



TAPE RECORDER

Service Instructions

OPTACORD 416 and 416 DIA

PORTABLE, ALL-TRANSISTOR TAPE RECORDERS

Mechanical part (drive mechanism)

Adjustment of Tape speed (at 3³/₄ ips)

Put on a tape and push the "Start" key. - A stroboscopic disc, pasted on the flywheel, in conjunction with a 50 c/s-flashlight stroboscope lamp can be used to check the tape speed. If the tape is travelling with the normal speed, you will have the impression that the disc, illuminated by the flashlamp, is »standing still«.

By an axial shifting of the motor, the speed can be altered by about 1%. However, make sure that the speed change-over from 1⁷/₈ to 3³/₄ ips. still works satisfactorily.

Tape speed should be measured by means of a speed meter EMT-420a for constancy, using a reference tape with a record of 3150 cps. For this test, the combination record-playback head should be connected with the speed meter and tape speed should be adjusted to 3³/₄ ips. with an admissible tolerance of 2%. If a new motor has been built in, it should be set so that it will rotate with an about 0.5% higher speed, as the rotational speed of the motor will drop somewhat after a certain running time.

Adjustment of motor to right position, while tape is running with a speed of 3³/₄ ips.

With a setting of about 2°, the motor should be rotated in a clockwise direction against the radial direction of the flywheel, so that the pinion on the motor shaft is moved toward the rotor, when the motor is started.

The current consumption of the motor should be adjusted to a minimum value, i. e. with normal speed, no tape reel put on, not more than 160 mA should be measured.

This adjustment being completed and the start key pressed, the pressure of the pinion to the flywheel should be 100 . . . 125 g. If the flywheel is detained, the motor should stop.

Pressure of motor drive roller

No tape is needed for this test. Press the key "Fast wind" or the key "Fast rewind" and stop the rotation of the top part of the left- or righthand turntable gripping it with your hand. The flywheel should stop at once and the pressure of the motor drive roller should be hard enough to stop the rotation of the motor. If the motor should continue rotating, the draw spring must be shortened by 2—3 mm. If with detained coupling the flywheel should continue its rotation or if it should come to a stop too slowly, there is no proper power transmission between the flywheel, the friction wheels and the couplings and, in such case, the outer border of the

couplings, of the friction wheels or of the flywheel should be cleaned with a cloth, moistened in spirits, to remove grease.

Adjustment of the flywheel

Adjust the flywheel by means of the lower bearing screw which is protected against self-acting distortion by a spring in such a way that the shaft protrudes 0.3 . . . 0.5 mm out of the upper bearing. Thereupon, thighten the upper axial support. After the completed adjustment, check the flywheel - with pressed start key and lifted-off motor - for easy running and vertical shaft slackness; retighten the lower bearing screw, if necessary.

Motor lift-off

To test motor lift-off, press key "Stop" and, at the same time, key "Start", which must be locked by its stop device. The motor should rotate, while the flywheel must stand still. - The readjustment is done by dislocating the switch hook. For that aim, loosen the setting screw of the switch hook, adjust the hook, retighten the screw and, after checking, provide varnish.

Attention! The stop key should always be pressed with sufficient force **to be locked in its stop position**, because, otherwise, the motor will not lift off properly.

Speed Selection

When changing the speed, make sure that in normal running position the motor is lifted off far enough, so that the motor pinion, at the speed of 3³/₄ ins., does not touch the flywheel. For a readjustment use the setting screw, situated in front of the switching lever.

Tighten the counter-nut well and provide with varnish. The maximum switching power may be for switching to 1⁷/₈ ips 500 g and to 3³/₄ ips. 1050 g.

Fast stop

Press stop key and fast stop key. Hereby, the rubber pinch roller is lifted abt. 2 mm off the sound shaft. If the coupling is correctly adjusted, the inserted tape stops instantaneously. Adjust the sheet lever, protruding from the rubber roller, in such a way that the fast stop key cannot drop by itself. The switch lever must not brush against the revolution counter.

