STORNOMATIC 900
TYPE SM9662D025AP

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Service Co-ordination
82 - 02
2nd Edition

Storno

TECHNICAL SPECIFICATIONS

STORNOMATIC 900

The listed specifications are measured and stated according to the NMT System Specifications.

GENERAL SPECIFICATIONS

Frequency Range
Transmit 453 - 457.475 MHz
Receive 463 - 467.475 MHz

Number of channels
180

Channel Separation
25 kHz

Mode of Operation
Duplex

Duplex Separation
10 MHz

Radio Unit Dimensions

Height	78.9 mm
Width	286 mm
Depth	376 mm
Weight	10 kg
Volume	8.5 litre

Control Head Dimensions

	SC91	SC92	SC93
Height			
Width			
Depth			
Weight			

Temperature Range
Functional: -25°C to +55°C
Storage: -40°C to +70°C

RECEIVER SPECIFICATIONS

Frequency Range
463 - 467.475 MHz

RF Sensitivity, 20 dB SINAD CEPT
Better than 1 uV e.m.f.

Co-channel Rejection
less than 8 dB

Adjacent Channel Selectivity
greater than 80 dB

Intermodulation Rejection
greater than 70 dB

Spurious Response Rejection
greater than 70 dB

Blocking

greater than 90 dB/1 uV

Spurious Emissions

Radiated: Less than 2 nW

Conducted: less than -57 dBm

AF Output Power

5 W or 15 W

AF Harmonic Distortion

less than 3%

Volume Control Range

8 steps covering approx. 30 dB

TRANSMITTER SPECIFICATIONS

Frequency Range

453 - 456.475 MHz

RF Power Output

15 W

RF Power Reduction

-10 dB ±3 dB (single step)

Maximum Frequency Deviation

±4.7 kHz

Adjacent Channel Power

-70 dB

Spurious Emission

Radiated: 0.2 uW

Conducted: 0.2 uW

Harmonic Distortion in Transmission

less than 3%

RF Carrier Rise/Decay Time

less than 6 ms

POWER SUPPLY SPECIFICATIONS

Battery Voltage

10.8 - 16.6 V

Current Drain

Off:	<20 mA
Standby:	<0.8 A
Receive (5 W):	<2.4 A
Transmit (15 W):	<7.0 A

GENERAL DESCRIPTION

STORNOMATIC 900

RADIO UNIT

The STORNOMATIC 900 mobile radiotelephone is trunk mounted and controlled from a control head which connects to the radio via a cable. The radio package is rugged and splash-proof 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 front of the package which is shaped to protect the connectors.

The mobile package contains the receiver, the transmitter, the voltage regulators, the control logic, the signalling functions, and the duplex filter.

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 STORNOMATIC 900 are built with descrete components on printed wiring boards as the primary technology, but some modules also incorporate 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 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 phase-locked loops with crystal controlled reference oscillators. In the transmitter phase-locked loop (PLL) the reference oscillator is used for frequency modulation of the transmitter. The transmitter PLL approach is a broad band design which together with the broad band power amplifier (PA) and the 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 (Programmable Read Only Memory), and the necessary microcomputer interface circuitry. The microcomputer memory size is 4 Kbyte Program Memory (ROM) and 256 byte data Memory (RAM).

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.

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 CONSTRUCTION

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.

Internally, the RF modules (except RF 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 engages 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

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 a 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 C9JB04, C9JB05

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 PWB 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.

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 bracket with rubber suspensions.

HANDSET C9MT03

The handset consists of a microtelephone and 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 KITS

C9CC04: 12 V, 25 W duplex.
C9CC05: 24 V, 25 W duplex.

The cable kit consists of a control cable, a battery cable and a fuse box. The control cable between the radio and the junction box has 13 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 contracts. 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 DESCRIPTION

The UHF 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 conventional 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 diagram.

The receiver module is:

High intermodulation front-end	RC963
Receiver injection signal source	PL961
21.4 MHz IF and detector	IA902
Receiver audio amplifiers	AA903, AA904

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

RECEIVER FRONT END, RC963

This receiver front-end RC 963 is a high intermodulation module which can be tuned over the 403-470 MHz band.

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

The receiver front-end consists of a helical UHF 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 bandpass filter with two resonators 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.

INJECTION SIGNAL SOURCE, PL961

The injection signal for the mixer is generated by a phase locked loop module.

PL961 covers the 381-449 MHz band, corresponding to the receiver input frequency band 403-470 MHz.
The loop is locked to an 11-21 MHz channel synthesizer.

The module consists of a printed wiring board and 3 micromodules, the MX961, the PD901, and the XO905.

MX901 and PD901 are soldered in and XO905 is a plug-in type.

The voltage controlled oscillator (VCO) is working at the output frequency and is an LC clapp oscillator with a dual gate MOS-FET as the active element. The tuning coil is a piece of 90 ohm transmission line shorter than a quarter wavelength at the highest frequency. The transmission line transforms the tuning capacitor, which is used for the main frequency setting, into an equivalent inductance. The voltage tuning is done by two varicap diodes placed across the tuned circuitry.

The VCO is followed by a broadband buffer stage for achieving adequate output level, and it isolates the VCO from its load. From the output of the buffer a portion of the signal is fed to the isolation amplifier. The buffer is followed by a lowpass filter which removes the harmonic contents of the signal.

The isolation amplifier feeds the injection frequency (Fo) to the mixer and prevents the reference frequency (Fr) from entering the VCO circuit. The amplifier consists of two broadband, untuned stages, of which the first stage is placed on the PWB along with the VCO and the second stage is placed in the mixer micromodule. The total isolation is approximately 80 dB.

The PLL mixer micromodule (MX961) contains a J-FET mixer, a bandpass filter, and a part of the isolation amplifier.

The mixer has two inputs, Fo and Fr, both broadband and approx. 100 MHz wide. To achieve a high signal-to-noise ratio in the loop, the mixer is driven with high signal levels (Fo= +7 dBm and Fr= -6 dBm). The bandwidth of the mixer output is determined by the bandpass filter which removes the harmonics, and is approx. 10 MHz wide (11-12 MHz).

The phase comparator micromodule (PD901) compares two signals in the 11-21 MHz band, one from the PLL mixer and one from the channel synthesizer. The output from the phase comparator is fed to an amplifier through a loop filter. The amplifier produces the tuning control voltage (2-5.5 V) for the varicap diodes in the VCO. The phase comparator actually consists of two detectors, a phase detector and a frequency detector. If the loop is out of lock, the frequency detector will activate a search oscillator, a ramp generator, and switch off the loop filter. When the mixer signal is within the capture range of the frequency detector, the ramp generator stops and the loop filter is switched on. Then the loop is locked and the phase detector is comparing the signals. Most of the comparator circuitry is contained in a custom designed integrated circuit. The micromodule has two metering points, one for checking the lock function and one for measuring the tuning voltage to the VCO.

The master oscillator (XO905) is a plug-in micromodule. It is made on a PWB with a mix of chip components a 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.

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, IA902

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

IA902 is used for 25 kHz channel spacing.

The required selectivity is obtained by two crystal filter blocks, each containing a 6 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 an 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 cricuitry.
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:
Phase locked loop exciter PL962
including micromodules AA901, XO906, RA962, MX961 and PD901.
RF power amplifier PA962

The basic channel frequencies are generated by the frequency synthesizer module. The output of the channel frequency generator is fed to the phase locked loop (PLL) module which 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 before being applied to the modulation stage.

A 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 duplexer.

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

TRANSMITTER SIGNAL SOURCE PL962

The phase locked loop module consists of an voltage controlled oscillator (VCO), a buffer amplifier, RA962, a PA driver, RA961, a mixer, MX961, a phase detector, PD901, an oscillator, a frequency tripler, and an audio processor AA901. Furthermore the module contains some logic function circuits, and has several central metering points for testing and adjusting the module.

PL962 is for the 403-470 MHz band.

The circuit is almost indentical to the receiver PLL module (PL961), and for a detailed description refer to the receiver description. However, compared to the PL961 module, the PL962 has three additional micromodules and some control logic, which are described in the following.

The transmitter PA driver, RA961, is a two-stage broadband amplifier for the 403-512 MHz band. It drives the PA stages via a harmonic filter placed on the PWB. The module has a central metering point for measuring the output level. It is soldered in.

The buffer amplifier, RA962, contains a broadband amplifier which follows the VCO, and the first stage of the isolation amplifier. The second stage is placed in the mixer micromodule, refer to PL961. It is soldered in.

The control logic is placed on the PWB and prevents the transmitter from being keyed when the PLL circuit, or the frequency synthesizer is out of lock. The audio processor micromodule, AA901 is for use in 20/25 kHz equipment. It contains a pre-emphasis circuit, an audio amplifier, a limiter, a channel guard level control, and two roll-off filters. The circuitry shapes the audio properly to produce a phase-modulated carrier when used in conjunction with a frequency modulated oscillator, and limits the deviation to be within the values required by the authorities. An audio input is provided prior to the pre-emphasis and limiting circuits, and a channel guard tone input is provided after these circuits.

The microphone bias is provided via the TX audio pin.

The audio micromodule which is a plug-in type utilizes a quad-op-amp to provide the necessary gain. The microphone signal is fed to the first amplifier through a passive pre-emphasis network to achieve a rising audio characteristic which is needed with the true FM oscillator. The oscillator thus produces a phase-modulated type of signal.
Limiting diodes are used to ensure the second amplifier not being overdriven.

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

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

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

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.

UHF POWER AMPLIFIER PA962

The UHF power output amplifier module (PA) contains three broadband stages, a directional coupler, a lowpass filter, and power control micromodule PC903.
The module can be used in both simplex and radios.

The signal from the exciter, approx. 300 mW, is applied to the input connector, and a broadband, untuned matching network transforms the 50 ohm input impedance to the low impedance of the first transistor stage.
The output signal from the first amplifier stage is impedance-matched to the second stage with broadband networks. The second amplifier boosts the signal to the required power and a network adapts the amplifier impedance to 50 ohm.

A 50 ohm microstrip line conducts the RF signal through a directional coupler to the lowpass filter which attenuates the harmonic frequencies. A second microstrip line passes the signal to the output connector.
The directional coupler samples the forward power and rectifies the sampled signal. The resultung DC voltage is proportional to the RF output level and is applied to the power control micromodule, PC903.
The PC903 regulates the DC voltage supply to the first RF amplifier stage to maintain the required power level. A power set control is used to adjust the control voltage to the PC903 micromodule.

Because the power control circuit consumes some current in the "TX unkeyed" condition, a switching circuit reduces the current drain during idle periods. The drive power to the PA stage is sampled and detected by a diode circuit and when drive signal is present, a DC voltage turns on the voltage regulator in the integrated circuit of the PC903 micromodule. The turn-on is sequenced such that the feedback loop is gradually brought up to the required power level. A remote power reduction terminal is provided so the power may be reduced in steps by the command system of the radio.
Central metering is used in the PA module to measure the input from the exciter, the PA driver current, the current in the final PA stage, the power control voltage, and the voltage from the directional coupler.

DC voltage is applied to the PA module through feedthrough capacitors mounted in the PA shelf. The voltage leads are isolated from chassis ground causing the PA stages to float with respect to the vehicle chassis. Some filtering is provided by a large electrolytic capacitor placed across the voltage input terminals.

A large diode connected across the DC terminals protects against accidental application of reverse battery polarity. If the battery leads are reversed the diode will conduct and the large current will blow the fuse.

The PA module is designed to operate over a DC battery voltage range of 10.8 to 16.6 volts. The output power is set to rated level at 13.5 volts and will remain almost constant for all higher voltages. However, if the voltage is reduced below 13.5 volts the power will remain at rated level only as long as the control loop has excess gain. At a certain voltage the power output will descrase with decreasing voltage.

To prevent excessive radiation of spurious signals, the PA is shielded by a metal cover, and the printed wiring board is held to the heat sink by several screws. The shield between the active PA circuitry and the harmonic filter is a separate filter cover.

Proper impedance matching between the stages is performed with broadband networks without tuning.

The additional stage is placed between the 10-watt amplifier and the directional coupler to boost the RF level to at least 25 watts.

MICROCOMPUTER CONTROL CIRCUIT DESCRIPTION

CENTRAL LOGIC CL904

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 communication and interchange of data with the control head and accessories is also done by the central logic.

As the exchange of data between the MTX and the mobile station is performed by means of 1200 Baud FFSK (Fast Frequency Shift Keying) binary signalling, a FFSK modem must be included.
It transforms the received FFSK data (part of the received LF signal) into a stream of digital signals. In the opposite direction it transforms the outgoing digital information to FFSK form.

The logic and control unit is based upon a 8049 single-chip microcomputer. It functions as the program controlled master of the station. In addition to the processing unit, this chip includes program memory (2 K bytes), data memory and a group of I/O ports. To fulfill the requirements, the microprocessor is expanded with:

An I/O expander (adding 16 I/O lines) to give an adequate number of signals to control the radio.

External program memory (max. 2 K bytes).

Identity PROM (32 x 8 bit) for 7 digit identity no. (and any other signature for this specific unit).

A C-MOS RAM (256 x 4 bit) with battery back-up to store information during mobile station off periods (abbreviated number store, abuse protection code; actual data and digit information to be retrieved in case of short power failure).

An autonomous timer unit (as required in the NMT spec.) to supervise the microprocessor operation, and perform emergency switching off.

The FFSK modulator transforms a stream of digital data to FFSK data.

Fast frequency shift keying, FFSK, means subcarrier modulation, where binary "1" corresponds to 1200 Hz, binary "0" corresponds to 1800 Hz.
The transformation is implemented using a number of C-MOS counters fed by a 14.4 kHz clock. According to input "1" and "0", the output is 1200 Hz or 1800 Hz.

The FFSK demodulator makes a frequency-to-voltage conversion of the incoming FFSK signal and generates an output stream of digital (unsynchronized) data.

The bit synchronizer adjusts the RX clock phase to the received data bits (RX data). The RX clock is an approximately 1200 Hz clock. For each new bit the clock phase is adjusted.

The clock phase is advanced/delayed 1/16th of a period, according to the actual phase of the received data.

The clock generator circuit generates a 14.4 kHz and a 1200 Hz clock from a 360 kHz (crystal controlled) clock available from the microprocessor.

The FFSK detector (data squelch) circuit makes an analysis of the frequency contents of the received signal and thereby detects if FFSK signal is available on the actual channel. The max. detection time is about 12-15 ms.

Most of the functions of the control unit are to some extent fixed by the NMT spec.
Some of these functions are:

Decoding orders from the MTX such as:
- alerting the user to an incoming call (ringing order)
- channel command
- adjusting the transmitter output power
- identity request
- releasing the mobile station at completion of a call or forced release

Receiving general identification signals from the MTX such as:
- traffic area identification
- calling channel identification
- free traffic channel identification

Evaluating and ordering the necessary steps to be taken by the mobile station.

Encoding the signalling information to the MTX such as:
- call initiation from MS (identification)
- clearing signal when terminating a call
- updating roaming information
- dialled digits for call origination

Providing subscriber signalling information such as:
- ringing signal
- roaming alarm
- malfunction alarm
- service indicator
- call received indicator

Decoding and correcting the data frames received from the MTX. As is well-known the data are coded according to a convolutional code, which makes it possible to combat errors on the radio path, due to fading and interference. The correcting capability is 6 errors when there are at least 19 error free bits between the bursts.

Encoding (convulution, add redundance and synchronization bits) the message to the MTX before transmission.

Send (serial coded) information to the control box.

Collect and decode serial information from the control box.

The 8049 microprocessor has a total of 27 I/O lines. 12 of these are reserved as data- and address busses for the external memories and the expander (in the commonly used manner). In the implemented form, the processor has

the capability to access 2048 external program memory bytes and 256 data memory locations. As the 8049 multiplexes data and addresses on the data bus, an 8 bit address latch catches the 8 lower bits of the address. The higher part of the address (4 bits) is supplied directly from the processor (P20-P23).
These address lines also feed to the expander (type 8243), which adds 12 output lines and 4 input lines.
The remaining 15 I/O lines (P24-P27, P10-P17, T0, T1, INT) of the 8049 are used directly for status and control.

The 2 interrupt lines (T1, INT) of the 8049 are reserved for the synchronization with the data bits to and from the modem. The related clocks (TX clk.: 1200 Hz exactly, RX clk.: 1200 Hz with jitter) are fed to the interrupt lines (T1, INT) and invoke the processor to make an interrupt, each time the modem requires to get next bit to send or to deliver next bit.
Internally in the microprocessor the bit exchanging with the modem therefore is located in the interrupt programs.

As the exact 1200 Hz generates interrupts with a precise timing it is used for the internal timing and for timing of the serial communication with the control box.

The program controls the mobile station according to the commands from the MTX and the control box, and it sends messages in the opposite direction.

FILTER NETWORK, FN901

The FN901 performs the audio filtering and gating.

The discriminator audio signal enters a 4 kHz lowpass filter which together with the 4 kHz notch filter forms the pilot tone notch filter. The 4 kHz bandpass filter picks out the pilot tone and via a matching network the tone is looped back into the transmitter's CG input. Output from FFSK mod. and 4 kHz pilot tone are added in the matching network. An audio gate is placed between the lowpass and the notch filters. This mutes the whole audio path, including the pilot tone, controlled by the RX mute.
The telephone amplifier/driver is fed from the Aux. audio and is controlled by the HS/HF (handset/hands-free button), i.e. in position hands-free the handset is muted.

One of the two micorphones (handset or fixed microphone) is selected by the HS/HT control while the transmitter audio path can be blocked by the audio mute.

BRANCHING FILTER BF964

The branching filter (duplexer) allows the receiver and transmitter to be connected to the same antenna.
The BF964 is tuneable to frequencies within the 403-470 MHz band. The spacing between the receiver- (RX) and the transmitter channels (TX) is 10 MHz.
The branching filter contains 7 helical resonators, 5 in the TX branch and 2 in the RX branch.

The duplexer is a double notch filter which in the RX branch has a notch on the TX frequency band to prevent the transmitter signal from entering the receiver. In the TX branch there is a notch on the RX frequency band to prevent transmitter side band noise from entering the receiver. The branches are joined at the antenna connector via two quarter-wave lines that isolate 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.

INTERFACE TO THE OPERATOR

KEYBOARD

For operation of the system the operator is equipped with the control box which contains:

1) Keyboard
2) Display

The keyboard is made in 2 different layouts, which both have the keypad part of the push-buttons arranged in a square pattern.

The pattern used for Denmark and Norway is

7	8	9	D
4	5	6	C
1	2	3	B
0	*	#	A

And the pattern used for Sweden and Finland is

1	2	3	A
4	5	6	B
7	8	9	C
*	0	#	D

On the keyboard the push-buttons are functionally divided into groups with each group individually colour coded.

The green colour is the true keypad part of the keyboard, i.e. the part used for preselecting numbers and initiating calls (16 buttons).

The yellow colour covers that part of the keyboard used for frequent adjustment procedures, i.e. ON/OFF, volume increase, volume decrease and selection of hands-free operation (4 buttons).

The red coloured area is the part of the keyboard which is used to control secondary functions, i.e. is used relatively infrequently. The red coloured functions are the following:

S1 - gimmick for total keypad lock
S2 - gimmick for keypad lock with the exception of pre-selected numbers
P - Priority button for selected users - allows message traffic on call channel
⟷ - Display shift button
↦ - Data transmission enabling/disabling button (engages MFT generator in MTX for data signalling over telephone lines) (5 buttons in all).

In addition to the above buttons the control head is provided with a four position, coin operated, rotary country selector switch.

DISPLAY

The 9-digit display is placed behind a lustreless, dark surface in such a way that only the lit digits can be seen. As the single digits are keyed (on the green keyboard) the display will be filled from right to left. The system renders a possibility for keying up to 16 digits of which the last 9 keyed are displayed. If it is desired to see the rest of the digits this can be done by keying the button marked "⟷". By doing so the 9 digits will disappear and the rest of the digits will be visible, digit No. 10 being to the far right. By again keying the "⟷" button the first 9 digits will again be visible, and vice versa.

Under the display of the figures are placed a number of indicators and alarms in a similar manner. The green indicator, marked "Y" is the "service indicator", which tells the user that the MS is locked to a calling channel. When a call is received the equipment switches to a traffic channel and the " Y" is switched off while the "call received" indicator, marked " ▲ ", goes on with a flashing yellow light.

If the user drives outside of the coverage area or if it proves impossible to carry out an automatic up-dating, the red diode, called "roaming alarm" - marked " ✎ " goes on. The remaining 3 LEDs are indicators which indicate the condition in which the system has been placed by the use of the keyboard.

The symbol P goes on if a priority call has been placed. " ◁ " goes on if the corresponding push-button has been used for putting the equipment in the "Hands-free" mode and " ↦ " goes on, when the data transmission push-button has been pushed.

Lastly is to be mentioned that the telephone number of the equipment must be visible. The figures can be seen to the left of the 6 LED.

Storno

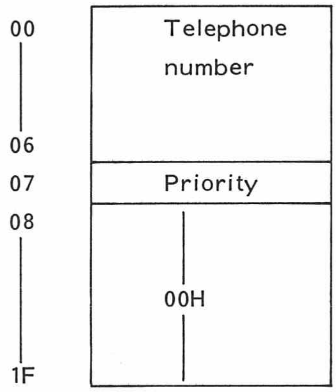
PROGRAMMING INSTRUCTION

STORNOMATIC 900

MEMORY LAYOUT

PROM TYPE: 32 x 8 BIT CODE 19J706247P2

Address



Address

00 = 1. digit
01 = 2. digit
02 = 3. digit
03 = 4. digit
04 = 5. digit
05 = 6. digit
06 = 7. digit

0 = 0A H		
1 = 01 H	4 = 04 H	7 = 07 H
2 = 02 H	5 = 05 H	8 = 08 H
3 = 03 H	6 = 06 H	9 = 09 H

Address 07
Priority yes = FFH
Priority no = 00FH

Address 08 - 1F = 00H

øst
vest

ADJUSTMENT PROCEDURE

STORNOMATIC 900

GENERAL

This adjustment procedure covers a UHF Stornomatic 900 radio for the NMT system operating in the 450 MHz frequency band. The procedure comprises the following:

- Service mode operation
- Test setup, RX-TX
- Measuring instruments
- Cables, connectors
- Adjustment tools
- Central metering connectors, CM
- Voltage regulator check
- Receiver adjustments
- Transmitter adjustments

SERVICE MODE

The microcomputer has a resident service mode program which is enabled by the mode switch S1 on CL904. The switch is accessible through a hole in the MM901 module. Operation of the mode switch must always be made with the power switched off. When selecting service mode the following can be controlled from the control head:

c. Channel selection
d. Transmitter keying
e. FFSK modulator test
a. Volume setting
b. Audio control

<u>Always remember to set the mode switch to normal after service operation</u>

SERVICE MODE OPERATION

The functions are shown in the following table:

NUMBER KEY	FUNCTIONS				REMARKS
	$\overline{\text{RX MUTE}}$	TX MUTE	$\overline{\text{LS MUTE}}$	HF/HS	
0	0	1	Ø	Ø	Audiopaths closed
1	1	0	Ø	0	Handset mode
2	1	0	1	1	Hands free mode
3	1	0	1	1	
4	Ø	Ø	0	Ø	Operate LS MUTE only 4= PTT push
5	Ø	Ø	1	Ø	5= PTT release

Ø= unaffected

Channel Selection:
Enter channel number, then push V-.
The channel number must always have 3 digits, if not enter leading zero(s).

S1 → V+ giver ob.nr. i G5.

Transmitter keying:
Push a number key, then push P.
The number keys have the following effect:

0= Transmitter off
1= Transmitter on, 1.5 W
2= Transmitter on, 1.5 W
3= Transmitter on, 15 W

Digits disappear from display

FFSK modulator test:

Push a number key, then push |▶

The number keys have the following effect:

0= FFSK test telegram off.

1= FFSK test telegram on.

Volume setting:

Push a number key, then push V+.

The number keys have the following effect:

0= Lowest volume step

1=
2=
3= intermediate steps
4=
5=
6=

7= Highest volume step

Audio control:

Push a number key, then push ◁| .

The number keys have the following effect:

0= Squelched mode, audio muted.

1= Handset mode, handset conversation.

2= Hands free mode

3= Same as 2

If number key 4 is pushed after mode 2 has been selected, the 'Hands free microphone' is enabled and the loudspeaker is disabled.

If number key 5 is pushed after mode 2 has been selected, the loudspeaker is enabled and the 'Hands free microphone is disabled.

The functions are shown in the following table:

INDICATORS

When the radio set is in service mode the indicators on the control head show the status of some key signals in the radio and/or control logic.

Y = RX data

P = Slow squelch

● = Not used

⊸ = Fast squelch

◁| = Carrier detector

|▶ = Data squelch

MEASURING INSTRUMENTS

RF signal generator	10-512 MHz
Multimeter	Ri= 20 Kohm/V
AC Voltmeter	Zi= >20 Kohm/V
Distortion meter with psophometric filter	
Deviation meter	406-512 MHz
Frequency counter	10-512 MHz
AF signal generator	0-5 kHz
RF Power meter	0-25 W
DC Power supply	10-20 V/10 A Current limiter Adjustable 0.1-10 A
DC Amperemeter	0-0.1 A
DC Ampere meter	0-10 A
AF Dummy load	8 ohm/5 W (15 W)
Signal Sampler	95.2001-00

Control head SC92P00D1

Junction box

Cable kit

Central metering box

ADJUSTMENT TOOLS

Adjustment tool	Code. no. B800775G1
Adjustment tool	Code. no. B800773G1
Adjustment tool	Code. no. B800770G1
Phono plug	Code. no. A700171P1
BNC-plug	Code. no. 41.0145-00
RG196/U Cable	Code. no. 175. 5021-00

CENTRAL METERING CONNECTORS

RX JP904-J8 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. RX oscillator	1 - 10

TX JP904-J7 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 level	1 - 6
7. TX status	1 - 7
8. TX filter	1 - 8
9. TX tripler	1 - 9
10. TX oscillator	1 - 10

PA962-J4 Function	Connect meter to - +
1. A-	
2. A+	1 - 2
3. Not used	
4. Final current	4 - 2
5. Drive current	5 - 2
6. Not used	
7. Not used	
8. Power control	1 - 8
9. Forward power	1 - 9
10. Input drive	1 - 10

When the microcomputer executes the service mode program the entire function of the control head is changed and the functions of the keys and the indicators are quite different to normal. When the microcomputer accepts a service mode command the response is that the digits on the display disappear.

Specified voltage readings are measured with a 20 Kohm/V meter and for reference only; readings may vary for different sets.

The correct type of control head and accessories must necessarily be used to control the radio during the alignment and test procedures. Refer to test setup.

When using the central metering (CM) it is convenient to use a 20 Kohm/V meter and a central metering test box for testing.

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.

CHECKING THE INTERNAL VOLTAGES

Connect a voltmeter to TP1 on JP904.
The meter should read 5 V ±0.2 V.
Connect a voltmeter to TP2 on JP904.
The meter should read 9 V ±0.04 V.

NB. These measurements are not accurate enough for adjusting the voltage to be within the 0.5 % tolerance. To do that it's necessary to use a digital voltmeter and adjust the voltages by means of R5 on VR901.

FREQUENCY SYNTHESIZER ADJUSTMENT

Put the RX/TX plug in the TX connector and connect a voltmeter to 1-3.

Select channel 179.

If the voltmeter reading is greater than 0.65 V adjust the trimmer of L3 (FS901) for 0.65 V ±10 mV.
If the voltage is less than 0.65 V select channel 001 and measure the voltage. If the voltage is less than 0.3 V adjust the trimmer of L3 (FS901) for 0.3 V ±10 mV.

Connect a frequency counter to the FS901 output J1.

Select channel 001.
Measure the frequency.
Requirement: 12.800000 MHz ±10 Hz.
Select channel 180.
Measure the frequency.
Requirement: 17.275000 MHz ±10 Hz

If the frequency is not within tolerance adjust L1 (XO9011) until it is.

RECEIVER ALIGNMENT

RECEIVER INJECTION SIGNAL ADJUSTMENT PL961

Put the RX/TX plug on the test box in the RX CM connector and connect a voltmeter to 1 and 10.

a) Tune L3 (PWR XO905) and L12 (PL961) for maximum voltmeter reading (1.5 V)

b) Connect the voltmeter to 1 and 9.
Adjust L12 (PL961) for maximum volmeter reading.
Readjust L3 (PWR XO905), L12 and L13 (PL961) for maximum voltmeter reading.
The voltage shall be approximately 0.9 V (0.7 - 1.0 V).

c) Connect the voltmeter to 1 and 8.
Detune outwards L14 and L15 (PL961) as much as possible.
Adjust L14 for maximum voltmeter reading and after this adjust L15 slowly for minimum voltage (0.9 V).

CAUTION
The maximum of L14 and the minimum of L15 shall be well defined and easy to find.
Do not readjust L14 to find the minimum of L15.

d) Connect the voltmeter to 1 and 7.
Adjust C1 (PL961) slowly until the voltmeter reading goes high (0.85 V).

e) Select channel 001 on the control head.
Connect the voltmeter to 1 and 6.
Fine tune C1 (PL961) for 0.6 V on the voltmeter.

f) Connect the voltmeter to 1 and 5.
Adjust C24, C21 and C16 (RC963) for maximum voltmeter reading, approximately 0.4 V.

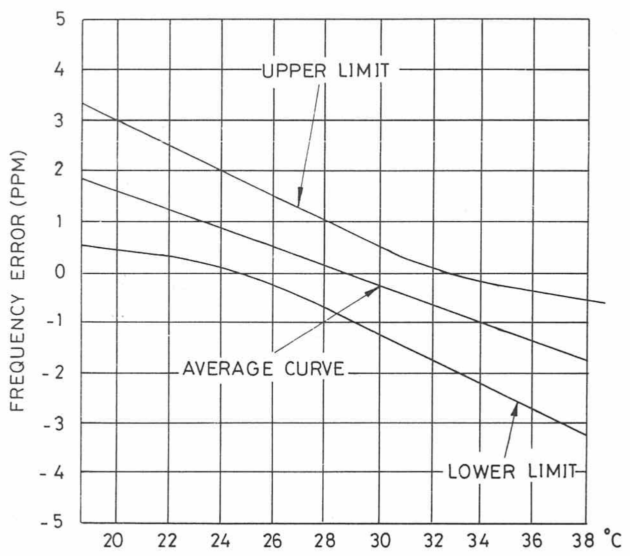
INJECTION FREQUENCY ADJUSTMENT PL961

Before adjusting the injection frequency the synthesizer frequency should be checked.

Connect a frequency counter to the FS901 output, J1.
The synthesizer output level is 0 dBM and the frequency should be:
12.800000 MHz on channel 001
17.275000 MHz on channel 180
Refer to Frequency Synthesizer Adjustment.

Connect FS901 to PL961, J2.

Connect the frequency counter to the PL961 output, J2.
The PL961 output frequency should be:
441.600000 MHz on channel 001.
The frequency is adjusted with L2 (FREQ-XO905).



XO900 FREQUENCY ERROR CURVE

D403.172

FINAL FREQUENCY ADJUSTMENT XO905

Because of power supply and load variations the oscillator must be adjusted to the correct frequency after being installed. The graph shows the frequency error in setting the frequency as the ambient temperature varies about the reference, approx 28.6°C.
All oscillators fall within the upper and lower limit but since each oscillator's characteristic is unknown the average curve should be used.
The metal can must be in place when adjusting.

Example:
The frequency is adjusted at 23°C (equipment's temperature).
Adjust the oscillator for f_{nom} +1 ppm=
441.6000 MHz + 441 Hz= 441.600441 MHz

RECEIVER FRONT-END
RC963

The receiver front-end factory adjusted to the NMT specifications and need not be readjusted.

WARNING
Any attempt to readjust the front-end will result in maladjustment and the module must be taken out and returned to the factory for adjustment of the bandpass filter characteristic and its dependance on temperature be checked to be within tolerance.

DUPLEX FILTER ALIGNMENT

The duplex filter BF964 is factory adjusted to the NMT frequency band and need not readjustment.

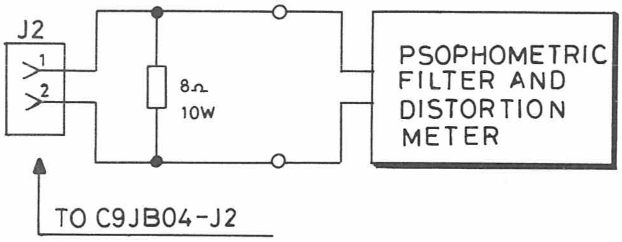
IF AMPLIFIER ADJUSTMENT

Select channel 001.

Connect a signal generator to the antenna connector.
Set the signal generator output to 1 mVEMF.
Modulate the signal generator with 1 kHz to ±5 kHz frequency deviation.
Connect a distortion meter and psophometric-filter to central metering (CM) pin 3 (hot) and pin 1 (ground).
Adjust L1, L6, L8 in IA902 and L17 in RC963 for minimum distortion. Repeat the adjustments until no further improvement is possible.
Read the distortion.
Requirement: less than 3%.

AUDIO SIGNAL ADJUSTMENT

Connect an 8-ohm/5 W load between LS HI-LS LO.



Connect an AF voltmeter across the load.

Set the RF level from the signal generator to 1 mV EMF on the signal frequency. The signal shall be modulated with 1 kHz and the deviation set to ±3.0 kHz.

The squelch control shall be unactivated and the LS function activated.
Refer to Service Mode Operation.

Set the volume on the controlbox to level 7.
With potentiometer R11 (R_{VOLUME}) adjust the output level for 5 W in a 8-ohm load corresponding to 6.3 V RMS across the load.

RECEIVER SENSITIVITY CHECK

Select channel 90.
Set the signal generator to f_{ant} and 1 mV EMF.
Connect a distortion meter with psophometric-filter across the 8-ohm AF load.
Set the volume to level 6.
Reduce the signal generator output to obtain 20 dB SINAD.
Requirement:

20 dB psophometric SINAD (CEPT) for $V_{input} \leq 0.9$ uV EMF.

Measure the sensitivity on channel 01 and 180.
Compared with the measurement on channel 90 the sensitivity degradation shall be less than 1 dB.

SQUELCH ADJUSTMENT

Connect the signal generator to the antenna connector. (0,4)
Set the generator output to 0.8 uV EMF.
Set the modulation to 1 kHz and ±3 kHz frequency deviation.
Select the squelched mode, refer to service mode operation.
Adjust R10 (Rsq-AA902/3) until the roaming indicator on the control head flashes with a duty cycle of approximately 50%.
Check the squelch hysteresis by increasing and decreasing the signal generator output.

The indicator shall be constantly on at 1 uV EMF imput and constantly off at 0.6 uV EMF.

10 uV DETECTOR ADJUSTMENT

Connect the signal generator to the antenna connector. (4,0) 6,5
Set the generator output to 10 uV EMF.
Set the modulation to 1 kHz and ±3 kHz frequency deviation.
Adjust R71 (CL904) until the indicator on the control head just turns on.
Check the detector hysteresis.

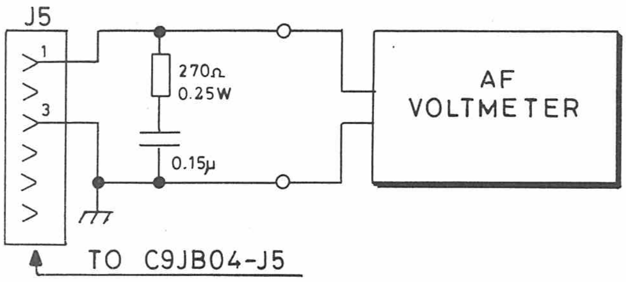
indicator off for 8.0 uV EMF input.
indicator on for 12.5 uV EMF input.

If the detector hysteresis is not within tolerance repeat the adjustment of R71 (CL904).

TELEPHONE LEVEL ADJUSTMENT

Connect the signal generator to the antenna connector.
Set the generator output to 1 mV EMF.
Set the generator modulation to 1 kHz and ±3 kHz frequency deviation.
Connect a telephone dummy network to J5 in C9JB05.

250 mV



Connect an AF voltmeter across the dummy network.
Adjust R26 (FN901) for 0.4 V on the AF voltmeter.

DATA MODEM CHECK

Connect the signal generator to the antenna connector.
Select channel 090.

Set the signal generator to the receiver frequency and the output to 1 mV EMF.
Modulate the signal generator with 1 kHz and ±3 kHz frequency deviation.
Tune the modulation frequency from 100 Hz and upwards and watch the control head indicators.
At 900 Hz the "data squelch" goes high and the H▶ indicator goes ON. The hysteresis is approximately 50 Hz.
At approximately 1550 Hz the RX data indicator on the control head Y turns off without hysteresis.

MEASURING THE RECEIVER CURRENT DRAIN

Measure receiver current drain at V_{BAT} = 13.6 V

Off condition:	less than 70 mA
Standby:	less than 1.0 A
Receive 5 W AF:	less than 2.4 A

TRANSMITTER ALIGNMENT

Connect a UHF power meter, 25 W, to the antenna connector.
Set the power supply voltage to 13.6 V.
Set the current limiter to 10 A.
Select channel 90.
Key the transmitter when adjusting.

EXCITER ALIGNMENT

Put the RX/TX plug on the test box in the TX CM connector and connect a voltmeter to 1 and 10.
Key the transmitter.
Adjust L3 (XO906 - PWR) for maximum voltmeter reading.
Adjust L16 (PL962) for maximum voltmeter reading (approximately 0.85 V).

Connect the voltmeter to 1 and 9.

Adjust L3 (XO906), L15 and L16 (PL962) for maximum voltmeter reading, 0.7 V - 1.0 V.

Connect the voltmeter to 1 and 8.

Detune L11 and L12 (PL962) outwards as much as possible. Then adjust L12 for maximum voltmeter reading, and after this adjust L11 for minimum reading (2.8 V).

1,7

CAUTION

The maximum of L12 and minimum of L11 shall be well defined and easy to find.
Do not readjust L12 to find the minimum of L11.

Connect the voltmeter to 1 and 7.
Adjust C2 (PL962) slowly until the voltmeter reading goes high, approx. 0.7 V.

Select channel 001.
Connect the voltmeter to 1 and 6.
Fine tune C2 (PL962) for 0.6 V on the voltmeter. The setting of C2 is critical and the adjustment is performed by turning it to maximum and then a little back (flat part of the curve).

TRANSMITTER FREQUENCY ADJUSTMENT

Before adjusting the exciter frequency the synthesizer frequency should be checked, refer to Frequency Synthesizer Adjustment.

