STORNOPHONE 900

M9112

M9113

M9114

SIMPLEX/DUPLEX

138 - 174 MHz

CONTENTS

Service Co-ordination
82 - 02
2nd Edition

Storno

TECHNICAL SPECIFICATIONS

M9110

The stated values are guaranteed minimum performance specifications unless otherwise noted.

Height
75.4 mm

Width
286 mm

Depth
40 W Simplex: 289 mm
25 W Duplex: 376 mm

Weight
Simplex: 10 kg

Volume (H x W x D)
6 to 40 W Simplex: 6.23 liter
25 W Duplex: 8.2 liter

Battery Voltage
10.8 - 15.6 V
21.6 - 31.2 V

Battery Drain (Amp.) (at 13.6 V incl. C92)

	SIMPLEX	DUPLEX
OFF Condition	0.075	0.075
Standby	1.0	1.0
Receive 5 W	2.4	2.4
Transmit - 6 W/10 W	4.0	4.5
Transmit 18 W	7.0	7.5
Transmit - 25 W	7.0	11.5
Transmit - 40 W	11.5	

Duty Cycle (EIA)
Simplex: TX 20%
RX 80%
Duplex: TX Continuous
RX Continuous

Temperature Range
-30°C to +60°C (-40°C to +70°C optional)

Humidity (EIA)
90-95% at 50°C and S-Q-3B

Rain
MIL-STD-810C Method 506.1,
Process 1 and S-Q-3B.

Vibration
EIA and Forst Service and S-Q-3B,
MIL-STD 810C, Method 514.2. Procedure VIII, Curve W.

Shock
EIA and S-Q-3B, MIL-STD-810C, Method 516.2, Procedure III.

Altitude, Operating
4.000 Meters

Speaker Rating (EIA)
7.5 W at 8 ohm
15 W at 8 ohm

Dust
MIL-STD-810C, Method 510.1, Procedure 1.

Salt Atmosphere
MIL-STD-810C, Method 509.1, Procedure 1.

CONTROL HEAD

Type	C92S	C91S
Height	95 mm	95 mm
Width	193 mm	136 mm
Depth	32 mm	23 mm
Weight	0.6 kg	0.5 kg
Volume, H x W x D	0.6 l	0.4 l
$^{+}$Temperature Range	-40^{o}C to $+60^{o}$C	
Humidity (EIA)	90-95% at 50^{o}C and S-Q-3B	
Vibration	EIA, USFS and S-Q-3B; MIL-STD-810C, Method 514.2, Procedure VIII, Curve W.	
Shock	EIA and S-Q-3B; MIL-SDT-810C, Method 516.2, Procedure III.	
Altitude Operation	4.000 m	
($^{+}70^{o}$C with reduced light intensity)		

RECEIVER SPECIFICATIONS

(Simplex and duplex specifications are same unless otherwise noted)

Frequency Range
138-174 MHz

Channel Spacing
M9112: 25 kHz
M9113: 20 kHz
M9114: 12.5 kHz

Frequency Stability PPM
±5 ppm (-30^{o}C to $+60^{o}$C)
±5 ppm (-40^{o}C to $+70^{o}$C)
±10 ppm (-25^{o}C to $+55^{o}$C)

SINAD SENSITIVITY, 12 dB EIA (½ EMF)

Low Intermodulation (RC911)
0.35/0.45 uV

High Sensitivity (RC912)
0.20 uV

Varactor Tuned (RC913)
0.35 uV

20 dB QUIETING SENSITIVITY

Low Intermodulation (RC911)
Simplex: 0.50 uV
Duplex: 0.63 uV

High Sensitivity (RC912)
0.30 uV

Varactor Tuned (RC913)
0.5 uV

Modulation Acceptance Bandwidth
(25 kHz Channel Spacing)
±7.0 kHz

Modulation Acceptance Bandwidth
(12.5 kHz Channel Spacing)
±3.0 kHz

ADJACENT CHANNEL SELECTIVITY EIA/CEPT

M9112: 95 dB
M9113: 92 dB
M9114: 75 dB
Degraded by 5 dB when a channel synthesizer is used in the system.

INTERMODULATION EIA/CEPT/FTZ

		CHANNEL GENERATOR		RECEIVER FRONT-END		
		FS901	FG911	RC911	RC912	RC913
CHANNEL SPACING		SYNTHE-SIZER	CRYSTAL OSCILLATORS	LOW INTER-MODULATION	HIGH SENSITIVITY	VARACTOR TUNED
2	25 kHz	x		80 dB	78 dB	
			x	85 dB	78 dB	
3	20 kHz	x		78/70 dB	78/70 dB	
			x	82/70 dB	82/70 dB	
4	12.5 kHz	x		75 dB	75 dB	75 dB
			x	75 dB	75 dB	75 dB

2= EIA and CEPT measuring standard
3= EIA/CEPT measuring standards
4= EIA and CEPT measuring standard

SPURIOUS REJECTION EIA/CEPT

EIA:
Simplex: 100 dB
Duplex TX keyed: 85 dB
Duplex TX unkeyed: 100 dB
CEPT:
Simplex: 92 dB
Duplex TX keyed: 77 dB
Duplex TX unkeyed: 92 dB

Co-Channel Rejection
Better than 8 dB

Conducted Spurious
2.0 nW (∿ -57 dBm)

Radiated Spurious
2.0 nW (∿ -57 dBm)

MULTIFREQUENCY SPREAD - DUPLEX SPACING

MODE	RECEIVER FRONT - END FULL SPECIFICATION			RECEIVER FRONT - END 3 dB DEGRADATION[2]		
	RC911 LOW INTER-MODULATION	RC912 HIGH SENSITIVITY	RC913 VARACTOR TUNED	RC911 LOW INTER-MODULATION	RC912 HIGH SENSITIVITY	RC913 VARACTOR TUNED
SIMPLEX	1.0 MHz	2.0 MHz	2.0 MHz[1]	1.4 MHz	3.0 MHz	3.0 MHz
DUPLEX 4.5 MHz	0.7 MHz			1.0 MHz		
DUPLEX 6 MHz	0.9 MHz			1.2 MHz		
DUPLEX 8 MHz	1.0 MHz			1.3 MHz		
DUPLEX 10 - 12 MHz	1.0 MHz			1.3 MHz		

[1] One side step ≤28 MHz with 2 MHz bandwith of each "window"
[2] Degradation with respect to sensitivity

Nominal Input Impedance
50 ohm

Critical Squelch Sensitivity SINAD
4.0 dB

Maximum Squelch Sensitivity
≥20 dB Quieting
≤1.5 uV (RF Input)

Squelch Blocking
25 kHz Channel Spacing > ±5.0 kHz
12.5 kHz Channel Spacing > ±2.5 kHz

SQUELCH TAIL

Speaker Audio Squelch:
At Critical Squelch Setting
RF in= Critical Opening Threshold: <300 ms
RF in= >30 dB Quieting: <20 ms

At Maximum Squelch Setting
RF in= 30 dB Quieting: <10 ms

Fast Squelch Logic Control (PSLM etc.)
At Critical Squelch Setting
RF in= Critical Opening Threshold +6 dB:
<5.0 ms
RF in= >30 dB Quieting: <5.0 ms

At Maximum Squelch Setting
RF in= >30 dB Quieting: >5.0 ms

RECEIVER ATTACK TIME

At Speaker
RF in= Threshold: <200 ms
RF in= >30 dB Quieting: <40 ms

At Maximum Setting
RF in= >30 dB Quieting: <40 ms

FAST SQUELCH LOGIC CONTROL

At Critical Setting
RF in= Critical Opening Threshold +6 dB:
<10 ms
RF in= <30 dB Quieting: <5.0 ms

At Maximum Setting
RF in= ≥30 dB Quieting: <5.0 ms

Audio Power EIA
5.0 W

Audio Frequency Response at Speaker
20/25 kHz channel spacing
(dB relative to standard 6 dB/octave deemphasis)
400 - 2700 Hz: +1 dB, -1.5 dB
300 - 3000 Hz: +1 dB, -3.0 dB
With CG filter relative to 1000 Hz
70 - 204 Hz: <-16 dB
67 - 210.7 Hz: <-13 dB

12.5 kHz channel spacing
(dB relative to standard 6 dB/octave deemphasis)
300 - 2500 Hz: +0.5 dB, -3.0 dB
70 - 204 Hz: <-16 dB
67 - 210.7 Hz: <-13 dB

Audio Frequency Response at Discriminator Audio
(dB relative to 1000 Hz)
DC-3000 Hz: +0.5 dB, -1.0 dB
300 - 2000 Hz: ±0.5 dB

Audio Distortion at Rated Output
EIA at 1 kHz: 3.0%
CEPT: 10.0 (includes extremes at 2.25 W)

Speaker Impedance
8.0 ohm

Duty Cycle at Rated Audio
Continuous

FM Hum and Noise
Squelched: -80 dB
Unsquelched: -60 dB

12.5 kHz:
Squelched: -70 dB
Unsquelched: -54 dB

Channel Switching Time
(exclusive of control logic)
1 channel: <10 ms
With Synthesizer: full range (random): <20 ms
With Discrete Oscillators: <3 ms

TRANSMITTER SPECIFICATIONS

Frequency Range
138 - 174 MHz

Power Output
Intermittent Duty (Simplex): 25/10 W
Continuous Duty (Duplex): 25/18/6 W

Load Impedance
50 ohms

Power Adjust Range
Adjustable: 3:1

PA Protection to Load Variation
No damage for 0 to ∞ impedance loads and all phase angles.

Adjacent Channel Power
(25 kHz Channel - CEPT, Sweden)
-70 dB

Maximum Frequency Deviation
25 kHz Channel spacing: ±5 kHz
20 kHz Channel spacing: ±3 kHz
12.5 kHz Channel spacing: ±2.5 kHz

Audio Sensitivity for Rated Deviation (1000 Hz)
100 mV

MULTIFREQUENCY SPREAD - DUPLEX SPACING

MODE	FREQUENCY GENERATOR FULL SPECIFICATION		FREQUENCY GENERATOR 3 dB DEGRADATION[1]	
	FS901 SYNTHE-SIZER	XS901 CRYSTAL OSCILLATOR	FS901 SYNTHE-SIZER	XS901 CRYSTAL OSCILLATOR
SIMPLEX	3.15 MHz[2]	4.2 MHz[2]		6.0 MHz[2]
DUPLEX 4.5 MHz	0.7 MHz	0.7 MHz	1.0 MHz	1.0 MHz
DUPLEX 6 MHz	0.9 MHz	0.9 MHz	1.2 MHz	1.2 MHz
DUPLEX 8 MHz	1.1 MHz	1.1 MHz	1.3 MHz	1.3 MHz
DUPLEX 10 - 12 MHz	1.5 MHz	1.5 MHz	1.8 MHz	1.8 MHz

[1] Degradation with respect to output power.
[2] One side step $\leq$28 MHz with stated bandwidth of each "window".

Frequency Stability
±5 ppm (-30 to +60°C)
±5 ppm (-40 to +70°C)
±10 ppm (-25 to +55°C)+

Conducted Spurious
CEPT: 0.2 uW
FCC: 10.0 uW

Radiated Spurious
CEPT: 0.2 uW
FCC: 10.0 uW

FM Hum and Noise
25 kHz channel spacing: 70 dB
20 kHz channel spacing: 65 dB
12.5 kHz channel spacing: 60 dB
This specification is degraded by 15 dB when a channel synthesizer is used in the system.

AM Hum and Noise
-50 dB

Audio Response
(Ref. 6 dB/Octave Preemphasis)
400 - 2700 Hz: +1.0 dB, -1.5 dB
300 - 3000 Hz: +1.0 dB, -3.0 dB

Audio Distortion
(At 60% Rated deviation w/o CG)

At 1000 Hz: 3%
Using one oscillator from 138 - 174 MHz: 7%

At 300 - 3000 Hz: 5%
Using one oscillator from 138 - 174 MHz: 10%

Transmit Attack Time
With Relay Antenna Switch: 20 ms
With Duplexer or Solid State Antenna Switch at 25 Watts or less: 5 ms

Transmit Decay Time
With Relay Antenna Switch: 20 ms
With Duplexer or Solid State Antenna Switch at 25 Watts or less: 5 ms

Storno

GENERAL DESCRIPTION

STORNOPHONE 900

RADIO UNIT

The STORNOPHONE 900 mobile radiotelephone is trunk mounted and controlled from a Control Head which connects to radio via a cable. The radio package is rugged and splashproof and is fitted with a carrying handle. When the package is mounted on its mounting plate, the handle engages with the plate. Turning the key locks the radio to the mounting plate. All connectors are located on the front of the package which is shaped to protect the connectors. The design concept of the package allows an extension in length and thereby incorparates a great deal of flexibility for future options.

The mobile package contains the receiver, the transmitter, the voltage regulators, the control logic, the signalling functions, and has accomodation for a variety of options. In duplex radios the duplex branching filter is also contained inside the radio package.

The radio is modularized and most of the modules are plug-in types with dimensions in accordance with an established standard. The RF-modules are all self-contained and have their own shielding, if necessary.

To separate the RF-modules from the system and audio modules, the radio package is provided with an internal shelf which divides the volume into an RF-section and a system section.

Interconnections of modules are provided by a printed wiring board located on the system side of the shelf. This interconnect board establishes almost all connections between the modules, and between the modules and the control cable connector. RF connections are not included in the interconnect board, but are coax-cables with RF connectors. The control cable connector which is accessible from the radio front is mounted on the interconnect board and contains the pins for the control cable plug.

The modules of STORNOPHONE 900 are built with descrete components on printed wiring boards as the primary technology, but some modules also incorporates thick film micromodules. These micromodules are soldered in and will have their own shielding.
Some of the hybrid thick film circuits utilize custom designed integrated circuits.

Some micromodules are plug-in types and are made with chip components on PWB.

The RF circuit approach is highly influenced by the frequency synthesizer which means that both the transmitter exciter and the receiver injection circuitry include varactor tuned filters which can be side stepped over the full frequency band 146-174 MHz. The transmitter reference oscillator is used for frequency modulation of the transmitter. The transmitter approach is a broad band design which together with the broad band power amplifier (PA) and a varactor-tuned receiver front-end gives a wide flexibility in the choice of channel frequencies.

The radio is provided with a microcomputer which controls the frequency synthesizer, the key and squelch functions, the data conversion, the tone signalling, and other optional functions.
The control logic module is located in the system section and includes input/output (I/O) circuits, the PROM (Programable Read Only Memory), and the necessary microcomputer

interface circuitry. The microcomputer memory size is 2 Kbyte Program Memory (ROM) and 120 byte data Memory (RAM). A number of functions and options have been converted into Software and are programmed into the microcomputer's ROM. When a specific combination of standard functions and optional functions are selected, parts of the pre-programmed microcomputer software must be addressed. This is done by programming the Personality PROM which is also programmed with other data such as:

Channel frequencies
Tone Signalling frequencies
Control Head button functions

The microcomputer also controls the data communication between the radio unit and the Control Head, and other accessories.

Furthermore it controls the serial data flow, telegrams, in the control cable and converts data from parallel to serial form, and vice versa.

CONTROL HEAD

Two control heads are available for controlling the radio, type C91S and type C92S.

For applications where the control functions are limited the relative simple control head type C91S is used. It contains the necessary circuitry for interfacing the control buttons and the display, and for converting data from parallel to serial form and vice versa.

For more complex applications type C92S is used. This is a system control head with 20 buttons divided into an 8-button cluster in the left side and a 12-button keypad in the right side. A 3-digit LED display and 6 light indicators are placed in between.

The display screen will, when no indicators are on, appear as a lusterless surface. When a function is active, the corresponding symbol is backlighted and is visible on the screen.

To make the key pad universal and usable for different control functions the mode selection principle is utilized. After a key has been pushed, the appropriate mode button must be pushed to tell the control logic which operation is to be executed.

All controls are pushbuttons without mechanical latches and are arranged as the standard telephone layout. The function of the five undedicated buttons will depend on the options.

All buttons are automatically illuminated when the ambient light is below a certain level and a dimmer circuit automatically adjusts the brightness of the display accordingly.

The control heads are designed to fit the interior of a modern car or truck and can be mounted in several ways, for example on top of the dashboard, or under.

JUNCTION BOX

The control head and other accessories (microphone - loudspeaker - key switch - etc.) are connected to the radio via a junction box which is provided with internal multiconnectors for the cable plugs.

DESCRIPTION OF THE MECHANICAL CONSTRUCTIONS

RADIO PACKAGE

The cabinet contains the RF and system modules and is formed by a cast front, two extruded side rails, a cast heat sink forming the rear, and a top and a bottom sheetmetal

cover.
This design allows an extension in length and gives the required flexibility for a mobile system package.

Internally, the RF modules (except the Antenna Switch, RF power amplifier, and Duplexer) are mounted side by side on the upper side of a shelf which is suspended on three sides, to the two side rails and to the front. DC, audio, and control signals for all the modules are obtained from the System Interconnect Board located just under the shelf. All connections pass through the shelf via coaxial bypass capacitors.
The Control Logic, Voltage Regulator, and audio processing modules mount directly to the interconnect board and the shelf.

The front has a handle which serves as a means for carrying the radio and also engage with the mounting plate. A lock prevents the handle from being released by unauthorized persons.
The top cover cannot be opened unless the handle has been unlocked and lowered.
The bottom cover has four "mushroom" posts which engage with holes in the mounting plate. To remove the bottom cover four screws, one in each mounting post, must be removed.

CONTROL HEAD C91S, C92S

The fundamental idea of the mechanical design has been to build a range of components suitable for future applications as expansion or reduction of functions is required.

The basic component is an extruded aluminum profile with inside grooves for slide-in subassemblies such as the mainboard, the keyboard(s), and the displays. To close the profile and hold the subassemblies in position, two molded plastic pieces are attached to the ends of the profile with captivated screws.

The mounting bracket consists of an aluminum rail and two molded plastic brackets shaped to give high installation flexibility. The end pieces are provided with turnable fixtures for the mounting brackets thus allowing the operator to adjust the position of the control head. Furthermore, a 'push to release' function provides easy access for service. When the control head is released from the mounting bracket and the end pieces disengaged the control cable connector is revealed.

JUNCTION BOX C9JB01, C9JB02

The junction box consists of a molded plastic base plate containing a printed wiring board with accessory connectors. The base plate is provided with slots in one of its sides for cable entries. Two holes are provided in the base plate and p.w.b. for selftapping mounting screws, and two rubber strips cover unused cable entries in order to protect the connectors against dust. A plastic lid completes the box and it is fastened with one captivated screw.

HANDMICROPHONE C9MC01

The microphone housing is made of polycarbonate-plastic for maximum strength and durability, and the microphone cartridge is suspended in an opening in the end. The microphone suspension is made of rubber which absorbs vibrations from the vehicle and allows for tolerances of different makes of microphone cartridges. The microphone netting is black anodized aluminum. An internal p.w.b. contains the microphone amplifier and the transmitter key switch. The assembly is kept in place by a groove in the housing and a strain relief, which is locked to the housing by two screws. Optionally the microphone may be fitted with an extra button, f.ex. for tone keying.
The coiled cord is connected to the retainer with a connector.

The microphone retainer consists of a plastic housing with a fork that holds the microphone. Inside the housing is a receptacle for the cord plug, and space is provided for an optional hook switch.

FIXED MICROPHONE C9MC03

The microphone housing is made of plastic and consists of two parts snapped together. Inside is a directional microphone cartridge and an amplifier. A cable connects the unit to the junction box. The microphone housing may be attached directly to the mounting surface, or may be attached by means of a small backet with rubber suspensions.

HANDSET C9MT01

The handset consists of a microtelephone and a retainer. The microtelephone has a dynamic microphone with amplifier and a telephone cartridge. A PTT (Push-to-Talk) button is placed in the handle and a coiled cable connects to the retainer. The standard version of the retainer has two change-over switches, but can, optionally, be fitted with an extra switch.

LOUDSPEAKER C9LS01, C9LS02

The ball shaped loudspeaker enclosure consists of two halves that snap together. The base part has a flat side with holes for the mounting screws and is normally attached directly to the mounting surface. The loudspeaker part has a grill, ultrasonic welded to the enclosure, and holds the speaker. After installation this part can be rotated for adjustment of the sound direction.

CABLE KIT C9CC01

C9CC01: 12 V, 6 W - 25 W Simplex,
6 W - 25 W Duplex.
C9CC02: 24 V, 6 W - 25 W Simplex,
6 W - 25 W Duplex.

The cable kit consists of a control cable, a battery cable and a fuse box. The cable between the radio and the junction box has 14 conductors of which 6 are for medium current (2 for speaker and 4 for power control) and the rest for small signals. The radio uses 36 male round pins as signal contacts. 4 heavy, round pins are used for high current connections, and the other part of the contact is a female split contact which fit over the appropriate male pins to complete the connection. The radio will not be weatherproof when the cable is disconnected from the front panel.

GENERAL RECEIVER CIRCUIT DESCRIPTION

The VHF receiver is a single conversion receiver with 21.4 MHz 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 convertional manual control. It is divided into five modules, each a self-contained, multifunction module which comprises single function micromodules and descrete components. Refer to the block digram.

The receiver modules are:

High Intermodulation front-end RC911
High Sensitivity front-end RC912
Varactor tuned front-end RC913
Receiver Injection Signal Sources
FG911, FG912

21.4 MHz IF and Detector
IA901, IA902, IA903, IA904.

Receiver Audio Amplifiers
AA903, AA904

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 12 watts. A general description of each module and its characteristics is given in the following sections.

RECEIVER FRONT END RC911

This receiver front-end is the Low Intermodulation 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 bandpass 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.

RECEIVER FRONT END
RC912

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.

RECEIVER/TRANSMITTER SIGNAL SOURCE
FG911

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.

The Master Oscillator (XO905) is a plug-in micromodule. It is made on a PWB with a mix of chip components and normal components for PWB. It contains a 3rd mode overtone crystal oscillator and a compensating voltage circuitry that generates a voltage to compensate for oscillator drift due to changing temperature. The oscillator crystal is plugged into the circuit and its frequency is in the 31.6 - 65.3 MHz range. A buffer circuit provides the output frequency in the 94.8-195.9 MHz range.

RX CRYSTAL MODE OSCILLATOR (XO909)
(± 10 ppm $-25^{o}C$ to $+55^{o}C$)

Functional Description

XO909 is an oscillator module wich contains an oscillator circuit, and a buffer stage to provide a signal output at 94.8 - 196 MHz when selected by a resonant circuit. The crystal frequency range is 31.6 - 65.3 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 configuration 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.

The oscillator stability is within ± 5 p.p.m. of the nominal frequency.

IF AMPLIFIER AND DETECTOR
IA901, IA902, IA903 or IA904

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.

IA901 is used for 25/30 kHz channel spacing.
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:

IA901 - 6 pole filter - 4 pole filter
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.

AUDIO AMPLIFIER
AA903 or AA904

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 high-pass 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.

GENERAL TRANSMITTER DESCRIPTION

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

These are:
The receiver/transmitter signal source FG911
Including micromodules AA901/902/XO906/XO908/XO910

RF POWER AMPLIFIER
PA911/PA913

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 FG911 module. The FG 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 automative 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.

TRANSMITTER SIGNAL SOURCE FG911

This module is described in the receiver description.

The audio processor micromocule, 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-modutated 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 interferrence on ajacent 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.

The TX Master Oscillator, XO906, contains an oscillator circuit with FM capability, circuitry to generate a temperature compensation voltage and a buffer stage. The crystal frequency range is 42.3-58 MHz and the output frequency is 126.9-174 MHz.
The oscillator operates similar to the receiver oscillator except for the added modulation input. The signal from the audio processor is applied to two varicaps connected between the crystal and the frequency trimming inductor, and varies the oscillator frequency sufficiently to produce ±5 kHz frequency deviation at the carrier.

The frequency of the oscillator is stable to within ±5 p.p.m. in the -30°C to +75°C temperature range. It is a plug-in type.

VHF 6/10 W PA (PA911)

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 monolitic 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 feedthrough 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 excessivt 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.

VHF 25/40 W PA (PA913)

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.

The PA circuit for 25/40 watt operates like the 6/10 watt PA 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.

ANTENNA SWITCH AS901

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.

BRANCHING FILTER BF911

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

All resonators are helical coils, tuned by slugs. Interconnections between adjacent resonators are quarterwave microstriplines made on a common printed low loss teflon board.

MICROCOMPUTER CONTROL CIRCUIT

CENTRAL LOGIC CL901

The Central Logic module processes all the data received from the other modules and sets the controlling output data accordingly. It generates all the basic timing functions and the Channel Guard tones (D/A conversion in the CG module), and the communication and interchange of data with the control head and accessories is also done by the contral logic.

The functions of a radioset will be in accordance with the selected options and all variable data will be stored in the Personality PROM which will be programmed for this specific radio set.

The Central Logic module contains a microcomputer, input/output (I/O) expanders, and the Personality PROM.

The module has 41 input/output pin plus power supplies and ground. Three are used for the data telegrams to and from the Control Head, serial up/down, and the ON/OFF function. The rest of the inputs/outputs inter-

face the other modules in the radio set. A list and brief descriptions are given below:

INTERFACE CIRCUITS

SR Inputs:
The Sequential Decoder causes the Individual Call and Group Call lines to be low when an appropriate tone call is received on the channel.

Channel Guard Control:
The software is prepared for controlling a hardware Channel Guard module for single encode/decode function.

Channel Guard Detect:
This input determines whether a tone is present or not.

Channel Guard Encode Disable:
This input swithes the CG module from encode to decode.

Frequency Control:
These outputs carry either the control code for the Frequency Synthesizer, or on/off function for descrete crystal oscillators.
Four outputs are available for frequency side step, and one input is available for monitoring the transmitter status.

FUNCTIONAL DESCRIPTION

STORNOPHONE 900

Description of general operator - CB interface.

The seven segment display is used for displaying numerical information and optical indication of erroneous or illegal operation, which is done by flashing of the contents.
One example of an error condition is the situation where the radio is turned on, after the battery supply has been completely disconnected. The logic in the radio will find its operator selected data lost and will indicate that with a flashing channel number "suggestion" (ch. no. 1) for about 5 seconds, after which the flashing number will be used as the channel number.

In general an error indication will last for 5 seconds and the display will then return to the condition before the illegal operation.
The operator can stop the flashing by activating an arbitrary button (which must be functionally defined). In case of continous illegal operation, the display keeps flashing until the illegal situation ceases (e.g. when attempting transmitting on a busy channel or at CCT overflow (function nr. 13).

The display also acts as an "on" indicator. In the 8 button control head (C91) the on-state (stand-by state) is channel number indication (even in one channel radios). In the 20 button control head (C92 the on-state will be either the stand-by condition with the middle horizontal bars turned on, or in radios with address call or mobile status the last selected address.

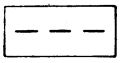
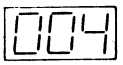
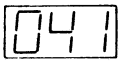
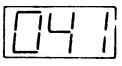
Finally the display will indicate with turned-on decimal points that a "mode selection" has been accepted by the radio logic.

BUTTON OPERATION

When a functionally defined button is activated, a feedback tone will sound in the speaker. The feed-back tone can be deleted at radio ordering. (NAF)
In the 20 button control head the number buttons (0-9) are always operated together with a "mode" button, in order to change the numerical status of a function to which the "mode" button is allocated.

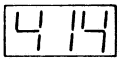
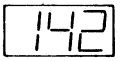
It is operated as follows:

Example: Channel no. 41 should be selected.
The display is the 3 digit version:

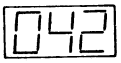
1) Display status: 
2) Operator action: depress the wanted number buttons, first "4":
3) Display status: 
- and then "1":
4) Display status: 
5) Now, the operator has approx. 5 seconds to check that the display shows the wanted number, and to allocate the number to the function by activating the appropriated button for function select (mode button).
After depressing the mode button: 
6) Display status:
(Notice the decimal points. Also notice the general approach that "leading zeros" are displayed).
The contents in the display remains for 5 seconds, whereafter it returns to the condition described in point 1 (normally stand-by).

Alternatives to the event in 5):

5a) More than 5 seconds elapse without any operator action. This causes the display to return to the condition in point 1) without any change has taken place in the radio system.
In other words, this is a way to delete an erroneous number selection.
Another way to correct is by "overwriting".

5b) Example: the number should have been "42", and not "41".
Operator depresses "4": 
Display status:
Operator depresses "2": 
Display status:

The first "4" overflows the display, but is still present in the buffer in the radio together with the displayed digits (the buffer size is 5 digits). Operator now depresses the channel mode button:

Display status: 
Notice: The leading "1" on the display is cancelled by mode selection because channel selection in C92 in this case, is supposed to be a 2 digits - and the same function could have different number of digits in different radios. (PROM defined).

If a mode button is depressed in stand-by condition, the respective functional data will appear on the display with the decimal points turned on for approx. 5 second.

Volume control is operated in 8 steps on the button marked V+ and V-. When the V+ (Volume up) is depressed, the volume is immediately increased by one step and the new setting is indicated on the display, by a digit with a decimal point (1. - 8.). If the button is released within about 0.4 second, the volume setting will remain on the selected level and the display will return to the condition, before volume selecting, after 5 seconds.

If the button is kept depressed, the volume level will increase 1 step every 0.4 second, until level 8 is reached, and no further stepping will take place.
When the V- (Volume down) is depressed, the operation will be analogous to the V+ operation.
Alert tone will sound each time the volume setting is stepped.

LS MUTE

For opening the loudspeaker it is necessary to push this button.
The ignition switch of the car can be used to control the on/off state of the radio system, instead of using the on/off button on the CB.
If ignition on/off is wanted, position 8 of the CB combination number should be "1".

The ignition switch can also be used as a control input for different functions as decribed in the following.

One function which is part of the basic "house keeping" will be described here:
If the radio is on in the moment where the ignition switch is turned off, then the operator will get an acoustical signal reminding him that the radio is still on. It is a condition that the ignition is connected to the junction box.

STORED DATA

When the radio is turned off, some of the operator selected data will be stored. These data are:

- Receiver audio level setting
- Channel number setting,
- Last selected number for address call

When the radio is turned on again, the stored data will automatically be used for the function in question.

Storno

ADJUSTMENT PROCEDURE

M9110

This adjustment procedure covers the Storno-phone 900 radiotelephones:

M9110	146-174 MHz simplex
M9110	146-174 MHz simplex with optional RX and TX side step frequencies
M9110	Duplex

The procedure comprises the following.

- Test set-up, RX-TX
- Measuring instruments
- Cables and connectors
- Adjustment tools
- Central Metering connectors, CM
- Voltage regulator checks
- Receiver adjustments
- Transmitter adjustments

For testing and adjustment the correct control head and accessories must necessarily be used. The type of control head and its function is depending on the software package of the radiotelephone.

When measuring voltages on the central metering connectors (RX CM, TX CM and SYSTEM CM) it is convenient to use a voltmeter with a sensitivity of 20 Kohm/V.

All central metering voltages stated for reference are measured with this type of meter and if another meter sensitivity is used readings must be considered for reference only.

MEASURING INSTRUMENTS

RF Signal generator	10-175 MHz
Multimeter	20 Kohm/V
AC Voltmeter	Z_i >20 Kohm/V
Distortion meter with psophometric filter	
Deviation meter	130-175 MHz
Frequency counter	10-175 MHz
AF Signal generator	0-5 kHz
RF Power meter	0-40 W
DC Power supply	10-20 V, Current limiter adjustable 0.1-10 A
DC Amperemeter	0-0.1 A
DC Amperemeter	0-10 A
AF Dummy load	8 ohm/5 W (15 W)
Control Head	C91/C92
Central metering box	
Junction box C9JB01	
Cable Kit C9CC01	
Adjustment tool kit	

CENTRAL METERING CONNECTORS (CM)

Power Amplifier Metering Connector

PA	Function	Connect meter to
		- +
1.	A-	
2.	A+	1 - 2
3.	Not used	
4.	Final current	4 - 2
5.	Drive current	6 - 2
6.	Not used	
7.	Not used	
8.	Power control	1 - 8
9.	Forward power	1 - 9
10.	Input drive	1 - 10

TX Central metering connector

TX	Function	Connect meter to −	+
1.	A-		
2.	A-		
3.	FS VCO tune	1	3
4.	FS Oscillator	1	4
5.	TX Level	1	5
6.	TX PLL Tune	1	6
7.	TX Status	1	7
8.	TX Filter	1	8
9.	TX Tripler	1	9
10.	Oscillator	1	10

RX Central metering connector

RX	Function	Connect meter to −	+
1.	A-		
2.	A-		
3.	Discriminator	1	3
4.	IF Amplifier	1	4
5.	RX Mixer	1	5
6.	RX PLL Tune	1	6
7.	RX Lock Detector	1	7
8.	RX Filter	1	8
9.	RX Tripler	1	9
10.	Oscillator	1	10

System	Function	Connect meter to −	+
1.	A-		
2.	A+	1	2
3.	+9 V	1	3
4.	+5 V	1	4
5.	Mic. HI	(1	5)+
6.	LS HI	6	7
7.	LS LO		
8.	TX Key	(1	8)+
9.	CG Disable	(1	9)+
10.	Spare		

+Connections used for instruments

Multiconnector

1.	Spare 2 (H22)	21.	Spare 8 (H53)
2.	Spare 3 (H23)	22.	
3.	Spare 1 (H24)	23.	
4.	Spare 5 (H26)	24.	
5.	N.C.	25.	
6.	LS High	26.	
7.	Serial Data Up	27.	
8.	Spare Audio	28.	
9.	MC High	29.	
10.	LS low	30.	
11.	Serial Data Down	31.	
12.	CG DISABLE	32.	
13.	MC Low	33.	
14.	Logic GND	34.	
15.	A-	35.	
16.	ON/OFF	36.	
17.	A+	37.	A+ (Battery)
18.	A-	38.	A- (Battery)
19.	A+	39.	A+ (Battery)
20.	Spare 7 (H27)	40.	A- (Battery)

ADJUSTMENT AND CHECKING

POLARITY AND OVERVOLTAGE CHECK

Set the power supply voltage to 13.6 V (V_{BATT}).
Set the current limiter to 0.1 A.
Connect the power supply with reverse polarity to the equipment.

Measure the voltage across the power leads with a voltmeter. The meter should read less than 1.5 V.
Connect the power supply with correct polarity to the equipment and set the current limiter to 3 A.
Turn the radio on.

CHECKING THE INTERNAL VOLTAGES

Put the test box system jack in the CM system connector.
Connect the voltmeter to 1 and 4 where +5 V is measured.
The meter should read 5.0 V.
Connect the voltmeter to 1 and 3 where +9 V is measured.
The meter should read 9.0 V.

These voltage measurements are not accurate enough for adjusting the voltages to be within the 0.5% tolerance. To do that a digital voltmeter must be used.
Both +5 V and +9 V are adjusted with potentiometer R5 in VR901.

FREQUENCY SYNTHESIZER ADJUSTMENT

Check the reference oscillator crystal frequency.

Type	Ref freq. MHz	Output freq. Range	Ch. Spacing
FS902	12.8000	12.8000-15.9875	12.5/25 kHz
FS903	10.2400	12.8000-15.3400	20 kHz
FS904	15.3600	11.5200-15.3400	15/30 kHz

Connect a frequency counter to the FS90x output J1.
Measure the frequency (output level 0 dBm).
For 12.5/25 kHz channel spacing the frequency should be a multiple of 12.5 kHz.
Example: 12.80000 MHz, 12.812500 MHz, etc.

For 20 kHz channel spacing the frequency should be a multiple of 20 kHz.
Example: 12.800000 MHz, 12.820000 MHz, etc.

For 30 kHz channel spacing the frequency should be a multiple of 30 kHz.
Example: 11.520000 MHz, 11.530000 MHz, etc.

The actual synthesizer frequency depends on the programming of the software programming of the channels.

If the frequency is not correct adjust the coil (FREQ. L1 in XO9012) in the FS90x reference oscillator.

RECEIVER ALIGNMENT

RECEIVER INJECTION SIGNAL ADJUSTMENT
FG911 (SIMPLEX)

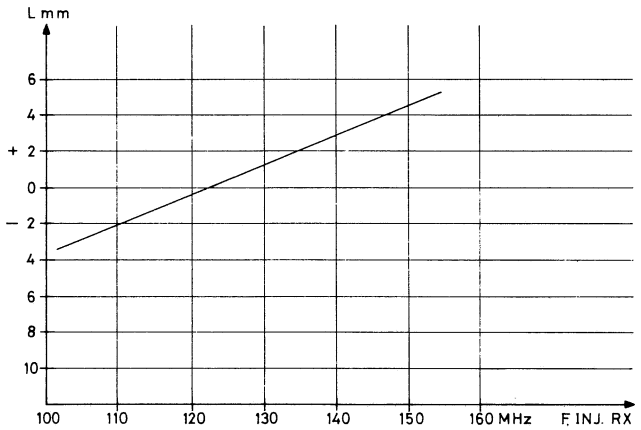
Put the RX/TX plug on the test box in the RX CM connector.
Connect the voltmeter to 1 and 10.
Adjust L3 (XO1) in FG911 for maximum voltmeter reading.
Select the center frequency channel.
Connect the voltmeter to 1 and 6.
Turn potentiometer R54 in FG911 completely clockwise.
Short R15 in FG911 to chassis through the hole in the FG911 cover.
Carefully adjust R54 in FG911 for maximum voltmeter reading, approx. 0.3 V.
Remove the R15 short.

NOTE
The varactor tuned filters in the FG911 have been factory adjusted to cover the entire frequency band and need not be readjusted.

If the receiver has side step channels:
Connect the voltmeter to 1 and 10.
Select the center side step channel.
Adjust L3 (XO3) in FG911 for maximum voltmeter reading.
Connect the voltmeter to 1 and 6.
Turn potentiometer R56 in FG911 completely clockwise.
Short R15 in FG911 to chassis through the hole in the FG911 cover.
Carefully adjust R56 in FG911 for maximum voltmeter reading, approx. 0.3 V.
Remove the R15 short.

RECEIVER INJECTION SIGNAL ADJUSTMENT FG912 (DUPLEX)

Put the RX/TX plug on the test box in the RX CM connector.
Connect the voltmeter to 1 and 10.
Preadjust all filter cores in FG912 according to the following diagram.



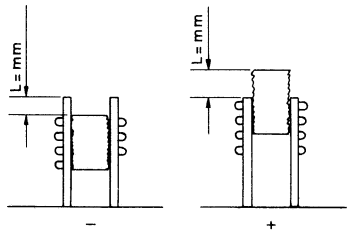


Fig. 1 TUNING SLUGS FG912/EX911 D403.214

Adjust L_{XO} (L3 in XO905) in FG912 for maximum reading, at least 0.3 V.
Connect the voltmeter to 1 and 8.

Adjust L2, L3 and L4 in FG912 for maximum voltmeter reading. The voltage peak is small and careful adjustment is necessary. Minimum increase in voltage reading should be at least 0.05 V.
Connect the voltmeter to 1 and 6.
Adjust L5, L6, L7, L8, L9, L10, L11 and L12 in FG912 for maximum voltmeter reading. Minimum increase in voltage reading should be 0.15 V.
Connect the voltmeter to 1 and 5.
Adjust L14 and L15 in FG912 for maximum voltmeter reading.
Adjust L2, L3 and C2 in RC911 for maximum voltmeter reading.

INJECTION FREQUENCY ADJUSTMENT FG912

Before adjustment of the injection frequency the synthesizer frequency should be checked, refer to Frequency Synthesizer Adjustment.
Connect a frequency counter to the output of FG912, J2.
Calculate the injection frequency:

$$F_{inj} = F_{ant} - 21.4 \text{ MHz}$$

Adjust L_X (L2 in XO905) for correct injection frequency according to the temperature curve.
See page 9 fig. 3.

RECEIVER INJECTION SIGNAL ADJUSTMENT RC911/RC912

Connect the voltmeter to 1 and 5.
Adjust L4, L5 and C2 in RC911/RC912 for maximum voltmeter reading.

INJECTION FREQUENCY ADJUSTMENT

Before adjustment of the injection signal frequency the synthesizer frequency should be checked, refer to Frequency Synthesizer Adjustment.
Connect a frequency counter to the RX output of the FG911, J2.
Calculate the injection frequency:

$$F_{inj} = F_{ant} - 21.4 \text{ MHz}$$

Adjust L2 (XO1) in FG911 for correct injection frequency according to the temperature curve. See page 9 fig. 3.

ALIGNMENT OF RECEIVER FRONT-END RC911/RC912

This adjustment is only necessary if the helix filters are out of adjustment or need readjustment.
Connect the signal generator to the antenna connector and set its frequency to the channel frequency.

Set the signal generator output level to 100 dB/1 uV or 100 mV.

Preadjust the tuning slugs TS1-TS2-TS3-TS4-TS5 to their approximate positions according to the following graph:

Connect the voltmeter to 1 and 4.
Adjust TS1-TS2-TS3-TS4, C2 and L2 for maximum voltmeter reading.
Decrease the signal generator level to be below the limiting point of the IF-amplifier as the sensitivity increases and before fine tuning.

Adjust TS5 to approximately the same height as TS4.

Detune TS2 and TS4 about 4 turns (~3 mm).

Adjust TS1, TS3, TS5 and C2 in RC911/RC912 for maximum voltmeter reading.

Adjust TS2 and TS4 for maximum voltmeter reading. Repeat the adjustment until no fur-

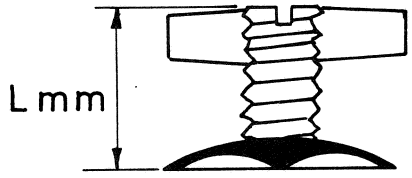
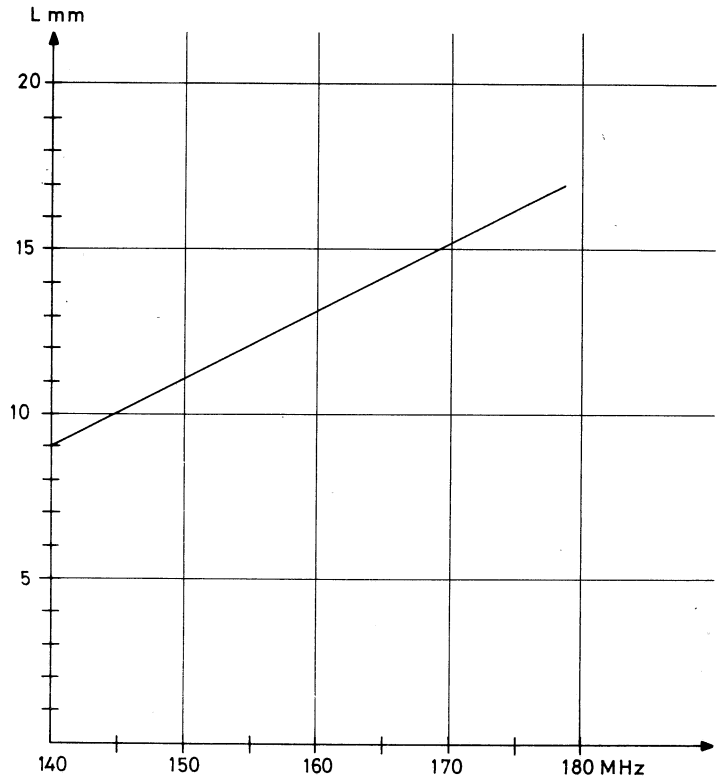


Fig. 2



TUNING SLUGS RC911/RC912
D403.215

ther improvement is possible.
Fine tune TS1, TS2, TS3, TS4, TS5, C2 and L2 for maximum voltmeter reading.

ADJUSTMENT OF SIDE STEP RECEIVER FRONT-END RC913

The RC913's side step function is controlled by the logic level on pin 2 of P1.
In normal mode the level is logical '1' (approx. 4 V) and in side step mode the logical level is '0' (approx. 0 V).
Select a normal mode channel.
Connect the signal generator to the antenna connector and set its frequency to the receiver frequency.
Adjust the signal generator output to 100 mV.
Connect the voltmeter to 1 and 4.

Decrease the signal generator output level to be below the limiting point of the IF-amplifier as the sensitivity increases during adjustment.

