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DESIGNS DEPARTMENT MANUFACTURING INFORMATION

NO. 5.406(82)

Dual UHF Frequency Synthesiser OS3/509A

PRODUCTION TEST SCHEDULE

D R A W I N G S

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Dual UHF Frequency Synthesiser OS3/509A

1. DESCRIPTION

This unit was designed as part of the television transposer TM4M/502. The two synthesised UHF oscillators contained in the OS3/509A are used to convert an incoming UHF television signal via an IF of 40.75MHz to an outgoing UHF signal. This intermediate Frequency was chosen to give local oscillator frequencies of 512MHz to 896MHz which are an exact multiple of 8MHz. In the case of the input local oscillator this is not quite true as the frequency can be shifted slightly to cope with five-thirds line frequency offsets.

The OS3/509A consists of two identical voltage controlled UHF oscillators (Printed Boards 1 and 2) mounted in screened sections of extrusion on either side of the control circuitry (Printed Board 3). The unit derives +28V and +15V power from the PS4/8 and the AM21/506 respectively. The oscillators are tuned by programming earth links in the PA1M/579. This sets the appropriate ratios in the synthesiser dividers which control the oscillators.

2. INFORMATION

(a) Design Section - Radio Frequency (5)

(b) Designer W. Murray and O. Cullum

(c) Engineer Responsible W. Murray

(d) Handbook - Part of the UHF TV Transposer TM4M/502 Handbook No. 5.156(81).

(e) Technical Instruction - Not available 1st January 1982

(f) Pre-production Batch - This Production Test Schedule has been tested on a pre-production batch of 1 in Designs Department.

3. MANUFACTURING PERFORMANCE SPECIFICATION

3.1 Signals

3.1.1 Outputs

(i) Two local oscillator outputs on free BNC plugs.

Frequency range 512 to 896MHz in 8MHz steps.

1st LO offset range ± 100kHz minimum.

Output impedance 50Ω

Minimum return loss 15dB

Phase noise less than 15 milli radians average in bandwidth 300Hz to 3kHz.

Output power +10dBm to +13dBm

(ii) 5MHz Crystal reference on filtercon.

Output level 300mV p-p.

(iii) Lock indication via filtercon.

LED drive +10mA

3.1.2 Inputs

IF vision carrier on free BNC plug.

Frequency	40.75MHz
Level	70mV RMS
Impedance high	

3.2 Power

Two inputs via filtercons C5 and C4

+28V at 80mA typical (350mA max)

+15V at 530mA ±40mA.

3.3 Controls

Via free 25 way D socket (from PA1M/509 or TE1/38).

3.3.1 16 synthesiser programming inputs (1.5mA current sink)

6	-	1st LO main divider
2	-	1st LO offset divider
1	-	1st LO band IV/V selection
6	-	2nd LO main divider
1	-	2nd LO bamd IV/V selection

3.3.2 3 control lines out to AM21/506 and AM14/561 (no internal connection - mechanical convenience only).

3.3.3 +15V power out for TE1/38 only.

4. WARNING

No voltages above 50 volts d.c. or 30 a.c. are connected to this unit.

5. TEST APPARATUS

Transposer tester TE1/38.

Synthesiser Test Socket to DSK 23062 A4 sheet 1.

2 x Bench PSU (Capable of +28V at 1A, with variable current limit.

Multimeter.

Frequency Meter.

RF Spectrum Analyser (up to 1GHz), e.g. HP 8554L.

UHF/VHF Signal Generator, e.g. HP 8640.

Modulation Analyser - HP 8901.

Lowpass (or bandpass) Filter at 40.75MHz.

UHF/VHF Amplifier (gain ≥ 10dB O/P level ≥ 0dB), e.g. AM14/558.

6dB Splitting Pad.

Double-balanced Mixer; e.g. Lorch Electronics FC-2012.

6. INSPECTION

6.1 Once the three boards that comprise this unit are fixed in place in the three compartments of the extrusion, the wiring side of the boards becomes inaccessible. For this reason inspection and preliminary performance checks are carried out prior to final assembly.

