Time and frequency standard device 414A HG
Technical description and operating instructions

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1 Purpose

1.1 Frequency time standard HG 414A is for testing Quartz oscillators, frequency and time-measuring instruments

1.2 Operating conditions:
Ambient temperature 0 to 50 ° C
rel. Humidity: up to 98% at 25 ° C
Line voltage: 220V ± 10% at 50 Hz,
or ± 5% at 400 Hz,
or + 27V ± 10%
Air pressure: 630-795 mm Hg

2 Technical data

2.1 Permissible frequency deviation at delivery < ± 2*10^-11

2.2 The relative systematic frequency change shall be after 24 hours of warm-up at a change in ambient temperature of ± 1 ° C no more than ±1*10 ^ -12 (Option A) and ±2*10 ^ -13 (Option B).

2.3 The relative main frequency deviation during the technical usage lifetime shall be no more than ± 4 * 10 ^ -10 in the variant A and ± 8 * 10 ^ -11 in the B variant.

2.4 The relative random square medium frequency deviation after 24 hours of warm-up
at ambient temperature change within ± 1 ° C shall be no more than 3*10^-12 in the variant A and 1*10^-12 in the B variant.

2.5 The relative square medium frequency deviation should not exceed:
after 2 hours warm-up:
16 * 10 ^ -12 at 1 s,
7 * 10 ^ -12 to 10 s,
3 * 10 ^ -12 to 100 s,
after 4 hours of warm-up
7 * 10 ^ -12 at 1 s,
3 * 10 ^ -12 to 10 s.

2.6 The relative frequency deviation after 4 hours to warm up shall be no more than 5*10^-12.

2.7 The average value of the temperature coefficient of frequency in the range of operating temperatures is around 8 * 10 ^ -13 / K.

2.9 The device displays on the main scale the data with the parameters:
Signal period: 1 s
Signal polarity: positive
Pulse length: 10 to 20 microseconds
A rise time of < 30 ns, as measured from 10% to 90% of pulse amplitude, with pulse amplitude > 2.5 V into 50 ohms.

2.10 The unit has an auxiliary scale of time with signal peridiod of 1 s or 0.1 s.
Otherwise. Data such as 2.9.
Pulse amplitude > 2.5 V into 50 ohms

2.11 Delay between the main and auxiliary signal between 0 to 999,999.9 microseconds with a resolution of 0.1 microseconds.

2.12 Synchronization error between the main and outer time scale should be not more than ± 0.1 μs.
The synchronization parameters of pulses:
Polarity: positive
Repetition Rate: 1 Hz
Length: > 2 μs
Rise time: < 100 ns
Amplitude: > 2.5 V into 300 ohms | | 300 pF

2.13 The tolerance of the time difference of pulses of the external time scale in contrast to the general time scale should be no larger than ± 0.1 μs.

2.14 The device has the time display: hh mm ss

The unit will display its specifications in the standards that were cited in the points 2.1 to 2.20 and operating conditions of 1.2, and after working in boundary conditions after 4 hours in normal conditions.

2.23 The device provides smooth continuous operation under the specification.

2.24 Operating time to failure of> 5000 hours. Useful life of 12 years
Gamma-percent resource 10,000 hours

4 Principle
4.1
The principle of the rubidium frequency generator HG 414A is sustand to the frequency stabilization of the crystal oscillator (via AFC) in the frequency range of electromagnetic absorption in the transition of the rubidium atom (Rb 87) from one energy to another, built. A high frequency stability of the output signal is caused by the frequency stability of the etalon atomic transition and the narrow width of the spectral line.

4.2
The principle of the AFC is shown in the diagram of Fig 4.1. The glass cell containing rubidium (Rb 87) is located in the cavity is tuned to the frequency of the microwave transition.
The light from the gas discharge lamp with the gas of the same substance is filtered optically and falls on the photodiode. Simultaneously, the absorption cell of the effect of the UHF Resonatorfeldes exposed. This is stimulated by the multiplied frequency of the quartz oscillator.
Because between the transition frequency of rubidium atoms (Rb87) and consists of the quartz oscillator frequency, no multiplicity, the UHF signal is obtained as follows:
The signal of 6840 MHz is obtained by multiplying the oscillator signal (5 * 3 * 3 * 2 * 2 * 2 * 19).
Then to the multiplied signal is added to the synthesis signal and receives the UHF signal from 6.834,682.54 MHzthat isis required for the excitation of transition in the rubidium atoms .

The UHF signal is frequency modulated. The low-frequency phase modulation is achieved in a multiplication. The absorption of rubidium atom light changes according to the modulation law. At the output of the photodiode get a signal showing the deviation of the multipliierten quartz oscillator frequency of the line center of the atomic transition.

The simplified schematic of the electrical structure of time and frequency standard device 414A HG
1 discriminator
2 Optical Filter
3 gas cell
4 NF-amplifier
5 Synchesator
6 frequency multiplier
7 modulator
8 Sychrondetektot
9 quartz oscillator

If the frequency of the RF field in the vertical range of the resonance curve of the etalon atomic transition line, the signal phase at the output of the photodiode 180 degrees compared to the modulating signal phase. The shift is similar to 0 if there is the frequency of the RF field in the emerging area (AbbA.2.). During the retuning of the RF signal line exactly on the center of the Atomic Absorption changes of the photodiode with (the) double modulation frequency.
The signal of the first harmonic is but it becomes zero.
Figure 4.2. explains how the results of the error signal from the output of the photodiode at different sites of the detuning. The signal from the photodiode is amplified and led to the synchronous detector simultaneously with the signal of the modulation generator. The output of the synchronous detector you get DC of plus or minus polarity depending on whether the frequency of the UHF field in increasing or decreasing the area of the resonance curve is the EtalonObergangs.
This DC voltage applied to the capacitancediode of the quartz oscillator and counteracts the frequency error.

