FCC ID: KVW60439043

# 5. Description of Function

## 5.1 General

(See circuit diagram 6044.0940.01S)

The adapter consists of the mechanical parts of the 19" frame, a regulator and a display board fixed to the adapter front panel as well several cable connections.

The **regulator** is made up of the following items:

- DC board
- Electrolytic capacitor C4
- Cooling and mounting brackets
- DC supply cable
- RF cable W1
- Fuse F1
- Temperature switch

The display board is made up of the following items:

- Display board
- Ribbon cable X13
- Toggle switches S1 and S2
- Connector X5

## 5.2 Regulator

(See circuit diagram 6044.1698.01S and Fig. 5.1)

The DC voltage (DC-IN, 22 to 31 VDC) is fed via flat connectors X3 and X13 as well as via an input filter (consisting of L1, C1 and C2) to series diode V1. This diode protects the input against wrong polarity connection. An automatic switchover facility installed in the optional Power Supply IN 251 becomes active in the case of a mains failure (AC / DC switchover).

Electrolytic capacitor C4 is an energy store and acts as filtering capacitor for both DC and AC operation.

Directly to electrolytic capacitor C4, the voltage supply for the VHF amplifier is connected (24 VDC unregulated, 10 A - connector X19). Via fuse F1 the Rx unit is provided with the operating voltage (+24 VDC unregulated, 1 A - connector X31, contacts 25 and 26).

Via fuse F2 and a preliminary control for dissipated-power distribution (V9, C20 and Zener diode V8), the integrated voltage regulator N5 (with R24, R25, R27, R41, R42 and C16) is connected which provides a permanent voltage of +8 VDC. The output voltage is 8 VDC (available at X31.12 / .14).

Via fuse F2 and FET switching stage V3, voltage regulators N1 to N4 and N6 are connected to the input voltage. Via resistor R4, transistor V4 connects the gate of V3 to ground potential once the signal ON-TX in on high level, and via resistor R5 transistor V4 is through-connected.

In the case that there is an excessive temperature at temperature switch S1, the base of V4 is shorted thus blocking V3. The combination of R3 / C6 and C7 suppresses any interferences.

The integrated voltage regulator N1 (L200) and resistors R6 to R8 together form a current limiter. In this way the current of the output voltage $V_{OPSW}$ is limited to 1 A.

The integrated voltage regulator N2 (with R9, R10, R11 and C9) generates a regulated voltage of +5 VDC ($V_{OPSW}$).

The integrated voltage regulator N3 (with R12, R13, R15 and C10) generates a regulated voltage of +10 VDC, adjustable with potentiometer R14.

The integrated voltage regulator N4 (with R16 to R18, R28 to R33, R35 and C11) provides the output voltage of +18 VDC. It also controls transistor V7 (distribution of dissipated power).

Parting from the +18-VDC operating voltage, the negative voltage of -10 VDC is generated by an integrated switching regulator (N6, switched-capacitor voltage converter). Subsequently it is regulated by series transistor V5 (with R23 and C14) and stabilized by Zener diode V6.

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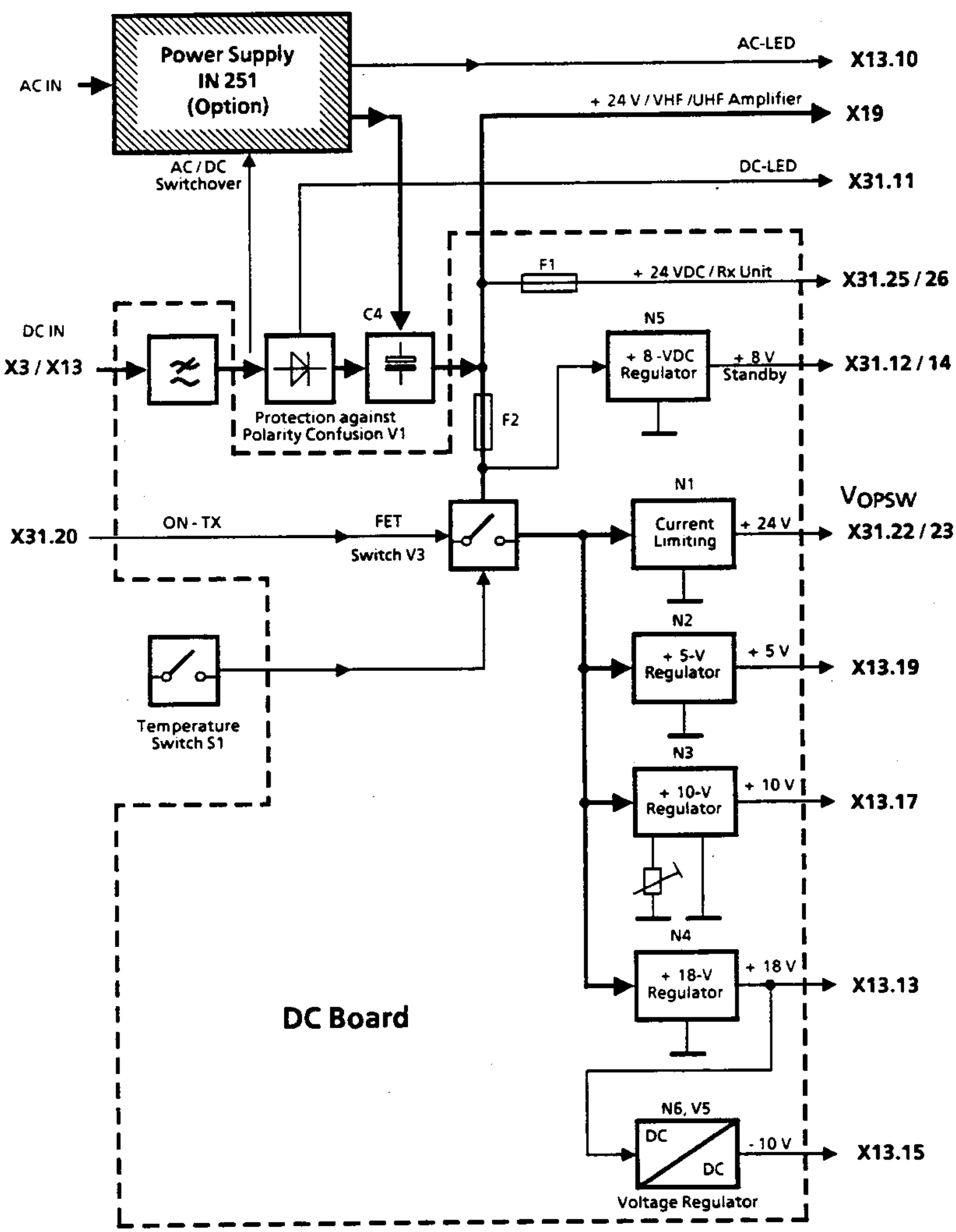


**Fig. 5.1 Regulator, Block Diagram**

## 5.3 Display Board

(See circuit diagram 6044.1498.01S and Fig. 5.2)

### 5.3.1 Display Section: Bargraph Indicator

The LED bargraph indicator, which is part of the display board, is controlled with three analog signals coming from the directional coupler and conditioned in the modulator. The analog signal DISR (X12.13) is equivalent to the reflected power, the signal DISF (X13.12) to the forward power and the signal DISM (X13.11) to the modulation depth (values: 4 VDC = 100 %). Resistors R55, R56 and R57 reduce any static charges.

With the aid of switch S2 in conjunction with resistors R40, R41, R50 and C51, the measuring function ($P_{OUT}$, m, VSWR) of the LED bargraph indicator is selected. Via a digital switching logic, built up of multiple demultiplexer D1, the respective analog signals are switched through to a divider circuit. This divider circuit consists of operational amplifiers N4C and N4D (wired with R42, R43, R44, R50 and V7) as well as the integrated circuit N5 driving the LEDs. Voltage divider R45 / R46 supplies the reference voltage for the lower and voltage divider R47 / R48 the reference voltage for the upper response threshold. The resulting analog voltage is digitized in the subsequent control circuit N5 (U 1096B), and the driver current for the LED bargraph indicator is through-connected (H5 and H6 = 20 LED segments).

### 5.3.2 Display Section: Individual LEDs

On the display board there are four LEDs. Availability of the operating voltage $V_{OP}$ (+5 VDC) is displayed by illumination of LED H2. The current is limited by R32.

Availability of an AC voltage within the equipment (with option IN 251 only) is indicated by illumination of the green LED **AC** H4. That a connected battery is drawn upon is indicated by illumination of the green LED **DC** H3.

In both cases the current of the two LEDs is limited by a Zener diode / resistor combination (V10, V11, R33 and R34). That all test signals are in order is indicated by illumination of the green LED **TEST** H1. The current is limited by R31.

### 5.3.3 AF Section: Headphone Output

The volume at the headphone output X5.A-B may be set with variable control R60 located on the front panel. The EMC filters L13 to L16, C30 to C33 protect the equipment against external RF noise pulses.

### 5.3.4 AF Section: Microphone Amplifier

In a screened part of the printed circuit board EMC filters for the AF inputs and outputs of the headset and the PTT key (connector X5) are located.

The signals at the microphone inputs for dynamic microphones X5.C and X5.D are routed via EMC filters L1, L2, C1 and C2 and L4, L5, C7, C8 to operational amplifier N1. Via the RC combination C4, R1 the AF signal is fed to the inverting input. Capacitors C5, C13, C54 and C55 stabilize the voltages and suppress any oscillations which may occur. Via R2 and C6, the amplifier is coupled, the level can be set with potentiometer R3.

The inputs for amplifier microphones X5.E and X5.G are also suitable to be used as line inputs (600-Ω impedance). Via EMC filters L7, L8, C9, C10 and L9, L10, C12 C7, C8 as well as via C11, the AF signal is transmitted to potentiometer R8 and via resistor R5 to sum amplifier N4B. At X5.E a DC voltage of approx. 8 VDC, max. 25 mA is available, which is generated by the combination R9, R10 and Zener diode V1.

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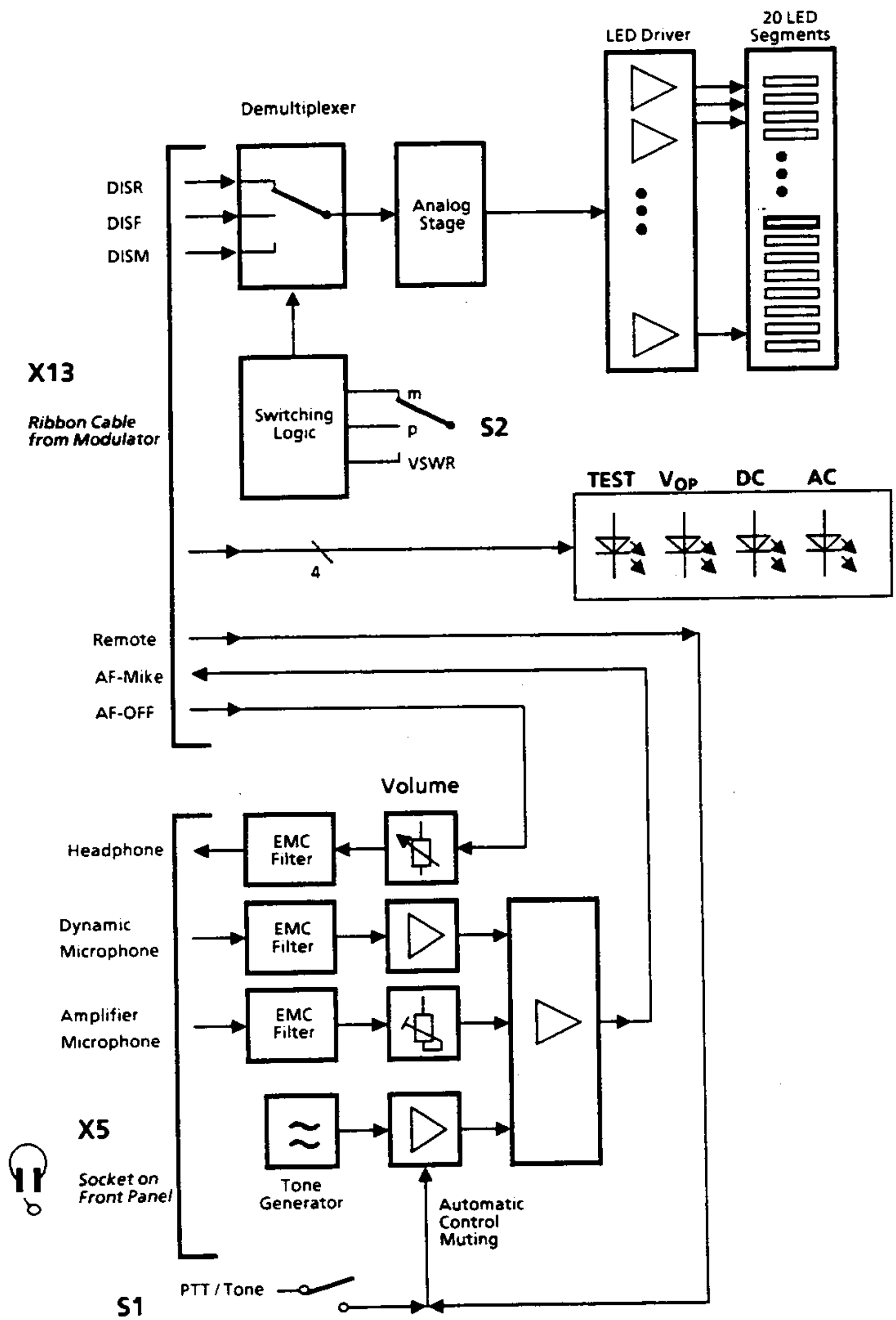


Fig. 5.2 Display Board, Block Diagram

## 5.3.5 AF Section: Test Tone Generator

For test purposes a tone generator can be switched on and its tone be used as modulation signal for the transmitter.

The RC combination R20, C20 and R21, C21 forms, together with the subsequent amplifier stages N4A (TL074) and N3 (SA 578), a Wien-bridge generator. The amplifier stage N4A wired with resistors R22, R23, R24 and R25 forms an inverting amplifier. Capacitors C52 and C53 stabilize the operating voltage, capacitor C37 corrects the frequency response.

The compander IC N3 is wired with R26, R27, R28, C16, C23 to C27 as ALC control circuit in order to keep the level and frequency of this Wien-bridge generator constant.

Via C15 and R7 the output is switched to sum amplifier N4B. Sum amplifier N4B decouples the signals and at the same time compensates attenuation losses. The tone amplifier is controlled via the "Mute" input N3.8 (active low). If switch S1 is open (position "0") transistor V5 is through-connected via R29 and R30 and the tone generator is blocked. In the switch position "TONE" transistor V5 will be blocked via the through-connected FET V4, thus switching on the tone generator.

At the same time a PTT signal is released via diode V2 (via X13.15). For remote control, FET V4 is blocked via X13.18 (*REMOTE-1), thus blocking the tone generator as well as the PTT signal.

# 6. Repair

(See also Circuit Diagrams, Parts Lists and Components Layouts in the Appendix to this Repair Manual.)

## 6.1 Preliminary Remarks

### 6.1.1 General

The repair of Adapter KR 201 starts with the initial check of the regulator and the display board in order to obtain information on the functional order of the unit and its technical data. If the faulty equipment function can be identified beforehand, however, it is also possible to start directly in the respective table in 6.3.2 or 6.3.3.

In the case where faults cannot be clearly localized, all tests must be carried out from the beginning.

### 6.1.2 Restoring the Nominal Characteristics

Any component that is proved to be defective by means of the initial check and other troubleshooting procedures should only be replaced by a component that meets the specifications of the relevant parts list in the Appendix to this Repair Manual.

Only in this way can the technical data be guaranteed that are given in Section 1 of the relevant User Manual.

After replacement of components, it is absolutely necessary to carry out the final test according to 6.6.

### 6.1.3 Spare Parts

All components are subjected to strict quality control before they are built into the unit.

For components from outside suppliers, e.g. resistors, capacitors and diodes, R&S have laid down their own delivery specifications for the purpose of ensuring maximum reliability.

For this reason we recommend that only original spare parts be used for replacing defective components.

When ordering a spare part, please state the following:

- Type,
- Ordering code of equipment,
- Serial number of equipment,
- Identification number of parts list,
- Designation plus stock number of component.

All of these details are to be found in the circuit diagrams, parts lists and components layouts that accompany the manual.

## 6.1.4 Important User Information

The following contains details which are essential when referring to Section 6 "Repair". This is in order to prevent misunderstandings at a later stage.

- All measurements and checks are to be performed at the permissible operating voltage only.
- The initial check as well as troubleshooting and fault elimination are to be carried out in the given order.
- Once a fault has been eliminated, the functional order of the equipment must be checked anew acc. to 6.3.2 by starting in the table where it was previously left.
- Perform all measurements and alignment at the given operating voltages.
- Abbreviations in the text such as X13.1 and T3.3 are to be understood as follows:

  Connector X13, contact 1,
  Transformer T3, contact 3.
- All signals in the text marked with an asterisk (*) are low-active signals
- Prior to any soldering the operating voltage must be switched off.
- Once the repairs are terminated, carry out the initial check once again as a final test in order to ensure that the technical data are still guaranteed.

# 5. Description of Function

## 5.1 General

(See circuit diagram 6044.2942.01S as well as Fig. 5.1)

The VHF Amplifier VU 221V is a module belonging to the 200 series of single-channel radio equipment. Available in two models (02 / 03), it is used in the VHF transmitters and transceivers of this series. The two models differ in that model 03 contains an optional PIN control circuit and a Tx / Rx switch in addition to the standard layout of model 02.

To the amplifier an optional circulator, also integrated in the transceiver, can be connected by using the supplied extension set.

