

M911x  
138-174 MHz  
MODULE MANUAL  
VOLUME II

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# Storno

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M911x  
138-174 MHz  
MODULE MANUAL  
VOLUME II

Service Coordination

DATE:

EDITION:

PUBLICATION NO:



## M9110

## RECEIVER CIRCUIT DESCRIPTION

The VHF receiver is a dual conversion receiver with 21.4 MHz and 21.4 MHz/455 kHz as intermediate frequency. It is modularized and utilizes integrated circuits, both standard and custom designed. Major emphasis has been placed on flexibility to allow use of standard modules in many specialized system applications. The receiver is compatible with microcomputer control as well as conventional manual control. It is divided into five modules, each a self-contained, multifunction module which comprises single function micromodules and discrete components. Refer to the block diagram (last chapter).

The receiver modules are:

- High intermodulation attenuation front-end RC911
- High sensitivity front-end RC912
- Varactor tuned front-end RC913
- Receiver injection signal sources: simplex FG911
- Receiver injection signal sources: duplex FG912

- Receiver injection signal sources: in multiplier version FG913
- RX crystal oscillator XO905, XO907, XO909
- 21.4 MHz IF and detector IA902, IA903, IA904.
- 21.4 MHz/455 kHz IF and detector IA907, IA908, IA909.
- Receiver audio amplifiers AA903, AA904
- Frequency synthesizer FS901, FS902, FS903,
- Crystal switch unit XS901
- Fundamental mode oscillators XO9011, XO9012, XO9013

The frequency band is determined by the RC and the FG modules and can be changed by simple replacement of these modules. Another option is the audio power module which may be 5 watts or 15 watts. A general description of each module and its characteristics is given in the following sections.



## M9110

## TRANSMITTER CIRCUIT DESCRIPTION

The transmitter is composed of modules built on printed wiring boards.

These are:

- Receiver/transmitter signal source simplex FG911
- Transmitter signal source duplex EX911.  
TX audio processor AA901/902.
- Transmitter signal source in multiplier version EX912
- TX crystal mode oscillator XO906, XO908, XO9010.
- RF power amplifiers PA911, PA913, PA915.
- Antenna switch AS901, relay.
- Antenna switch AS911, solid state.
- Duplex filter BF911

The basic channel frequencies are generated by the Frequency Synthesizer module, or in a multi-frequency oscillator module. The output of the channel frequency generator is fed to the FG/EX module. The FG/EX module converts the frequency generator signal to the RF channel frequency and modulates this carrier with the audio signal.

The microphone signal is pre-emphasized, limited, and filtered by the audio micromodule AA901/AA902 before being applied to the modulation stage.

The modulated RF signal is delivered to the Power Amplifier module which boosts the signal to the required power level.

A Power Control micromodule samples the output and stabilizes it at a constant level. The Power Control circuit also protects the PA-stages against excessive voltage generated by the automotive system.

A lowpass RF filter attenuates the harmonic frequencies before delivering the signal to the antenna switch or duplexer.

Either a relay antenna switch or a solid-state antenna switch is used to connect the antenna to the transmitter, or to the receiver. The antenna switch module is used in simplex radios, and is replaced by an internal duplex filter in duplex radios.

A detailed description of the transmitter modules and their micromodules is given in the following sections.



## AA901/902

## AUDIO PROCESSOR MICROMODULE

The audio processor micromodule, AA901 is for use in 20/25 kHz equipment and AA902 is for use in 12.5 kHz equipment. It contains a pre-emphasis circuit, an audio amplifier, a limiter, a channel guard level control, and two roll-off filters. The circuitry shapes the audio properly to produce a phase-modulated carrier when used in conjunction with a frequency modulated oscillator, and limits the deviation to be within the values required by the authorities. An audio input is provided prior to the pre-emphasis and limiting circuits, and a channel guard tone input is provided after these circuits.

The microphone bias is provided via the TX Audio pin.

The audio micromodule which is a plug-in type utilizes a quad-op-amp to provide the necessary gain. The microphone signal is fed to the first amplifier through a passive pre-emphasis network

to achieve a rising audio characteristic which is needed with the true FM oscillator. The oscillator thus produces a phase-modulated type of signal. Limiting diodes are used to ensure the second amplifier is not being over driven.

The second amplifier performs the actual audio limiting by using biased diodes in the feedback network. If the audio signals exceed a pre-set level these diodes will conduct and prevent any further increase of the output.

After the limiter, the signal passes a roll-off filter which prevents interference on adjacent channels by limiting the audio frequencies above 3 kHz. This filter is an active type and utilizes the other two op-amps contained in the IC.

Channel Guard signals are applied before the roll-off filter and their amplitude must be adjusted separately to produce the correct modulation.

## TECHNICAL SPECIFICATIONS

Input voltage

9.0 V DC  $\pm 5\%$

Load impedance

2.2 Kohm AC/DC min.

Output voltage

6.6 V peak to peak max.

3.3 V peak to peak min.

for 1.0 V rms into mike input at 1000 Hz

Current consumption

4 mA max. (mike excluded)

Transmit audio response

6 dB octave relative to 1000 Hz

- AA901

mike input 300 Hz - 3000 Hz: +1, -3 dB

400 Hz - 2700 Hz: +1, -1.5 dB

- AA902

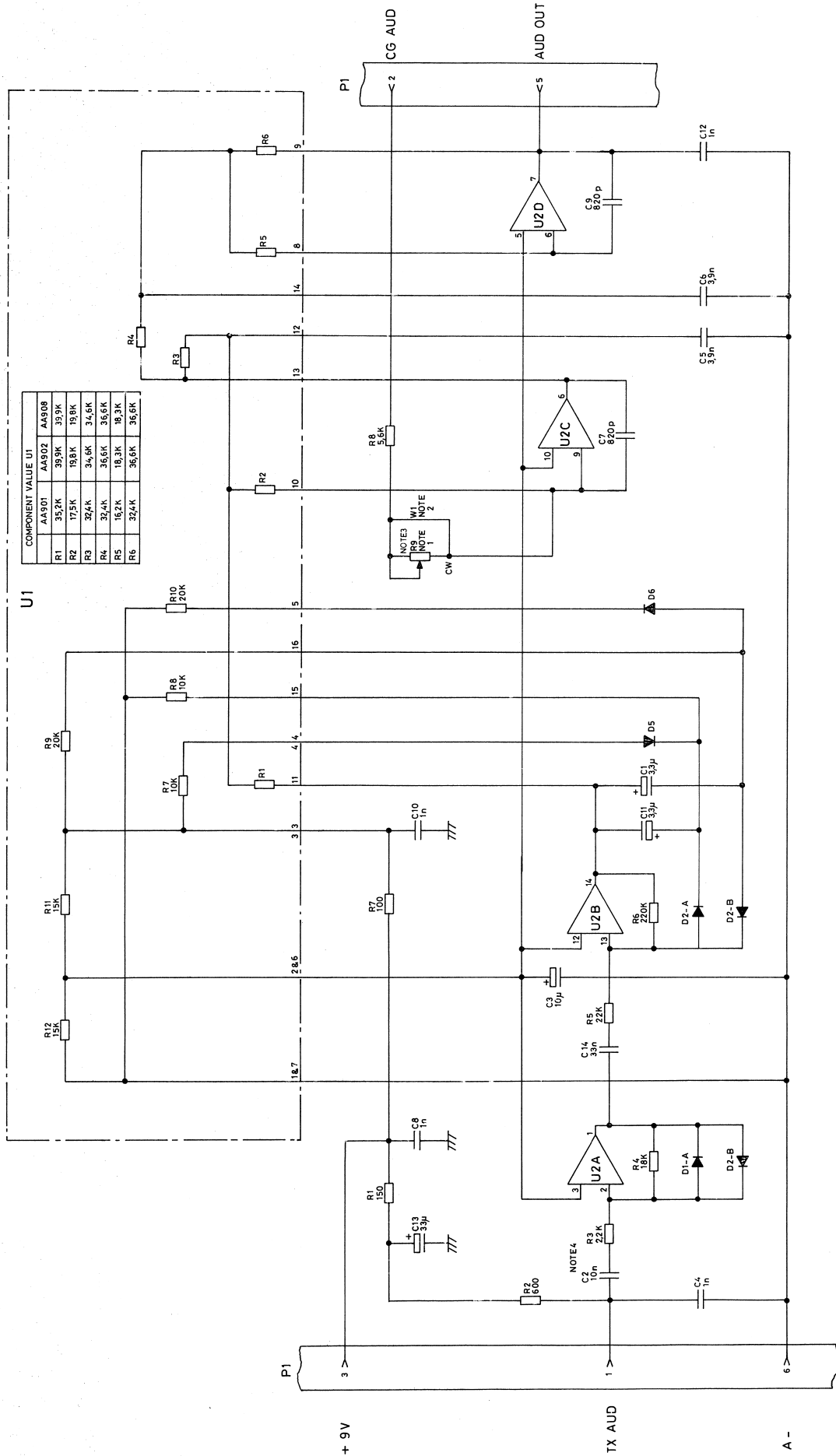
mike input 300 Hz - 2550 Hz: +1, -3 dB

3000 Hz : +1, -4.5 dB

Distorsion

less than 1% for 1000 Hz at threshold





AA901: 19D900072G1 WITH CG LEVEL ADJUST  
 AA902: 19D900072G2 WITH CG LEVEL ADJUST  
 AA903: 19D900072G3 WITHOUT CG LEVEL ADJUST  
 AA904: 19D900072G4 WITHOUT CG LEVEL ADJUST  
 AA905:

AUDIO PROCESSOR  
 AA901, AA902, AA908

D402.918/2



## AA903/AA904

## AUDIO AMPLIFIER

The Audio Amplifier module provides the audio frequency shaping, the squelch, the volume control, the audio muting, and the audio power amplification.

AA903 is a 5 W module and AA904 a 15 W module. Both are designed to drive an 8-ohm speaker.

The module interfaces with the discriminator, and the outputs to the mobile system include auxiliary audio, a fast squelch, a slow squelch, and speaker high and low. Control inputs include receiver mute, speaker mute, DC volume control, and squelch adjust.

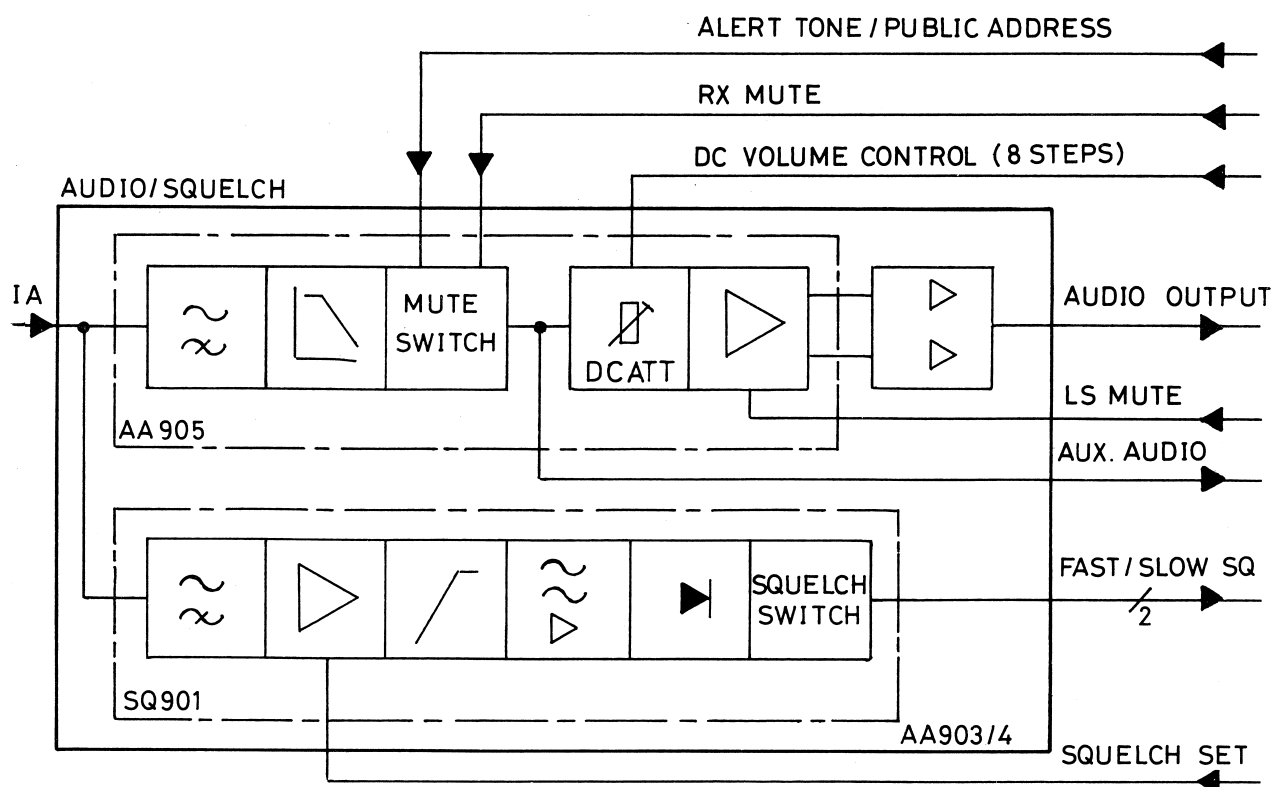
The Audio Amplifier module consists of two micromodules and an output power stage with transformer, and is built on a printed wiring board. One micromodule, SQ901, contains all the squelch circuitry and the other, AA905, the audio circuitry.

The squelch micromodule contains a custom designed IC and four functional blocks:

1. Attenuator
2. Limiter
3. Detector
4. Mute Switch

The squelch control is a voltage controlled (DC) electronic attenuator. The control voltage is 2.0 – 3.8 V DC and can adjust the squelch sensitivity from being critical at 4 dB noise quieting to a maximum which is about 26 dB noise quieting. Hysteresis is provided to avoid popping. A trimmer is provided on the detector to set the squelch sensitivity. The limiter, the filter, and the detector determine most of the squelch performance.

The "Slow Squelch" has a dual response time with respect to the RF at the receiver input.



Below 20 dB noise quieting the squelch tail will be in the order of 50-500 ms (milliseconds), depending on the squelch setting, and about 8 ms above 20 dB noise quieting. A "Fast Squelch" for use in certain application, is provided, and the typical squelch tail for this circuit is 3 ms.

The audio micromodule contains two custom designed ICs. The first is the active circuitry to provide the frequency shaping, the receiver mute switch, and the DC volume control. The frequency shaping is divided into four filter blocks of which the first provides the Channel Guard tone filter and uses a "Twin-T" active filter to achieve a minimum of 16 dB tone rejection. The second block is a highpass active filter used to improve the tone rejection while minimizing the roll-off at 300 Hz. The third block is

the 6 dB de-emphasis which is obtained with a single RC section, and the fourth block is the roll-off at 6 kHz which is by means of a lowpass filter.

The mute switch is a dual Darlington differential amplifier which accomplishes the switching without transients that would cause pops and clicks to be heard in the loudspeaker.

The volume control is a DC controlled electronic attenuator.

The second IC contains the active circuitry required to perform the speaker mute and the audio driver functions.

The two PA transistors are biased in class AB and is DC coupled to the audio driver. The transistors are driving the 8 ohms loudspeaker through a transformer and the entire configuration gives a low distortion output.

## TECHNICAL SPECIFICATIONS

### AA903

#### Drain current at 13.6 V

squelched:	0.1 mA
standby:	0.5 mA
rated output:	1.0 mA

#### Drain current at 9 V

squelched:	20 mA
standby:	50 mA
rated output:	50 mA

#### Ripple rejection

with 500 mV peak to peak, 13.6 V  
- 70 dB

with 5 mV peak to peak, 9 V  
- 70 dB

#### Audio output (rated value)

5.5 W across an 8 ohm load

#### Audio distortion

2.0% max.

### AA904

#### Drain current at 13.6 V

squelched:	0.1 mA
standby:	0.5 mA
rated output:	2.3 mA

#### Drain current at 9 V

squelched:	20 mA
standby:	60 mA
rated output:	60 mA

#### Ripple rejection

with 500 mV peak to peak, 13.6 V  
- 70 dB

with 5 mV peak to peak, 9 V  
- 70 dB

#### Audio output (rated value)

15 W across an 8 ohm load

#### Audio distortion

2.0% max.



AA903

AA904

Audio response

- discriminator

67-210 Hz -14 dB  
300-3000 Hz +10.5 - -10.5 dB

- alert tone

67-210 Hz -1 to 0 dB  
300-6000 Hz -0.5 to 0 dB

DC volume attenuation

65 dB min.

RX mute attenuation

65 dB min.

LS mute attenuation

80 dB min.

Temperature range

-40°C to +85°C

Audio response

- discriminator

67-210 Hz -14 dB  
300-3000 Hz +10.5 - -10.5 dB

- alert tone

67-210 Hz -1 to 0 dB  
300-6000 Hz -0.5 to 0 dB

DC volume attenuation

65 dB min.

RX mute attenuation

65 dB min.

LS mute attenuation

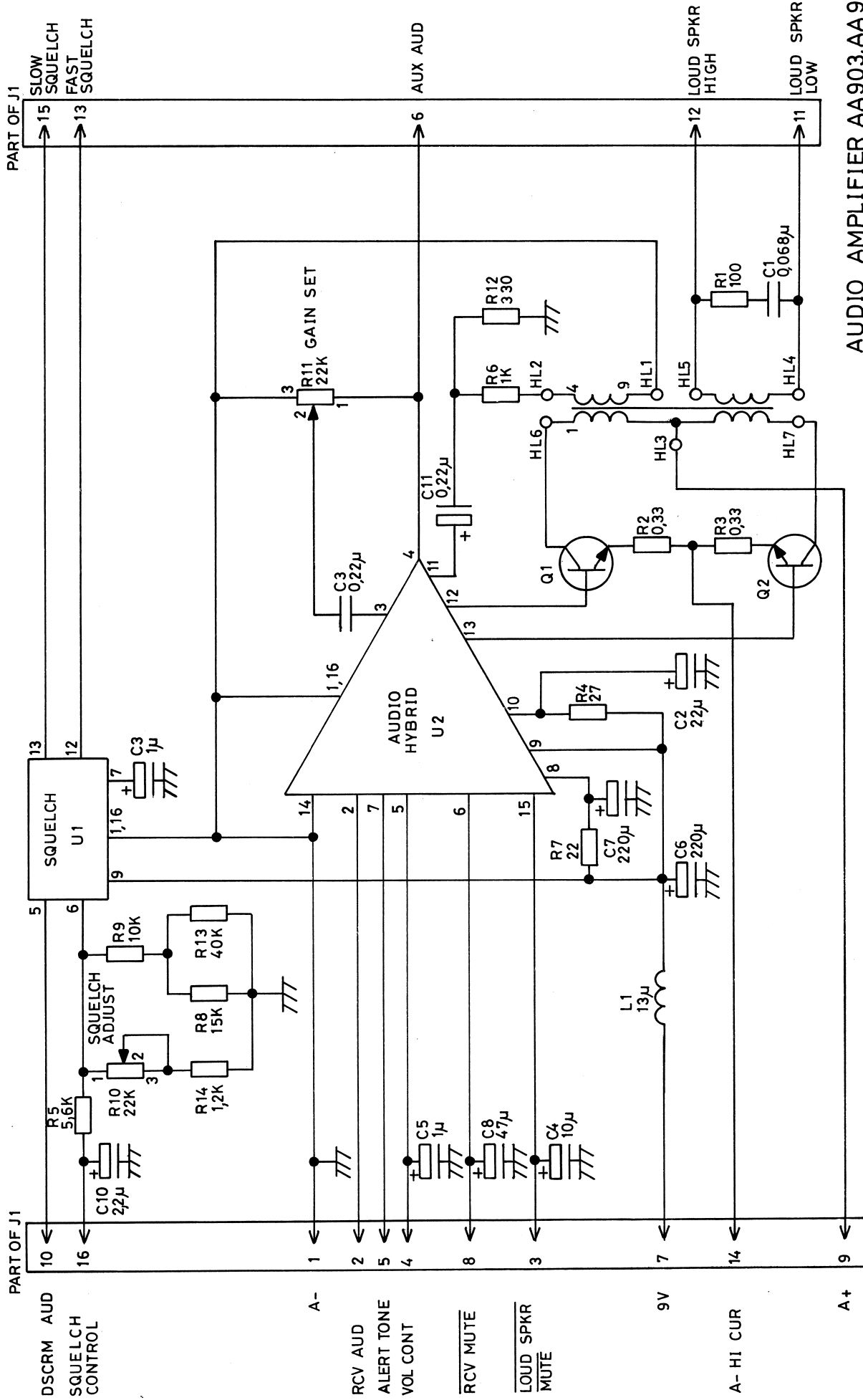
80 dB min.

Temperature range

-40°C to +85°C

**Storno**

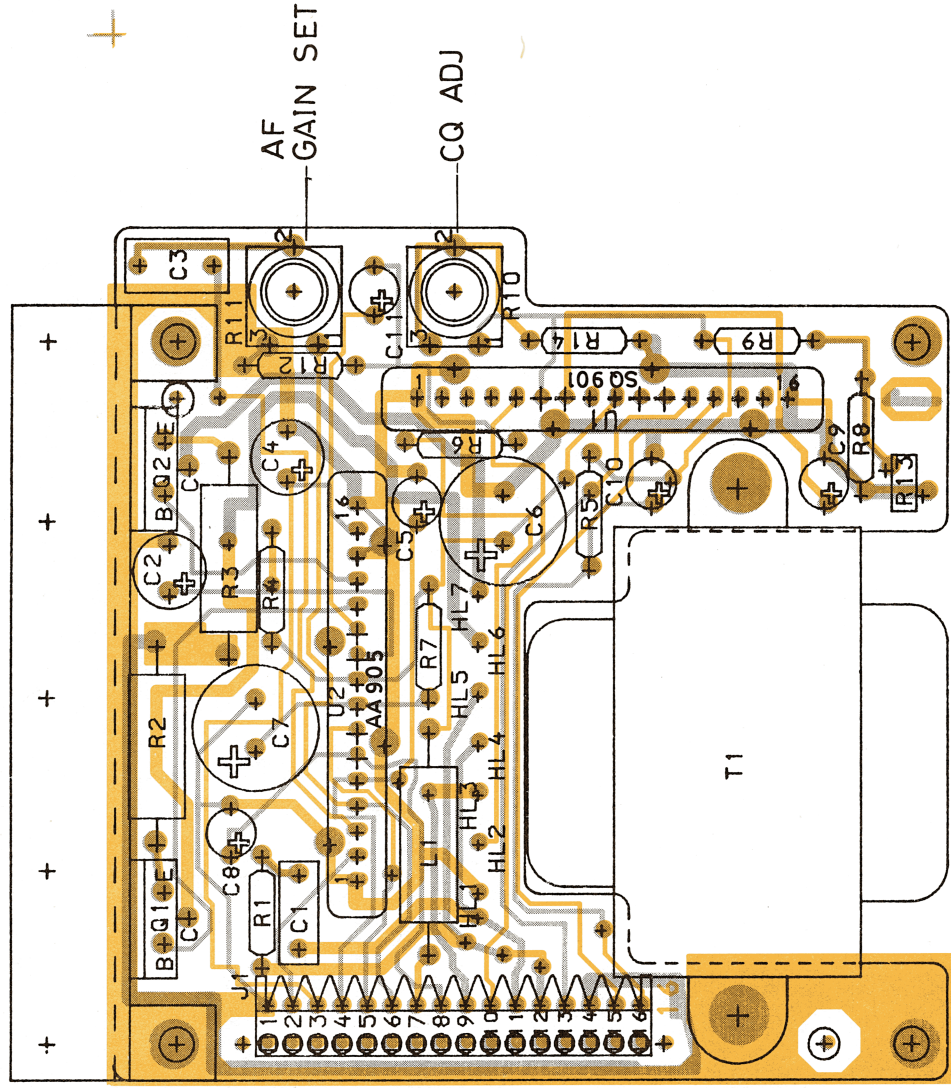
**Storno**



AUDIO AMPLIFIER AA903,AA904

PL 19C850521 G1 AA903  
PL 19C850521 G2 AA904

D402.917/2



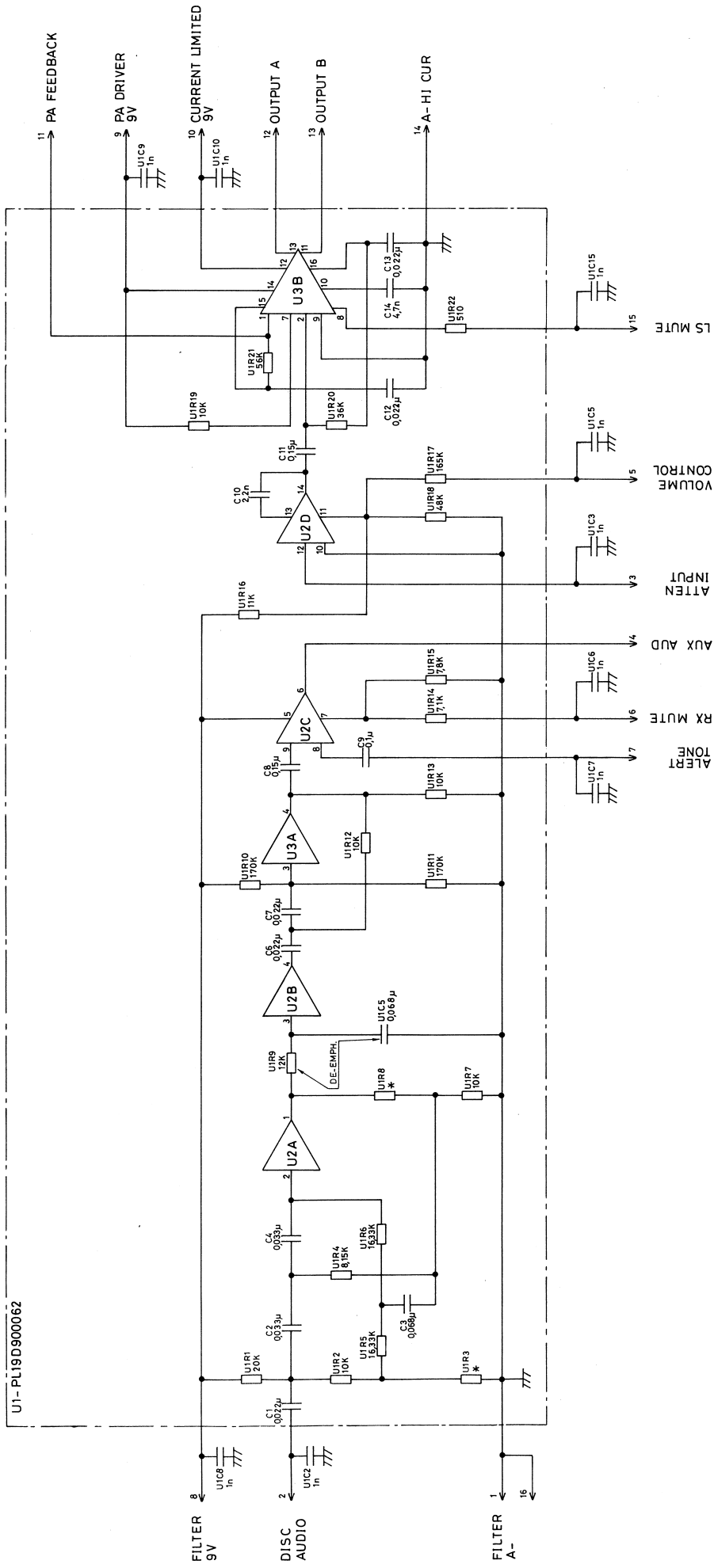
AA 903: 19C850521G1

AA 904: 19C850521G2

AUDIO AMPLIFIER AA903 , AA 904  
COMPONENT LAYOUT

D402.960/3





NOTE:  
\* FACTORY ADJUSTED

**AUDIO AMPLIFIER  
AA905**

19D90000063G1 **D402.914/3**



# SQUELCH CIRCUIT

## SQ901

19M900067G2

D402.915 / 2

## AS901

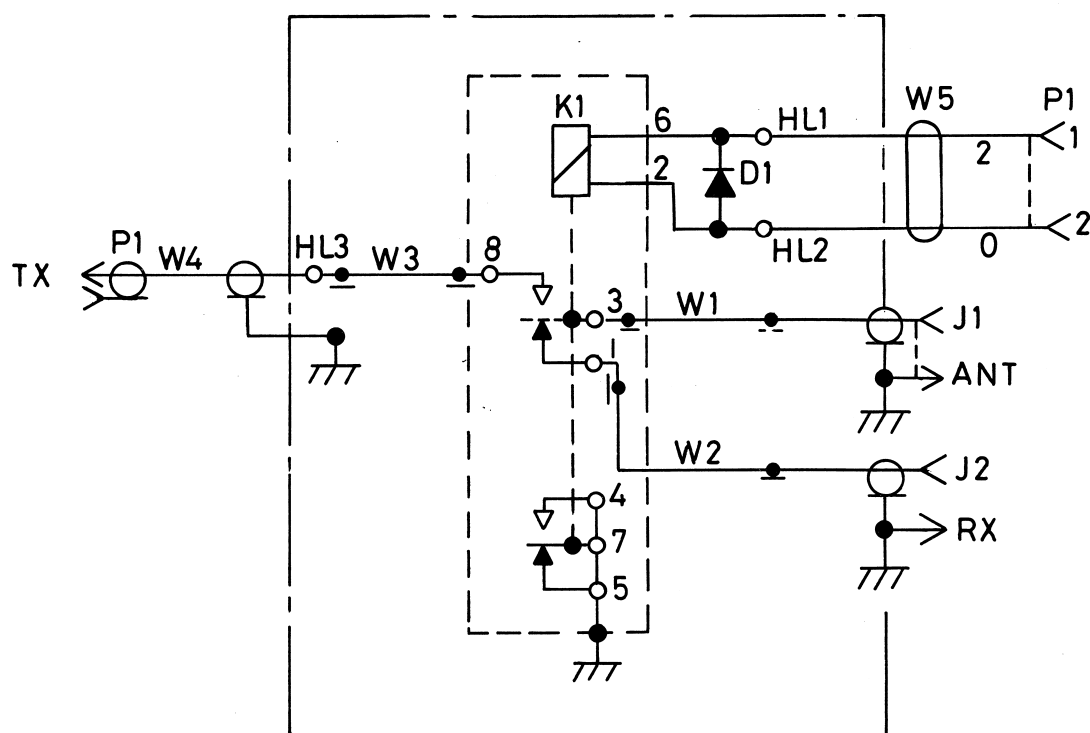
### ANTENNA SWITCH

The relay operated antenna switch is used in simplex radio sets and can handle up to 110 Watts of RF power. When not activated it connects the

antenna connector to the receiver input, and when activated the transmitter output is connected to the antenna.



# Storno



D402.909

## AS911

## ANTENNA SWITCH

AS911 is an antenna switching module for use in the 134-174 MHz range in STORNOPHONE 900 simplex radios when fast switching time is required. A diode switch performs the antenna switching.

The module is used in radios up to 40 Watt and connects the antenna to either the receiver input or the transmitter output.

The circuit consists of a control part by which the different diodes are forward or reverse biased and an RF-part which either directs the signal from the antenna to the receiver input or from the transmitter output to the antenna.

D1 and D2 are two low-harmonic PIN-diodes while D3 is a switch-diode placed in the receiver

branch to increase the isolation from transmitter to receiver when AS911 is in the transmit mode.

In the receive-mode L3-C3-C4 act like a low-pass filter. D1 and D2 are reverse-biased while D3 is forward biased.

In the transmit-mode D2 and D1 are forward biased while D3 is reversed. D2 is now short-circuiting the capacitor C4 and L3-C3 is a parallel resonant circuit constituting a high impedance to the RF-signal which is lead to the antenna. To optimize the VSWR in this mode an extra capacitor, C11, is in parallel to C3.

To prevent damage of the antenna switch if the center conductor of the transmitter cable accidentally is shorted to ground, the circuit contains a current limiter.

## TECHNICAL SPECIFICATIONS

Frequency range

138-174 MHz

Max. transmitted power

40 W

Antenna impedance

50 ohm nominal

Power supply (A+)

9.0 to 16.6 V

Attack time

<10 uS switching of TX to antenna

Release time

<20 uS switching of RX to antenna

Insertion loss TX and RX

typical 0.4 dB

Current consumption

TX= <90 mA (A+= 13.6 V)

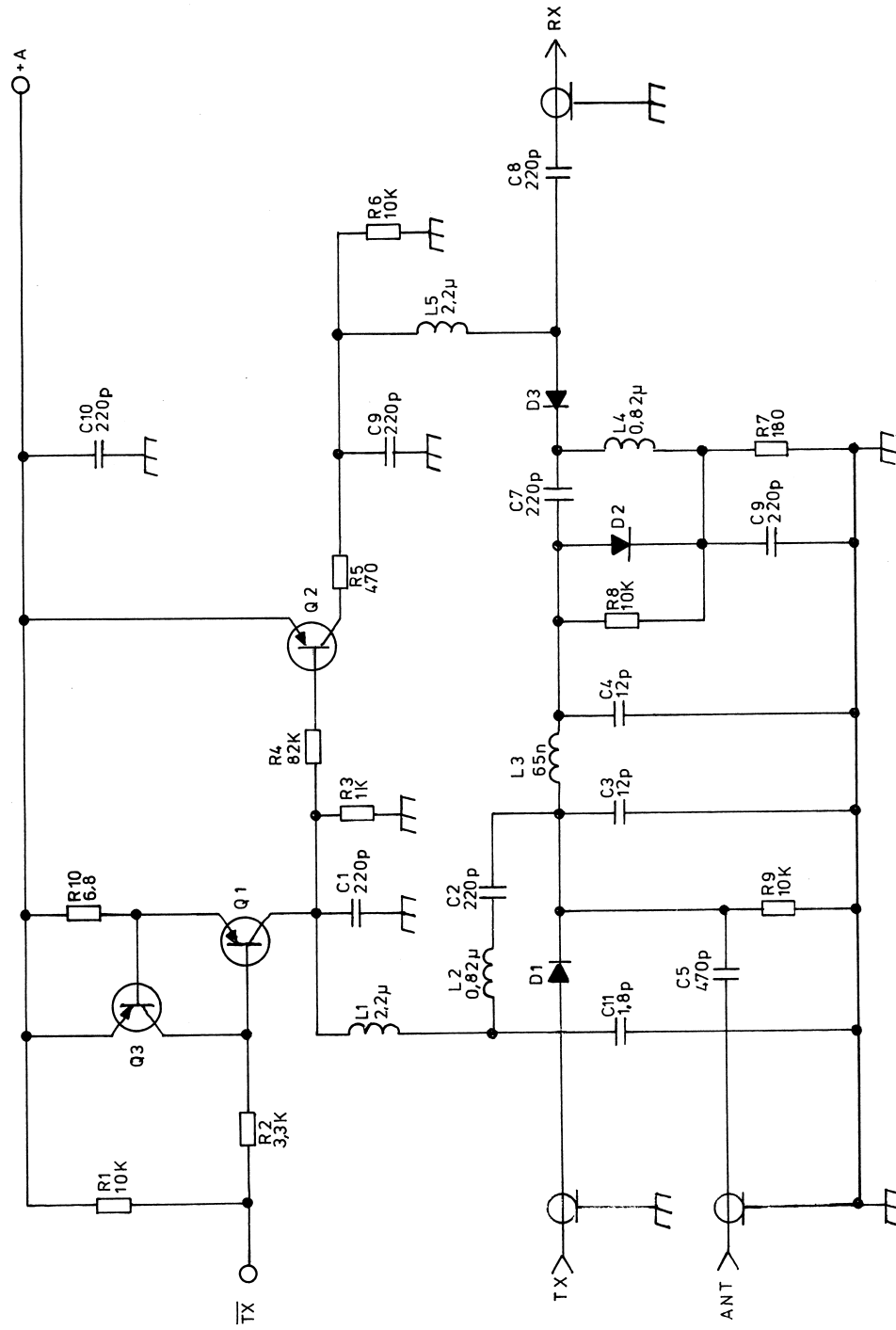
RX= <25 mA (A+= 13.6 V)

Temperature range

-40°C to 85°C

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**Storno**



ANTENNA SWITCH AS911

D403.365





## BF911

## BRANCHING FILTER

The branching filter (duplexer) allows the receiver and transmitter in a duplex radio to be connected to the same antenna.