4.3
Now we want a closer look at the work of the AFC by us to the wiring diagram Fig 4.3. . See A sinusoidal signal of 5 MHz quartz oscillator comes from the frequency multiplier, which multiplies the frequency to 90 MHz (5 * 3 * 3 * 2) and then to the high frequency amplifier.
The curve of the microwave transition in atoms of rubidium (Rb 87) Figure 4.2. The output of the RF amplifier is converted by three successively switched frequency divider into two signals:
the sinusoidal signal with frequency of 86.8 Hz, which is used for phase modulation in the frequency multiplier and pulse signals (Meander-Type) with pulse repetition frequency of 86.8 Hz, which serves as the carry signal for the synchronous detector. From the output of frequency multiplier that the signal to the harmonic generator includes a diode and is located in the rubidium discriminator. To get the UHF value equal to the frequency of the rubidium transition, the output of frequency multiplier with the signal of the frequency synthesizer is mixed. The diode plays simultaneously the role of a multiplier and a mixer. The resonator of rubidium discriminator is tuned to the frequency of the 0-0-transition and is similar:

f (Trnsfer) = f (Qg) * n * m-f (synt) k (1)
where
f (Trnsfer) = 6834.68254 MHz, the frequency of the 0-0-transition is
f (Qg) = 5 MHz (crystal frequency)

n = 18 coefficient of the multiplier
k = 1
m = 76 coefficient of the harmonic generator
f (synt) = 5.31746 MHz = output frequency of the synthesizer

The discriminator output, the signal of the error to the low-frequency amplifier, which comes from the amplified signal to the synchronous detector. The synchronous detector of the direct current goes to the integrating amplifier, which the regulators koffizient automatic retuning increased frequency systems, without stability problems. From the output of the integrating amplifier is retuning the voltage to the capacitance diode of the quartz oscillator and acts so that its value approaches zero detuning. In this way the frequency of the quartz oscillator in the automatic retuning range is the same:

f (Qg) = [f (Trnsfer) + f (synt) * k] / [n * m] (2)

4.4
The device HG 414A formed, frequency other than the etalon, and etalon signals of the main time-and-Help scale, shows the running time in hours, minutes and seconds and measures the time base of foreign and auxiliary scales in terms of peak time-scale, synchronized with the main time scale the role of foreign aid or time scale and measures the relative frequency deviation of the external signal to 5 MHz frequency standard.

4.5
The formation of time scales in the device by the division of the highly stable signal of 10 MHz using a frequency divider (Fig. 4.3.) carried out. This frequency divider consists of: the main frequency divider, which is the main time scale and the auxiliary frequency divider, which is the auxiliary time scale. The signal 10 MHz is permanently connected to the input of the auxiliary frequency divider, regardless of the mode of operation of the device, the main frequency divider, it is only by an electronic switch that is open for all functions except the function of measuring the relative frequency deviation Δ f / f.

4.6
In the function of the current time counter (function "t") on the switching system (see figure 4.3.. to Dechiffrator the timer one, which is connected to the output of the main frequency divider and outputs pulses at a frequency of 1 Hz Release Dechiffrator comes for display, which shows the current time.

4.7
In the function measuring the deviation of the outer or auxiliary time scale compared to the main timeline (function "DT") switches, the switching system (Figure 4.3) to Dechiffrator a memory block that is connected to the output of the main frequency divider. If the impulse comes from the outside or auxiliary scale, the state of the main frequency divider is stored. This condition corresponds to the deviation value of the time scale. This information comes from Dechiffrator for display in this case, the deviation value indicates the time scale. Measurement error may resemble a period of the input signal coming to the main frequency divider: ± 0.1 μs.

4.8
During synchronization, the main time scale (Fig. 4.3.) the momentum of the outer or auxiliary time scale goes to the main frequency divider. At the moment of receipt of this pulse resets the decades of the main frequency divider, which is the moment of pulse signals of the main timeline. They shall be synchronization of the main frequency scale.

4.9
The measurement of the relative frequency deviation of the external signal 5 MHz from the signal frequency (function! sp ^ [(19M ^ [(s1p12vOsOb16686TlD! r1 f / f), is based on multiplying this deviation 10 ^ 4 times. The multiplier of the relative frequency deviation are rectangular pulses, their length with the relative frequency deviation is connected:

T = To * (1 ± K * Δf / f) (3)
where
To = 1 sec
K = 10 ^ 4 Multiplizierkoeffizient the relative frequency deviation
Δf / f = the relative frequency deviation of the measured signal from the frequency of the signal equipment.

During the pulse from the multiplier of the relative frequency deviation is the key (Abb.4.3) is open and the entrance of the main frequency divider M is number of pulses:
M = T / to = To (1 ± K * Δ f / f) / t (4)
where to = the period of the signal is 10 MHz. After the end the pulse of the multiplier effect of the relative frequency deviation of the key is closed. The block is automatically in order to save the memory block of information of the main frequency divider (as well as in the function "Δ t"). The switching system switches to this function (Δ f / f) for decoding the memory block that is connected to the output of the main frequency divider. The signal goes from decoding output to the display where a number is presented. This number will be different from the normal rate by a full numerical value of the deviation.
After the information of the main frequency divider has been stored in the memory block, is the automatic block of the command the status of the main frequency divider switch to zero. From that moment on, the main frequency divider is ready to receive the impulses. To shorten the intervals between successive measurement cycles, are the automatic block (after the main frequency divider is set to zero) command the frequency divider of the multiplier of the relative frequency deviation to "9" set. Right after that it is the first impulse at the input of a frequency divider to zero. From that moment, the momentum starts to form, coming from the output of the multiplier of the relative frequency deviation for regulating key, ie A new cycle begins.

4.10 Formatting the main time scale
To the entrance of the frequency is the sine signal 5 MHz (Figure 4.4). From the output of the frequency sinusoidal signal is the frequency of 10 MHz for root. In forming the sinusoidal signals with frequency of 10 MHz in pulses of positive polarity with the repetition rate changed from 10 MHz, then go to the input of the auxiliary frequency divider, and a starting circuit to the entrance of the main frequency divider (10 '1 MHz, 1 MHz "1 Hz) come (connection circuit and down wondering forming). Of short-term elimination of the input signal or current is the signal not by the start circuit, thus the accuracy of the information increases. The main frequency divider is composed of seven decade frequency dividers according to the scheme "front transmission" to minimize the delay from the signal. This is for (the) reduce the instability of channels of the formation of the main frequency range and for creation of favorable conditions for storage of the information available in the main frequency divider in the function "Δ t" is necessary. The impetus of the last decade of the main frequency divider are used to start the time counter and will be formed with the length (T = 15 microseconds) and are related to the clock frequency to 10MHz, which minimize next to the "front transmission" in the main frequency divider, the instability of the forming channel of the main time scale . Then, the pulses amplified and led to the device output.

4.11 Value measurement of the time base between the time Skala.
The electrical diagram of the structure formation of the main timeline.

