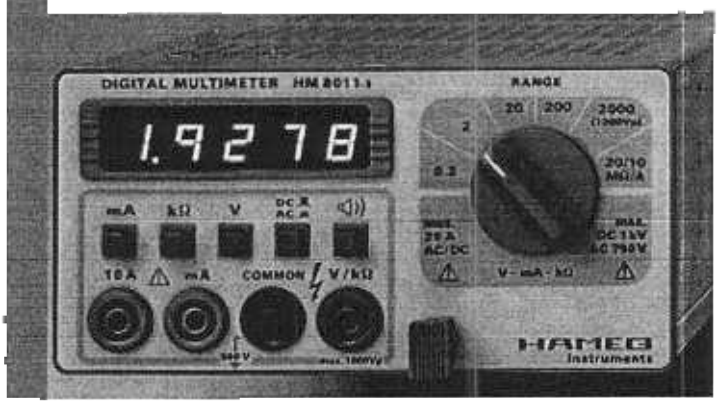
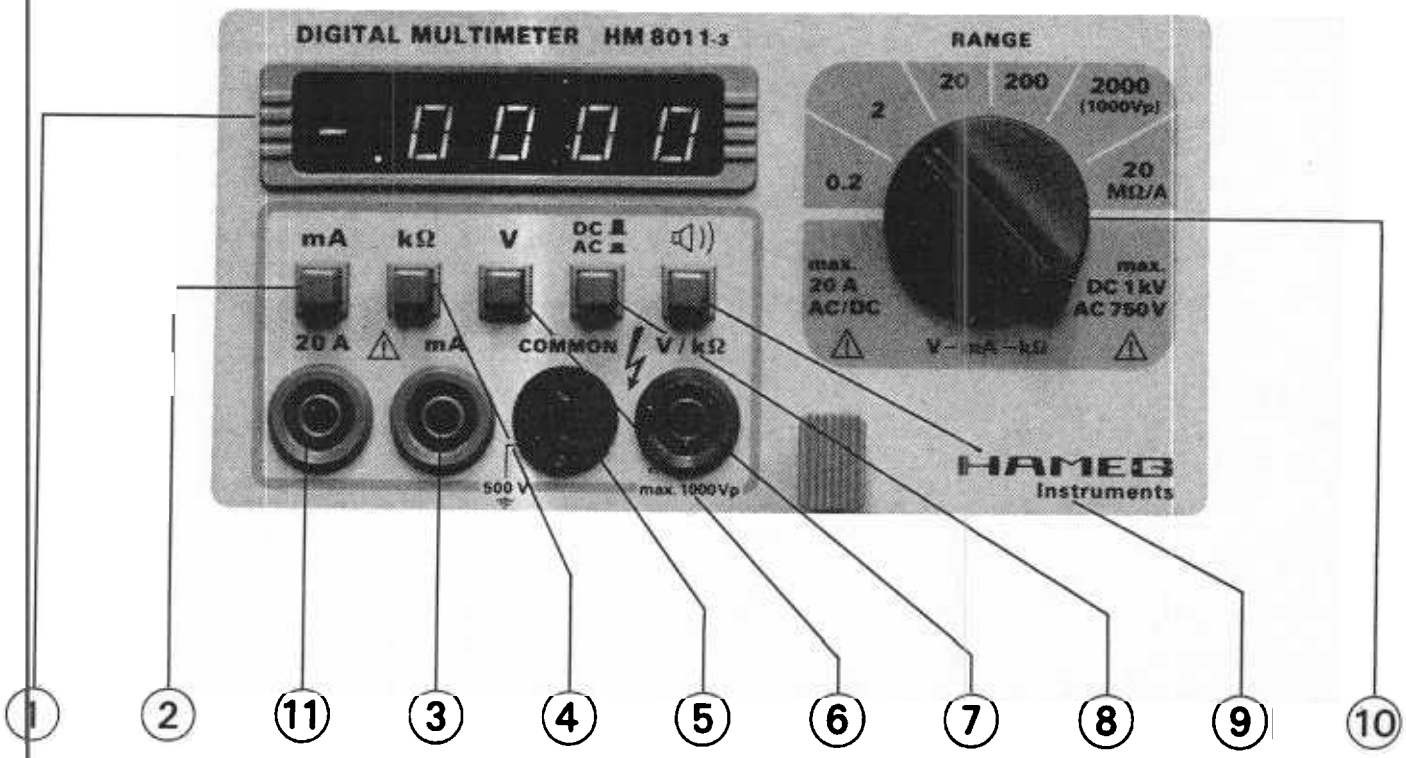
HAMEG®
Instruments

Service Manual
HM8011-3



Control elements of HM8011-3



① **DIGITAL DISPLAY** (7-segment LEDs)
The digital display indicates the measured value with a resolution of 4½ digits, the most significant digit being used up to "1". The measured value is displayed with correct point position and sign. When DC values are measured, the digits are preceded by a minus sign, if the positive pole of the measured quantity is connected to the COMMON input ⑤. If the measurement range is exceeded (>19999), the display flashes and displays "0", and the buzzer beeps intermittently.