6.2 Voltage Controlled Oscillators (VCO) boards 1 and 2 of OS3/509A

Note that boards 1 and 2 are identical electrically and in board layout. Check that each has been assembled to drawings Assembly Information D 52032 A2. Comp. Loc. D 52026 A2.

6.2.1 Voltages above 50V d.c. or 30V a.c. are absent from this board.

6.2.2 Inspect the board CAREFULLY for soldering defects, as the faults these can induce can be difficult to locate.

6.2.3 Check the polarity of the Tantalum capacitors.

6.2.4 Check the insertion of all components in particular TR102, TR103, D101, D102, IC101 and IC102.

6.2.5 Also check that TR101 and TR104 do not stand further than 8mm above the board.

6.3 Synthesiser Board 3 of OS3/509A

6.3.1 Check that it has been assembled to drawing Comp. Loc. D 52029 A2. It is important that anti-static precautions are observed on this board.

6.3.2 Voltages above 50V d.c. or 30V a.c. are absent from this board.

6.3.3 Inspect the board carefully for soldering defects, in particular, check for absence of short circuits on PLW and PLX R301, R328 and R348.

6.3.4 Check the polarity of all tantalum capacitors.

6.3.5 Check the insertion of ALL IC's.

6.3.6 Also check the insertion of MOD 1, (the 5MHz Crystal oscillator) and D301 and D302.

6.4 Box and leads of OS3/509A

6.4.1 Check wiring and assembly of extrusion as per D 52023 A1 except for absence of boards 1, 2, 3.

7. PRELIMINARY TESTS

Voltage Controlled oscillators boards 1 and 2. The following tests apply to both boards.

7.1 To Set Damping Constant

(a) With an ohmmeter connected between TP101 and ground set R105 to 2.5k ± 100Ω.

(b) With an ohmmeter connected between TP102 and ground set R107 to 2.3k ± 100Ω.

These values should give stable synthesiser operation and are later optimised to give best phase noise performance.

7.2 To check Current Consumption

7.2.1 Connect a bench PSU to the +15V pin and ground.

7.2.2 Switch on and check that the current drawn is less than 100mA.

9.3 To check 5MHz Reference Oscillator Output Level

9.3.1 Monitor 5MHz output on filtercon with oscilloscope probe. Check level to be 300mV p-p approximately.

9.4 To check 5MHz Reference Oscillator can be set to correct Frequency

9.4.1 Wait till unit has been on for 5 minutes or more to allow oven to reach temperature.

9.4.2 Measure frequency with monitor points open circuit to be 5,000,010Hz or higher.

9.4.3 Measure frequency with monitor points connected to 900Ω to ground to be 4,999,990Hz or lower.

9.5 To check Frequency Setting of 2nd Local Oscillator

9.5.1 Connect bench power supply, test box TE1/38 and OS3/509A. Solder wires from power output of TE1/38 to the +28V and +15V input of the OS3/509A taking great care not to reverse them.

Plug SKT from the OS3/509A into the test box.

9.5.2 Connect the output of the 2nd Local Oscillator via a 6dB splitting pad to the modulation analyser (HP 8901) and the spectrum analyser (e.g. HP 8554L).

9.5.3 Use the push button switches on the TE1/38 to step through channels 21 to 38 inclusive on the output (2nd) Local Oscillator. While doing this observe the output on the spectrum analyser for spurious oscillations and check the frequency using the modulation analyser to be 512MHz rising to 648MHz in 8MHz steps. Note that since the 5Hz crystal is not set to the correct frequency until the unit is mounted on the TM4M/502 the frequencies are not exact. Check also that the output of the oscillator is greater than 9.5dBm (3.5dBm at input to either spectrum analyser or modulation meter) for all channels 21 - 38. If this is not acheived make the following extra checks.

(a) Is any output present? If not the fault is on board 2 or its wiring.

(b) Is the frequency below 500MHz? If so the most likely cause is a short on either the control voltage input to board or on the divider output.

(c) Is the output unstable? If so increasing R207 to increase damping may stop spurious oscillation.

9.6 To check Phase Noise Performance of 2nd Local Oscillator

9.6.1 Keep the bench power supply test box TE1/38 OS3/509A spectrum analyser and modulation meter connected as in previous test.