1 frequency doubler
2 Formation
3 to the auxiliary frequency divider
4 starting circuit
5 frequency divider
6 frequency divider
7 Forming
8 Connection diagram
9 power amplifier
10 Forming shedding 1, -2
11 Buffer Memory
12 Buffer Memory
13 multiplexer
14 Abfrageformierer
15 to the time counter
16 Outdoor S
17 S delay
18 outer linnen
19 query 1
20 Query 2
21 grid
22 to the indicator

The other information of information outputs of the seven decades of the main frequency divider 10 MHz to 1 Hz is the storage registers (Figure 4.4). The storage of information takes place through the income Impulse "query"is the outer time scale or time scale of the pulses of the auxiliary to the entrance of the formation. To avoid information errors, Impulse "Query 1 and Query 2 " are formed which are bound according to the frequencies 10 MHz and 1 MHz (Figure 4.5). The pulse "Query 1" is used for storing the rapidly änderden information from the frequency divider 10> 1 MHz, the pulse "Query 2" for storing the information from the frequency divider 1 MHz> 1 Hz when the input of the query form the pulses external or auxiliary time scale may be, the device according to the time base value of the role of foreign aid or time scale compared to the pulses of the main timeline.

Decadent condition of the main frequency divider changes from 0000000 to 9999999, 0000000 with the angular momentum of the main time scale corresponds. At the entrance to the query form of the pulses from the external or auxiliary time scale is in the storage register a seven-digit decimal number stored "N", to show the number of pulses the frequency of 10 MHz: The number of pulses that have arrived to the main frequency divider since the last pulse of the main timeline.

Pulse formation, "Query 1", "Query 2"
Query
Figure 5.4

The indicator shows it to temporary differences between the pulses of the main and the external scale or between the pulses of the main and auxiliary scale, dependent upon the switch position "EXT - INT.

4.12 Synchronization of the main time scale

During synchronization, the main time scale, the impetus from the external time scale or the auxiliary time scale (depending on the switching position EXT-INT) to Cdpoc?-forming 1, 2 (Figure 4.4), the pulses "Cdpoc? 1" and "Cdpoc 2" with lengths of 0.04 and 0.6 microseconds zero one share of the frequency divider 10> 1 MHz and 1 MHz frequency divider> 1 Hz in the main frequency divider. Because the zero state of the main frequency divider corresponding to the angular momentum of the main time scale, occurs in this case, the synchronization of the main time scale according to the external or auxiliary time scale, with a deviation of ± 0.1 μs.

4.13 Counting and setting the current time.

The electrical structure diagram of the time counter is shown in Fig 4.6. The time counter has six points. The two digits for seconds, minutes and hours. The positions of the individual second and minute counters are made on the basis of 10 times the frequency divider, and the bodies of tens of seconds and minutes based on the 6-frequency divider.

The time counter has a capacity of 23 St, 59 minutes and 59 seconds. Once that number is reached, the counter is at 00 h, 00 m, 00 s on. The time counter the overall time is provided, which is necessary for that purpose that the display in accordance with the function "t" in real time.

The electrical structure diagram of the time counter

1 grid
2 multiplexer
3 To counter
4 seconds clock pulse scheme
5 seconds counter
6 minutes clock pulse scheme
7 minutes counter
8 hours clock pulse scheme
9 hours counter
10 separation
11 seconds setting
12 minutes setting
13 supplementary
14 hours setting

To this end, the counter of seconds, minutes and hours through the assembly of the adjustment of seconds, minutes and hours are separated, the rule itself following signals:
- signal the separation of the hour, minute and seconds counter (log 0), this signal is forming in the function "t" and the switch “Time - Counting” is in the position "Time".
- signals h, m, s (log 1), which set the values of hours, minutes and seconds in the count, taking the flash at the selected rank Freq. 5 Hz (hours, minutes or seconds); These signals are obtained when pressing the "start", - single pulses adjusted with the help of a necessary value in the counter was, the signals h, m, s was selected, this Pulses by pressing the "correction" causes.

Note:
The time counter a correction is also possible. (Every second rank, with the switch position "counting" the switch "Time-counting"). Such a possibility Regiersignal realized the "insertion" (log 0).

4.14 Building auxiliary time scale.
Was made from seven decade frequency dividers according to the scheme "transfer fronts" - The formation of the auxiliary scale is performed using the auxiliary frequency divider (Figure 4.7), which - as the main frequency divider, formed the main time scale. This auxiliary frequency divider 10 MHz to 1 Hz is the assembly of the pulse Add center - is separate and peeling, which are used for the inhibition of the auxiliary time scale in relation to the main time scale in the range from 0 to 999,999.9 microseconds. The auxiliary time-scale deflection is done by adding or subtracting the pulses at the frequencies of 10 MHz, 100 kHz, 1 kHz and 10 Hz With the addition of the impulses out of date to the carrier frequency of the auxiliary time scale (a period), in the abduction of a period.

Electrical scheme of the structure formation of the auxiliary time scale
1 Selection Scheme
2 Formation
3 frequency divider
4 frequency divider
5 frequency divider
6 frequency divider
7 Connection Scheme
8 power amplifier
9 Delay S
10 Adjustment (h, m, s)

The regulation of the assembly of the pulse additions and removal is done by the following signals: - the signal of the timing Δ t (log 1), this signal is formed in the function "Δ t", - the signals A, h, m, s (log 1) - effect the deflection in the ranks of 100 ms, 1 ms, 10 microseconds, or 0.1 microseconds (where the selected rank flash at the frequency 5 Hz), these signals are formed by pressing the Start button, - single deflection pulses + and - with the help of the addition or subtraction of pulses in the selected rank is, these pulses are formed by pressing the "+ correction".

4.15 Measuring the relative frequency deviation of 5 MHz external signal.
The electrical structure diagram of the relative frequency deviation is given in Figure 4.8.
The Fig 4.8. shows the principle of a multiplier Ofachen relative frequency deviation by two-stage frequency conversion of the 5-MHz external signal. In this function (Δ f / f), and storage of data in the main frequency divider is in the storage register. The command of the information storage, which is output from the automatic block (see figure 4.3) comes to the query form (Fig. 4A) similar to the signals of the external and auxiliary scales in the function Δ t ". In this role," Δ f / f 'is the zero setting command of the main frequency divider (the command is the automatic block after the storage in the Storage tab of the main frequency divider-fig 4.3 formed) to the zero adjustment form (see Figure 4A), similar to the signals of external or auxiliary time scale for synchronization of the main time scale .
The electrical in structural scheme of the relative frequency deviation multiplier
- separate sheet -

4.16 Digital indication of the information
On the digital indicator, the information is displayed by the output of the resister memory of the main frequency divider (in the functions Δ t ", " Δ f / f ') or the output of the time counter (in the function "t" on the front of the device (see AbbA.3). To reduce the power consumption was used indicated a dynamic system, so the time code, time counter ranks by the multiplexer (Figure 4.6.) 1-2-4-8 on 4 lines is formed. In the same way, the information of the register memory .. of the main frequency

divider by the multiplexer (Fig. 4A) is formed in four lines of 1-2-4-8 The outputs of the multiplexer go to the switch block (Figure 4.3) which is activated depending on the selected feature Dechiffrator to the respective multiplexer, the code 1 - 2-4-8 from the output of the multiplexer is selected by the Dechiffrator 4 / 7 in seven processed signals.