Connect the frequency counter to the PL962 output (J1) through an attenuator (output level 0.5 W).
Select channel 001.
The frequency is adjusted with L2 (XO906)-FREQ.
Requirement: 453.000000 MHz ±200 Hz.

NOTE.
The transmitter shall be unmodulated when adjusting the frequency.

FINAL FREQUENCY ADJUSTMENT XO906

Because of power supply and load variations the oscillator must be adjusted to the correct frequency after being installed. The graph shows the frequency error in setting the frequency as the ambient temperature varies about the reference, approx 28.6°C.
All oscillators fall within the upper and lower limit but since each oscillator's characteristic is unknown the average curve should be used.
The metal can must be in place when adjusting.

Example:
The frequency is adjusted at 23°C (equipment's temperature).
453.00000 MHz + 453 Hz= 453.000453 MHz

Refer to frequency error curve page 5.

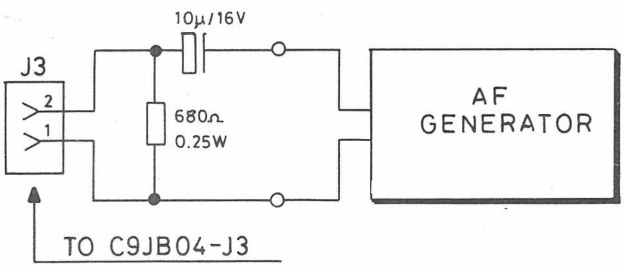
TRANSMITTER POWER OUTPUT ADJUSTMENT

Connect a UHF power meter to the antenna connector.
Select channel 90.
Key the transmitter with power reduction 1.5 W, refer to service mode operation.
Adjust R9 (Power-PA962) for 1.5 W ±2 dB.
0,9 - 2,4 W.

Key the transmitter without power reduction, refer to service mode operation.
Adjust R88 (CL904) for 15 W ±0.5 dB (through hole in MM901). 13,5 - 16,5 W.

TRANSMITTER MODULATION ADJUSTMENT

Connect the deviation meter through an attenuator and a signal sampler to the antenna connector.
Select channel 001.
Connect a signal generator to the signal sampler.
Set the generator frequency to the receiver frequency.
Set the generator output to 1 mV EMF, unmodulated.
Connect an AF generator to the microphone input J5 on C9JB04.



Select 'Hands free' mode by pushing 2 - , 4 - .
Set the AF generator frequency to 1 kHz and the output to 1 V.

Set R51 on FN901 to its middle position.
Adjust R24 on PL962 for Δf= 6 kHz.
Adjust R51 on FN901 for Δf= 4.2 kHz.

Set the AF frequency to 1000 Hz.
Reduce the AF generator output until the deviation is ±3.0 kHz.

blk. 25% dis. med 3 ksving. 1 mV. ind.
10% 2.

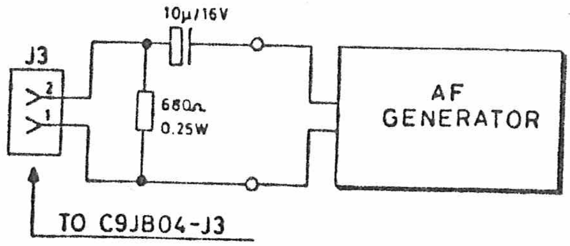
Select channel 001.

Connect a signal generator to the signal sampler.

Set the generator frequency to the receiver frequency.

Set the generator output to 1 mV EMF, unmodulated.

Connect an AF generator to the microphone input J5 on C9JB04.



Select 'Hands free' mode by pushing 2 - 🔈, 4 - 🔈.

Set the AF generator frequency to 1 kHz and the output to 1 V.

Set R51 on FN901 to middle position.

Adjust R24 on PL962 for Δf = 6 kHz.

Adjust R51 on FN901 for Δ = 4.2 kHz.

5% dis

Set the AF frequency to 1000 Hz.

Reduce the AF generator output until the deviation is ±3.0 kHz. ±4 kHz

3,5 kHz mod på RX 0,6% dis 1,3% — 1,1% dis 1,4%

The AF generator level for ±3.0 kHz deviation at 1000 Hz should be 180 mV' ±5 dB.

25 mV - 100 mV.

PILOT TONE ADJUSTMENT

Connect the deviation meter through an attenuator and a signal sampler to the antenna connector.

~~Connect an AF generator to the microphone input J5 on C9JB04.~~

Select channel 001.

Connect a signal generator to the signal sampler.

Set the signal generator frequency to the receiver frequency and set the output to 1 mV EMF.

Modulate the signal generator with 4000 Hz ±10 Hz and frequency deviation ± 500 Hz ± 50 Hz.

Disable 'Hands free' mode by pushing 2 - 🔈, 4 - 🔈.

Adjust R14 (FN901) for a frequency deviation, of ± 500 Hz ± 50 Hz as measured with the deviation meter.

Increase the frequency deviation on the signal generator slowly to ±1 kHz and check for equal frequency deviation as measured with the deviation meter.

Increase the frequency deviation further up to ±3 kHz and check for the transmitter frequency deviation being limited to approximately ±1.5 kHz.

DATA MODULATION ADJUSTMENT

Use the same test setup as described for Pilot Tone Adjustment.

Turn the signal generator modulation off.

Turn the FFSK telegram on, push 1 - ↦ on the control head.

Adjust R62 on CL904 for ±3.5 kHz frequency deviation as measured with the deviation meter.

MEASURING THE TRANSMITTER CURRENT DRAIN

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

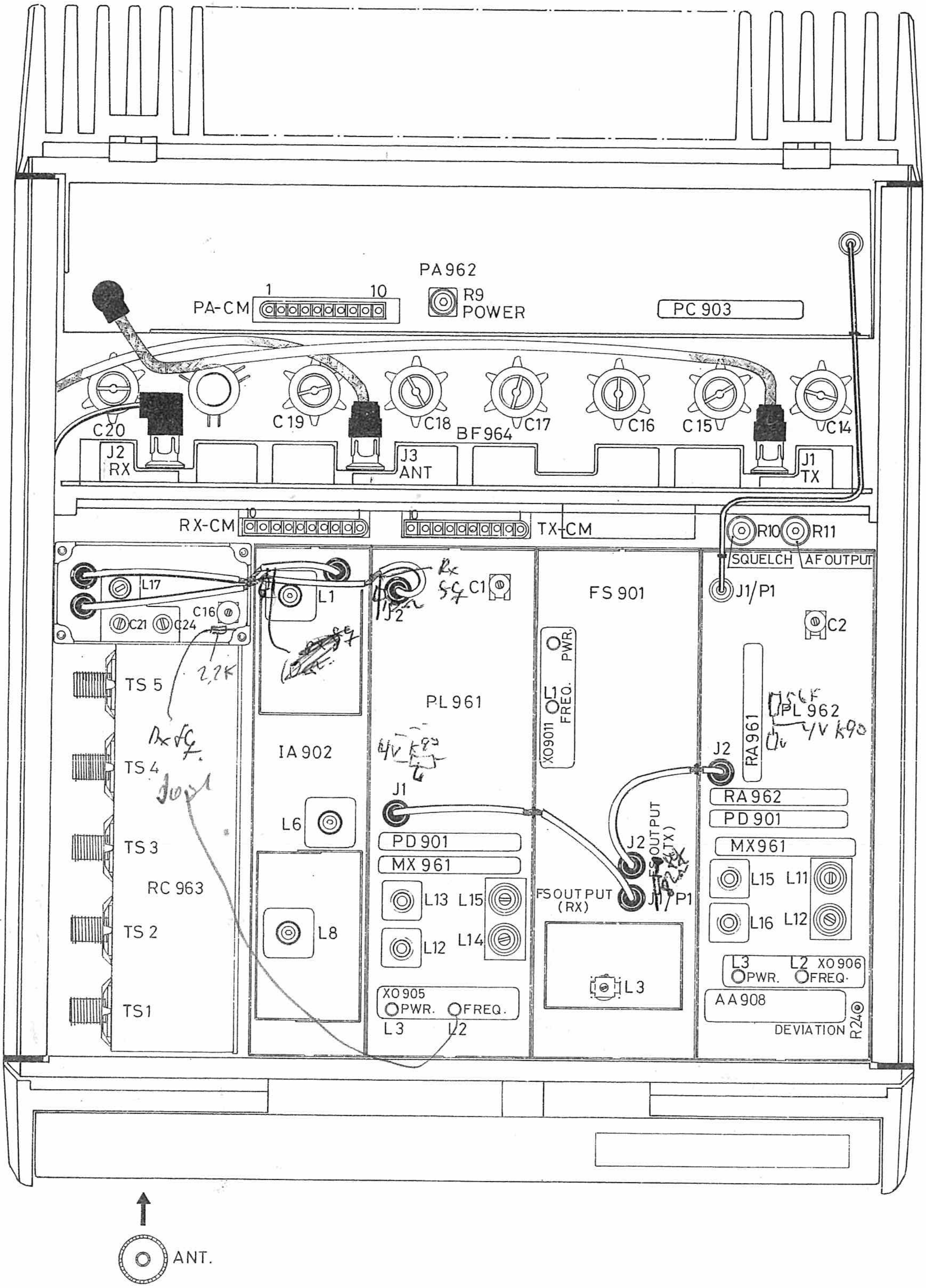
RF output 15 W: less than 6.5 A

RF output 1.5 W: less than 3.5 A.

kanal 1
2 P
Mod ⇒ 0
1 ↦ Mod ⇒ Δf 3,2 kHz
0 ↦ Mod ⇒ Δf 1,2 kHz
1 ↦ Mod ⇒ Δf 4,2 kHz
0 ↦ Mod ⇒ Δf 1,2 kHz

1 🔈 ⇒ Mod f 8/2 MT

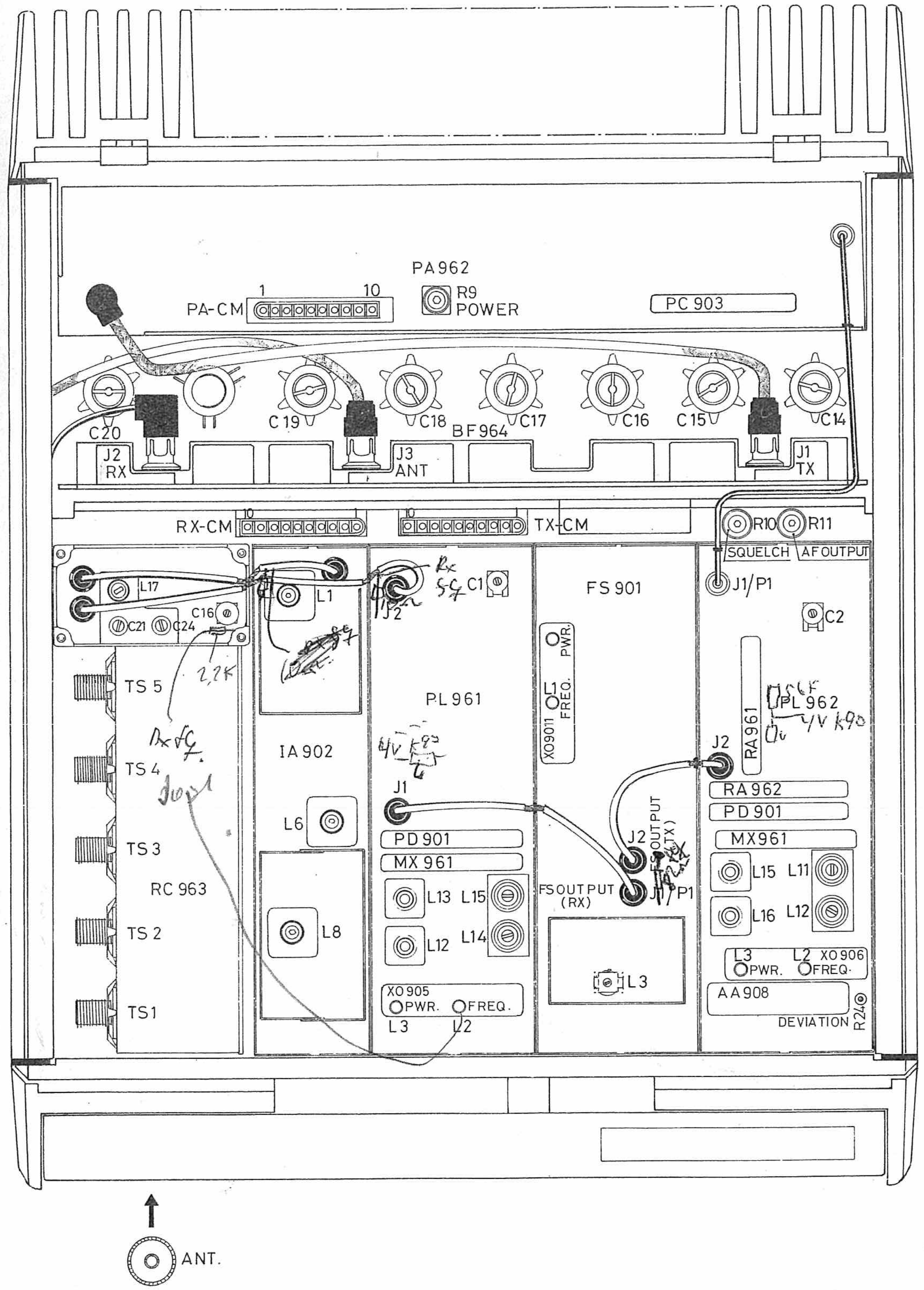
2 🔈
4 🔈
1 V 1kHz på J3 MC Mod ⇒ Δf 4,2 kHz
Test p 2. på FN901 kort sl Mod ⇒ 4,1 kHz



ADJUSTABLE COMPONENTS AND CENTRAL METERING
RF - SIDE

STORNOMATIC 900 NMT

D403.063/3

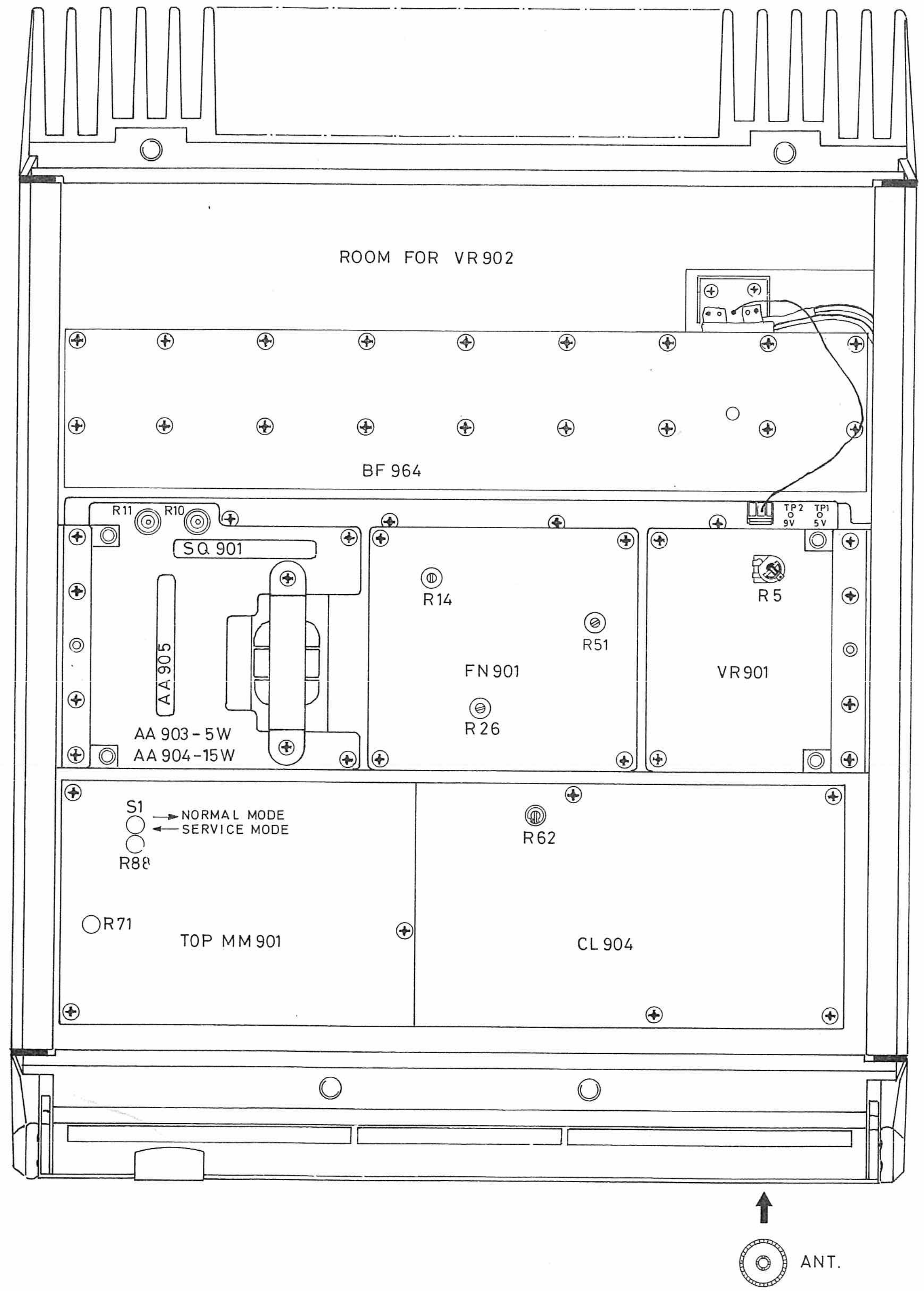


ADJUSTABLE COMPONENTS AND CENTRAL METERING
RF - SIDE STORNOMATIC 900 NMT

D403.063/3

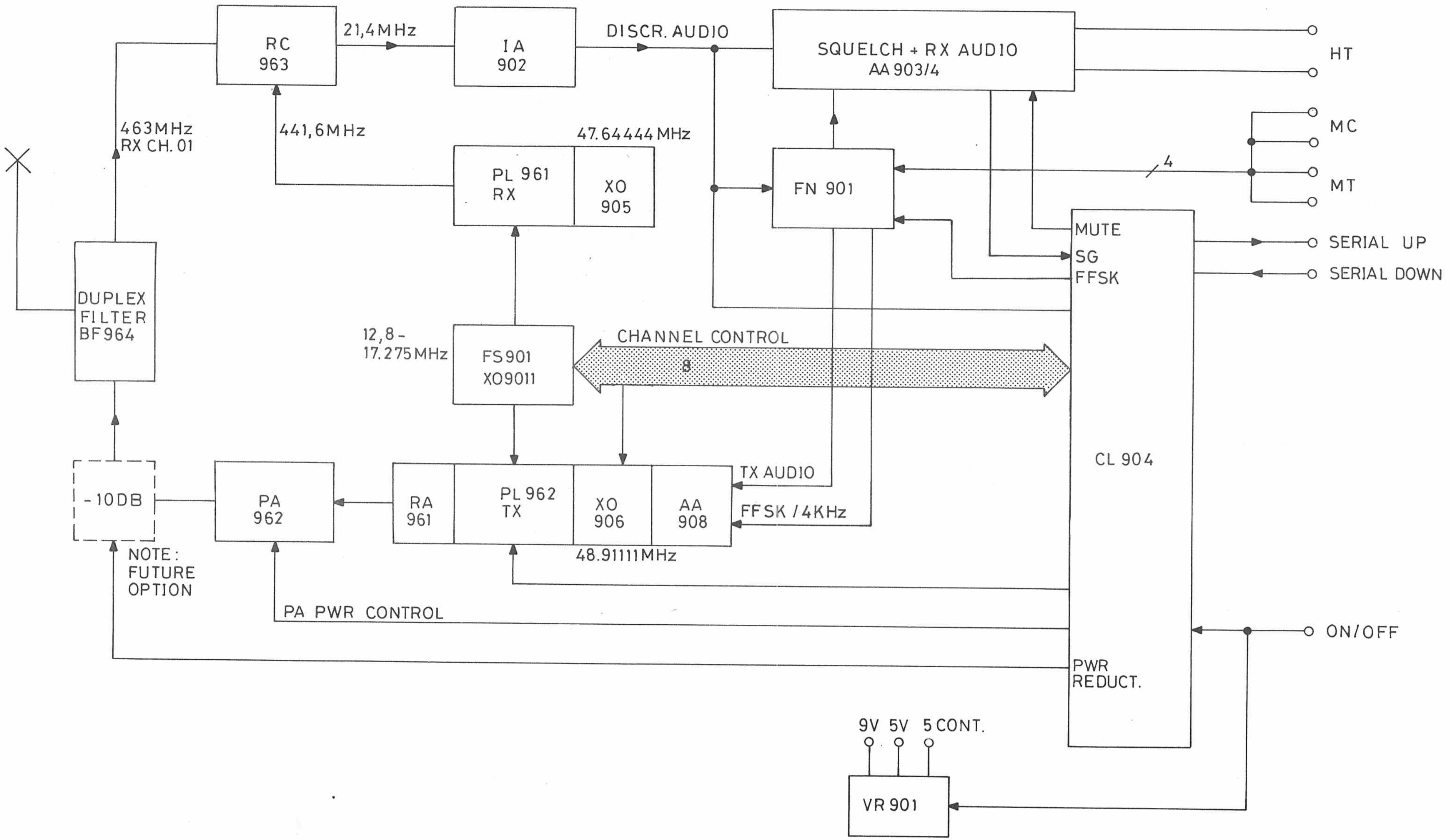
Storno

Storno



ADJUSTABLE COMPONENTS AND MODULE LAYOUT
SYSTEM SIDE STORNOMATIC 900 NMT

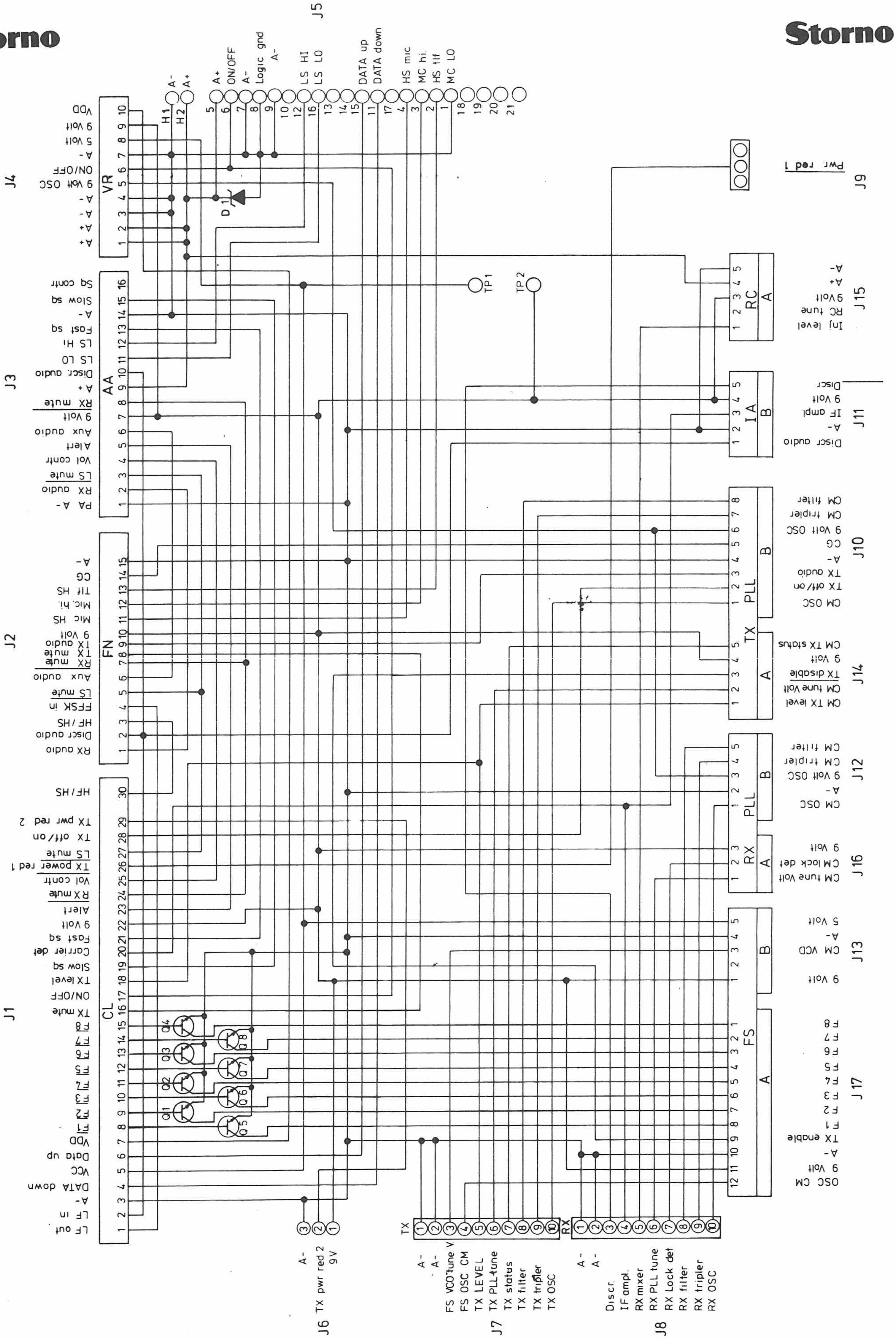
D403. 064/2



STORNOMATIC 900
BLOCKDIAGRAM

D403.085/2

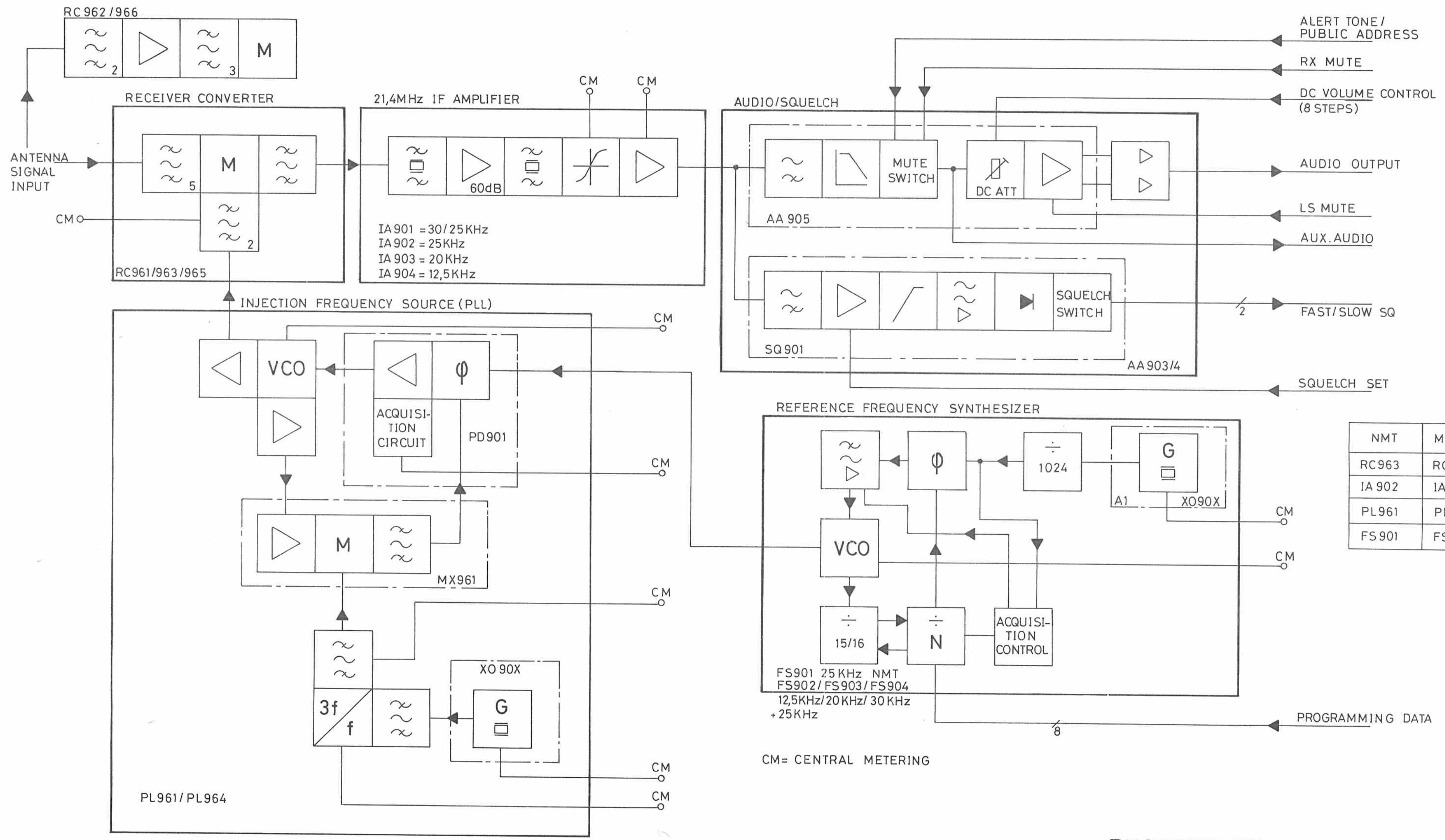
Storno



JUNCTION PANEL JP904

D403.069

Storno

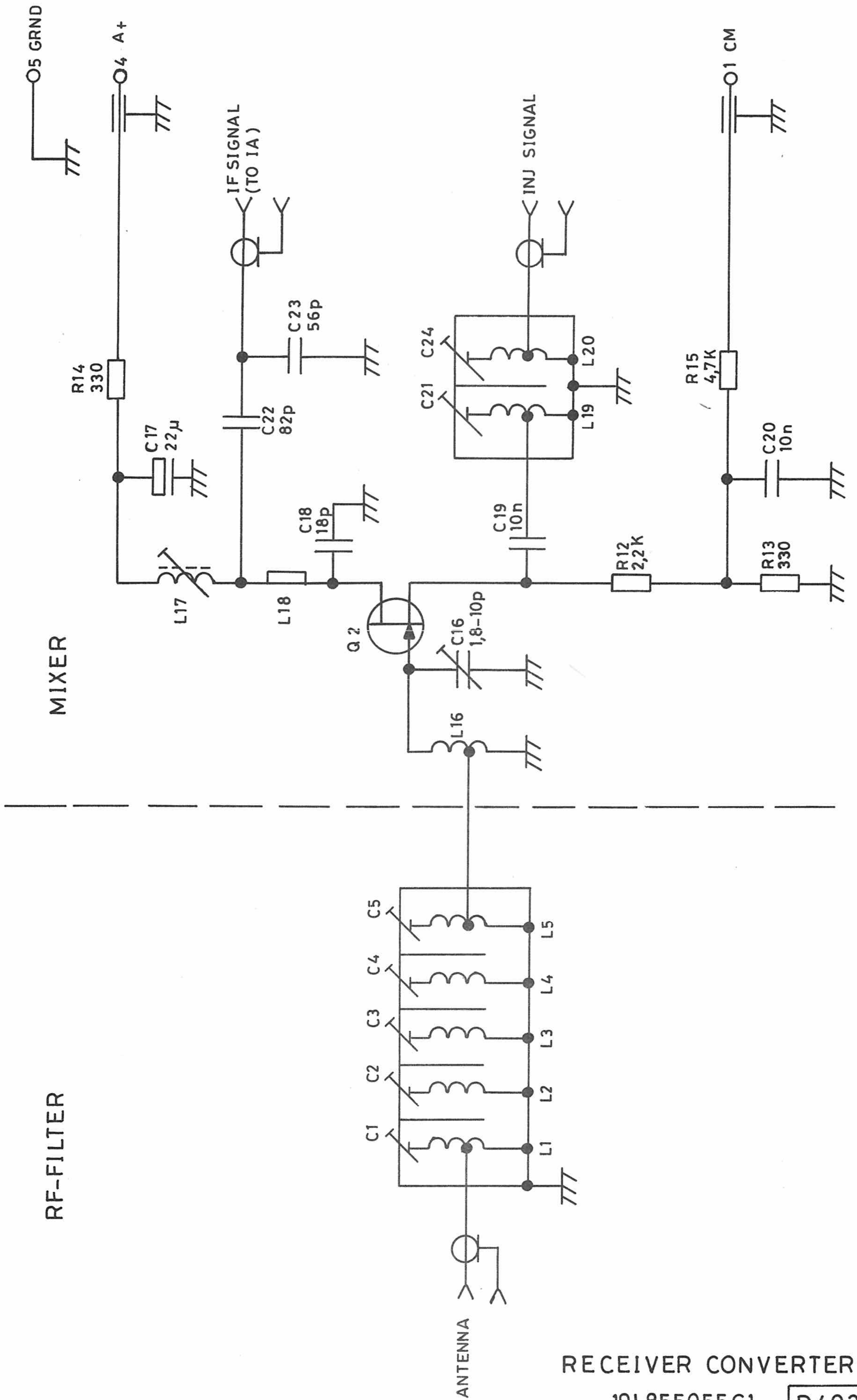


Storno

NMT	M966X
RC963	RC 96X
IA 902	IA 90X
PL961	PL 96X
FS901	FS 90X

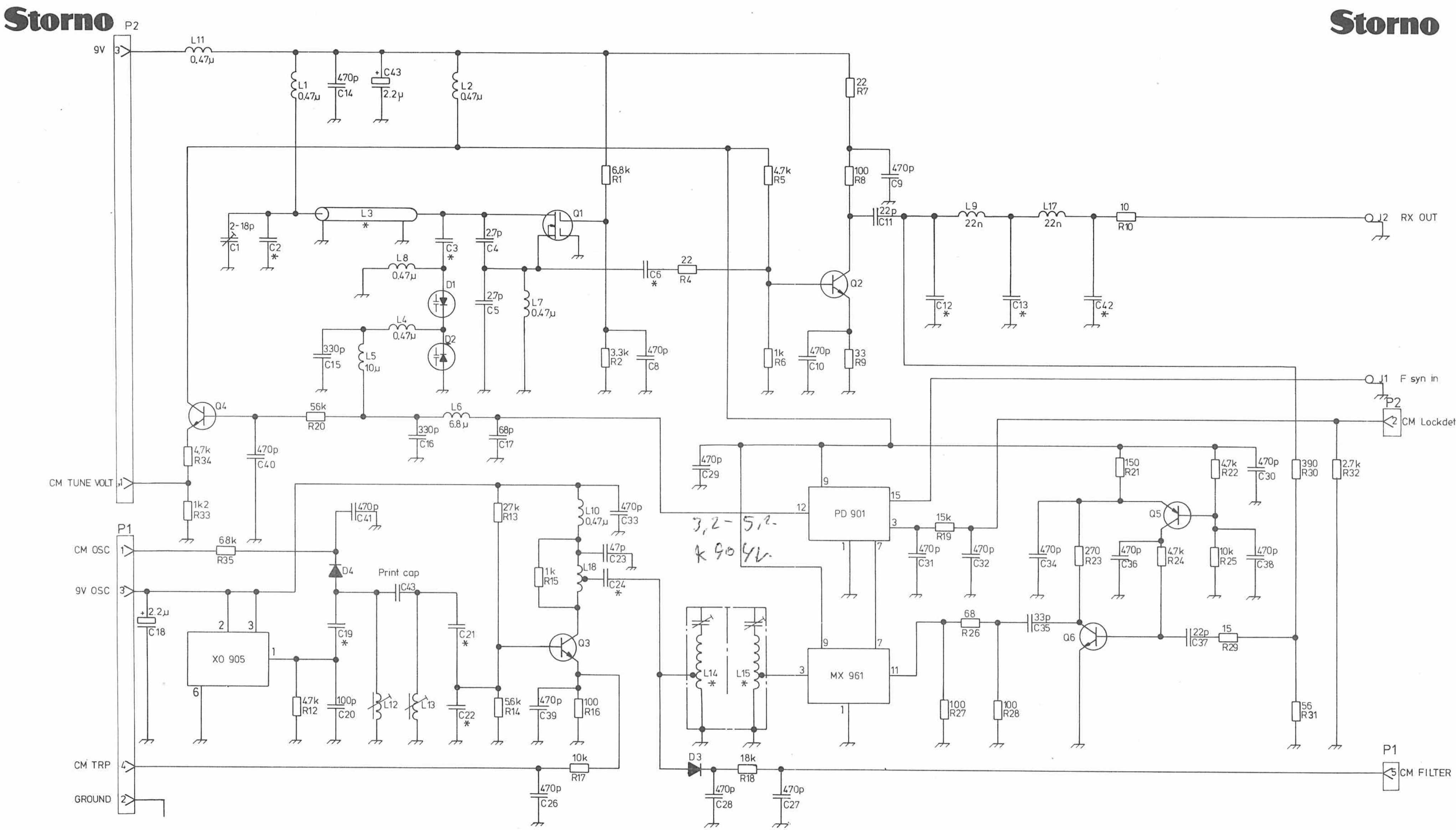
RECEIVER FUNCTIONAL DIAGRAM
M9660 PLL CIRCUIT

