Brüel & Kjær

Measuring Amplifier

2608

valid from serial no. 395964

0037–0092

Service

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0037–0092

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Trouble Shooting:

If some sort of trouble occurs with this instrument then first check the D.C. working voltages from the Power Supply.

Then use the Checking Procedure with Block Diagram in order to localize a trouble to be in one certain circuit.

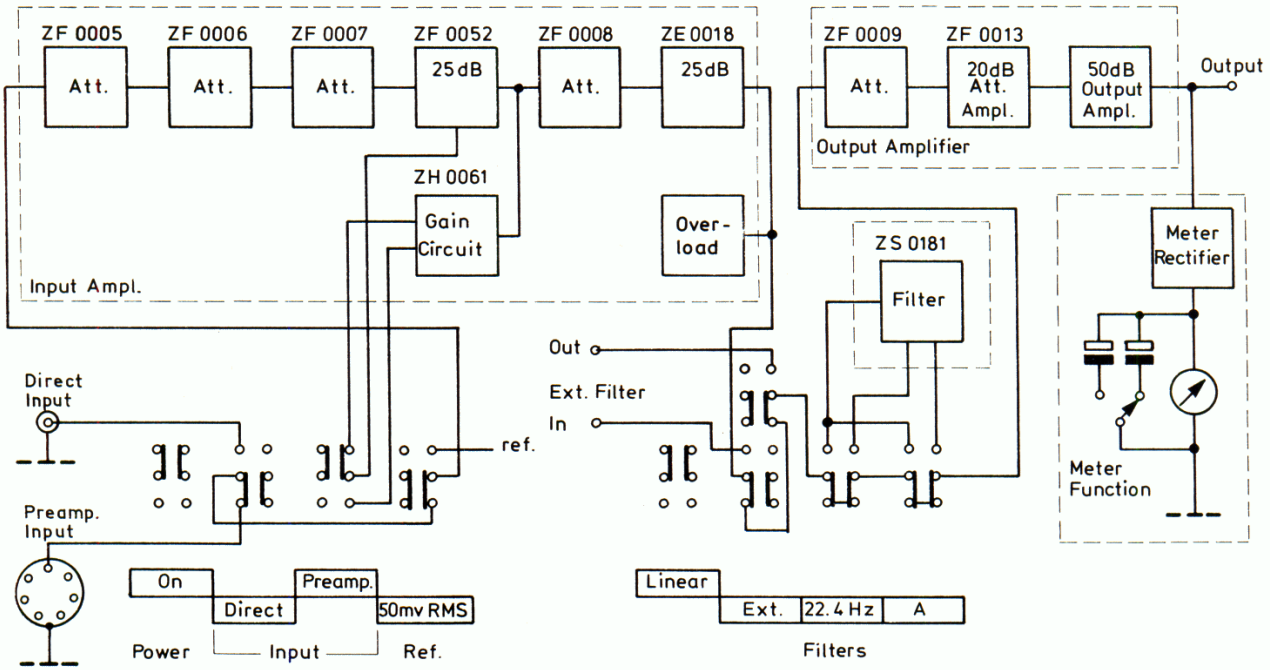
When a fault has been found and remedied the voltages and adjustments which are influenced by the remedy must be rechecked and the Checking Procedure can be used again to tell if all basic functions of the instrument are fulfilled.

The tolerance stated in the instructions can only be used as a guide for adjustment and control, but any deviations must not be corrected without being sure that the tolerances of the instrument used for making the adjustment are so small as to have no influence on the measurements.

The instructions in this Manual are given purely as a guide to the service of equipment. Some faults, as f.inst. small deviations in tolerances require for their correction special control equipment and extensive experience, and in these cases it is necessary to send the instrument to the factory.

Spare Parts:

Please state type and serial number of apparatus when spare parts are ordered.



The Measuring Amplifier 2608 consists of an Input Amplifier with Attenuator, a Filter Circuit, an Output Amplifier with Attenuator and a Meter Circuit.

The first stage of the input amplifier is a 0–90 dB attenuator which is positioned on three circuits boards ZF 0005, 0006 and 0007.

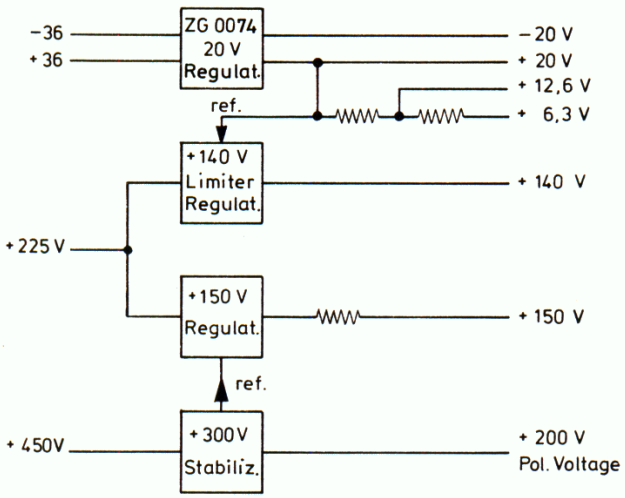
The input attenuator is followed by a low noise 25 dB amplifier ZE 0052 with protection diodes across the input.

Then comes a 0–30 dB attenuator ZF 0008 and another 25 dB amplifier ZE 0018.

The resulting Input Amplifier has an amplification of 50 dB and a 0–120 dB attenuation.

Furthermore the first 25 dB amplifier can be sensitivity adjusted by "Gain Control" (–12 dB) and "Direct Sens." and "Preamp. Sens." each having an adjustment range of + 4 to –10 dB in respect to normal sensitivity.

An overload indicator positioned on the bottom circuit board is connected to the output of ZE 0018 to indicate when the output voltage is more than 13 dB above 1 V.



The output of ZE 0018 being low impedance is meant to feed a filter as f.inst. the A-weighting network or HP 22.4 Hz filter placed on ZS 0181.

The "Lin. 2–200.000 Hz" selection corresponds a direct connection between input and output amplifier.

Also an external filter can be connected to sockets on the rear of the instrument.

The output amplifier section consists of a 0–20 dB attenuator with a 300 kHz LP filter ZF 0009, a 20 dB amplifier with 0–30 dB attenuation ZF 0013 and a 50 dB output amplifier which is mounted on the bottom circuit board.

This gives a resulting amplification of 70 dB and an attenuation of 0–50 dB.

The final stage of the output amplifier has a max. output voltage of 56 V Peak which ensures a crest factor of 5.

The output is overload- and short circuit protected by current limitation of the + 140 V supply and by two diodes Q 14 and 15.

The last section of the whole amplifier is the meter section consisting of a passive diode circuit coupled to give true RMS indication on the succeeding moving coil instrument. A "Meter Function" selector selects two different meter time constants: "Fast" and "Slow".

The Power Supply for the instrument is designed according to the block diagram shown.

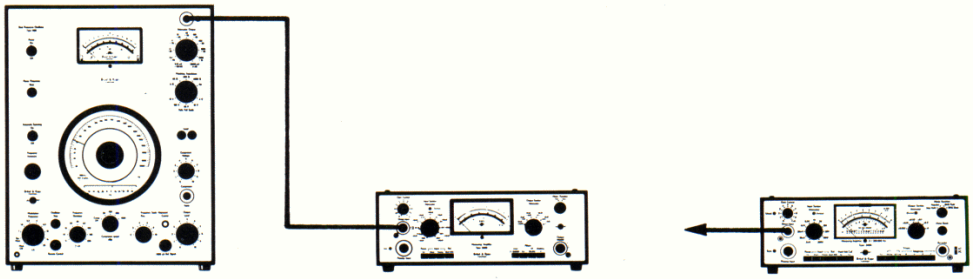
ZG 0074 is a shortcircuit protected + and –20 V regulator which supplies all the active circuits through the instrument.

Furthermore + 20 V is led through two voltage droppers to power the filament of preamplifiers connected to the 7-pin socket, and is used as a reference voltage for the + 140 V regulator.

