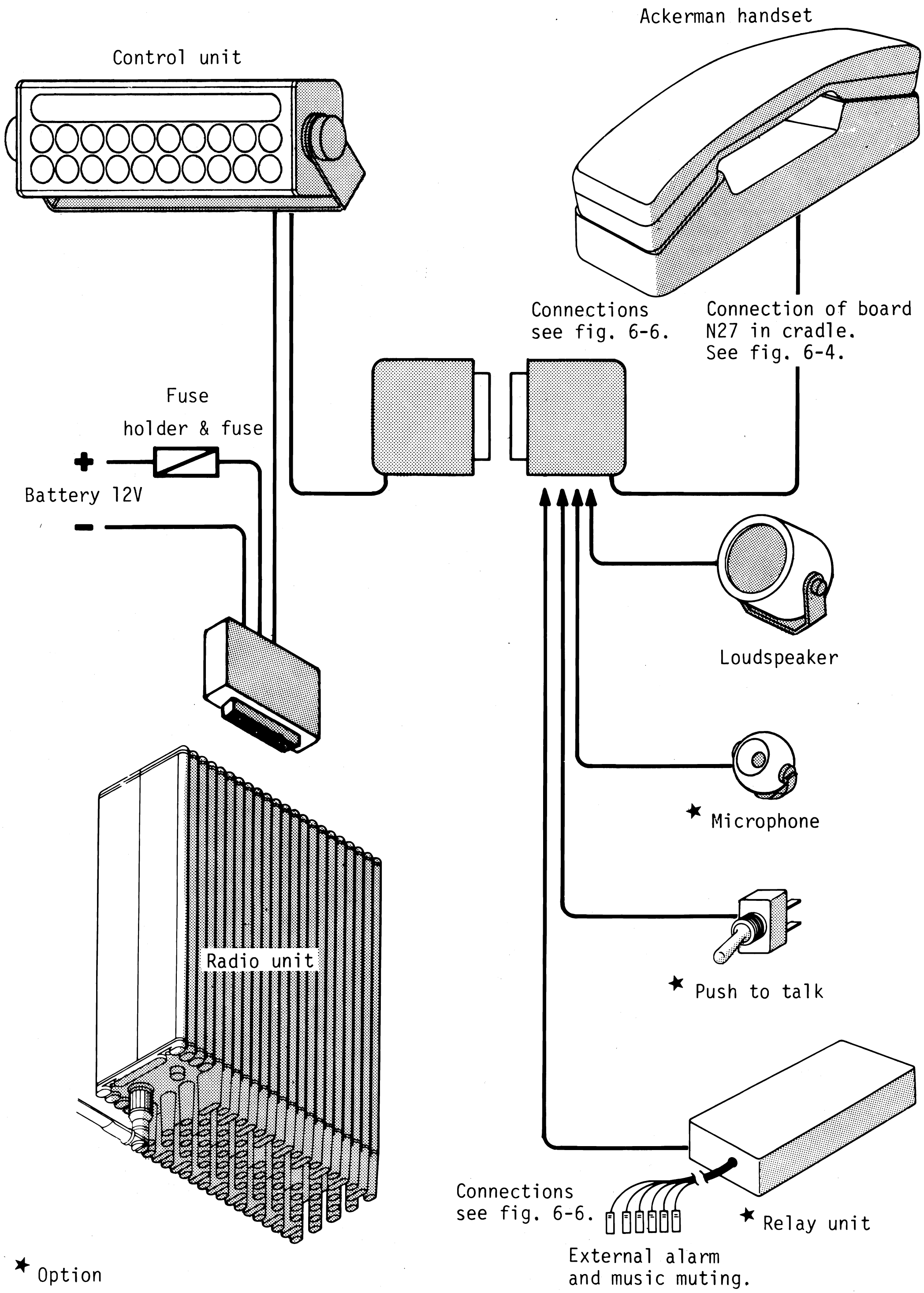


Fig. 6-3 Installation with Ackerman handset

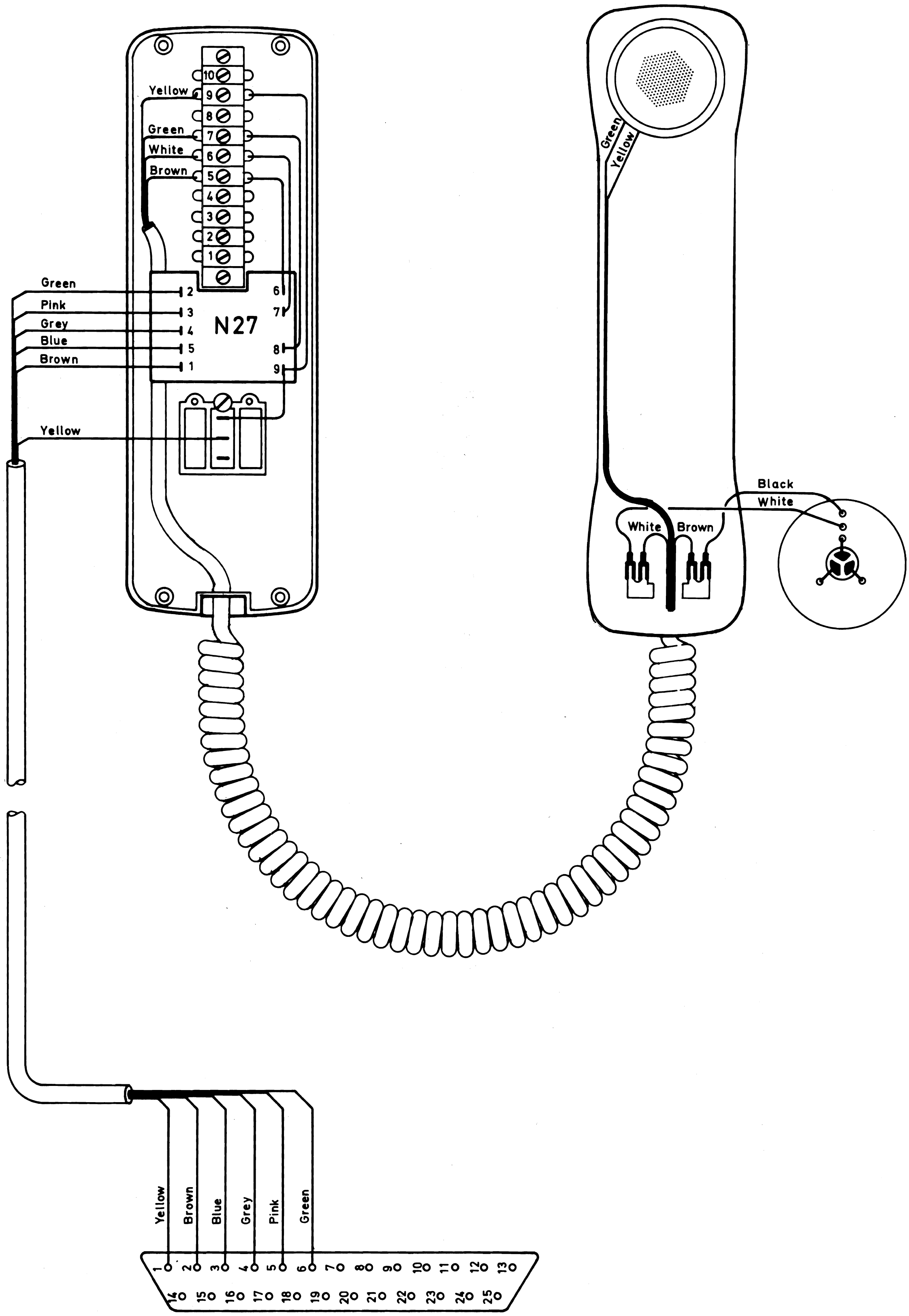


Fig. 6-4 Installation of board N27 in Ackerman cradle.

D. Relay unit and handsfree accessories when active handset is used

See fig. 6-1

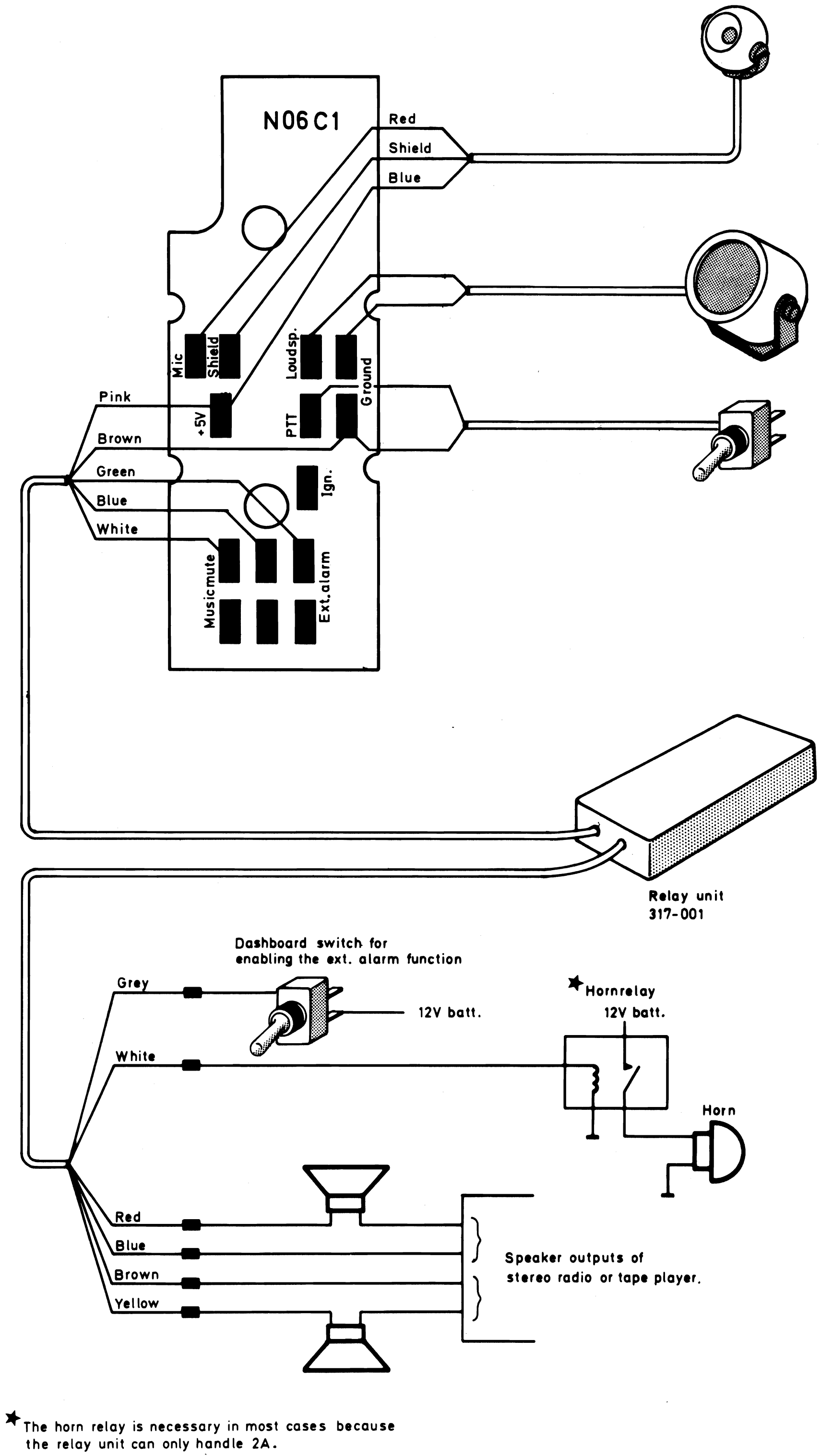
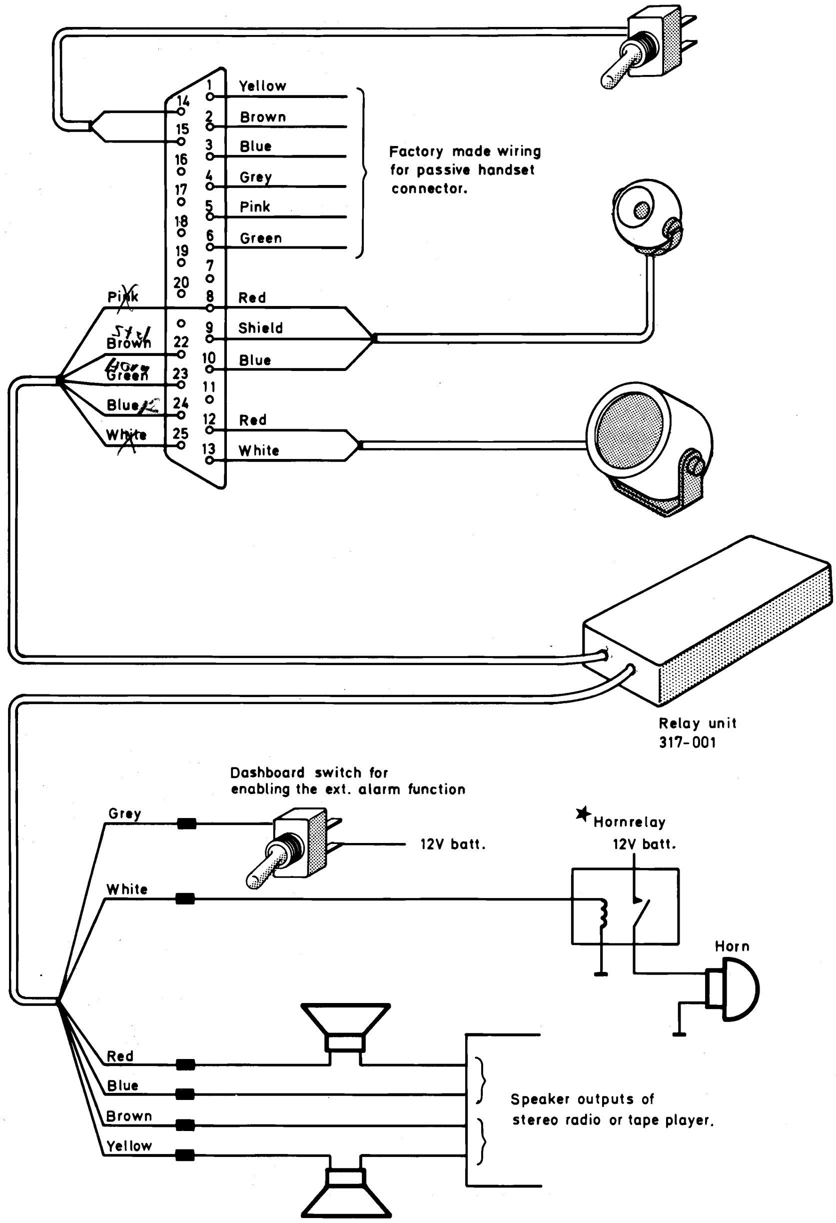


Fig. 6-5 Connection of accessories. Active handset

E. Relay unit and handsfree accessories when passive handset is used

See fig. 6-2 and 6-3



*The horn relay is necessary in most cases because the relay unit can only handle 2A.

Fig. 6-6 Connection of accessories. Passive handset

AP3533
Service instructions

7. Description of the radio unit

Introduction

In the following chapters the circuitry of the units will be explained.
The description of the handset/controller and accessories and the tuning instructions are not covered here as they have separate sections.
Please remember the following notes:

- The diagrams are provided with figures for reference; [2] in the diagram for example, refers to oscillogram no.2 (TP2) in the diagram, for example, refers to the test point 2 on the printed wiring board.
- The logic levels are indicated by the signal names $\overline{\text{TX on}}$/off means that a high level (+5V) gives TX off condition while a low level gives TX on condition.
- The battery voltage is shown as +13.2V.
  The reason is that this voltage is the one which is used during checking and adjusting.

The block diagram is, to a large extent, selfexplanatory. The following remarks are intended as a guide to the use of the diagram. The arrows in the block diagram indicate the signal paths through the circuits, and the main signal paths are indicated by heavy lines. The block diagram is divided into three main sections: Transmitter, receiver and common circuits.

The radio unit contains many functions of an ordinary mobile radio for a closed net. Examples: Channel selection, squelch and volume control. The difference is that the radio is completely remote controlled. All these functions are controlled by a built in microprocessor. This is mounted on the CPU. The CPU can regarded as a "black box" which is fed with information from the handset, the radio and the MTX (telephone exchange for NMT). The information is treated according to a program stored in a PROM. The result is commands to the handset, the radio and MTX. For communication with the MTX, the radio speech path is used. As this is of limited bandwidth it cannot be used directly for data transmission. Therefore the data stream is converted to audio type signals in a MODEM (modulator/demodulator).

Receiver

RF, mixer, IF and detector N10 & N12

The received signal is via the duplex filter fed to N10.01. The RF amplifier consists of two cascade coupled transistors Q1,2. Six tuned helical coils are tuned for a passband about 463 - 468MHz. The mixer Q3 is fed by a local oscillator at 21.4MHz above the received freqeuency. The oscillator injection affects the DC level at TP2. The 21.4MHz crystal filter has a bandwidth of about 25kHz. The 21.4MHz IF is converted to a 2nd IF of 455kHz. The 455kHz IF signal is fed to the quadrature detector IC1. The detector phase shift is adjustable with L1. The 455kHz IF is also fed to the AGC amplifier on daughter board N09. The output on N12.04 is a DC voltage in the range 0-3V depending on the field strength. A high dynamic range is obtained by regulating IC2 with the output voltage.

AF amplifier NO2

The AF amplifier is mounted on the same board as the modulation amplifier. The AF from N12 is fed to IC1/4 which removes very low frequencies. The output of IC1/4 is fed to the AF amplifier, the squelch circuit and to the supervisory signal circuit. IC3 forms a notch filter which prevents the supervisory tone from being audible. IC4 is a variable gain amplifier controlled by the CPU. Gain is controlled by the voltage to N02.04. The CPU controls blocking of either the complete speech path (N02.05) or the loudspeaker output only (N02.06). Q1 and Q2 interrupts the signal path when N02.05 and N02.06, respectively, are grounded. After the transistor switches Q1 and Q2, the outputs from a ringing signal oscillator and a malfunction oscillator are added to the speech path. The oscillators are enabled by commands from the CPU. The supervisory signal circuit picks out the 4kHz supervisory tone with two stagger tuned BP filters. These are tuned to 3855Hz and 4145Hz respectively. When the supervisory tone is received it will be re-transmitted by the radio, provided that N02.12 is high. I.e. the supervisory tone is fed to the modulation amplifier. Q3,4 form an HP filter which picks out the noise obtained when the received signal (if any) is weak. The noise is detected and in IC6/2 the resulting DC is compared with the level set by R52 "Squelch adj.".

Receiver synthesizer loop NO3 & NO8

The receiver synthesizer loop contains the units N03 and N08. The circuit gives a signal in the range 484.4 to 488.875MHz and in 25kHz steps. This corresponds to the received frequency + 21.4MHz. The frequency is determined by a channel code from the CPU. The output is used as receiver local oscillator and as a control signal for the transmitter synthesizer loop. For the PLL the VCO signal at N08.03 is fed back to N03.03. In IC1 and IC2 it is divided with a ratio determined by a 16-bit number. The 4 most significant bits are obtained from an internal switch (always the same setting in NMT). The other 12 bits are obtained from the CPU. The 16 bits are fed to the programmable divider IC2 over 4 lines only. This is possible because IC2 has a latch circuit and the multiplexers IC3 and IC4 send in suquence 4 bits at a time. This is done on command from IC2 with the data select lines.

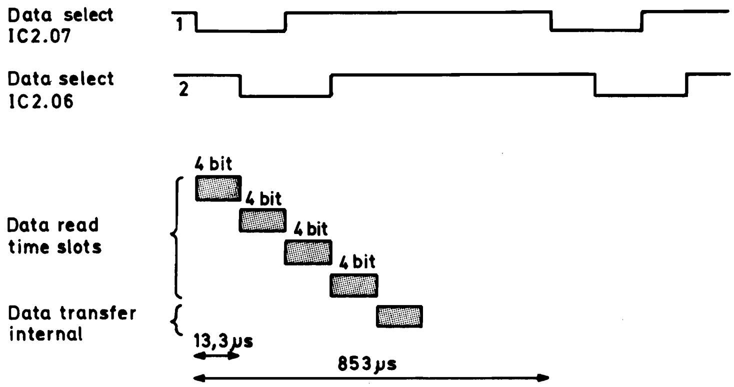


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Fig. 7-1 Multiplexing the channel number

To divide fvco down to 25kHz it is necessary to have a programmable divider which can divide by fractions of units. This is performed by IC1 and IC2 in co-operation. The internal programmable divider in IC2 (set by the channel code) gives the coarse division ratio, while the fine division ratio is obtained with IC1. This is a 4-modulus counter which divides according the control A and B inputs (see fig. 7-2).

Control A	Control B	Ratio
1	1	256
0	1	255
1	0	240
0	0	239

Fig. 7-2 Divide ratios of N03/IC1.

The division ratio of IC1 is 256 most of the time. To get the "fine" division ratio this is occationally changed to 239, 240 or 255. This is controlled by IC2.

The following equation applies for the synthesizer:

$$N = \frac{fvco}{0.025} - 3840$$

N= channel code (decimal) from CPU + 49152 (fixed from S1)

fvco = output frequency (MHz) of N08.

Transmitter

Modulation amplifier NO2

The modulation amplifier is mounted on the same board as the AF amplifier. The transmitter can be modulated with the handset microphone (mic.2), the handsfree microphone (mic.1), the modem and the supervisory tone. The CPU selects which source shall be connected. With the control signal to NO2.15 either the handset or the handsfree microphone is selected. The preemphasis of the selected microphone signal is done with C53. IC8 forms together with Q8-10 a compressor which keeps the modulation constant. Q8 is a voltage controlled attenuator. This is via the loop amplifier Q9,10 controlled by the output of IC8/2. The microphone(s) can be disconnected by the CPU. This is done by disabling IC8/3 (NO2.02 LOW).

Transmitter synthesizer loop N18 & NO7

The transmitter synthesizer loop contains the units N18 and NO7. The VCO in NO7 operates as a slave oscillator with an output of 31.4MHz below the RX VCO. This is the wanted transmitter frequency and corresponds to 10MHz duplex separation (31.4 - 21.4MHz = 10MHz). After the mixer N18/Q2 the difference frequency (RX VCO - TX VCO) is obtained. This frequency (31.4MHz when locked) divided by 4 in IC1 gives 7.85MHz. IC1 also contains a phase comparator. It compares the down divided difference frequency with 7.85MHz obtained from the VCXO (Voltage Controlled X-tal Oscillator). In addition to providing the reference frequency, the VCXO is the modulated stage. The modulation signal is obtained from NO2.19. The modulation amplifier IC2 operates in push-pull mode. Thereby maximum voltage variation is obtained across the capacitance diode D2.

PA and power control NO5

This unit contains four tuned amplifiers. The output power is blocked if either the TX or RX synthesizer pulls NO5.02 low. This happens when the synthesizer loops are not locked. The settling time for the stabilizing loop is less than 0.5ms. Total bandwidth of the amplifier is about 10MHz. The PA (power amplifier) is by the CPU switched to 1.5W (N05.04 low) or 15W (N05.04 high) output power. These levels are adjusted with trimpotentiometers.

Common circuits

CPU N15

The CPU (Central Processing Unit) can be regarded as a "black box" which is fed with status information (high or low) to input ports, e.g. squelch condition.
One of the inputs, N15.03, is fed with an analog signal. This is the field strength signal from the IF amplifier. The analog signal is converted to a high or low level with the comparator IC17/2. The switch level is adjustable with the trimpotentiometer R94.
Via terminal N15.25 the CPU is fed with data from the modem. This serial data is arranged in frames so that the CPU can separate different information, e.g. channel number, call etc. Via terminal N15.19 the CPU receives information from the handset/control unit (abbreviated HS/CU in some signal names). All the received information is processed according to programmes stored in the PROM IC2.
The resulting output information is fed to the output ports. One of the outputs N15.36 has a DC level which can take one of 15 values (volume control). The level can be stepped by the 🔊/🔉-buttons on the handset/control unit. The level is set via the digital-to-analog converter IC17 determined by IC7.17-20. With R93 a "mean" volume is set. The CPU also has serial data outputs to the modem and to the handset/control unit. IC5-7 are expanders that make it possible for the microprocessor IC1 to have more inputs and outputs than the number of pins otherwise would allow.
During checking and adjusting the function of the CPU is taken over by a test box which is connected to the CPU. When the power is switched on, the CPU is kept passive by a low level to IC1.04. After a delay, the reset circuit Q11,12 pulls IC1.04 high so that the programme execution can start. The μP starts with setting the output of the unit to certain conditions. Then the telephone number which is set by the diodes Q1-28 is read and stored in the RAM. Now the μP starts channel scanning. In order to distribute call attemps evenly among all free marked traffic channels, the scanning starts from a channel selected at random. A random number is taken from IC10 which is a binary divider clocked by the down-divided crystal frequency. The random number is by the μP converted to a random channel number which is fed to the receiver synthesizer. The scanning stops when a base station with a FFSK signal is found and with sufficient field strength. Checking of field strength is done with the "Field strength" input N15.03. If the field strength is too low the scanning continues, otherwise the FFSK is checked with the "RX data present" signal N15.24. If the received signal disappears during conversation (squelch off), the radio is switched off after about 30s.

This can happen, e.g. when driving through a tunnel, into a garage etc. This function is called "Time out". IC11 is clocked by the lowest frequency output of IC10. The output of IC11 is normally low, as the µP now and then resets IC11 and thus prevents IC11 to count the whole cycle. If the µP does not detect squelch during conversation the resetting of IC11 stops. Thereby IC11.12 goes high and the power is switched off (see handset/control unit).

Modem N14

The modem (modulator/demodulator) is the interface between the CPU and the transmitter/receiver. Thereby full duplex data communication between the CPU and the base station/MTX is possible.

Demodulator

The audio from the receiver is fed to N14.08. Noise is removed with the BP filter IC1 which forms an HP and an LP filter in series. Demodulation takes place in the PLL circuit of IC2. This IC contains a VCO which is adjusted by means of R1. A full period of 1200Hz gives a "1" while $1\frac{1}{2}$ period of 1800Hz give a "0" (same duration). When the PLL is locked, IC2.05 is low. Via the inverter IC14/1 this gives a high level at N14.11. R20 and C8 suppress noise which could otherwise give a false "Data present" signal. The data transmitted from the base station is arranged in frames of 166 bits, see fig. 7-3. Every other bit in the encoded message is a parity bit. The feature of this system is that error correction can be made (by inverting an erronous "1" to "0" and reverse). In order to separate the encoded message from the bit and frame sync, the decoder delivers data output only when the frame sync word is detected. The true frame sync detect pulse is obtained at IC13.13 and is fed to the clock input of IC8/2. The circuit with IC26 and IC9 gives a synthetic frame sync detect pulse if the received frame sync bits are disturbed. This signal is taken out by the diode matrix D9,10,13&15 from the shift register IC9 which is clocked by the 1200Hz regenerated clock. An "end of frame" pulse is taken out via the diode matrix D11,12&14. The events are synchronized by a regenerated clock signal derived from the incoming data stream.

1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 1 1 1 0 0 0 1 0 0 1 0 - - - - - - - - - - - - - - - - - -

Bit sync	Frame sync	Encoded message
15 bits	11 bits	140 bits

Fig. 7-3 Frame structure

The 1200Hz regenerated clock is obtained by dividing the 144kHz from the modem receiver. This is done in two steps. IC6 has a nominal division ratio of 12 and IC5 divides by 10. IC6 is programmable with the levels to pins 5,11,14&2. The D flip-flop IC8/1 measures the phase difference between the regenerated clock on Tp5 and the data transitions. Thereby it can change the division ratio of IC6 to 11 or 13 in order to obtain synchronization. The regenerated clock frequency is twice the data frequency in order to obtain reading of data in the expected middle of the bits.

Modulator

The data from the CPU is already coded with every second bit a parity bit. The modulator just converts the 1200 baud signal to an FFSK signal (fast frequency shift keying). A "1" gives a full period of 1200Hz while a "0" gives a 1½ period of 1800Hz. The microprocessor initiates a data transmission by pulling the "TX data reset" line low. Thereby the frequency divider IC23 delivers 18kHz and 72kHz. The 18kHz signal is via IC25/2 used to clock the decimal counter IC21. The 72kHz signal is divided by 3 in IC22/1 to give 24kHz. The other half, IC22/2, is clocked by the 24kHz signal and delivers 12kHz to the decimal counter IC21.

IC25/1 detects when IC22/2 reaches the zero state. Then IC25/1 feeds pulses with a 2.4kHz repetition frequency to the clock input of IC20/1 which divides by 2. The positive flanks of the resulting 1200Hz signal (TX clock) are used by the CPU which presents new data bit by bit. The synthetic sine-wave signal is filtered so that a clean sine-wave signal is obtained.

Motherboard NO1

In addition to performing various interconnections the motherboard contains a power on/off relay. The relay is controlled by a S/R flip-flop in the handset/control unit. The switched voltage is regulated to +5V and +9V. The battery voltage is routed via the relay to many units. The power for the two final transistors in PA NO5 is taken out before the relay. As they operate in class C they do not consume power when the power is switched off. The reason for this arrangement is to avoid the high relay switching current which would be caused by accidental "power off" during conversation.

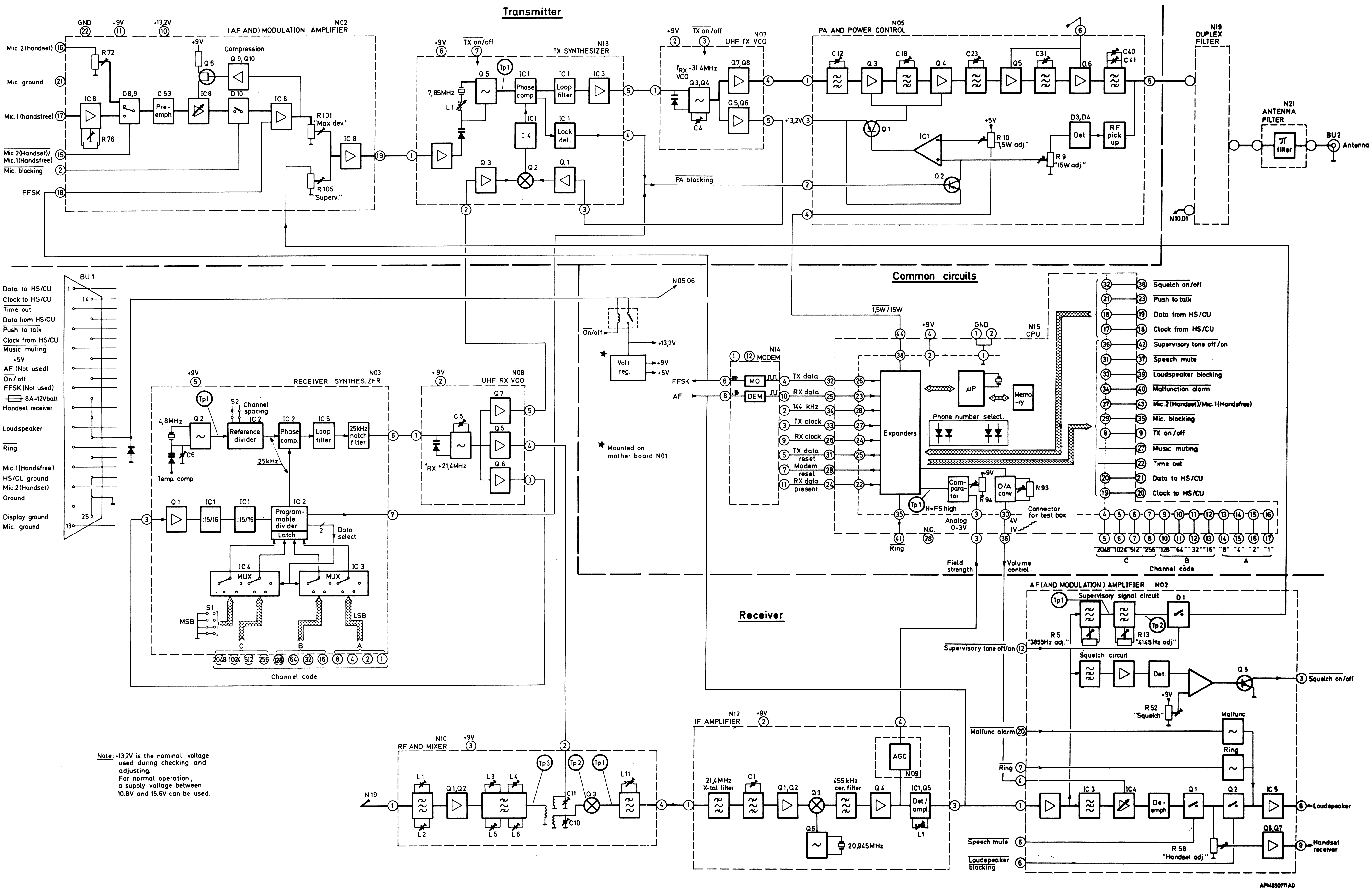


Fig. 7-4 Block diagram, radio unit

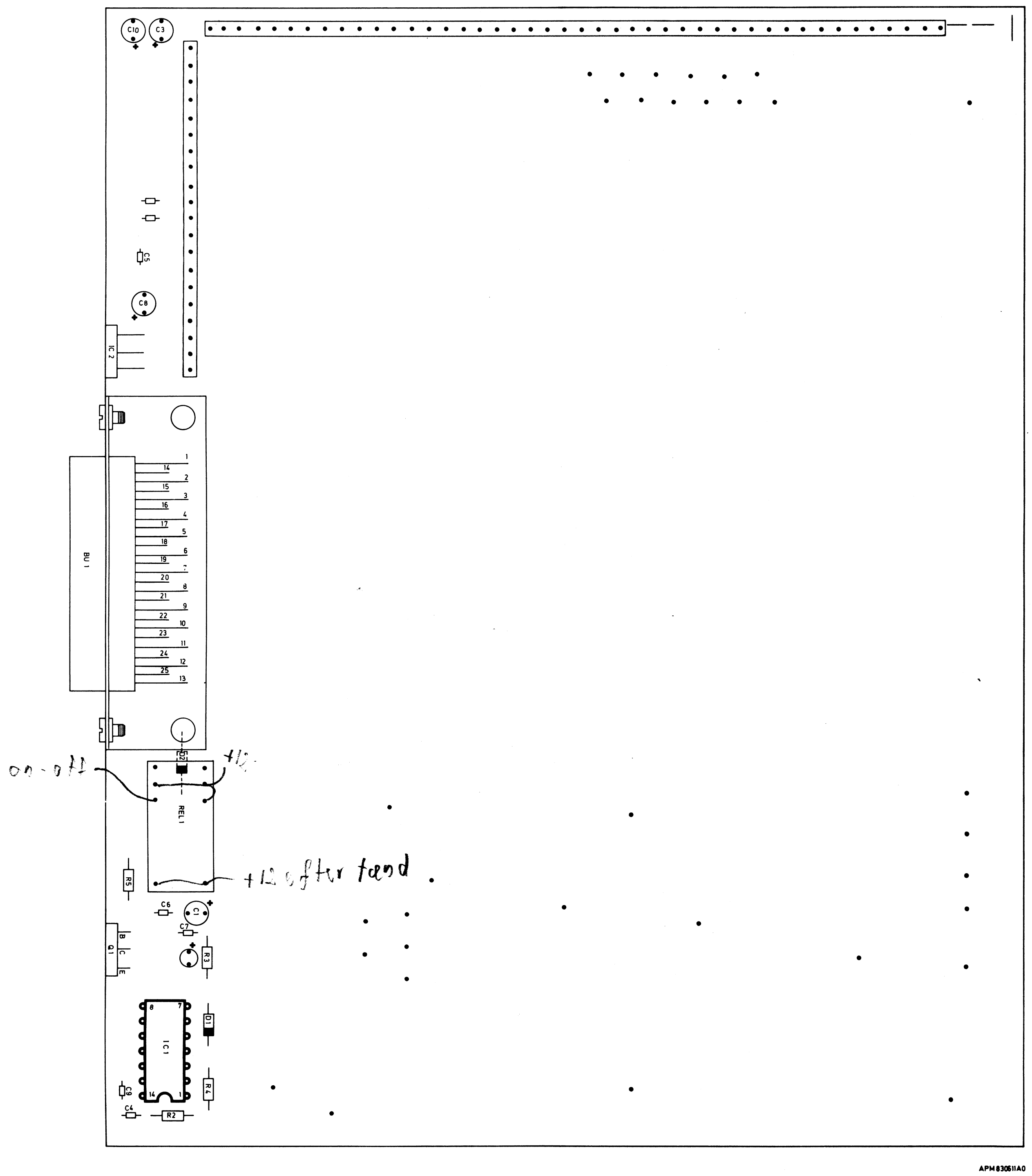


Fig. 7-5 Component location, mother board, N01E

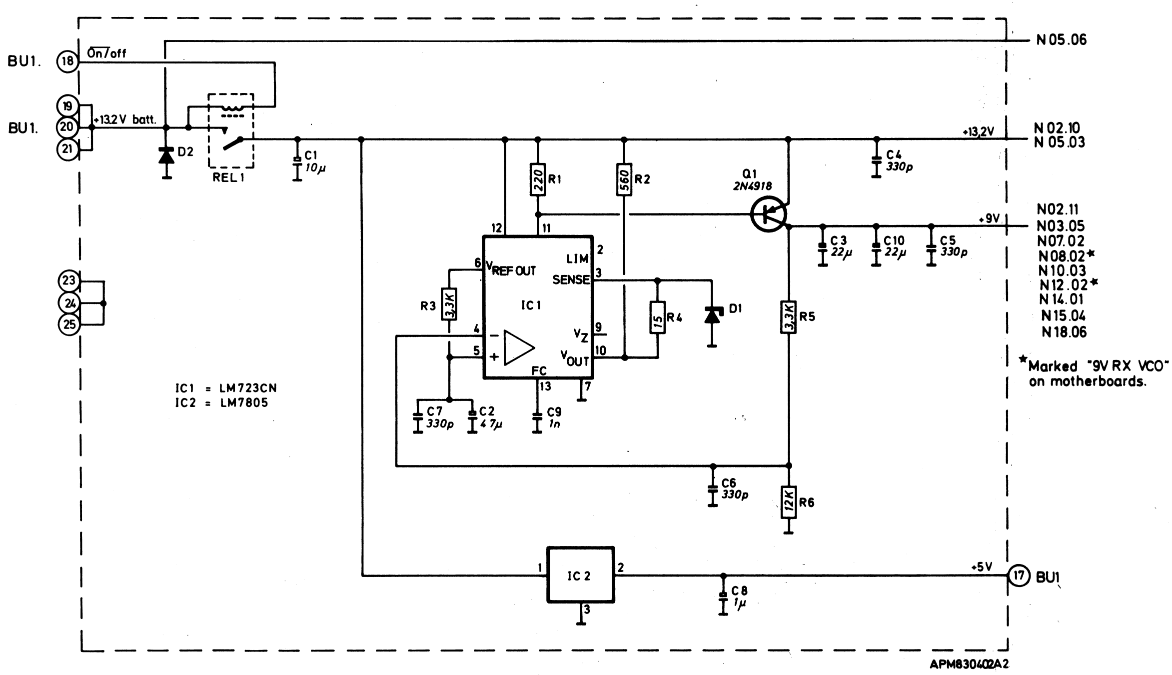
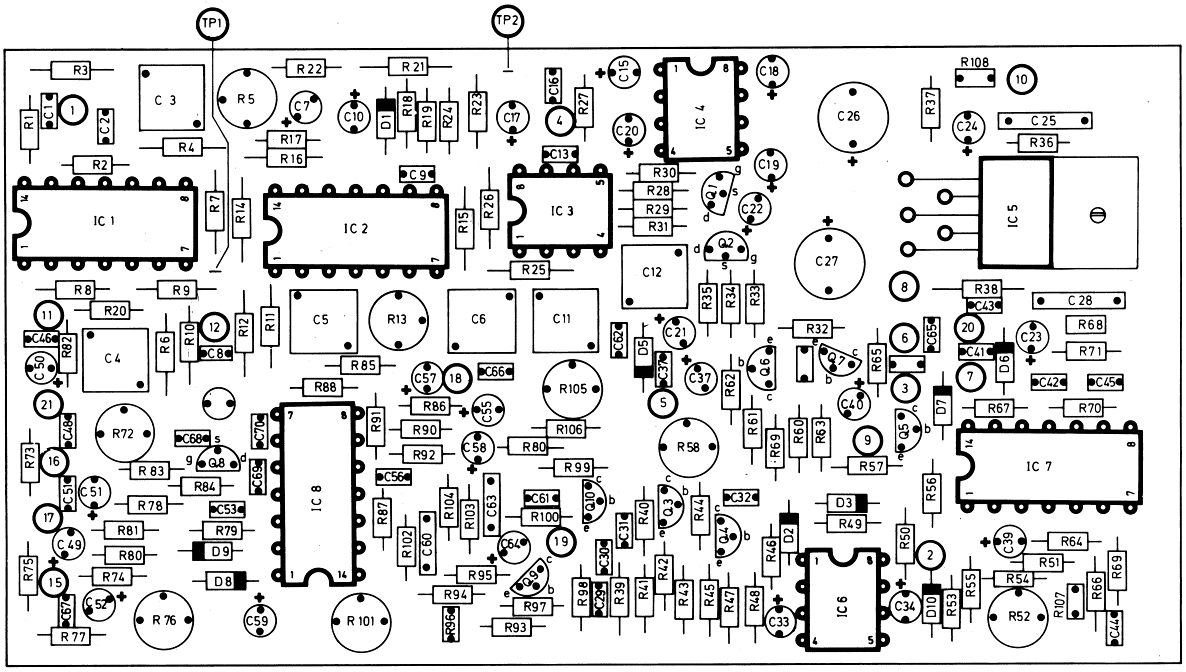