Adjust R18 on RC913 for maximum voltmeter reading.
Select a side step channel.
Adjust R17 on RC913 for maximum voltmeter reading.

WARNING
The RF filters in RC913 are factory adjusted to cover frequency range 146-174 MHz and must not be touched.

After adjustment of IA90x (L1, L6 and L8 for min. distortion.
Adjust L8 in RC913 for minimum distortion.

IF AMPLIFIER ADJUSTMENT
IA90x

Connect the signal generator to the antenna connector.
Set the generator frequency to the channel frequency and its output level to 1 mV EMF.

Modulate the signal generator with 1 kHz to:
3.0 kHz for 25 kHz channel spacing
1.5 kHz for 12.5 kHz channel spacing
2.5 kHz for 20 kHz channel spaning

Connect an 8-ohm/5 W load between LS HI-LS LO.
Connect a distortion meter across the load. (System CM connector 6-7).
Set the volume on the control head to position 6.
Adjust L1, L6, L8 in IA90x for minimum distortion.
Adjust L2 in RC911/RC912 for minimum distortion.

RC911
Connect the voltmeter to 1 and 4.
Check the voltmeter reading for being approximately 0.5 V for 10 uV input signal (EMF).

RC912
Connect the voltmeter to 1 and 4.
Check the voltmeter reading for being approximately 0.5 V for 3 uV input signal (EMF).

AUDIO SIGNAL ADJUSTMENT

Connect an 8-ohm/5 W load between LS HI-LS LO (6-7).
Connect an AF voltmeter across the load.
Set the output level from the signal generator to 1 mV EMF on the channel frequency.
Modulate the signal generator with 1 kHz to:
3.0 kHz for 25 kHz channel spacing
1.5 kHz for 12.5 kHz channel spacing
2.5 kHz for 20 kHz channel spacing

Set the volume on the control head to position 7.
The squelch control on the control head shall be unactivated and a possible subaudio signal (Channel Guard tone) shall be unmuted.
Activate the LS function (Monitor function).
Adjust R_{VOL} (R11 on AA903) for 5 W into the 8-ohm load (6.3 V RMS).

RECEIVER SENSITIVITY MEASUREMENT

Select the center channel.
Set the signal generator to the receiver frequency and adjust the output level to 1 mV EMF.
Connect an 8-ohm/5 W load between LS HI-LS LO (6-7).
Connect a distortion meter with a psophometric filter across the load.
Set the volume to position 6 on the control head.
Measure the receiver sentitivity according to CEPT specifications (or EIA).

CEPT SENSITIVITY SPECIFICATION, SIMPLEX

RC911/RC913:
20 dB psophometric SINAD for
V_{input} less than 0.7 uV EMF.

RC912:
20 dB psophometric SINAD for
V_{input} less than 0.4 uV EMF.

EIA SENSITIVITY SPECIFICATION, SIMPLEX

RC911/RC913:
12 dB SINAD for
V_{input} less than 0.35 uV (½ EMF).

RC912:
12 dB SINAD for
V_{input} less than 0.2 uV (½ EMF).

In radios with RC912 the sensitivity can be optimised by finetuning TS2 for maximum SINAD.

CEPT SENSITIVITY SPECIFICATION, DUPLEX

With RC911 and BF911:
20 dB psophometric SINAD for
V_{input} less than 0.95 uV EMF.

EIA SENSITIVITY SPECIFICATION, DUPLEX

With RC911 and BF911:
12 dB SINAD for
V_{input} less than 0.45 uV (½ EMF).

Measure the sensitivity on the highest and lowest channel frequencies.
Compared with the measured sensitivity on the center channel the sensitivity degradation shall be less than 1 dB.

SQUELCH ADJUSTMENT

Connect the signal generator to the antenna connector and set it to the receiver frequency.
Modulate the signal generator with 1 kHz to:

- 3.0 kHz for 25 kHz channel spaning
- 1.5 kHz for 12.5 kHz channel spacing
- 2.5 kHz for 20 kHz channel spacing

Set the signal generator output level to the measured SINAD sensitivity.
Reduce the signal generator output 2 dB.
Activate the squelch function on the control head.
Adjust R_{SQ} (R10 on AA903) until the squelch circuit just opens the receiver AF output.
Check that the squelch closes when the RF signal is removed from the antenna input.

DUPLEX FILTER
BF911

The duplex filter is factory adjusted to the ordered channel frequencies and need not be readjusted.

MEASURING RECEIVER CURRENT DRAIN

Measure the receiver current drain at
V_{BATT}= 13.6 V.

Off condition:	less than 75 mA
Standby:	less than 1 A
Receive 5 W:	less than 2.4 A

TRANSMITTER ALIGNMENT

Connect a VHF power meter, 25 W (40 W), to the antenna connector.
Set the power supply voltage to 13.6 V.
Set the current limiter to 10 A.
Select the center channel.
Key the transmitter when adjusting.

EXCITER ALIGNMENT, SIMPLEX
FG911

Put the RX/TX plug on the test box in the TX CM connector.
Connect the voltmeter to 1 and 10.
Key the transmitter.
Adjust L3 in XO2 (XO906-PWR) in FG911 for maximum voltmeter reading.
Connect the voltmeter to 1 and 7.
Turn potentiometer R55 (FG911) fully clockwise.
Short R15 (FG911) to chassis through the hole in the cover.
Carefully adjust R55 (FG911) for maximum voltmeter reading (at least 0.3 V).
Remove the R15 short.

If the transmitter has 1 side step:
Connect the voltmeter to 1 and 10.
Select the center channel of the 1. side step.
Key the transmitter.
Adjust L3 in XO3 (XO906-PWR) for maximum voltmeter reading.
Turn R56 (FG911) fully clockwise.
Short R15 (FG911) to chassis through the hole in the cover.
Carefully adjust R56 (FG911) for maximum voltmeter reading (at lest 0.3 V).
Remove the R15 short.

If the transmitter has 2 side steps:
Connect the voltmeter to 1 and 10.
Select the center channel of the 2. side step.
Key the transmitter.
Adjust L3 in XO4 (XO906-PWR) for maximum voltmeter reading.
Turn R57 (FG911) fully clockwise.
Short R15 (FG911) to chassis through the hole in the cover.
Carefully adjust R57 (FG911) for maximum voltmeter reading (at least 0.3 V).
Remove the R15 short.

NOTE
The varactor tuned filters in the FG911 are factory adjusted to cover the 146-174 MHz band and should not be touched.

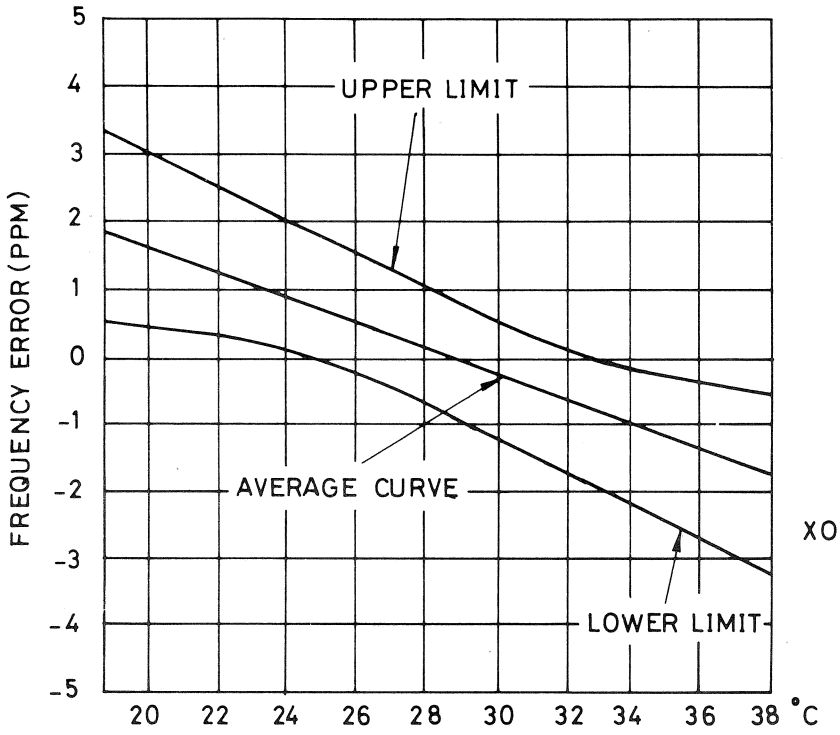
TRANSMITTER FREQUENCY ADJUSTMENT

Before adjusting the transmitter frequency the synthesizer frequency should by checked, refer to Frequency Synthesizer Adjustment.

Connect the frequency counter to the output of FG911 (J3) through an attenuator (output level 0.5 W).

Select a normal mode channel.
Key the transmitter.
Measure the frequency and if necessary adjust the frequency with L2 (XO2) in FG911 (XO906-FREQ.).
Requirement: $F_{ant} \pm 100$ Hz

The frequency setting is temperature dependent according to the following graph.



XO900 FREQUENCY ERROR CURVE
D403.172

Fig. 3

If the transmitter has 1 side step:
Select the center channel of 1. side step band and measure the frequency. If necessary adjust the frequency with L2 (XO3).

If the transmitter has 2 side steps:
Select the center channel of 2. side step band and measure the frequency. If necessary adjust the frequency with L2 (XO4).

NOTE
The transmitter shall be unmodulated when adjusting the frequency.

EXCITER ALIGNMENT, DUPLEX
EX911

Put the RX/TX plug on test set in the TX CM connector.
Connect the voltmeter to 1 and 10.

In EX911 adjust L12 for maximum voltmeter reading, L13 for minimum reading and L14 for maximum reading.
Minimum voltage reading should be at least 0.1 V.
Connect the voltmeter to 1 and 9.

In EX911 adjust L3 (XO), L12, L13 and L14 for maximum voltmeter reading.
Repeat the adjustment until no further improvement is possible.

Connect the voltmeter to 1 and 7.
Set R7 (EX911) to its center position.
Select the center frequency channel.

Preset the tuning slugs of L3, L4, L5, L8, L9, L10 and L11 (EX911) to approximately the same position as L12. This ensures selection of the correct mixer output frequency.

Adjust L3, L4, L5 and L8 for maximum voltmeter reading. Minimum reading should be at least 0.25 V.
Note that L8 can be in a position where absolutely maximum reading does not appear.
If so chose another setting of L8 and readjust.

Connect the voltmeter to 1 and 6.
Adjust L8 and L9 for maximum voltmeter reading. If the output level is not high enough to give a meter deflection.
Put the RX/TX plug on the test box in the PA CM connector.
Connect the voltmeter to 1 and 10.

Adjust L8, L9, L10 and L11 for maximum voltmeter reading. The reading should be at least 0.3 V.

Select the lowest and highest transmitting frequency channel. If the voltmeter reading differs from the center channel reading by more than 0.1 V then readjust L8, L9, L10 and L11.

Select the center transmitting frequency channel.
Connect a spectrum analyzer (130-200 MHz) to the output of EX911 (J1).

Adjust potentiometer R7 (EX911) for minimum spurious outputs in the frequency range $f_o \pm 14$ MHz.

TRANSMITTER FREQUENCY ADJUSTMENT

Before adjusting the transmitter frequency the synthesizer frequency should by checked, refer to Frequency Synthesizer Adjustment.

Connect the frequency counter to the output of EX911 (J1) through an attenuator (output level 0.5 W).

Key the transmitter.
Measure the frequency and if necessary adjust the frequency with L_x (L2 in FG911) (XO906-FREQ.).
Requirement: $F_{ant} \pm 100$ Hz

The frequency setting is temperature dependent according to the graph (fig. 3).

Note: The transmitter shall be unmodulated when adjusting the frequency.

TRANSMITTER OUTPUT POWER ADJUSTMENT

Key the transmitter.
Adjust R_{PA} in the power amplifier for rated output power.

TRANSMITTER MODULATION ADJUSTMENT

Connect an AF generator to the modulation input on the test box (System CM connector 1-5).
Set the AF generator frequency to 1 kHz and the output to 1.0 V.
Read the deviation on the deviation meter.

Change the AF frequency between 300 and 3000 Hz to find the peak deviation. At this frequency adjust R61 (FG911) or R_{18} (EX911) for:

- ±5 kHz for 25 kHz channel spaning
- ±4 kHz for 20 kHz channel spaning
- ±2.5 kHz for 12.5 kHz channel spaning

If the transmitter has side step channels (FG911) the deviation for side step 1 is adjusted with R62 and for side step 2 with R63.

The Channel Guard deviation is adjusted with R_A (FG911) or R_{CG} (EX911).
(Potentiometer in AA901/2).

Set the AF generator frequency to 1000 Hz.
Reduce the AF generator output until the deviation is:

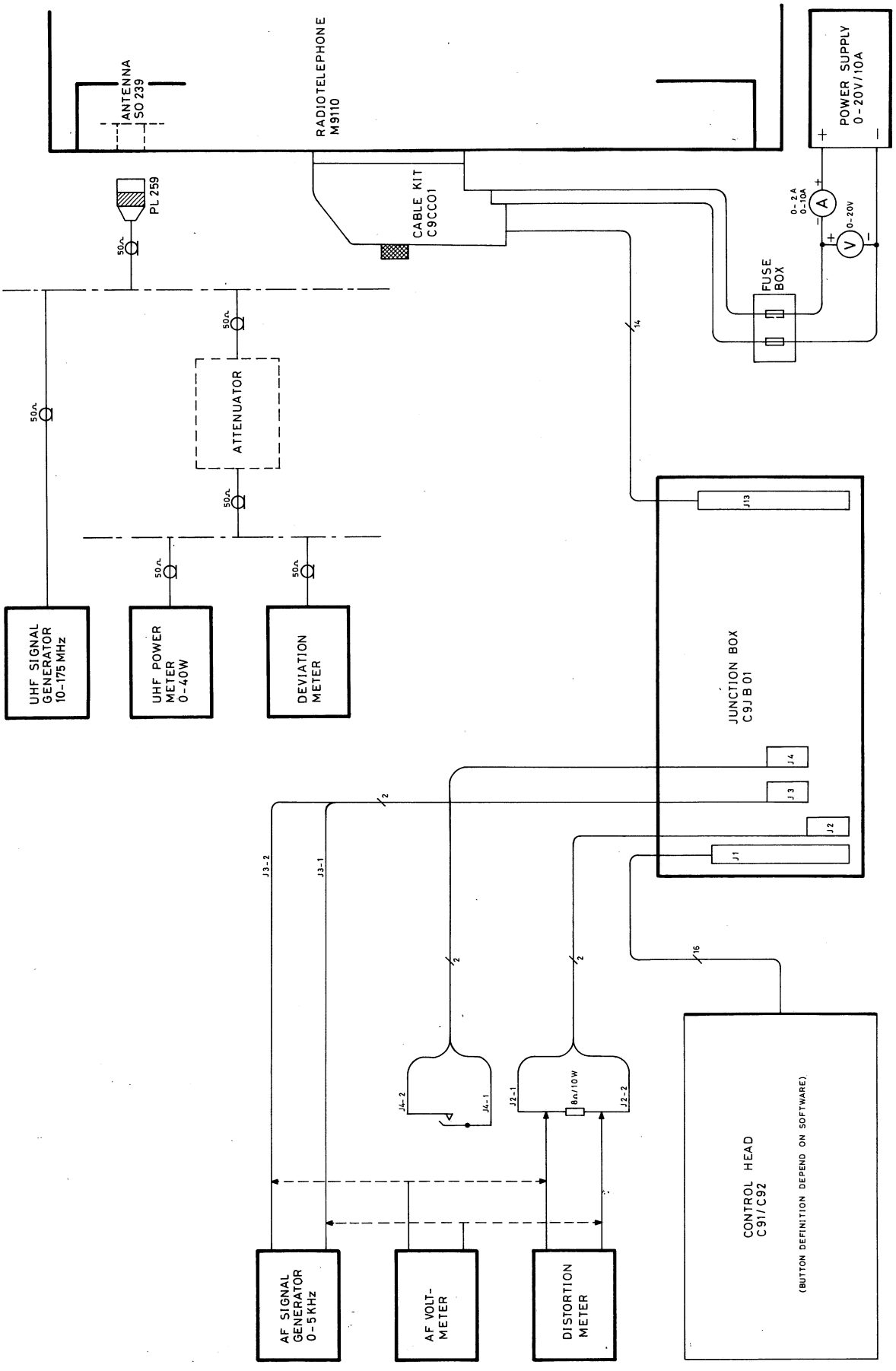
- ±3 kHz for 25 kHz channel spacing
- ±2.4 kHz for 20 kHz channel spacing
- ±1.5 kHz for 12.5 kHz channel spacing

The AF generator level should be 100 mV ±3 dB.

MEASURING THE TRANSMITTER CURRENT DRAIN

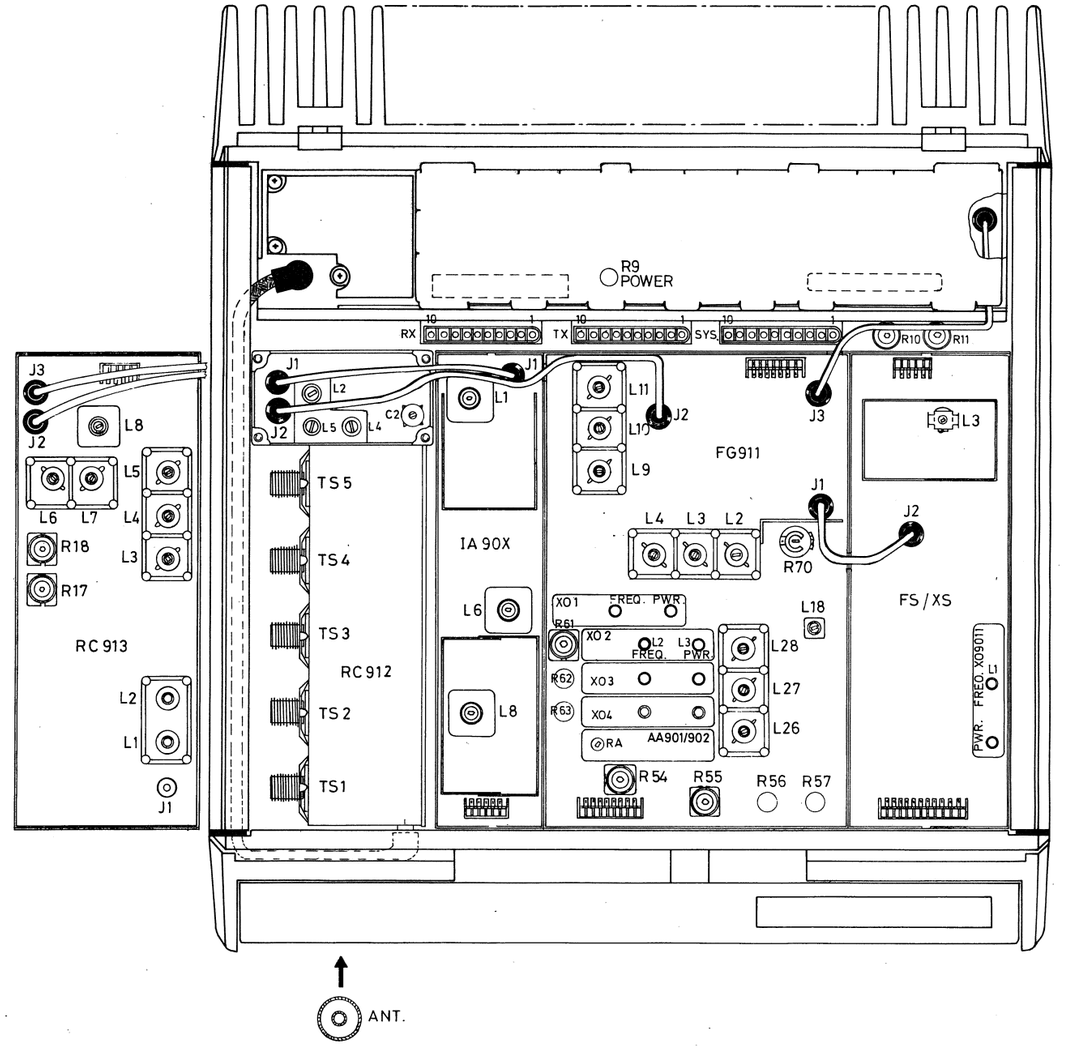
Measure the current drain at $V_{BATT} = 13.6$ V.

Requirement:
RF output 10 W (simplex): less than 4.5 A
RF output 25 W (simplex): less than 7.5 A
RF output 25 W (duplex): less than 11.5 A

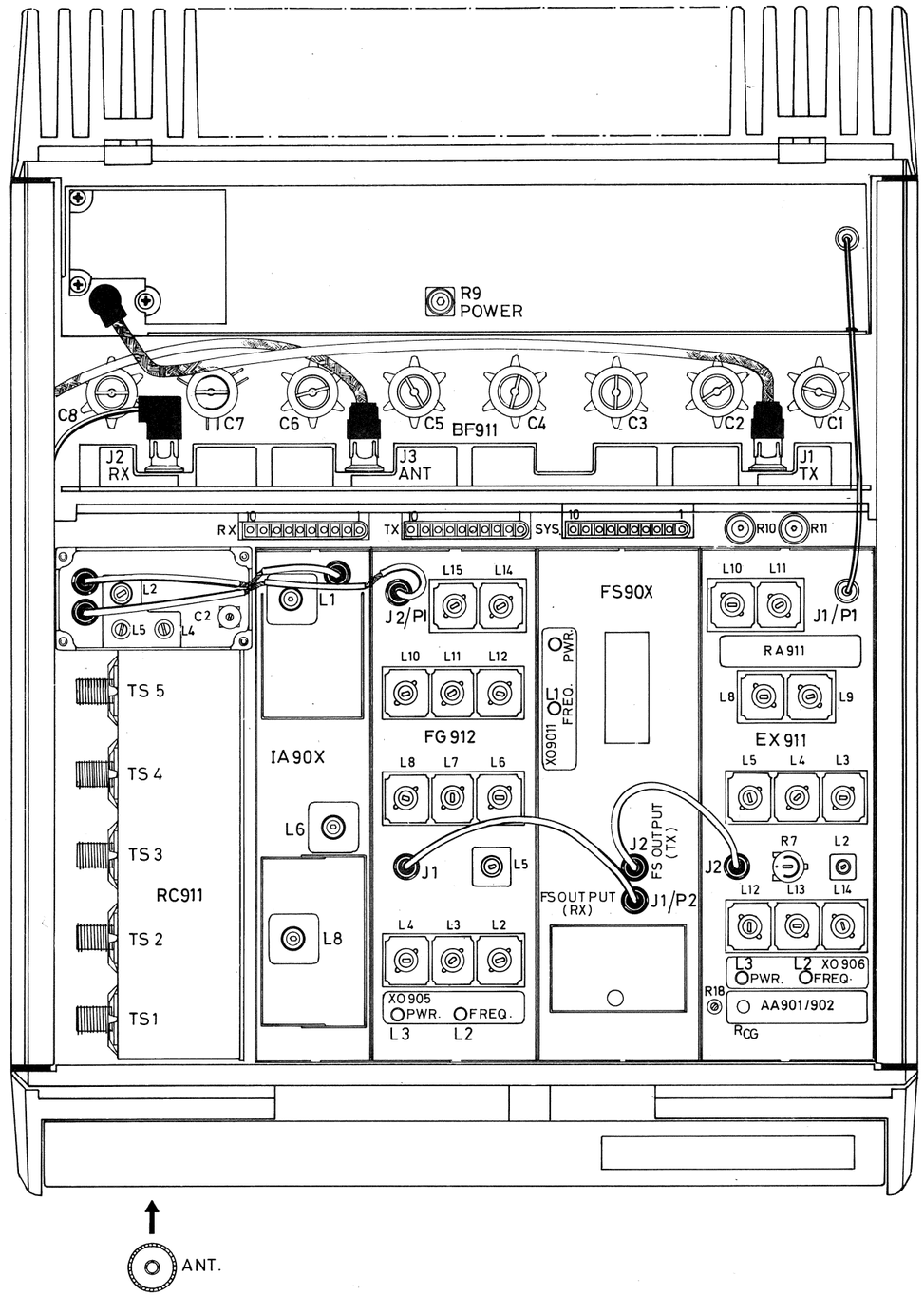


TEST SETUP M9110

D403.225



ADJUSTABLE COMPONENTS AND CENTRAL METERING
RF - SIDE **M9110 SIMPLEX** **D403.182/2**



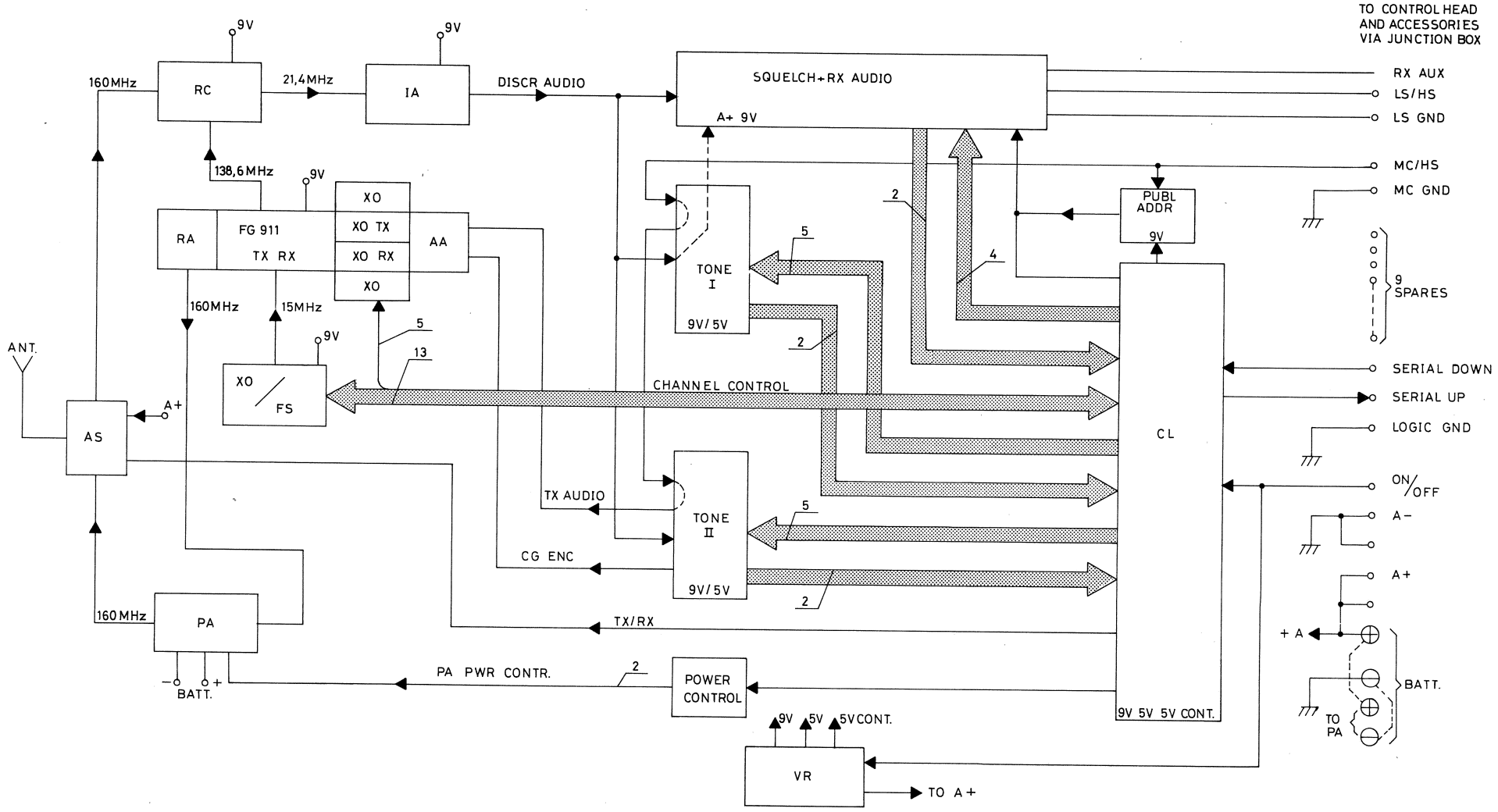
ADJUSTABLE COMPONENTS AND CENTRAL METERING
RF - SIDE