The following description refers to the maximum layout of model 03. Wherever there are substantial differences between the two models, they will be especially mentioned.

Within the VHF transmitters and transceivers, VHF Amplifier VU 221V carries out the following functions:

- In transmission, it amplifies and modulates (AM) the signal fed in from the synthesizer. The amplified signal is routed via the adapter frame to the Tx or Tx / Rx antenna. Important operating parameters (power, temperature and VSWR) are detected and applied to the modulator.
- In reception, it switches the signal from the Tx / Rx antenna to an output to the receiver.

The connection to the modulator is made with the aid of X93. Via this connector the control, monitoring and modulation signals as well as the supply voltages of the pre-stages are routed. The operating voltages for the output stages are fed to the amplifier from the adapter frame via X19.

## 5.2 Amplifier Board

The amplifier board accommodates the following functional groups:

- Driver amplifier with Preamplifier and Power driver
- Output stage
- Harmonic filter
- Directional coupler
- Tx / Rx switch
- Amplifier control
- Quiescent-current generator

### 5.2.1 Driver Amplifier

(See circuit diagram 6044.2994.01S, sheets 2 and 3)

The driver amplifier consists of the functional units preamplifier and power driver.

#### 5.2.1.1 Preamplifier

The input signal PREAMPin (+ 14 dBm) is applied via a 10-dB attenuator (R110 to R112) to transistor V112. The attenuator separates the synthesizer output from the amplifier.

The base bias for setting the collector quiescent current of transistor V112 (A-B operation) is obtained from the + 5-V Tx voltage by means of voltage divider R113, R116 and R114. Diode V114, parallel to the base / emitter diode of the transistor as far as direct current is concerned, ensures the temperature compensation of the quiescent current.

By means of potentiometer R113 the quiescent current can be adjusted, typically it assumes a value of approx. 5 mA.

As the collector voltage, a modulated DC voltage (signal MOD from the modulator) is fed in via lead-through filter T120, an L / R / C filter (L116, R120, C120) and transformer T116. The amplified signal is coupled out via transformer T116 and controls transistors V123 and V124 via balancing transformer T122.

The transistors work in push-pull operation. The 180° phase shift required for transistor control is obtained by way of balancing transformer T122. As the transistor collector voltage, once again the modulated DC voltage (signal MOD) is used.

At the output of this stage, the signal PREAMPout is available with a maximum power of 1 W / 50 Ω. For an output power of 50 W, here approx. 0.2 W are required.

### 5.2.1.2 Power Driver

Via a 5.4-dB attenuator (R210 to R215, C214), 4:1 transformer T215 and coil L216 the base of transistor V220 is controlled. Capacitor C214 has an influence on the frequency response of the attenuator, thus compensating the loss of gain in the upper frequency range.

Due to transformer T215, the 50-Ω input impedance of the power driver is reduced to 12.5 Ω. Impedance matching is made with capacitor C216 and coil L216.

The base bias for setting the collector quiescent current of transistor V220 (A-B operation) is obtained from the +5-V Tx voltage by way of voltage divider R250 to R252 and fed in via transformer T215.

The temperature compensation of the quiescent current is ensured by diode V252 connected in parallel to the base / emitter diode of transistor V220. By means of potentiometer R250 the quiescent current can be adjusted, typically it assumes a value of approx. 20 mA.

As the collector voltage, the voltage +24 V-D1 is routed via the lead-through filter Z254 as well as an L / C filter (L254, C256) and coil L221. Resistor R256 and capacitor C256 suppress low-frequency oscillations.

The amplified signal at the collector of the transistor is coupled out by a π filter (C220, L223, C223) used for impedance transformation and controls the subsequent stage via a 1.5-dB attenuator (R230 to R233). At the soldering strap X224 the signal is available with 10 W / 50 Ω. For service purposes soldering strap X224 may also be opened.

Transistor V240 is controlled via 4:1 transformer T234 and a π filter (C235, L235, C236 / C237). The base bias for setting the collector quiescent current (approx. 25 mA) of transistor V240 (A-B operation) is obtained from the temperature-dependent voltage ICR-3.

The voltage is applied to the transistor base via lead-through filter Z260, a filter (C263, C262, L260, C234), transformer T234 and coil L235. With the heat sink temperature rising (see 5.2.4) the voltage ICR-3 decreases, stabilizing the collector quiescent current of the transistor to approx. 25 mA.

As the collector voltage, the voltage +24 V-D2 is routed via lead-through filter Z264 and an L / C filter as well as coil L268. The amplified signal at the collector of the transistor is coupled out by a π filter (C240, L242, C242, C243) used for impedance transformation.

At soldering strap X243, the signal DRVout is available with max. 11 W / 12.5 Ω. For service purposes soldering strap X243 may also be opened.

*Note:*

*12.5-Ω interface!*

*In cases where measurements are to be made or signals fed in via a 50-Ω termination, a 1:4 RF transformer must be used.*

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## 5.2.2 Output Stage

(See circuit diagram 6044.2994.01S, sheet 4)

The signal DRVout is routed via a 1-dB attenuator (R244, R310, R311, R314) and balancing line W315 to the matching network of transistors V326 and V327. The transistors work in push-pull operation. The 180° phase shift required for transistor control is achieved by way of balancing line W315. The inductances of L321 and L323 are realized in the form of printed coils on the printed circuit board.

The base bias for setting the collector quiescent currents (approx. 50 mA) of the transistors (A-B operation) are obtained from the temperature-dependent voltages ICR-1 and ICR-2. These voltages are applied to the bases of the transistors via lead-through and other filters. With the heat sink temperature rising (see 5.2.4), the voltages are reduced, thus stabilizing the collector quiescent current of the transistors in each case to 50 mA.

The collector voltages +24 V-PAR and +24 V-PAL are routed to the transistors via lead-through and L / C filters (suppression of low-frequency oscillations). By means of an output network as well as balancing lines W336 and W337 the output impedance of the circuit (12.5 Ω) is transformed to 50 Ω.

The output signal is fed as signal AMPout via soldering strap X337 or a circulator (contacts CIRin and CIRout) to the subsequent harmonic filter. For service purposes, soldering strap X337 may also be opened. In the event that the amplifier is operated in conjunction with the optional circulator, soldering strap X337 must be open with the signals being applied to sockets X101 and X102.

The collector voltages are monitored by using the signal parts coupled out at the feedback circuit (L353, C353, R353 and L343). These signal parts are rectified by diodes V328 and V329 and filtered by the subsequent lowpass filters. Via lead-through filters Z345 and Z355 they are summed up as signals PAERR1 and PAERR2, monitored by V5 (see circuit diagram 6044.2994.01S, sheet 6) and fed as unbalanced *PAERR signal to the monitoring circuit of the modulator.

The heat sensor R525 (see circuit diagram 6044.2942.01S, sheet 1) connected at contacts X506 and X507 is located in a bore hole of the output stage's heat sink. The voltage dropping at R525 is routed via lead-through filter Z526 as signal TEMP to the modulator. In the case of an excessive temperature the modulator will reduce the supply voltage of the pre-stage (signal MOD), maintaining the modulation depth.

In this way the amplifier output power is reduced and a further temperature increase prevented. In addition, error messages and a signal driving an external blower are generated. The heat sensor B1 connected at contact X304 provides the temperature information for the quiescent-current sources (see 5.2.4).

## 5.2.3 Harmonic Filter and Directional Coupler

(See circuit diagram 6044.2994.01S, sheet 5)

### 5.2.3.1 Harmonic Filter

The output signal AMPout of the output stage is supplied to the harmonic filter consisting of coils L2, L4, L6, L8 and L10 as well as to capacitors C1 to C11. The transmission loss for the transmit signal is ≤ 0.4 dB.

The stopband attenuation for the multiples of the transmit frequency in the range of 230 to 500 MHz is ≥ 58 dB. In the range of 500 to 700 MHz the stopband attenuation is > 50 dB. The signal is applied to the directional coupler via the 50-Ω soldering strap X30 .

#### 5.2.3.2 Directional Coupler

The directional coupler is built in strip-line technology directly on the printed circuit board. It consists of a main line (5-6) and two coupling lines (3-4 and 1-2). For adjusting the directivity, the coupling lines are fitted with vane attenuators. Adjustment is made by bending the vane attenuators.

The coupling line 3-4 couples out a signal which is proportional to the forward power. This signal is rectified by diode V30 (signal DIR-F), amplified by operational amplifier N500A (circuit diagram, sheet 6) and fed as signal DIRF to the modulator.

The coupling line 1-2 couples out a signal which is proportional to the reflected power. This signal is rectified by diode V23 (signal DIR-R), amplified by operational amplifier N500B (sheet 6) and fed as signal DIRR to the modulator.

Level matching and DC offset of the signals are carried out by the operational amplifiers N500A and N500B (sheet 6). Diode V510 serves for temperature compensation of rectifying diodes V23 and V30 of the directional coupler. It influences the reference voltage at the non-inverting inputs of operational amplifiers N500A and N500B.

Potentiometer R501 permits to adjust the DC offset for the signal DIRF. With potentiometers R506 and R515 the signal amplitude is set.

With model 02 of the amplifier, the transmit signal is routed from the 50-Ω soldering strap X30 via main line 5-6 and soldering straps X41 and X52 as signal ANT to the transmit antenna. With model 02, the soldering straps X40 and X51 are not fitted.

With model 03 of the amplifier, the soldering straps X41 and X52 are not fitted. In this case the transmit signal is supplied via soldering strap X40, capacitor C40, PIN diode V42 and soldering strap X51 as signal ANT to the Tx / Rx antenna. In receive operation, the signal is routed from the Tx / Rx antenna via soldering strap X51 and PIN diodes V44, V46 as signal Rx to the receiver. Functioning of the Tx / Rx switch is described in chapter 5.3.

### 5.2.4 Amplifier Control

(See circuit diagram 6044.2994.01S, sheet 6)

This part of the circuitry contains the operational amplifiers N500A and N500B for the signals of the directional couplers, as mentioned under 5.2.3. In addition,- it generates the temperature-dependent voltages ICR-1, ICR-2 and ICR-3 for the base bias of driver transistor V240 (sheet 3) and output transistors V326 and V327 (sheet 4). A temperature variation will result in a voltage change in the opposite direction. Therefore the collector quiescent currents always remain constant.

As the voltage sources for the voltages ICR-1, ICR-2 and ICR-3 are of identical design, the following only describes the generation of the voltage ICR-2.

The heat sensor B1 (sheet 1) is part of the voltage divider (also containing resistors R550 to R521 / R551 / R560). The voltage drop at heat sensor B1 will decrease with rising temperature. Via the tap of potentiometer R560 this voltage acts upon the non-inverting input of impedance converter N537D / V562. Thus the output voltage ICR-2 (V562.3) will also decrease with rising temperature. The collector quiescent current of output stage transistor V327 (sheet 4) is therefore independent of the temperature.

The diode V546 connected in parallel to heat sensor B1 prevents the output transistors from being destroyed if diode B1 is defective (high impedance). Via voltage divider R547 / R546, the cathode is on approx. 10 mV. For this reason, there will only be a current flow through diode V546 if heat sensor diode B1 is defective.

By means of the FET V544, which is also connected in parallel to B1, the quiescent-current sources are switched on and off depending on the signal *PTT-A. Thus, in no-transmission intervals no quiescent current will flow in the output stage transistor. The signal *PTT-A equally controls the gate of FET V540. The latter switches the + 5-V voltage which is used to generate the base bias voltages of the prestage transistors (signal + 5 V-Tx).

## 5.3 Tx / Rx Switch and PIN Control (with Model 03 only)

(See circuit diagrams 6044.5693.01S, sheet 1 and 6044.2994.01S, sheet 5)

Switching the signal ANT from the Tx / Rx antenna to the transmitter output stage or the receive path (signal Rx) respectively is made by means of PIN diodes V42, V44, V46 and V48. The control voltages RxTx-1, RxTx-2, RxTx-3 for the Tx / Rx switch are supplied by the PIN control submodule via X601 to X603. Coils and R / C filters prevent any leakage of RF voltages.

The DC voltage required to ensure that the PIN diodes of the Tx / Rx switch will block by all means is approx. 200 V for the maximum possible transmit power. The voltage is generated with the aid of a voltage transformer (step-up regulator). The supply voltage is applied to this regulator in transmission only (*PTT-A1 = low level).

The PTT signal *PTT-A1 switches the comparator output N600A.2 to low level. Transistor V604 switched the + 8-$V_C$ operating voltage to the voltage transformer.

Operational amplifier N600C is wired as rectangular-signal generator. The output frequency at N600C.14 is approx. 31 kHz ± 3 kHz. The complementary transistor stage V614 / V615 matches the low-impedance output of the operational amplifier with the input impedance of the subsequent switching transistor V616. At test point X1 the signal is available with an amplitude of approx. 5 to 6 $V_S$.

With switching transistor V616 being through-connected, a magnetic field builds up in storage choke L616. During the blocking phase the energy stored herein is transferred via diode V617 to capacitor C617. Zener diodes V621 to V623 limit the voltage to approx. 200 V. This voltage is monitored by comparator N600D. The signal *PAERR1 changes to low level if the signal *PTT-A1 is on low level (transmission) and the 200-V output voltage of the transformer is missing.

### 5.3.1 Transmission

The signal RxTx-1 is tapped at the collector of transistor V604 and routed via X601 to the anodes of PIN diodes V42 and V48. In transmission here approx. + 8 V are available.

Further, the signal *PTT-A1 is applied to the input of the inverting comparator N600B. In transmission the comparator output N600B.1 blocks transistor V606. The signal RxTx-2 is tapped at the collector and fed via X602 to the cathodes of PIN diodes V42 and V48 as well as to the anodes of PIN diodes V46 and V44.

In transmission a low level is available at these components, since transistor V618 has been switched through by the signal RxTx-1. The cathodes of PIN diodes V44 and V46 are on approx. 200 V (signal RxTx-3). PIN diodes V42 and V48 are conductive and PIN diodes V44 and V46 are blocked.

### 5.3.2 Reception

The signal RxTx-1 is available with low level at the anodes of PIN diodes V42 and V48. The signal RxTx-2 is available with high level at the cathodes of PIN diodes V46 and V44. Transistor V618 is blocked. The cathodes of PIN diodes V44 and V46 are on low level (signal RxTx-3), since transistor V619 is conductive due to the high level of the signal RxTx-2. PIN diodes V42 and V48 are blocked and PIN diodes V44 and V46 are conductive.

# 5. Description of Function

## 5.1 General

(See circuit diagram in the appendix and Fig. 5.1)

The Power Supply IN 251A is an optional module belonging to the transmitters and transceivers of the R&S 200 series. By using the option the operating possibilities are extended even further from pure DC operation to AC / DC operation with automatic switchover.

## 5.2 Primary Side

The mains voltage is routed via a mains connector combination to the primary side of toroidal-core transformer TR1. The circuitry on the primary side contains the fuses F1 and F2, power switch S1 (contacts S1.1 and S1.2), the voltage selector and resistors R18 to R20 connected in series.

The mains connector, fuses, fuse holders, the filter and the voltage selector are all part of the mains connector combination.

Relay REL4 and the series connection of resistors R18 to R20 belong to the starting-current limiting circuit described in the following.

### 5.2.1 Starting-current Limiting Circuit

The main load at the time of switching on is due to the filtering capacitors on the secondary side of the toroidal-core transformer TR1 and its remanence. The resulting high starting currents are avoided as follows:

After switch-on, to begin with the reduced starting current flows through the series connection of the resistors.

As soon as a defined delay time is passed, relay REL4 through-connects the mains voltage via its contact 4.1 directly to the primary winding of the transformer.

## 5.3 Secondary Side

### 5.3.1 AC Operation

Fuses F3 and F4 protect toroidal-core transformer TR1 from overloads on the secondary side. The AC voltage is rectified by a power rectifier circuit made up of double diodes D1 and D2, each of which is mounted to a heat sink.

The resulting voltage (24-VDC output voltage) is filtered by means of capacitor C1 and applied to connectors ST3 ( + ) and ST4 (-).

From this voltage the signal AC LED (at ST5) is obtained via resistor R1 and Zener diode D5. The Zener diode limits the signal to approx. 5 V (TTL level). LED AC lights up as soon as the mains voltage is available. In addition, the voltage acts upon the control winding of relay REL3 of the switchover circuit. Capacitors C8 and C9 suppress any reactive RF effects of the connected transmitting stages.

### 5.3.2 DC Operation

The +24-VDC battery voltage is fed in via connectors ST2 (-) and ST1 ( + ). In the absence of the AC supply voltage contact 3.1 of relay REL3 is closed.

Relay REL2 is energized via diode D6, contact 3.1 and power switch contact S1.3, and contacts 2.1 and 2.2 are closed.

This leads to the following processes:

1. Via resistor R2, the DC input voltage charges capacitor C1 with a limited charging current.

2. Capacitor C4 is charged via resistor R4. If the voltage exceeds the response threshold of transistor switching stage T1, relay REL1 is energized by means of transistor T2, and resistor R2 is bypassed via contact 1.1.

The DC input voltage of battery connections ST2 (-) and ST1 ( + ) is now directly connected to connectors ST3 ( + ) and ST4 (-) ( = full charging current).

### 5.3.3 AC / DC Switchover

If a battery supply is available, the AC / DC switchover circuit triggers a switchover to the DC supply in the case of a mains failure.

During a mains failure the voltage at capacitor C2 and at the winding of relay REL3 breaks down, relay REL3 is de-energized and closes its break contact 3.1.

By way of diode D6, contact 3.1 and switch contact S1.3 relay REL2 is energized and the 24-VDC input voltage (22 to 31 VDC at ST1 / ST2) is routed via contact 2.1 and resistor R2 to connection ST3 / ST4. As soon as C4 is charged, relay REL2 through-connects the full battery current. Once AC power is restored, the battery current is interrupted by REL3 via its contact 3.1.