+ 140 V is current limited to approx. 20 mA and supplies the final stage of the output amplifier.

+ 150 V (unloaded) supplies the preamplifier connected to the 7-pin socket on the front plate.

+ 200 V is the polarization voltage for condenser microphones through the preamplifier.



LF-Oscillator 2608 Electronic Voltmeter

2.1. Sensitivity

a. GAIN CONTROL: "10"
POWER: "On"
INPUT: "Direct"
REF.: "Released"
INPUT ATT.: "0.1 V"
OUTPUT ATT.: "x1"
FILTERS: "Linear"
METER FUNCTION: "Fast"

Input signal to "Direct Input" of 2608: 1000 Hz – 0.1 V exactly.

Adjust "Direct Sens." for 0.1 V deflection on 2608 meter (adjustment range for "Sens." adjustments approx. + 4 to –10 dB).

Check the "Output" voltage with an electronic voltmeter: 10 V RMS ± 0.5 dB.

b. FILTERS to "A and HP 22.4 Hz"

Deflection on 2608 for both positions: 0.1 V ± 0.2 dB.

c. FILTERS to "Ext."

Output voltage on "Ext. Filter Input": 1 V ± 0.5 dB.

2.2. Frequency Response

INPUT: "Direct"
FILTERS: "Linear"
METER FUNCTION: "Fast"

Input signal: 1000 Hz adjusted to give an 18 dB deflection on 2608.

Vary the frequency from 2 Hz to 200 kHz: Deflection 18 dB ± 0.5 dB.

From 10 Hz to 50 kHz the tolerance is ± 0.2 dB (+ tolerance of generator).

2.3. Overload Indication

GAIN CONTROL: "10"
INPUT: "Direct"
INPUT ATT.: "0.1 V"
OUTPUT ATT.: "x1"
FILTERS: "Linear"

Input to "Direct Input": 1 kHz – 0.1 V RMS corresponding full scale deflection on 2608.

Raise the input signal to 11 dB above 0.1 V: No overload indication.

Raise the input signal to 13 dB above 0.1 V: Overload indication.

2.4. Noise

GAIN CONTROL: "10"
INPUT: "Direct"
INPUT ATT.: "3 mV"
OUTPUT ATT.: "x0.01"
FILTERS: "Linear"

The instrument must be in the cabinet or in other way effectively screened.

Max. noise deflection for correctly adjusted sensitivity: 14 μV

Max. noise with shortconnected input: 7 μV

2.5. Reference

a. GAIN CONTROL: "10"
INPUT: "Direct"
INPUT ATT.: "0.1 V"
OUTPUT ATT.: "x1"
FILTERS: "Linear"
REF: "50 mV RMS"

Adjust "Direct Sens." for a deflection to the ref. mark on the 2608 meter scale.

b. REF: "Released"

Input signal to "Direct Input": 1 kHz, exactly 0.1 V

Deflection on 2608: 0.1 V ± 1%.

If necessary see item 4.7.

2.6. Sensitivity with Microphone

a. GAIN CONTROL: "10"
INPUT: "Preamp."
INPUT ATT.: "0.1 V"
OUTPUT ATT.: "x1"
FILTERS: "Linear"
REF: "50 mV RMS"

Connect a preamplifier to "Preamp. Input" and adjust "Preamp. Sens." to the correct sensitivity of the microphone and preamplifier.

b. REF: "Released"
INPUT ATT.: "3 V"

Check the sensitivity with a Pistonphone type 4220 or a similar wellknown sound source.

The meter deflection on 2608 should be equal to the Sound Pressure Level produced by the Pistonphone. (Remember corrections for the actual static pressure).

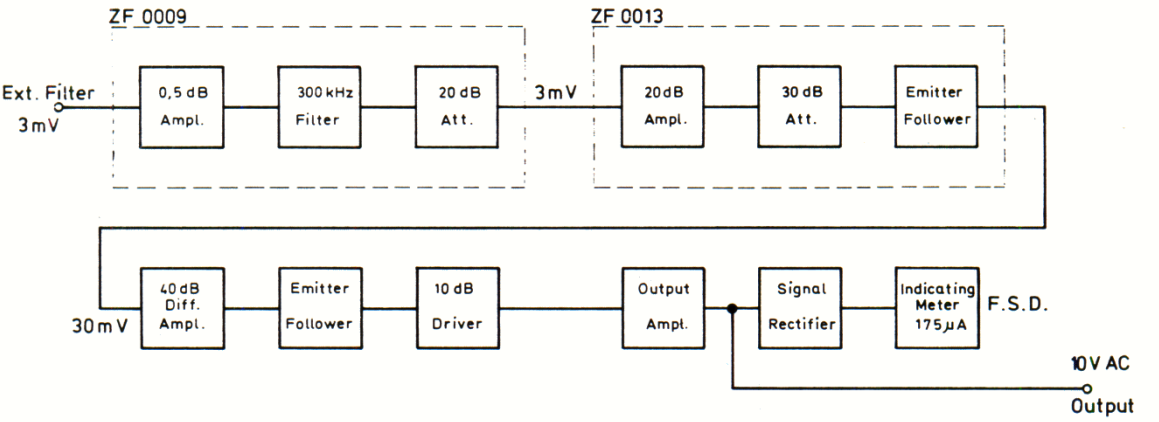
Tolerance: 0.2 dB (Pol. Voltage 200 V ± 1 V).

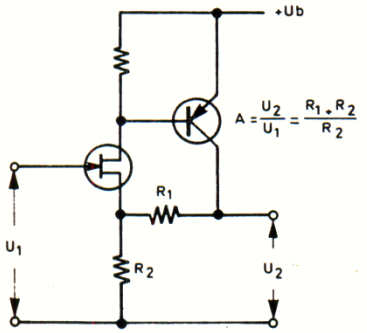
The following tells which care to take when replacing printed circuit boards with components:

By replacement of:

ZE 0018	25 dB Amplifie	Check items 4.1, 4.2 and 4.8
ZE 0052	Low noise 25 dB Amplifier	Check items 4.1, 4.2 and 4.8
ZF 0005	Attenuator	No adjustment necessary
ZF 0006	Attenuator Input	Check item 4.2 and 4.3
ZF 0007	Attenuator	Check item 4.2 and 4.3
ZF 0008	Attenuator, 0–30 dB	Check item 4.3
ZF 0009	Attenuator, 0–20 dB + LP Filter	Check item3.3 and 3.7
ZF 0013	Attenuator, 0–30 dB + 20 dB Ampl.	Check items 3.1, 3.3 and 3.7
ZG 0074	20 V Regulator	Adjust P 440 for + 20 V on V 450_E and check –20 V on V 449_E
ZH 0061	Gain Circuit	Check item 2.5
ZH 0062	Basic Circuit	Run through the whole Checking Procedure
ZS 0181	Filter	Adjust according to item 5.1

Output Amplifier and Meter Circuit





The sensitivities given on the block diagram are valid for OUTPUT ATT. in position "x 0.003".

When troubleshooting the passive meter circuit can be checked by applying 10 V AC into the "Output" socket corresponding full scale deflection.

The amplification of the small circuit shown to the left is dependent of the ratio between R1 and R2 as given by the formula. This type of circuit is used in ZF 0009 and ZF 0013.

3.1. Sensitivity

FILTERS: "Ext."
OUTPUT ATT.: "x1"

Apply a 1 kHz signal to "Ext. Filter Out" and adjust the level to give exactly 10 V RMS on the "Output".

The input signal should be 1 V ± 0.5 dB.

If not check the 30 mV on V 360_E (output from ZF 0013)

The meter deflection should be exactly full scale (10 V).

If necessary adjust P 6 (FSD on the bottom circuit board).

3.2. Frequency Response

FILTERS: "Ext."
OUTPUT ATT.: "x1"

Input signal to "Ext. Filter Out": 1 kHz adjusted to give 10 V on "Output".