M9110 DUPLEX

D403.183/2

Storno

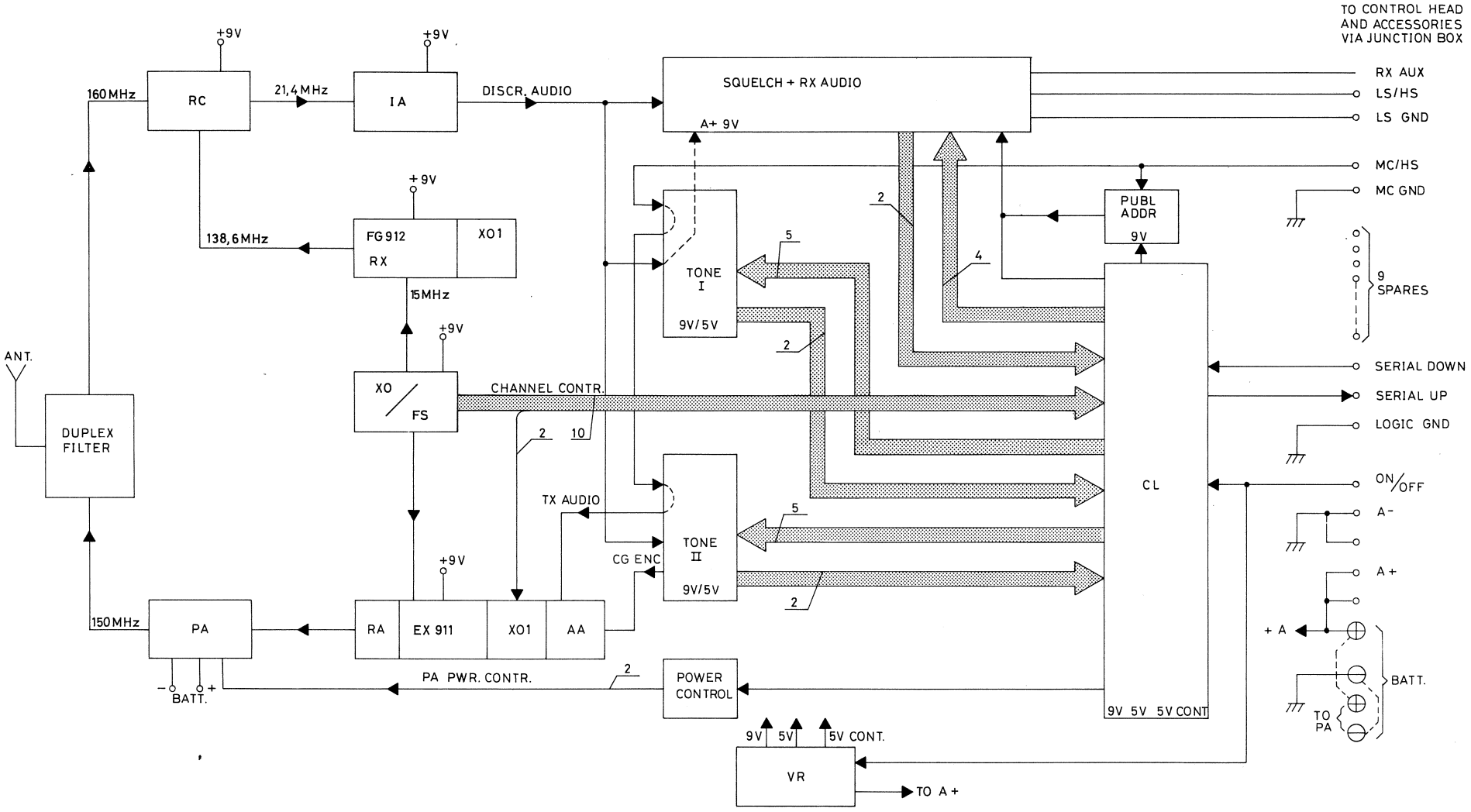
Storno



STORNOPHONE M9110
FUNCTIONAL DIAGRAM
SIMPLEX

D403.126

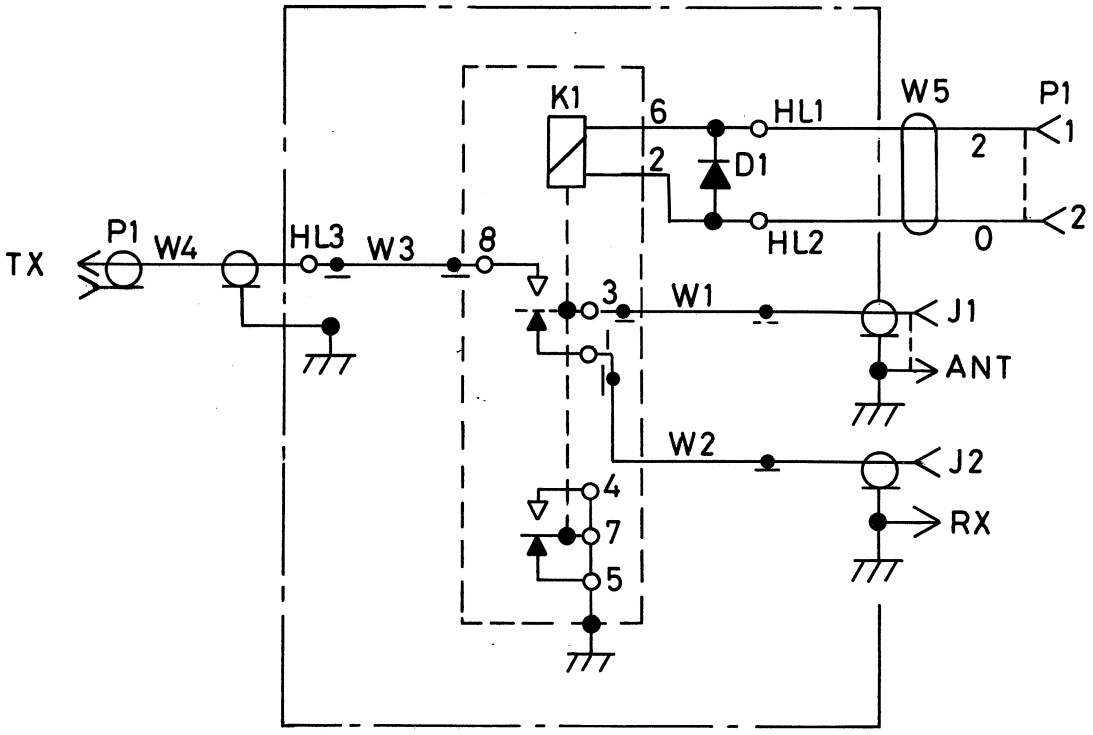
Storno



STORNOPHONE M 9110
FUNCTIONAL DIAGRAM
DUPLEX

D403.127

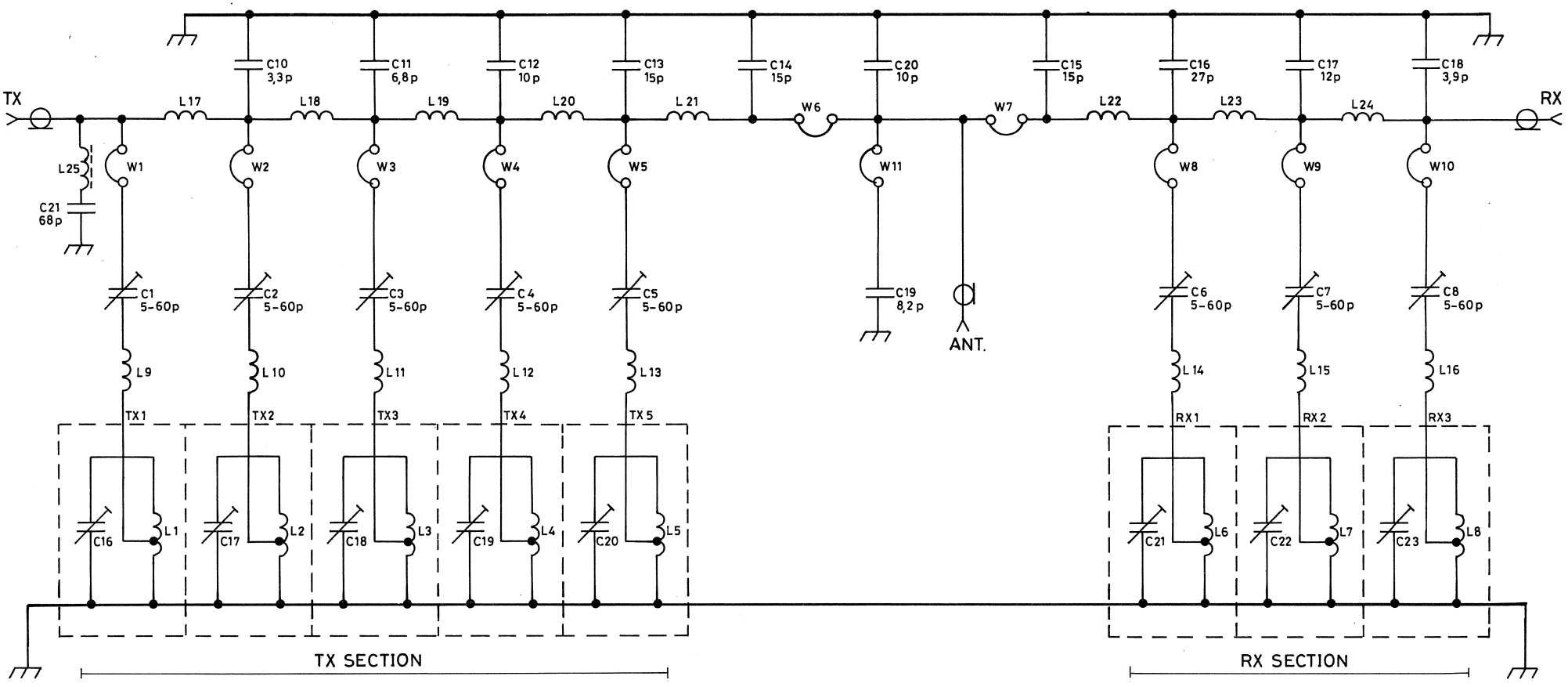
Storno



ANTENNA SWITCH AS901

D402.909

Storno

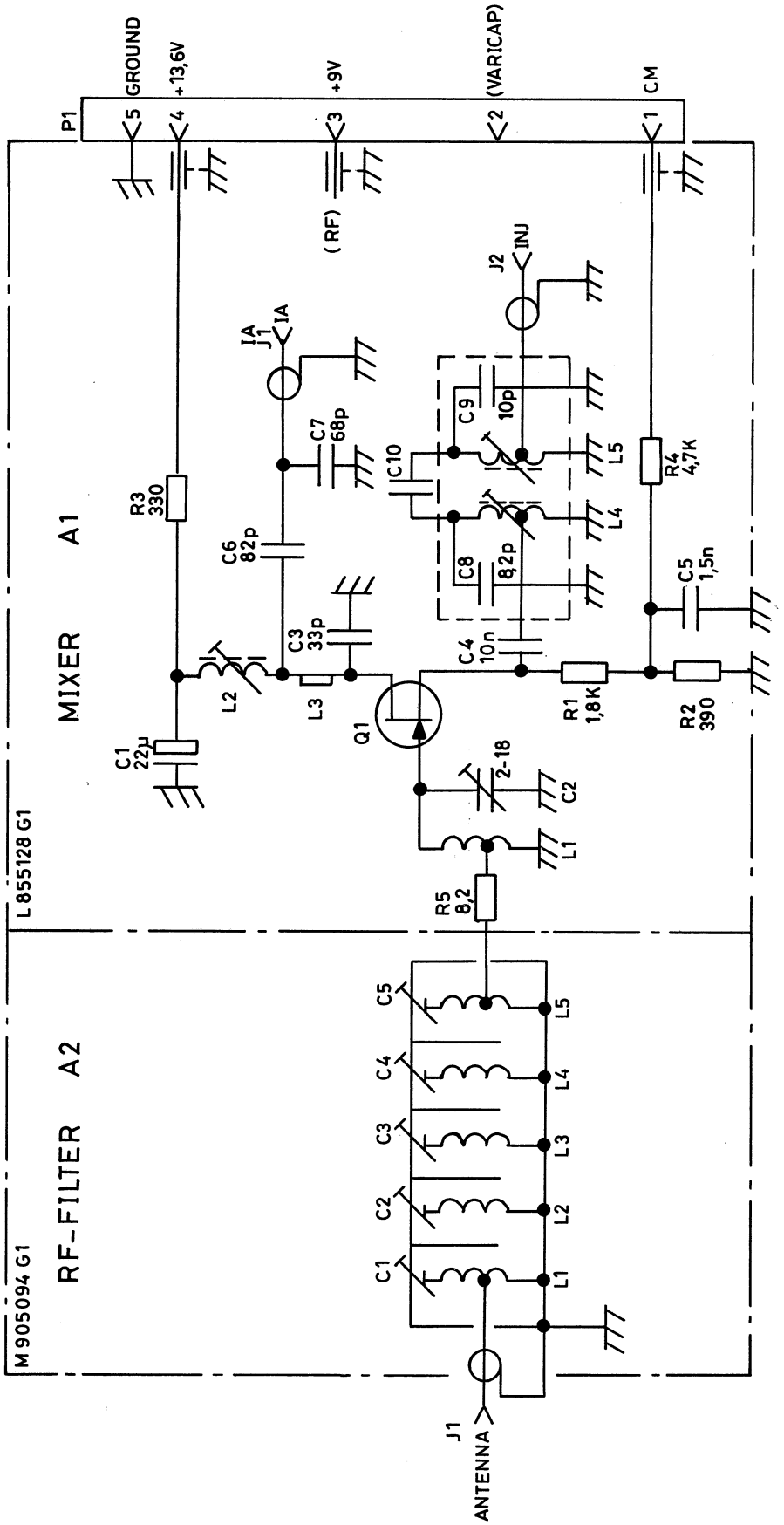


L9 - L24 : PART OF PWB
C16 - C26 : CORE TUNING

BRANCHING FILTER BF 911

D 403.153

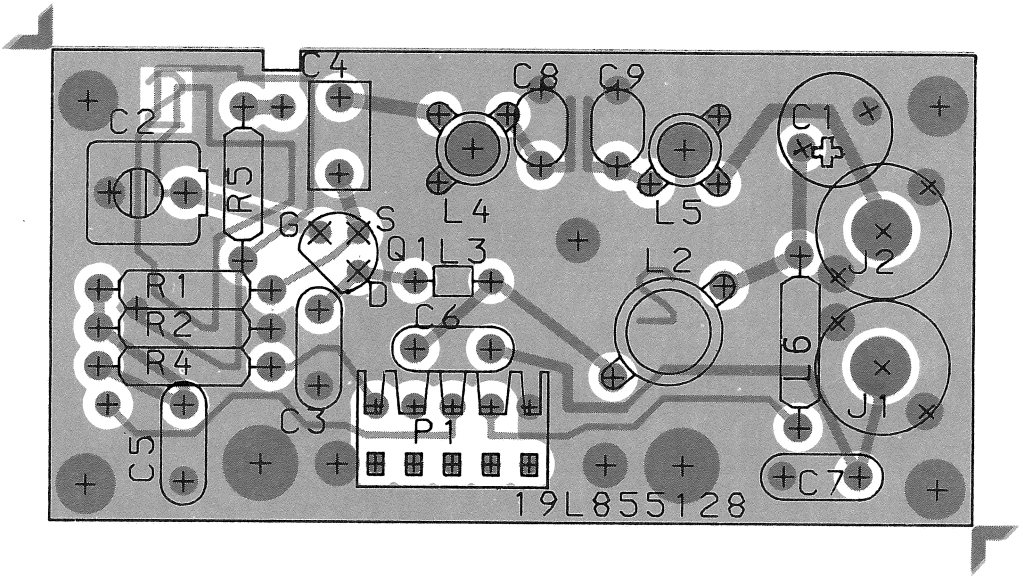
Storno



RECEIVER CONVERTER RC911

D403.121

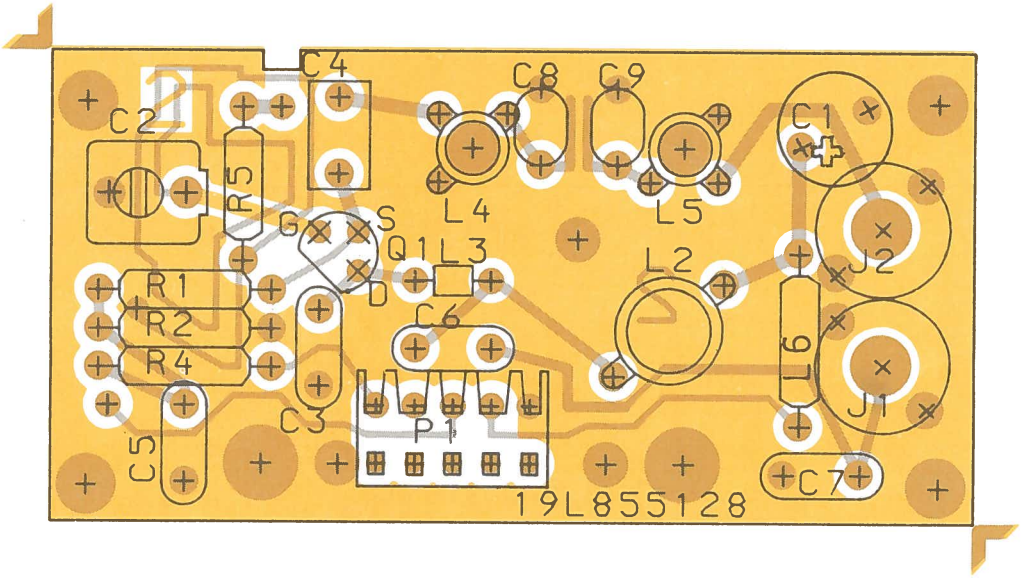
Storno



HIGH IM RC 138-174 MHz RC911
COMPONENT LAYOUT

D402.962/2

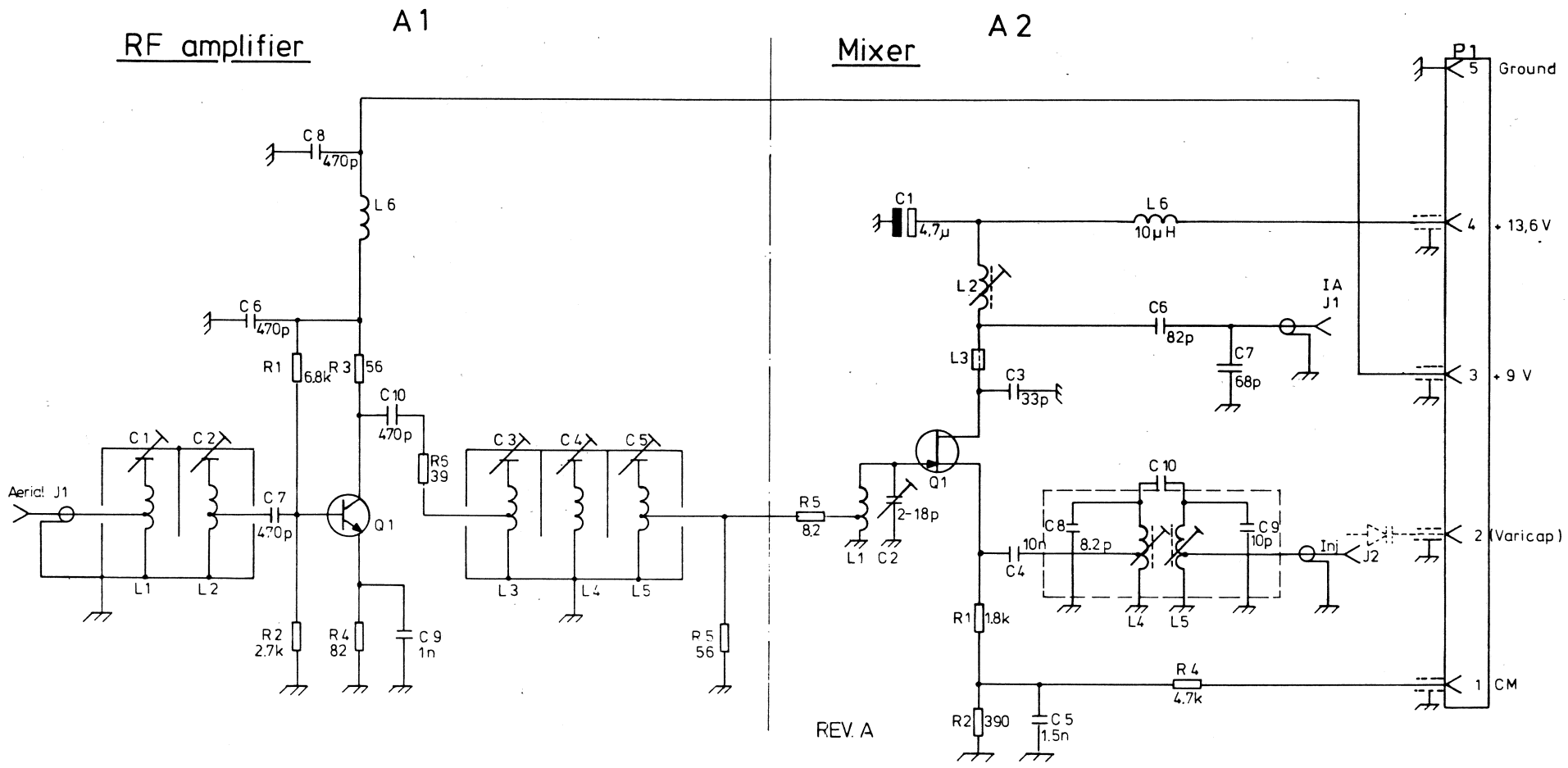
Storno



HIGH IM RC 138-174 MHz RC911
COMPONENT LAYOUT

D402.962/2

Storno

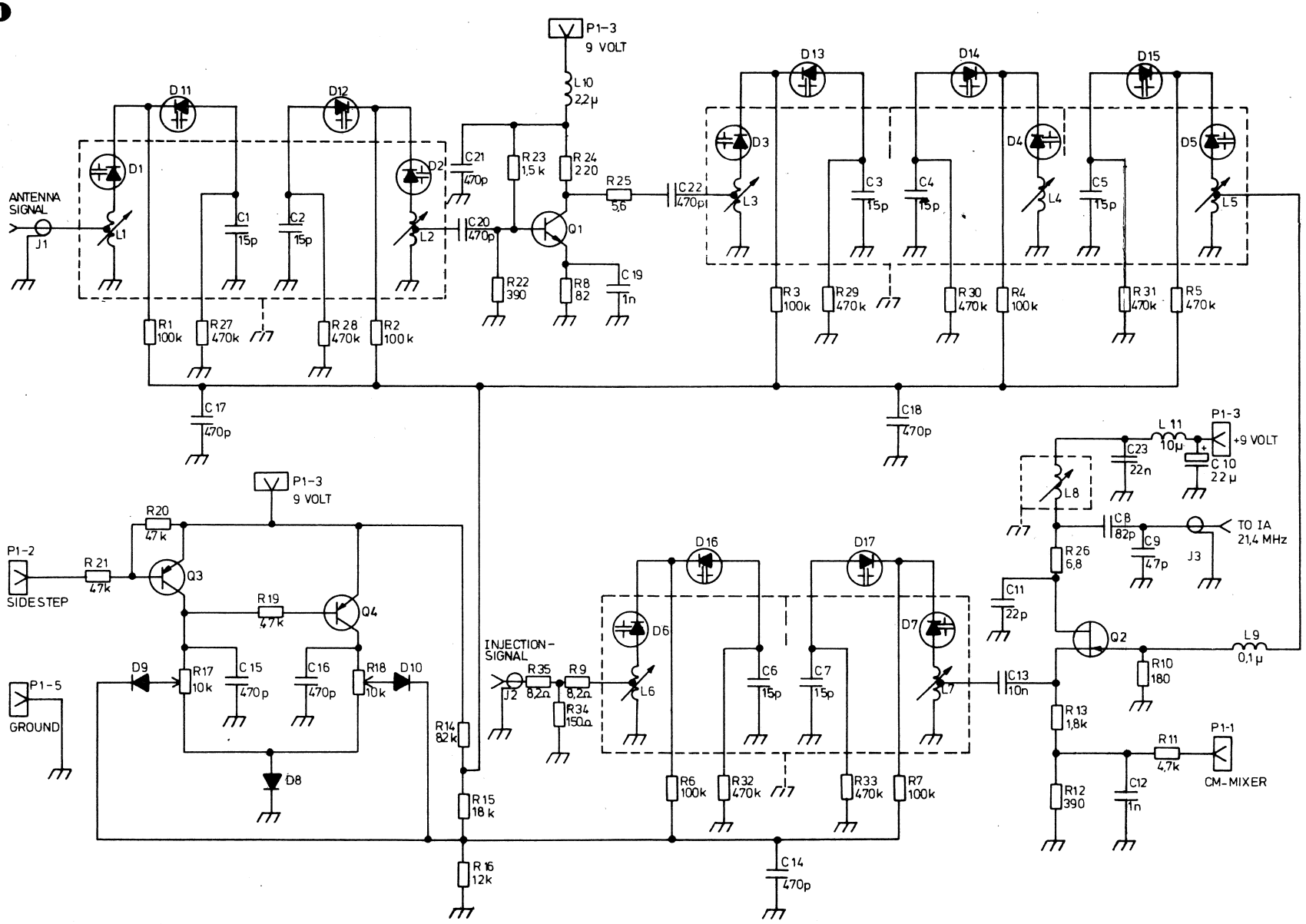


RECEIVER CONVERTER RC912

D403.188

Storno

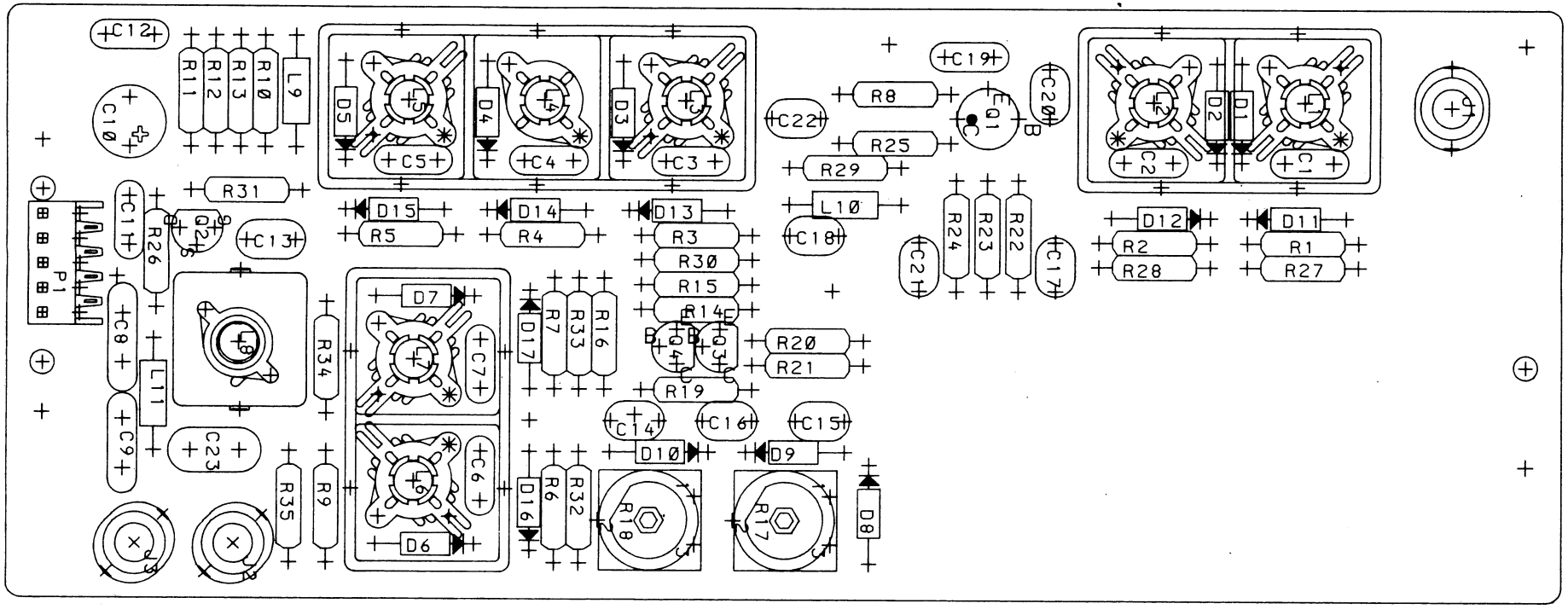
Storno



VARACTOR TUNED RECEIVER CONVERTER RC913

D403.189

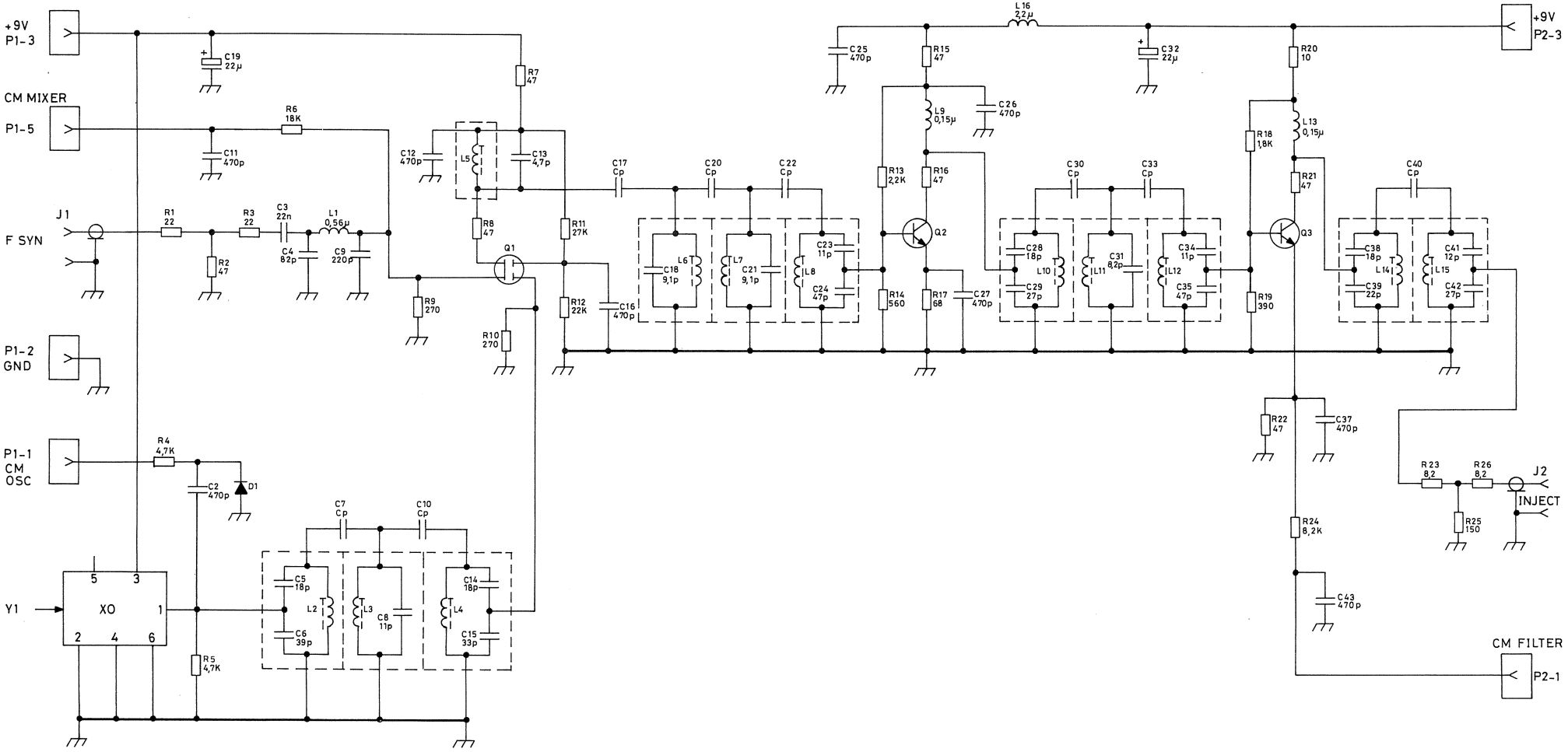
Storno



VARACTOR TUNED RECEIVER CONVERTER RC913
COMPONENT LAYOUT

D403.239

Storno



FREQUENCY GENERATOR FG912

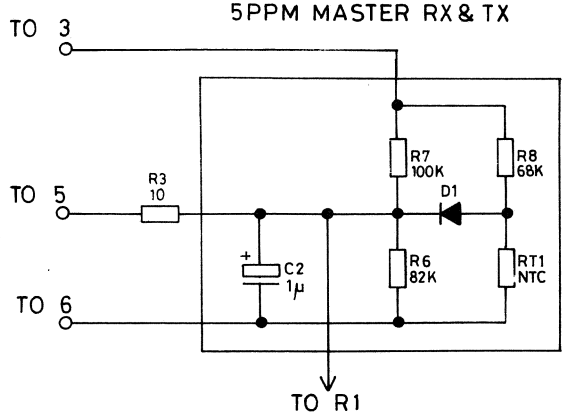
D403.146

Storno

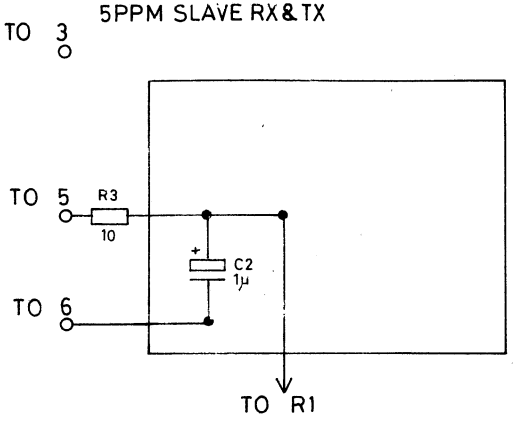
TEMPERATURE COMPENSATION CIRCUITS

Storno

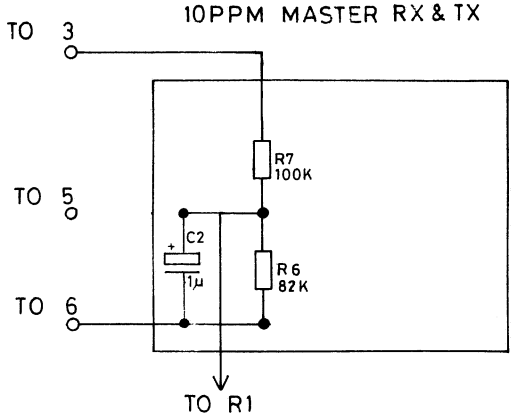
XO905 - XO906
5PPM MASTER RX & TX

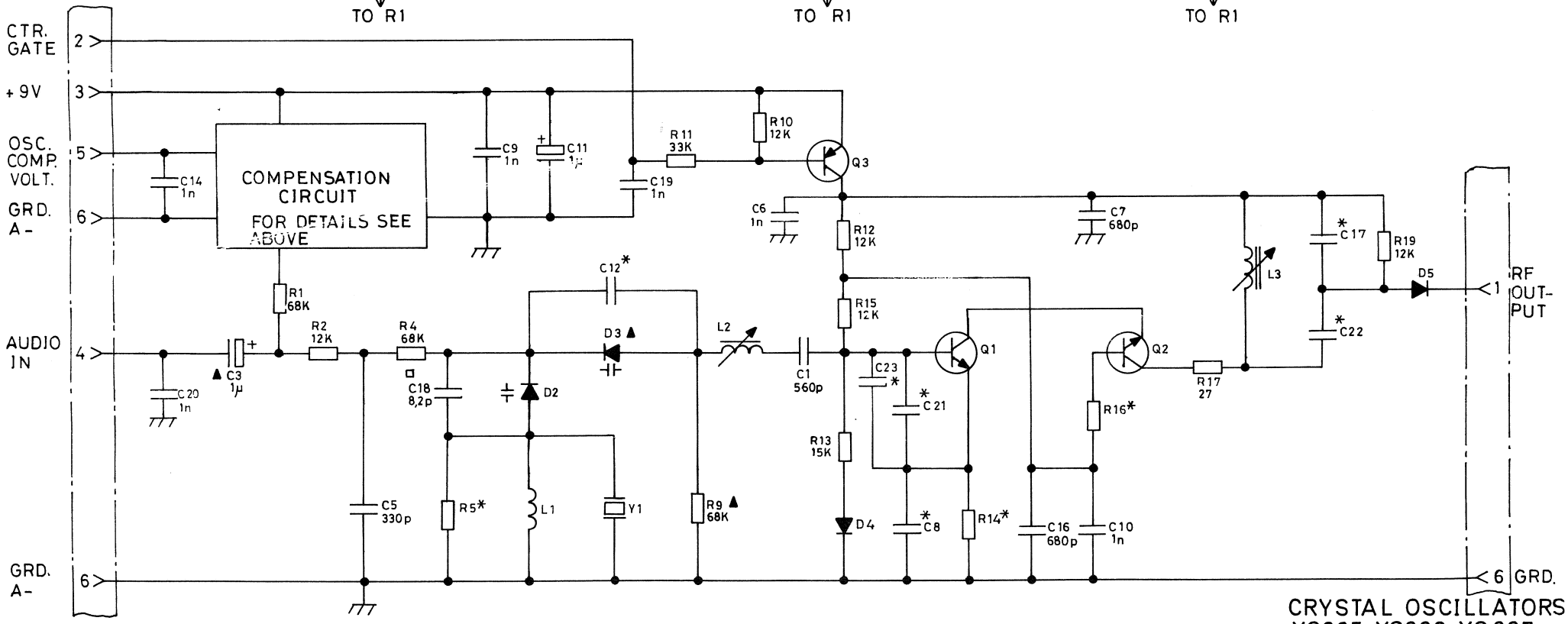


XO907 - XO908
5PPM SLAVE RX & TX



XO909 - XO9010
10PPM MASTER RX & TX





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

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

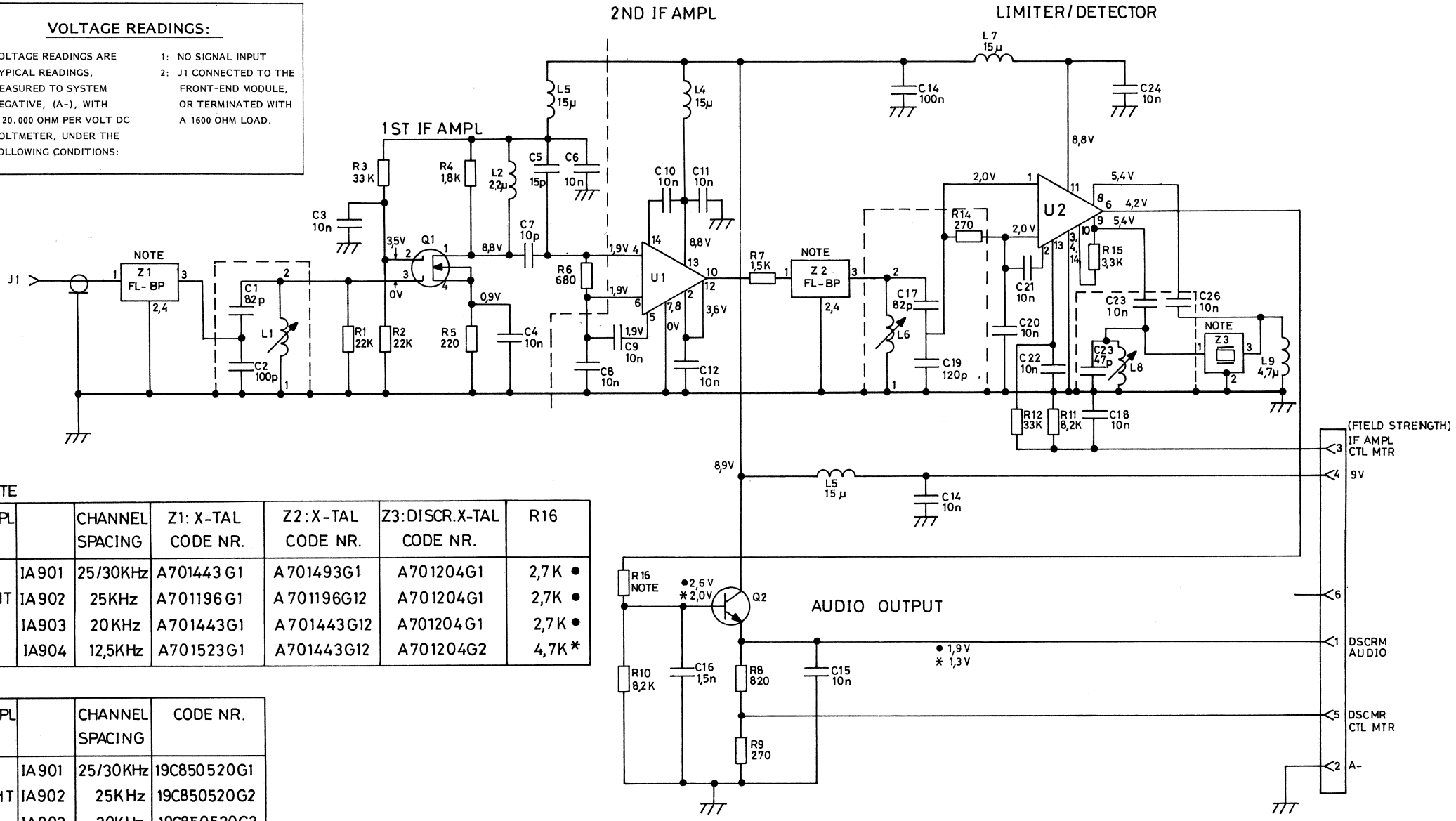
D403.024/3

Storno

VOLTAGE READINGS:

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.



NOTE

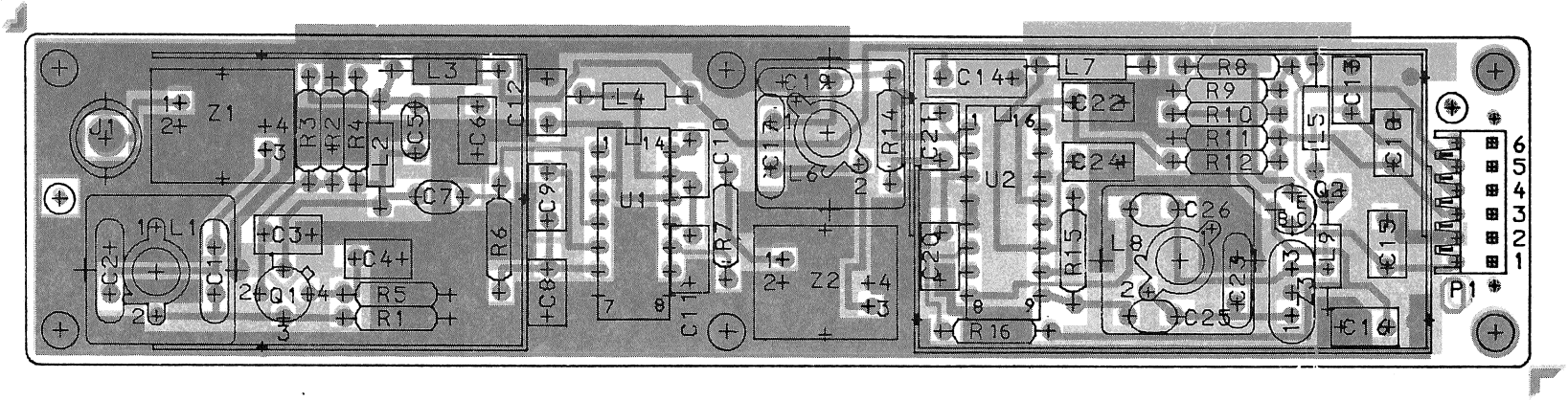
APPL		CHANNEL SPACING	Z1: X-TAL CODE NR.	Z2: X-TAL CODE NR.	Z3: DISCR.X-TAL CODE NR.	R16
NMT	IA901	25/30KHz	A701443G1	A701493G1	A701204G1	2,7K •
	IA902	25KHz	A701196G1	A701196G12	A701204G1	2,7K •
	IA903	20KHz	A701443G1	A701443G12	A701204G1	2,7K •
	IA904	12,5KHz	A701523G1	A701443G12	A701204G2	4,7K *

APPL		CHANNEL SPACING	CODE NR.
NMT	IA901	25/30KHz	19C850520G1
	IA902	25KHz	19C850520G2
	IA903	20KHz	19C850520G3
	IA904	12,5KHz	19C850520G4