In other words, the circuit causes an AC / DC switchover, the AC supply always having priority over the DC supply.

The switchover circuit only responds to correct polarity and limits the starting current by time-staggered switching via series resistor.

### 5.3.4 Switch-on Reset

From the secondary winding TR1.8 to TR1.10 a further DC voltage is generated. The latter is rectified by diodes D3 and D4 and filtered by capacitor C2.

Via resistor R1 and Zener diode D5 the signal AC LED (at ST5) is derived from this voltage. The Zener diode limits the signal to approx. 5 V (TTL level). LED AC lights up as soon as the mains voltage is available.

The voltage also acts upon the control winding of relay REL3 of the switchover circuit (refer to 5.3.2).

At a mains failure, the voltage at C2 drops faster than the voltage at C1. Therefore the open collector output of comparator IC1B is switched to ground (capacitor C6 is discharged). Comparator IC1A, switched as Schmitt trigger, through-connects the hitherto inhibited transistor T3. Thus transistor T4 is inhibited and relay REL4 is de-energized.

At renewed switch-on or return of the mains voltage the voltage at C2 rises more quickly than the voltage at C1. The output of comparator IC1B becomes high-impedance.

Once the charging time of R12 and C6 is over, comparator IC1A is connected to ground and transistor T3 is inhibited. As a result transistor T4 is switched on and the current limiting in the primary circuit of the transformer is once again bypassed by relay contact 4.1.

# 6. Repair

(See also circuit diagram, parts lists and components layouts in the Appendix to this Repair Manual.)

## 6.1 Preliminaries

### 6.1.1 General

The repair of Power Supply IN 251A starts with the initial checks according to 6.3 in order to obtain information on the functional order of the module and its technical data.

In the case where faults cannot be clearly localized the results of the initial checks will be the starting point for repairs.

Following repairs the complete initial checks must be carried out again as final check to ensure that the technical data are maintained.

### 6.1.2 Restoring the Nominal Characteristics

Any component that is proved to be defective by means of the initial checks and other troubleshooting measures should only be replaced by a component that meets the specifications of the appropriate parts list in the Appendix to this Repair Manual.

Only in this way can the technical data be guaranteed given in Section 1 of the User Manual.

Following the replacement of components the final check according to 6.6 must be carried out.

### 6.1.3 Spare Parts

All components are subjected to strict quality assurance before they are built into the module.

For components from outside suppliers, such as resistors, capacitors and diodes for example, Rohde & Schwarz have laid down their own defined specifications for the purpose of ensuring maximum reliability.

For this reason we recommend that only original spare parts be used to replace defective components.

When ordering spare parts, please state the following:

- Type,
- Ordering code of the module,
- Serial number of the module,
- Identification number of the parts list,
- Designation plus stock number of the component.

All of these details are to be found in the circuit diagram, parts lists and components layouts accompanying the manual.

### 6.1.4 Important User Information

The following contains details which are essential for carrying out repairs. This information is provided to avoid any misunderstanding which may occur at a later stage.

*CAUTION*

***Do not commence any work on the power supply, such as soldering and the connection of test cables for instance, unless the operating voltage is switched off.***

- **Carry out the initial check of the power supply and the resulting troubleshooting and fault elimination in the given order.**
- **Carry out all measurements only at the given operating voltages.**
- **Carry out all measurements to ground, unless stated otherwise.**
- **The abbreviations in the text, such as IC2.1 e.g., are to be understood as follows:**

  **IC 2, terminal 1**
- **Following the elimination of a fault the appropriate check in accordance with the Table "Check of Equipment Function" must be repeated.**

# 5. Description of Function

(See Fig. 5.1, Block Diagram and Circuit Diagram 6044.7244.01S)

## 5.1 General

The VHF Synthesizer GF 201V, models 22 and 23, is a module belonging to the 200 series. In the VHF single-channel transmitter or VHF single-channel receiver / exciter it generates a frequency in the 118.0000 to 143.9975 MHz range which is routed to the connected modulator. The frequency spacing can be preset and is either 8.33 kHz or 12.5 kHz.

For the generation of the synthesizer frequency the VHF synthesizer contains three low-noise voltage-controlled oscillators (VCOs). These oscillators syntonize within a phase-locked loop (PLL). The reference frequency required for this is derived from a 10-MHz frequency. In model 22 this is generated by a temperature-compensated oscillator. In model 23 in order to obtain a higher frequency accuracy the10-MHz frequency is generated with the aid of an oven-thermostat-stabilized oscillator (OCXO).

The VHF synthesizer is controlled by a microcontroller. The data required for setting the frequency and operating mode are called up from an EPROM. From these data the microcontroller generates data, clock and control signals for the integrated synthesizer module and functional groups of the single-channel unit.

The phase detector of the synthesizer module generates pulses not only during frequency tuning and fine tuning but also following completed tuning. These are integrated in the loop filter which follows. The direct voltage resulting from this is routed to the VCOs as control voltage (tuning and fine tuning voltage).

The output frequency of the VCO activated by the microcontroller is returned via a modulus-2 prescaler to the synthesizer module where it is compared with the reference frequency.

For as long as there are deviations of frequency from the nominal value and phase coincidence has not yet been established, the synthesizer module will continue to create varying pulses. Their pulse width and polarity will depend on the frequency deviation and phase difference.

Following correct tuning a stable direct voltage will be found at the loop filter output. The output frequency of the active VCO will thus be kept constant by this direct voltage.

## 5.2 Oscillators VCO 1 to VCO 3

To provide coverage of the entire frequency range the VHF synthesizer is equipped with three voltage-controlled oscillators (VCOs). The frequency range is distributed over these oscillators as follows:

VCO 1: 118.0000 to 126.0000 MHz

VCO 2: 126.0025 to 135.0000 MHz

VCO 3: 135.0025 to 143.9975 MHz

VCO 1 contains transistor V314 as active component, VCO 2 contains transistor V309 and VCO 3 contains transistor V304.

<u>*Note:*</u>

*The three VCOs are of identical functional design, differing only in the ratings of the passive components. For this reason the description of VCO 1 which follows may be taken as referring to VCO 2 and 3 as well. Attention will be drawn to peculiarities of these last two at the corresponding place.*

Once a frequency in the range 118 to 126 MHz has been set VCO 1 is activated by microcontroller D401 with DIL switches S1 to S3.

This is achieved by the signal OSEL1 routed from output D401.8 with high level via resistor R315 to switching transistor V310. This opens and causes the next switching transistor V311 to open as well. Via its emitter-collector section and choke L309 the + 12-VDC supply voltage is conducted to the RF transistor V314. This activates VCO 1. When the OSEL1 signal is at low level V310 and V311 are inhibited and VCO 1 is switched off.

The frequency of VCO 1 is basically determined by the parallel oscillatory circuit L312, C338, V312 and V313. The capacitance of the two capacitance diodes V312 and V313 is set by the control voltage TUNE (see 5.4.3). A change in this control voltage brings about a change in the resonance frequency of the parallel oscillatory circuit and thus a frequency change of VCO 1.

The VCO frequency is routed as signal RF_OUT via transformer T302 and diode pins V316.1 and .3 to the following buffer amplifier.

VCO 2 is switched on or off with signal OSEL2 and VCO 3 with signal OSEL3. The microcontroller switches only one of the three VCOs on, which one being dependent on the frequency range. The TUNE control voltage is applied simultaneously to all three VCOs but is only processed by the active VCO.

## 5.3 Buffer Amplifier

The frequency generated by one VCO is routed to the buffer amplifier via coupling capacitor C224 and an attenuator.

The buffer amplifier is a modified cascade circuit consisting of transistors V201 and V202. The first stage with V201 is an emitter circuit, while the second stage with V202 functions as base circuit. This thus ensures a high amplification of the VCO output signal and at the same time good isolation of the VCOs from the following modulator of the single-channel unit.

From the output transformer T200 of the buffer amplifier the VCO frequency reaches RF output X94 as signal RF_OUT via coupling capacitor C218, attenuators R224 to R226 and a bandpass filter.

## 5.4 Phase-locked Loop

The VCO which is switched on forms part of a phase-locked loop (PLL). This causes the VCO to oscillate at the set frequency with a constantly high accuracy.

The phase-locked loop consists of the active VCO and transistor V314, V309 or V304, the synthesizer module N202, the modulus-2 prescaler N203 and the loop filter with N200 / N201.

As reference frequency a highly stable 10-MHz frequency is fed into the phase-locked loop via the gate of NAND circuit D404. The frequency is generated either by the temperature-compensated oscillator (TCXO) U100 (model 22) or by the oven-thermostat-stabilized oscillator (OCXO) U101 (model 23).

### 5.4.1 Synthesizer Module N202

The synthesizer module N202 is a complex PLL circuit. It consists of bus interface with control logic, 7-bit A divider, 12-bit N divider, 16-bit R divider, phase detector, modulus control logic, tuning and protective circuits and also circuits for internal control features.

Modulus-2 mode is set and the division ratio of the A, N and R dividers is selected via the 3-conductor bus by the microcontroller D401. To do so the ENABLE_1 signal for enabling (low level) the synthesizer module, the serial data signal DATA and the clock signal CLD are applied to inputs N202.3 to .5 respectively.

Once the synthesizer module has been enabled, serial data are accepted at each positive edge of the clock signal. The data signal here contains information on the setting for the division ratios for the nominal frequency set with S2 and S3 and also for the frequency spacing set with S1 and the transmit frequency OFFSET.

The 10-MHz reference frequency is fed into the synthesizer module at reference frequency input N202.2 (RI). The R divider prepares this frequency as a reference frequency for the phase detector.

At VCO frequency input N202.8 (FI) the 1:64 / 65-divided frequency of the active VCO is fed into the synthesizer module via the modulus-2 prescaler. This frequency is routed to the internal A and N dividers and is divided according to the setting. The division process creates frequencies in the 4.1666-Hz or 2.5-kHz spacing. These are also fed into the phase detector.

The phase detector generates anti-backlash pulses not only during frequency tuning and fine tuning but also following completion of tuning. The width and polarity of these pulses are dependent on the frequency deviation (with respect to the nominal frequency) and on the phase difference. The anti-backlash pulses are available at output N202.12 (PD) and are fed into loop filter N200 / N201.

The modulus-2 prescaler connected to the synthesizer module is controlled via the modulus control output N202.7 (MOD). At the beginning of a tuning cycle this output will be at low level. When the A divider reaches its set value during the tuning cycle the output will switch to high level (1:64 division). When the N divider reaches its set value during the tuning cycle the output will reset to low level (1:65 division).

Via LD output N202.14 the synthesizer module signals whether the phase-locked loop has locked. In its locked state the width of the low signal corresponds to the pulse width of the anti-backlash pulses at the output of phase detector N202.12.

### 5.4.2 Modulus-2 Prescaler N203

The output frequency of the active VCO is fed back to input N203.8 (*IN) of modulus-2 prescaler N203 via attenuators R210 to R213 and filters C213 / L200 / C212. The modulus-2 prescaler can divide the frequency either at the division ratio 1:64 / 65 or 1:128 / 129. Due to the circuitry in the VHF synthesizer the 1:64 / 65 division ratio is set. Switchover to the 1:64 / 1:65 ratio is triggered by the MC signal (modulus control) from the synthesizer module at N203.6.

The output signal of the modulus-2 prescaler at N203.4 (OUT) is routed via the RC network R238 / C209 to the VCO frequency input N202.8 of the synthesizer module.

### 5.4.3 Loop Filter N200 / N201

The anti-backlash pulses at phase detector output N202.12 of the synthesizer module are fed into the loop filter. This consists of an integrator with operational amplifier N200 and an active low-pass filter with operational amplifier N201.

The anti-backlash pulses are first of all integrated in integrator N200. The direct voltage resulting from this is fed into the following low-pass filter. It is here that interference voltages which arise due to the anti-backlash pulses are attenuated.

Afterwards, the DC voltage is fed as control voltage TUNE from the output of the operational amplifier N201.6 via the RC section R235 / R236 / C231 to the VCOs.

If tuning was correct a stable direct voltage will appear at the loop filter output as the result of the output pulses (which will now not change again) of the synthesizer module. The output frequency of the active VCO is kept constant by this direct voltage.

### 5.4.4 Quartz Oscillators U100 / U101

The 10-MHz quartz oscillator generates the reference frequency for the phase detector of synthesizer module N202 and the clock frequency for microcontroller D401.

In model 22 this frequency is generated by the temperature-compensated oscillator (TCXO) U100. The frequency can be finely tuned by means of potentiometer R101 of the voltage dividers R100 to R102.

In model 23 to achieve a higher frequency accuracy the 10-MHz frequency is generated by the oven-thermostat-stabilized oscillator (OCXO) U101. Fine tuning is possible using the internal trimmer.

The oscillator frequency signal (signal OCXO) is routed via the gate of circuit D404 to the clock input D401.36 of the microcontroller and via filters C402 / L400 / C401 to the reference frequency input N202.2 of the synthesizer module.

## 5.5 Control

Control of the VHF synthesizer is handled by microcontroller D401. Among other things the microcontroller carries out the following functions:

- Output of control and frequency information (for frequency and frequency spacing setting and also for transmit frequency OFFSET setting) to the synthesizer module,
- Switching the VCOs on and off depending on the frequency range,
- Switching VCOs off when the frequency range is exceeded.

To be able to carry out these functions the microcontroller is programmed via DIL switches S1 to S3. S1 is used for programming the transmit frequency OFFSET and frequency spacing, while S2 and S3 program the synthesizer frequency.

As specified by the program the microcontroller calls up data from EPROM D403. To do so, first of all the EPROM is addressed by the microcontroller via address signals A8 to A15 and data signals D0 to D7. Here data signals D0 to D7 are routed via latch D402 to the EPROM as address signals A0 to A7.

Corresponding to this addressing, data signals D0 to D7 are called up via EPROM terminals D403.11 to D403.19 and routed to the microcontroller. Latch D402 is blocked while data is being transmitted from the EPROM to the microcontroller.

The microcontroller converts the frequency information from S1 to S3 not only into discrete control signals (for example, OSEL1) but also into serial data signals (DATA) for the synthesizer module.

In addition the microcontroller generates status and control signals which are routed via connector X43 to the functional groups of the single-channel unit.

The SYTEST signal is output as a status message by the microcontroller. This signal has low level if the phase-locked loop has not locked. In this case the synthesizer module generates a low signal at N202.14. In the following monostable multivibrator D200 this is converted into a low pulse of defined width after which it is routed to microcontroller input D401.7 as the UNLOCK signal. The SYTEST signal is routed to connector contact X43.7 via output D401.4 and transistor V400.

If the output signal OFFSET has high level then the higher-level unit is signalled that a transmit frequency OFFSET has been set in the VHF synthesizer. With the 12C bus signals SCL and SDA the VHF synthesizer can be remotely controlled for multi-channel operation via connector X43. A precondition of this however is that the corresponding multi-channel software has been loaded into the VHF synthesizer.

If the single-channel unit is fitted with receiver units then in receive mode the synthesizer frequency is raised 50 kHz above the transmit frequency. In this case the *PTT signal is fed in with high level via X43.9. If the *PTT signal has low level, the synthesizer frequency will be reduced by 50 kHz again.

The 10-MHz reference frequency of quartz oscillator U100 or U101 is used as clock frequency for the microcontroller.

## 5.6 Power Supply Unit

The VHF synthesizer is supplied with a + 18-VDC voltage. This is fed in via connector contact X43.3.

From the + 18-VDC voltage regulator N100 generates a + 12-VDC supply voltage and voltage regulator N101 generates a + 5-VDC supply voltage for the VHF synthesizer components.

# 5. Description of Function

## 5.1 General

(See also circuit diagram 6044.6048.01S and Fig. 5.1)

The Modulator GM 201 is used in the transmitters and transceivers of the series 200 of single-channel radio equipment. Within such a transmitter or transceiver Modulator GM 201 has the following general functions:

- Distribution of the supply voltages fed in from the adapter to the synthesizer, interface 1 and amplifier*.
  (* To the amplifier, only the pre-stage supply voltage and the quiescent current are applied.)
- Conditioning of the modulation and control signals for modulation and carrier activation from the amplifier, fed in via the adapter or interface 1.
- Monitoring the limit values of the synthesizer and amplifier as well as an external amplifier. Once the limit values are exceeded or fallen short of, the operating parameters for the amplifier are modified in such a way that the impact on the functional order is as small as possible.
- Parting from the limit-value monitoring results, generation of a sum message for test indication of the adapter and the external interfaces.
- Conditioning of control signals for the adapter display elements.
- Conditioning of various remote control signals and and the related messages.

Further, Modulator GM 201 may be subdivided into the functional units AF part and control part which in turn are made up of the following subunits:

**AF part:**

- ALC unit (Automatic Level Control)
- Filter unit (300 to 3400 Hz)
- Reduction unit
- Loop amplifier

**Control part:**

- ON / OFF control
- PTT control
- Reduction control
- Monitoring unit
- Bus interface
- Error monitoring unit

## 5.2 AF Part

(See circuit diagram 6044.6048.01S, sheet 3)

### 5.2.1 ALC Unit

(See circuit diagram 6044.6048.01S, sheet 4)

The symmetrical input amplifier is made up of operational amplifier N100A. Control is by means of the signal of a dynamic microphone fed in via contacts X13.8 and X13.9 and / or the signal of a 600-Ω remote line fed in via contacts X73.31 and X73.32.

The amplified output signal (N100A.1) is routed as signal AF-OPT-1 to the interface with an option which may be installed (X35.2). In addition, the signal AF-OPT-1 is applied via a voltage divider to input N100B.5 of operational amplifier N100B.