D402. 913 /2



RECEIVER CONVERTER RC963

19L855055G1 D403.062/2



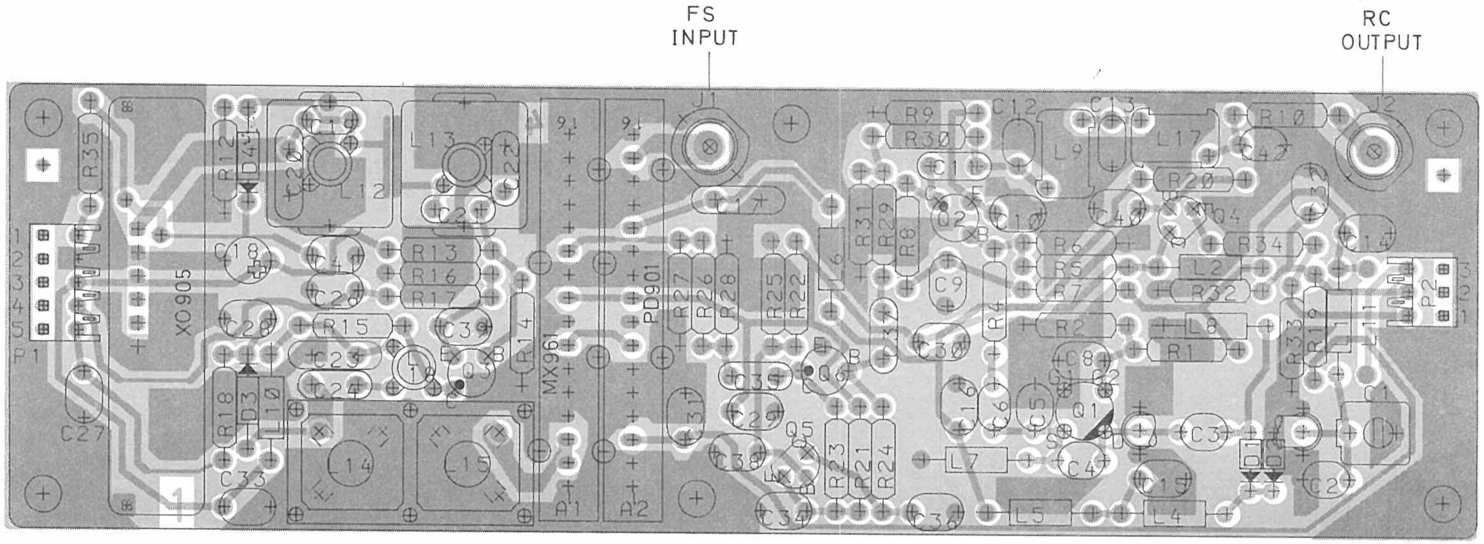
FREQ. RANGE MHz	MODULE/CODE NO.	C2	C3	C6	C12	C13	C19	C21	C22	C24	C42	L3	L14	L15
403-470	PL961 19M905002G1	4,7p	5,6p	6,8p	6,8p	12p	12p	18p	27p	18p	6,8p	COAX L855090G1	HEL.COIL J706154P2	HEL. COIL J706154P2
450-512	PL964 19M905002G2	3,3p	3,9p	3,3p	4,7p	10p	10p	15p	22p	8,2p	4,7p	COAX L855090G2	HEL.COIL J706154P3	HEL. COIL J706154P3

RX PHASE LOCKED LOOP PL961/PL964

PL961: 19M905002 G1
PL964: 19M905002 G2

D402.942/2

Storno



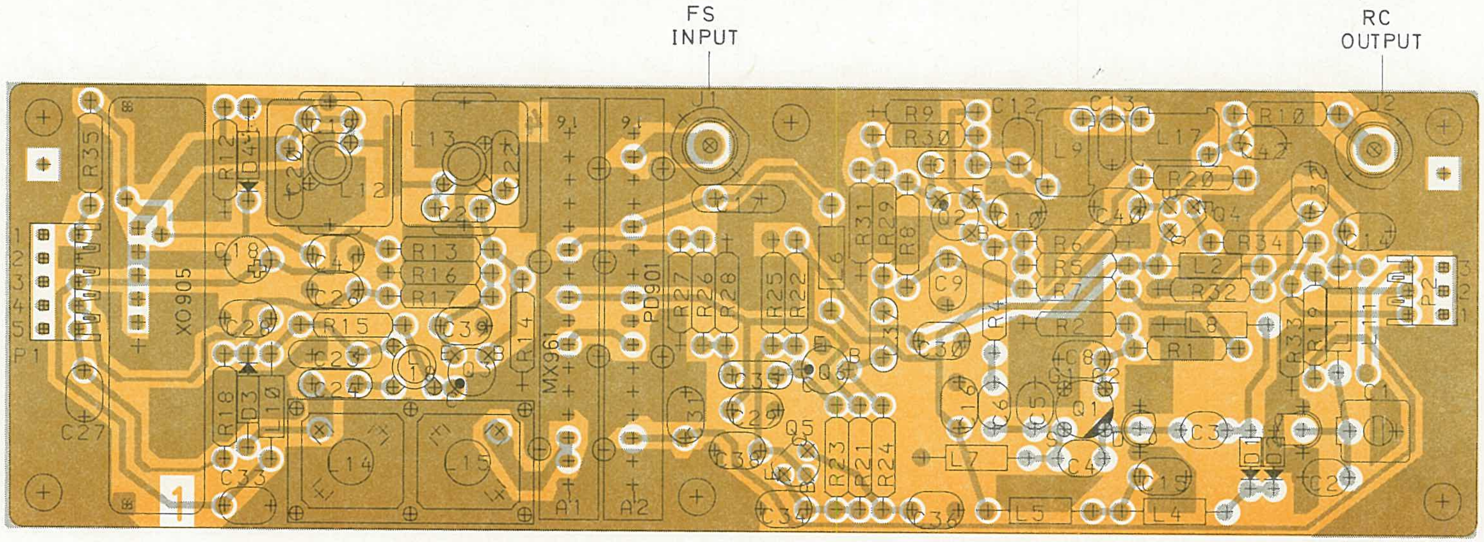
RX PLL PL961/964
COMPONENT LAYOUT

PL961:19M905002G1
PL964:19M905002G2

D402.975/2

Storno

Storno

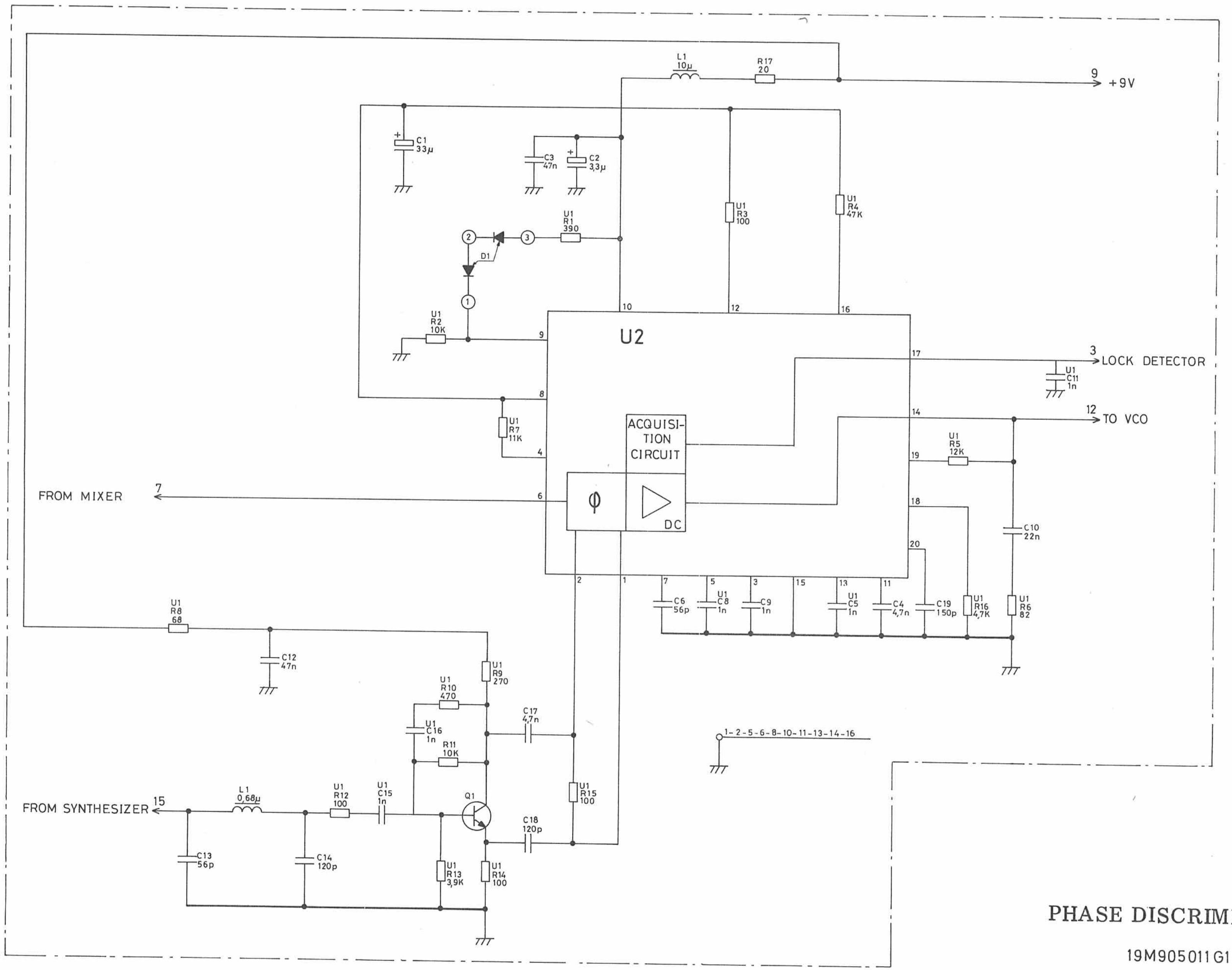


RX PLL PL961/964
COMPONENT LAYOUT

PL961:19M905002G1
PL964:19M905002G2

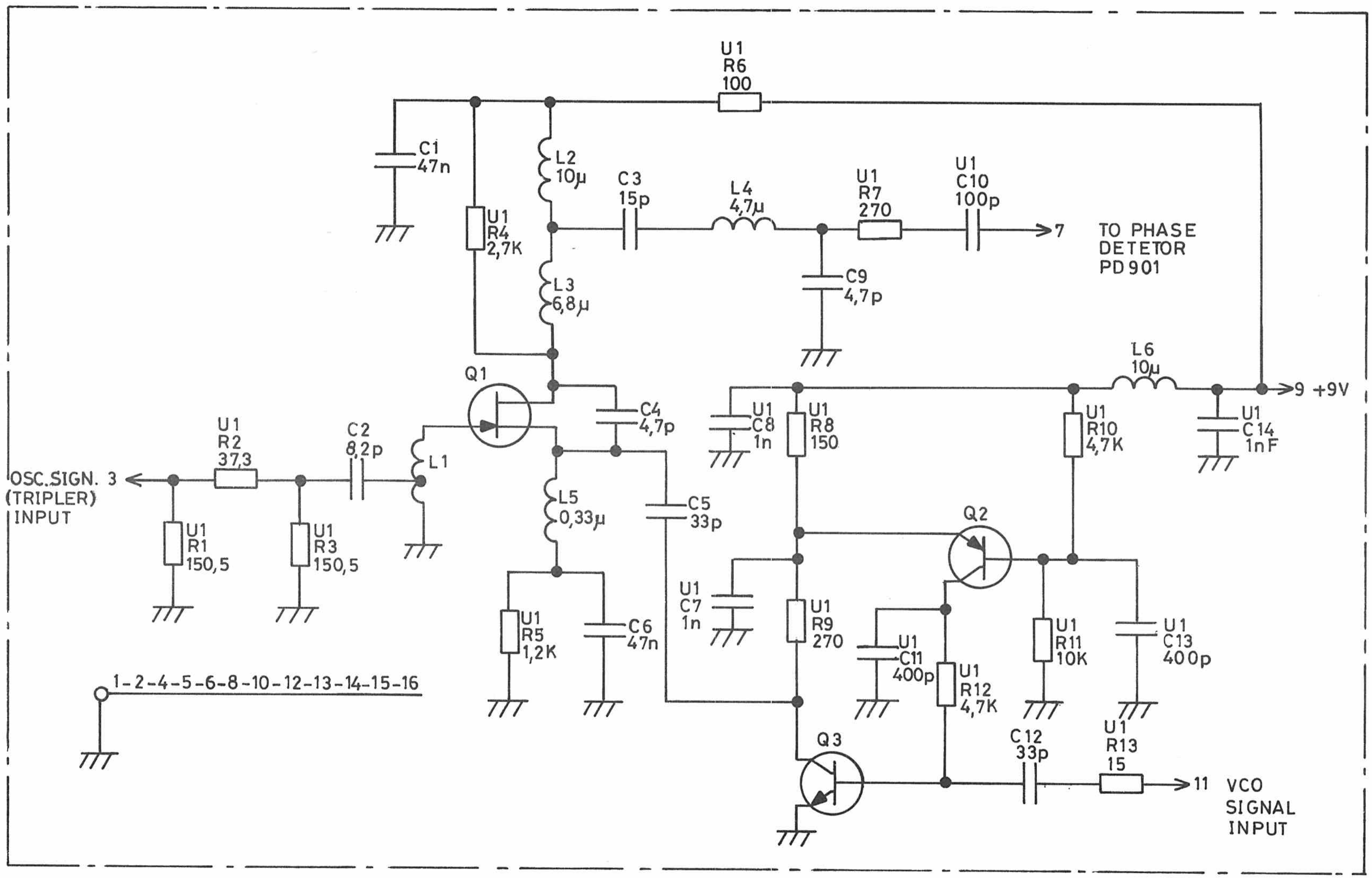
D402.975/2

Storno



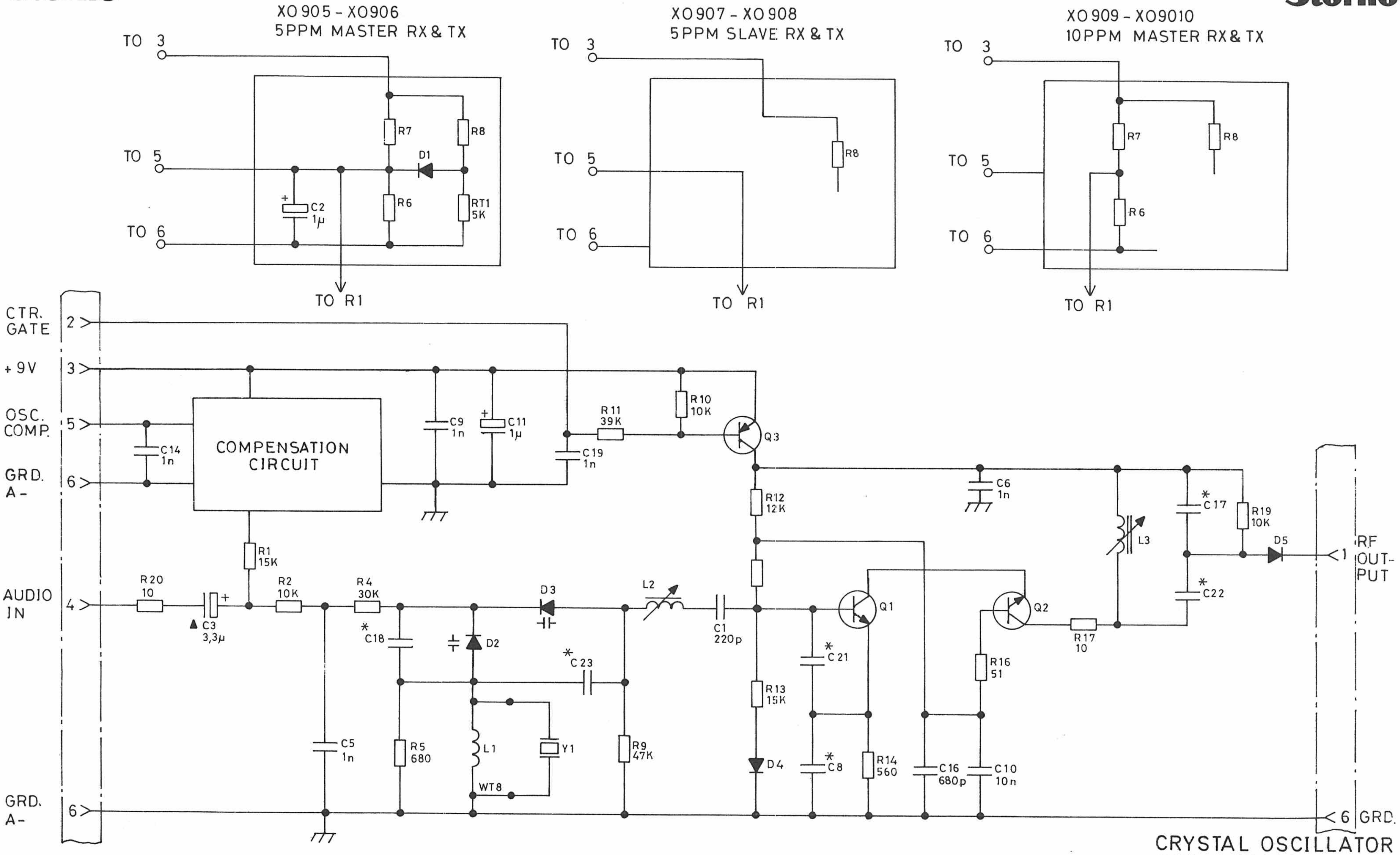
PHASE DISCRIMINATOR PD901

19M905011G1 D402. 921 /2



MIXER CIRCUIT MX961

19M905061G1 D402.919/2

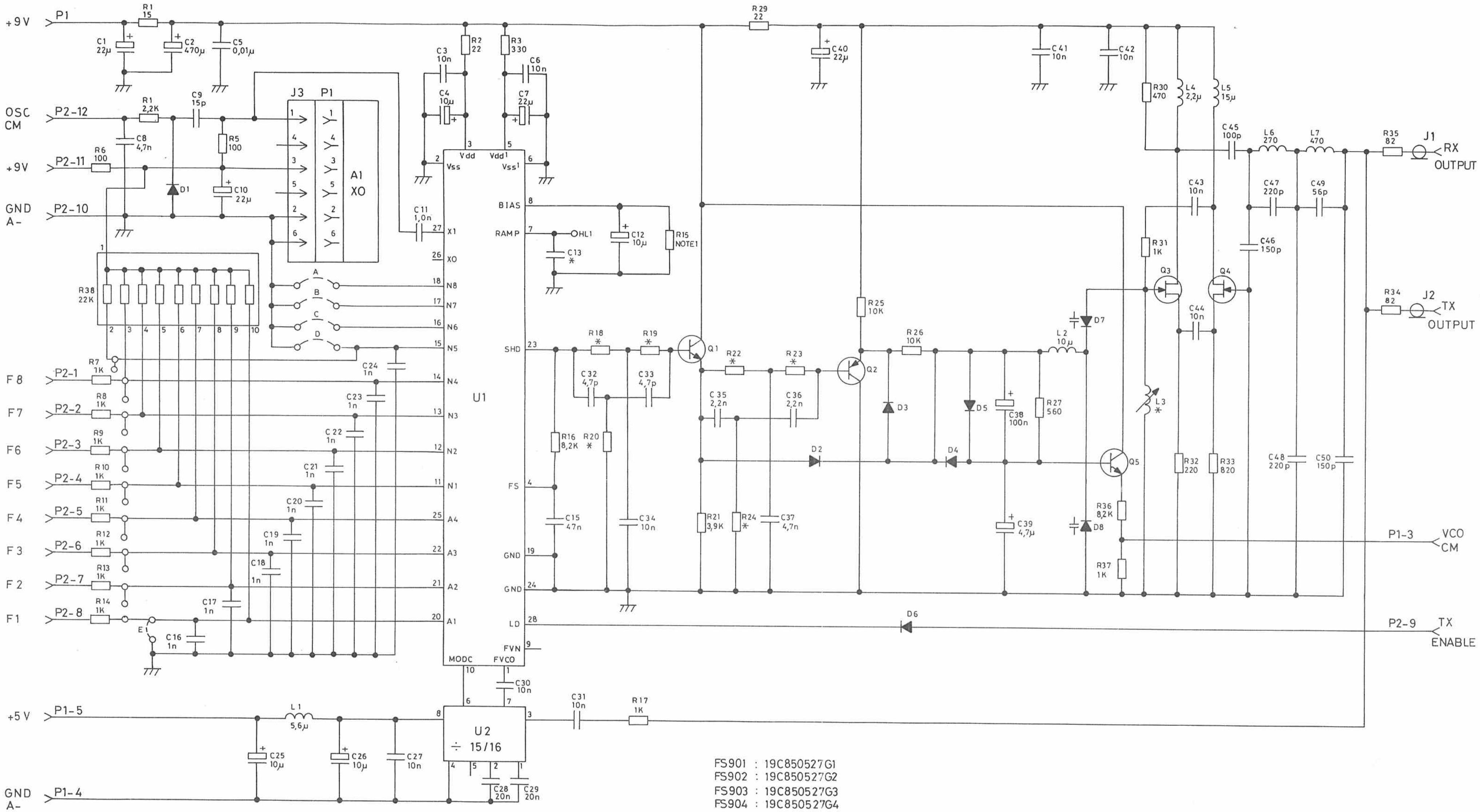


CRYSTAL OSCILLATOR
XO905-XO906-XO907-
XO908-XO909-XO9010

D403.024

NOTES: * ADJ. VALUE REFER TO PART LIST
▲ IN TX OSC. ONLY

Storno



Storno

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

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

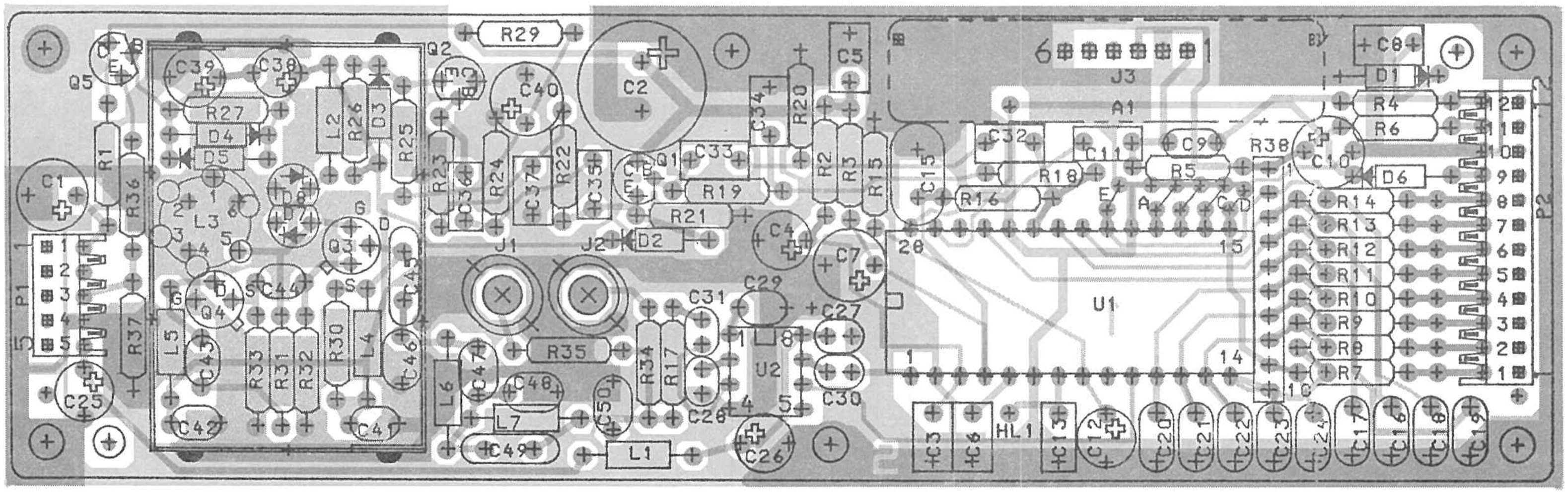
* VALUE CHART

TYPE	REFERENCE FREQ. SPACING	R18	R19	R20	R22	R23	R24	A1 FREQ.	PROGRAM STRAPPING	C13	L3
FS901(NMT)	25KHz	2610	2610	1400	2800	2800	1500	12,8MHz	A, C, E	1,5n	≈1,8µH
FS 902	2x12,5KHz	2610	2610	1400	2800	2800	1500	12,8MHz	A, C, D	1,5n	≈1,8µH
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

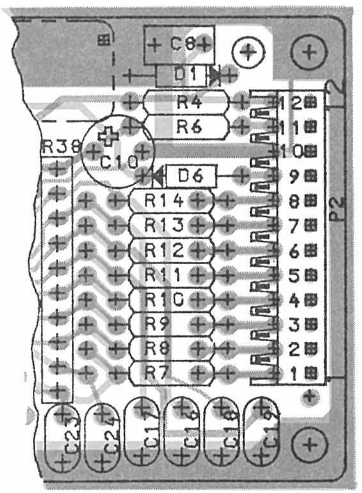
FREQUENCY SYNTHESIZER FS 90X

D403.077/3

Storno



FS901
NMT



FS902/3/4

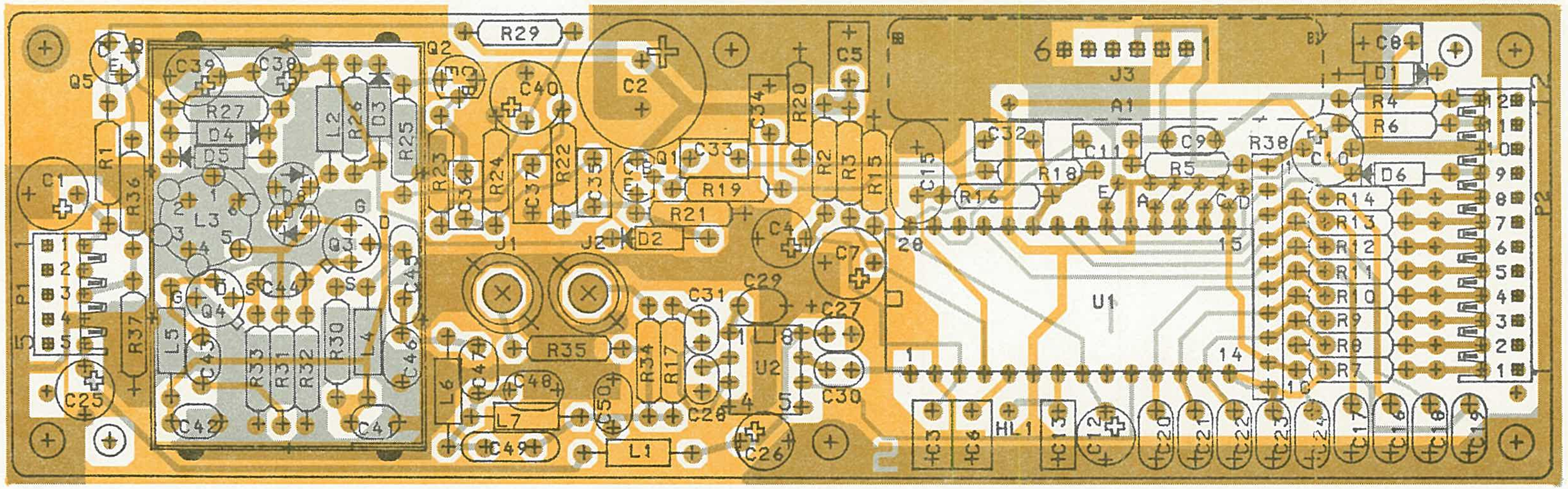
FS901 : 19C850527G1
FS902 : 19C850527G2
FS903 : 19C850527G3
FS904 : 19C850527G4

FREQUENCY SYNTHESIZER FS90X

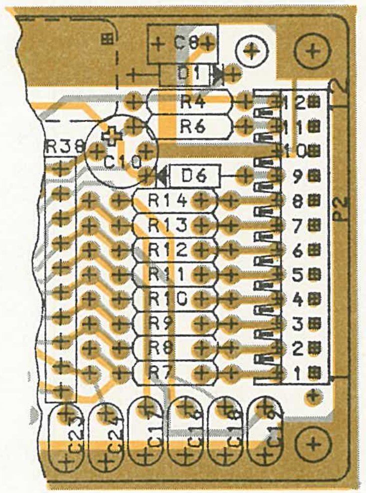
REV. B D402.980/3

Storno

Storno



FS 901
NMT



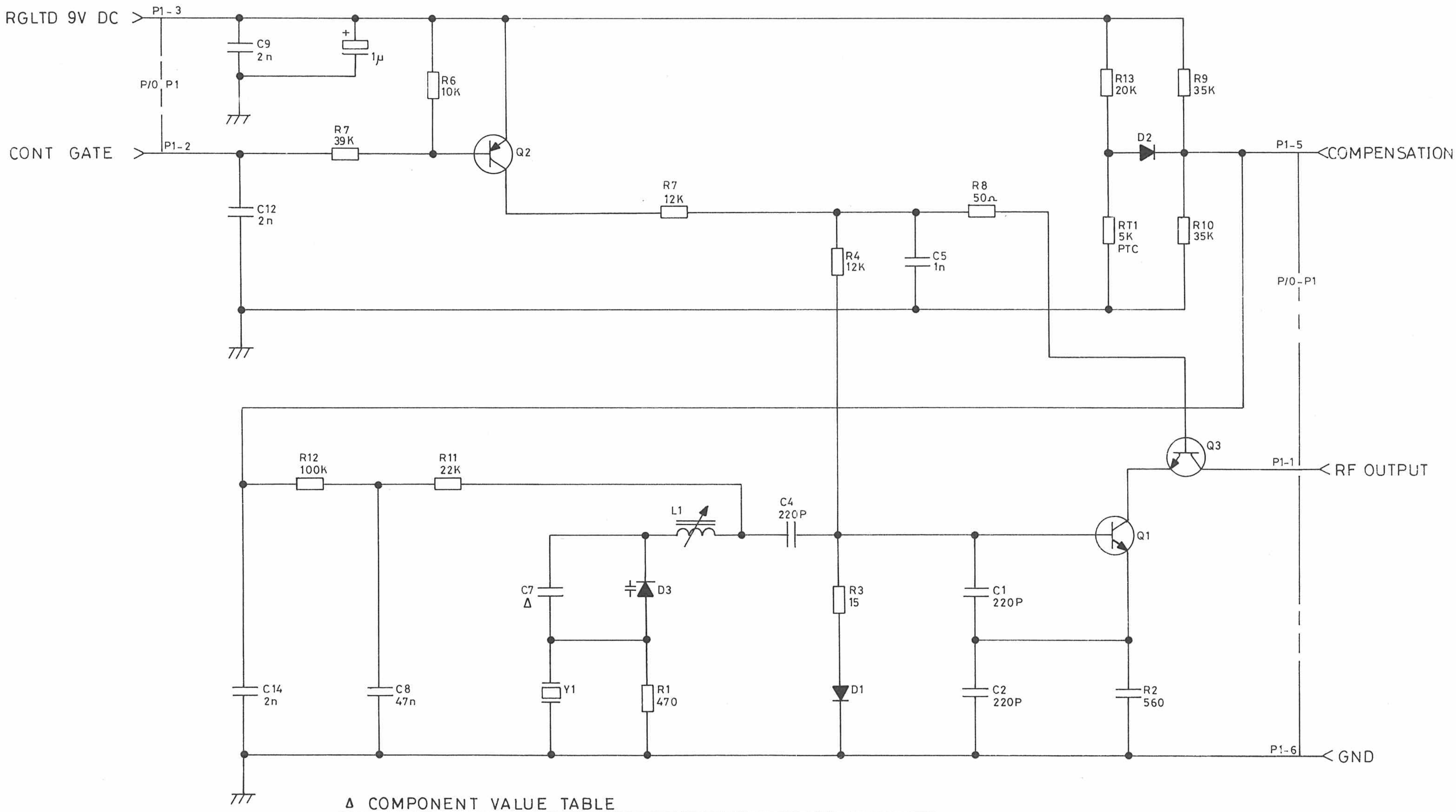
FS902/3/4

FS 901 : 19C850527G1
FS902 : 19C850527G2
FS903 : 19C850527G3
FS904 : 19C850527G4

FREQUENCY SYNTHESIZER FS90X

REV. B D402.980/3

Storno



Δ COMPONENT VALUE TABLE

	GR. 1-8, 13-20, 25-27, 31-33	GR. 9-12, 21-24, 28-30, 34-36
C7	47P	82P

CRYSTAL OSCILLATOR XO9011-12-13

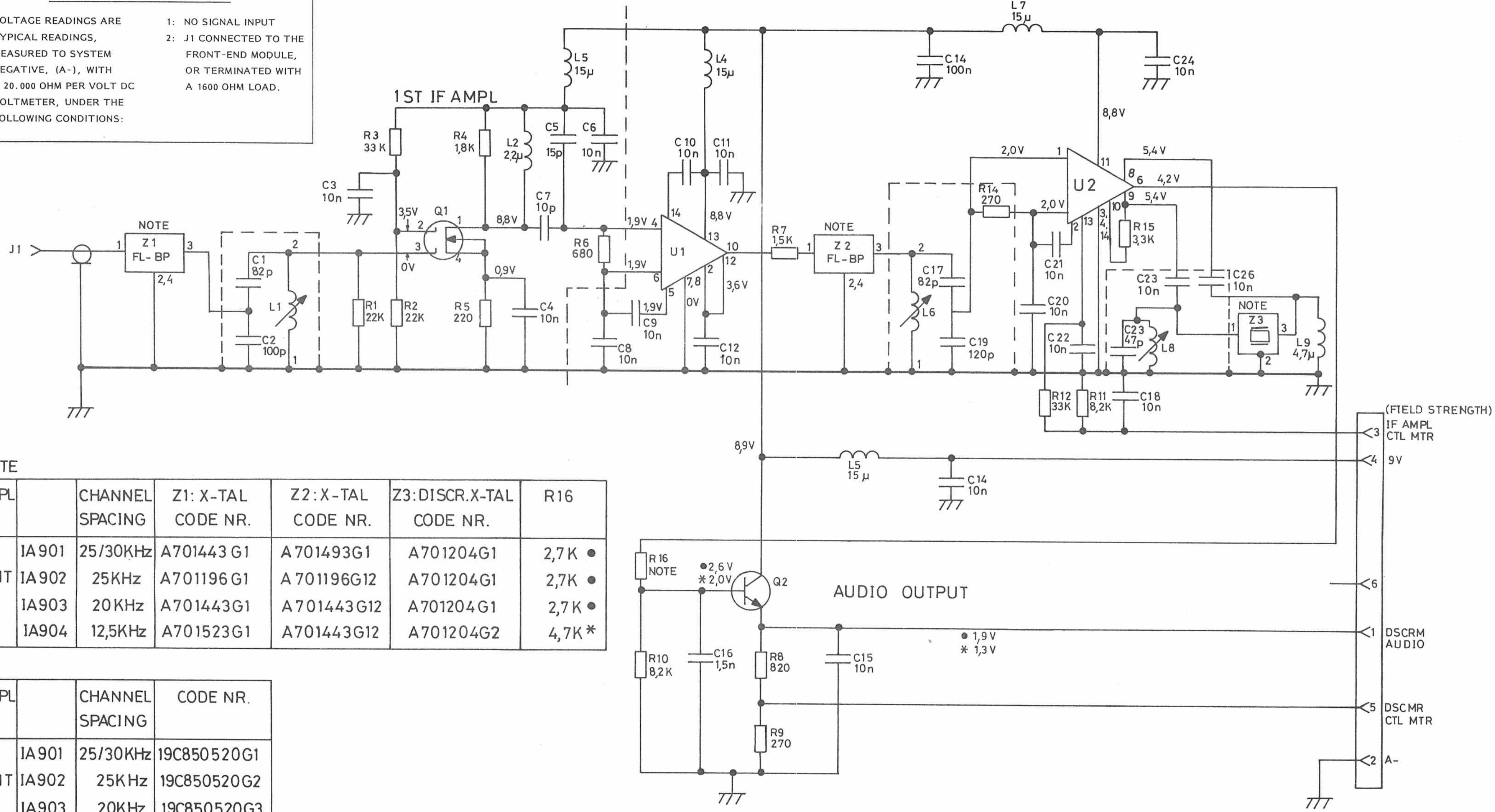
D403.015

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.