The BF911 is tuneable to frequencies within the 138 - 174 MHz band. The spacing between the receiver (RX) channels and the transmitter (TX) channels can be 4.5 MHz to 12 MHz, and the TX channels may be placed above or below the RX channels without rearranging the filter terminals.

The branching filter contains 8 helical resonators, 5 in the TX branch and 3 in the RX branch. For certain applications the number of resonators will depend on the spacing between the RX and TX frequencies.

The duplexer is a double notch filter which in the RX branch has a notch on the TX frequency band to prevent the transmitter signal from entering the receiver. In the TX branch there is a notch on the RX frequency band to prevent transmitter side band noise from entering the

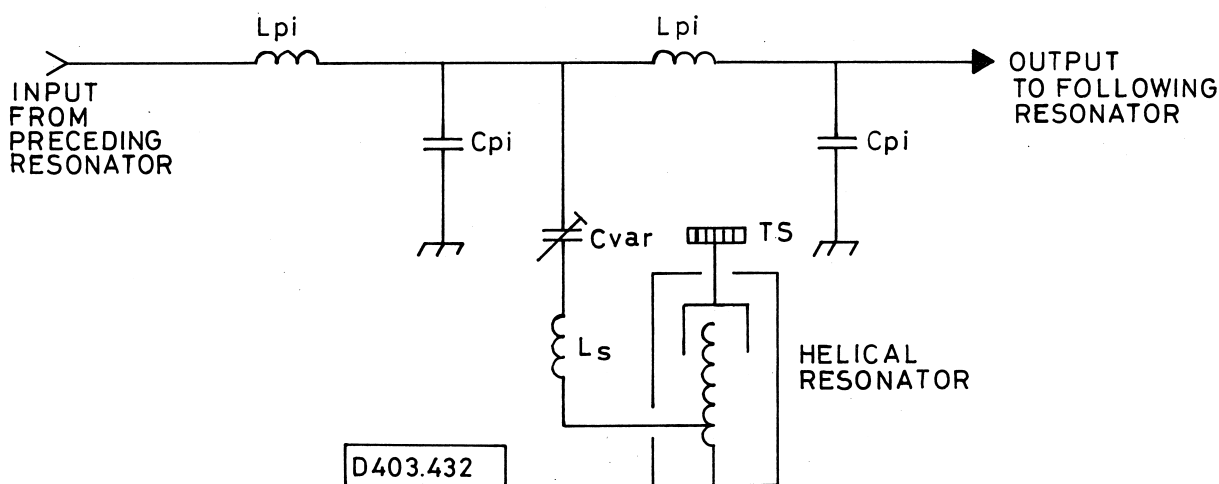
receiver. The branches are joined at the antenna connector via two quarterwave lines that isolates the two branches from each other.

The principle is the same in all the resonators. In each resonator there is a helical coil  $L_p$  which is tuned to the desired parallel resonant frequency with a slug symbolized with TS. Near the bottom of the helical coil there is a tap which is connected to a printed coil  $L_s$  on a printed wiring board.

Together with the helical  $L_p$ ,  $L_s$  and the variable capacitor  $C_{var}$  provides the series resonant frequency on both sides of the parallel resonances.

The pi-network  $C_{pi} + L_{pi}$  which gives the connector to the adjacent resonators is working as a quarter-wave line and is made with printed coils and discrete capacitor on the printed wiring board.

This design with one common printed board for all 8 resonators gives a filter with very few components.



## TECHNICAL SPECIFICATIONS

Frequency range (tunable)

132-174 MHz

Frequency separation

4-12 MHz

Nominal impedance

50 ohm, input/output

Power input

&lt;40 W

VSWR

Max. 1.5

Temperature range

-40°C to +85°C (ambient)

Inserting loss

Frequency separation    Bandwidth    at +25°C

TX

4.5-8 MHz	0.9-1.2 MHz	<1.8 dB
8-12 MHz	1.2 MHz	<1.5 dB

RX

4.5-8 MHz	0.9-1.2 MHz	<1.3 dB
8-12 MHz	1.2 MHz	<1.2 dB

Freq. Attenuation    Bandwidth    at +25°C

TX in RX branch

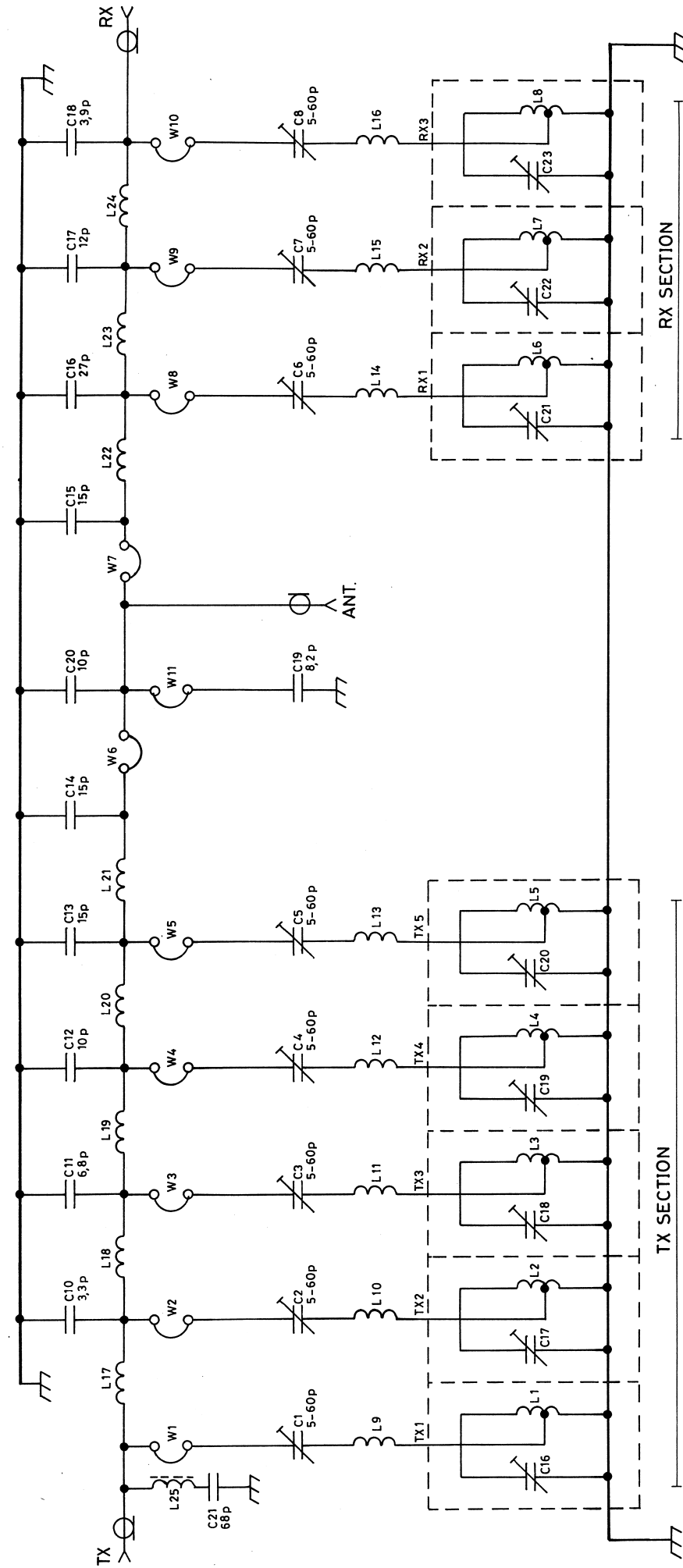
4.5-8 MHz	0.9-1.2 MHz	>40 dB
8-12 MHz	1.2 MHz	>40 dB

RX in TX branch

4.5-8 MHz	0.9-1.2 MHz	>70 dB
8-12 MHz	1.2 MHz	>70 dB

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L9-L24 : PART OF PWB  
C16-C26 : CORE TUNING

BRANCHING FILTER BF 911

D403.153



## EX911

## TRANSMITTER EXCITER

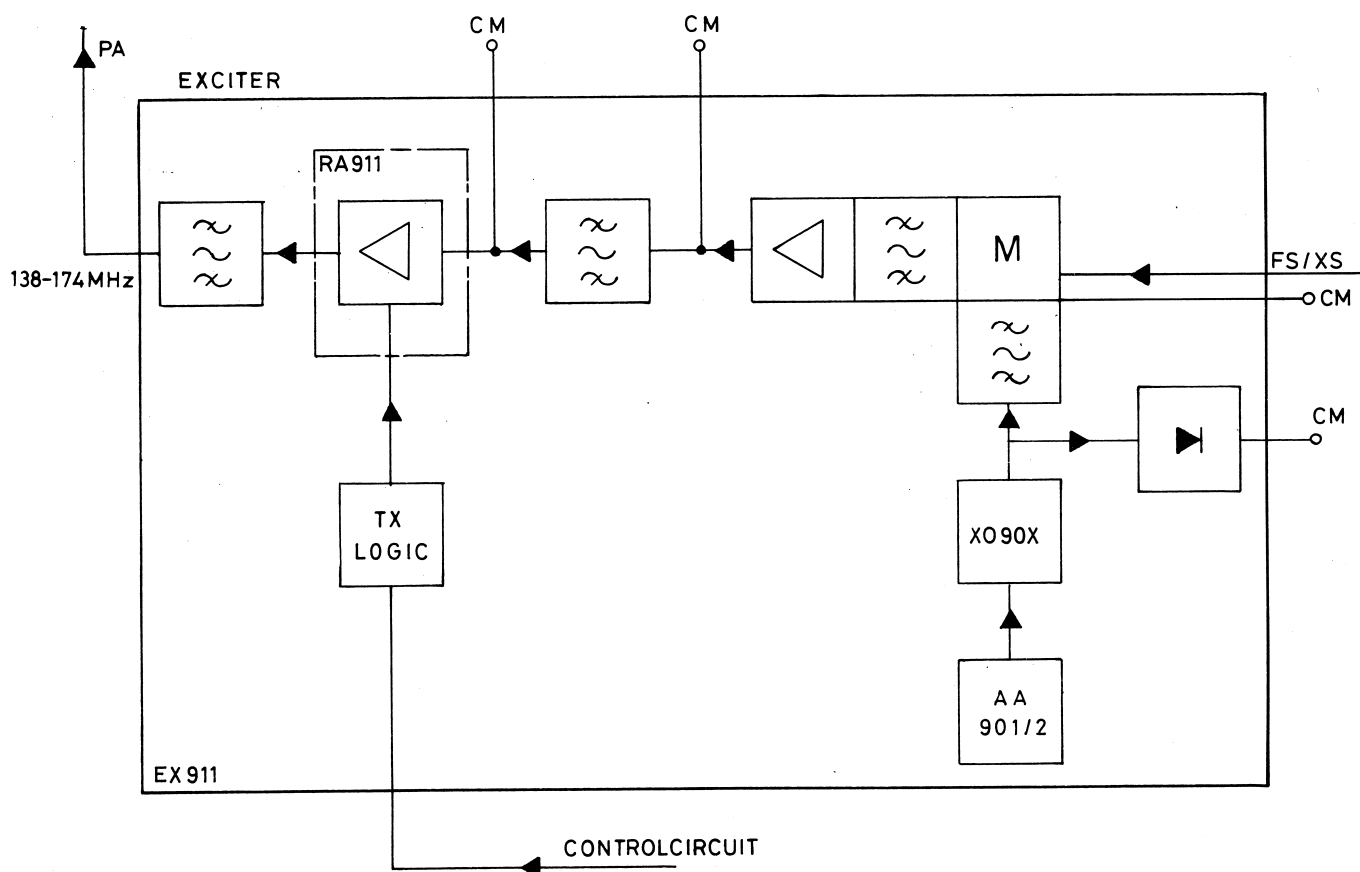
The EX911 is used in duplex radios and provide the signal to drive the power amplifier.

It includes the micromodules AA901/AA902 audio processor, the crystal oscillator XO9xx and the RF amplifier RA911.

The exciter signal is generated by mixing the reference frequency signal with a crystal oscillator signal in a balanced J-FET mixes and fil-

tering and amplifying the output signal to a level adequate to drive the power amplifier, approx. 400 mW.

A switch circuit is used to turn the module on and the control input-TX disable is wired together with the lock signal of the frequency synthesizer so that it is impossible to transmit while the frequency synthesizer is out of lock.



## TECHNICAL SPECIFICATIONS

Channel guard input levelfor  $\Delta f = 0.75$  kHz300 mV  $\pm 2$  dBAF input with preemphasisfor  $\Delta f = 3$  kHz,  $f_{\text{mod}} = 1$  kHz100 mV  $\pm 2$  dBAF input impedance

600 ohm

TX ON/OFF

&lt;0.8 V/open coll.

RF output level

24.5 to 27.5 dBm

RF nominal impedance

50 ohm

RF load impedance

50 ohm

TX status

&lt;5 V/&lt;0.45 mA

Supply voltage9 V  $\pm 5\%$ XO Voltage9 V  $\pm 0.5\%$ Current consumption

(without XO's and AA)

&lt;300 mA

Output frequency

138-174 MHz

Max. channel spacing

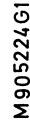
3.5 MHz

AF distortion (EIA)

&lt;2%

Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

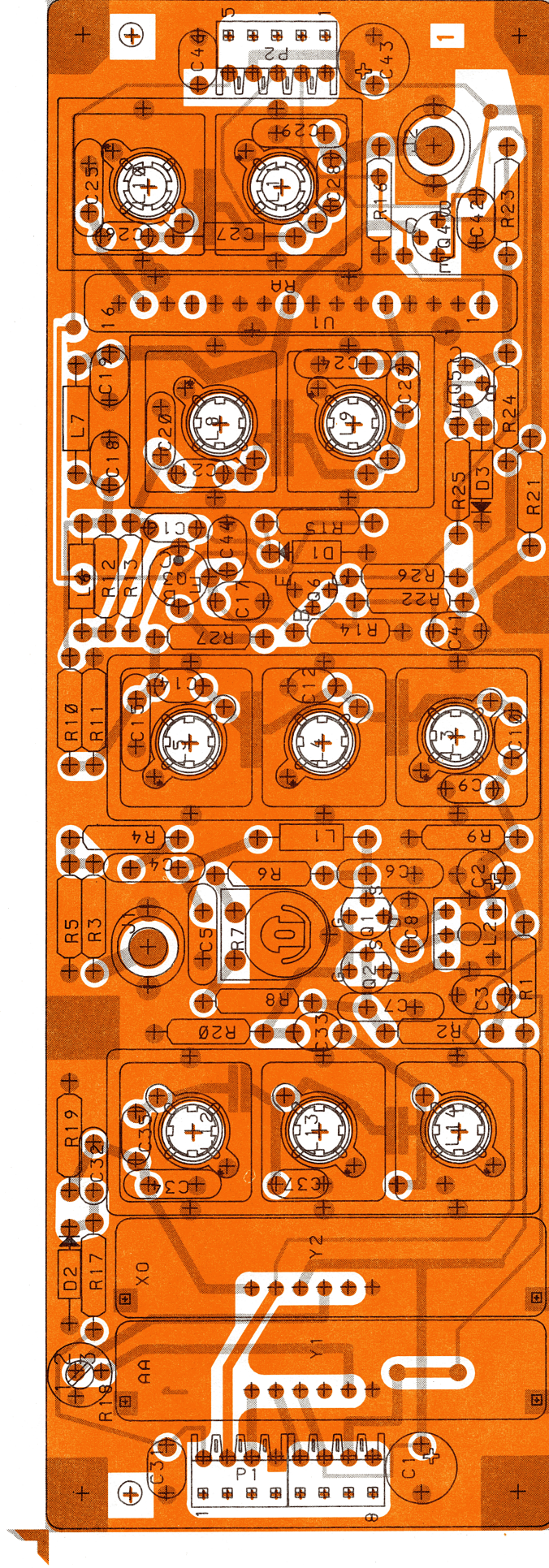
# Sorno



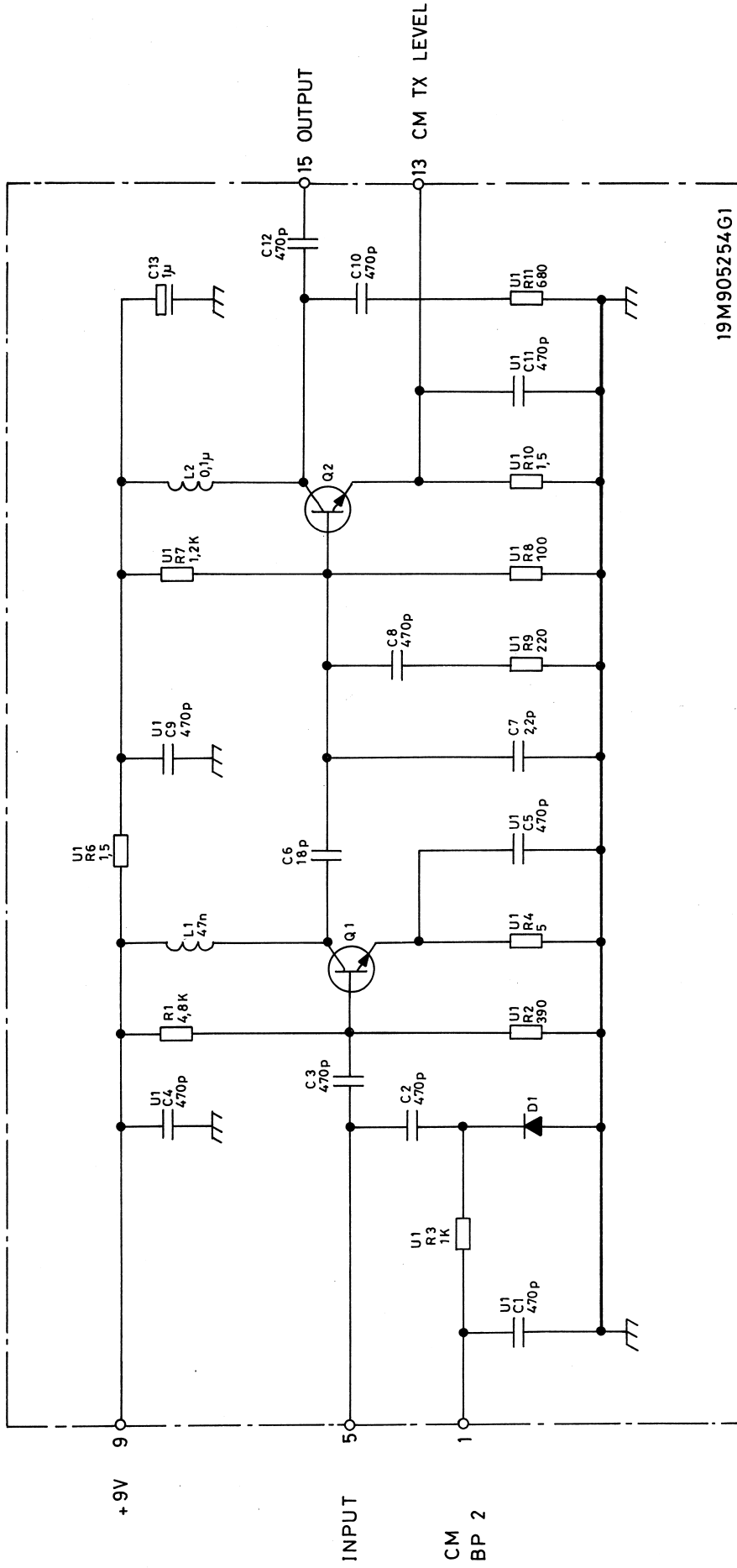
EXCITER EX911

**Storno**

**Storno**



EXCITER EX911  
COMPONENT LAYOUT  
M905224G1 D403.422



PIN - 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 16 ARE

RF AMPLIFIER RA911

D403.154

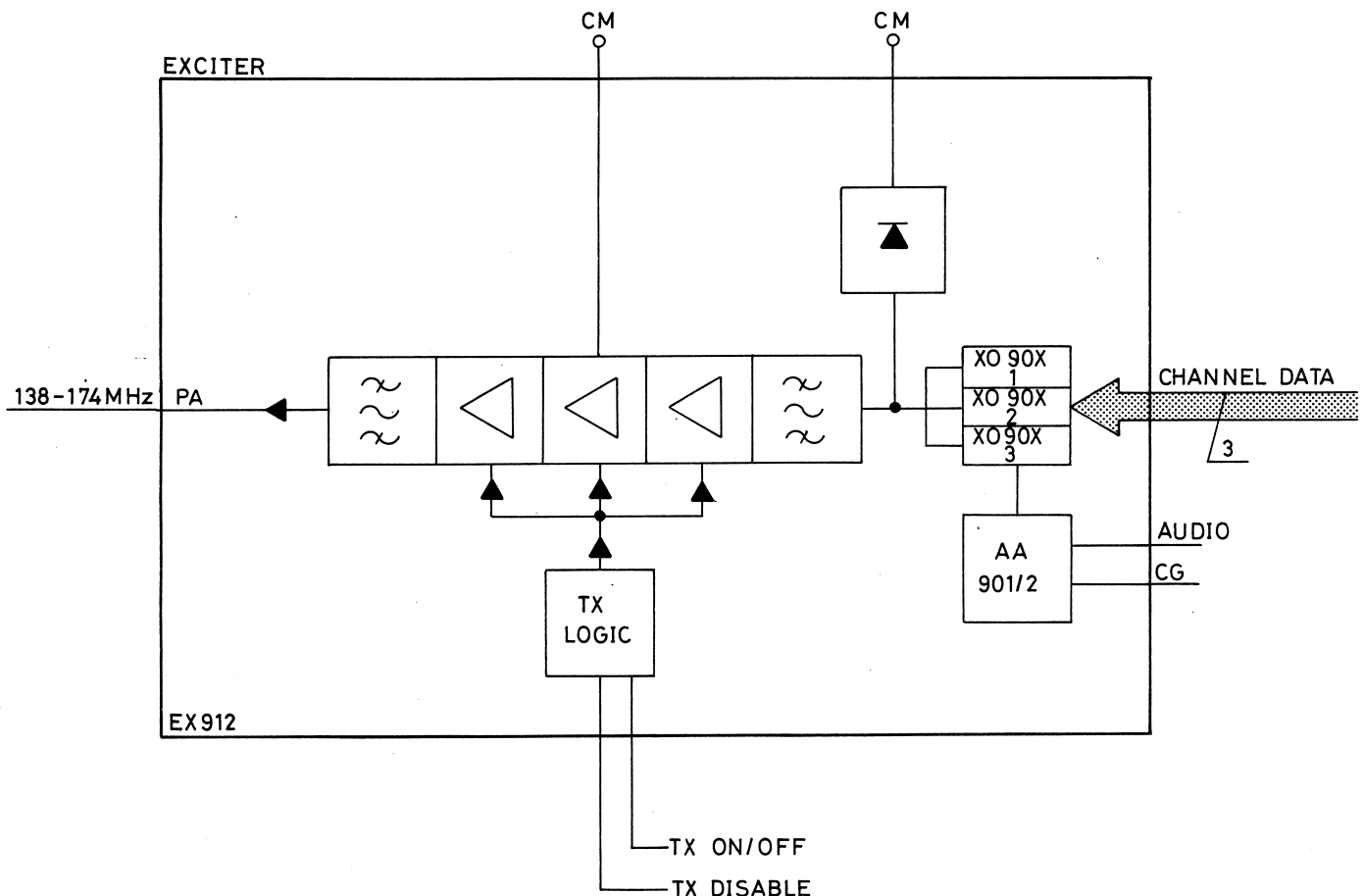
## EX912

### EXCITER

EX912 is used in the 900 duplex radios and in the FM9 base station, both in the frequency range 160 MHz.

EX912 supplies the PA with a modulated RF signal. The frequency range is 138-174 MHz and the maximum number of channel frequencies is 3.

Each channel frequency is generated in a plug-in crystal oscillator (XO). Maximum frequency spacing of the 2 channels is 6 MHz. If only one XO is used, it shall be placed as XO no. 1 and it will be on continuously. If two or three XO's are used, W1 is disconnected and the channel frequency is selected from P3.



### TECHNICAL SPECIFICATIONS

Channel guard input level  
for  $\Delta f = 0.75$  kHz  
300 mV  $\pm 2$  dB

AF input with preemphasis  
for  $\Delta f = 3$  kHz,  $f_{mod} = 1$  kHz  
100 mV  $\pm 2$  dB



AF input impedance

600 ohm

TX ON/OFF

&lt;0.8 V/open coll.

RF output level

24.5 to 27.5 dBm

RF nominal impedance

50 ohm

RF load impedance

50 ohm

TX status

&lt;5 V/0.8 -1.5 mA

Supply voltage9 V  $\pm$  5%XO Voltage9 V  $\pm$  0.5%Current consumption

(without XO's and AA)

&lt;300 mA

Output frequency

138-174 MHz

Max. channel spacing

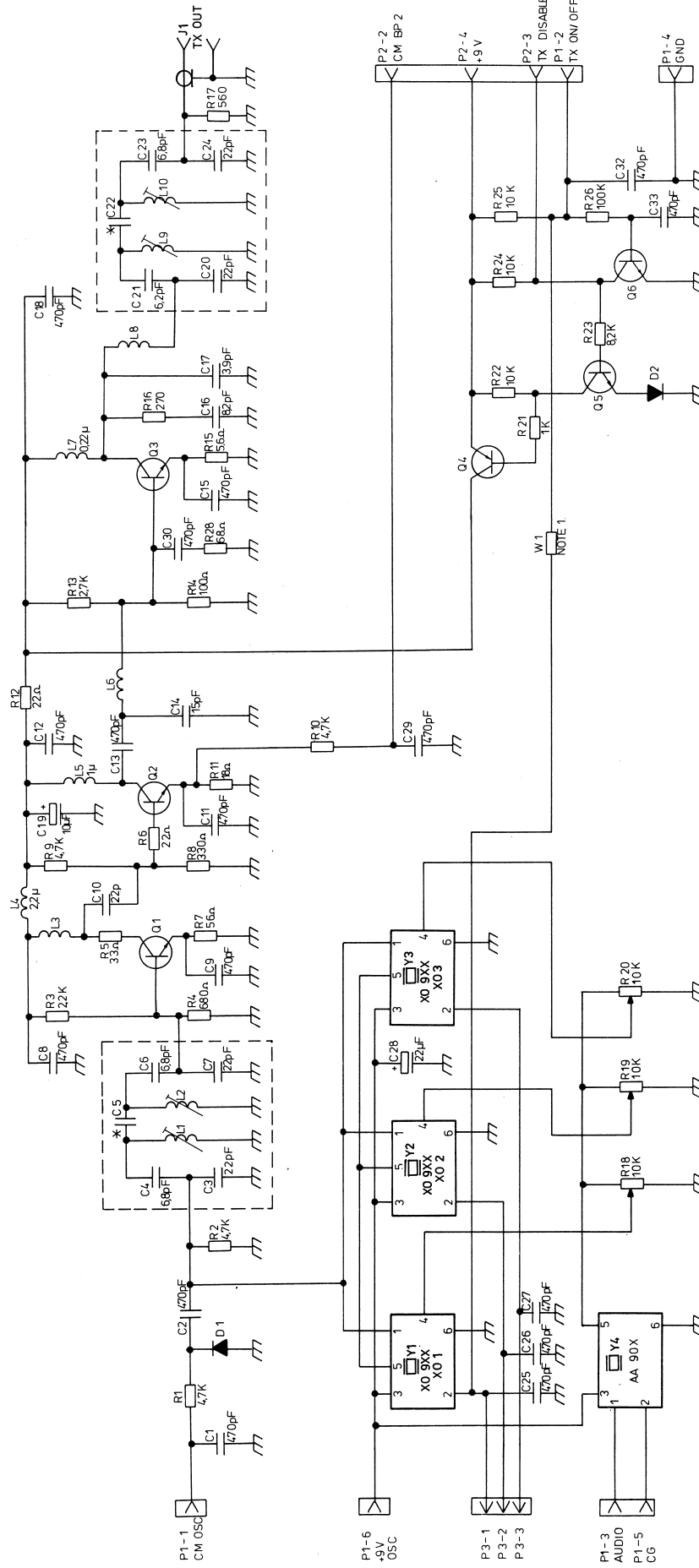
6 MHz

AF distortion (EIA)

&lt;2%

Temperature range

-40°C to +85°C



\* PRINTED BOARD CAPACITOR.

NOTE 1: W1 ARE REMOVED WHEN MORE THAN ONE XO ARE MOUNTED.

# Sorno



D403.302

## FG911

## RECEIVER/TRANSMITTER SIGNAL SOURCE

Functional Description

FG911 gives the injection signal for the receiver and the exciter signal for the transmitter in a simplex radio.

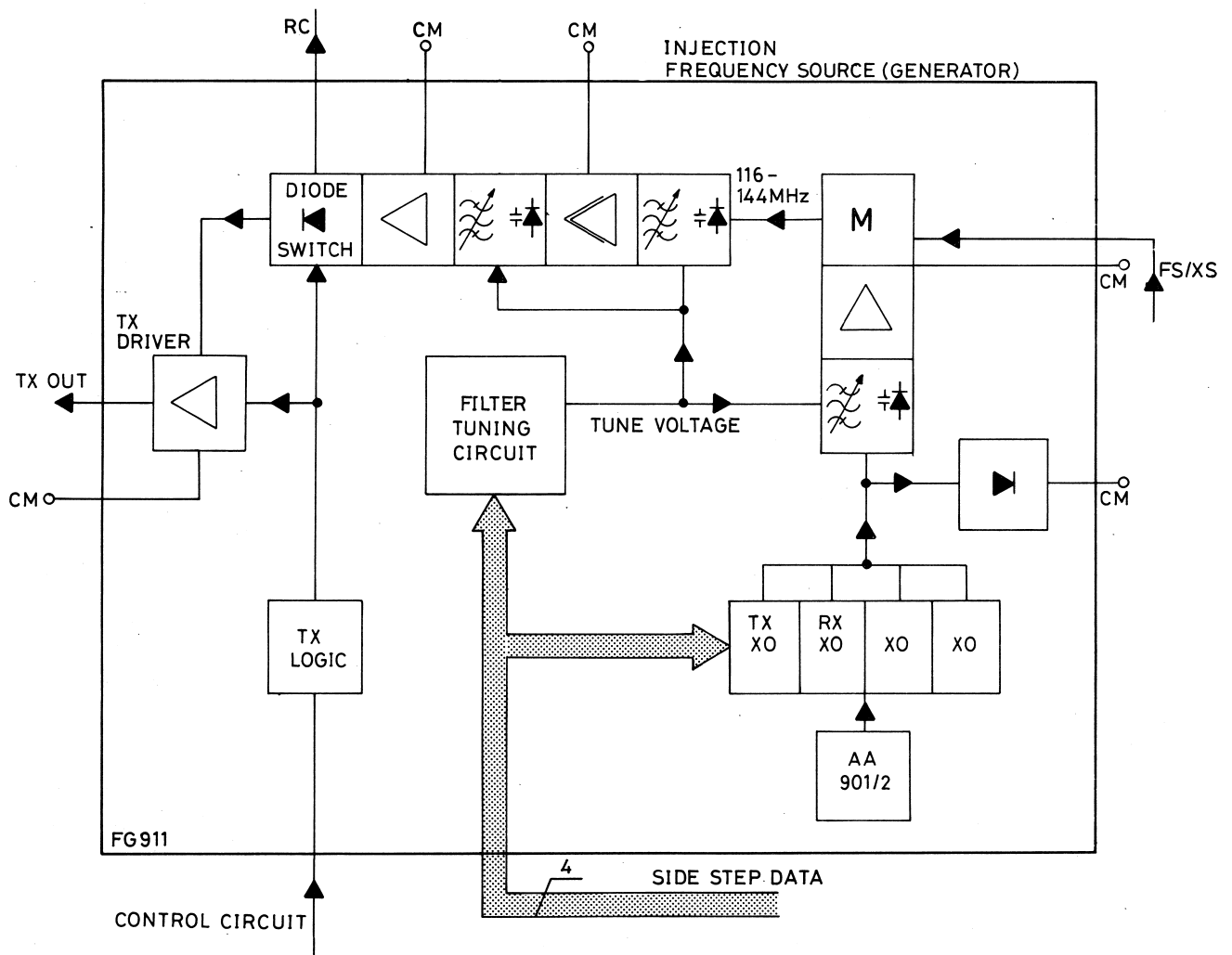
It covers the frequency band of 146-174 MHz.

The module converts the 12.5-16 MHz signal from the channel generator to the receiver - or the transmitter frequency and modulates the transmitter signal. There is room for four XO's, one

for the transmitter, one for the receiver and the last two can be used individually for RX or TX.

Then, it is possible to make up to two side steps on the transmitter or one on the transmitter and one on the receiver.

There are several central metering points for adjustments and test of the module.



Circuit Description

The module consists of a printed circuit board and some thick film plug-in modules.

The XO's and the AA are plug-in modules.

The rest of the circuit is mounted on the PWB.

It is possible to modulate all the XOs if they are TX XO's. The output  $F_1$  from the XO is fed to the first varicap tuned BP filter. All BP filters is 3-section filters. After the filter,  $F_1$  is amplified and fed into the mixer.

This is a balanced FET -mixer which gives some attenuation of  $F_1$  in the mixer output signal.

From the mixer's output signal is  $F_o = F_1 + F_2$

and this is amplified and filtered in two amplifier stages and two varactor filters. The bandwidth of the filters for  $F_o$  is min. 3.5 MHz. The diode switch after the last amplifier switches the signal between the RX output and the TX driver. The TX logic controls the TX driver and the diode switch. "TX disable" is wired together with "lock detector" from the frequency synthesizer. When the synthesizer is out of lock it is not possible to activate the TX driver.

The filter tuning circuit gives the tuning voltage for the varicap tuned filters. With the "side step" the circuit shifts from one XO to another XO and the tuning voltage side steps the varicap filters to the new frequency.

