G L 08

Automatic Digital Multimeter

PM2517E DM02 4926
PM2517X DM01 3051

Service Manual

9499 475 01311
790507

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SERVICE

Cryogenic Equipment / Electro Analytical Equipment / Electronic Weighing / Electron Optics / Industrial Data Processing systems / Numerical Control / Radiation Measuring Equipment / Test and Measuring Equipment / Welding Equipment / X-Ray Analysis

equipment for science and industry

79 06 06 PM 2517E/X SME 83

Already issued:

Re : New version of OQ 0063

- Documentation survey

Documentation \ Instrument versions		E DM01 600 - DM02 4926	X DM01 600 - DM01 3051	E DM02 4926 - onwards	X DM01 3051 - onwards
Instruction manual	9499 475 01011	■	■		
Instruction manual	9499 475 01311			■	■
Service note	SME 83	■	■	■	■

- New version of OQ 0063

In the new version of the OQ 0063 pin 17 is internally connected.
Using the new OQ 0063 in the earlier versions of the PM 2517,
(E DM01 600 - DM02 4926 and X DM 01 600 - DM01 3051) results in malfunctionning of the Ω-function. The ordering number of the OQ 0063, 5322 209 85886 remains the same. Concern Service will deliver only the new version of the OQ 0063.
To avoid problems with the Ω-function, pin 17 of the OQ 0063 should be cut-off when using them in the earlier PM 2517.

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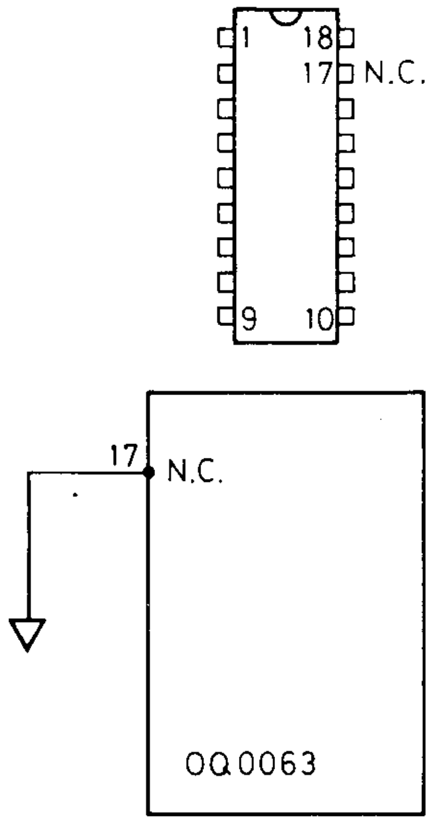
Old OQ 0063

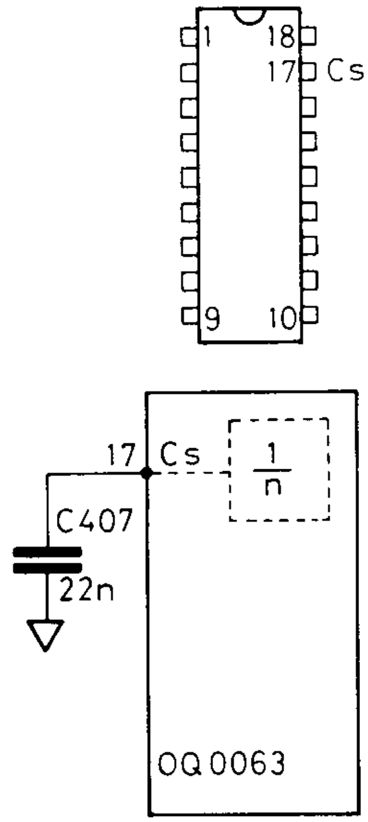
E DM01 600 - DM02 4926
X DM01 600 - DM01 3051



(OLD P.C. BOARD)

New OQ 0063

E DM02 4926 - onwards
X DM01 3051 - onwards



(NEW P.C. BOARD)

ST 2717

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800218 | PM2517 E/X | SME84

Already issued : SME 83
Re : 1. Starting problems OQ0063
: 2. Battery cover
: 3. Predeflection in the mA ⎓ range
: 4. Incorrect reading in the mA ranges

1. <u>Starting problems OQ0063.</u>

- Error description

  If the PM2517 is switched-on in the function Ω, →| or °C with open input or Rx>800Ω, it may happen that the OQ0063 does not start. This can result in the following errors:
  - Display indicates overload
  - Display indicates a too low reading

  In both cases the PM2517 does not react on range commands. After switching OFF and ON again or to the functions V⎓, V∿, mA⎓ or mA∿ the instrument functions correctly again.

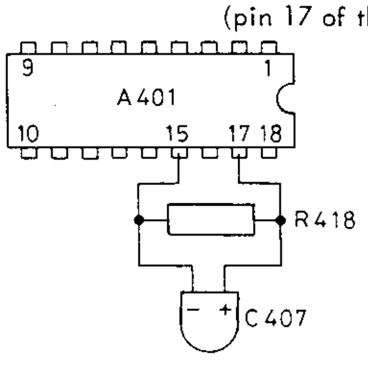
- Cause

  Starting problems of the OQ0063.
  The problem only occurs with new I.C.'s with weeknumber 7919 and higher (refer to SME 83).