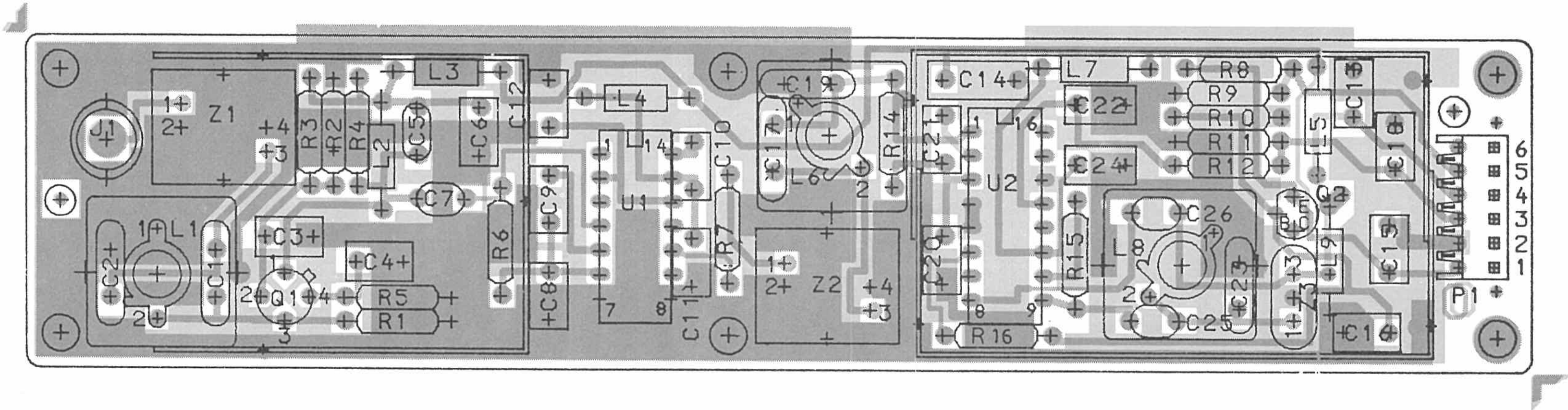
NOTE

APPL		CHANNEL SPACING	Z1: X-TAL CODE NR.	Z2: X-TAL CODE NR.	Z3: DISCR. X-TAL CODE NR.	R16
	IA901	25/30KHz	A701443 G1	A701493G1	A701204G1	2,7K ●
NMT	IA902	25KHz	A701196 G1	A701196G12	A701204G1	2,7K ●
	IA903	20KHz	A701443G1	A701443G12	A701204G1	2,7K ●
	IA904	12,5KHz	A701523G1	A701443G12	A701204G2	4,7K *

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

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

D402.912/4

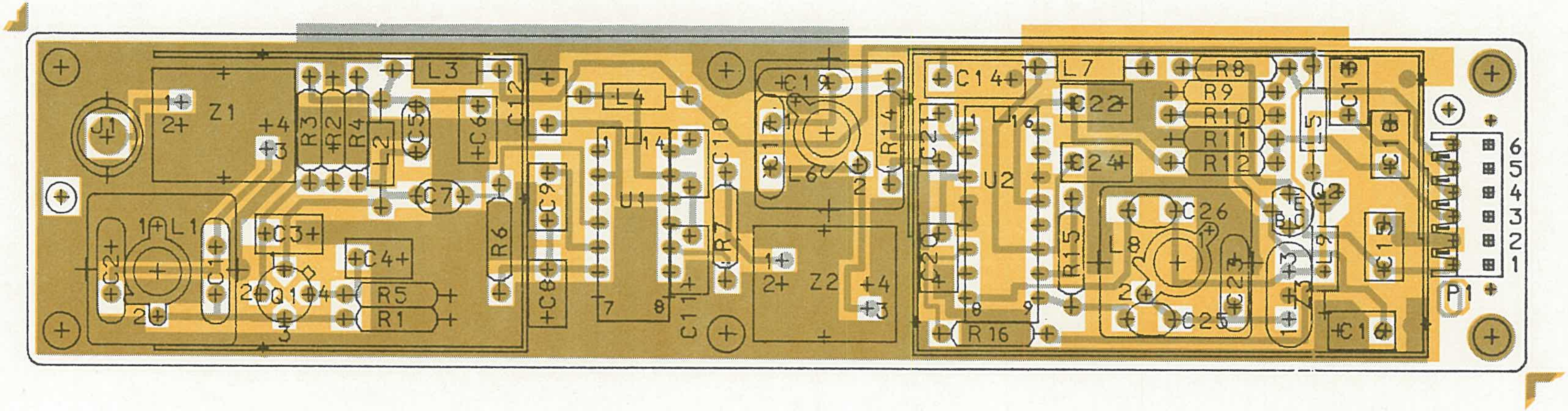


IA901 : 19C850520 G1
NMT IA902 : 19C850520 G2
IA903 : 19C850520 G3
IA904 : 19C850520 G4

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

D402.961/2

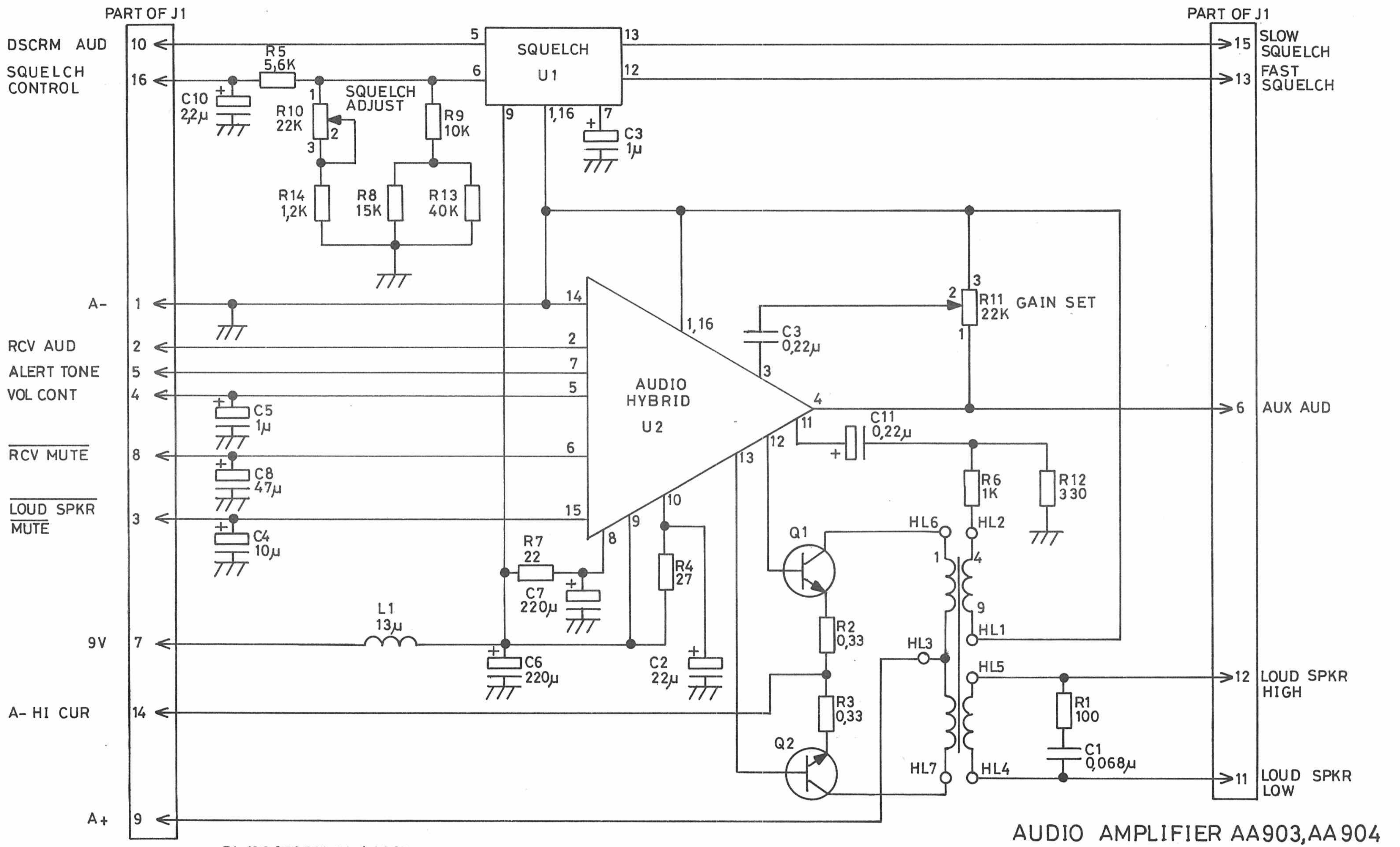
Storno



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

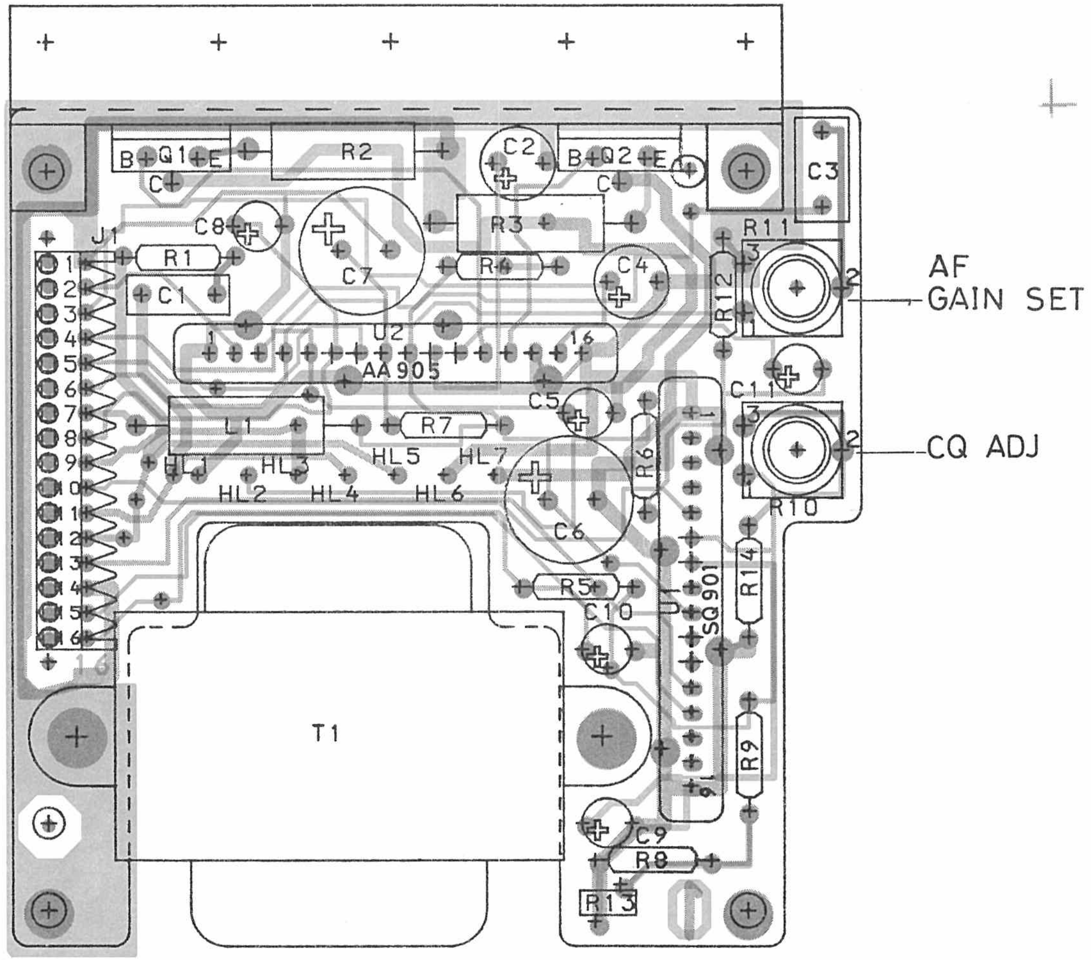


PL 19C850521 G1 AA903
PL 19C850521 G2 AA904

AUDIO AMPLIFIER AA903, AA904

D402.917/2

Storno

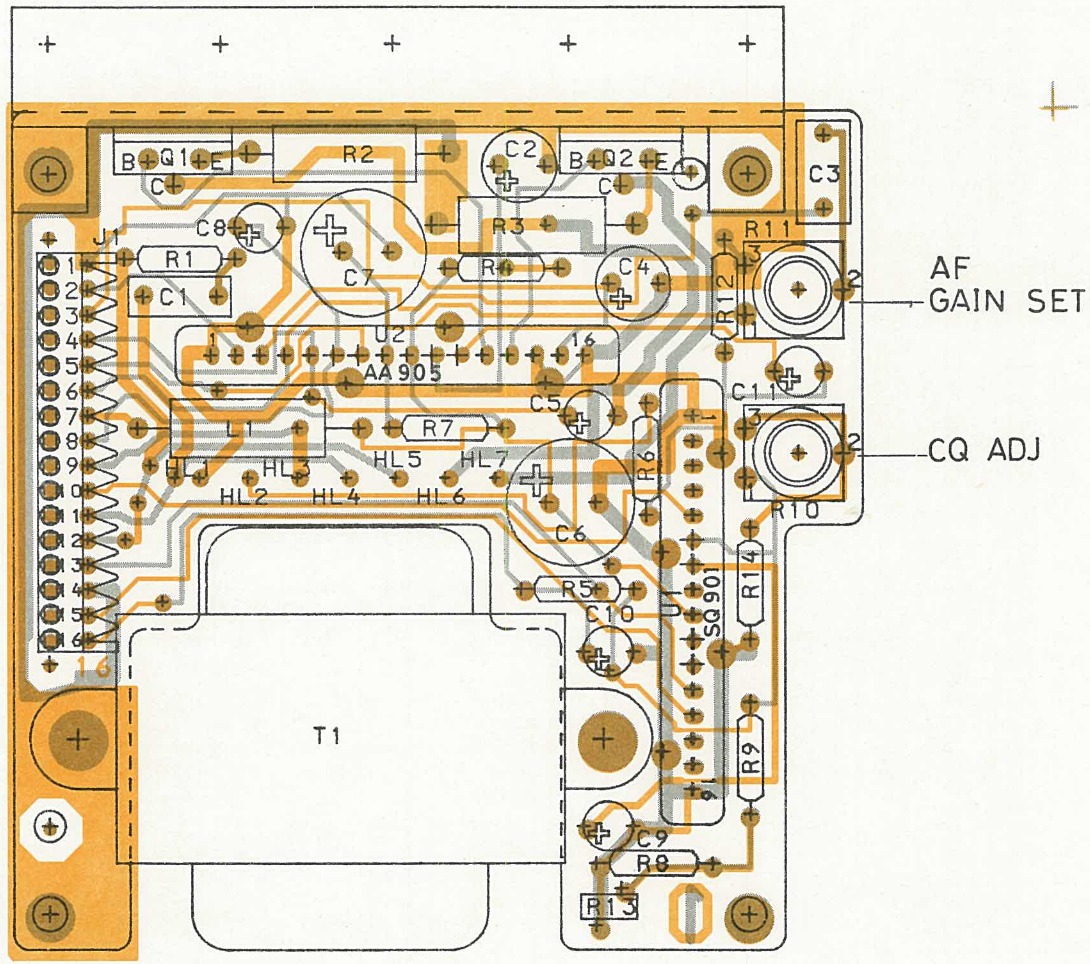


AA903: 19C850521G1
AA904: 19C850521G2

AUDIO AMPLIFIER AA903 , AA904
COMPONENT LAYOUT

D402.960/3

Storno

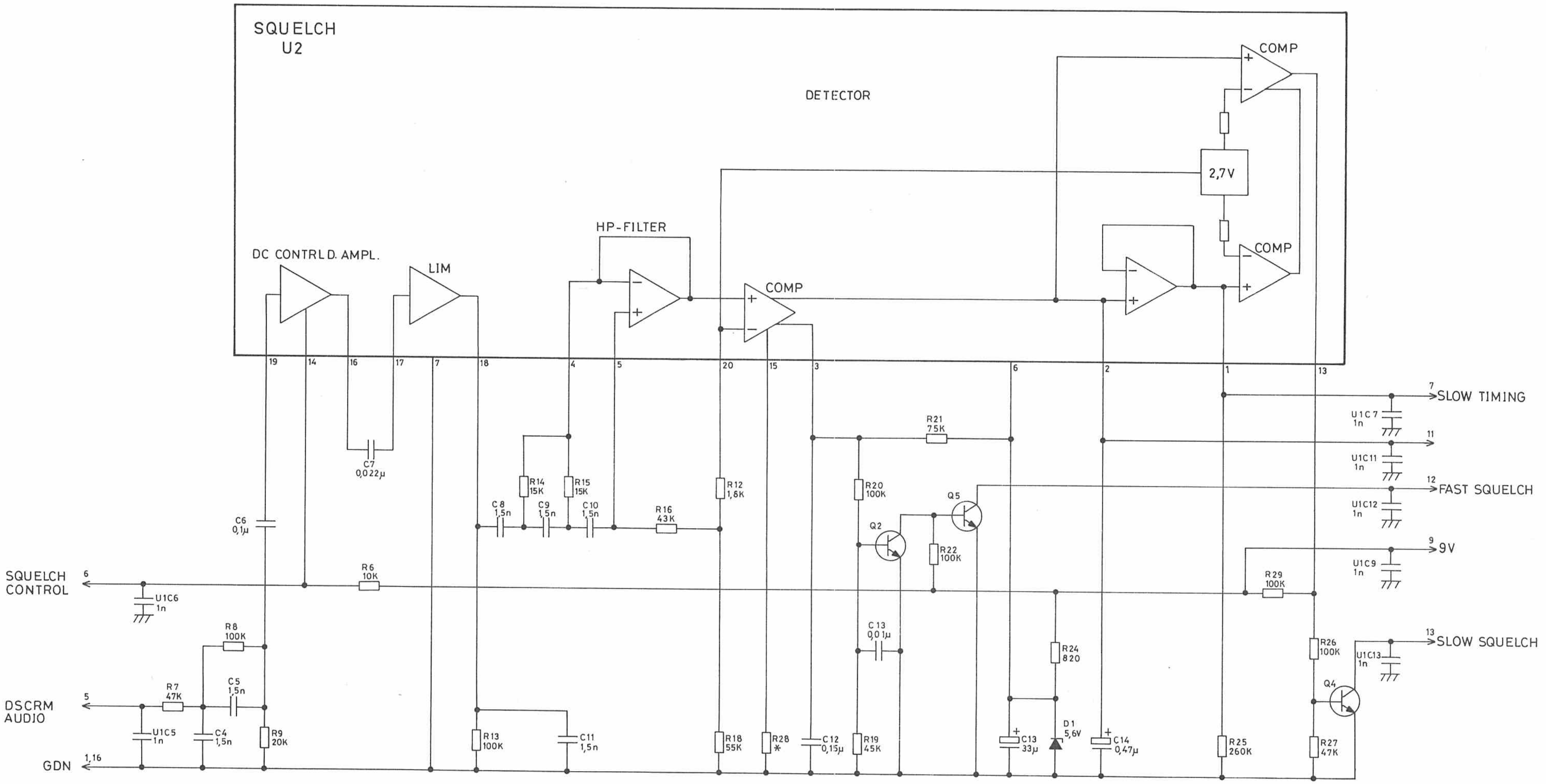


AA 903: 19C850521 G1
AA 904: 19C850521 G2

AUDIO AMPLIFIER AA903 , AA 904
COMPONENT LAYOUT

D402.960/3

Storno



NOTE:
* FUNCTIONAL TRIMMED

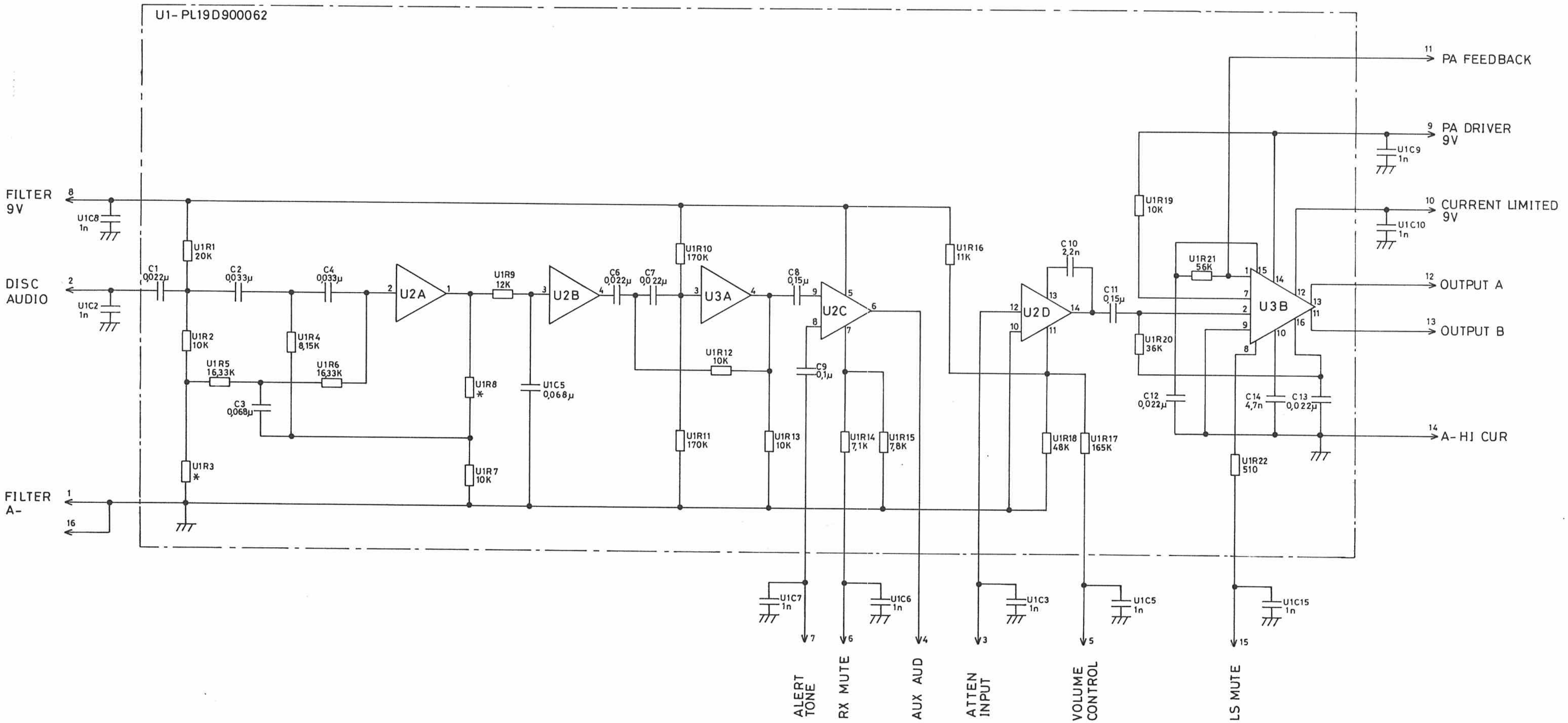
Storno

SQUELCH CIRCUIT
SQ901

19M900067G2

D402.915 /2

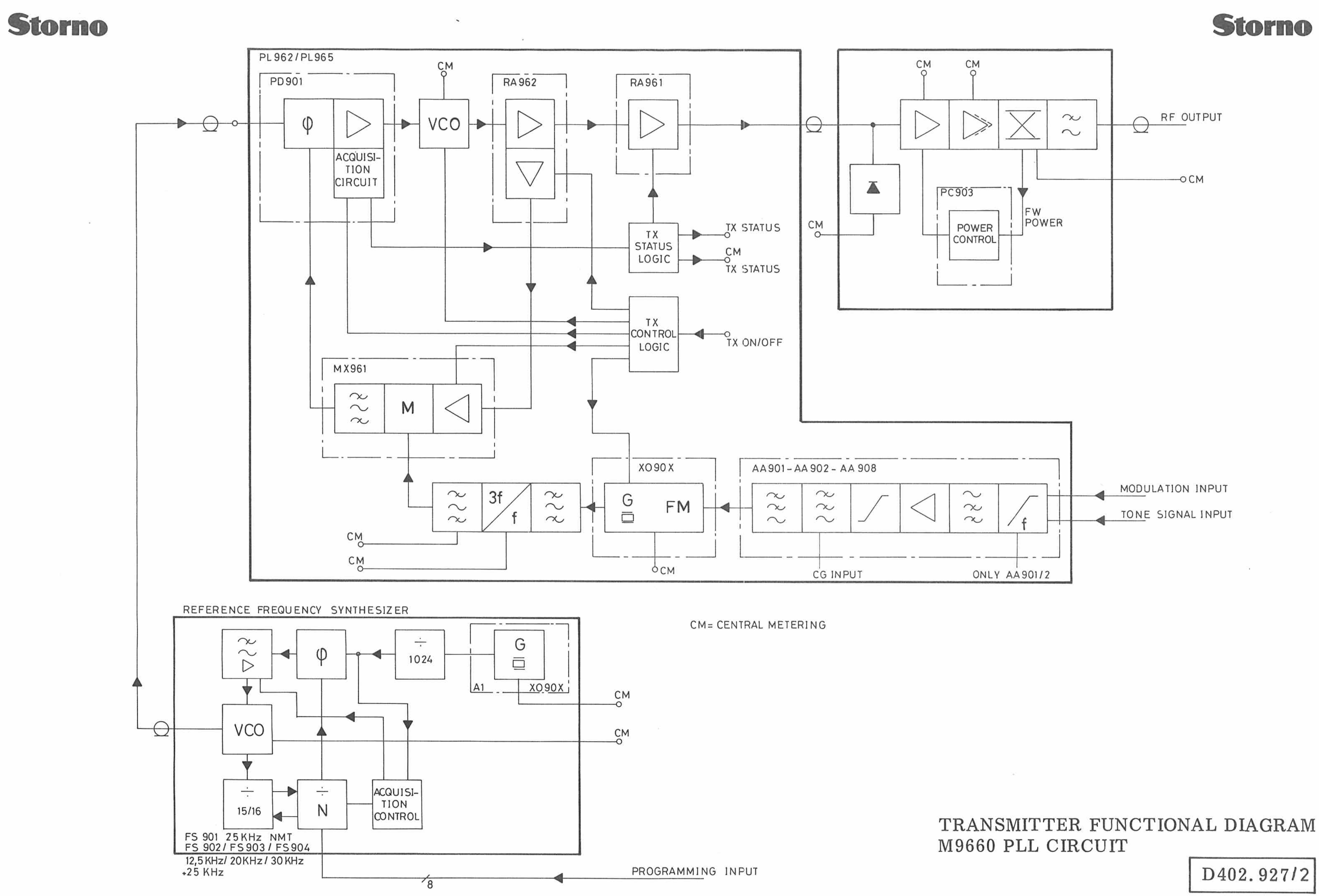
Storno



NOTE:
* FUNCTIONAL TRIM PER 9A701209

AUDIO AMPLIFIER AA905

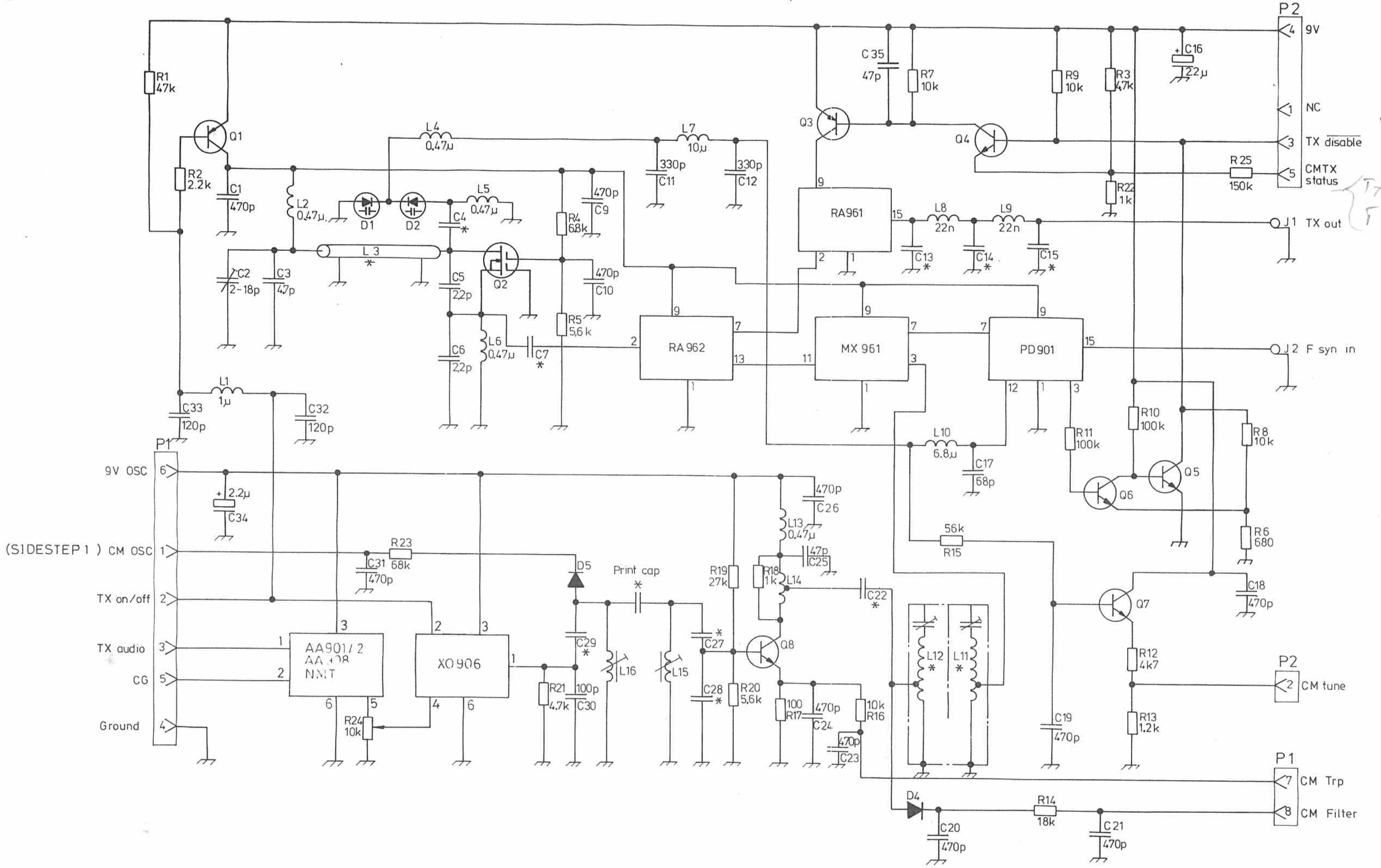
D402.914



TRANSMITTER FUNCTIONAL DIAGRAM
M9660 PLL CIRCUIT

D402. 927/2

Storno



NOTE: *

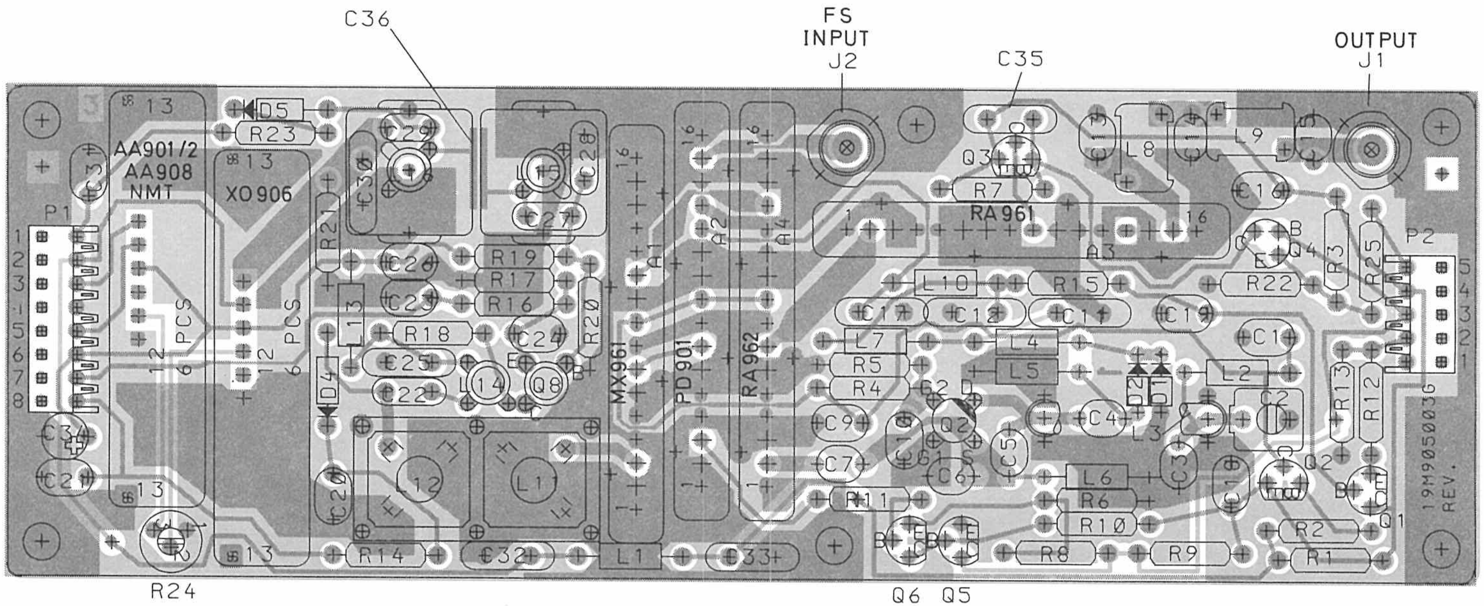
FREQ. RANGE MHz	MODULE/CODE NO.	COMPONENTS *C4	*C7	*C13	*C14	*C15	*C22	*C27	*C28	*C29	*L3	*L11	*L12
403-470	PL962 19M905003G1	5,6p	3,9p	5,6p	10p	5,6p	18p	18p	27p	12p	COAX L855090G1	HEL.COIL J706154P2	HEL.COIL J706154P2
450-512	PL965 19M905003G2	3,9p	3,3p	4,7p	8,2p	4,7p	8,2p	12p	22p	8,2p	COAX L855090G2	HEL.COIL J706154P3	HEL.COIL J706154P3

TX PHASE LOCKED LOOP PL962/PL965

PL962:19M905003 G1
PL965:19M905003 G2

D402.974/2

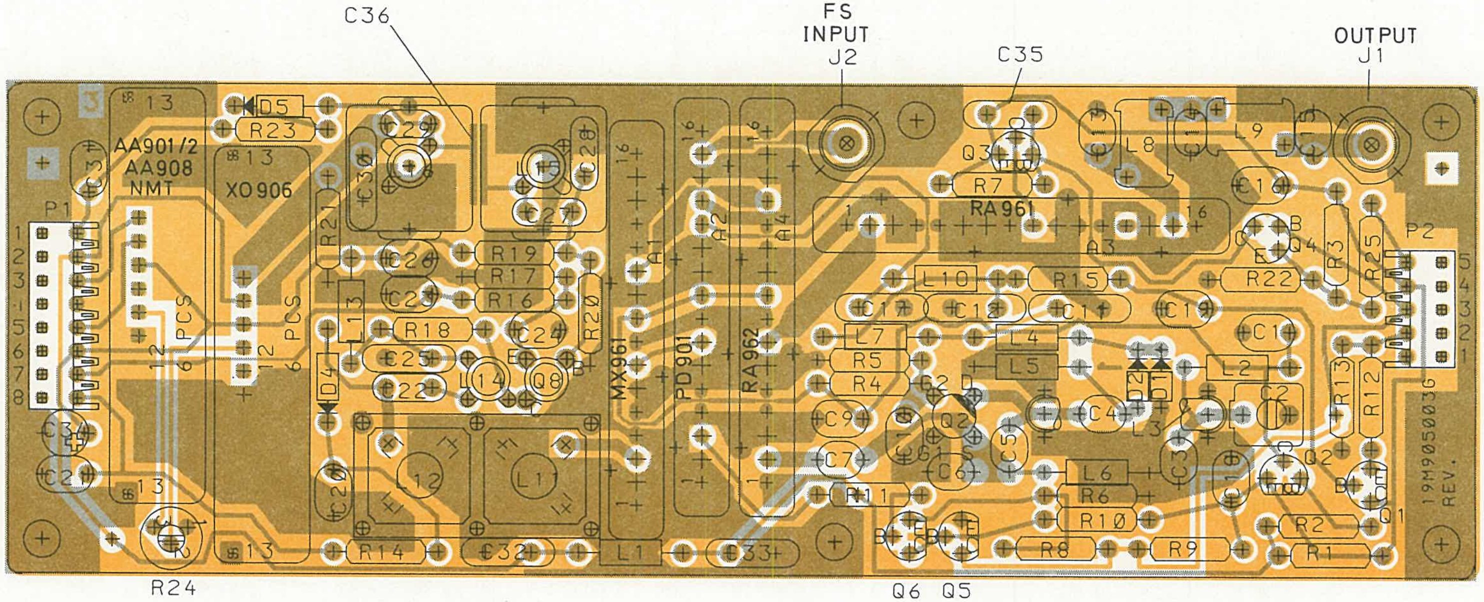
Storno



TX PLL PL962/965
COMPONENT LAYOUT

PL962 :19M905003G1
PL965 :19M905003G2

D402. 976 /2

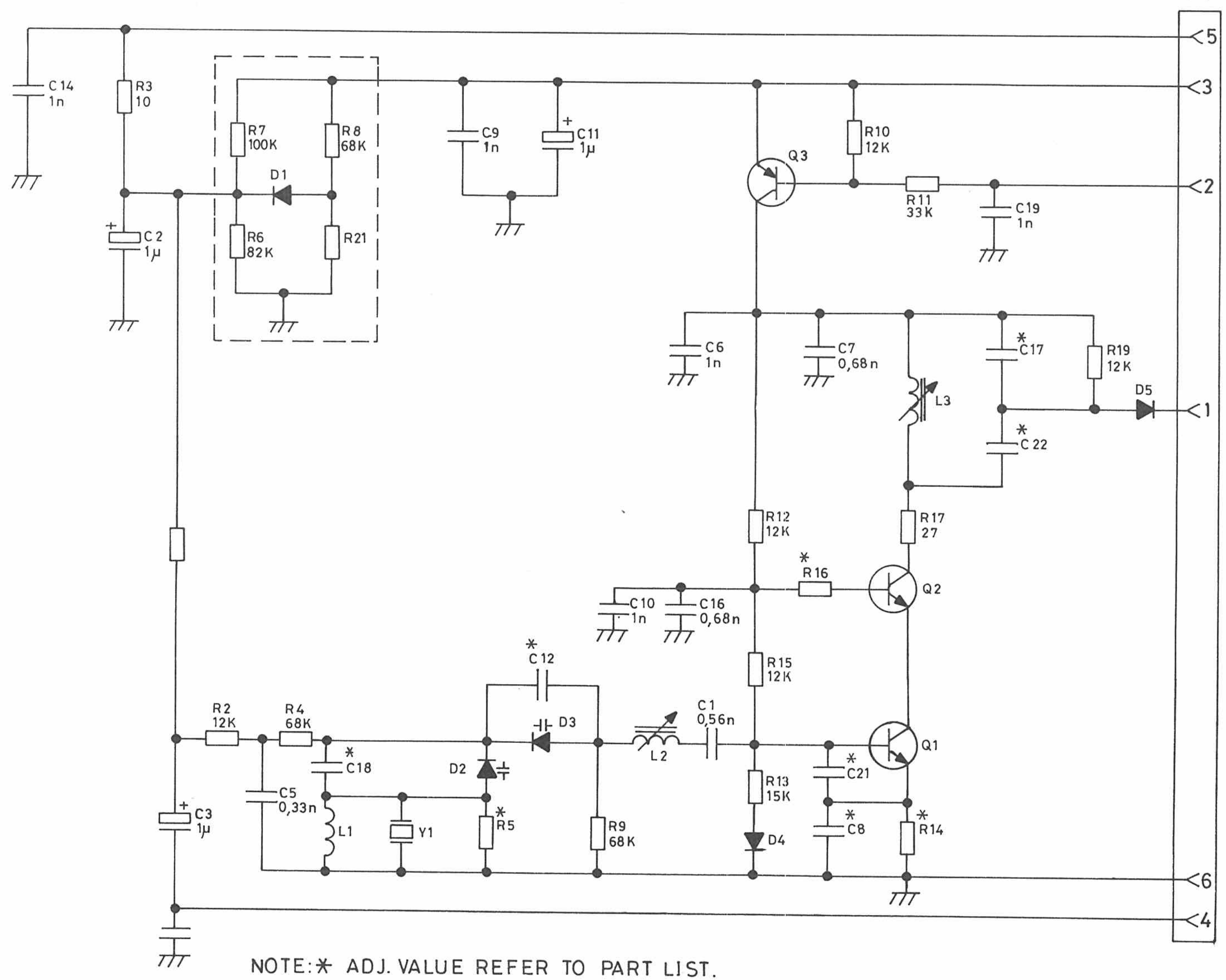


TX PLL PL962/965
COMPONENT LAYOUT

PL962 :19M905003G1
PL965 :19M905003G2

D402. 976 /2

Storno

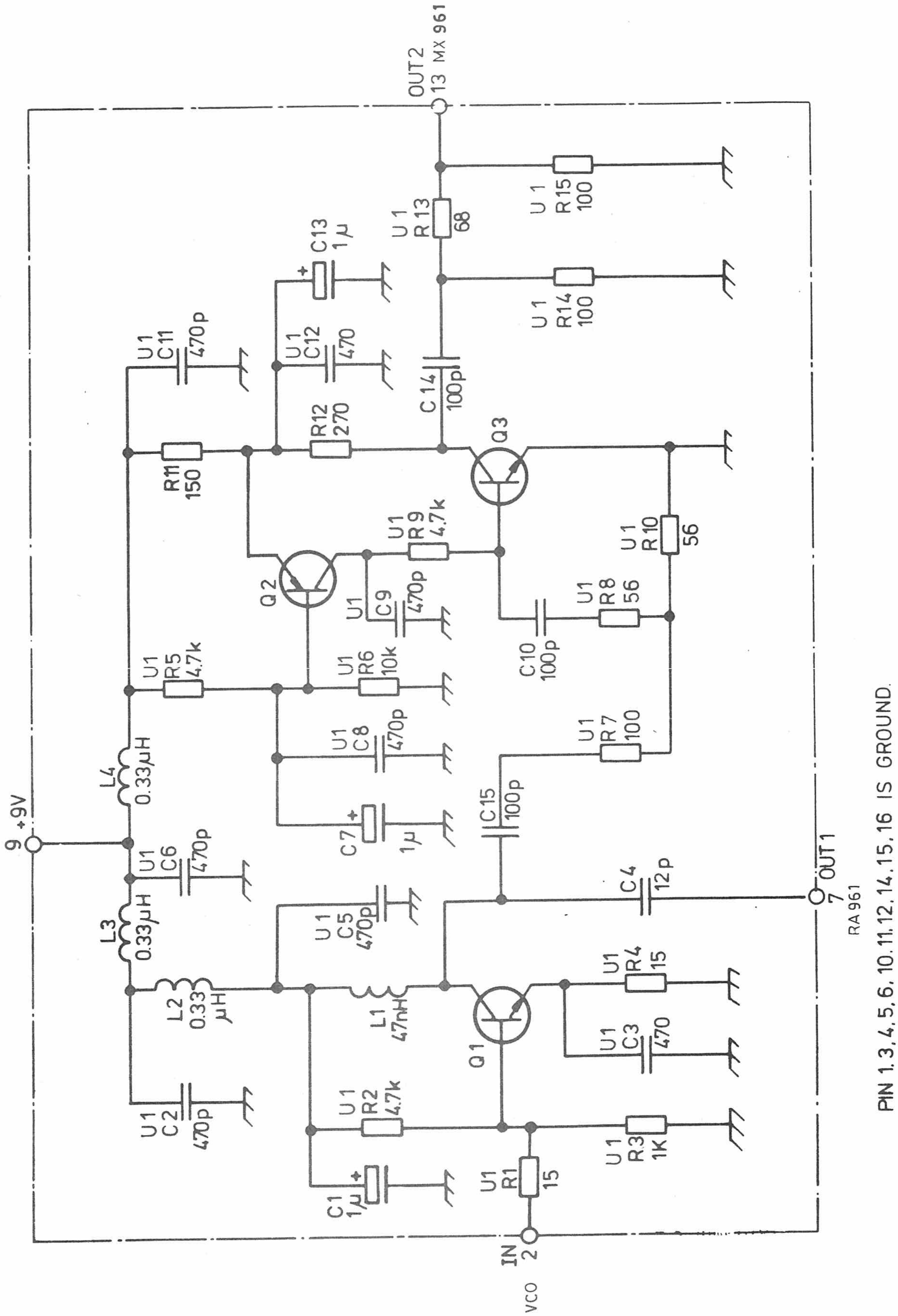


NOTE: * ADJ. VALUE REFER TO PART LIST.