## TECHNICAL SPECIFICATIONS

CG input

300 mV RMS

AF input level

for  $\Delta f = 3$  kHz,  $f_{mod} = 1$  kHz

100 mV RMS

AF input impedance

600 ohm/1500 ohm bias to +9 V

Side-step voltage

Open coll. / <0.8 V (-1.5 mA)

Nominal impedance RX/TX

50 ohm

Load impedance RX/TX

50 ohm

Supply voltage

9 V  $\pm 5\%$

Current consumption

TX =  $\leq 350$  mA

RX =  $< 125$  mA

Output frequency, RX

116 - 144 MHz or 124 - 152.6 MHz

Output frequency, TX

138 - 166 MHz or 146 - 174 MHz

Channel gen. frequency

12.8 - 16 MHz

Channel bandwidth

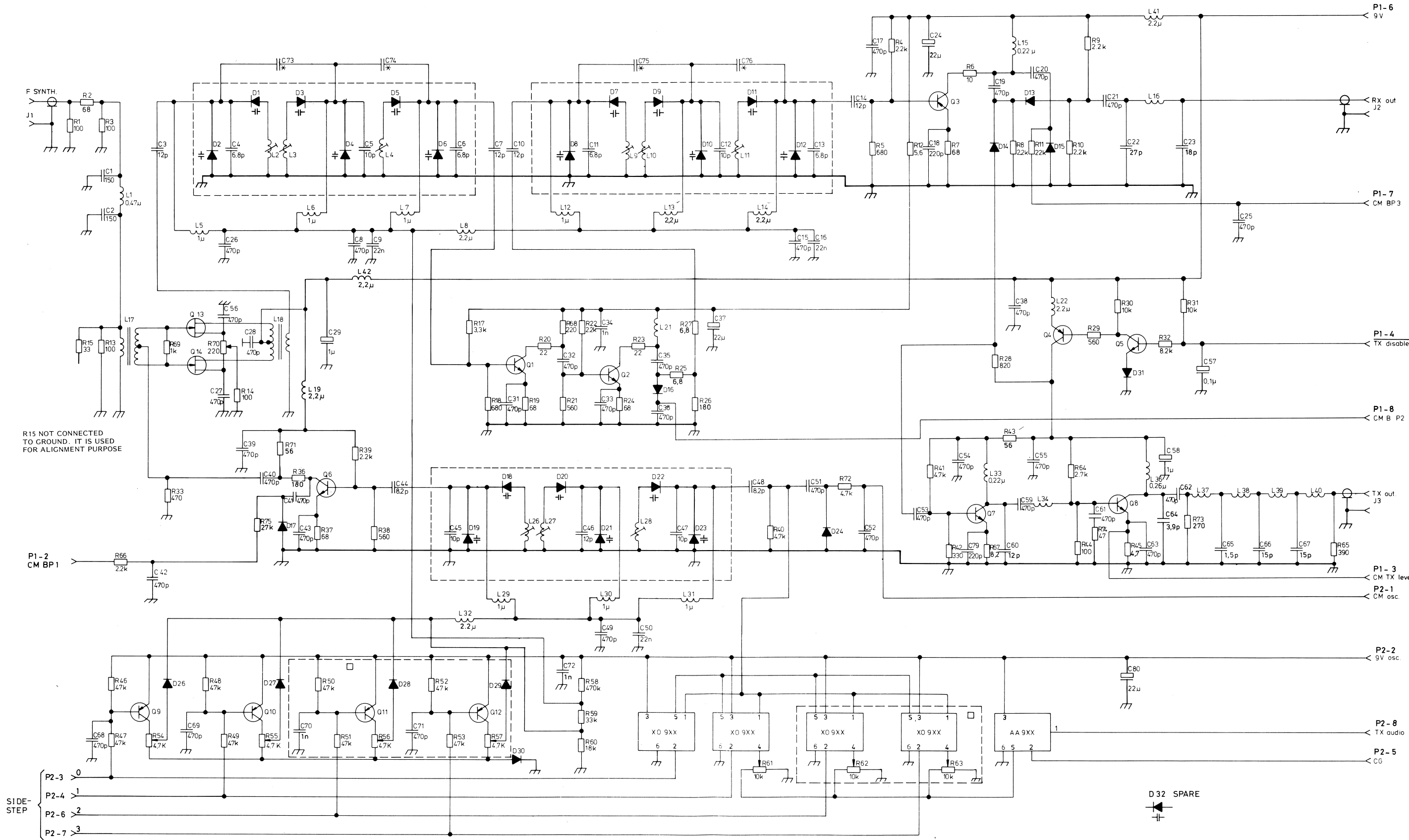
3.2 MHz

AF distortion (EIA)

$< 2\%$

Temperature range

$-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$

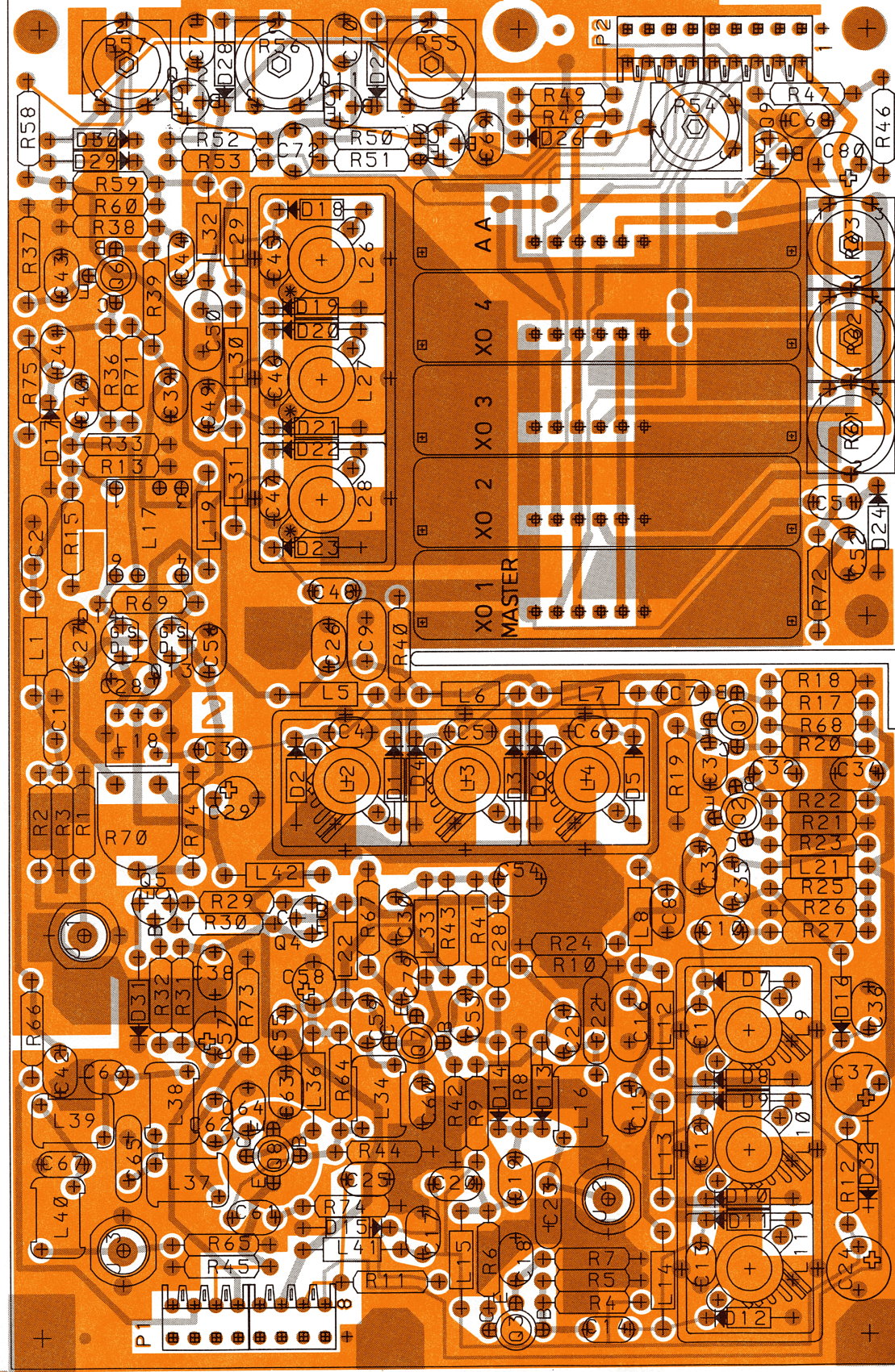


CODE NO.  
M905012 G1  
M905012 G2 WITH SIDE-STEP

□ MOUNTED ONLY IN G2 RADIOS  
\* PRINTED BOARD CAPACITORS

FREQUENCY GENERATOR FG911





CODE NO:  
M905012G1  
M905012G2 WITH SIDE-STEP

FREQUENCY GENERATOR FG911  
COMPONENT LAYOUT

D402.943/2



## FG912

## RECEIVER INJECTION SOURCE

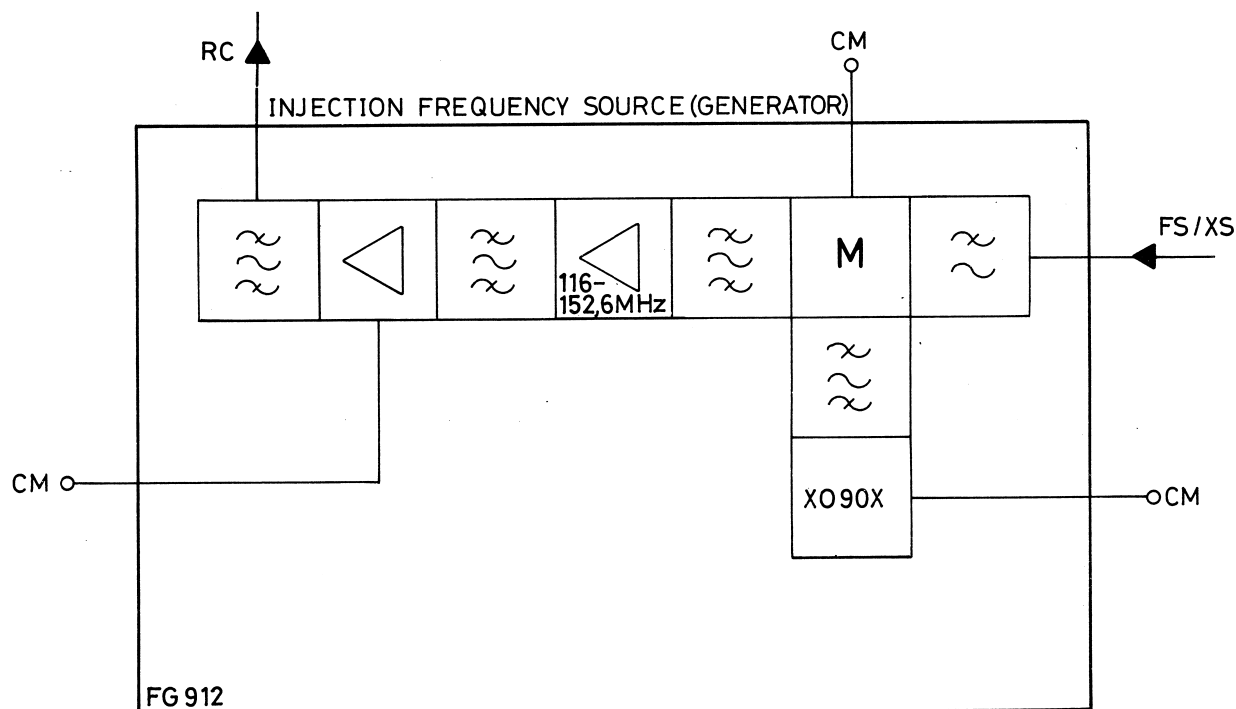
FG912 gives the RX injection signal for the receiver, and is used in a duplex radio. It covers the frequency band of 116.6-152.6 MHz which is the RX injection frequency for the receiver of 138-174 MHz ant. frequency. The module converts the 11.5-16 MHz signal from the synthesizer to the right RX injection frequency. Central metering points is incorporated for adjustment and test of the module.

The components are placed on a printed circuit board. The oscillator is a plug-in module and the output is the third harmonic of the crystal frequency.

Circuit Description

The output of oscillator is first filtered in a 3-section filter and fed to the gate of Q1. The source of the same mixer is also fed with the synthesizer signal through a low-pass-filter. The mixer output is filtered in two 3-section filter and one 2-section filter and amplified to the right output level in Q2 and Q3.

Q3 provides limitation to minimize variation with temperature and frequency. The filter arrangement attenuates the oscillator frequency in the output. Central metering points are provided for measuring and adjustment.



## TECHNICAL SPECIFICATIONS

Specifications at 25°C

FS input frequency

11.5-16 MHz

FS input level

0 dBm (-1 dB/+3 dB)

Impedance

50 ohm

RF output level

+10 to +14 dBm

Supply Voltage

9 V  $\pm 5\%$

XO Voltage

9 V  $\pm 0.5\%$

Current consumption

<60 mA

Output frequency

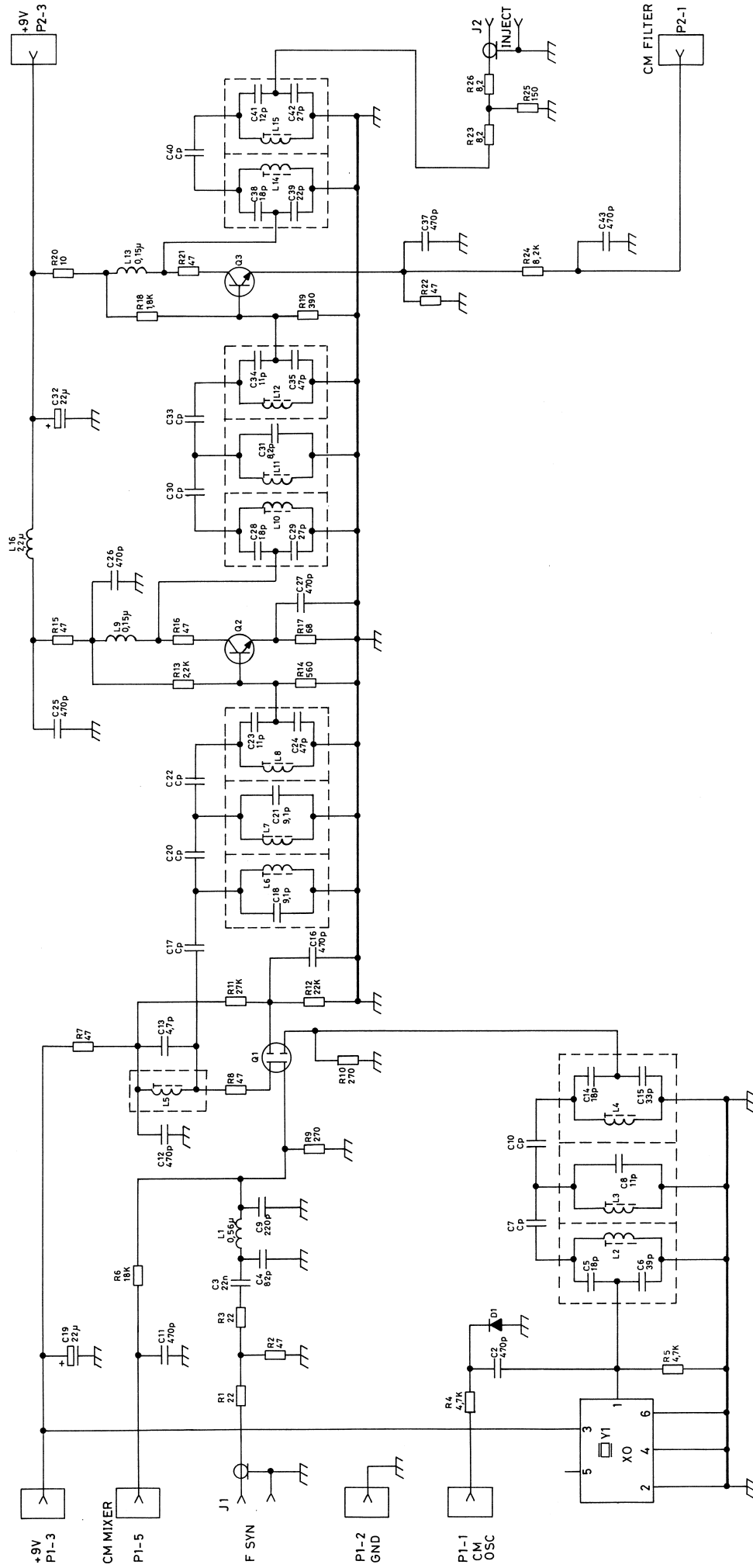
116.6-152.6 MHz

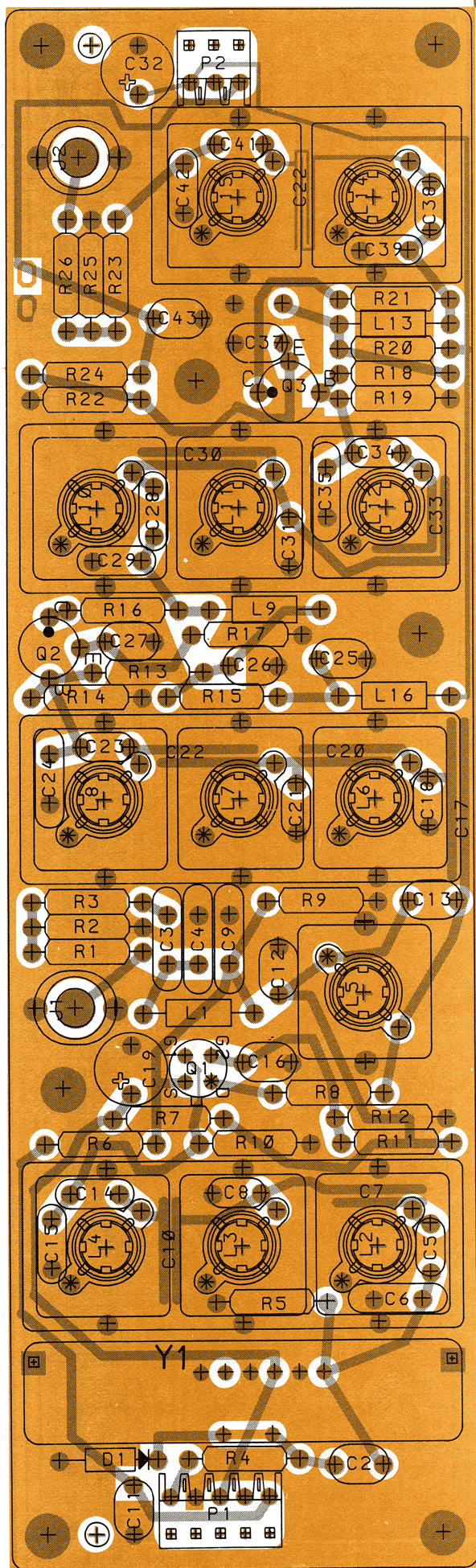
Channel gen. bandwidth

4.5 MHz

**Storno**

**Storno**





FREQUENCY GENERATOR FG912  
COMPONENT LAYOUT

19M905216

D403.301

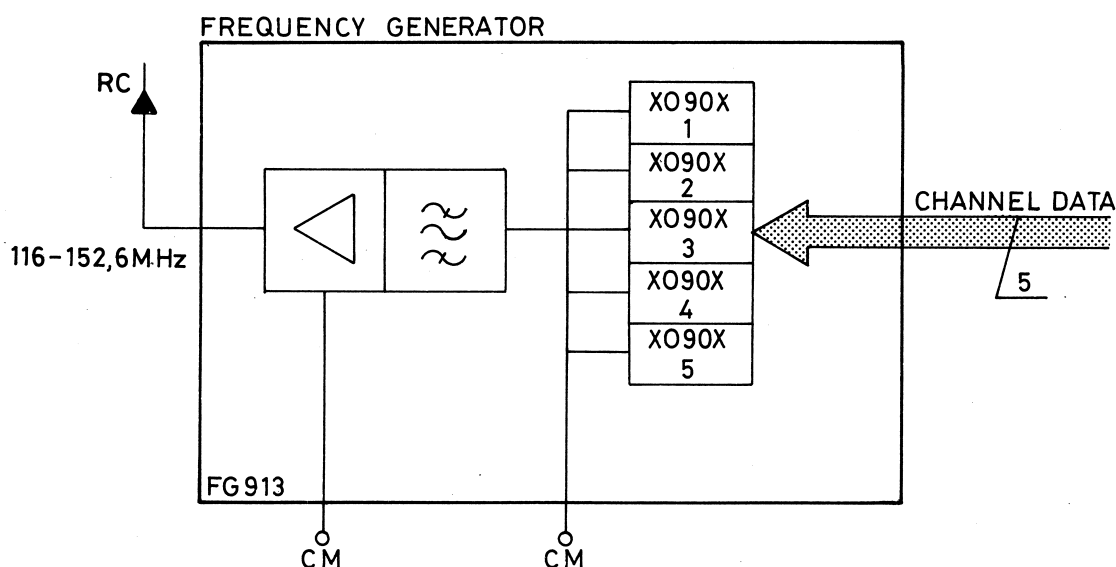
## FG913

### FREQUENCY GENERATOR

FG913 supplies the receiver with the injection signal in simplex or duplex radio, multiplier version. The output frequency range 116.6 - 152.6 MHz corresponds to the antenna frequency range 138-174 MHz.

Max. number of channels are 5 with max. spacing on 8 MHz. If only one XO is used, it shall be placed as XO no. 1 and it will be on continuously. If two or more are used, the shorting W1 is disconnected and the channel frequencies are selected from the control unit.

The module can be supplied with max. 5 XO's which are plug-in modules. The output from the selected XO is filtered through a 3 section bandpass filter, before amplification to the specified output level. There are two central metering points for use during test and alignment. Q1 provides limitation to minimize variation with temperature and frequency.



### TECHNICAL SPECIFICATIONS

Output frequency  
116.6 - 152.6 MHz

Output level  
+9 - +13 dBm

Impedance  
50 ohm

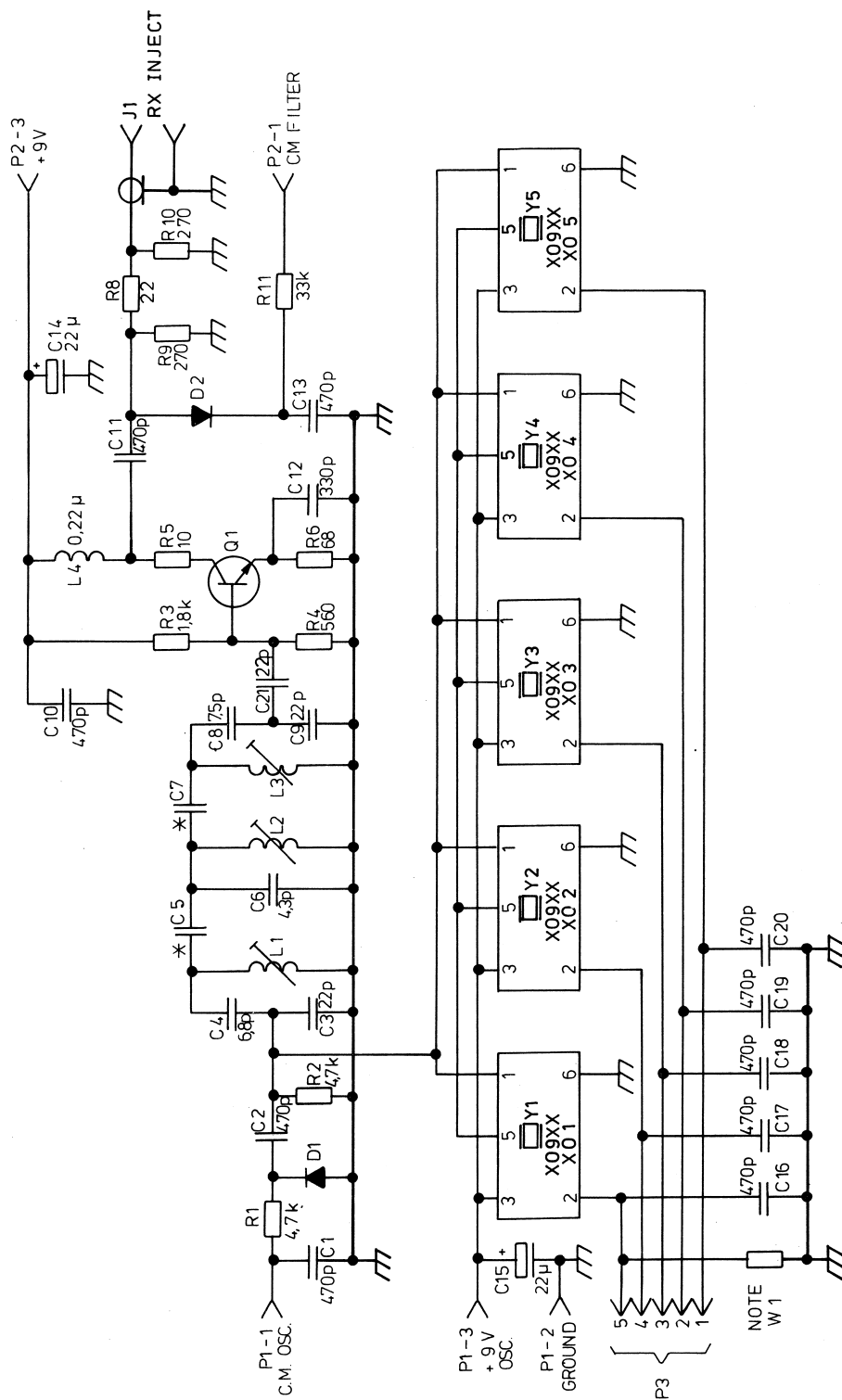
Max. channel spacing  
8 MHz

Supply voltage  
9 V  $\pm$  5%

XO Voltage  
9 V  $\pm$  0.5%

Current consumption  
<30 mA excl. oscillators

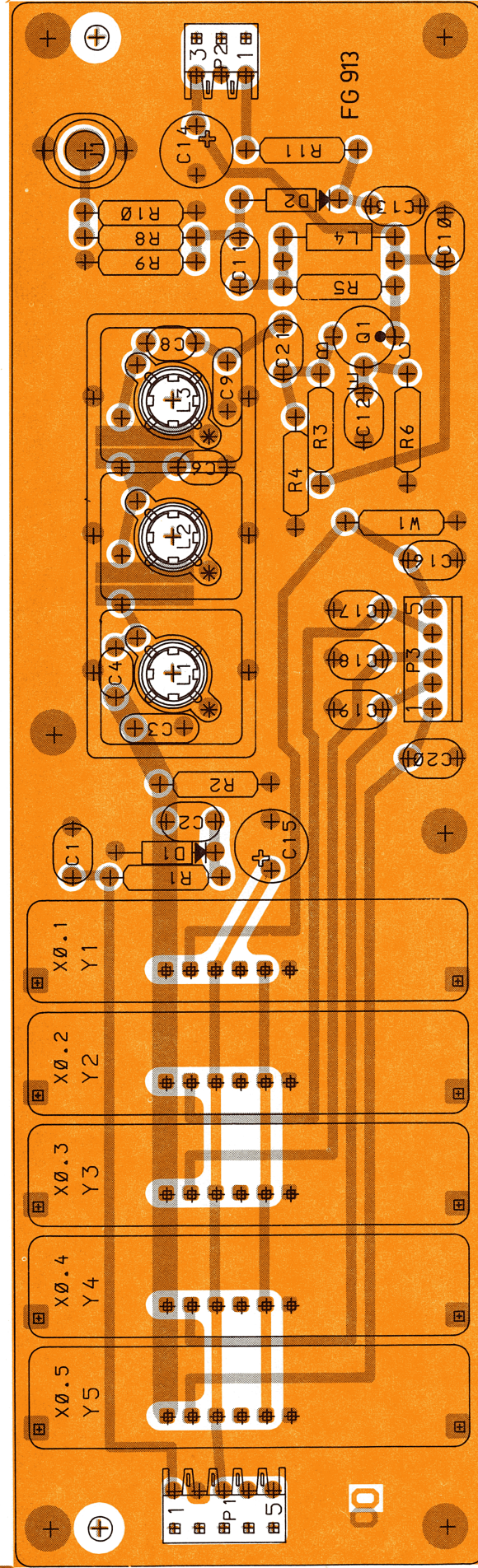
Temperature range  
-40°C to +85°C



\* PRINTED BOARD CAPASITORS.

NOTE: W1 ARE REMOVED WHEN  
MORE THAN ONE X0 ARE MOUNTED.





FREQUENCY GENERATOR FG913  
COMPONENT LAYOUT

CODE NO M905398 G1

D403.436

# FS901/FS902/FS903

## Functional description

FS90X is a frequency synthesizer module to program up to 256 channels.

The synthesizer reference frequency is generated by a fundamental crystal controlled oscillator whose frequency is 10.24 MHz, 12.8 MHz.

The stability of the plug-in oscillator module determines the frequency stability of the synthesizer.

The synthesizer is the channel determining module and works as a reference for the high frequency PLL's.

FS901:	25 kHz
FS902:	12.5 kHz
FS903:	20 kHz

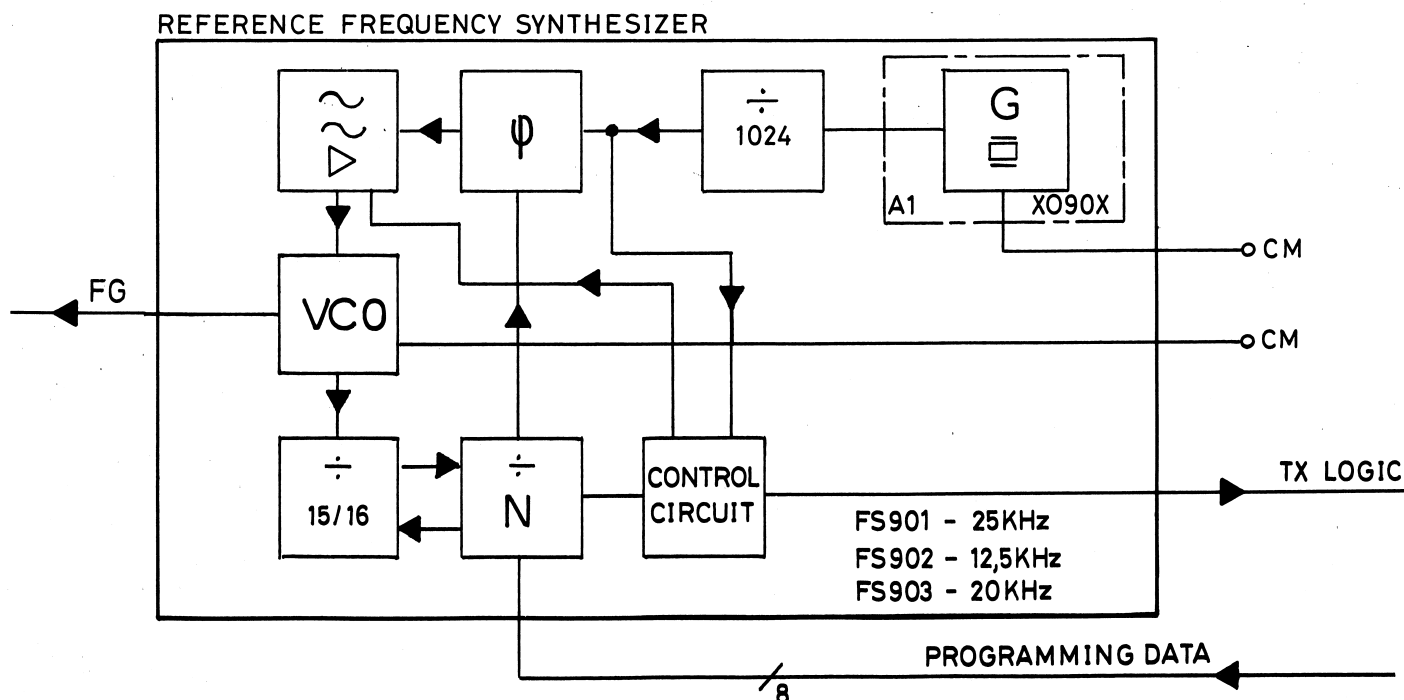
### Circuit description

The synthesizer module contains a custom MOS integrated circuit which performs several functions: reference divider, phase detector, programmable divider, acquisition and lock detector.

The reference frequency is coupled into the IC and is first buffered and amplified to make the level compatible with the CMOS counters. The reference counter divides the input frequency by 1024 and the output pulse turns on a constant current source which stays on until the VCO divided down pulse turns it off. This constant current source produces a linear ramp voltage driving a capacitor.

The phase error voltage produced at the IC's SHD gate is applied via a loop filter to the voltage controlled oscillator (VCO) to hold it phase locked to the counted down reference frequency and assure the loop stability.

The active devices of the VCO are two J-FETS transistors. The tuning of the VCO is performed through a pot core coil and two varactors. The phase of the frequency at the drain of the second J-FET transistor is used as positive feedback to make the two stages oscillate. The output



of the VCO is filtered for harmonics before the RX and TX output terminals.

Another output of the filtered VCO frequency is coupled to the DIVIDE BY 15/16 counter. This high speed counter (Dual Prescaler) divides the VCO frequency to a much lower frequency compatible with the speed of the CMOS logic and this lower output frequency is used as the clock for the IC, except for the reference divider.

The programmable counters control the sample point of the ramp voltage and changing the division ratio will change the number of "count to 15". This results in another sample point of the ramp voltage and hence the control voltage for the VCO is adjusted until the new frequency is phase locked to the reference frequency.

The lock detect function is derived from the acquisition circuitry. It gives a high level output when lock exists and low level (in some cases as pulses) for unlocked condition.