Testing the adjustment of the couplings

Testing proper operation of left-hand turn-table

Press key "Start", make a mark of the momentary position of the lower part of the left-hand turntable, turn the upper part by hand. The lower part of the coupling must remain stationary. The nose of the grip-ring, securing the rubber-pressure cover, should be on the side toward the turn-table. The rubber cover should be compressed but slightly and no rotation should set in.

Adjusting the left-hand coupling by means of a spring balance

Pull the power plug and press key "Start". - Place a reel with only a few turns of starting tape on the left-hand turntable. Fasten end of tape to spring balance. The lower part of the coupling standing still, the coupling should rotate in an anticlockwise direction. When using a reel with a core diameter of 4.5 cm, the spring balance should indicate a pull of between 8 and 10 g.

The coupling moment can be adjusted by screwing down or loosening the setting screw in the upper part of the turntable. Care should be taken that this screw is not completely unscrewed, as this might lead to loosening the nut so that it will drop out.

Right-hand coupling

The right-hand coupling is different from the left-hand one, as its lower part has a belt groove.

Checking operation of right-hand coupling without auxiliary device

Place recorder in an upright position. Let tape wind on to the right-hand reel. At the end of the tape (right reel almost full) the coupling must work properly. No tape kinks should be formed, when pressing the "temporary stop" key. If a readjustment should be necessary, screw down the setting screw of the upper part of the coupling a certain amount. If the coupling should operate noisily, fit a new felt piece on the brake and grease the shaft and the lower part of the coupling properly (use "Depot grease" F 2). For cementing the felt piece, use a glue that is not absorbed by the felt (f. i. EC-870, Makers Minnesota Mining, Düsseldorf).

Adjustment of right-hand coupling by means of a spring balance

Pull the power plug. Press the "Start" key. - Put an empty reel with a core diameter of 4.5 cm and a few turns of tape on the right-hand turntable, as already described for testing the left-hand coupling, and fasten the end of the tape to the spring balance (50 g-type). Pull the tape off in a clockwise direction. - The spring balance should indicate a pull of 26 to 27 g. The adjustment is, also in this case, effected by screwing down or loosening the setting screw in the upper part a certain amount. - The adjustment of the height of the turntable is effected by putting or taking away thin discs of plastic foil, placed under the turntable. The shafts of the turntable should, then, again be secured by means of the grip ring, putting a washer under same (axial play should be abt. 0.2 mm).

Brakes

The brakes are more effective in one direction than in the other one. - In "Stop"-position, the brakes will be in touch with the upper part of the capstan.

Adjustment of brakes in "Stop"-position

Left-hand brake

The left-hand brake should be set into the correct position, by a corresponding displacement of the rubber covering used for braking. - Push grip ring, in the position, as hard as possible against the metal sheet.

Move the clamping sleeve on the wire cord sideward and secure it by soldering it in such a position that a play of about 2 mm will remain between the left-hand brake and the bolt. - Cut the wire cord immediately behind the clamping sleeve (the spring, fastened in the eye, should pull with a

force of 10 to 15 g). - Turn the left-hand coupling in an anti-clockwise direction. The force of the pull can be adjusted by bending the metal sheet correspondingly.

Right-hand brake

Set brake into the proper position. - Push grip ring securely against the metal sheet. - The metal sheet should be bent in such a manner that there will remain a play of about 2 mm from the bolt. (The spring, fastened in the eye, should pull with a force of abt. 10 to 15 g). Turn the upper part of the turntable in a clockwise direction. Check the braking power. It is adjustable by bending the metal sheet correspondingly.

Position of brakes, when pressing the "Start" key.

Press the "Start" key.

Left-hand brake

The left rubber-covered brake must be lifted off properly. If this should not be the case, bend the metal sheet upward or downward.

Lower part of turntable. Rubber-covered brake.

Make certain that the sponge rubber piece on bolt is securing the lower part of the turntable in its position. - (Make a pencil mark on the lower part of the coupling and turn the upper part of same by hand in either direction. The lower part of the coupling must remain stationary.)

Right-hand brake

The rubber-covered brake should press slightly against the part of the upper half of the coupling above the junction line: turntable-centre/rotation point of brake. - (The pull of the spring, fastened in the eye, should have a force of 10 to 15 g).