Vary the frequency from 2 to 200.000 Hz and check that the "Output" voltage is 10 V ± 0.2 dB.

If necessary adjust trimmer capacitor FR on the bottom circuit board at 200 kHz.

Check that the meter deflection is correct for all frequencies as well.

3.3. Output Attenuator

FILTERS: "Ext."
OUTPUT ATT.: "x1"
METER FUNCTION: "Fast"

Input signal to "Ext. Filter Out": 1 kHz adjusted to give 18 dB deflection on 2608 meter.

Check the steps of the OUTPUT ATTENUATOR compared to the attenuator of the Frequency Generator or a special Attenuator Box.

Tolerance: ± 0.1 dB (+ tolerance of the test attenuator).

At 200 kHz the tolerance is ± 0.2 dB.

3.4. Meter Linearity

FILTERS: "Ext."
OUTPUT ATT.: "x1"
METER FUNCTION: "Fast"

Input signal to Ext. Filter Out": 1 kHz adjusted to give exactly full scale deflection, (20 dB)

OUTPUT ATT.: "x0.3"

Deflection: 10 dB ± 0.3 dB.

3.5. Output Impedance

FILTERS: "Ext."
OUTPUT ATT.: "x1"

Input signal to "Ext. Filter Out": 1 kHz adjusted to give exactly 10 V RMS on "Output".

Load the "Output" with a resistor at 1 kΩ.

The "Output" voltage should drop max. 0.5 dB corresponding an output impedance of 50 Ω.

The check should be made at 200 kHz as well.

3.6. Distortion

FILTERS: "Ext."
OUTPUT ATT.: "x1"

Adjust a 1 kHz input signal to give 10 V RMS on "Output".

With a Frequency Analyzer type 2107 in Rejection Mode distortion down to 0.25% can be measured.

However, the tolerance for 2608 is 0.1% at 1 kHz and 0.3% at 50 kHz, but to measure this a more complex set up is necessary.

3.7. Noise and Hum

FILTERS: "Ext."

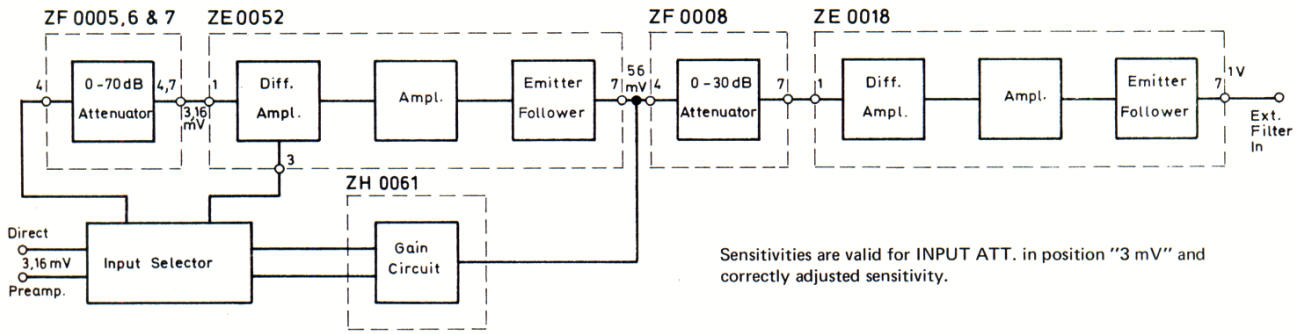
Shortconnect "Ext. Filter Out" socket.

OUTPUT ATT.: "x1"

2–40.000 Hz Max.: 3 mV

OUTPUT ATT.: "0.003"

2–40.000 Hz Max.: 50 mV



Sensitivities are valid for INPUT ATT. in position "3 mV" and correctly adjusted sensitivity.

4.1. Sensitivity

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Input signal to 2608 "Direct Input": 1 kHz 0.1 V.

Voltmeter connected to "Ext. Filter In" socket: 1 V ± 0.5 dB (for correctly adjusted sensitivity).

The DC voltage on "Ext. Filter In" socket should be from −0.5 V to + 2.5 V.

4.2. Frequency Response

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Input signal to "Direct Input": 1 kHz adjusted to give 18 dB deflection on a voltmeter connected to "Ext. Filter In". (1 V equal to 20 dB).

Vary the frequency from 2 Hz to 200 kHz.

Deflection on the voltmeter: 18 dB $^{+0.1}_{-0.2}$ dB (+ tolerance of generator and voltmeter).

If necessary adjust C 160 on ZE 0018 for that response at 200 kHz.

4.3. Input Attenuator

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Input signal to "Direct Input": 1 kHz adjusted to give 18 dB deflection on a voltmeter connected to "Ext. Filter In" (1 V equal to 20 dB)

Check the steps of INPUT ATTENUATOR compared to the attenuator of the frequency generator or a special attenuator box.

Tolerance ± 0.1 dB (+ tolerance of the test attenuator).

At 200 kHz the tolerance is ± 0.2 dB.

If necessary adjust C 220–223 on ZF 0006 at 200 kHz.

4.4. Overload Indicator

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Input signal to "Direct Input": 1 kHz adjusted to give exactly 5.6 V peak on a voltmeter connected to "Ext. Filter In".

The "Input Section Overload" should indicate overload within ± 0.5 dB of this condition.

Check at 200 kHz if the indication is still correct and with an oscilloscope that the output has not yet been limited.

If necessary adjust P 5 "Overl." until correct overload indication.

4.5. Output Impedance

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Input signal to "Direct Input": 1 kHz adjusted to give 1 V RMS on "Ext. Filter In" socket.

Load the socket with a resistor of 200 Ω.

The output voltage should drop max. 0.5 dB corresponding an output impedance of 10 Ω.

This check should be made at 200 kHz as well.

4.6. Distortion

GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
FILTERS: "Ext."

Adjust a 1 kHz input signal to give 1 V RMS on "Ext. Filter In" socket.

With a Frequency Analyzer type 2107 in Rejection Mode distortion can be measured down to 0.25%.

However, the distortion of 2608 input amplifier is 0.01% at 1 kHz and 0.03% at 50 kHz, but to measure this a much more complex set up is necessary.

4.7. Reference

a. GAIN CONTROL: "10"
INPUT ATT.: "0.1 V"
INPUT: "Direct"
OUTPUT ATT.: "x1"
FILTERS: "Linear"

Input signal: 1000 Hz exactly 0.1 V RMS.

Adjust "Direct Sens." to exactly 10 V RMS on "Output".

Adjust P 6 FSD on bottom circuit board for full scale deflection.

b. REF. to "50 mV RMS"

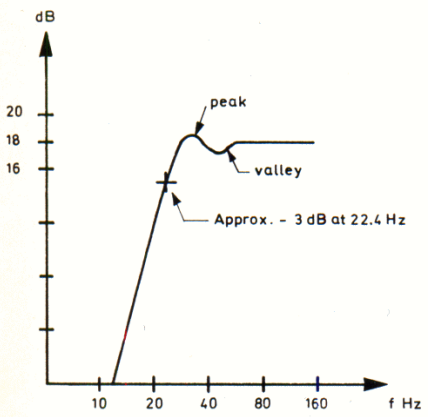
Adjust P 3 Ref. on bottom circuit board for a deflection to the reference mark on the 2608 meter scale.

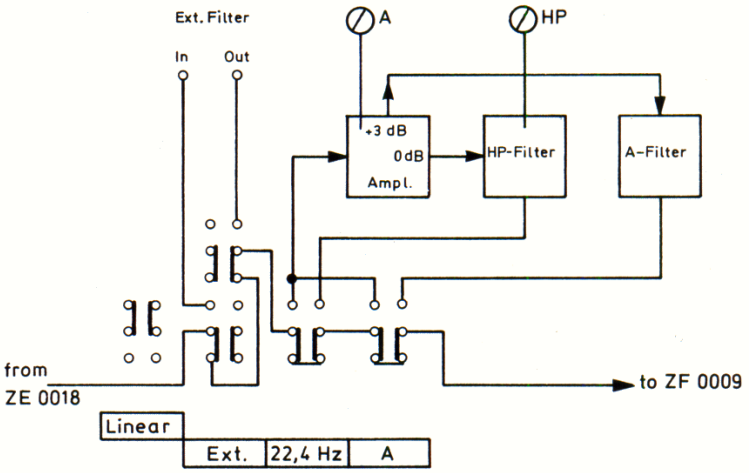
4.8. Hum

GAIN CONTROL: "10"
INPUT: "Direct"
FILTERS: "Ext."