Fig. 7-6 Circuit diagram, mother board, N01E



APM 830414A2

Fig. 7-7 Component location, AF and modulation amplifier, NO2E sec. 1

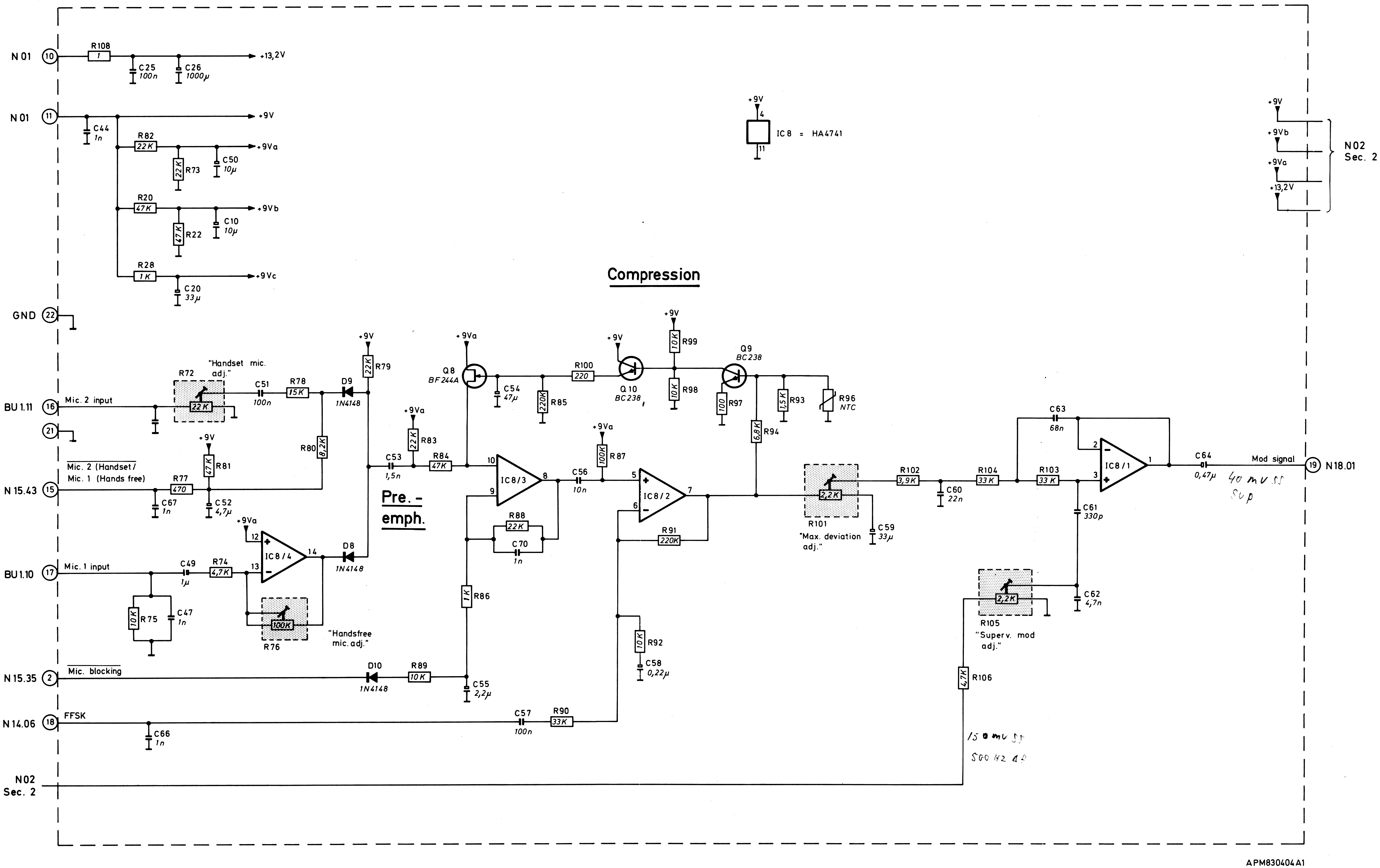


Fig. 7-8 Circuit diagram, AF and modulation amplifier, NO2E sec. 1

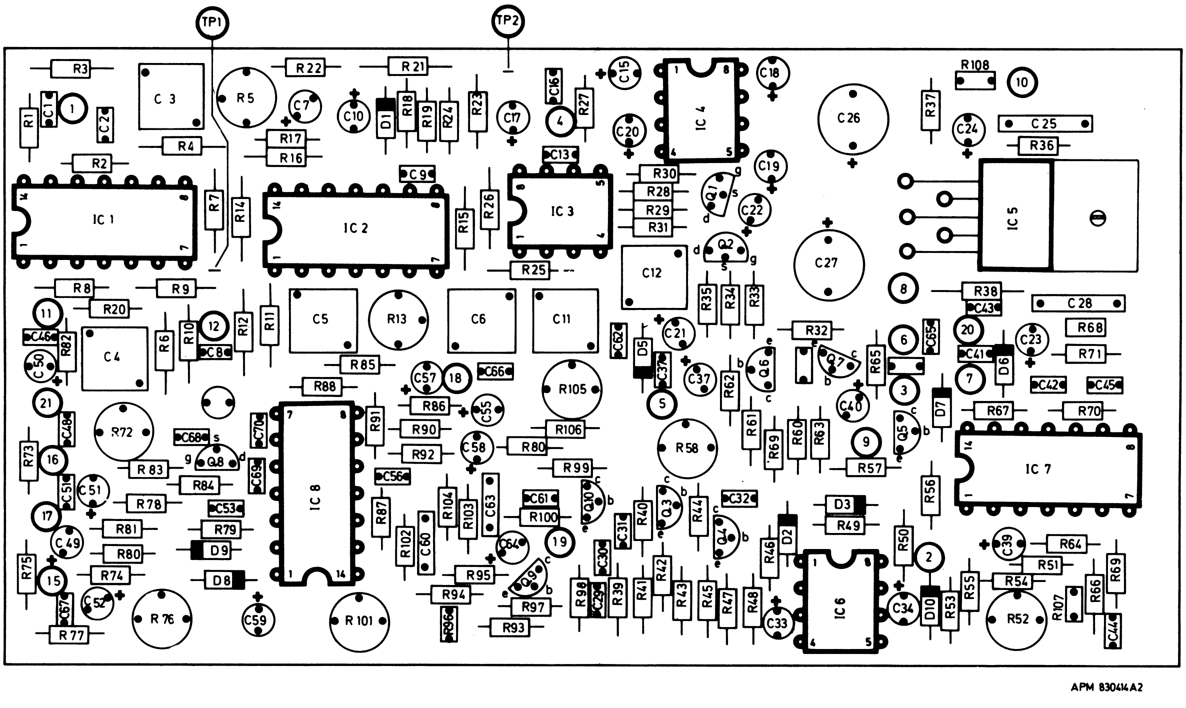


Fig. 7-9 Component location, AF and modulation amplifier, N02E sec. 2

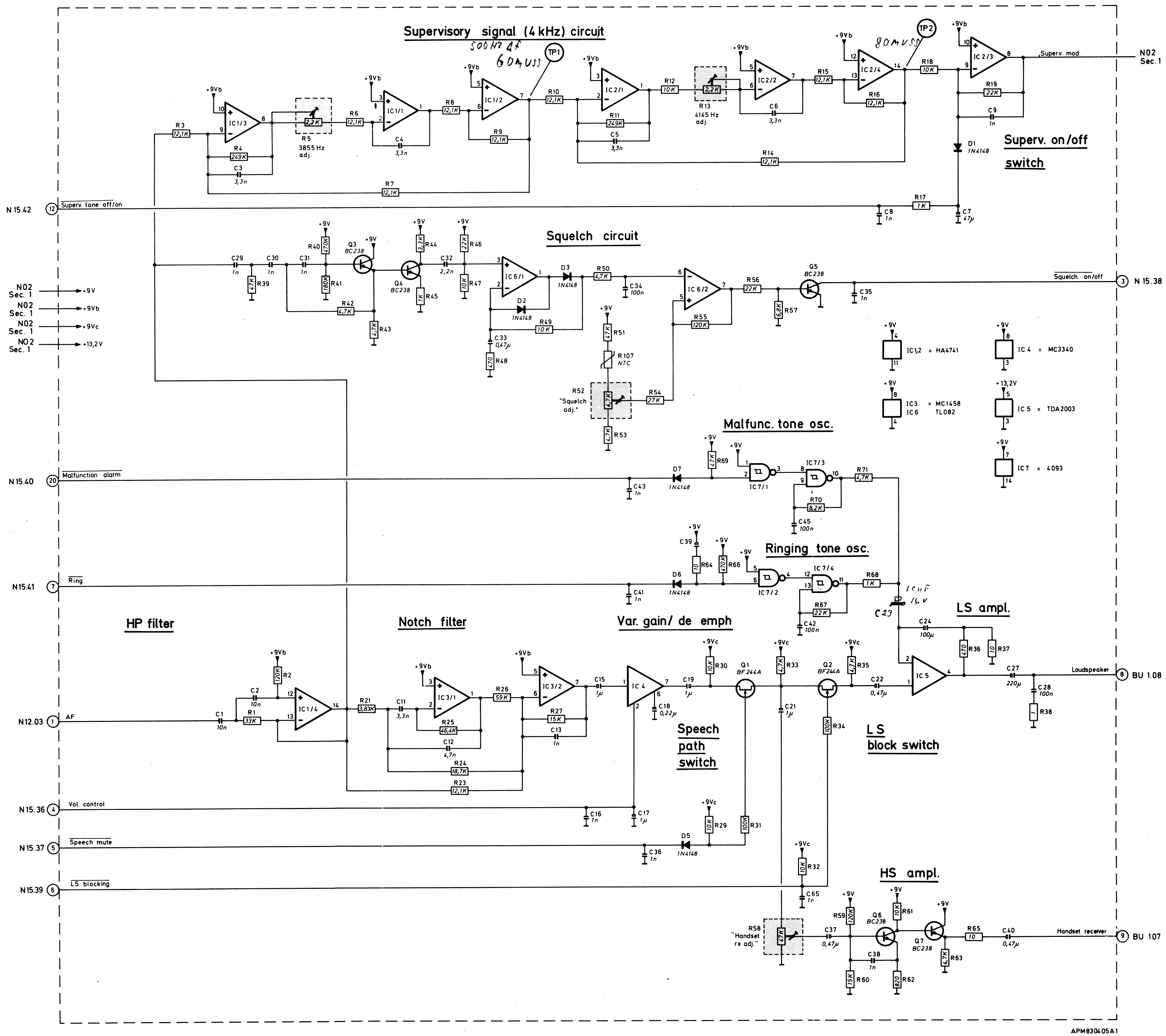


Fig. 7-10 Circuit diagram, AF and modulation amplifier, N02E sec. 2

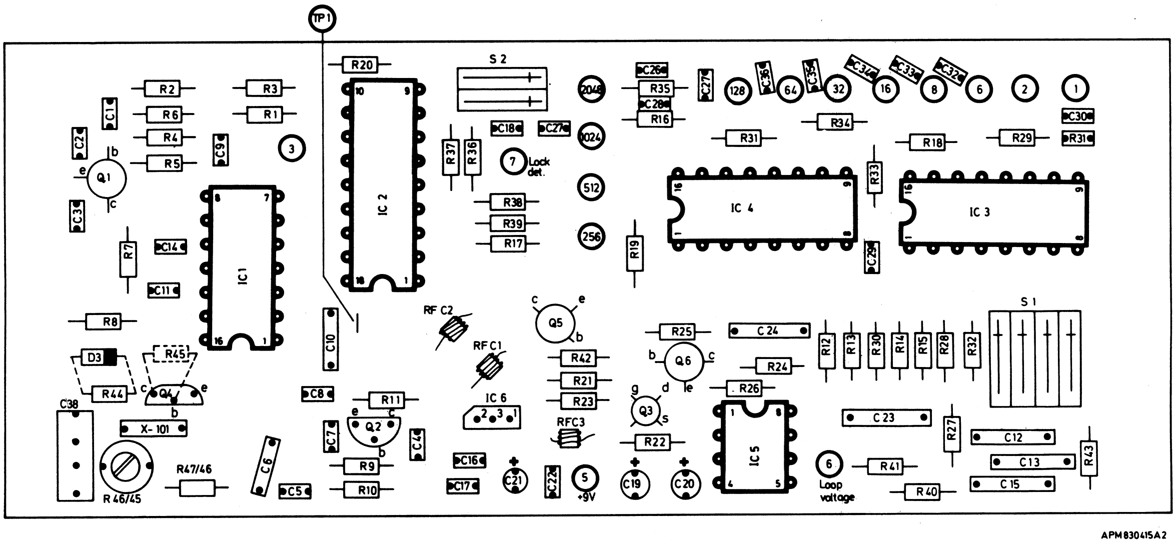


Fig. 7-11 Component location, RX synthesizer, N03F

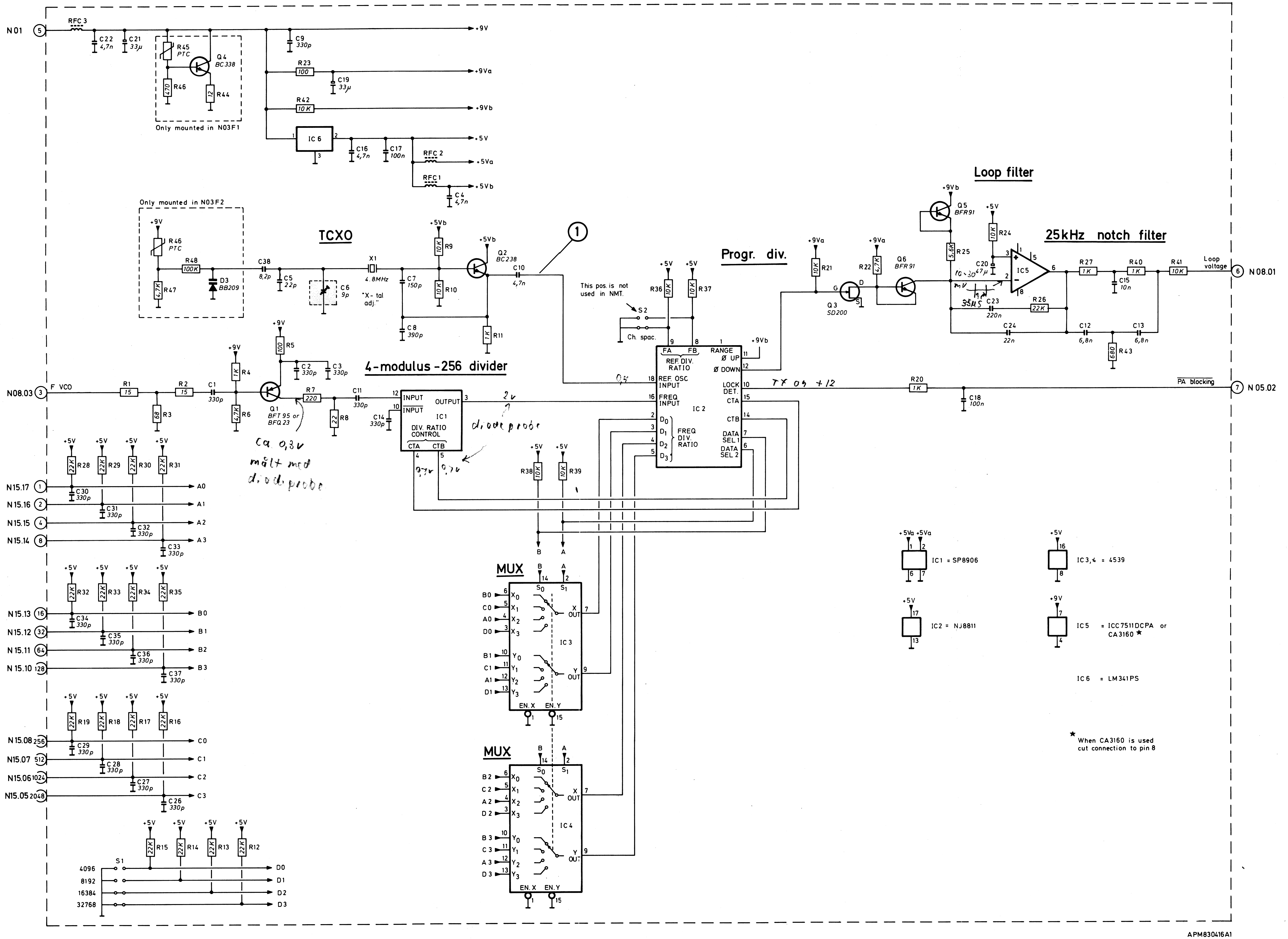


Fig. 7-12 Circuit diagram, RX synthesizer, N03F

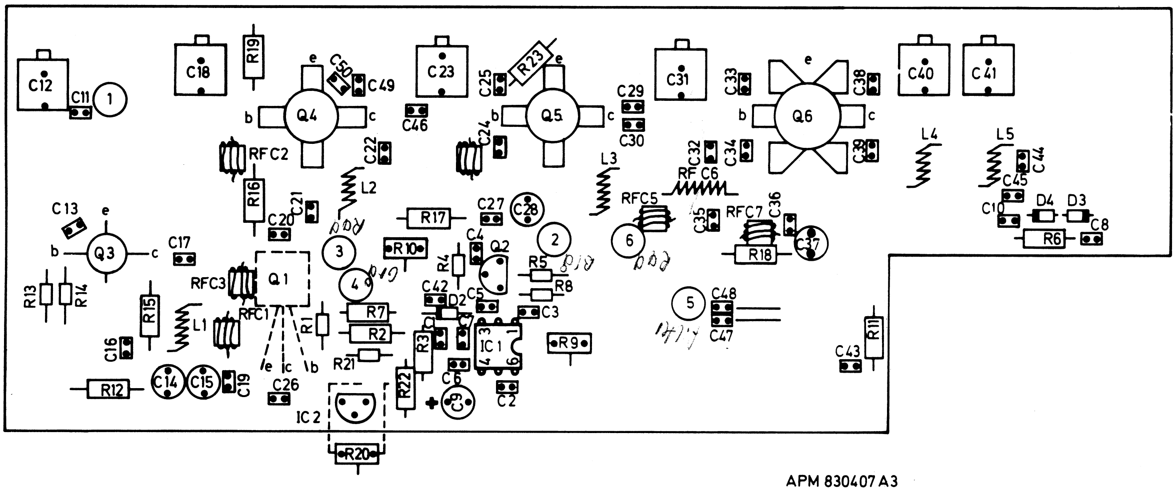
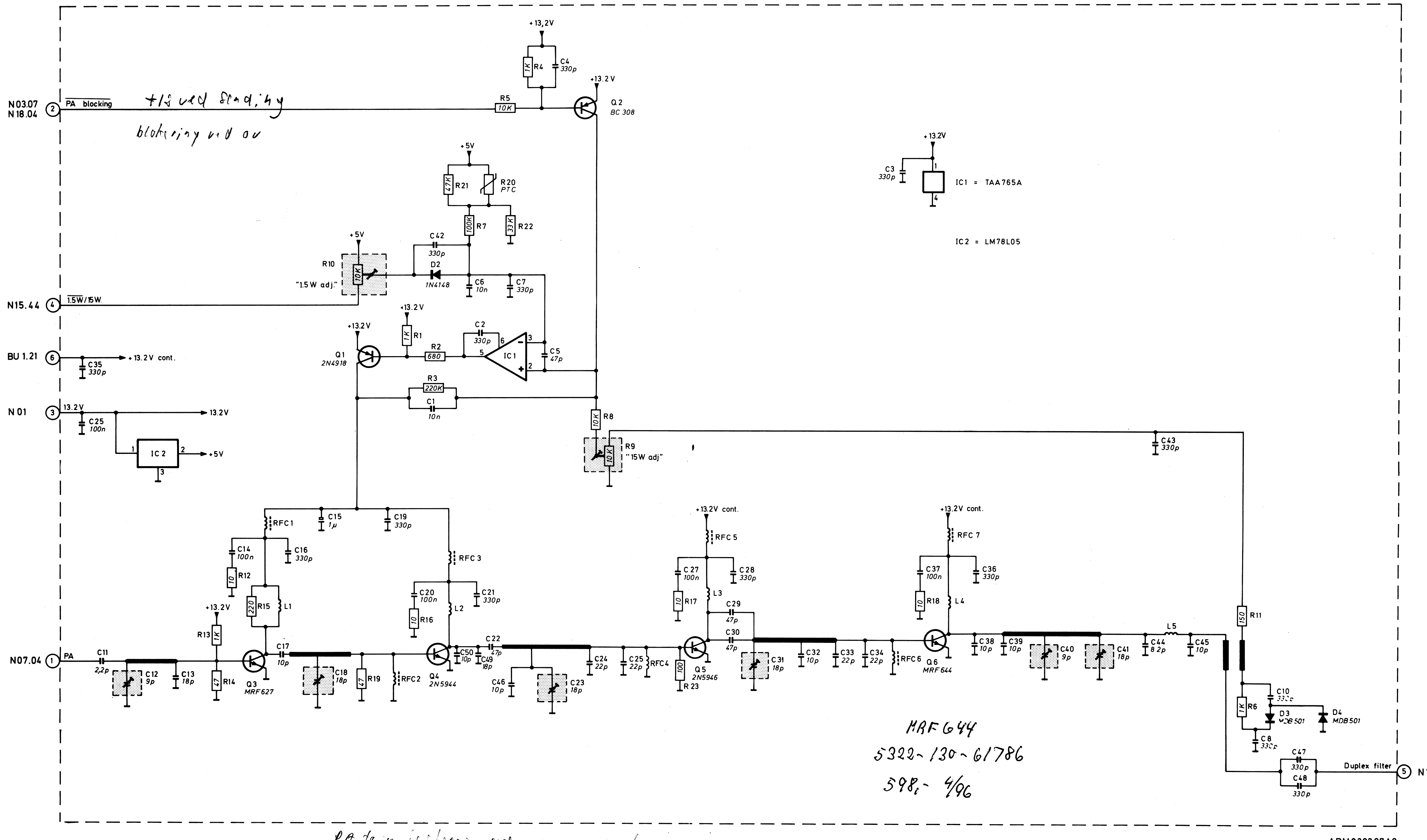


Fig. 7-13 Component location, PA and power control, N05B



PA kan justeres uden om ... til 50 belastning.
Ved ustabil PA:
monter C50 og R23 hvis de mangler
(gælder print N05A)