RX-CRYSTAL OSCILLATOR
XO905, XO907, XO909

D403.027/2

Storno

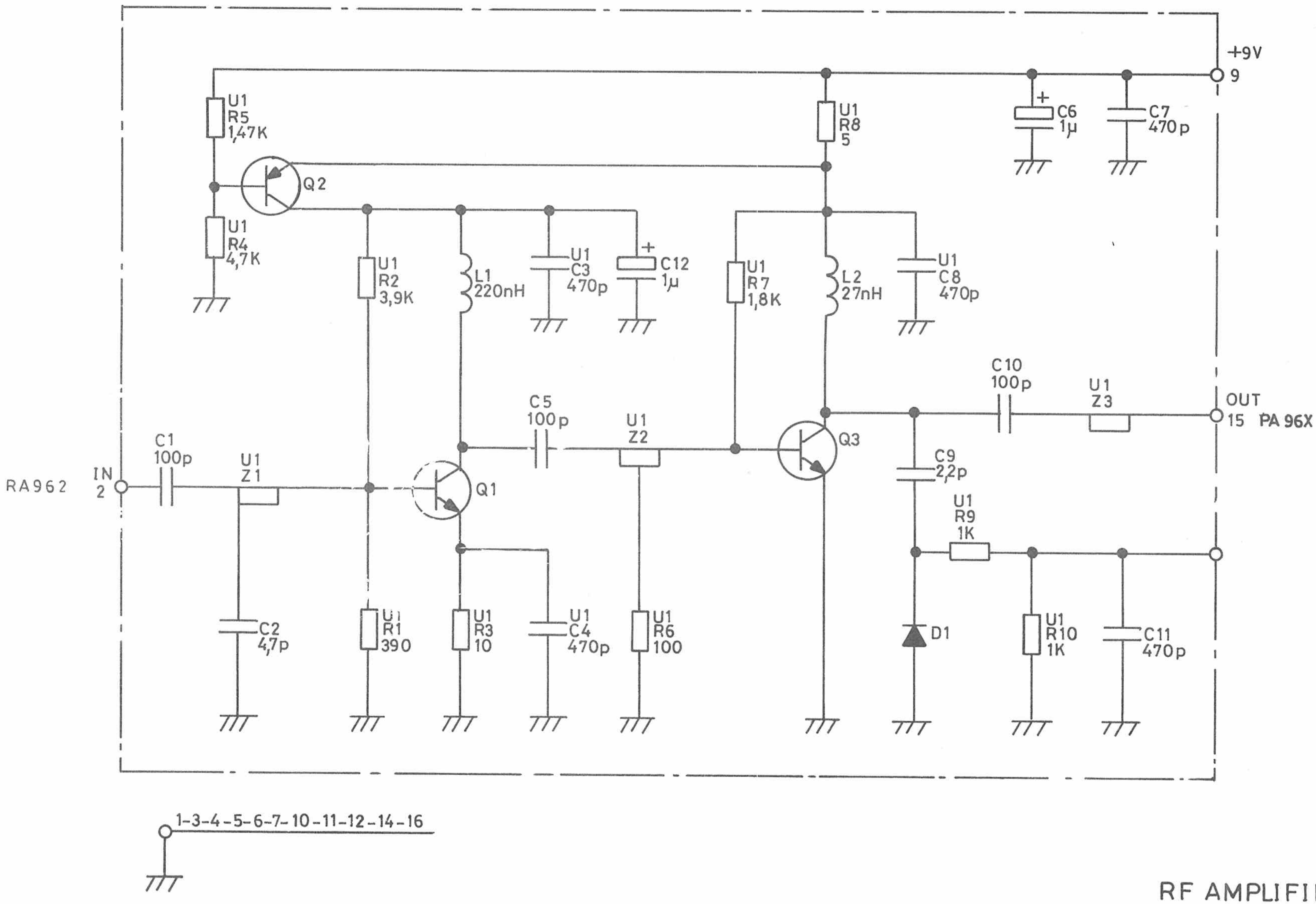


RF AMPLIFIER RA962

19M905059G1 | D403 078/2

Storno

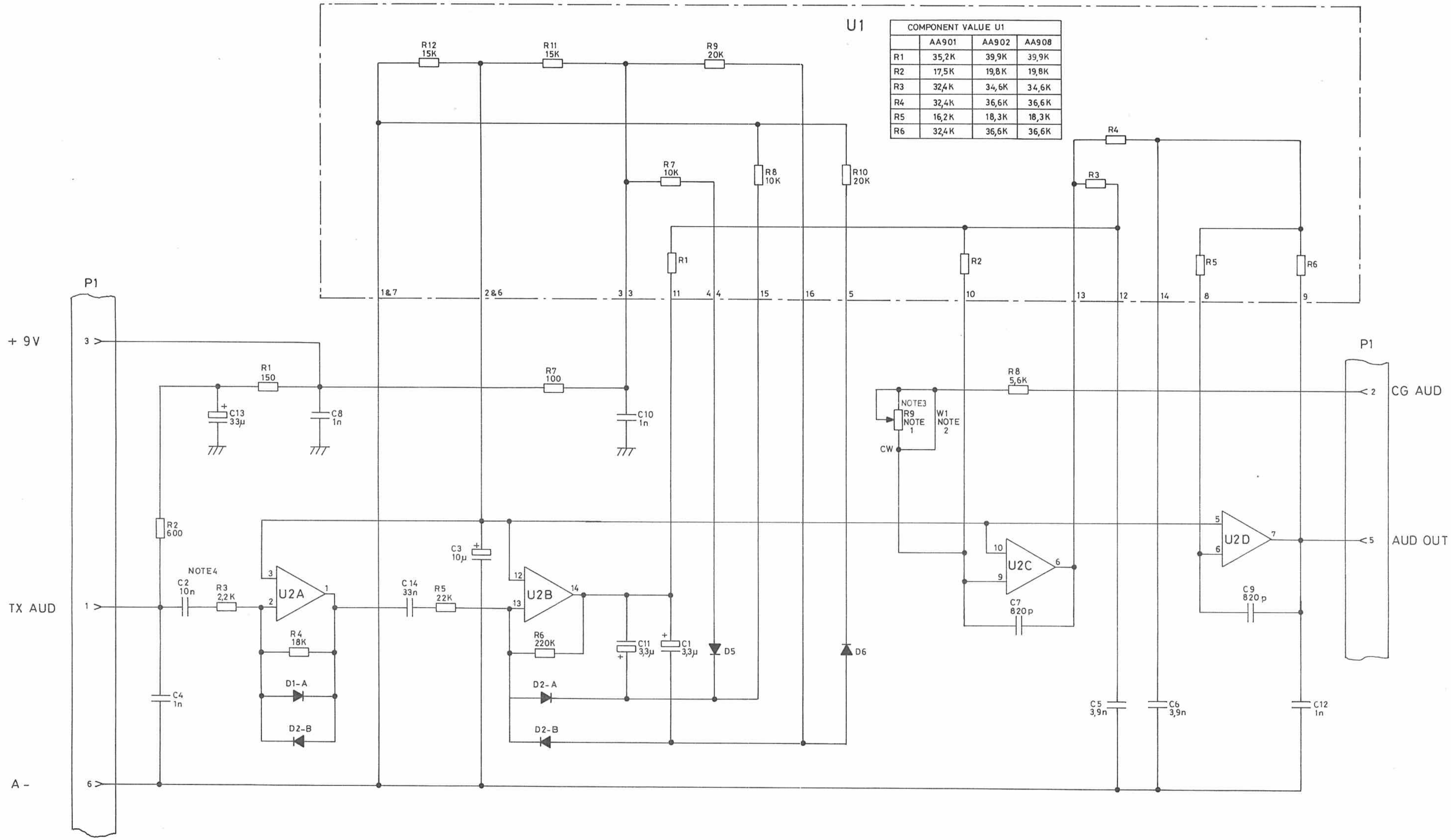
Storno



RF AMPLIFIER RA961

19M905057G1 D402.920/2

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

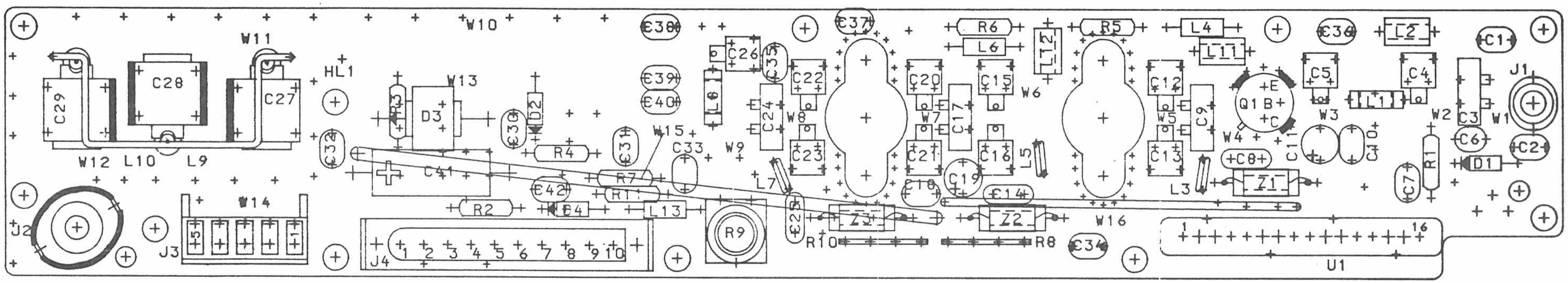
AA901: 19D900072G1 WITH CG LEVEL ADJUST
AA902: 19D900072G2 WITH CG LEVEL ADJUST
AA901: 19D900072G3 WITHOUT CG LEVEL ADJUST
AA902: 19D900072G4 WITHOUT CG LEVEL ADJUST
AA908

Storno

AUDIO PROCESSOR
AA901, AA902, AA908

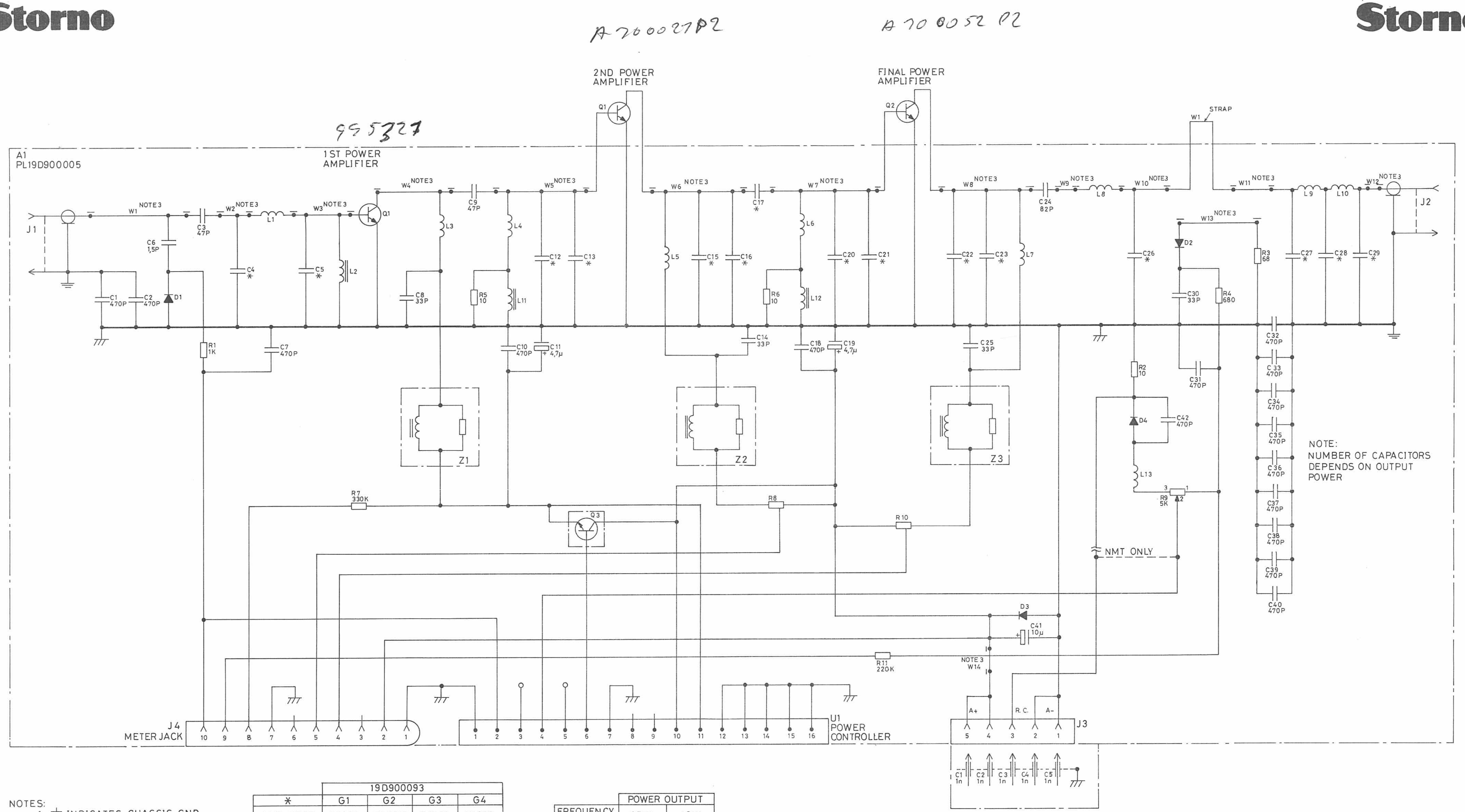
D402. 918/2

Storno



POWER AMPLIFIER PA962
COMPONENT LAY-OUT

D402.959/2



NOTES:
1. ⏚ INDICATES CHASSIS GND

3. PART OF PWB

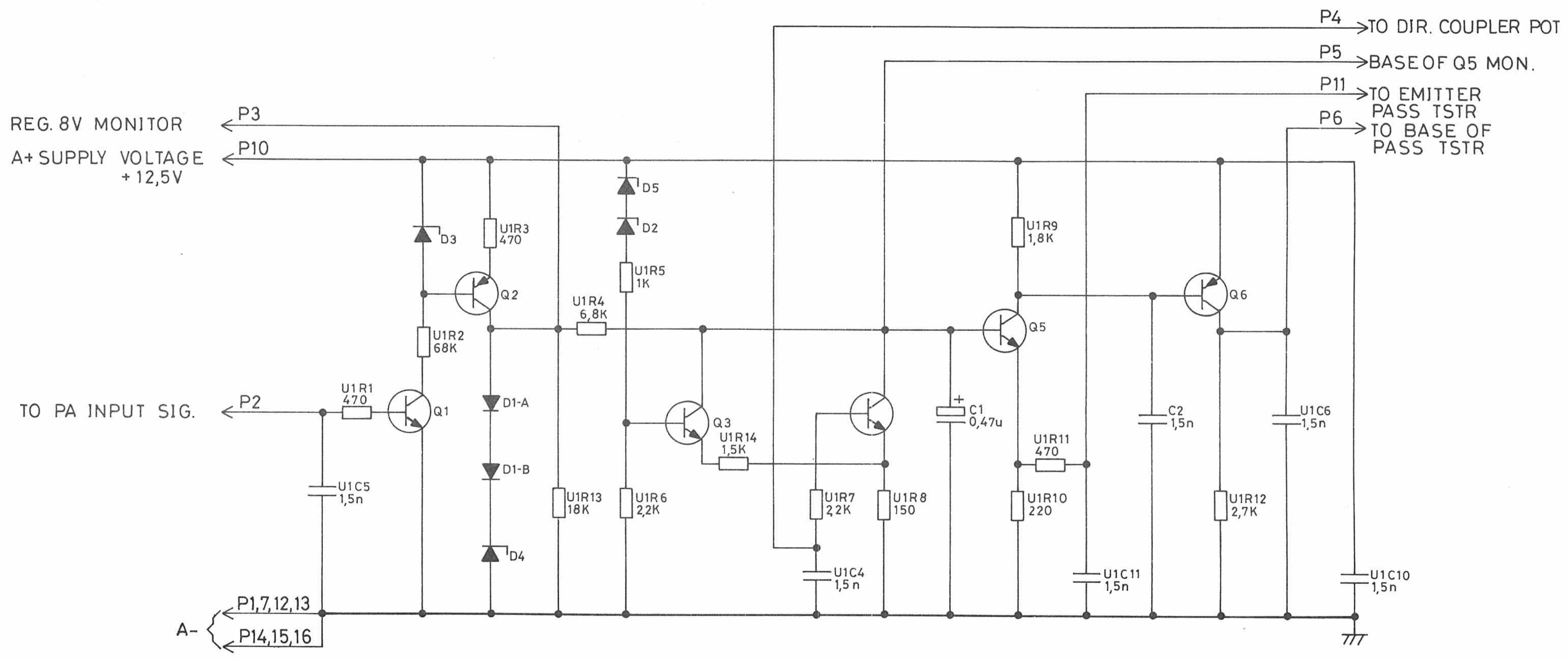
	19D900093			
*	G1	G2	G3	G4
CAFACITOR	PA962	PA9610	PA963	PA966
C4	8,2P	10P	8,2P	10P
C5	39P	36P	39P	36P
C12	22P	20P	22P	20P
C13	22P	20P	22P	20P
C15	20P	13P	15P	15P
C16	15P	15P	20P	18P
C17	15P	13P	15P	13P
C20	27P	24P	27P	24P
C21	27P	24P	27P	24P
C22	43P	39P	43P	36P
C23	43P	36P	43P	36P
C26	14P	13P	15P	11P
C27	12P	10P	12P	10P
C28	23P	18P	23P	18P
C29	13P	9P	13P	9P