21,4 MHz IF AMPLIFIER IA901, IA902, IA903, IA904

D402.912/4

Storno

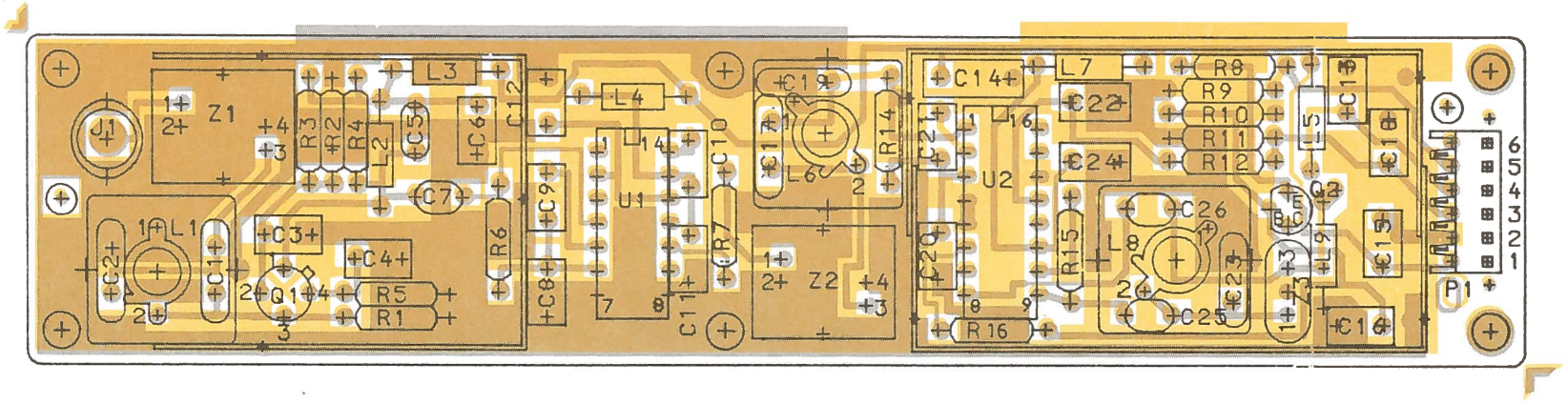


IA901 : 19C850520 G1
NMT IA902 : 19C850520 G2
IA903 : 19C850520G3
IA904 : 19C850520G4

21,4 MHz IF AMPLIFIER IA901, IA902, IA903, IA904
COMPONENT LAYOUT

D402.961/2

Storno

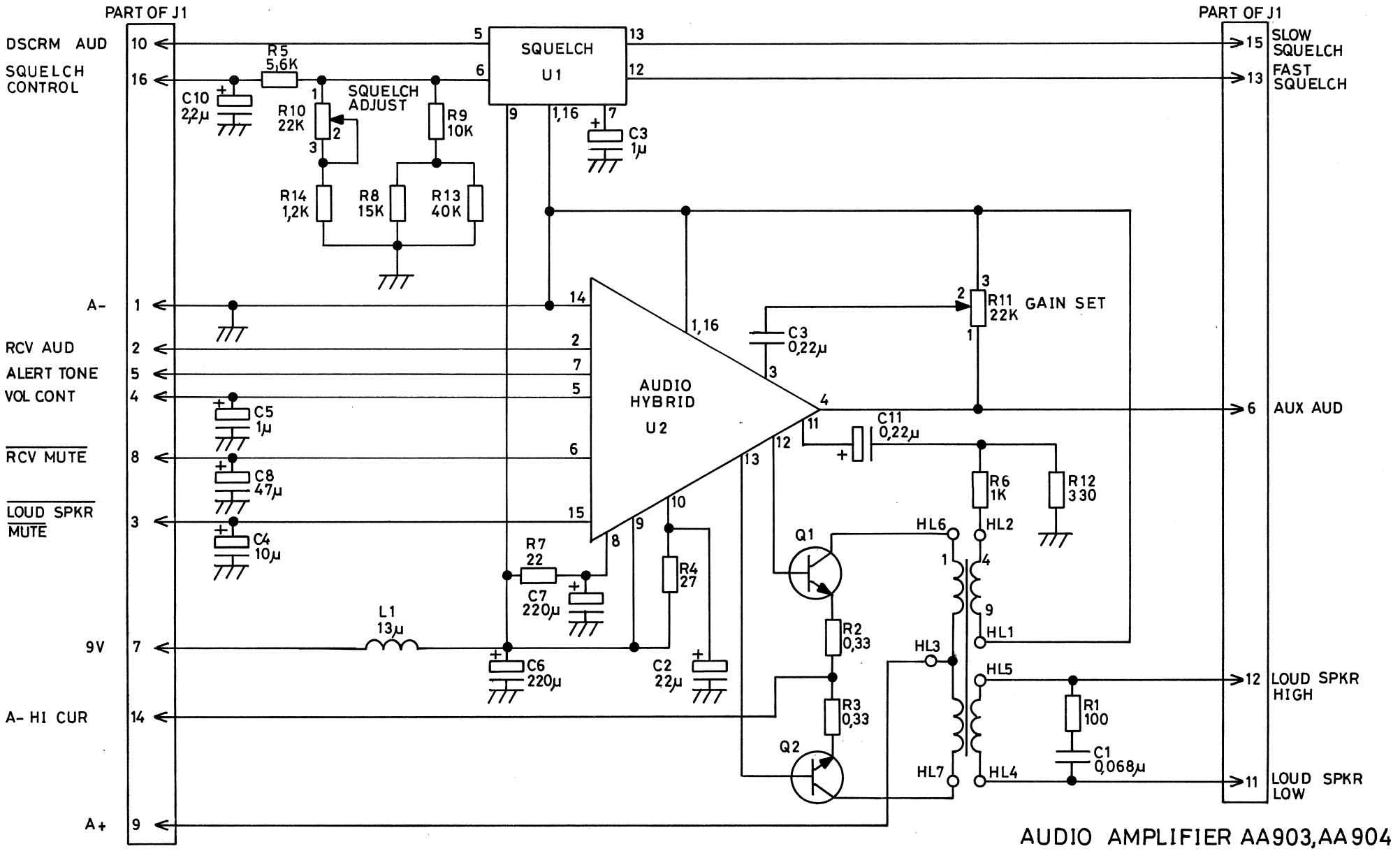


IA901 : 19C850520 G1
NMT IA902 : 19C850520 G2
IA903 : 19C850520 G3
IA904 : 19C850520 G4

21,4 MHz IF AMPLIFIER IA901, IA902, IA903, IA904
COMPONENT LAYOUT

D402.961/2

Storno

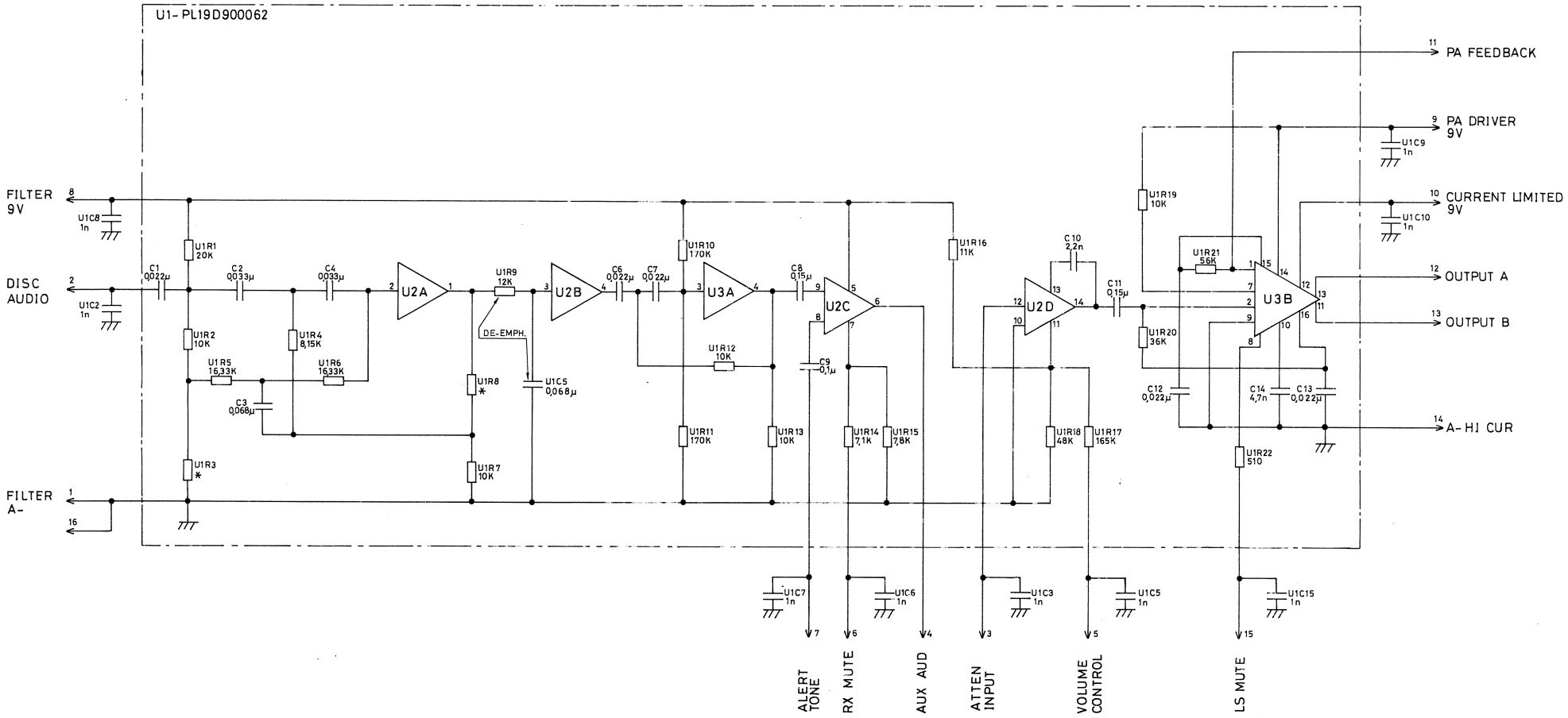


PL 19C850521 G1 AA903
PL 19C850521 G2 AA904

AUDIO AMPLIFIER AA903,AA904

D402.917/2

Storno

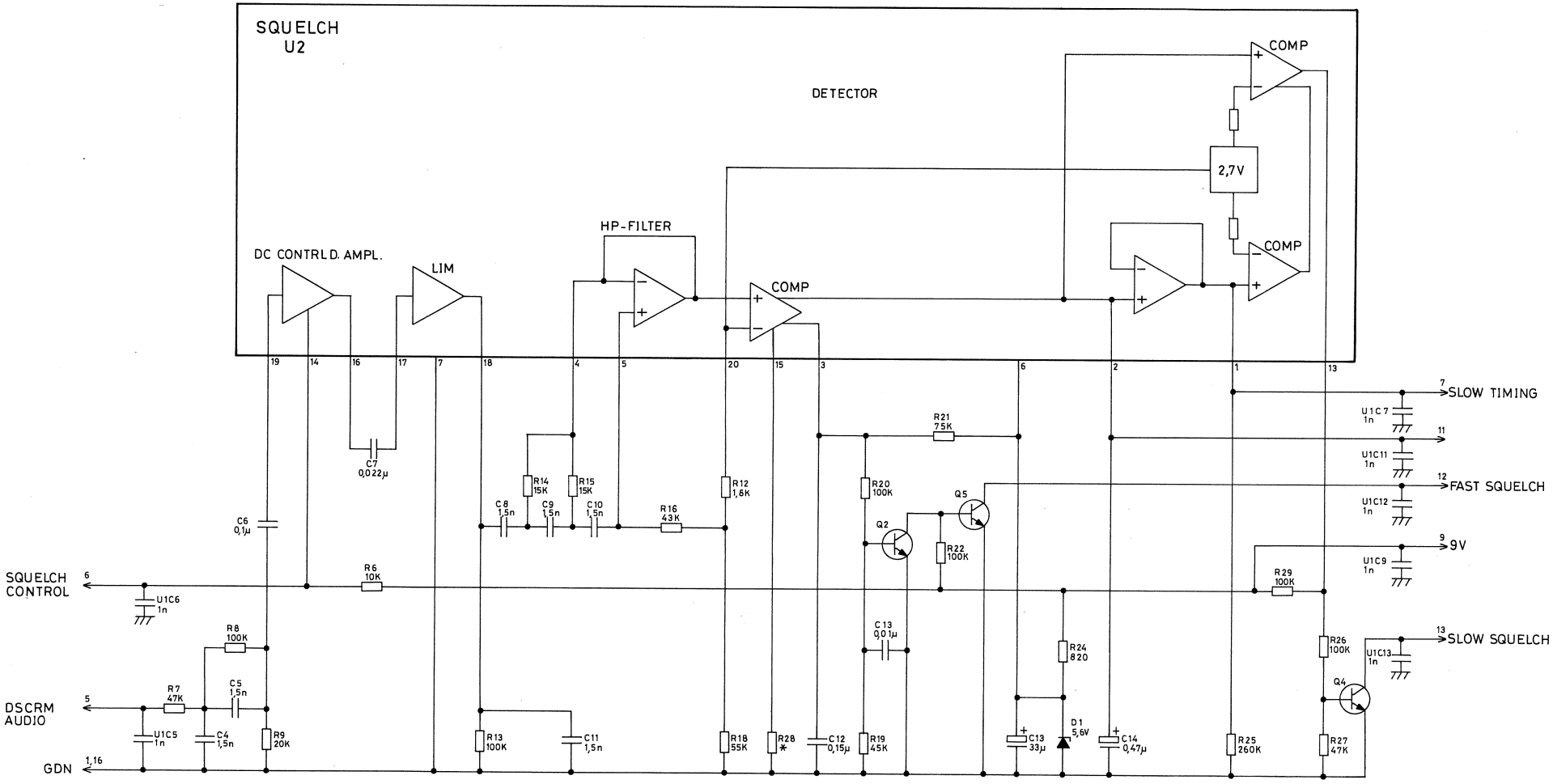


NOTE:
* FUNCTIONAL TRIM PER 9A701209

AUDIO AMPLIFIER
AA905

19D9000063G1 | D402.914/2

Storno

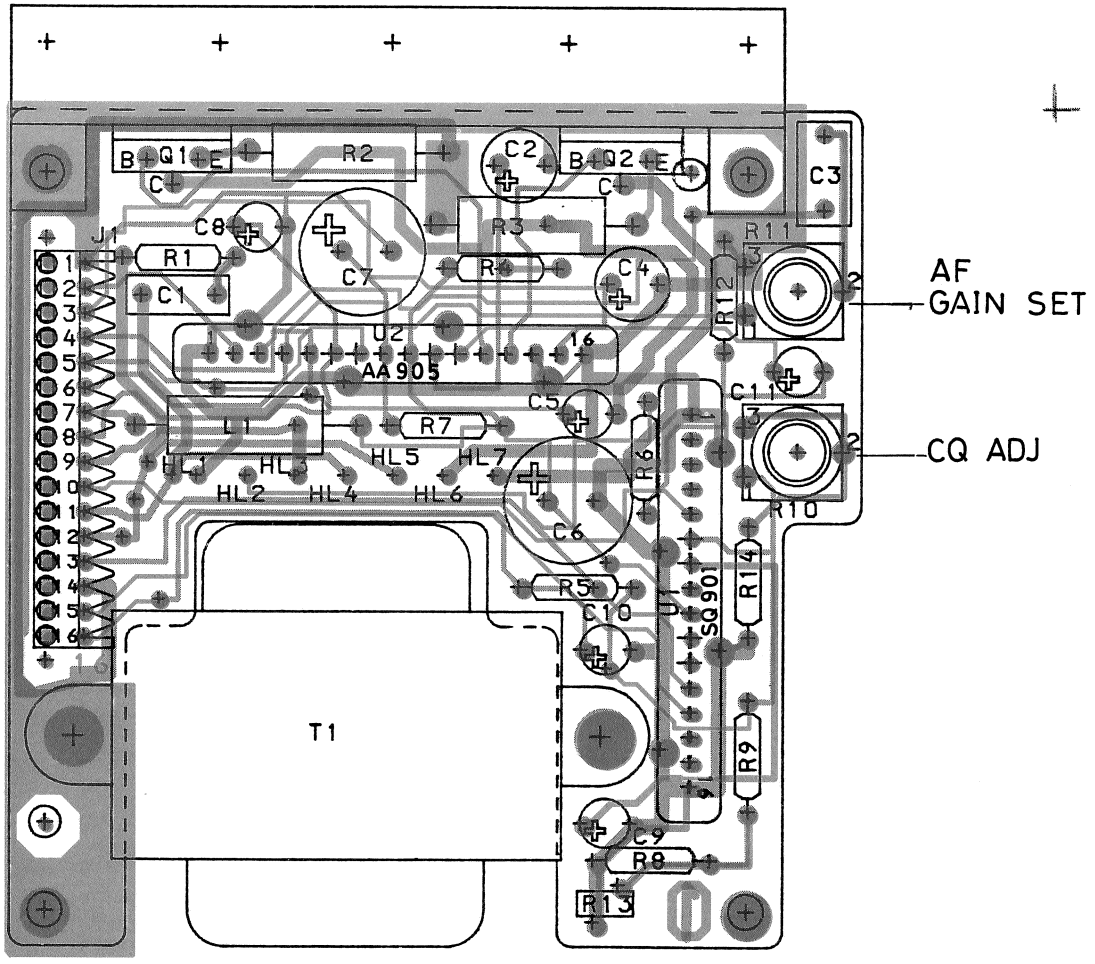


NOTE:
* FUNCTIONAL TRIMMED

SQUELCH CIRCUIT
SQ901

19M900067G2 | D402.915/2

Storno

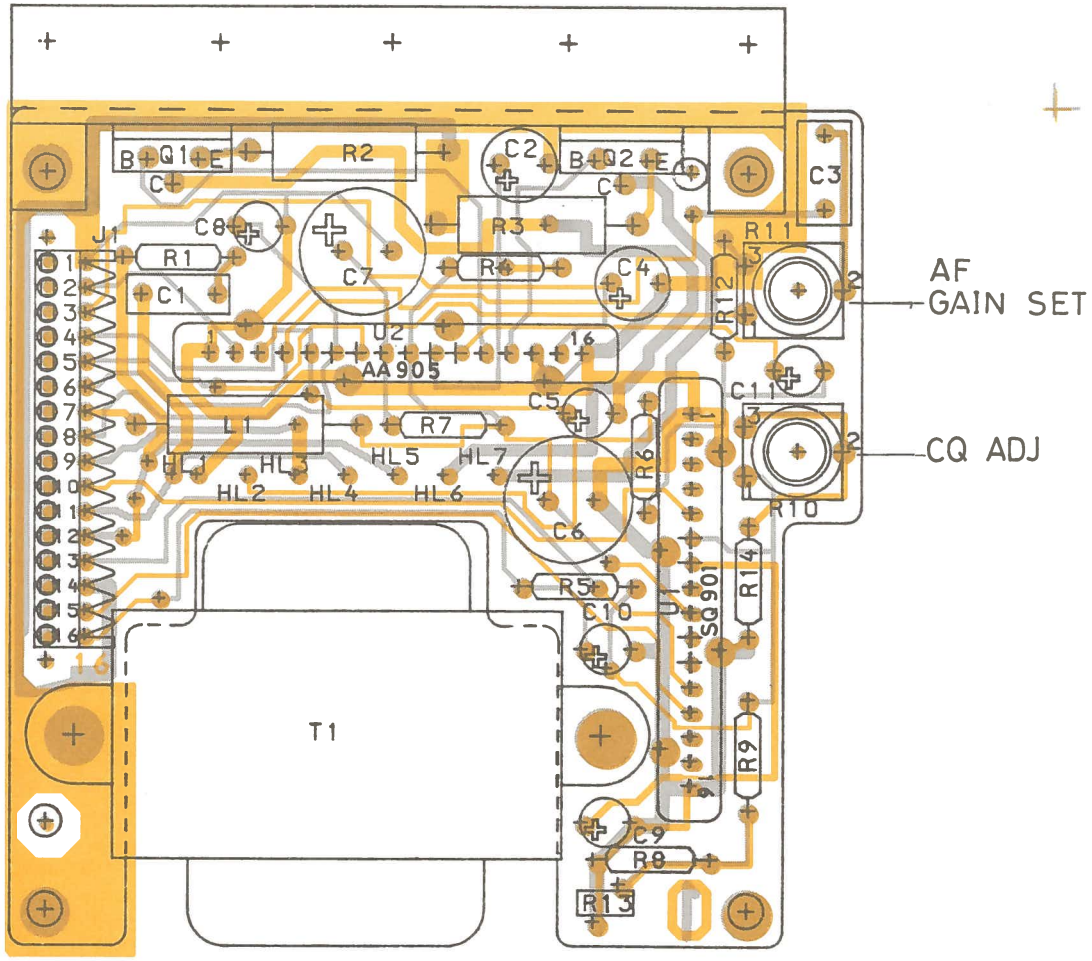


AA 903: 19C850521 G1
AA 904: 19C850521 G2

AUDIO AMPLIFIER AA903 , AA 904
COMPONENT LAYOUT

D402.960/3

Storno



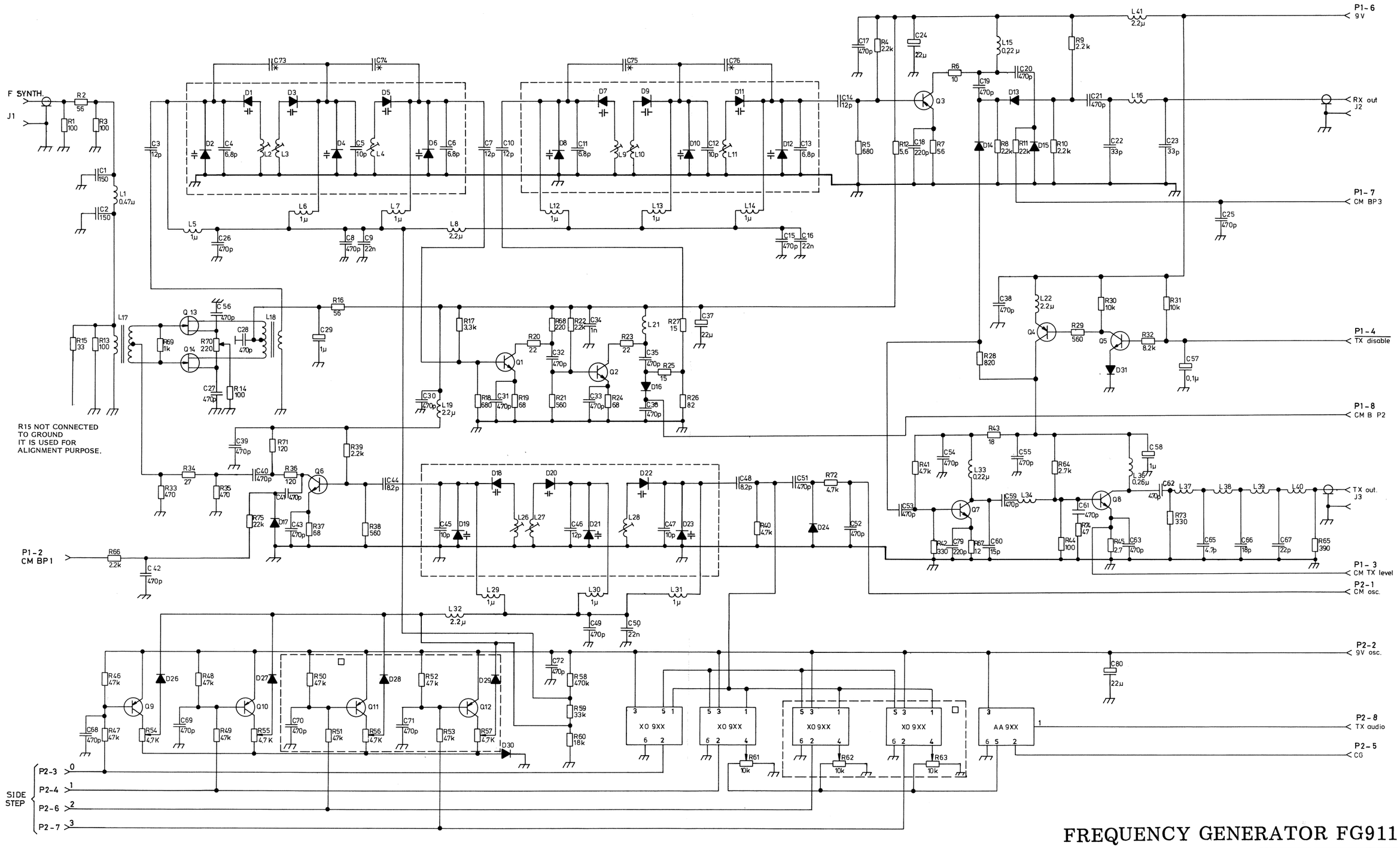
AA 903: 19C850521 G1
AA 904: 19C850521 G2

AUDIO AMPLIFIER AA903 , AA 904
COMPONENT LAYOUT

D402.960/3

Storno

Storno

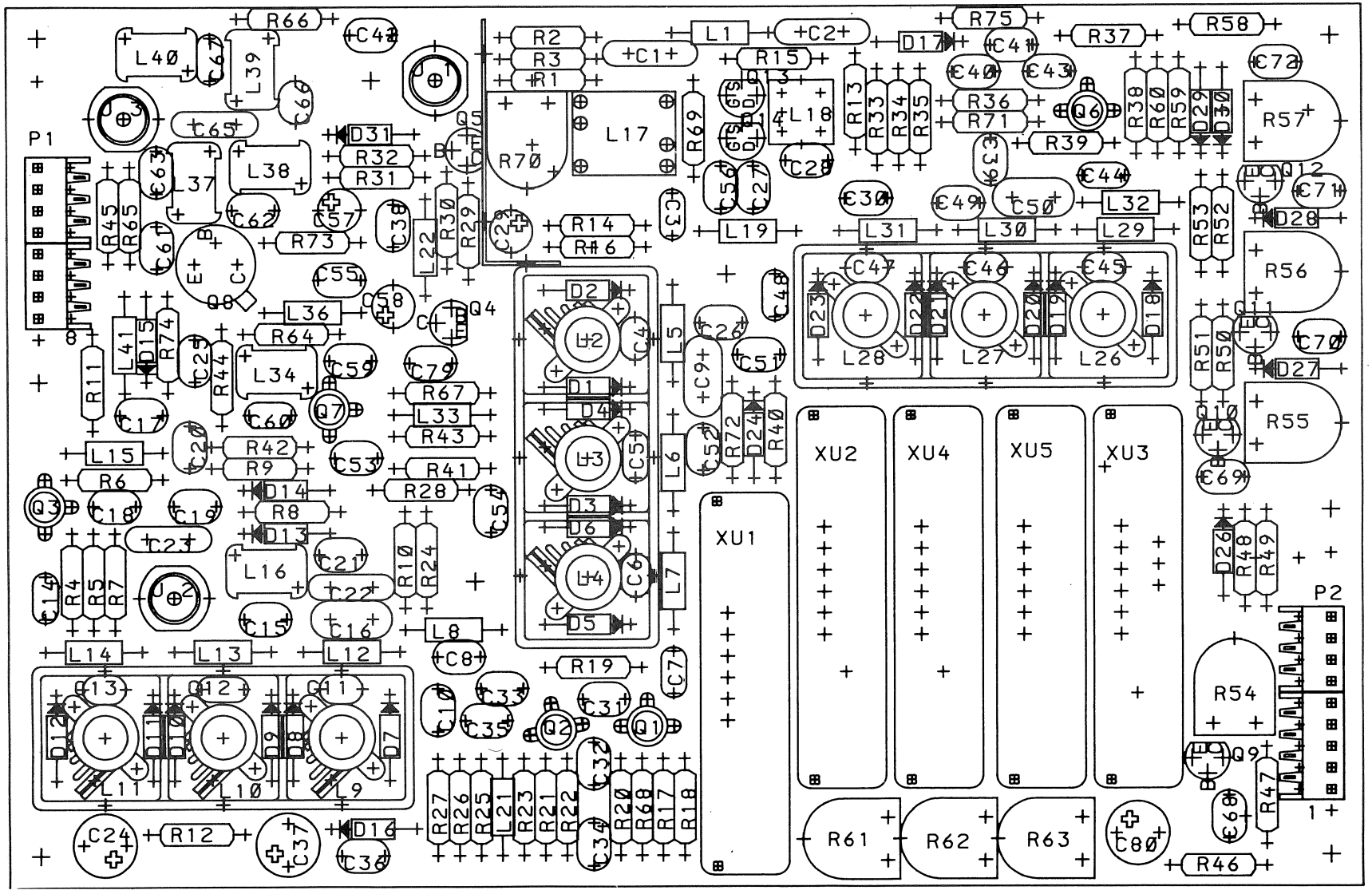


□ MOUNTED ONLY IN G2 RADIOS
* PRINTED BOARD CAPACITORS

FREQUENCY GENERATOR FG911

D403.145

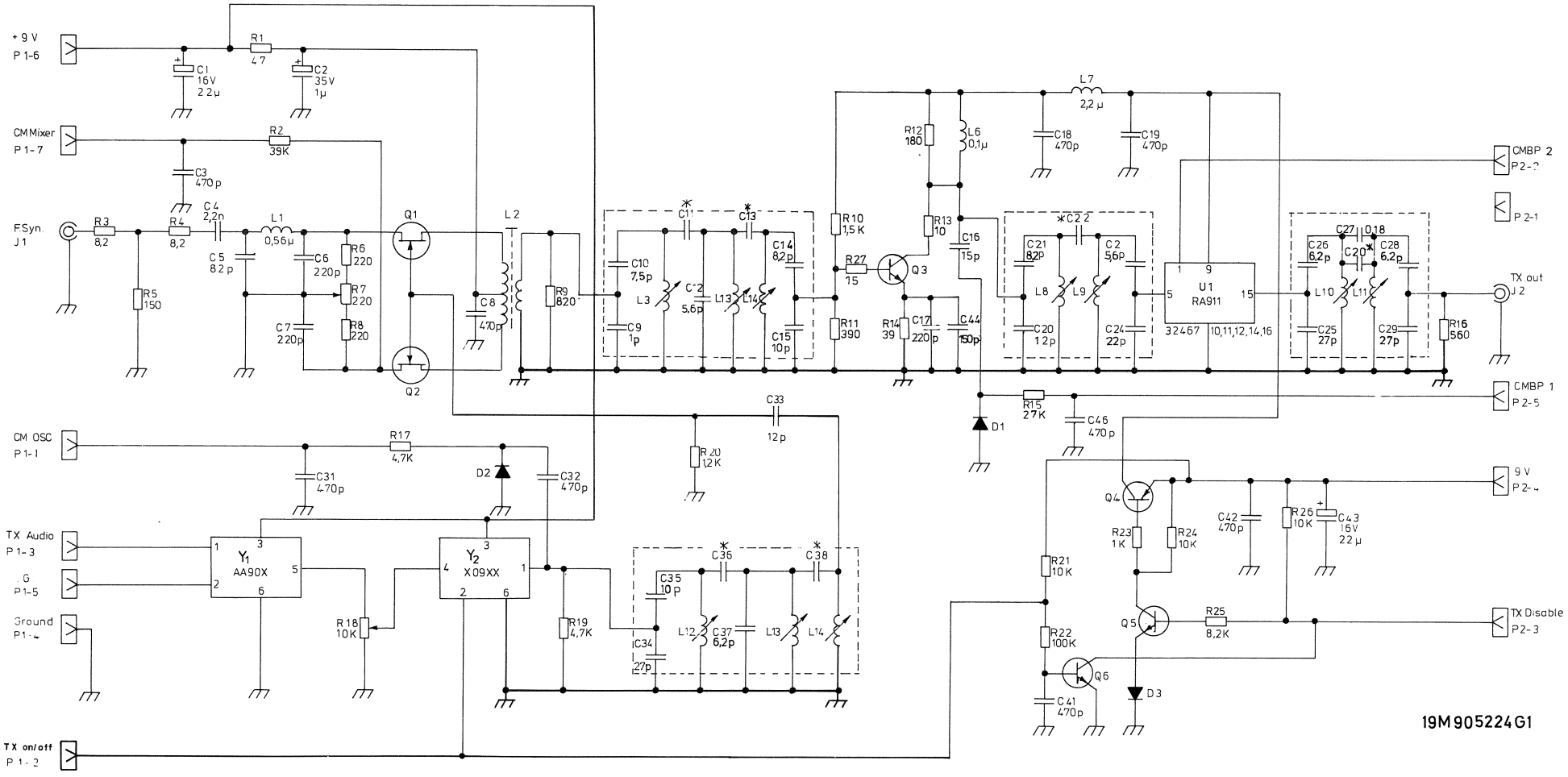
Storno



160 MHz SIMPLEX FREQUENCY GENERATOR FG911
COMPONENT LAYOUT

D402.943

Storno

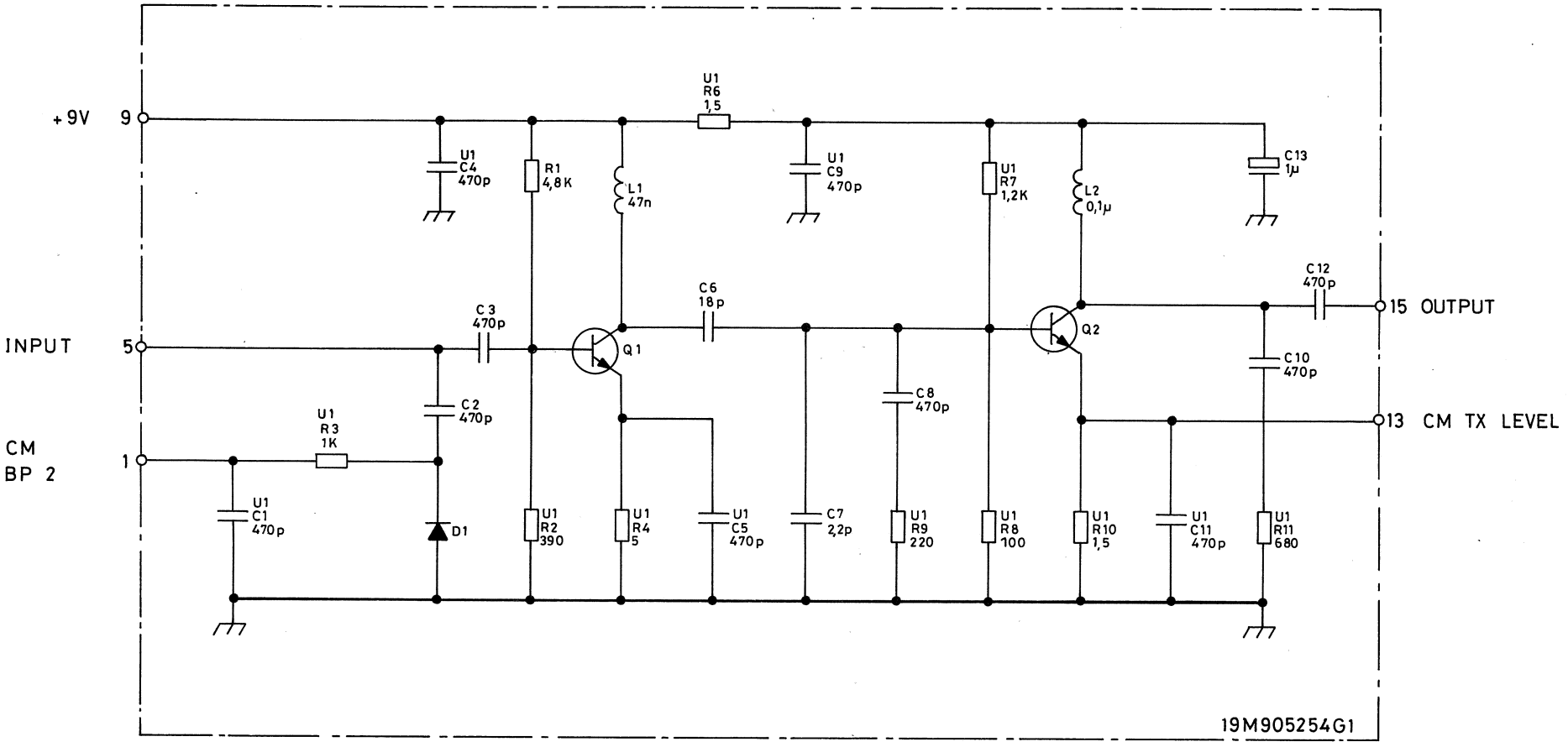


* PRINTED CAPACITORS

EXCITER EX911

D403.156

Storno

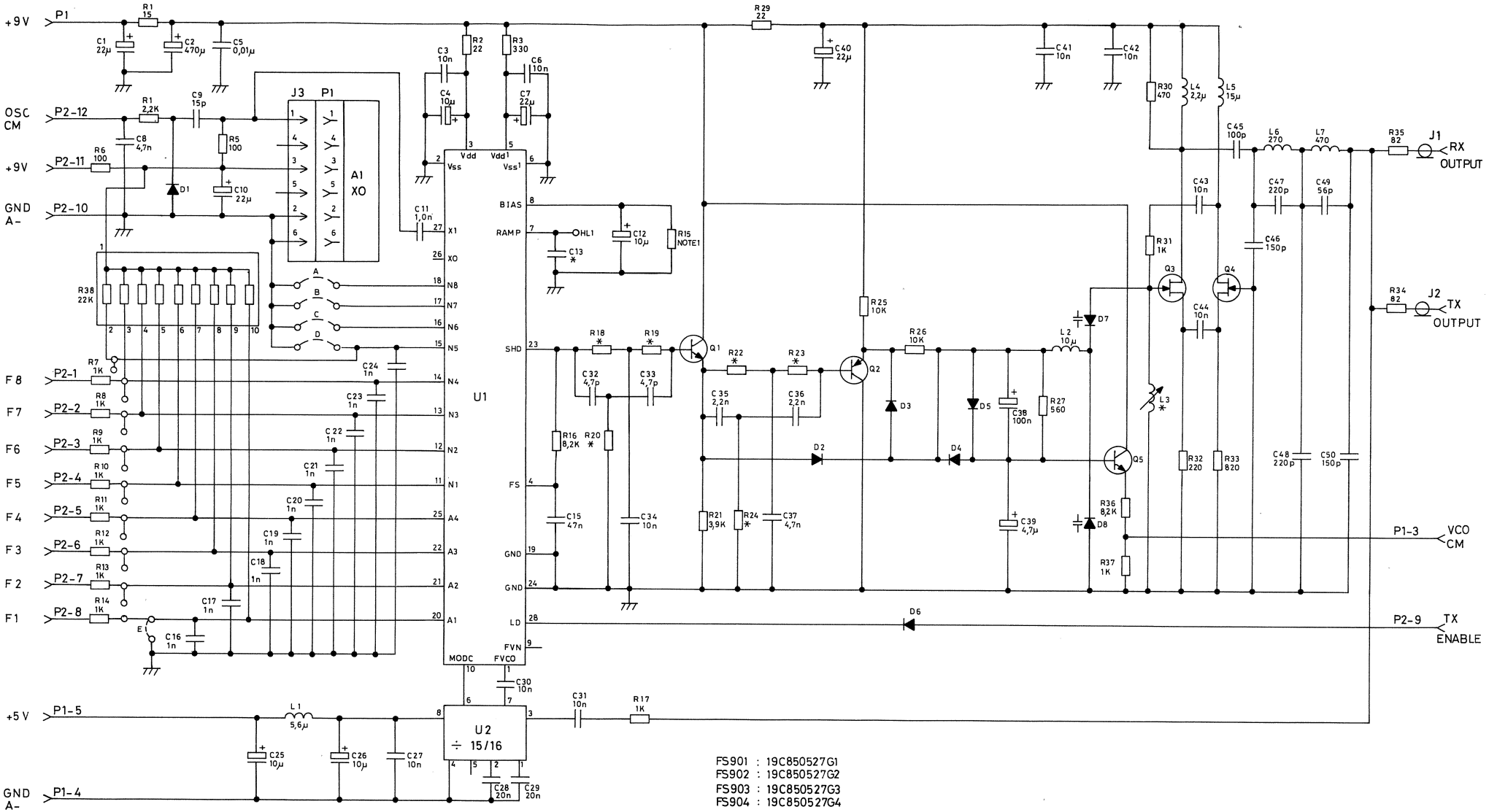


PIN - 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 16 ARE ⏚

RF AMPLIFIER RA911

D403.154

Storno



FS901 : 19C850527G1
FS902 : 19C850527G2
FS903 : 19C850527G3
FS904 : 19C850527G4

* VALUE CHART

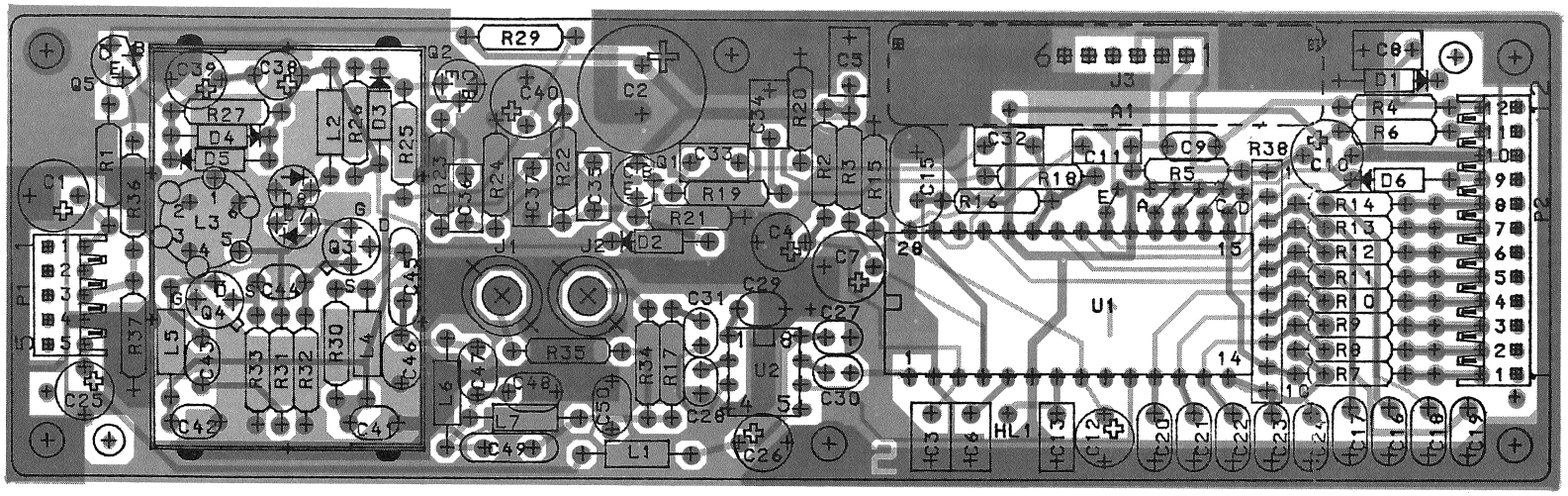
TYPE	REFERENCE FREQ. SPACING	R18	R19	R20	R22	R23	R24	A1 FREQ.	PROGRAM STRAPPING	C13	L3
FS901(NMT)	25 KHz	2610	2610	1400	2800	2800	1500	12,8 MHz	A, C, E	1,5n	≃ 1,8 µH
FS 902	2x12,5KHz	2610	2610	1400	2800	2800	1500	12,8 MHz	A, C, D	1,5n	≃ 1,8 µH
FS 903	2x10KHz	3320	3340	1740	3480	3480	1870	10,24MHz	A, C	2,2n	≃ 2,5µH
FS 904	2x15KHz	2210	2210	1150	2320	2320	1240	15,36MHz	A, B	1,5n	≃ 2,5µH

NOTE 1:
THE VALUE OF R15 HAS BEEN SELECTED FROM ONE OF THE FOLLOWING VALUES - 27K, 33K, 39K, 47K, & 56K TO MATCH THE CHARACTERISTICKS OF U1 AND IS STAMPED ON THE PART.
REPLACEMENT OF U1 MAY NECESSITATE THE REPLACEMENT OF R15

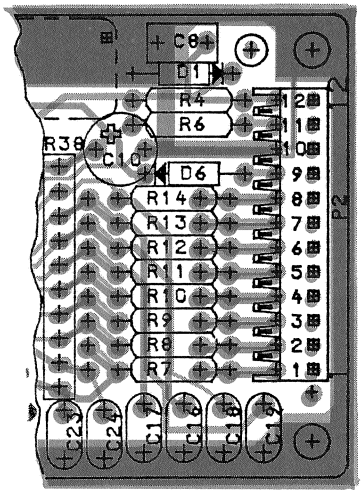
FREQUENCY SYNTHESIZER FS 90X

D403.077/3

Storno



FS901
NMT



FS902/3/4

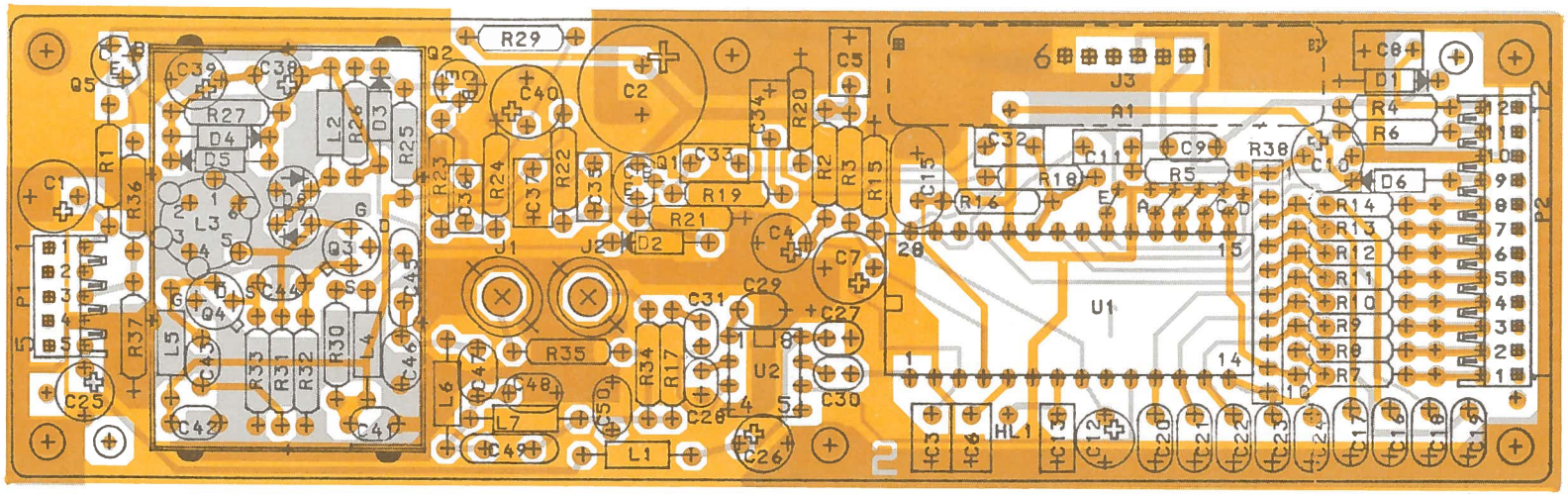
FS901 : 19C850527G1
FS902 : 19C850527G2
FS903 : 19C850527G3
FS904 : 19C850527G4

FREQUENCY SYNTHESIZER FS90X

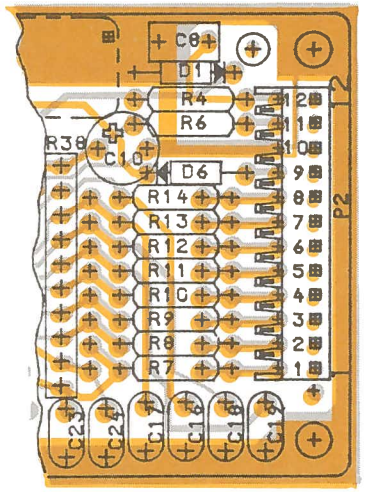
REV. B D402.980/3

Storno

Storno



FS901
NMT



FS902/3/4

FS901 : 19C850527G1
FS902 : 19C850527G2
FS903 : 19C850527G3
FS904 : 19C850527G4

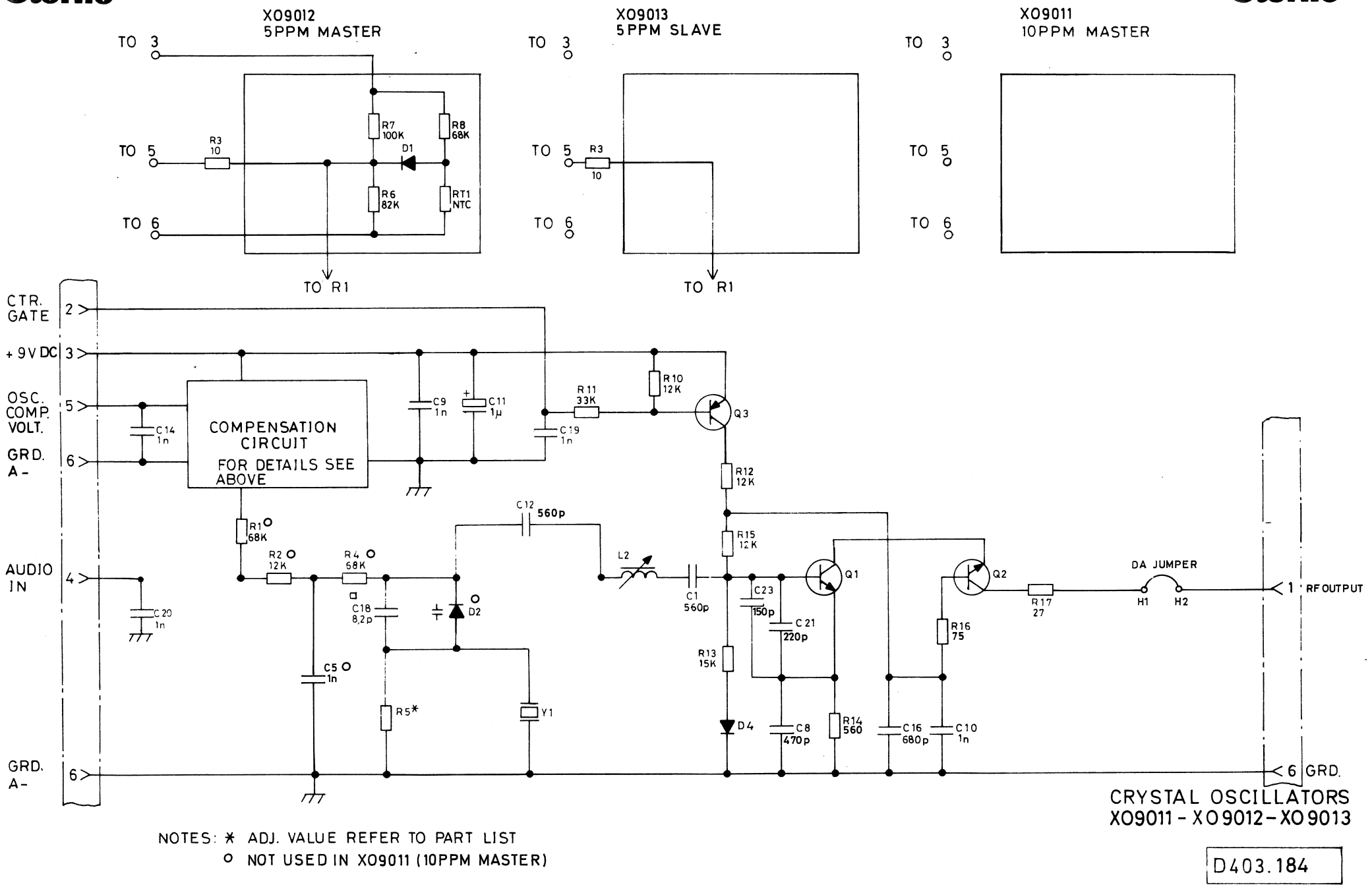
FREQUENCY SYNTHESIZER FS90X

REV. B D402.980/3

Storno

TEMPERATURE COMPENSATION CIRCUITS

Storno



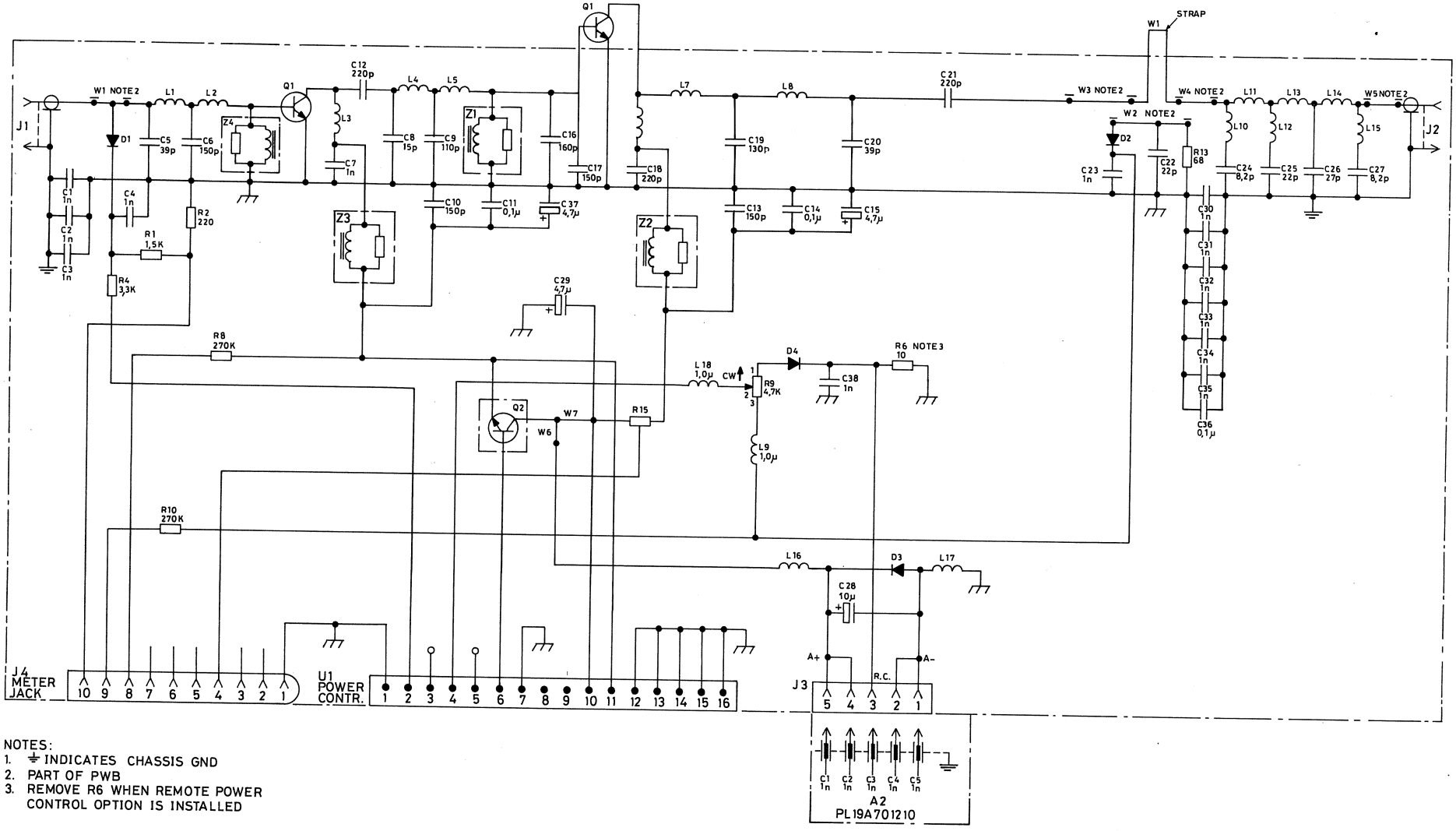
NOTES: * ADJ. VALUE REFER TO PART LIST

o NOT USED IN XO9011 (10PPM MASTER)