Position of brakes, when pressing the key "Fast wind"

Press key "Fast wind". - Left- and right-hand brakes must be lifted off an amount of abt. 1.5 mm. - For adjustment of right-hand brake (if necessary) bend the metal sheet correspondingly. - Press key "Fast rewind" and check spacing once more.

Last test

Press key "Fast wind" and, thereupon, key "Fast rewind". The tape must be wound properly around the middle of the core of the reel (if this should not be the case, adjust height of turntable by adding or removing plastic foil spacer disks).

Pressure of rubber-covered pinch roller

Press Start key. The shaft of the rubber-covered pinch roller should have a play of abt. 1 mm in the slot toward the front (minimum play abt. 0.5 mm). An adjustment can be effected by means of the metal sheet, used for this purpose, having loosened the M-2 setting screw. - The pressure of the rubber pinch roller should have a force of about 450 to 550 g. An adjustment can be made by turning the setting screw.

Pressure of felt-covered brake. Screening

Press Start key. - Test: Pull felt of brake backward. Minimum play between brake and head 1.0 mm. - Pressure of spring should have a force of 25-30 g. - For adjustment of proper fitting of felt and screening, loosen the M-2 screw.

Replacement of combination record-playback head

Having replaced the head or checked the position of the head with regard to the tape, loosen the M-3-screw and withdraw the screening with the pressure spring from the lever of the tape pinching roller. The head is, then, adjusted in such a manner that the upper edge of the upper magnet head system is exactly in line with the upper edge of the tape, passing along the head.

Thereupon, the screening with the pressure plate is again put on. The screening sheet must be exactly in mid-position, i. e. the chamfer must not be in touch with the screening of the head. The small felt pressure plate also, should, possibly, be pulled out by 1 mm, and it must not be canted.

If the rear part of the head should be in too low a position, the tape would form a small kink at its upper edge. This is wrong. The head must always be adjusted in such a manner that the tape is running off the sound shaft in a perfectly smooth condition.

Test

Now, a record of a musical item or of a test tone should be made and the tape reels be interchanged. Then, the recorder should be switched for playback and you listen to the reproduction of the record. - With the sound volume control turned fully on, nothing should be heard. - If the head should be in too low a position, you would hear the reproduction with a certain loudness. - After this test, the vertical position of the magnet gap is tested in the usual manner, either by listening to the reproduction of a testing tape with a record of a 5 to 8 Kc/s-tone and adjusting for the highest sound level or by listening to the reproduction obtained with a DIN-testing tape and adjusting for the highest output tension of the amplifier (see section "Adjustment of magnet gap" page 6).

Adjusting height of tape guide

For adjustment of the height of the tape guide bolts, proceed as follows: The tape should run smoothly and in a perfectly stretched condition through the height guiding device. When pressing the key "Start", the tape must still run smoothly through the named device.

Adjustment of the switches S I, S II, AV I/II

The switches S I and S II should be set so that, when pressing one of the keys for fast rewind or fast wind, the contacts 4 to 5 of the switch S II are already closed, before the contacts 1 to 3 of the switch S I are opened. - The contacts of switch AV II should be closed before those of switch AV I. A readjustment could be effected by bending the switch lever. The excess lift of the switching contact amounts to 0.5 mm.

Testing and adjusting the constancy of tape speed

The constancy of tape speed should be checked with a speed meter EMT 420a (same as above), using a reference tape with a record of 3150 cps. Occuring fluctuations of tonal pitch should be evaluated by listening, while the tape is running with a speed

of 3 3/4 ips varying less than 0.3%

of 1 7/8 ips varying less than 0.5%

The slip may amount to 2% max. for a period of 15 seconds. An auditorial test of the constancy of speed is possible when replaying a piano concert. In the case of a bad speed constancy, sound level fluctuations can be observed.

Calibration of the moving coil instrument for the checking of the operating voltage

The operating voltage of the recorder is reduced to 6 v. by means of a regulating transformer or, in case of battery operation by the removal of one of the dry cells of 1.5 v. The pointer of the instrument is then adjusted to stand above the separation line between the red and black range of the dial. Use R 44 for this adjustment.