FREQUENCY RANGE MHz	POWER OUTPUT 25W	40W
403 - 470	PA962	PA963
450 - 512	PA9610	PA 966

POWER AMPLIFIER PA962 , PA9610 , PA963 , PA966

D402. 930 / 2

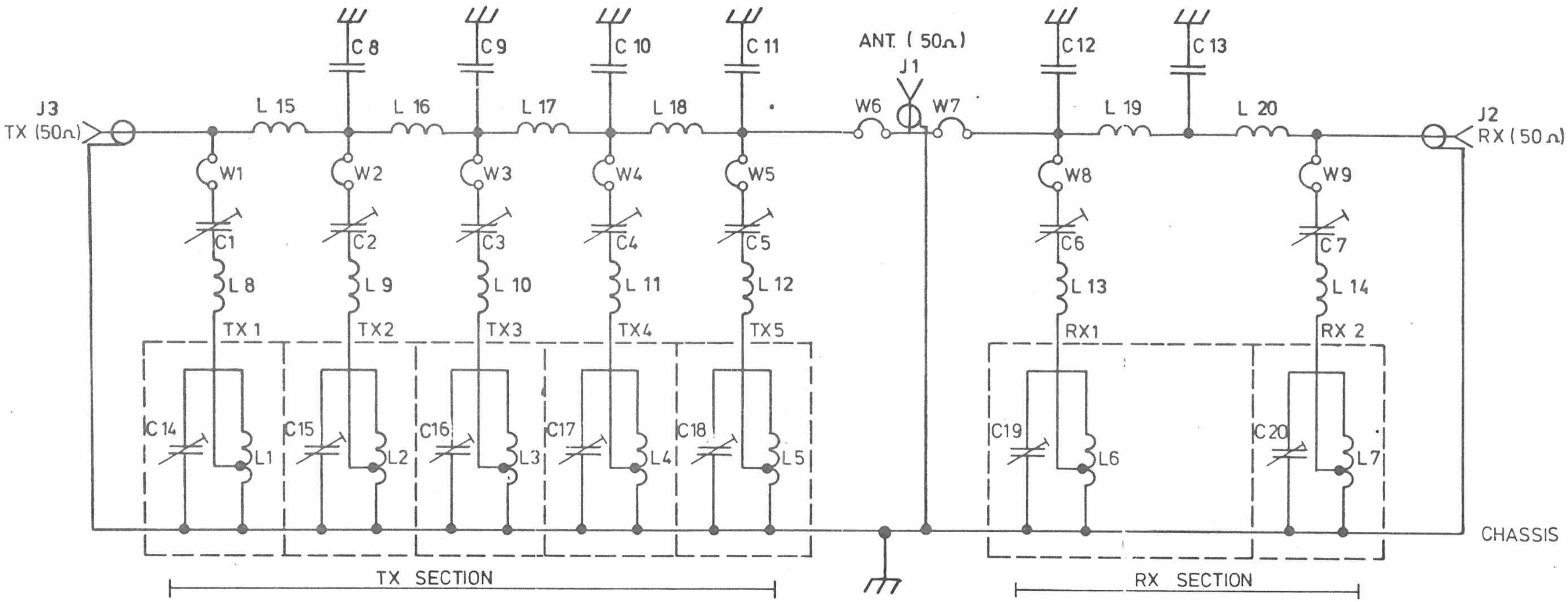
Storno



POWER CONTROL PC903

19D900111G1 D402.928/2

Storno

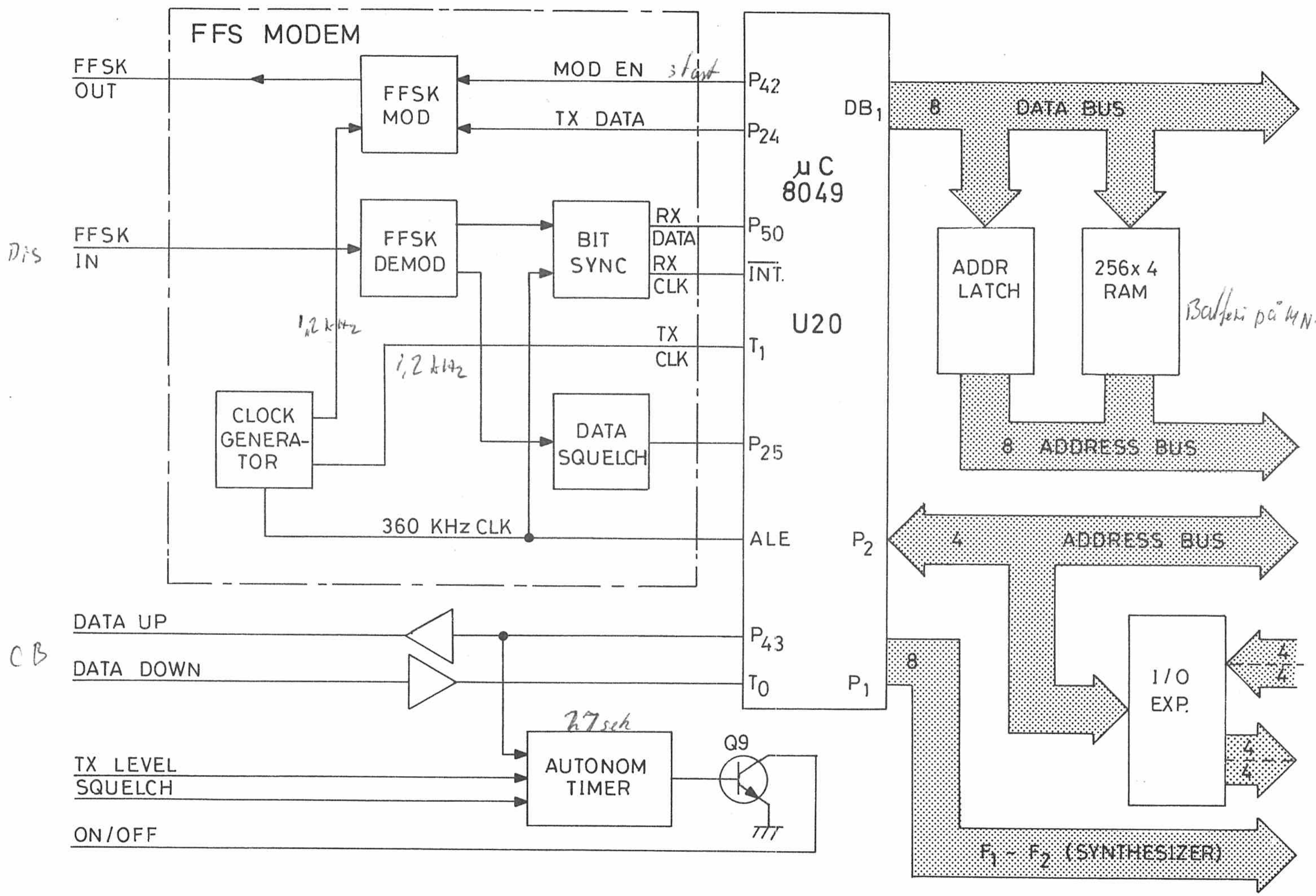


C8 - C13 : PART OF PWB
L8 - L20 : PART OF PWB
C14-C20 : CORE TUNING

BRANCHING FILTER BF964

19L855111G1 | D403.068/2

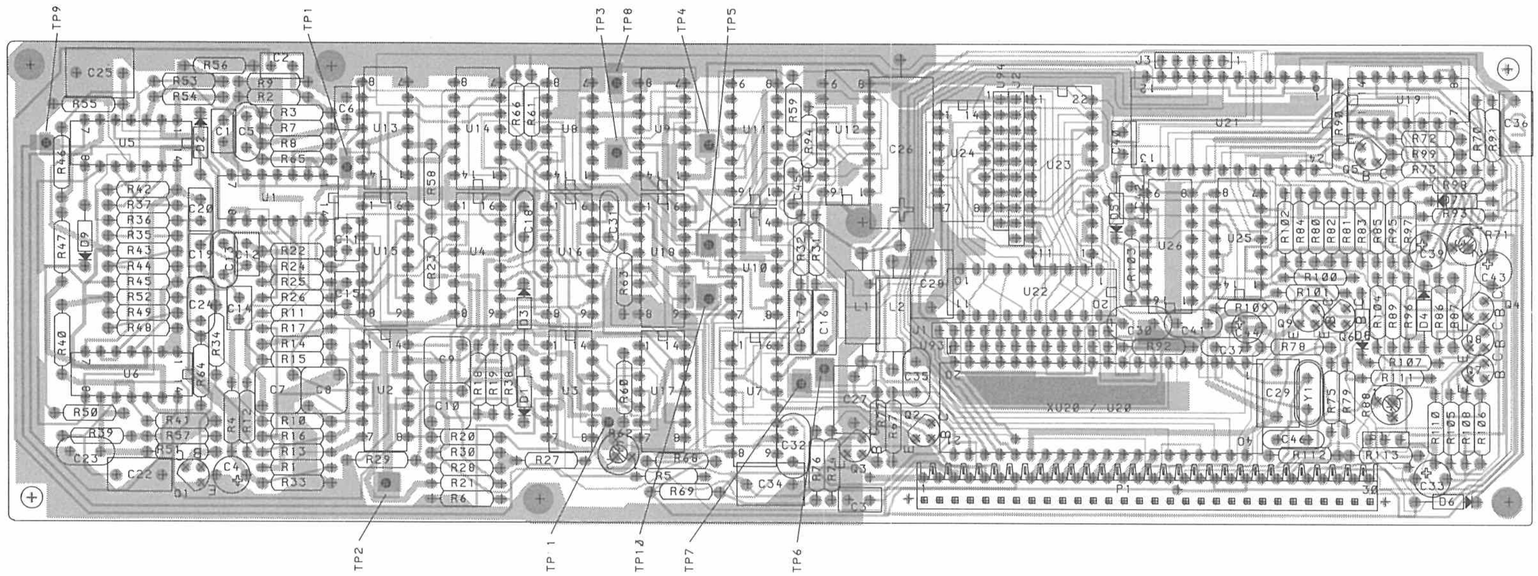
Storno



FUNCTIONAL DIAGRAM CL904

D403.065/2

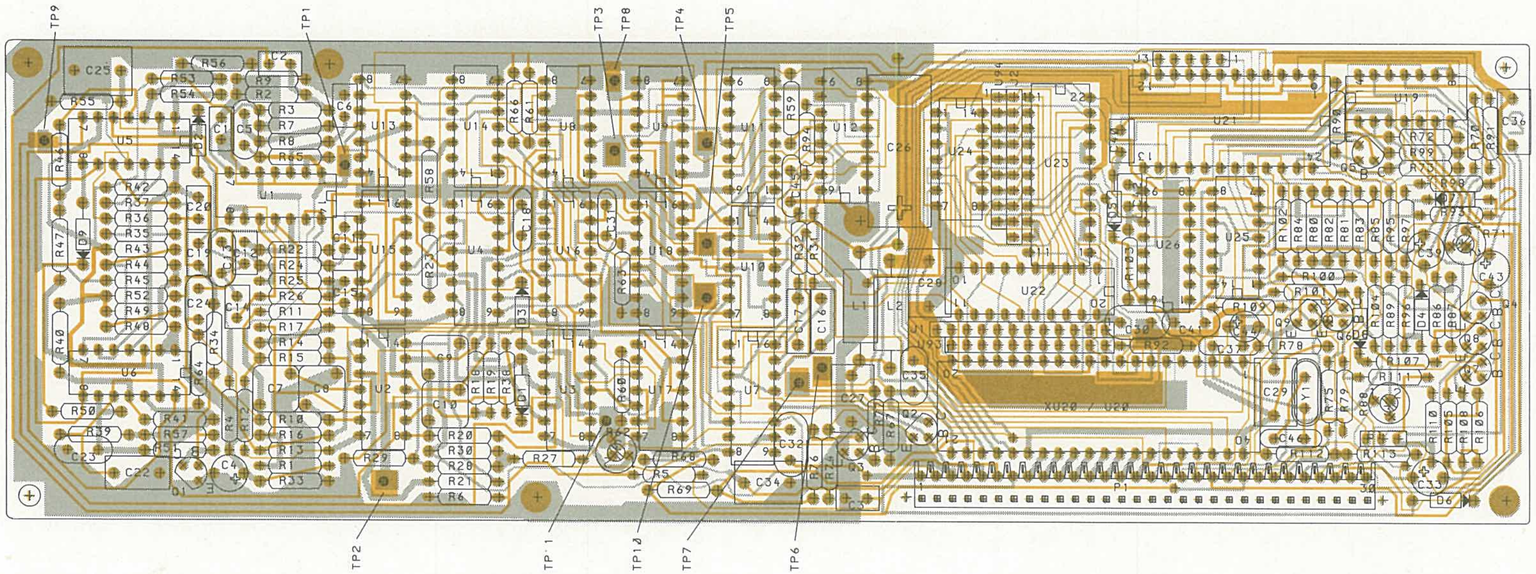
Storno



COMPONENT LAYOUT CL 904

D403.117

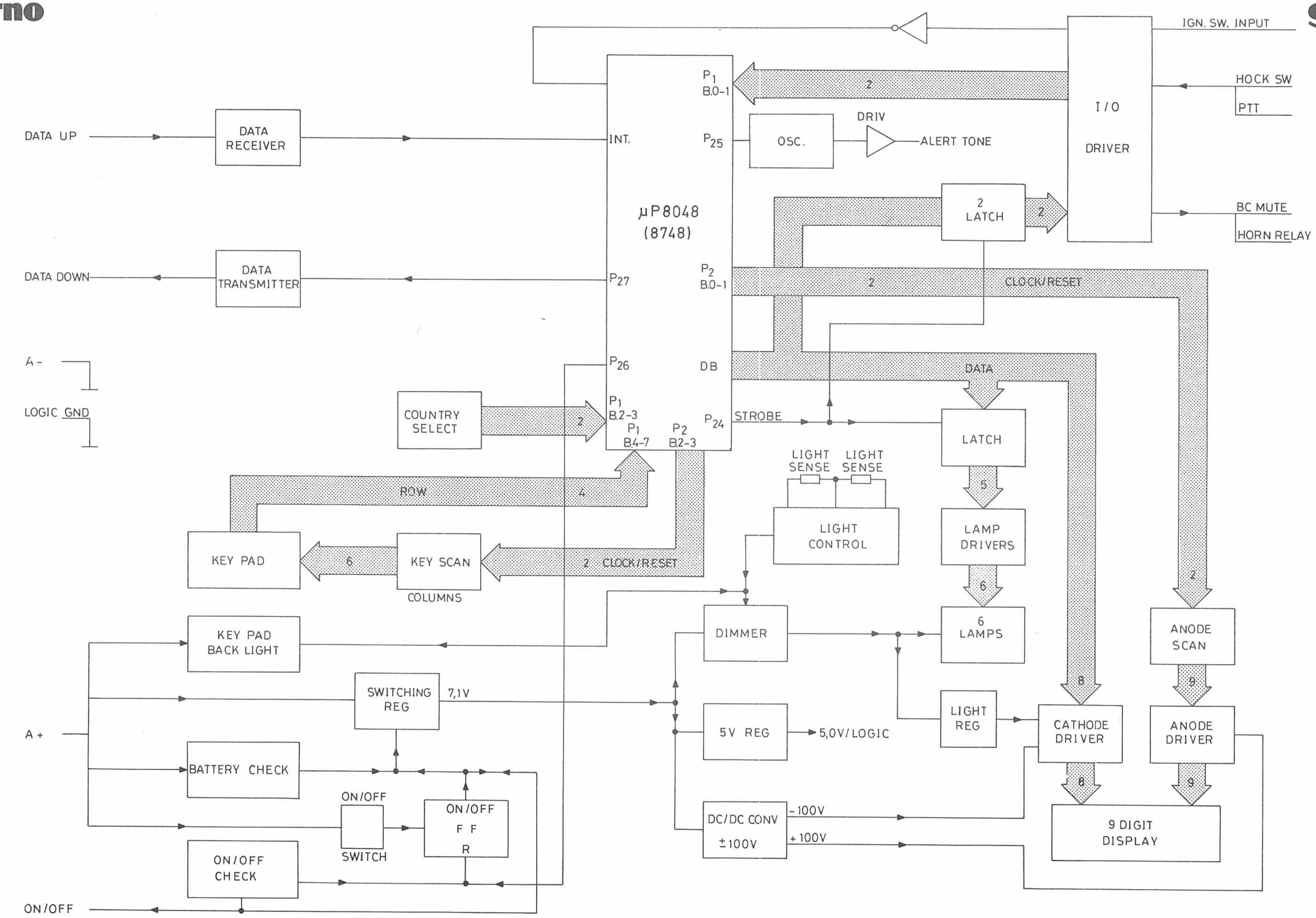
Storno



COMPONENT LAYOUT CL 904

D403.117

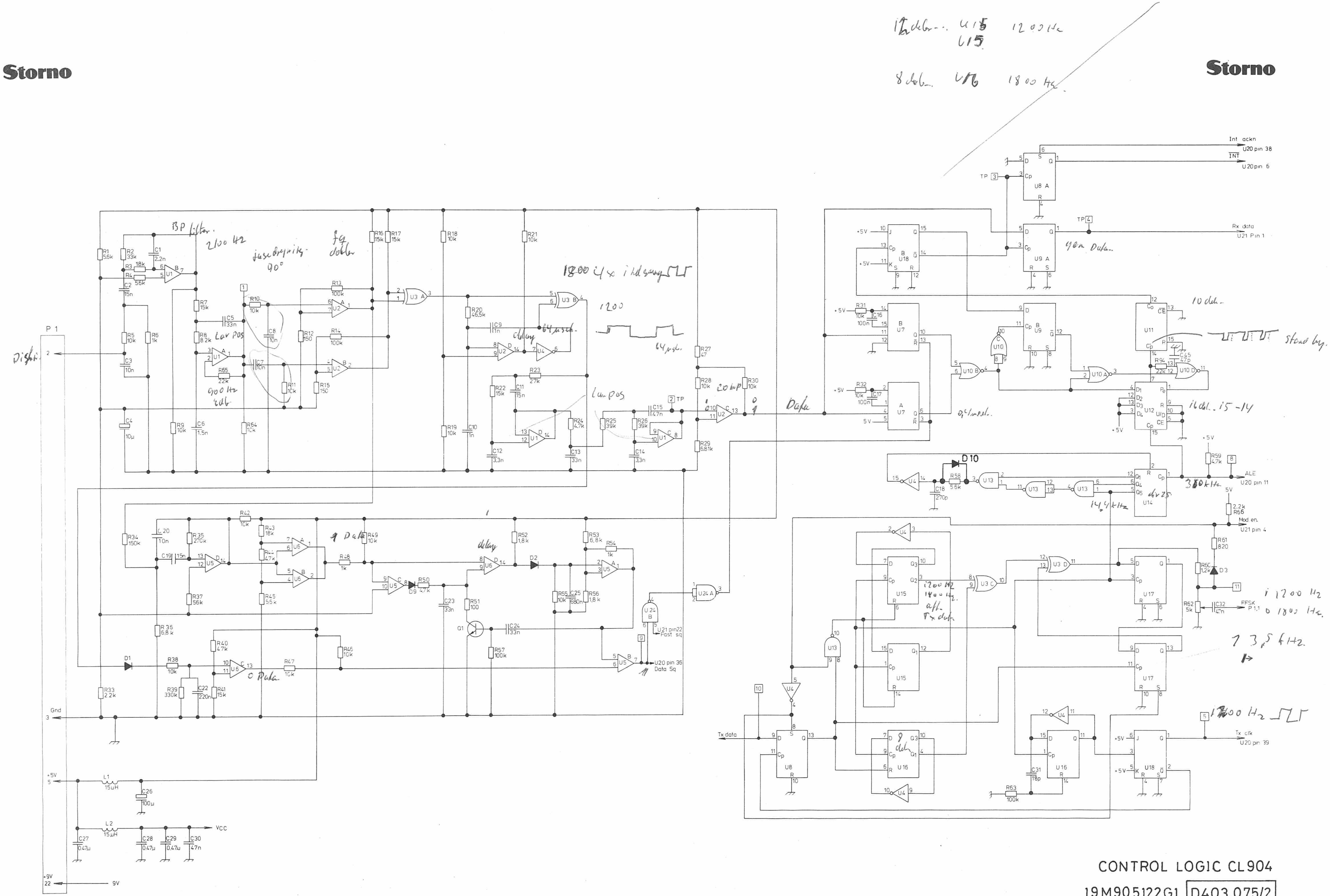
Storno



FUNCTIONAL DIAGRAM SC92P00

D403.067/2

Storno

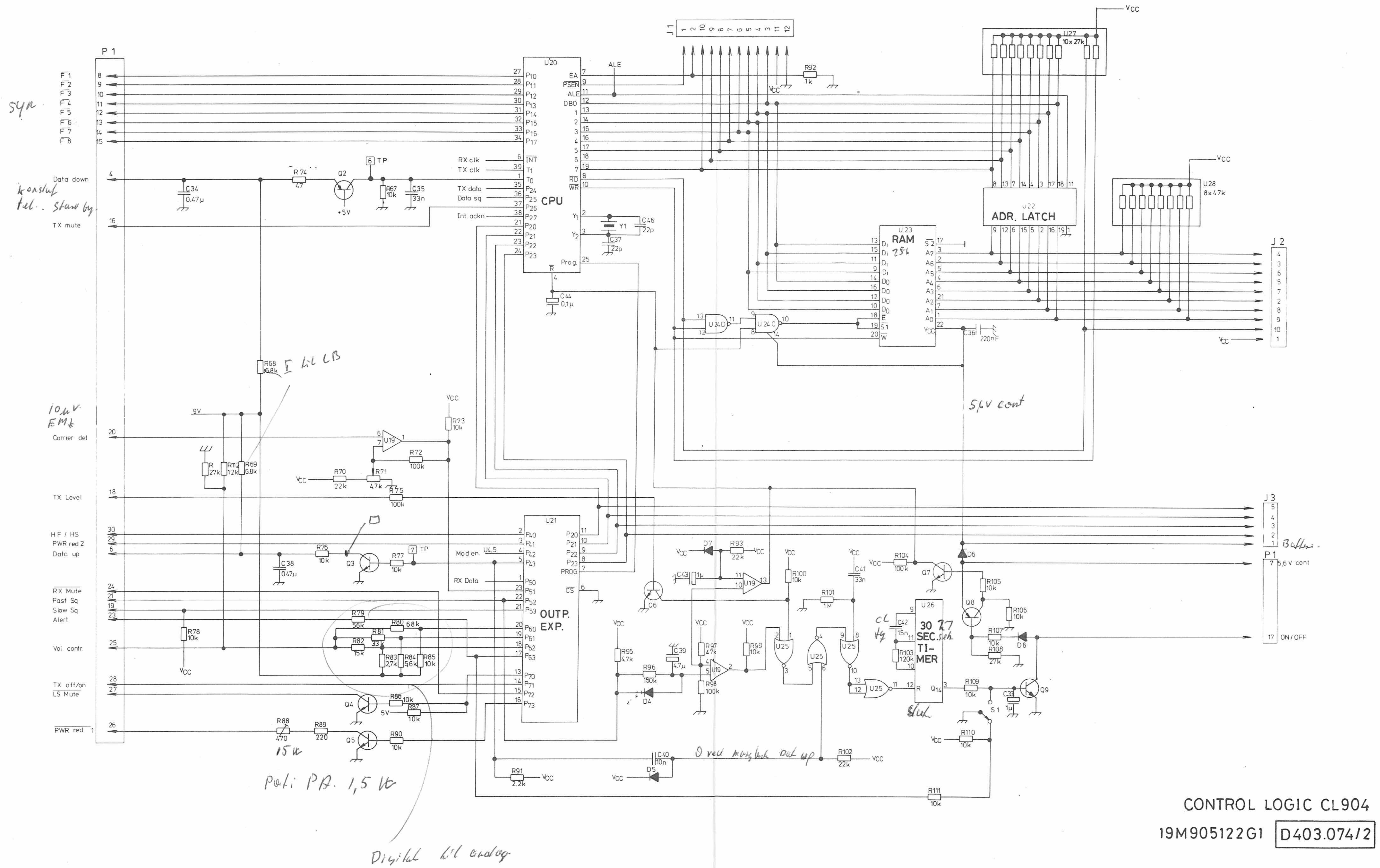


Storno

CONTROL LOGIC CL904

19M905122G1 D403.075/2

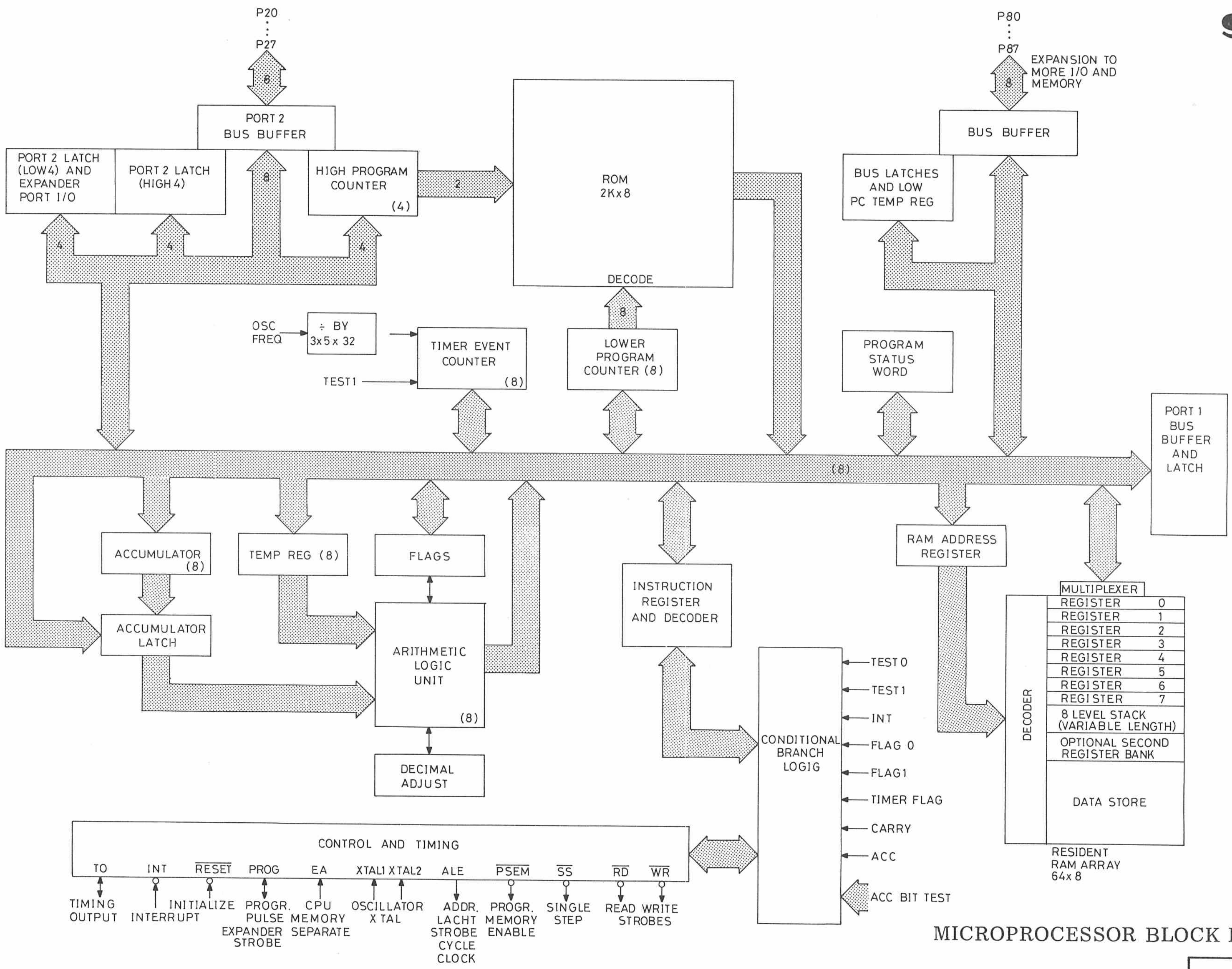
Storno



CONTROL LOGIC CL904

19M905122G1 D403.074/2

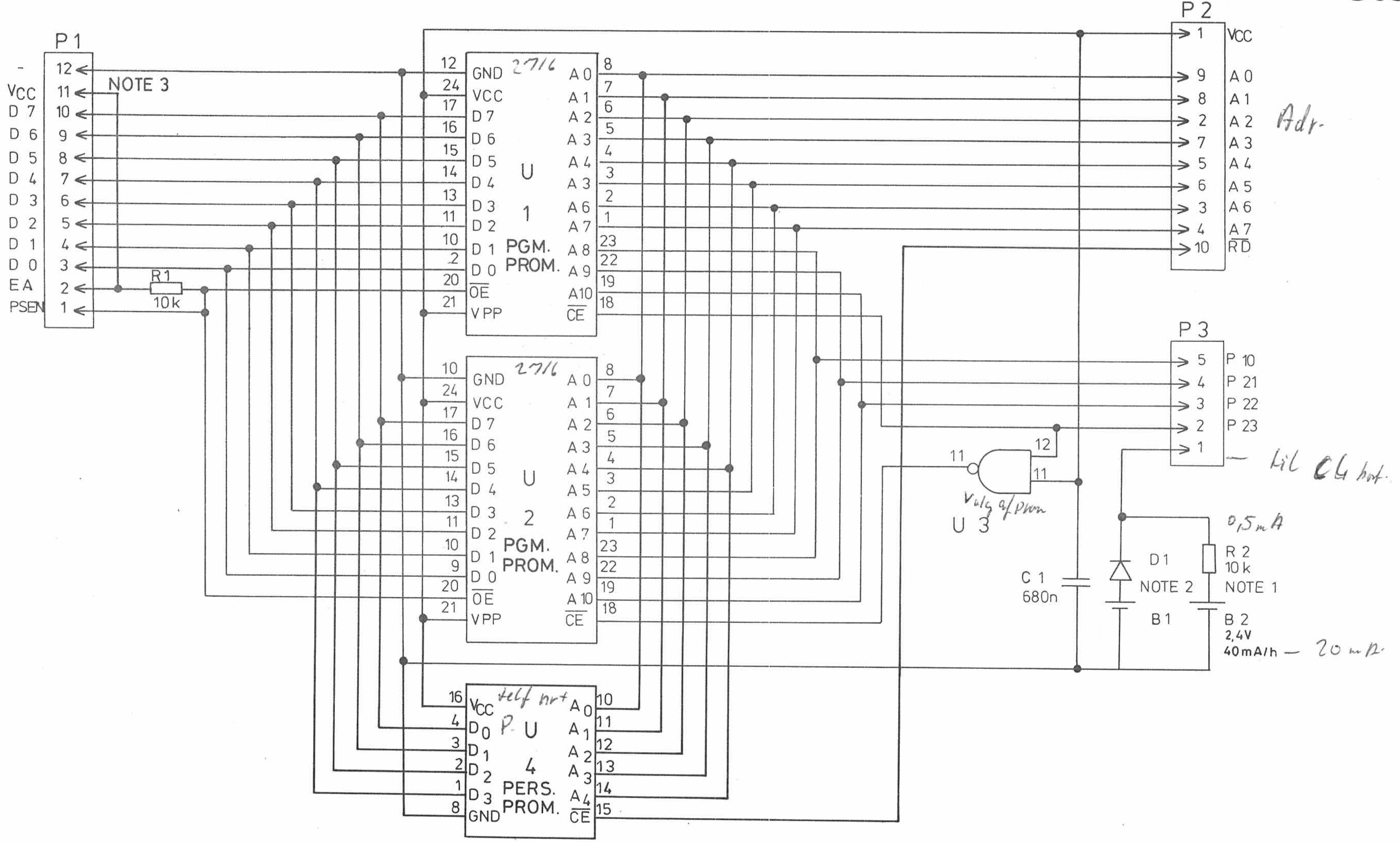
Storno



MICROPROCESSOR BLOCK DIAGRAM

D402. 940

Storno

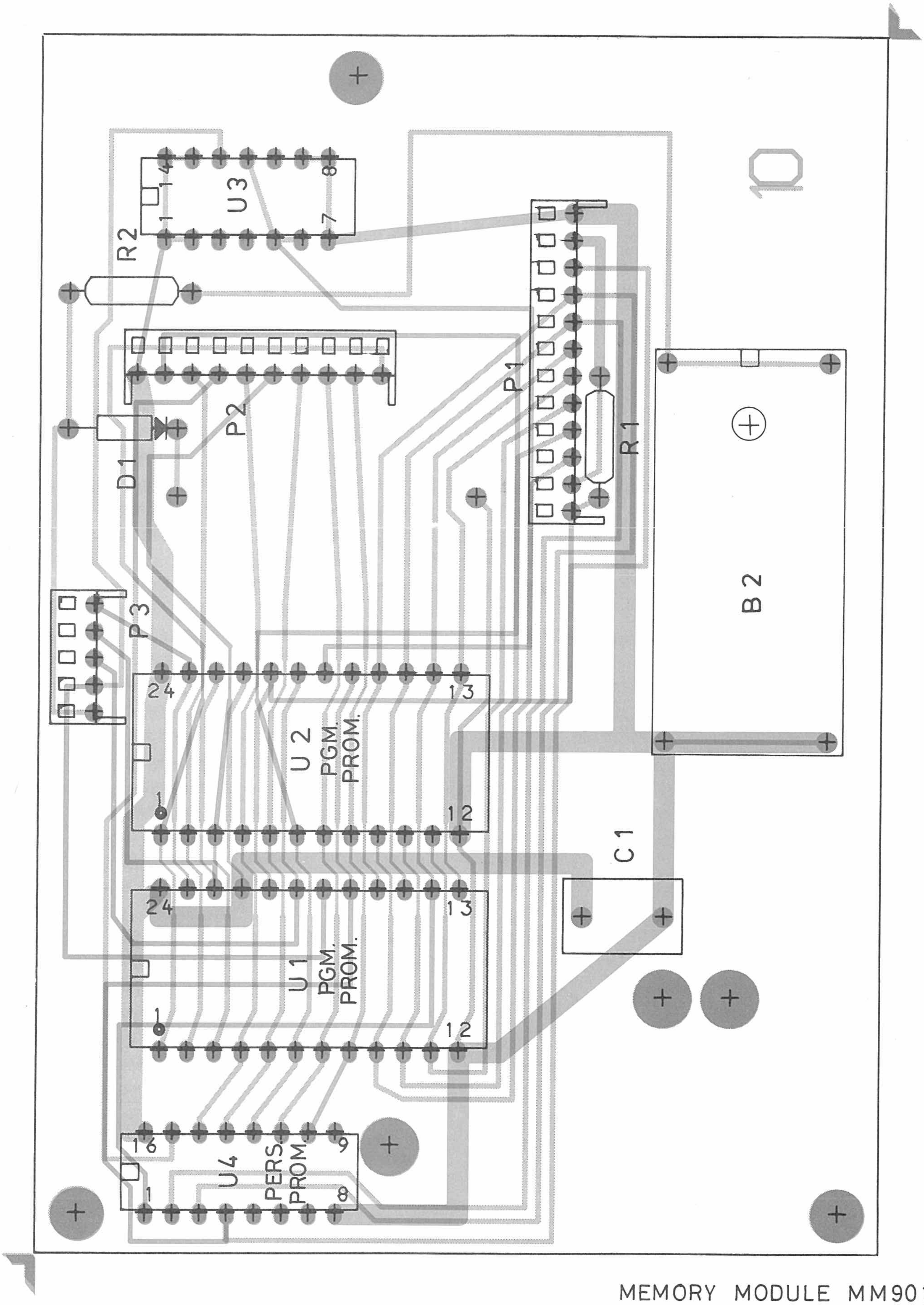


NOTE 1: IN VERSION 1 R2, B2 ARE NOT MOUNTED
NOTE 2: IN VERSION 2 D1, B1 ARE NOT MOUNTED
NOTE 3: OMIT FOR EXTERNAL PROGRAM

MEMORY MODULE MM901

19L855146G2 D403.072/2

Storno Storno

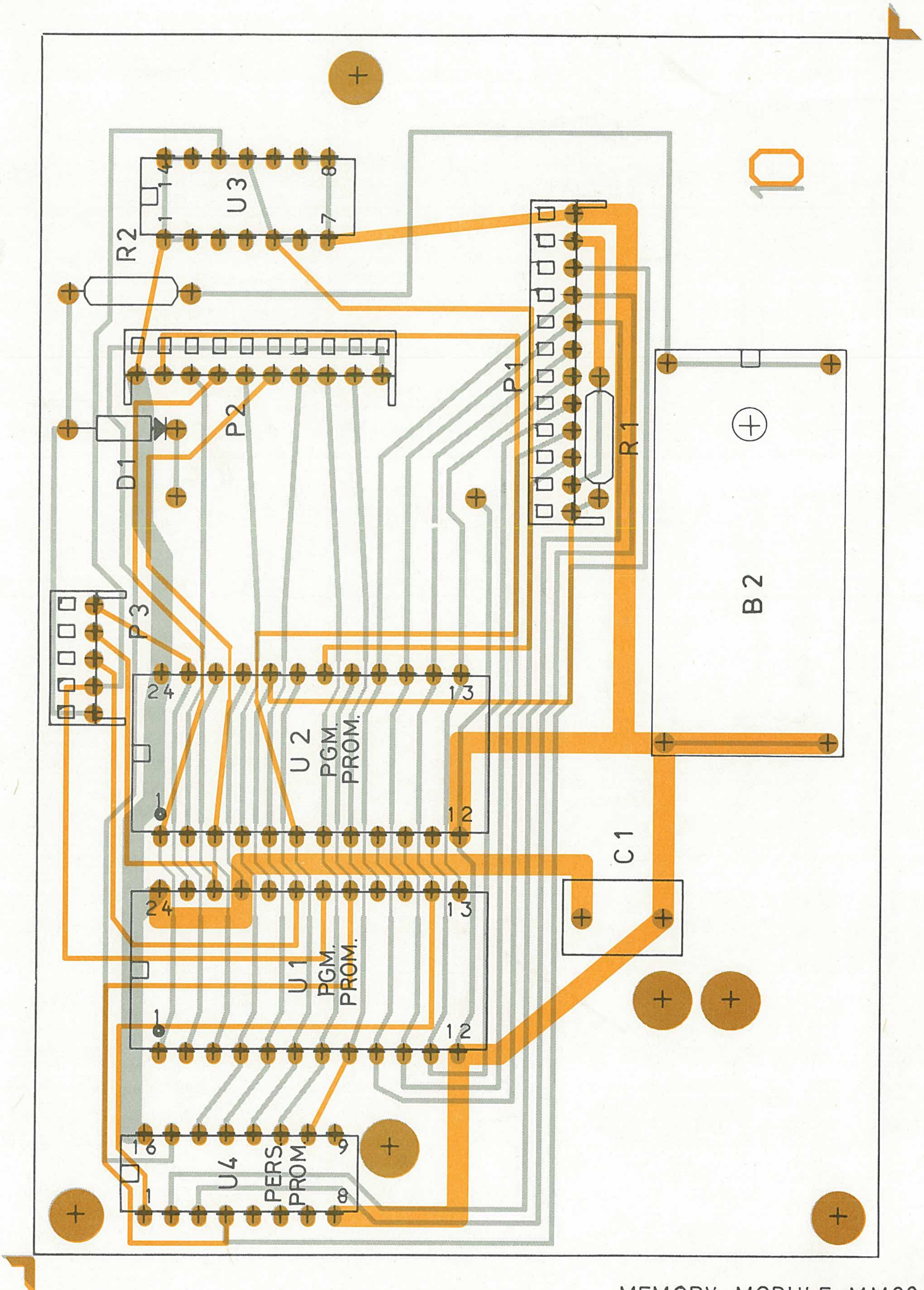


MEMORY MODULE MM901
COMPONENT LAYOUT

19L855146G2 D403.170

Storno

Storno

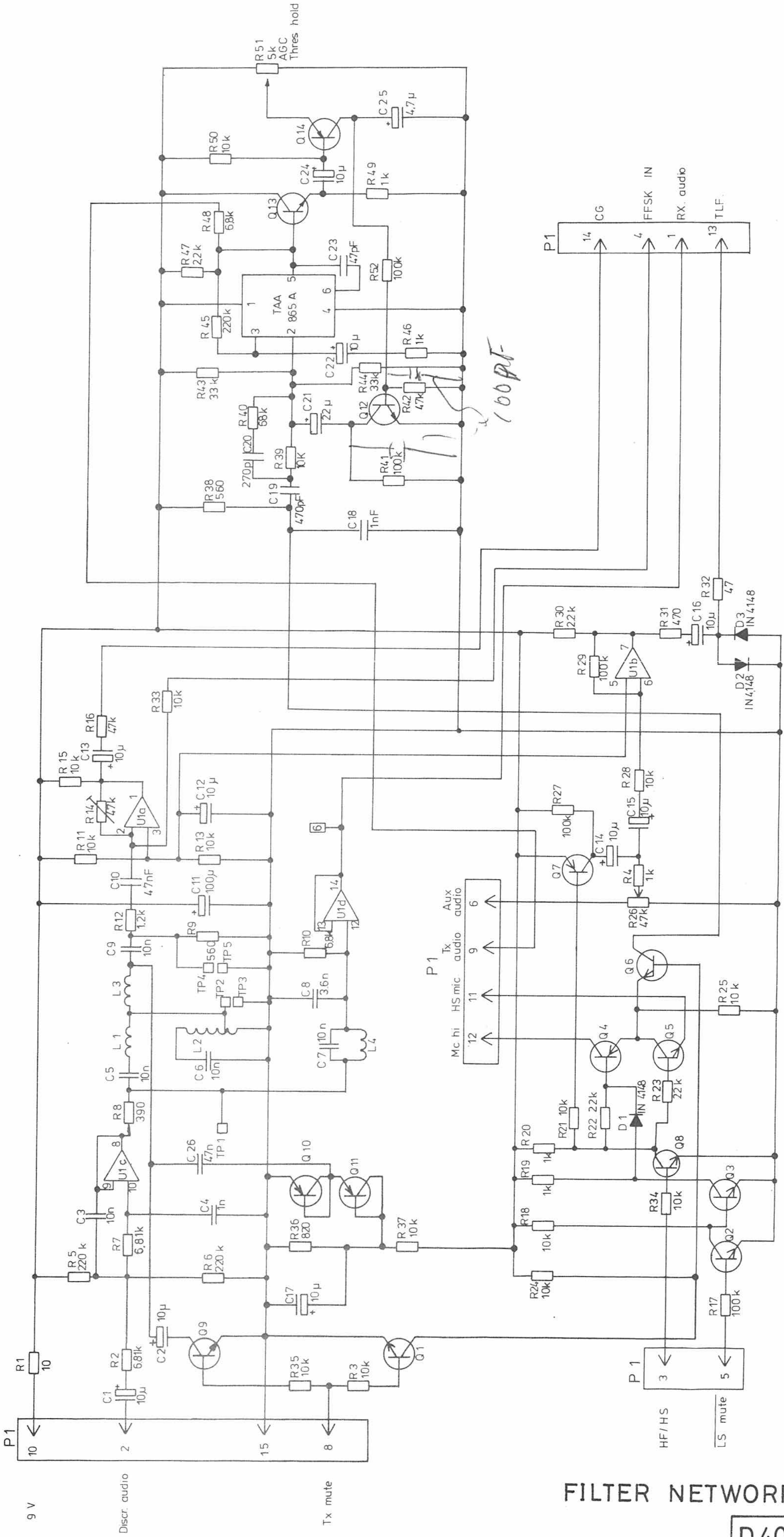


MEMORY MODULE MM901
COMPONENT LAYOUT

19L855146G2 D403.170

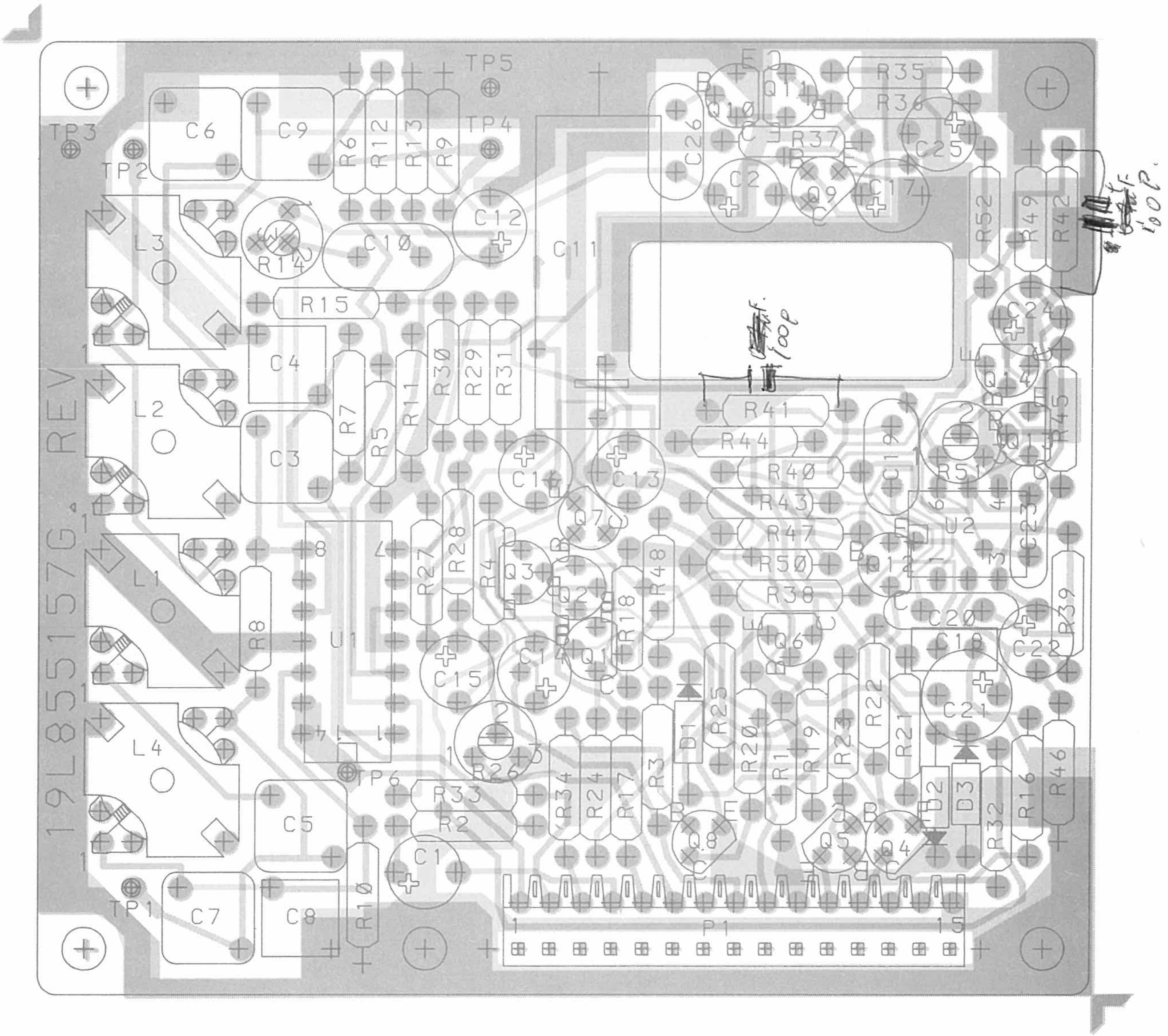
Storno

Storno



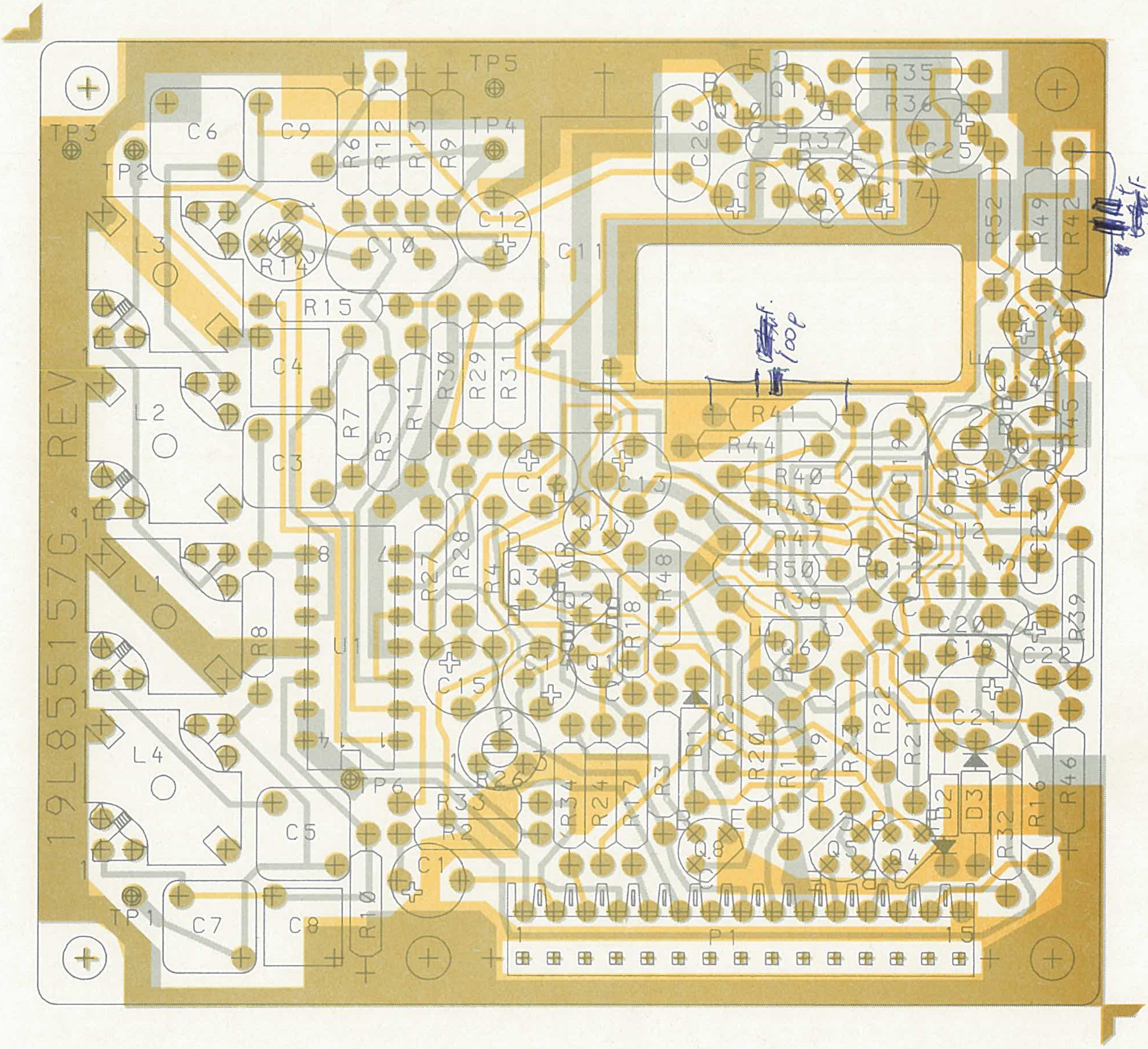
FILTER NETWORK FN901

D403.070/2



COMPONENT LAYOUT FN901

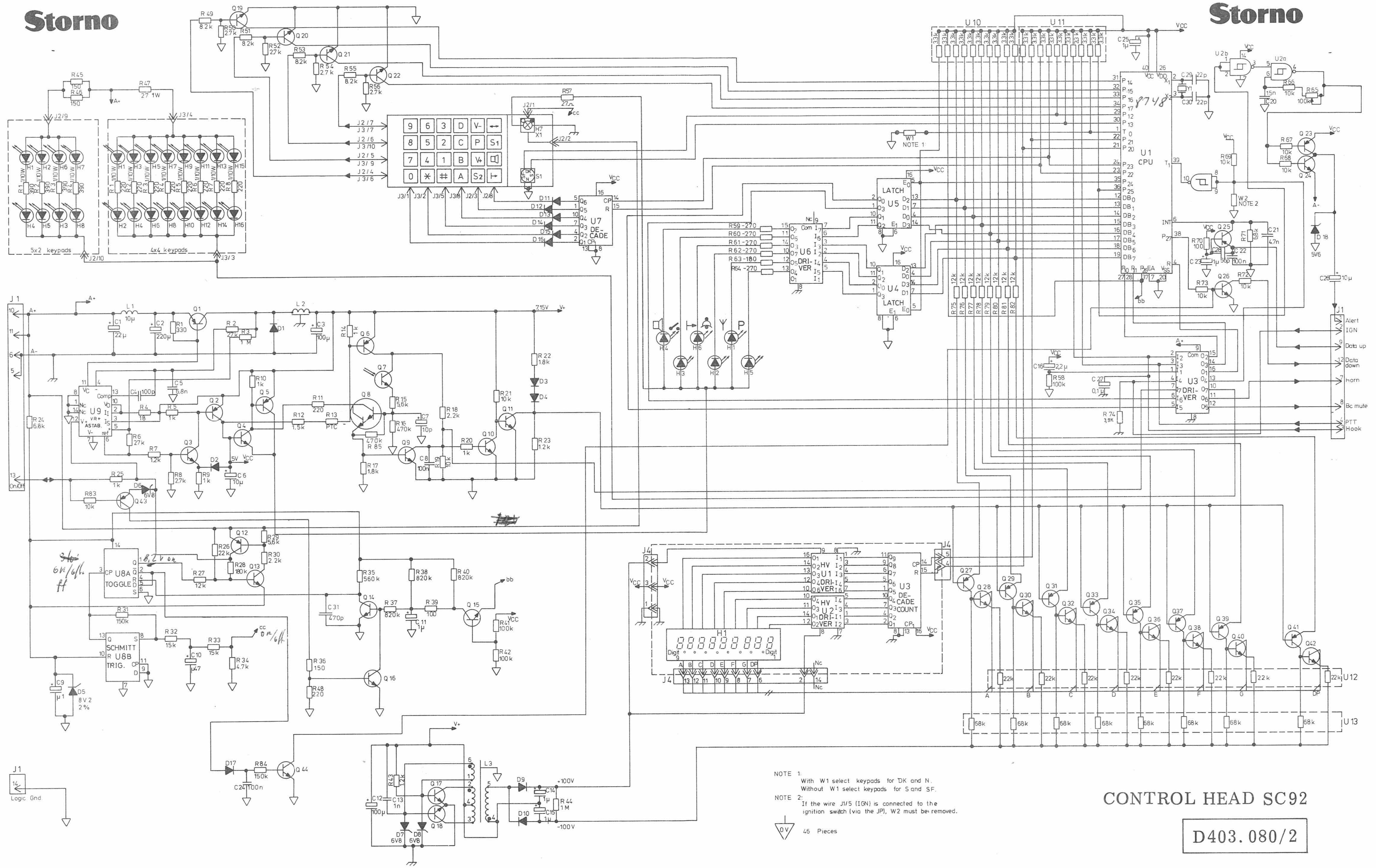
D403.071/2



COMPONENT LAYOUT FN901

D403.071/2

ny. El. 1,5 sek horn fone keypad. automatisk tilbage på disp. horn ved gentagen opkald



NOTE 1:
With W1 select keypads for DK and N.
Without W1 select keypads for S and SF.

NOTE 2:
If the wire J1/5 (IGN) is connected to the ignition switch (via the JP), W2 must be removed.