## TECHNICAL SPECIFICATIONS

	Ref. osc. MHz	Ch. spac. kHz	Min. freq. MHz	Max. freq. MHz	No of ch. up to	Min/Max. count N counter
FS901	12.80	25	12.8000	17.8000	200	1024 1424
FS902	12.80	12.5	12.8000	15.9875	256	1024 1279
FS903	10.24	20	12.8000	15.3400	128	1280 1534

### Lock detector

locked: >8.0 V  
unlocked: <0.8 V DC

### RF output J1/J2

level: 0 dBm  
source impedance 50 ohm  
load impedance 50 ohm

### Power supply

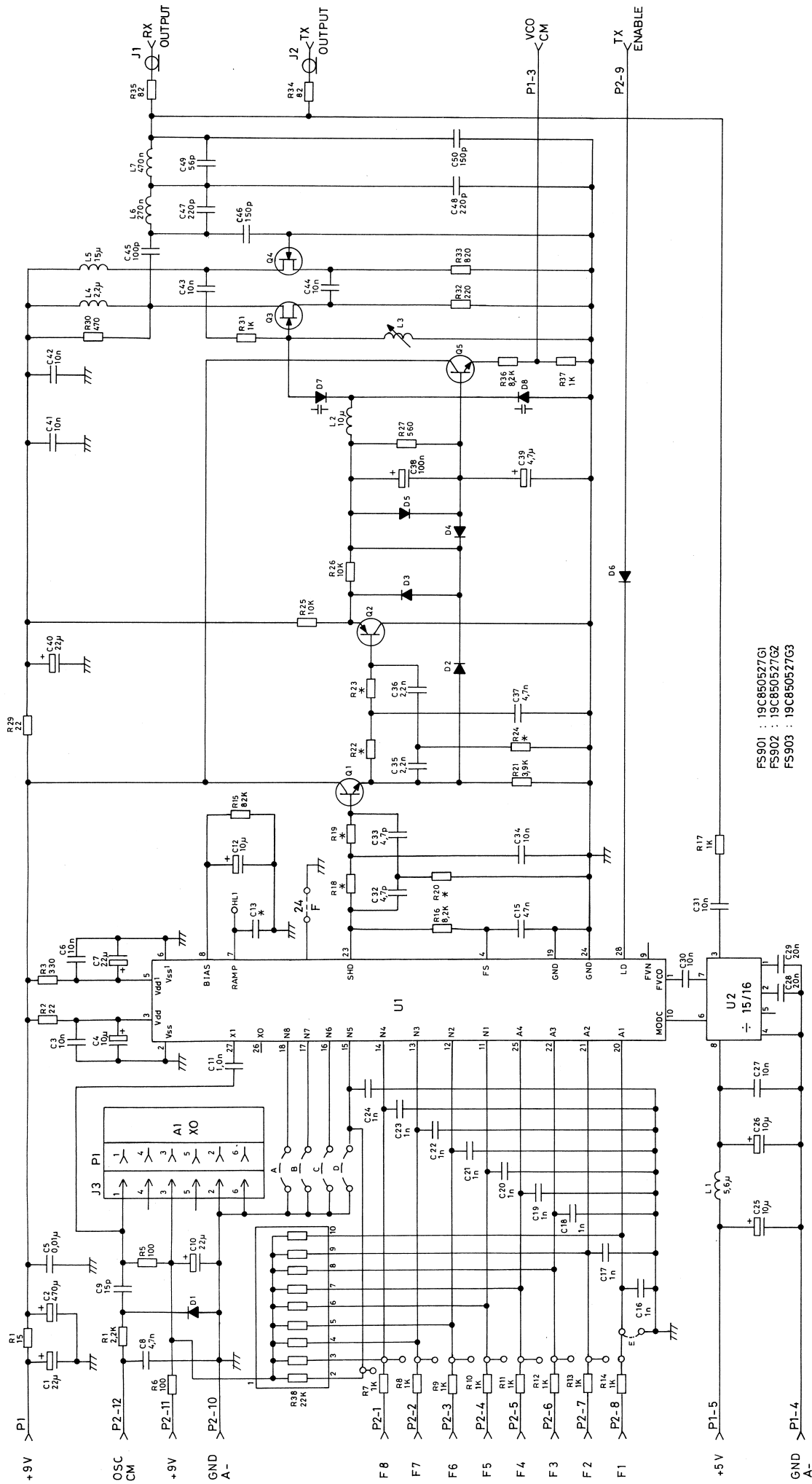
9 V  $\pm 0.5\%$  at 5 mA  
9 V  $\pm 5\%$  at 55 mA  
5 V  $\pm 5\%$  at 60 mA

### Frequency stability

determined by the XO9xx

### Temperature range

-40°C to +85°C



\* VALUE CHART

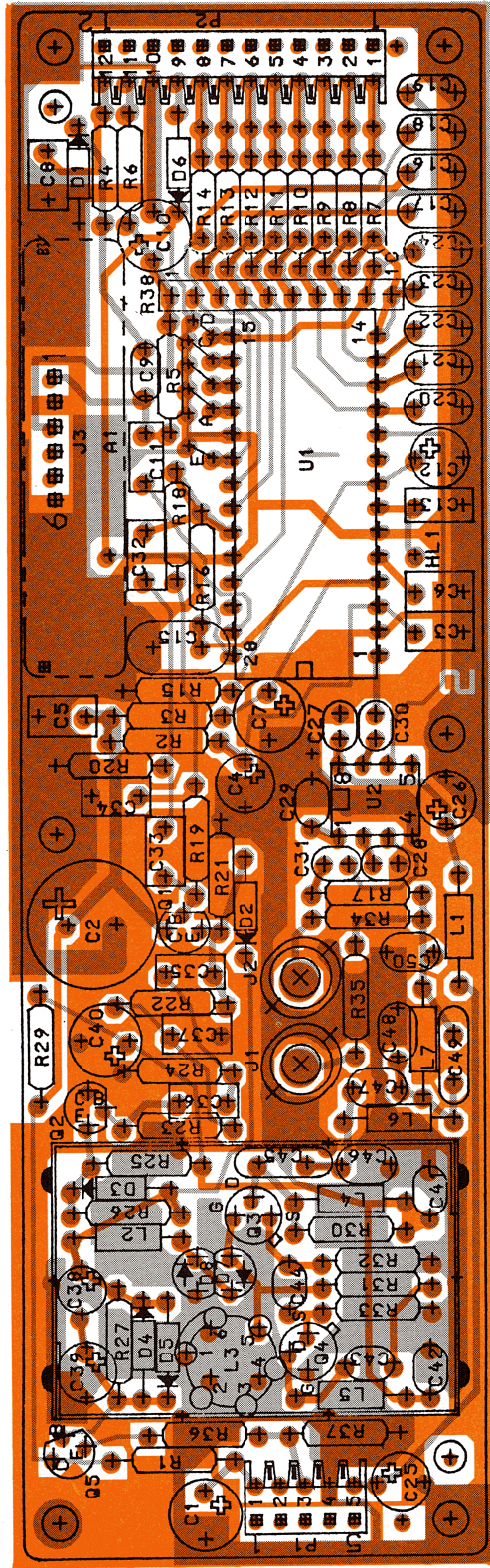
TYPE	REFERENCE	R18	R19	R20	R22	R23	R24	A1	PROGRAM	C13
FS901	25 KHz	2610	2610	1400	2800	2800	1500	1500	A, C, E, F	1.5n
FS 902	12.5KHz	2610	2610	1400	2800	2800	1500	1500	A, C, D, F	1.5n
FS 903	20KHz	3320	3320	1740	3480	3480	1870	1870	A, C, F	2.2n

FS901 : 19C850527G1  
 FS902 : 19C850527G2  
 FS903 : 19C850527G3

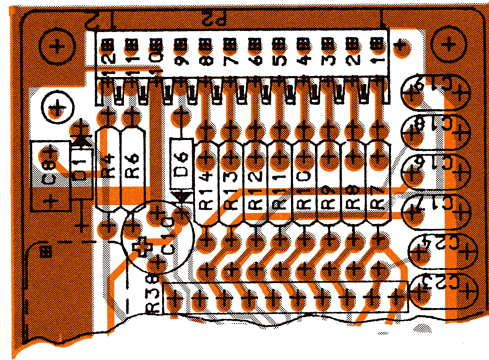


**Storno**

**Storno**



FS901



FS902/3

- FS901 : 19C850527G1
- FS902 : 19C850527G2
- FS903 : 19C850527G3

## IA902/IA903/IA904

### IF AMPLIFIER AND DETECTOR

The Intermediate Frequency module amplifies the 21.4 MHz signal and detects the modulation. The module accepts a narrowband FM signal and delivers an audio output from DC to 3000 Hz into a load of 2000 ohms or greater.

IA902 is used for 25 kHz channel spacing.

IA903 is used for 20 kHz channel spacing.

IA904 is used for 12.5 kHz channel spacing.

The required selectivity is obtained by two crystal filter blocks as follows:

IA902 - 6 pole filter - 6 pole filter

IA903 - 6 pole filter - 6 pole filter

IA904 - 6 pole filter - 4 pole filter

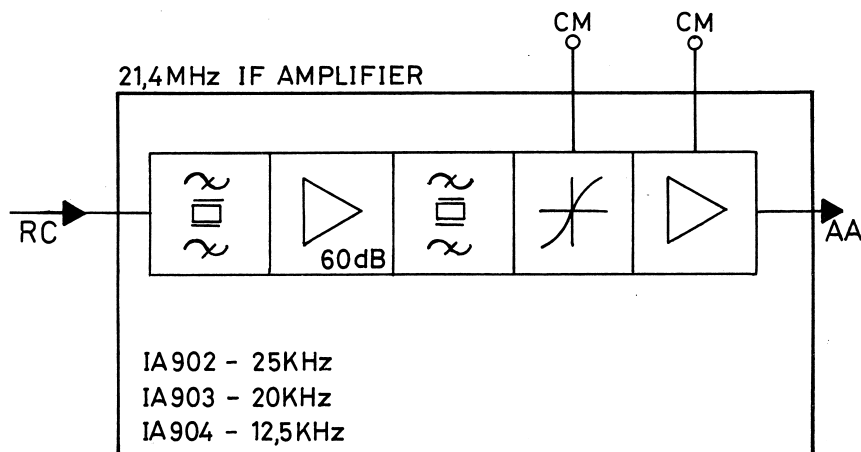
The two filters and the amplifying stages provide the necessary gain and selectivity distribution and set the noise figure. They also protect

against desensitization and intermodulation.

The first block of gain after the input filter provides about 60 dB IF gain. The input amplifier is a dual-gate FET with 15-20 dB gain and it overcomes the noise figure of the following stage and stabilizes the load on the crystal filter. The second stage in the first gain block is an integrated circuit with approx. 40 dB of gain. Following this IC is the second crystal filter.

The second block of gain is an integrated circuit containing a 70 dB IF amplifier, a discriminator, and an audio amplifier. The discriminator is a quadrature type with a crystal as the phasing element, thus providing a high level of recovered audio and good temperature stability.

The audio output is DC coupled through an emitter follower to provide the AF response which is required in some signalling applications.



### TECHNICAL SPECIFICATIONS

Input frequency

21.4 MHz

Nominal input impedance

1600 ohm

Source impedance

1600 ohm  $\pm 5\%$

AF output impedance

<100 ohm

Minimum external load

2000 ohm

Power supply voltage9 V  $\pm 5\%$ Current consumption

&lt;60 mA

Sensitivity, 12 dB SINAD

0.20 uV max., 1/2 emf, 50 ohm input

Static selectivity

	IA902	IA903	IA904
6 dB	$\geq \pm 7.4$ kHz	$\geq \pm 6$ kHz	$\geq \pm 3.75$ kHz
72 dB			$\leq \pm 11$ kHz
100 dB		$\leq \pm 17.6$ kHz	
110 dB	$\leq \pm 22$ kHz		

Discriminator bandwidthIA902/903  $\geq \pm 12$  kHzIA904  $\geq \pm 7$  kHzAF outputfor  $f_{\text{mod}} = 1$  kHz

IA902/903:

300 mV  $\pm 2$  dB ( $\Delta f = \pm 3$  kHz)

IA904:

300 mV  $\pm 2$  dB ( $\Delta f = \pm 1.5$  kHz)AF response

flat from 300 to 3000 Hz

Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$



VOLTAGE READINGS ARE  
TYPICAL READINGS,  
MEASURED TO SYSTEM  
NEGATIVE, (A-), WITH  
A 20,000 OHM PER VOLT DC  
VOLTMETER, UNDER THE  
FOLLOWING CONDITIONS:

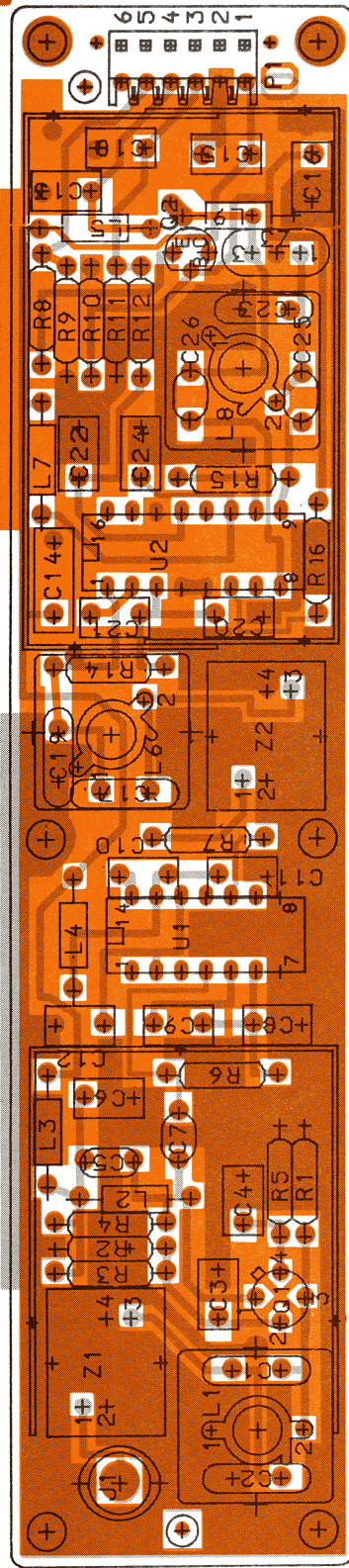
- 1: NO SIGNAL INPUT
- 2: J1 CONNECTED TO THE  
FRONT-END MODULE,  
OR TERMINATED WITH  
A 1600 OHM LOAD.



APPL	CHANNEL SPACING	CODE NR.
IA902	25KHz	C850520G2
IA903	20KHz	C850520G3
IA904	12,5KHz	C850520G4

IA902,IA903,IA904

D402.912/5



1A902 : C850520 G2  
 1A903 : C850520 G3  
 1A904 : C850520 G4

21,4 MHz IF AMPLIFIER

1A902,1A903,1A904  
 COMPONENT LAYOUT

D402.961/3

## IA907/IA908/IA909

## IF AMPLIFIER AND DETECTOR

The Intermediate Frequency module amplifies the 21.4 MHz signal convert it to 455 kHz, amplifies this signal and detects the modulation. The module accepts a narrowband FM signal and delivers an audio output from DC to 3000 Hz into a load of 2000 ohms or greater.

IA907 is used for 25 kHz channel spacing.  
IA908 is used for 20 kHz channel spacing.  
IA909 is used for 12.5 kHz channel spacing.

The required selectivity is obtained by two crystal filter blocks, one on 21.4 MHz and one on 455 kHz.

The two filters and the amplifying stages provide the necessary gain and selectivity distribution and set the noise figure. They also protect against desensitization and intermodulation.

The input amplifier after the crystal filter is a dual-gate FET with 15-20 dB gain and it

overcomes the noise figure of the following stage and stabilizes the load on the crystal filter.

The input amplifier is followed by an integrated circuit which includes oscillator, mixer, 455 kHz amplifier, discriminator and AF amplifier.

The mixer crystal frequency is either:

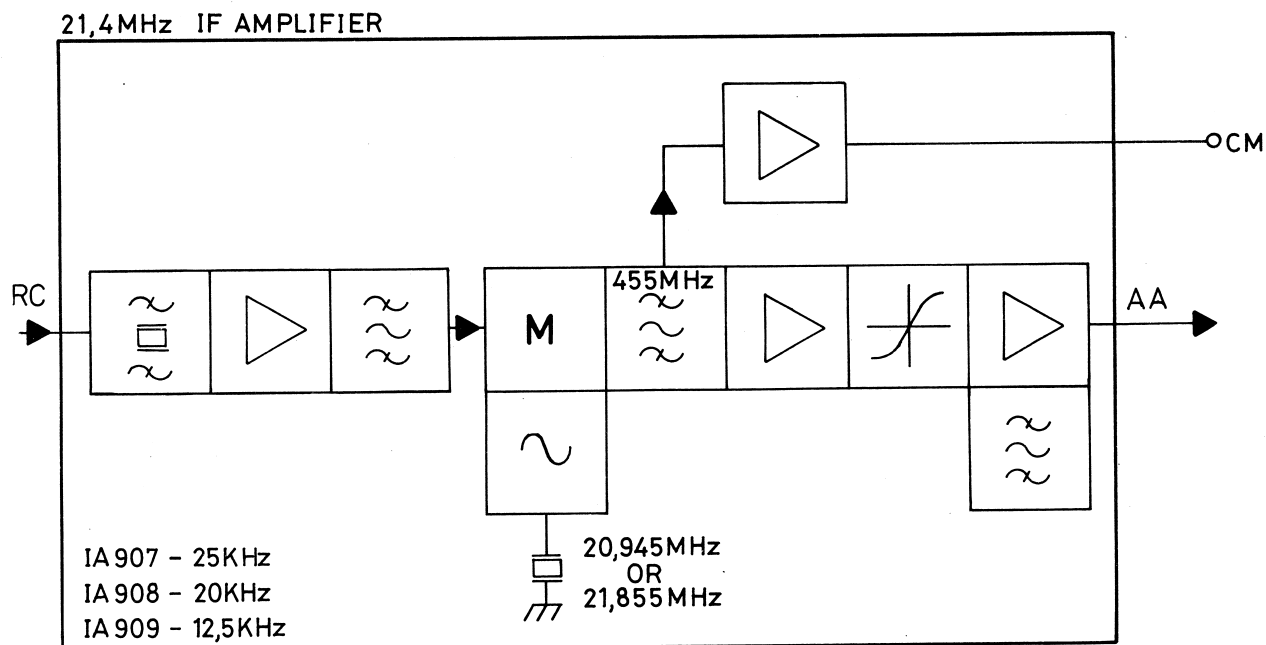
$$21.4 \text{ MHz} + 0.455 \text{ MHz} = 21.855 \text{ MHz}$$

$$\text{or } 21.4 \text{ MHz} - 0.455 \text{ MHz} = 20.945 \text{ MHz}$$

The discriminator is a quadrature type with a tuned LC-circuit as the phasing element.

The audio output is DC coupled through an emitter follower to provide the AF response which is required in some signalling applications.

A circuit for detecting the signal strength is included in the module and is used for adjustment and measurements.



## TECHNICAL SPECIFICATIONS

Input frequency

21.4 MHz

Nominal input impedance

1600 ohm

Source impedance1600 ohm  $\pm 5\%$ AF output impedance

&lt;100 ohm

Minimum external load

1000 ohm

Power supply voltage9 V  $\pm 5\%$ Current consumption

&lt;15 mA

Sensitivity, 12 dB SINAD

0.50 uV max., emf, 50 ohm input

Static selectivity

	IA907	IA908	IA909
6 dB	$>\pm 7.5$ kHz	$>\pm 6$ kHz	$>\pm 3.75$ kHz
80 dB			$\leq \pm 11$ kHz
100 dB	$\leq \pm 22$ kHz	$\leq \pm 17.5$ kHz	

Discriminator bandwidthIA907/908  $\geq \pm 10$  kHzIA909  $\geq \pm 7$  kHzAF outputfor  $f_{\text{mod}} = 1$  kHz

IA907:

300 mV  $\pm 2$  dB ( $\Delta f = \pm 3$  kHz)

IA908

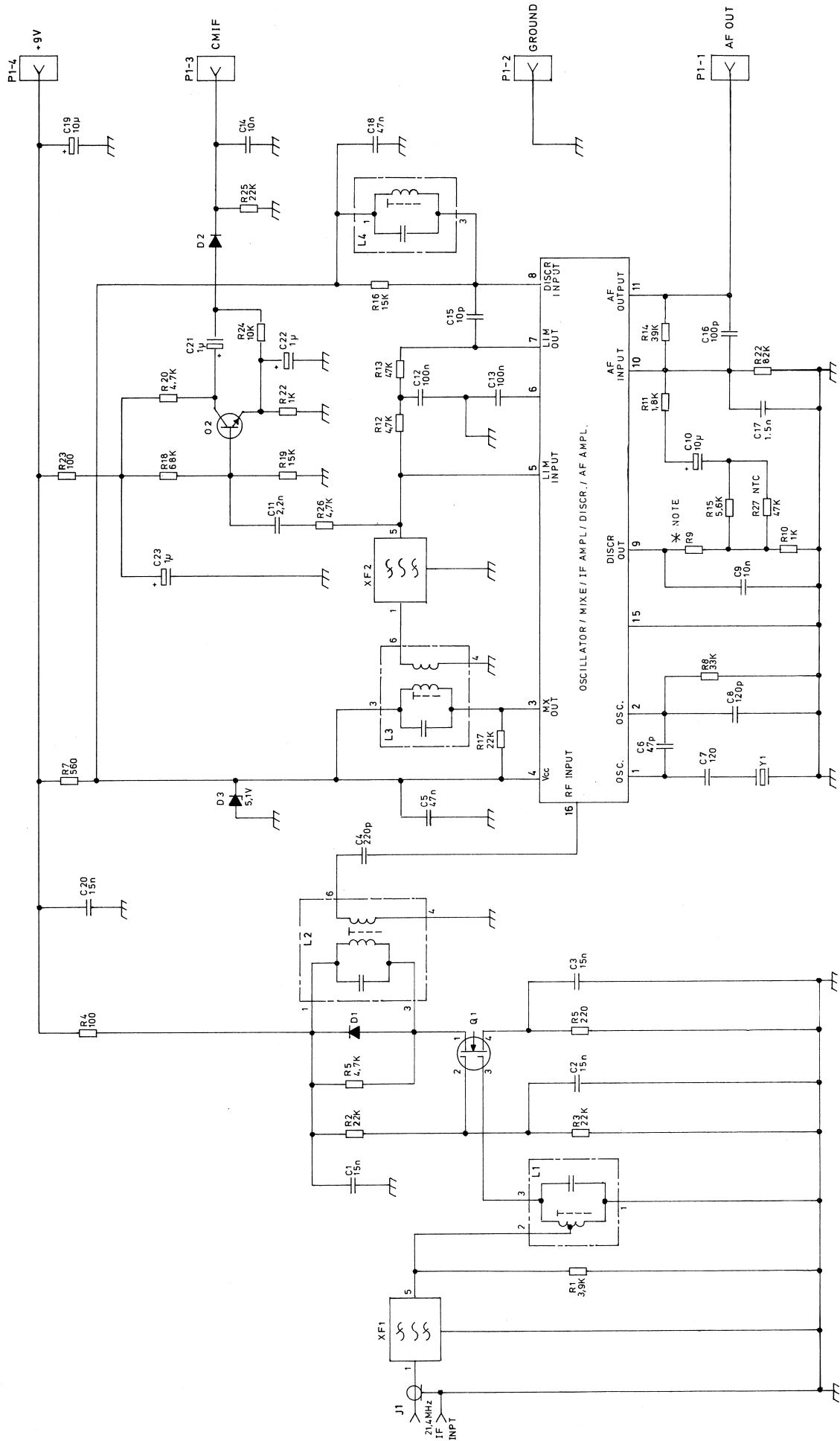
300 mV  $\pm 2$  dB ( $\Delta f = \pm 2.5$  kHz)

IA909:

300 mV  $\pm 2$  dB ( $\Delta f = \pm 1.5$  kHz)AF response

flat from 300 to 3000 Hz

Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

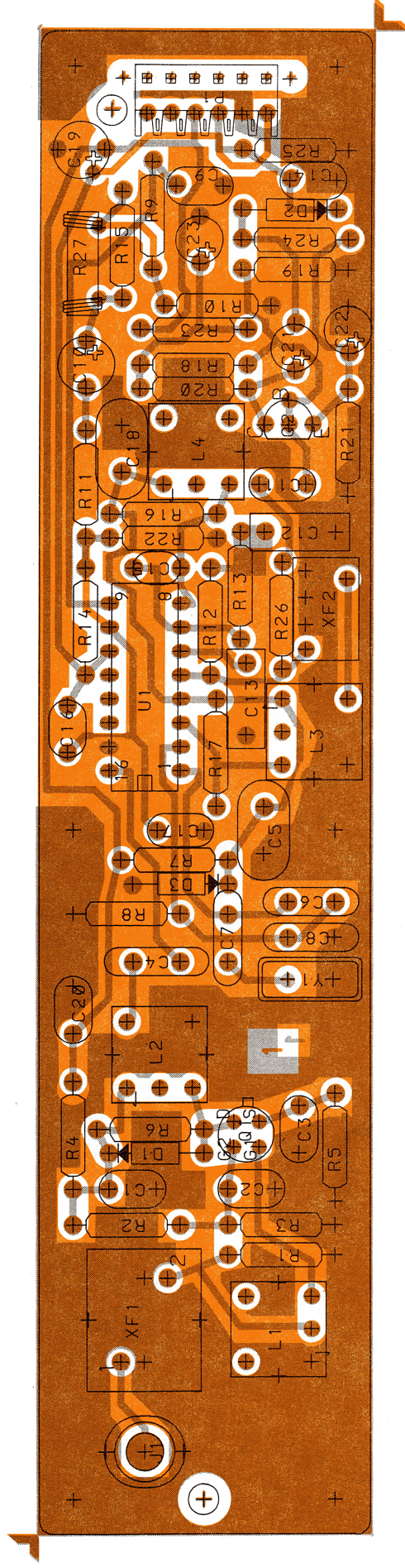


CODE NO.	R9	CHANNEL SPACING
IA 907	19M905348 G1	2.7K 25KHz
IA 908	19M905348 G2	2.2K 20KHz
IA 909	19M905348 G3	1.0K 12.5KHz

IF AMPLIFIER IA907/8/9

D403.367





CODE NO. 19M905348	CHANNEL SPACING
G1: IA 907	25KHz
G2: IA 908	20KHz
G3: IA 909	12,5KHz

IF AMPLIFIER IA907/908/909  
COMPONENT LAYOUT

D403.373

## **JP903**

### **INTERCONNECT BOARD**

The interconnect board provides all connections between the modules except for RF signals.

The board is used in duplex stations and are universal for all configurations of modules.

The modules plug onto connectors and guide pins ensure proper insertion.

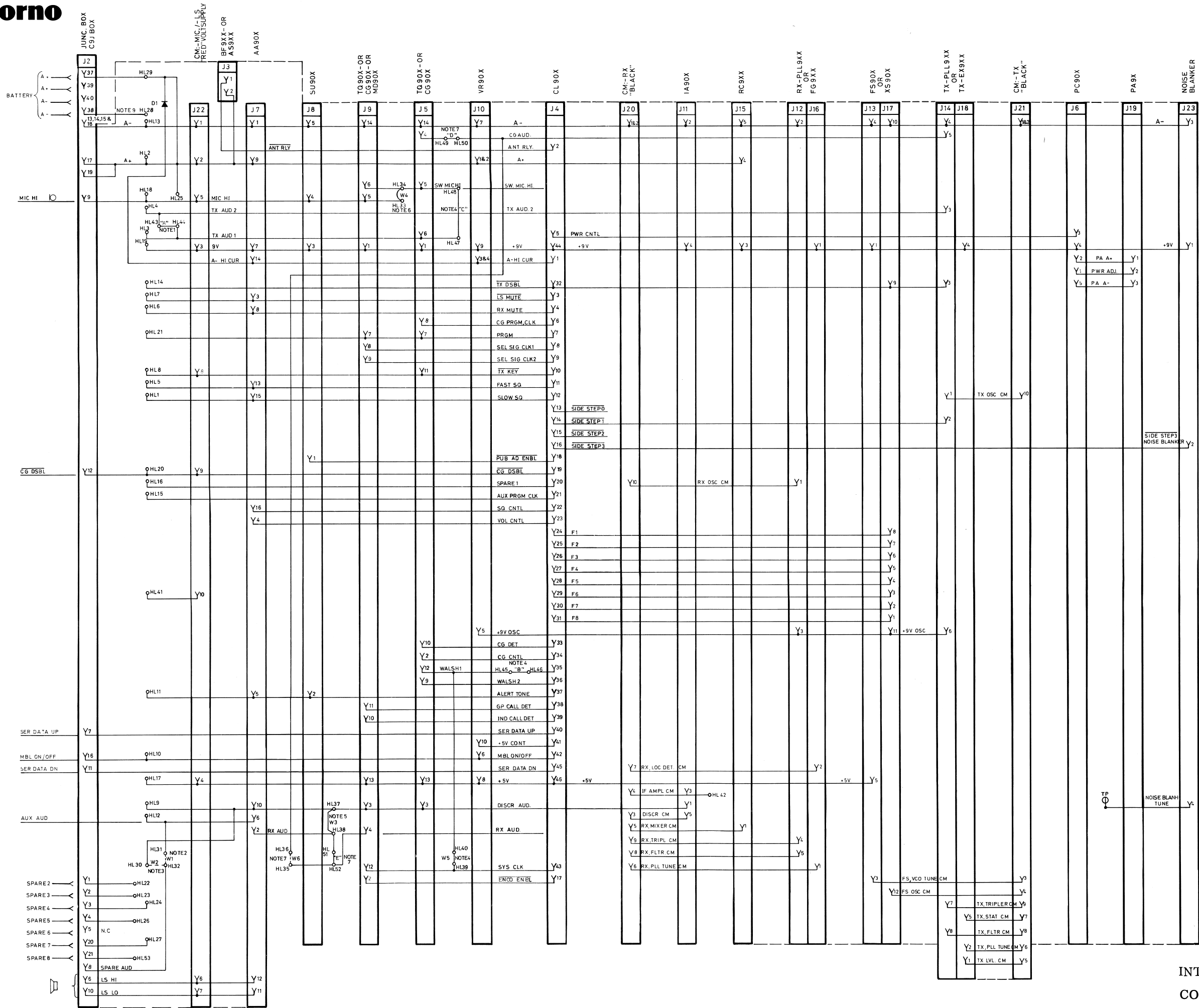
The front connector for the control cable is mounted on the board and protrude through the front plate.

The board has a number of holes and straps for special options.

The connectors for RF modules have built-in feed-through capacitors in order to reduce any unintentional coupling and radiation.

Three central metering connectors are located on the board and are accessible from the radio's RF side.

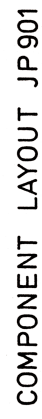


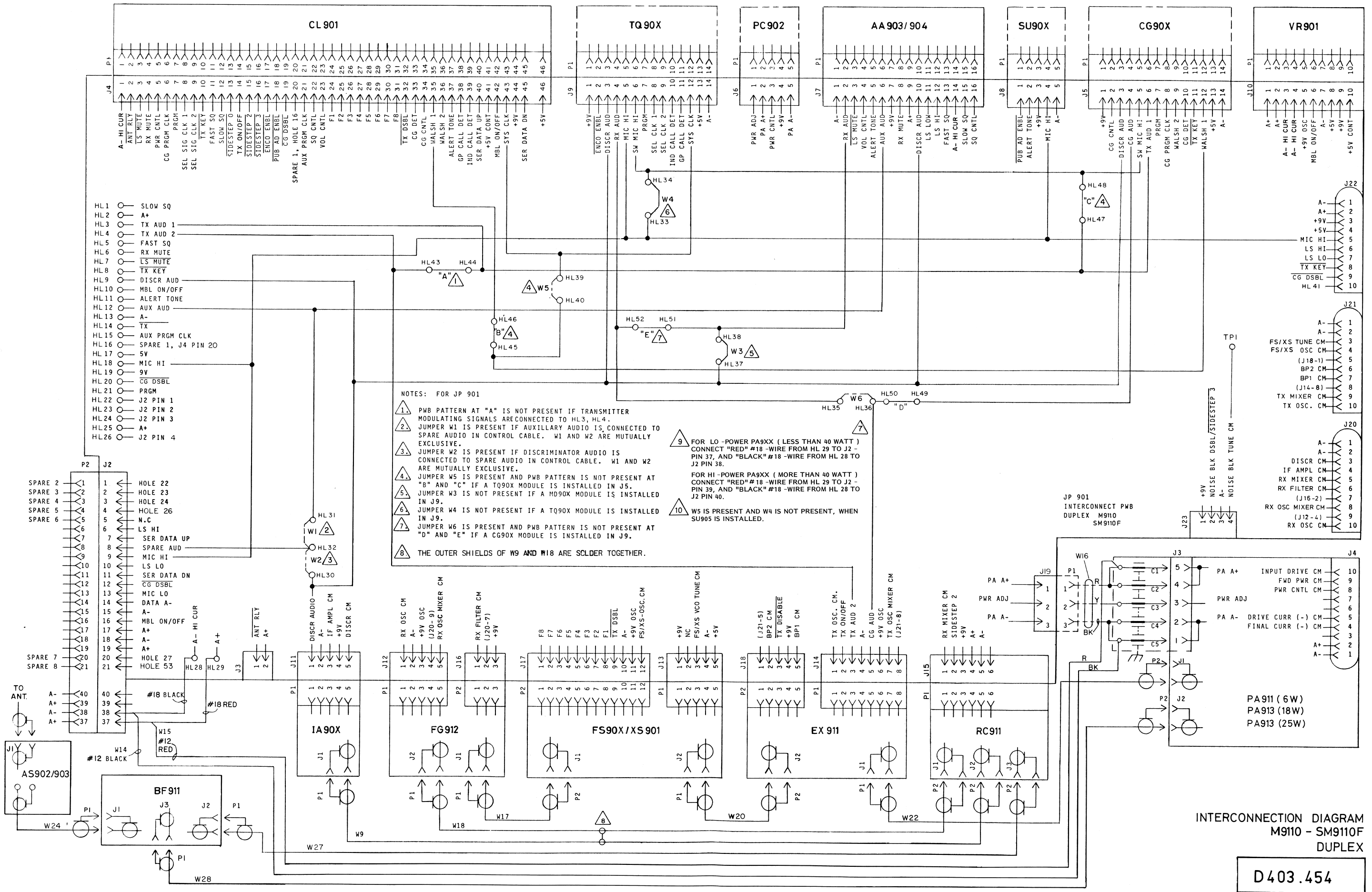


NOTES FOR JP901:

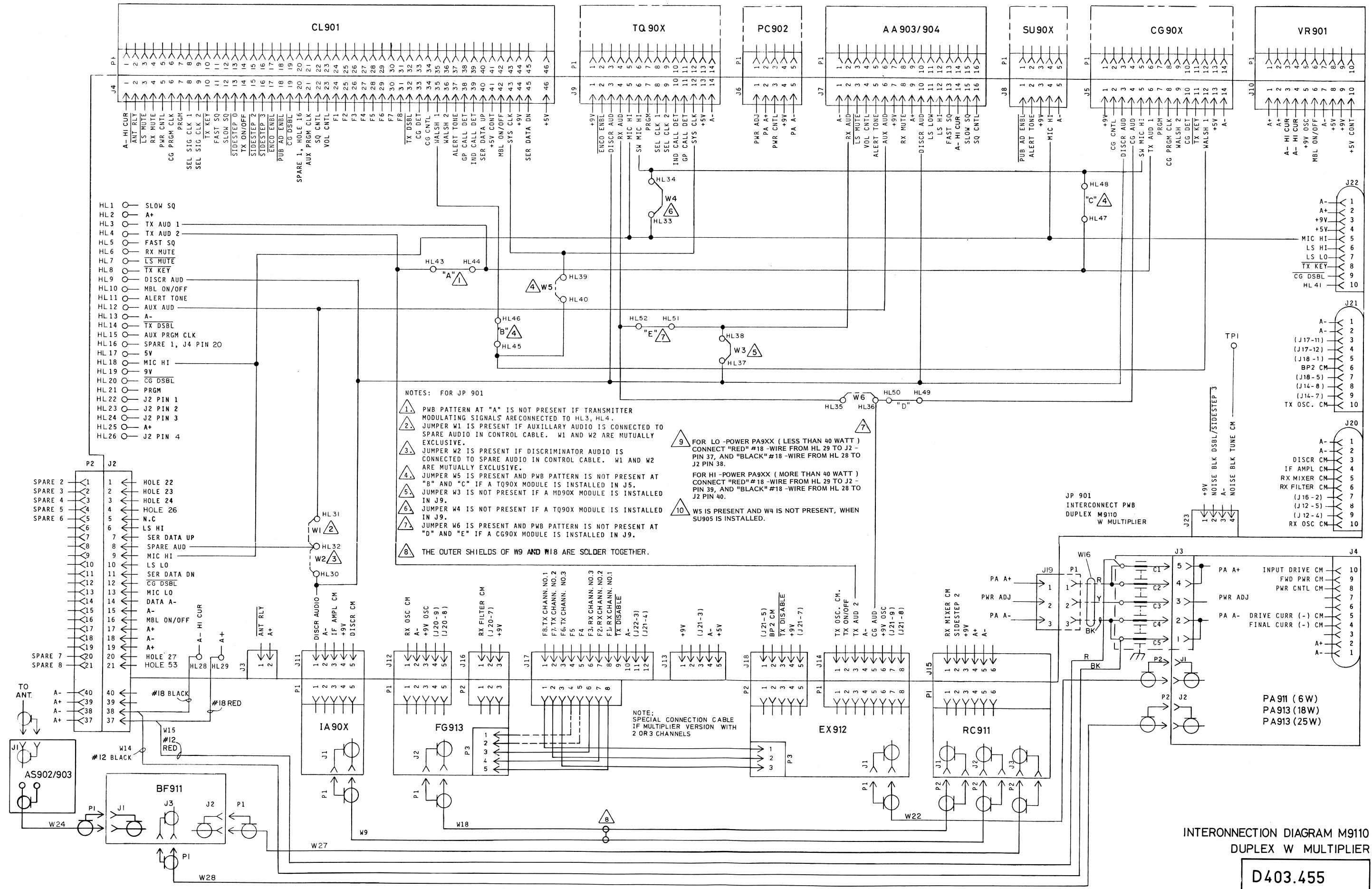
1. PWB PATTERN AT "A" IS NOT PRESENT IF TRANSMITTER MODULATING SIGNALS ARE CONNECTED TO HL3 AND HL4.
2. JUMPER W1 IS PRESENT IF AUXILIARY AUDIO IS CONNECTED TO SPARE AUDIO IN CONTROL CABLE. W1 AND W2 ARE MUTUALLY EXCLUSIVE.
3. JUMPER W2 IS PRESENT IF DISCRIMINATOR AUDIO IS CONNECTED TO SPARE AUDIO IN CONTROL CABLE. W1 AND W2 ARE MUTUALLY EXCLUSIVE.
4. JUMPER W5 IS PRESENT AND PWB PATTERN IS NOT PRESENT AT "D" AND "E" IF A TQ90X MODULE IS INSTALLED IN J9.
5. JUMPER W3 IS NOT PRESENT IF A MD90X MODULE IS INSTALLED IN J9.
6. JUMPER W4 IS NOT PRESENT IF A TQ90X MODULE IS INSTALLED IN J9.
7. JUMPER W6 IS PRESENT AND PWB PATTERN IS NOT PRESENT AT "D" AND "E" IF A CG90X MODULE IS INSTALLED IN J9.
8. THE OUTER SHIELD OF W9 AND W18 ARE SOLDERED TOGETHER.
9. FOR "LO" POWER PA9XX (LESS THAN 40 WATT), CONNECT RED 18 WIRE FROM HL29 TO J2 PIN 37 AND BLACK 18 WIRE FROM HL28 TO J2 PIN 38.  
FOR "HI" POWER PA9XX (GREATER THAN 40 WATT), CONNECT RED 18 WIRE FROM HL29 TO J2 PIN 39, AND CONNECT BLACK 18 WIRE FROM HL28 TO J2 PIN 40.
10. IN CASE OF MULTIPLIERS: (FG9XX + EX9XX ONLY), THE LOCATION FOR FS / XS: (J17 + J13) WILL BE EMPTY AND W17 AND W20 WILL NOT BE PRESENT:  
IN CASE OF 2 - CHANNEL MULTIPLIER VERSION A CABLE - KIT WILL CONNECT FG AND EX TO "F1": (TERM.8) AND "F2": (TERM. 7) ON J17.