Connector X110 permits to switch the ALC function on and off. Depending on the wiring of connector X110 the voltage divider mentioned above consists of

- R110 / R111 (ALC function off) or
- R110 / V112 (ALC function on).

Field-effect transistor V112 is the regulating element within the control loop. Operational amplifier N100B amplifies the signal for control of the filter unit (N100B.7, AF-ALC).

Further the signal AF-ALC is applied to the inputs of comparators N130B.7 and N130C.9. The reference voltages of these comparators are obtained from the +10-V voltage via voltage divider R124 to R127, R125, R126. Once the input voltage of the comparators exceeds the reference voltage, the outputs N130C.14 and then N130B.1 will change to high level.

Via resistors R130 and R131 the negative bias at the gate of FET V112 is compensated and the FET's impedance is reduced. The input voltage of operational amplifier N100B decreases, keeping the output amplitude constant.

The output signal AF-ALC is fed to the filter unit via connector X10. Depending on the wiring of X10, the signal may also be routed via an external filter to the reduction unit.

## 5.2.2 Filter Unit

(See circuit diagram 6044.6048.01S, sheet 5)

The filter unit obtains the output signal of the ALC unit or of an external filter via connector X10. The filter unit consists of five active filters connected in series.

The active part of each individual filter consists of an operational amplifier.

Filters 1 and 5 (N100C and N200C) are wired as highpass filter and filters 2 to 4 (N100D, N200A and N200B) as lowpass filters. Summing up the passband curves results in a bandpass filter for the frequency range of 300 Hz to 3.4 kHz.

The output signal of the filter unit is transmitted to the reduction unit via connector X10.

## 5.2.3 Reduction Unit

(See circuit diagram 6044.6048.01S, sheet 6)

The reduction unit generates a DC voltage (0 to -2.2 V) the level of which is determined by the control part by way of the regulated quantity REDU (+5 V to -10 V). This voltage is modulated with the output signal REDin of the filter unit.

The signal REDin is amplified by operational amplifier N200D and fed via the temperature-compensated limiter stage (diodes V223 / V224) to AGC amplifier N230. The supply voltages (-5 $V_{ref}$ and +5 $V_{ref}$) for the diode current of the limiter stage are generated by operational amplifiers N250C and N250D.

AGC amplifier N230 is a linear-controlled AC amplifier. The controlling quantity is the control voltage REDU routed via buffer N250A. Amplifier N240 adds the AC signal from N230.4 (modulation) to the DC value also depending on REDU (mean value of carrier; via R237). Output DESI controls the subsequent loop amplifier

### 5.2.4 Loop Amplifier

(See circuit diagram 6044.6048.01S, sheet 7)

The loop amplifier constitutes a regulated voltage source for supply of the amplifier pre-stage. The level of this voltage determines the amplifier output power and the modulation depth.

Acting as control signal, the output signal DESI (conditioned modulation signal) is routed to the reduction unit.

The circuit D310 (triple 2-channel analog multiplexer / demultiplexer) contains three independent analog switches (switches X, Y and Z). The switch X is switched over by means of the signal PLOHI (switchover of power). In this way the signal DESI is switched either via potentiometer R303 or via R304 to the integrating control amplifier N322. By means of the potentiometers the output powers for the power levels high and low (0 = nominal value) are set.

Switches Y and Z of analog switch D310 serve to switch over between internal and external power control loop. For operation with an external power amplifier, its output voltage is switched to the subsequent difference amplifier (N316).

For operation with the integrated amplifier, the forward signal DIRF of the amplifier is switched to the difference amplifier (N316). Switchover between internal and external control loop is by means of the signal EXTAGC (see chapter 5.3.6, Error Monitoring).

The output signal of the difference amplifier (N316, = actual value) is available with opposite polarity at the same control amplifier N322. For enabling control amplifier N322 (in transmission) the signal *PTT is fed in via diode V320. The output of the control amplifier (N322.6) controls, via diode V326 and FET V337, the base of transistor V330.

FET V337 is blocked via transistor V340 if the -10-V voltage is missing. Zener diode V327 limits the base voltage of transistor V330 to approx. 12 V.

On the emitter of transistor V330 the supply voltage (signal MOD) for the pre-stage of the amplifier module is tapped. For voltage monitoring part of the signal is branched off via resistor R355 (signal MOD-C1).

Transistor V352 and resistors R350 / R351 form a circuit for current monitoring of the signal MOD. For too high a current the transistor becomes conductive and the level of the signal MOD-C1 will rise. The signal is monitored by the control part (reduction control (sheet 12)).

For further monitoring capacitor C348 is charged via diode V347 and resistor R347 to the peak value of the MOD signal. This signal (MOD-C2) is also routed to the control part.

## 5.3 Control Part

(See circuit diagram 6044.6048.01S, sheet 8)

### 5.3.1 ON / OFF Control

(See circuit diagram 6044.6048.01S, sheet 9)

The ON / OFF control generates the control signal ON-TX by logic interconnection of the various control possibilities and the operating-voltage monitoring signals. A high level of this signal causes the power supply to be switched on. In general, the transmitter will always be switched on if none of the various OFF signals is active.

The +5-V supply voltage of the ON / OFF control and the REM bus modules must also be available in standby operation

A stabilizing circuit around a Zener diode (V404, R404 / R405) generates the required +5-V supply voltage directly from the +24-V input voltage.

<u>Note:</u>

*The subsequent text printed in italics only applies for 1:1 changeover operation (jumper on X410.2 ⇒ 3):*

*Due to the negative edge of the output signal *ERROR of the error flipflop (sheet 15) the inverting Schmitt trigger D404D is briefly activated. Via NOR gate D405A, inverting Schmitt trigger D404C, NOR gate D405D and transistor V440 the signal *OFF-TX-1 is set to high level. A second unit connected at this output is enabled (= switched on) and switches its output *OFF-TX-1 to low level. This level will disconnect the first unit via the input *OFF-TX-2.*

*If the voltage is too low, the inverting Schmitt trigger D404A will ensure the switch-off. Across resistor R401 it will drop the voltage difference between the nominal voltage of Zener diode V401 and the input voltage. If this voltage is below the trigger threshold of Schmitt trigger D404A, output D404A.2 will change to high level. Via NOR gate D405A, this high level prevents the transmitter from being switched on.*

### 5.3.2 PTT Control

(See circuit diagram 6044.6048.01S, sheet 10)

The PTT control circuit coordinates the various internal and external possibilities for PTT as well as the various conditions for enabling the carrier activation.

The following PTT signals are summed up:

*PTT-MIC and *PTT-VOX (always possible);
*PTT-INT, 2*PTT-INB and *PTT-I2C (only if *REMOTE-1 = low).

All PTT signals are fed in via inverting Schmitt triggers. If one of the inputs mentioned above is on low level, output SUM-PTT will change to high level.

For disabling the PTT function the signal NOPTT (high level = carrier activation disabled) is available via inverting Schmitt trigger D522F at input D520.13 of NAND gate D520D. This gate prevents the PTT signal from being transmitted any further.

The low level at output D520.11 of NAND gate D520 is monitored as to its timing, if a jumper is on X523 (2 ⇒ 3). With each PTT signal counter D538 starts anew and after 3 to 300 s (depending on the resistance of R534, 0 to 500 kΩ) blocks the PTT signal transmission via the 3-port NOR gate D505C.

In the case of a failure, PTT will also be blocked by the signal *ERROR. The output signal of NOR gate D505C is routed as signal *SOFT-PTT via inverting Schmitt trigger D522A to the control part. In addition, the prolonged signals *PTT, PTT and *PTT-A are derived from the output signal of NOR gate D505C. The prolongation is determined by RC filter R522 / C522.

### 5.3.3 Reduction Control

(See circuit diagram 6044.6048.01S, sheets 11 and 12)

**Circuit diagram:** sheet 11
The reduction control circuit is fed with the following internal and external operating and status data of the transmitters:

- Temperature,
- VSWR,
- Supply voltage,
- PTT,
- Pre-stage supply.

From the sum of these data a DC voltage (RED) is obtained which controls the output power of the amplifier. In addition, the data are used to produce internal and external control signals for monitoring purposes.

The input quantities are compared with nominal values by means of operational amplifiers. The individual results are summed up by a diode matrix and fed to the reduction unit of the AF part.

The signal *SOFT-PTT from the PTT control is shaped by the operational amplifier N621A, which is wired as a lowpass filter, and added to the signal REDU by way of the diode.

Thus the RF power is keyed in a continuous way.

The signal TEMP (heat sensor on the heat sink of the output stage) is amplified by operational amplifier N621D and added to the signal REDU by way of diode V633 (= power reduction for overtemperature). Here the signal OVTEMP is also available. For the external message "temperature > 80" it is output via inverting Schmitt trigger D668E (see sheet 12) as signal TEMP-1. For the internal monitoring function this signal is routed via diode V675 to comparator N603D.

From the signal +24 V (24-V supply voltage) a voltage is produced which reduces the transmitter output power for over- and undervoltage. Undervoltage reduction is made by operational amplifier N621B. Overvoltage reduction is made by operational amplifier N621C wired as inverting amplifier. The output voltages of both operational amplifiers are added to the signal REDU by means of diodes V624 and V633. The signal resulting from of the overvoltage reduction (N621C.8) is available as signal OVVOLT at comparator N603D via diode V675 (sheet 12).

The signal AMP-RED fed in from an external power amplifier via interface 2 is added directly to the signal REDU via diode V662. In this way the control power for the external power amplifier can be reduced if for example the latter's output stage temperature is too high.

The signal DIRR (reflected power; VSWR) from the directional coupler of the amplifier is applied to difference amplifier N611A. For quick reduction of the carrier power the output signal is fed to comparator N611C. Further the signal REVE is routed as signal DISR via lowpass filter R703 / C703 to the integrating comparator N611B of the monitoring unit. Both the direct and the mean-value signal are added to the signal REDU via double diode V640.

By means of the inverting Schmitt trigger D668F, the TTL signal VSWR for error monitoring (see chapter 5.3.6) is generated. The signal MOD-C2 resulting from the peak-value rectification of the output voltage MOD (from the loop amplifier) is amplified by inverter N611D and added to the signal REDU (reduction in the case of overamplification).

**Circuit diagram:** sheet 12

**Blower control**
The signal TEMP from the heat sensor of the amplifier is monitored by Schmitt trigger N603A. Output N603.1 changes to high level, if the heat sink temperature rises above 63 to 70 °C. Via transistor V605 (signal BLW-1) and power MOS-FET V260 of interface 1 an external blower can be switched on.

**Error signal AMTEST**
Comparator N603C monitors the signal MOD-C1 (overcurrent or overvoltage of the loop amplifier). Comparator N603D monitors the signals OVTEMP and OVVOLT. NAND gate D603B sums up the signals at the comparator outputs and D603C masks the error condition, so that only for PTT the error signal AMTEST (low level) can become active after a brief delay (R677 / C675).

**Carrier message (CARRIER)**
The reduction signal REDU is a direct measure for the relative output power. Via comparator N603B and NAND gate D603A, it is used as carrier message CARRIER if the comparators N603C, D do not signal any errors.

## 5.3.4 Monitoring Unit

(See circuit diagram 6044.6048.01S, sheet 13)

The monitoring unit conditions the signals REVE and FORW for control of the adapter display board. For indication of the forward and reverse powers the signals are amplified by the identically designed amplifier stages N700A and N700B and routed each via an R / C lowpass filter to the display board. The active diodes N710A / V703 and N710N / V708 limit the signals to a minimum level (0 V).

The signal for indication of the modulation depth is generated from the signal FORW by means of the active rectifier circuit N710D / V710.

Also contained in the monitoring unit are the amplifiers for the AF outputs "headset" and "600 Ω". These signals allow the transmit signal to be monitored.

## 5.3.5 Bus Interface

(See circuit diagram 6044.6048.01S, sheet 14)

Via the bus interface status messages are inquired and control commands for remote operation transmitted. The serial data input and output are synchronized by the signal SCL (serial clock line). This signal is fed via resistor R805 and inverter D803B to the clock inputs (contact 14) of I / O expanders D810, D820 and D830.

The incoming data (signal SDAO) are transmitted to the data inputs and outputs (contact 15) of the I / O expanders via inverter D803C, resistor R802, inverter D803A and transistor V807.

The outgoing data are transmitted from the data inputs and outputs (contact 15) of the I / O expanders via inverter D803C, resistor R297 (signal SDAI) to a driver transistor of interface 1.

I / O expander D810 serves as extension decoder for the REM bus unit address. Its address ( + 56) is determined by the jumper position on X812. Expanders D820 and D830 are accessed under the addresses 56 (D820) and 57 (D830) respectively. However, access is only possible for a unit with secondary address. Addressing is by placing a jumper onto X813. The selected port output of expander D810 is switched to low level by inscription of the correct secondary address.

The results at the test points of the transmitter are inquired via the bidirectional 8-bit port of expander D830 and the first 4 bits of expander D820.

The signals for the various REM bus control possibilities of the transmitter are forwarded from the second 4 bits of the bidirectional 8-bit port of I / O expander D820 via OR gates D870A to D870D to the control contacts. The second inputs of the OR gates are used to set a time limit for the control signals. Thus unwanted "continuous carriers" resulting from REM bus failures are prevented. Timing control is made by the 14-bit binary counter / oscillator D860. Output Q12 (D860.1) inhibits the OR gates D870A to D870D if within approx. 20 s there are no activities at the selected output of I / O expander D810.

**Circuit diagram:** **sheet 15**
The signal AC-LED fed in via the regulator (adapter) is available, via R / C lowpass filter R953 / C953, at the input of inverting Schmitt trigger D902F. The output signal of D902F is present as signal DC / *AC at tristate bus driver D84 of the bus interface and may be inquired via the REM bus interface.

The REM bus control signal *IPLow and the signal *PLow from the parallel remote interface are combined via diode V923 and inverting Schmitt trigger D902D to form the signal PLO-HI. This signal is applied to the loop amplifier where it leads to a change of the power level.

The REM bus control signal *IPHigh and the signal *PHigh from the parallel remote control interface are combined via diode V927 and inverting Schmitt trigger D902E to form the signal PHI. This signal is transmitted to the interface and causes the external power amplifier to be switched on. Simultaneously, the signal is available in inverted form via NOR gate D951B at an input of NOR gate D951A. At the second input of the NOR gate there is the signal *SOFT-PTT. At the gate output the result (signal PTT-AMP) is available for activation of an external power amplifier.

### 5.3.6 Error Monitoring

(See circuit diagram 6044.5941.01S, sheets 15 and 16)

The error monitoring circuit contains the logic control for sum error messages CBIT-TX-1.

**Circuit diagram: sheet 15**

NAND gates D906 and D911A are interconnected in the form of a flipflop. This flipflop stores error messages occurring at the remaining seven inputs of NAND gate D906. The flipflop is reset for each switch-on or carrier activation of the transmitter by the signal SUM-PTT or ON-TX. The output signal of AND gate D955C is fed to the remaining input of NAND gate D911A. The signal *RESET1 is routed as "Power On Reset" to the PTT control where it causes the PTT time limiting to be reset (counter D538). The signal *RESET serves to reset the error flipflops in the bus interface.

The output signal *ERROR is available at NAND gate D911B (sheet 16). For service purposes it may be deactivated by means of a jumper on X960.

**Circuit diagram: sheet 16**

Via the 4-port NAND gate D911B the output signal *ERROR of the error flipflop is linked with further internal or external signals. External signals are the status messages of an external power amplifier fed in via interface 2. All external signals (TEST-AMP, *VSWR-AMP, *CAR-AMP, ENABLE, PHI and AGC-EXT) are decoupled via inverting Schmitt triggers.

The signals will only be included into the monitoring procedure, if an external amplifier is available. This is signalled by the signal ENABLE being on high level. Via inverting Schmitt trigger D929E this signal enables the NOR gates D930B, D930A, D951C and D930C.

Via NOR gates D960C, D960B, D930D the resulting signals are linked with the internal status messages VSWR, CARRIER and *PTT. In addition, the signals CARRIER-1 and VSWR-1 are coupled out. The output signal of gate D930B.4 (EXTAGC) is fed to the loop amplifier for switchover between internal and external power control loop.

By means of jumpers on X971 and X972, the signals *VSWR and CAR-OK can be isolated from the inputs of NAND gate D991B and applied to the inputs of the error flipflop (sheet 15, D906 / D911A). In this case the messages are stored.

Once the internal and external status messages are linked the result is output as signal CBIT-TX-1 via AND gate D955.

# 5. Description of Function

## 5.1 General

(See circuit diagram 6044.2042.01S and Fig. 5.1)

The Interface 1 GI 201S is used in the transmitters of the Rohde & Schwarz 200 series of radio equipment. Apart from a mode selector (REM, LOC, OFF) and various matching circuits it contains the connectors for the external interfaces REM BUS (X8) and REMOTE (X9) as well as interfaces to the transmitter-internal modules inband interface (X1), interface 2 (X78) and modulator (X73).

## 5.2 REM BUS Interface

(See circuit diagram 6044.2042.01S, sheet 2)

Via the REM BUS interface (X8), operating commands are entered in a serial fashion and the equipment status is inquired. The actual preparation of the input and output data is made by the functional unit "bus interface" of the modulator. The input signals SCL (clock, X8.3) and SDAO (data, X8.4) are routed from REM BUS interface X8 via L / C lowpass filters to socket X73 (modulator). The output signal *SDAI (X73.45) of the modulator is fed via transistor V31 to contact X8.5 (open collector). In addition, a +24-VDC voltage for supply of an external unit (e.g. control unit) is output via contact X8.7.

## 5.3 REMOTE Interface

(See circuit diagram 6044.2042.01S, sheets 3 and 4)

Via the REMOTE interface (X9), the TTL inputs and outputs for parallel control and status inquiry are available. Further the (remote) line inputs and outputs for modulation, PTT and inband control signals as well as the monitoring signal can be tapped at this interface.