- Remedy

  PM2517E DM01 600 - DM02 4926
  PM2517X DM01 600 - DM01 3051

  Only when the OQ0063 is replaced by a new type (weeknumber ≥7919) the following modification must be built-in:
  - Remove capacitor C407 (22nF)
  - Short circuit resistor R413 (3k3)
  - Connect to pin 17 and pin 15 (⏚) of the OQ0063 an electrolytic capacitor of 15 μF, 10V in parallel with a resistor of 68 kΩ, CR16.
    (pin 17 of the OQ0063 should be cut off, refer to SME83).



R418 = 68 kΩ, CR16 5322 111 30291
C407= 15μ F , 10V 5322 124 14036

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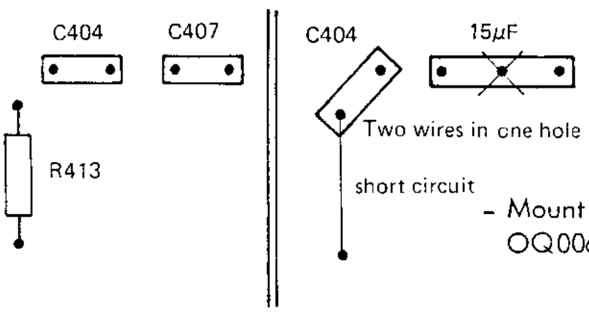
PM 2517E DM 02 4926 - DM 04 10491
PM 2517X DM 01 3051 - DM 04 8611

If the OQ0063 has a weeknumber of 7919 or higher the following modification must be built in.

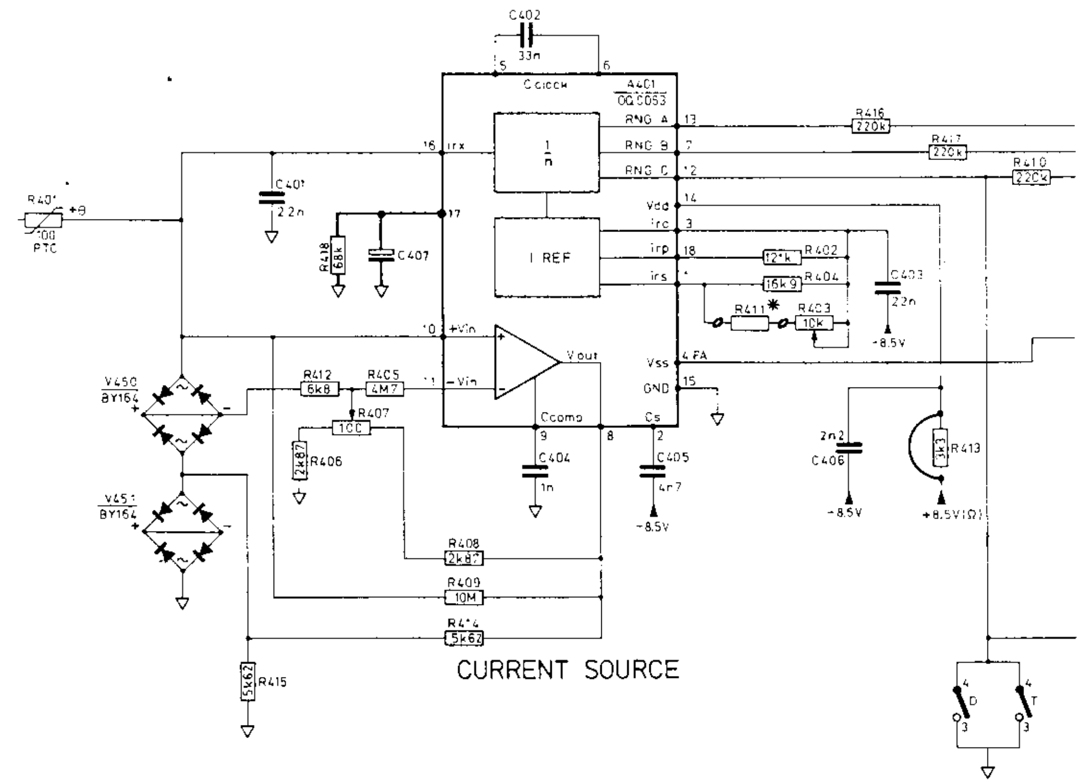
Connect to pin 17 of the OQ0063 and supply zero ⏚ an electrolytic capacitor of 15µ F in parallel with a resistor of 68 kΩ and short circuit resistor R413.
Proceed as follows:

- Remove capacitor C407 (22nF)
- Remove capacitor C404 (1nF)
- Remove resistor R413 (3k3)
- Short circuit the spots where R413 has been removed
- Mount capacitor C404 on the p.c. board again. (see figure)
- Mount the new capacitor C407 (15 µ f)on the p.c. board again (see figure).