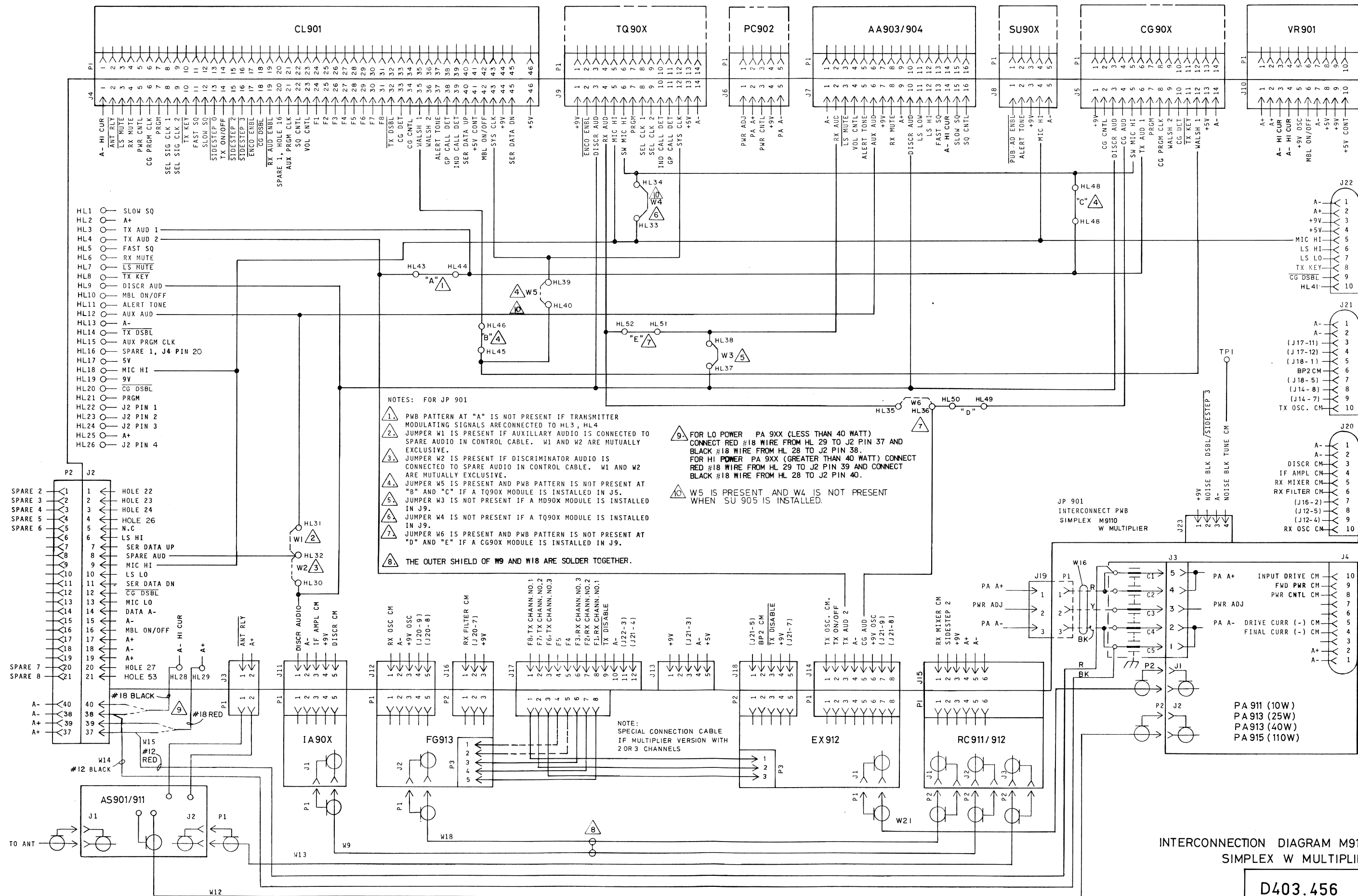
M9XXX SYNTHESIZER DUPLEX  
M9XXX 1 TO 8 CHANN. DUPLEX  
M9XXX 1 OR 2 CHANN.  
MULTIPLIER DUPLEX/SIMPLEX











INTERCONNECTION DIAGRAM M9110  
SIMPLEX W MULTIPLIER

## **JP901**

### **INTERCONNECT BOARD**

The interconnect board provides all connections between the modules except for RF signals.

The board is used in simplex stations and are universal for all configurations of modules.

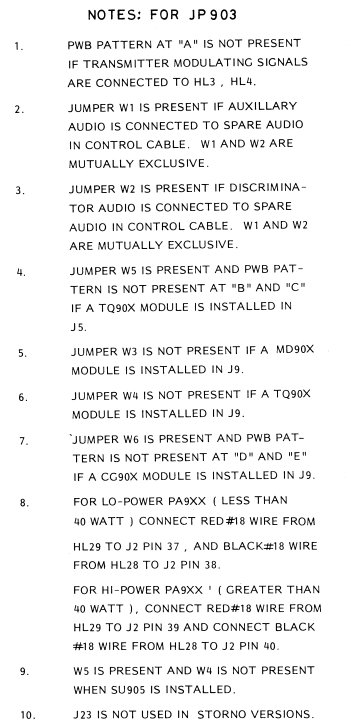
The modules plug onto connectors and guide pins ensure proper insertion.

The front connector for the control cable is mounted on the board and protrude through the front plate.

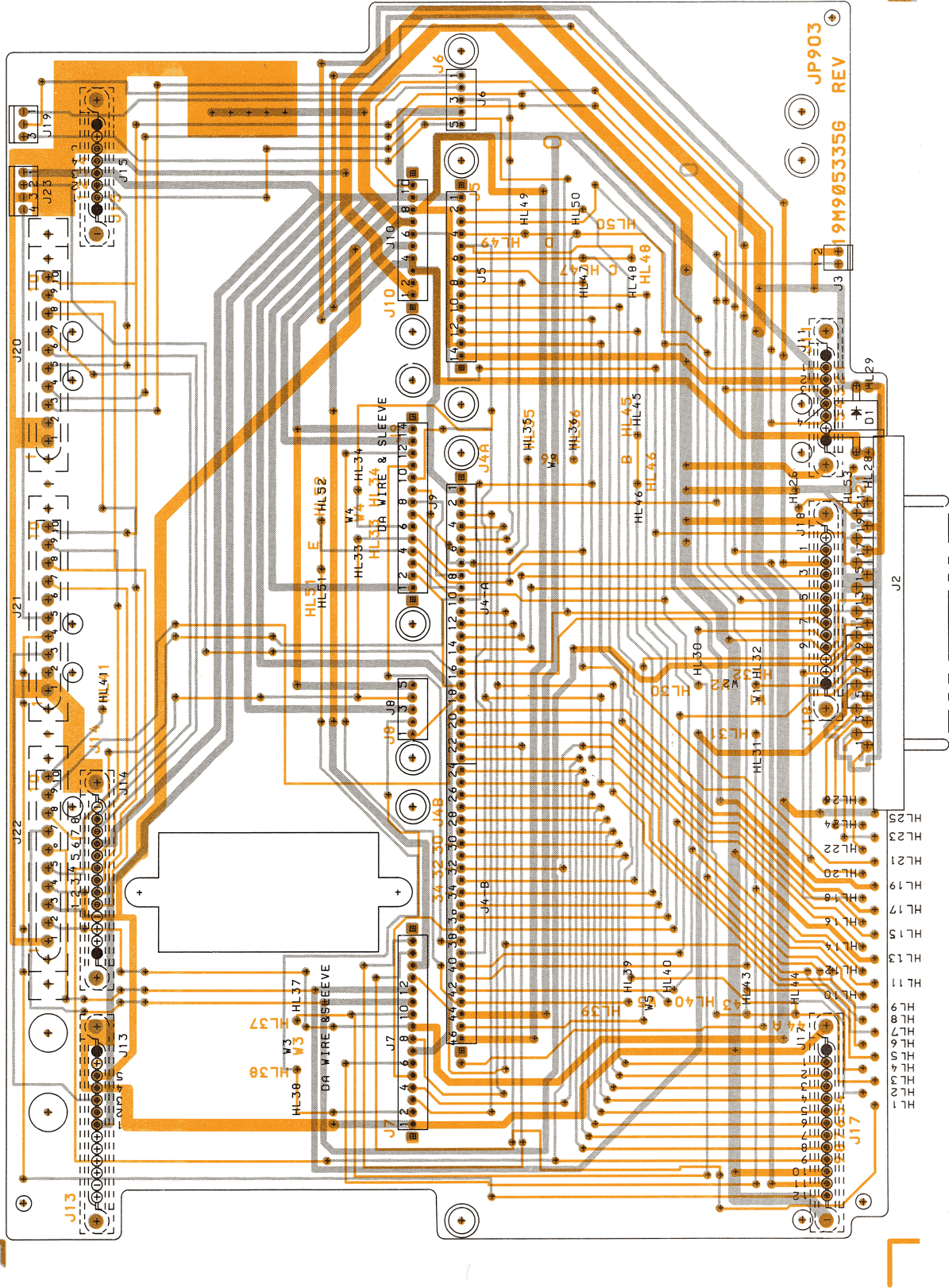
The board has a number of holes and straps for special options.

The connectors for RF modules have built-in feed-through capacitors in order to reduce any unintentional coupling and radiation.

Three central metering connectors are located on the board and are accessible from the radio's RF side.



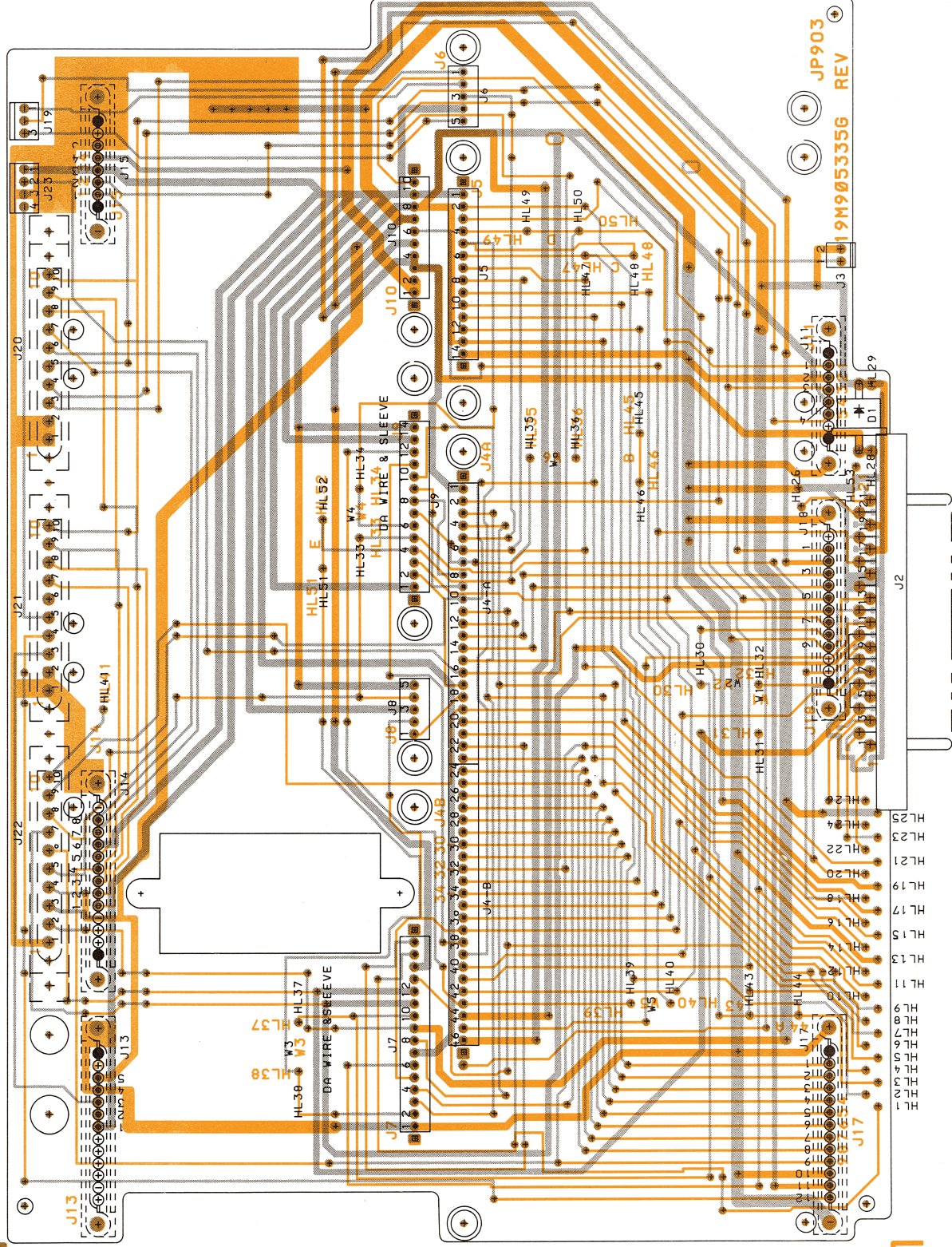




INTERCONNECTION BOARD JP903  
CODE D900080G1

D403.316





INTERCONNECTION BOARD JP903  
CODE D900080G1

D403.316

## PA911

### POWER AMPLIFIER

#### Functional Description

PA911 is a broadband power amplifier for use in the 160 MHz band. This module contains two RF amplifier stages, a directional coupler, a low-pass filter, and a hybrid IC power control circuit. This module is intended for use in both simplex and duplex radios. PA911 covers 138 - 174 MHz.

#### Circuit Description

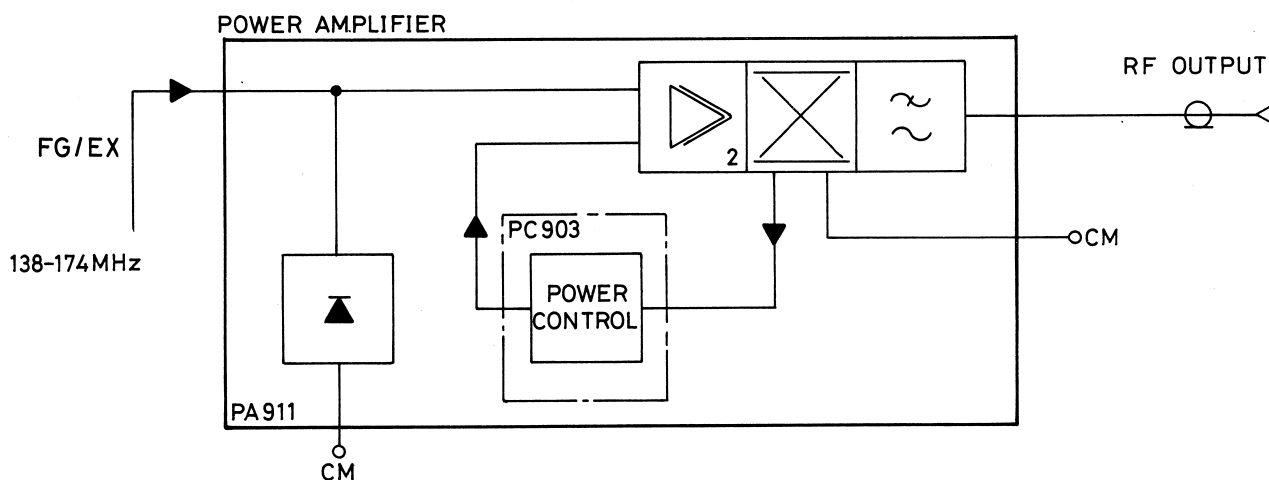
A signal of at least 250 mW and on the desired carrier frequency is applied to the input connector of the PA. Wideband matching networks (no tuning) are used to convert the 50-ohm input impedance down to the input impedance of the first transistor and deliver the input signal to the base of the first amplifier where it is increased in level. The first amplifier uses a TO39 cased transistor with the silicon chip electrically isolated from the case. The emitter is connected to this case which is grounded by soldering to the printed board pattern.

The output signal from the first amplifier is impedance-matched to the input of the second stage with wideband networks. The second amplifier again increases the level of the RF signal to the desired amplitude and wideband networks match the output impedance of the second transistor to 50 ohms. The second transistor is a 4-lead flange device.

A 50 ohm microstrip line conducts the RF signal through a Directional Coupler to the low-pass filter where the harmonic energy is removed from the RF signal.

The desired RF level is then passed to the output "Phono" connector along a 50 ohm microstrip line.

The Directional Coupler samples the forward power level and rectifies the RF producing a DC voltage proportional to the forward signal. This DC voltage is applied to the Power Control Hybrid IC. A power set control sends a desired output power



level command to the Power Control IC which in turn regulates the DC voltage to the first RF-amplifier to maintain the desired output power level.

Because the Power Control IC consumes some current in the "TX Unkeyed" condition, a switch circuit is included to reduce the current drain during idle periods. Drive power to the first stage of the PA is sampled and detected by a diode circuit. When drive is present, a DC voltage then turns on the voltage regulator included in the monolithic IC chip. The turn-on is sequenced such that the feedback loop is brought up to power rather than coming on "full blast" and then regulating back.

A remote power reduction terminal is provided so the power can be reduced in a step function by the command system of the radio.

For ease of troubleshooting, a central metering jack is provided in the PA to meter input drive from the exciter, PA driver current, PA final amplifier current, control voltage, and voltage proportional to the forward power from the directional coupler.

DC power is brought into the PA through feed-through bypass capacitors mounted in the PA

shelf. These voltage leads are isolated from chassis ground causing the PA to float with respect to the DC levels of the vehicle. Some filtering is provided by a large electrolytic capacitor placed across the two connections.

The module is protected against accidental reverse voltage application by a large diode connected across the DC terminals. If the battery leads are connected to the wrong terminals, the diode conducts a large amount of current which then blows the fuse.

The PA is designed to operate over a DC battery voltage range of 11.0 to 16.6 volts. The output power is set to rated level at the EIA nominal voltage of approximately 13.8 volts and will remain almost constant for all higher voltages. However, as the voltage is reduced below 13.8 the power will remain at rated level only as long as the control loop has excessive gain. At some voltage, the power output will start to decrease with decreasing voltage.

To prevent excessive spurious signals from being radiated the PA module is shielded by a metal cover. The printed board is held down to the heat sink by several screws. The shielding required between the active PA circuitry and the lowpass filter is done by a separate filter cover.

## TECHNICAL SPECIFICATIONS

### FOR LOW PASS-FILTER IN PA MODULE

#### Frequency range

135 - 185 MHz

#### Pass-Band insertion loss

0.4 dB: 138 - 174 MHz

#### Stop band attenuation

50 dB

#### Operating Temperature Range

-40°C to 85°C

### FOR PA MODULE

#### Power input

250 mW min. to 500 mW max.

#### Input VSWR

≤2.5:1 at rated power output

#### Frequency range

138 to 174 MHz

Supply voltage at PA terminals

13.6 V nominal for rated power output.

Operating voltage range 12.5 to 15.5 V

Power output

10 W

Current consumption

3.5 A max.

Nominal load impedance

50 ohms non-reactive

Stability

Stable into any load with up to 3:1 VSWR.

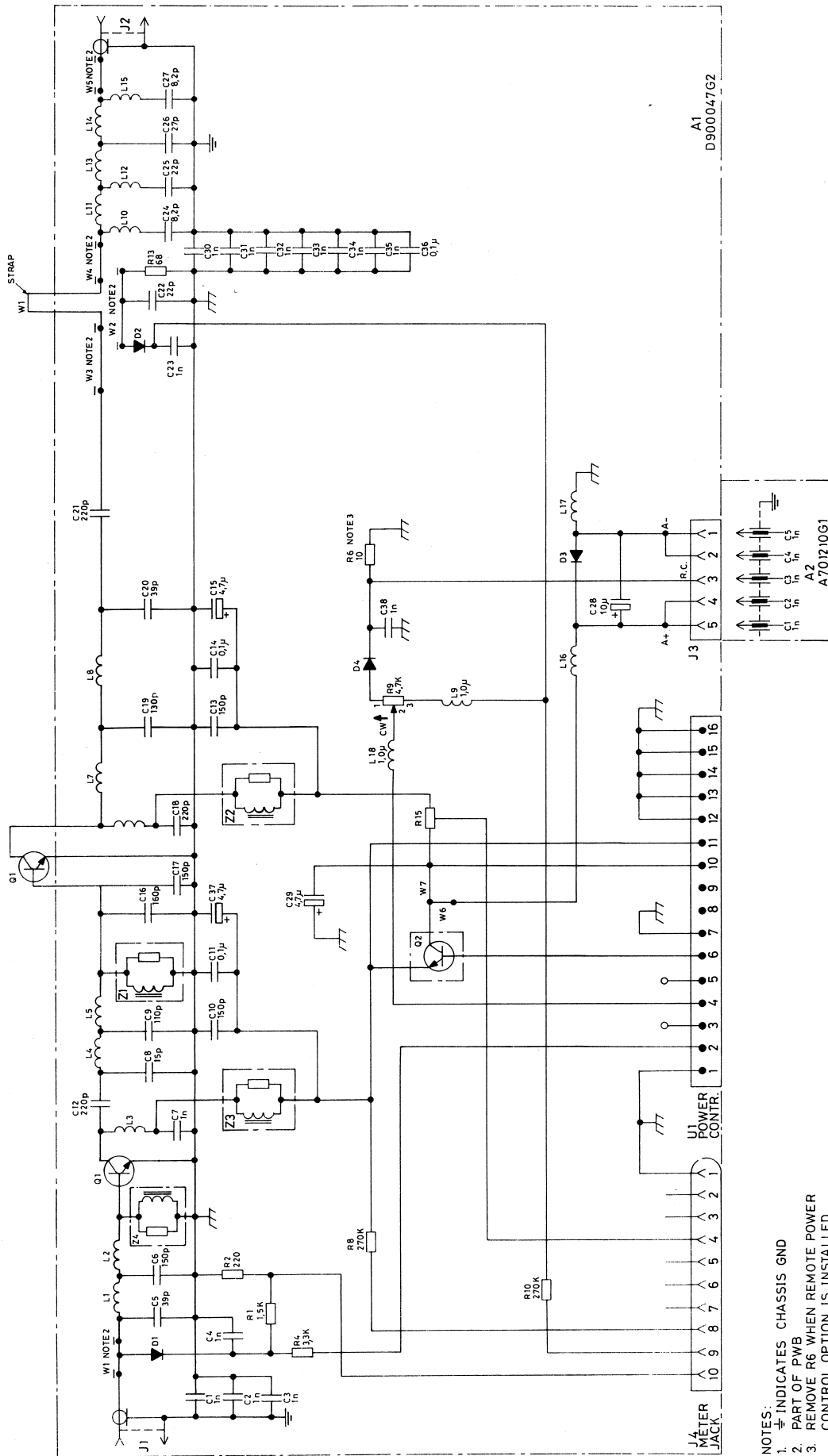
VSWR greater than 3:1 will not damage modules if operated at  $\leq$  rated power with supply voltage less than 15.5 V.

Current with no RF drive

12.0 mA max.

Temperature range

-40°C to 85°C



- NOTES:
1.  $\neq$  INDICATES CHASSIS GND
  2. PART OF PWB
  3. REMOVE R6 WHEN REMOTE POWER CONTROL OPTION IS INSTALLED

POWER AMPLIFIER PA911

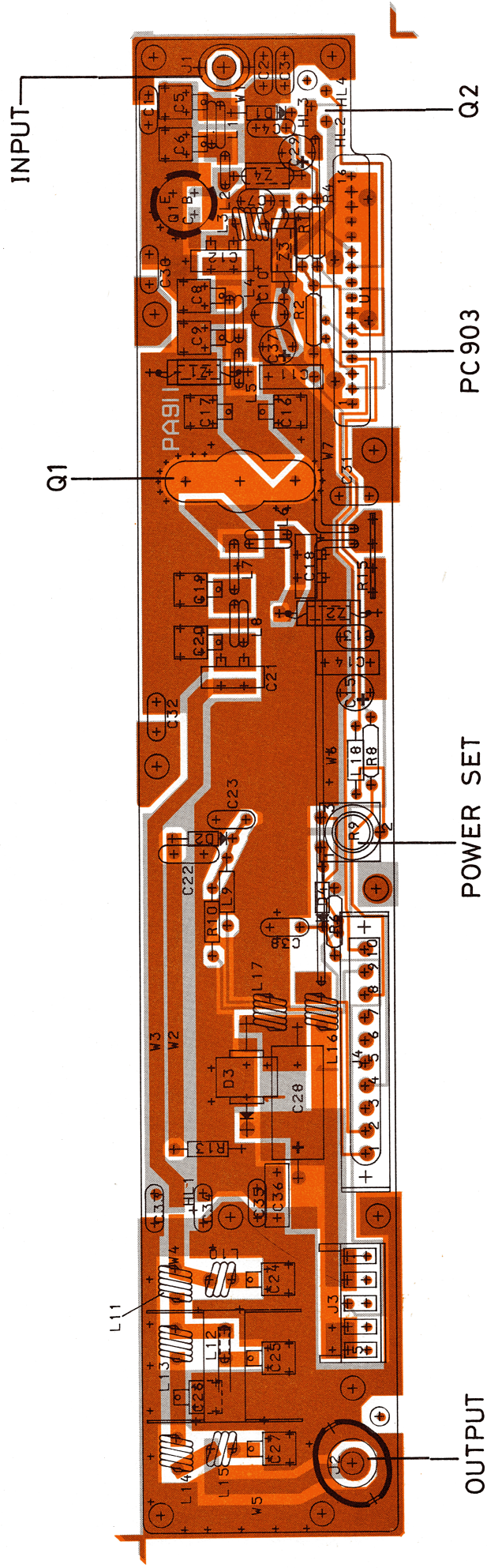
CODE NO. D900184G3

D403.115/2



**Storno**

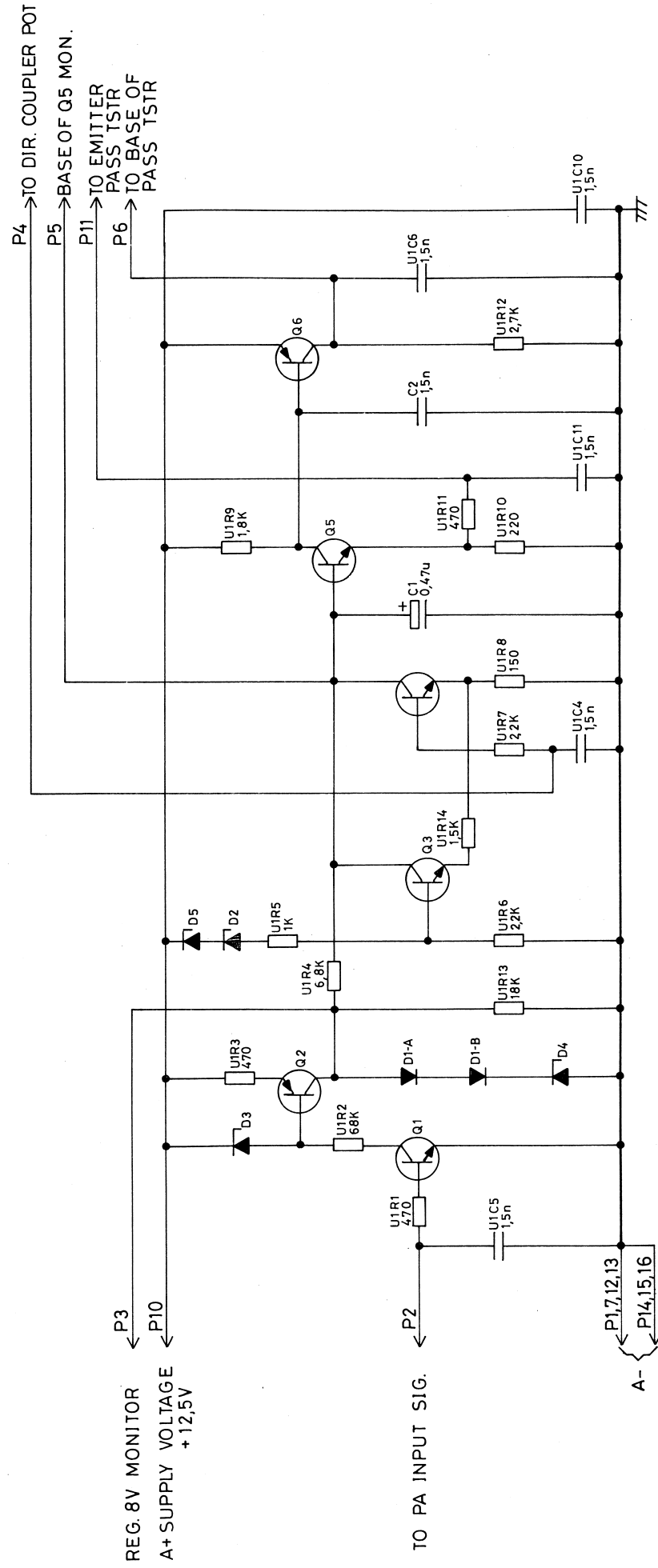
**Storno**



POWER AMPLIFIER PA911  
COMPONENT LAYOUT

CODE NO. D900184 G3

D403.438



## PA913

## POWER AMPLIFIER

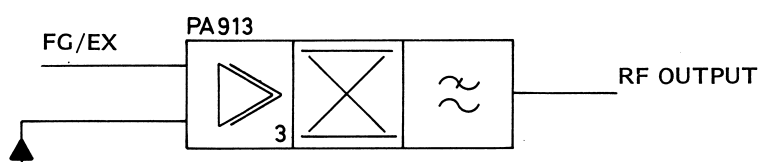
PA913 is a broadband power amplifier for use in the 160 MHz band. This module contains three RF amplifier stages, a directional coupler, a low-pass filter, and a hybrid IC power control circuit. This module is intended for use in both simplex and duplex radios. The PA covers 138 - 174 MHz.

This PA circuit operates like the PA911 except for the addition of one more RF amplifier stage.

The proper impedance matching is achieved with broadband networks which require no tuning.

The final PA stage is placed between the 10 watt amplifier and the directional coupler to raise the RF power level to at least 45 watts. This third stage uses a 6-leaded flange transistor.

All other circuit functions remain the same.



## TECHNICAL SPECIFICATIONS

Power input

250 mW to 500 mW

Input VSWR

$\leq 2.5:1$  at rated power output

Frequency range

138 - 174 MHz

Supply voltage at PA terminals

13.6 V nominal for rated power output.

Operating voltage range 12.5 to 15.5 V

Maximum PA current at rated Power output

(40 W): 9 A

(25 W): 6 A

Nominal load impedance

50 ohms non-reactive

Stability

Stable into any load with up to 3:1 VSWR.

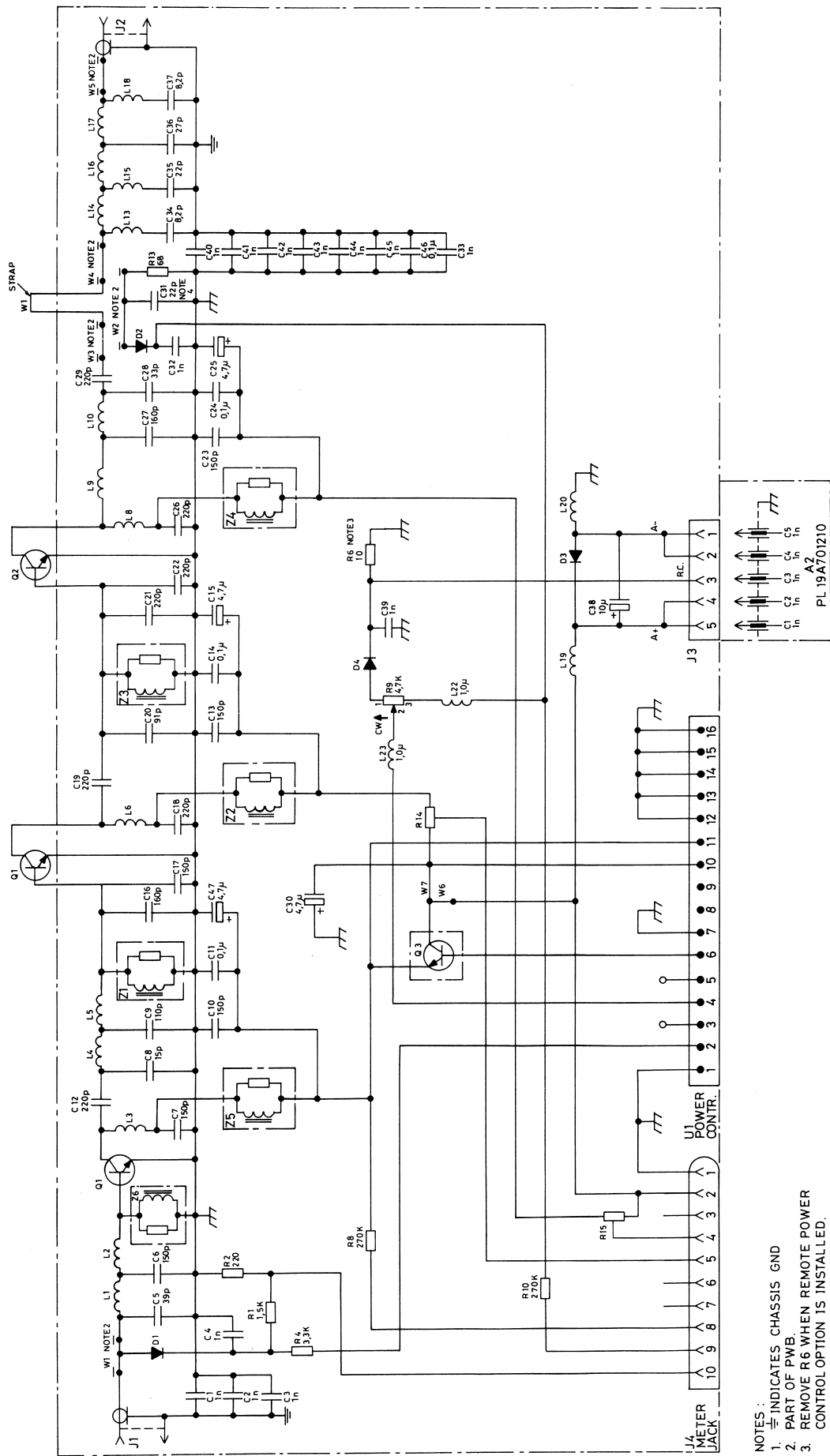
VSWR greater than 3:1 will not damage modules if operated at rated power with supply voltage less than 15.5 V.