The unit of selection (Figure 4.7) plays the role of the switch to point the pulses of 15 ms duration with repetition rates of 1 or 10 Hz for the pulse form. Then, the formed (full length) bound pulses of the auxiliary time scale for the 10 MHz frequency (which guarantees the "front transmission" in the auxiliary frequency divider to minimize the instability of the formation of the auxiliary time scale). Then, these pulses increased and led to the output of the device.

Grid signals (output signals) for multiplexing
Control of the delay value of the auxiliary time scale is relative to the main time scale in the displacement introduced in the function "Δt" in the switch function "inside" the switch "inside-outside", while accepting the delay value shown in the indicator in the form of a seven-digit decimal.

4.17
To facilitate the handling device is in a constant operating control and automatic diagnosis of ten types of errors that are indicated by LD and 7segment on the front of the device installed. To this end, the unit control block (Figure 4.3) installed, come to the direct current signals of the controlled assemblies and chains.

The principle of the LD "operation " (green) and "Alarm " (red) is that it is on the vote of the UHF signal to the center of the Atomabsorbtionslinie (for normal operation of the device), only the second harmonic in Diskriminatorausgangs, the first Harmonics approaches zero. Then, the green light, the red is dark.

Upon failure of the circuit, the red LD and the green is dark. The number of the faulty block is displayed in the seven-segment display. The Alogarithmus the automatic determination of the error control block is determined with regard to the following restrictions. The number of concurrent defects should not exceed 1.

The control block also monitors the voltage level of the direct current from the output of the integrating amplifier and switches the LD "+" or "-"when the voltage at the output of retuning lntegrier amplifier exceeds the value of |0.5| volts.

4.18
In the HG device 414A is a power supply (Figure 4.10) that enables operation of the device at 220V AC, as well as at 27V DC. Upon failure of the 220V network, the device automatically without interruption of the 27V supply. The stabilized voltage of 20 volts is obtained by using longitudinal stabilizers, and the voltage +15, +5 and -15 volts is obtained by pulses of the stabilizer of the pulse width modulation.
The structure diagram of the pulse stabilizers are identical (Figure 4.11).

6 General information on commissioning
Operating the device is important to ensure the natural ventilation.

7 Safety measures
7.1 The unit is of safety class 01

8 Operation

8.1 Operation - matching and switching regulator

Item 1 (as shown in figure 15)
Ad
running time,
the relative frequency deviation,
the postponement of the time scale

Item 2
Indication of normal operation, or failure,
Display the error number

Item 3
Quartz, +, -
Potentiometer for adjusting the crystal frequency
Initial position: on earth

Item 4
AFC
Switch turns on AFC
Switched off during warm-up. Then switched

Fig 8.1

Item 5
EXT-INT
Switch - Choice of synchronization and measuring the time shift of time scale
AP (starting position): INT

Item 6
COUNT - SET TIME
Function Switch - Timer - Timed
AP: count

Item 7
1s, 10s, 100s
Meßzeitumschalter
AP: 1 s

Item 8
10Hz, 1 Hz
Switch frequency pulses of the auxiliary time scale
AP: 1 Hz

Item 9

Synch.
Button - synchronizing with simultaneous pressure on the button "Start"

Pos 10.11
Correction +, -
Buttons - the auxiliary shift time scale.
Set the current time (button "Correction + ")

Item 12
>
Button - Function switch

Pos 13
Start
Button - Start the main time scale

Item 14
t, Δ f / f, T
LD, see what features

Pos 15
Power switch
From AP, down

Pos 16
Jack - input of the external signal 5 MHz

Pos 17.18
Jack - Output of the main and auxiliary time scale

Item 19
Jack - Input of the external time scale

Item 20
2 Amp, security of the direct current 27V +

Item 21
Network

Item 22

Pos 23.24
0.1 MHz, 1 MHz
Sockets of the output signals

Pos 25.26
5 MHz, 10 MHz
Sockets of the output signals

8.2 Preparation for measurements

8.2.1 Check the initial positions of control in accordance with Table 8.1.1

8.2.2 Turn on the "power" (not open)

8.2.3 Warm up the unit for 2 hours.

8.2.4 Check the device and its operation as follows:
- Turn the AFC switch one, then to the green light LD.
If any of the LD "+" or "-" blinks, turn the knob "quartz" in Direction of this LD are off to both.
Press the button "Start" then the button ">" until the LD "t" lit. Here, the display will show a random time, which changes every second. Check the signals of the time scales. To do so button ">" repeatedly until the display disappears. Here, the LD "t" and "T" seconds of a Peridiode 1 flashing. This speaks for a be present the main and auxiliary scale. The item "10Hz" the switch "10 Hz - 1 Hz, "the AP flash with a period of 0.1s.

If, after the warm-up time, the red "Alarm" LD lights and lights on the seven segment display a number with a breakdown of the device is to be expected. Each number corresponds to a particular error. When Troubleshooting, follow the instructions in § 12

The signals the main time scale are shown by pressing the button "Start ". After the short-term elimination of the device can be started, the main time scale after pressing the button "Start ".

8.3 Measurements

8.3.1 Function - frequency and timing circuit
This function (this rays "t ") is typical when the device is used in time service, or as a generator of stable carrier frequencies.

8.3.2 Measuring the relative frequency deviation of the external signal 5 MHz.
This function is used during the investigation of quartz generators with the output of 5 MHz. The button "> " You want the "Δ f / f a '.
Enter the external 5 MHz signal to the bush "external 5 MHz. Set the necessary measuring time "1s", "10s" or "100s"field. The measurement result is shown in relative units on the display. We have to note that the last point, ie at a measurement time of 1 sec, 1 * 10 ^ -11. With a measurement time of 10 or 100 sec, the resolution is 1 * 10 ^ -12.