Measure the hum on "Ext. Filter In" socket selectively according to following scheeme:

	Input shortconnected			Input Open		
INPUT ATTENUATOR	50 Hz	100 Hz	150 Hz	50 Hz	100 Hz	150 Hz
3 mV	300 μV	200 μV	300 μV	630 μV	630 μV	630 μV
10 mV – 300 V	90 μV	90 μV	90 μV	210 μV	210 μV	210 μV





5.1. Filter Adjustment

a. INPUT ATT.: "0.1 V"
INPUT: "Direct"
OUTPUT ATT.: "x1"
FILTERS: "Linear"

Input to "Direct Input" of 2608: 1 kHz adjusted to give 18 dB meter deflection.

b. FILTERS to "A"

Adjust A (P 700 on ZS 0181) to give 18 dB deflection ± 0.2 dB.

c. FILTERS to "HP"

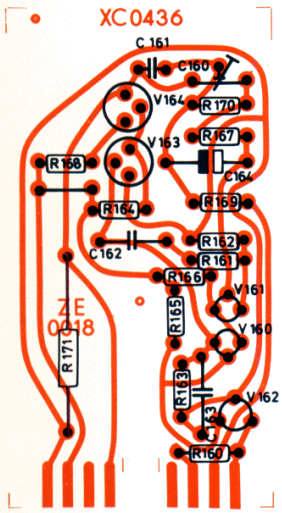
Vary the frequency around the filter frequency and adjust HP (P 701 on ZS 0181) to obtain a peak and a valley of the same value around 18 dB as shown.

Circuit Diagram with Parts List

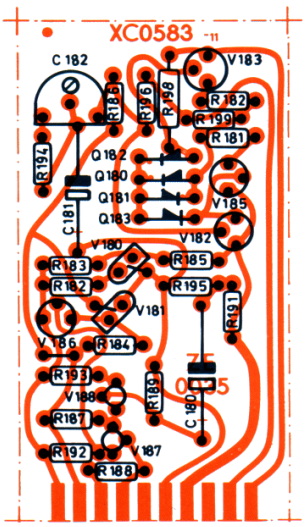
CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
O 1	Input Attenuator			OD 1017
O 2	Output Attenuator			OD 1018
	Contact Slider for above			OD 0179
	M3 allen screw for do.			YQ 2003
	1.5 mm allen key for screw			QA 0042
O 3	See section ZH 0062			
O 4	See section ZH 0062			
O 5	Power Voltage Selector			OA 0021
O 8	Meter Punction Selector			OH 2044
P 1	Gain Control	Carbon	10 kΩ	PQ 3103
V 21	Fuse		1 A	VF 0008
V 23	Overload lamp			VS 0015
	Retainer for do			JO 0016
V 24,25	Dial lamps		6.8 V/0.25 A	VS 1273
T 1	Mains transformer			TN 0050
	Moving coil instrument			IM 0029
	Screened socket			JJ 0127
	Preamplifier socket			JJ 0703
	Banana socket, insulated			JT 8344
	Banana socket			JT 6204
	Multi socket, 10-way for circuit boards			JJ 1002
	Power Cord EUR			AN 0005
	Power Cord USA			AN 0006
	Screened Cable			AO 0013

CIRCUIT DIAGRAM REF.	COMPONENT TYPE	STOCK REF.
	Knob 20 mm	SN 2022
	Knob 31.5 mm	SN 3222
	Retaining ring for 31.5 mm knob	DB 0674
	M4 allen screw for do.	YQ 2083
	2 mm allen key for above	QA 0043
	Metal Cabinet	KQ 0099
	Mahogany Cabinet	KA 0026
	Retaining Nuts for cabinet	YM 0425
	Rubber Feet, rear	DF 7015
	Rubber Feet, front	DF 7018
	Front stand	DV 0141
	Side handles	DH 0052
	Circuit Boards with Components:	
	25 dB Amplifier	ZE 0018
	25 dB Amplifier (low noise)	ZE 0052
	Input Attenuator	ZF 0005
	Input Attenuator	ZF 0006
	Input Attenuator	ZF 0007
	Input Attenuator	ZF 0008
	Attenuator with 300 kHz LP Filter	ZF 0009
	Attenuator with 20 dB Amplifier	ZF 0013
	20 V Voltage Regulator	ZG 0074
	Gain Circuit	ZH 0061
	Basic Circuit Board	ZH 0062
	HP and A-Weighting Network	ZS 0181

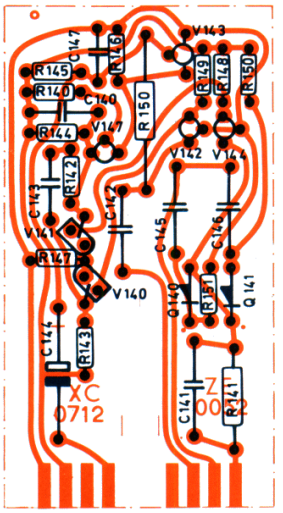
Layout Diagrams with Parts List



ZE 0018 – 25 dB Amplifier



ZE 0035 – 50 dB Amplifier



ZE 0052 – 25 dB Amplifier

viewed from the printed circuit side

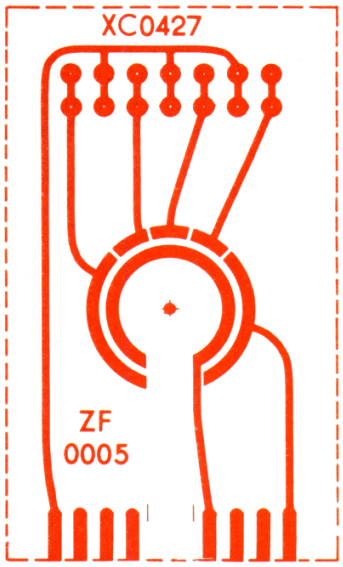
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZE 0018					
C 160	Ceramic trimmer		6–25 pF		CV 0037
C 161	-		10 pF/400 V		CK 1100
C 162	Polystyrene		200 pF/125 V		CT 1118
C 163	-		620 pF/125 V		CT 1109
C 164	Electrolytic		12.5 µF/ 25 V		CE 0416
R 160	Carbon	1/8 W	10 %	10MΩ	RA 0025
R 161	-	1/4 W	5 %	470 Ω	RB 2470
R 162,163	-	-	-	4.7 kΩ	RB 3470
R 164	-	-	-	10 kΩ	RB 4100
R 165	-	-	-	47 kΩ	RB 4470
R 166	-	-	-	68 kΩ	RB 4680
R 167	-	-	-	470 kΩ	RB 5470
R 168	Metal	-	1 %	182 Ω	RF 2182
R 169	-	-	-	619 Ω	RF 2619
R 170	-	-	-	11 kΩ	RF 4110
R 171	Carbon	1/2 W	2 %	800 Ω	
V 160,161	Silicon	NPN		BC 107	VB 0032
V 162	FET	N		2 N 4302	VB 1024
V 163,164	Silicon	PNP		2 N 2905	VB 0059
	Printed Circuit Board				XC 0436
ZE 0035					
C 180,181	Electrolytic		100 µF/ 6.4 V		CE 0207
C 182	Ceramic trimmer		6–25 pF		CV 0037
R 180,181	Carbon		5 %	33 Ω	RB 1330
R 182	-		-	100 Ω	RB 2100
R 183	-		-	1.2 kΩ	RB 3120
R 184	-		-	4.7 kΩ	RB 3470
R 185,186	-		-	18 kΩ	RB 4180
R 187	-	1/4 W	-	22 kΩ	RB 4220