Current with no RF drive

22.0 mA max.

Temperature range

$-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$



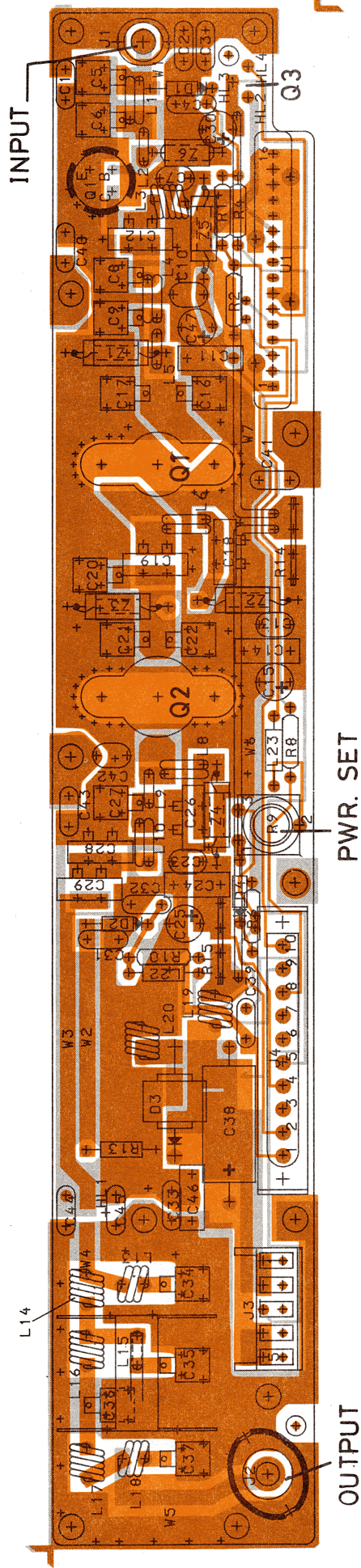
- NOTES :
1.  $\text{---}$  INDICATES CHASSIS GND
  2. PART OF PWB.
  3. REMOVE R6 WHEN REMOTE POWER CONTROL OPTION IS INSTALLED.
  4. C31 IS REMOVED WHEN EXTENDED LOWER RANGE POWER OPTION IS INCORPORATED

POWER AMPLIFIER PA913

D403.114

**Storno**

**Storno**



NOTE:  
AMPLIFIER BOARD CODE NO. D900010G2

POWER AMPLIFIER PA913  
COMPONENT LAYOUT  
CODE NO. D900184G4 D403.423



## PA915

## POWER AMPLIFIER

Functional Description

PA915 is a broadband power amplifier for use in the 160 MHz band. This module contains five RF amplifier stages, a directional coupler, a low-pass filter, and a hybrid IC power control circuit. This module is rated at 110 watts and covers 132 - 174 MHz.

Circuit Description

A signal of at least 320 mW and on the desired carrier frequency is applied to the input connector of the PA. Wideband matching networks (no tuning) are used to convert the 50-ohm input impedance down to the input impedance of the first transistor and deliver the input signal to the base of the first amplifier where it is increased in level. The first amplifier uses a TO39 cased transistor with the silicon chip electrically isolated from the case. The emitter is connected to this case which is grounded by soldering to the printed board pattern.

The output signal from the first amplifier is impedance-matched to the input of the second stage with wideband networks. The second amplifier again increases the level of the RF signal to the desired amplitude and wideband networks provide interstage matching into the third amplifier. The output of this stage is split and matched into the input of the final two-stage amplifier. The outputs of the two stages are combined and matched to 50 ohms.

A 50 ohm microstrip conducts the RF signal through a Directional Coupler to the low-pass filter where the harmonics are removed. The desired RF level is then passed to the output connector via the antenna relay and a 50 ohm microstrip line.

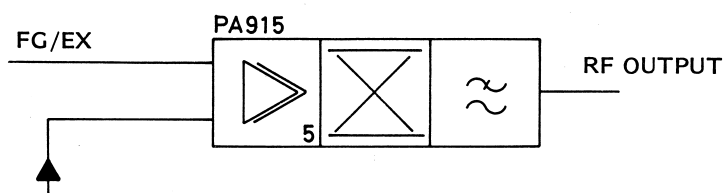
The Directional Coupler samples the forward power level and produces a DC voltage proportional to the forward signal. This voltage is applied to the power control circuit. The power control circuit regulates the DC voltage on the first RF-amplifier to maintain the desired output power level. The power control also protects against high battery voltage, high temperature, and an excess drive.

The PA is protected against accidental adjustment of the power set control to maximum by a "power limit" potentiometer.

A switch circuit is included to reduce the current drain during idle periods. Drive power to the first stage of the PA is sampled and detected by a diode circuit. When drive is present, this DC voltage then turns on the voltage regulator included in the power control.

The feedback loop brings the PA up to power rather than coming on at maximum power and then regulating back.

A central metering jack is provided in the PA to meter input drive from the exciter, driver



current, final amplifier current, control voltage, and voltage proportional to the forward power from the directional coupler.

DC power is brought into the PA through feed-through capacitors. The voltage leads are isolated from chassis ground causing the PA to float with respect to the DC levels of the vehicle. Some filtering is provided by a large electrolytic capacitor placed across the two connections.

Accidental reverse power application is prevented by the large diode connected across the DC ter-

minals. If the battery leads are connected to the wrong terminals, the diode conducts a large amount of current which then blows the fuse.

The PA is designed to operate over a DC battery voltage range of 10.7 to 16.1 volts. The output power is set to rated level at the EIA nominal voltage of approximately 13.4 volts and will remain almost constant for all higher voltages. However, as the voltage is reduced below 13.4 the power will remain at rated level only as long as the control loop has excess gain.

To prevent excessive radiated signal, the PA module is shielded by a metal cover.

## TECHNICAL SPECIFICATIONS

### Power input

320 mW min. to 500 mW max.

### Input VSWR

$\leq 2.5:1$  at rated power output

### Frequency range

132 to 174 MHz

### Supply voltage at PA terminals

13.4 V nominal for rated power output

### Nominal load impedance

50 ohms non-reactive

### Stability

Stable into any load with up to 3:1 VSWR.

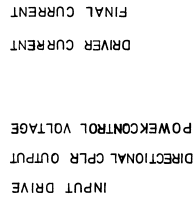
VSWR greater than 3:1 will not damage modules if operated at rated power with supply voltage less than 15.5 V.

### Current with no RF drive

42.0 mA max.

### Temperature range

-40°C to 70°C



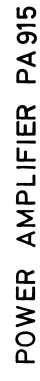
F HEATSINK  
F PWB  
E GRD

MODEL NO:	REV	LETTER
PL19D900518G1		
PL19D900518G3		
PL19D900278G1		
PL19D900278G2		

POWER AMPLIFIER PA915

SH. 1 of 2

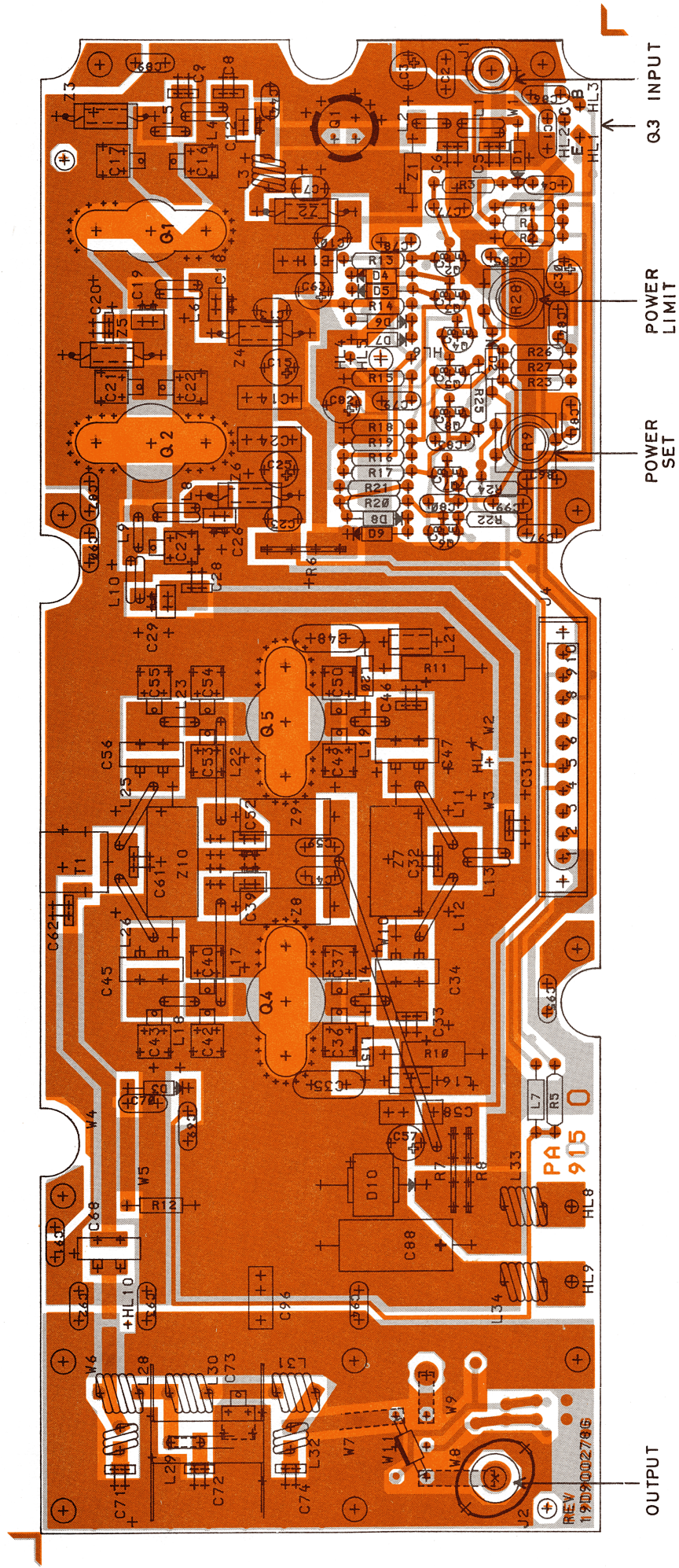
D403.439





**Storno**

**Storno**



POWER AMPLIFIER PA915  
COMPONENT LAYOUT

CODE NO. D900518G3 D403.440



## PS902

## POWER SUPPLY

PS902 is a power supply unit used in Storno-phone 900 mobile radio.

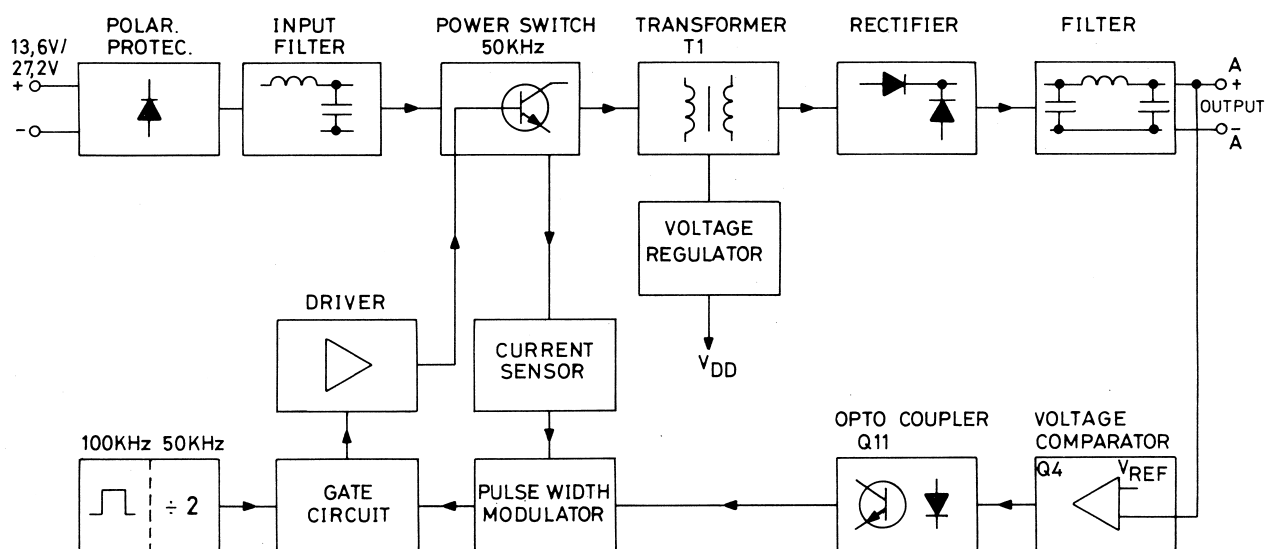
It is a switchmode power supply available in two versions which converts 24 V to 12 V at a maximum load of 8 A or 12 V to 12 V at maximum load of 3 A.

The PS902 interfaces the mobile radio to the car

battery where isolation is needed.

The power supply can stand a continuous short circuit of the output or overloading for a short period.

The power supply output can be connected to a 12 V battery without damaging the regulator circuit as long as the input is not connected at the same time.



## MODE OF OPERATION

The power supply module is a forward switch mode circuit with a switch frequency of 50 kHz. Refer to block diagram.

A diode placed across the input wires protects PS902 against reverse polarity. The filter avoids spikes on the supply wires and prevents noise generated in the circuitry from being conducted to the supply wires.

The input voltage is switched in a 50 kHz power converter and transformed to approximately 24 V. The 24 V a.c. is rectified and filtered in an LC-filter to obtain 13,6 V at the output.

A voltage comparator circuit senses the output voltage and sends information to a circuit that controls the duty cycle of the power switch. The obtained output voltage is constant, independent of input voltage and load variations.

A current sensor reduces the duty cycle of the power switch, if the maximum current in the switch transistor is exceeded. Thus the power supply is protected against overload and short circuit.

The power supply can be strapped to produce a voltage of 13.6 V on either 12 V or 24 V input voltage.

## CIRCUIT DESCRIPTION

### INPUT FILTER

The input filter consisting of C13, L1, C12 and C11 is damping spikes from supply lines and also prevents noise being conducted to the supply cables.

The diode D7 prevents PS902 from being damaged, when connected to reverse polarity.

### POWER CONVERTER AND TRANSFORMER

The power converter is a forward type consisting of two power switch transistors and a transformer.

When the power switch transistors Q9 and Q10 are on, the electrical energy is transformed by transformer T1, diode D5 is conducting and the transformed energy is stored in L2 and C14.

When Q9, Q10 are turned off the negative voltage swing across L2 forces diode D6 to conduct and L2 and C14 deliver energy to the output. The energy stored in the primary inductance of T1 during on time is dissipated in R27. Then a new cycle begins.

The supply voltage from the drive circuit is taken from T1 and is proportional to the input voltage. The driver, Q6 and Q7, is a switched current source.

Q8 clamps the bases of Q9 and Q10 when they are switched off to lower storage and fall times for Q9, Q10.

### REGULATION CIRCUIT

The regulation circuit consists of a timer, an oscillator, a divider, a pulsewidth modulator, a voltage feedback circuit and a current sense circuit.

When power is turned on, timer U1.C run out and ground the reset input (pin 4) of U2.A. The divider is then active. Gates U1.A, U1.B and U1.C form a multivibrator running at 100 kHz which frequency is divided by 2 in flip-flop U2.A to give a 50 kHz drive signal with 50% duty cycle.

The drive signal is gated with the signal from flip-flop U2.B which is controlled by the current sense circuit (R29, Q3) and the voltage feedback to give a pulsewidth modulated signal. This signal is used to drive switch transistors Q9-Q10 via U3, Q5-Q6, Q8-Q7.

The output voltage is compared to the reference voltage across D3 by Q4 whose output is feedback to the regulation circuit via optocoupler Q11. The current through the optocoupler is amplified by Q2 and gated with the current sense signal in Q3.

The output from Q3 controls the duty cycle of the switch transistors by the reset pin of U2.B.

## TECHNICAL SPECIFICATIONS

## INPUT VOLTAGE

Battery voltage27.3 V  $\pm$  5.8 V13.6 V  $\pm$  2.9 VMax. transients $\pm$  100 V, <0.5 msec.Ripple voltage

500 mVpp at nominal battery voltage

Ripple frequency

800 - 3000 Hz

## OUTPUT VOLTAGE

Nominal output

At 27.3 V input voltage with 0.5-8 A load,  
nominal output: 13.2-16.6 V

At 13.6 V input voltage with 0.5-3 A load,  
nominal output: 13.6 V  $\pm$  2.9 V

Ripple voltage $\leq$  100 mV RMS with 0.5-8 A loadRipple frequency

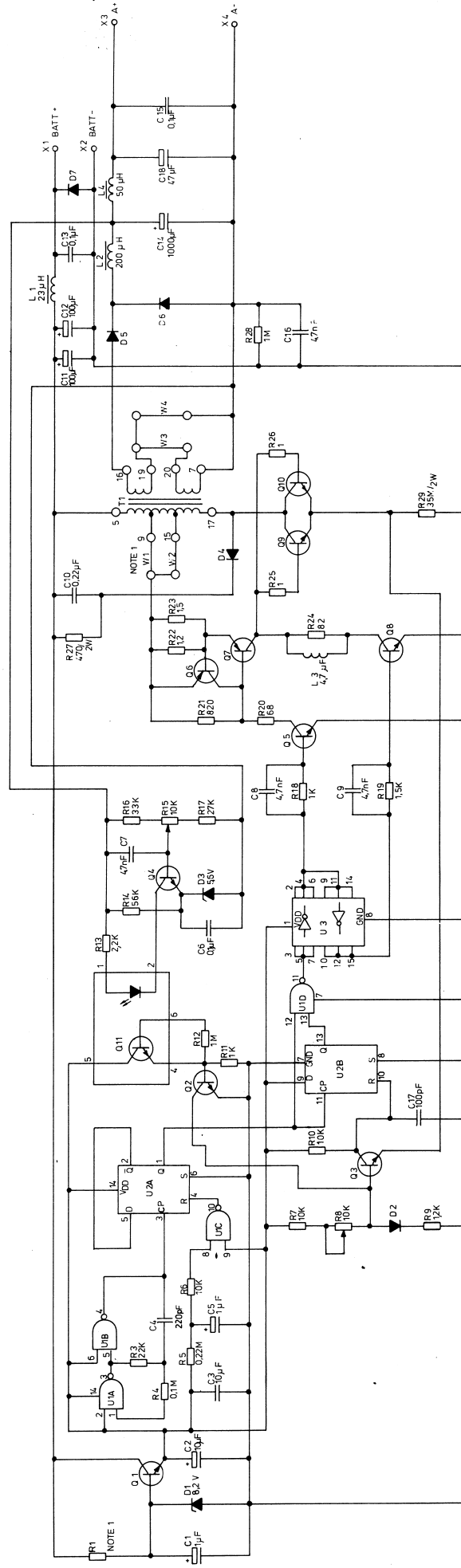
40 - 60 kHz

## CURRENT CONSUMPTION

- at input voltage 27.3 V with 50 mA load  
supply: <70 mA
- at input voltage 13.6 V with 50 mA load  
supply: <135 mA.

## TEMPERATURE RANGE

 $-40^{\circ}\text{C}/+60^{\circ}$



NOTE 1	
FOR 13.6V OPERATION INSERT	FOR 27.2V OPERATION INSERT
R1 = 1.8 K W1 W3	R1 = 12 K W 2 W 4

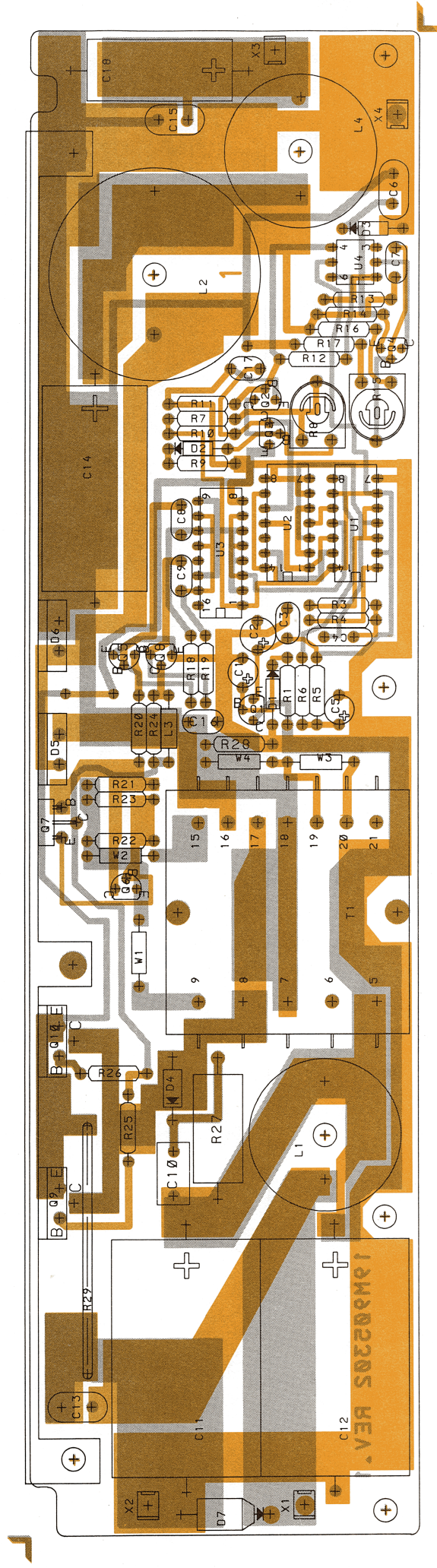
**POWER SUPPLY PS902**

MOUNTED BOARD CODE NO: {19M905301 G1 - 12V  
19M905301 G2 - 24V}

**D403.256**

**Storno**

**Storno**



MOUNTED BOARD CODE NO: 19M905301 G1 -12V  
19M905301 G2 -24V

POWER SUPPLY PS 902  
COMPONENT LAYOUT

D403.257



## RC911

## RECEIVER FRONT END

This receiver front-end is the High Intermodulation Attenuation module with narrow-band front-end. It can be tuned over the 138-174 MHz band.

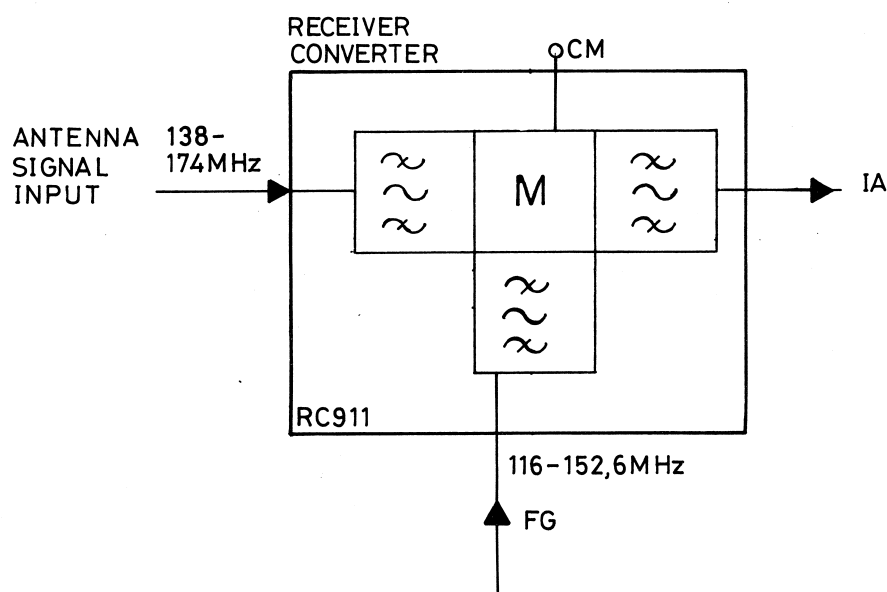
The output from the front-end is the 21.4 MHz IF signal.

This module is used when high intermodulation and blocking attenuation is needed, and in duplex applications.

The receiver front-end consists of a helical VHF bandpass filter with 5 resonators and a J-FET

mixer. Between the bandpass filter and the mixer is an LC-circuit for matching the filter to the mixer gate. The injection signal is fed to the FET mixer's source through a two circuit band-pass filter for suppressing spurious signals in the injection signal. The drain of the FET mixer is connected to an IF resonant circuit which adapts the output impedance to the crystal filter in the IA module.

The receiver circuitry has a central metering point for testing the injection signal level.



## TECHNICAL SPECIFICATIONS

Antenna impedance

50 ohm

Signal level

<2 V

Injection impedance

50 ohm

Output, IF impedance

1600 ohm  $\pm 10\%$

Supply voltage

13.6 V  $\pm 20\%$

Current consumption

<5 mA

Antenna frequency, (tunable)

138 - 174 MHz

Bandwidth, 1 dB

Room temp. &lt;3.0 MHz

Bandwidth, 3 dB

Room temp. &lt;5.0 MHz

Injection frequency, (tunable)

116 - 153 MHz

Bandwidth, 3 dB

&gt;3.5 MHz

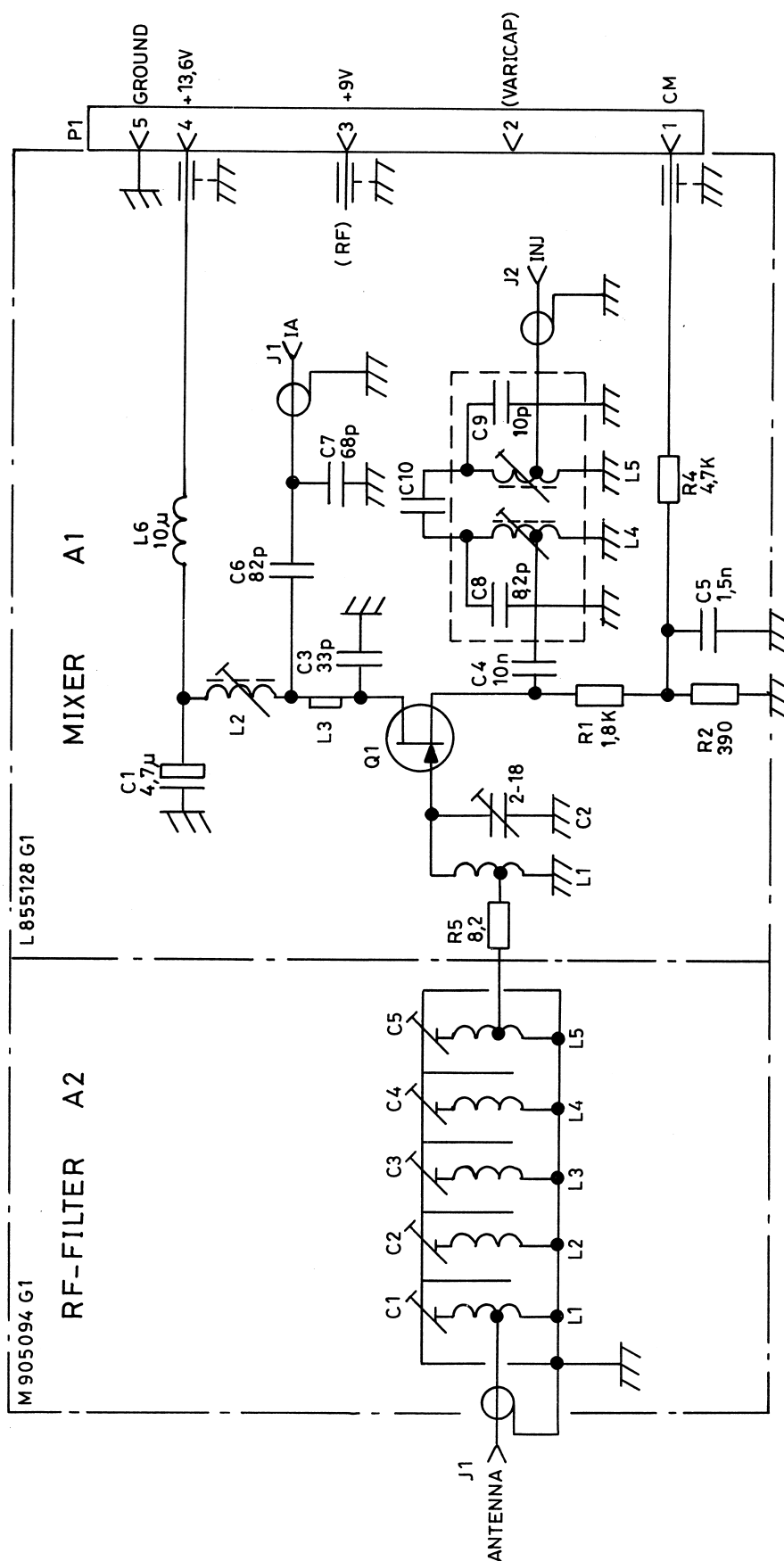
Bandwidth, 20 dB

40 MHz

Intermediate frequency

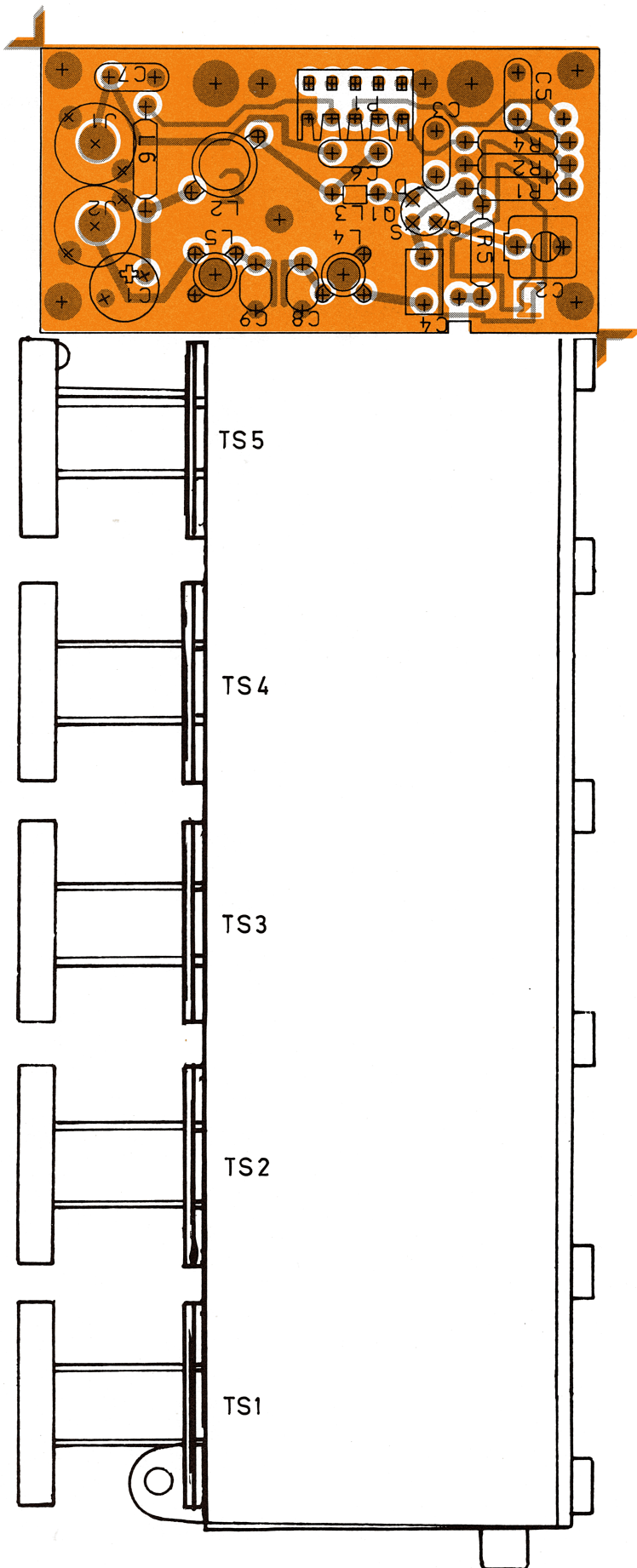
21.4 MHz

Sensitivity, 12 dB EIA 1/2 EMF $\leq 0.35 \text{ uV}$ Intermodulation, EIA $\geq 85 \text{ dB}$ Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$



RECEIVER CONVERTER RC911

CODE NO. M905093G1 REV. A D403.121/2



RECEIVER CONVERTER RC911  
COMPONENT LAYOUT

CODE NO. M905093G1 D402.962/3

## RC912

## RECEIVER FRONT END

This receiver front-end is the High Sensitivity module containing an RF-amplifier.

The RC912 is a broad-band front-end which can be tuned over the 138-174 MHz band.

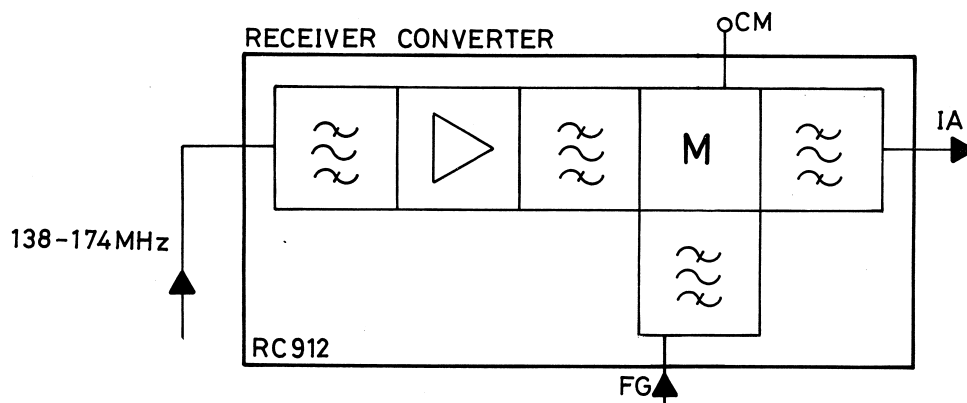
The output from the front-end is the 21.4 MHz IF signal.

This receiver front-end is used when high RF sensitivity is required, and for simplex only.

The module consists of a dual-resonator helical bandpass filter, an RF amplifier, a triple helical resonator bandpass filter, and a J-FET mixer.

The input bandpass filter is rather wide and has low insertion loss, approx. 1 dB. The RF amplifier is a bipolar transistor which is driven at a relative high current in order to obtain good intermodulation performance. The following bandpass filter is rather narrow for obtaining the necessary RF selectivity and its insertion loss is approx. 3 dB. For mixer description refer to RC911.

The receiver front-end is built on a printed wiring board on which the helical coils and the RF amplifier is mounted. The assembly is then screwed onto a casting which forms the rest of the receiver front-end.