Fig. 7-14 Circuit diagram, PA and power control, N05B

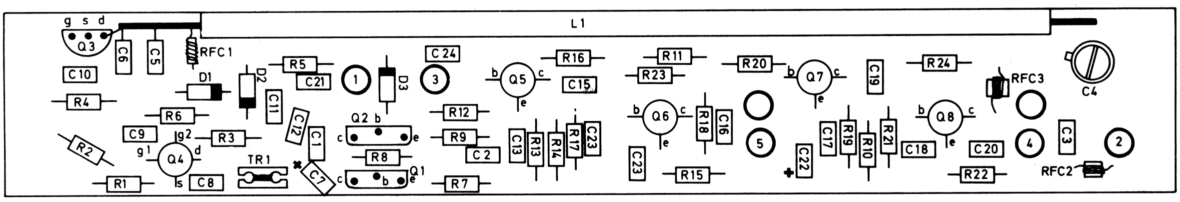


Fig. 7-15 Component location, UHF TX VCO, N07C

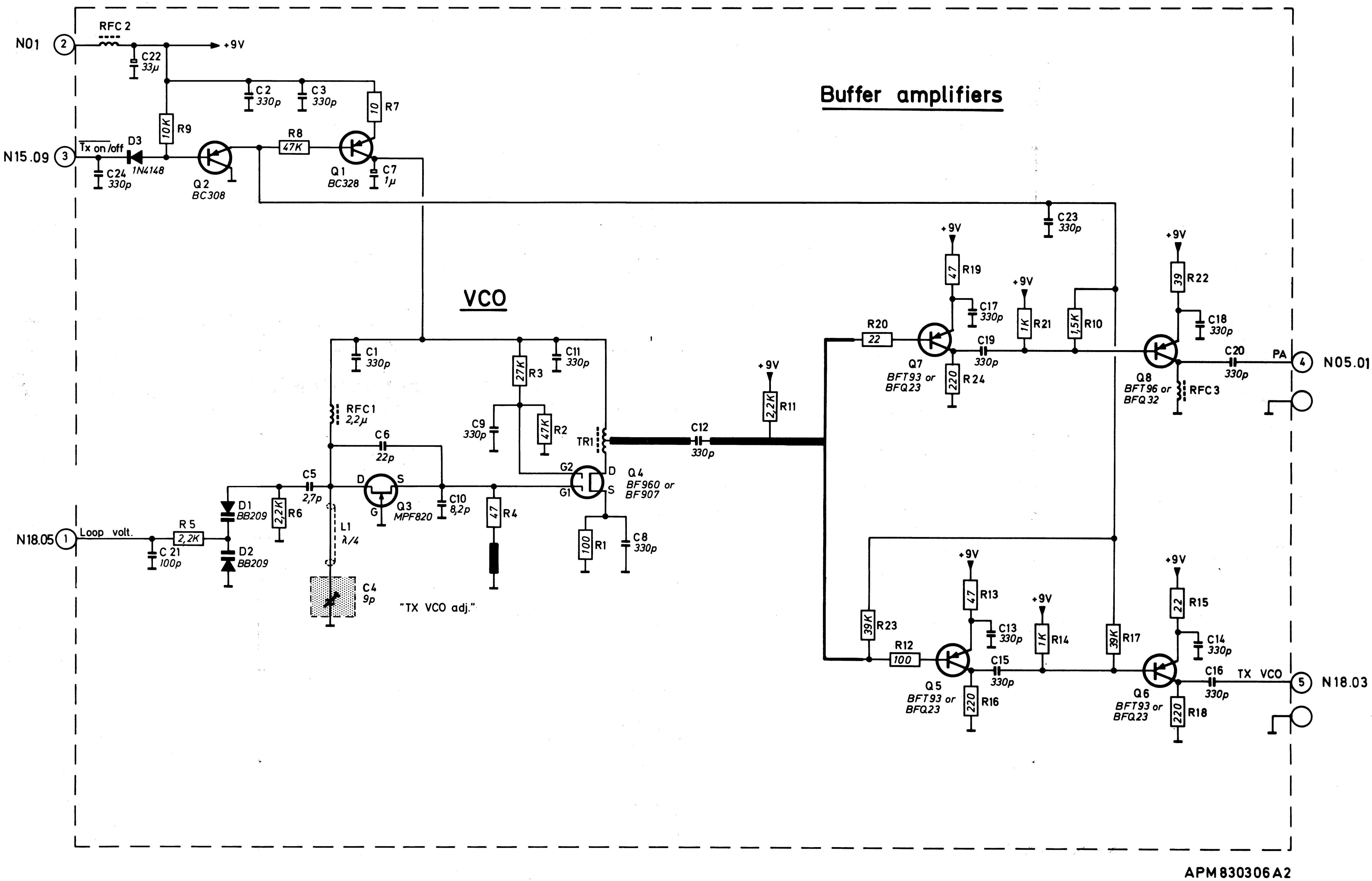


Fig. 7-16 Circuit diagram, UHF TX VCO, N07C

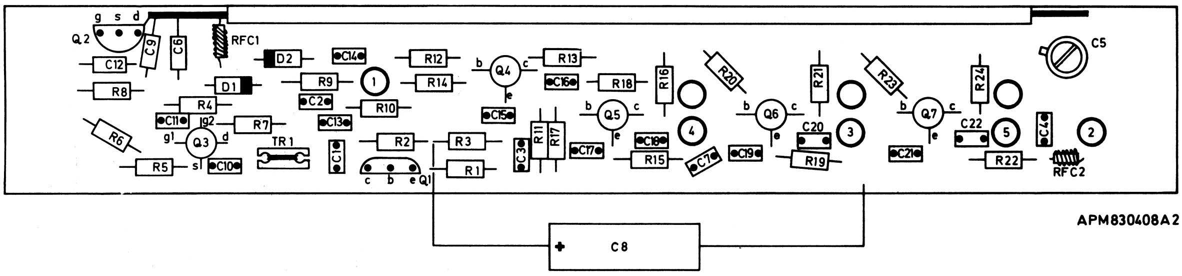


Fig. 7-17 Component location, UHF RX VCO, N08C

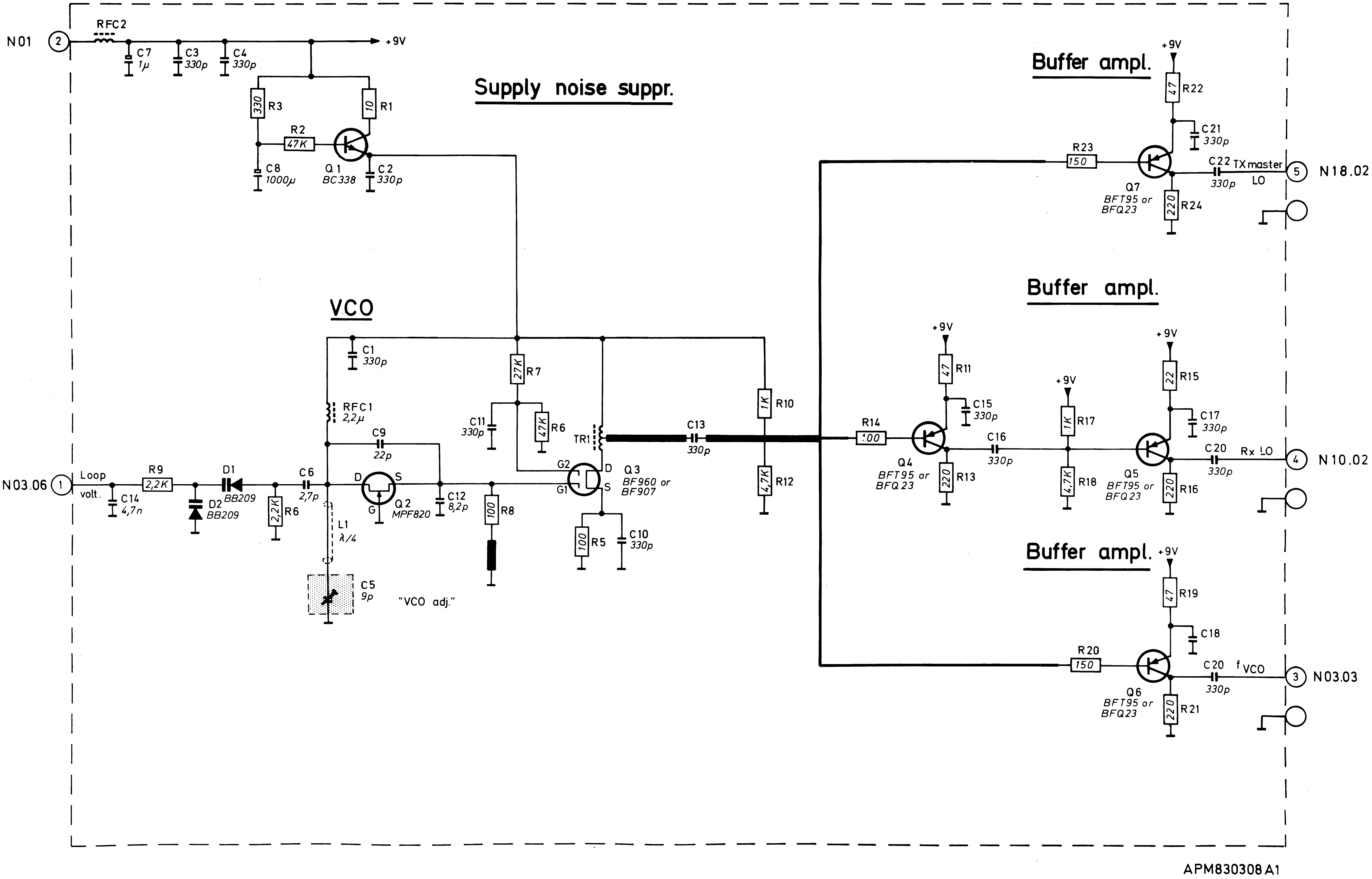


Fig. 7-18 Circuit diagram, UHF RX VCO, N08C

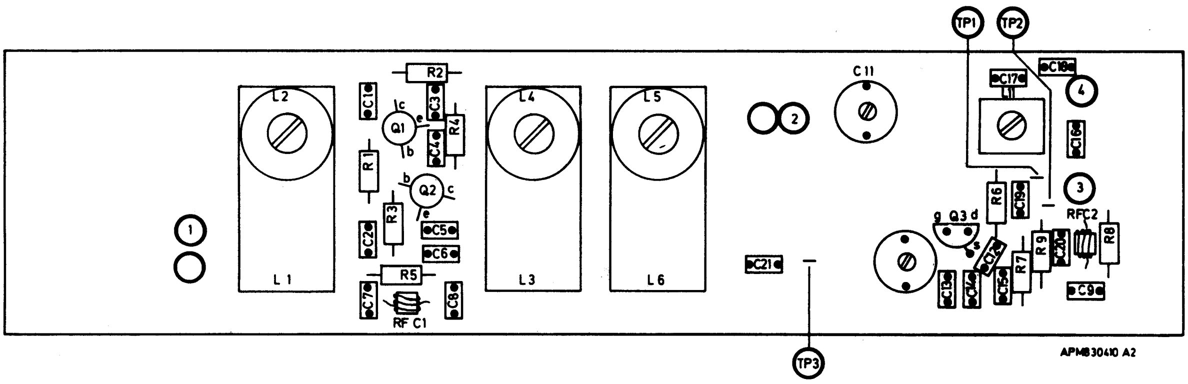


Fig. 7-19 Component location, RF and mixer, N10B

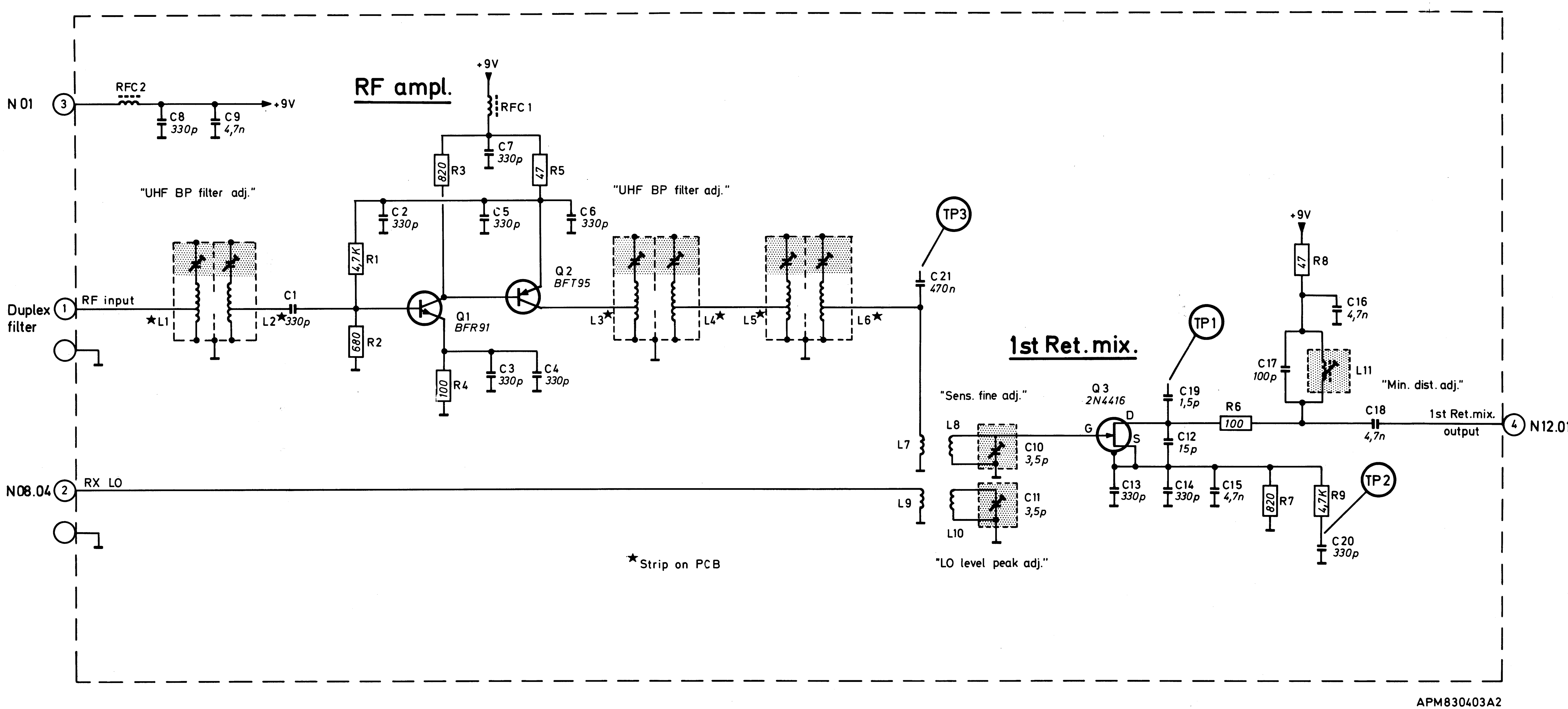


Fig. 7-20 Circuit diagram, RF and mixer, N10B

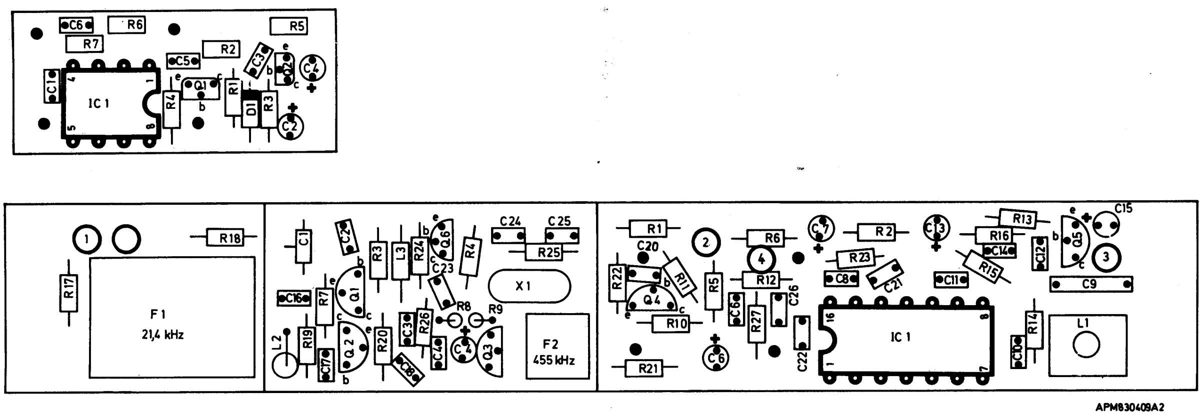


Fig. 7-21 Component location, IF amplifier, N12C

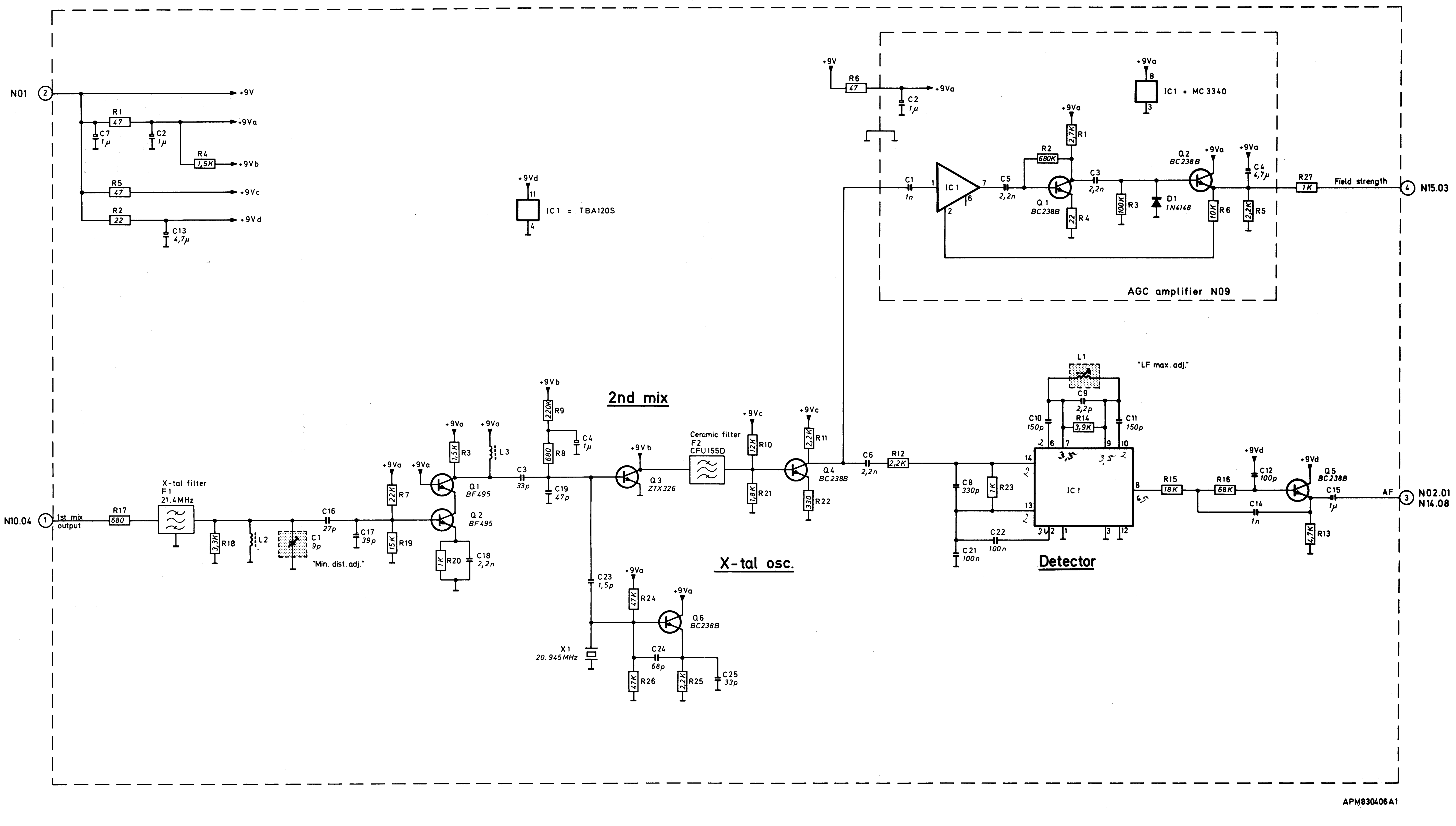


Fig. 7-22 Circuit diagram, IF amplifier, N12C

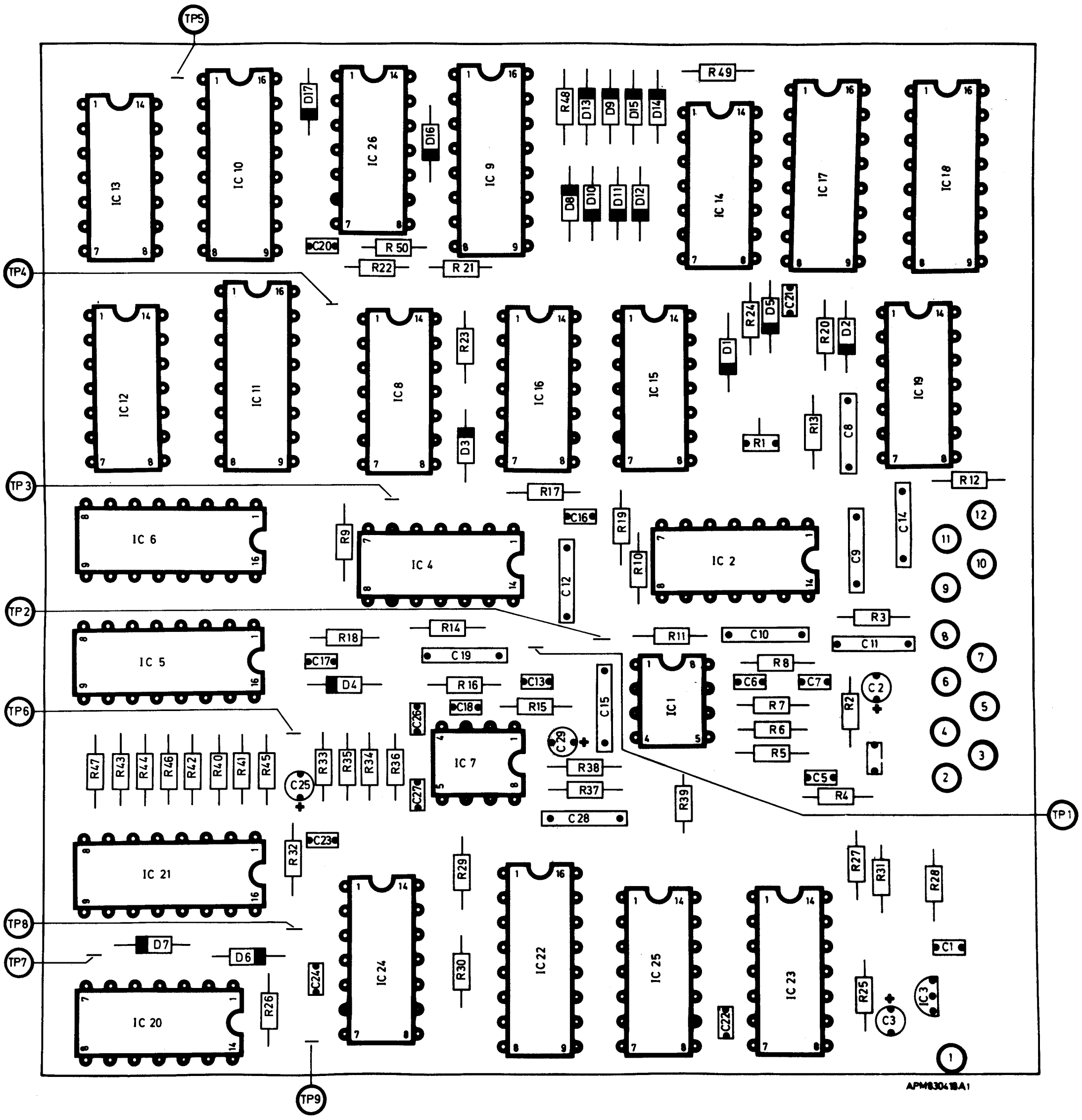


Fig. 7-23 Component location, modem, N14E sec. 1

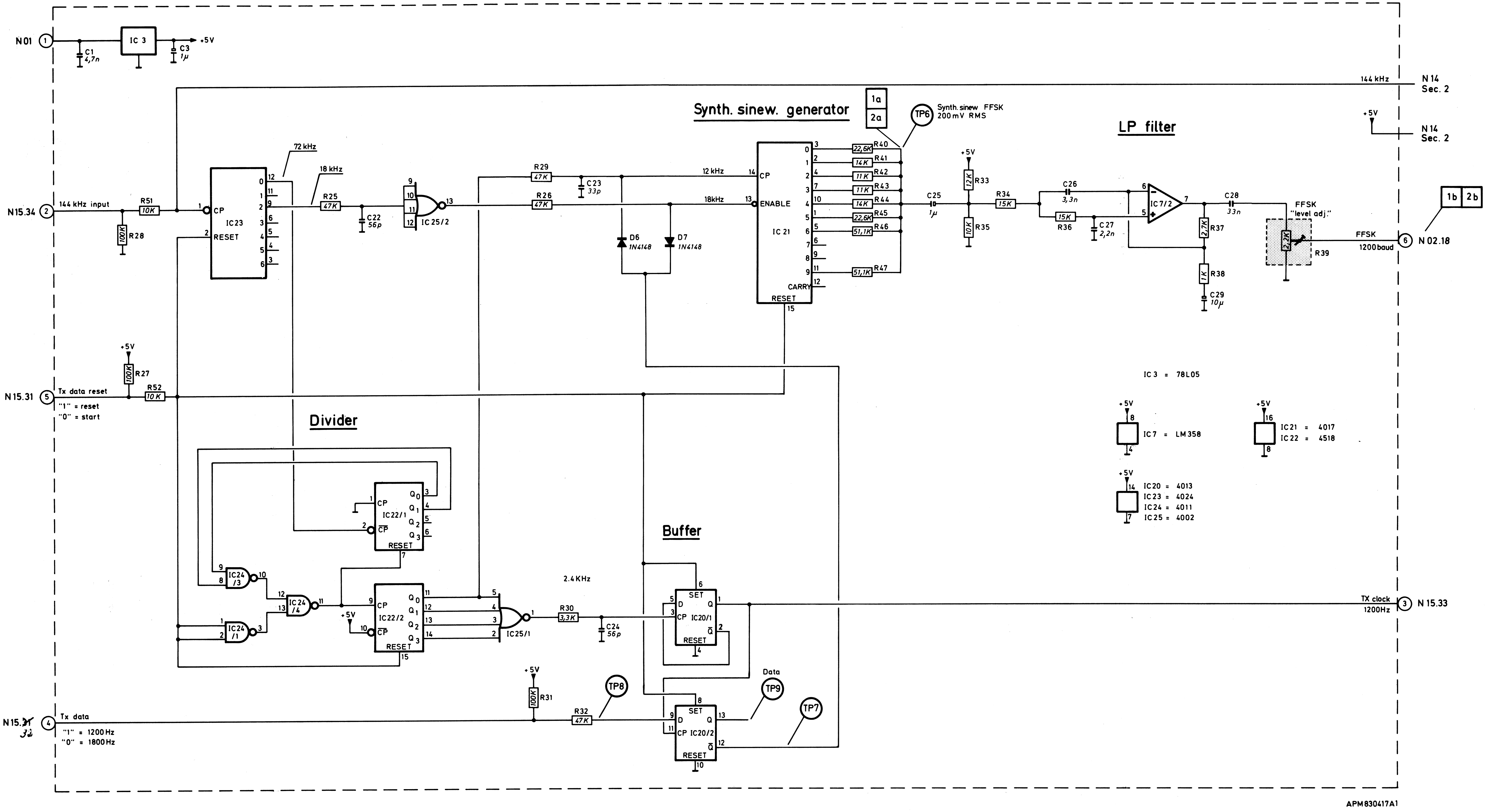


Fig. 7-24 Circuit diagram, modem, N14E sec. 1

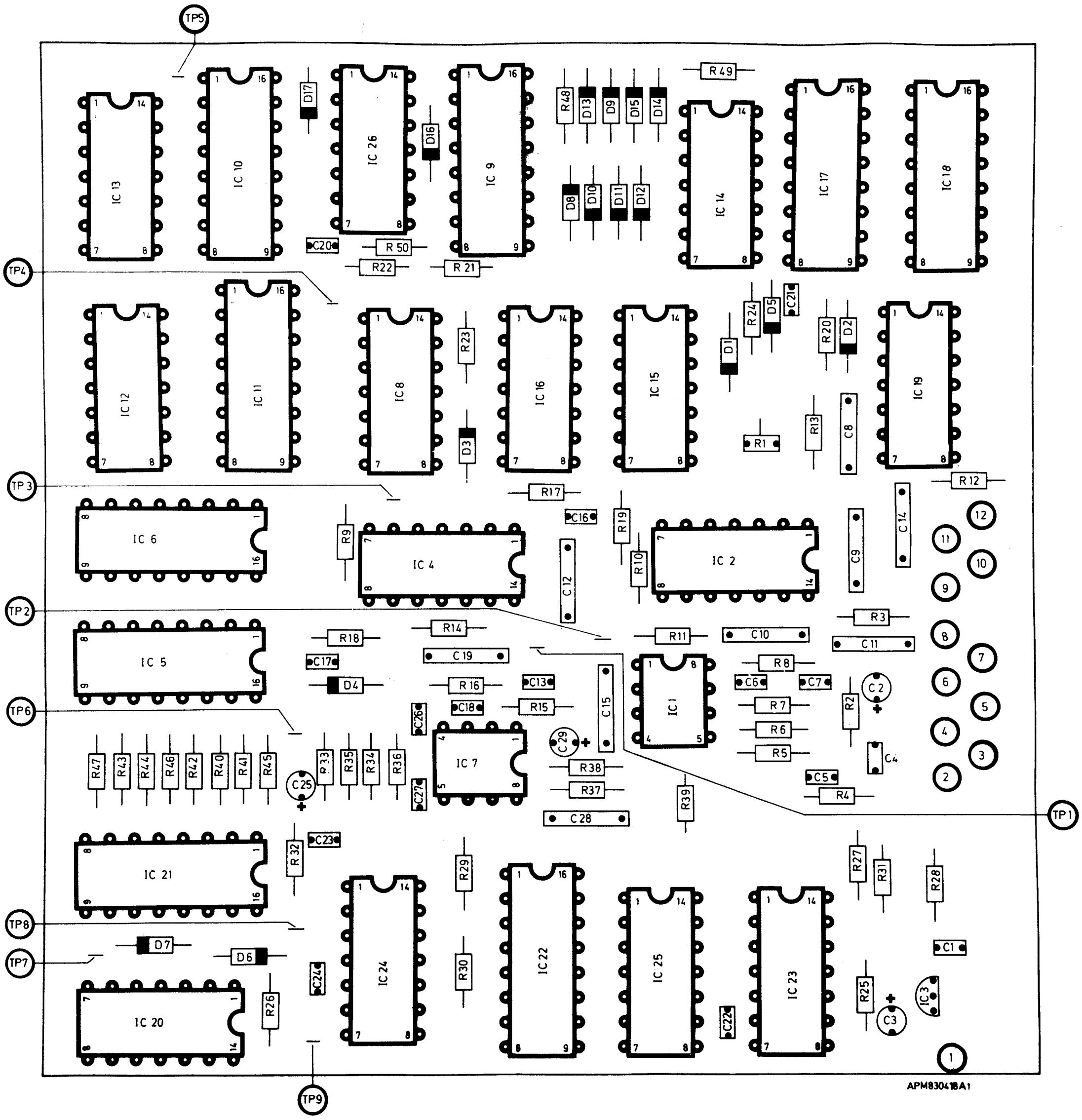


Fig. 7-25 Component location, modem, N14E sec. 2

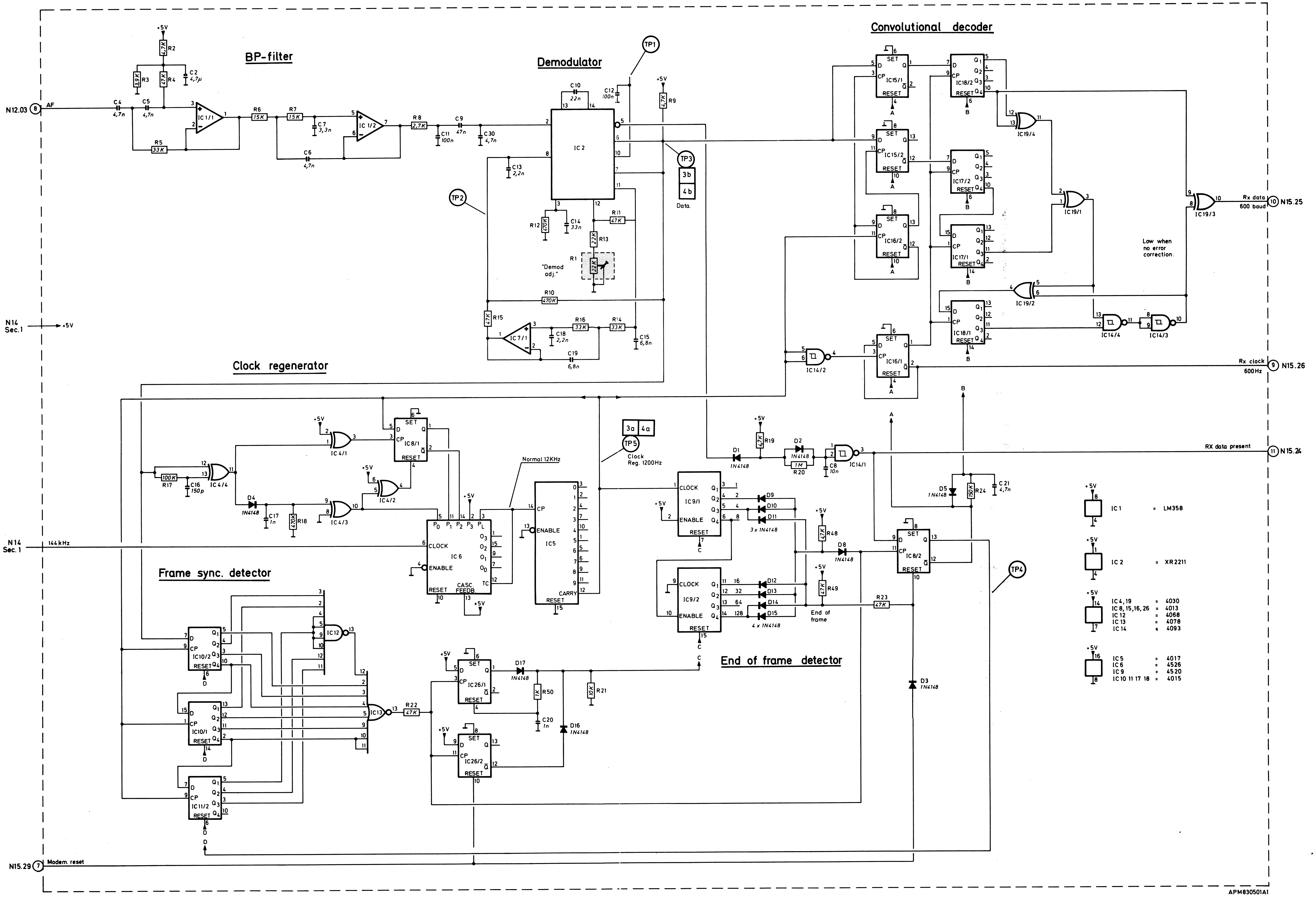


Fig. 7-26 Circuit diagram, modem, N14E sec. 2

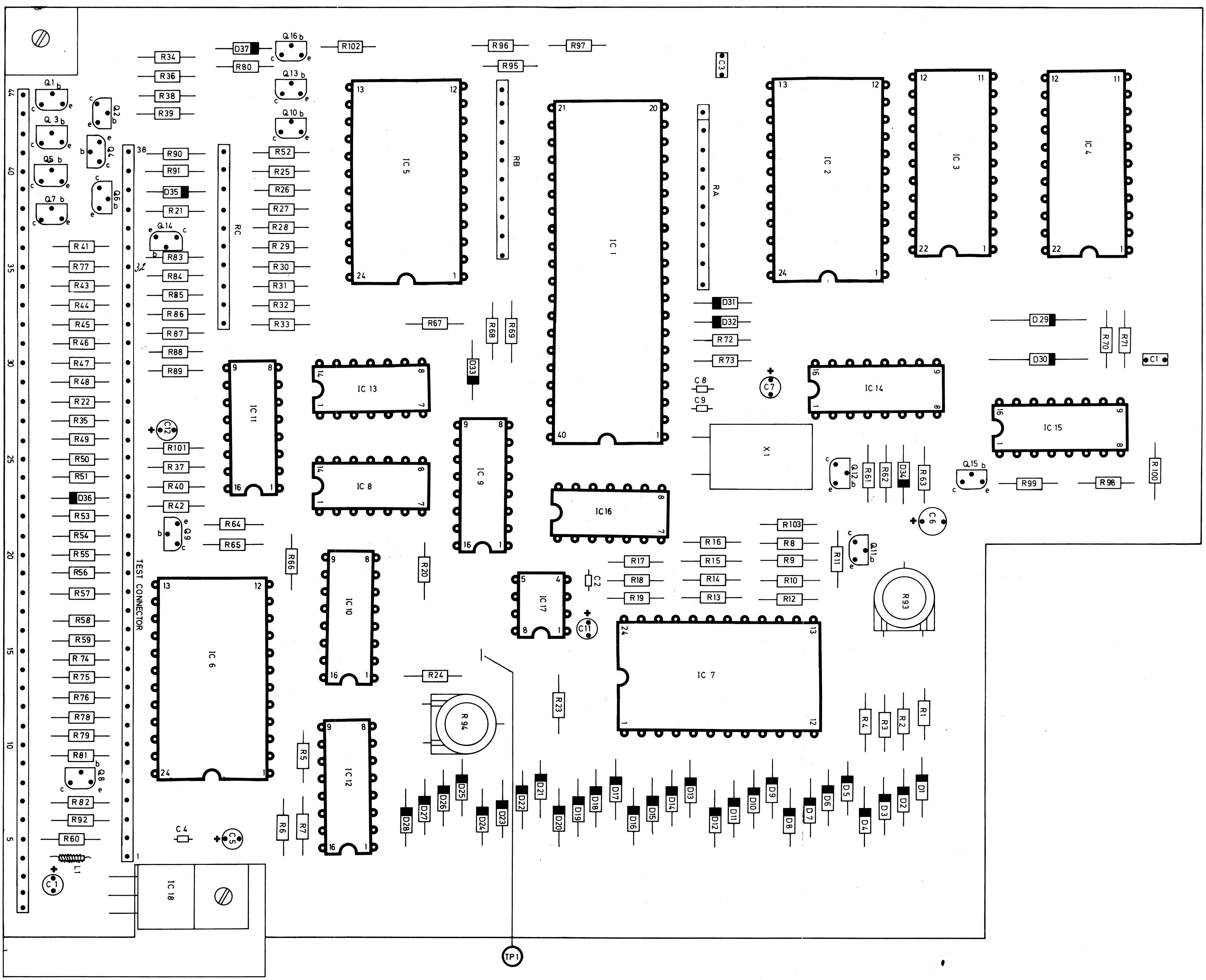


Fig. 7-27 Component location, CPU, N15D

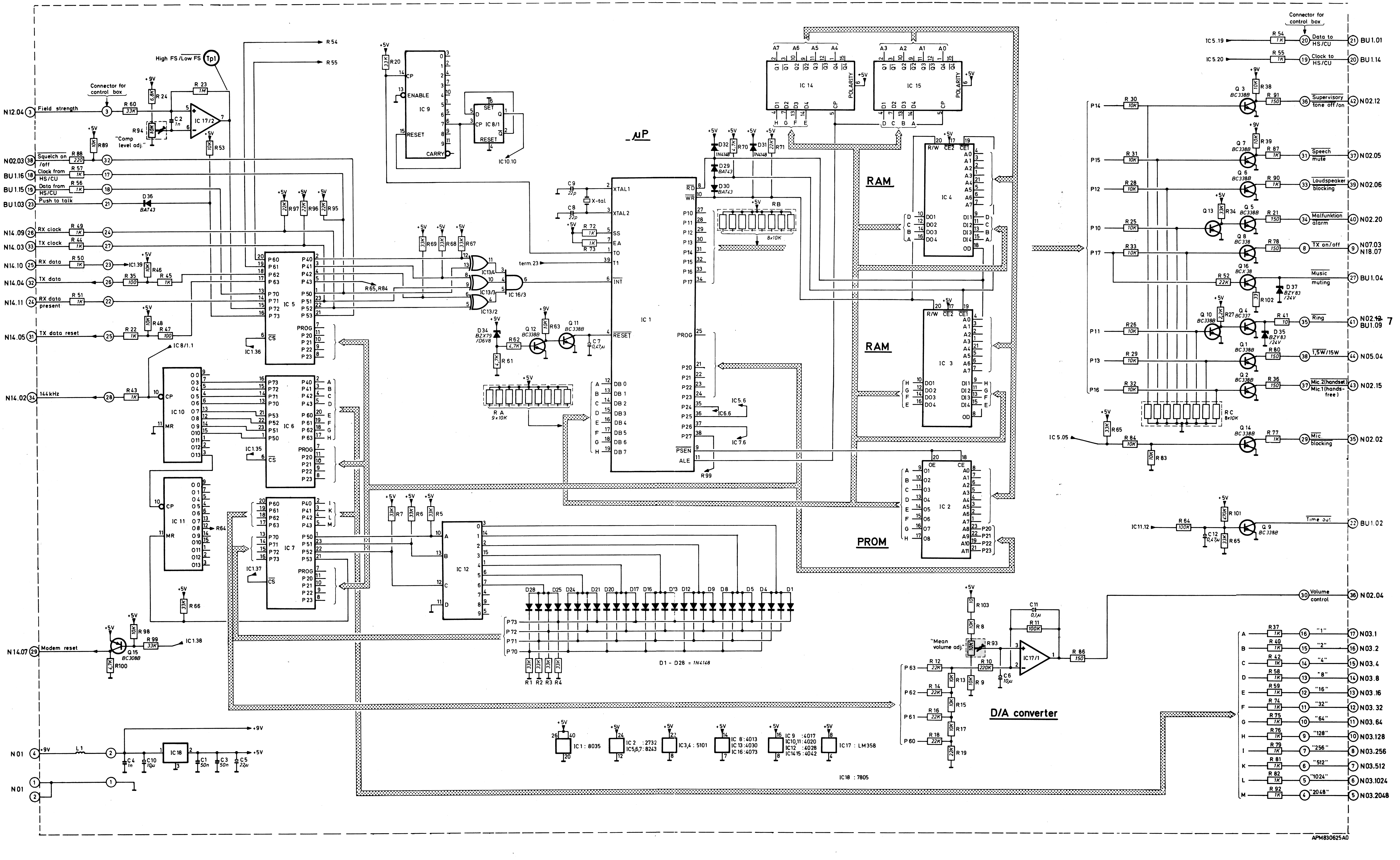


Fig. 7-28 Circuit diagram, CPU, N15D

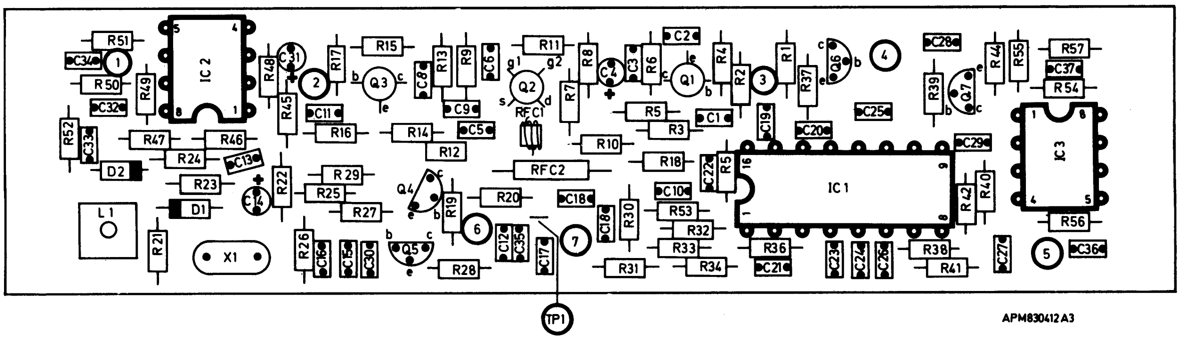


Fig. 7-29 Component location, TX synthesizer, N18D

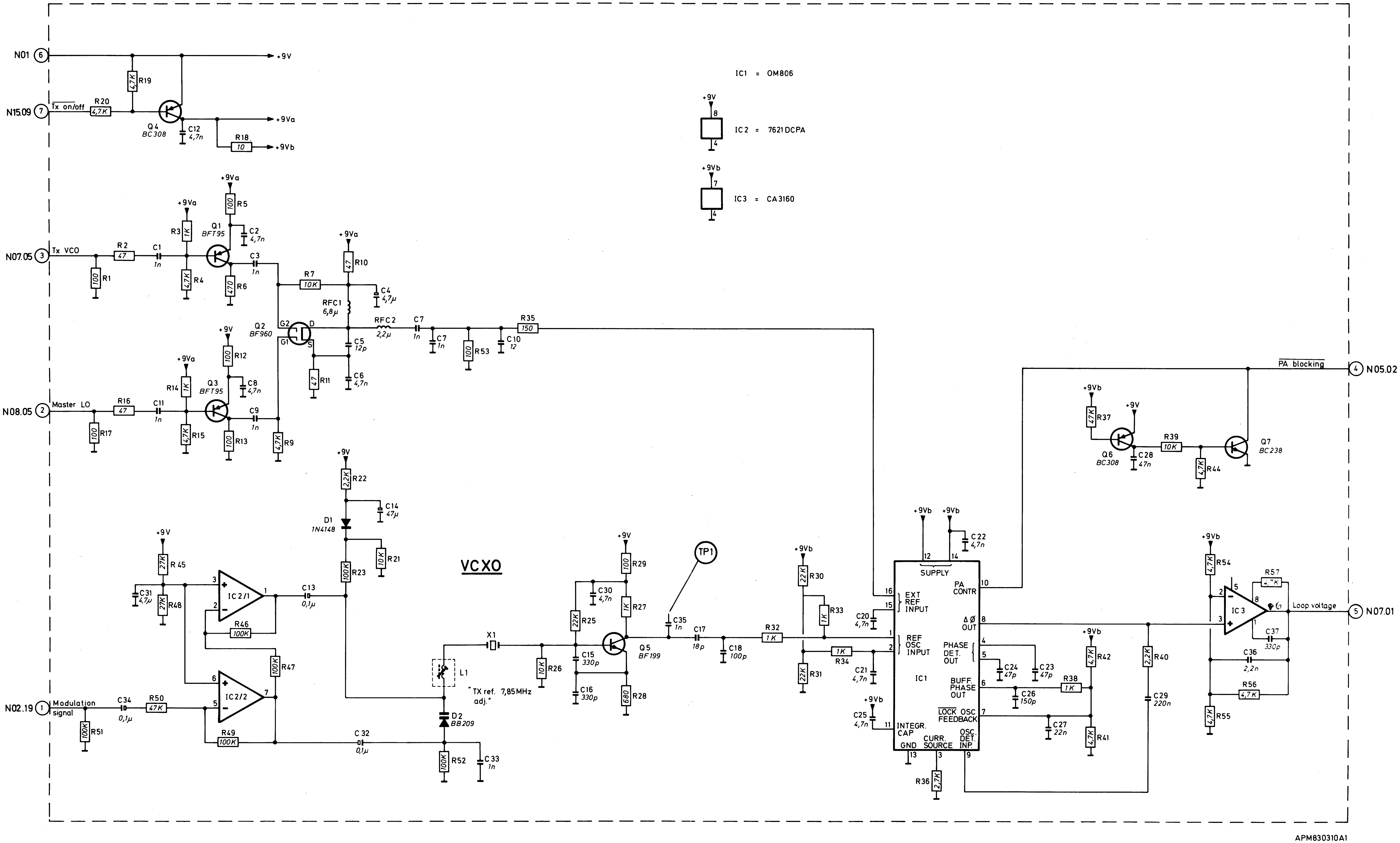


Fig. 7-30 Circuit diagram, TX synthesizer, N18D

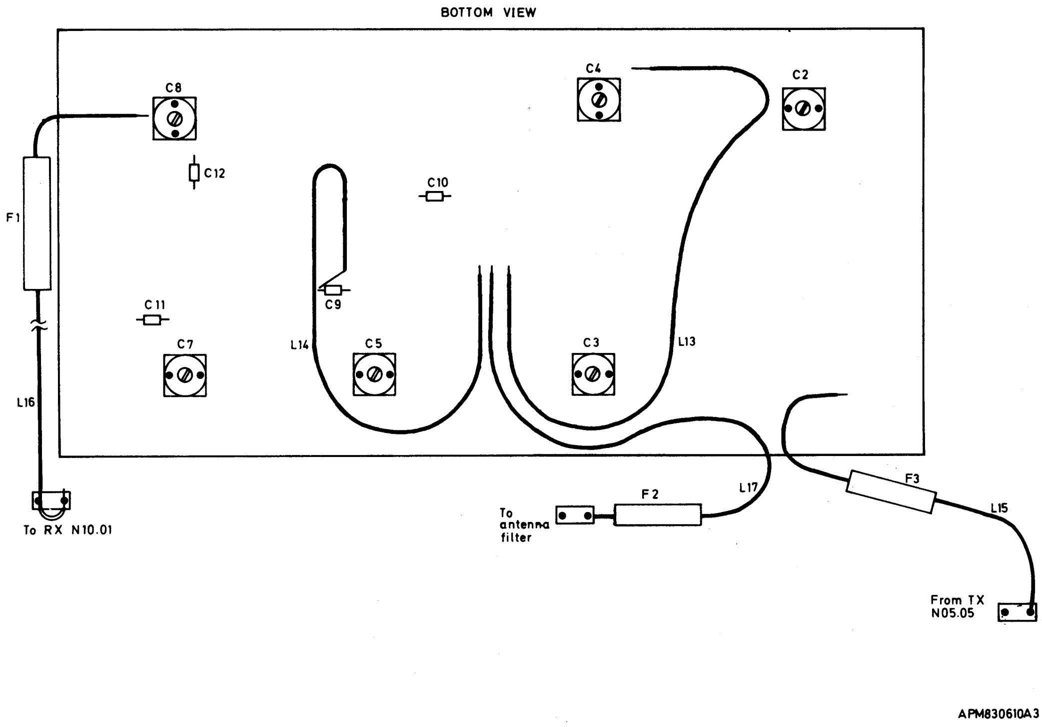


Fig. 7-31 Component location, duplex filter, N19B

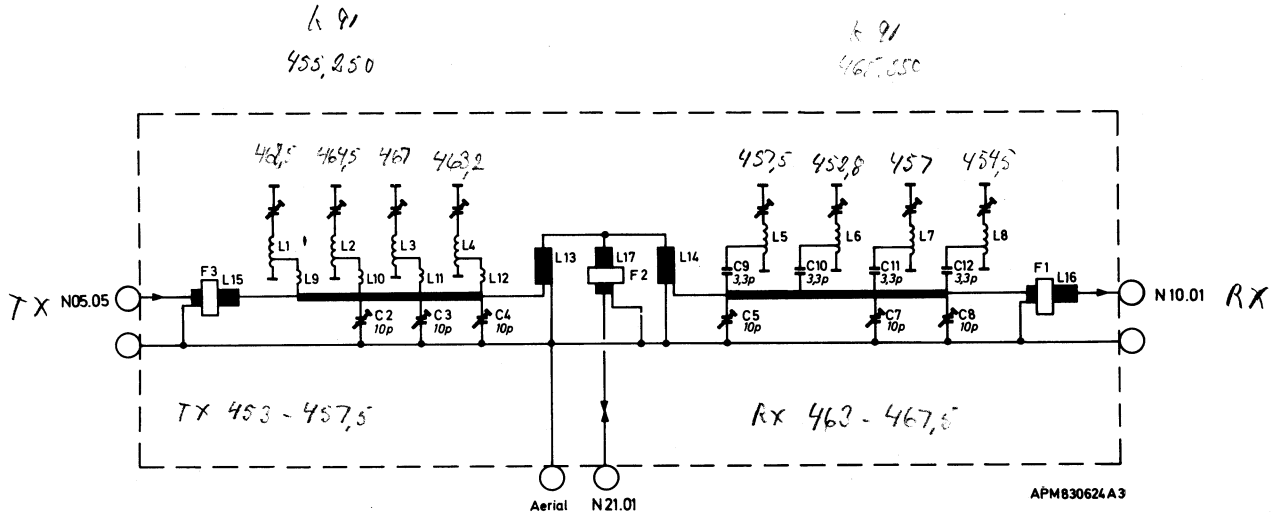


Fig. 7-32 Circuit diagram, duplex filter, N19B

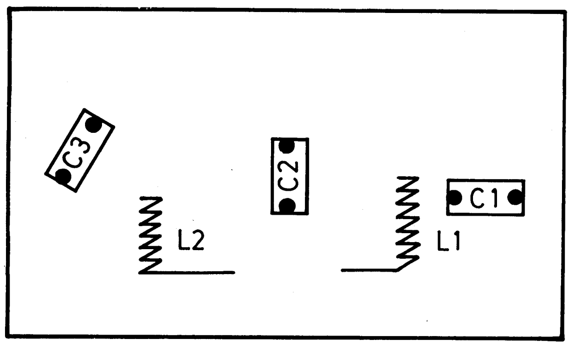


Fig. 7-33 Component location, antenna filter, N21A

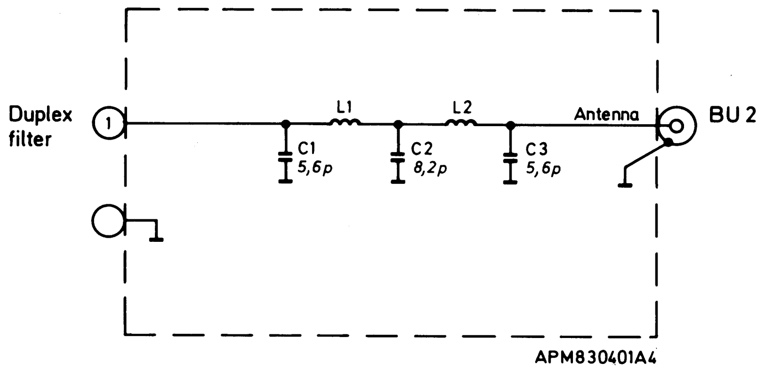


Fig. 7-34 Circuit diagram, antenna filter, N21A

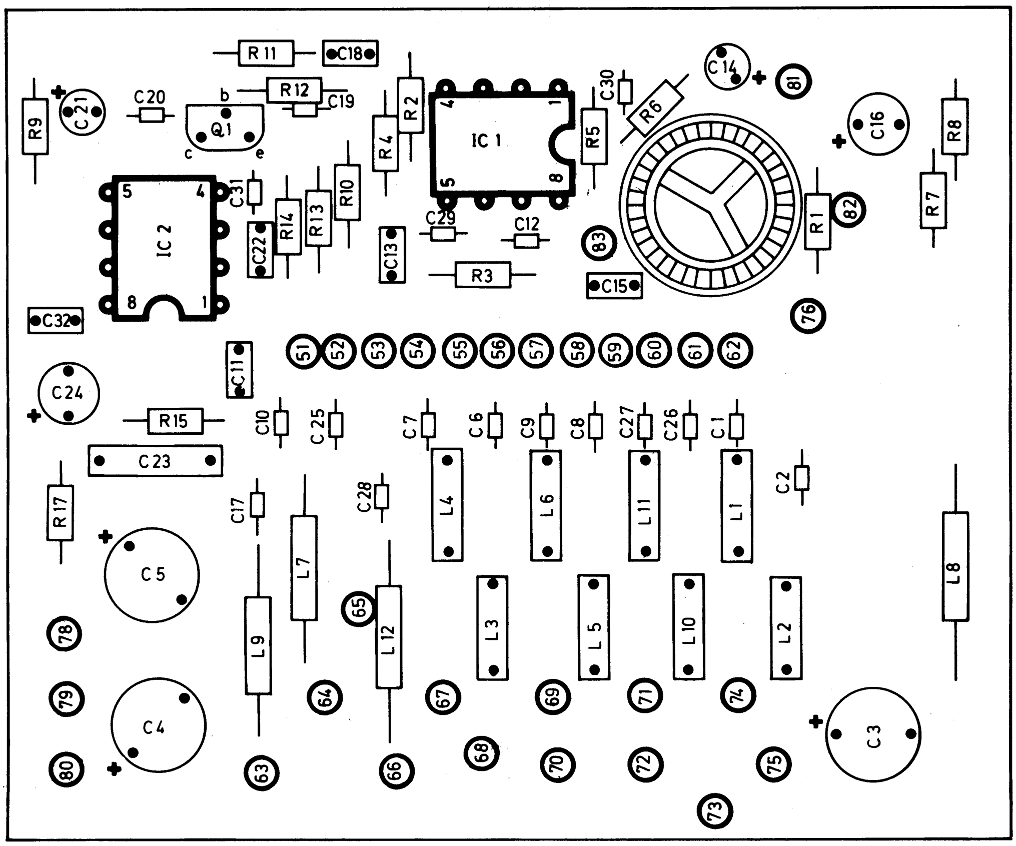


Fig. 8-2 Component location, active handset, N50A

8. Description of the handset/control unit and cradles

Active handset and cradle

The active handset contains a microphone and receiver as well as a control part with keyboard and display. It also contains a reed switch which is operated by a permanent magnet in the cradle. Thereby "off hook" is detected.
The control part is provided with a microprocessor. The RAM IC3 stores among other things short nos. These are also kept when disconnecting the handset or power off, thanks to a back-up battery.
The microprocessor IC1 communicates with the CPU in the radio, the keyboard and with the display. This communication is done with the ports P10-P27 either directly or via the expander IC4. Some ports are devoted entirely to a specific purpose while others have a double function. Pins (C), (A) and (M) are connected together in the radio.

Display dimmer

The display dimmer Q3-Q7 can be regarded as a voltage regulator. The output is the supply voltage for the display. The reference is dependent on the ambient light which is detected by Q17. The base of Q6 is used to shut off the circuit completely. This is done during reset.

Illumination switch

The illumination switch Q1,2 is controlled by the output voltage from the dimmer. In order to save the battery, the illumination LED's D1-D9 only light up when it is almost completely dark.