Motor Control

The oscillator should still well oscillate at the lower voltage limit of $U_B = 5.6$ V. At the upper voltage limit of $U_B = 10$ V adjust R 31 in a way that the control still effects a clear switching. Use oscilloscope for testing; h. f. oscillation should drop to zero.

Tabla I Current consumption at $U_B = 7.5$ V, without amplifier

| | |
|---|---------------|
| Motor running with a load of 10 cmg | ≤ 150 mA |
| Regular operation (without tape) with a speed of 3 3/4 ips | ≤ 160 mA |
| Regular operation (without tape) with a speed of 1 7/8 ips | ≤ 130 mA |
| Regular operation (without tape) with a speed of 3 3/4 ips and with pinch roller lifted off | ≤ 140 mA |
| Regular operation (without tape) with a speed of 1 7/8 ips and with pinch roller lifted off | ≤ 110 mA |

| | |
|--|---------------|
| Regular operation and stop with remote control microphone | ≤ 90 mA |
| Fast forward wind (without tape) at a speed of 3 3/4 ips | ≤ 250 mA |
| Fast forward wind (without tape) at a speed of 1 7/8 ips | ≤ 190 mA |
| Fast rewind (without tape) at a speed of 3 3/4 ips | ≤ 260 mA |
| Fast rewind (without tape) at a speed of 1 7/8 ips | ≤ 200 mA |
| Regular operation (with tape) at a speed of 3 3/4 ips | ≤ 200 mA |
| Regular operation (with tape) at a speed of 1 7/8 ips | ≤ 170 mA |
| Regular operation (with tape) at a speed of 3 3/4 ips and with pinch roller lifted off | ≤ 190 mA |
| Regular operation (with tape) at a speed of 1 7/8 ips and with pinch roller lifted off | ≤ 160 mA |
| Fast forward wind (with tape) at a speed of 3 3/4 ips | 510 mA (max.) |
| Fast forward wind (with tape) at a speed of 1 7/8 ips | 350 mA (max.) |
| Fast rewind (with tape) at a speed of 3 3/4 ips | 570 mA (max.) |
| Fast rewind (with tape) at a speed of 1 7/8 ips | 400 mA (max.) |

| Test points B = Base E = Emitter K = Collector | D. c. tension against chassis with battery tension of - 7.5 V | Playback level with 1 Kc input via 10 ohms into "cold" lead of connection cable of head. R 13 turned on. | Recording level with 1 Kc applied via series resistor of 5 kohms at Micr. Input, R 13 turned on |
|---|---|--|---|
| B 1 | — | 1.5 mv. rms | 100 microv. rms |
| K 1 | - 1.3 v. | 6.5 mv. rms | 300 microv. rms |
| K 2 | - 3.7 v. | 250 mv. rms | 12 mv. rms |
| E 2 | - 1.3 v. | — | — |
| K 3 | - 7.0 v. | 2.65 v. rms | 0.4 v. rms |
| E 3 | - 1.5 v. | — | — |
| K 4/5 | - 7.5 v. | 3.5 v. rms | — |
| E 4/5 | 7-12 mV adj. by means of R 29 | — | — |
| U_{Lsp} | — | 2.65 v. rms across 4.7 ohms | — |
| H. f. (r. f.) supplied to erasure head, adjusted at 80 v. rms by means of R 33 ("Optacord 416") and to 45 V in "Optacord 416 DIA" | | | |
| at recording head, adjusted by means of C 16 at about 15 v. rms (h. f. 55 Kc/s \pm 5 Kc/s) | | | |
| (H. f. at test point K 3 max. 300 mv. rms eff) | | | |

Checking the operating voltage

During this measurement, the a. c. mains voltage should not fluctuate more than $\pm 10\%$. Test with a tape put on and playing back at maximum level.

| | |
|--|--------------------------|
| Mains (power line) tension | D. c. voltage across C 1 |
| A. C. of 242 v., sound volume turned off | 9.4 v. d. c. (max.) |
| A. C. of 198 v., sound volume turned on | 5.6 v. d. c. (max.) |

| Power consumption (reactive power and effective power) at 220 v. A. C. (maximum values) | I (ma.) | N (VA) |
|---|---------|--------|
| Idle current of power transformer | 23 | 5.06 |
| While recording | 29 | 6.38 |
| While playing back (top level) | 44 | 9.58 |
| Wind back (max. after 1 sec.) | 42 | 9.24 |

Noise voltage ratio

The noise voltage ratio is determined by the ratio of the full modulation level to the noise level, measured at the radio output, the recorder being operated on 220 V / 50 c/s mains. The noise voltage ratio should be 40 dB at a minimum, even for both-way application of the mains plug.