R418 R= 68 kΩ, CR16 5322 111 30291
C407 C=15µ F, 10V 5322 124 14036

- Mount the 68 kΩ resistor between pin 15 and 17 of the OQ0063 at the conductor side of the p.c. board.



PM 2517E DM04 10491 - onwards
PM 2517X DM04 8611 - onwards

The modification has already been built in from the factory on.

Erratum for SME 84 code nr 9499 478 10811.

Concerns: 1. Starting problems OQ0063

The polarity of the new capacitor C407 is drawn incorrectly. The drawing of the I.C. and the circuitdiagram must be changed to show; Pin 17 of the OQ0063 (A401) = –

Pin 15 of the OQ0063 (A401) = + (⏚)

2. Batterycover.

Safety requirements made it necessary that the battery spring where the battery voltage is measured on should be placed lower.
Therefore the battery spring and the battery cover (larger hole) have been changed.
The ordering number of the battery cover reamains the same. In old instruments where the battery cover is replaced also the battery spring should be replaced.

Description	Ordering number	Qty.
Battery cover	5322 443 64026	1
Battery spring low	5322 492 64746	1

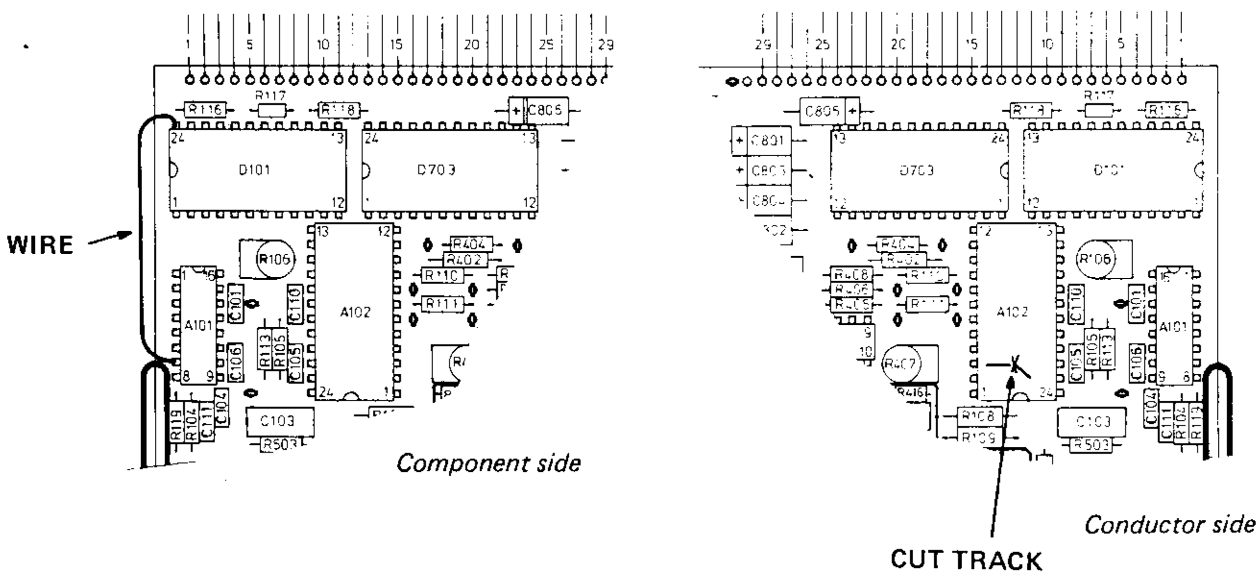
3. Predeflection in the mA ⎓ range.

- Error description
  In the mA ⎓ range the PM 2517 has a predeflection of 2 digits at shortcircuited input.

- Remedy

  Cut track which is situated under the OQ0064 (A102) at the conductor side of the p.c. board (see figure).
  Interconnect pin 24 of the OQ0059 (D101) and pin 7 of the OQ0060 (A101) (see figure)

  From serial number DM 06 15321 PM 2517E and DM 06 14986 PM 2517X on the modification has already been built in by the factory.



4. Incorrect reading in the mA ranges.

- Error description
  High current peaks can influence permanently the value of resistor R603 in the mA range. This will give a permanent incorrect reading.

- Remedy
  A new resistor type R603, ordering number 5322 116 44011.

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800408 PM 2517X SME 85

Already issued: SME 83
SME 84
Re: New LX display

– Documentation survey

Documentation \ Instrument versions	E DM01 600 – DM02 4926	X DM01 600 – DM01 3051	E DM02 4926 ONWARDS	X DM01 3051 – DM07 17361	X DM07 17361 ONWARDS
Instruction manual 9499 475 01011	■	■			
Instruction manual 9499 475 01311			■	■	■
Service note SME 83	■	■	■	■	■
SME 84	■	■	■	■	■
SME 85				■	■

1. New LX display

From serial number DM 07 17361 onwards the PM2571X is equipped with a new LX display (type BBC) and from serial number DM 07 19138 with a new rubber interconnection strip. The dimensions of the new LX display (height) differ from the excisting display.