② **mA** (pushbutton)
Function selection switch for current measurements (AC and DC current).

③ **mA** (shock-proof socket for connectors of 4 mm diameter)
Connection (high potential) for AC and DC current measurements in combination with the COMMON input ⑤ (low potential). The input is fuse-protected.

④ **kΩ** (pushbutton)
Function selection switch for resistance measurements.

⑤ **COMMON** (shock-proof socket for connectors of 4 mm diameter)
The COMMON socket (low potential) serves as a common connection for all measurement functions, to which the earthy potential of the measured quantity is applied. This input is connected with the internal shielding of the set.
The voltage across this terminal with respect to the cabinet (non-fused earthed conductor, ground) should not exceed 500 V to ensure safety of operation.

⑥ **V** (pushbutton)
Function selection switch for voltage measurements (AC und DC voltage).

⑦ **V/kΩ** (shock-proof socket for connectors of 4 mm diameter)
Connection (high potential) for voltage and resistance measurements in combination with the COMMON input ⑤.
CAUTION! ***The voltage across this terminal with respect to case (non-fused earthed conductor, ground) should not exceed 1000 V to ensure safety of operation.***

⑧ **DC / AC** (pushbutton)
Function selection between DC and AC measurements.

⑨ (pushbutton)
Swich for disconnecting the acoustic signal. The buzzer beeps with every change of the measurement range, when overload occurs, and if the display is zero in the resistance range.

⑩ **RANGE** (6-position rotary switch)
The range switch permits to adjust the measurement ranges within the selected functions. When voltages and currents of unknown magnitude are measured, ***firstly select the highest measurement range!*** Then set the switch to the next range in order, until optimum resolution is obtained.

⑪ **20 A** (shock-proof socket for connectors of 4 mm diameter)
Terminal (high potential) for AC and DC current measurements in the 20A range in combination with the common input ⑤. ***The input is not fuse protected. At currents which exceed 10 A the maximum admissible measuring time is 30 sec. Measuring times exceeding 30 sec. can cause thermal damage of the internal resistors.***

Mode selection

A mode selection switch set serves to activate the desired measurement function. Resistance, current and voltage measurements are selected with mutually releasing switches. In the current and voltage ranges, an additional selection between AC and DC measurements is possible.

Range selection

The measurement ranges are subdivided into decades. The full-scale values of the lowest ranges are 0.2V, 0.2mA or 0.2kΩ, e.g. maximum full-scale values of 199.99mV, 199.99µA or 199.99Ω are indicated. In the 20MΩ and 20A ranges, a maximum full-scale value of 19.999MΩ and 19.999A respectively is displayed. In all other ranges, the measured values are indicated directly in V, mA or Ω.

When voltages or currents of unknown magnitude are to be measured, firstly select the highest measurement range, then switch over to the range with the optimum display.

Indication of the measured value

The measured values are displayed by five 7 segment LED displays. The maximum value of the first digit is "1", which corresponds to a 4½ digit display with a capacity of 19999 digits. The measured value is indicated with correct point position and sign. The digits are preceded by a minus sign, if the positive pole of the device under test is connected to the COMMON socket ⑤ in case of DC measurement. If the input terminals are short-circuited, a value of max. ±2 digits (according to the measurement range) is displayed. If the full-scale value of the measurement range is exceeded (or open input is used during resistance measurements), the display will flash and indicate "0" value. The buzzer beeps intermittently when the resistance is near zero in the resistance ranges.

Test value application

The HM8011-3 module is provided with four shockproof connecting sockets, preventing accidental contact with the measured quantity, if adequate test cables (such as HZ15) are used. To ensure safety of operation, the test cables should be checked for isolation damage periodically and replaced, if necessary. The COMMON socket ⑤ (black) is used for all measurement ranges and accepts the earthy potential for all measured quantities. Zero potential and internal shielding of the HM8011-3 module are connected to this terminal. The inputs ③/⑪ (blue) are exclusively reserved for current measurements, whereas the V/kΩ input ⑦ serves for all other types of measurement.