Power on/off latch

This circuit consists of the S/R flip/flop IC7. When the power on button (I) is pressed, IC7 activates via Q9 a relay in the radio unit. The relay is energized until the flip/flop is reset. This is done either manually by the power off button (O) or automatically by the time out signal from the radio.

Keyboard scanning

The keyboard matrix is scanned with two ports. The common conductor for the (X) and (≡) buttons (N16.05) is connected to P25.

In other time instants P25 is used for the RAM IC3. The N22/IC4 port 6 is used for kevboard scanning and for transferring the country code to the latch IC3. The diodes D18-21 detect when any of the buttons (except ⓞ and ⓘ) is pressed. When a button is being pressed the monostable multivibrator IC5 gives a pulse which in turn activates the beep oscillator IC5, Q25. The beep signal is fed to the handset receiver. The beep will be blocked during the reset time (see fig. 8-1).

Reset

The reset input of the microprocessor is kept low until certain feeding voltage requirements are met. This is necessary to avoid error condition caused by incorrect feeding voltages just after power on. The reset signal comes from IC7. After power is on, reset is dependent on the C11/R42 time constant. The time constant is long enough to allow the feeding voltages to build up. The delay is also chosen so that reset for the radio CPU takes place before reset in the handset. There is continuous supervision of the battery voltage with Q10-14. Too low voltage (<9V) is detected by Q10.11 and the zener diode D12.
Too high voltage (> 16V) is detected by Q12 and the zener diode D13. Both cases give immediate reset. A too low voltage gives after approx. 1s power off while a too high voltage immediately gives power off.

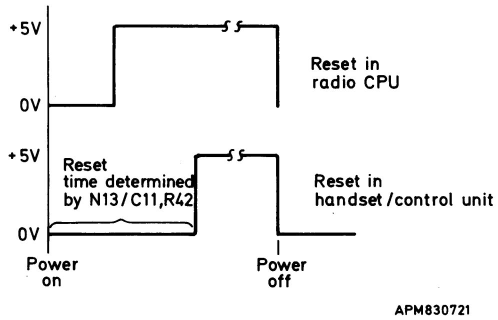


Fig. 8-1 Timing of reset

Display

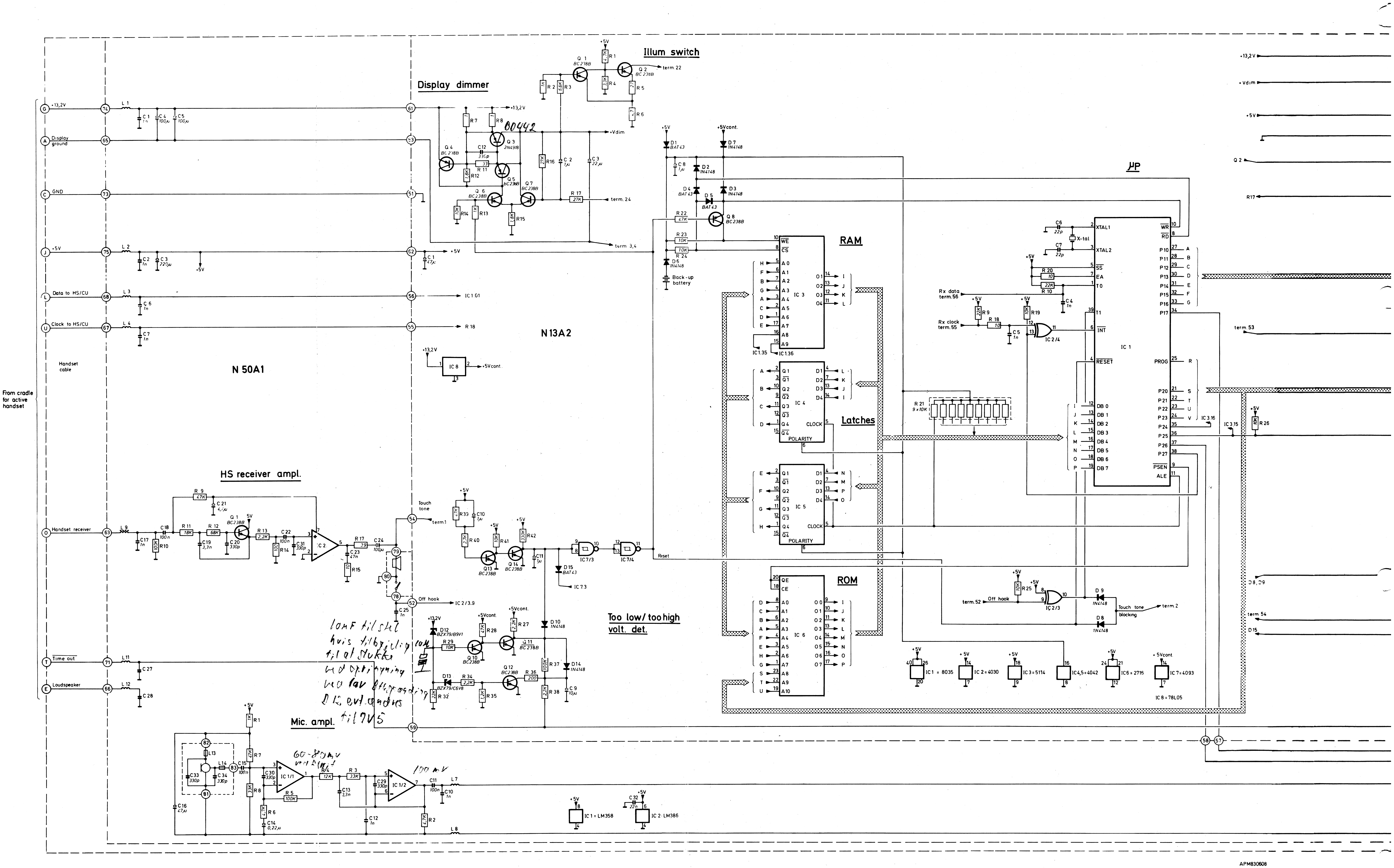
The display is multiplexed i.e. only one digit is enabled at the time but at a fast rate. Selection of one of the 16 digits is done with a binary code from 1C4.02-05 and is converted to decimal (one of 16) by IC2.
The segment code is fed in parallel to all displays, from port 1.

Country code

The country code is transferred to the latch IC3 with port 6 (also used for keyboard). The diodes D5 and D6 ensure that the same intensity is obtained for one and two LED's being activated.

Passive handset, control unit and cradle

The previous text about active handset and cradle applies with minor changes. The control parts (boards N22 and N13) have been moved to a separate control unit. In the control unit, the board N24 is the interface between the two 25-pole cables and N13.


Illum switch
Display dimmer
N13A2
N 50A1
RAM
Latches
ROM
µP
HS receiver ampl.
Too low/ too high volt. det.
Mic. ampl.
From cradle for active handset
Handset cable
Back-up battery
IC 1 = 8035
IC 2 = 4030
IC 3 = 5114
IC 4,5 = 4042
IC 6 = 2716
IC 7 = 4093
IC 8 = 78L05
IC 1 = LM358
IC 2: LM386
APM830606

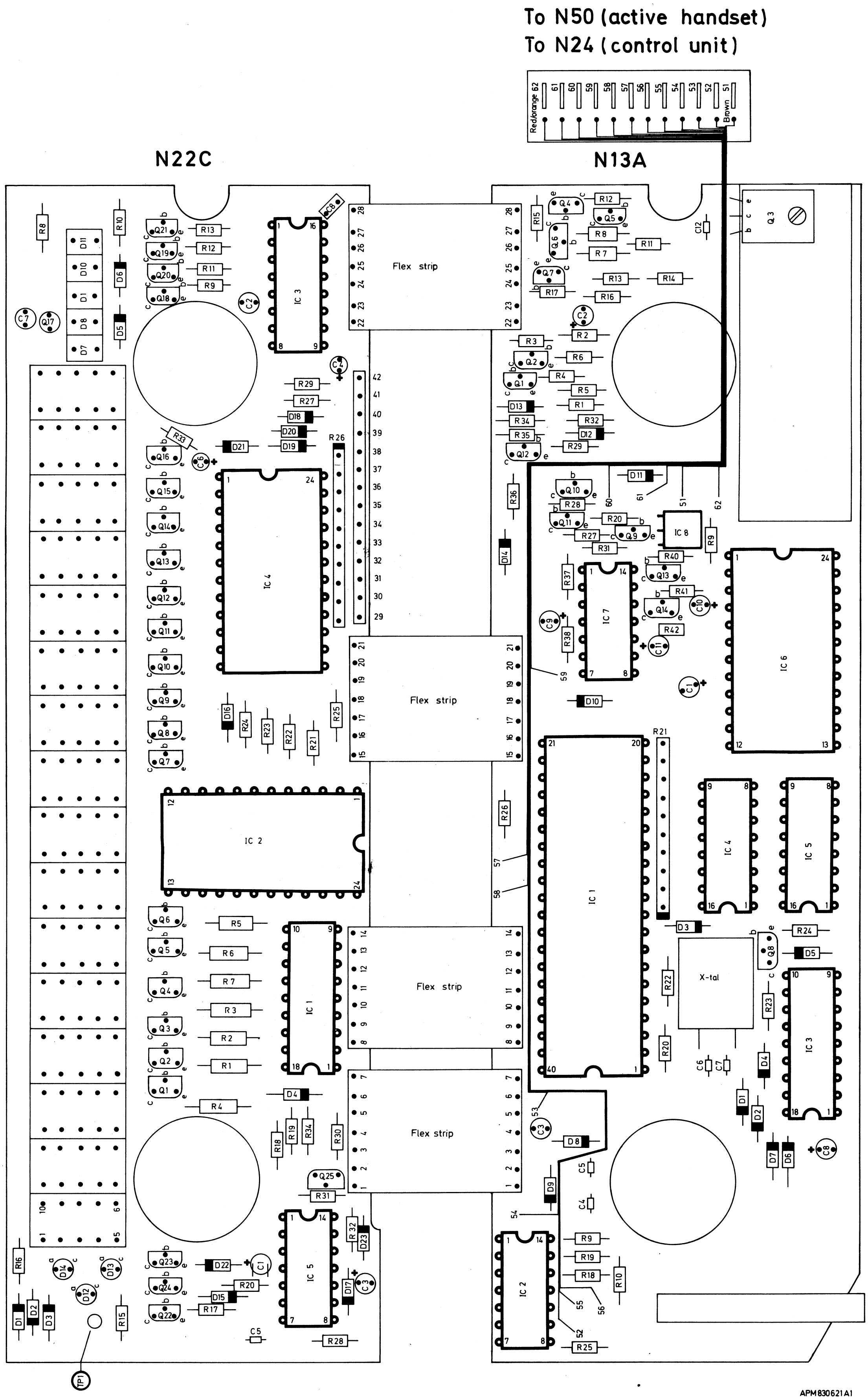


Fig. 8-3 Component location, active handset, N13A N22C

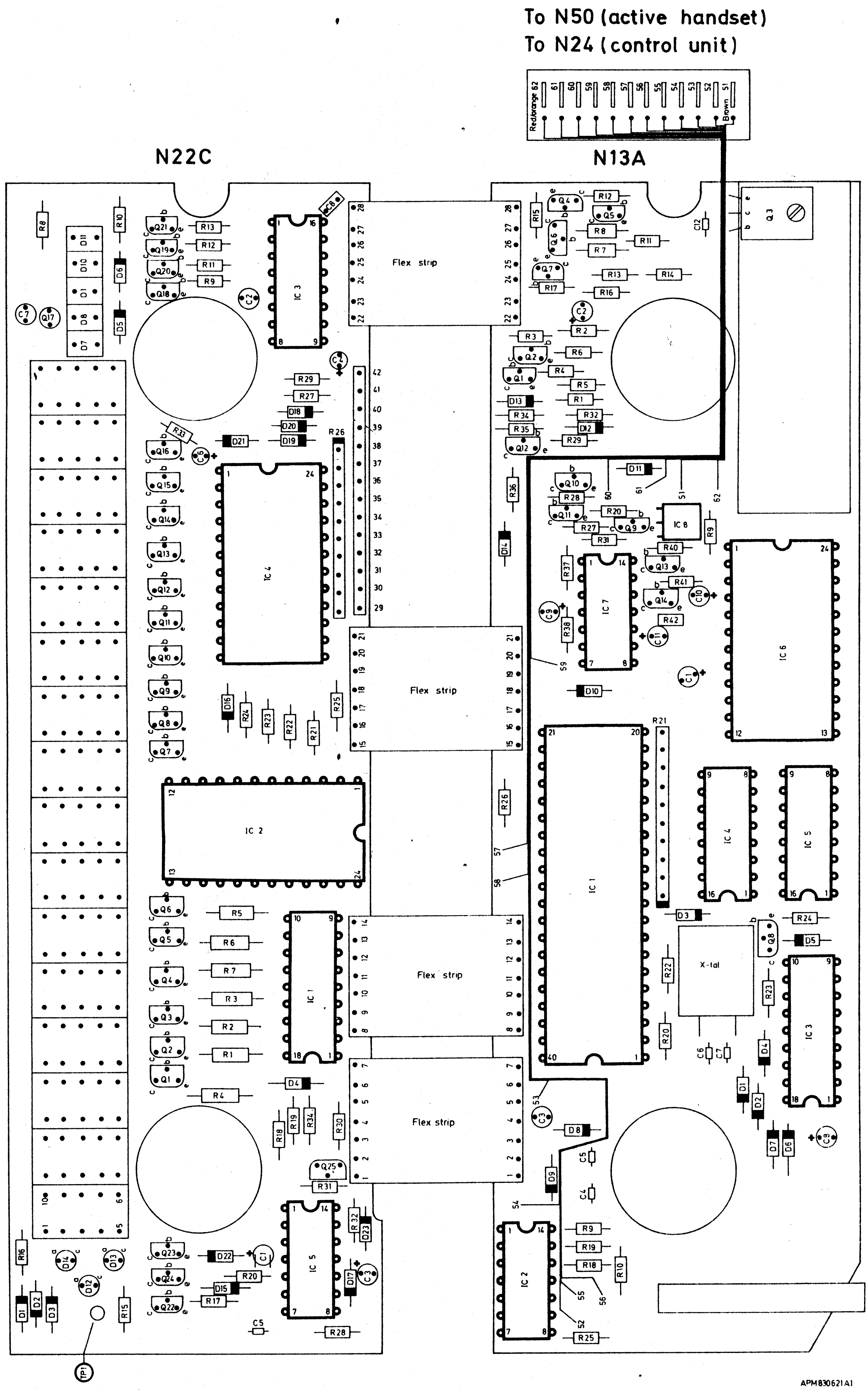


Fig. 8-3 Component location, active handset, N13A N22C

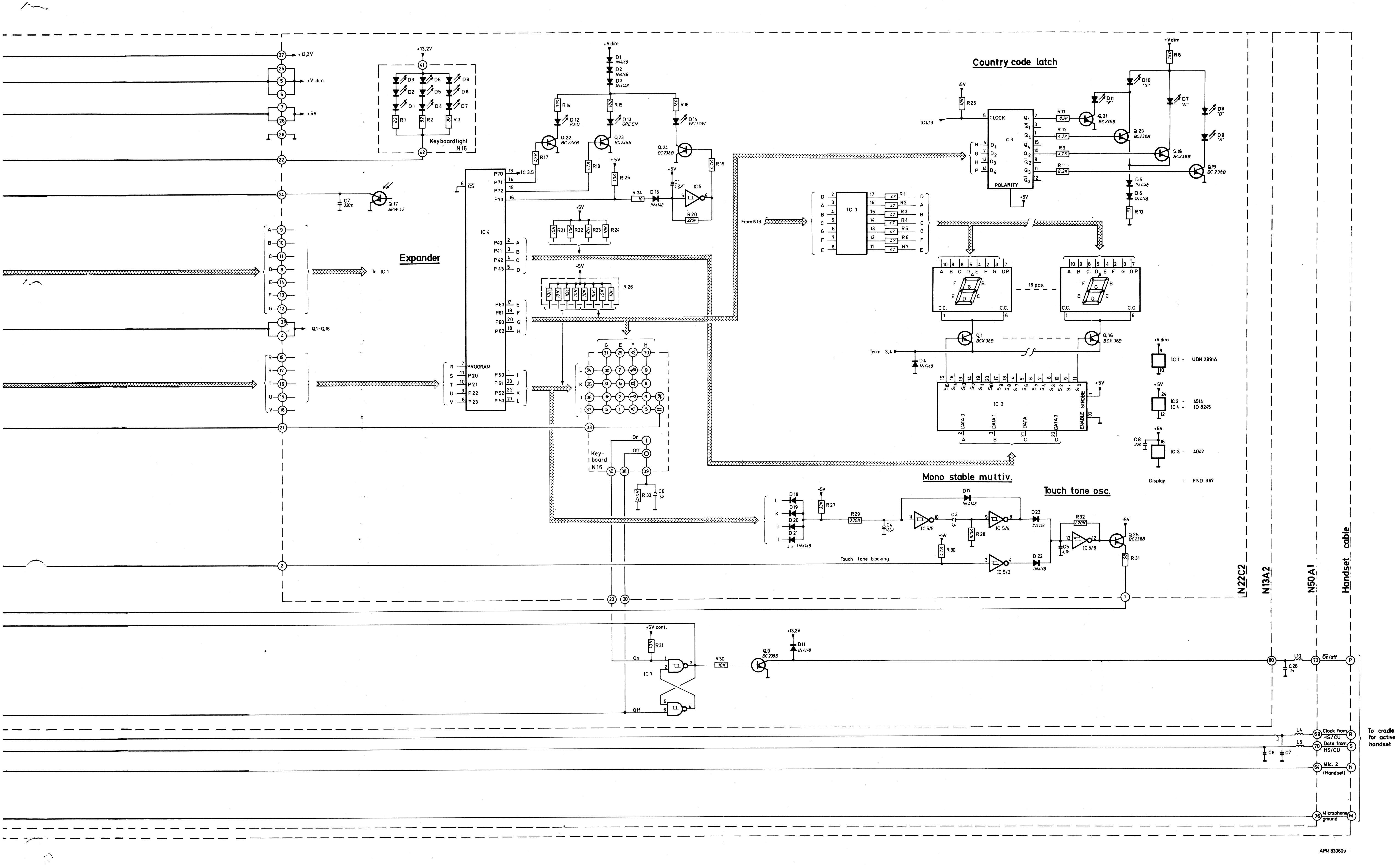
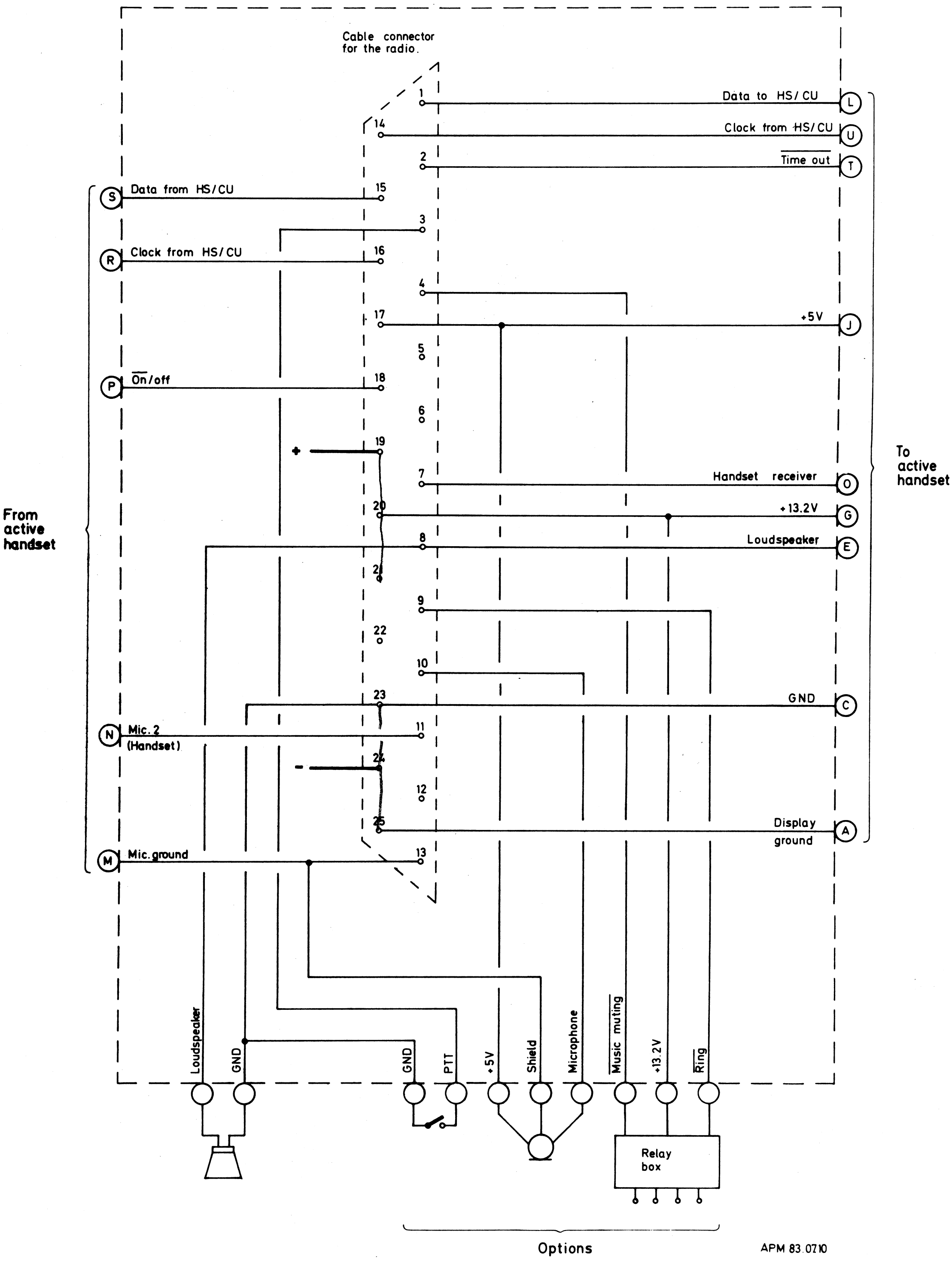