If the result on the display a number with zeroes in front, it means that the frequency of the test generator is lower than that of the standard unit.

If the result has nine on the display front, the frequency of the test generator is higher than that of the standard unit (up to 10'7).

Example 1:
Ad 0000324, measuring time 10 sec.
The frequency of the test generator is lower than that of the standard appliance, by a factor of 324 * 10 ^ -12.

Example 2:
Ad 9999841, measuring time 100 sec.
The frequency of the test generator is higher by a factor of 159 * 10 ^ -13 than that of the standard unit. (Should probably be a 159 * 10 ^ -12!).

8.3.3 Correction of the main time scale
This function is used when it is necessary to move the main time scale to a specific time interval.

This must be set with the button ">" the "T" and the switch "EXT - INT to INT. Want this display shows the Zeiverschie tender value between the main and auxiliary time scale with the knob." Correction +, - "you set the display the necessary shift value (value of last digit 0.1 ch243 s!), with the button
"Start" button, make the field shift. The area can be changed flashes, with a frequency of 5 Hz, the displayed value shift in the main time scale enter, you have to for about 3 seconds the buttons "Start" and
"Sync." simultaneously press and then 10ßlassen. The display should thereby indicate 000000.0! Ch254 0.1 (ie 0000001 or 0000000 or 9999999).

Example of Entering a delay

Suppose that the time scale of the device has a delay of 35.5 microseconds to the calibration period, ie You need a correction of + 35.5 microseconds. For this correction must be on display, the number M = 10000000 - set 355 = 9,999,645th If you need a correction of minus 35.5 ms, is used to set the display shows the number 355th Acquisition?

The correction of the main time scale by the external signal is carried out as follows:
Turn the switch "EXT - INT" to the "EXT". In the bush "outside S2" you give the signal of the external time scale. The display shows the time difference value between the main and the outer scale. Press simultaneously the buttons "Start" and "Sync" for about 3 seconds and then release. The ad should be 0000000 ± 1.

8.3.4 Measuring the time difference between the external time scale and the main time scale
This function is needed if you want to measure the difference between the outer time scale for Haupotzeitskala. With the help of the button> select the "t".

The switch "EXT - INT", set to "EXT ". In the bush "outside S" you give the signal of the external time scale. The display shows the time difference between the time scales in 0.1 microseconds.

8.3.5 Set the current time
Press the "Start" button and set the "T ". The switch "COUNT - SET TIME", set to "TIME SET ". Then you set using the buttons "Start" and "Correction +, -" the desired time and turn the switch "COUNT - SET TIME" to the "COUNT".

10 Accommodation units in the unit det

11 Description of the circuit diagram

11.1 Quartz Oscillator

11.2 5 MHz Amplifier

11.2.1
The amplifier 5 MHz (2.030.509 2.030.526 S22 and S26) are:
- For starting the forming 1 MHz, the synthesizer 5.31746 MHz, the forming 1, the synthesizer 2.206.557 S103 (included in the multipliers of the relative frequency deviation)
- For the formation of the sinusoidal calibration signals with the frequency 5 MHz;
- to avoid the effect of external fields.

11.2.2
The structural scheme of the amplifier 5 MHz is shown in Figure 11.2 (see there).
The 5 MHz output amplifier is built as a cascade circuit with the transistors VT3 and VT2.
It avoids reverse isolation of signal from output to input.
The resonant circuit L2, C7 and L1, C5 provide the necessary amplification and spectral purity of the output signal of 5 MHz.
The elements VT4, VD2, VD3, R11, R14, R14 and R16 are used for current and temperature stability.
Supervision of the functioning of the amplifier is 5 MHz 2.030.509 detects the signal output block (VD1, C2, C3, R5) and the control block out (3.035.219 S123).

11.2.4
The 5 MHz amplifier 2.030.526 S26 is the same structure as the 5 MHz signal to the synchronizer 2.206.557 S103 and 5 MHz jack.

11.3 Forming 1 MHz

11.4 Forming 0.1 MHz

11.5 5.31746 MHz synthesizer

11.6 Frequency multiplier

11.6.1
The frequency multiplier (2.208.467 S49) is used for multiplying the frequency of the output signal of the Quarzoscillators to 90 MHz and the phase modulation of this signal.

11.6.2
The frequency multiplier works as follows. The 5 MHz signal coming from the quartz oscillator through resistor R3 to the input of the first block of the frequency multiplier (2.208.467 S49) fulfills the function of the resonance amplifier, the amplitudelimiter, the phase modulator and frequency doubler. The modulated signal with frequency 86.8 Hz is about the resistors R1, R2 and the inductor L1 to the resonant circuit L3, C4, VD1 and VD2, which is tuned to 5 MHz. The resistor R4 provides the Haltbarkheit (?) of the circle. The Varicaps VD1 and VD2 change their capacity enstprechend the modulation signal. Thus, the phase modulation of the 5 MHz signal will be achieved. The assembly with VT3 and VT4 serves as 5 Mhz selective bonding strengths. The tripling concerned VT5 and VT6. The transistors operate in the overdriven mode. From the collector circuit of transistor VT5 the best impulses to produce the 30 MHz signal are obtained.

The transistor block VT7 and VT8, which is an analogous structure to ensure the necessary filtering of the signal level is to control the following cascade REQUIRED.

D1, the IC is a voltage stabilizer and provides the necessary filtering of the power supply, to avoid the work requires a parasitic signal modulation at the line frequency or its harmonics.

In det assembly with the VT9 The frequency is again tripled.

The bonding strength of the signal power 90 MHz with the AGS is eye builds up with the transistors VT10 to VT12 and IC D2. The output of the multiplier is 90 MHz for the harmonic generator, which is located near the Diskriminatorresonator. The AGC of the multiplier stabilizes the power of the output signal of the generator of harmonics by stabilizing the voltage of the multiplicatordiode.

AGC

The AGC works as follows:
At the entrances of the two operational amplifiers (the terminals 2 and 3 of the IC D2) are virtually identical voltages. On contact 3 - is an automatic shift of the multiplier diode, and output 2 - Basic voltage.
If for any reason, such as the change in temperature, the output signal level is reduced, leads to the reduction of the 90 MHz level. This leads to lower the voltage of the displacement of the car Multiplizierdiode R31 with the resistance. The amplifier amplifies this voltage difference D2. It listens to the voltage of the transistor VT11. As a result, it increases the gain of the feedback block (VT10). The result is a constant signal level 90 MHz output sum.