Voltage measurements

The maximum input voltage to the HM8011-3 with the COMMON socket connected to ground potential is 1000 V_p. E.g.: ***If the HM8011-3 is connected to the device under test, the sum resulting from the test voltage and the voltage across the COMMON terminal to ground should not exceed 1000V. The maximum admissible COMMON socket-ground potential difference is 500 V_p.***

The mean value of the input voltage and AC voltages are determined by the true rms value. When measuring AC voltages, a DC component is suppressed. If possible, the COMMON terminal ⑤ should be connected directly to ground or to the test circuit point carrying the lowest potential to ground.

During measurements of circuits containing inductive components, inadmissibly high voltages may occur, when the test circuit is opened. In this case, appropriate precautions should be taken to prevent destruction of the HM8011-3 module by induced voltages.

Current measurements

For current measurements, the device to be tested is connected to the mA socket ③ or the 20A socket ⑪. ***The HM8011-3 module should be inserted into the line which carries the lowest potential to ground. To ensure safety of operation, the voltage to ground across the COMMON terminal should not exceed 500 V_p.***

AC currents are determined by their true rms value (see "Crest factor"). When measuring AC currents, a DC component is suppressed.

The current measurement ranges are microfuse-protected from overload condition (2000mA range: up to 2A; lower ranges: up to 200mA). The 20A input is not fuse protected. If a fuse has blown, firstly eliminate the overload cause. Then re-establish the operating condition of the HM8011-3 multimeter.

At currents which exceed 10A the max. admissible measuring time is 30sec.

Resistance measurements

For resistance measurements, the device to be tested is inserted between the COMMON terminal ⑤ and the V/kΩ socket ⑦. A DC voltage is applied across the connecting terminals (see specifications on page 7). Therefore only devices which are not under voltage should be measured, because any voltage present in the test circuit will give an erroneous result.

If very small resistances are measured, the line resistance of the connecting leads must be taken into consideration.

When the resistance measurement inputs are shortened (approx. 0Ω) the buzzer beeps continuously.

Overload protection

All measurement ranges of the HM8011-3 multimeter are protected against different types of overload conditions. General procedure: ***When measuring unknown magnitudes, firstly select the highest measurement range, before switching over to the optimum readout range. If a failure of the HM8011-3 module is detected, firstly eliminate the failure cause, before performing any further measurement.***

Fuse replacement: If overload occured in a current measurement range, one of the two microfuses must be replaced before re-starting operation of the HM8011-3 module. For this purpose, the set must be opened, the fuses being only accessible from the inside. In any case, only fuses of the specified type shall be used to avoid damaging of the HM8011-3 multimeter and to ensure continuity of specification in the current measurement ranges.

Crest factor

The evaluation of complex or distorted signals requires detection of the true rms value. The HM8011-3 multimeter permits to measure AC values and indicate their ***true rms value.*** The ***crest factor*** is an important magnitude for test value interpretation and accuracy evaluation. It is defined by the signal peak voltage to signal rms value:

$$\text{Crest factor} = CF = V_p/V_{rms}$$

This factor is a measure of the dynamic input voltage range of an AC/DC converter and expresses its capability of handling test signals having a high crest factor without reaching the converters saturation limit.

The crest factor of the HM8011-3 multimeter ranges from 1 to 7 (for errors of <1%) and depends on the rms value of the signal to be measured. The crest factor has a maximum value of 3.5 at full-scale reading, e.g. of 7 at the mid-scale point of the selected measurement range. The reading accuracy is reduced for signals having a higher crest factor.

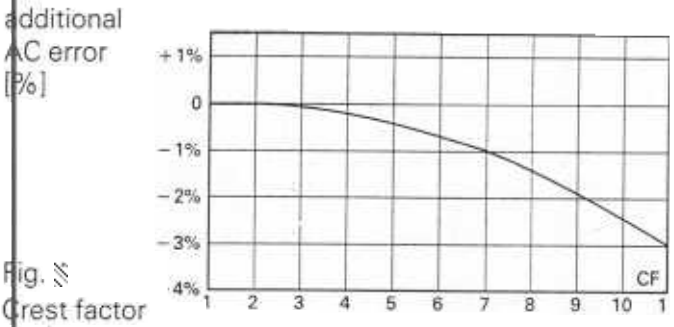


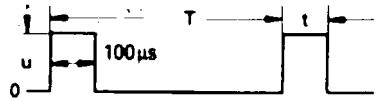
Fig. 5
Crest factor

Among others, the reading accuracy depends on the bandwidth of the rms converter. Measurements of complex signals are hardly affected, unless important harmonics of the measured signal are beyond the converter bandwidth of 150 kHz (−3 dB).