Fig. 8-4 Circuit diagram, active handset, N50A N13A N22C



3533

Fig. 8-5 Circuit diagram, cradle for active handset

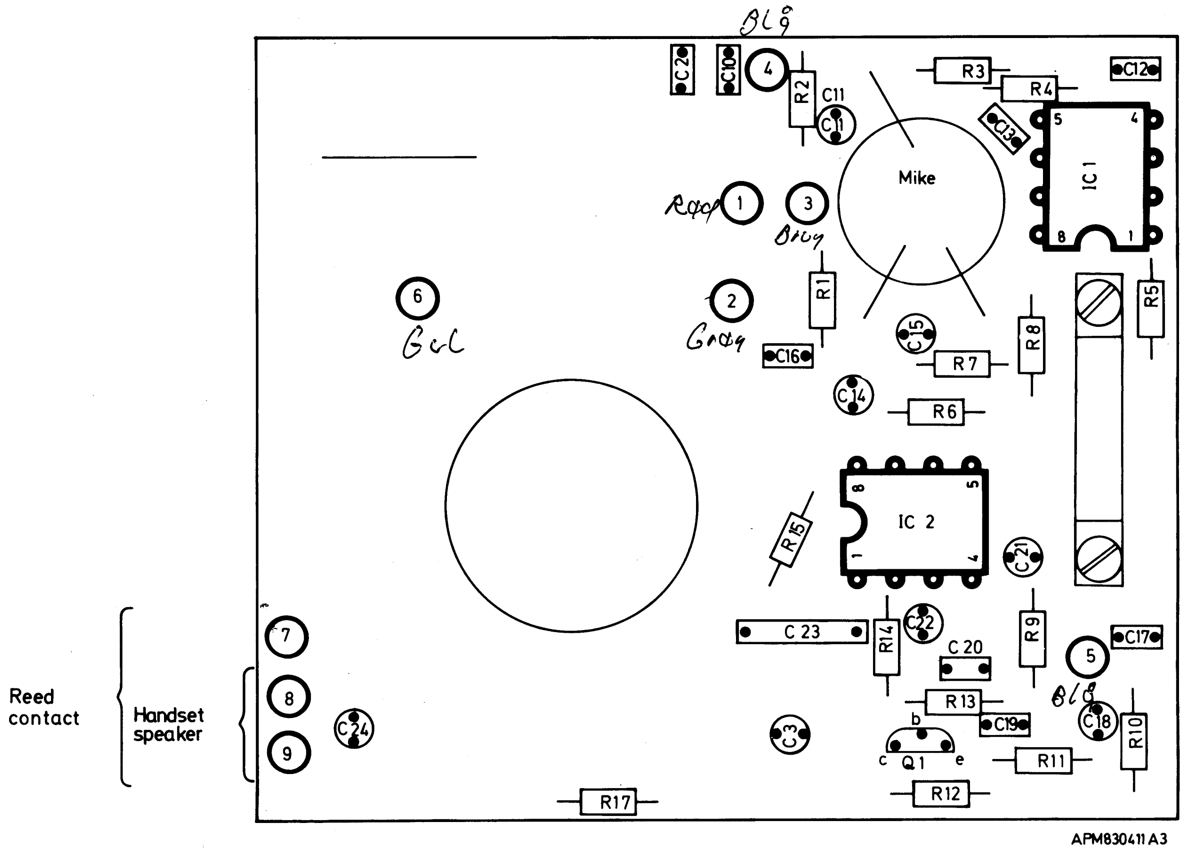


Fig. 8-6 Component location, passive handset, N11B

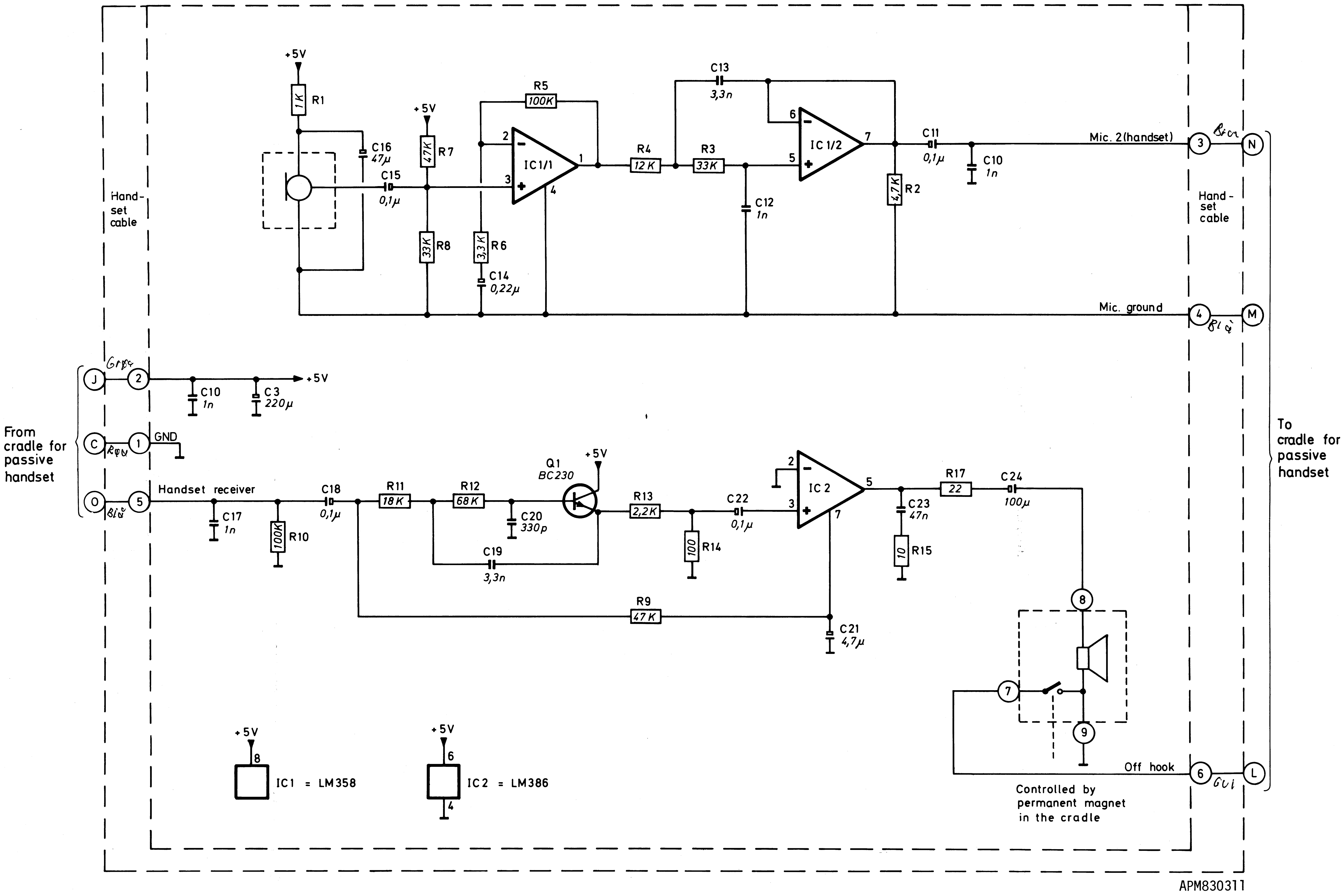


Fig. 8-7 Circuit diagram, passive handset, N11B

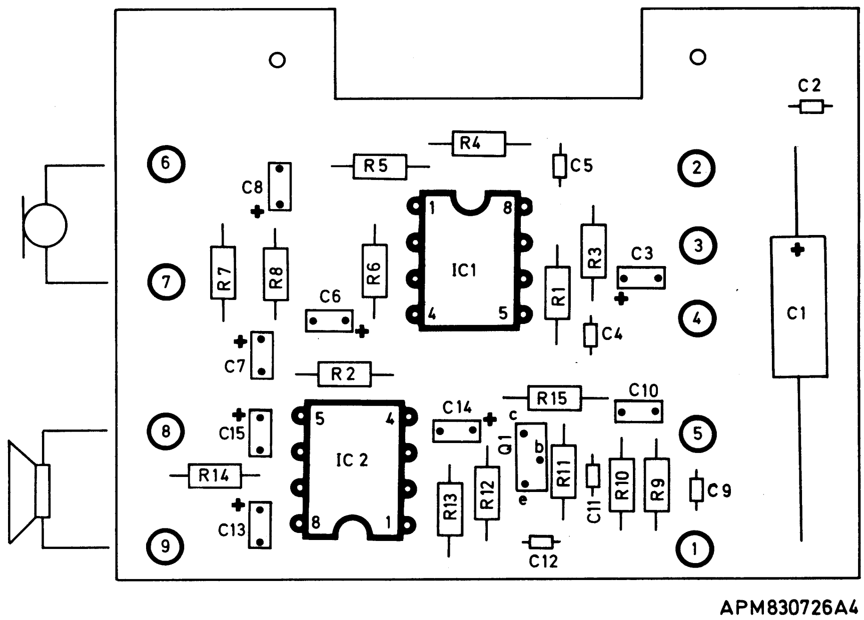


Fig. 8-8 Component location, Ackerman handset, N27

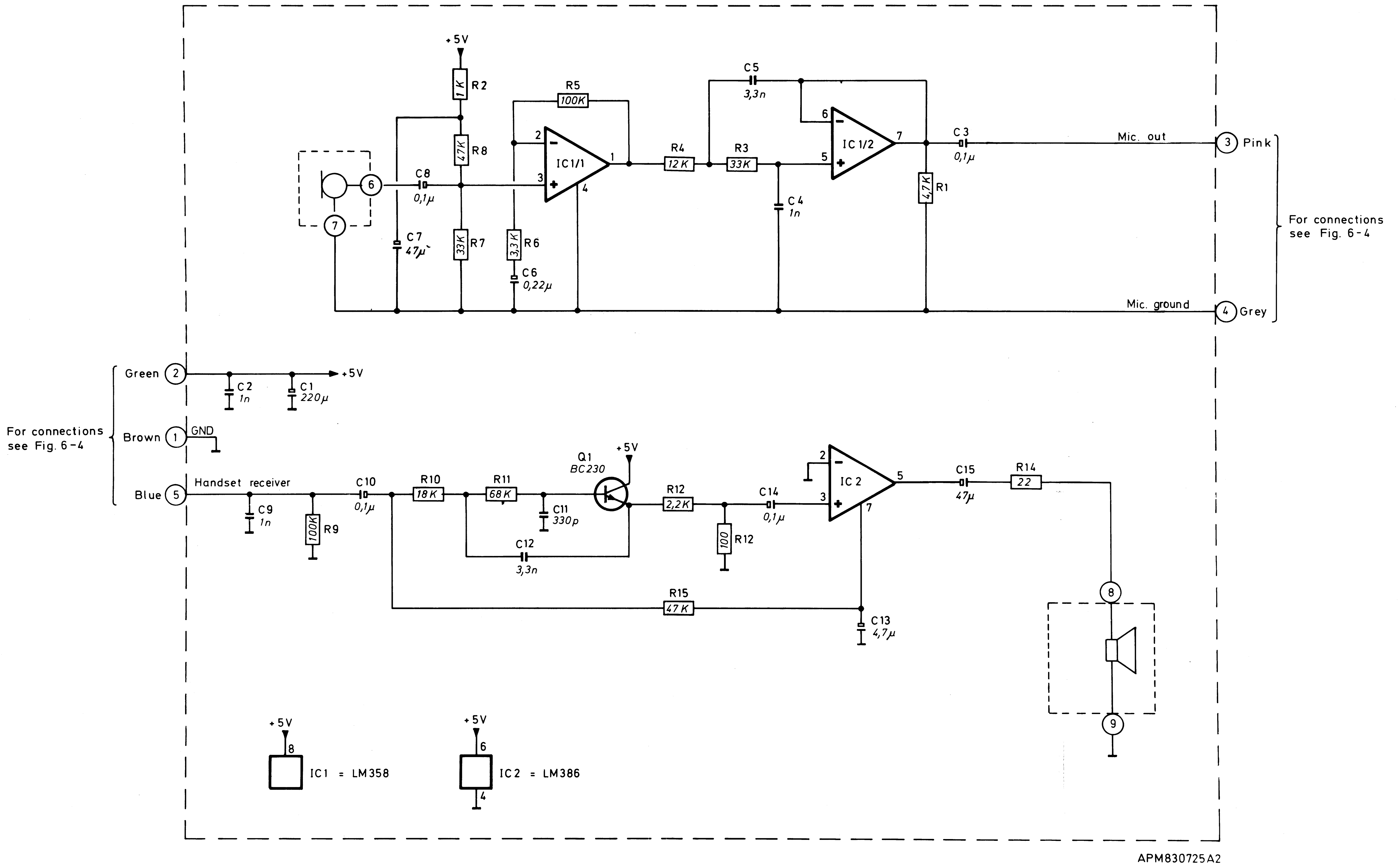
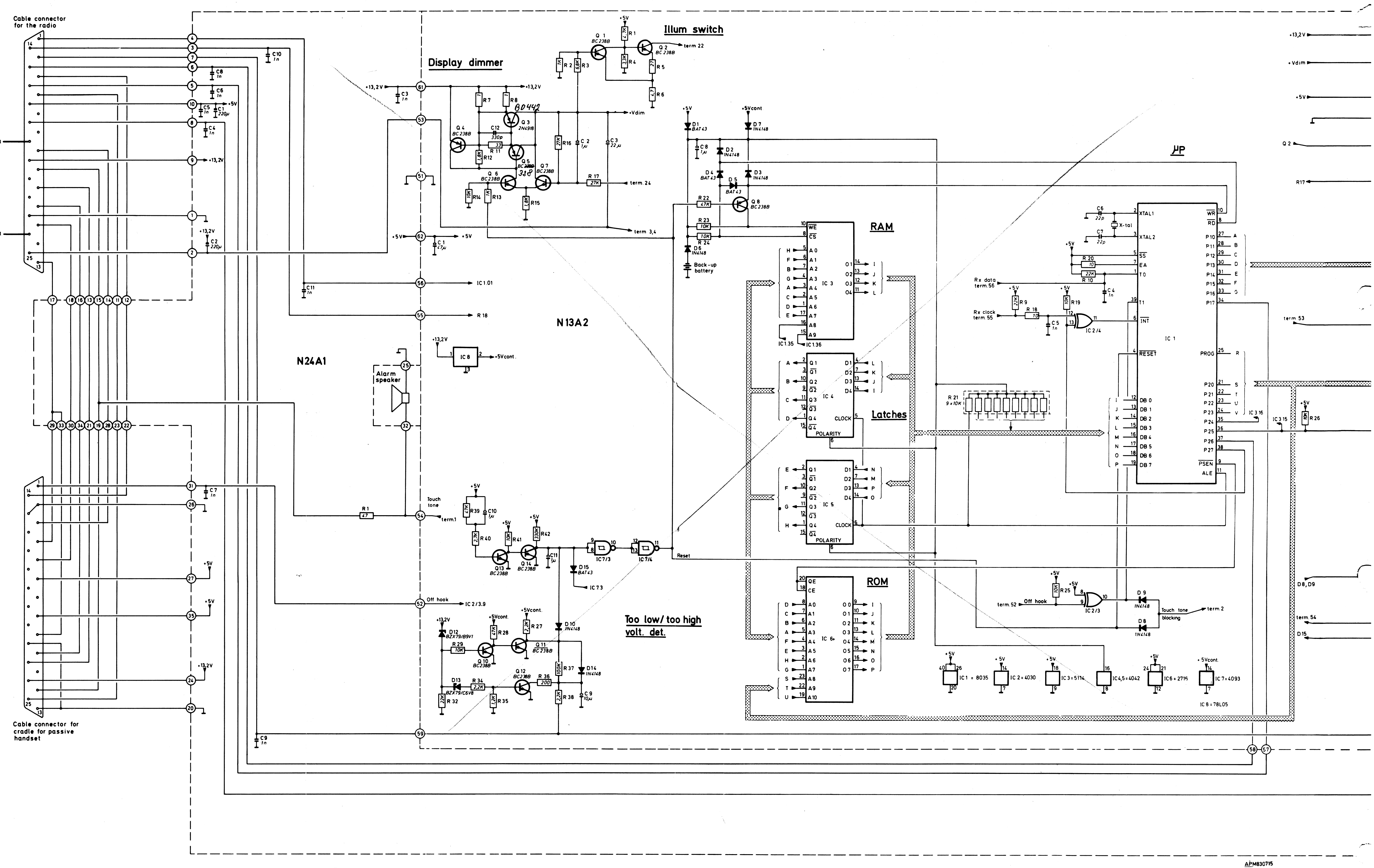


Fig. 8-9 Circuit diagram, Ackermann handset, N27


Cable connector for the radio
Display dimmer
Illum switch
RAM
Latches
ROM
µP
N24A1
N13A2
Alarm speaker
Touch tone
Too low/ too high volt. det.
Cable connector for cradle for passive handset
IC 1 = 8035
IC 2 = 4030
IC 3 = 5114
IC4,5 = 4042
IC6 = 2716
IC 7 = 4093
IC 8 = 78L05
APM830715

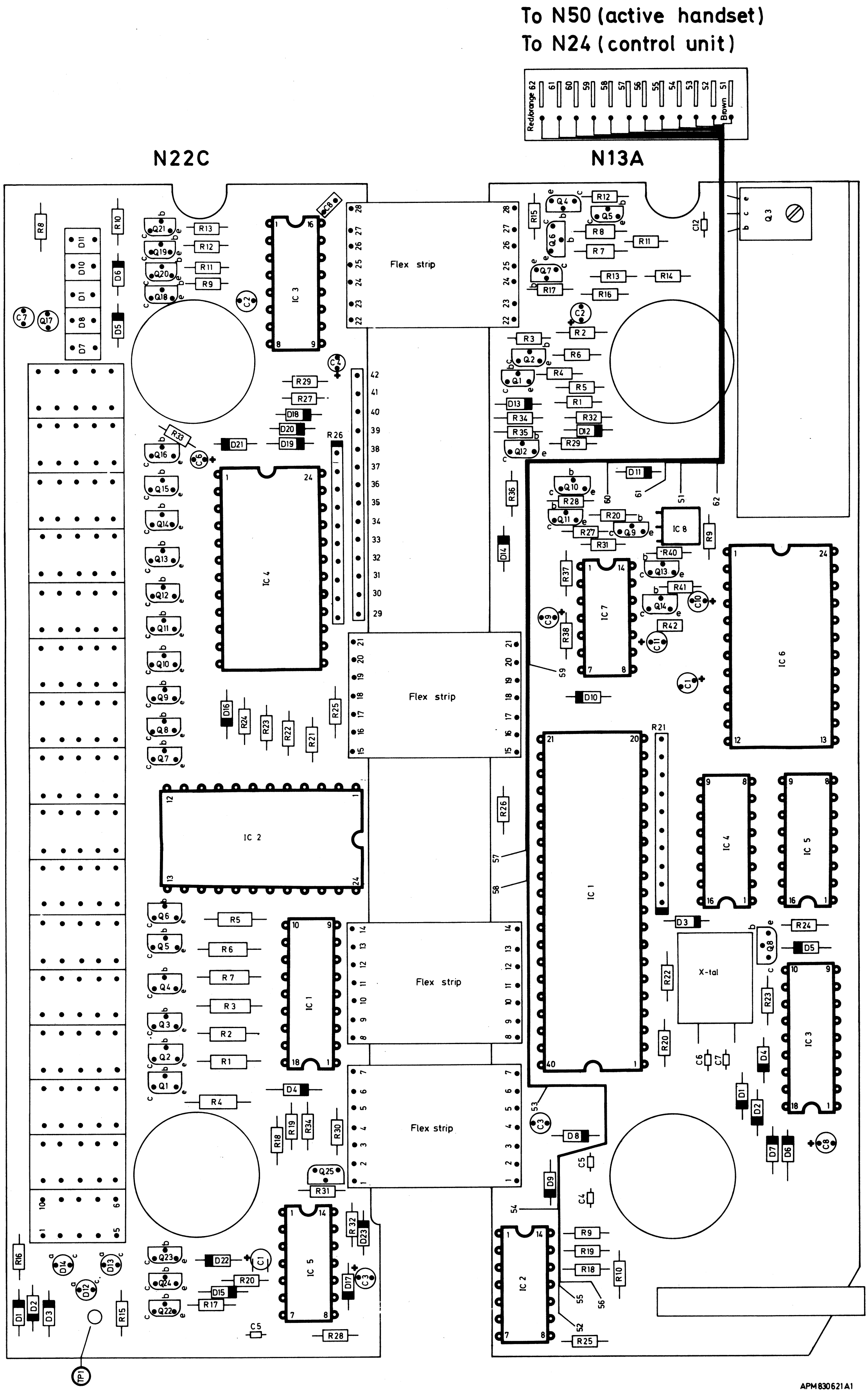


Fig. 8-10 Component location, control unit, N13A N22C

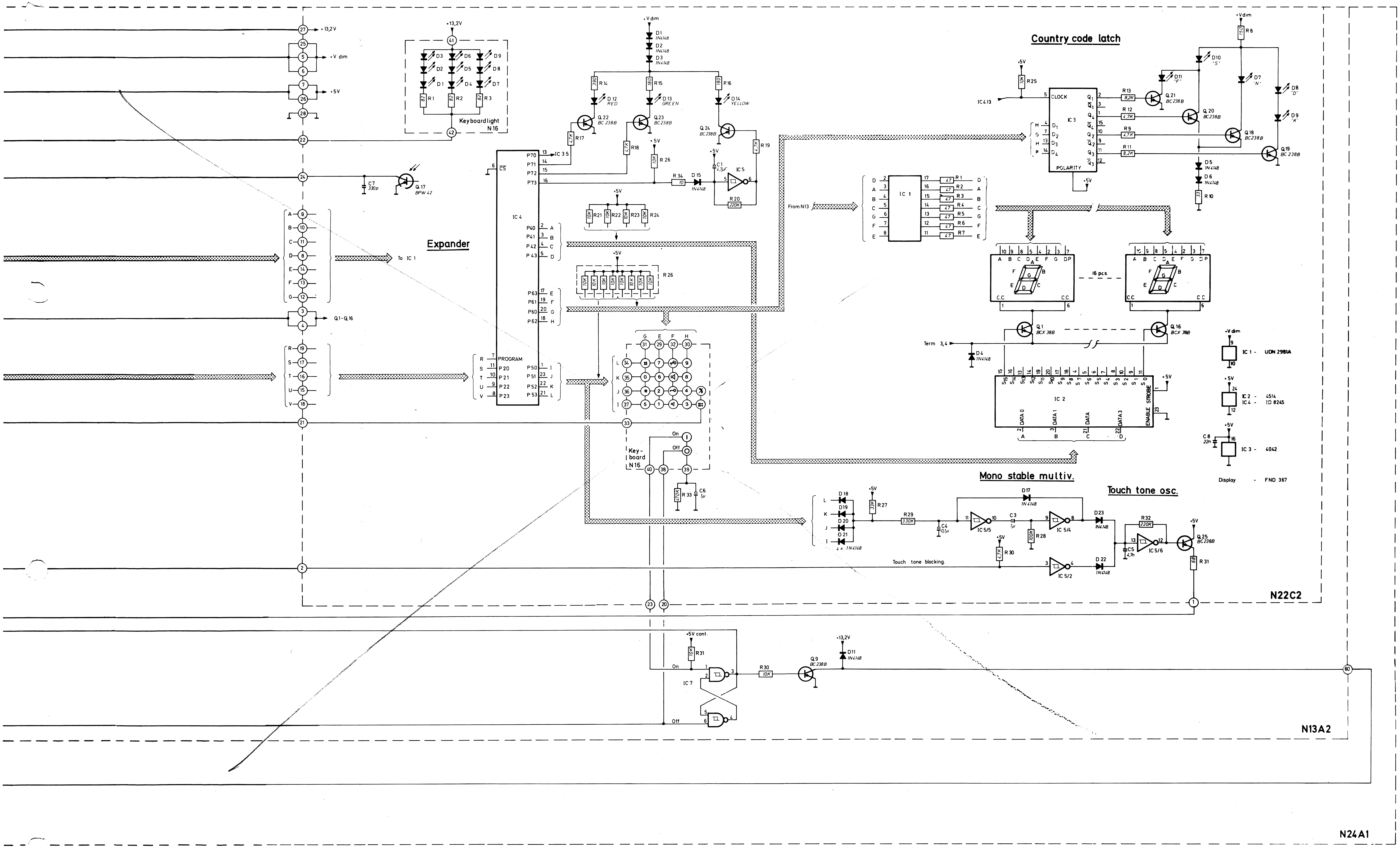


Fig. 8-11 Circuit diagram, control unit, N24A N13A N22C

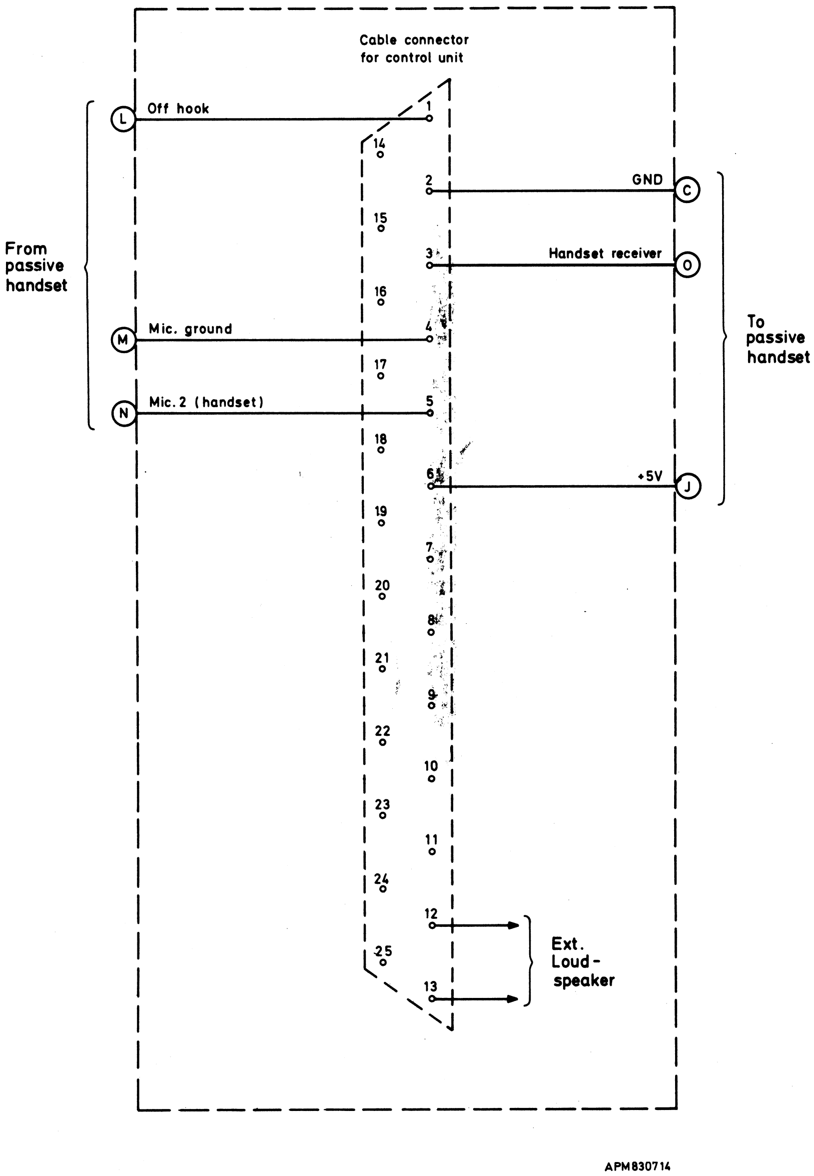


Fig. 8-12 Circuit diagram, cradle for passive handset

9. Disassembling and wiring diagram

A. Disassembling of the radio unit

1. Removing the cover

- Loosen the screw A and remove the cover.

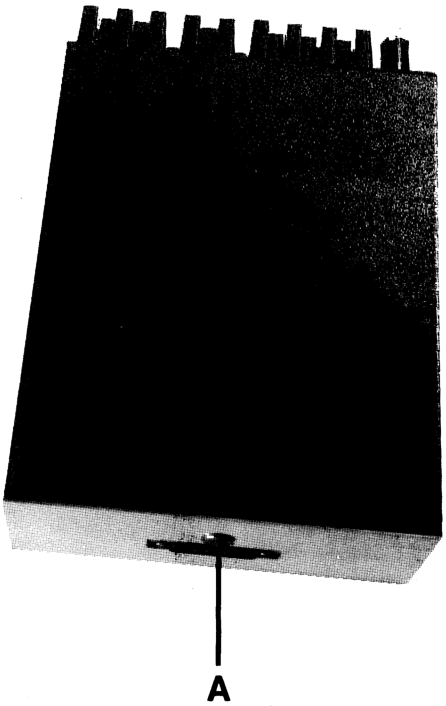


Fig. 9-1

2. Access to the units, RF side

Each unit is provided with a metal lid.
After removal of the lid the component side of the unit in question is accessible.

3. Replacement of the units, RF side

The units are provided with connector sockets for direct plug in connection to the motherboard N04.

Each unit can be removed after removal of 4 screws A.

Note 1: Before removing N07 and N10, remove the lid and the coaxial cables.

Note 2: Before mounting a unit, observe the location of the connector pins in order to turn the unit properly.

4. Removing the PA N05

- Remove the lid J (see fig. 9-5).
- Remove the screws B and D.
- Remove the two nuts on the heat sink (between the cooling flanges).
- Unsolder the various cables.

5. Removing the antenna filter N21

- Unsolder and remove the lid E.
- Remove the three screws inside the screened compartment.
- Unsolder the coaxial cable.
- Unsolder the antenna connector.

6. Removing the motherboard N04

- Remove the two metal bars by removing the screws F. Now N04 can be pulled out.

  Note: When mounting N04, observe that the interconnection N04-N01 is made without damage.

7. Removing the CPU N15

- Remove the screws G. Now the unit can be swinged out for access to the component side. For removal of the unit the hinges/screws H must also be removed.
- Unplug the flex strips in motherboard N01.

8. Removing the modem N14

- Remove the four screws K and pull the string N.

  Note: When mounting, observe that the connection with motherboard N04 is made without damage.

9. Removing the AF and modulation amplifier N02

- Remove the distance pieces L and the screws M.
  Note: When mounting, observe that the connection with motherboard N04 is made without damage.

10. Removing the motherboard N01

- Motherboard N04 must be removed first.
- Unsolder the three wires R.
- Unsolder the wire C (see fig. 9-2).
- Remove the two metal bars by removing the screws Q.
- Remove the two screws O for the multiplier connector.
- Remove the two screws P. Now N01 can be removed.

11. Removing the duplex filter N19

- Disconnect the coax cables at N05, N10 and N21.
- Remove the screws S.

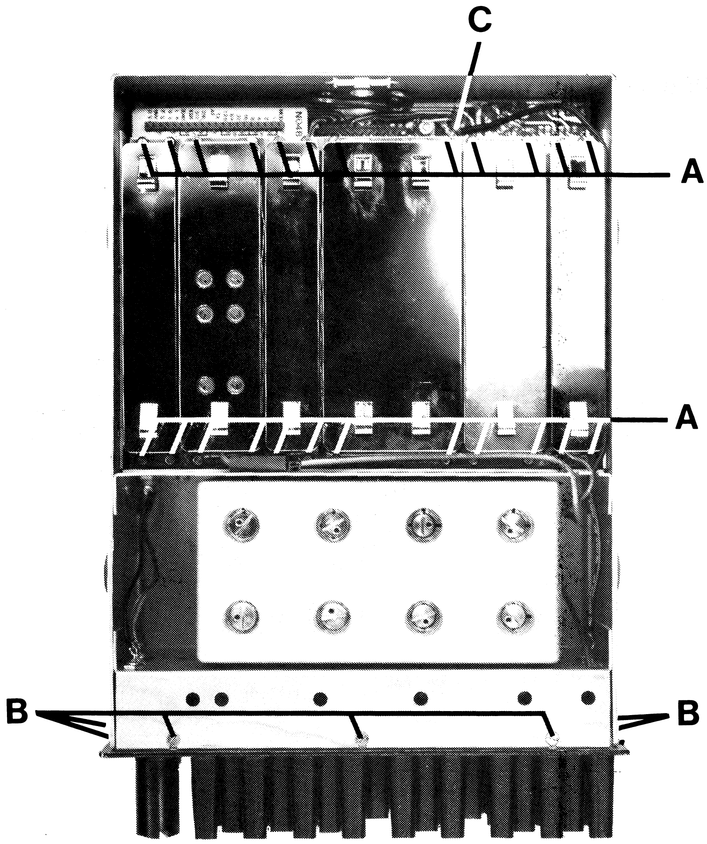


Fig. 9-2

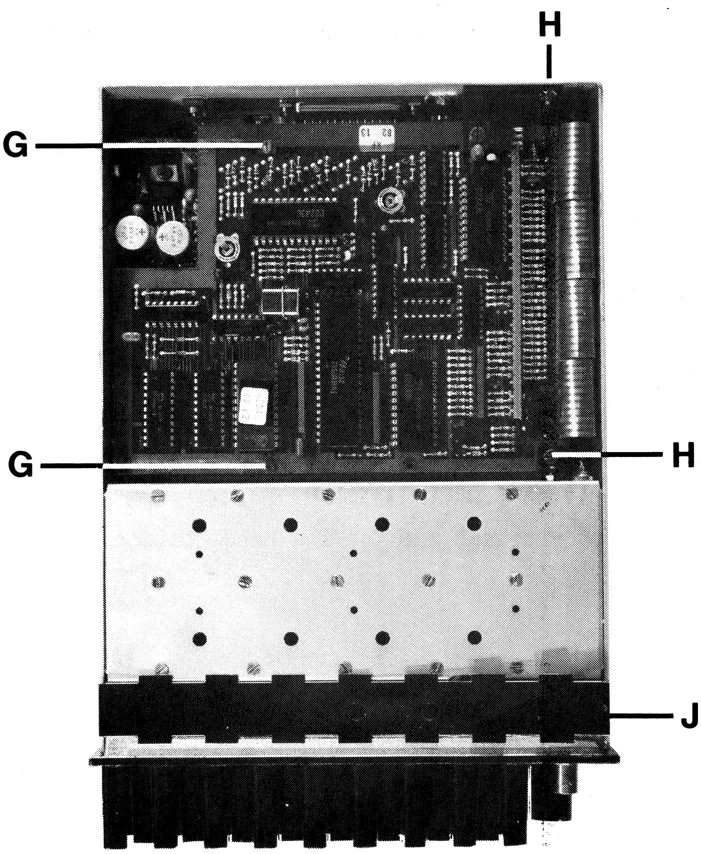


Fig. 9-5

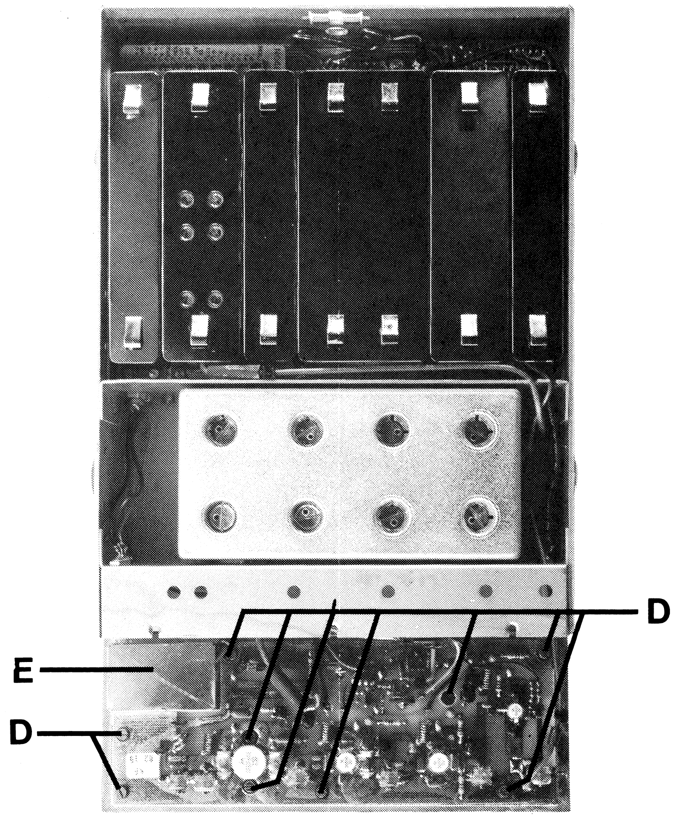


Fig. 9-3

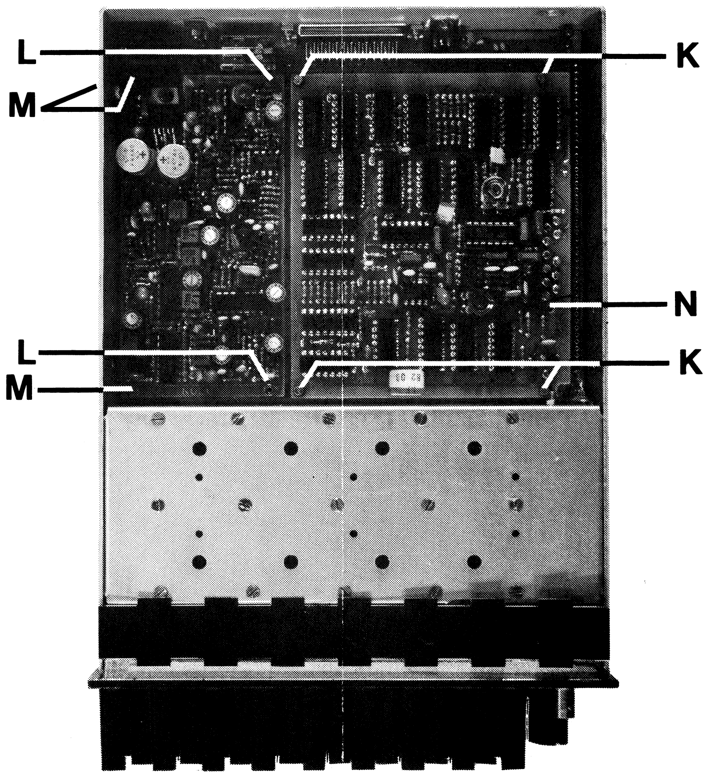


Fig. 9-6

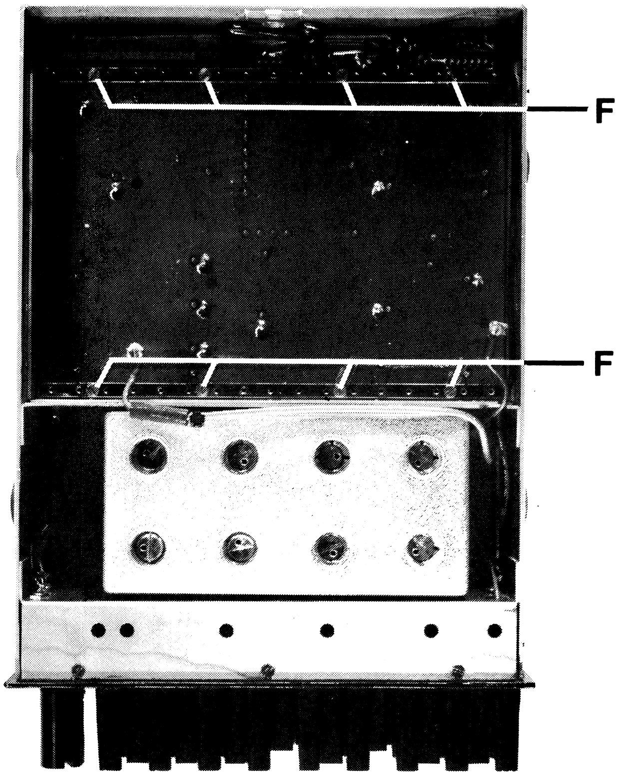


Fig. 9-4

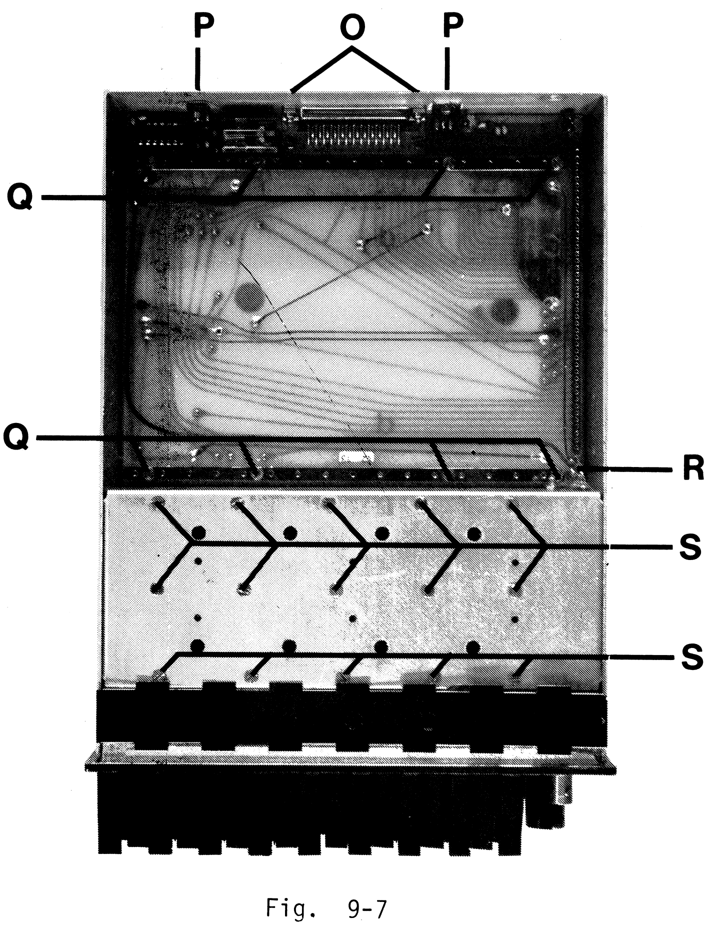


Fig. 9-7

B. Disassembling of the active handset

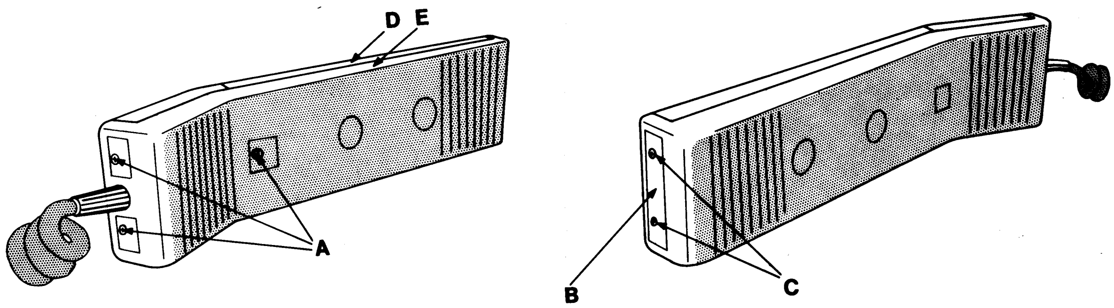


Fig. 9-8

1. Opening the handset

- Remove the three labels A and the screws hidden by these.
- With a pointer (e.g. small screwdriver or pincette) applied at point B, remove the plastic screw cover.
- Remove the two screws C.
- Separate gently the two halves D and E (they are interconnected with a flex strip.
- Unplug the flex strip at the part E. Part D contains board N16.