Multiplicatordiode comes over to R32 and the resonant circuit L23, C39, the signal of the synthesizer with frequency 5.31746 MHz for incorporation the 76th Harmonic of frequency 90 MHz, which is produced by Resontator.

The output of the operational amplifier is used to control the Multiplikaterfunktion and comes to the control block.

11.7 Discriminator

11.7.1

The discriminator 2.803.008 S59 is used to compare the frequency multiplication of the quartz oscillator frequency with the Absorbtionsfrequency of rubidium atoms and are differencesignal of the error that contains the information about the comparative value of the difference frequencies.

11.7.2

The discriminator consists of the following main elements (Figure 11.3): Spectral source 7, piston filter 8, Absorbtionschamber 10, cylindrical UHF resonator 9, Photodetector 2, RF filter 11, thermostat 5.6 preamplifier 1, line filter and control circuit 4, mu-metal shielding 3.

The rubidium vapor is resonance radiation of which is stimulated by high frequency discharge in the spectral source, VL3 goes through the piston filter. The piston filter can notify the radiation component, cause the inversion of the state of rubidium atoms in the Absorbtionskolben VL2. The absorbtion chamber is in the cylindrical resonator, where the RF field is energized. At the coincidence of the UHF frequency field with the frequency of the atomic transition, the density inversion of the main state of rubidium atoms will be eliminated. The elimination of the inversion of the density difference causes the intensity of the luminous flux that passes through the absorbtion chamber and is registered by the

photodetector.

The intensity of the luminous flux is converted into electrical signal by photodetector that is amplified by a preamplifier and is the retuning of the Quarzoscillators to the frequency of the atomic transition.

11.7.3
To protect against external magnetic fields Diskriminatorelemente be accommodated in a triple magnetic shield. The outer shield is also the case.

WARNING! The discriminator will have no residual magnetic fields. Because of the easy magnetization of the magnetic shields, all repairs are carried out with non-magnetic tools.

11.7.4
In the Permalloyshield following modules are placed:
1 Spectral source 3.374.023
2 optical filter VL3
3 Absorbtionschamber VL2
4 Photodetector
5 Power filter and ignition generator AP2
6 Thermostat

11.7.5
To spectral source 3.374.023 include the high-frequency generator vapour spectral chamber AP5 and AP6 and VL1, the ignition transformer T1. The Spectral tube is filled with the noble gas krypton and rubidium (Rb 87). The high-frequency generator is used to ensure the gas discharge in the spectral source. The oscillator is built as a three-point oscillator VT1. The frequency is about 60 to 80 Mhz.

11.7.6
The optical filter VL3 contains the inert gas argon and rubidium, and is used to filter the ultra-fine components of the spectral source.

11.7.7
The absorption cell VL2 is filled with the inert gas argon and rubidium.
11.7.8
The photoreceiver consists of a photoelectric cell VD1 and the AP1 preamplifier. On the MC D1 is a low-Cham amplifier and MC D2 and the transistors VT1, VT2, the control circuit of the ignition generator ust with forced warming of Spectral source.

11.7.9
The schemes of the line filter and the ignition generator in AP2. The line filter is built with transistors VT1 and VT2 and is used to power the high frequency circuit of the spectral source.

The ignition generator is built with the thyristor VS1, providing a Relaxionsgenerator. The generator output is through the primary coil of ignition transformers T1, which is in the spectral source. The box is the ignition generator by the control circuit, which is to AP1. In the absence of the gas discharge in VL1 is the photocell dimmed VD1 and ignition generator circuit is supplied by the open gate on the transistor VT2 (AP1) with electricity. The ignition of the gas discharge in the Spectral carried by the high voltage pulses from the secondary coil of the transformer T1, they are introduced to the ignition electrode 10 of the tube VL1. At the same time introduced by the diode VD1 and the limiting resistor

R4 (AP2), the increased power to the heater 7 of Spekralröhre VL1, they shall be forced heating of the tube.

At the moment, the gas discharge ignition in the Spektral source the photocell is illuminated VD1, the voltage drops on the photocell and the key of transistor VT2 (AP1) joins. The circuit of the ignition generator and the forced heating of the Spectral source is set.

11.7.10
The thermostat circuit (AP3, AP4) has two thermostats, the heater coil of the E1 and the thermal resistance R1 (Geber1) are in the case of the UHF part of the first filter and thermostat. The heat coils E2 and E3 and the thermal resistors R3 and R4 are the second thermostat, and are located on the cylindrical resonator in the case of the spectral source. On the IC D1, R1 for Brüchkendiagonale det resistors R1, R2, R3, R4, and the thermal resistance and the IC D2 is hold, which in turn are the diagonal bridge of resistors R9, R10, R11 and the thermal resistors R3 and R4 on, are two direct current amplifier (AP3) was built.

The DC voltage is from the DC amplifier of the first thermostat to match amplifier VT2 and VT3 (AP4?). The voltage of the output of the DC amplifier of the second thermostat comes to inverting input of the comparator D1 (AP4). For the inverting input of the comparator D1 are the zigzag-shaped voltage from the voltage stabilizer + 15 V - 15 V, +5 V, 3.233.269 S99 (IC D1, transistor VT4, VT5, VT6 and diodes VD3 and VD4 on Shaltung AP4).

11.8

11.8.1
The assembly 3.668.290 S71 performs the following tasks:
- The production of sinusoidal Moduliersignals with the frequency 86.8 Hz
- the gain of the error signal coming from the discriminator output. The signal will reach the level that is necessary for the normal functioning of synchronization detector.
- the synchronic detection of the error signal after its amplification,
- the integration and amplification of the output signal of the synchronous detector,
- Detection of signals for which the LD "green " and "red " in the front panel.

11.8.2
The modulation signal is obtained by dividing the input signal frequency 0.1 MHz, which comes from the output of the forming 0.1 MHz. With the help of 1 / 1152 divider (D1, D2, D4) to get the frequency of 86.8 Hz from the output of this divider go two out of phase signals of type "Meander"with the pulse frequency of 86.8 Hz for the phase rotator and then to the Filter. Then the sinusoidal signal is the frequency of 86.8 Hz to the frequency multiplier as modulating signal 2.208.467 S49.

Furthermore, does the signal from the output of the 1/1152 divider, being of the "Meander" type, with the pulse frequency of 86.8 Hz for synchronous phase detector signal as a support.