Diagram (see table II)

Specifications subject to change

Double track recording-playback head UK 104

For connection to a 110 V mains supply

Put shunt wires between red-red and white-white

Tape speed selection

| | | | |
|--------------|----------------|-----------------------|--|
| tone control | Temporary stop | Micr.-Radio Switch | Volume and for Signal level control |
|--------------|----------------|-----------------------|--|

SR = Fast rewind, A = Recording, ST = Stop, V = Normal speed,
SV = Fast wind

Switches shown in position recording

recording-playback switch

double track ferrite erasing head 5 mH UL 117

Printed circuit board — View to component parts

Colours of transistor wirings:

Emitter (E) = green, Base (B) = yellow, Collector (C) = red

Playback amplifier

Make certain that no capacitive or magnetic stray couplings from other parts of the apparatus are rendering the measurements unreliable. Use an audio generator, a millivolt-valve voltmeter (permitting a. f. measurements) and a LOEWE OPTA testing tape 9/4,5 or a tape DIN 45513.

Demagnetizing the magnet heads and the base plate of same

Before beginning the tests, the magnet heads should be demagnetized by means of a demagnetizer choke. For this purpose you may use an audio output transformer with a core of E-I-shaped laminations (removing the I-leg of the core). A special demagnetizer choke is also available (Makers: Telefunken). The choke is connected to an a. c. mains (power line) of 50 c/s. The choke is moved very slowly toward the base plate of the magnet heads and then removed from the heads in the same manner, when it can be switched off. Otherwise, a current surge, due to selfinduction, caused by the interruption of the current supply, would cause a renewed magnetization of the metal parts. A magnetized head would increase the production of noise and impair the test tape (slow erasure of the record on the tape). The tools, used for the test, should also be demagnetized in the same manner, before using them. - During the demagnetizing procedure, no tapes with records on them, f. i. the test tape, should be left near the demagnetizing choke, while it is under current.

Playback

Before checking the level, proper operation of tape transport should be checked. The adjustment of vertical position of gap of head is performed with the help of a reference record DIN 45 513 played back (using the 10 Kc-track of the tape). The deviation tolerance from the maximum is ± 4 dB.

While playing back the track with a signal level record with the volume control turned to zero, a voltage of 330 mV or more should be measured between the terminals 2/3 of the socket for radio recordings.

Distorsion when playing back the reference record of level at 333 cps on the testing tape DIN 45 513 should not exceed 5%. It must be possible to adjust the output power of the final stage, loaded with a resistance of 4.7 ohms, to 1.5 W = 2.65 V across 4.7 ohms by turning the volume control full on, while playing the record of the reference level on the named test tape at the final-stage charged with a 4.7 ohms resistance.

With the volume control in turned-down position, a net a. c. voltage of = 25 mV should remain at the 4.7 ohms resistance. The distorsion factor at the output transformer, charged with 4.7 ohms, may amount to a maximum of 10% with an output of 1.5 W (measured with the 333 c/s reference level of the DIN testing tape section).

Frequency response curve of playback amplifier

When adjusting the frequency response, beginning with 20 c/s up to 15 Kc/s, the standard response curve 1, shown in the fig., should be obtained. As shown in this graph, the curve will first drop slightly toward the higher frequencies and, then, show a slight rise.

- 1 Playback (plotted at radio output)
- 2 Recording (current supplied by recording head)
- 3 Record-Playback (at radio output)
- 4 Record-playback (across moving coil of loudspeaker) with tone control set for treble drop.

Steady current of the amplifier

This current is measured by connecting a voltmeter to R 4. Then, press key "Start" and turn the sound volume off. The steady current has its right intensity of 7.5 ma., if a tension of 90 mv. is measured across R 4/12 ohms.