Another magnitude acting upon the reading accuracy is the duty factor of the test signal. It is related to the crest factor as follows:

$$CF = \sqrt{T/t}$$

T = period duration
t = pulse duration
u = pulse voltage



The shown waveform with a 1% duty factor for example has a crest factor of 10. The accuracy specified in Fig. 1 is given for such a waveform and a constant pulse voltage of 1V.

Operational check

To obtain the normal operating temperature, the mainframe with inserted module should be turned on at least 60 minutes before starting the test.

Measuring equipment required

Fluke 5101 B calibrator/Rotek 600 AC/DC calibrator
1 Resistor 180 kΩ ± 0.01%

Test procedure

If one of the calibrators specified above or a standard of adequate accuracy is available, all measurement ranges of the HM8011-3 multimeter can be checked by comparison with the limits indicated in the following tables. If any results deviate from the values specified in the tables, the concerned HM8011-3 measurement ranges must be re-aligned. However, a re-alignment should only be performed, if a calibrator of adequate accuracy is available.

In all measurement ranges, the HM8011-3 test modes must be checked by comparison with the values specified in the following tables. However, before changing the measurement range, care should always be taken that the signal applied to the HM8011-3 module does not inadmissibly stress the device under test.

At the beginning of a new series of measurements, the calibrator should always be reset to the minimum output value. Before changing the measurement range, the calibrator output must be switched off and not be reactivated, unless the next higher HM8011-3 measurement range in order is selected. A shielded cable should be used to connect the calibrator and the HM8011-3 multimeter to avoid undesired external influences on the measured signal.

For better survey, the checks should be performed in the recommended sequence.

a) DC voltage measurement range (Tab. 1)

Range	Reference (+23°C)	Limits of indication
200 mV	100.00 mV	99.94–100.06
2 V	1.0000 V	.9994–1.0006
20 V	10.000 V	9.994–10.006
200 V	100.00 V	99.94–100.06
2000 V	1000.0 V	999.4–1000.6

b) AC voltage measurement range (Tab. 2)

Range	Reference (+23°C)	Limits of indication
200 mV	100.00 mV	(1) 99.34–100.64 (2) 98.86–101.14
2 V	1.0000 V	(1) .9934–1.0064 (2) .9886–1.0114
20 V	10.000 V	(1) 9.934–10.064 (2) 9.886–10.114
200 V	100.00 V	(3) 99.34–100.64 (4) 98.86–101.14
2000 V	750.0 V	(3) 745.2–754.8 (4) 741.4–758.6

(1) = 40 Hz to 10 kHz
(2) = 20 Hz to 20 kHz
(3) = 40 Hz to 100 Hz
(4) = 20 Hz to 100 Hz

c) DC current measurement range (Tab. 3)

Range	Reference (+23°C)	Limits of indication
200 µA	100.00 µA	99.78–100.22
2 mA	1.0000 mA	.9978–1.0022
20 mA	10.000 mA	9.978–10.022
200 mA	100.00 mA	99.78–100.22
2A/20A	1000.0 mA	991.8–1008.2

d) AC current measurement range (Tab. 4)

Range	Reference (+23°C)	Limits of indication
200µA	100.00µA	99.16–100.84
2mA	1.0000mA	.9916–1.0084
20mA	10.000mA	9.916–10.084
200mA	100.00mA	99.16–100.84
2A/20A	1000.0mA	88.6–1011.4

e) Resistance ranges (Tab. 5)

Range	Reference (+23°C)	Limits of indication
200Ω	100.00Ω	99.83–100.17
2kΩ	1.0000kΩ	.9987–1.0013
20kΩ	10.000kΩ	9.987–10.012
200kΩ	100.00kΩ	99.87–100.12
2000kΩ	1000.0kΩ	998.7–1001.2
20MΩ	10.000MΩ	9.968–10.022

Alignment procedure

A – Clock frequency
Connect counter to „100kHz" point of testconnector CN101. Adjust clock with [1] VR107 to 100kHz ± 50Hz.

B – Zero point DC
Select 0.2V DC range. Adjust display for zero reading with [2] VC103 at open input.

C – Reference voltage
Select 2V DC range. Apply 1.8000V DC. Adjust for a reading of 1.800V with [3] VR106.