9.6.2 Connect signal generator to PLA and apply an input of -10dBm at 40.5MHz. This is to prevent spurious oscillation of IC310 which occurs if no input is present and can cause some degradation in phase noise performance.

9.6.3 In the following tests the input channel selected on the TE1/38 should always be different from the output channel. Please note that selections less than channel 21 cause a default to channel 21 and selections over channel 69 cause a default to channel 69.

9.6.4 Select channel 21 for the output channel to set the 2nd local oscillator to 512MHz. The phase noise measured using the modulation analyser should be less than:

(i) 0.014 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.008 radians average in a bandwidth 300Hz 3kHz.

(iii) Optimise these measurements by adjusting R207 on board 2 in the following way. For operation on channel 21 the phase noise in a 300Hz to 3kHz bandwidth will get better the lower the value of R207 until the loop goes unstable. However before the loop goes unstable the noise spectrum peaks in the region of 6kHz to 10kHz. In this state the loop is underdamped R207 should be adjusted to decrease the noise in the 300Hz to 3kHz bandwidth without peaking the noise in the 300Hz to 15kHz bandwith. With this setting the R207 the loop will be overdamped when channel 38 is selected.

Select channel 38 for the output channel to set the 2nd local oscillator to 648MHz.

9.6.6 The measured phase noise should be less than:

(i) 0.015 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.012 radians average in a bandwidth 300Hz to 3kHz.

If not adjust R207 and repeat tests 9.6.4 to 9.6.6. to ensure wide band phase noise not raised out of specification on channel 21.

If these phase noise figures cannot be achieved listen to the modulation output of the modulation analyser for any obvious tones. Otherwise consider changing D202 after doing tests 9.6.7 and 9.6.8. if wide band phase noise at channel 38 high.

9.6.7 Set the output to channel 39 which sets the 2nd local oscillator to 656MHz and measure the phase noise to be less than:

(i) 0.020 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.012 radians average in a bandwidth 300Hz to 3kHz.

(iii) Optimise measurements using R205 on board 2.

9.6.8 Set the output to channel 69 which sets the 2nd local oscillator to 896MHz and measure the phase noise to be less than:

(i) 0.025 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.015 radians average in a bandwidth 300Hz to 3kHz.

If not adjust R205 and repeat 9.6.7.

If these phase noise figures cannot be achieved listen to the output of modulation analyser for any obvious tones. Otherwise consider changing D201 if wide band phase noise at channel 69 high.

9.7 To check the Frequency Setting of the 1st Local Oscillator

9.7.1 Connect the output of the 1st Local Oscillator via a 6dB splitting pad to the modulation analyser (HP 8901) and the spectrum analyser (HP 8554L).

9.7.2 Use the push button switches on the TE1/38 to step through channels 21 to 38 inclusive on the input (1st) Local Oscillator. While doing this observe the output on the spectrum analyser for spurious oscillations and check the frequency using the modulation analyser to be 512MHz rising to 648MHz in 8MHz steps. Note that since the 6MHz reference is not locked during this test the frequencies may be out by as much as 250kHz. Check also that the ouput power level is greater than 9.5dBm.

9.7.3 Use the push button switches on the TE1/38 to step through channels 39 to 69 inclusive on the input (1st) Local Oscillator. While doing this observe the output on the spectrum analyser for spurious oscillations and check the frequencies using the modulation analyser to be 656MHz rising to 896MHz

7.3 To check Operation of Regulator and Band Switching

Check the following voltages with respect to ground:-

7.3.1 Collector of TR103 for 10V ± 0.25V.

7.3.2 Base of TR103 for 4.8 ± 0.2 volts.

7.3.3 Pin 4 of IC101 for 12 ± 0.5 volts.

7.3.4 Base of TR102 for less than 0.7 volts.

With a crocodile clip short the band switching pin to ground. Check the following voltages with respect to ground.

7.3.5 Base of TR102 for 4.8 ± 0.2 volts.

7.3.6 Base of TR103 for less than 0.6 volts.

7.4 To check Oscillator Output Power and Frequency Range

The following tests should be made with board not in extrusion and not near any conducting surface.