The new rubber interconnection strip has been mounted, to ease the mounting.

In addition to the new LX display a wire is soldered between the soldering bulb on the LX display and N1 pin 3.

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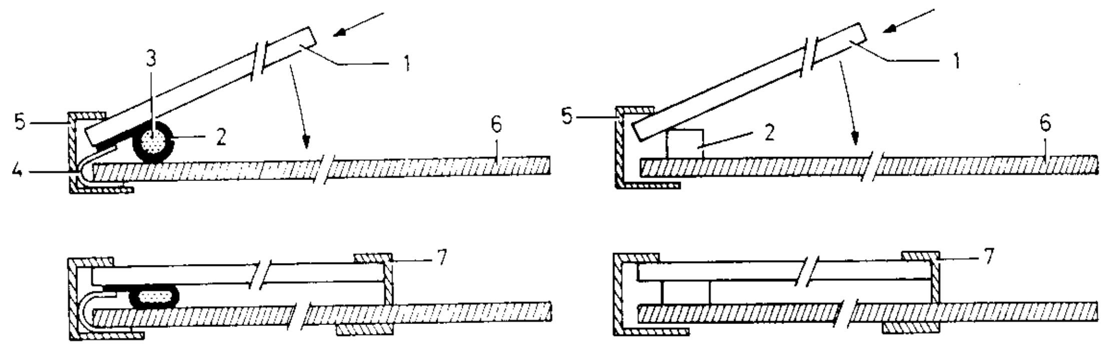
OLD SITUATION
PM2517X DM01 600 – DM07 17361

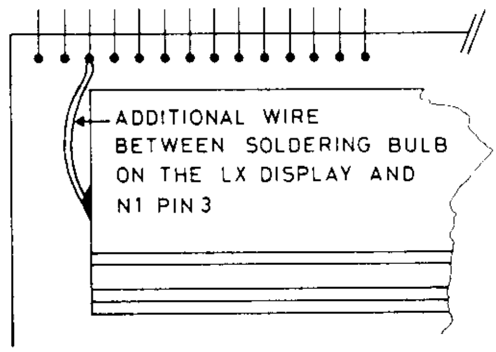
1= LX display (5322 130 94011 obsolete)
2= Flexible interconnection strip
3= Rubber roller
4= Tape
5= Large fixing clip
6= Display unit
7= Fixing clip 2x
8= Positioning hook

NEW SITUATION
PM2517X DM07 19138 onwards

1= LX display (5322 130 94025)
2= Flexible rubber interconnection strip
(5322 263 54014)
5= Large fixing clip
6= Display unit
7= Fixing clip 2x
8= Positioning hook



ST 2541



ST 2945

In the new arrangement the rubber roller (3) and tape (4) are not required. To replace the LX display, refer to page 112 of the PM2517 Instruction Manual.

2. *How to proceed with old instruments (PM2517X DM01 600 – DM07 17361)*
   The existing LX display 5322 130 94011 is obsolete
   When the LX display has to be replaced, the existing interconnection strip should also be replaced.
   For replace refer to page 112 of the PM2517 instruction manual and point 1 of this information sheet.

3. *Ordering numbers.*

Obsolete until present stocks are exhausted	
LX DISPLAY	5322 130 94011
Replaced by	
LX DISPLAY (Type BBC)	5322 130 94025
Rubber interconnection strip	5322 263 54014

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801009	PM2517 E/X	SME87

Already issued: SME83, SME84, SME85.

Rc :
1. Starting problems OQ0063
2. ON/STAND BY/OFF switch PM2517E
3. Textplates
4. Corrections of the Service manual

Documentation Survey

(▒ = shaded in original)

Documentation \ Instrument versions	E. DM 01 600 – DM02 4926	X DM01 600 – DM01 3051	E DM02 4926 – DM06 16386	X DM01 3051 – DM07 17361	X DM07 17361 – DM07 19671	E DM06 16383 onwards	X DM07 19671 onwards
Instruction manual 9499 475 01011	▒	▒					
Instruction manual 9499 475 01311			▒	▒	▒	▒	▒
Service note SME83	▒	▒	▒	▒	▒	▒	▒
SME84	▒	▒	▒	▒	▒	▒	▒
SME85		▒		▒	▒		▒
SME87	▒	▒	▒	▒	▒	▒	▒

1. **Starting problems OQ0063.**

The remedy for the starting problems of the currentsource OQ0063 as described in Service note SME84, is not sufficient.
It should be replaced by the remedy as described in this Service note.

– Error description
If the PM2517 is switched-on in the function Ω, ⯒ or °C with open input or Rx > 800 Ω , it may happen that the OQ0063 does not start. This can result in the following errors:
  – Display indicates overload
  – Display indicates a too low reading
In both cases the PM2517 does not react on range commands. After switching OFF and ON again or to the functions V⎓, V~, mA⎓ or mA~ the instrument functions correctly again.

– Cause
Starting problems of the OQ0063
The problem only occurs with new I.C.'s with weeknumber <u>7919</u> and higher (refer to SME83).