CRYSTAL OSCILLATORS
XO9011 - XO9012 - XO9013

D403.184

Storno

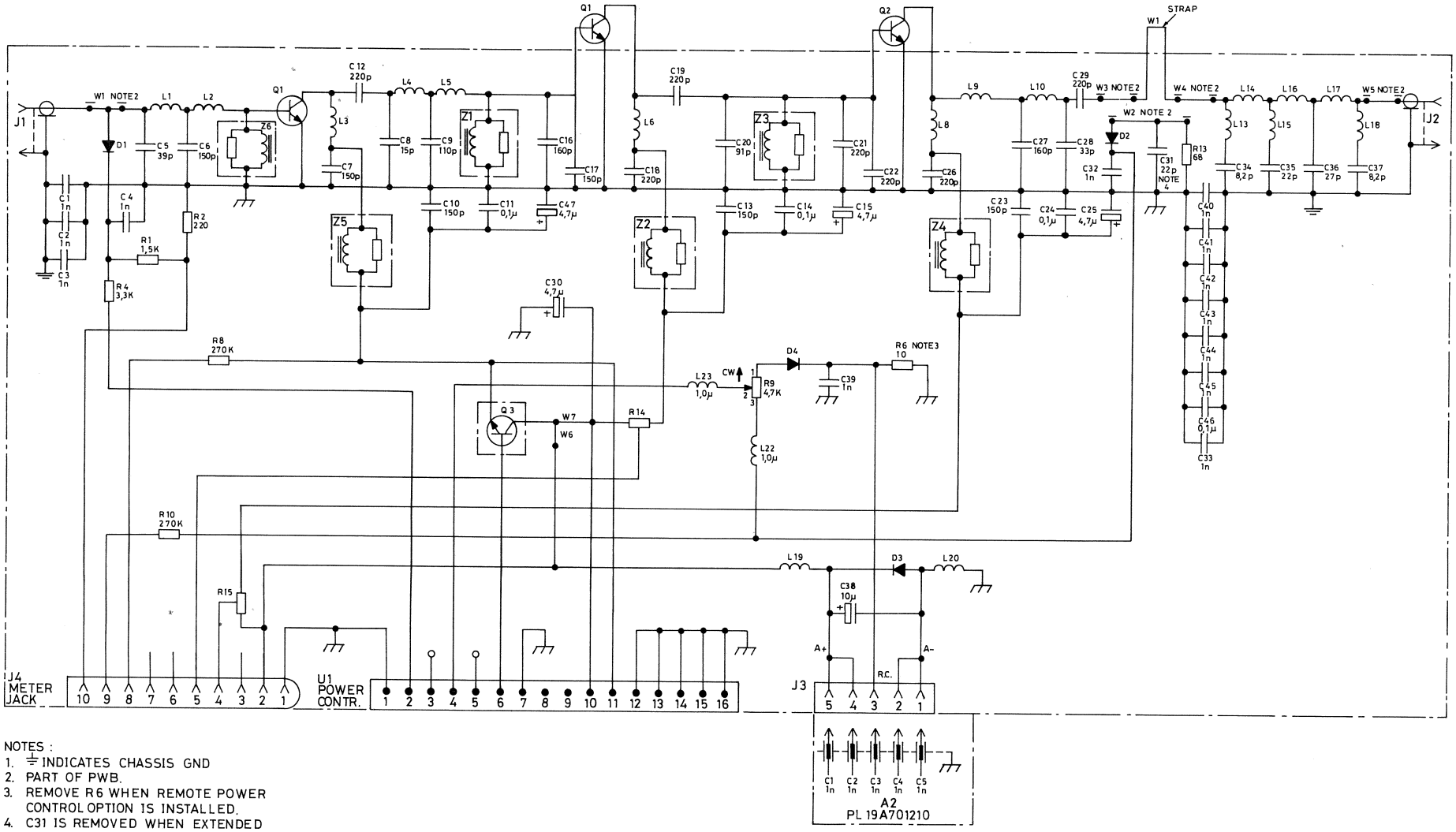


NOTES:
1. ⏚ INDICATES CHASSIS GND
2. PART OF PWB
3. REMOVE R6 WHEN REMOTE POWER CONTROL OPTION IS INSTALLED

POWER AMPLIFIER PA911

D403.115

Storno



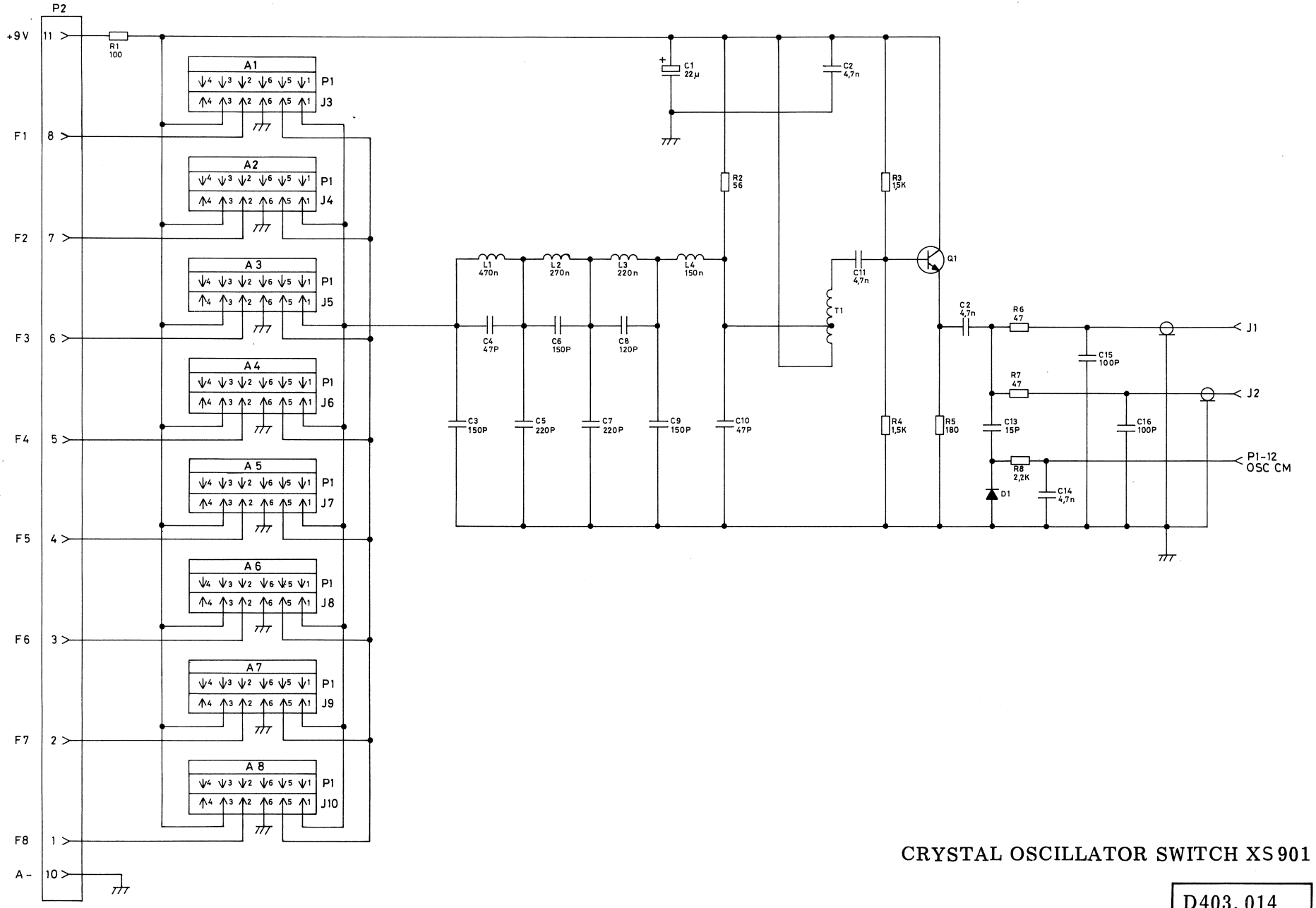
NOTES :
1. ⏚ INDICATES CHASSIS GND
2. PART OF PWB.
3. REMOVE R6 WHEN REMOTE POWER CONTROL OPTION IS INSTALLED.
4. C31 IS REMOVED WHEN EXTENDED LOWER RANGE POWER OPTION IS INCORPORATED

POWER AMPLIFIER PA913

D403.114

Storno

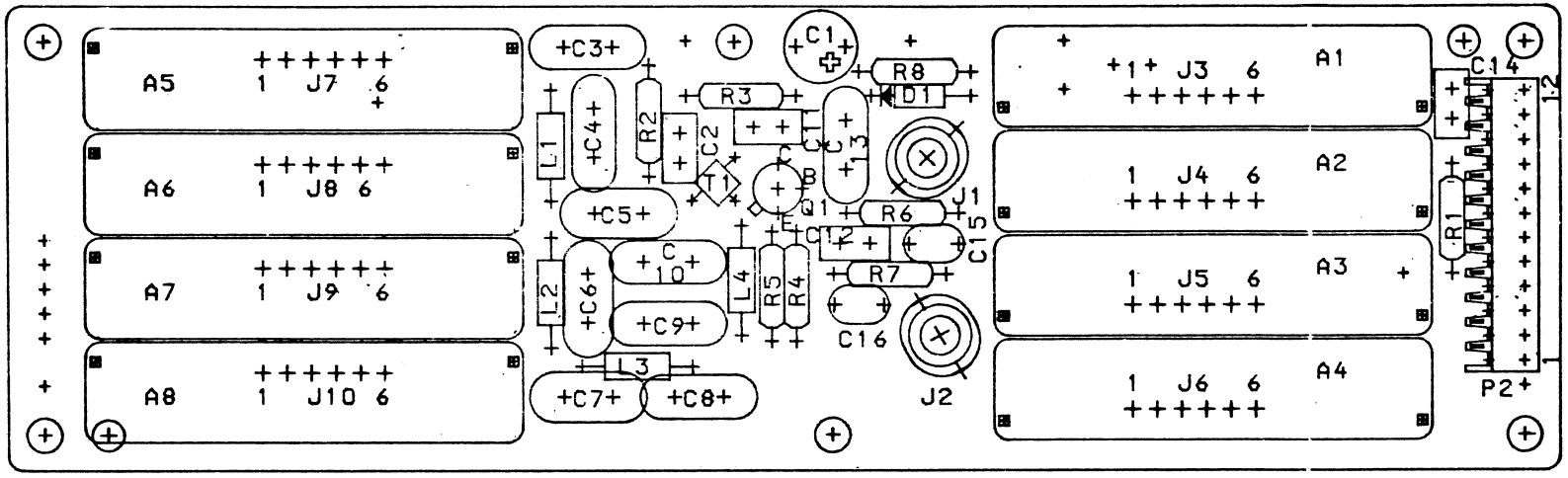
Storno



CRYSTAL OSCILLATOR SWITCH XS 901

D403. 014

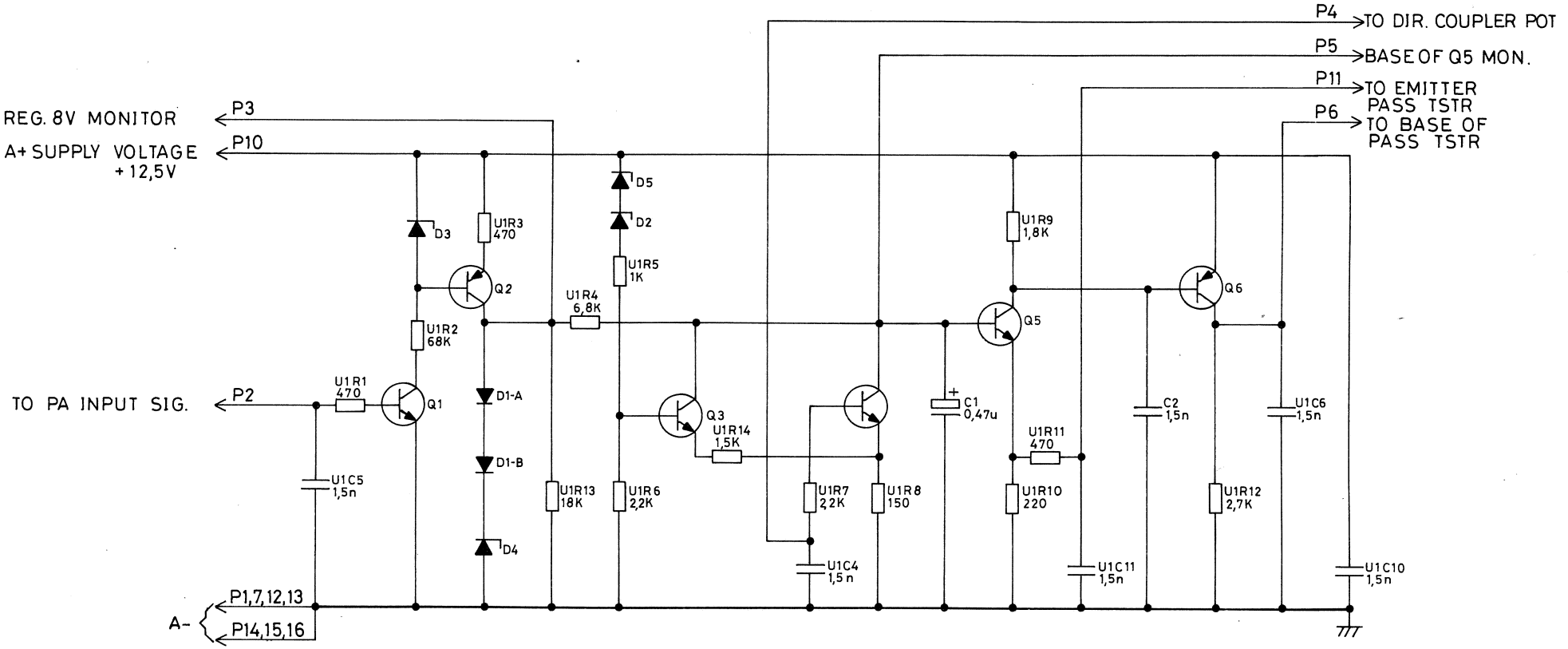
Storno



CRYSTAL OSCILLATOR MODULE XS901
COMPONENT LAYOUT

D402.969

Storno

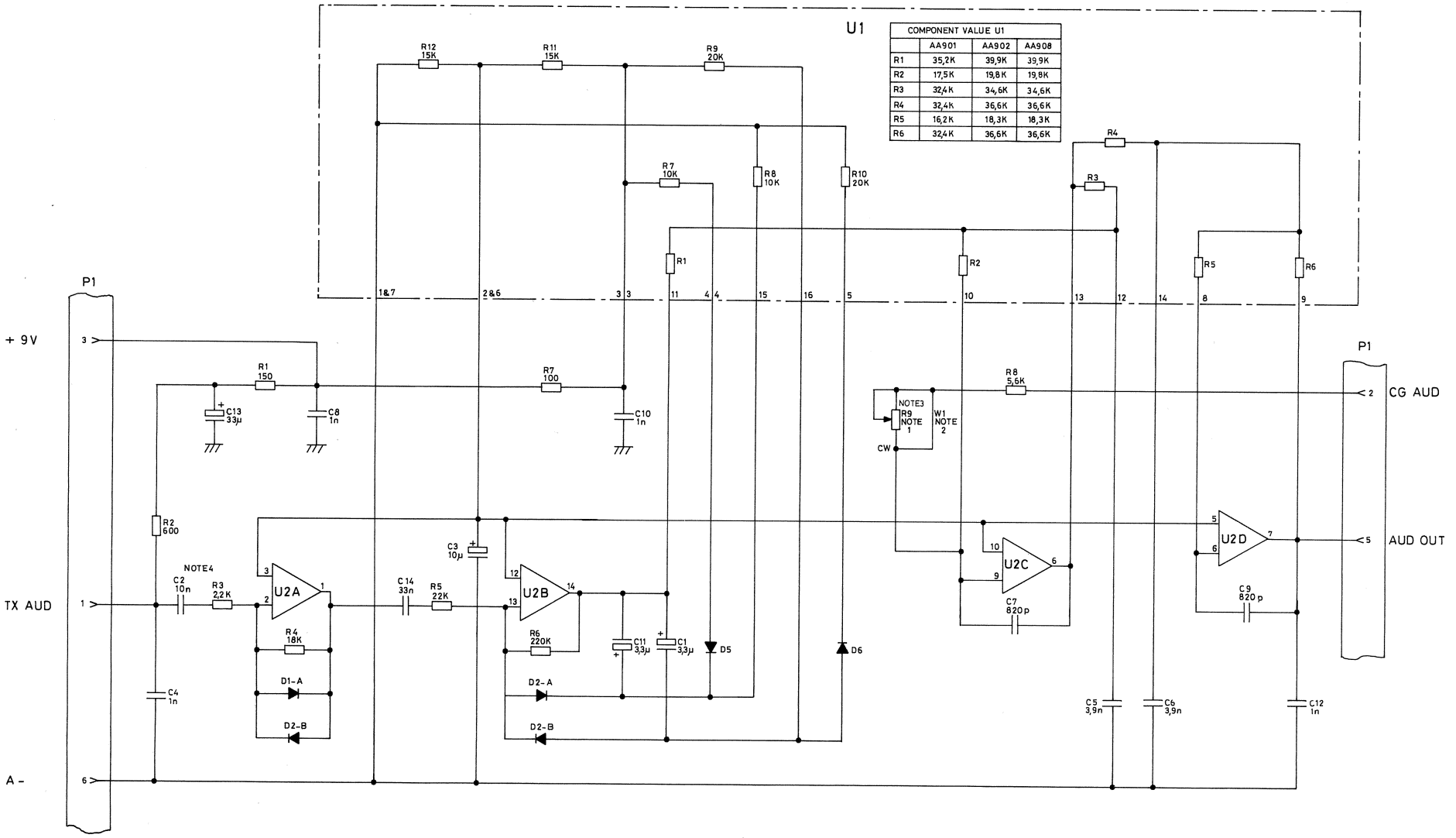


POWER CONTROL PC903

19D900111G1 | D402.928/2

Storno

Storno



COMPONENT VALUE U1			
	AA901	AA902	AA908
R1	35,2K	39,9K	39,9K
R2	17,5K	19,8K	19,8K
R3	32,4K	34,6K	34,6K
R4	32,4K	36,6K	36,6K
R5	16,2K	18,3K	18,3K
R6	32,4K	36,6K	36,6K

NOTE 1: R9 PRESENT FOR CG LEVEL ADJUST (5K-500K)
NOTE 2: W1 PRESENT WITHOUT CG LEVEL ADJUST
NOTE 3: FOR AA908 OMIT R9 AND INSERT W1
NOTE 4: FOR AA908: C2= 220n, R3=18K

AA901: 19D900072G1 WITH CG LEVEL ADJUST
AA902: 19D900072G2 WITH CG LEVEL ADJUST
AA901: 19D900072G3 WITHOUT CG LEVEL ADJUST
AA902: 19D900072G4 WITHOUT CG LEVEL ADJUST
AA908:

AUDIO PROCESSOR AA901, AA902, AA908

D402.918/2

Storno

Storno

NOTES		WIRING
1	SYSTEM CLOCK WITH 5,7 MHz CRYSTAL	INSERT W1
2	SYSTEM CLOCK WITH 11 MHz CRYSTAL	INSERT W2
3	CL901, CODE L855008G1	INSERT W3
4		INSERT W4
5	OPTIONAL OUTPUT JUMPER FIELD	INSERT W5
6		INSERT W6
7		INSERT W7
8	OPTIONAL INPUT JUMPER	INSERT W8
9	U5 USED AS PERSONALITY PROM	INSERT W9
10	U5 USED AS EXTERN PROGRAM MEMORY	INSERT W10
11	INTERNAL PROGRAM MEMORY ENABLED	INSERT W11
12	INTERNAL PROGRAM MEMORY DISABLED	INSERT W12
13		INSERT W13
14		INSERT W14
15		INSERT W15
16	OPTIONAL PROM JUMPER FIELD	INSERT W16
17		INSERT W17
18		INSERT W18
19		INSERT W19

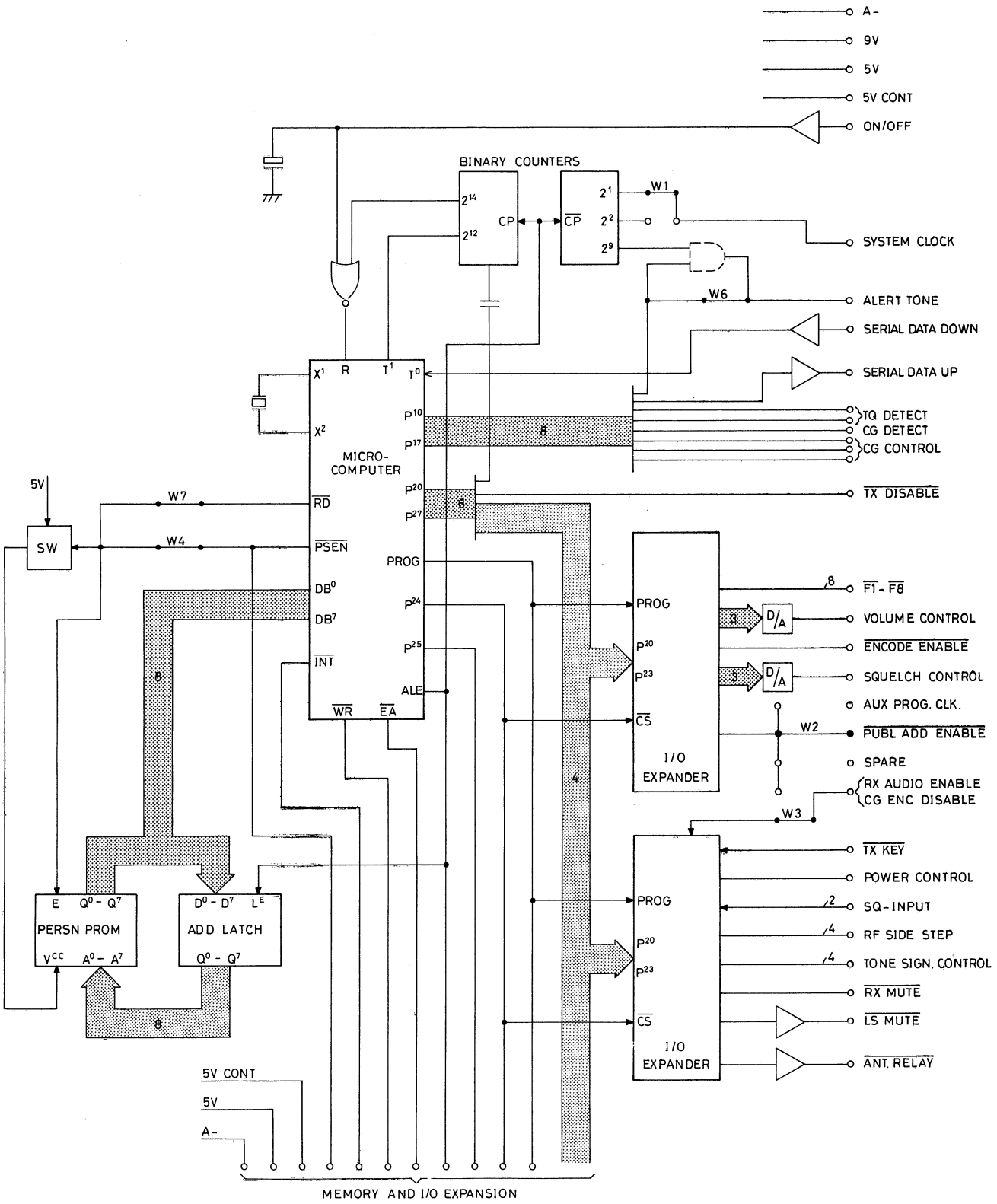
SEE STRAPPING INSTRUCTION CL901, D403.155

CONTROL LOGIC CL901

REV. A

D402.945/2

Storno

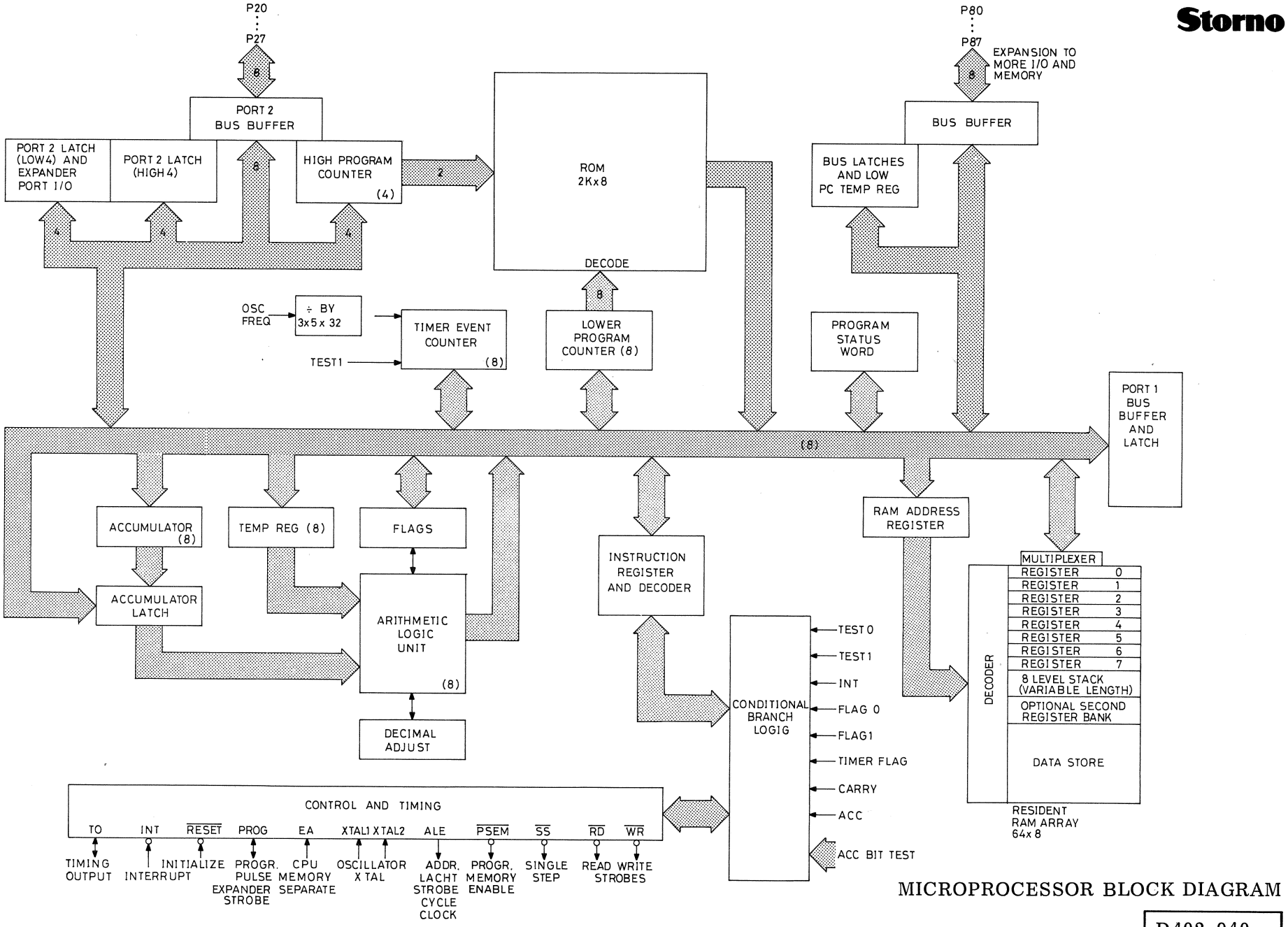


BLOCK DIAGRAM CONTROL LOGIC
CL901

D402. 931

Storno

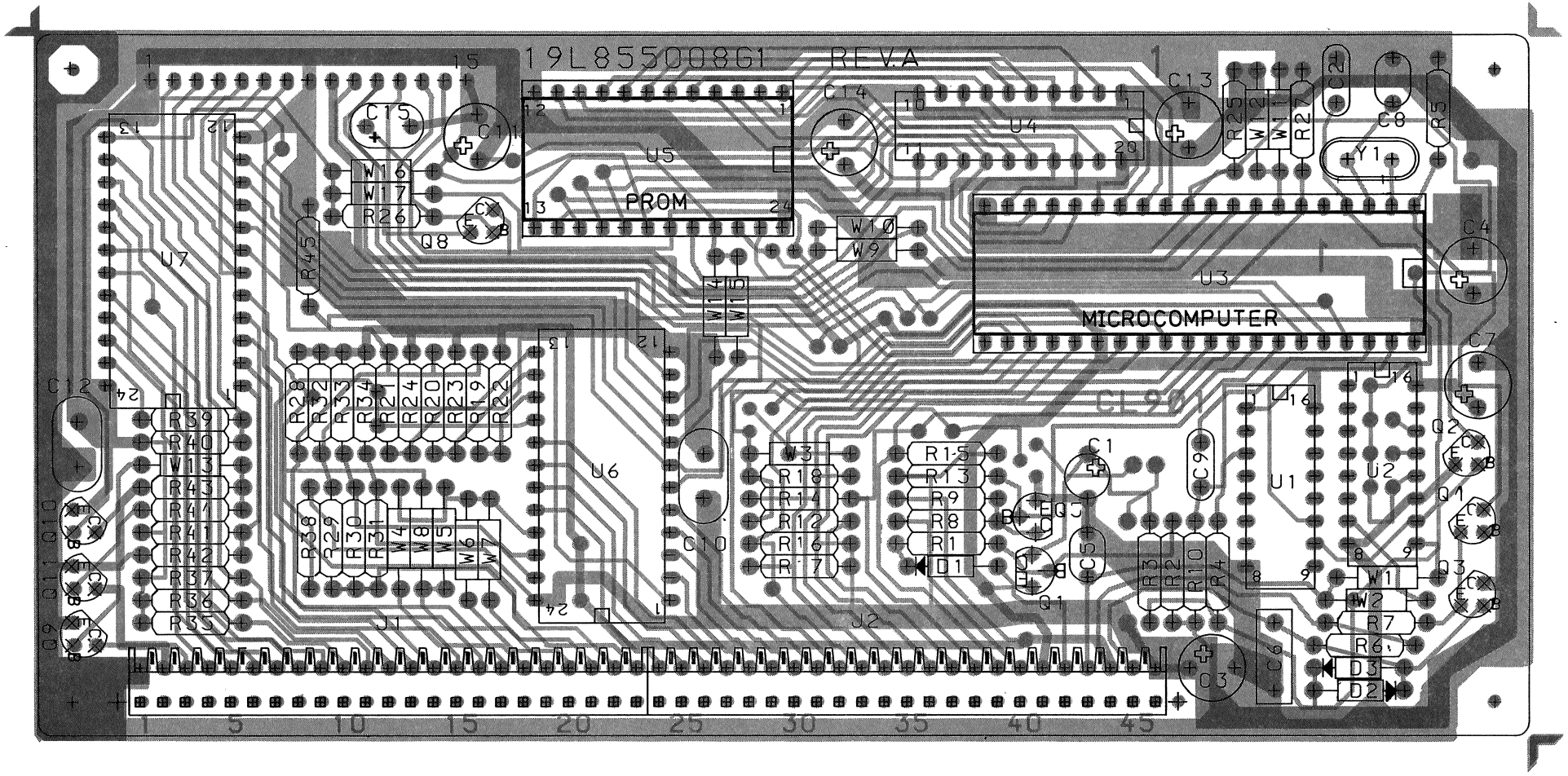
Storno



MICROPROCESSOR BLOCK DIAGRAM

D402.940

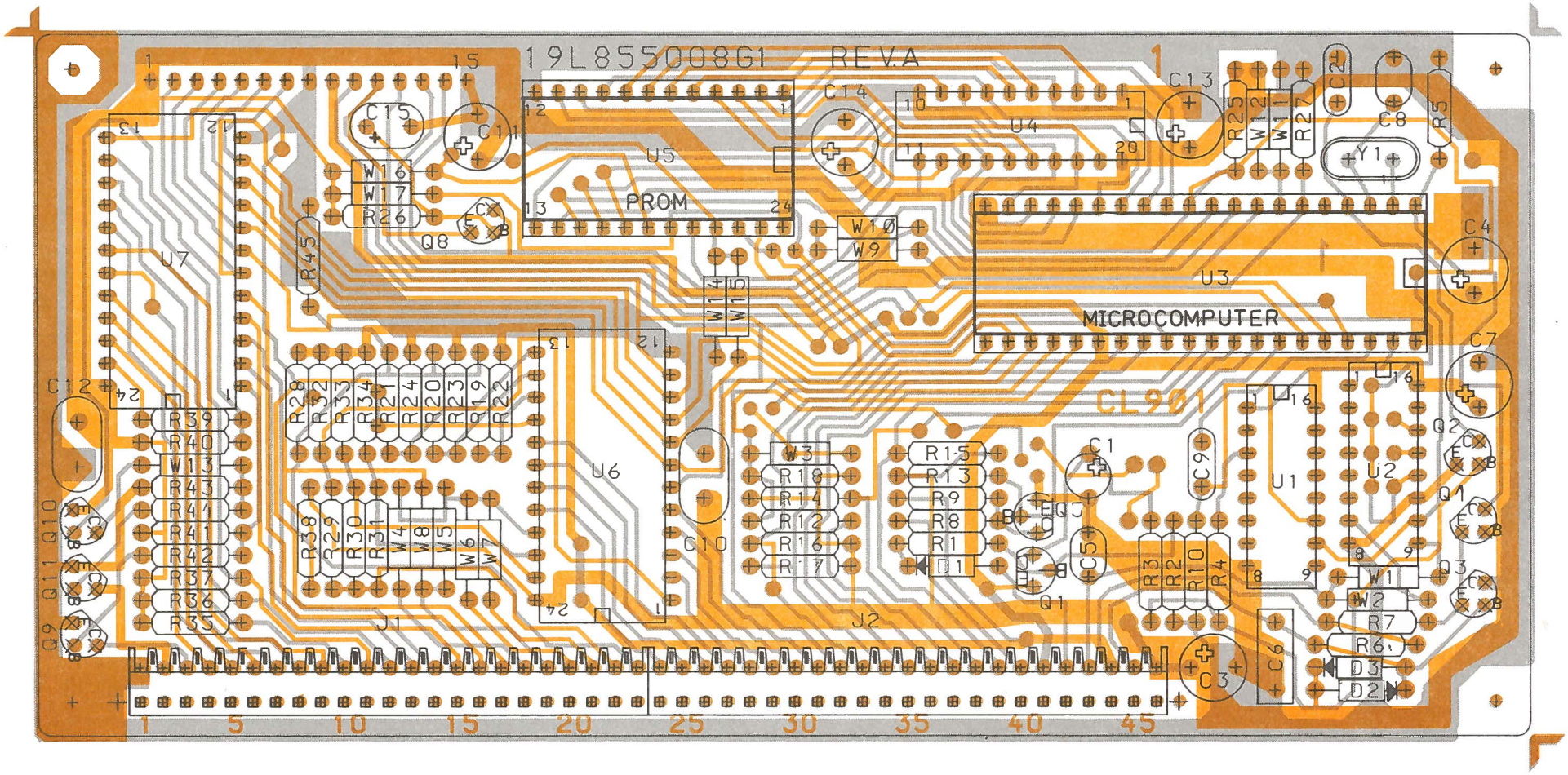
Storno



CONTROL LOGIC CL901
COMPONENT LAYOUT

19L855008G1 REV. A | D402.946/2

Storno

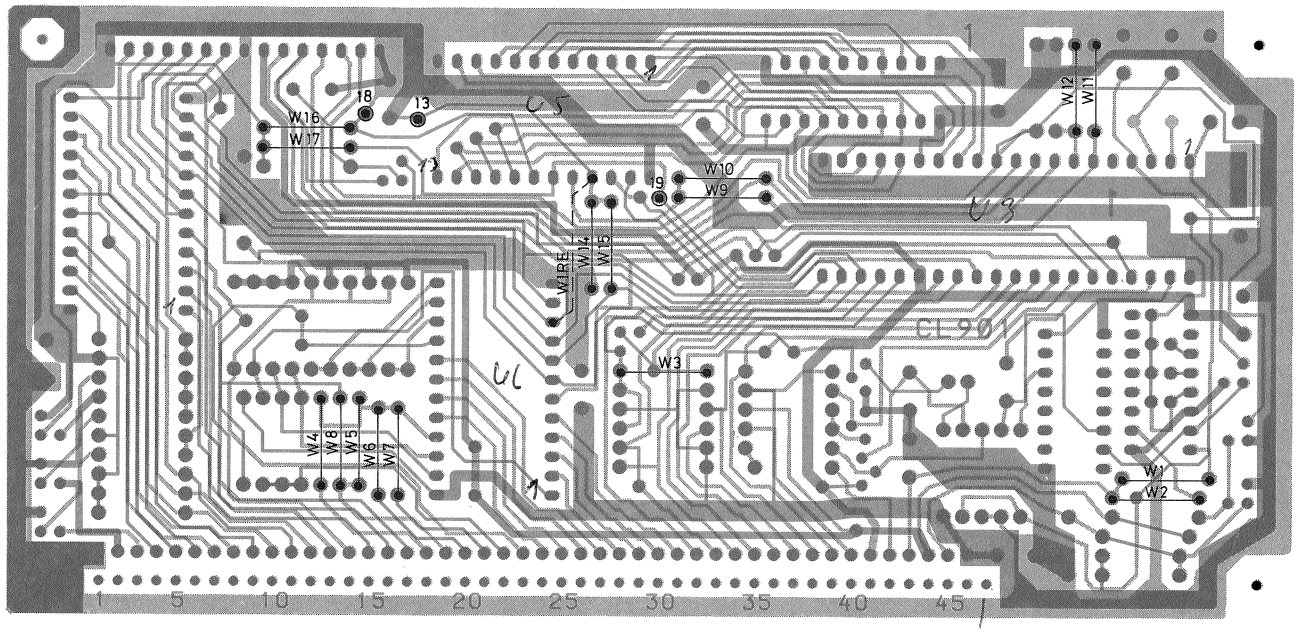


CONTROL LOGIC CL901
COMPONENT LAYOUT

19L855008G1 REV. A | D402.946/2

Storno

Storno



PROM JUMPER FIELD
IF OTHER THAN STANDARD: 2KUV PROM. IS USED
TYPE 2716 CODE 19J706385

CL901 19L855008G1	NOTES	DESCRIPTION
W1	1	SYSTEMCLOCK WITH 5.7MHz CRYSTAL
	2	SYSTEMCLOCK WITH 11 MHz CRYSTAL
W3	3	Q6, Q7, H1 AND R11 ARE NOT PRESENT IN 19L855008G1
W4	4	OPTIONAL OUTPUT JUMPER FIELD
	5	
	6	
	7	
W8	8	OPTIONAL INPUT JUMPER
	9	U5 IS USED AS PERSONALITY PROM
W10	10	U5 IS USED AS EXTERN PROGRAM MEMORY

NOTES	19A702222P1 4 KUV PROM I 2732	19A701662 P1 1K BIPOL. PROM	(HM7661-2) 2K BIPOL. PROM
11		W11	W11
12	W12		
13	◉DRILL	◉DRILL	◉DRILL
14		W14	
15	W15		
16		W16	W16
17		W17	W17
18		◉DRILL	◉DRILL
19		◉DRILL	◉DRILL

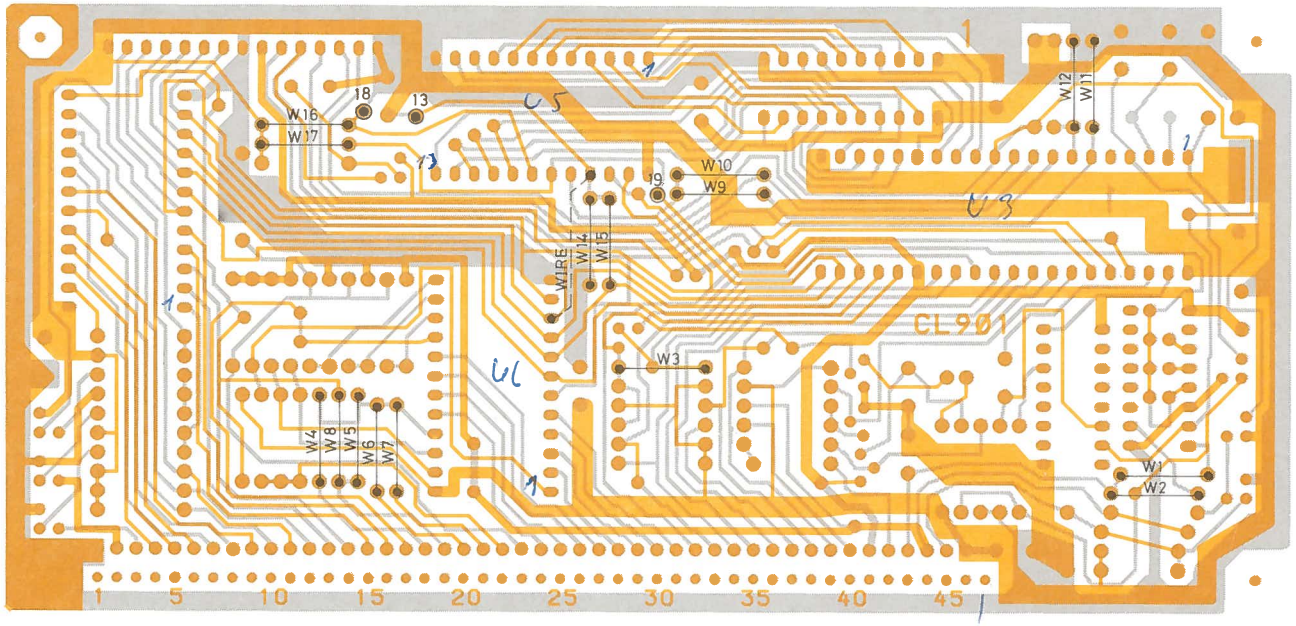
REMARKS:
WIRECONNECT PIN9 OF U6 AND PIN 21 OF U5 (P22)AS SHOW ON BOARD-DRAWING.

CONTROL LOGIC CL901
STRAPPING INSTRUCTION

D403.155

Storno

Storno



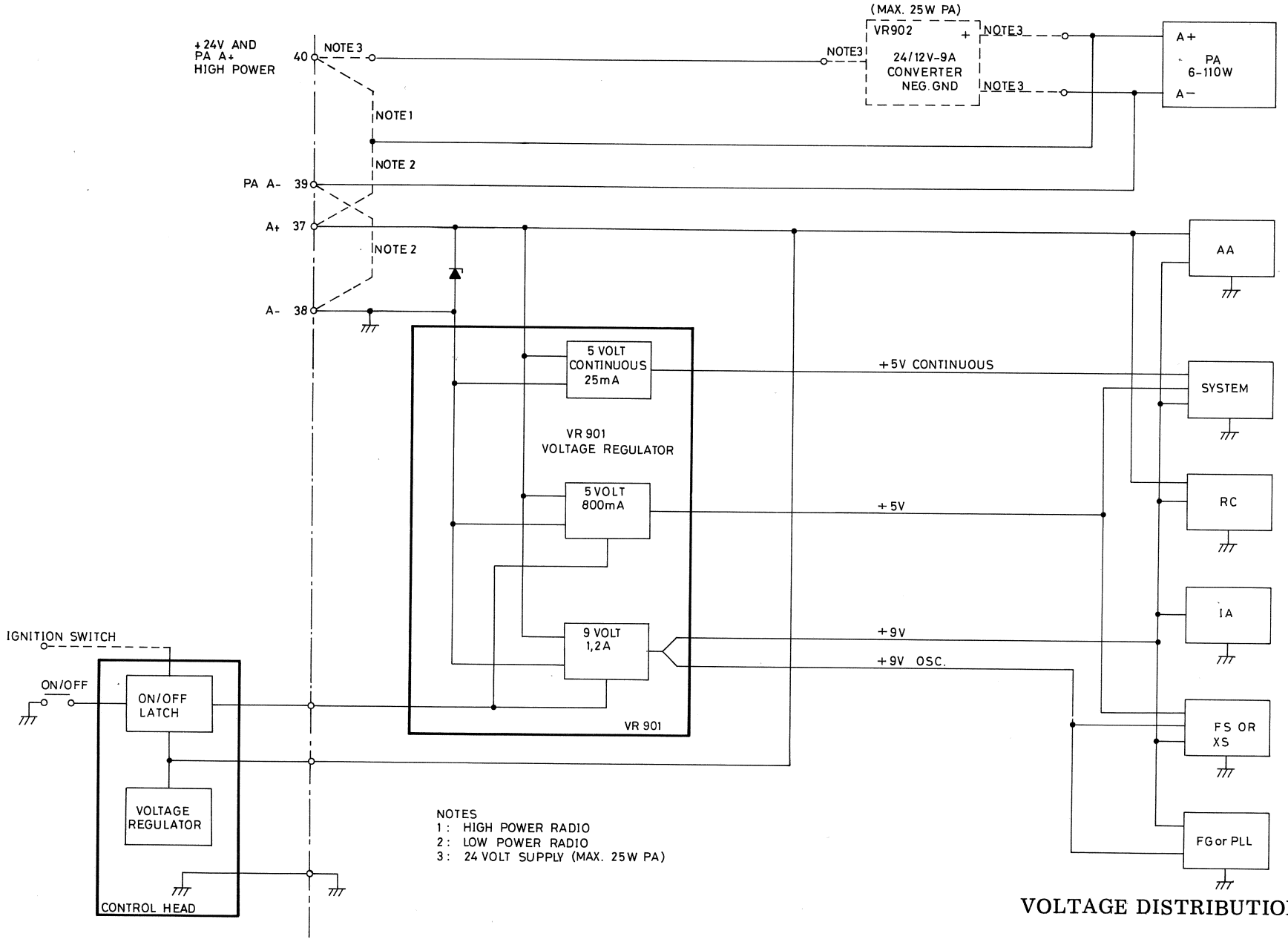
PROM JUMPER FIELD
IF OTHER THAN STANDARD: 2KUV PROM. IS USED
TYPE 2716 CODE 19J706385

CL 901 19L855008G1	NOTES	DESCRIPTION	NOTES	19A702222P1 4 KUV PROM I 2732	19A701662 P1 1K BIPOL. PROM	(HM7661-2) 2K BIPOL. PROM
W1	1	SYSTEMCLOCK WITH 5.7MHz CRYSTAL	11		W11	W11
	2	SYSTEMCLOCK WITH 11 MHz CRYSTAL	12	W12		
W3	3	Q6, Q7, H1 AND R11 ARE NOT PRESENT IN 19L855008G1	13	◉DRILL	◉DRILL	◉DRILL
W4	4	OPTIONAL OUTPUT JUMPER FIELD	14		W14	
	5		15	W15		
	6		16		W16	W16
	7		17		W17	W17
W8	8	OPTIONAL INPUT JUMPER	18		◉DRILL	◉DRILL
	9	U5 IS USED AS PERSONALITY PROM	19		◉DRILL	◉DRILL
W10	10	U5 IS USED AS EXTERN PROGRAM MEMORY				REMARKS: WIRECONNECT PIN9 OF U6 AND PIN 21 OF U5 (P22) AS SHOW ON BOARD-DRAWING.