## TECHNICAL SPECIFICATIONS

Antenna impedance

50 ohm

Injection impedance

50 ohm

Signal level

<2 V

Output, IF impedance

1600 ohm  $\pm 10\%$  Cp max. = 12 pF



Supply voltage9.0 V  $\pm$  5%Current consumption

&lt;20 mA

Antenna frequency

138 - 174 MHz

Bandwidth, 3 dB

4.5 MHz

Injection frequency

116 - 153 MHz

Bandwidth, 3 dB

3.5 MHz

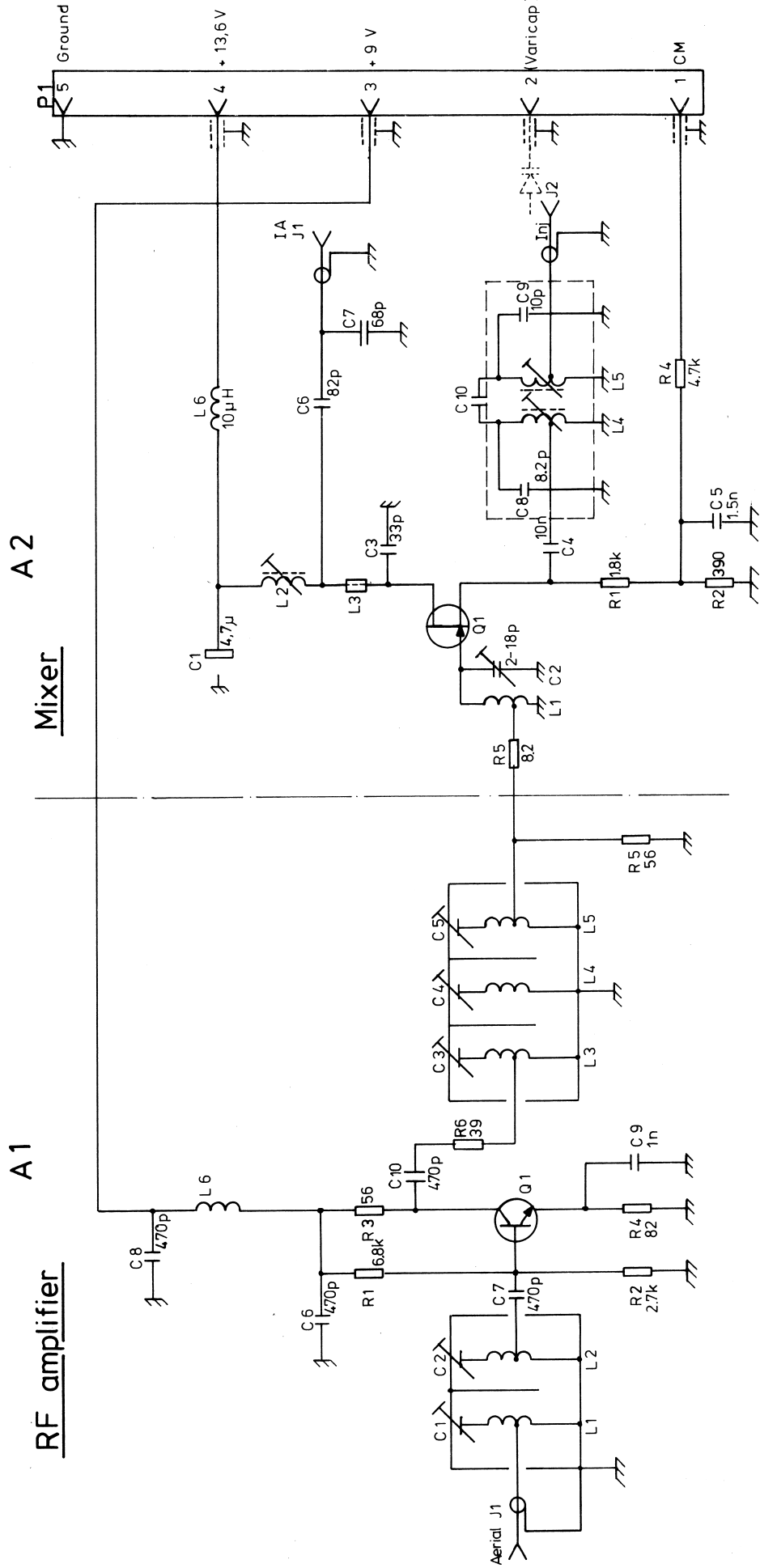
Intermediate frequency

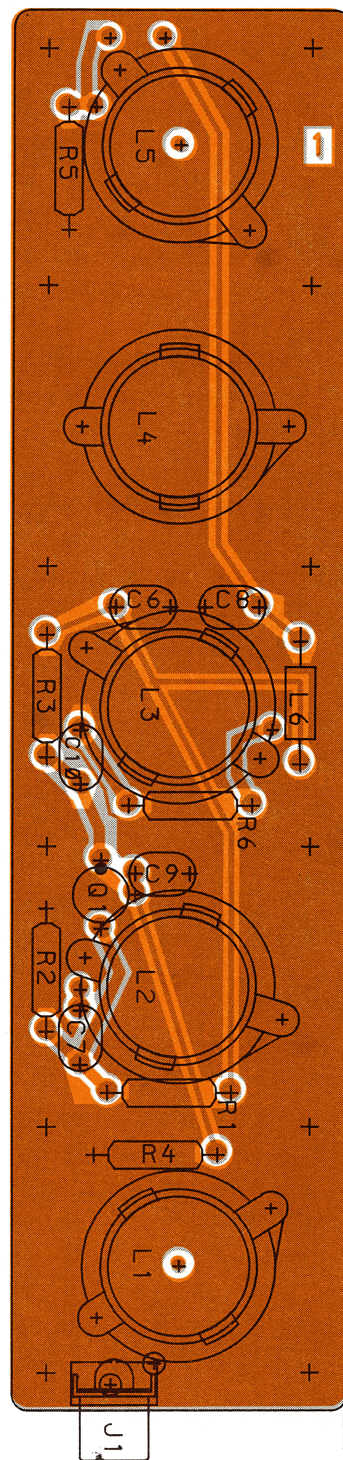
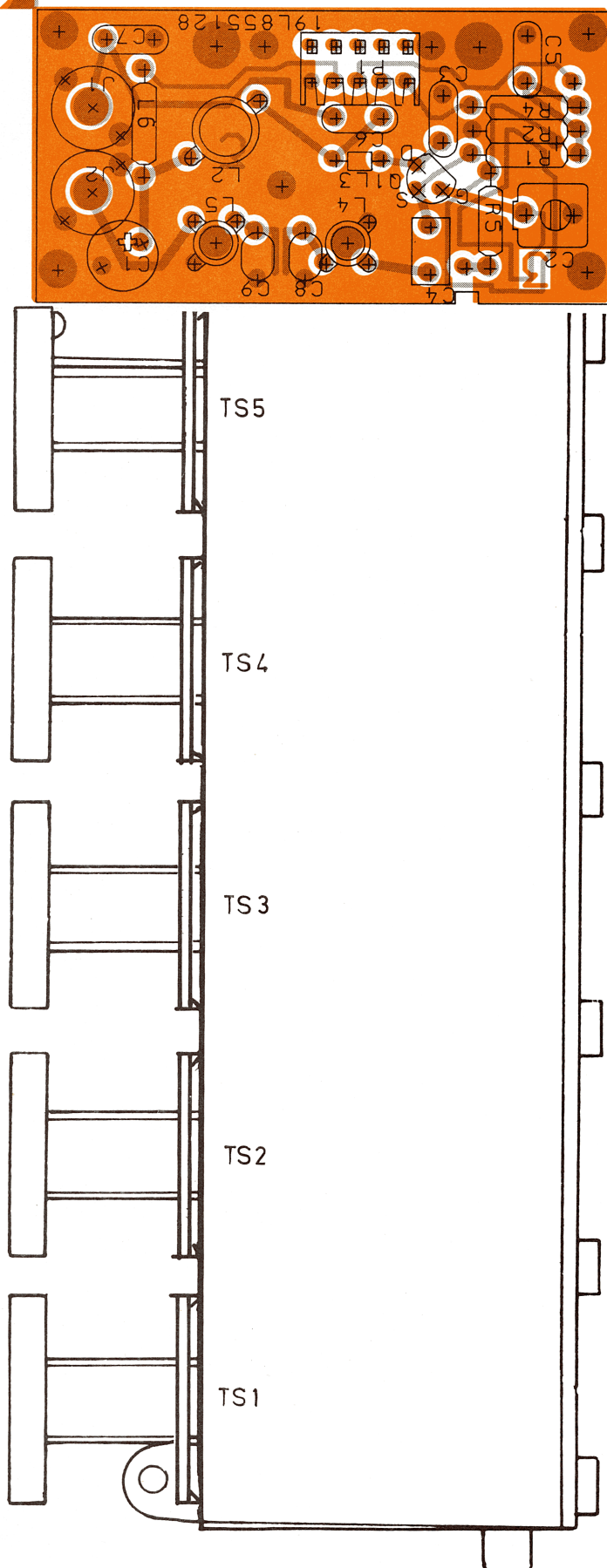
21.4 MHz

Sensitivity, 12 dB EIA 1/2 EMF $\leq 0.18$   $\mu$ VIntermodulation, EIA

&gt;80 dB

Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$





RECEIVER CONVERTER RC912  
COMPONENT LAYOUT

CODE NO. M905095G1 D403.441

## RC913

## RECEIVER FRONT END

Functional description

This receiver front-end is the varactor tuned version with narrow-band front-end. It can be tuned over the frequency band, 138-174 MHz and by changing the voltage (2-8 V).

The output from the front-end is the 21.4 MHz IF signal.

This module is used when a broad-band receiver (receiver side step) is needed.

Circuit description

The receiver front-end consists of a dual circuit LC varactor tuned bandpass filter, an RF amplifier, a triple circuit varactor tuned BP-filter and a J-FET mixer.

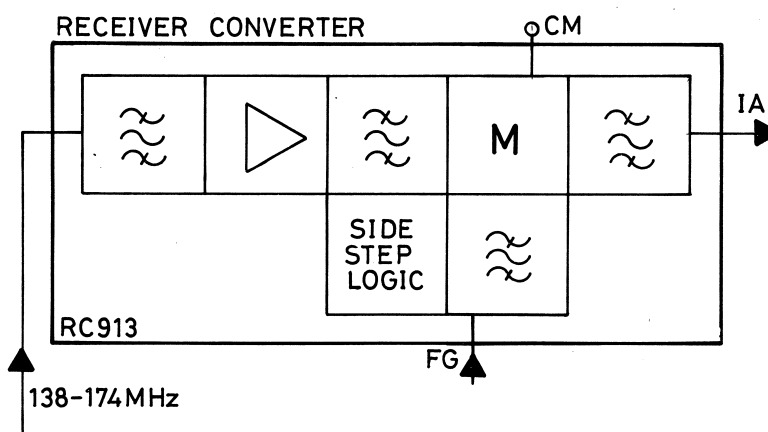
The BP-filter preceeding the RF amplifier is rather wide to provide a low insertion loss (2 dB). The RF amplifier is a bipolar transistor which is driven at a relative high current in order to obtain good intermodulation performance.

The following bandpass filter is rather narrow for obtaining the necessary RF selectivity and its insertion loss is approx. 7 dB.

For mixer description refer to RC911.

The varicap tuned filters can be stepped in the frequency ranges 138-166 MHz and 146-174 MHz.

The receiver front-end is built on a printed wiring board on which the LC circuits and the RF amplifier are mounted. The assembly is then screwed onto a casting which forms the rest of the receiver front-end.



## TECHNICAL SPECIFICATIONS

Antenna impedance

50 ohm

Injection impedance

50 ohm

Signal level

<2 V

Output, IF impedance

1600 ohm  $\pm 10\%$  Cp max. = 12 pF

Supply voltage9.0 V  $\pm$  5%Antenna frequency

138 - 174 MHz

Bandwidth, 3 dB

2.5 MHz

Injection frequency

116.6 - 152.6 MHz

Bandwidth, 3 dB

3 MHz

Intermediate frequency

21.4 MHz

Sensitivity, 12 dB EIA 1/2 EMF $\leq 0.35$   $\mu$ VIntermodulation, EIA

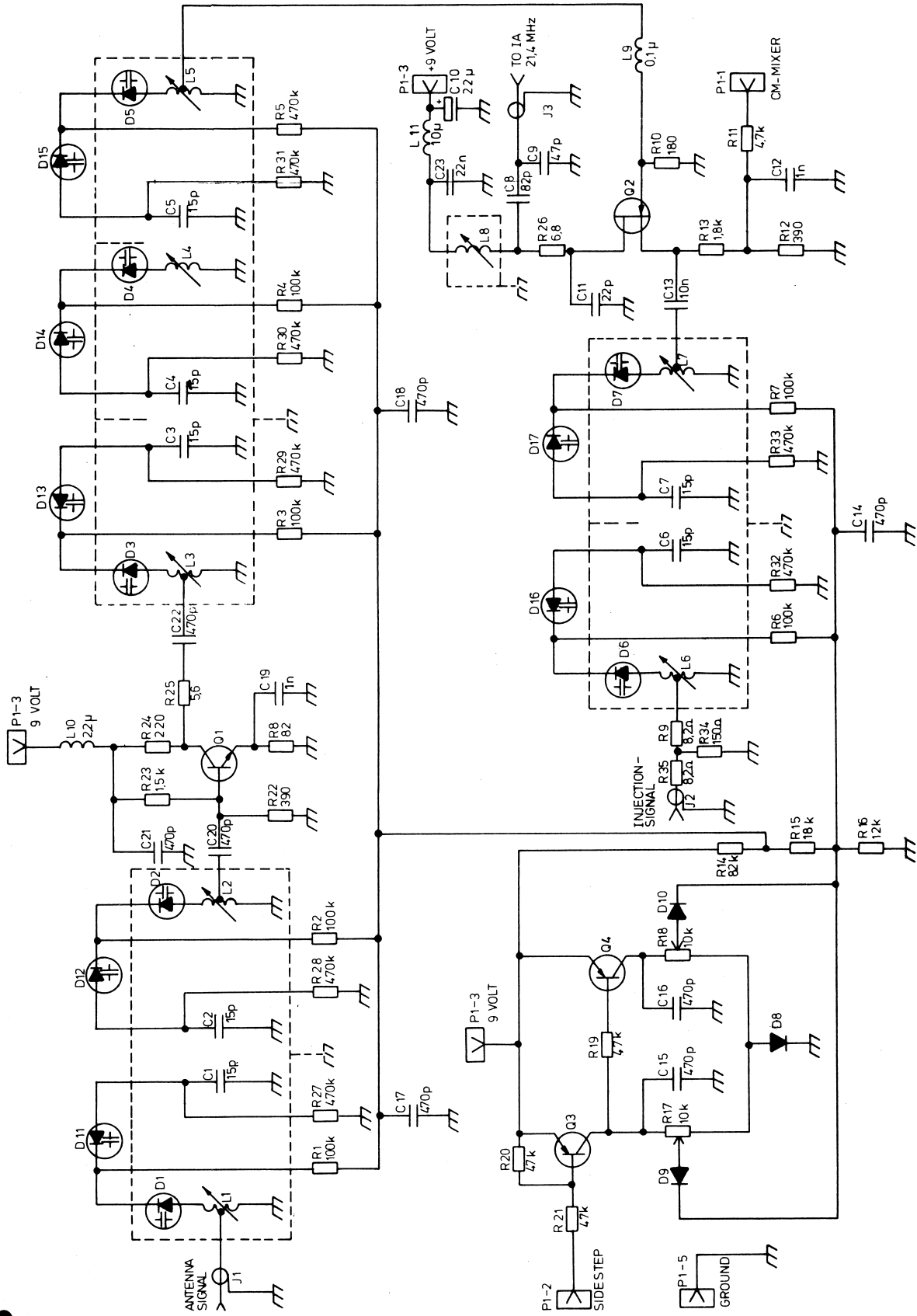
&gt;75 dB

Temperature range $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$



**Storno**

**Storno**

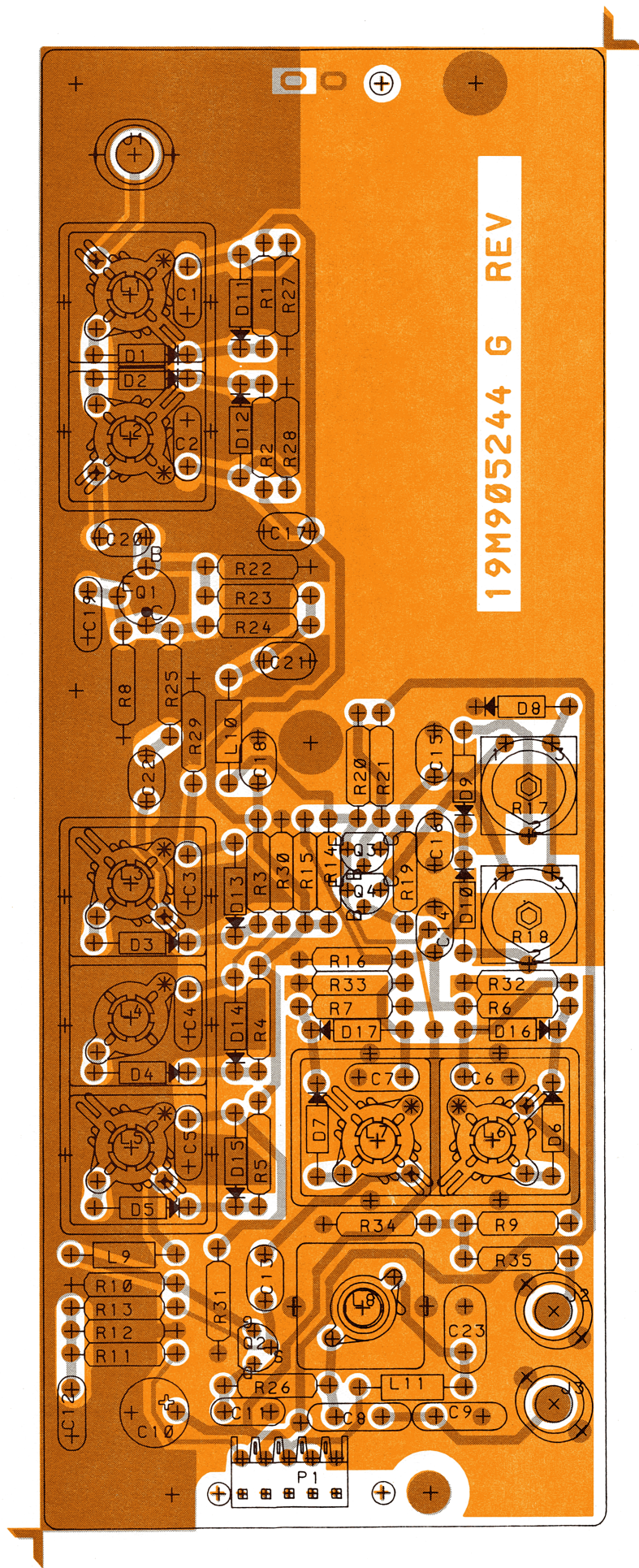


VARACTOR TUNED RECEIVER CONVERTER RC913

CODE NO.M905244G1 D403.189/2

**Storno**

**Storno**



VARACTOR TUNED RECEIVER CONVERTER RC913  
COMPONENT LAYOUT  
CODE NO. M905244G1 D403.239/2

## VR901

## VOLTAGE REGULATOR

The VR901 module is the central voltage regulator module for 900 mobile radios. It generates three voltages, a 9 volt high stability, a 5 volt medium stability, and a 5 volt continuous voltage. The two voltages from VR901 can be gated on and off by means of an external control voltage. Ground or floating will leave the two outputs off, while high voltage will turn on. The 5 volt continuous will be present whenever the radio has battery supply.

All three regulators are based on conventional series regulator principle. All outputs are able to stand overload for a shorter period of time, and continuous short circuit due to fold-back current limiting in each regulator. Two of the regulators are sharing their reference and have to be adjusted with a common potentiometer. The reference is formed by a standard IC regulator.

The 5 V continuous is a fixed voltage.

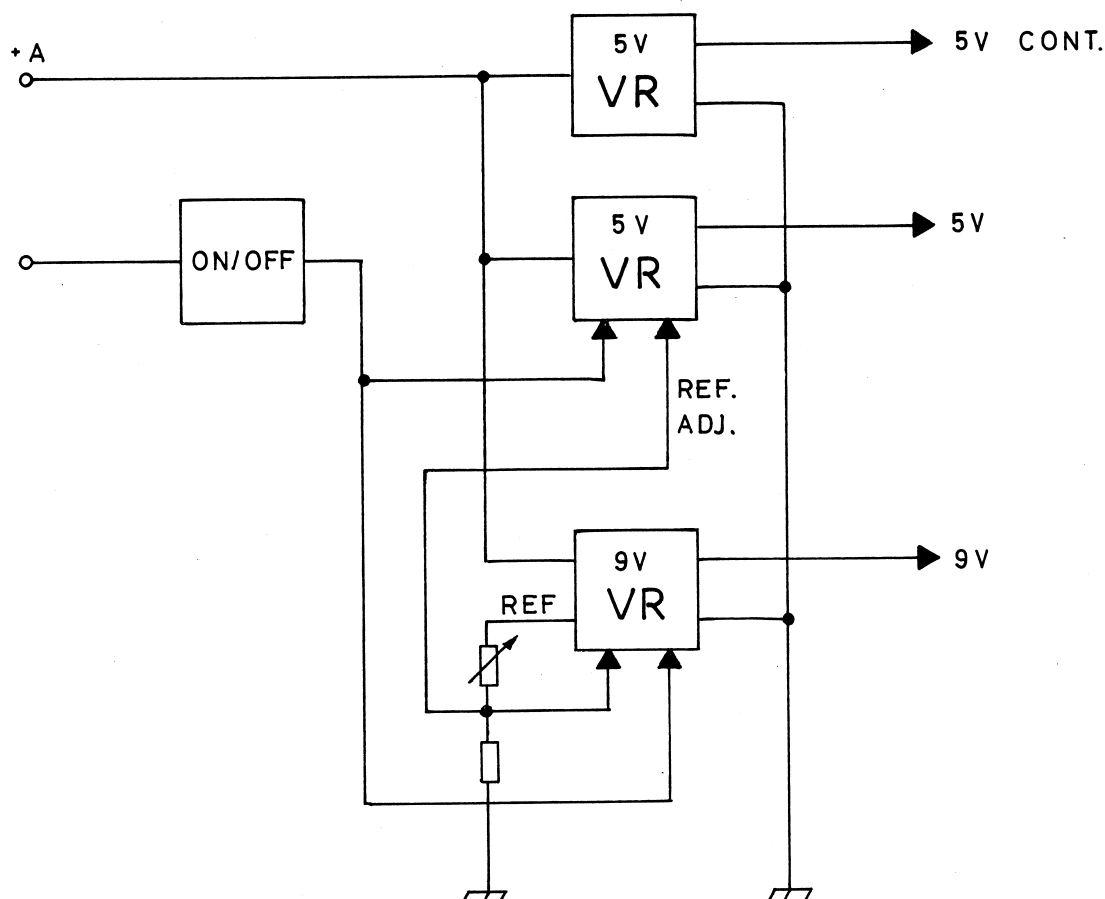
The series transistors of the 9 V and 5 V regulators need to be heat sunk to the siderails of the mobile package.

The on/off relations, and levels for the two gated regulators, are controlled by the ON/OFF circuit.

## 9 V REGULATOR

The 9 V regulator is built around a standard IC regulator (LM723). This IC regulator has a built-in reference, which is also used for the 5 V regulator. Current sensing is done by a resistor in the output. Fold back current limiting is made by two transistors.

On/off is made by removing base drive for the series pass transistor.



## 5 V REGULATOR

The 5 V regulation is done by a differential amplifier, an error amplifier, and a darlington as the series element. Current limiting is done by limiting base drive to the series pass transistor. Fold back characteristic is achieved by recuding reference when current limiting.

On/off is done by removing base drive for the series pass transistor.

5 V Continuous regulator

This regulator is made from a constant current source, a zener diode and an emitter follower. Current limiting is made by one transistor and a sensing resistor.

## TECHNICAL SPECIFICATIONS

Input voltage

13.6 V nominal

Output voltage

Stability 5 V:  $\pm 4\%$   
Temperature 5 V continuous:  $\pm 9\%$   
load input 9 V:  $\pm 0.5\%$

Short circuit ability

Continuous without damage

Overload protection

10 s without damage

Output current

5 V: 800 mA  
9 V: 1.2 A  
5 V continuous: 75 mA

Internal Current Drain

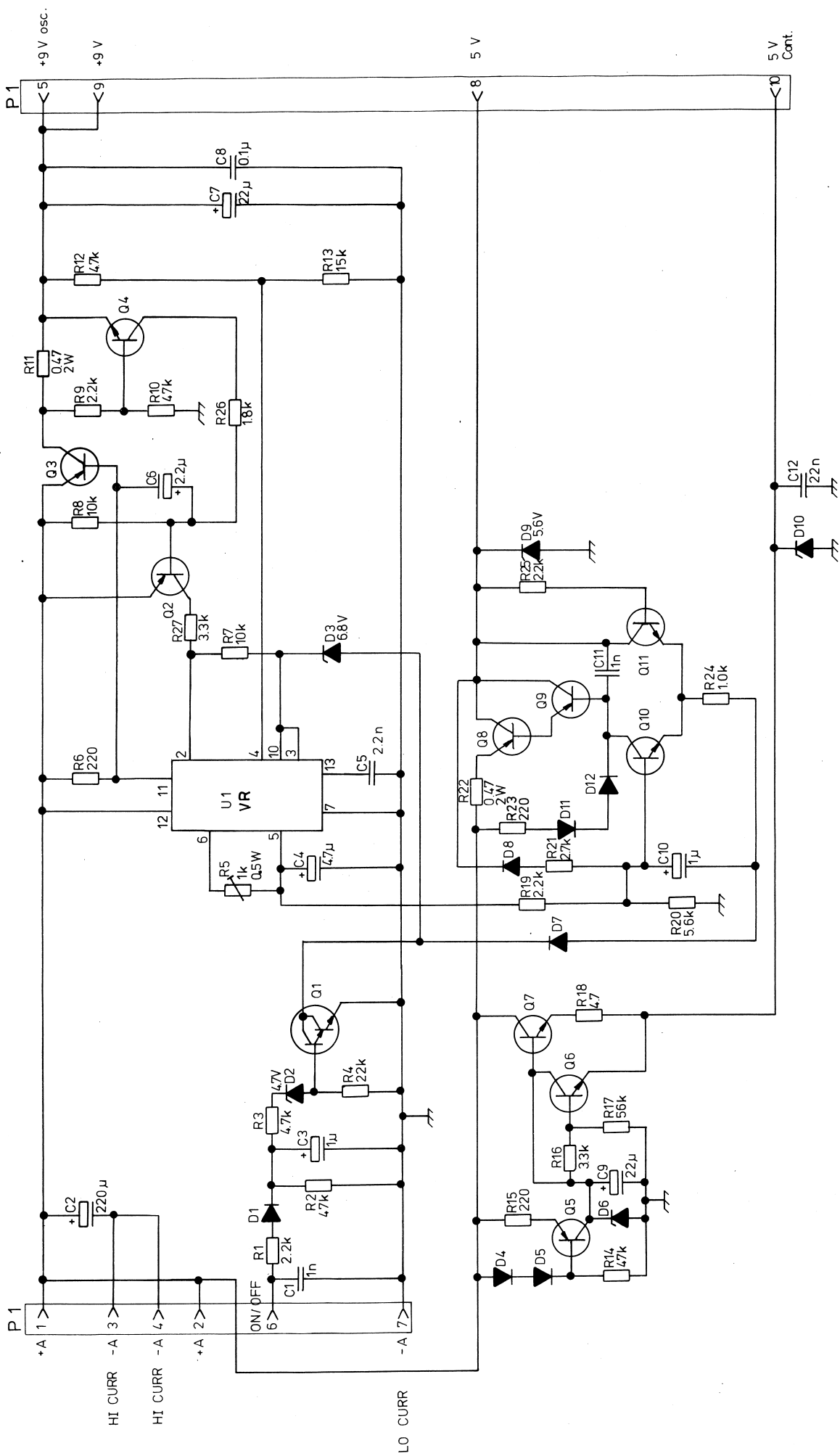
On:  $1 \leq 50$  mA  
Off:  $1 \leq 6$  mA

Temperature range

$-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$

**Storno**

**Storno**

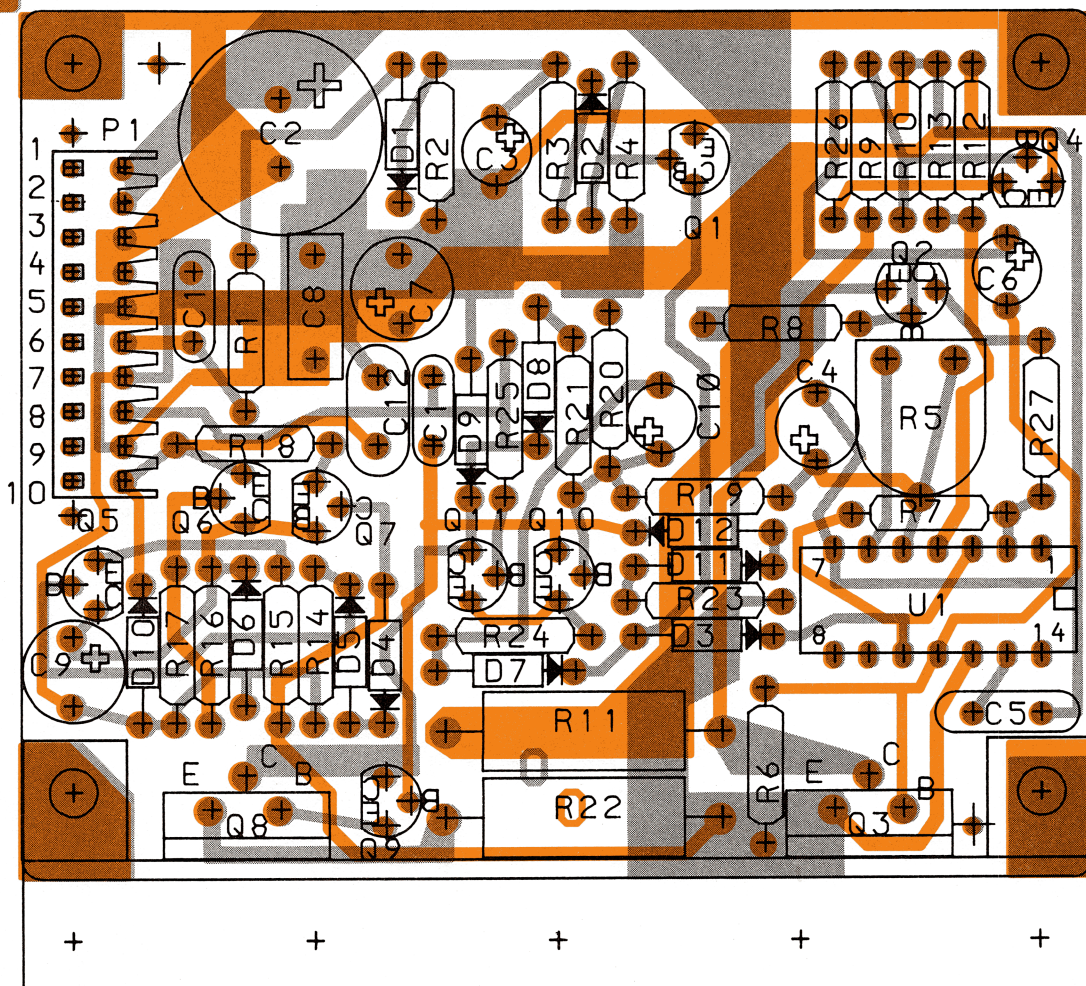


VOLTAGE REGULATOR +9V, +5V VR901

19L855013G2

D402.968/2





VOLTAGE REGULATOR + 9V, +5V VR901  
COMPONENT LAYOUT

19L855013 G2 D403.164

## VR902

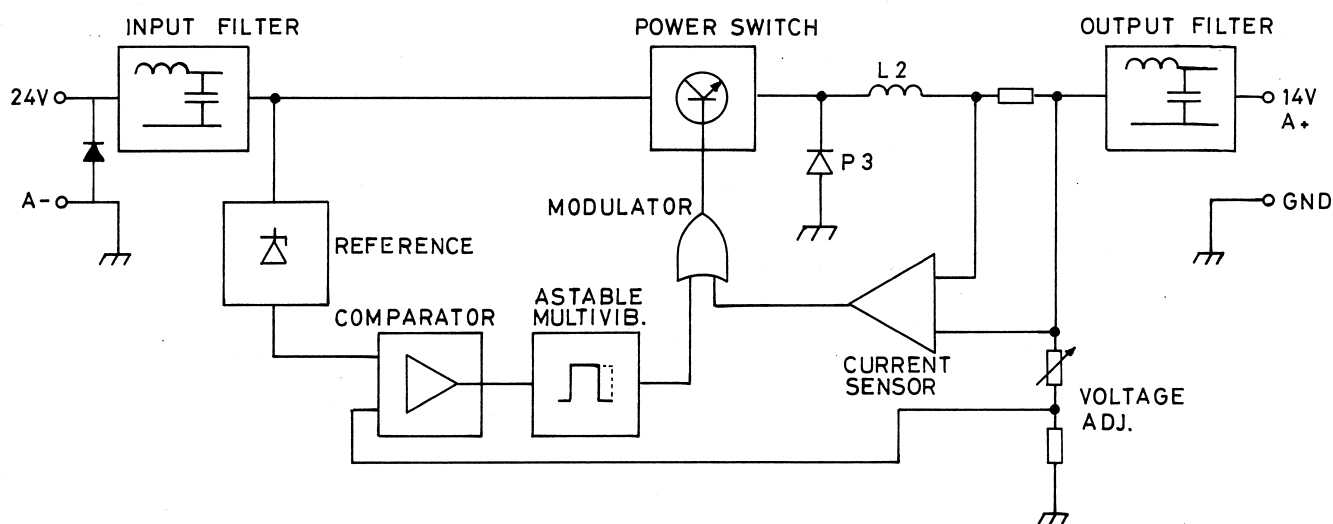
### VOLTAGE REGULATOR

VR902 interfaces the 900 mobile to a 24 V supply. VR902 is a switching voltage regulator, which converts 21 V-36 V to 14 Volts. The module can deliver 8 Amperes, can stand a continuous short circuit on the output, and overload for a shorter period of time. The input has a reverse polarity protection diode.

VR902 includes a step down switch mode regulator, with constant switch frequency (about 32 kHz) and variable duty cycle. The module is contained in a shielded box, and has low-pass filters in the input and output, in order to minimize conducted and radiated switch noise. A switch transistor is turned on and off by a square wave signal with constant frequency and variable duty cycle.

The output from the transistor is fed to a LC filter (L2-C8). When the transistor is on, the input voltage will be across the diode D3, and the coil L2 is energized. When the transistor is off, the voltage across D3 will be near zero, because the energy in the coil L2 will discharge, and thereby make D3 to conduct. The output from the filter will be equal to the mean value of the filter input voltage.

A negative feedback keeps the output voltage constant, independent of load and input voltage. A current sensing circuit provides overload and short circuit protection.



### CIRCUIT DESCRIPTION

Input filter is formed by C1, C2, L1, C3 and C4. Output filter is L2, C8 and L3-C9 and C10.

Q1, D4, D5 and D2 makes a stable reference for the regulator. This reference is also used for supplying the operational amplifiers.

U1-1a is a free running astable multivibrator. It forms the 32 kHz signal used as switching frequency. U1-1b is used as buffer for the switching signal.