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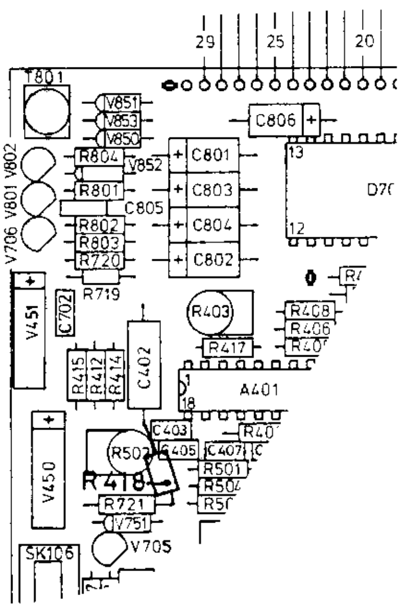
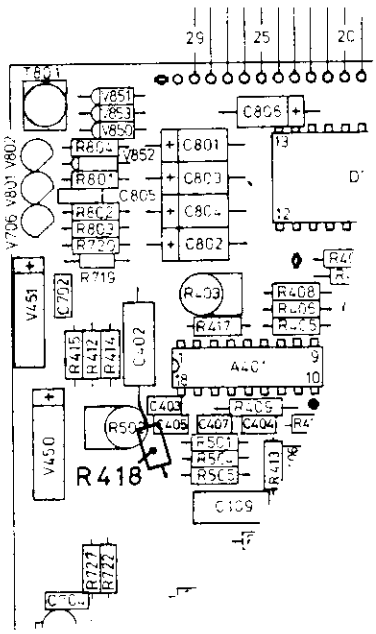
– Remedy
PM2517E DM01 600 – DM04 10491
PM2517X DM01 600 – DM04 8611

Only when the OQ0063 is replaced by a new type (weeknumber ≥ 7919) the following modifications must be built-in:
- Short circuit resistor R413
- Place a resistor of 220 kΩ, CR16 5322 111 30302 between pin 1 of the OQ0059 (DS1) and pin 6 of the OQ0063 (clock) (C402 and R721) Refer to Fig. 1.



PM2517E DM01 600 onwards
PM2517X DM01 600 – DM01 3051



PM2517X DM01 3051 onwards

Fig. 1. P.c. board N1 conductor side

PM2517E DM04 10491 – DM06 16386
PM2517X DM04 8611 – DM07 19671

In these instruments, the modification as mentioned in Service note SME84 are already built-in.
For the correct modification proceed as follows:
- Remove resistor R418 (SME84)
- Replace capacitor C407, 15 uF 10V 5322 124 14036 by a capacitor of 22nF, 4822 122 30103 Ceramic plate
- Place a resistor of 220 kΩ, CR16 5322 111 30302 between pin 1 of the OQ0059 (DS1) and pin 6 of the OQ0063 (Clock) (C402 and R721) Refer to Fig. 1.

PM2517E DM06 16386 onwards
PM2517X DM07 19671 onwards

The modification has already been built-in by the factory.

NOTE: There are several instruments with a lower serial number than DM06 16386 and DM07 19671 in which the modifications are already built-in.

2. **ON/STAND BY/OFF switch PM2517E**

The lockspring, 5322 492 64675, of the power switch in the topcover has been modified to ensure a smooth switching. The topcover part now consists of a locking-spring, two ball bearings and a knob.
The new ordering numbers are:

Lockspring	5322 492 64742
Ball bearing	4822 520 40012

3. **Textplates**

To conform with the international standards, the text on the topcover and the batterycover has been modified. The ordering numbers for the topcover and batterycover with the new texts are:

Topcover	5322 447 94558
Batterycover E/X	5322 443 64029
Topcover X	5322 447 94537

4. **Corrections of the Service manual (ordering number 9499 475 01311)**

Page 65 5.2. Adjusting table

NO.2 ADJUSTING ELEMENT

Adj. resistor R107
(MR25, 1%, E48 series)

Should be changed into:
Adj. resistor R107, coarse.
(MR25, 1%, E48 series)
Potentiometer R106, fine.

Adjustment NO.11 must be omitted.

CONTENTS

IMPORTANT

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

WICHTIG

Bei Schriftwechsel über dieses Gerät wird gebeten, die genaue Typenbezeichnung und die Gerätenummer anzugeben. Diese befinden sich auf dem Leistungsschild.

IMPORTANT

RECHANGE DES PIECES DETACHEES (Réparations)

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Note: *The design of this instrument is subject to continuous development and improvement. Consequently, this instrument may incorporate minor changes in detail from the information contained in this manual.*

Bemerkung: *Die Konstruktion und Schaltung dieses Geräts wird ständig weiterentwickelt und verbessert. Deswegen kann dieses Gerät von den in dieser Anleitung stehenden Angaben abweichen.*

Remarques: *Cet appareil est l'objet de développements et améliorations continuels. En conséquence, certains détails mineurs peuvent différer des informations données dans la présente notice d'emploi et d'entretien.*

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ST 2334

Service Manual

Automatic Digital Multimeter

PM 2517 E

9447 625 170.1

From serial number DM 02 4926 onwards

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9499 475 01311

790507

LIST OF FIGURES

1. TECHNICAL DATA

All values mentioned in this description are nominal; those given with tolerances are binding and guaranteed by the manucfacturer.