CONTROL LOGIC CL901
STRAPPING INSTRUCTION

D403.155

Storno

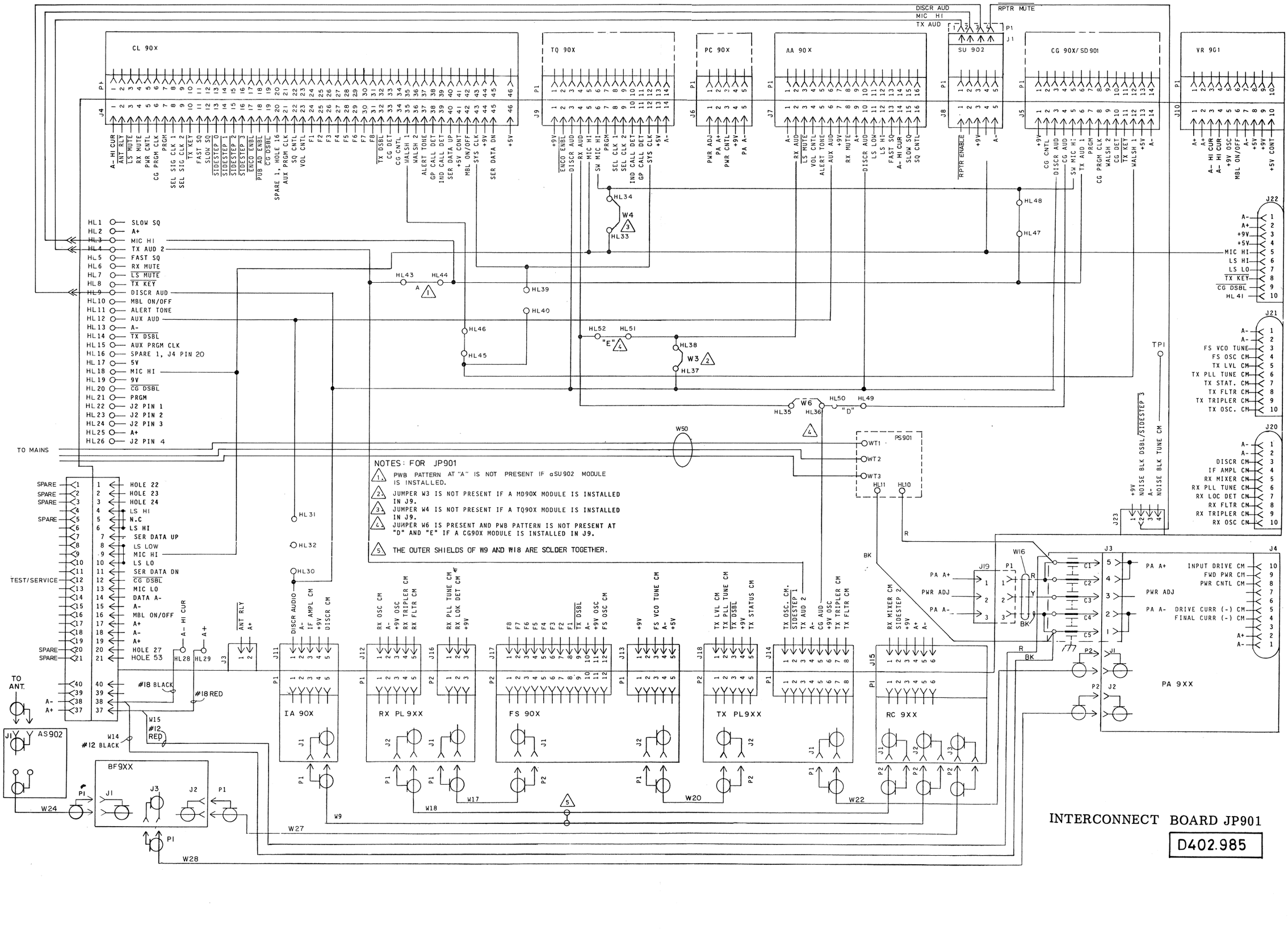


VOLTAGE DISTRIBUTION SYSTEM M 900

D402.938/2

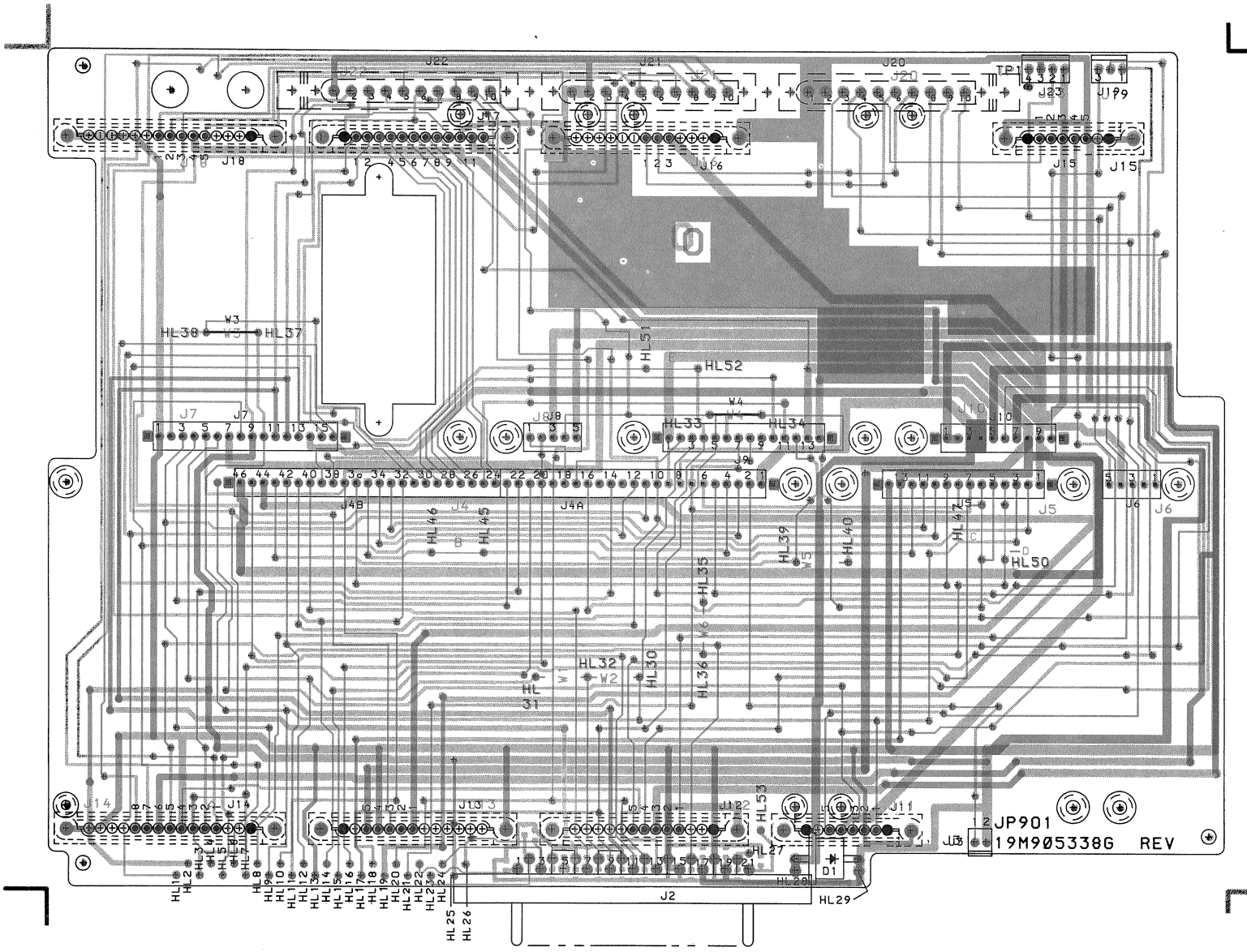
Storno

Storno



Storno

Storno

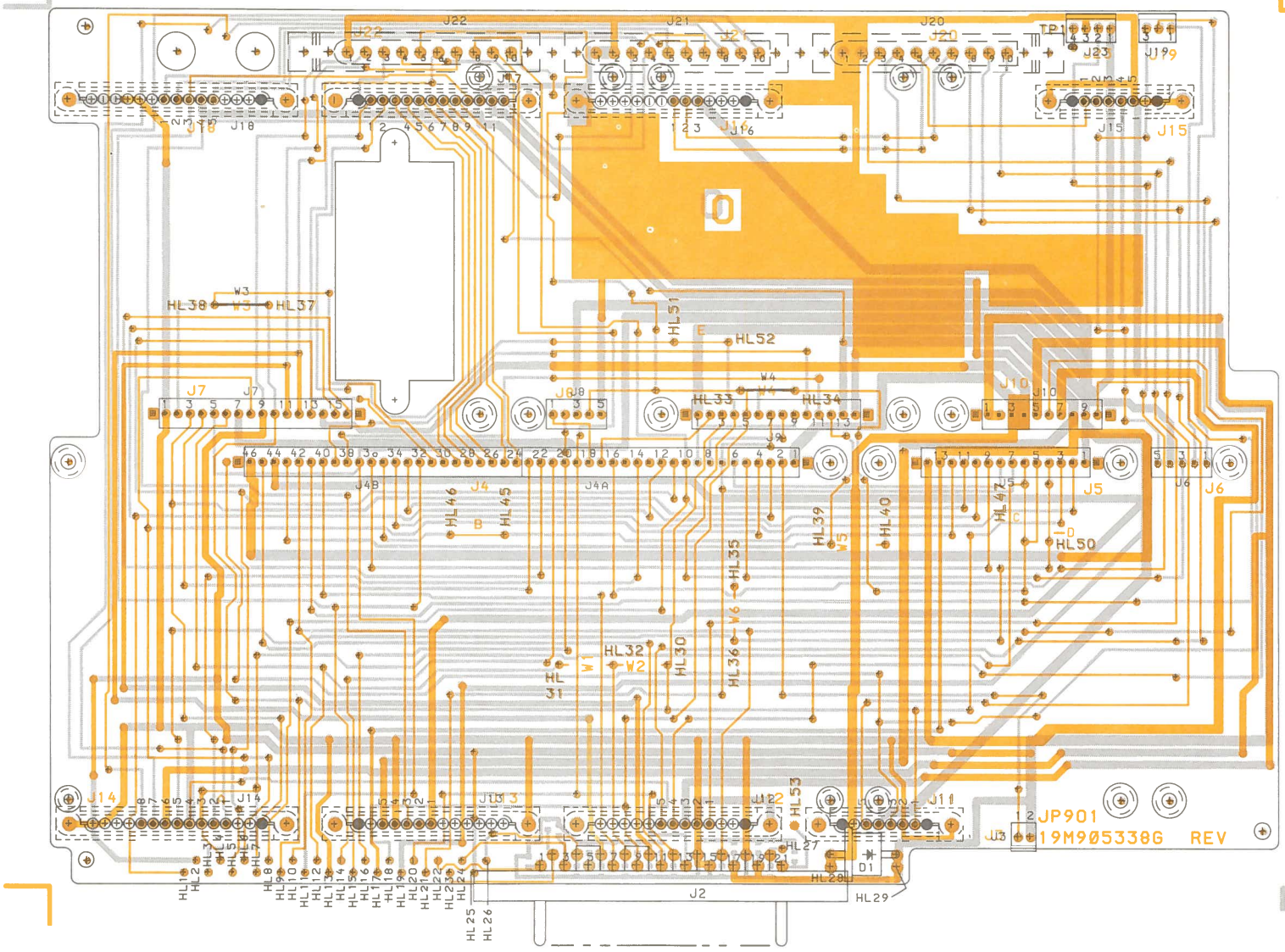


COMPONENT LAYOUT JP 901

D403.118

Storno

Storno

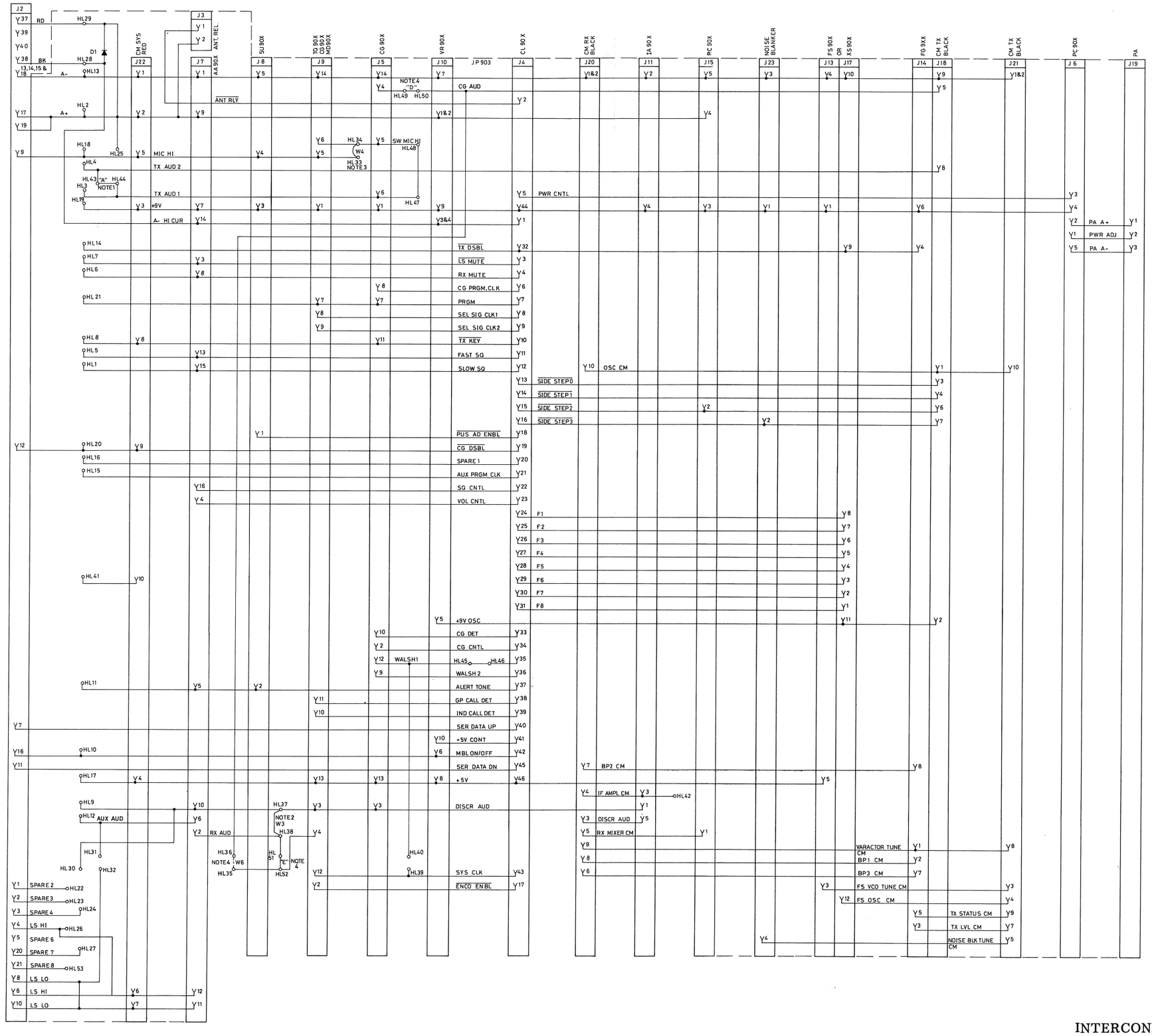


COMPONENT LAYOUT JP 901

D403.118

Storno

Storno



NOTES: FOR JP 903

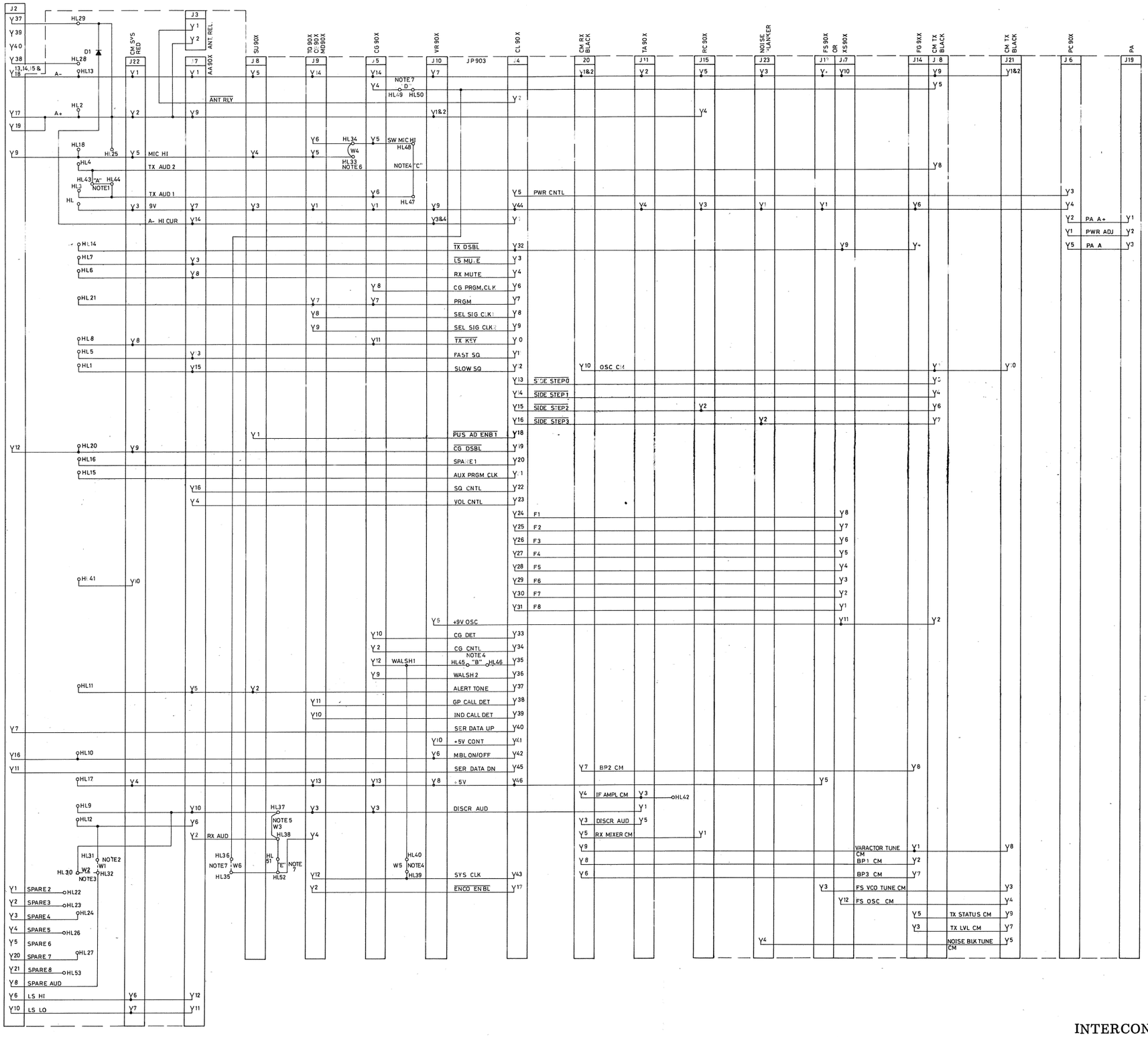
1. PWB PATTERN AT "A" IS NOT PRESENT IF TRANSMITTER MODULATING SIGNALS ARE CONNECTED TO HL3, HL4.
2. JUMPER W3 IS NOT PRESENT IF A MD90X MODULE IS INSTALLED IN J9
3. JUMPER W4 IS NOT PRESENT IF A TQ90X MODULE IS INSTALLED IN J9
4. JUMPER W6 IS PRESENT AND PWB PATTERN IS NOT PRESENT AT "D" AND "E" IF A CG90X MODULE IS INSTALLED IN J9.

INTERCONNECTION BOARD JP903

D403.123

Storno

Storno



NOTES: FOR JP 903

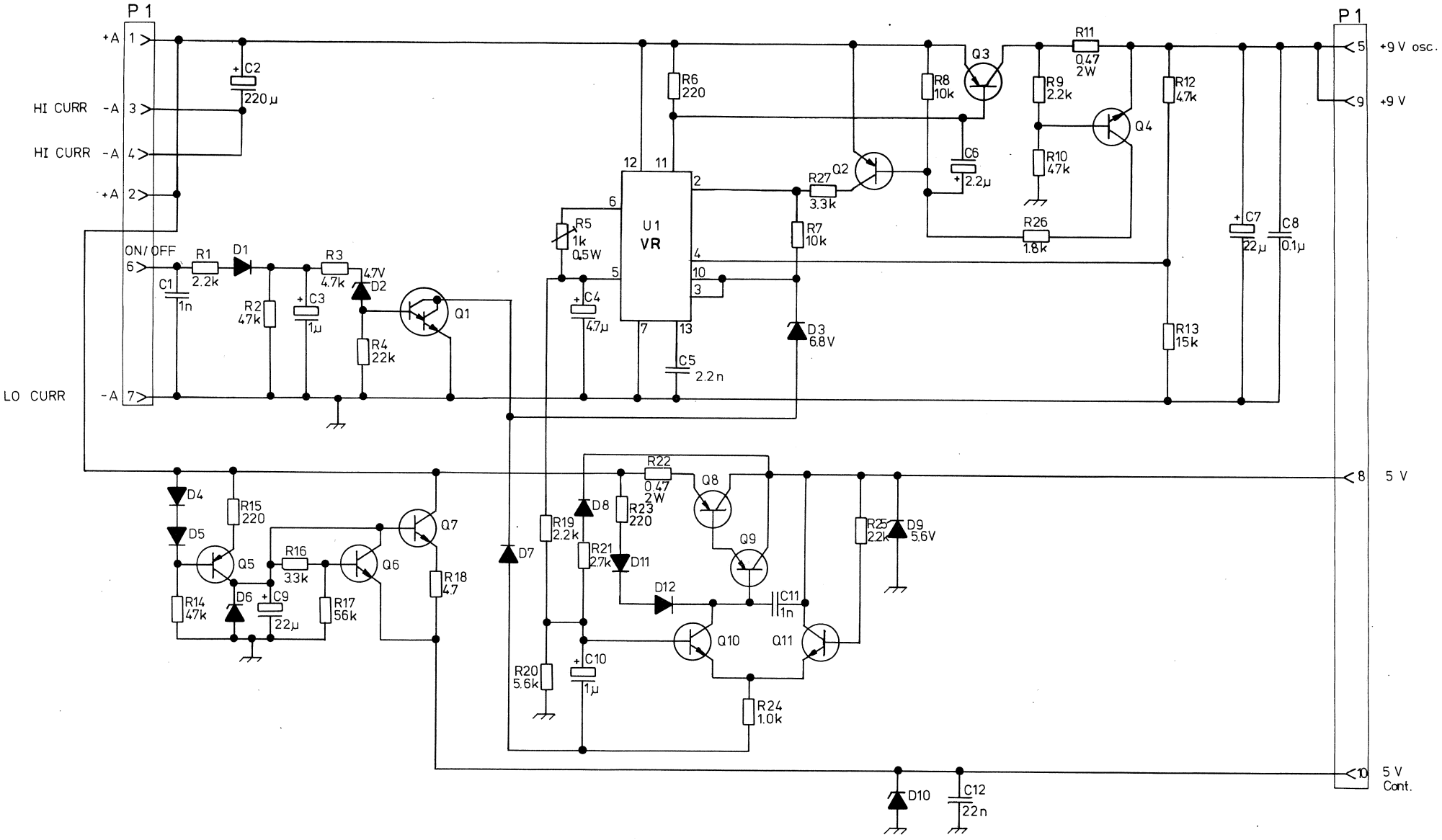
1. PWB PATTERN AT "A" IS NOT PRESENT IF TRANSMITTER MODULATING SIGNALS ARE CONNECTED TO HL3, HL4.
2. JUMPER W1 IS PRESENT IF AUXILLARY AUDIO IS CONNECTED TO SPARE AUDIO IN CONTROL CABLE. W1 AND W2 ARE MUTUALLY EXCLUSIVE.
3. JUMPER W2 IS PRESENT IF DISCRIMINATOR AUDIO IS CONNECTED TO SPARE AUDIO IN CONTROL CABLE. W1 AND W2 ARE MUTUALLY EXCLUSIVE.
4. JUMPER W5 IS PRESENT AND PWB PATTERN IS NOT PRESENT AT "B" AND "C" IF A TQ90X MODULE IS INSTALLED IN J5
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.

INTERCONNECTION BOARD JP903

D402.907

Storno

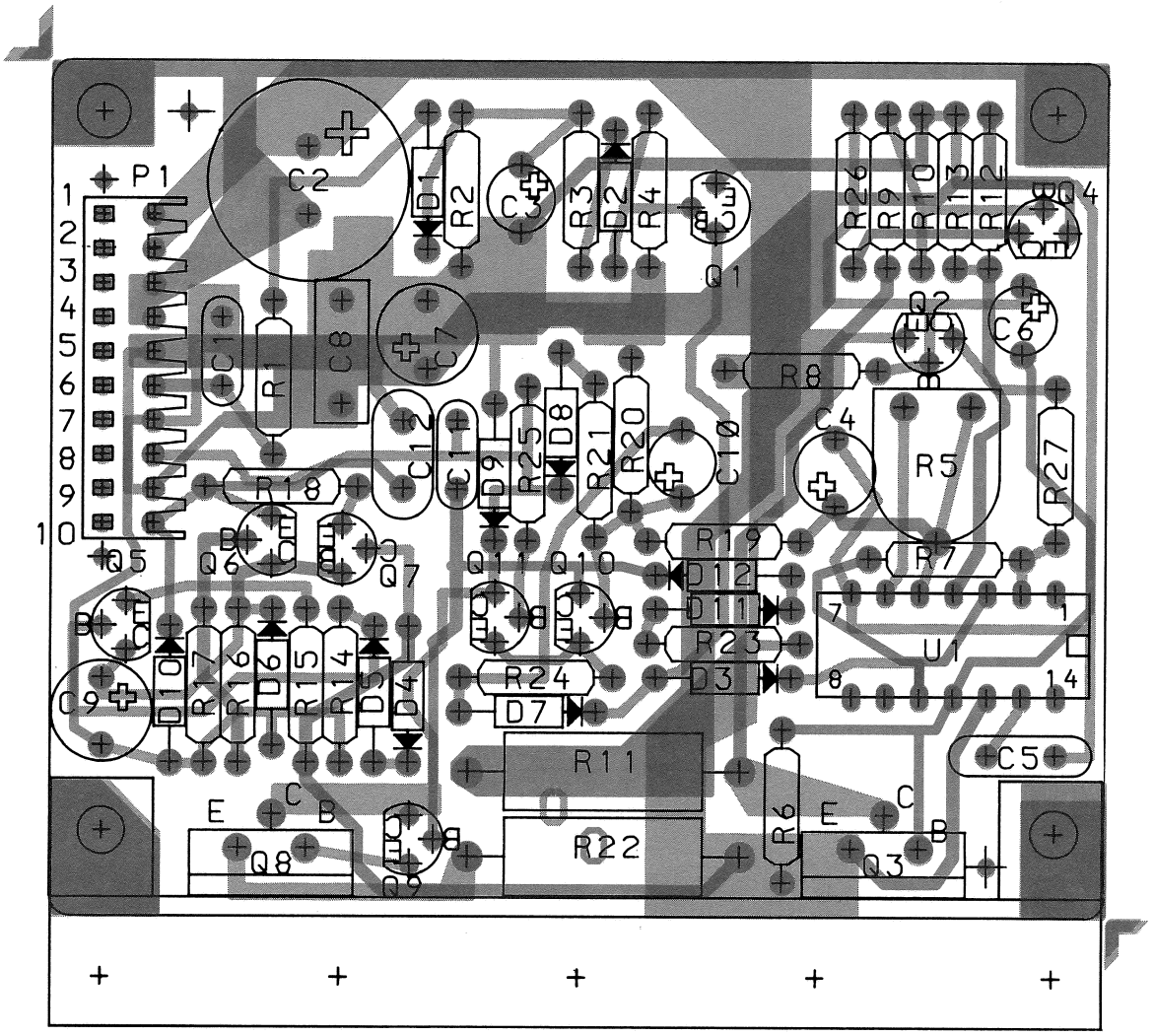
Storno



VOLTAGE REGULATOR +9V, +5V VR901

19L855013G2 D402.968/2

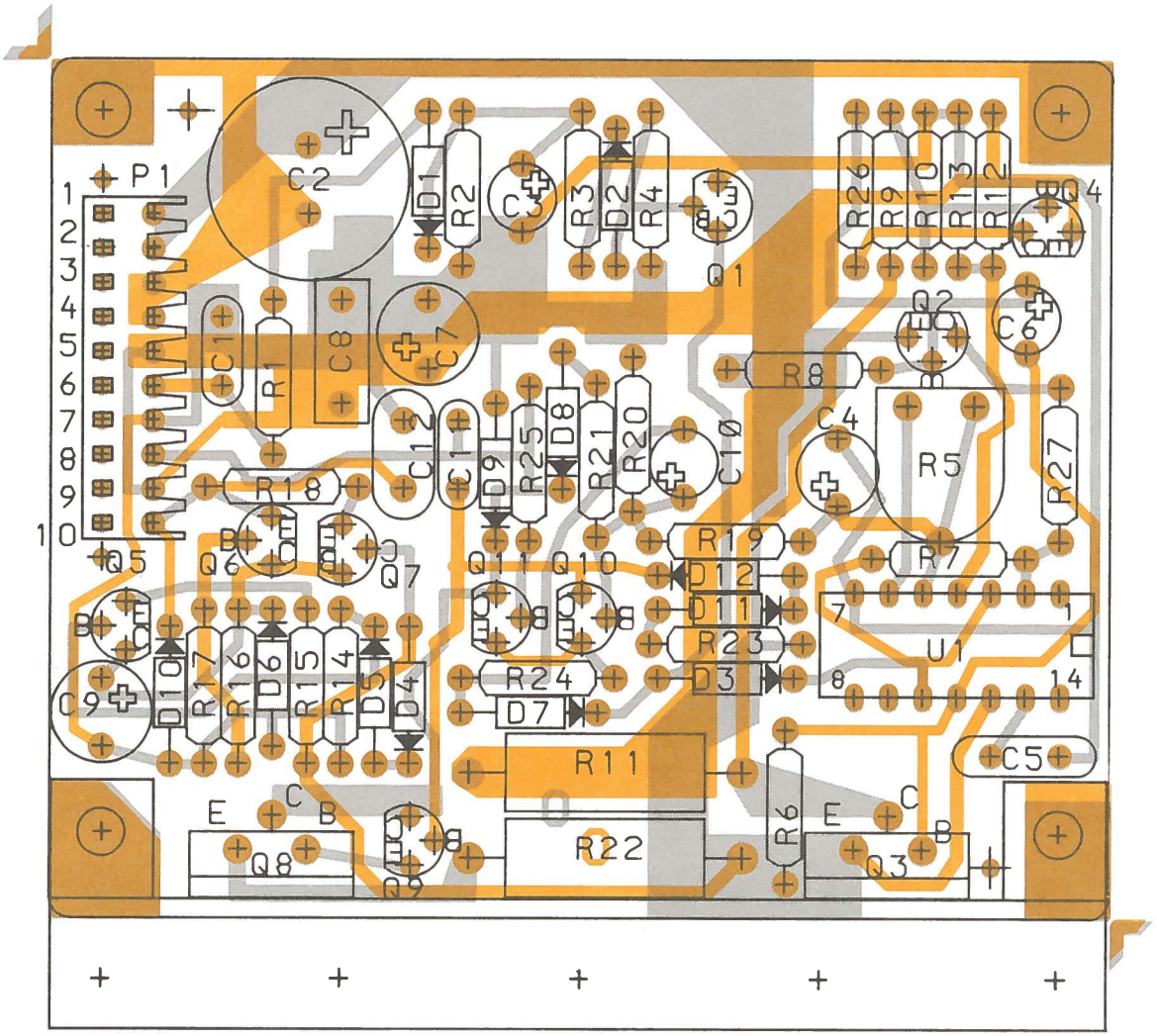
Storno



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

19L855013G2 | D403.164

Storno

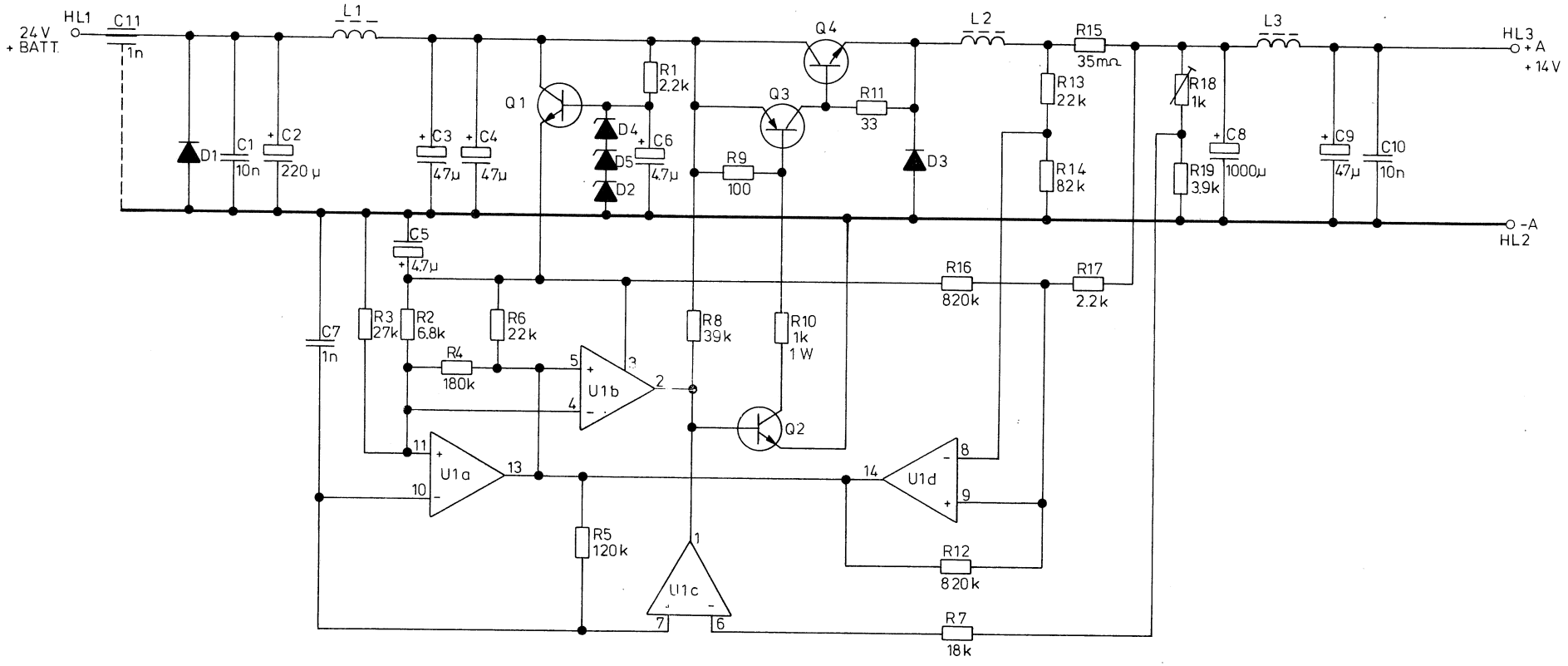


VOLTAGE REGULATOR + 9V, + 5V VR901
COMPONENT LAYOUT

19L855013G2 | D403.164

Storno

Storno

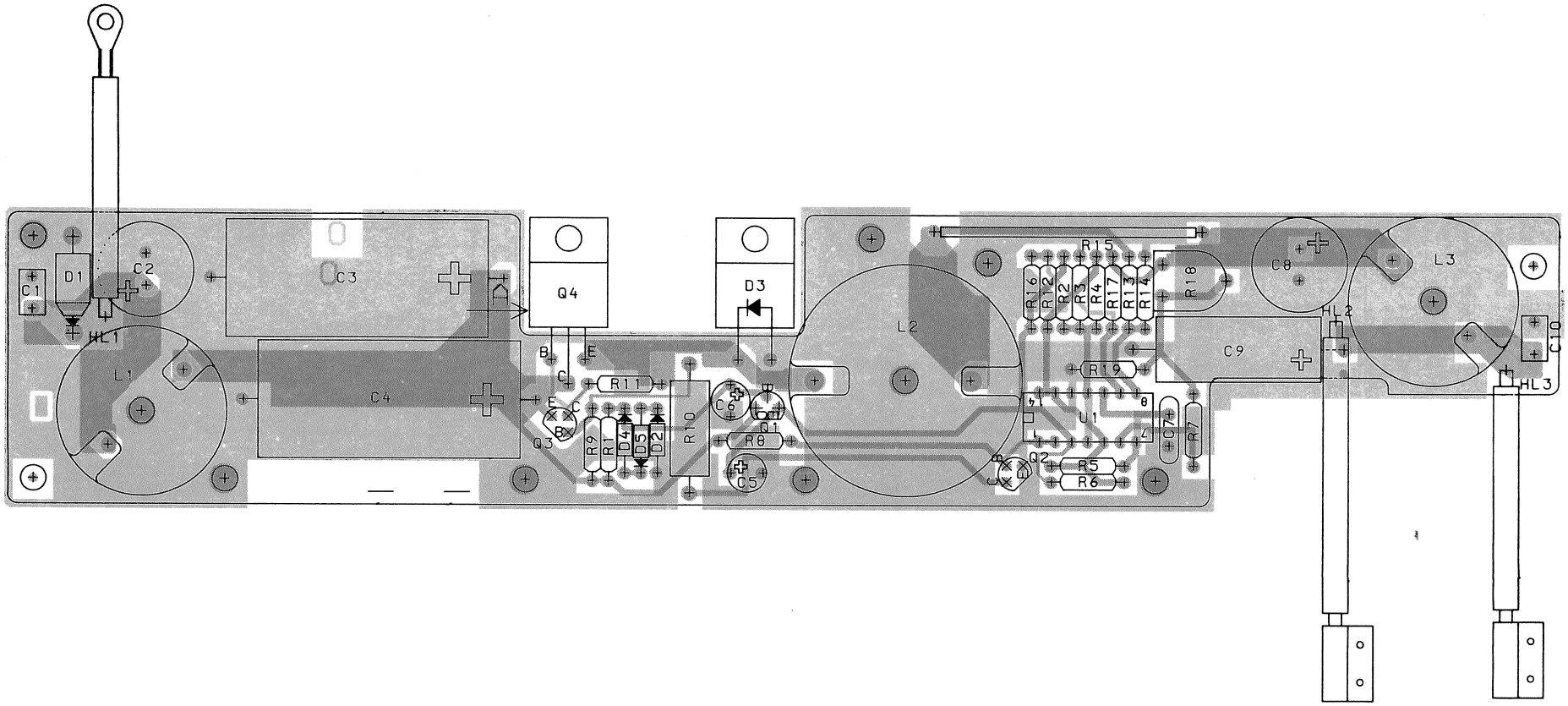


VOLTAGE REGULATOR 24/12V NEG GND VR902

19L855018G1 D402.966/2

Storno

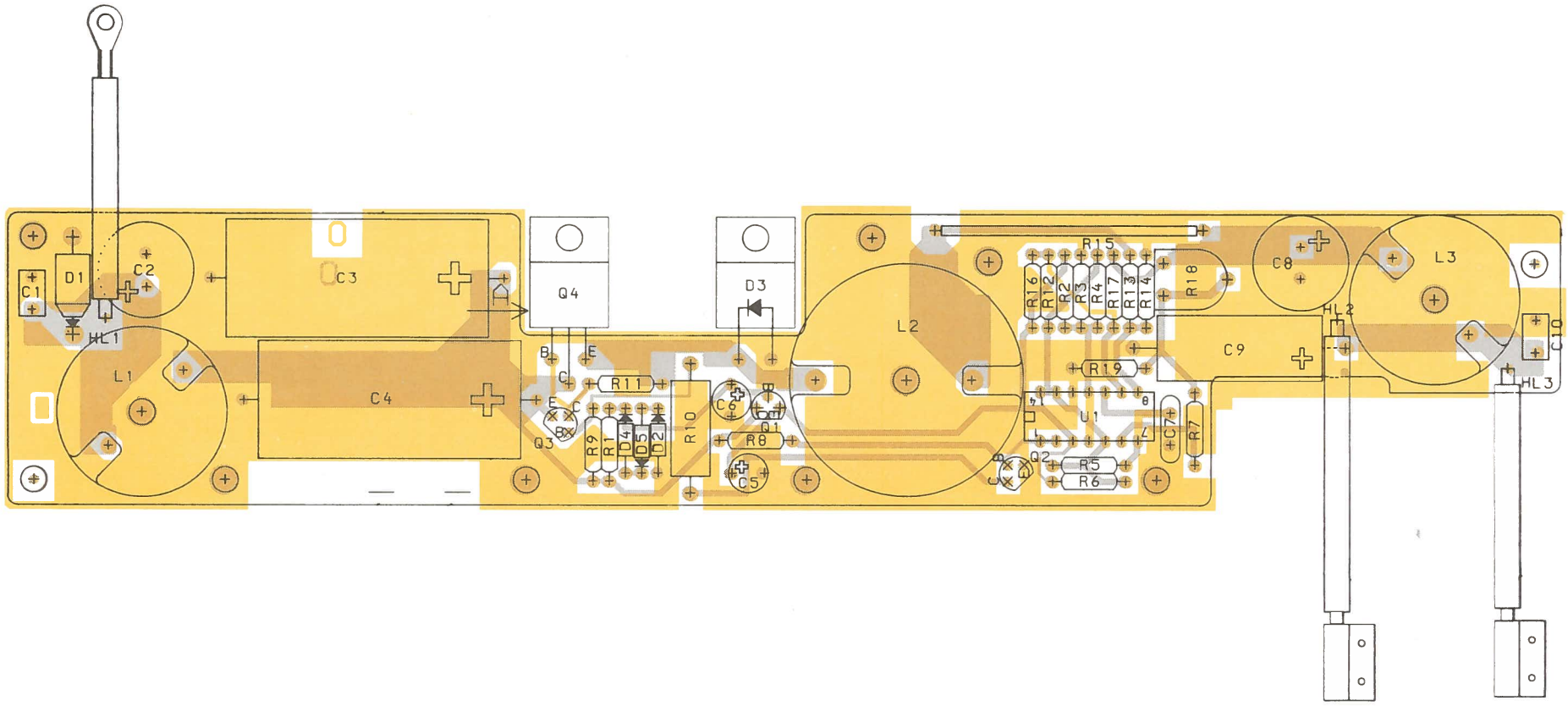
Storno



VOLTAGE REGULATOR VR902
COMPONENT LAYOUT

19L855018G1 | D403.165

Storno

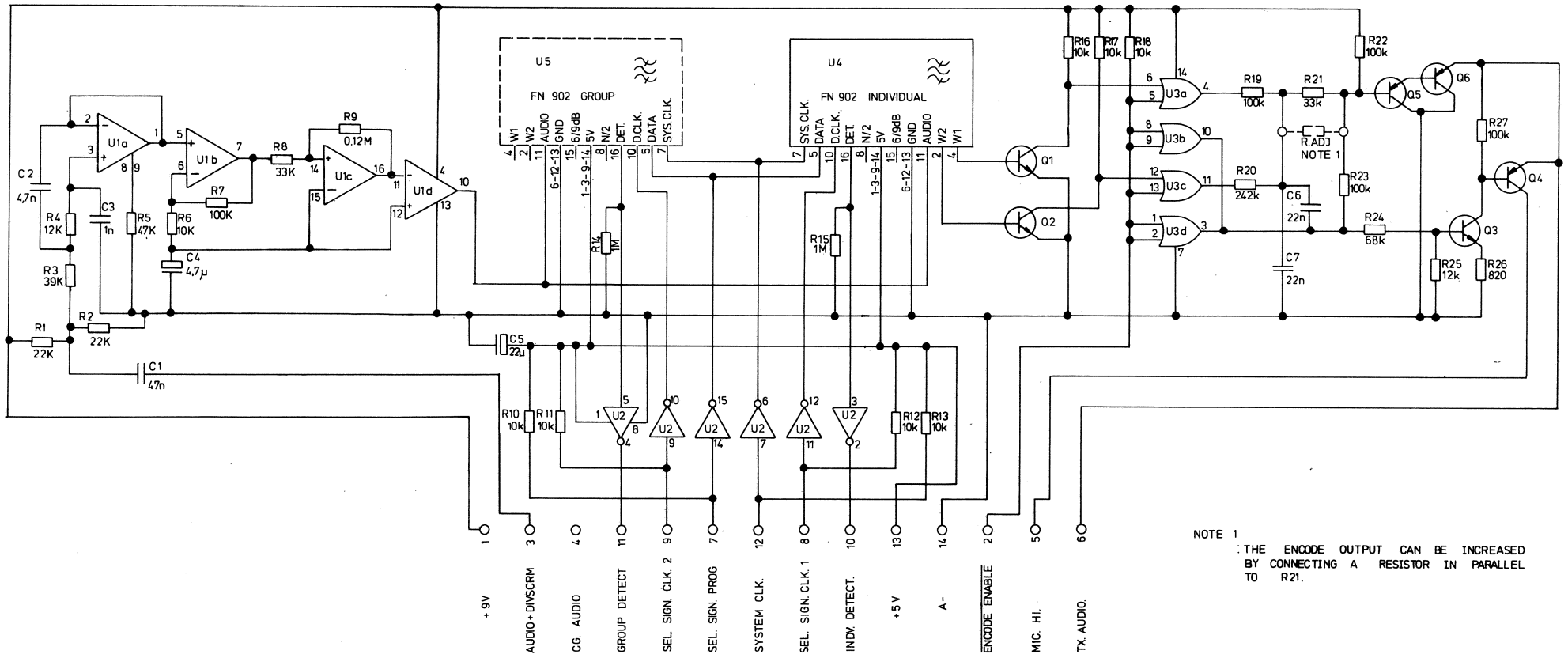


VOLTAGE REGULATOR VR902
COMPONENT LAYOUT

19L855018G1 | D403.165

Storno

Storno

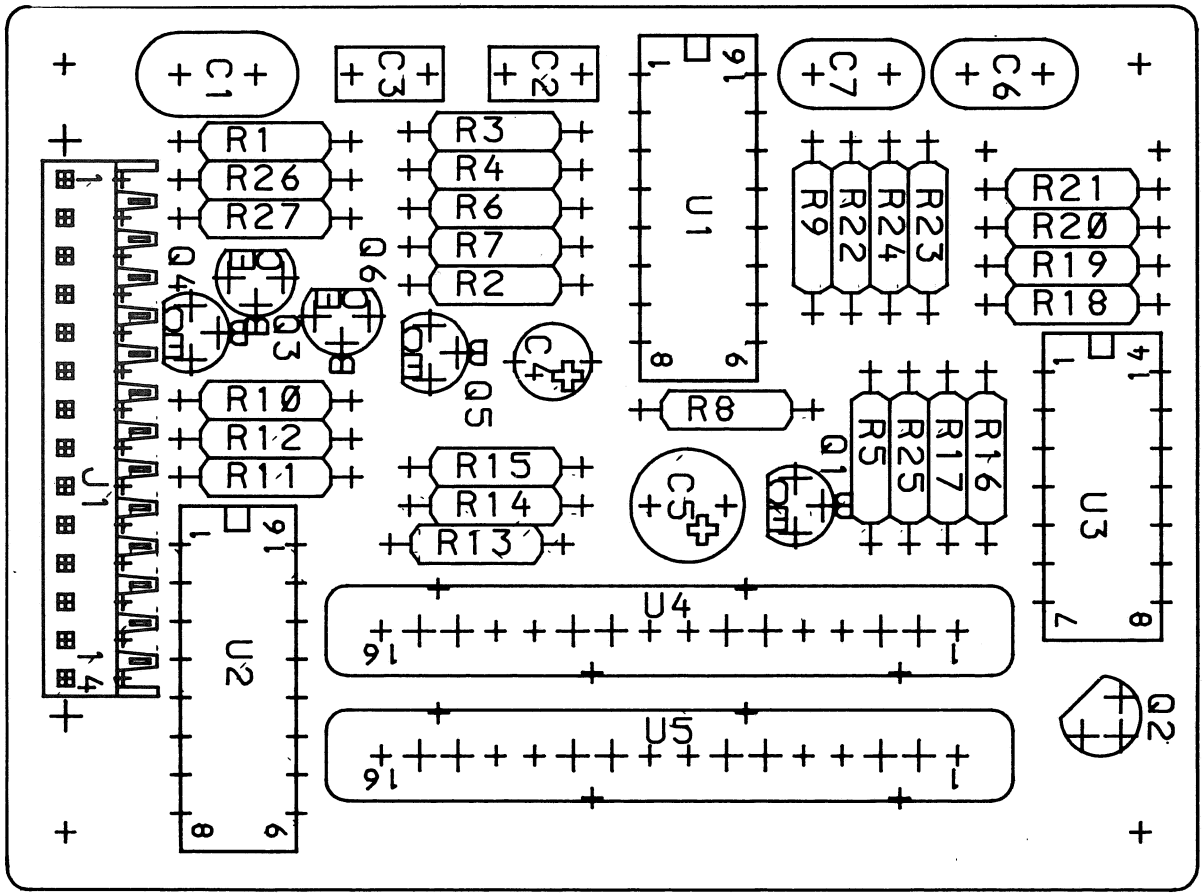


NOTE 1
: THE ENCODE OUTPUT CAN BE INCREASED BY CONNECTING A RESISTOR IN PARALLEL TO R21.