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZE 0035					
R 188	Carbon	1/4 W	5%	100 kΩ	RB 5100
R 189	-	-	-	1MΩ	RB 6100
R 191	Metal	-	1 %	365 Ω	RF 2365
R 192,193	-	-	-	1.1 kΩ	RF 3110
R 194	-	-	-	16.9 kΩ	RF 4169
R 195	-	-	-	37.4 kΩ	RF 4374
R 196	-	-	-	59 kΩ	RF 4590
R 198	Carbon	1/3 W	5 %	33 kΩ	
R 199	-	1/4 W	-	100 Ω	RB 2100
V 180,181	Silicon	PNP		2 N 4289	VB 0049
V 182,183	-	NPN		BF 178	VB 0052
V 185	-	PNP		MM 4003	VB 0068
V 186	-	PNP		2 N 2905	VB 0059
V 187,188	-	NPN		BC 107b	VB 0257
Q 180,181	Silicon	50 V/150 mA		BAX 13	QV 0223
Q 182,183	-	150 V/300 mA		BAX 16	QV 0217
	Printed Circuit Board				XC 0583
ZE 0052					
C 140	Polystyrene			470 pF/125 V	CT 1111
C 141	Polyester			22 nF/400 V	CS 0105
C 142	-			0.15 µF/100 V	CS 0337
C 143	Polystyrene			620 pF/125 V	CT 1109
C 144	Electrolytic			25 µF/ 25 V	CE 2002
C 145,146	Polyester			0.15 µF/100 V	CS 0337
C 147	Ceramic			100 pF/400 V	CK 2100
R 140	Carbon	1/4 W	5 %	47 Ω	RB 1470
R 141	Metal	1/2 W	1 %	8.25 kΩ	RF 0118
R 142	-	1/4 W	-	475 Ω	RF 2475
R 143,144	-	-	-	2.21 kΩ	RF 3221
R 145	-	-	-	3.09 kΩ	RF 3309

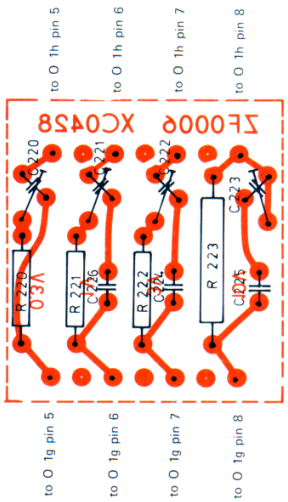
ZE 0018 – 0035 – 0052

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 146	Metal	1/4 W	1%	5.62 kΩ	RF 3562
R 147	-	-	-	26.7 kΩ	RF 4267
R 148	-	-	-	39.2 kΩ	RF 4392
R 149	-	-	-	60.4 kΩ	RF 4604
R 150	Carbon	1/2 W	10 %	20MΩ	
R 151,152	-	1/4 W	5 %	100 Ω	RB 2100
Q 140,141	Silicon	50 V/150 mA		BAX 13	QV 0223
V 140,141	Silicon	PNP		2 N 4289	VB 0049
V 142,143	-	NPN		BF 173	VB 0065
V 144,145	FET	N		E 102 (matched)	VB 1010
	Printed Circuit Board				XC 0712

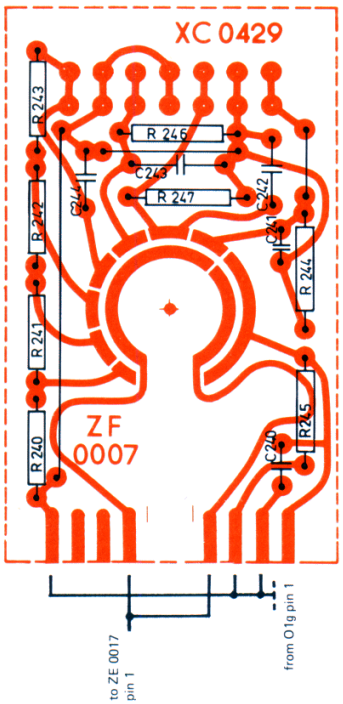
Layout Diagram with Parts List



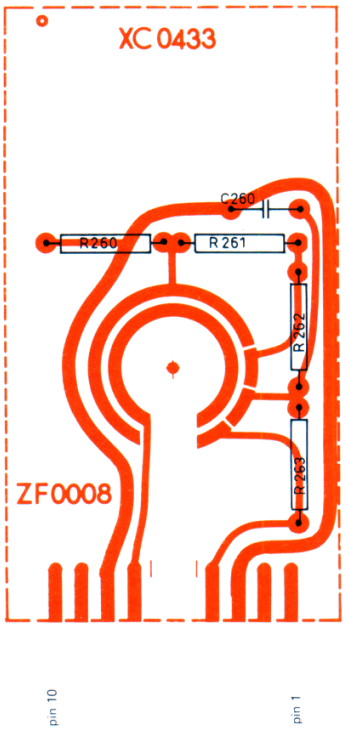
ZF 0005 Attenuator



ZF 0006 Attenuator



ZF 0007 Attenuator

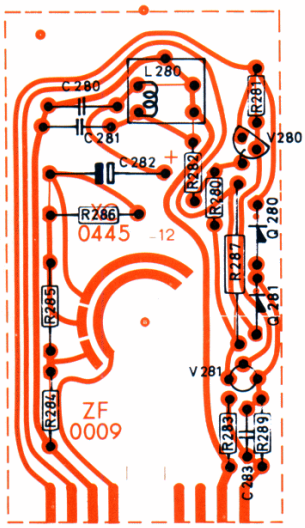


ZF 0008 Attenuator

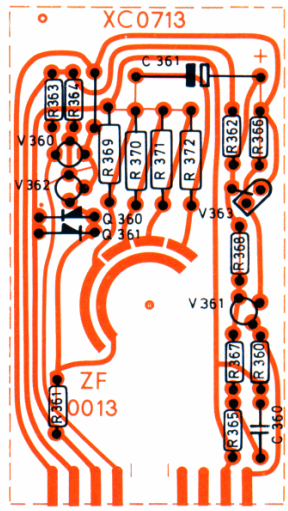
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZF 0006 Attenuator					
C 220-223	Ceramic trim.		4.5–20pF/160 V		CV 0020
C 224,225	Ceramic		22 pF/400 V		CK 1220
C 226	-		47 pF/400 V		CK 1470
R 220	Metal	1/4 W	1/2%	684 kΩ	RF 6009
R 221	-	-	-	900 kΩ	RF 6014
R 222	-	-	-	968.4kΩ	RF 6015
R 223	-	-	-	990 kΩ	RF 6016
	Printed Circuit Board				XC 0428
ZF 0007 Attenuator					
C 240	Ceramic		3.9 pF/400 V		CK 0390
C 241	-		10 pF/400 V		CK 1100
C 242	-		47 pF/400 V		CK 1470
C 243	-		270 pF/400 V		CK 2270
C 244	-		800 pF/400 V		CK 2800
R 240	Metal	1/4 W	1/2%	316 Ω	RF 6000
R 241	-	-	-	684 Ω	RF 6002
R 242	-	-	-	2.162 kΩ	RF 6005
R 243	-	-	-	6.84 kΩ	RF 6007
R 244	-	-	-	316 kΩ	RF 6008
R 245	-	-	-	1MΩ	RF 6010
R 246	-	-	-	31.6 kΩ	RF 6012
R 247	-	-	-	100 kΩ	RF 6013
	Printed Circuit Board				XC 0429

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZF 0008 Attenuator					
C 260	Ceramic		39 pF/400 V		CK 1390
R 260	Metal	1/4 W	1/2%	462 Ω	RF 6001
R 261	-	-	-	1 kΩ	RF 6003
R 262	-	-	-	3.16 kΩ	RF 6006
R 263	-	-	-	10 kΩ	RF 6011
	Printed Circuit Board				XC 0433