### 5.3.1 TTL Input Signals

All external control input signals (*OFF-1, NOPTT, *PHIGH and *PLOW) are routed from the REMOTE interface (X9) via R / C lowpass filters to socket X73 (modulator).

### 5.3.2 TTL Output Signals

(See circuit diagram 6044.2042.01S, sheet 4)

The TTL output signals (CBIT-IB, CBIT-TX-1, CARRIER-1, VSWR-1 and PTT) of the modulator are routed via transistors and L / C lowpass filters to socket X9 (open collectors). In addition, AND gate D200C links the signal CBIT-IB to CBIT-TX-1 to form the signals TEST-TTL (X9.9) and TEST-TX (X9.8).

The 5-VDC supply voltage for AND gate D200 is obtained from the +24-VDC supply by using the voltage stabilizer R270 / V270.

In the Interface 1 GI 201S, there are two lines to be defined by the user, namely input U-DEF1 (X9.15) and output U-DEF2 (X9.31), only one of which can be active at a time. Switchover is possible by making use of jumper X841 on the Modulator GM 201.

The user-defined lines coming from the inband interface, i.e., USER-DEF-1 (X27.C26) and USER-DEF-2 (X27.C15) are linked to the lines U-DEF1 and U-DEF2 respectively by WIRED-OR gates including diode V293 and transistor V291 respectively.

### 5.3.3 Switching Output for External Blower

(See circuit diagram 6044.2042.01S, sheet 4)

The signal BLW-1 (X73.2) from the modulator through-connects power MOSFET V260 for overtemperature of the output stage heat sink. Via L / C lowpass filter L260 / C260 the drain is connected to contact X9.37 (signal *BLW). Via this contact an external DC blower, which on one side is connected to a positive supply voltage, can be switched directly.

### 5.3.4 Line Inputs / Outputs with Phantom Circuits

At the following contacts of the REMOTE interface X9 the line inputs and outputs for an external remote control unit are available:

**X9.32 AF RELAY**
High level input, potential not isolated from ground (GND)

**X9.2 AF / TX / A**
**X9.3 AF / TX / B**
Symmetrical input for modulation and inband control signals as well as DC input for PTT control (phantom-PTT)

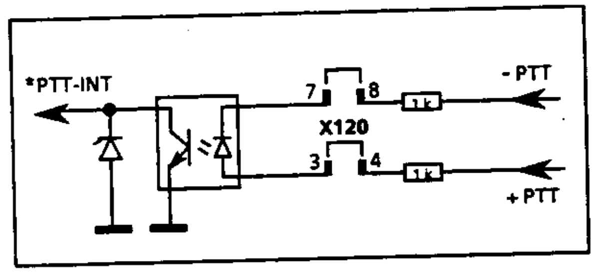
**X9.16 -PTT**
**X9.17 +PTT**
Inputs for PTT DC control voltage

**X9.5 AF / RX / A**
**X9.6 AF / RX / B**
Symmetrical AF output for monitoring of the Tx signal (with signal tones from the inband interface, where applicable) and DC part for carrier monitoring (phantom CARRIER).

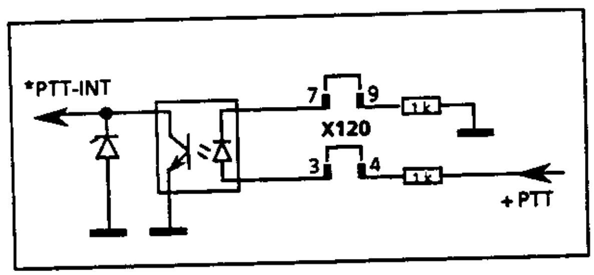
The isolation of the DC control signals from the AF signals as well as the galvanical isolation of the remote line (without phantom) are made by transformers.

### 5.3.5 Processing of PTT Control Signals

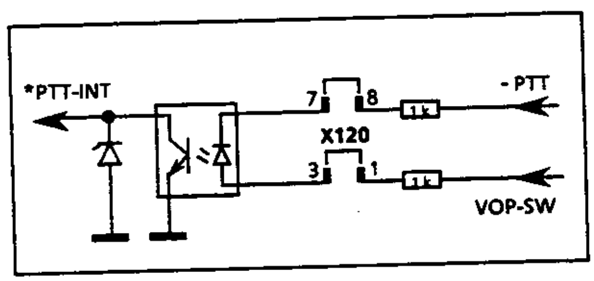
The various possibilities of PTT control signal processing are selected by placing jumpers onto pin block X120. The following figures provide information on the functions related to the individual positions.



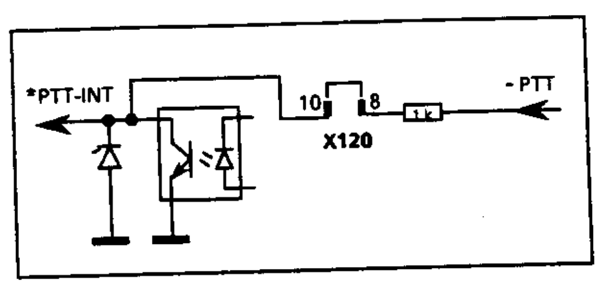

PTT Opto / Float



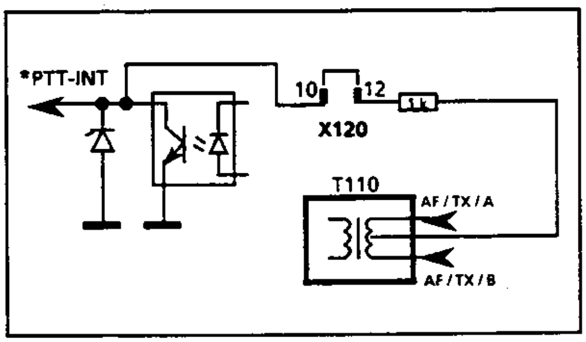

PTT Opto / GND



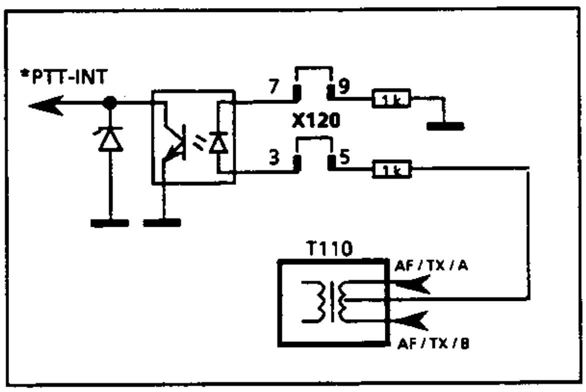

PTT Opto / $V_{OP}$




PTT Norm




PTT Phantom




PTT Phantom / GND

## 5.3.6 AF Input AF / TX / A / B

The modulation and the PTT signals from an external control unit are routed via the remote line to contacts X9.2 (AF/TX/A) and X9.3 (AF/TX/B). Via L / C filters, a level limiter and an impedance switchover facility the signal is fed to 600-Ω transformer T110.

The level-limiting diode V115 responds at approx. 3.3 $V_{pp}$. Impedance switchover from 600 Ω to 1200 Ω allows parallel control of two transmitters from one control unit (standby operation). This switchover is made by placing a jumper onto contacts X115.2 and 3.

Via the centre tap on the primary side of 600-Ω transformer T110 the DC control voltage for carrier activation is coupled out (phantom circuit).

The voltage is applied to pin block X120. By placing jumpers onto the contacts of X120 it is possible to select the different possibilities for carrier activation.

The secondary side of 600-Ω transformer T110 is connected via potentiometer R110 to pin block X110. Depending on the jumper position on X110, the signal is fed either directly or via the optional inband interface to the modulator.

## 5.3.7 AF Output AF / RX / A / B

Depending on the jumper position on pin block X130, either the signal AF-RX-A from the optional inband interface or the signal AF-TX from the modulator is available on the primary side of 600-Ω transformer T130. The secondary signal is applied via an impedance switchover facility, a level limiter and an L / C filter to contacts X9.5 (AF / RX / A) and X9.6 (AF / RX / B).

The level-limiting diode V135 responds at approx. 3.3 $V_{pp}$. Impedance switchover from 1200 Ω to 600 Ω is made by placing a jumper onto contacts X135.1 and 2.

By means of the jumpers on pin block X140, the carrier message (signal PH-CAR) can be switched to the centre tap on the secondary side of 600-Ω transformer T130.

# 6. Repair

(See circuit diagram, parts list and components layout in the appendix to this repair manual.)

## 6.1 Preliminary Remarks

### 6.1.1 General

The repair of VHF Synthesizer GF 201V begins with the initial checks in order to obtain information on the functional order of the unit and its technical data. In the case that faults cannot be clearly localized, the test results obtained by the initial checks will be the starting point for repair.

<u>Note:</u>

*During the initial checks and the troubleshooting the VHF synthesizer is switched to different, exactly defined configurations. Before starting repairs, the basic configuration has to be noted and must be restored after the final test.*

### 6.1.2 Restoring Nominal Characteristics

Any component which is proved to be defective by the initial checks and other troubleshooting procedures should only be replaced by a component which fully meets the specifications given in the respective parts list in the appendix to this Repair Manual.

Only in this way can the technical data stated in section 1 of the User Manual be guaranteed.

Following any repairs, the final test acc. to 6.6 must be carried out.

### 6.1.3 Spare Parts

All components are subjected to strict quality control before they are built into the unit.

For components from outside suppliers, e.g. resistors, capacitors, diodes, transistors and integrated through to high-integrated circuits, R&S have laid down delivery specifications for the purpose of ensuring maximum reliability.

For this reason we recommend that only original spare parts be used for replacing defective components.

When ordering a spare part, please state the following:

- Type,
- Ordering code of equipment,
- Serial number of equipment,
- Identification number of parts list,
- Designation plus stock number of the component concerned.

The above can be found in the circuit diagram, parts list and components layout supplied with this manual.

## 6.1.4 Important User Information

The following contains details which are essential when referring to Section 6 "Repair". This is in order to prevent misunderstandings at a later stage.

### *CAUTION*

***Do not carry out any soldering or re-arranging of jumpers nor replace any components unless the operating voltage is disconnected.***

- Carry out the initial checks of the VHF synthesizer as well as troubleshooting and fault elimination in the order given.
- If parameters are set for testing, which are not equal to the operating parameters, restore the operating parameters after final test.
- All measurements, alignment and functional checks are to be made at the permitted operating voltage only.
- All measurements are referred to ground, unless stated otherwise.
- Abbreviations in the text such as X43.7 or D401.8 are to be understood as follows:

  Connector X43, contact 7,

  Integrated circuit D401, pin 8.
- All signals in the text marked with an asterisk (*) are low-active signals.
- Once a fault has been eliminated, the complete check concerned must be carried out once more in accordance with Section 6.3.2.

### *CAUTION ESD!*

***The VHF synthesizer includes, among others, MOS, MOSFET and CMOS components. These devices are extremely sensitive to extraneous high voltages (static discharge).***

***Static discharge may produce very high voltage spikes which are capable of damaging these devices.***

***Therefore when work is being carried out on these devices a special CMOS work station is required.***

If no special work station is available, the following minimum requirements must be met:

- Conductive bench and floor covering
- Chair or stool with conductive covering
- Earthed, metallic working top and conductive wrist-straps with a resistance of >200 kΩ,<1 MΩ as well as an insulated lead and plug
- Soldering iron with safety grounding
- All conductive covering, wrist-straps and working tops must be interconnected by insulated lines.

## 6.2 Test Equipment and Special Tools

The test equipment listed in the table below will be required for the tests described in this manual.

<u>Note:</u>

*Equivalent items of test equipment can be used.*
*Special tools are not required.*

### 6.2.1 List of Test Equipment

| Item | Test equipment, required data | Equipment recommended by R&S | Ordering code |
|---|---|---|---|
| 1 | Power supply (adjustable), 2 pieces<br>18 VDC / 1 A | NGA 35 | 0192.0010.04 |
| 2 | Digital multimeter<br>0 to 20 VDC, 0 to 1 A | UDL 45 | 1037.1507.02 |
| 3 | Modulation analyzer<br>50 kHz to 200 MHz, FM | FMA | 0852.8500.52 |
| 4 | Spectrum analyzer<br>1 kHz to 200 MHz | FSA | 0804.8010.55 |
| 5 | Frequency counter, digital<br>0.1 kHz to 250 MHz | conventional workshop model | - |
| 6 | Buffer oscilloscope<br>bandwidth appr. 10 MHz | conventional workshop model | - |
| 7 | Termination<br>50 Ω | conventional workshop model | - |

# 6.3 Initial Checks

## 6.3.1 Visual Check

If the VHF synthesizer is suspected of being faulty, subject the unit first of all to a visual check.

For this remove the module from the single-channel unit according to chapter 6.5.

For visual inspection proceed as follows:

1. Carefully examine all connectors for bent, corroded or broken contacts / pins or sockets.

   If necessary, replace any defective connectors in accordance with 6.5.2.

**CAUTION**

***If a connector shows any discolouration due to excessive heat, the mating part is also defective and must always be replaced too.***

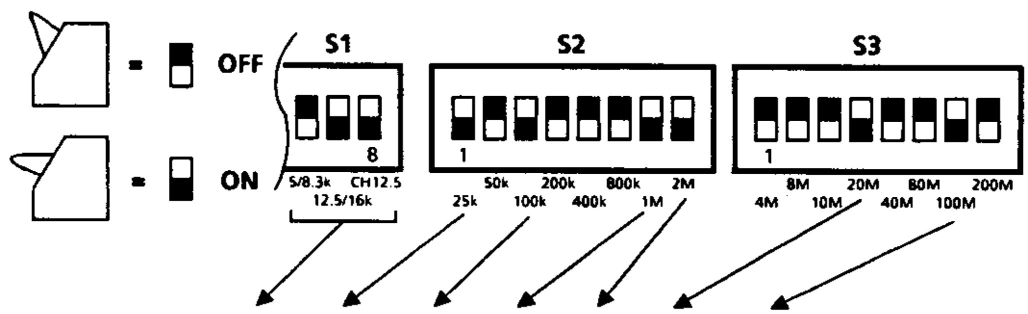
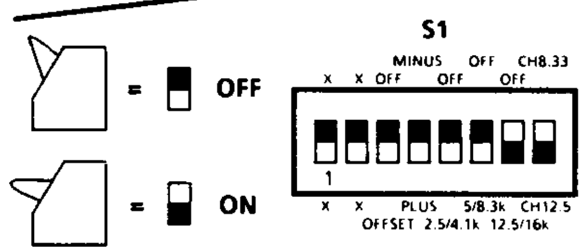
2. Examine the PCB for discolouration and interruptions. If any damage is found due to heat, we recommend to replace the entire PCB.

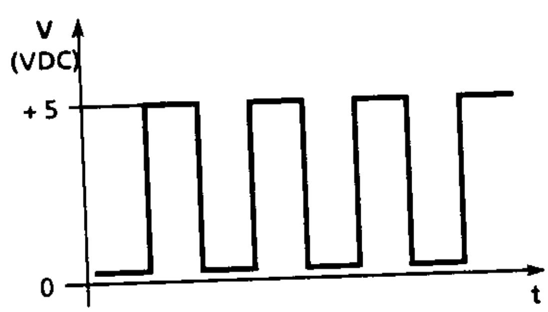
3. In order to guarantee the reliability of the module, it is absolutely essential to replace any discoloured or burnt components in compliance with 6.5.2.