SEQUENTIAL TONE ENC/DEC TQ901
SEQUENTIAL TONE ENC/DEC WITH GR CALL TQ902

D402.941

Storno

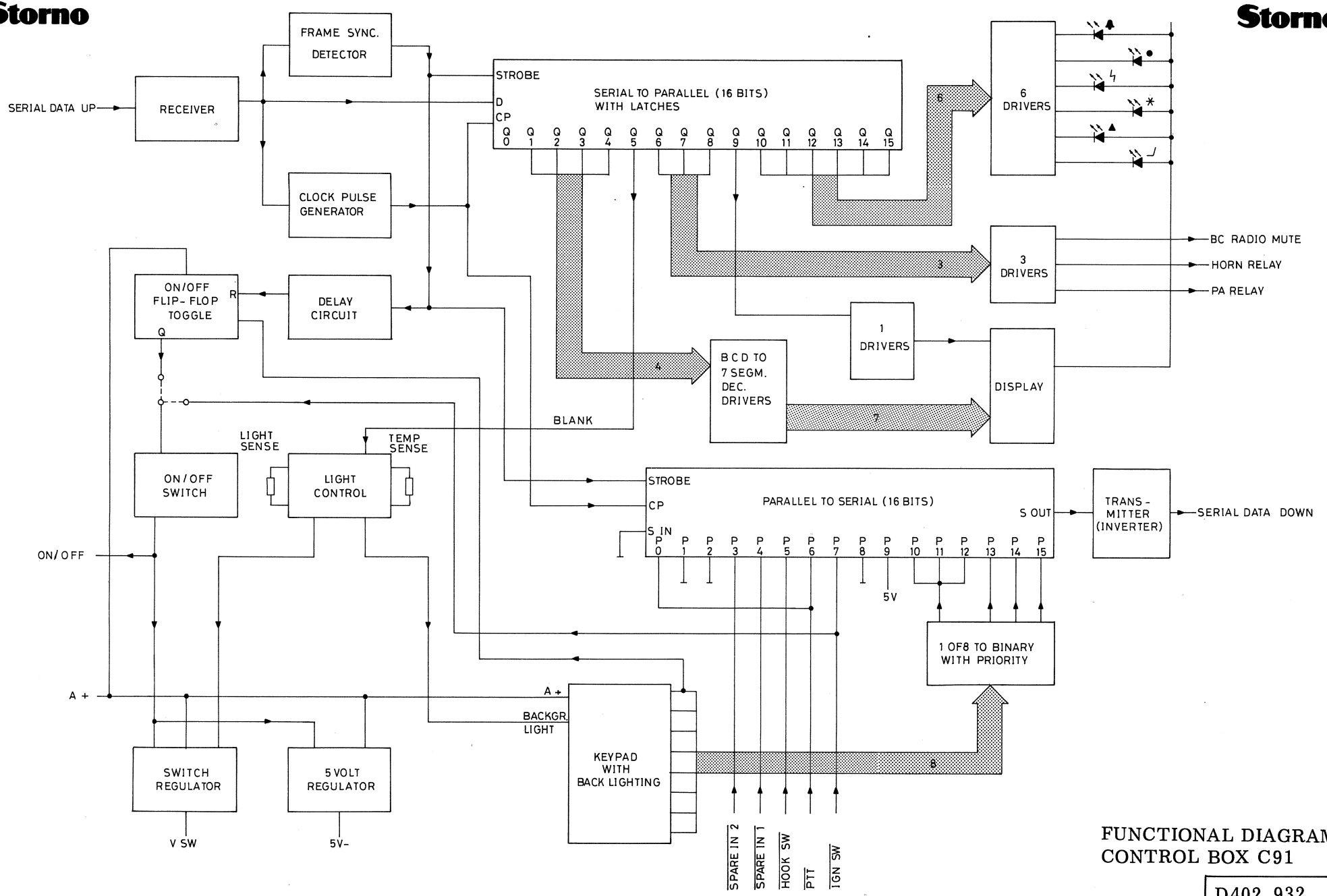


SEQUENTIAL TONE ENC/DEC TQ901
COMPONENT LAYOUT

D402.964

Storno

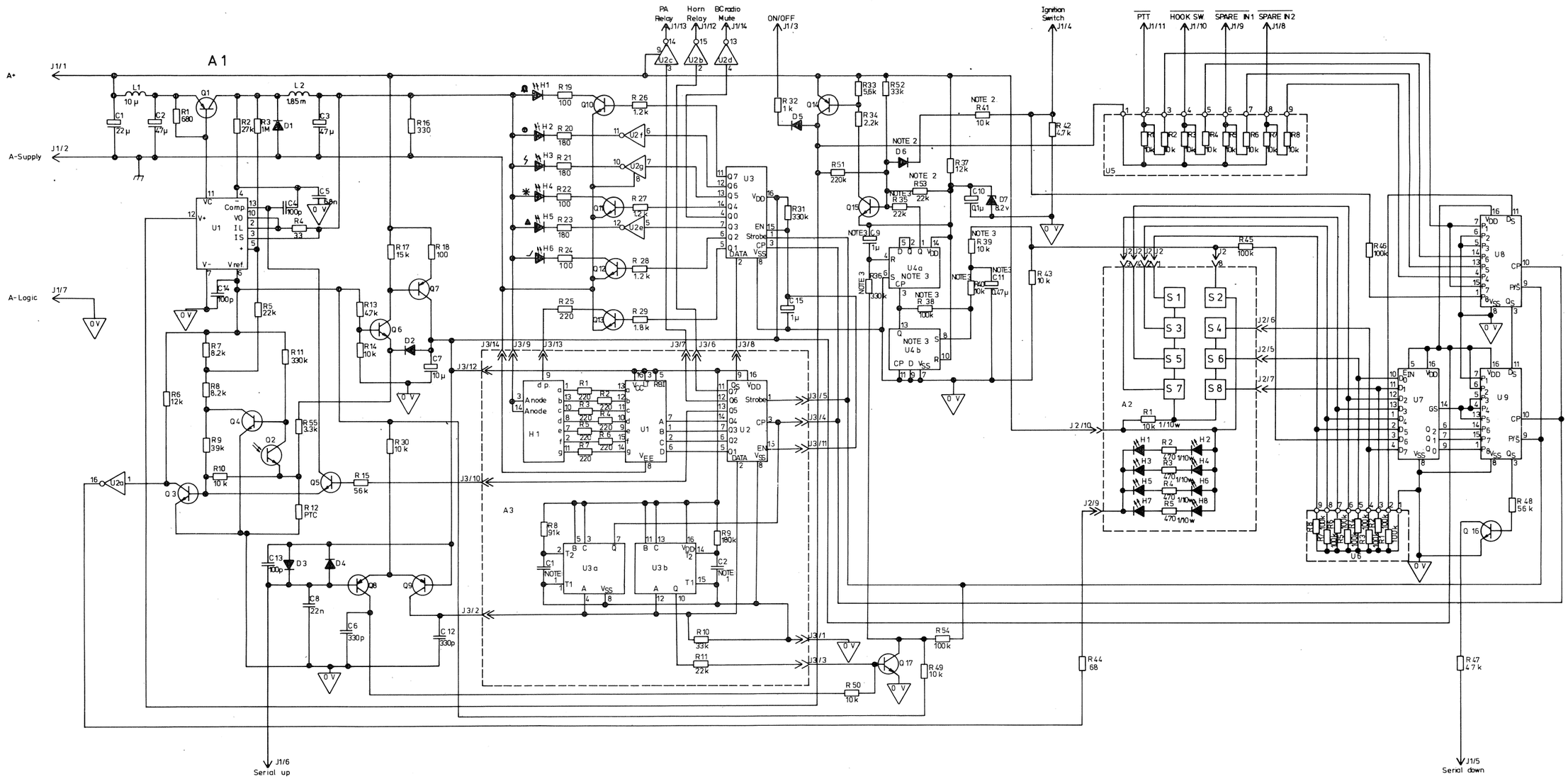
Storno



FUNCTIONAL DIAGRAM
CONTROL BOX C91

D402.932

Storno



Note 1 : For Storno format C1 = C2 = 6.8 nF
For GE format C1 = C2 = 3.3 nF

Note 2 : With key pad on/off, D6, R41 and R53 are deleted.

Note 3 : With ignition switch on/off, C9, C11, R35, R36, R38, R39, R40 and U4 are deleted.

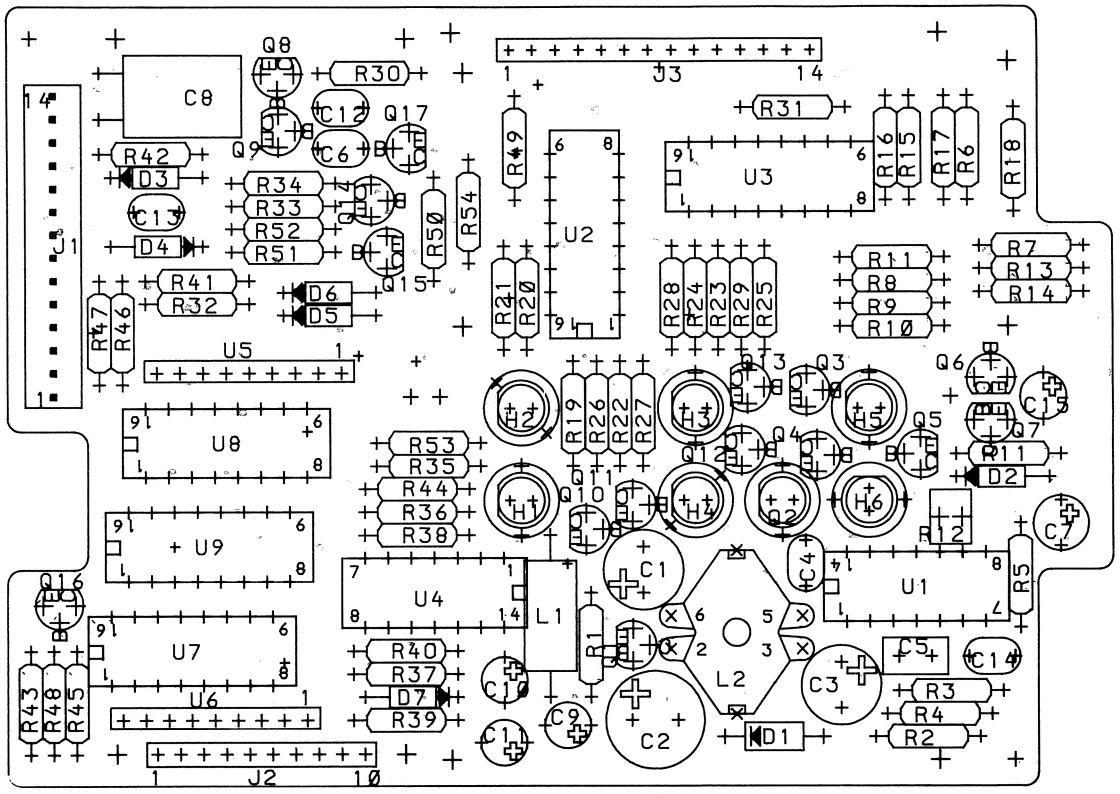
Note ,

All resistors are 1/4 watt unless otherwise specified.
Resistor values in Ω unless followed by multiplier k or M.
Capacitor values in F unless followed by multiplier µ, n or p.
Inductance values in H unless followed by multiplier m or µ.