The signal from the discriminator output comes to the blocking filter (the double T-bridge), which is tuned to the second harmonic of the error signal (173.6 Hz), and the entrance of the control circuit of the second harmonic one.

After the separation filter (R5, R8, R9, R10, G5 to G8), the signal to the AC amplifier (MC D6), whose amplification factor can be changed by the resistor R14. From the output of this amplifier is the error

signal to the selective amplifier (D7) that is tuned to the frequency of 86.8 Hz, and then to the synchronization detector and the control circuit of the first harmonic. The control signal is taken from the middle point of the transformer T1 and to the integrating amplifier (D8 - D10) out who is responsible for two functions, the gain of the DC current coming from the output of the synchronous detector, and signal integration. The integration amplifier for reducing the temperature deviation deviation is built according to the M-DM (modulation-demodulation) circuit. By the MC D8 is the transformation of the signal of the DC current coming from the synchronous detector. Then, the signal is amplified 300 times and the MC D9 (it is set by the resistance R51), in a direct current signal, using the demodulator in the MC D8, converted.

Following is the amplification and integration of the signal of direct current:
- for control of the quartz generator for his AFG
- the control circuitry of the limit of integration, which is in the control block 3.035.219 S123, and the involvement of the LED "+,-" caused when the control voltage of +0.5 V or integration amplifier - exceeds 0.5V.

The signals of the circuits first and second harmonic with the help of some circuit V03, V06. The output of this circuit controls the power amplifier that is located in the control block 3.035.219 S123 and the LED "green" or "red " is loaded.

11.9 Forming 1

11.9.1

For root 1 (2,035,253) includes the following components:
- Frequency (V01, V02, VT1, VT2, DU),
- starting circuit (D3.1, D3.2, D1.2, VT3)
- the pulse forming circuit "query1" (D2.1), "Query 2" (D2.2, 4.2, D4.1, D4.3).
- the main frequency divider (10 MHz> 1 Hz) (D6, D18, D22, D26, D30, D34, D38) with the buffer memory (D5, D17, D21, D25, D29, D33, D37) and multiplexers (D8, D16 , D20, D24, D28, D32, D36) in each decade of the divider.
- the Rasterformierer (D9 - D11)
- The control scheme of the key characters (D12 - D15)
- character key (VT4 - VT11)
- the electrical switch (D7).

11.9.2

The frequency doubling is performed by two semi-periodic rectifier of the 5 MHz signal using diodes VD1 and VD2. The resistor R1 is used for the symmetry of the balanced signal (the circle G1, L2 is the Harmonic 10 MHz). The differential block (VT1, VT2) formed the pulses with a frequency of 10 MHz, the inverter D1.1 gives the pulse signal with 10 MHz logic level.

When giving the signal to 10 MHz input 3 of the IC D3.1 no signal from the output of IC D3.1, when the "Start" button is not pressed. When you press the button "START" comes to the input 5 of the MC D3.1 log 1 and the pulse signal 10 MHz is the entrance to the main frequency divider. When you release the button, the signal does not stop, because the pulses with the frequency 10 MHz the capacitor through the transistor VT3 G4 always invite to 4V. At the entrance to 5, the IC constantly D3.1 of the log level 1 is held.

11.9.3

The frequency divider consists of seven decade dividers. The decades of the divider 1 MHz> 1 Hz as a

transit scheme (Figure 11.4, 11.5) built to minimize the signal delay. This is necessary to reduce the instability of the channel formation and the timescale for creation of favorable conditions for information written to the buffer memory. The variable information about the current time is coming to the registers of the buffer memory of the information outputs of the seven decades of the main frequency memory 10 MHz> 1 Hz, the transfer of information into memory is done by the external impulse "interrogation"of which temporal position in relation to the time code can be changed arbitrarily. To avoid information errors, the pulses are "Query 1 and Query 2 " (D2.2, D4.2, D1.4) formed with the frequencies 10 and 1 MHz. The pulse "Query 1" is used for the conveyance of information from the decade 10> 1 MHz, the pulse "Query 2" is used for the transcription of other information. The information from the output of the buffer memory of the main frequency divider is converted by the multiplexer in 4 lines:
1-2-4-8.
Abb.11.4
Abb.11.5
The multiplexer is built on the logical elements with open collector outputs for control signals are then special screen ... 0-1 Formed 0 up. You are feeding the pulses with the frequency 10 kHz to the inputs of the shift registers D10, D11. The scanning signals are also used for the excitation of the key (VT4 to VT11) through the valves D12 - D15 used.

The power consumption of the dynamic display is temporally uneven and rises rapidly as every 100 ms depending on the number of switched segments of the digital display. Therefore, the power to the display through the filter (L2, L3, C5 - C8) also isolated an effect on the remaining power supply to avoid.

11.10 Forming 2
11.10.1
Formation of 2 (2.035.254 S84/85) consists of three functional parts:
- auxiliary frequency divider
- timers
- Tax Scheme

11.10.2
The auxiliary frequency divider consists of the frequency divider consists of the frequency divider 10 MHz> 1 MHz (D8) with the scheme of Impulshizufügens and puller of 0.1 ms (D9, D14, D3, D12.3, D12.4, D23.1) , the frequency divider 1 MHz> 1 Hz (D16, D26, D29, D34, D38, D42) Add to the passage schemes (D22, D28, D35, D41) and the schemes of the pulse and deduct 10 ms (028,019.1,019.2) 1 ms (037?, 019.3, 036.1), 100 ms (039,036.2,036.3).

The function of the frequency divider 10> 1 MHz does not need any explanation. The scheme of the pulse adding and extractor 0.1 ms causes the function of the auxiliary scale correction! ch254 0.1 ms. In this role comes to the entrance of 4,9,3, 10 of the IC of the first log level D3

In the correction of "-0.1 ms", an input pulse 10 MHz (Figure 11.6) is blocked. In correcting the "+ 0.1 ms of zero momentum of the Decade 1 0> 1 MHz (D8) is formed, which is bound to state" 8 "of the decade. The pulse blocked the 9th Input pulse (Figure 11.7). Finally gets the Decade is an overhaul of plus 0, 1 microsecond.

The frequency divider 1 MHz> 1 Hz consists of 6 decades, which are built from the main frequency dividers and the passage scheme.

The signal delay in the passage Scheme 20 ns is much less than the delay of the 200-ns-decade. The function of the nomenclature of the pulse-adding and removal tool 11 ms (D25, D19. 1, D19.2) is explained by the figure 11.8.