Layout Diagrams with Parts List



ZF 0009 – Attenuator



ZF 0013 – Attenuator

viewed from the printed circuit side

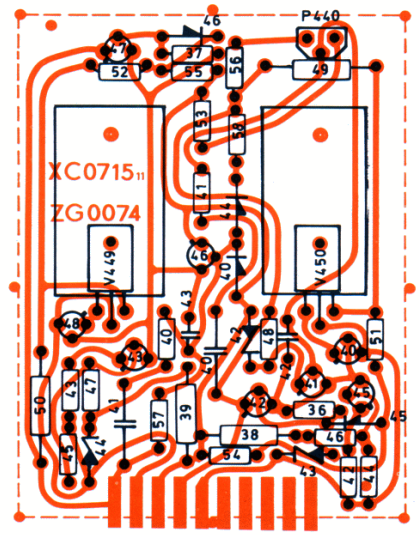
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZF 0009					
C 280	Polystyrene			1 nF/ 63 V	CT 1132
C 281	-			470 pF/125 V	CE 0315
C 282	Electrolytic			200 µF/ 10 V	CE 0306
C 283	Polyester			10 nF/250 V	CS 0403
Q 280,281	Silicon	50 V/150 mA		BAX 13	QV 0223
R 280	Carbon	1/4 W	5 %	47 Ω	RB 1470
R 281	-	-	-	22 kΩ	RB 3220
R 282	Metal	-	1 %	715 Ω	RF 2715
R 283	-	-	-	147 kΩ	RF 5147
R 284	-	Stab.	0.5 %	1.462 kΩ	RF 6004
R 285	-	-	-	3.16 kΩ	RF 6006
R 286	-	-	-	10 kΩ	RF 6011
R 287	Carbon	1/2 W	5%	1.25 kΩ	
R 289	Metal	1/4 W	1%	31.5 kΩ	RF 4316
L 280	300 kHz LP Filter			0.518 mH	LB 0666
V 280	Silicon	PNP		2 N 3702	VB 0038
V 281	FET	N		2 N 4302	VB 1025
	Printed Circuit Board				XC 0445

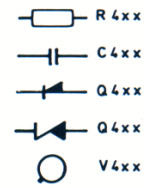
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZF 0013					
C 360	Polyester			10 nF/250 V	CS 0403
C 361	Electrolytic			200 µF/ 12 V	CE 0315
Q 360,361	Silicon	100 V/225 mA		EC 401	QV 0213
R 360,361	Carbon	1/8 W	10 %	10MΩ	RA 0025
R 362	-	1/4 W	5 %	4.7 kΩ	RB 3470
R 363	-	-	-	10 kΩ	RB 4100
R 364	-	-	-	47 kΩ	RB 4470
R 365	Metal	-	1 %	162 Ω	RF 2162
R 366	-	-	-	2.21 kΩ	RF 3221
R 367	-	-	-	3.01 kΩ	RF 3301
R 368	-	-	-	31.6 kΩ	RF 4316
R 369	-	Stab.	0.5 %	462 Ω	RF 6001
R 370	-	-	-	1 kΩ	RF 6003
R 371	-	-	-	3.16 kΩ	RF 6006
R 372	-	-	-	10 kΩ	RF 6011
V 360	Silicon	NPN		BC 107	VB 0032
V 361	FET	N		E 102	VB 1009
V 362	-	N		E 102	VB 1025
V 363	Silicon	PNP		2 N 4289	VB 0049
	Printed Circuit Board				XC 0713

Layout Diagram with Parts List

ZG 0074

20 V Regulator

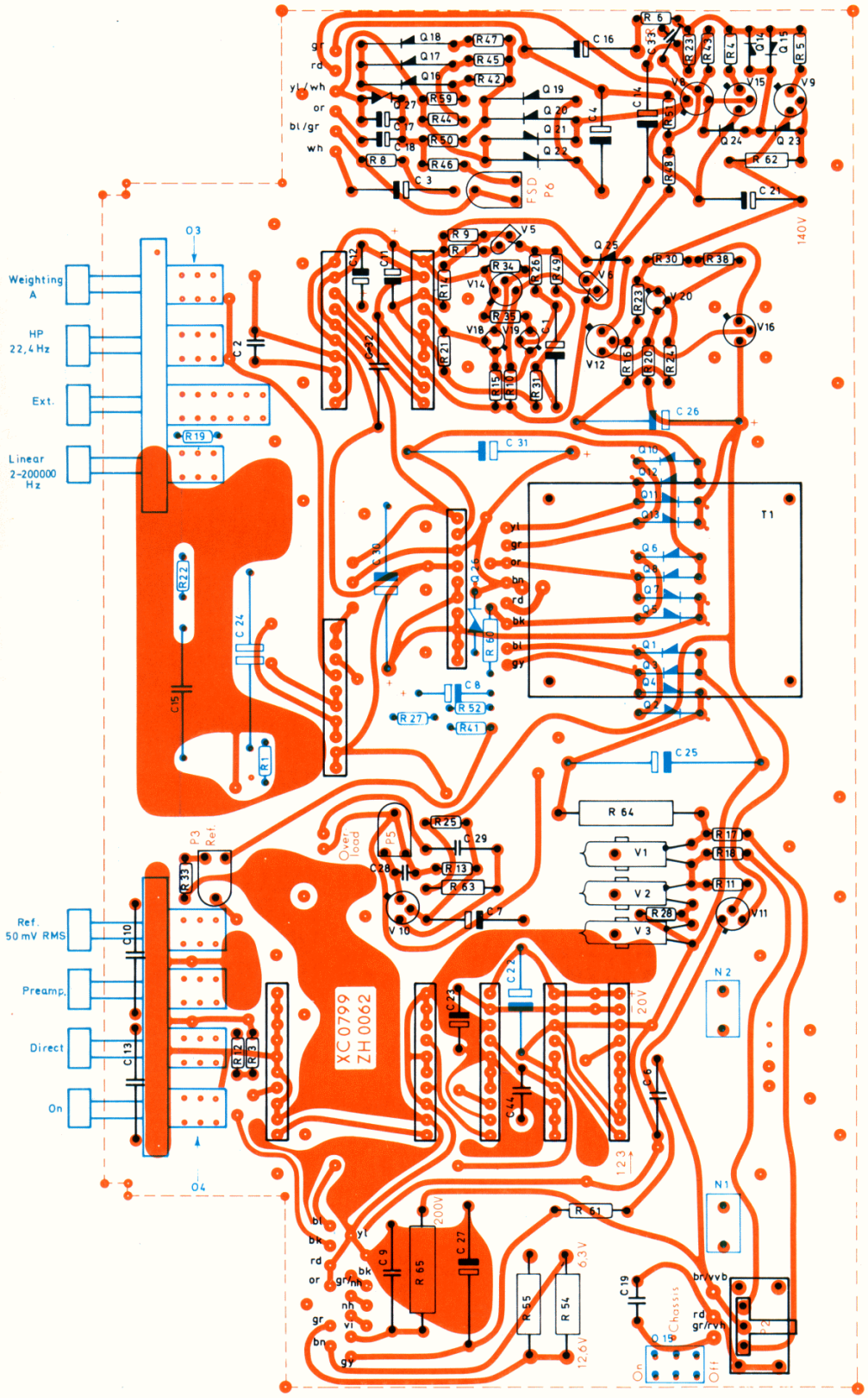




CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 440,441	Polycarbonate			1 µF/100 V	CS 0384
C 442,443	Ceramic			4.7 nF/500 V	CK 3470
P 440	Cermet	0.5 W	lin.	1 kΩ	PG 2109
Q 440,441	Si. diode			150 V/ 0.3 A BAX 16	QV 0217
Q 442	Ze. diode			6.8 V/0.25W ZG 6.8	QV 1106
Q 443,444	-			6.2 V/0.25W ZG 6.2	QV 1322
Q 445,446	Si. diode			150 V/ 0.3 A BAX 16	QV 0217
R 436,437	Carbon	1/4 W	5%	8.2 kΩ	RB 3820
R 438,439	-	1/3 W	-	3.9 kΩ	
R 440-443	-	1/4 W	-	470 Ω	RB 2470
R 444,445	-	-	-	1.2 kΩ	RB 3120
R 446,447	-	-	-	4.7 kΩ	RB 3470
R 448	-	-	-	3.3 kΩ	RB 3330