2. Access to and replacement of N50

- Step 1 gives access to the component side.
- For replacement, unsolder at the solder pins the 14 wires of the microphone cable and the three wires F for the microphone. Unplug the connector G (print N20). Remove the two screws H and the cable strap I.
- Unsolder the wires at L for the handset receiver and for the reed contact.

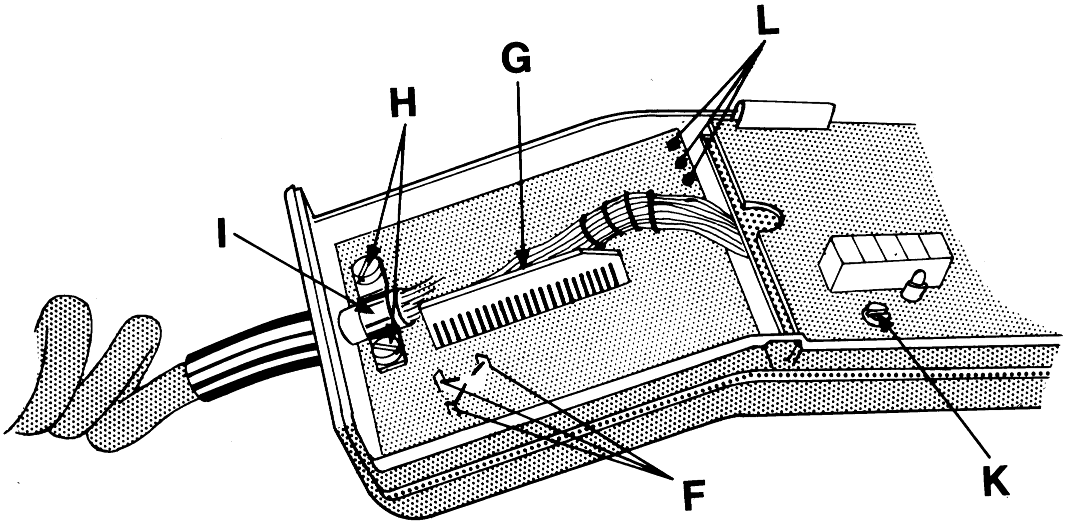


Fig. 9-9

3. Access to the printed side of N22

- Step 1 gives access to the component side.
- Remove the screw K and the plastic spacer on the opposite side.
- Fold the board over (the flex strips act as hinges).

4. Replacement of N22

- Perform steps 1 and 3.
- Unsolder the flex strips at M.

5. Access to the printed side of N13

- Perform steps 1 and 3.
- Remove the insulating clear plastic separating N22 and N13.

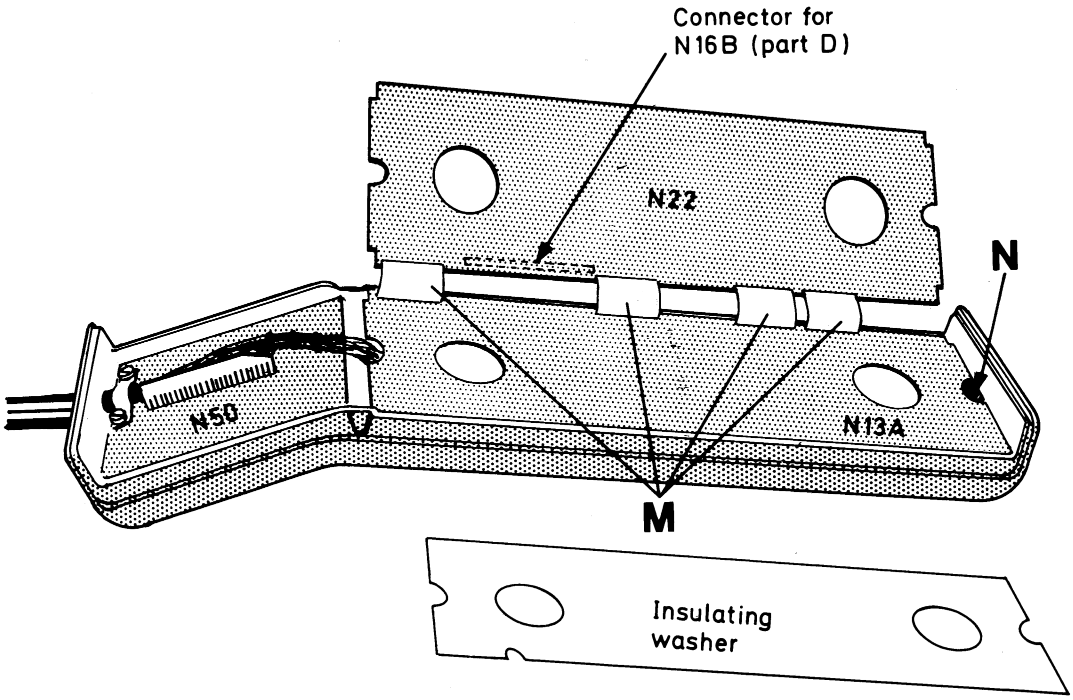


Fig. 9-10

Note: When assembling, assure that the slots in the transparent plastic insulation are properly aligned with the corresponding guiders of the "box".

6. Access to the component side of N13

- Perform step 1.
- Use the big holes in the boards N22 and N13 to pull both boards out simultaneously.
- Be careful that the spacer N does not get lost.

7. Replacement of N13

- Perform steps 1 and 6.
- Unsolder the flex strips at M
- Unplug the connector G (print N20).

8. Replacement of the memory backup battery

The battery is accessible on the component side of the board N13. Perform steps 1 and 6. During battery replacement it is recommended to have the handset connected to the radio (or handset test box) with power on. Otherwise all stored numbers and the code lock number must be entered again.

C. Disassembling of passive handset

1. Opening the handset

See fig. 9-8

- Remove the three labels A and the screws hidden by these.
- With a pointer (e.g. small screwdriver or pincette) applied at point B, remove the plastic screw-cover.
- Remove the two screws C.
- Separate gently the two halves D and E.

2. Access to and replacement of N11

See fig. 9-9

- Step 1 gives access to the component side.
- For replacement, unsolder at the solder pins the 6 wires of the microphone cable and the three wires F for the microphone. Remove the two screws H and the cable strap I.
- Unsolder the wires at L for the handset receiver and for the reed contact.

D. Disassembling of the control unit

1. Opening the unit

- Remove the four screws A.
- Separate gently the two halves B and C.
- You now have access to the keyboard N16 and to the component side of N22. For access to N13 just pull out the boards. The memory back-up battery is accessible on the component side of N13. During battery replacement it is recommended to have the control unit connected to the radio (or handset test box) with the power on. Otherwise all stored numbers and the code lock number must be entered again.

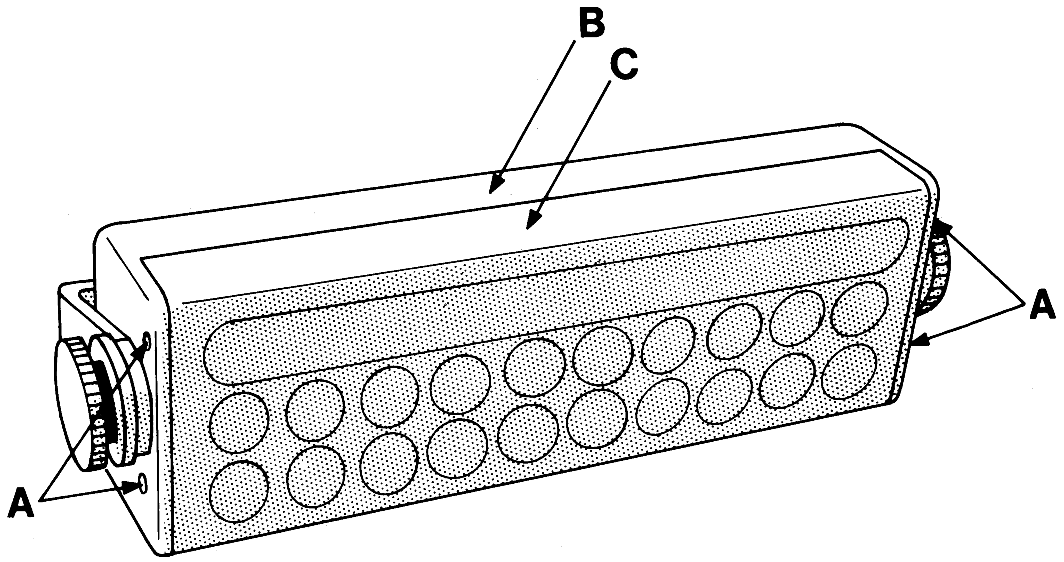


Fig. 9-11

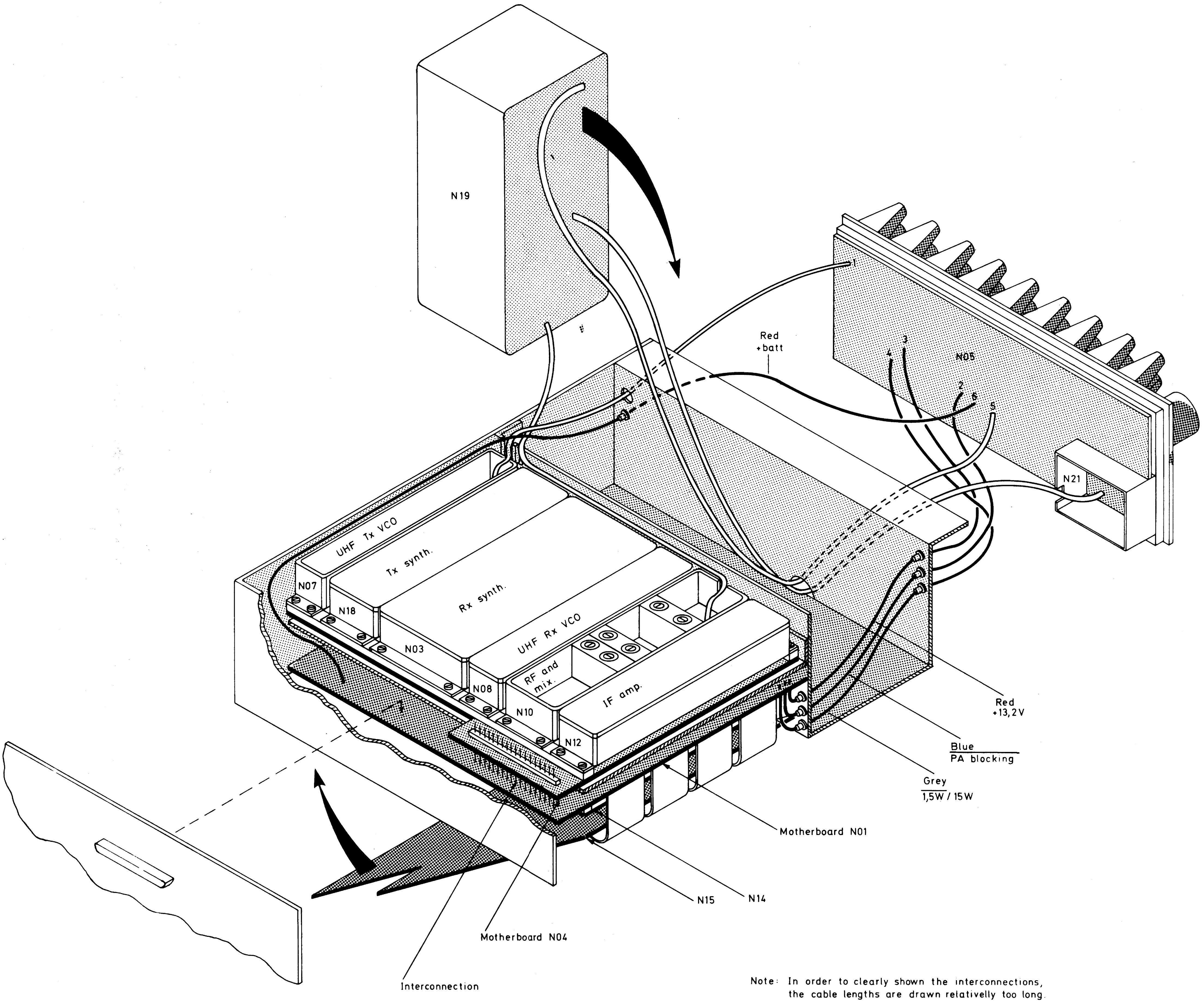


Fig. 9-12 Wiring survey of the radio unit

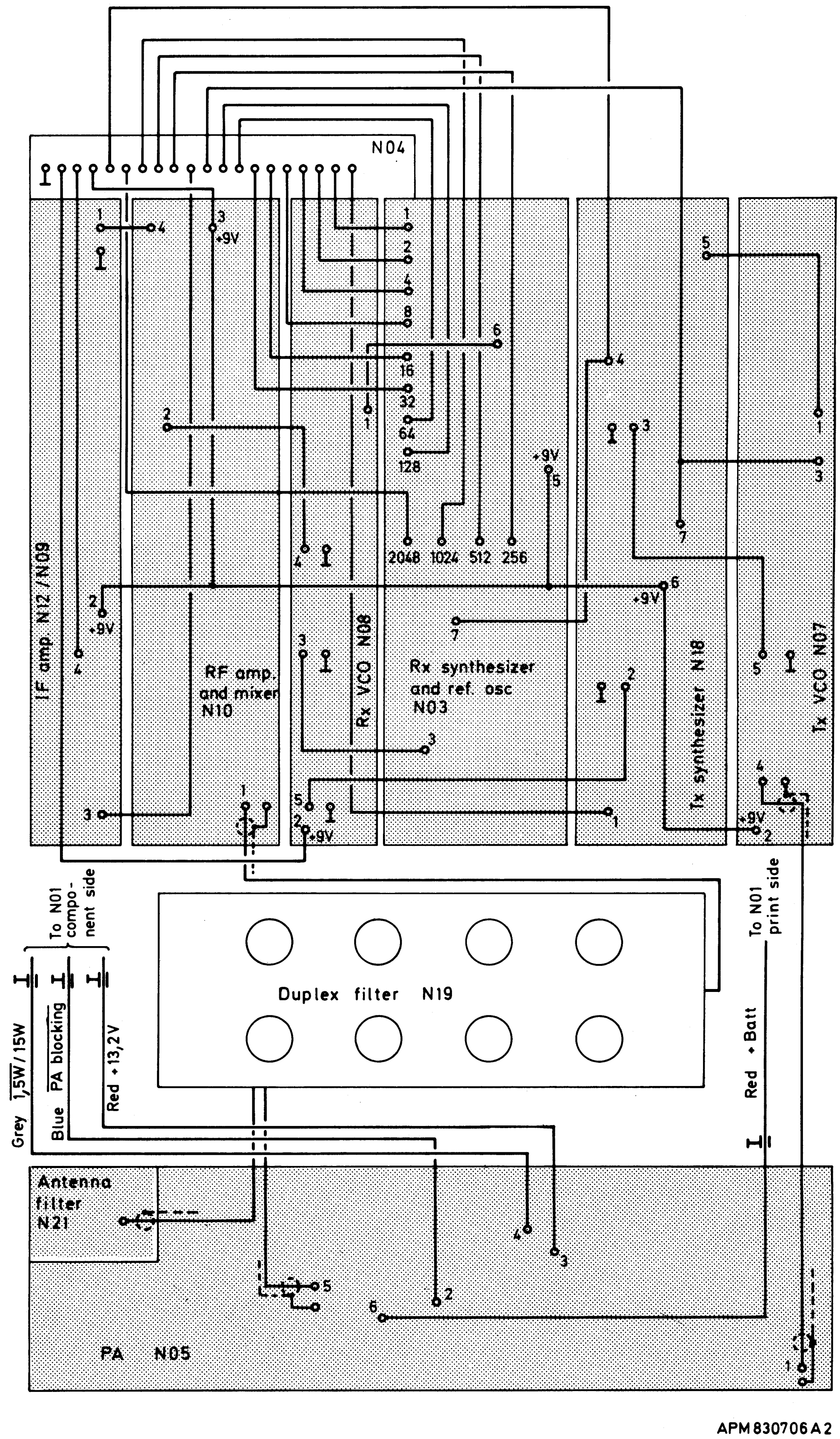


Fig. 9-13 Wiring diagram, radio unit ("RF side")

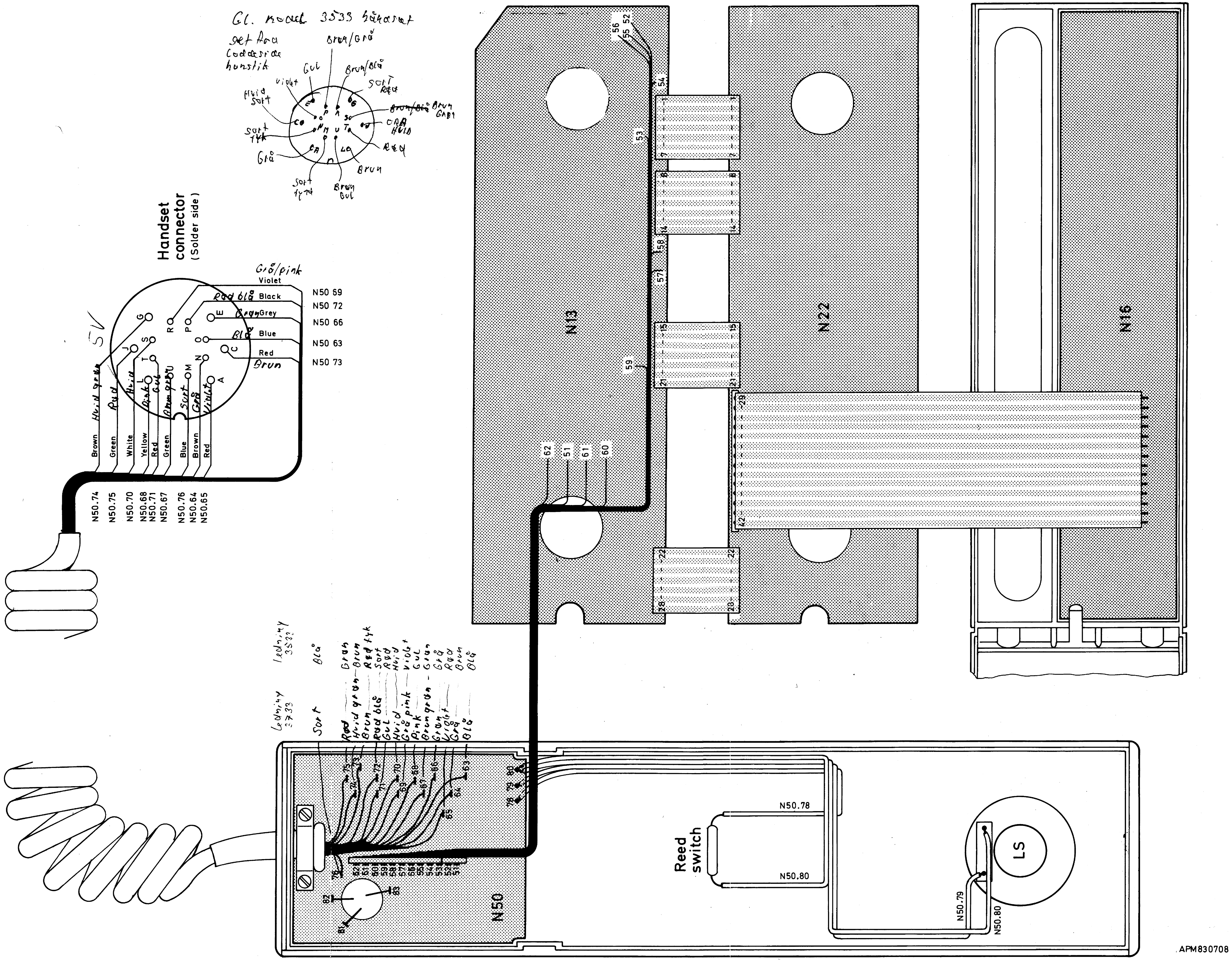


Fig. 9-15 Wiring diagram, active handset

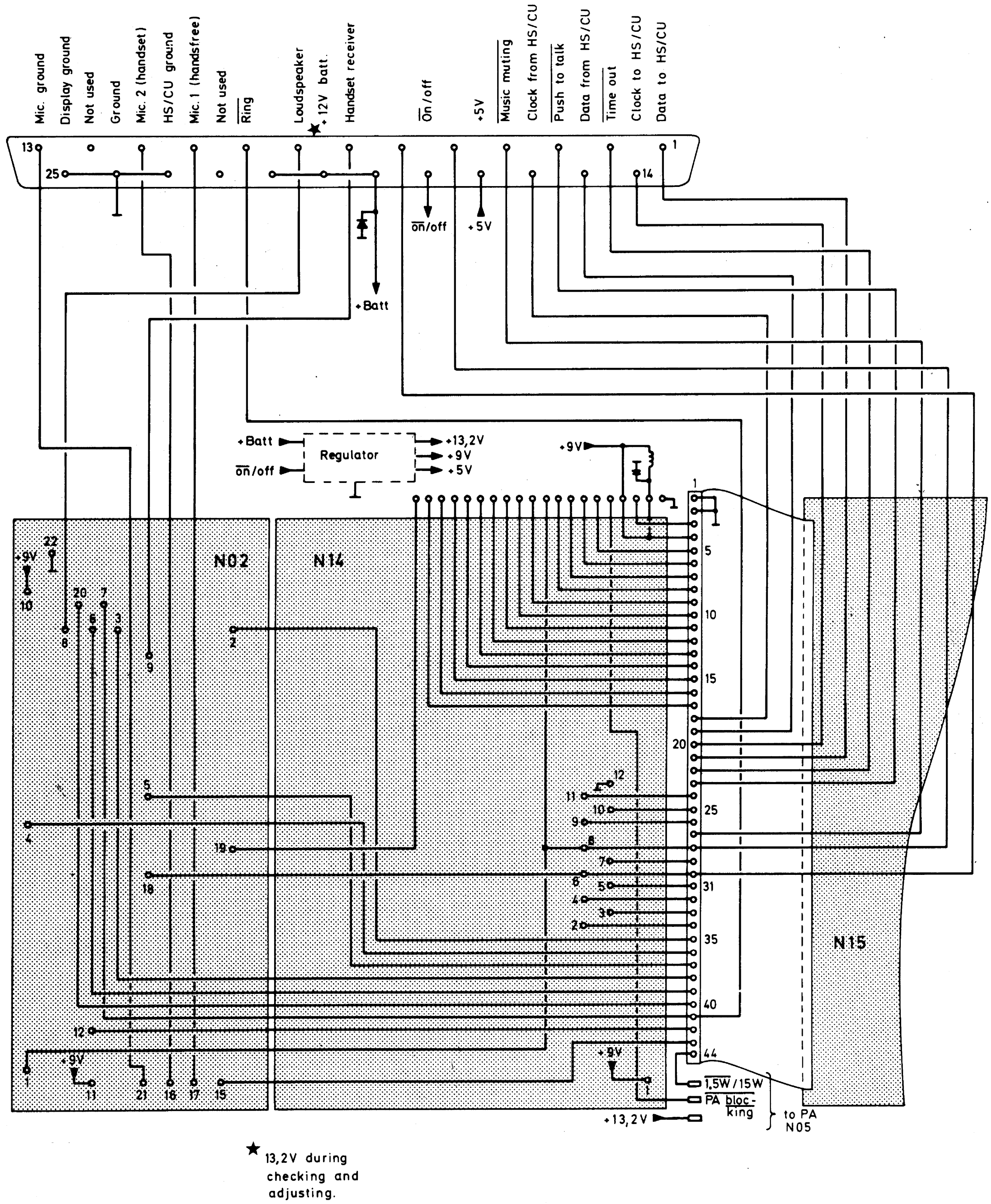
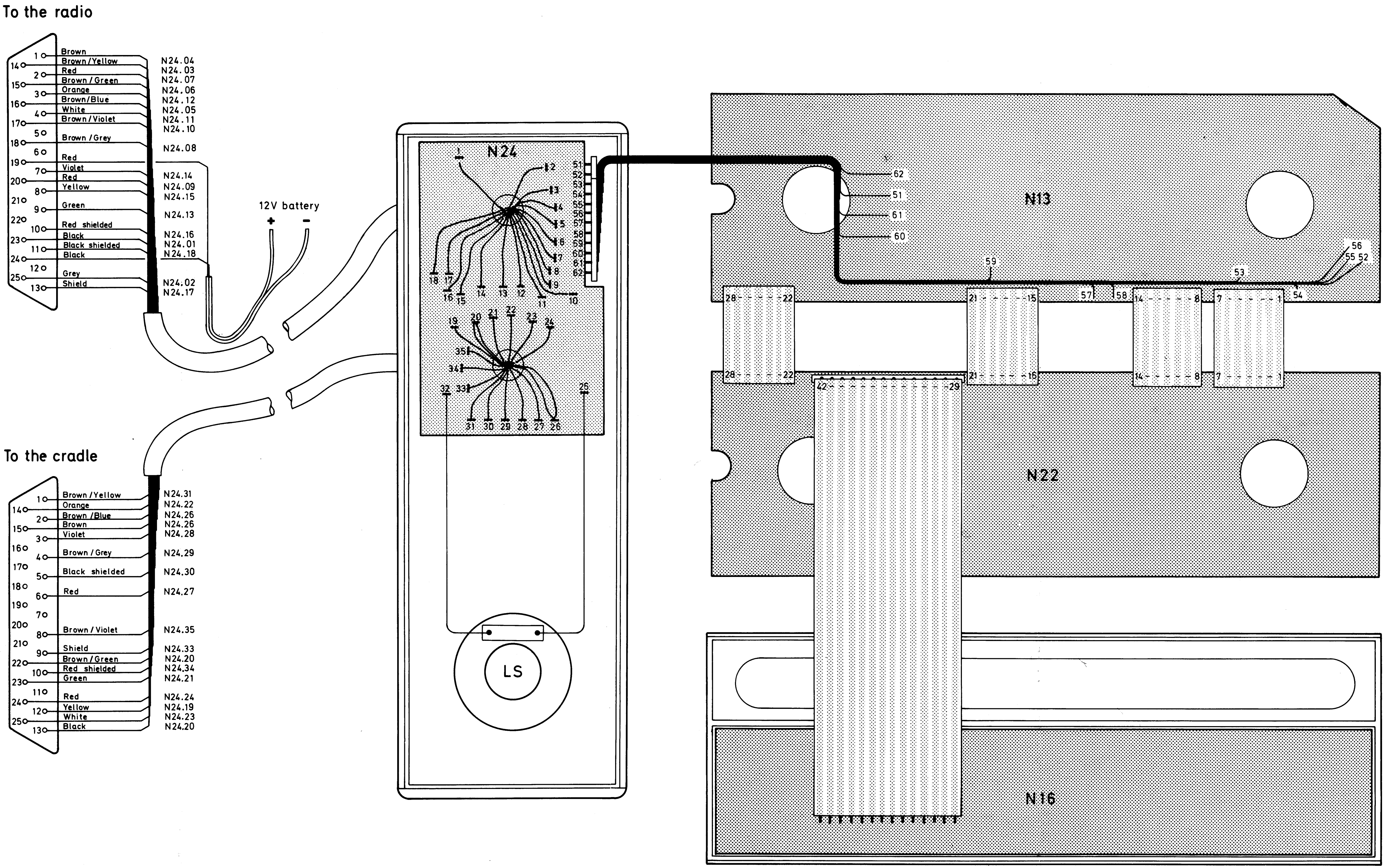


Fig. 9-14 Wiring diagram, radio unit ("CPU side")



APM830702

Fig. 9-16 Wiring diagram, control unit

10. Checking and adjusting

1. General information

Measuring instruments:

Test box	: AP accessory 319-050
Handset test box	: AP accessory 315-004
Power meter	
Dummy load 50Ω/25W	
Attenuator 30-40dB/50Ω/20W	
Attenuator 20dB/50Ω/20W	
Deviation meter	
Tone generator	
RF signal generator with attenuator	
Distortion meter	
Oscilloscope	
Modulation meter	
Frequency counter	
Power supply 13.2V/6A	

In the following instructions adjusting elements are indicated with the unit no. and the component no. e.g. N05/R10. The same principle is also used for indication of test points, e.g. N14/TP5 indicates unit N14 test point 5. N10.04 indicates unit N10 terminal 4. The location of test points, adjusting elements etc. is shown in fig. 10-9 and fig. 10-10.

We presume that the technician performing the adjusting is familiar with the test box and the test cradle.

2. Connecting the box and handset test box

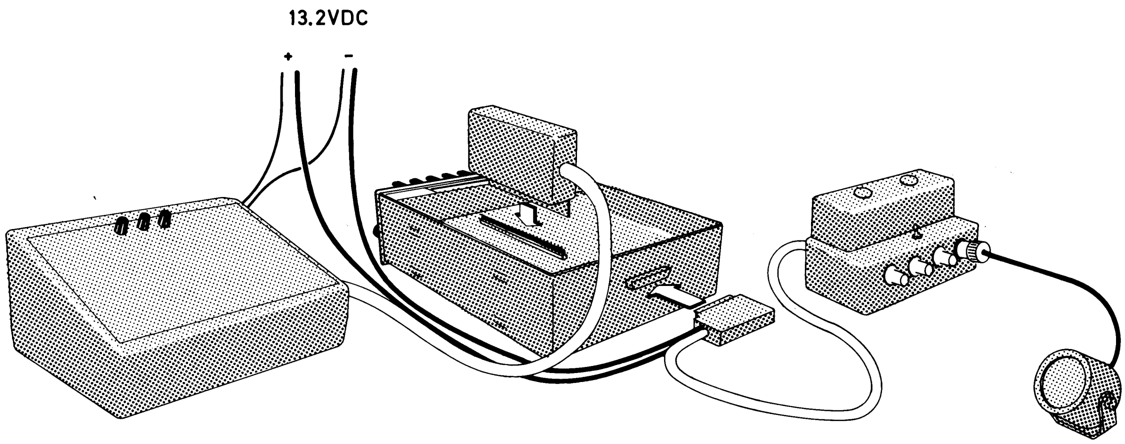
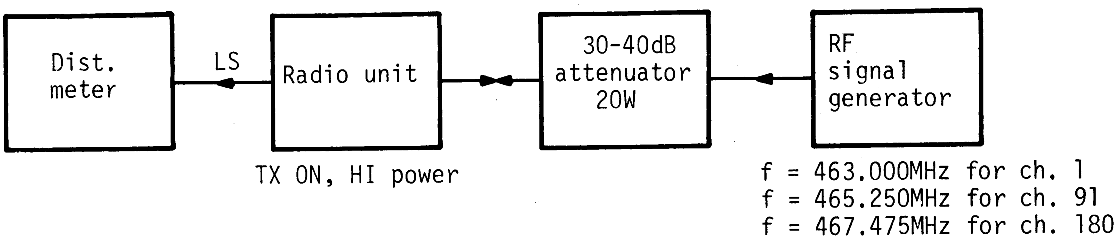


Fig. 10-1 Connection of the test box and the handset box APM830615

3. Quick functional test

The following test is not complete, but it gives an indication of the transmitter/ receiver performance.

- By using e.g. the set-up in fig. 10-2, check the receiver sensitivity at the channels 1, 91 and 180 while transmitting with high power.



Note: The exact value of the att. is not important but must be known in order to determine the sensitivity.

Fig. 10-2 Test set-up for quick functional test

4. Adjusting the RX synthesizer loop

- Check that 4.8MHz is obtained on N03/TP1.
- If not, adjust N03/C6.
- Set the switches SK1-3 to channel 91.
- Check that 5V DC is obtained on N03.06.
- If not, adjust N08/C5.
- Check that the frequency on N08.03 is 486.650MHz.
- If not, check N03/TP1 again (see above).

5. Adjusting the TX synthesizer loop

- It is assumed that the RX synthesizer loop works OK, see point 4.
- Set the switches SK1-3 to channel 91.
- Check that 7.850MHz is obtained at N18/TP1.
- If not, adjust N18/L1.
- With a dummy load connected, activate the transmitter with the test box.
- Check that the loop voltage on N07.01 is 4.5VDC while the output frequency (measured e.g. on N07.04) is 455.250MHz.
- If not, adjust N07/C4
- When the loop is locked, N18.04 will be high (approx. 12V).

6. Adjusting the PA and power control

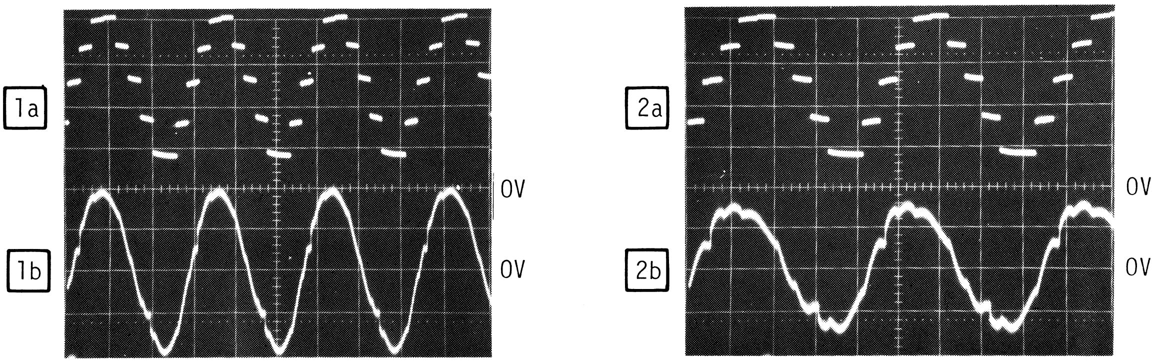
- Connect a 25W dummy load via a power meter to the antenna connector.
- As it is important that the PA is terminated with 50ohms, it is assumed that the duplex filter is OK.
- Still using channel 91, enable a high power transmission without modulation (SK12 in MIC BL position) with the test box.
- Adjust all the trim capacitors in unit N05 for maximum output (critical adjustment).
- Adjust N05/R9 for 15W output power.
- Check that the output power at channels 1 and 180 is minimum 12W. If not, suspect the duplex filter.
- Enable a low power transmission on channel 91.
- Adjust N05/R10 for 1.5W output power.

7. Adjusting the modulation amplifier

- Connect a deviation meter to N04.04 or via a power attenuator to the antenna connector.
- Connect a tone generator to the "MIC 1" connector at the test cradle.
- Set SK16 to "MIC 1" position, SK12 to "OPEN" position and SK9 to "SUP OFF" position.
- With 1000Hz/10mV from the tone generator, check that ±4.5kHz deviation is obtained. If not, adjust N02/R101.
- With an output 20dB less (1mV output), check that ±3kHz deviation is obtained.
- If not, adjust N02/R76.
- Repeat the procedure once.
- Connect the tone generator to the "MIC 2" connector at the test cradle.
- Set SK16 to "MIC 2" position.
- With 1000Hz/100mV RMS from the tone generator, check that ± 3kHz deviation is obtained.
- If not, adjust N02/R72.

8. Checking the modem

Some checking of the modem can be made without sophisticated test equipment. The modulator can be forced to transmit 1800Hz or 1200Hz by connecting TP8 to ground or + 5V respectively.



a: TP6 0.2V/div. 0.2ms/div.
b: N14.06 0.2V/div.

Note: TP8 grounded

a: TP6 0.2V/div. 0.2ms/div.
b: N14.06 0.2V/div.

Note: TP8 to +5V

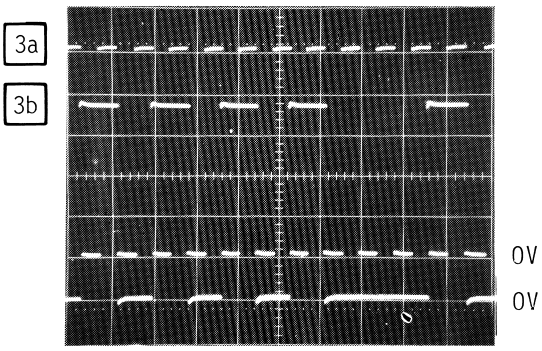
Fig. 10-3 Modem TX test

The receiver can be checked with the signal transmitted from the base station. If the modem receiver is defect, the base station must first be found with another radio unit (which is OK) connected to the test box. When the channel is noted, the defect radio can be forced to this channel.

Now the following should be checked:

a) regenerated clock b) data on TP3

c) received data d) RX clock (transition in the middle of data bits).



a: TP5 1V/div. 1ms/div.
b: TP3 1V/div.

Note: Ext. trig from TP4. The picture is taken with overlapping curves.

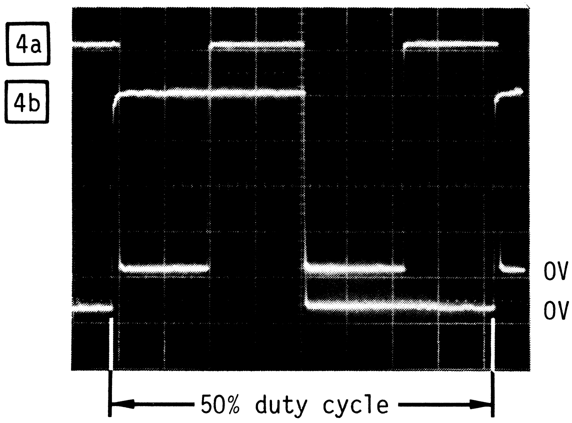
Fig. 10-4 Modem RX test

9. Adjusting the modem-TX

- With the switch SK12 in "MIC BL" position and SK5 in "TRANS" position, check that ±4.2kHz deviation is obtained.
  If not, adjust N19/R39.