The scheme of the pulse-adding and subtract 1 and 100 ms is similar to the scheme of 10 ms.

Depending on the position of the switch 10 Hz> 1 Hz is the signal of 10 Hz or 1 Hz from the output of the auxiliary frequency divider for forming the pulse duration. Two monostable multivibrators are built on IC D37. They form the pulse width of the main and auxiliary time scale (t = 15 ms), the IC D40 (the Trggers 2D) matches the time scale for Impuse 10MHz clock frequency. The transistors VT1 - VT4 strengthen the impulses of the time scale for the output jack of the device.

11.10.3
The time counter functions like this:
The last second parts (D44) and the last minute parts (D49) have a capacity of 10, each of the previous bodies such of 6 the hour counter has a capacity of 24 The Parallelkode the current time comes to the multiplexer, which contains the logical elements (D45, D48, D51, D53, D56, D58).

The multiplexer makes the adjustment of the Parallelkodes of decades in 4 lines 1-2-4-8 (outputs of 12,2,6,10 le D58) using scanning signal 0-1 ... 0, coming from the forming 1 (2.035.253). The setting of the current time is the second setting scheme (D43), minutes (D46), hours (D50). All control signals are formed in the control scheme.

11.10.4
To control scheme includes the following components:
- the schema of the function selection
- the scheme of choice of RangsinsteIlung
- the forming of the control pulses.

The schema of the function selection formed the sub-signals the cessation of the current time "t"and measuring the time "Δ t" measuring the relative frequency deviation Δ f / f ', the elimination of the ad. The circuit consists of a binary counter (D4) and 4 logic elements (D11), which realize the shift function. The shift register is through the EinzeIregisterimpulse the function selection "<" controlled and formed in the indicator 2429033. The scheme is also the signals for the display of the selected function by the AP's "t "," Δ t ", " Δ f / f 'shaped. The scheme of rank selection formed part of the signals (log 1)

It consists of a two-digit counter (D5) and the 4 logic elements (D10), fulfilling the function of the shift register. The shift register is controlled by the individual pulses from the indicator 2429033 S88 when pressing the button "START"formed.

The shift register also controls the display format of the selected adjustment range (D17, D18, D24).

The display format of the selected range (D17, D18, D24, D63) gives the signal (D6.3 (8)), the entrance to the "delete" the Dechiffrators 4 / 7 (the terminal le D7?) of the indicator is 2429033 . This signal marks the spot where the timing or displacement of the auxiliary time scale is being done. For this input le are also sub-signals A, B, C, D? Grid signals 0-11, 0-111, O VII, O VII, the signal from the function selection of the time counter and the time intervals and the modulated signal 5 Hz flashing of the time setting or the auxiliary scale.

For forming the control pulses are:
- Pulse Transformer D33, D27.1
- Pulse Transformer "query"
- Pulse Former D33.8, D33.11
The Impulse Cupoc 1.2 "to reset the divider 10> 1 MHz and 1 MHz> 1 Hz for the correction of the time scale and duration of 0.05 and 0.5 ms. Inputs 1 and 3 of the IC are D31 correction. To the entrance of the forming "query" get the pulses of the external or auxiliary time scale of forming "query" (Exit 8 of the lC D30.2). In forming "query " (D27.2, D30.1, D30.2), the output pulse "query" by the auxiliary or external time scale (depending on switch position "outside-inside) is forming.

In the measurement function provides the frequency deviation of the main pulse formation from folgerderweise:
The negative momentum of the relative frequency deviation multiplier is inverted by the IC D6.2, goes to the occasion scheme of the main frequency divider. Then the pulse setting on "0" (output of the IC D2.1) of the main frequency divider formed. This impulse comes into forming a zero-setting pulse 1.2 "and pulse"9-setting "(the output of the IC D2.3) of the frequency divider in the mixer 500 Hz 2.20656 million S114 (IC D4-D8).

11.11 indicator

11.12 + 20 V voltage regulator

11.13 voltage stabilizer + 15, - 15, + 5 V

11.14 synthesizer

11.15 Crystal Filters

11.16 mixer 50 kHz

11.17 mixer 500 Hz

11.18 Line Filter

11.19 control block

11.19.1
The control block 3.035.219 S123 is used to control the device function and determination of the possible error on the basis of the indicator. It works as follows:
From the IC D1 of the two-step voltage comparator is built. The comparator levels are determined by the voltage divider (R7, R9, R12, R13) and the same plus 0.5 and minus 0.5 V. The inputs 2 and 7 of IC D1 is the signal from the integrating amplifier. The outputs of the comparator are by the power amplifier (D6) charged. Then comes the signal to the AP's "+ " (VD8), and - are switched on when the voltage of the integrating amplifier exceeds ± 0.5 volts (VD7).

11.19.3
The power amplifier control the D6 LD "green"(VD5) and "red " (VD10). In the absence of the signal of the second harmonic flashes LD "red, " the LD "green" lights up (?) and the output 11 of the IC D6 is to decoder (D20), an "H" level for its activation. For decoding indicator is the refusal "8HI) turned

on, indicating in this case, the number of defective assembly of the table 12.1.

The error state is determined from dedicated of logic signals from the output of the controlled components. The processing of logical signals is performed by the IC's D8 to D19, which are specifically interconnected. Here, the search algorihm determine the error as being determined with the following limitation: the number of errors does not exceeds 1 (not function cancellation of the assemblies the occasion of the faulty module is done that is outside of the unit is not counted.)

11.19.4
For the function of the IC which are responsible for the failure determination, the DC voltage signals used come from the corresponding levels.

12 Notes on fault recovery

12.1
Table 12.1 - Fault Table
1 AFC - Block, discriminator
2 The spectral lamp of the discriminator
3 The thermostat of the discriminator
4 The Formation 0.1 MHz
5 The synthesizer 5.31746 MHz
6 The Formation 1 MHz
8 The amplifier 5 MHz
9 The quartz generator

12.5
Before beginning repairs, one must consider the input signals and supply voltages.

12.6
The disturbances of the block of the formation of the time scale and the multiplier is determined in relation to the frequency deviation as defined in points 8.2.4 and 8.3.2.

Note: The functionality of the multiplier, the relative frequency deviation can be checked when connecting the 5 MHz output signal to the input "External 5 MHz". That way the 5 MHz output signal is measured. The display should be "0000000" ± 1 digit.
Table of voltages at the terminals of the transistors and IC.