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 449,450	Wire	1 W	5%	2 Ω	RO 1106
R 451,452	Metal	1/4 W	-	140 Ω	RF 2140
R 453	-	-	-	2.49 kΩ	RF 3249
R 454,455	-	-	-	4.02 kΩ	RF 3402
R 456	-	-	-	4.75 kΩ	RF 3475
R 457	-	-	-	11.5 kΩ	RF 4115
R 458	-	-	-	12.1 kΩ	RF 4121
V 440-443	Si. trans.	NPN		BC 107	VB 0032
V 445-448	-	PNP		BC 177	VB 0071
V 449	-	PNP		2 N 4919	VB 0061
V 450	-	NPN		2 N 4922	VB 0063
	Printed Circuit Board				XC 0715

Layout Diagram with Parts List



Black Components are mounted on the Top Side

Blue Component are mounted on the Bottom Side

viewed from the bottom of the instrument

ZH 0062

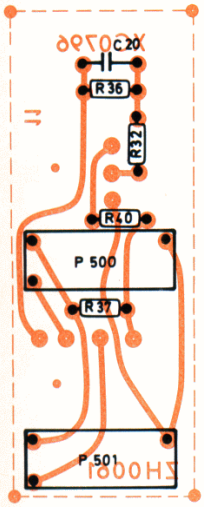
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1	Electrolytic		100 µF/ 6.4 V		CE 0207
C 2	Ceramic		33 pF/400 V		CK 1330
C 3	Electrolytic		100 µF/ 15 V		CE 0310
C 4	-		200 µF/ 10 V		CE 0306
C 6	Polyester		0.1 µF/250 V		CS 0013
C 7	Electrolytic		200 µF/ 10 V		CE 0306
C 8	-		10 µF/ 25 V		CE 0416
C 9	Polycarbonate		0.22 µF/400 V		CS 0117
C 10	-		0.33 µF/400 V		CS 0119
C 11,12	Electrolytic		10 µF/ 25 V		CE 0416
C 13	Polycarbonate		1.5 µF/100 V		CS 0343
C 14	Electrolytic		100 µF/ 35 V		CE 0443
C 15	Polycarbonate		5.6 µF/100 V		CS 0346
C 16	Electrolytic		32 µF/150 V		CE 2038
C 17	Tantalum		4.7 µF/ 10 V		CF 0018
C 18	-		22 µF/16 V		CF 0031
C 19	Ceramic		100 pF/400 V		CK 2100
C 21	Electrolytic		4 µF/250 V		CE 2034
C 22	-		100 µF/ 35 V		CE 0443
C 23	-		10 µF/ 25 V		CE 0416
C 24	-		10 µF/ 25 V		CE 0416
C 25	-		16 µF/550 V		CE 0915
C 26	-		32 µF/250 V		CE 0711
C 27	-		32 µF/250 V		CE 0711
C 28	Ceramic		330 pF/400 V		CK 2331
C 29	Polyester		0.1 µF/250 V		CS 0013
C 30,31	Electrolytic		400 µF/ 40 V		CE 0417
C 32	Polycarbonate		1.5 µF/100 V		CS 0443
C 33	Trimmer		4.5–20 pF/		CV 0020
C 44	Ceramic		56 pF/400 V		CK 1560
N 12	Power Switches				NT 0021
O 3	Filter Selector				OJ 0024
O 4	Input Selector				OJ 0023
O 15	Chassis on/off switch				NN 0032
P 2	Carbon	0.5 W	lin	50 kΩ	PB 3501
P 3	Cermet	0.25 W	-	470 Ω	PG 1507
P 5,6	-	-	-	10 kΩ	PG 3109
Q 1-4	Silicon	1200 V/150 mA		BYX 10	QV 0025
Q 5-8	-	400 V/ 1 A		1 N 4004	QV 0237
Q 10-13	-	1200 V/150 mA		BYX 10	QV 0025
Q 14,15	-	50 V/150 mA		BAX 13	QV 0223
Q 16	Germanium	45 V/100 mA		OA 79	QV 0079
Q 17-22	-	115 V/150 mA		OA 85	QV 0085
Q 23-25	Silicon	150 V/300 mA		BAX 16	QV 0217
Q 26	Zener	6.0–7.5 V/0.25 W		1 N 710	QV 1106
Q 27	-	11–13 V/0.25 W		MZ 716	QV 1117
	10-way connector for Circuit Boards				JJ 1002
	Clamps for Neon stabilizers				JO 0023
	Printed Circuit Board				XC 0799
	Heat Sink for 2 N 3440 (V16)				DT 0040
T 1	Mains Transformer (seperate item, not included in ZH 0062)				TN 0050

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1	Carbon	1/4 W	5 %	22 Ω	RB 1220
R 3	-	1/8 W	10 %	10MΩ	RA 0025
R 4,5	-	1/4 W	5 %	33 Ω	RB 1330
R 6,7	-	-	-	100 Ω	RB 2100
R 8	-	-	-	220 Ω	RB 2220
R 9	-	-	-	1.2 kΩ	RB 3120
R 10	-	-	-	4.7 kΩ	RB 3470
R 11,12	-	-	-	10 kΩ	RB 4100
R 13	-	-	-	15 kΩ	RB 4150
R 14	-	-	-	18 kΩ	RB 4180
R 15,16	-	-	-	22 kΩ	RB 4220
R 17,18	-	-	-	33 kΩ	RB 4330
R 19,20	-	-	-	47 kΩ	RB 4470
R 21-23	-	-	-	100 kΩ	RB 5100
R 24	-	-	-	150 kΩ	RB 5150
R 25	-	-	-	390 kΩ	RB 5390
R 26-28	-	-	-	1MΩ	RB 6100
R 29	-	-	-	120 kΩ	RB 5120
R 30	Metal	-	1 %	154 Ω	RF 2154
R 31	-	-	-	365 Ω	RF 2365
R 33	-	-	-	787 Ω	RF 2787
R 34,35	-	-	-	1.1 kΩ	RF 3110
R 38,39	-	-	-	237 kΩ	RF 3237
R 41	-	-	-	6.65 kΩ	RF 3665
R 42	-	-	-	8.66 kΩ	RF 3866
R 43	-	-	-	16.9 kΩ	RF 4169
R 44	-	-	-	19.6 kΩ	RF 4196
R 45	-	-	-	21.5 kΩ	RF 4215
R 46	-	-	-	22.6 kΩ	RF 4226
R 47	-	-	-	34.0 kΩ	RF 4340
R 48	-	-	-	35.7 kΩ	RF 4357
R 49	-	-	-	37.4 kΩ	RF 4374
R 50	-	-	-	56.2 kΩ	RF 4562
R 51	-	-	-	59.0 kΩ	RF 4590
R 52	-	-	-	64.9 kΩ	RF 4649
R 54	Wire	5,5 W	10 %	30 Ω	RX 0309
R 55	-	-	-	39 Ω	RX 0321
R 60	Carbon	1/3 W	5 %	3.15 kΩ	
R 61	-	-	-	12.5 kΩ	
R 62	-	-	-	31.5 kΩ	
R 63	-	-	-	50 kΩ	
R 64	-	1 W	-	50 kΩ	
R 65	-	1/2 W	10 %	20MΩ	
V 1-3	Neon Stabilizers			ZZ 1000	VA 0088
V 5,6	Silicon	PNP		2 N 4289	VB 0049
V 8-12	-	NPN		BF 178	VB 0052
V 14	-	PNP		2 N 2905	VB 0059
V 15	-	PNP		MM 4003	VB 0068
V 16	-	NPN		2 N 3440	VB 0250
V 18-20	-	NPN		BC 107b	VB 0257