D – DC voltage gain
Select 0.2V DC range. Apply 0.1800V DC. Adjust for a reading of 180.00mV with [4] VR105.

E – Resistance reference
Select 200kΩ range. Connect 180kΩ ± 0.01% or appropriate Calibrator to input terminals. Adjust with [5] VR101 for a reading of 180.00kΩ.

F – Zero point AC
Select 2V AC range. Short circuit at input terminals. Adjust for zero reading with [6] VR104.

G – AC voltage gain of 1
Select 2V AC range. Apply 1.8000V AC/400Hz. Adjust with [7] VR103 for a reading of 1.8000V ± 5 digit.

H – AC voltage gain of 10
Select 0.2V AC range. Apply 0.1800V AC/400Hz. Adjust with [8] VR102 for a reading of 180.00V ± 5 digit.

I – Frequency compensation
a) Select 200V AC range. Apply 180.00V/400Hz. Adjust with [9] VC101 for a reading of 178,60V ± 10 digit.
b) Select 20V AC range. Apply 18.000V/20kHz. Adjust with [10] VC102 for a reading of 17.860V ± 10 digit.
c) Repeat steps a) and b).

Specification HM 8011-3

Temperature coefficient per °C
(Reference temperature: 23°C)

V_{DC}	200mV range	0.007% o.v.	+0.001% o.r.
	other ranges	0.005% o.v.	+0.001% o.r.
V_{AC}	all ranges	0.02% o.v.	+0.005% o.r.
mA_{DC}	all ranges	0.02% o.v.	+0.005% o.r.
mA_{AC}	all ranges	0.05% o.v.	+0.01% o.r.
Ω	all ranges	0.015% o.v.	+0.001% o.r.

o.v. = of value o.r. = of range

Current at resistance measurements:
200Ω -range: 1mA; 200kΩ -range: 1µA
2kΩ -range: 100µA 2/20MΩ -range: 100nA
20kΩ -range: 10µA

Voltage at resistance measurements:
0.3V typ. at open input; depending of the measured resistor value. Negative potential of measuring voltage is at common terminal.

Voltage drop at current measurements:
0.2mA – 20mA range: 0.5Vmax.
200mA range: 1.5Vmax.
2000mA range: 0.5Vmax.

Overload protection

Voltage ranges:
0.2V and 2V range: U_i max. 380V_{pk}
all other ranges: U_i max. 1000V_{pk}.

Current measuring ranges:
0.2mA to 200mA: Microfuse 200mA
Type Wickmann 19193 200mA quick
2000mA-range: Microfuse 2A
Type Wickmann 19194 2A quick
Max. Input voltage for all ranges 250V_{pk}.

Resistance ranges:
Max. Input voltage for all ranges 350V_{pk}.

Operating conditions:
+10°C to +40°C max. relative humidity: 80%

Display
4½digit 7 segment LED display, 8x5mm
Measurement rate: 2.5 measurements/s

Supply: (from HM 8001)
25V~/140mA (Σ = 3.5VA)

Dimensions (without 22pol. multipoint connector):
B 135 **H** 68, **T** 228 mm Weight: approx. 1 kg