10. Adjusting the modem-RX

Point 8 shows how the modem receiver can be checked. It is important that the duty cycle is 50±3% (when receiving 01010 etc).
This can be adjusted with R1. Adjustment is normally required after replacing IC2.



a: TP5 1V/div. 0.2ms/div.
b: TP3 1V/div.

Note: Ext. trig from TP4. The picture is the same as oscillogram 3a,b but is obtained with a storage oscilloscope.

Fig. 10-5 Modem RX test

11. Adjusting the IF amplifier

- If the RF and mixer unit is working you can connect the signal generator to the antenna connector. Then perform the measurement at 465.250MHz. You can "by-pass" the RF and mixer unit by connecting the signal generator to N10/TP1 instead. In this case the measurement is performed at 21.4MHz.
- Connect the distortion meter to the loudspeaker output on the test cradle.
- Modulate the signal generator with 1kHz to ±3kHz deviation.
- Adjust N10/L11 and N12/C1 for minimum distortion and N12/L1 for maximum LF output.

12. Adjusting the RF amplifier

The adjustment of N10/L11 is described together with the IF amplifier.
- Set the radio to channel 91.
- Adjust N10/C11 for max. DC voltage at N10/TP2 (approx. 1.5 to 2.5V DC).
- Adjustment of the RF filter should be avoided unless e.g. a sweep generator provided with a logaritmic horizontal amplifier (min. 40dB dynamic range) is available.

- If the required instrument is available the specifications in fig. 10-3 can be checked. The generator is connected directly to N10.01 input and the RF probe to N10/TP3.
- If necessary, adjust with N10/L1-L6.
- With N10/C10 the sensitivity can be fine-tuned (on ch. 91).

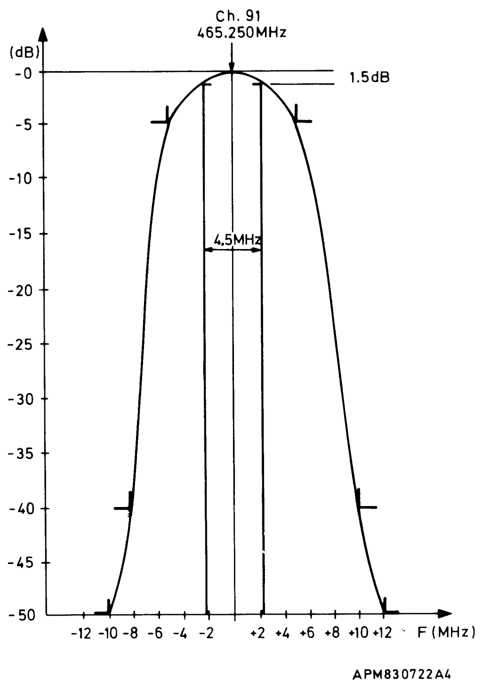


Fig. 10-6 Receiver RF filter (without duplex filter)

13. Adjusting squelch, handset output and field strength controls

- Disable the transmitter by setting SK11 in position "OFF".
- Disable the loudspeaker with SK14 in position "LSP BL".
- Connect the RF signal generator to the antenna input and an oscilloscope to the handset connector of the test cradle.
- Set the RF signal generator to 465.250MHz, modulation 1000Hz tone / ±3kHz deviation and the output level for 20dB SINAD measured with a psophometric filter (=14dB SINAD measured without psophometric filter).
- Adjust N02/R52 until the "SQL" lamp LA16 just lights up.
- Reduce the RF signal generator output with 4dB.
- Check that the "SQL" lamp is off.
- Readjust the RF signal generator to 10µV EMF.
- Set the receiver for maximum volume by setting SK7 in position "MAN" and turning the "VOLUME" control P1 fully clock-wise (grounding N02.04).

- Check that 560mV (1,58Vpp) without limiting/distortion is obtained at the handset output.
- If not, adjust N02/R58.
- Set SK7 in position "NOM".
- Check that 200mV (0,57Vpp) is obtained at the handset output.
- If not, adjust N15/R93.
- Adjust N15/R94 so that N15/TP1 just goes high (at 10µV from the RF signal generator).

14. Adjusting the supervisory filters

- Connect an RF signal generator to the antenna input (10µV). Modulate with 3855Hz (±0.1%), ±500Hz deviation.
- Adjust N02/R5 for max. AC voltage at N02/TP1.
- Modulate the RF generator with 4145Hz (±0.1%), ±500Hz deviation.
- Adjust N02/R13 for max. AC voltage at N02/TP2.

15. Adjusting the supervisory modulation level

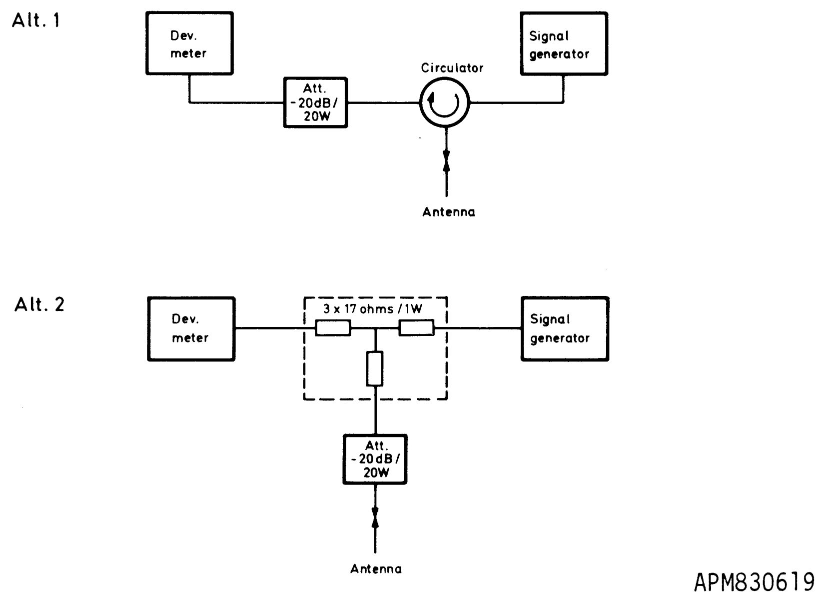
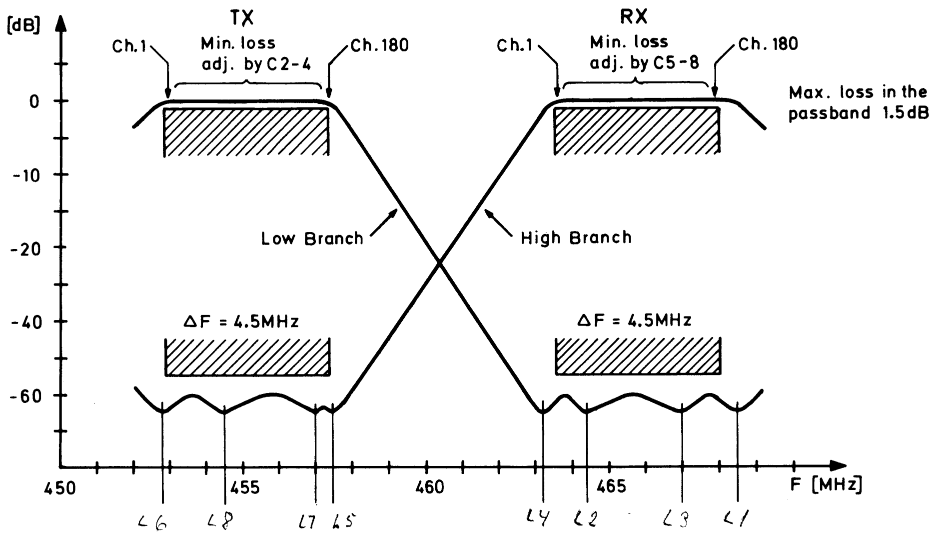


Fig. 10-7 Test set up. Supervisory modulation level

- Set the RF signal generator to the receiver frequency.
- Modulate the RF signal generator with 4000Hz to ±500Hz deviation (10µV).
- Open the supervisory path and enable the transmitter with the test box.
- Check that the transmitter deviation is ±550Hz.
- If not, adjust N02/R105.

16 Adjusting of the duplex filter

Note: We recommend that adjustment of the duplex filter is made in the factory only. Not only are expensive instruments necessary but the test set-up is also critical.
For fault-isolation we recommend that a duplex filter is kept in the work-shop.
For adjustment a network analyzer or a "Polyskop" with minimum 60dB dynamic range is required.



APM830623

Suggested adjustment frequencies for fulfilling the requirements:

L1:	468.5MHz	L5:	457.5MHz
L2:	464.4MHz	L6:	452.8MHz
L3:	467.0MHz	L7:	457.0MHz
L4:	463.2MHz	L8:	454.5MHz

Fig. 10-8 Duplex filter characteristics

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.16 Adjusting of the duplex filter

Note: We recommend that adjustment of the duplex filter is made in the factory only. Not only are expensive instruments necessary but the test set-up is also critical.
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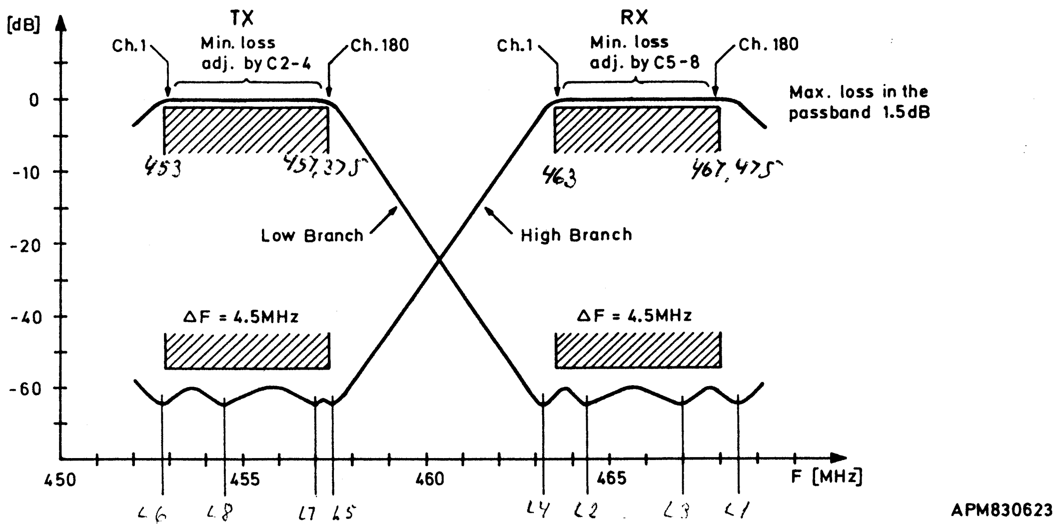
For adjustment a network analyzer or a "Polyskop" with minimum 60dB dynamic range is required.



Suggested adjustment frequencies for fulfilling the requirements:

L1:	468.5MHz	L5:	457.5MHz
L2:	464.4MHz	L6:	452.8MHz
L3:	467.0MHz	L7:	457.0MHz
L4:	463.2MHz	L8:	454.5MHz

Fig. 10-8 Duplex filter characteristics

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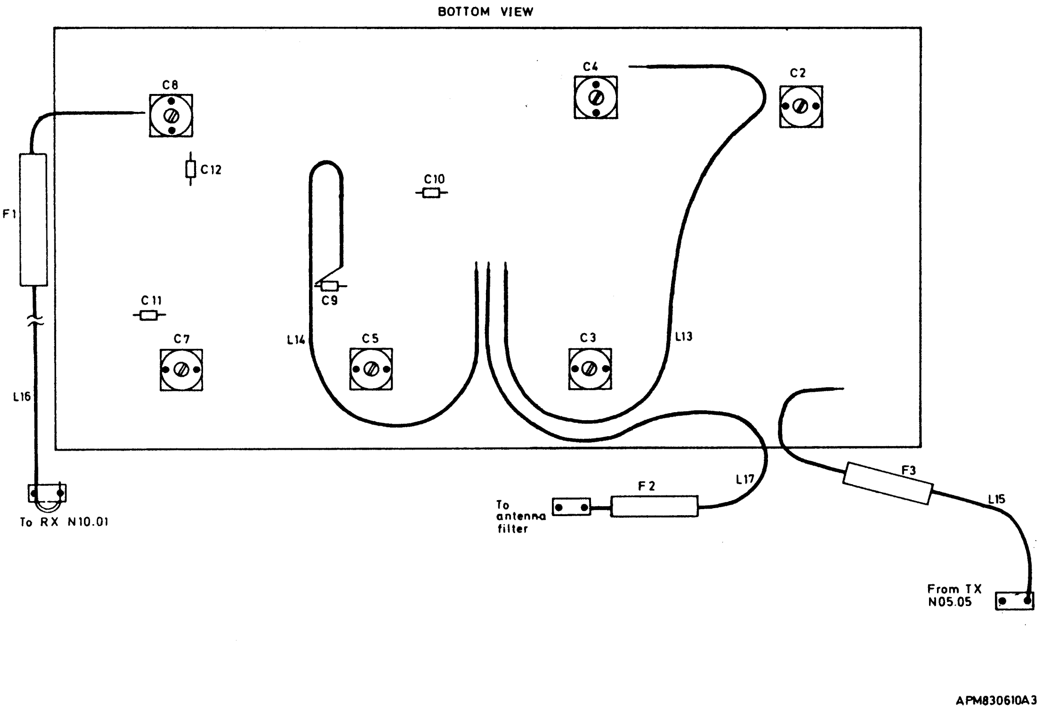


Fig. 7-31 Component location, duplex filter, N19B

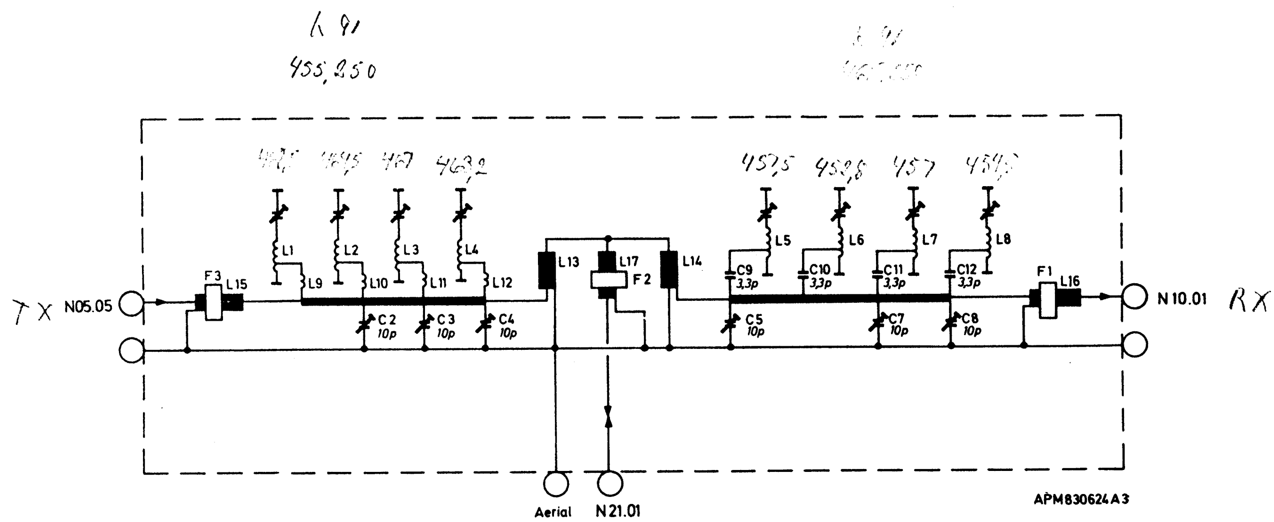
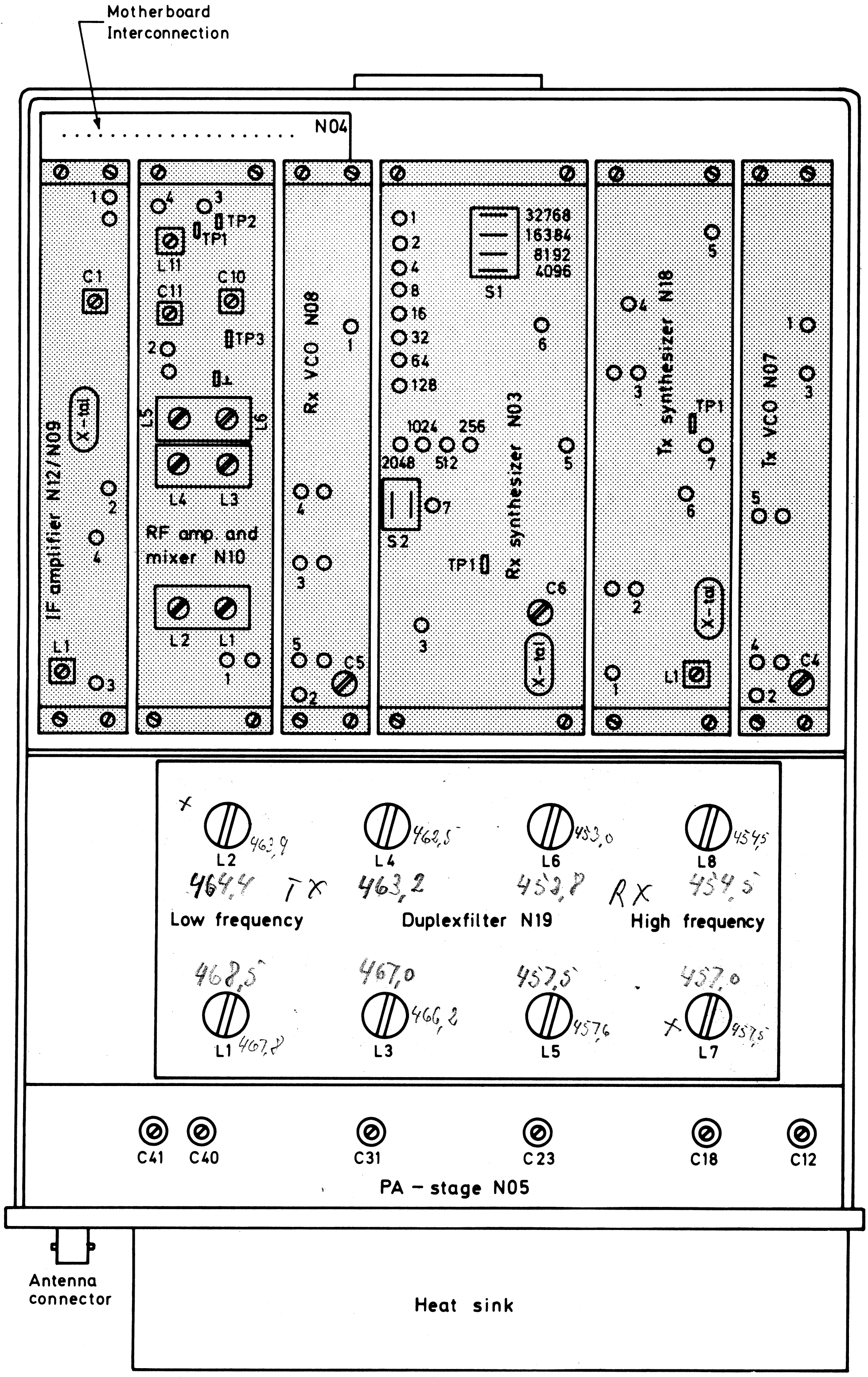


Fig. 7-32 Circuit diagram, duplex filter, N19B

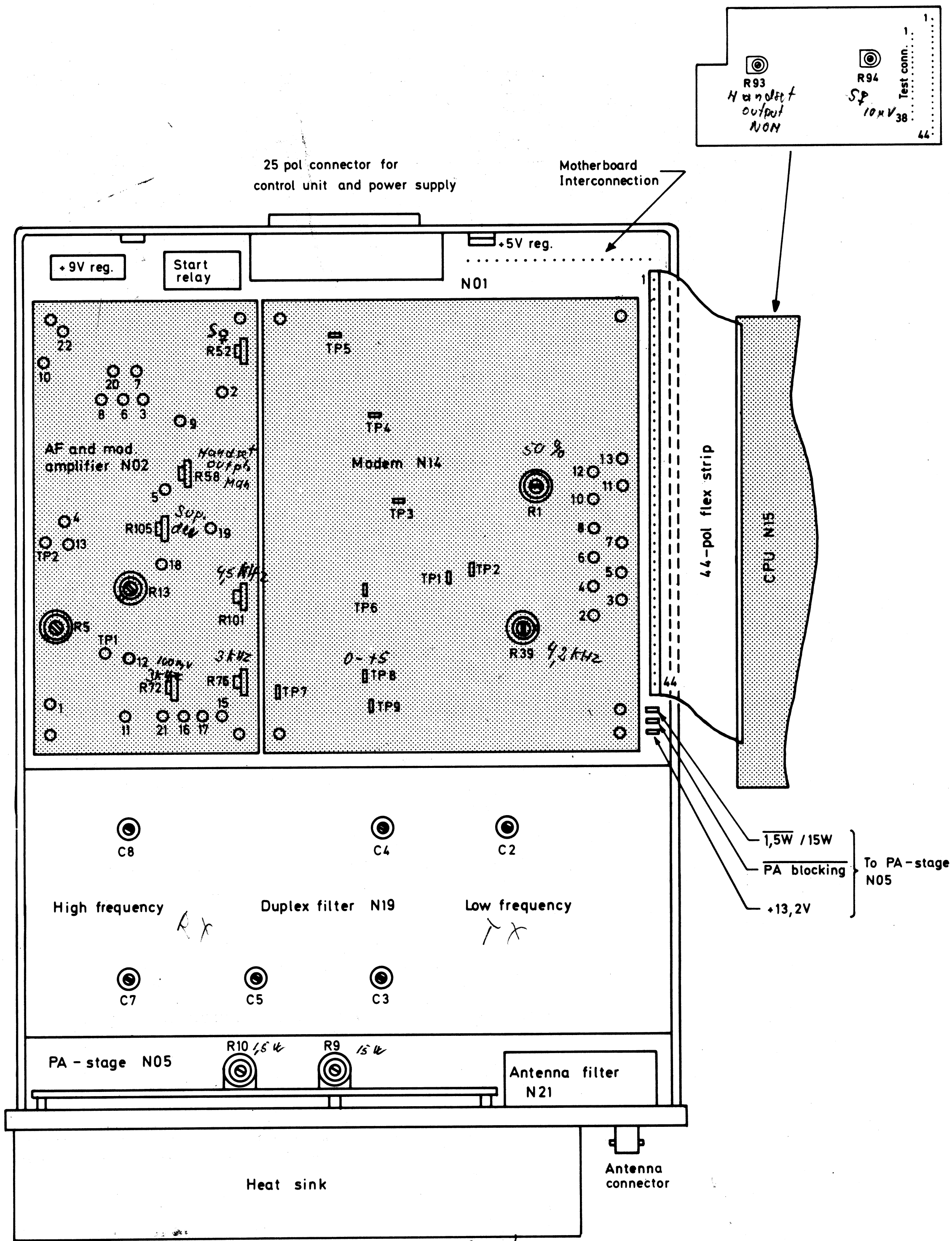


APM830705A2

Fig. 10-9 Location of adjusting elements, test points and terminals. "RF side"

RX 463,000 - 467,475 Center 465,250

TX 453,000 - 457,475 - 455,250



C3 kritisk ved justering
evt. effekt bør kontrolleres ved
kold og varm filter

Fig. 10-10 Location of adjusting elements, test points and terminals, "CPU side"

Channel	1	0 1011 0000	463.000MHz	Channel	46	0 1101 1101	464.125MHz
"	2	0 1011 0001	463.025 "	"	47	0 1101 1110	464.150 "
"	3	0 1011 0010	463.050 "	"	48	0 1101 1111	464.175 "
"	4	0 1011 0011	463.075 "	"	49	0 1110 0000	464.200 "
"	5	0 1011 0100	463.100 "	"	50	0 1110 0001	464.225 "
"	6	0 1011 0101	463.125 "	"	51	0 1110 0010	464.250 "
"	7	0 1011 0110	463.150 "	"	52	0 1110 0011	464.275 "
"	8	0 1011 0111	463.175 "	"	53	0 1110 0100	464.300 "
"	9	0 1011 1000	463.200 "	"	54	0 1110 0101	464.325 "
"	10	0 1011 1001	463.225 "	"	55	0 1110 0110	464.350 "
"	11	0 1011 1010	463.250 "	"	56	0 1110 0111	464.375 "
"	12	0 1011 1011	463.275 "	"	57	0 1110 1000	464.400 "
"	13	0 1011 1100	463.300 "	"	58	0 1110 1001	464.425 "
"	14	0 1011 1101	463.325 "	"	59	0 1110 1010	464.450 "
"	15	0 1011 1110	463.350 "	"	60	0 1110 1011	464.475 "
"	16	0 1011 1111	463.375 "	"	61	0 1110 1100	464.500 "
"	17	0 1100 0000	463.400 "	"	62	0 1110 1101	464.525 "
"	18	0 1100 0001	463.425 "	"	63	0 1110 1110	464.550 "
"	19	0 1100 0010	463.450 "	"	64	0 1110 1111	464.575 "
"	20	0 1100 0011	463.475 "	"	65	0 1111 0000	464.600 "
"	21	0 1100 0100	463.500 "	"	66	0 1111 0001	464.625 "
"	22	0 1100 0101	463.525 "	"	67	0 1111 0010	464.650 "
"	23	0 1100 0110	463.550 "	"	68	0 1111 0011	464.675 "
"	24	0 1100 0111	463.575 "	"	69	0 1111 0100	464.700 "
"	25	0 1100 1000	463.600 "	"	70	0 1111 0101	464.725 "
"	26	0 1100 1001	463.625 "	"	71	0 1111 0110	464.750 "
"	27	0 1100 1010	463.650 "	"	72	0 1111 0111	464.775 "
"	28	0 1100 1011	463.675 "	"	73	0 1111 1000	464.800 "
"	29	0 1100 1100	463.700 "	"	74	0 1111 1001	464.825 "
"	30	0 1100 1101	463.725 "	"	75	0 1111 1010	464.850 "
"	31	0 1100 1110	463.750 "	"	76	0 1111 1011	464.875 "
"	32	0 1100 1111	463.775 "	"	77	0 1111 1100	464.900 "
"	33	0 1101 0000	463.800 "	"	78	0 1111 1101	464.925 "
"	34	0 1101 0001	463.825 "	"	79	0 1111 1110	464.950 "
"	35	0 1101 0010	463.850 "	"	80	0 1111 1111	464.975 "
"	36	0 1101 0011	463.875 "	"	81	1 0000 0000	465.000 "
"	37	0 1101 0100	463.900 "	"	82	1 0000 0001	465.025 "
"	38	0 1101 0101	463.925 "	"	83	1 0000 0010	465.050 "
"	39	0 1101 0110	463.950 "	"	84	1 0000 0011	465.075 "
"	40	0 1101 0111	463.975 "	"	85	1 0000 0100	465.100 "
"	41	0 1101 1000	464.000 "	"	86	1 0000 0101	465.125 "
"	42	0 1101 1001	464.025 "	"	87	1 0000 0110	465.150 "
"	43	0 1101 1010	464.050 "	"	88	1 0000 0111	465.175 "
"	44	0 1101 1011	464.075 "	"	89	1 0000 1000	465.200 "
"	45	0 1101 1100	464.100 "	"	90	1 0000 1001	465.225 "

Fig. 10-11 RX frequency list (1 of 2)

Channel	91	1 0000 1010	465.250MHz
"	92	1 0000 1011	465.275 "
"	93	1 0000 1100	465.300 "
"	94	1 0000 1101	465.325 "
"	95	1 0000 1110	465.350 "
"	96	1 0000 1111	465.375 "
"	97	1 0001 0000	465.400 "
"	98	1 0001 0001	465.425 "
"	99	1 0001 0010	465.450 "
"	100	1 0001 0011	465.475 "
"	101	1 0001 0100	465.500 "
"	102	1 0001 0101	465.525 "
"	103	1 0001 0110	465.550 "
"	104	1 0001 0111	465.575 "
"	105	1 0001 1000	465.600 "
"	106	1 0001 1001	465.625 "
"	107	1 0001 1010	465.650 "
"	108	1 0001 1011	465.675 "
"	109	1 0001 1100	465.700 "
"	110	1 0001 1101	465.725 "
"	111	1 0001 1110	465.750 "
"	112	1 0001 1111	465.775 "
"	113	1 0010 0000	465.800 "
"	114	1 0010 0001	465.825 "
"	115	1 0010 0010	465.850 "
"	116	1 0010 0011	465.875 "
"	117	1 0010 0100	465.900 "
"	118	1 0010 0101	465.925 "
"	119	1 0010 0110	465.950 "
"	120	1 0010 0111	465.975 "
"	121	1 0010 1000	466.000 "
"	122	1 0010 1001	466.025 "
"	123	1 0010 1010	466.050 "
"	124	1 0010 1011	466.075 "
"	125	1 0010 1100	466.100 "
"	126	1 0010 1101	466.125 "
"	127	1 0010 1110	466.150 "
"	128	1 0010 1111	466.175 "
"	129	1 0011 0000	466.200 "
"	130	1 0011 0001	466.225 "
"	131	1 0011 0010	466.250 "
"	132	1 0011 0011	466.275 "
"	133	1 0011 0100	466.300 "
"	134	1 0011 0101	466.325 "
"	135	1 0011 0110	466.350 "
Channel	136	1 0011 0111	466.375MHz
"	137	1 0011 1000	466.400 "
"	138	1 0011 1001	466.425 "
"	139	1 0011 1010	466.450 "
"	140	1 0011 1011	466.475 "
"	141	1 0011 1100	466.500 "
"	142	1 0011 1101	466.525 "
"	143	1 0011 1110	466.550 "
"	144	1 0011 1111	466.575 "
"	145	1 0100 0000	466.600 "
"	146	1 0100 0001	466.625 "
"	147	1 0100 0010	466.650 "
"	148	1 0100 0011	466.675 "
"	149	1 0100 0100	466.700 "
"	150	1 0100 0101	466.725 "
"	151	1 0100 0110	466.750 "
"	152	1 0100 0111	466.775 "
"	153	1 0100 1000	466.800 "
"	154	1 0100 1001	466.825 "
"	155	1 0100 1010	466.850 "
"	156	1 0100 1011	466.875 "
"	157	1 0100 1100	466.900 "
"	158	1 0100 1101	466.925 "
"	159	1 0100 1110	466.950 "
"	160	1 0100 1111	466.975 "
"	161	1 0101 0000	467.000 "
"	162	1 0101 0001	467.025 "
"	163	1 0101 0010	467.050 "
"	164	1 0101 0011	467.075 "
"	165	1 0101 0100	467.100 "
"	166	1 0101 0101	467.125 "
"	167	1 0101 0110	467.150 "
"	168	1 0101 0111	467.175 "
"	169	1 0101 1000	467.200 "
"	170	1 0101 1001	467.225 "
"	171	1 0101 1010	467.250 "
"	172	1 0101 1011	467.275 "
"	173	1 0101 1100	467.300 "
"	174	1 0101 1101	467.325 "
"	175	1 0101 1110	467.350 "
"	176	1 0101 1111	467.375 "
"	177	1 0110 0000	467.400 "
"	178	1 0110 0001	467.425 "
"	179	1 0110 0010	467.450 "
"	180	1 0110 0011	467.475 "

Fig. 10-11 (2 of 2)

AP3533
Accessories

11. Test box

A. Introduction

The test box is used in conjunction with a test cradle during checking and adjusting (see chapter 10). The box is provided with a cable which is plugged into a test connector on the CPU N15. With the switches and the potentiometer, many functions can now be manually controlled.

B. Survey of controls

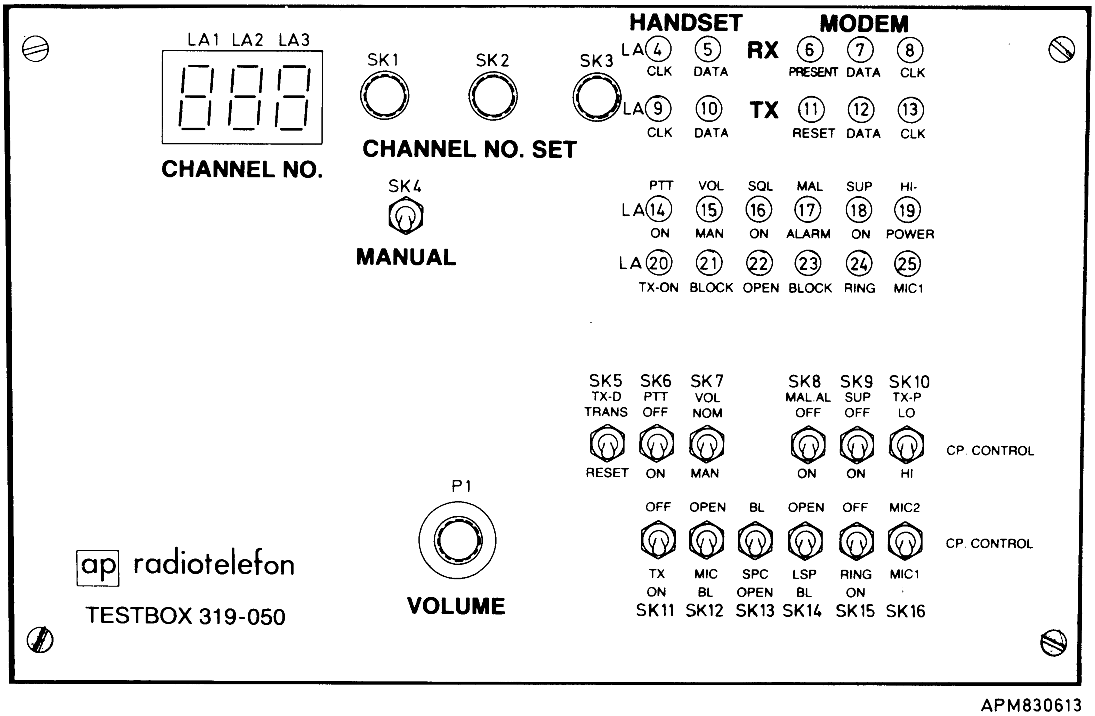


Fig. 11-1 Test box

LA1,2,3 "CHANNEL NO."
LED display which indicates the channel number choosen with SK1-3.

LA4 - LA25 LED's indicating status on the CPU terminals:

Signal name on diagrams

LA4 Clock from HS/CU

LA5 Data from HS/CU

Signal name on diagrams

LA6 RX data present
LA7 RX data
LA8 RX clock
LA9 Clock to HS/CU
LA10 Data to HS/CU
LA11 TX data reset
LA12 TX data
LA13 TX clock
LA14 Push to talk
LA15 (When on, the LED indicates that the volume is controlled by P1. i.e. SK7 in pos. "MAN").
LA16 Squelch on/off
LA17 Malfunction alarm
LA18 Supervisory tone off/on
LA19 1.5W/15W
LA20 TX on/off
LA21 Mic. blocking
LA22 Speech mute
LA23 Loudspeaker blocking
LA24 Ring
LA25 Mic. 2 (Handset)/Mic. 1 (Handsfree)

SK1 - SK3 "CHANNEL NO. SET"
Switches for controlling the channel selection manually (if SK4 is set in position "MANUAL").

SK4 "MANUAL"
When the switch is set in the upper position the CPU controls the radio. When in the "MANUAL" position, the control is taken over by the control box switches and volume control.

SK5 - SK16 The switches (except SK7) have three positions. In the middle position the corresponding CPU control line is controlled by the CPU. In the other two positions the switches overrides the CPU according to the the front labelling.

Notes: TX-D = TX data, TX-P = TX power, SPC = Speech path.

12. Portaphone 20

A. Introduction

Fig. 12-1 Portaphone

With the portaphone carrying case, a fully portable installation is obtained and with the same features as with the mobile installation. The portaphone is provided with connectors for charging the built-in NiCd battery either from a DC supply or from the mains. The handset is protected with a cover of clear plastic when not in use.

B. Instructions for use

Mounting

The radio unit and the active handset is easily moved from the mobile installation and placed in the portaphone case. See fig. 12-1
The radio must be switched off before being disconnected. The radio unit is oriented as shown and pushed into the case. Lock the radio by turning a locking stud at the heat sink 90°. The portaphone can be used standing or laying on its side. In any case the antenna should be turned to vertical position.

Power supply/battery charging

The portaphone has a built-in NiCd battery and a built-in mains power supply which also charges the battery. The built-in power supply charges the battery and also supplies the receiver part of the radio during stand-by. During conversation the built-in power supply is automatically switched off. Then the battery supplies all the power. As the battery is discharged during conversation, this mode can be unsatisfactory if the conversation time exceeds 10% and/or the portaphone often is disconnected from the external supply. In these cases we recommend charging with a high capacity 12VDC supply instead of with the built-in mains power supply. Fig. 12-2 shows three possibilities which permit conversation while the battery is being charged. Then the portaphone will always be ready to be disconnected.