1.1. ELECTRICAL SPECIFICATIONS

1.1.1. D.C. voltage measurements

Range — 100 μV . . . 1000 V
4 sub-ranges: 999.9 mV; 9.999 V; 99.99 V; 999.9 V

Resolution — 100 μV

Accuracy — ± 0.2% of reading ± 0.05% of full scale

Temperature coefficient — 300 ppm/°C of reading

Input impedance

Range	Input impedance
999.9 mV 9.999 V	10 MΩ ± 1%
99.99 V 999.9 V	9 M 01 ± 1%

Protected up to — 1000 V . . . or 1000 V~ rms
1400 V peak

1.1.2 A.C. voltage measurements

. Range — 100 μV . . . 1000 V
4 sub-ranges: 999.9 mV; 9.999 V; 99.99 V; 999.9 V

Resolution — 100 μV

Accuracy — ± 0.5% of reading ± 0.1% of full scale (50Hz)
Valid > 1% of range

Frequency influence — Additional error

Error	± % of full scale
40 Hz. . . 1 kHz	± 0.5
1 kHz. . . 10 kHz	± 1
10 kHz. . . 20 kHz	± 5

Temperature coefficient — 300 ppm/°C of reading

Input impedance

Range	Input impedance
999.9 mV 9.999 V	2 M Ω ± 1%
99.99 V 999.9 V	1 M 802 ± 1%

AC-DC conversion — True RMS

Crest factor — 2 at end of range

Protected up to — 600 V~ rms + 400 V ⎓
1400 V peak

1.1.3. D.C. current measurements

Range

10 μA - 100 mA
1 mA - 10 A
2 fixed ranges with separate inputs; 99.99 mA
9.999 A

Resolution

Range	Resolution
99.99 mA	10 μA
9.999 A	1 mA

Accuracy — ± 0.5% of reading ± 0.1% of full scale

Temperature coefficient — 500 ppm/^{o}C of reading

Voltage drop over shunt

Range	Voltage drop
99.99 mA	< 200 mV
9.999 A	< 150 mV

Protected up to

Range	Protection
99.99 mA	Fuse 315 mA quick 250 V rms
9.999 A	No protection

1.1.4. A.C. current measurements

Range

10 μA - 100 mA
1 mA - 10 A
2 fixed ranges with separate inputs; 99.99 mA
9.999 A

Resolution

Range	Resolution
99.99 mA	10 μA
9.999 A	1 mA

Accuracy — ± 0.8% of reading ± 0.1% of full scale at 50 Hz input signal

Temperature coefficient — 500 ppm/^{o}C of reading

Voltage drop over shunt

Range	Voltage drop
99.99 mA	< 200 mV
9.999 A	< 150 mV

Protected up to

Range	Protection
99.99 mA	Fuse 315 mA quick 250 V rms
9.999 A	No protection

1.1.5. Resistance measurements

Range

0.1 Ω .... 10 M Ω
5 sub-ranges: 999.9 Ω ; 9.999 kΩ ; 99.99 kΩ
999.9 kΩ; 9.999 M Ω

Resolution — 0.1 Ω

Accuracy

Range	± % of reading	± % of full scale
999.9 Ω 9.999 kΩ 99.99 kΩ	± 0.5	± 0.1
999.9 kΩ 9.999 MΩ	± 1	± 0.1

Temperature coefficient

Range	Temp. coefficient
999.9 Ω 9.999 kΩ 99.99 kΩ 999.9 kΩ	300 ppm/°C of reading
9.999 M Ω	500 ppm/°C of reading

Protected up to — 250 V rms

1.1.6. Diode measurements

Driving current — 1 mA

Range — +999.9

Protected up to — 250 V rms

1.1.7. Temperature measurements

Probe to be used — PM 9248

Measuring range — −60 °C . . . +200 °C

Accuracy
(Probe combined with PM 2517)

Range	± %of reading	± °C
− 60 °C . . . +100 °C	1	2
+ 100 °C . . . + 200 °C	+1, −3	2

1.2. GENERAL DATA

Display — 7-segment 11 mm LED display, with automatic decimal point indication.

Maximum reading — 9999

Overrange indication — 0 (only 0 of 10^2 digit is lighted)

Polarity indication — + or − automatically

Unit indication — mV, Ω , MΩ by LED's
V, kΩ , °C, (m)A by function selector

Function indication — V ⎓ , V~, kΩ, , °C, (m)A ⎓ , (m)A~by function selector

Inputs — Combined V, mA, ⯒, Ω socket
Common socket
Special 10A input socket
Floating inputs

Range selection — Automatic : for function V and Ω
Manual : for all ranges

Series mode rejection ratio
(SMRR) dc ranges

Range	SMRR	
99.99 mV 9.999 V	60 dB	48 HZ — 1 kHz
99.99 V 999.9 V	40 dB	48 Hz — 1 kHz

Common mode rejection ratio (CMRR) — dc ranges 100 dB
ac ranges 80 dB 50/60 Hz

Analog to digital conversion — Integrating

Conversion time — 200 msec.