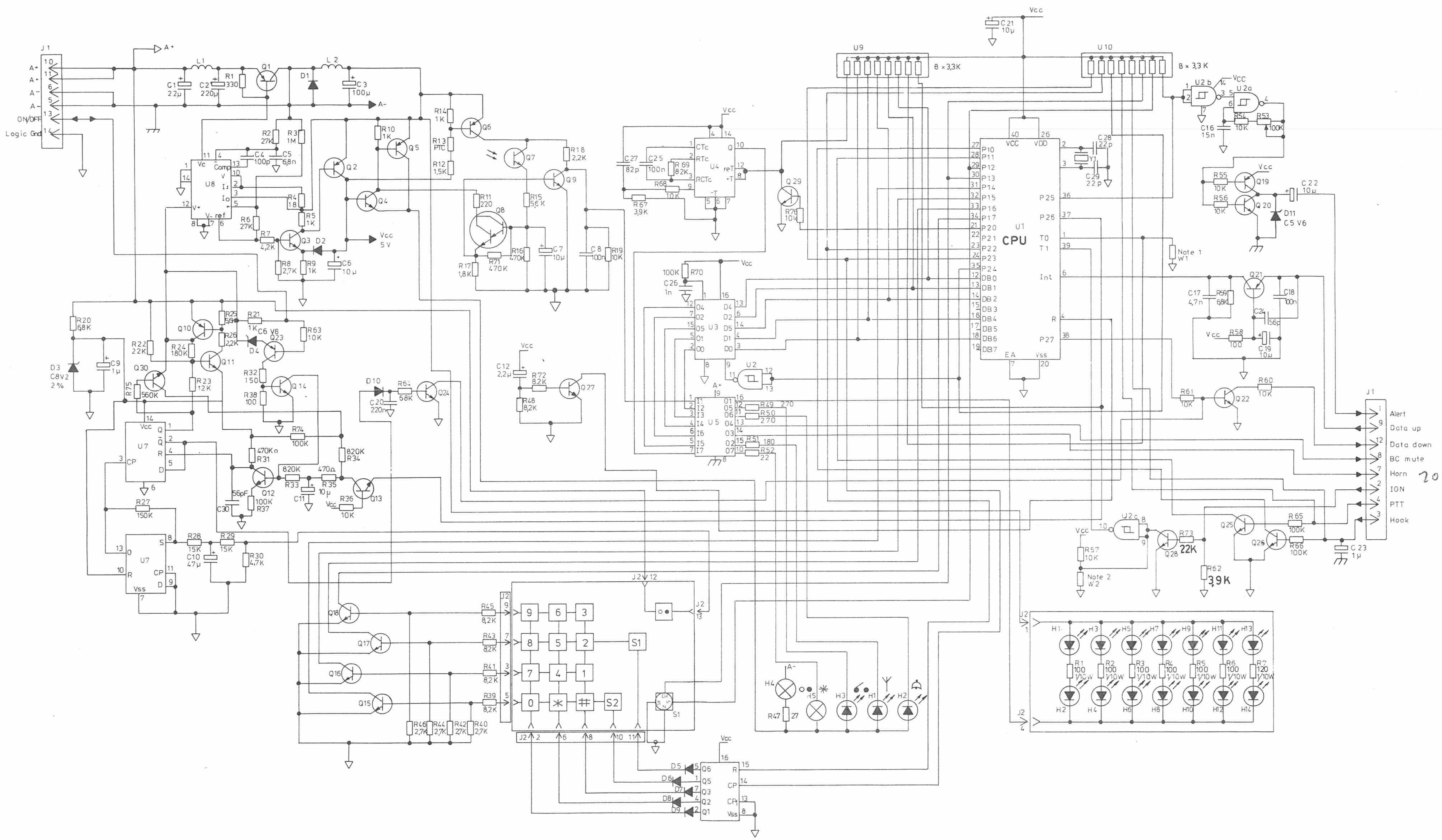
0V 46 Pieces

CONTROL HEAD SC92

D403.080/2

Storno

Storno

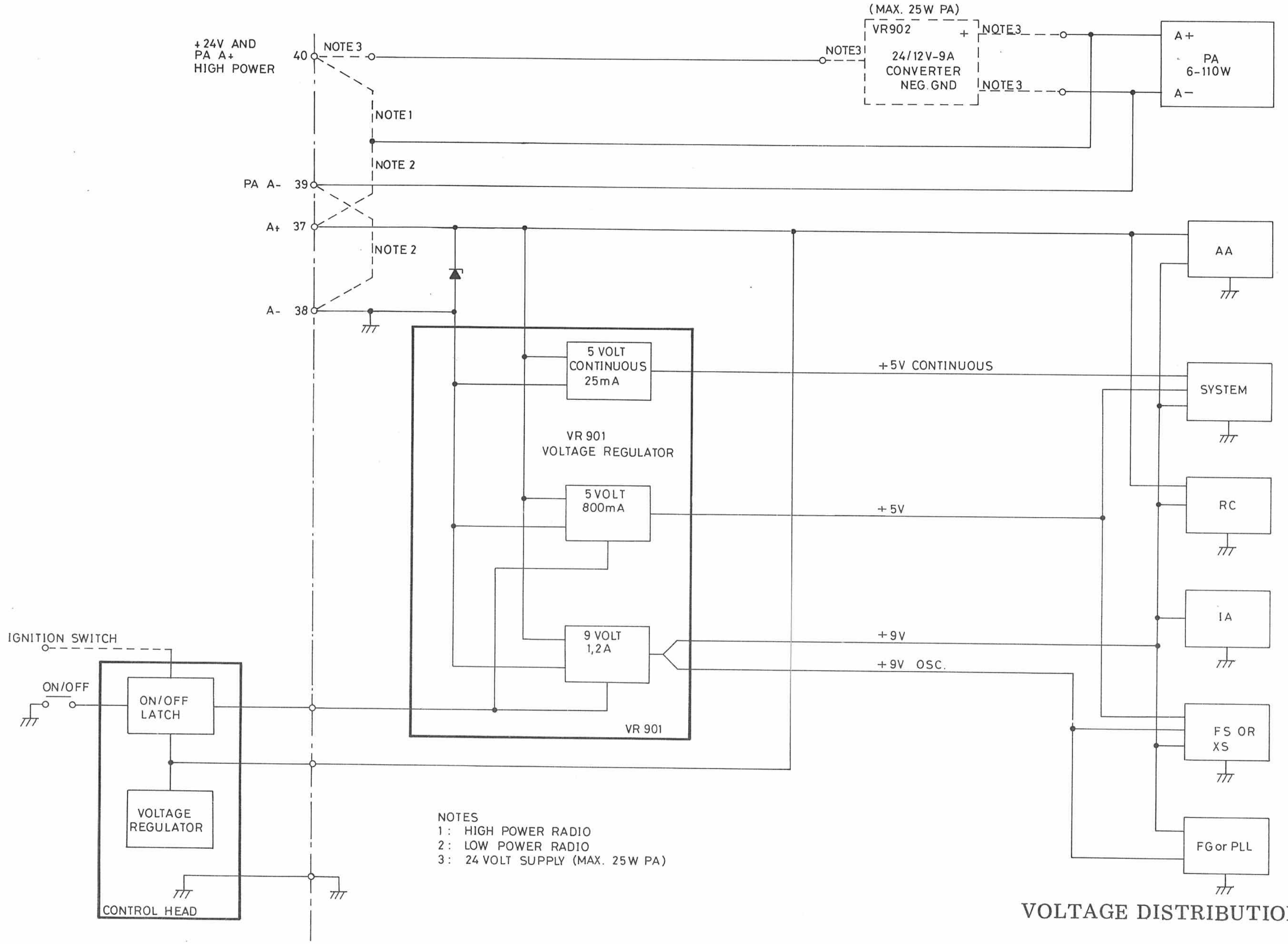


Note 1: With W1 select keypads for DK and N.
Without W1 select keypads for sand SF.

Note 2: If the wire J1/2 (ign) is connected to the ignition switch (via the JP), W2 must be removed.

CONTROL HEAD SC91

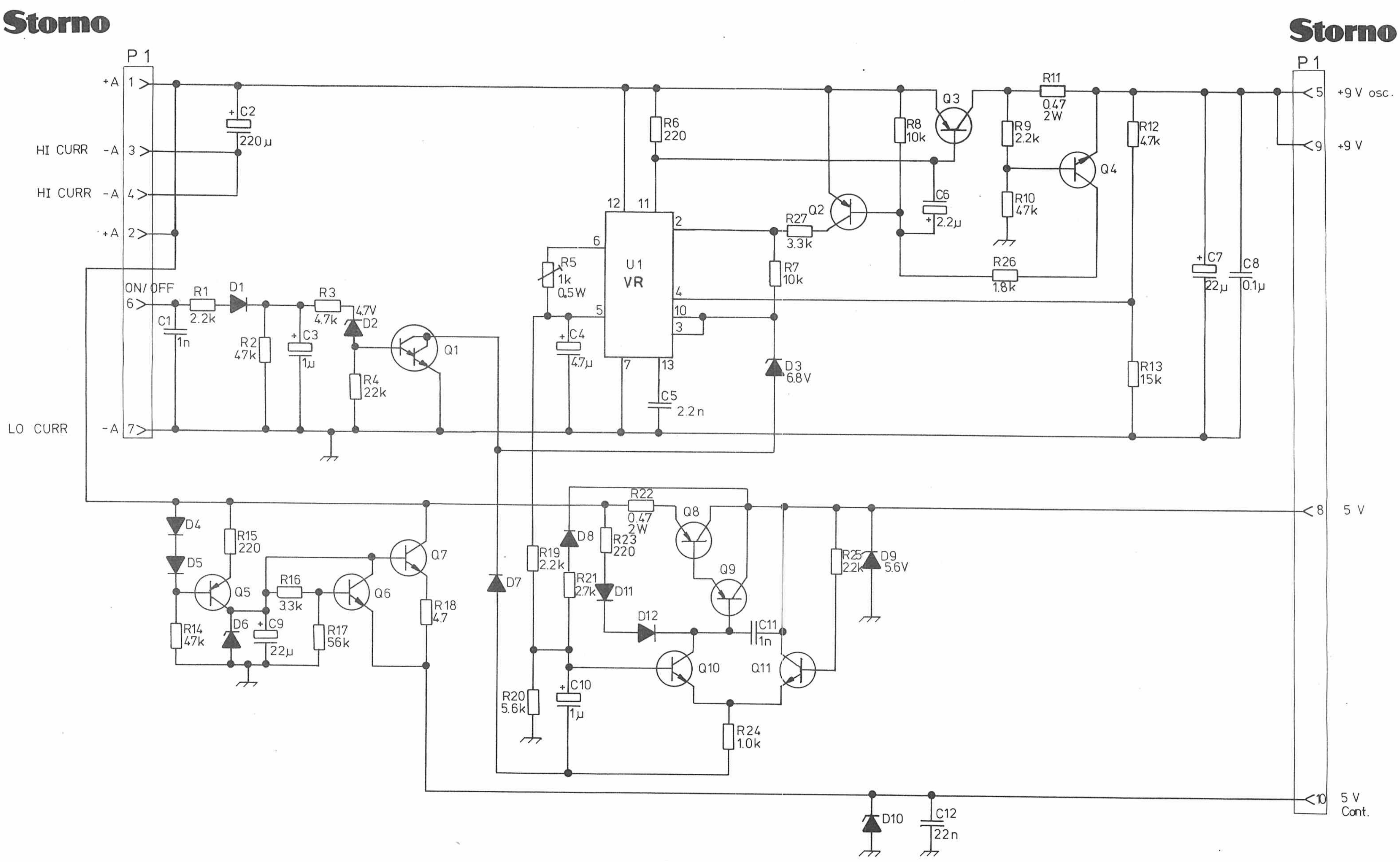
D403.079/2



NOTES
1 : HIGH POWER RADIO
2 : LOW POWER RADIO
3 : 24 VOLT SUPPLY (MAX. 25W PA)

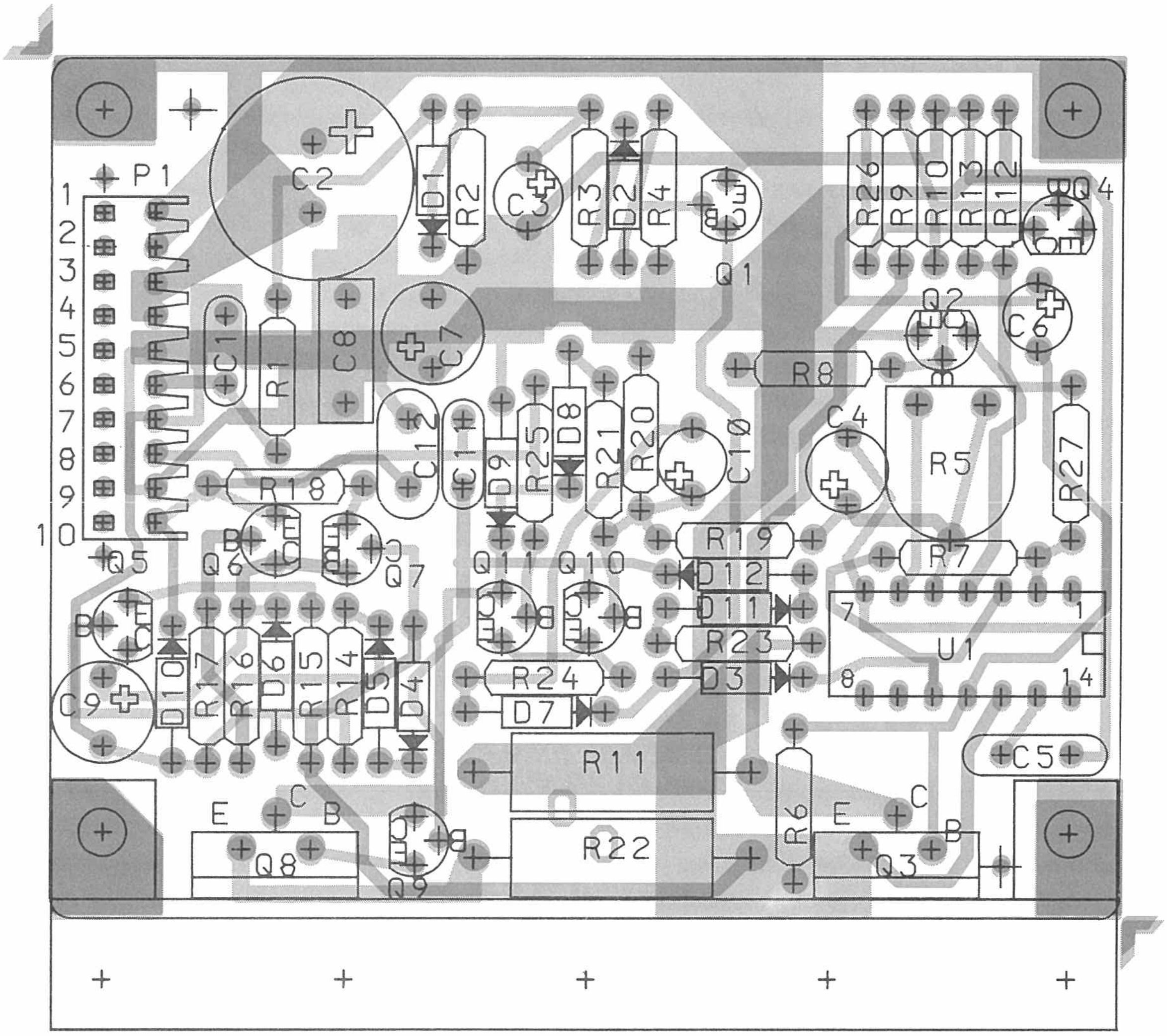
VOLTAGE DISTRIBUTION SYSTEM M 900

D402. 938/2



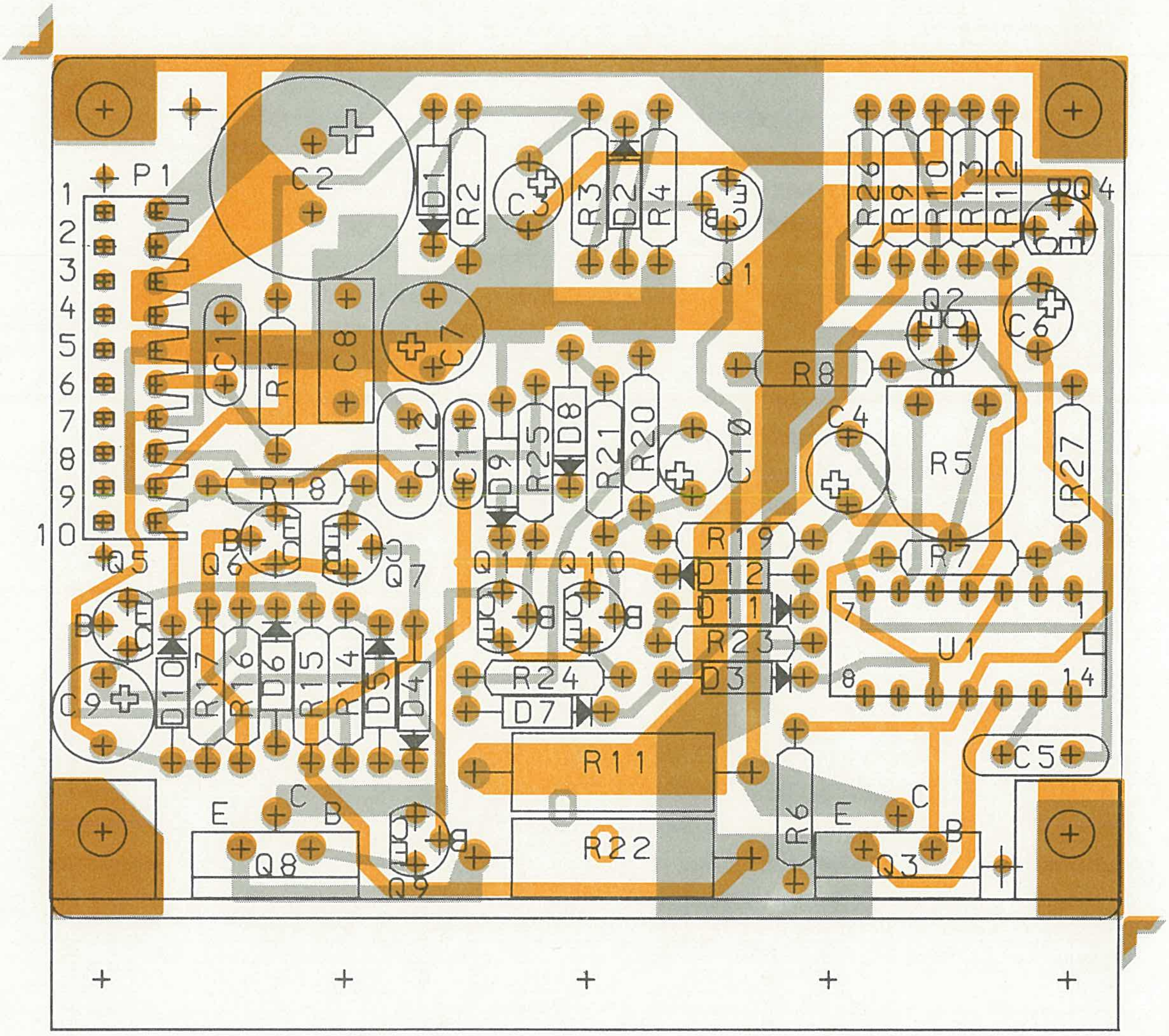
VOLTAGE REGULATOR +9V, +5V VR901

19L855013G2 D402.968/2



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

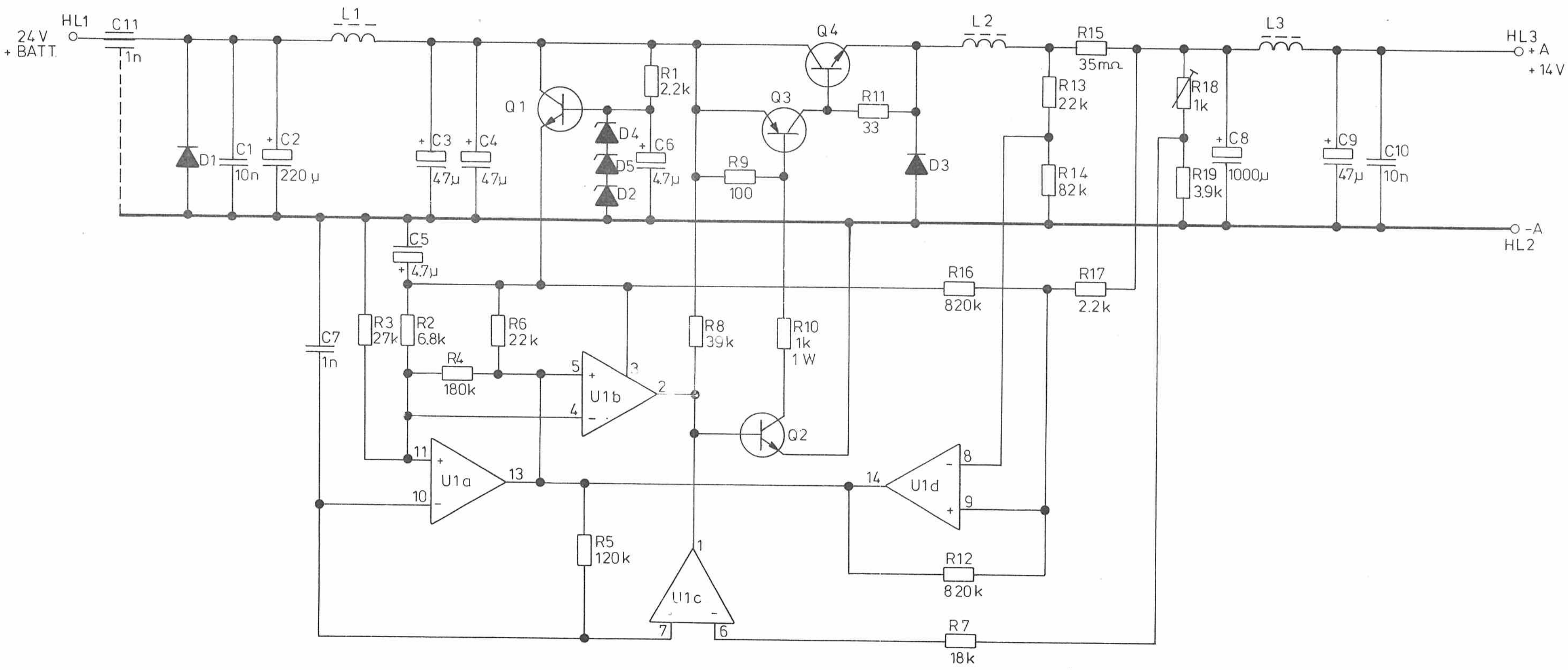
19L855013G2 | D403.164



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

19L855013G2 | D403.164

Storno

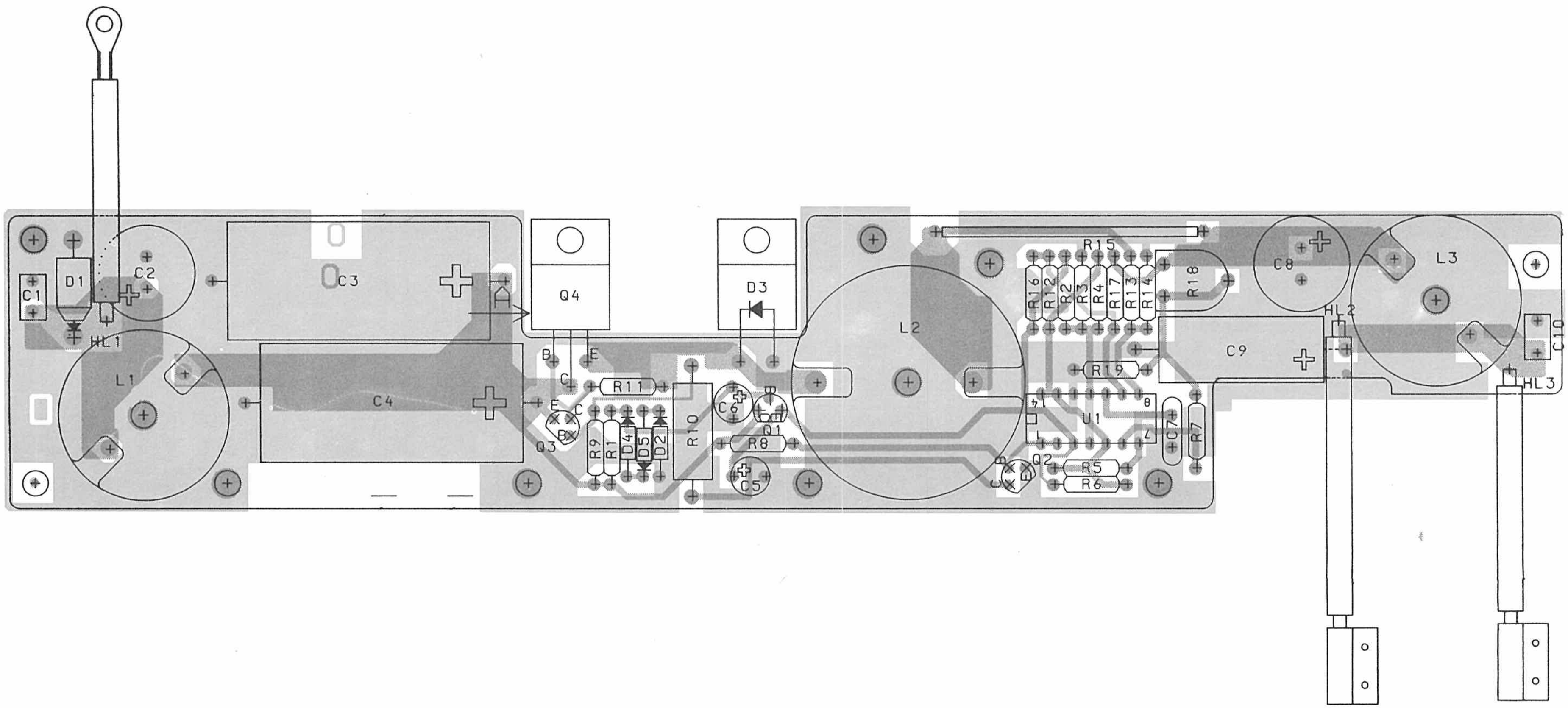


VOLTAGE REGULATOR 24/12V NEG GND VR902

19L855018G1 D402.966/2

Storno

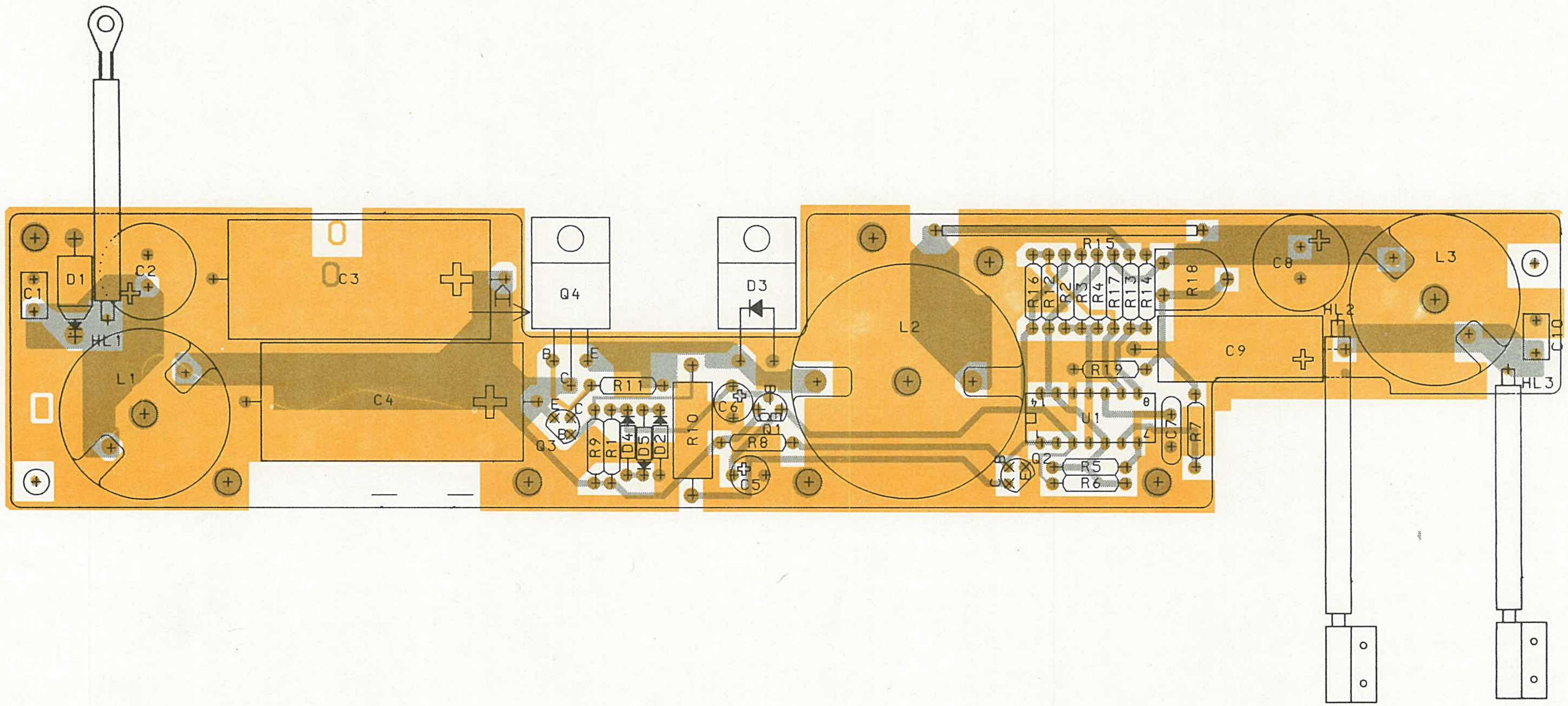
Storno



VOLTAGE REGULATOR VR902
COMPONENT LAYOUT

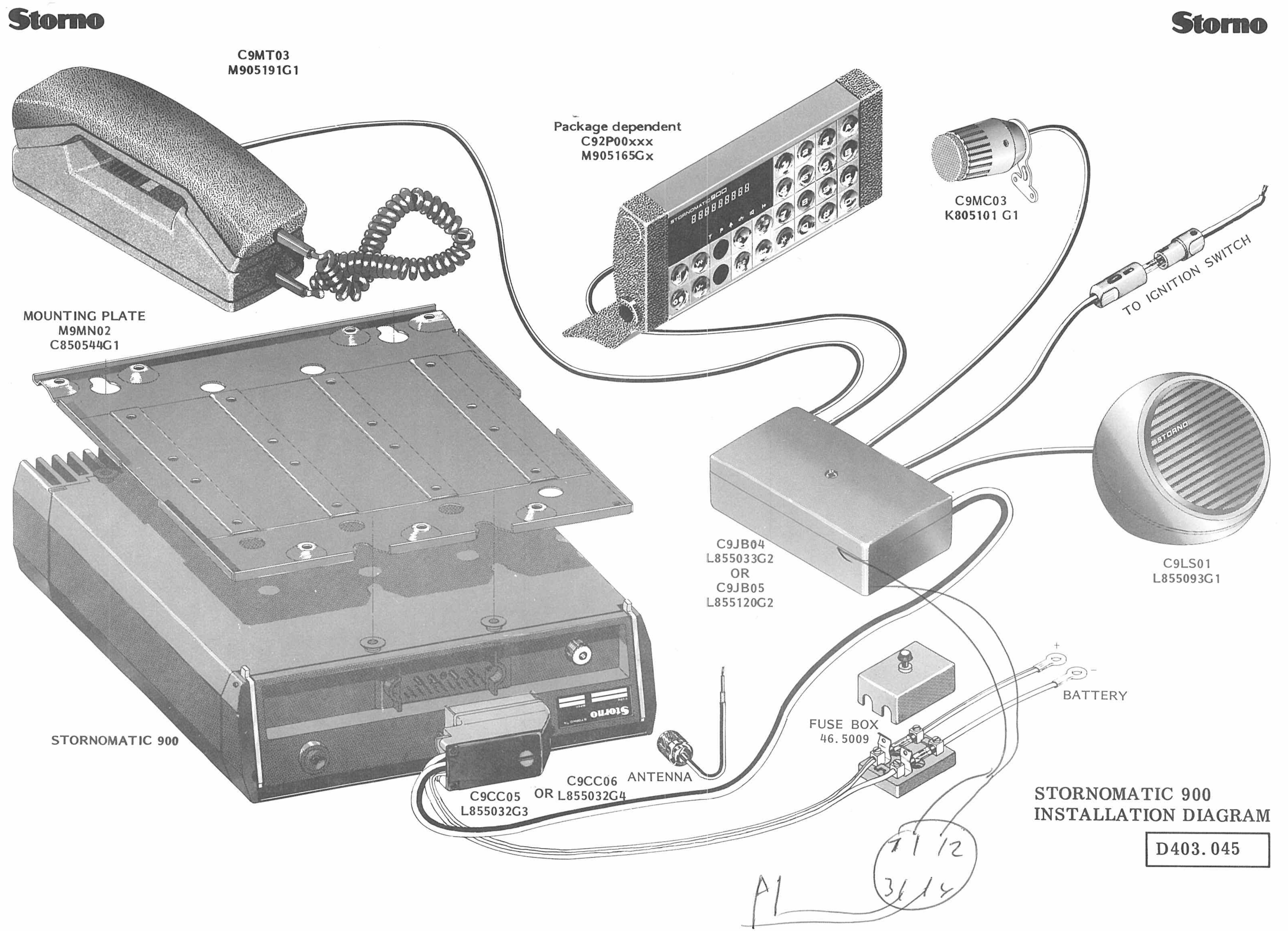
19L855018G1 | D403.165

Storno



VOLTAGE REGULATOR VR902
COMPONENT LAYOUT

19L855018G1 | D403.165



STORNOMATIC 900
INSTALLATION DIAGRAM

D403.045

Storno

Nº	CODE	DATA		
	19D900072G3	AA901	Audio Amplifier	
	19C850521G1	AA903	Audio Amplifier	5 W
	19C850521G2	AA904	Audio Amplifier	15 W
	19C850579G1	AC902	Antenna Connector	
	19L855111G1	BF964	Antenna Branching filter	
	19C850544G2	C9MN02	Mounting Plate	
	19A901273G1	CC904	Cable Kit	
	19M905122G1	CL904	Control Logic	
	19L855157G1	FN901	Filter Network	
	19C850527G1	FS901	Frequency Synthesizer	
	19C850520G2	IA902	IF Amplifier	
	19M905130G1	JP904	Interconnect Board	
	19L855146G2	MM901	Memory Module	
	19D900093G1	PA962	Power Amplifier	
	19M905002G1	PL961	Phase Locked Loop	
	19M905003G1	PL962	Phase Locked Loop	
	19L855055G1	RC963	Receiver Converter	
	19L855013G2	VR901G2	Voltage Regulator	
	19L855018G1	VR902	Voltage Regulator	24 V
	19A701453G5	XO905	Crystal Oscillator	
	19A701453G11	XO906	Crystal Oscillator	
	19D900065G23	XO9011	Crystal Oscillator	
	19J706247P2	82S123	Prom	