CONTROL HEAD C91

D402.981

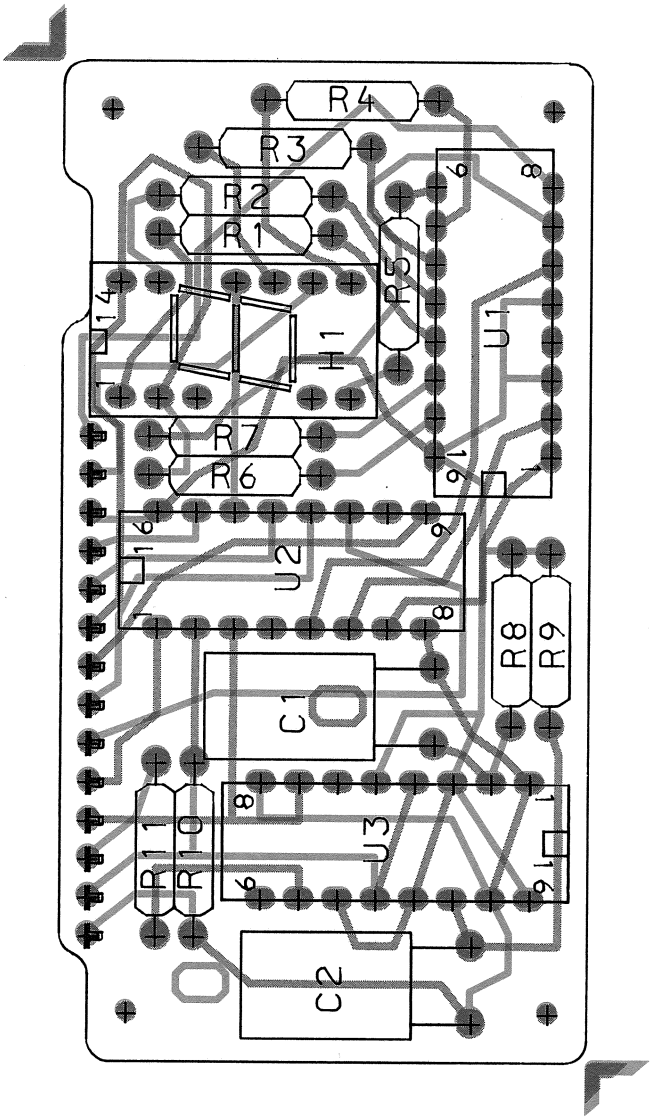
Storno



PART OF CONTROL HEAD C91
COMPONENT LAYOUT

D402. 947

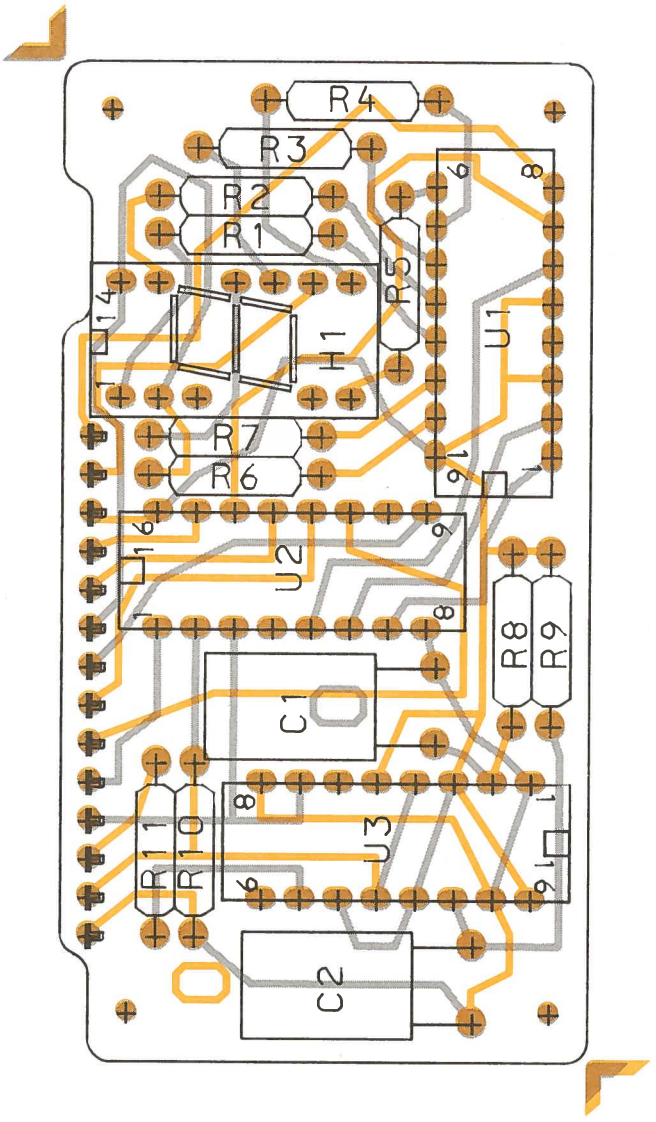
Storno



CONTROL HEAD C91
COMPONENT LAYOUT

19L855058 D402.949

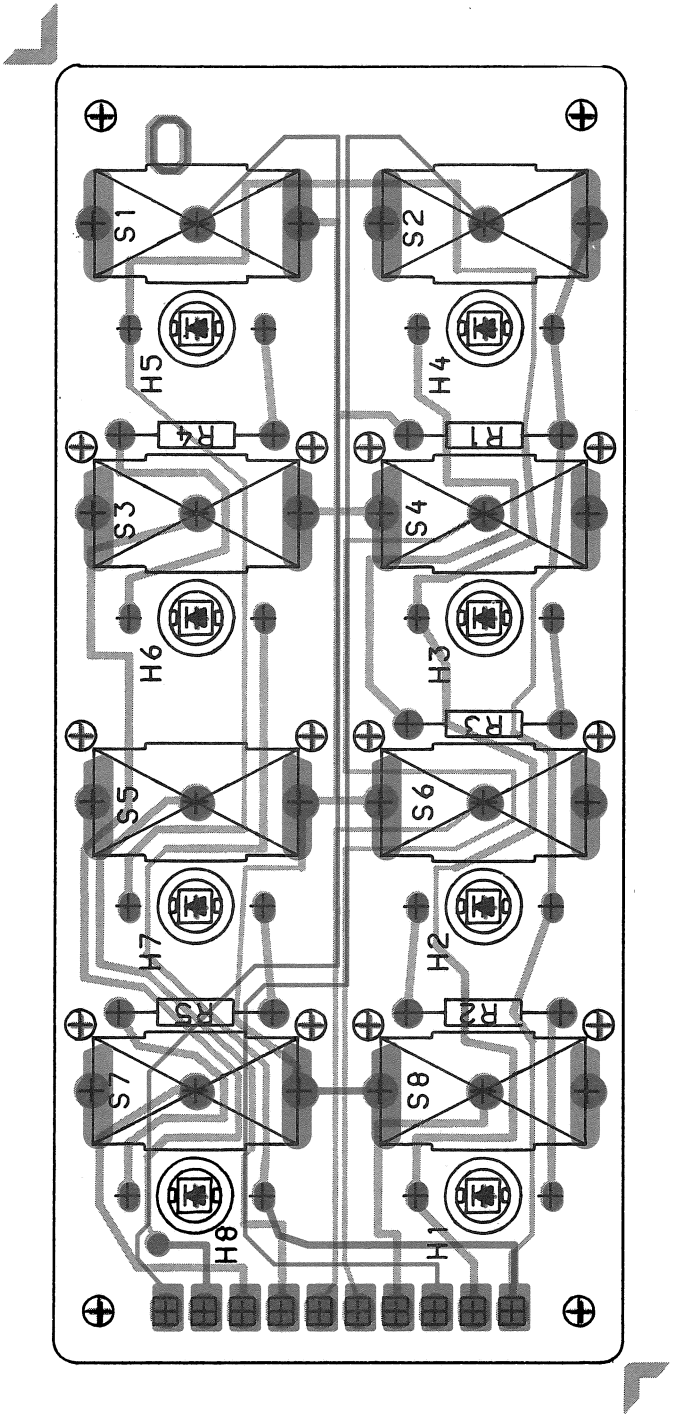
Storno



CONTROL HEAD C91
COMPONENT LAYOUT

19L 855058 D402.949

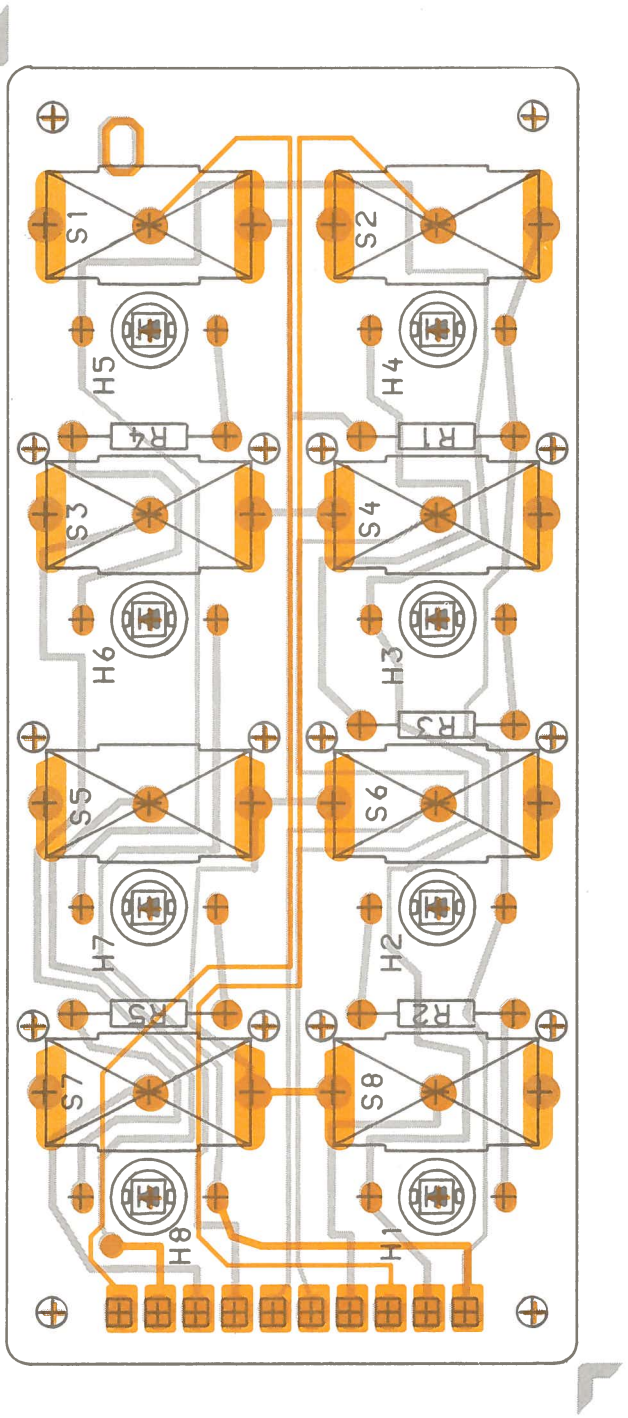
Storno



CONTROL HEAD C91
COMPONENT LAYOUT

19M905209 D402.948

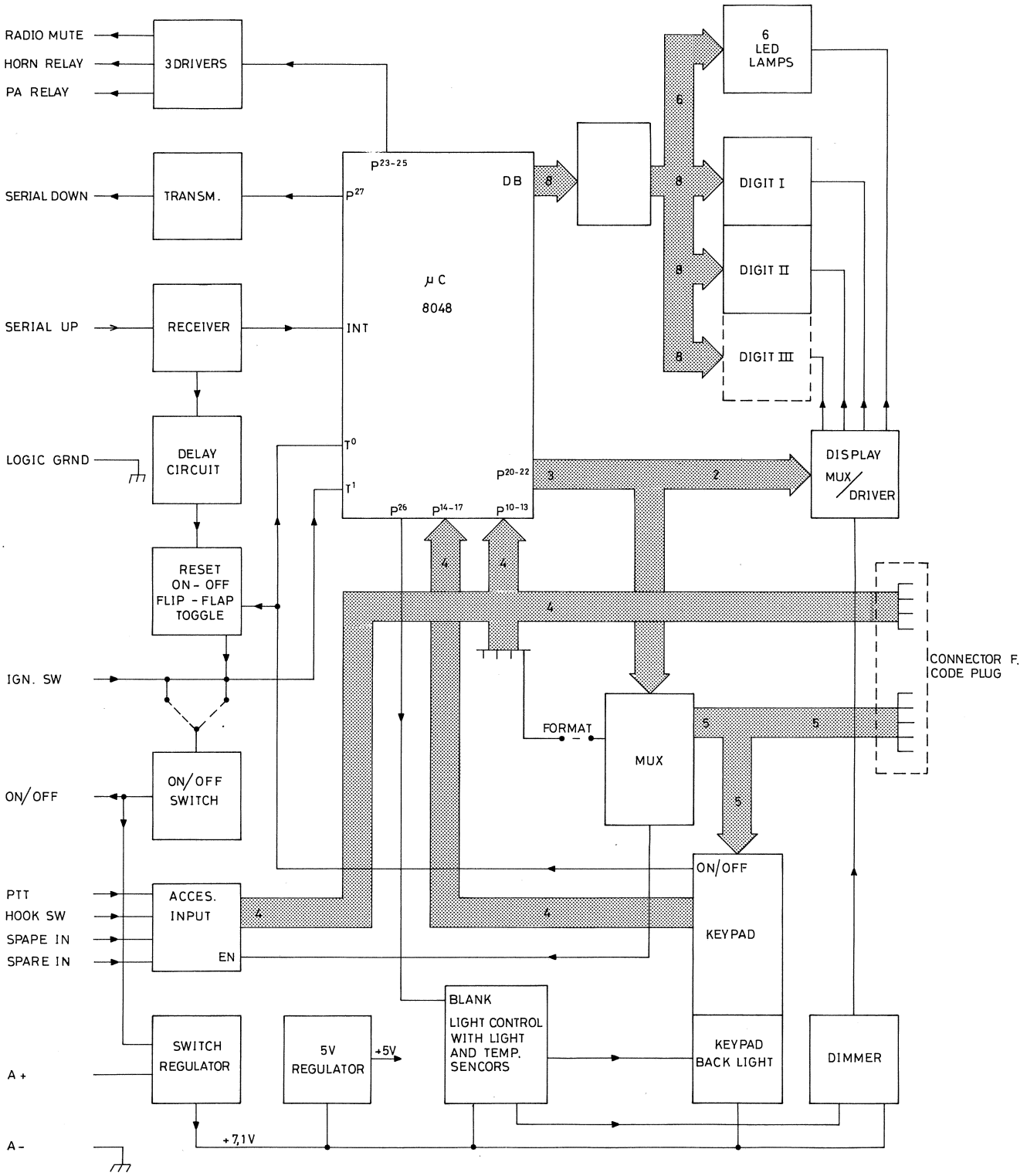
Storno



CONTROL HEAD C91
COMPONENT LAYOUT

19M905209 D402.948

Storno

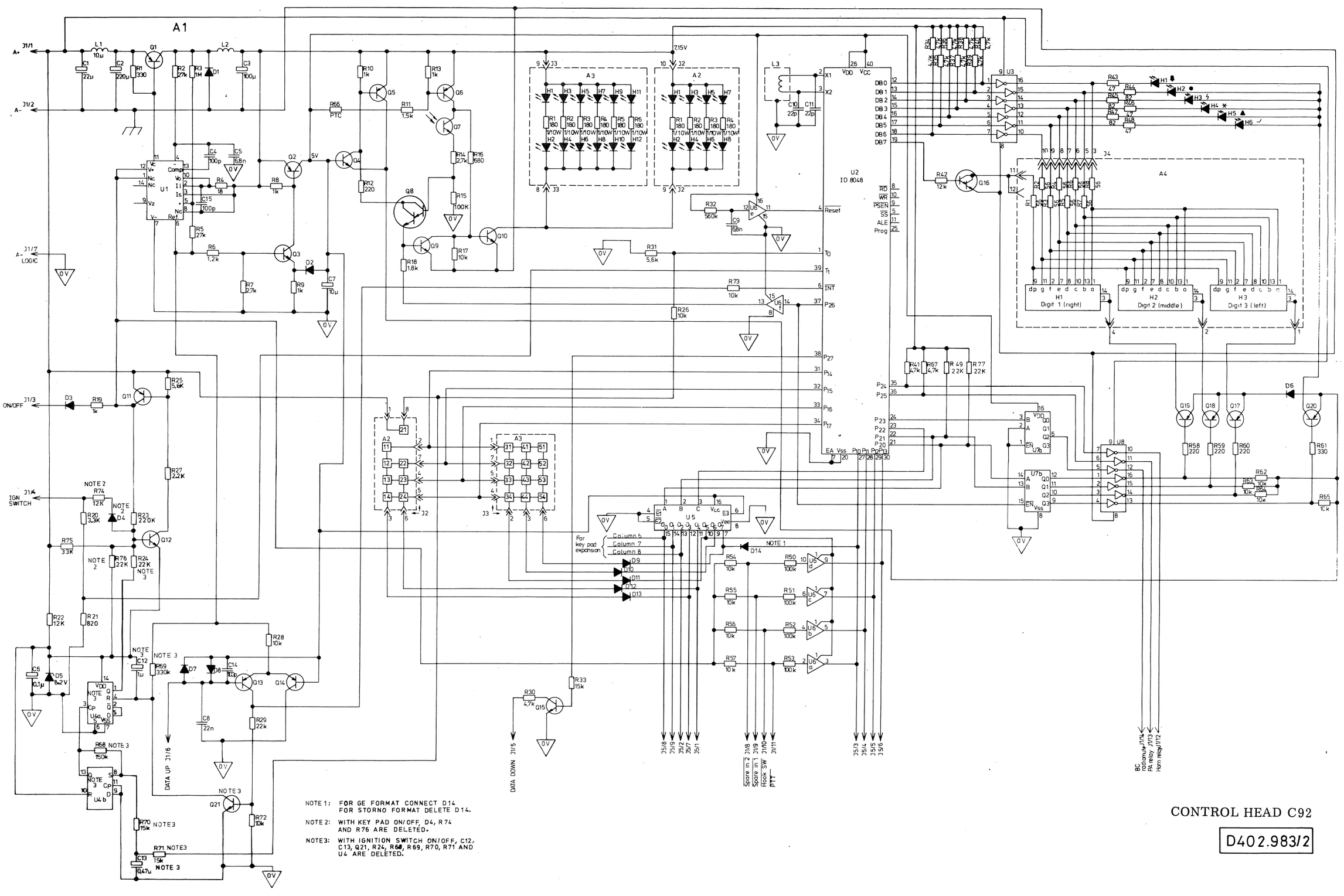


FUNCTIONAL DIAGRAM
CONTROL BOX C92

D402.933/2

Storno

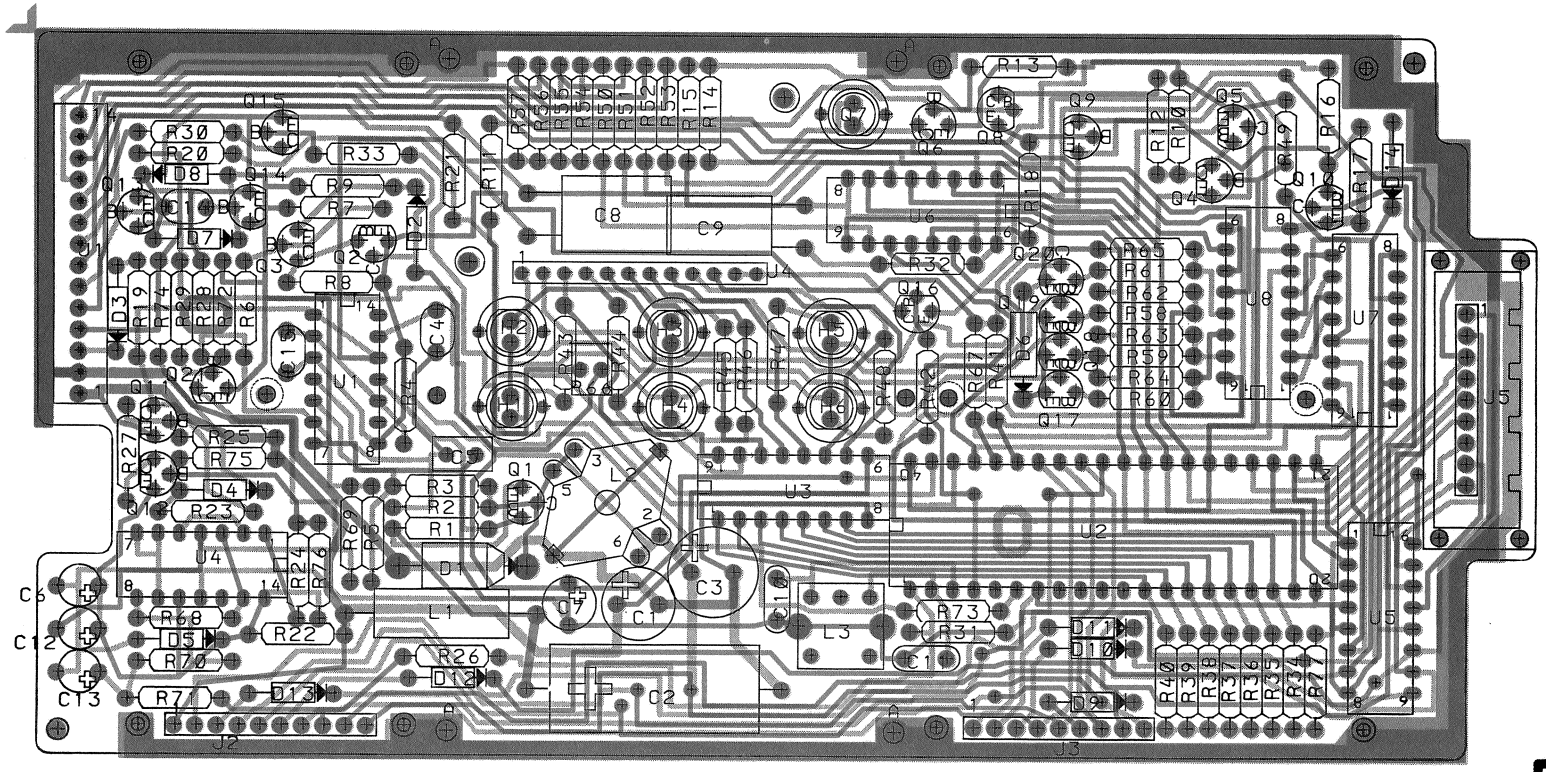
Storno



CONTROL HEAD C92

D402.983/2

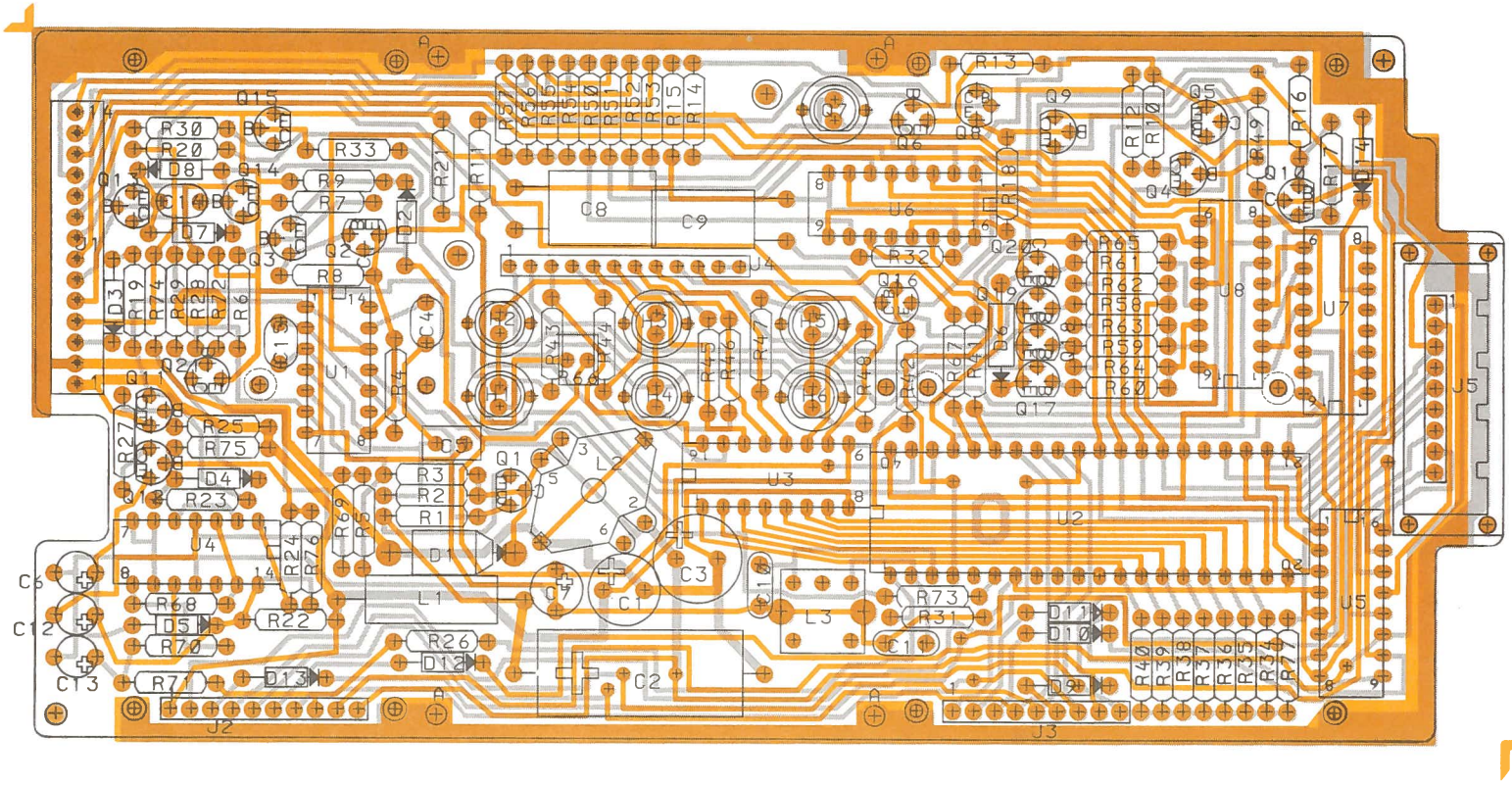
Storno



PART OF CONTROL HEAD C92
COMPONENT LAYOUT

D402. 950

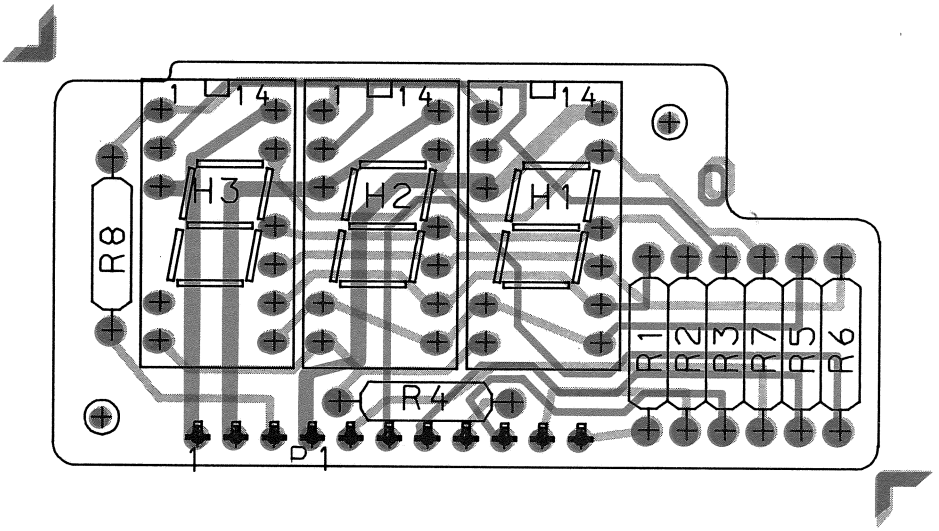
Storno



PART OF CONTROL HEAD C92
COMPONENT LAYOUT

D402. 950

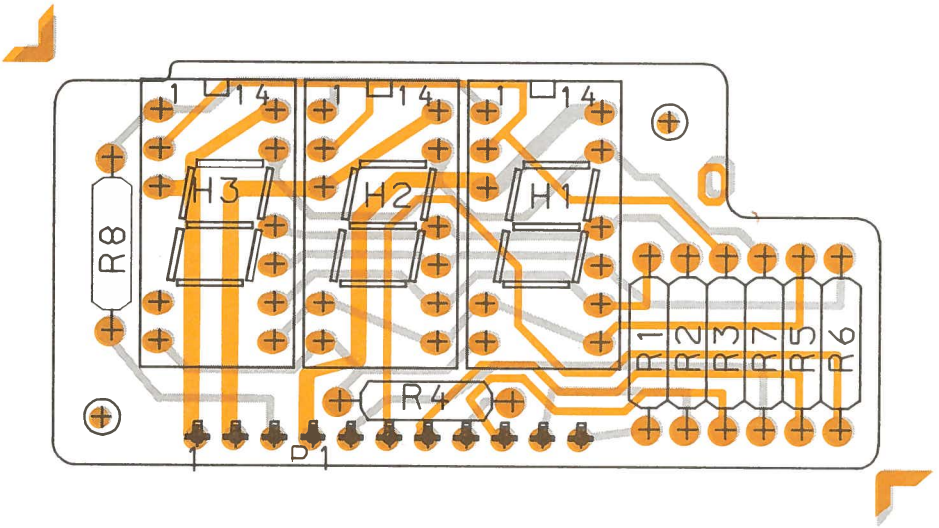
Storno



CONTROL HEAD C92
COMPONENT LAYOUT

19L855078 D402.951

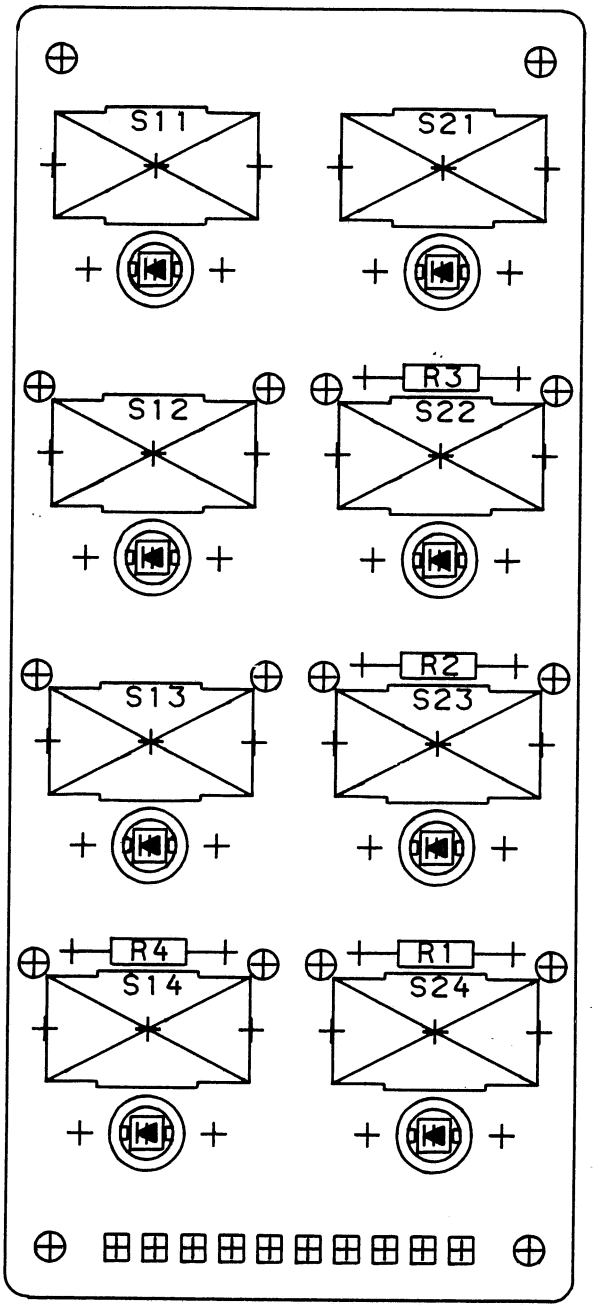
Storno



CONTROL HEAD C92
COMPONENT LAYOUT

19L855078 D402.951

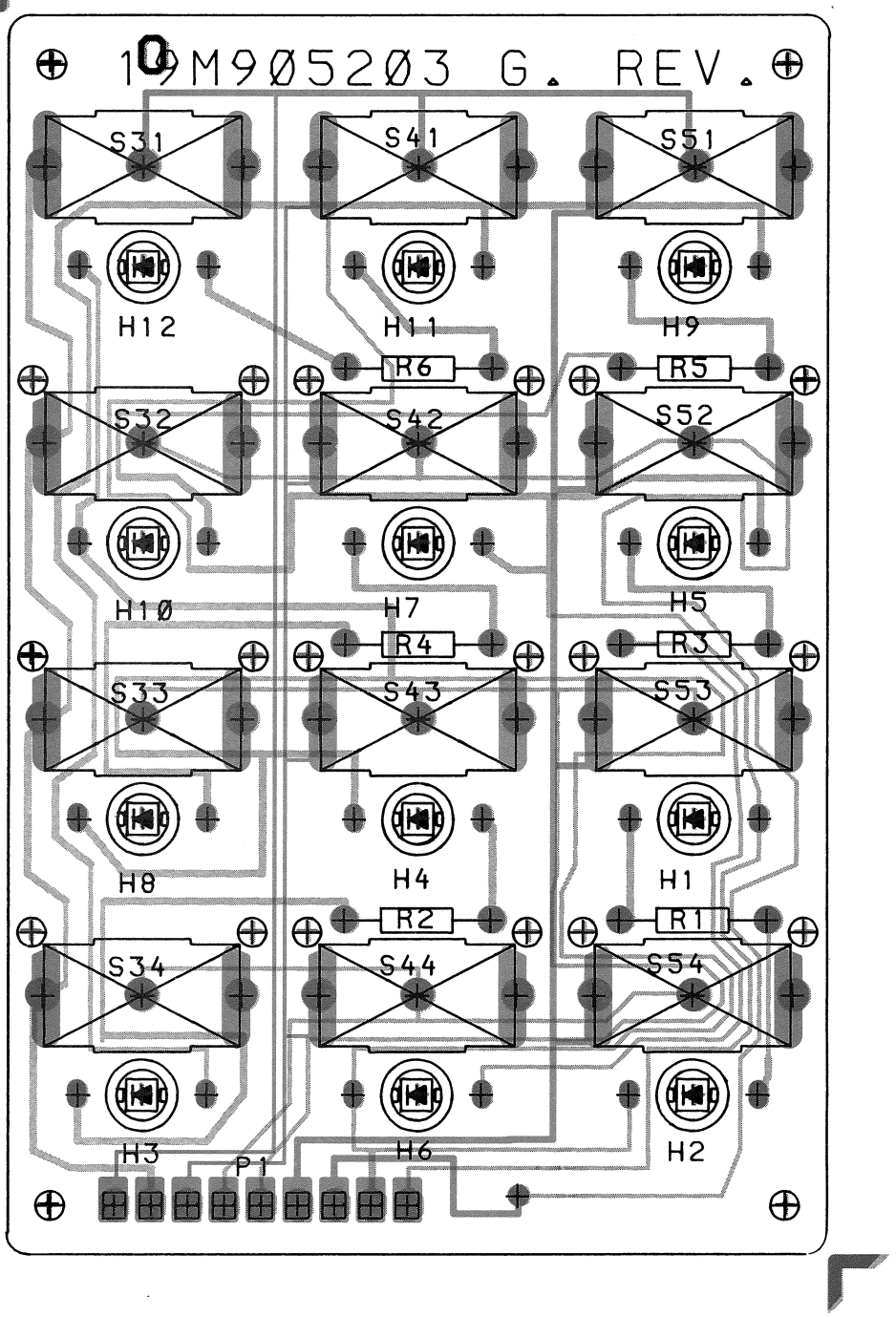
Storno



PART OF CONTROL HEAD C92
COMPONENT LAYOUT

D402.953

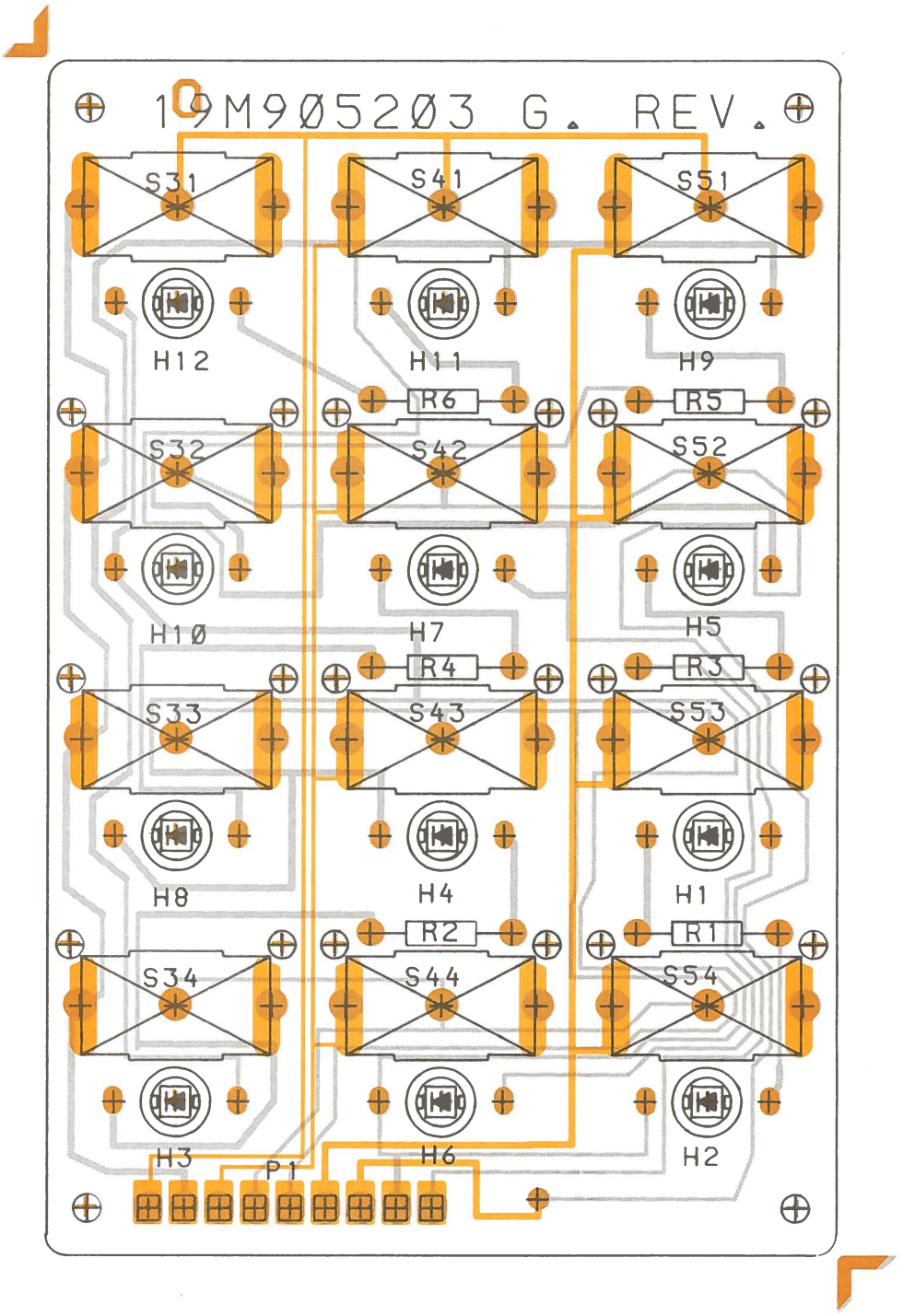
Storno



CONTROL HEAD C92
COMPONENT LAYOUT

19M905203G1 | D402.952

Storno



CONTROL HEAD C92
COMPONENT LAYOUT

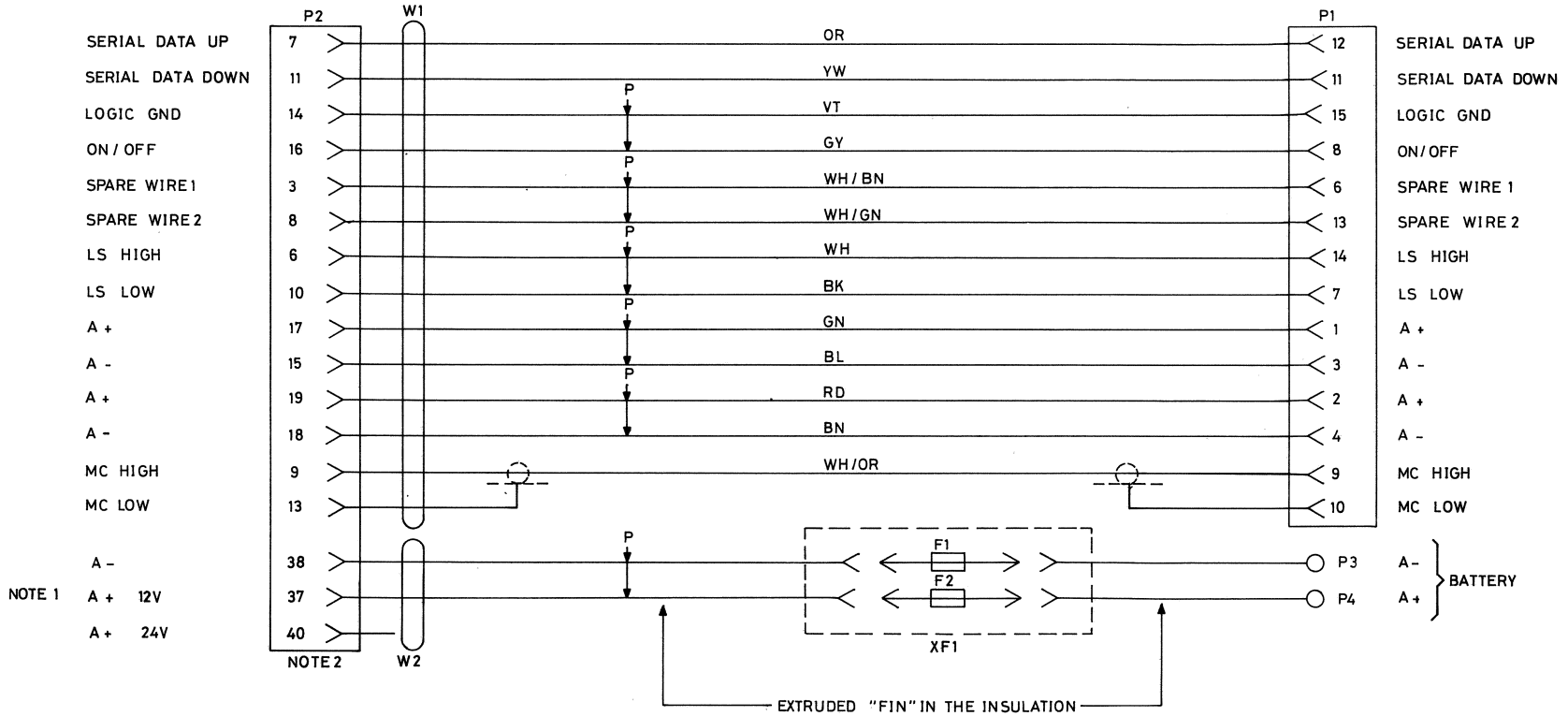
19M905203G1 | D402.952

Storno

Storno

RADIO CONNECTOR P2

JB CONNECTOR P1



NOTE 1:
C9CC05 - 12V CONNECT TO PIN 37 AS SHOWN
C9CC06 - 24V CONNECT TO PIN 40

NOTE 2:
WHEN HIGH POWER IS MORE THAN 40W
INTERCONNECT PIN 37 AN PIN 40

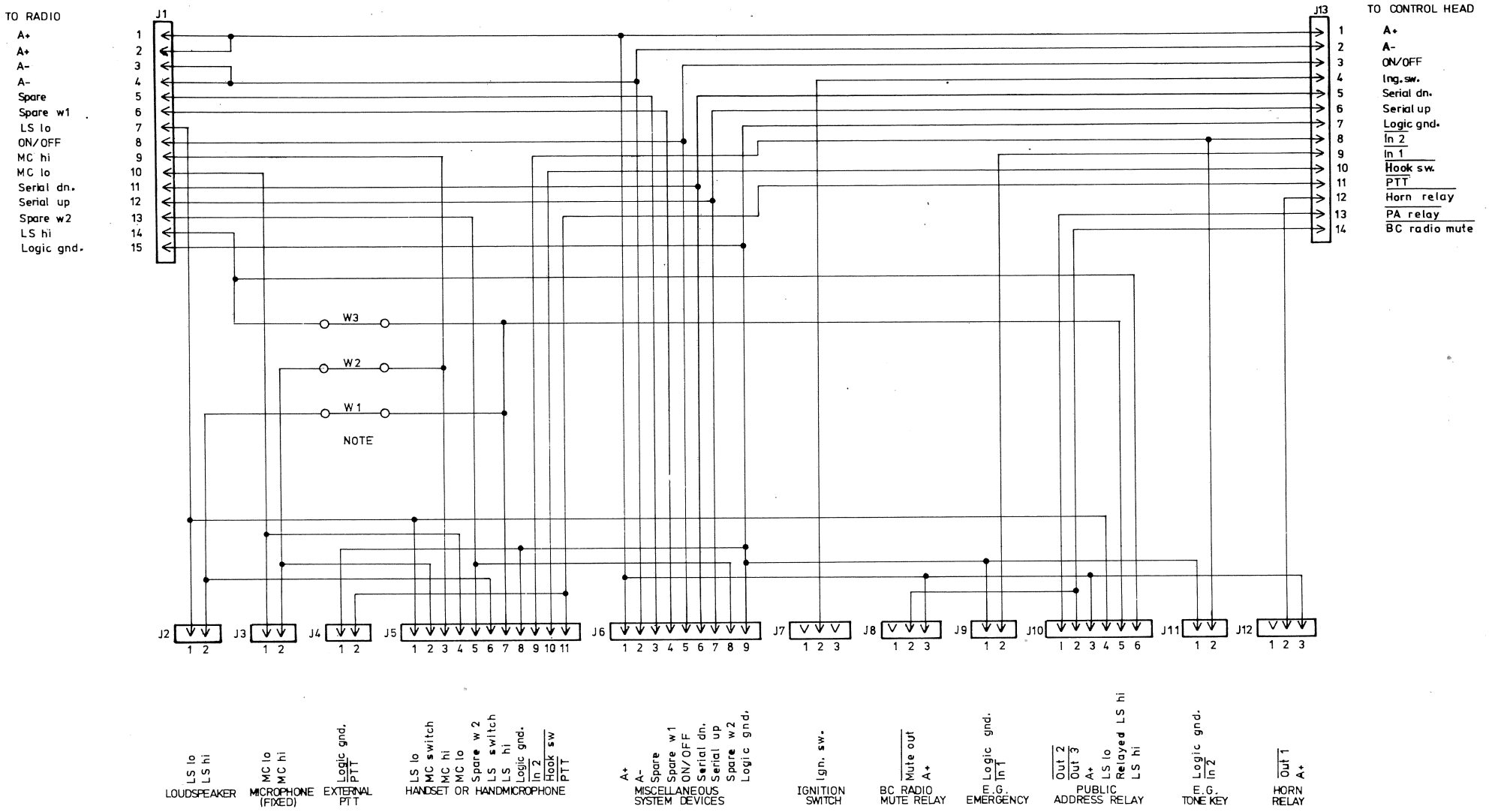
	F1	F2	CODE NO.
+12V : C9CC01	16A	16A	19L85 5032 G1
+24V : C9CC02	8A	8A	19L855032 G2

CABLE C9CC01, C9CC02

D403.136/3

Storno

Storno



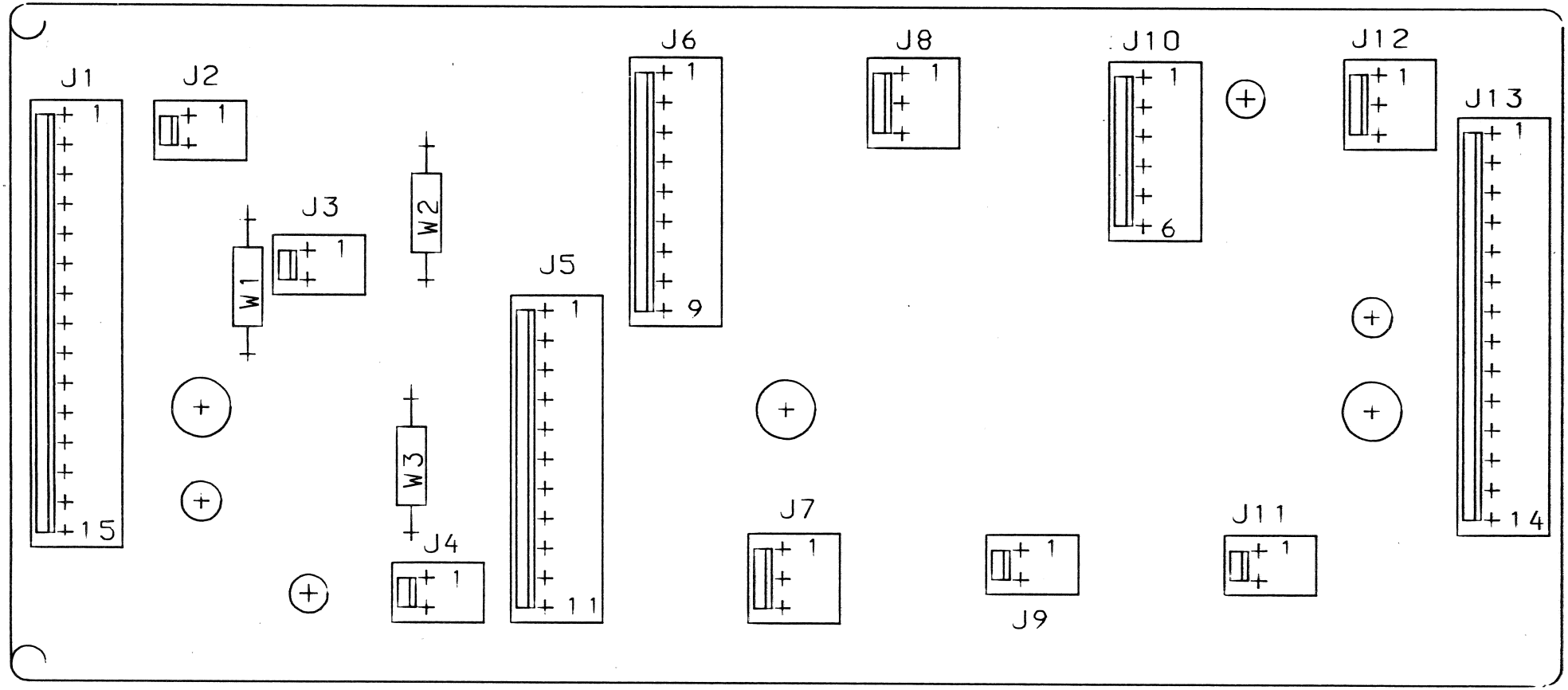
NOTE: To switch LS hi via J5, cut w1
To switch MC hi via J5 cut w2

Using public address relay
cut w3.

JUNCTION BOX C9JB01

D402.978

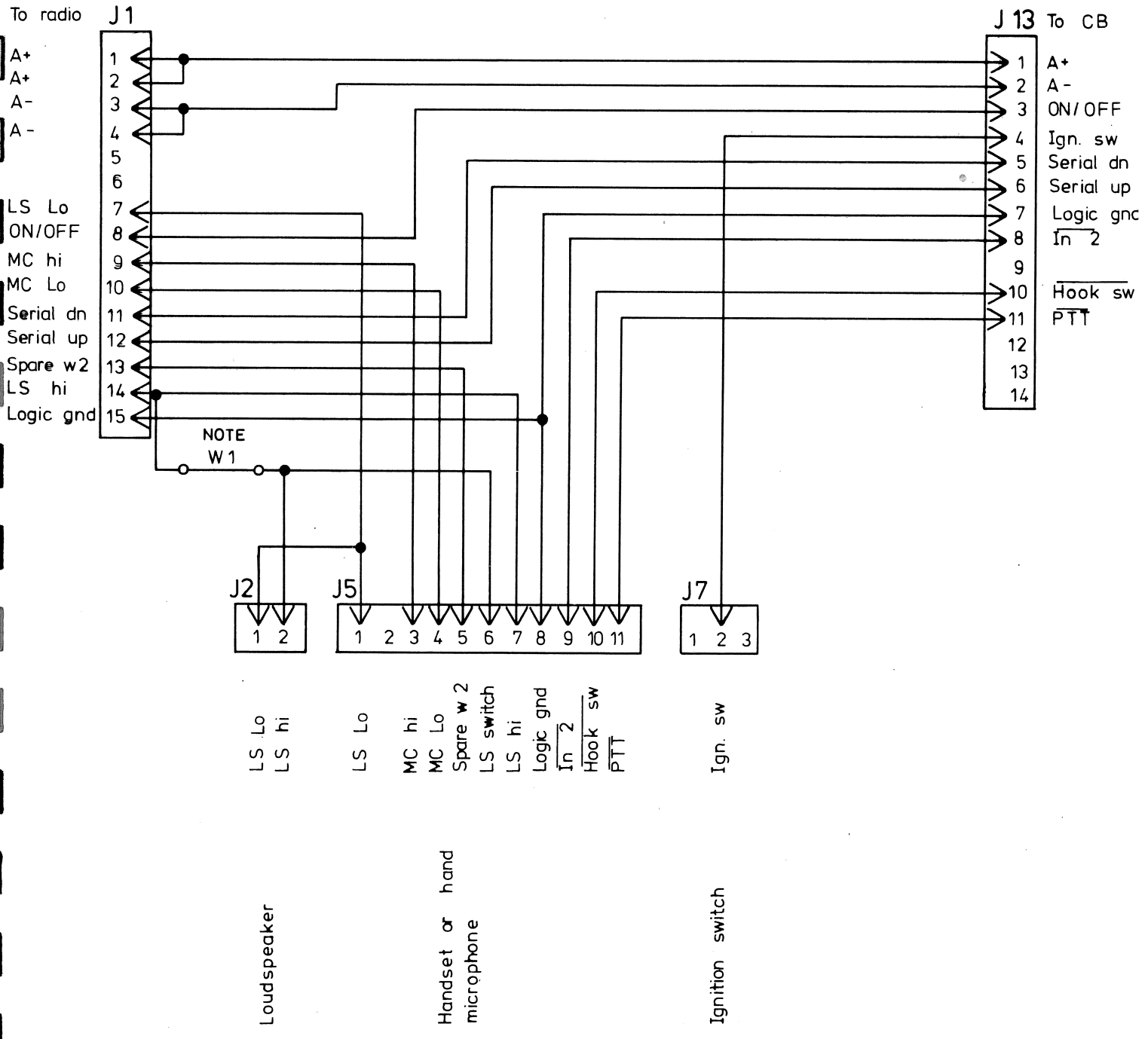
Storno



JUNCTION BOX C9JB01
CONNECTOR LAYOUT

D402.972

Storno

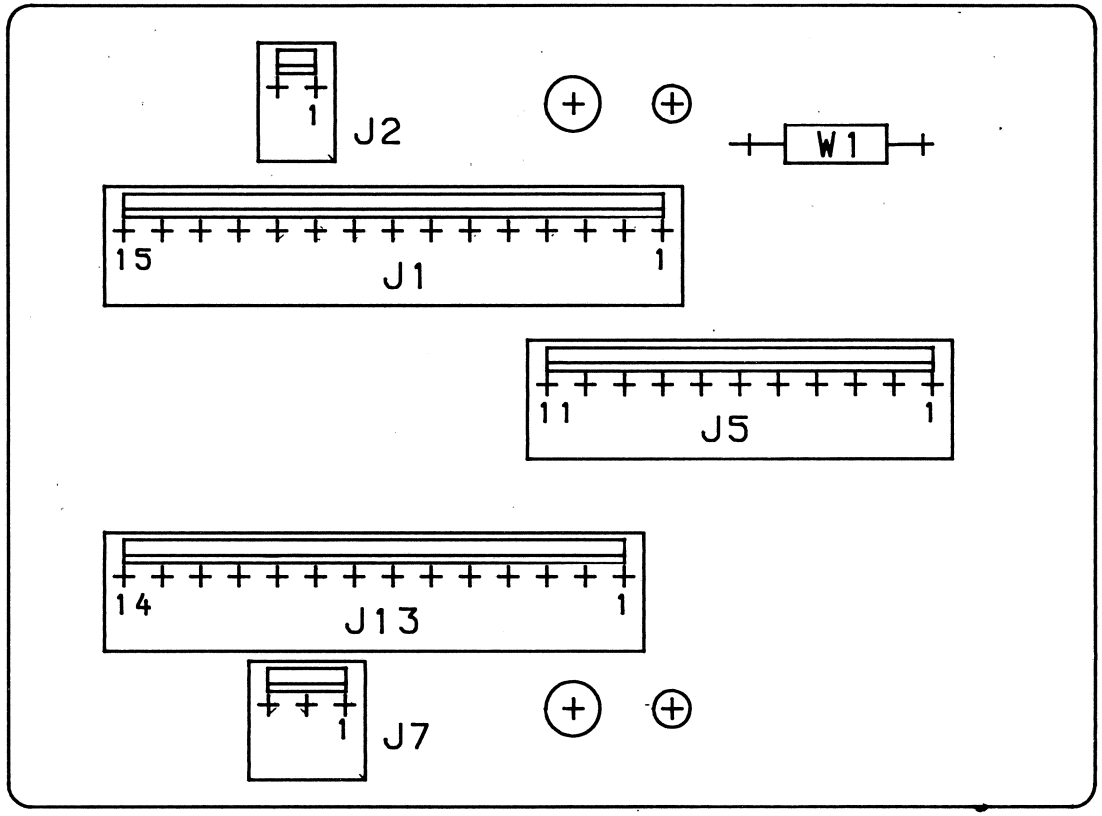


NOTE: TO SWITCH LS HI VIA J5, CUT W1

JUNCTION BOX C9JB02

D402.955/2

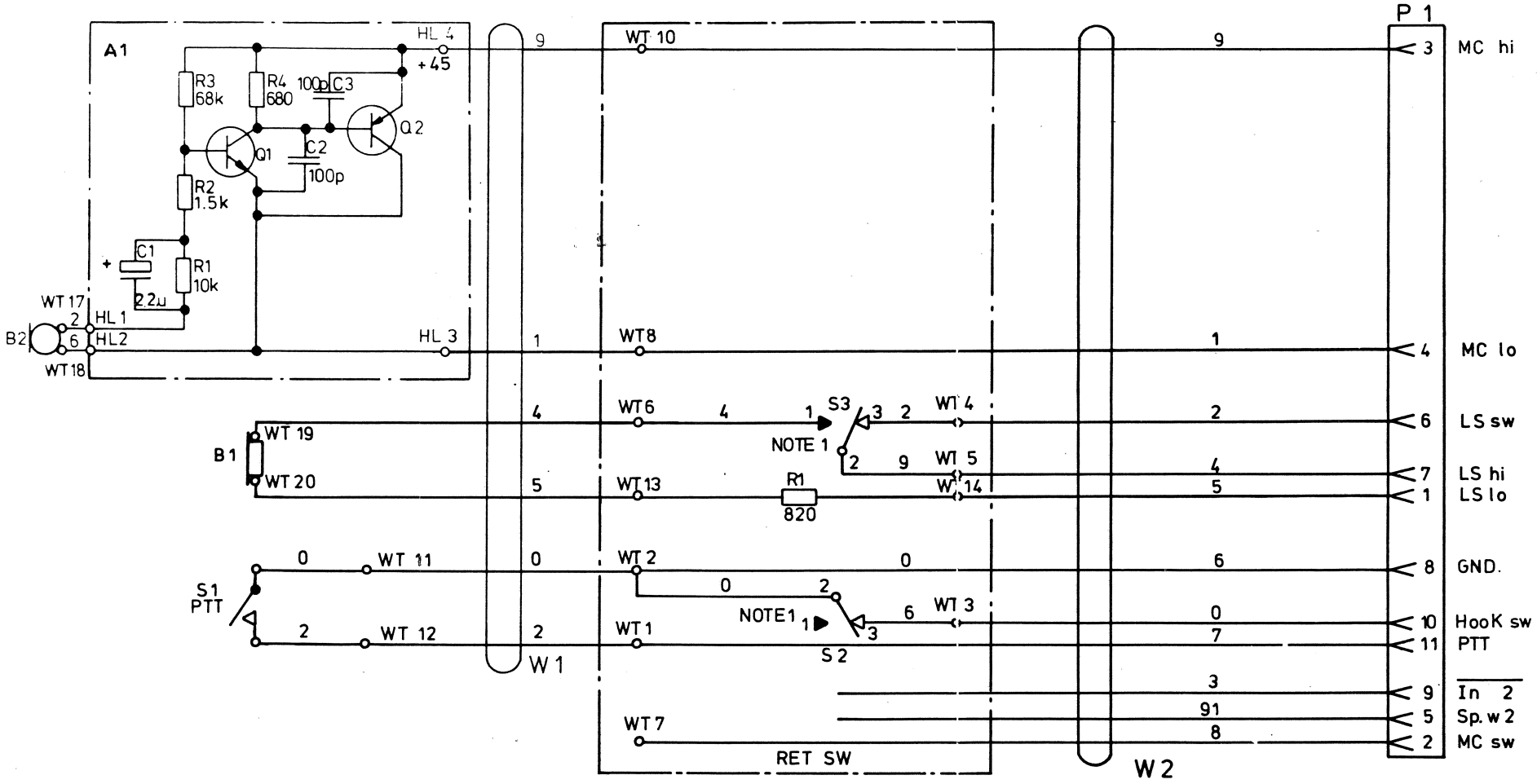
Storno



JUNCTION BOX C9JB02
CONNECTOR LAYOUT

D402.973

Storno

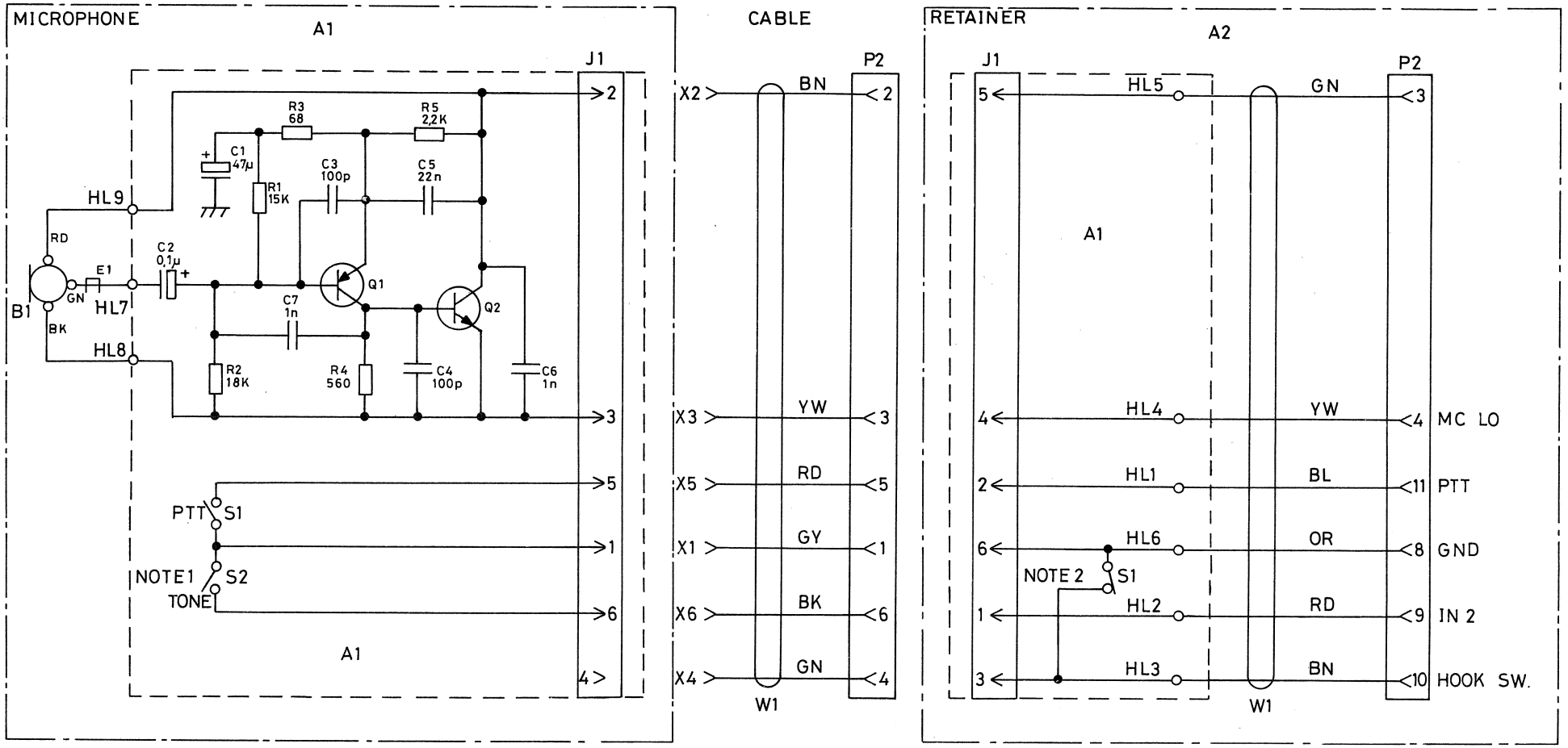


NOTE 1: SWITCHES SHOWN WITH HANDSET 'ON HOOK'

HANDSET C9MT01

D403. 144

Storno

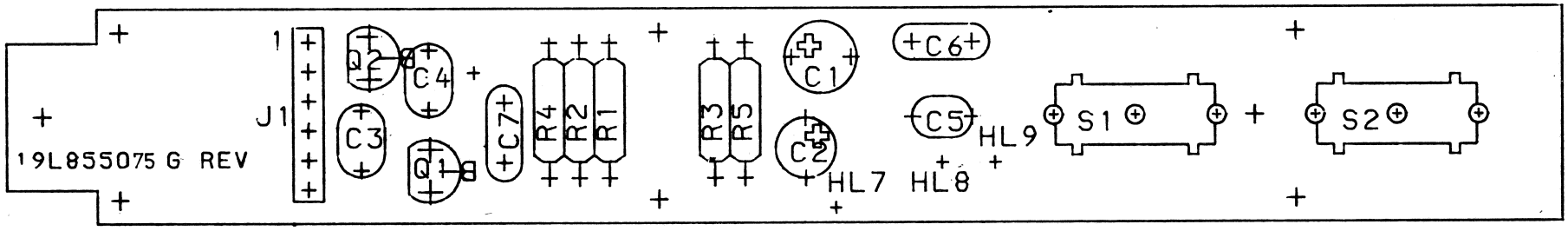


NOTES:
1. S2 ONLY MOUNTED WHEN MC901 IS EQUIPPED WITH TONE KEY.
2. S1 ONLY MOUNTED WHEN MC901 IS EQUIPPED WITH HOOK-UPSWITCH.
   S1 SHOWN WITH MIKE IN RETAINER.

HANDHELD MICROPHONE C9MC01

D402.956/2

Storno

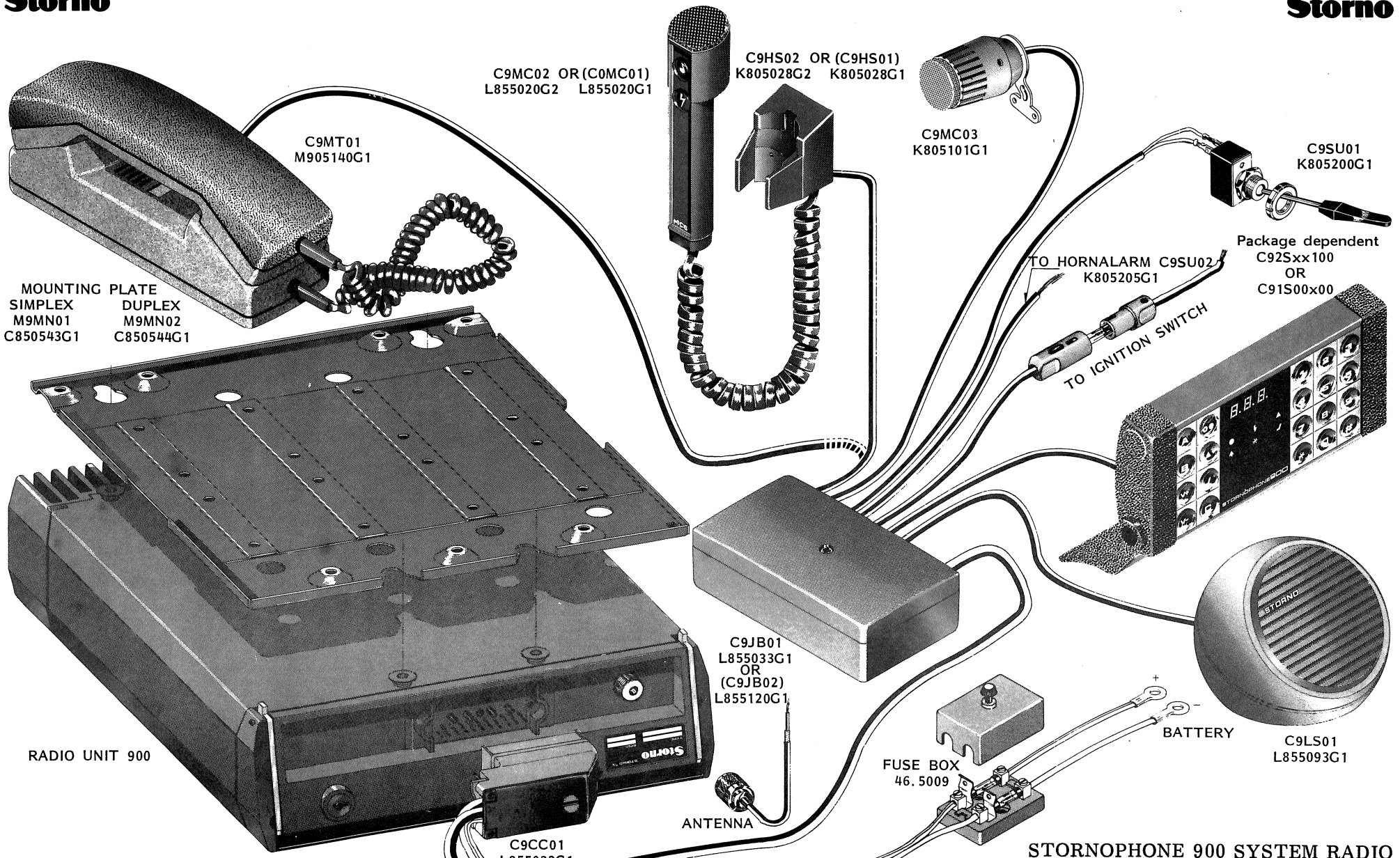


HANDHELD MICROPHONE C9MC01
COMPONENT LAYOUT

D402.957

Storno

Storno



STORNOPHONE 900 SYSTEM RADIO
INSTALLATION DIAGRAM

D402.987