Conversion rate — 5 conv/sec.

Protection — Max. voltage between 0 and mains earth (⏚) 400V ⎓
For specific protections refer to the function specifications

Response time

Without ranging

Function	Response time
V ⎓ , A ⎓ , °C	max. 1 sec.
V~ A~	max. 1 sec.
Ω ▶|	max. 1 sec.

With ranging

Function	Response time
V ⎓	max. 3 sec.
V~	max. 5 sec.
Ω	max. 6 sec.

Recovery time max. 3 sec.

Data hold Via probe input

Climatic conditions

Reference temperature	±23 °C ± 2 °C
Rate range of use	–10 °C... + 55 °C
Specified range	0 °C... + 45 °C
Limit range of storage and transport	–40 °C... + 70 °C
Relative humidity (excluding condensation)	20% ... 80%

Power supply

4x 1.5 V batteries, e.g. types: Philips R 14 TR
4x 1.5 V NiCd rechargeable batteries; refer to 1.3.
(special requirements), e.g. types: DEAC, RS 15
GENERAL ELECTRIC, GCT 1.5 SB
FURUKAWA, S 104
External 9 V power supply PM 9218

Operation

OFF
STAND BY, display for 40 sec. if DISPLAY switch is activated
ON, continuous display

Battery life-time 30 hours (continuous display)

Mechanical data

Dimensions	Length	165 mm
	Width	115 mm
	Height	50 mm
Cabinet	Material	ABS
Weight	≈0.7 kg (without batteries)	

1.3. POWER SUPPLY WITH RECHARGEABLE BATTERIES

The PM 2517 delivered from the factory is wired for use with dry-cell batteries power supply or for a 9 V external power supply using the PM 9218. For rechargeable batteries power supply the wiring inside the instrument has to be modified. The charging time is 18 hours.

Note: *When the instrument is wired for rechargeable battery power supply, dry-cell batteries should not be used.*
The 9 V external power supply will damage the dry-cell batteries. When dry-cell batteries are used again, the instrument should be wired to its original state.

For changing the wiring proceed as follows:

- Remove the battery cover
- Remove the two special nuts situated under the battery cover
- Pull the rear cover from the instrument.

Note: *Take care that the wiring to the battery compartment does not break. When mounting the rear cover again take care that the wiring is fitted properly.*

PM 2517 E

– Instruments with serial number DM600 upto DM900, version /01.
  Interconnect points 2 and 3 of the power plug.

Note: *Some instruments with serial numbers DM600 upto DM900 are already equipped with a voltage regulator diode as shown in figure 1. For these instruments proceed as for instruments with serial numbers greater than DM900.*

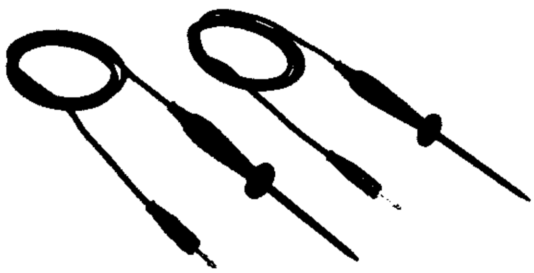
– Instruments with serial numbers greater than DM900.
  Interconnect points 2 and 3 of the power plug.
  Short-circuit the voltage regulator diode.

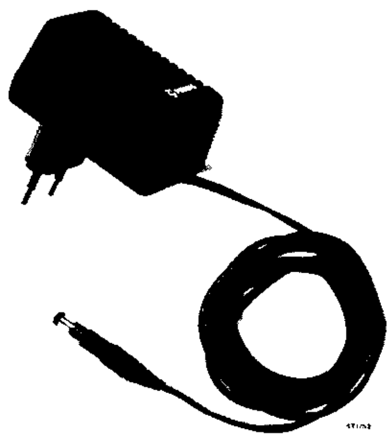
Note: *The voltage regulator diode is used for decreasing the external 9 V to 7 V for the instrument.*