Storno

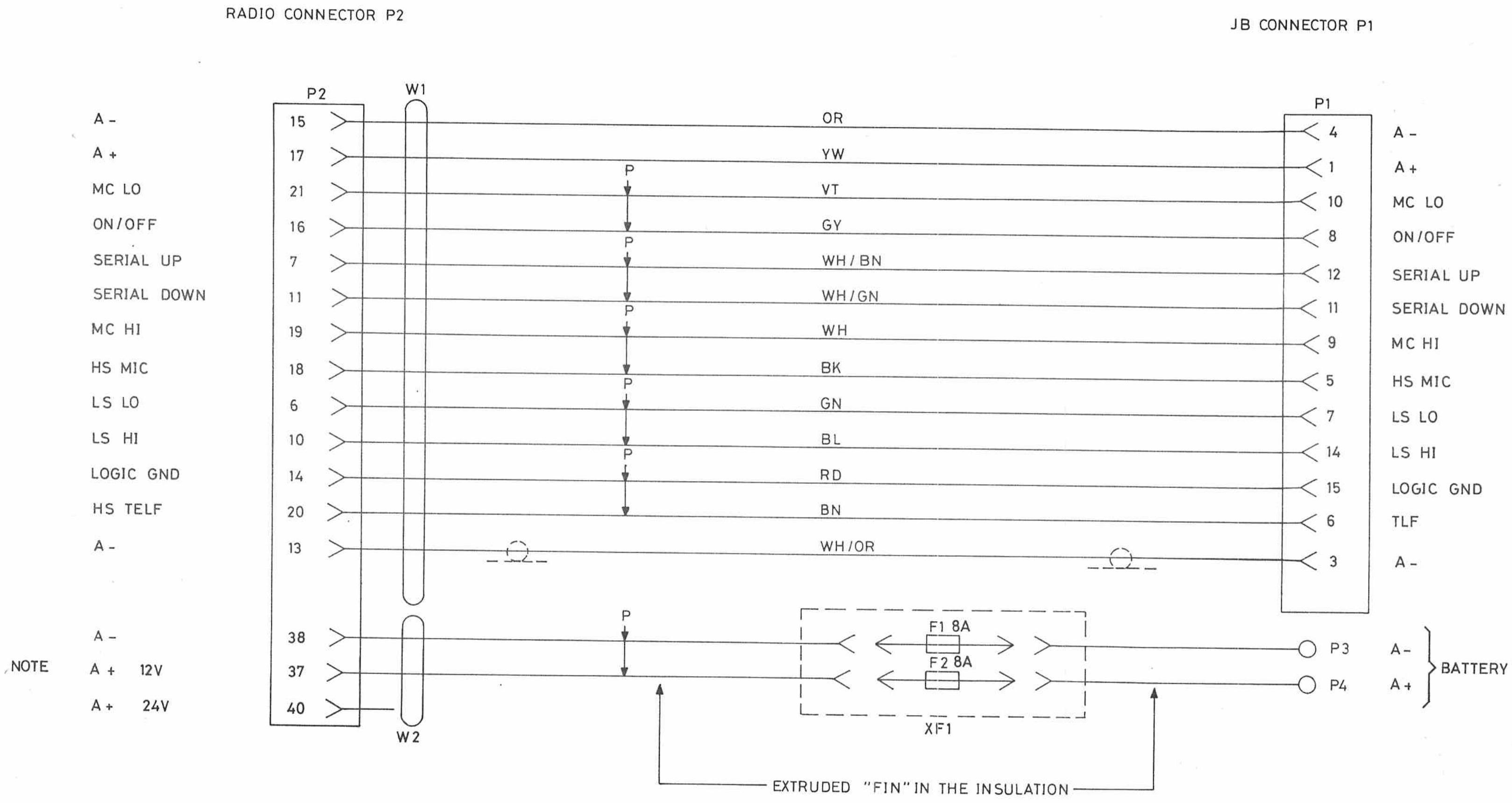
Nº	CODE	DATA

STORNOMATIC 900 SM9662D 0025AP

MODULE LIST

X403.052

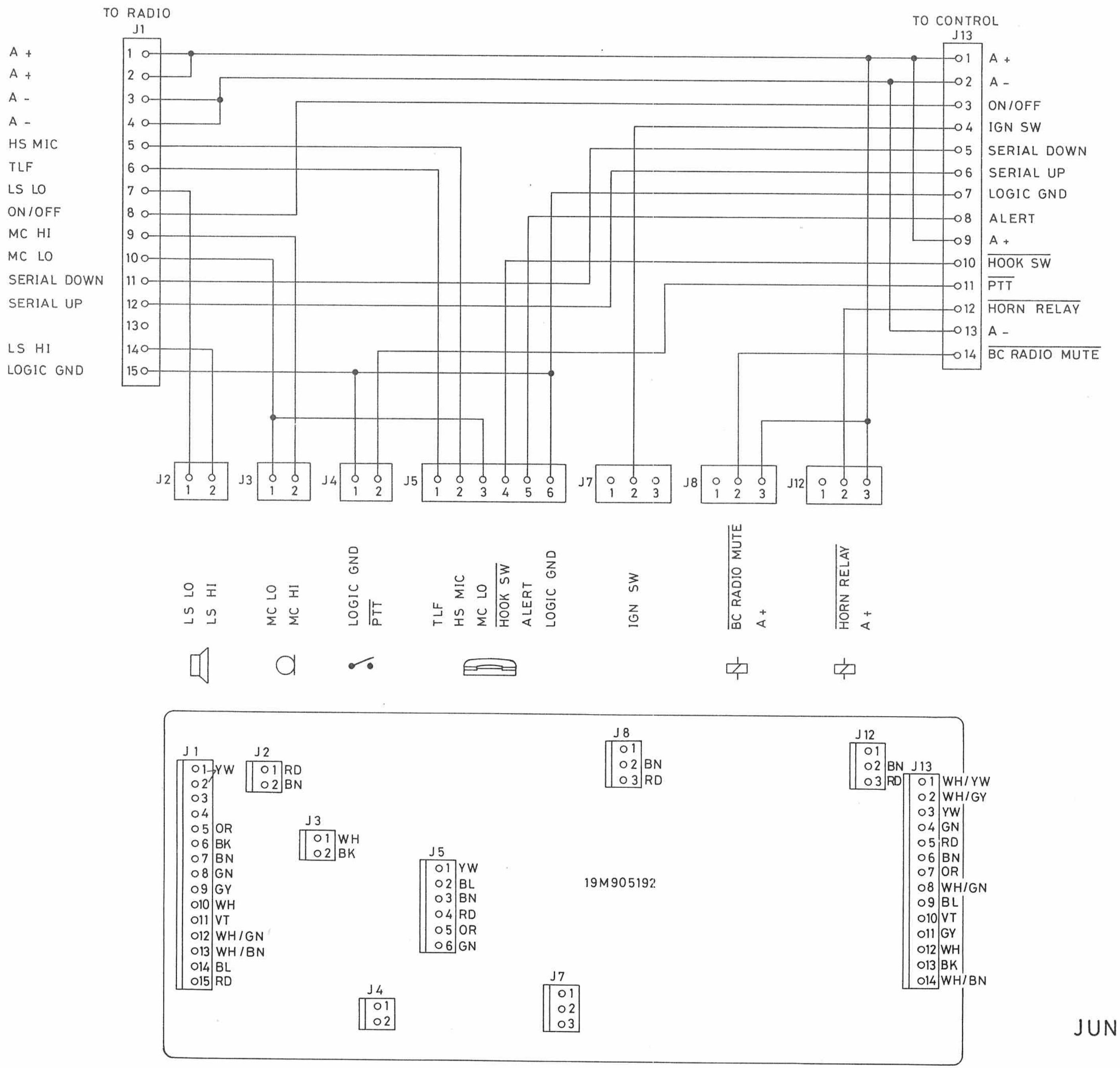
Storno



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

CABLE C9CC05,C9CC06

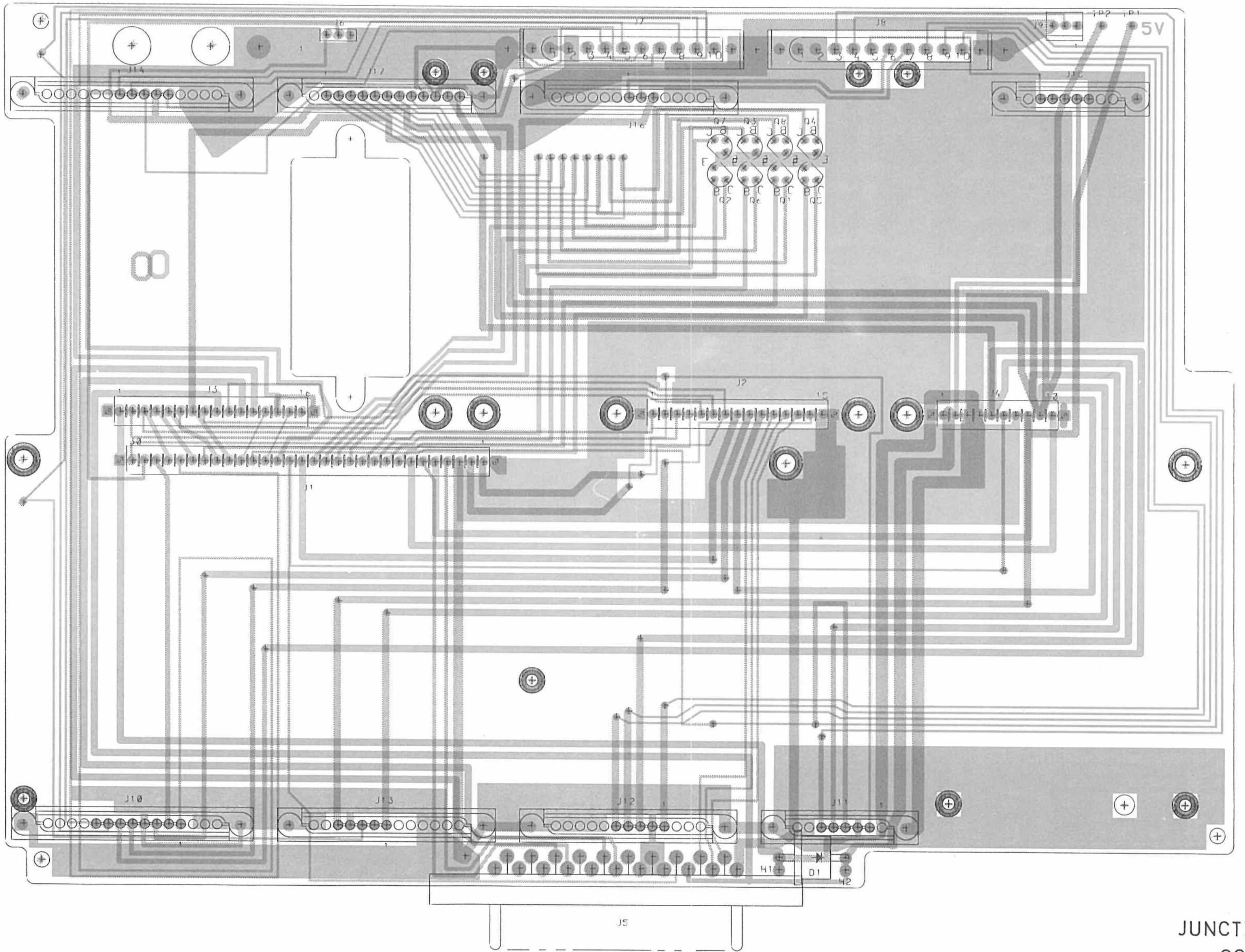
D403.137



JUNCTION BOX C9JB04

D403.083/2

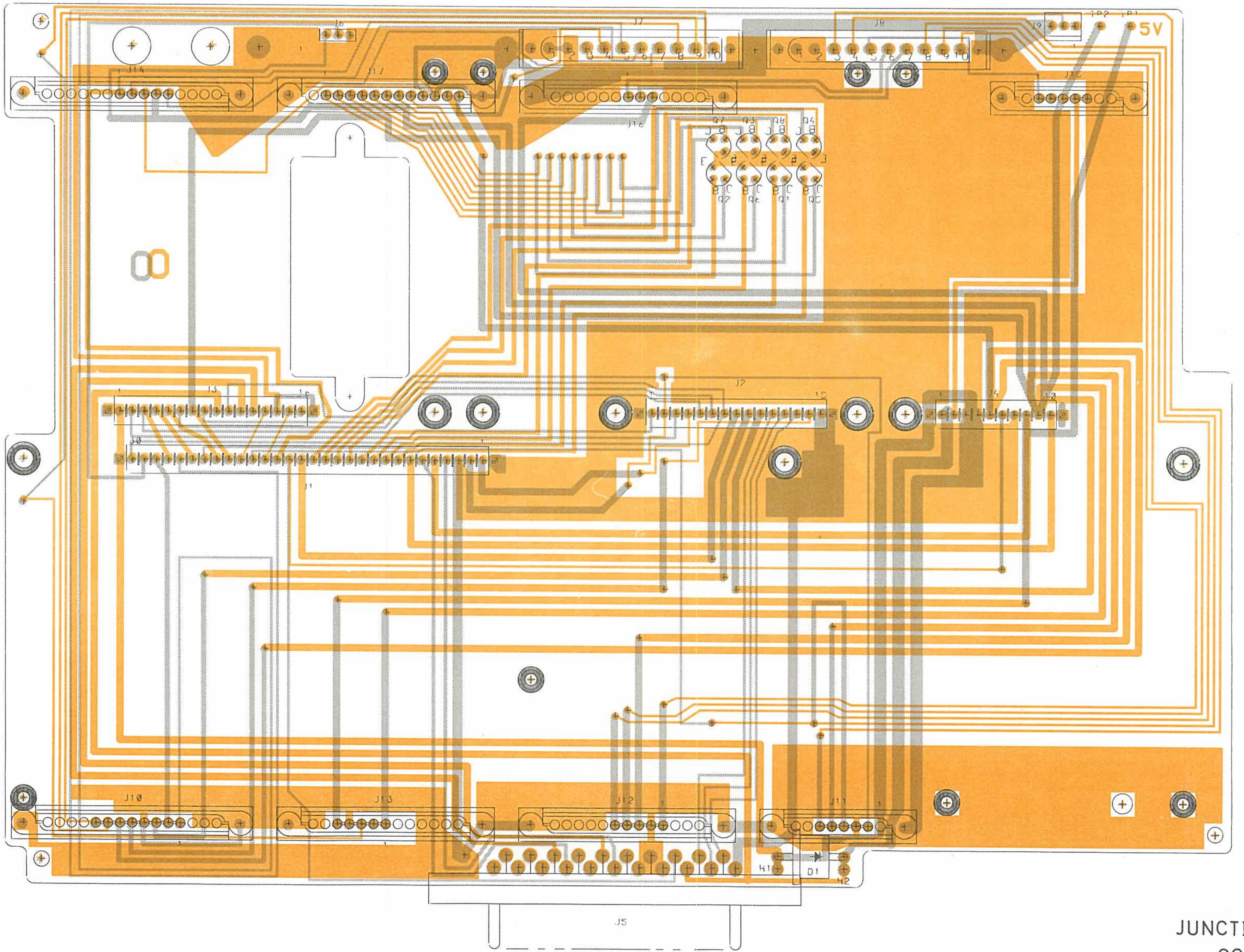
Storno



JUNCTION BOARD JB904
COMPONENT LAYOUT

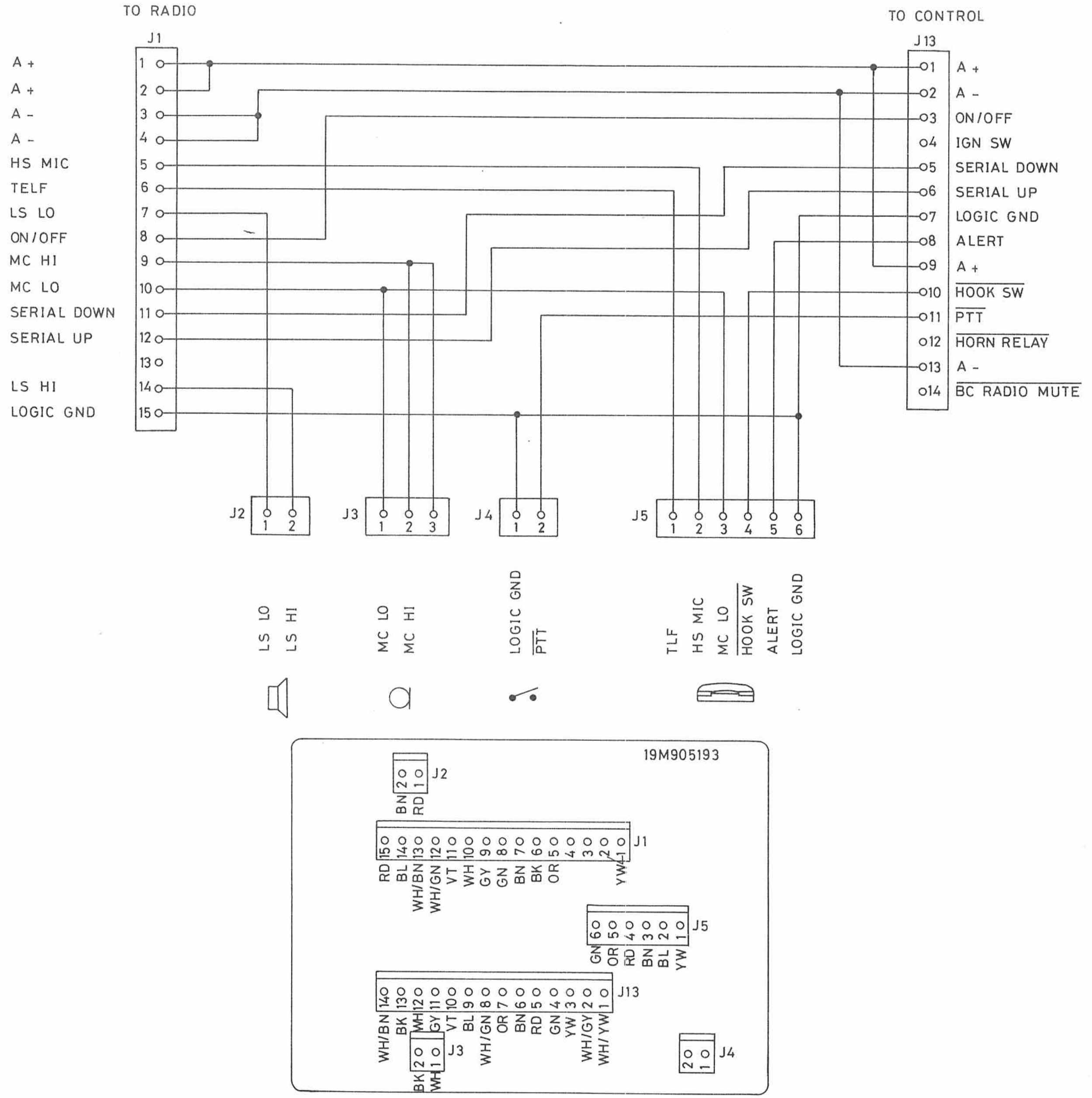
19M905130G1 | D 403.166

Storno



JUNCTION BOARD JB 904
COMPONENT LAYOUT

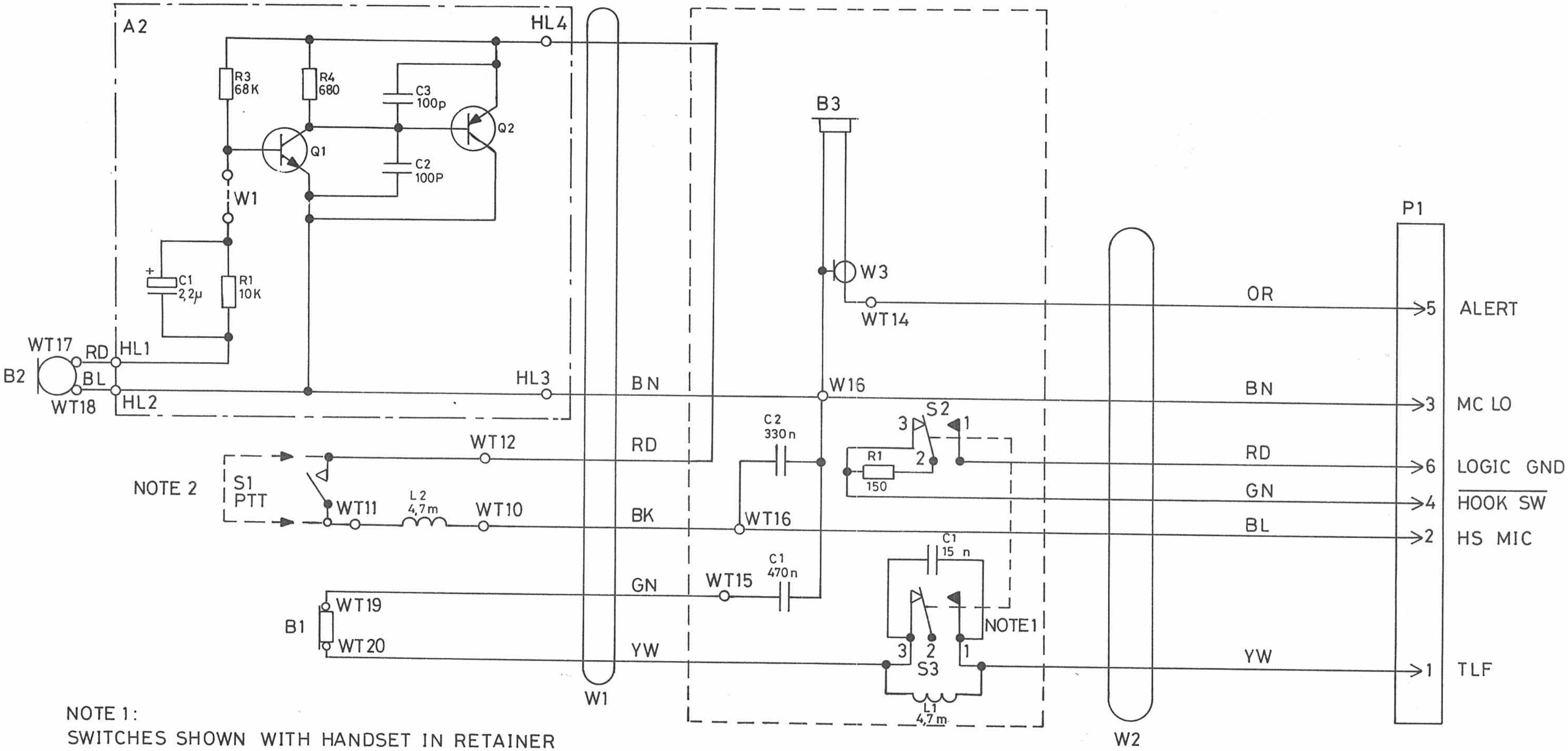
19M905130G1 | D 403.166



JUNCTION BOX C9JB05

D403.084/2

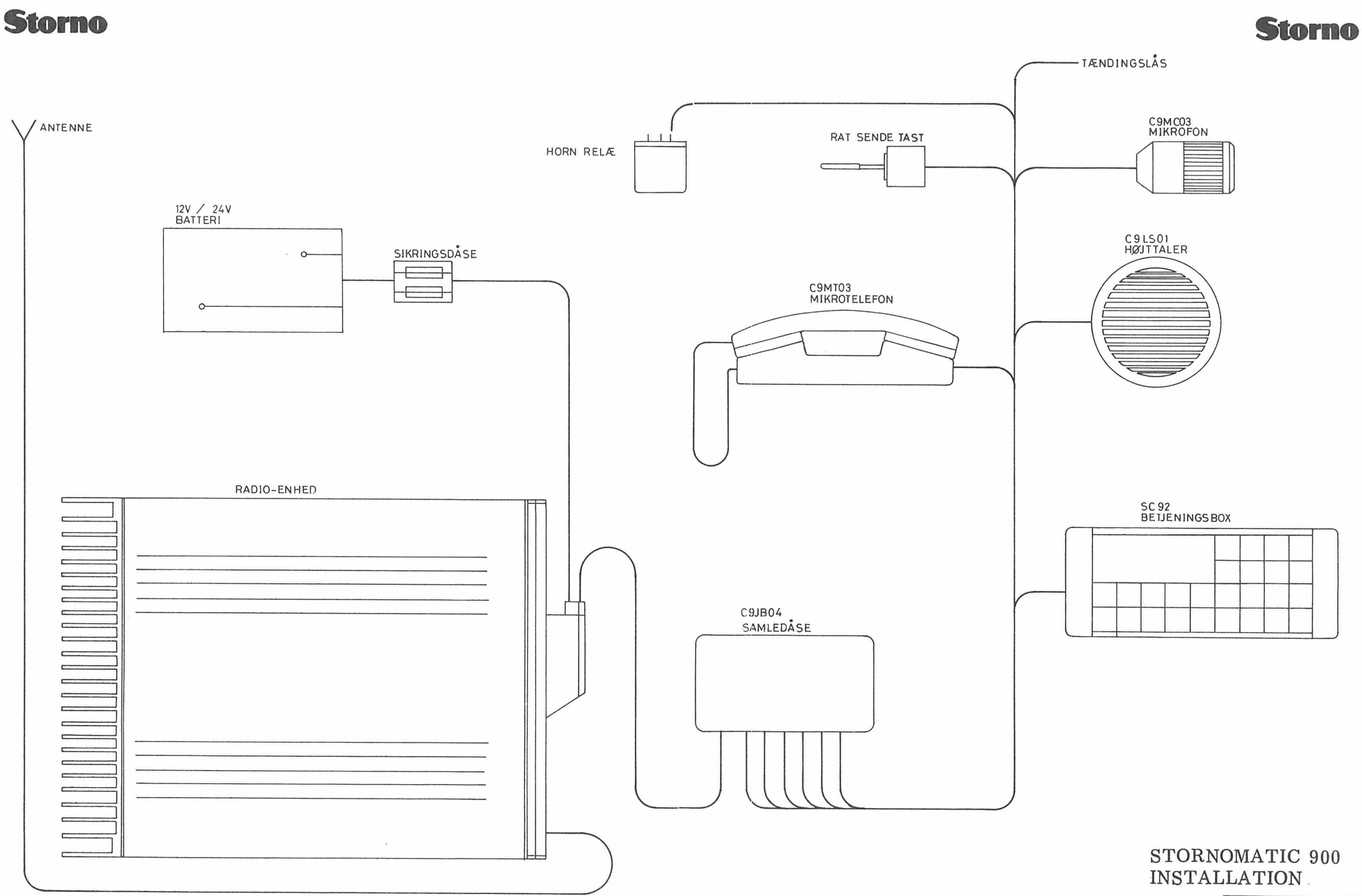
Storno



NOTE 1:
SWITCHES SHOWN WITH HANDSET IN RETAINER
NOTE 2:
G1 = NMT
G2 = PRT. S4 (REMOVE S1 AND SHORT WT11-WT12)

HANDHELD MICROPHONE C9MT03

19M905191 REV. C D403.082/3

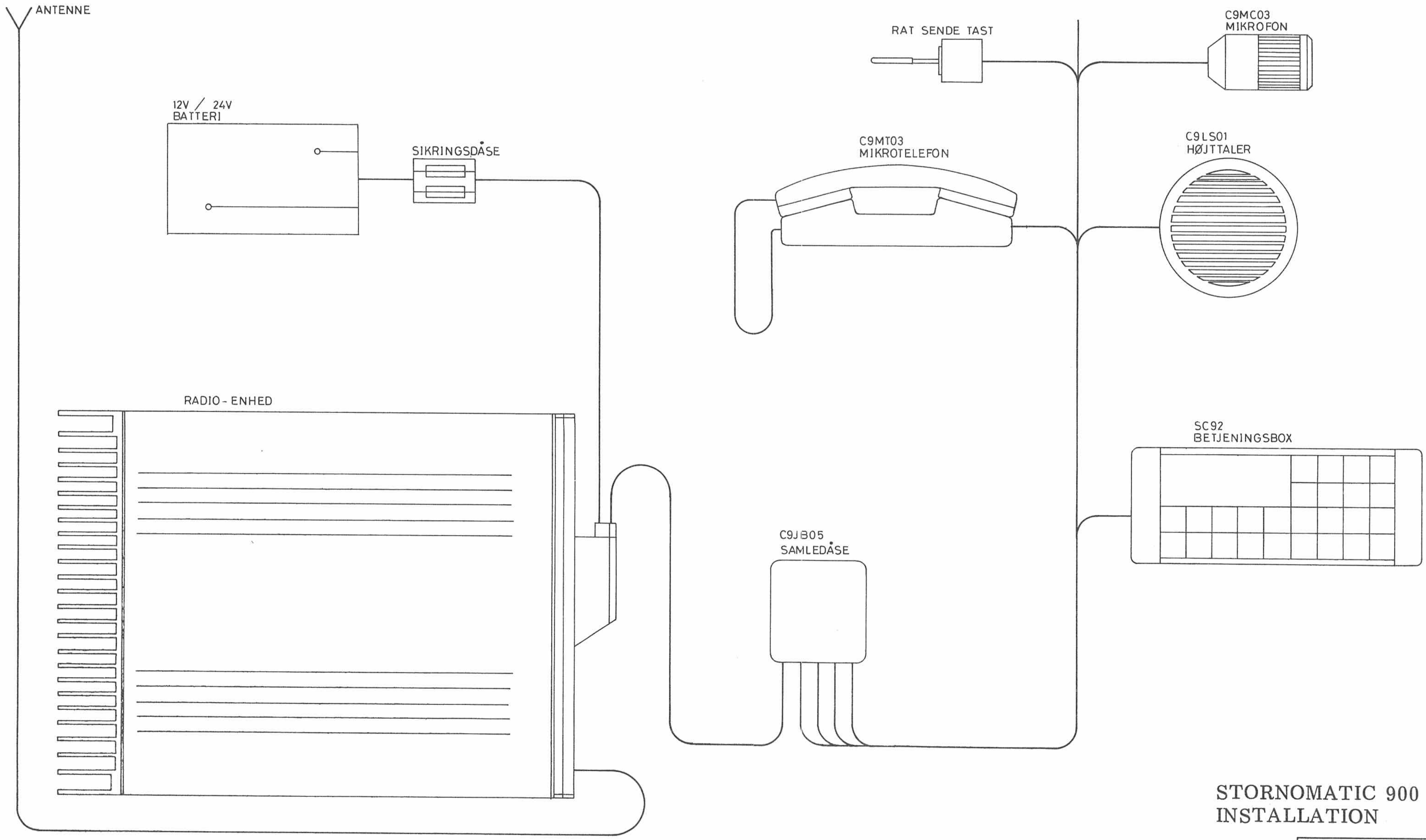


STORNOMATIC 900
INSTALLATION

D402.989

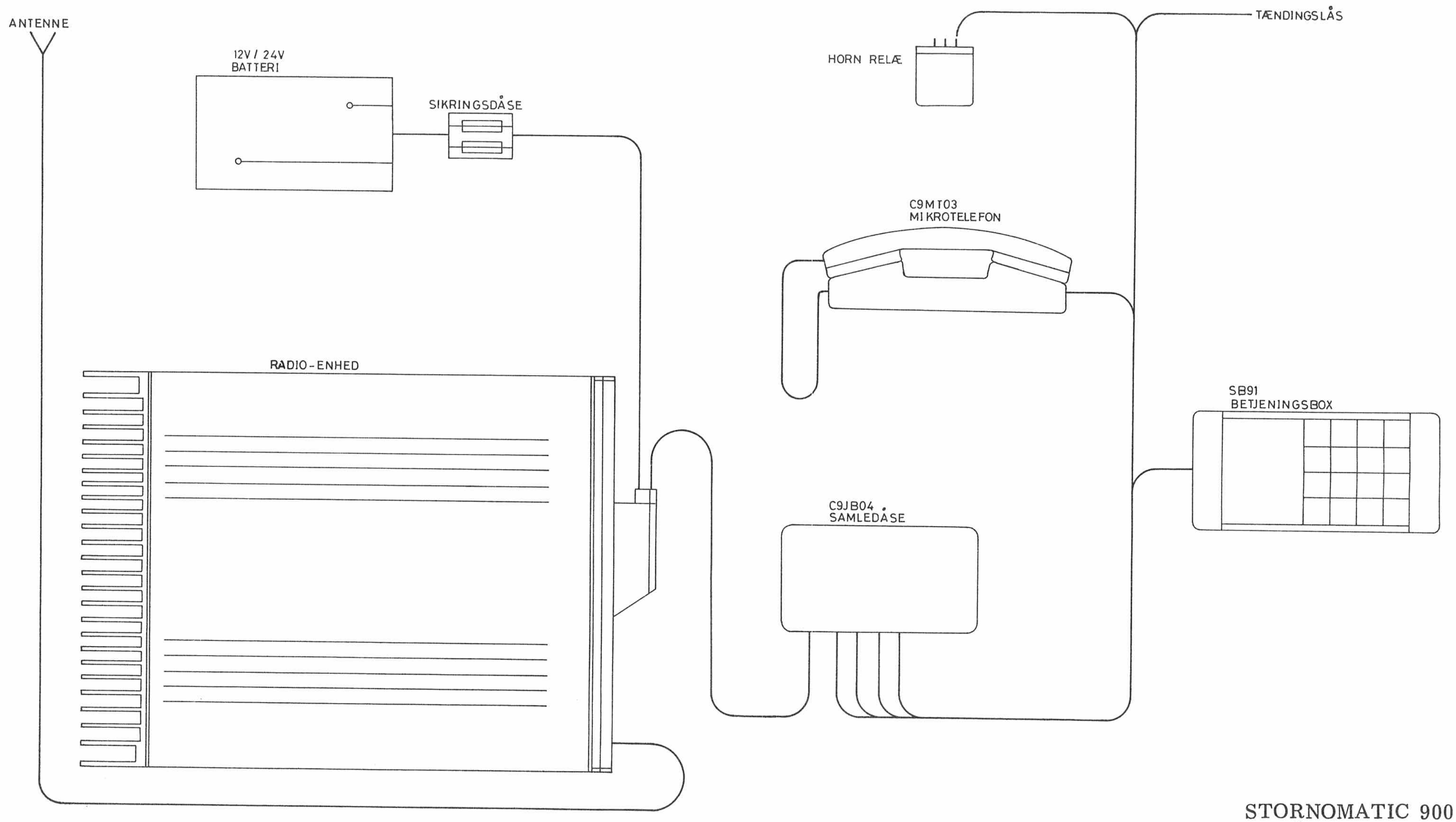
Storno

Storno



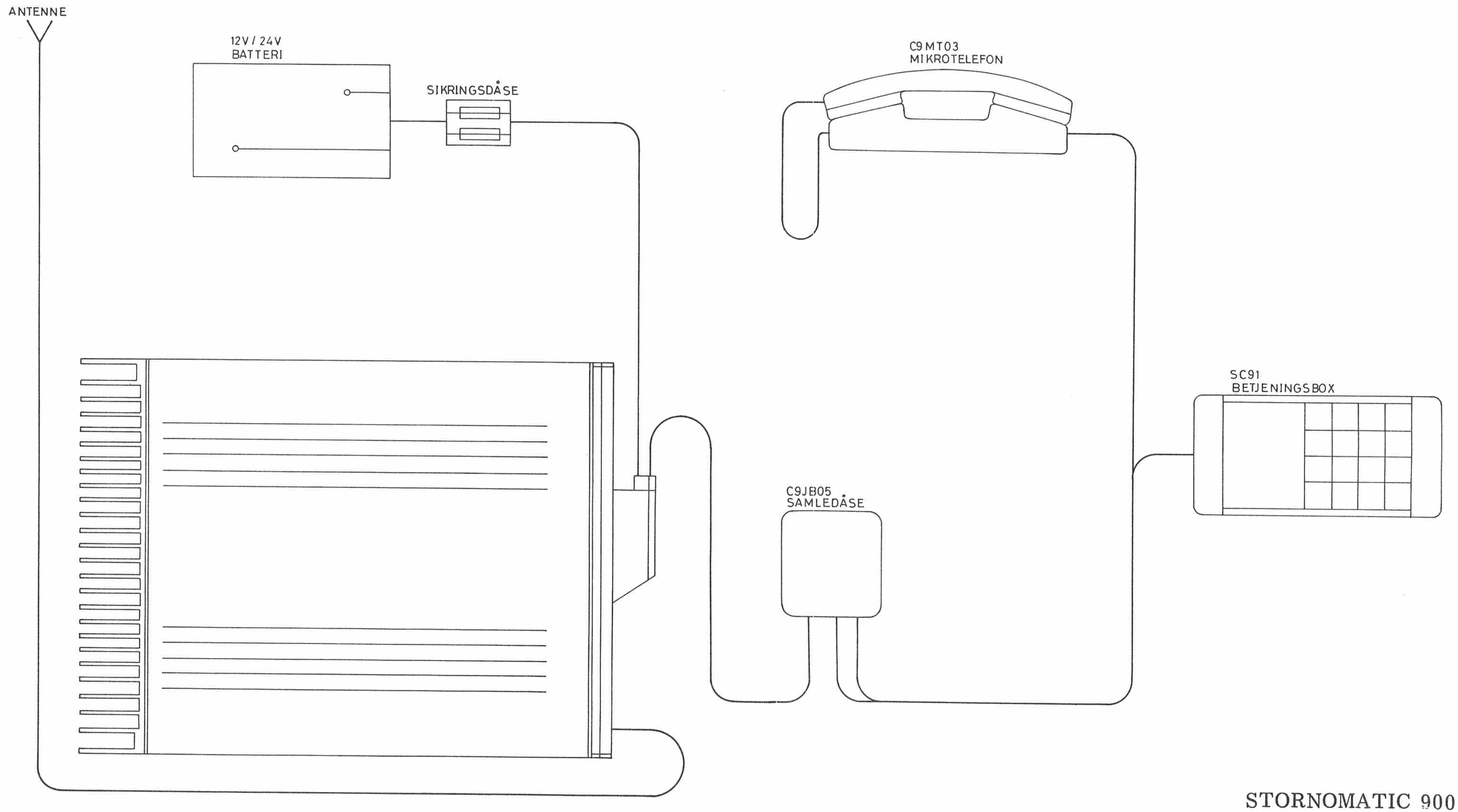
STORNOMATIC 900
INSTALLATION

D402. 988



STORNOMATIC 900
INSTALLATION

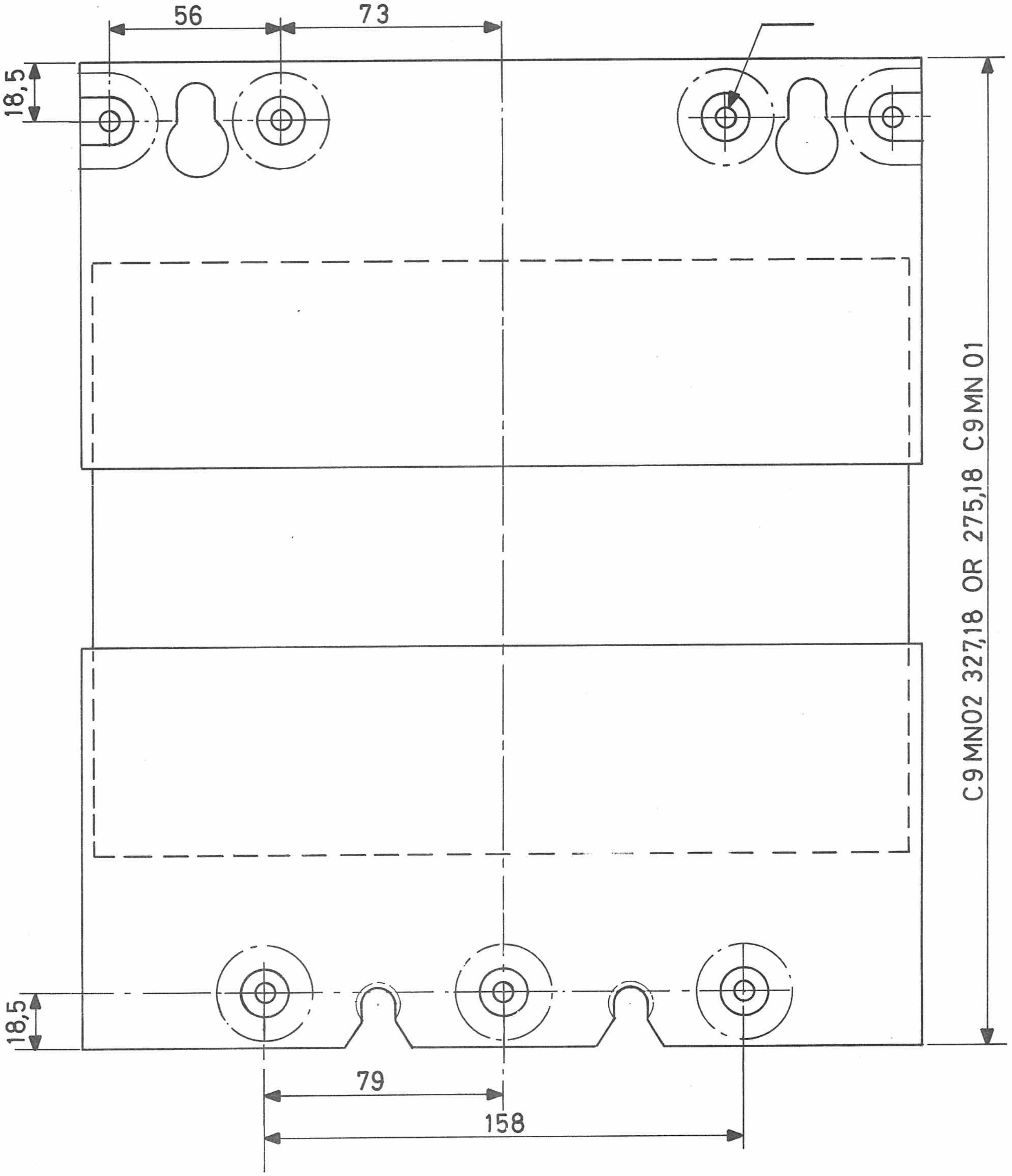
D402. 991



STORNOMATIC 900
INSTALLATION

D402. 990

 Storno



MOUNTING PLATE C9MN01, C9MN02

C9MN01:19C850544G1 - C9MN02:19C850544G2 D402.905/2