Liste elektronischer Teile

Electronic Parts List

Ref. No.	Description		
R 101	100kΩ	5%	2W
R 102	1kΩ	5%	2W
R 103	PTC 800		
R 104	10MΩ	0.025%	268Q
R 105	4.64kΩ	1%	TK50
R 106	21.5kΩ	1%	TK50
R 107	4.02kΩ	0.5%	TK25
R 108	19.6kΩ	0.5%	TK25
R 109	900 Ω	0.1%	TK25
R 110	90 Ω	0.1%	TK25
R 111	10 Ω	0.1%	IWN-48
R 112-115	100kΩ	1%	TK50
R 116	10kΩ	1%	TK50
R 117	464kΩ	1%	TK50
R 118	100kΩ	1%	TK50
R 119	8.25kΩ	1%	TK50
R 120	46.4kΩ	1%	TK50
R 121	4.64kΩ	1%	TK50
R 122	4.64kΩ	1%	TK50
R 123	100kΩ	1%	TK50
R 124	56.2kΩ	1%	TK50
R 125	56.2kΩ	1%	TK50
R 126	26.1kΩ	1%	TK50
R 127	3.01kΩ	1%	TK50
R 128	464kΩ	1%	TK50
R 129	274 Ω	1%	TK50
R 130	23.7kΩ	1%	TK50
R 131	1.21kΩ	1%	TK50
R 132-133	470kΩ	2%	1W
R 134-136	10kΩ	1%	TK50
R 137	14.7kΩ	1%	TK50
R 138	10kΩ	1%	TK50
R 139	127kΩ	0.1%	TK25
R 140	13.3kΩ	0.1%	TK25
R 141	562 Ω	1%	TK50
R 142	100kΩ	1%	TK50
R 143-144	10kΩ	1%	TK50
R 145	100kΩ	1%	TK50
R 146	12.1kΩ	1%	TK50
R 147	46.4kΩ	1%	TK50
R 148	464kΩ	1%	TK50
R 149	59kΩ	1%	TK50
R 150	3.01kΩ	1%	TK50
R 151	100kΩ	1%	TK50
R 152	1MΩ	1%	TK50
R 153	12.7kΩ	1%	TK50
R 154	10kΩ	1%	TK50
R 155	95.3kΩ	1%	TK50
R 156-157	100kΩ	1%	TK50
R 158	33.2 Ω	1%	TK50
R 159	196kΩ	1%	TK50
R 160	21.5kΩ	1%	TK50
R 161	adj. only		
R 162	5.11kΩ	1%	TK50