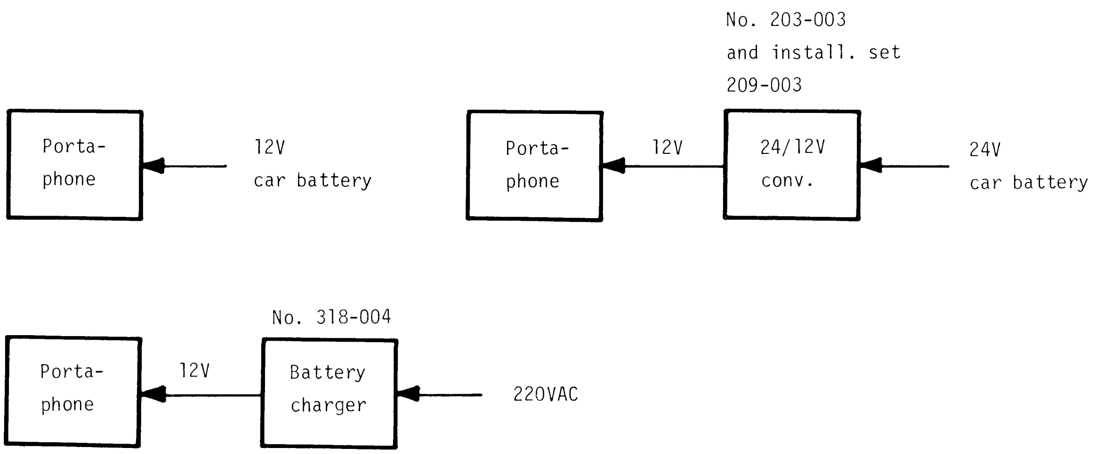


Fig. 12-2 Charging possibilities for high demands.

Note: In cases where the car battery (or other DC supply) cannot supply enough current during conversation, connection must be made to terminals 1 & 2 instead of 2 & 3. Cable connector soldering side: 1 2 (minus) 3

When the built-in battery has been discharged to a certain level, the built-in loudspeaker gives a signal (▬ ▬ ▬ 1kHz) to draw to your attention that charging is necessary. If discharging continues further, the radio is automatically switched off. This feature protects the battery as it will be damaged by being disharged below this certain level. When charging takes place, no indication is given when the battery is fully charged. However, if conversation is attempted too early either by own call or when being called, the conversation will be interrupted by the attention signal and later by automatic power off. If the internal charger is used, it is practical to charge the battery in the periods when the portaphone is not needed. Charging also takes place if the radio unit is not inserted in the phortaphone. The battery capacity will be kept high by normal use since the battery alternately is being charged and discharged. When the portaphone has not been in use for an extended period of time, the battery capacity will be insufficient.
To maintain the capacity we recommend discharging and charging e.g. every 2nd month. This is done by having the radio switched on until it is switched off by the automatic power off circuit. Then charge the battery. The capacity of an apparently dead battery can be restored by using the same procedure several times. We recommend that the procedures above are followed as insufficient battery capacity may not be noticed until the transmitter is enabled either by calling or when being called.

Cleaning

We recommend cleaning of the portaphone with a cloth soaked in dishwater.

C. Configuration

As the same radio unit is used for mobile installation and for the portaphone, the information in chapter 5 applies for the radio unit. Note that the portaphone is delivered with the batteries uncharged as the life-time of the batteries starts when they are charged for the first time.

D. Description

The portaphone is provided with a DC/DC converter which supplies 13.2V to the radio and to the built-in NiCd battery. The DC/DC converter is fed either from a DC supply or from the mains. In the latter case via a mains transformer and rectifier. When connected to the mains or a low power external DC source, the relay RE1 is not energized. If the radio unit is mounted, the charging time is prolonged if the radio is switched on. During conversation the DC/DC converter is blocked by the Music muting signal. Then the NiCd battery supplies all the power. When connected to a high power DC supply, the relay RE1 is energized. Thereby the radio is connected directly to the DC supply while the DC/DC converter only charges the battery.

E. Checking and adjusting

- Unplug the three connectors to N41.
- Connect the radio unit to board N44 and the handset to the connector BU2.
- Connect an external +10.6VDC voltage to N41.06. Minus to N41.08.
- Power on.
- Adjust the trimpotentiometer R4 on N41 so that IC1.05 just goes "low".
- Check that 10.4VDC gives IC1.05 "high".

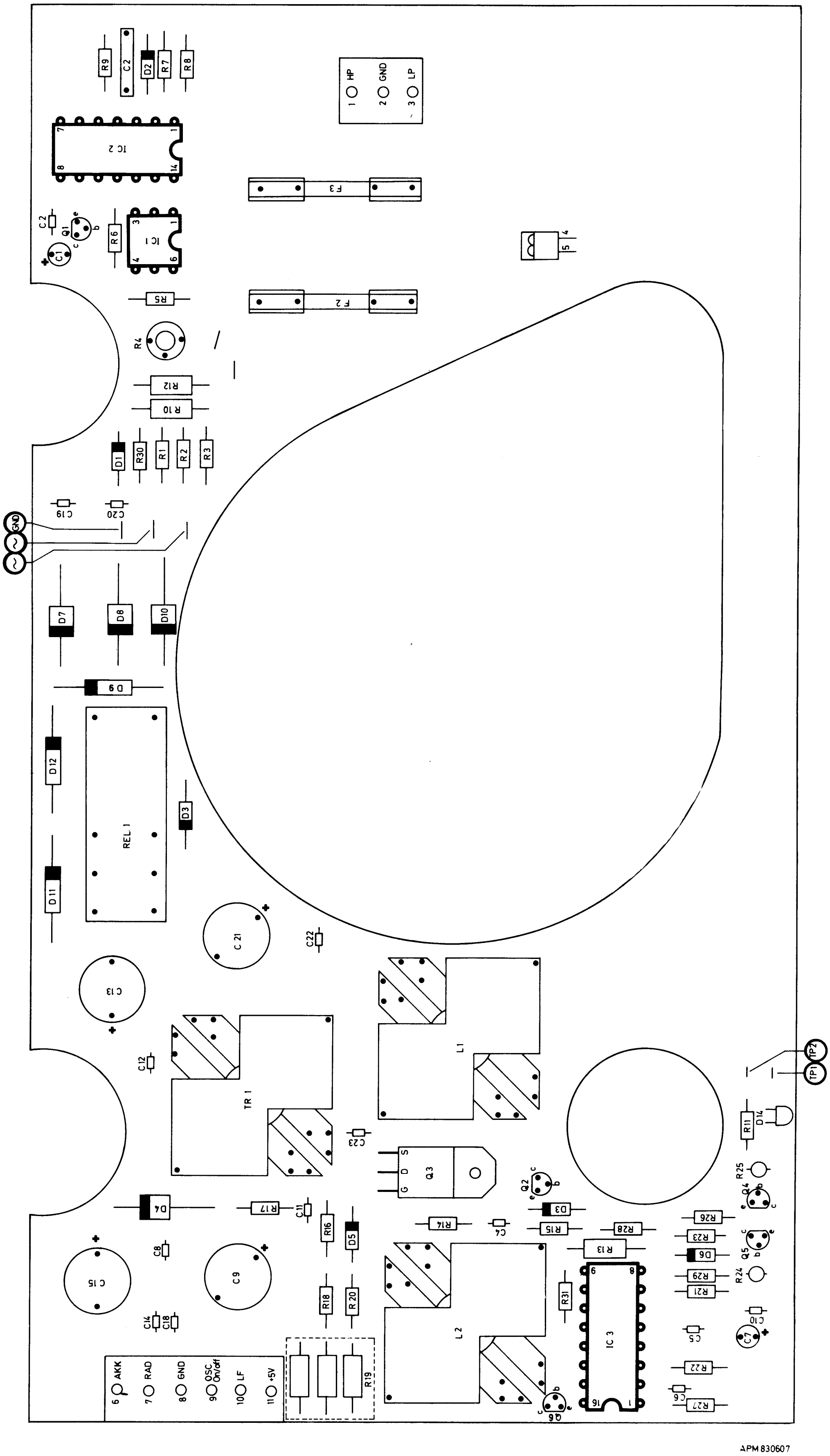


Fig. 12-3 Component location, power supply/charger, N41D

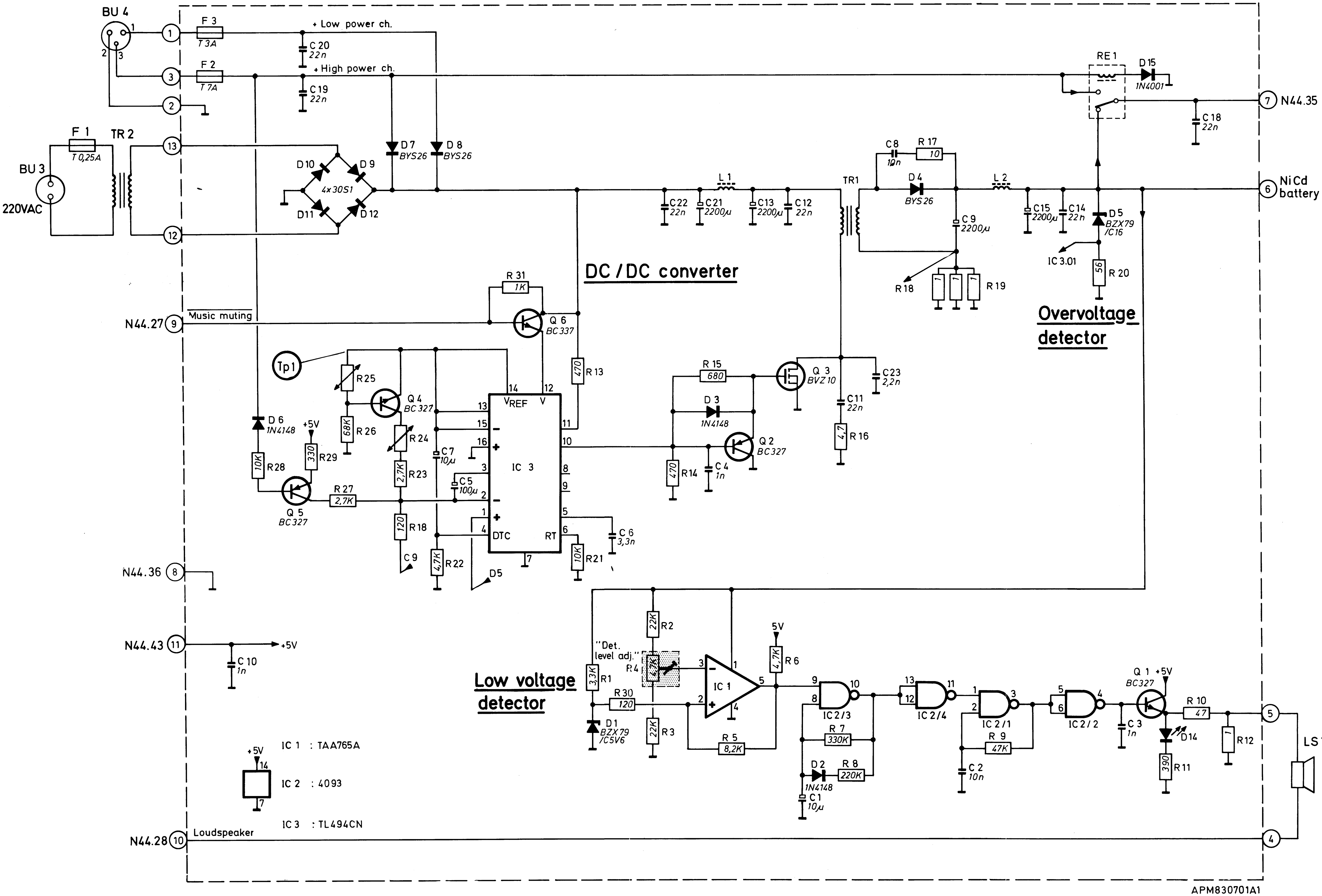


Fig. 12-4 Circuit diagram, power supply/charger, N41D

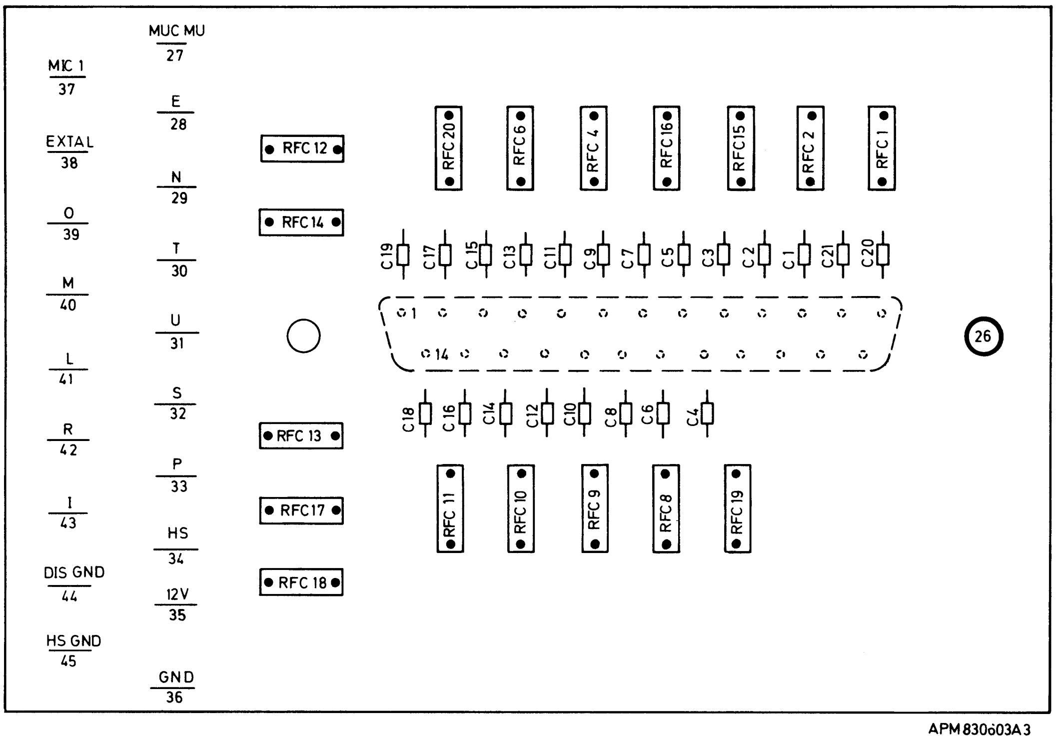


Fig. 12-5 Component location, connection board, N44B

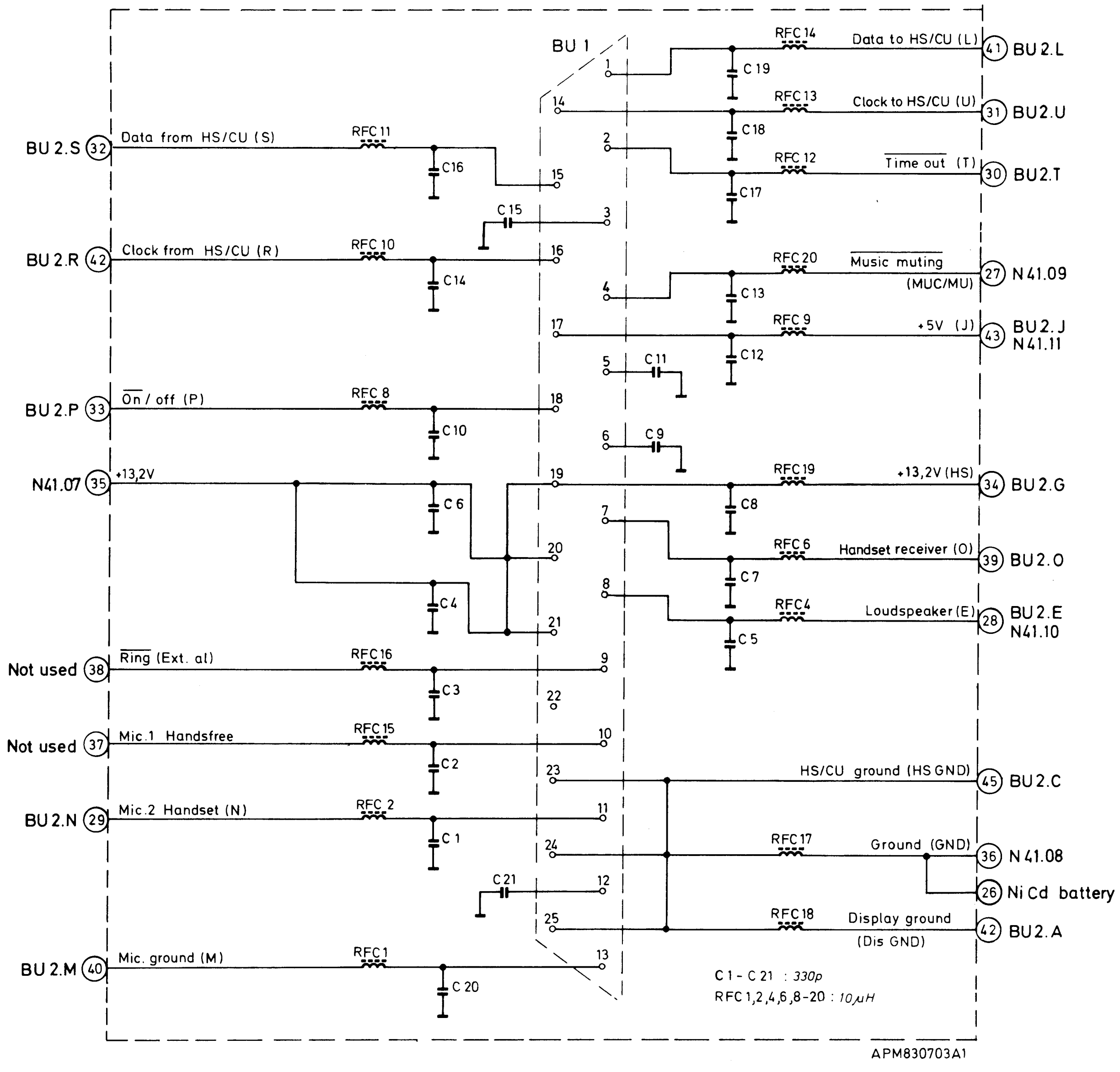


Fig. 12-6 Circuit diagram, connection board, N44B

F. Disassembling and wiring diagram

Disassembling the portaphone 20

Place the case standing on the table and with the opening for the radio to the right.

- Slide the clear plastic cover to mid-position as shown in fig. 12-7.
- Press the plastic holders A and B carefully in-wards and remove cover.
- Remove the plastic caps C and D.
- Remove the carrying strap and the plastic washers E and F.
- Remove the screws and plastic washers in the bottom.
- Loosen the screws C.
- Lay the case down and separate the two halves. The part not containing the electronics is removed.
- Remove the four screws G.
- Remove the two plastic pieces L.
- Lift with H and K.
- Disconnect the loudspeaker, 12V and the battery (2-pole, 3-pole and 6-pole connector respectivelly).

Assembling the portaphone 20

- Connect the cables.
- When assembling, check that the primary cable for the mains transformer runs outside the distance stud J. Check that no cable is squeezed.
- Mount the 4 screws G and tighten firmly.
- Check that the square nuts M and N are correctly positioned.
- Put the two plastic pieces L back.
- Mount the remaining half while:
  a) Pressing the metal grounding strap in the opening for the radio into the right position.
  b) Checking that the metal bracket H slides correctly into the corresponding guider.
  c) Checking that no cable is squeezed.
- Press gently the portaphone together.
- Tighten the screws C.
- Mount the screws in the bottom.
- Mount the plastic caps D.
- Mount the carrying strap. Do not overtighten the screws.
- Mount the plastic caps C. The slots for removing with a screwdriver shall be aligned for easy access.
- Press the plastic holders A and B in wards and mount the clear plastic cover. See fig. 12-7

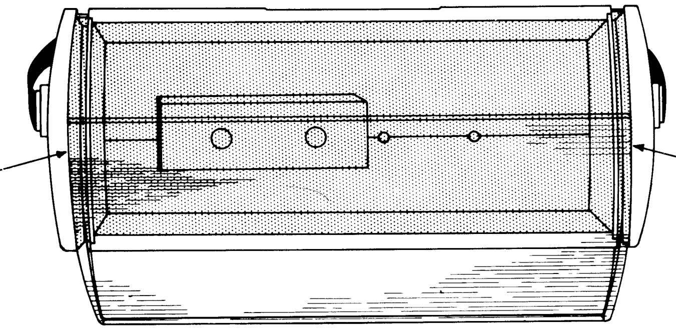


Fig. 12-7

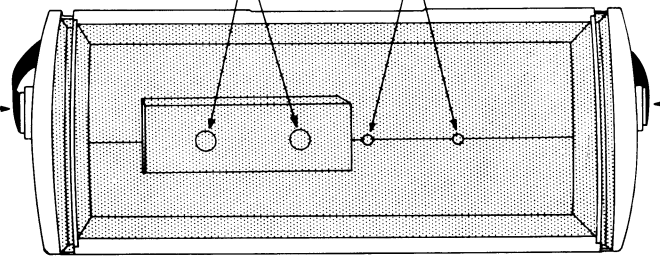


Fig. 12-8

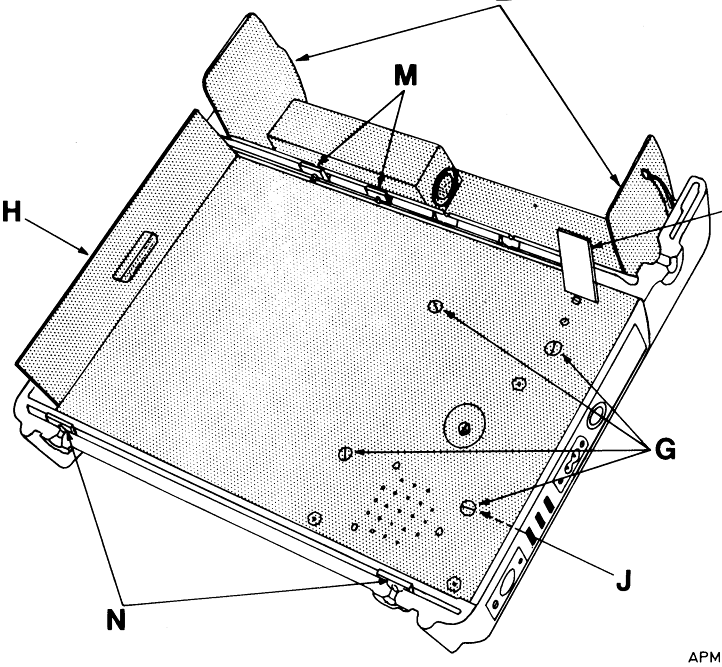


Fig. 12-9

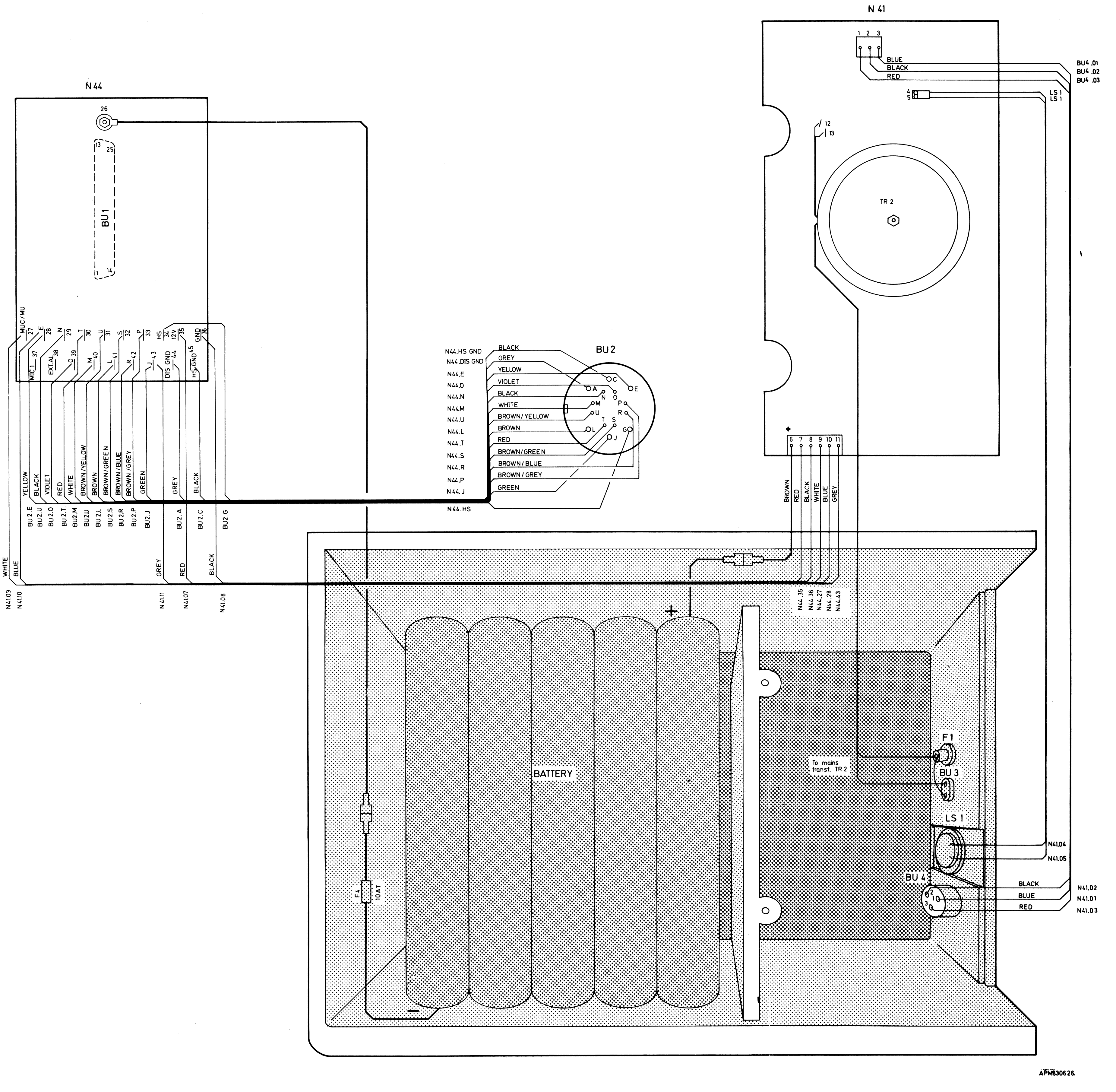


Fig. 12-10 Wiring diagram, portaphone 20

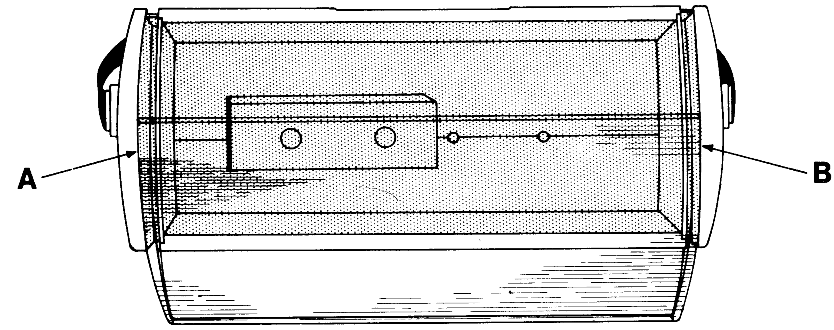


Fig. 12-7

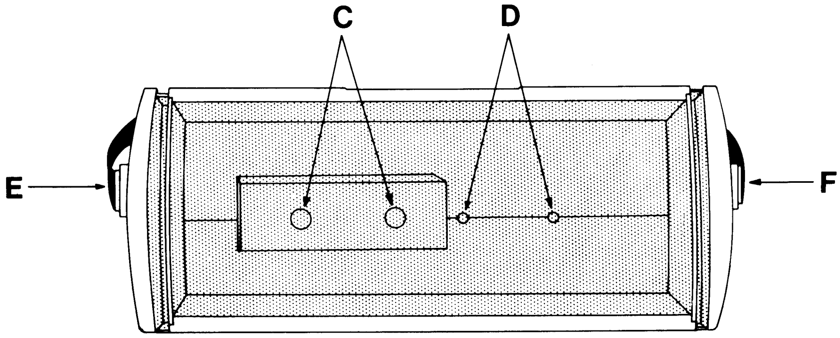


Fig. 12-8

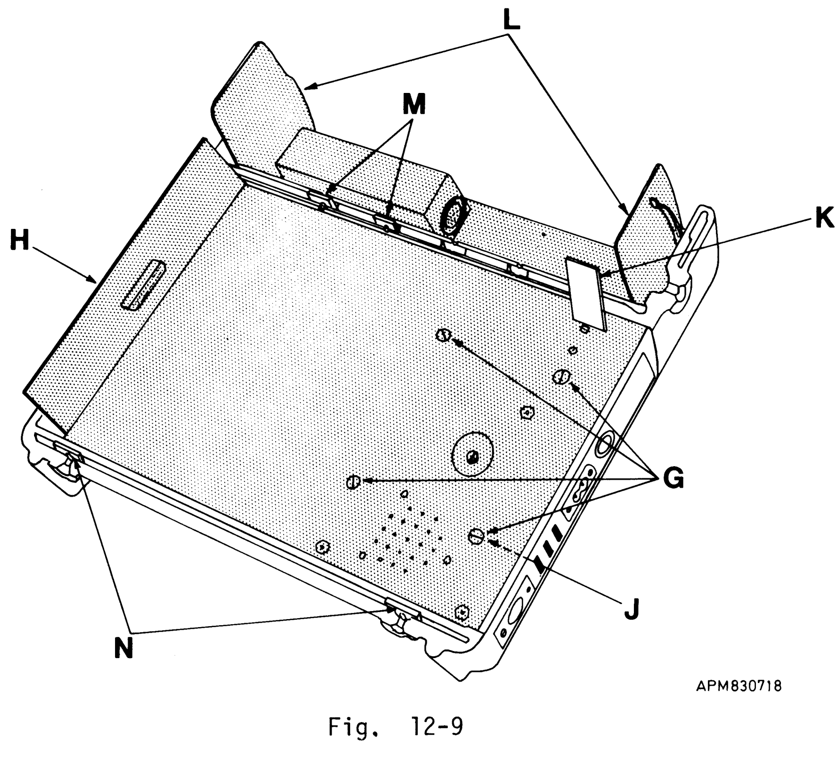


Fig. 12-9

13. Relay unit

The relay unit is an option. It has two independent functions, external alarm and music muting.

The external alarm function is activated by the $\overline{\text{Ring}}$ signal from the CPU N15. The relay output (Rel.1) is intended for activating a horn, bell or other alarm device when a call is received. A 30s timing circuit prevents activating the horn on each ringing signal. Normally the relay must be connected to a remote relay as the maximum permissible relay contact current is 2A. The remote relay is connected is series with a dashboard switch for convenient enabling/disabling of the function. The duration of each "ring" is approx. 0.7s. If R6 is removed, the relay is activated on each ringing signal. If C2 is short-circuited, the relay is continuously activated when a call is received. In this case the relay is reset when the power is switched off.

The music muting function is activated by the $\overline{\text{Music muting}}$ signal from the CPU N15. The signal is "low" during conversation. This activates the relay Rel. 2. The two sets of contacts (normally closed) are used for disconnecting stereo loudspeakers.

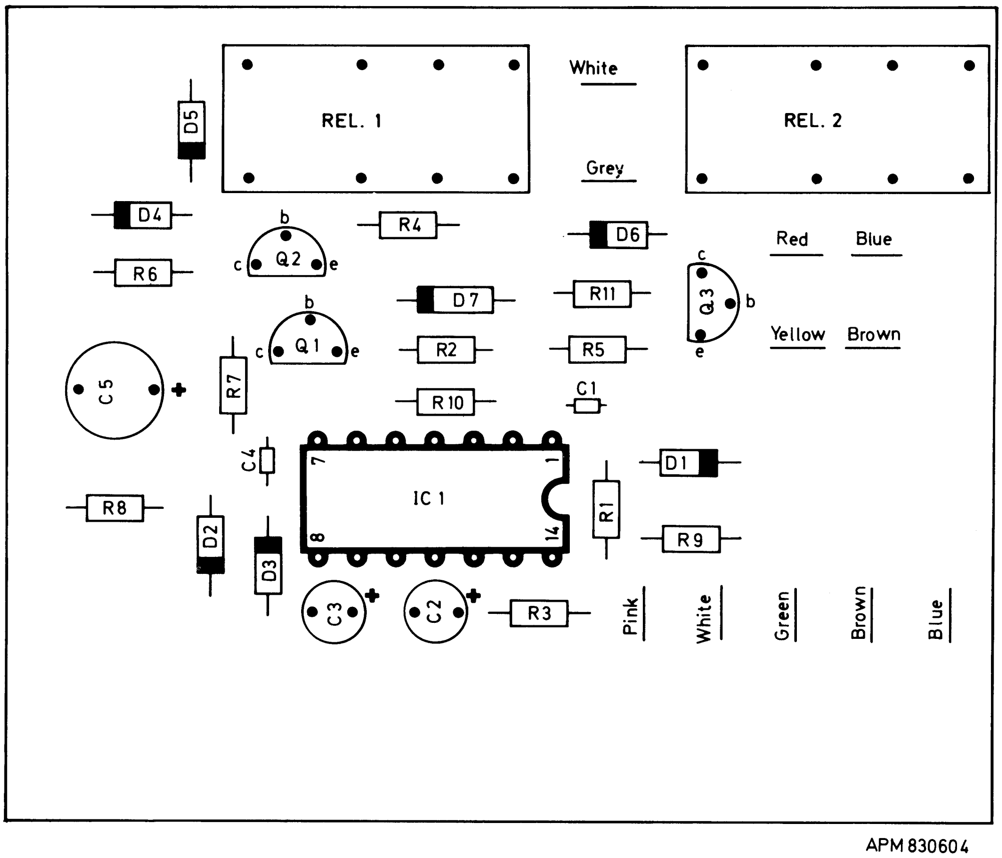


Fig. 13-1 Component location, relay unit, N45A

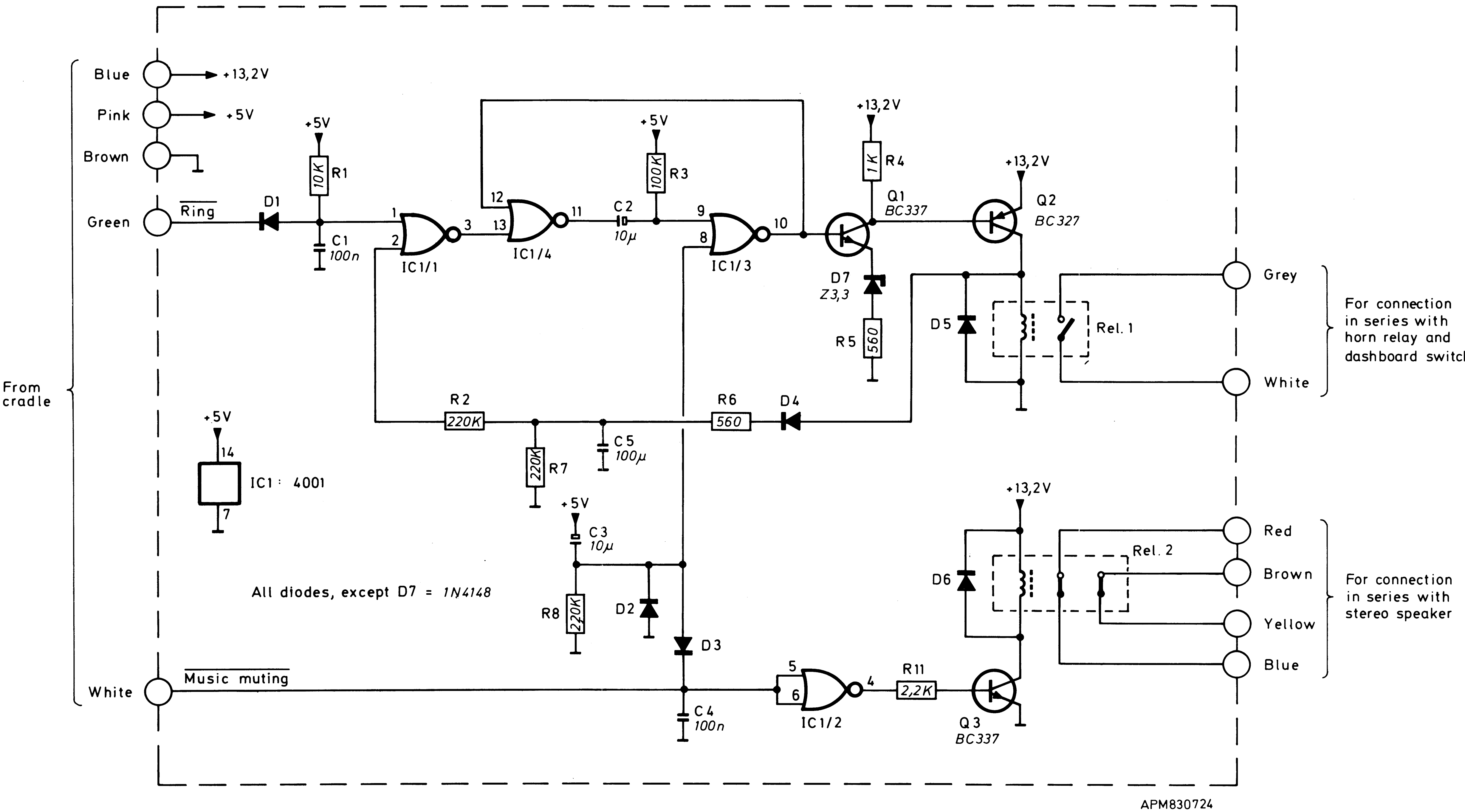


Fig. 13-2 Circuit diagram, relay unit, N45A