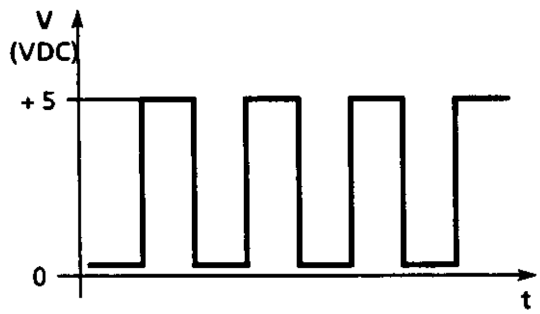
## 6.3.2 Check of Equipment Functions

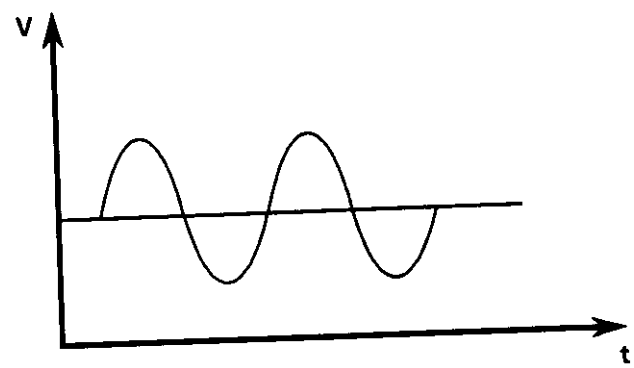
*Note:*

***The activities and nominal values listed below and also fault elimination refer equally to models 22 and 23 of the VHF synthesizer unless specified otherwise.***

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 1. | **Preparations** | | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | | |
| 1.2 | Check to see whether DIL switches S1 to S3 have been set in line with the operating frequency required (synthesizer frequency).<br><br><br>Example: $f_s$ = 12.5 k + 25 k + 100 k + 1 M + 2 M + 20 M + 100 M = 123.1375 MHz | Setting (example) | Set synthesizer frequency |
| 1.3 | Check to see whether DIL switch S1 has been set to the operating modes required.<br><br><br>Example: Transmit frequency OFFSET switched off, frequency spacing 12.5 kHz | Setting (example) | Set operating modes |
| 1.4 | Prepare the test setup shown in Fig. 6.1 and switch on the test equipment. | | |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| **2.** | **Checking the Supply Voltage** | | |
| 2.1 | With a digital multimeter (voltmeter) check the supply voltage at connector contact X43.3. | 18.0 VDC<br>+ 2 / - 0.2 VDC | see 6.4.1 |
| **3.** | **Checking the Power Consumption** | | |
| 3.1 | With a digital multimeter (ammeter) check the current between the 18-VDC power supply unit and connector contact X43.3. | ≤ 450 mA | see 6.4.1 |
| **4.** | **Checking the Internally Generated DC Voltages** | | |
| 4.1 | With a digital multimeter (voltmeter) check the DC voltages at the following contacts. | | |
| | + 12-VDC voltage at IC pin N100.3 | + 12 VDC | see 6.4.1 |
| | + 5-VDC voltage at IC pin N101.3 | + 5 VDC | see 6.4.1 |
| **5.** | **Checking the Reference Frequency, Model 22** | | |
| 5.1 | Connect the oscilloscope to IC pin D404.3 and check the signal shape of the reference frequency.<br> | | see 6.4.2 |
| 5.2 | Connect the frequency counter to IC pin D404.3 and check the reference frequency. | 10 MHz | see 6.4.2 |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| **6.** | **Checking the Reference Frequency, Model 23** | | |
| 6.1 | Make sure that the VHF synthesizer has been in operation for at least 30 minutes (warming-up phase of the oven-thermostat-stabilized oscillator). | | |
| 6.2 | Connect the oscilloscope to IC pin D404.3 and check the signal shape of the reference frequency.   | | see 6.4.2 |
| 6.3 | Connect the frequency counter to IC pin D404.3 and check the reference frequency. | 10 MHz | see 6.4.2 |
| **7.** | **Checking the VHF Synthesizer Output Signal** | | |
| 7.1 | Model 22 only:<br><br>Make sure that the VHF synthesizer has been in operation for at least 30 minutes (warming-up phase of the oven-thermostat-stabilized oscillator). | | |
| 7.2 | Connect the spectrum analyzer to X94 and check the signal shape of the RF signal. | | |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| |  | | see 6.4.3 |
| 7.3 | Connect the spectrum analyzer to X94 and check the frequency of the RF signal. | Operating frequency $f_s$ of the VHF synthesizer | see 6.4.3 |
| 7.4 | Connect the spectrum analyzer to X94 and check the RF level of the RF signal. | 13 ± 1 dBm | see 6.4.3 |
| **8.** | **Checking the Operating Frequency Offset in Transmit and Receive Modes** | | |
| 8.1 | Connect the spectrum analyzer to X94 and check the frequency of the RF signal. | Operating frequency $f_s$ of the VHF synthesizer | see 6.4.9 |
| 8.2 | Disconnect IC pin X43.9 (*PTT) from ground (= receive mode).<br><br>Note:<br><br>*When the pin is disconnected from ground, high level is applied automatically, due to an internal pull-up resistor (high level = receive mode).* | | |
| 8.3 | Check the frequency of the RF signal with the spectrum analyzer at X94. | $f_s$ + 50 kHz | see 6.4.9 |
| 8.4 | Switch off the test equipment and dismantle the test setup. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | | |

## 6.4 Troubleshooting and Fault Elimination

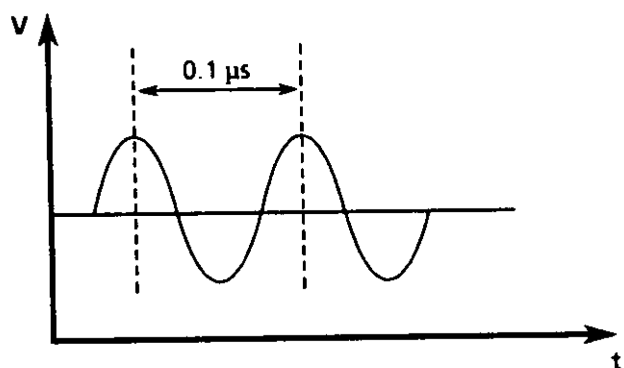
<u>*Note:*</u>

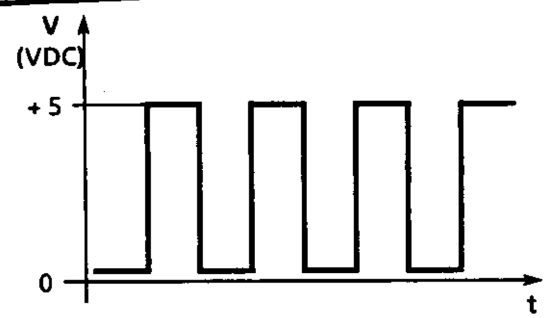
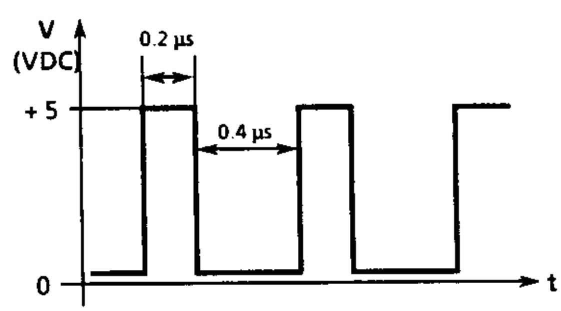
*The activities and nominal values listed below and also fault elimination refer equally to models 22 <u>and</u> 23 of the VHF synthesizer unless specified otherwise.*

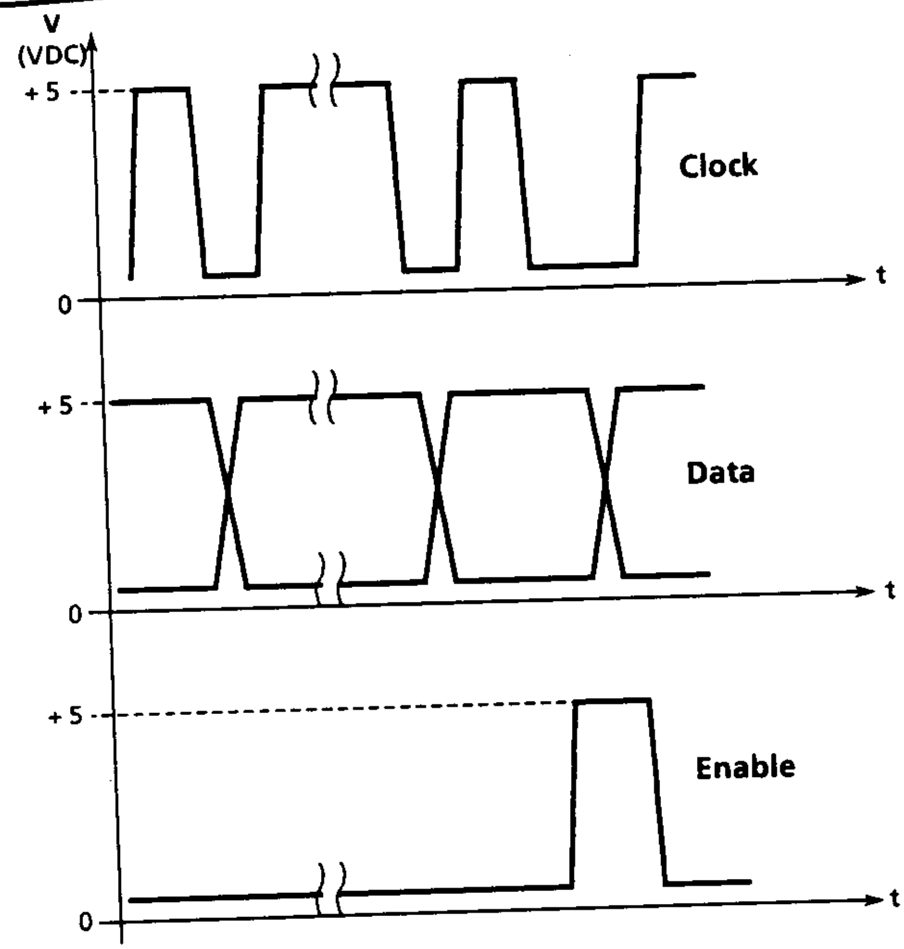
### 6.4.1 Fault: "Power Supply"

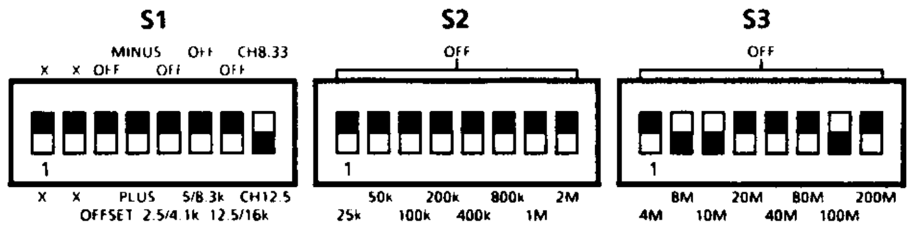
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1 and switch on the test equipment required. | |
| **2.** | **Checking the Incoming Supply Voltage and Current** | |
| 2.1 | With a digital multimeter (voltmeter) check the voltage at connector contact X43.3.<br>Possible cause of fault: L100, C102, C103, N100, L101, C106, C107, N101 | + 18 VDC + 2 / - 0.2 VDC |
| 2.2 | With a digital multimeter (ammeter) check the current between the 18-VDC power supply unit and contact X43.3.<br>Possible cause of fault: L100, C102, C103, N100, L101, C106, C107, N101, faulty PCB | ≤ 450 mA |
| **3.** | **Checking the Internally Generated DC Voltages** | |
| 3.1 | With a digital multimeter (voltmeter) check the DC voltages at IC pin N100.3.<br>Possible cause of fault: N100, C100, C101, connected components | + 12 VDC |
| 3.2 | With a digital multimeter (voltmeter) check the DC voltages at IC pin N101.3.<br>Possible cause of fault: N101, C104, C105, connected components | + 5 VDC |
| 3.3 | Switch off the test equipment and dismantle the test setup. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

## 6.4.2 Fault: "Reference Frequency, Clock Generation and Clock Processing"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1 and switch on the test equipment required. | |
| **2.** | **Checking the Quartz Oscillator Frequency, Model 22** | |
| 2.1 | With an oscilloscope connected to quartz oscillator pin U100.2 check the signal shape of the oscillator frequency.<br><br><br>Possible cause of fault: U100, R100 to R102 | |
| 2.2 | Connect the frequency counter to quartz oscillator pin U100.2 and check the oscillator frequency.<br>Possible cause of fault: U100, inaccurate calibration<br>If necessary, adjust the oscillator frequency using potentiometer R101. | $f_{osc}$ = 10.000 MHz<br>Accuracy: $1.5 \times 10^{-6}$ |
| **3.** | **Checking the Quartz Oscillator Frequency, Model 23** | |
| 3.1 | Make sure that the VHF synthesizer has been in operation for at least 30 minutes (warming-up phase of the oven-thermostat-stabilized oscillator). | |

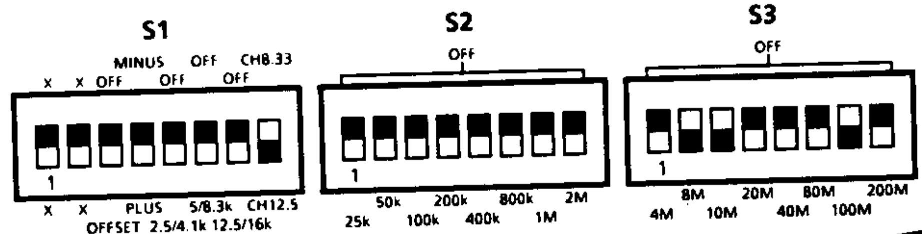
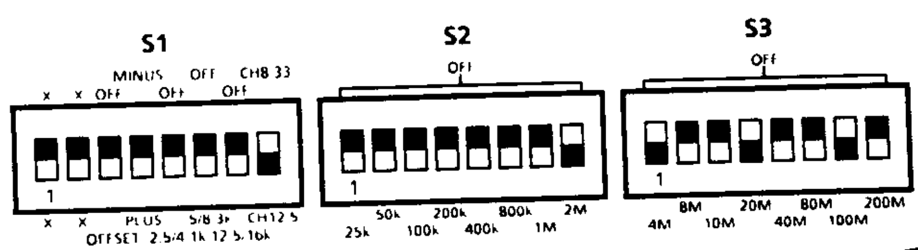
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 3.2 | With an oscilloscope connected to quartz oscillator pin U101.1 check the signal shape of the oscillator frequency. | For signal shape, see step 2.1 |
| 3.3 | Connect the frequency counter to quartz oscillator pin U101.1 and check the oscillator frequency.<br><br>Possible cause of fault: U100<br><br>If necessary, adjust the oscillator frequency using the trimmer of the quartz oven. | $f_{osc}$ = 10.000 MHz<br>Accuracy: $0.2 \times 10^{-6}$ |
| 4. | **Checking the Reference Frequency** | |
| 4.1 | Connect the oscilloscope to IC pin D404.3 and check the signal shape of the reference frequency.<br><br>Possible cause of fault: D404, R400, C403 | |
| 5. | **Checking the Microcontroller Clock** | |
| 5.1 | Connect the oscilloscope to IC pin D402.11 and check the signal shape of the microcontroller clock.<br> | |

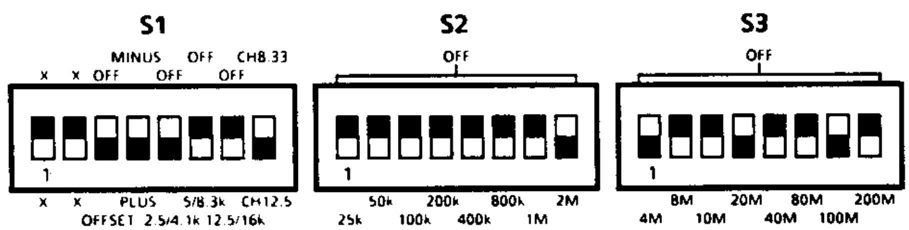
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| | Possible cause of fault: D401, connected components | |
| **6.** | **Checking the Data Output (Qualitative) on the 3-Conductor Bus** | |
| 6.1 | Remove jumper X200 from contacts X200.2, .3 (interrupting the PLL). | |
| 6.2 | Connect the storage oscilloscope to IC pins D400.3 (CLD, clock signal), D400.8 (DATA, serial data signal) and D400.6 (ENABLE_1, enable signal) and make a qualitative check of the data telegrams.<br><br>The data telegrams are repeated every 90 ms.<br>Possible cause of fault: D401, D400, connected components, D402, D403, software in D403 | |

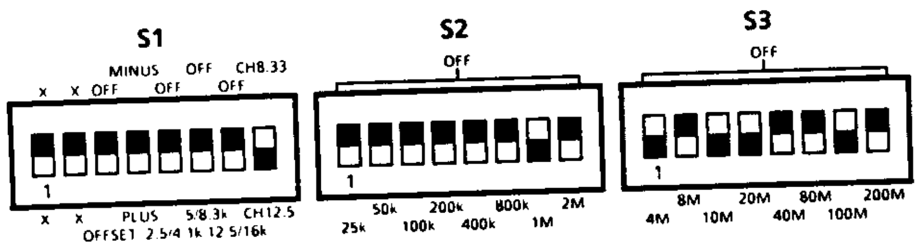
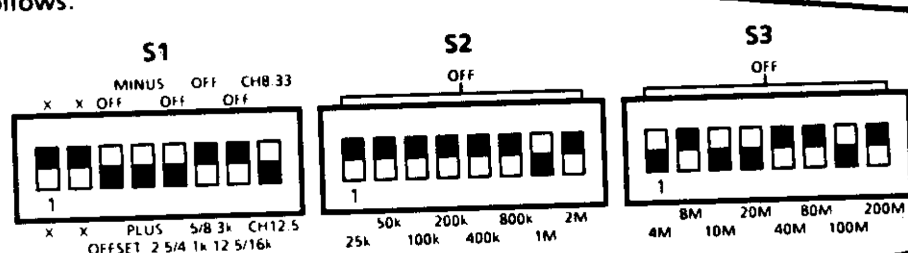
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 6.3 | Bridge contacts X200.2, .3 again with jumper X200 (PLL closed). | |
| 6.4 | Using DIL switches S1 to S3 set a frequency of 118 MHz as follows:   | |
| 6.5 | Connect the storage oscilloscope to IC pins D400.3 (CLD, clock signal), D400.8 (DATA, serial data signal) and D400.6 (ENABLE_1, enable signal) and make a qualitative check of the data telegrams.<br>Possible cause of fault: D401, D400, connected components, D402, D403, software in D403 | no data telegrams |
| 6.6 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