Steady current of output stage with $U_B = 7.5$ V

The steady current of this stage is adjustable by means of R 29 to a value of 10 mA = 10 mV across R 37. Thereupon, a lead of 4.7 ohms is put across the output transformer and the proper operation with full modulation (1 k/c) is checked by means of an oscilloscope. A voltage of 2.65 V should exist across the resistance. Care should be taken that no overlap errors appear on the rising and dropping shoulders of the sine curve. Small overlap errors can be eliminated by a readjustment of the steady current. With a perfectly matched pair of output transistors, a steady current of 7 mA (min.) and 12 mA (max.) should be measured at an operating temperature of + 20° C.

Head-gap alignment

Switch recorder for playback. Otherwise, the record on the testing tape will be erased.

Testing by listening. Play part 2 of the DIN test tape for the adjustment of the magnet gap. Set tone control for treble lift. - The magnet head should be adjusted in such a position that the "hiss" from the speaker reaches its maximum intensity.

Recording amplifier

Sensibility of recording amplifier

The current supply of the h. f. generator should be interrupted by unsoldering the bridge U, pressing the recording key and turning the sound volume to maximum intensity. The balancing switch is set for microphone recording and a frequency of Kc with a voltage of 300 μ V is injected into the microphone inlet. The voltage must then be amplified to 900 mV or more at test point K 3.

Adjusting the h. f. bias magnetization

Use R 33 to adjust the voltage so that a tension of 80 v. rms is applied to the erasing head. The bias magnetization current is controlled by means of C 16, so that a frequency response according to DIN 45511 is obtained, when playing back. At a lower limiting frequency of 60 c/s and an upper one of 12 Kc/s, the frequency response from 90 c/s to 8 Kc/s must remain within the tolerance range of 3 dB. - The intensity of the bias magnetization current should reach a value from 14 to 20 v. rms. at the recording/playback head, but individual heads will require different bias currents. - The h. f. voltage at test point K 3 must not be too high (maximum tension 300 mv. rms). It can be controlled by changing the capacity of C 33.

The current carrying capacity of the h. f. generator is abt. 55 mA at the max.

The erasing generator

An erasure voltage of about 80 v. rms should be measured. The adjustment of R 33 should take place with a battery tension of about 7.5 v.

Maintenance

The maintenance of the recorder is essentially restricted to an occasional cleaning of the magnet heads etc., so as to remove the magnetic dust deriving from the coated side of the tape and collecting mainly in the magnet gaps. Use a soft brush to remove this dust. If solid residuals should be left on the parts in question, use a cloth, moistened in spirits, to clean them. - Never use a metal part for the cleaning, as this might cause damage to the magnet heads. - The rubber covering of the friction wheels should never be soiled with oil or grease. If this should happen by mistake, clean them carefully with a linen cloth, moistened in spirits. - For friction points, which must be lubricated, use Depot grease F 2. - When servicing a recorder, always demagnetize the magnet heads, before starting the work.

Driving part for Dias

T 11 and T 12 are operating as amplifiers. T 13 has the function of an impedance transformer, the S-relay with T 14 serves to switch on the projector. T 14 AC 153 may be replaced by an AC 128. The upper system of the combined head BL 210 is used as erasing head for the upper track, the lower system is used as recording head and for the reproduction of the control pulses. At the same time, it serves as d. c.-erase head for erasing wrongly injected driving pulses. The resistance R 72/390 ohms limits the erase current, the erase voltage being abt. 4,5 V.

The driving pulses are generated by 50 c/s mains from a 7 V tension at the recording head. The duration of the pulses is optional. The maximum amplification of the driving amplifier is tuned to the second harmonic i. e. 150 c/s. A corresponding strong harmonic oscillation will be obtained by the oversaturation of the tape by means of a recording current of abt. 8 mA. For checking the recording current, measure the voltage drop over R 71/470 ohms ($UR\ 71 = 4.7\ V$). The control pulses can only be recorded by mains operation. R 83/500 ohms serves for the adjustment of the base current for T 14. With an operating voltage of 7.5 V the a. c. voltage at the switching transistor T 14 is 250 to 400 mV. The voltage drop at the S-relay should amount to abt. 5 V.