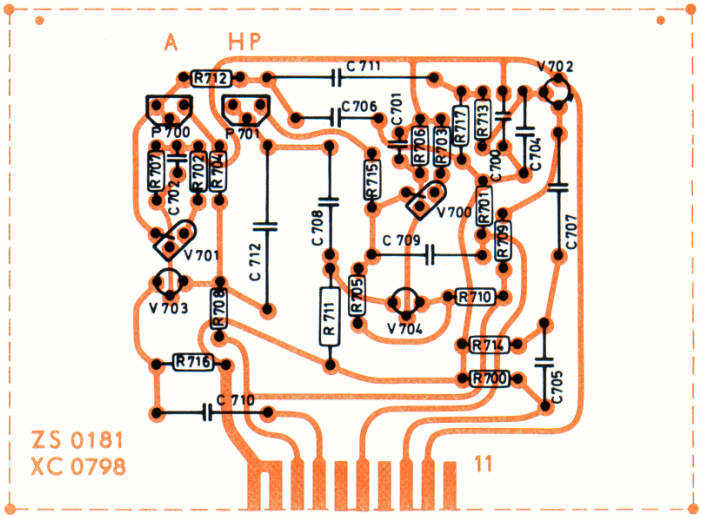
Layout Diagrams with Parts List

ZH 0061
Gain Circuit

ZS 0181
A-Weighting Network



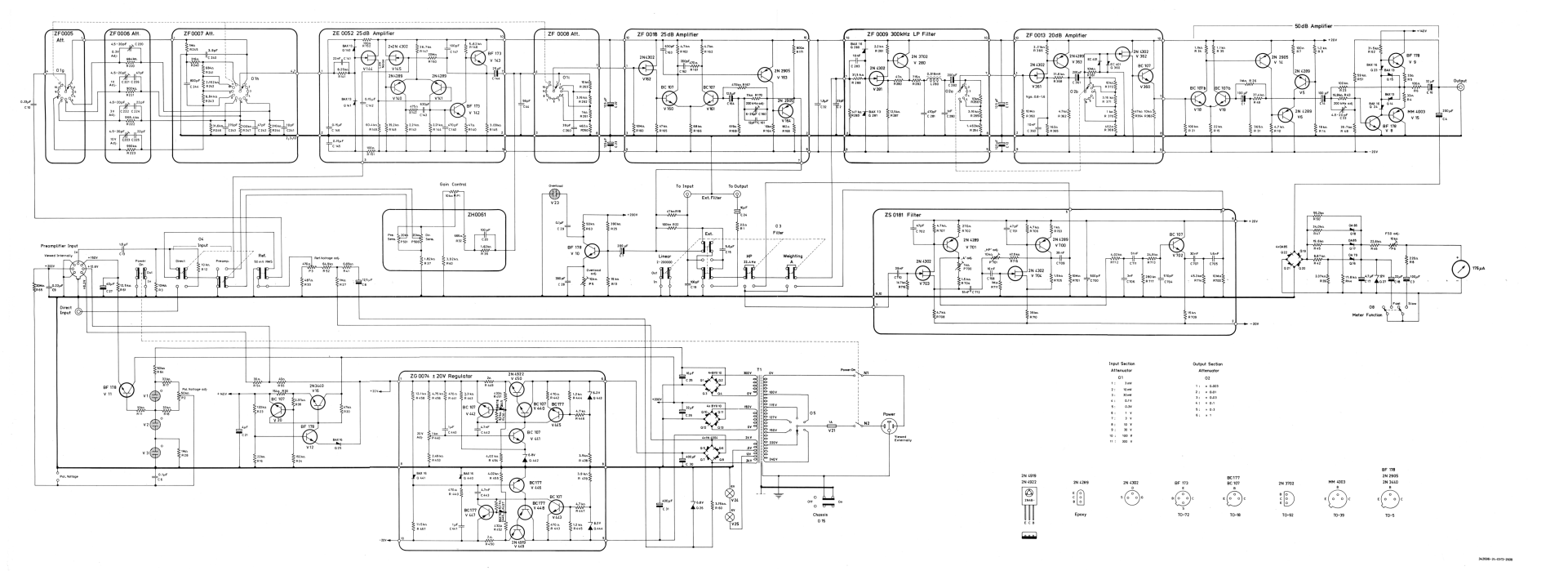
ZH 0061 – Gain Circuit
viewed from component side



ZS 0181 – Weighting Network
viewed from printed circuit side

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZH 0061					
C 20	Ceramic		100 pF/400 V		CK 2100
R 32	Metal	1/4 W	1 %	665 Ω	RF 2665
R 36	-	-	-	1.62 kΩ	RF 3162
R 37	-	-	-	1.82 kΩ	RF 3182
R 40	-	-	-	3.92 kΩ	RF 3392
P 500,501	Wire	1/2 W	lin	20 kΩ	PG 3203
	Printed Circuit Board				XC 0796
ZS 0181					
C 700	Ceramic		500 pF/400 V		CK 0083
C 701,702	-		47 pF/400 V		CK 1471
C 704	Polystyrene	1%	470 pF/125 V		CT 1111
C 705	-	-	1.6 nF/ 63 V		CT 1152
C 706	-	-	3 nF/ 63 V		CT 1157
C 707	-	-	30 nF/ 63 V		CT 1519
C 708	-	-	16 nF/ 63 V		CT 1539
C 709,710	-	-	39 nF/ 63 V		CT 1541
C 711,712	-	-	51 nF/ 63 V		CT 1542

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
ZS 0181					
R 700,701	Carbon	1/8 W	10 %	10MΩ	RA 0025
R 702	-	1/4 W	5 %	270 Ω	RB 2270
R 703	-	-	-	1 kΩ	RB 3100
R 704,705	-	-	-	1.5 kΩ	RB 3150
R 706-708	-	-	-	4.7 kΩ	RB 3470
R 709	-	-	-	15 kΩ	RB 4150
R 710	-	-	-	39 kΩ	RB 4390
R 711	Metal	1/2 W	1 %	1MΩ	RF 0111
R 712	-	1/4 W	-	4.02 kΩ	RF 3402
R 713	-	-	-	24.9 kΩ	RF 4249
R 714	-	-	-	45.3 kΩ	RF 4453
R 715	-	-	-	47.5 kΩ	RF 4475
R 716	-	-	-	147 kΩ	RF 5147
R 717	-	-	-	280 kΩ	RF 5280
P 700	Cermet	0.5 W	lin	1 kΩ	PG 2109
P 701	-	-	-	10 kΩ	PG 3110
V 700,701	Silicon	PNP		2 N 4289	VB 0049
V 702	-	NPN		BC 107b	VB 0257
V 703,704	FET	N		E 102	VB 1025
	Printed Circuit Board				XC 0798


ZF 0005 Att.
ZF 0006 Att.
ZF 0007 Att.
ZE 0052 25dB Amplifier
ZF 0008 Att.
ZF 0018 25dB Amplifier
ZF 0009 300kHz LF Filter
ZF 0013 20dB Amplifier
50dB Amplifier
ZH 0061
Gain Control
Overload
To Input
To Output
Ext. Filter
Linear
Ext.
HP
Weighting
Q 3 Filter
ZS 0181 Filter
Preamplifier Input
Viewed Intensity
Direct Input
Q4 Input
Direct
Preamp.
Ref.
Ref. Voltage adj.
Pwr. Voltage adj.
Pwr. Voltage
Meter Function
ZG 0074 ±20V Regulator
Power On
Power
Viewed Extremely
Chassis
Input Section
Attenuator
Q1
Output Section
Attenuator
Q2
Epoxy
TO-72
TO-18
TO-92
TO-39
TO-5