R 163	19.6kΩ	1%	TK50
R 164	100kΩ	1%	TK50
R 165	18.2kΩ	1%	TK50
R 166	100kΩ	1%	TK50
R 201	464 Ω	1%	TK50
R 202-203	100 Ω	1%	TK50
R 204	464 Ω	1%	TK50
R 205-214	100 Ω	1%	TK50

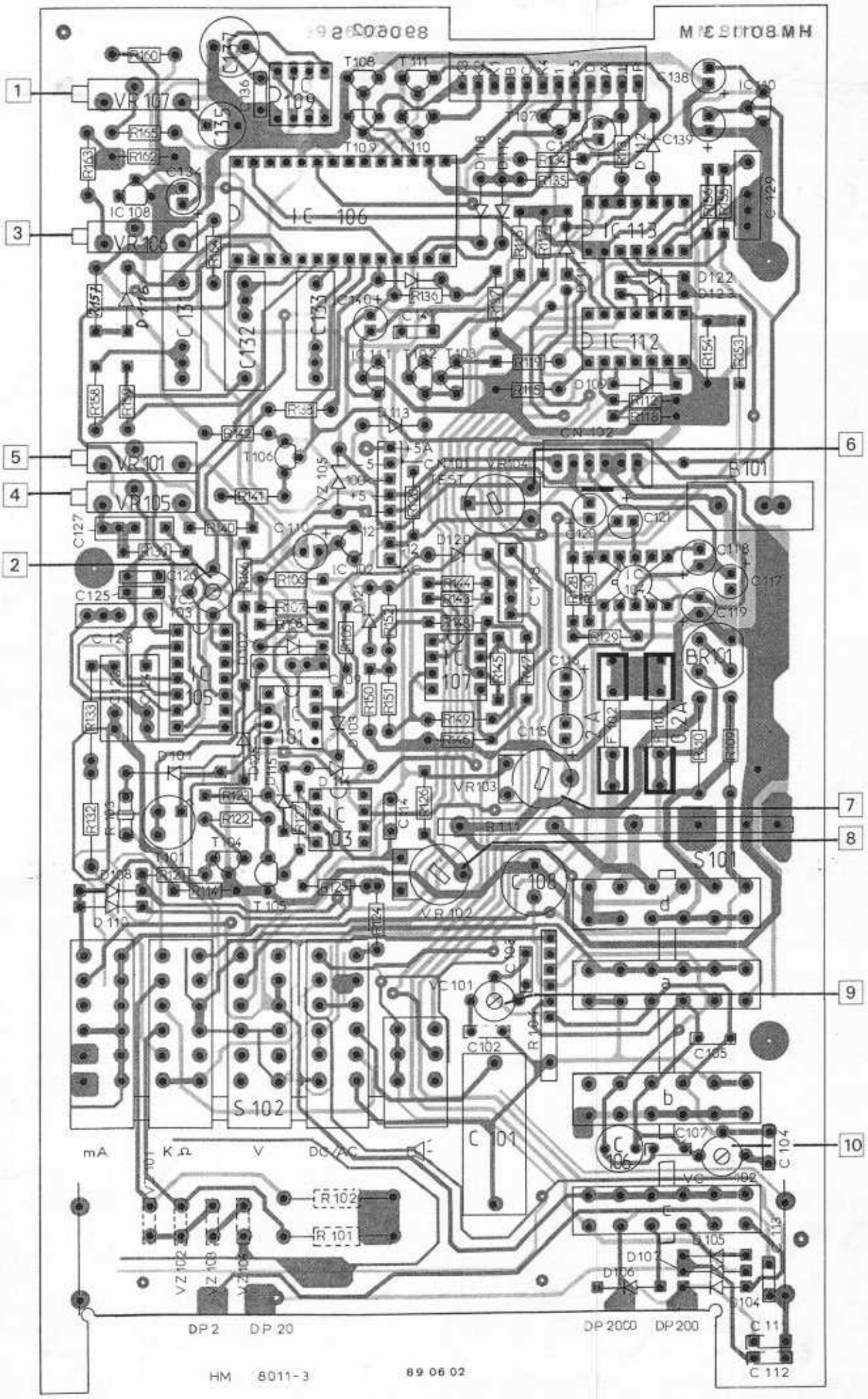
Ref. No.	Description		
C 101	0.1µF	1000V	20%
C 103	27pF	1000V	5%
C 104	100pF	63V	20%
C 105	82pF	63V	10%
C 106	2.2nF	160V	2.5%
C 107	68pF	63V	10%
C 108	24.4nF	63V	1%
C 109	10nF	630V	20%
C 110	10µF	35V	
C 111-113	22nF	63V	20%
C 114	6.8pF	400V	5%
C 115	22µF	40V	
C 116	22µF	40V	
C 117	10µF	35V	
C 118	2.2µF	63V	
C 119	10µF	35V	
C 120	2.2µF	63V	
C 121	2.2µF	63V	
C 122	10nF	630V	20%
C 123	0.1µF	250V	20%
C 124	0.1µF	250V	20%
C 125	6.8pF	400V	5%
C 126	6.8pF	400V	5%
C 127	0.22µF	100V	20%
C 128	0.22µF	100V	20%
C 129	10nF	630V	20%
C 130	10µF	35V	
C 131	0.33µF	160V	2.5%
C 132	1µF	100V	20%
C 133	1µF	100V	20%
C 134	10µF	35V	
C 135	220pF	160V	2.5%
C 136	22nF	63V	20%
C 137	47µF	25V	20%
C 138	10µF	35V	
C 139	10µF	35V	
C 140	10µF	35V	
C 201	100µF	16V	
C 301	1000µF	25V	
C 302	10µF	35V	
C 303	22nF	63V	20%
C 304	1000µF	25V	
C 305	10µF	35V	
C 306	22nF	63V	20%
C 307	1000µF	25V	
C 308	10µF	35V	
C 309	22nF	63V	20%
C 310	0.01µF	3kV	
C 311	10µF	35V	
C 312	10µF	35V	
C 313	10µF	35V	