7.4.1 Switch off the +15 volts supply and remove shorting clip from band switching input.

7.4.2 Solder a suitable co-axial lead to the local oscillator output. Connect this lead to the UHF spectrum analyser.

7.4.3 Connect the varactor control pin input to ground with a shorting clip and switch on the +15V supply. Check for output frequency between 470MHz and 500MHz and level in range between 10dBm to 14dBm.

7.4.4 Switch off +15V supply. Connect varactor control input to +20V ± 0.1V and switch +15V supply on again. Check for output frequency between 690MHz and 740MHz and level of between 10dBm to 14dBm.

7.4.5 Connect shorting clip to band switching input. Check for output frequency between 910MHz and 950MHz and level of between 10dBm to 14dBm.

7.4.6 Connect shorting clip to varactor control input.

Check for output frequency between 680MHz and 720MHz and level of between 10dBm to 14dBm.

8. SYNTHESISER Board 3 of OS3/509A

The following tests are carried out on board 3 prior to fixing in extrusion.

8.1 To check Current Consumption

8.1.1 Taking care to connect the correct pin, connect flying leads to the +15V and ground. Connect up a bench power supply, switch on and check that the current taken is 380mA ± 20mA.

8.1.2 Connect flying leads to the +28V pin and ground from a second PSU and check that the current consumption does not exceed 350mA (may lie anywhere between 60mA to 350mA dependent on ambient temperature).

8.2 To check Voltage Regulators

8.2.1 Check that the following voltages are present with respect to ground.

(i) Check output pin 1 of IC302, IC308, IC316, IC323 for 5 volts ± 0.2 volts.

(ii) Check output pin of IC303 and IC318 for 8 volts ± 0.3 volts.

8.3 To check Reference Oscillators

8.3.1 With an oscilloscope check that the signal seen

(i) at TP312 is 5MHz (period 0.2µS) and greater than 3V p-p.

(ii) at TP303 is 6MHz (period 0.167µS) and greater than 6V p-p.

8.4 To check 1st Local Oscillator Divider Chains

8.4.1 Connect UHF signal generator via temporary lead connected to copper track at junction of R301, R302. Set amplitude to -10dBm and frequency to 511MHz. Insert test socket (made to DSK 23062 A4) into PLW and connect its flying lead to ground. (This sets IC304 to divide by 64.)

8.4.2 Check that TP304 is at a voltage greater than 25V.

8.4.3 Change input frequency to 513MHz.

8.4.4 Check that TP304 is at a voltage less than 0.6V.

If these tests fail check the output of each divider in reference and programmed chains and also the phase comparator.

8.1 To check Current Consumption

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(i) at TP312 is 5MHz (period 0.2μS) and greater than 3V p-p.

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8.4 To check 1st Local Oscillator Divider Chains

8.4.1 Connect UHF signal generator via temporary lead connected to copper track at junction of R301, R302. Set amplitude to -10dBm and frequency to 511MHz. Insert test socket (made to DSK 23062 A4) into PLW and connect its flying lead to ground. (This sets IC304 to divide by 64.)

8.4.2 Check that TP304 is at a voltage greater than 25V.

8.4.3 Change input frequency to 513MHz.

8.4.4 Check that TP304 is at a voltage less than 0.6V.

If these tests fail check the output of each divider in reference and programmed chains and also the phase comparator.

8.5 To check 2nd Local Oscillator Divider Chains

8.5.1 Connect signal generator to junction of R342 and R343 and set amplitude to -10dBm and frequency to 511MHz insert test socket into PLX and connect flying lead to ground.

8.5.2 Check TP313 for 25V or greater.

8.5.3 Change frequency to 513MHz.

8.5.4 Check TP313 for .6V or less.

8.6 To check Carrier Locking Divider Chains

8.6.1 Connect signal generator to copper track at C326, using lead less than 300mm. Set level to -12dBm and frequency to 40.5MHz.