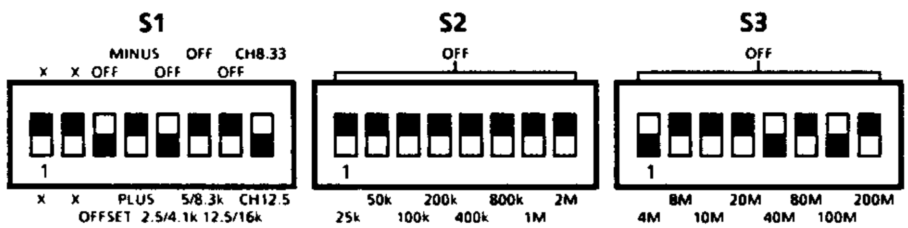
### 6.4.3 Fault: "Tuning and RF Level"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 1. | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the digital multimeter to contact X200.3 and the spectrum analyzer to connector X94. Now switch on the test equipment. | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **2.** | **Checking the Synchronization at the Frequency Range Limits of the VCOs** | |
| 2.1 | Set a reference level of + 20 dBm at the spectrum analyzer. | |
| 2.2 | Using DIL switches S1 to S3 set a frequency of 118 MHz as follows:  | |
| 2.3 | With the spectrum analyzer check the output frequency.<br>Possible cause of fault: V312 to V314, D401, D402, D403, N202, software in D403 | 118.0000 MHz |
| 2.4 | With the spectrum analyzer check the RF level of the output frequency.<br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 2.5 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br>Possible cause of fault: N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |
| 2.6 | Using DIL switches S1 to S3 set a frequency of 126 MHz as follows:  | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.7 | With the spectrum analyzer check the output frequency.<br><br>Possible cause of fault: V312 to V314, D401, D402, D403, N202, software in D403 | 126.0000 MHz |
| 2.8 | With the spectrum analyzer check the RF level of the output frequency.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 2.9 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br><br>Possible cause of fault: N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |
| 2.10 | Using DIL switches S1 to S3 set a frequency of 126.0025 MHz as follows:<br> | |
| 2.11 | With the spectrum analyzer check the output frequency.<br><br>Possible cause of fault: V307 to V309, D401, D402, D403, N202, software in D403 | 126.0025 MHz |
| 2.12 | With the spectrum analyzer check the RF level of the output frequency.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 2.13 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br><br>Possible cause of fault: N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |

| No. | Activity / fault elimination | | Nominal value |
|---|---|---|---|
| 2.14 | Using DIL switches S1 to S3 set a frequency of 135.0000 MHz as follows:<br> | | |
| 2.15 | With the spectrum analyzer check the output frequency.<br><br>Possible cause of fault: | V307 to V309, D401, D402, D403, N202, software in D403 | 135.0000 MHz |
| 2.16 | With the spectrum analyzer check the RF level of the output frequency.<br><br>Possible cause of fault: | V201, V202, T200 | + 13 ± 1 dBm |
| 2.17 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br><br>Possible cause of fault: | N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |
| 2.18 | Using DIL switches S1 to S3 set a frequency of 135.0025 MHz as follows:<br> | | |
| 2.19 | With the spectrum analyzer check the output frequency.<br><br>Possible cause of fault: | V302 to V304, D401, D402, D403, N202, software in D403 | 135.0025 MHz |

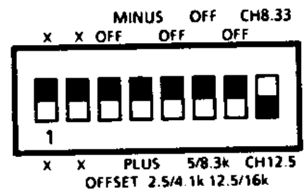
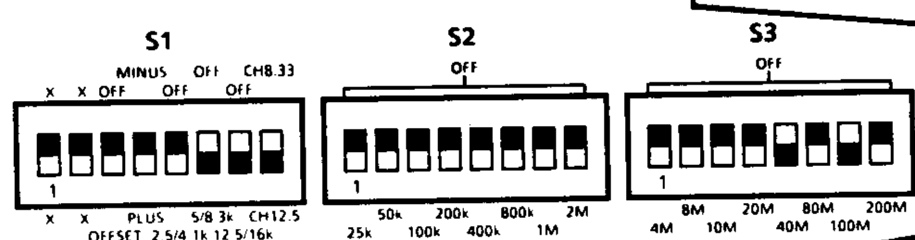
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.20 | With the spectrum analyzer check the RF level of the output frequency.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 2.21 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br><br>Possible cause of fault: N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |
| 2.22 | Using DIL switches S1 to S3 set a frequency of 143.9975 MHz as follows:<br>  | |
| 2.23 | With the spectrum analyzer check the output frequency.<br><br>Possible cause of fault: V302 to V304, D401, D402, D403, N202, software in D403 | 143.9975 MHz |
| 2.24 | With the spectrum analyzer check the RF level of the output frequency.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 2.25 | With the digital multimeter (voltmeter) check the control voltage TUNE.<br><br>Possible cause of fault: N200 to N202, D402, D403, software in D403 | + 2 to + 8 VDC |
| **3.** | **Checking the RF Signals within the Tuning Ranges of the VCOs** | |
| 3.1 | Remove jumper X200 from contacts X200.2, .3 (interrupting the PLL). | |

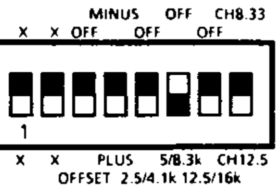
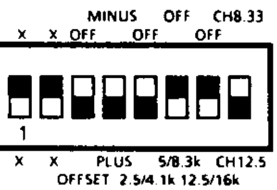
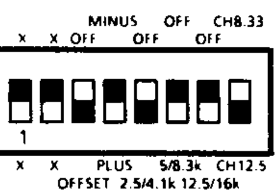
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 3.2 | Connect the positive pole of the adjustable power supply unit to contact X200.3 and the negative pole to X200.4. | |
| 3.3 | At the spectrum analyzer set a reference level of + 20 dBm. | |
| 3.4 | Using DIL switches S1 to S3 set any frequency between 118.0000 MHz and 126.0000 MHz.<br><br>__Note:__<br><br>*If an impermissible frequency is set all VCOs will be blocked. If a pseudo-tetrad is input all VCOs will also be blocked. This means that with each BCD decade the total value of '9' must not be exceeded.*<br><br>*Example: 4 MHz + 8 MHz > 9 MHz* not permissible !!<br>*therefore 10 MHz + 2 MHz permissible* | |
| 3.5 | At the adjustable power supply unit change the control voltage continuously within the range + 1 to + 8 VDC. | |
| 3.6 | Using the spectrum analyzer check the frequency response of VCO 1 over the entire tuning range.<br><br>Possible cause of fault: V312 to V314, passive components of the VCO 1 | 118.0000 MHz to 126.0000 MHz |
| 3.7 | Using the spectrum analyzer check the RF level over the entire frequency range of the VCO 1.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 3.8 | Using DIL switches S1 to S3 set any frequency between 126.0025 MHz and 135.0000 MHz. | |
| 3.9 | At the adjustable power supply unit change the control voltage continuously within the range + 1 to + 8 VDC. | |
| 3.10 | Using the spectrum analyzer check the frequency response of VCO 2 over the entire tuning range.<br><br>Possible cause of fault: V307 to V309, passive components of the VCO 2 | 126.0025 MHz to 135.0000 MHz |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 3.11 | Using the spectrum analyzer check the RF level over the entire frequency range of the VCO 2.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 3.12 | Using DIL switches S1 to S3 set any frequency between 135.0025 MHz and 143.9975 MHz. | |
| 3.13 | At the adjustable power supply unit change the control voltage continuously within the range + 1 to + 8 VDC. | |
| 3.14 | Using the spectrum analyzer check the frequency response of VCO 3 over the entire tuning range.<br><br>Possible cause of fault: V302 to V304, passive components of the VCO 3 | 135.0025 MHz to 143.9975 MHz |
| 3.15 | Using the spectrum analyzer check the RF level over the entire frequency range of the VCO 3.<br><br>Possible cause of fault: V201, V202, T200 | + 13 ± 1 dBm |
| 3.16 | Replace jumper X200 on contacts X200.2, .3. | |
| 3.17 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

### 6.4.4 Fault: "DIL Switches S1 to S3 (Frequency Setting)"

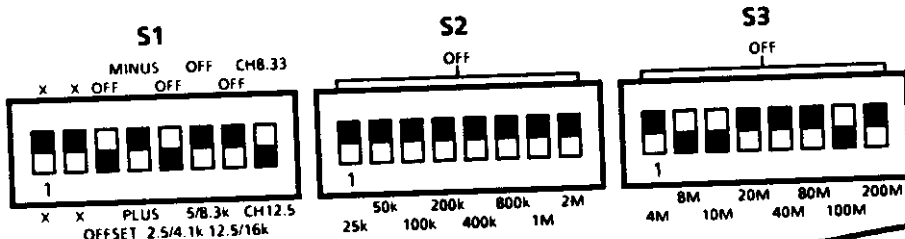
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 1. | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the spectrum analyzer to connector X94. Now switch on the test equipment. | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **2.** | **Checking DIL Switches S1 to S3** | |
| 2.1 | Set DIL switches S1 to S8 as follows:<br><br> | |
| 2.2 | Make the following settings one after the other with DIL switches S1 and S2 and each time check the frequency with the spectrum analyzer:<br>100 M + 40 M<br>100 M + 20 M<br>100 M + 10 M + 8 M<br>100 M + 20 M + 4 M<br>100 M + 20 M + 2 M<br>100 M + 20 M + 1 M<br>100 M + 20 M + 800 k<br>100 M + 20 M + 400 k<br>100 M + 20 M + 200 k<br>100 M + 20 M + 100 k<br>100 M + 20 M + 50 k<br>100 M + 20 M + 25 k<br>Possible cause of fault: the DIL switches used in each case, D401 to D403, D400, N202 | 140.0000 MHz<br>120.0000 MHz<br>118.0000 MHz<br>124.0000 MHz<br>122.0000 MHz<br>121.0000 MHz<br>120.8000 MHz<br>120.4000 MHz<br>120.2000 MHz<br>120.1000 MHz<br>120.0500 MHz<br>120.0250 MHz |
| 2.3 | Set DIL switches S1 to S3 as follows:<br><br> | |
| 2.4 | Using the spectrum analyzer check the frequency.<br>Possible cause of fault: S1.6 to S1.8, D401 to D403, D400, N202 | 140.0125 MHz |

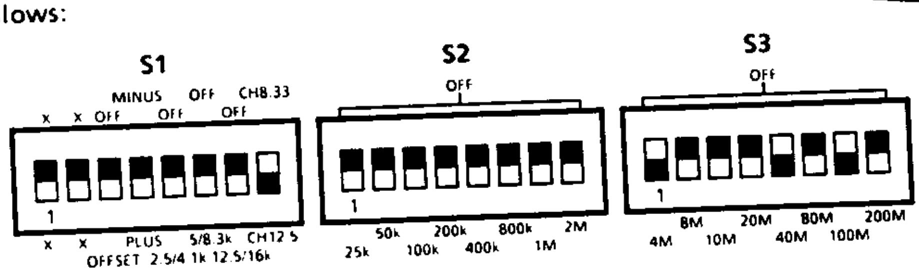
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.5 | Change the setting of the DIL switches S1.1 to S1.8 as follows:<br><br> | |
| 2.6 | Using the spectrum analyzer check the frequency.<br><br>Possible cause of fault: S1.6 to S1.8, D401 to D403, D400, N202 | 140.00833 MHz |
| 2.7 | Change the setting of the DIL switches S1.1 to S1.8 as follows:<br><br> | |
| 2.8 | Using the spectrum analyzer check the frequency.<br><br>Possible cause of fault: S1.3 to S1.5, D401 to D403, D400, N202 | 140.0025 MHz |
| 2.9 | Change the setting of the DIL switches S1.1 to S1.8 as follows:<br><br> | |
| 2.10 | Using the spectrum analyzer check the frequency.<br><br>Possible cause of fault: S1.3 to S1.5, D401 to D403, D400, N202 | 139.9975 MHz |
| 2.11 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

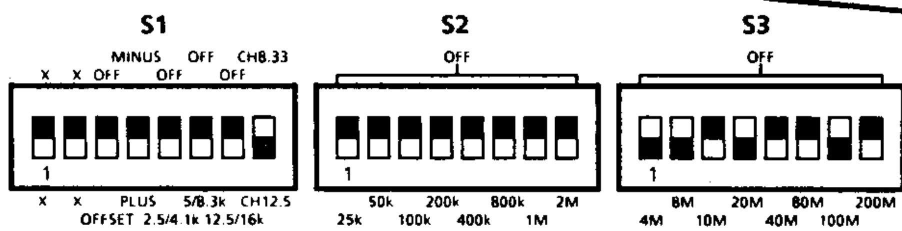
## 6.4.5 Fault: "VCO Block"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 1. | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the spectrum analyzer to connector X94. Now switch on the test equipment. | |
| 2. | **VCO Block for Synthesizer Frequencies below 118 MHz** | |
| 2.1 | With DIL switches S1 to S3 set a frequency of 117.9975 MHz as follows: | |




| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.2 | Using the spectrum analyzer check the output frequency and the RF level of the output frequency. Possible cause of fault: S1 to S3, D401 to D403 | no RF output signals |
| 3. | **VCO Block for Synthesizer Frequencies above 143.9975 MHz** | |
| 3.1 | With DIL switches S1 to S3 set a frequency of 144.0000 MHz as follows: | |



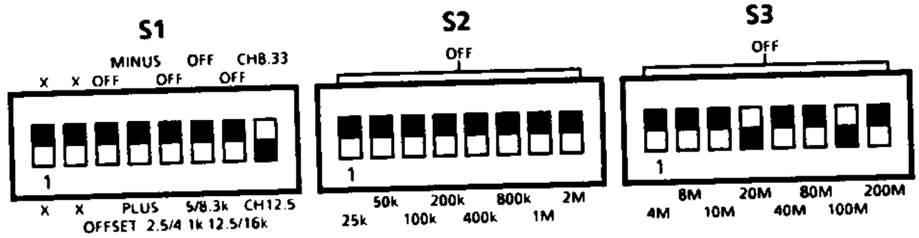
| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 3.2 | Using the spectrum analyzer check the output frequency and the RF level of the output frequency.<br><br>Possible cause of fault: S1 to S3, D401 to D403 | no RF output signals |
| **4.** | **VCO Block with Pseudo-Tetrad Settings** | |
| 4.1 | With DIL switches S1 to S3 set a frequency of 132.0000 MHz as follows:  | |
| 4.2 | Using the spectrum analyzer check the output frequency and the RF level of the output frequency.<br><br>Possible cause of fault: S1 to S3, D401 to D403 | no RF output signals |
| 4.3 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |



## 6.4.6 Fault: "Frequency Accuracy"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the spectrum analyzer to connector X94. Now switch on the test equipment. | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **2.** | **Frequency Accuracy, Model 22** | |
| 2.1 | With DIL switches S1 to S3 set a frequency of 120.0000 MHz as follows: | |




| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.2 | Using the spectrum analyzer check the output frequency.<br>Possible cause of fault: U100, R100 to R102, not correctly calibrated with R101<br>If necessary, use R101 to set the nominal frequency . | 120.0000 MHz ± 30 Hz<br>Accuracy: $1.5 \times 10^{-6}$ |
| **3.** | **Frequency Accuracy, Model 23** | |
| 3.1 | Make sure that the VHF synthesizer has been in operation for at least 30 minutes (warming-up phase of the oven-thermostat-stabilized oscillator). | |
| 3.2 | With DIL switches S1 to S3 set a frequency of 120.0000 MHz as described in step 2.1. | |
| 3.3 | Using the spectrum analyzer check the output frequency.<br>Possible cause of fault: U101, not correctly calibrated with the trimmer of the quartz oven<br>If necessary, use the trimmer of the quartz oven to set the nominal frequency. | 120.0000 MHz ± 20 Hz<br>Accuracy: $0.2 \times 10^{-6}$ |

### 6.4.7 Fault: "FM Signal-to-Noise Shift"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the modulation analyzer to connector X94. Now switch on the test equipment. | |
| **2.** | **Checking the FM Signal-to-Noise Shift** | |
| 2.1 | Make the following settings at the modulation analyzer:<br>Modulation type: FM<br>Filter: CCITT-weighted<br>Detector: RMS*`2 | |
| 2.2 | With DIL switches S1 to S3 set any frequency in the frequency range between 118.0000 and 143.9975 MHz. | |
| 2.3 | Using the spectrum analyzer check the signal-to-noise shift.<br>Possible cause of fault: Components of the VCOs, V201, V202, connected components | ≤ 20 Hz |
| 2.4 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

### 6.4.8 Fault: "Signal-to-Noise Ratio at 25 kHz from the Carrier Frequency"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the spectrum analyzer to connector X94. Now switch on the test equipment. | |
| 2. | **Checking the Signal-to-Noise Ratio** | |
| 2.1 | With DIL switches S1 to S3 set any frequency in the frequency range between 118.0000 MHz and 143.9975 MHz. | |
| 2.2 | At the spectrum analyzer set a frequency span of 100 kHz with respect to the VHF synthesizer frequency which has been set. | |
| 2.3 | Using the spectrum analyzer check the spurious emission distance 25 kHz beside the carrier frequency.<br>Possible cause of fault: Components of the VCOs, V201, V202, connected components | ≥ 85 dBc |
| 2.4 | Switch off the test equipment and dismantle the test setup. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

## 6.4.9 Fault: "Frequency Offset in Receive and Transmit Modes"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 1. | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1. | |
| 1.3 | Connect the modulation analyzer to connector X94. Now switch on the test equipment. | |
| 2. | **Checking the Frequency Offset** | |
| 2.1 | With DIL switches S1 to S3 set any frequency in the frequency range between 118.0000 MHz and 143.9975 MHz. | |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.2 | At the spectrum analyzer set a frequency span of 100 kHz with respect to the VHF synthesizer frequency which has been set. | |
| 2.3 | Using the spectrum analyzer check the frequency of the RF signal. | set frequency $f_s$ |
| 2.4 | Disconnect connector contact X43.9 (*PTT) from ground (= receive mode).<br><br>*Note:*<br><br>*When the contact is disconnected from ground, high level is applied automatically, due to an internal pull-up resistor (high level = receive mode).* | |
| 2.5 | Using the spectrum analyzer check the frequency of the RF signal.<br><br>Possible cause of fault: D401 to D403 | $f_{s,rec.} = f_s + 50\,kHz$ |
| 2.6 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

## 6.4.10 Fault: "Status Signals UNLOCK and SYTEST"

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| **1.** | **Preparations** | |
| 1.1 | Remove VHF Synthesizer GF 201V from the single-channel unit as described in Section 6.5 and open it. | |
| 1.2 | Prepare the test setup shown in Fig. 6.1 and switch on the test equipment. | |
| **2.** | **Checking the Status Signals UNLOCK and SYTEST** | |
| 2.1 | With DIL switches S1 to S3 set any frequency in the frequency range between 118.0000 MHz and 143.9975 MHz (PLL locked). | |
| 2.2 | With a digital multimeter (voltmeter) check the signal voltage at connector contact X43.7 (SYTEST).<br><br>Possible cause of fault: N202, D200, D401 | high level |

| No. | Activity / fault elimination | Nominal value |
|---|---|---|
| 2.3 | With DIL switches S1 to S3 set any frequency outside the frequency range between 118.0000 MHz and 143.9975 MHz (PLL not locked). | |
| 2.4 | With a digital multimeter (voltmeter) check the signal voltage at connector contact X43.7 (SYTEST).<br><br>Possible cause of fault: N202, D200, D401 | low level |
| 2.5 | Switch off the test equipment and dismantle the test set-up. Now install the VHF synthesizer again into the single-channel unit as described in Section 6.5. | |

## 6.5 Replacement of Components

### 6.5.1 Removing and Opening the VHF Synthesizer GF 201V

**WARNING**

***Do not remove and open the VHF Synthesizer GF201V unless the supply voltage is disconnected.***

Proceed as follows to remove the VHF synthesizer from the single-channel unit:

1. On the front panel of the single-channel unit switch the **REM / LOC / OFF** switch to the **OFF** position.
2. Switch the mains switch of the single-channel unit to the **OFF** position.
3. Unplug the mains or battery cable.
4. Undo the Phillips screws which attach the cover to the top of the single-channel unit. Remove the cover.
5. Remove the soldered-on ribbon cable with connector X43 from the modulator of the single-channel unit.
6. Unplug the RF cable with connector X94 from the VHF synthesizer.
7. Undo the two screws on the mounting brackets.
8. Lift the VHF synthesizer upwards and out.