D 101	EM513
D 102 - D 113	1N4149
D 114	FDH300
D 115	FDH300
D 116	1N4149
D 117	1N4149
D 118	1N4149
D 119	FDH300
D 120 - D 123	1N4149
D 125	EM513

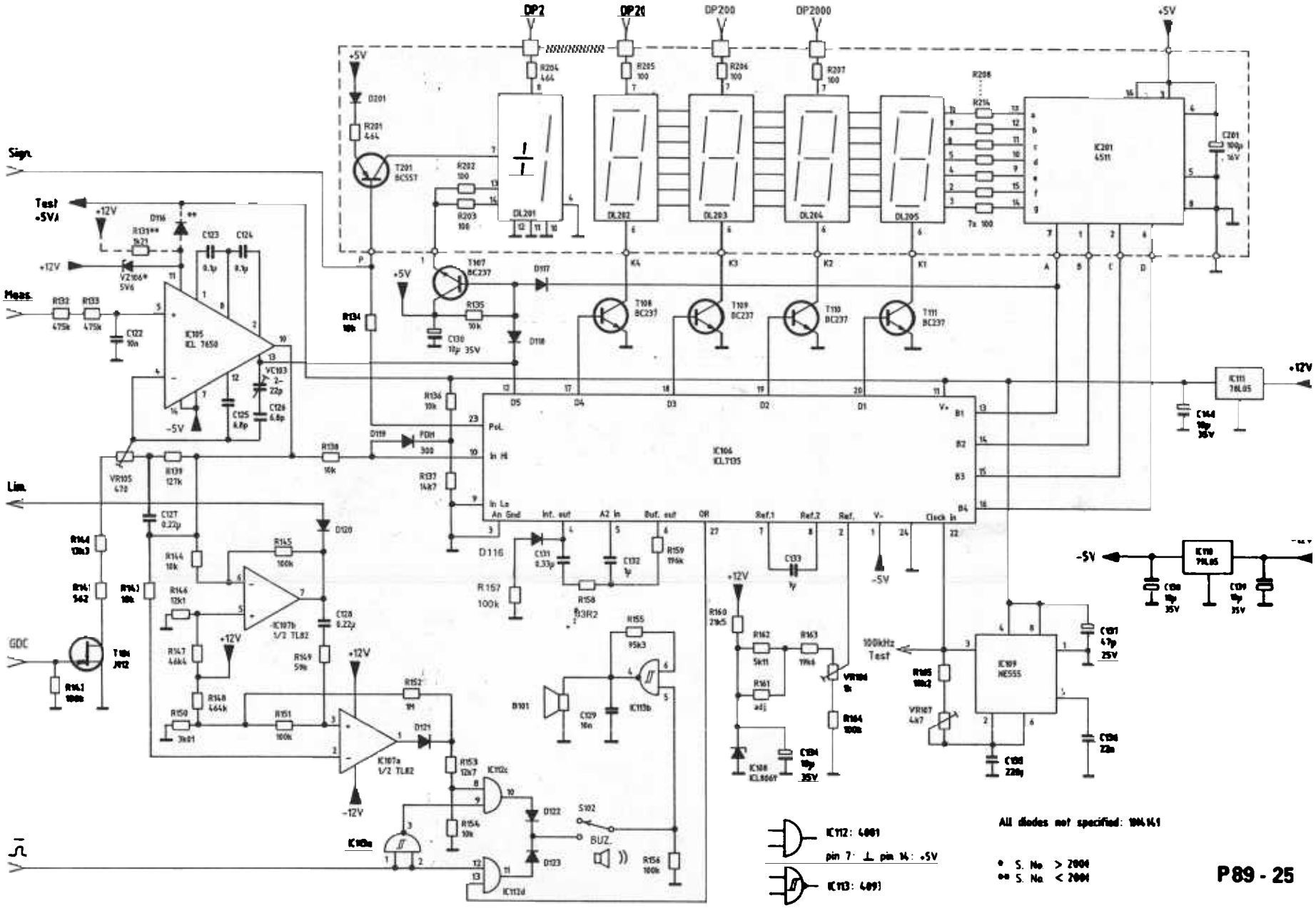
Ref. No.	Description	
IC 101	TL81	
IC 102	ICL8069 1.2V	
IC 103	LF356	
IC 104	AD536	
IC 105	ICL7650	
IC 106	ICL7135	
IC 107	TL82	
IC 108	ICL8069	
IC 109	NE555	
IC 110	79L05	
IC 111	78L05	
IC 112	4081	
IC 113	4093	
IC 201	4511	
IC 301	7805	
IC 302	7812	
IC 303	7812	
DL 201	HP 5082-7616	
DL 202-205	HP 5082-7613	
T 101	2N2219	
T 102-104	BC557	
T 105-106	J112	
T 107-111	BC237	
T 109	BC239C	
T 201	BC557	
VR 101	1kΩ lin. 20%	
VR 102	2.5kΩ lin. 20%	
VR 103	500 Ω lin. 20%	
VR 104	100kΩ lin. 20%	
VR 105	470 Ω lin. 20%	
VR 106	1kΩ lin. 20%	
VR 107	4.7kΩ lin. 20%	
VC 101	2-22pF	
VC 102	2-22pF	
VC 103	2-22pF	
VZ 101-104	300V	
VZ 105	5.6V	1/4W
F 101	0.2A	
F 102	2A	
BR 101	B250 C1500	
BR 301	B250 C1500	
BR 302	B250 C1500	
BR 303	B250 C1500	
TR 301	Trafo 2x12.5V	

Components Location, Main Board
Localizacion des componentes

Bestückungsplan, Hauptplatine
Implantation des composants



Referenzspannung, A/D-Wandler
Tension de reference; convertisseur A/N
Reference Supply, A/D Converter
Voltaje de referencia; convertidor A/D



Eingangsteiler
Ω/V-Wandler
Effektivwert-Meßwandler

Diviseur d'entrée
Convertisseur Ω/V
Convertisseur de valeur efficace

Divisor de entrada
ConvertidorΩ/V
Convertidor RMS/DC

Input Divider
Ω/V Converter
RMS/DC-converter