8.6.2 Check TP309 for 25V or greater.

8.6.3 Set frequency to 41MHz.

8.6.4 Check TP309 for 0.6V or less.

8.7 To check Frequency Pulling of 6MHz Oscillator

8.7.1 Connect high impedance frequency counter to TP303.

8.7.2 Repeat frequency inputs of previous test.

8.7.3 Check frequency at TP303 to be 5.999MHz or less and 6.001MHz or more respectively.

9. SYSTEM TEST OF DUAL UHF OSCILLATOR OS3/509A

9.1 Complete the assembly of the inspected boards and box as for D 49993 A1. Note that only the M3 screws shown should be fitted (the extra holes are maintenance spares). The M4 screws holding down boards 1 and 2 should be fitted after the M3 screws.

In addition the synthesiser board 3 should be temporarily held down by two M4 screws, nuts and washers to the extrusion.

9.2 To check Current Consumptions

9.2.1 Taking care not to reverse the +15 volt and +28 volt rails, apply +15 volts to the unit from a bench PSU and check that the current consumption is 530mA ± 40mA.

9.2.2 Apply, from a second bench PSU +28 volts to the unit and check the curent consumption is less than 350mA. This will reduce as the oven heats up.

in 8MHz steps note that the frequency error may be up to 250MHz. Check that the output of the oscillator is greater than 9.5dBm.

9.8 To check Carrier Locking Circuit

This circuit gives fine frequency control of the 1st Local Oscillator.

9.8.1 Connect test items as follows:

(a) Plug 25 pin "D" connector into TE1/38.

Solder +28V and +15V outputs of TE1/38 to appropriate filtercons.

(b) Connect output of first Local Oscillator to a 6dB splitter pad.

(c) Connect one output of this pad to the modulation meter HP 8901 via a 6dB pad.

(d) Connect the second output via a 6dB pad to a mixer.

(e) The other input to the mixer is a signal generator HP 8640 or similar.

(f) The output of the mixer is filtered to pass only the 40.75MHz frequency component and simplified by 15dB to a level corresponding to -10dBm.

9.8.2 Set the signal generator frequency to 471.25MHz an output level of +7dBm. Set the offset switch on the test box TE1/38 to '0' and the input channel to 21.

9.8.3 Using the modulation analyser check that the frequency is 512MHz within the limits of accuracy of the signal generator frequency and modulation meter. This is about ± 1kHz.

9.8.4 Measure current from filtercon C6 to ground to be 10 ± 2mA.

9.8.5 Set the front offset switch on the test box TE1/38 to '+' and check that the frequency falls from '512MHz' by exactly 26040Hz. Set the offset switch on the test box TE1/38 to '-' and check that the frequency rises from the original '512MHz' by exactly 26040Hz.

9.8.6 Set the offset switch on the test box TE1/38 to '0'. Set the signal generator to 471.15MHz and check that the current measured at filtercon C6 is still 10mA.

9.8.7 Set the signal generator to 471.35MHz and check that the current measured at filtercon C6 is still 10mA.

9.9 To check Phase Noise Performance of Input (1st) Local Oscillator

9.9.1 Keep equipment connected as in previous test and in following tests ensure output channel is different from the input channel.

9.9.2 Set input channel to 21 and offset to '0'. Set signal generator to 471.25MHz and output level of +7dBm.

9.9.3 Measure the phase noise to be less than:

(i) 0.014 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.008 radians average in a bandwidth 300Hz to 3kHz.

(iii) Optimise using R107 on board 1 (cf 9.6).

9.9.4 Select channel 38 for the input channel and set the signal generator to 607.25MHz. Measure the phase noise to be less than:

(i) 0.015 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.012 radians average in a bandwidth 300Hz to 3kHz.

If not adjust R107 to board 1 and repeat previous test (cf 9.6).

9.9.5 Set the input channel to 39 and the signal generator to 615.25MHz.

9.9.6 Measure the phase noise to be less than:

(i) 0.020 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.012 radians average in a bandwidth 300Hz to 3kHz.

(iii) Optimise using R105 (cf 9.6).

9.9.7 Set the input channel to 69 and the signal generator to 8.55.25MHz.

9.9.8 Measure the phase noise to be less than:

(i) 0.025 radians average in a bandwidth 300Hz to 20kHz.

(ii) 0.015 radians average in a bandwidth 300Hz to 3kHz.

If not adjust R105 and repeat previous test (cf 9.6).