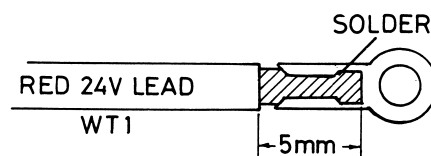
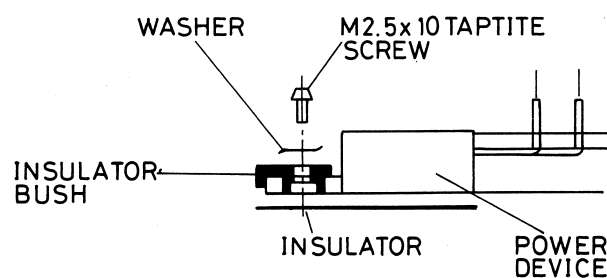
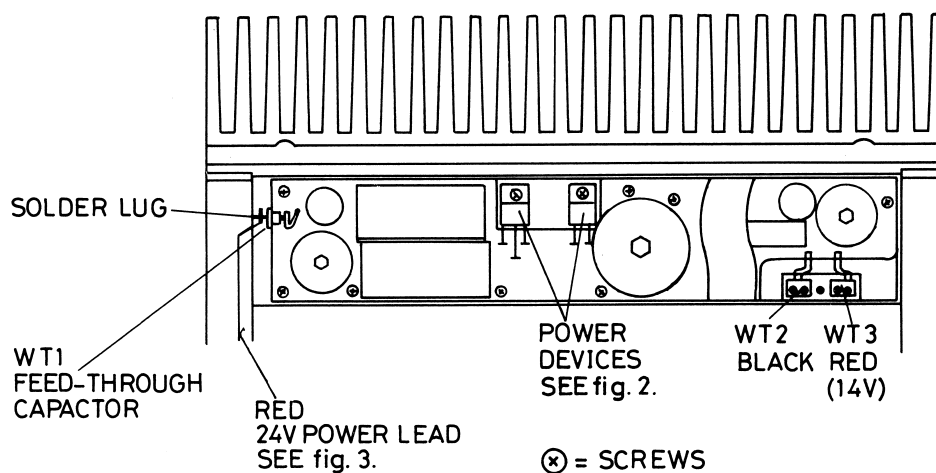
The necessary variation in duty cycle, is done

by gating together the two collectors from the buffer and the error amplifier.

The buffered output from the multivibrator is amplified in Q2 and Q3, before it is led to the switchtransistor Q4.

U1-1d senses the output current. If the current limit is exceeded, the output of U1-1d will pull down the output of the multivibrator, and thereby turn off the switch transistor.

## MOUNTING INSTRUCTION



The VR902 regulator kit includes all necessary hardware and the following instruction should be used.

1. Apply thermal compound to both sides of the plastic insulators and place them on the heat sink where the power devices are mounted, see fig. 2.

2. Place the VR902 modules as shown in fig. 1.  
Adjust the power device holes to match the heat sink holes. Take care of the power leads WT1, WT2 and WT3.  
Screw the transistor and diode to the heat sink as shown in fig 2.  
  
Fasten the VR902 module and its can to the heat sink with screws and washers.
3. Solder the black and red power lead WT2 and WT3 to the feed-through capacitors. Take care not to short the red wire to the chassis screen.
4. Remove approx. 5 mm of insulation on the red 24 V input wire, WT1, and solder the lug to the wire. Solder the lug to the feed-through capacitor, see fig. 3.
5. Move contact 37 in cable C9CC05 to position 40. The modified cable designation then becomes C9CC06.
6. Connect 24 volts to the input of the radio and check the VR902 output voltage at WT3 for being 14 volts.
7. Install the VR902 cover.

## TECHNICAL SPECIFICATIONS

### Nominal Input voltage

27.2 V

### Output voltage with no load

14.0 V  $\pm$  0.1 V (25°C)

### Internal impedance

100 mohm

### Max. output current

8 A

### Ripple (32 kHz)

$\leq$  50 mV pp

### Short circuit ability

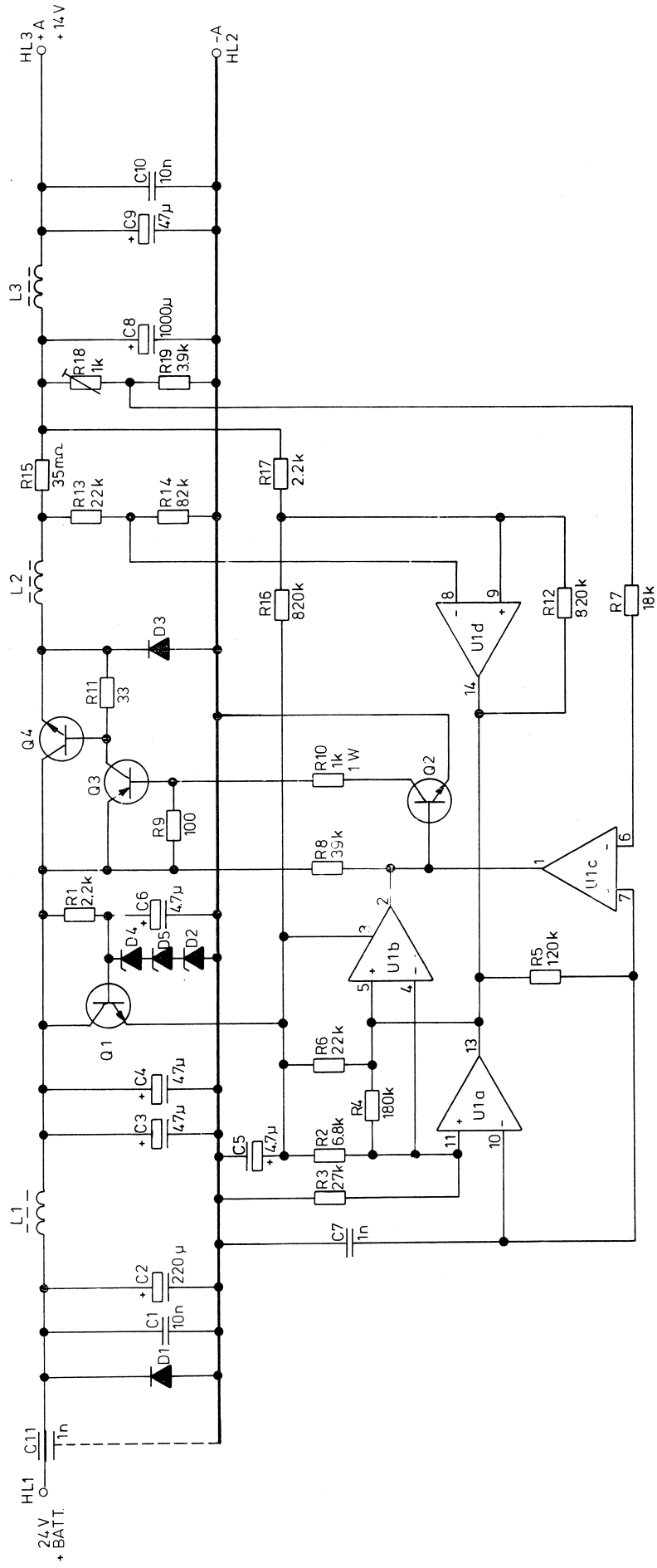
Continuous without damage

### Temperature range

-40°C to 55°C

**Storno**

**Storno**

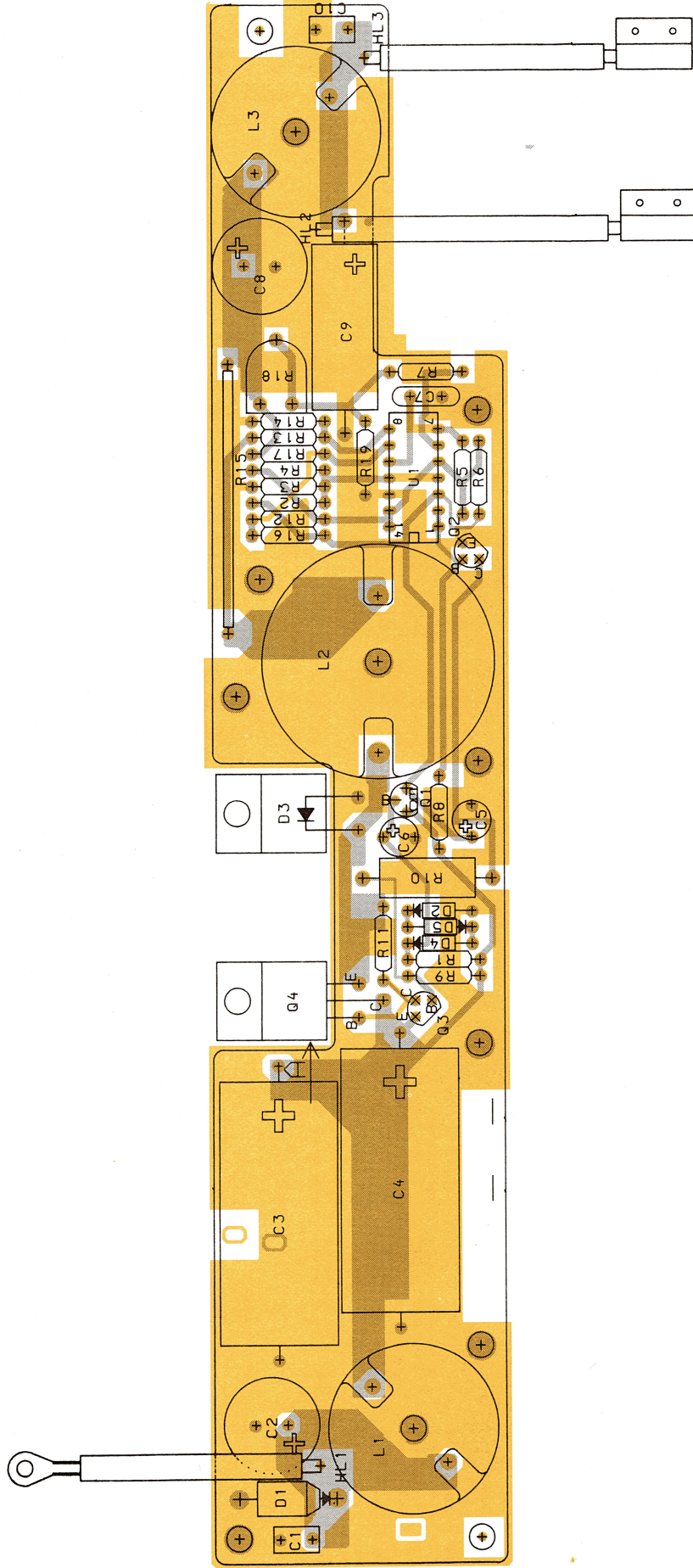


VOLTAGE REGULATOR 24/12V NEG GND VR902

19L855018 G1

D402.966/2





VOLTAGE REGULATOR VR902  
COMPONENT LAYOUT

19L855018G1 D403.165

## XO905/XO906

RX/ TX 3<sup>rd</sup> MODE MASTER OSCILLATORFunctional Description

The Receiver Master Oscillator XO905 and the Transmitter Master Oscillator XO906 are plug-in micromodules. Each contains an oscillator circuit, a switching stage circuitry to generate compensation voltage for temperature compensation and a buffer to provide output at 103 - 174 MHz. The crystal frequency is 34 - 58 MHz.

Circuit Description

This oscillator is a Colpitts configuration using a bipolar transistor and a quartz crystal for stability and operates in the third overtone mode. A bipolar-transistor buffer amplifier is included to isolate the oscillator circuit from load variations.

Frequency adjustment is accomplished with variable inductor placed in series between the crystal and the base terminal of the oscillator transistor.

Two varactor diodes, series connected between the crystal and the frequency adjust coil, perform the temperature compensation function.

The compensation voltage applied to the varactor is generated by a thermistor network which is included in the oscillator. This voltage varies in such a manner that the natural frequency variation of the crystal is countered by the changing varactor capacitance.

From about -10°C to 75°C, the compensation voltage is kept constant. The oscillator circuit is so designed that it follows the temperature compensation characteristic of the crystal.

A master module consists of an oscillator plus a compensator network.

## TECHNICAL SPECIFICATIONS

RF output impedance

50 ohm

Output frequency range

103 - 174 MHz

Oscillator compensation

3.6 - 5.5 V DC

Reference temperature

28°C

Supply voltage

9 V  $\pm$  5%

Output level

+3 dBm  $\pm$  3 dB

Current consumption

less than 10 mA

## FOR TX OSCILLATOR ONLY

Select line

low to select: less than 1 V  
high to unkey: more than 8 V

Audio sensitivity

for  $\pm$  5 kHz at output frequency:  
1.2 V RMS max. at 1000 Hz

Crystal frequency range

34 - 58 MHz

Audio frequency response

flat from 300 to 3000 Hz

Audio distortion

5% max. for 3 kHz deviation at 1000 Hz

## XO907 / XO908

### RX/TX SLAVE OSCILLATOR

A slave module consists of an oscillator circuit only. The function of the master module is to provide a compensation voltage both to itself and to all other slave modules. A slave module must be driven by a master module.

Since a master compensator must drive a group

of slave modules, the compensator output must not be tailored to match a particular set of oscillator characteristics, but must follow a more general curve which is acceptable to the whole group of oscillators. In addition, the master module may then be placed in any location among the oscillator group.

## XO909/XO9010

### RX/TX CRYSTAL OSCILLATOR

#### Functional Description

XO909 and XO9010 are oscillator modules. Each contains an oscillator circuit, and a buffer stage to provide a signal output at 90 - 186 MHz when selected by a resonant circuit. The crystal frequency range is 30 - 62 MHz.

#### Circuit Description

This oscillator is a Colpitts configuration using a bipolar transistor and a quartz crystal for stability. The frequency stability is solely determined by the crystal.

The oscillator circuit is a Colpitts configura-

tion using a transistor as the active element, and the buffer amplifier isolates the oscillator from the load. The buffer stage is followed by a circuit tuned to the 3rd harmonic of the crystal frequency. This circuit also adapts the output impedance to 50 ohms and to some extent attenuates unwanted harmonics. Frequency adjustment is accomplished with a tuneable inductor, and a Varicap, controlled by the compensating voltage, compensates for temperature drift.

The oscillator is turned on and off by a transistor which controls the bias voltage to the oscillator and the buffer transistor.

### TECHNICAL SPECIFICATIONS

#### RF output impedance

50 ohm

#### Supply voltage

9 V  $\pm 0.5\%$

#### Current consumption

less than 10 mA

#### Select line

low to select:           less than 1 V  
high to unkey:       more than 8 V

#### Crystal frequency range

30 - 62 MHz

#### Output frequency range

90 - 186 MHz

#### Reference temperature

28°C

#### Output level

+3 dBm  $\pm 3$  dB

#### FOR TX OSCILLATOR ONLY

#### Audio sensitivity

for  $\pm 5$  kHz at output frequency:  
1.2 V RMS max. at 1000 Hz  
for maximum audio output:  
2.5 V RMS

#### Audio frequency response

flat from 300 to 3000 Hz

#### Audio distortion

5% max. for 3 kHz deviation at 1000 Hz

**Storno**

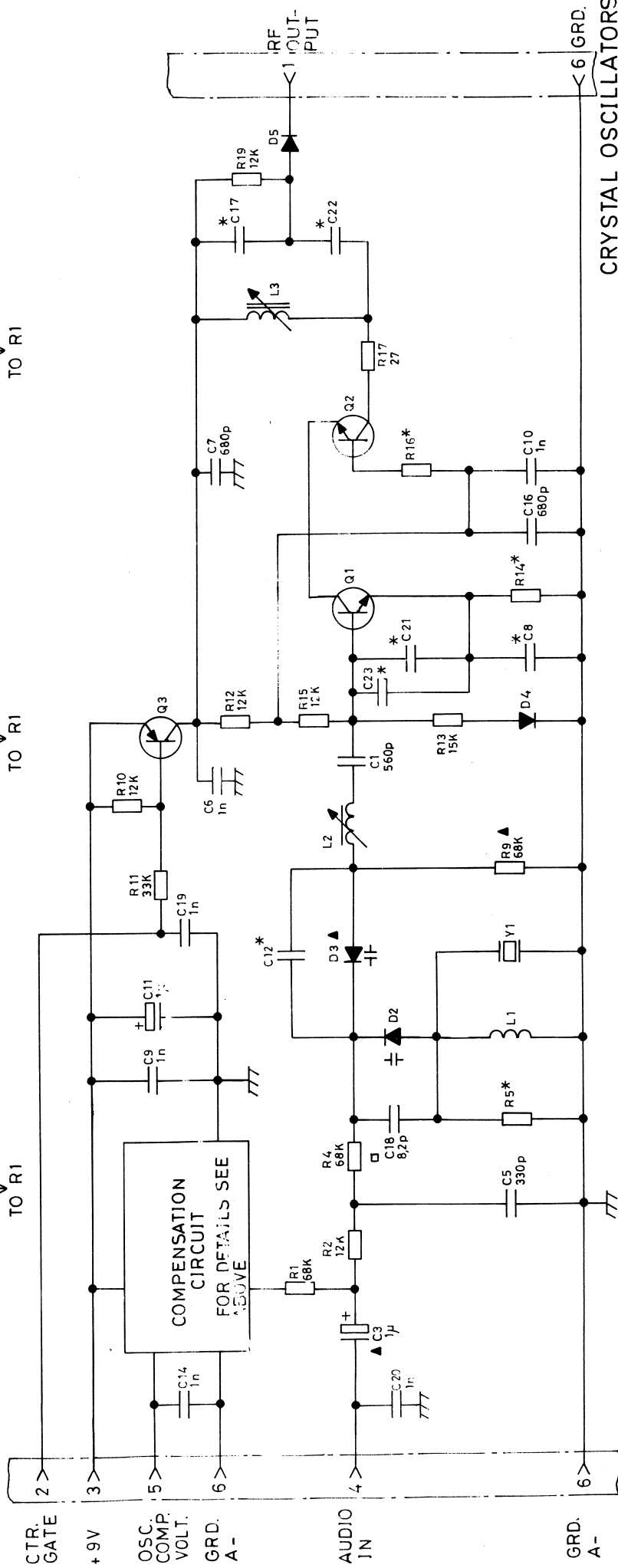
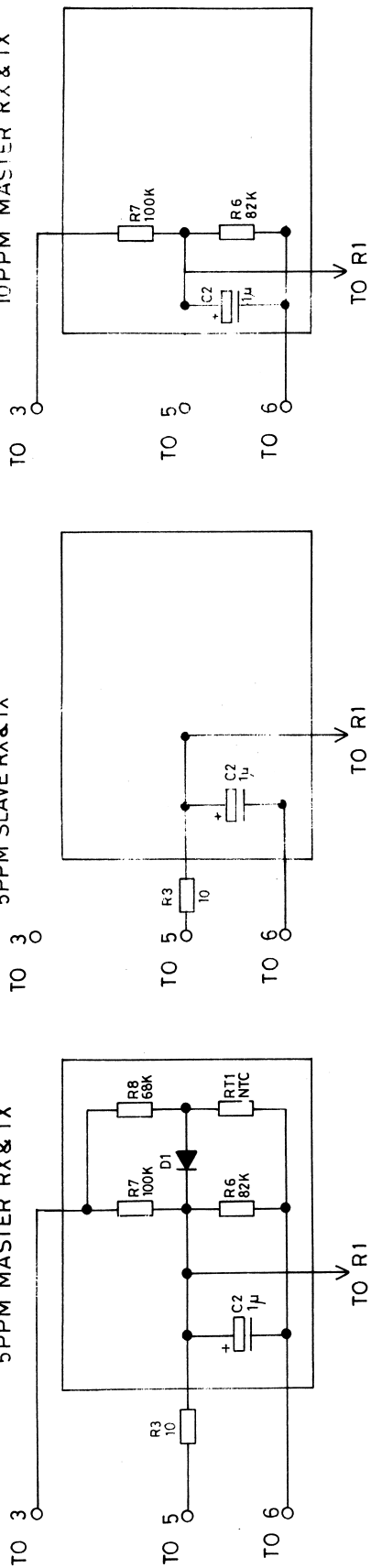
TEMPERATURE COMPENSATION CIRCUITS

**Storno**

XO905 - XO906  
5PPM MASTER RX & TX

XO907 - XO908  
5PPM SLAVE RX & TX

XO909 - XO9010  
10PPM MASTER RX & TX



CRYSTAL OSCILLATORS  
XO905-XO906-XO907-  
XO908-XO909-XO9010

D403.024/3

NOTES: \* ADJ. VALUE REFER TO PART LIST  
▲ USED IN TX OSC. ONLY  
□ USED ONLY IN 10PPM RX OSC.



## XO9011/XO9012/XO9013

### FUNDAMENTAL MODE OSCILLATORS

#### XO9011

XO9011 is a fundamental mode oscillator module which contains an oscillator circuit with an uncompensated crystal. The crystal frequency range is 10.24 - 21.0 MHz.

The oscillator is a Colpitts configuration, using a bipolar transistor and a quartz crystal for stability, and operates in the fundamental mode.

Frequency adjustment is accomplished with a variable inductor placed in series between the crystal and the base terminal of the oscillator transistor.

Frequency stability is determined solely by the crystal. The oscillator is turned on and off by a transistor, which controls the bias voltage to the oscillator transistor.

#### XO9012

XO9012 is a master fundamental mode oscillator hybrid module which contains an oscillator circuit to provide output at 10.24 - 21 MHz and circuitry to generate compensation voltage for temperature compensation.

The crystal frequency range is 10.24-21.0 MHz.

The oscillator is a Colpitts configuration using a bipolar transistor and a quartz crystal for stability and operates in the fundamental mode.

Frequency adjustment is accomplished with a variable inductor placed in series between the crystal and the base terminal of the oscillator transistor. A varactor diode, series connected between the crystal and the frequency adjust coil, performs the temperature compensation function. The oscillator is turned on and off by a transistor which controls the bias voltage to the oscillator transistor.

The compensation voltage applied to the varactor is generated by a thermistor network which is included in the oscillator. This voltage varies in such a manner that the natural frequency variation of the crystal is countered by the changing varactor capacitance and this keeps the oscillator frequency to within  $\pm 5$  ppm of the desired frequency.

#### XO9013

XO9013 is a fundamental mode oscillator module which contains an oscillator circuit to provide output at 10.24-21.0 MHz. The crystal frequency range is 10.24-21.0 MHz.

The crystal oscillator operates in the same manner as the XO9012 except that the compensator voltage generator is missing.

XO9012  
5PPM MASTER

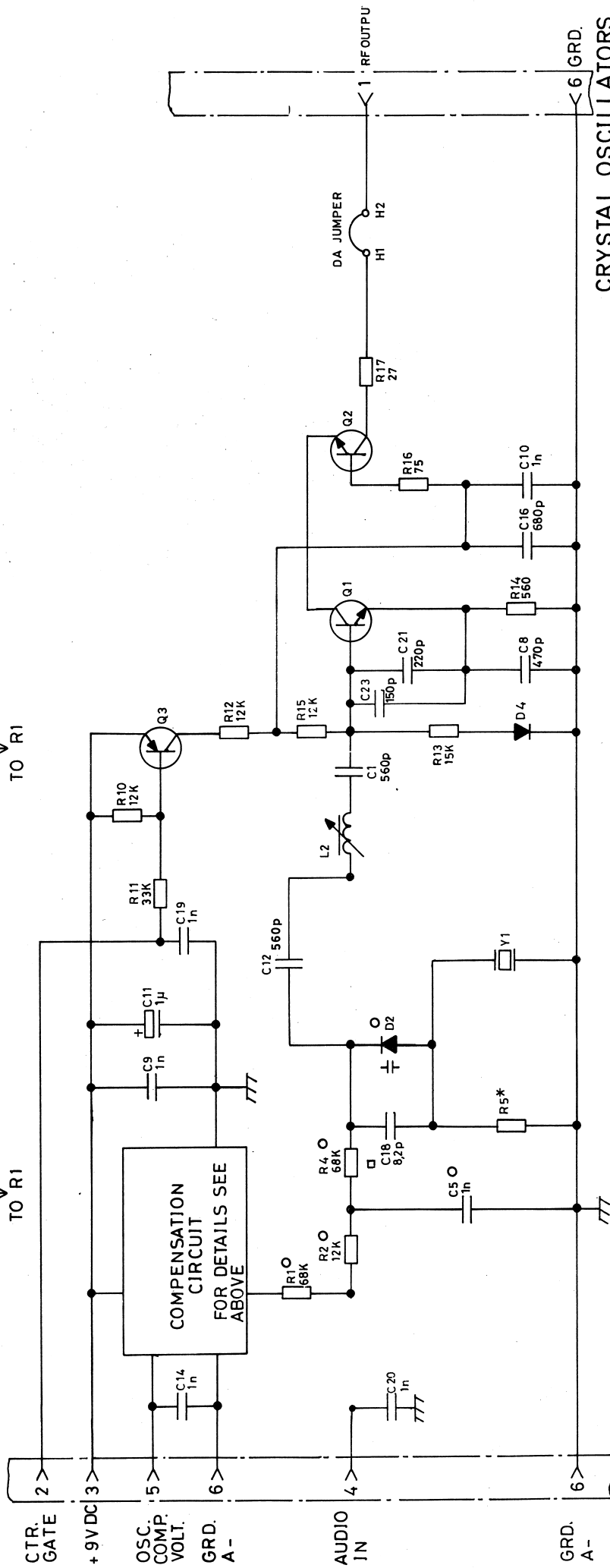
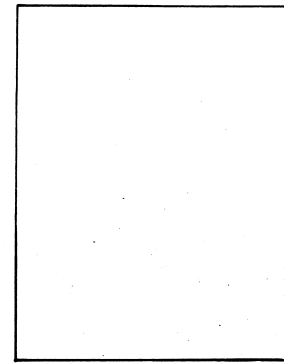
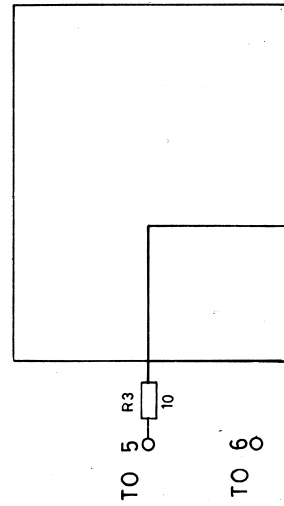
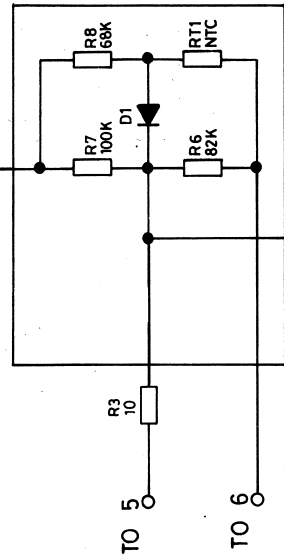
XO9013  
5PPM SLAVE

XO9011  
10PPM MASTER

TO 3  
TO 5  
TO 6

TO 3  
TO 5  
TO 6

TO 3  
TO 5  
TO 6



NOTES: \* ADJ. VALUE REFER TO PART LIST  
O NOT USED IN XO9011 (10PPM MASTER)

CRYSTAL OSCILLATORS  
XO9011 - XO9012 - XO9013

D403.184

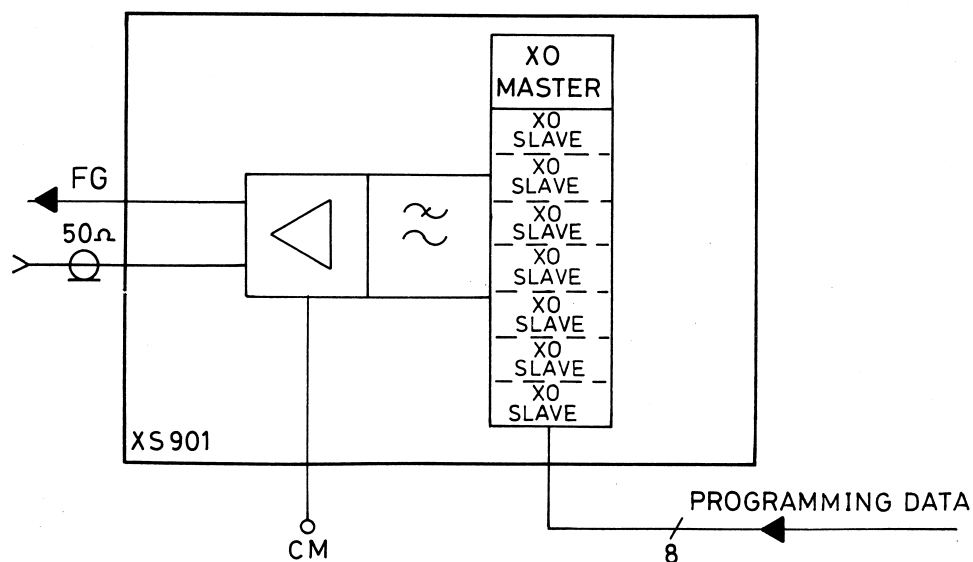
## XS901

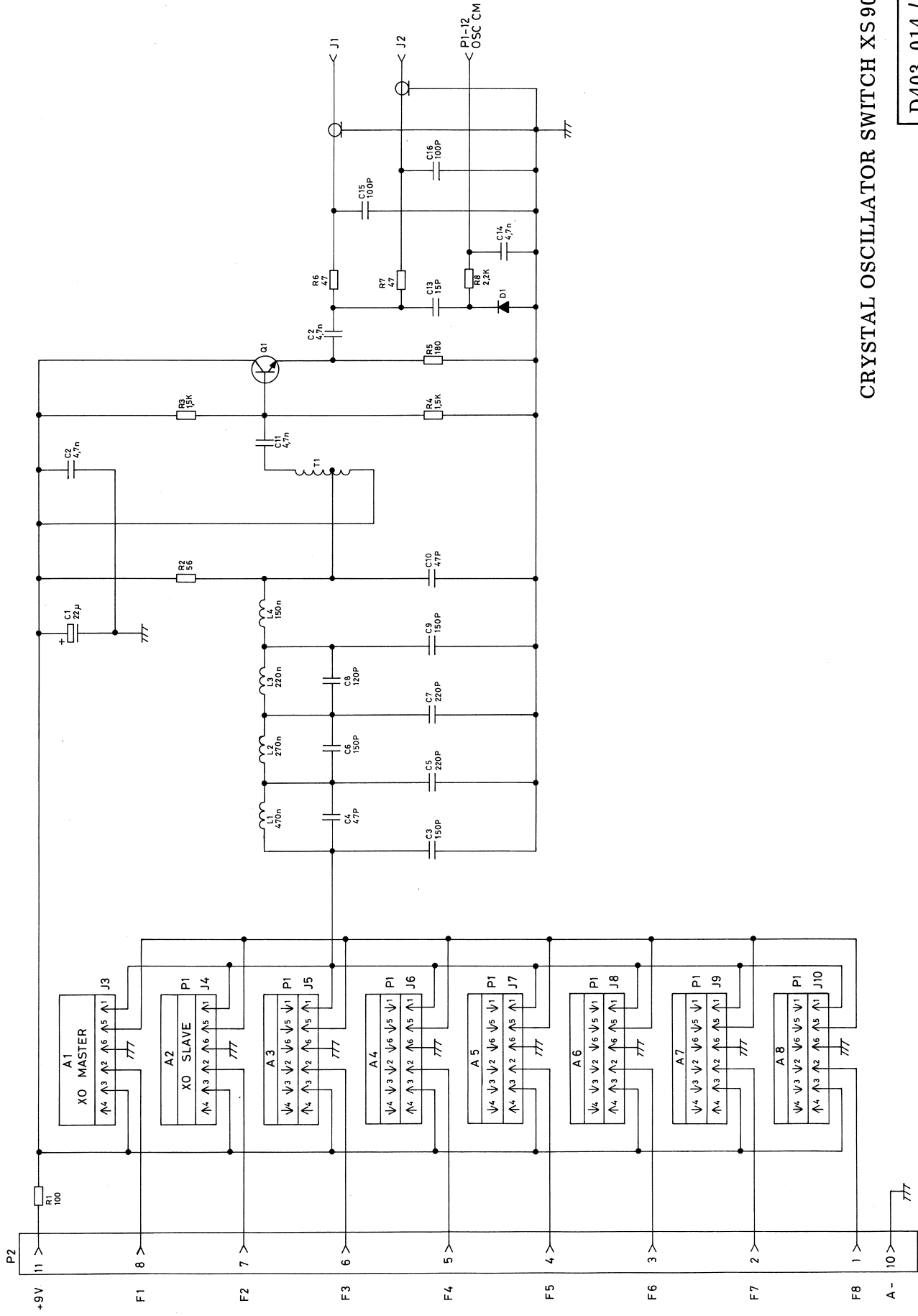
## CRYSTAL SWITCH MODULE

This module is a replacement module for the frequency synthesizer. The module contains up to 8 fundamental mode crystal oscillators in the 11.5 to 17 MHz frequency range and is used when only a few channels are required or when PSLM (Search Lock) or any other application requiring 3 ms channel switching time is needed.

Any one of eight plug-in oscillators is turned

on by connecting the respective frequency select line to A-ground. The output from the oscillator is passed through a three section low pass filter to reduce the harmonic energy. The signal is stepped up in a 2:1 transformer before being applied to an emitter follower output buffer stage. The output signal is applied to the transmitter exciter and the receiver local oscillator generator.

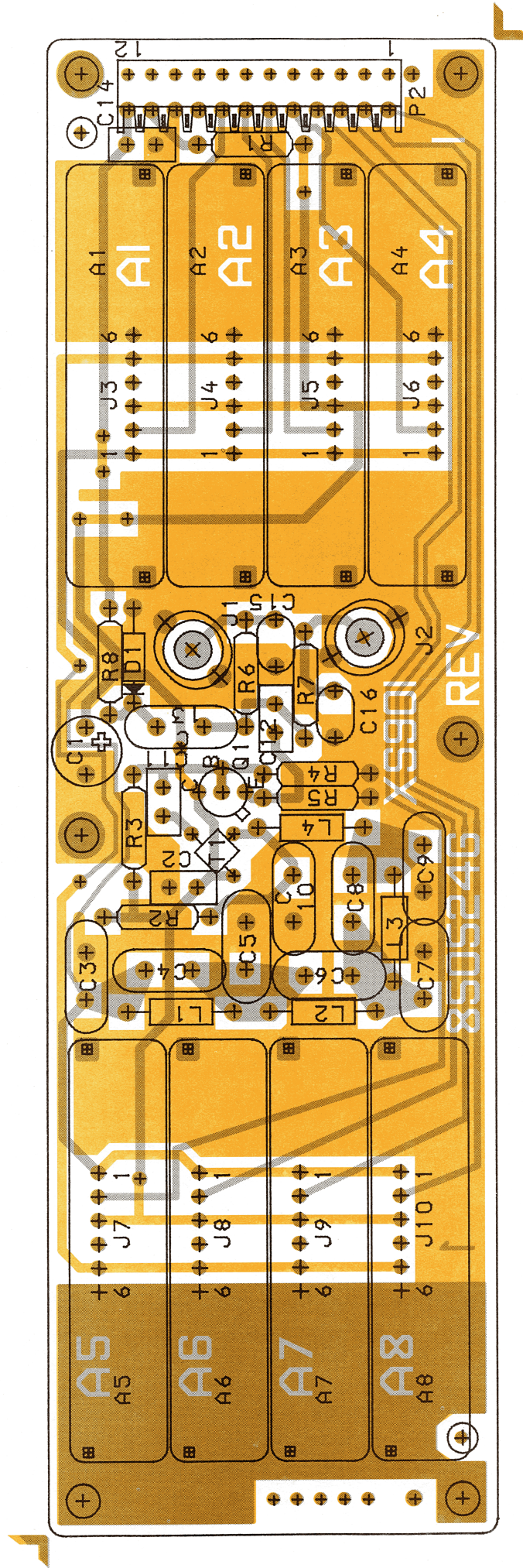




CRYSTAL OSCILLATOR SWITCH XS901

**Storno**

**Storno**



CRYSTAL OSCILLATOR MODULE XS901  
COMPONENT LAYOUT

D402.969