Proceed as follows to open the VHF synthesizer:

1. Undo 12 screws from the top and 12 from the bottom which fasten the covers to the VHF synthesizer.
2. Remove the two covers from the top and bottom.

### 6.5.2 Replacement of Individual Components

**WARNING**

***Do not remove any components from the VHF Synthesizer GF201V unless the supply voltage is disconnected.***

The replacement of components is to be carried out in line with common workshop practice.

For the replacement of conventional components use standard soldering and desoldering tools. No special instructions are needed.

However, among the components incorporated in the VHF synthesizer there are electrostatic-sensitive devices (ESD) and surface-mounted devices (SMD).

**CAUTION**

***For the replacement of electrostatic-sensitive devices, such as MOS and MOSFET components, etc., a special work station is required. If no special work station is available, the minimum requirements laid down in Section 6.1.4 must be met.***

*Note:*

- *During soldering on PCBs the metal foil may come away from the basic material if too much heat is applied. For this reason soldering times should be kept as short as possible.*
- *Charred, melted or burnt components, wire insulations or PCBs must be replaced. Components, discoloured as a result of heat, must be thoroughly checked in order to determine whether their technical characteristics were impaired. If so, the respective components must be replaced.*
- *Printed circuits, showing mechanical damage or broken tracks, must also be replaced.*

The replacement of SMDs or other miniature components follows common workshop practice. Special instructions are not needed.

Use the following tools for the replacement of SMDs:

- SMD soldering station,
- SMD desoldering station,
- SMD solder compound and
- SMD insertion tools such as
  - vacuum inserter,
  - insertion pliers,
  - tweezers.

Following the replacement of components it is absolutely essential to carry out the final test according to 6.6.

### 6.5.3 Closing and Installing the VHF Synthesizer GF 201V

The VHF synthesizer should be closed and installed in the reverse sequence of operations to removal and opening.

## 6.6 Final Test

Following any repairs the VHF synthesizer must be subjected to a final test in order to ensure that its technical data are still guaranteed.

For the final test carry out the entire initial checks. If these checks are successful, the repairs on the VHF synthesizer may be regarded as completed.

However, if the stated nominal values fail to be reached, carry out troubleshooting and fault elimination procedures once again in accordance with Section 6.4.

Repeat the procedure as many times as is necessary to eliminate all faults and to ensure that the technical data of the VHF synthesizer are maintained.

## 6.7 External Interfaces

The interface description in the appendix to this Repair Manual defines the interfaces of the VHF synthesizer in the form of tables.

It supplies information on the

- assignment of connectors,
- signal designations and
- signal levels.

Important details with regard to the described contact are found in the "Remarks" column and may be of value in the course of repairs.

## 6.2 Test Equipment and Special Tools

For the repairs described in this manual the test equipment laid down in the test equipment list is required.

<u>Note:</u>

*Equivalent test equipment may be used.*
*Special tools are not required.*

### 6.2.1 List of Test Equipment

| Item | Type of equipment, required data | Equipment recommended by R & S | Ordering code |
|---|---|---|---|
| 1 | Digital Multimeter<br>accuracy: 1 % of measured value | UDL 45 | 1037.1507.02 |
| 3 | 1 × Power Supply<br>triple: + 35 VDC / 0.6 A | NGL 35 | 192.0026.02 |
| 4 | Oscilloscope | common workshop model | |
| 5 | AF Generator<br>1 kHz / 0 to + 10 dBm | SPN | 0336.3019.02 |
| 6 | Level Meter<br>(used as AF millivoltmeter) | URV 35 | 1020.0002.03 |
| 7 | Test Adapter | see Fig. 6.1 | |

## 6.3 Initial Check

### 6.3.1 Visual Check

If a fault occurs first of all subject the adapter to a visual check. For this purpose it might be advisable to open the screening cover of the display board.

1. Carefully examine the connectors for broken, corroded or bent pins / sockets. If necessary, replace defective connectors according to 6.5.2.

   **CAUTION**

   ***If a connector shows any discolouration caused by heat, its mating connector is also defective. Both must therefore be replaced.***

2. Examine the PCBs for discolouration and disrupted tracks.

   If any damage is found on the PCBs due to heat, we recommend the replacement of the entire assembly.

3. In order to guarantee the high reliability of the module, it is absolutely essential to replace any discoloured components in compliance with 6.5

## 6.3.2 Check of Regulator

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 1. | Check of output + 24 V | | |
| 1.1 | Connect load resistor (3 Ω, 50W) at X19.1/.2/.3/.4 referred to ground. | | |
| 1.2 | Measure voltage at DC output X19.1/2/3/4 referred to ground with the following input voltages at X3 and X13: | | |
| | 22.0 VDC<br>31.0 VDC | 21 to 22 VDC<br>30 to 31 VDC | L1, C1, C2, V1, C4 |
| | Subsequently remove load resistor. | | |
| 1.3 | Connect load resistor (30 Ω, 30W) at X31.25/26 referred to ground (X31.24). | | |
| 1.4 | Measure voltage at DC output X31.25/26 referred to ground (X31.24) with the following input voltages at X3 and X13: | | |
| | 22.0 VDC<br>31.0 VDC | 21 to 22 VDC<br>30 to 31 VDC | F1 |
| | Subsequently remove load resistor. | | |
| 2. | Check of output + 8 V | | |
| 2.1 | Connect load resistor (10 Ω, 20W) at X31.12/14 referred to ground (X31.24). | | |
| 2.2 | Measure voltage at DC output X31.12/14 referred to ground (X31.24) with the following input voltages at X3 and X13: | | |
| | 22.0 to 31.0 VDC | 7.6 to 8.4 VDC | F2, C5, R40, V8, V9, C20, N5, R24, R25, R27, R41, R42, C16 |
| | Subsequently remove load resistor. | | |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 3. | **Check of output VOPSW ( + 24 V switched)** | | |
| 3.1 | Connect load resistor (30 Ω, 50W) at X31.22/23 referred to ground. | | |
| 3.2 | Connect supply voltage of 11.5 VDC (ON-TX) at X31.20 referred to ground. | | |
| 3.3 | Measure voltage at DC output X31.22/23 referred to ground with the following input voltages at X3 and X13:<br>22.0 to 31.0 VDC<br>Subsequently remove load resistor. | 20 to 31 VDC | S1, V3, V4, R2 to R8, N1, C6 to C8 |
| 4. | **Check of output + 5 V** | | |
| 4.1 | Connect load resistor (50 Ω) at X31.19 referred to ground (X31.21). | | |
| 4.2 | Measure voltage at DC output X31.19 referred to ground (X31.21) with the following input voltages at X3 and X13:<br>22.0 to 31.0 VDC | 4.75 to 5.25 VDC | N2, R9 to R11, C9 |
| 5. | **Check of output + 10 V** | | |
| 5.1 | Connect load resistor (50 Ω) at X31.17 referred to ground. | | |
| 5.2 | Measure voltage at DC output X31.17 referred to ground (X31.4).<br>Align to mean value of 10 VDC by means of variable resistor R14. Measure voltage at the following input voltages at X3 and X13:<br>22.0 to 31.0 VDC<br>Subsequently remove load resistor. | 9.9 to 10.1 VDC | N3, R12 to R15, C10 |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 6. | **Check of output + 18 V** | | |
| 6.1 | Connect load resistor (18 Ω) at X31.12/13 referred to ground. | | |
| 6.2 | Measure voltage at DC output X31.13 referred to ground (X31.1) with the following input voltages at X3 and X13: | | |
| | 22.0 to 31.0 VDC | 17.1 to 18.9 VDC | R16 to R18, R28 to R33, R35, V7, N4, C11 |
| | Subsequently remove load resistor. | | |
| 7. | **Check of output -10 V** | | |
| 7.1 | Connect load resistor (140 Ω) at X31.15 referred to ground. | | |
| 7.2 | Measure voltage at DC output X31.15 referred to ground (X31.24) with the following input voltages at X3 and X13: | | |
| | 22.0 to 31.0 VDC | -11 to -9 VDC | L3, R19 to R23, N6, V5, V6, C12 to C15 |
| | Subsequently remove load resistor. | | |
| 8. | **Check of output DC-LED** | | |
| 8.1 | Connect load resistor (4.7 kΩ) at X31.11 referred to ground. | | |
| 8.2 | Measure voltage at DC output X31.11 referred to ground with the following input voltages at X3 and X13: | | |
| | 22.0 to 31.0 VDC | 4.7 to 5.4 VDC | R1, R34, V2 |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 9. | **Check of output AC-LED**<br><br>Measure resistance at AC-LED output X31.10 referred to X611 by using digital multimeter. | < 3 Ω | interrupted tracks |

### 6.3.3 Check of Display Board

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 1. | **Check of LEDs** | | |
| 1.1 | Connect test adapter and power supply (see Fig. 6.1). | | |
| 1.2 | Set switch S11 to position ON. | H2 illuminated | R32, H2 |
| | Set switch S6 to position ON. | H1 illuminated | R31, H1 |
| | Set switch S7 to position ON. | H3 illuminated | R33, V11, H3 |
| | Set switch S8 to position ON. | H4 illuminated | R34, V10, H4 |
| | Subsequently set switches S6 to S8 to OFF. | | |
| 2. | **Check of headphone output** | | |
| 2.1 | Set switch S9 to position ON. | | |
| | Set switch S10 to position ON. | | |
| | Connect oscilloscope at socket BNC-3. | | |
| | Connect AF generator set to 1 kHz, 1 $V_{rms}$, $R_i$ = 600 Ω at socket BNC-2. | | |
| 2.2 | Turn variable resistor R60 on display board (volume of headset) and read off value indicated on oscilloscope. | 10 $mV_{pp}$ to 1.2 $V_{pp}$ | R60, L13 to L16, C15, C16, C30 to C32 |
| 3. | **Check of microphone amplifier (input of dynamic microphone)** | | |
| 3.1 | Connect AF generator set to 1 kHz, 2.5 $mV_{rms}$, $R_i$ = 50 Ω at socket BNC-4. | | |
| 3.2 | Turn variable resistor R3 on display board (sensitivity of microphone amplifier) and with digital voltmeter measure voltage at socket BNC-1 and set nominal value by means of R3. | 130 $mV_{rms}$ | C1, C2, C4 to C8, C13, C54, C55, L1, L2, L4, L5, N1, N4B, R1 to R7 |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| **4.** | **Check of microphone amplifier (input of amplifier microphone)** | | |
| 4.1 | Measure DC voltage at X5.E referred to X5.G. | 7.1 to 8.4 VDC | R9, R10, V1 |
| 4.2 | Connect AF generator set to 1 kHz, 150 $mV_{rms}$, $R_i$ = 50 Ω at socket BNC-5. | | |
| 4.3 | With digital voltmeter measure voltage at socket BNC-1 and with variable resistor R8 on display board (sensitivity microphone amplifier) adjust to nominal value. | 130 $mV_{rms}$ | C9 to C12, L7 to L10, R8 to R10, V1 |
| **5.** | **Check of tone generator** | | |
| 5.1 | Set switch S1 on display board to position TONE.<br>Set switch S9 to position OFF (X13.18 = high).<br>Set switch S10 to position OFF (X13.15 = high). | | |
| 5.2 | With digital voltmeter measure AC voltage at socket BNC-1. | 120 $mV_{rms}$ | C16, C20 to C27, C37, C52, C53, N3, V4, V5, R20 to R30, R49, V2, V4, V5 |
| **6.** | **Check of bargraph indicator** | | |
| 6.1 | Set switch S2 on display board to position m.<br>Set switch S3 to position DISM.<br>Set switch S4 to position ON.<br>Turn variable resistor R1 on adapter fully counter-clockwise (approx. 4 VDC at X13.11). | | |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 6.2 | Set switch S12 of test adapter to position ON (= * PTT).<br>LED bargraph indicator shows | 1.0 (full deflection) | |
| 6.3 | Set switch S12 of test adapter to position OFF.<br>LED bargraph indicator shows | 0 (zero deflection) | |
| 6.4 | Set switch S12 of test adapter to position ON (= *PTT).<br>Slowly turn variable resistor R1 on adapter fully counter-clockwise (approx. 30 mVDC at X13.11).<br>LED bargraph indicator shows | 1.0 → 0 | |
| 6.5 | Set switch S3 to position DISR.<br>Set switch S2 on display board to position **VSWR**.<br>Slowly turn variable resistor R1 on adapter fully counter-clockwise (approx. 30 mVDC at X13.11).<br>LED bargraph indicator shows | 0 → ∞ | |
| 6.6 | Set switch S2 on display board to position P.<br>LED bargraph indicator shows | full deflection | |
| 6.7 | Set switch S4 of test adapter to position OFF.<br>LED bargraph indicator shows | zero deflection | |

| No. | Activity | Nominal value | Fault elimination |
|---|---|---|---|
| 7. | Check of AF ground lines | | |
| 7.1 | Set switch S5 on test adapter to position X5.D. | | |
| 7.2 | With digital voltmeter (set to lowest ohmic range) measure impedance referred to ground. | approx. 2.3 Ω | |
| 7.3 | Set switch S5 on test adapter to position X5.G.<br>With digital voltmeter (set to lowest ohmic range) measure impedance referred to ground. | approx. 2.3 Ω | |
| 7.4 | Set switch S5 on test adapter to position X13.14.<br>Set switch PTT to position ON.<br>With digital voltmeter (set to lowest ohmic range) measure impedance referred to ground. | approx. 2.7 Ω | |
| 7.5 | Set switch S5 on test adapter to position OFF.<br>Set switch PTT to position OFF.<br>With digital voltmeter (set to lowest ohmic range) measure impedance referred to ground. | high impedance | |

## 6.4 Troubleshooting and Fault Elimination

### 6.4.1 Fault in Regulator

In the case that the fault cannot be clearly identified, follow the instructions in the table "Check of Regulator" in the given order.

Once a fault or a wrong measured value has been detected, check the components specified in the column "Fault elimination" in line with circuit diagram 6044.1698.01S and components layout 6044.1746.01, sheets 1 and 2.

After fault elimination, carry out the final test in accordance with 6.6.

### 6.4.2 Fault in Display Board

In the case that the fault cannot be clearly identified, follow the instructions in the table "Check of Display Board" in the given order.

Once a fault or a wrong measured value has been detected, check the components specified in the column "Fault elimination" in line with circuit diagram 6044.1498.01S and components layout 6044.1498.01, sheets 1 and 2.

After fault elimination, carry out the final test in accordance with 6.6.

## 6.5 Replacement of Components

**WARNING**

***Do not remove any components from the regulator or the display board unless the voltage is switched off.***

The replacement of components is to be carried out in line with common workshop practice. No special instructions are needed.

However, the regulator contains surface-mounted devices (SMD).

*Note:*

- *During soldering on PCBs the metal foil may come away from the basic material if too much heat is applied. For this reason soldering times should be kept as short as possible.*
- *Charred, melted or burnt components, wire insulations or PCBs must be replaced. Components, discoloured as a result of heat, must be thoroughly checked in order to determine whether their technical characteristics were impaired. If so, the respective components must be replaced.*
- *Printed circuits, showing mechanical damage or broken tracks, must also be replaced.*

The replacement of SMDs or other miniature components follows common workshop practice. Special instructions are not needed.

Use the following tools for the replacement of SMDs:

- SMD soldering station,
- SMD desoldering station,
- SMD solder compound and
- SMD fitting tools such as
  - vacuum tool,
  - pair of pliers,
  - pair of pincers.

For the replacement of conventional components use standard soldering and desoldering tools.

Following the replacement of components it is absolutely essential to carry out the final test according to 6.6.

## 6.6 Final Test

Following any repairs the regulator and the display board must be subjected to a final test in order to ensure that the technical data are still guaranteed.

For the final test carry out the entire initial check. If this check is successful the repairs on the adapter may be regarded as completed.

If the given nominal values are not reached, send the adapter for repair.

## 6.7 Interfaces

A detailed description of the interfaces of the regulator and the display board is found in the Appendix to this manual.

The description of interfaces offers the following information:

- contact assignment of connectors,
- signal designations and
- signal levels.

Details given in the remarks column regarding test points and terminals are provided for use in repairs.