2. ACCESSORIES

2.1. Accessories supplied with the instrument

– Measuring leads with test pins





– 2 Fuses 315 mA quick
– 9 V power supply PM 9218
– Directions for use

2.2. OPTIONAL ACCESSORIES

2.2.1. Temperature probe PM 9248 (Fig. 2)

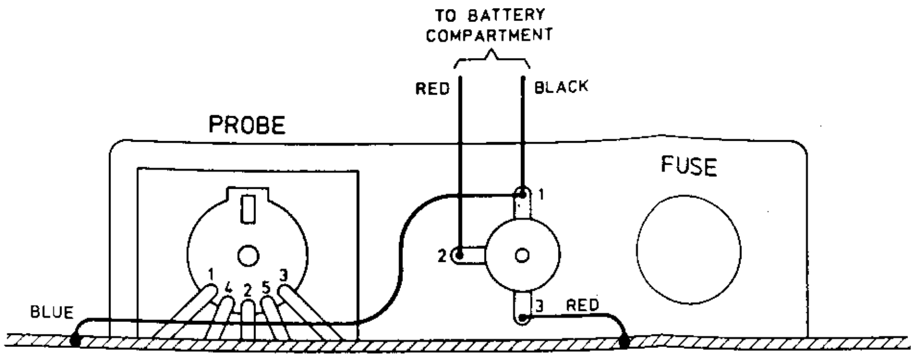
The resistance thermometer PM 9248 is a contact probe, suitable for measurement of surface temperatures between –60 °C and +200 °C.

Range	–60 °C to +200 °C		
Resolution	0.1 °C		
Accuracy (combined with PM 2517)	– 60 °C to +100 °C + 100 °C to +200 °C	± 1% of reading + 1% to –3% of reading	±2 °C ±2 °C
Permissible voltage at probe tip	60 V		

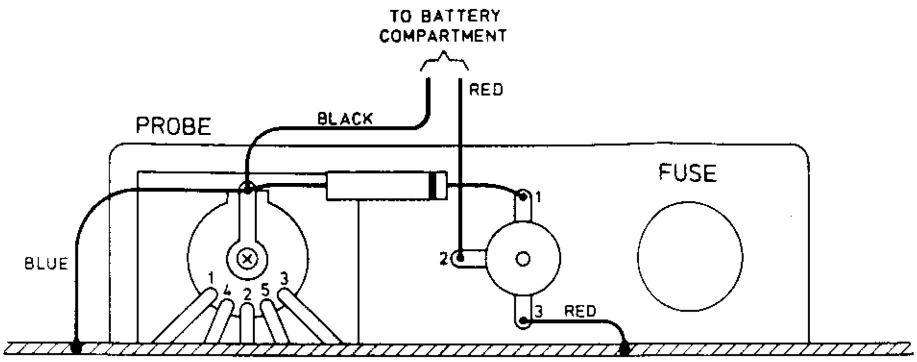
2.2.2. Data hold probe PM 9263 (Fig. 3)

The PM 9263 is a DATA HOLD probe which can be used in combination with multimeters which have a data hold facilities on the 5-pole DIN probe input. A switch ring on the probe is pushed forward to hold the data for display. Depending on the multimeter, voltage, resistance and current measurements can be made in combination with the probe.

DRY CELL BATTERIES OR 9V EXTERNAL POWER SUPPLY PM 9218

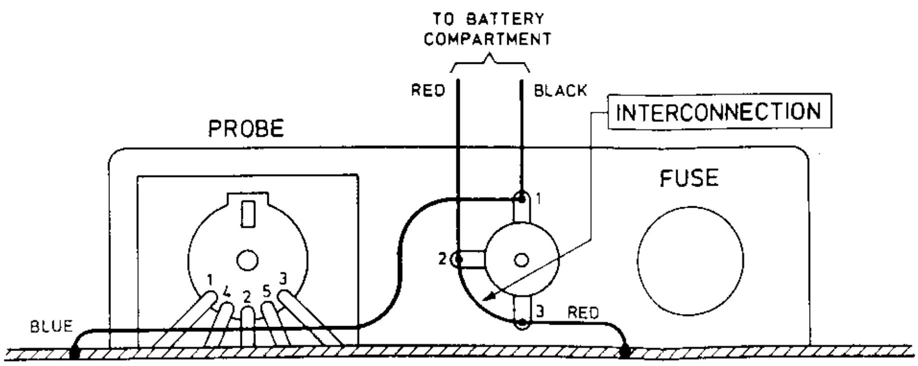


PM 2517E/01
Serial numbers DM600 – DM900

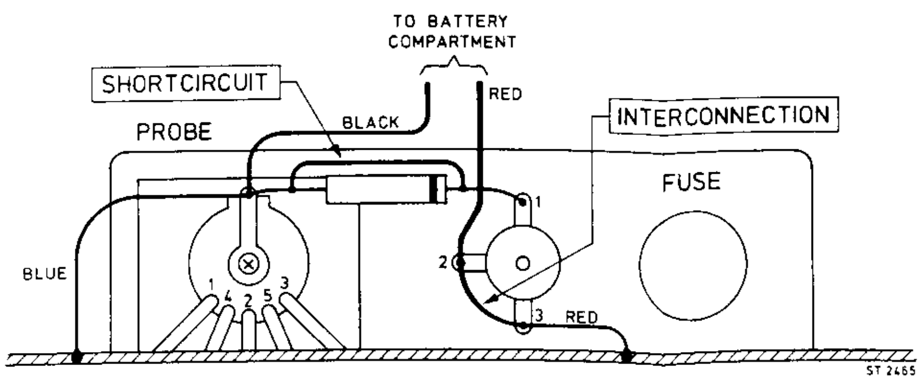


PM 2517E/01
Serial numbers DM900 and following

RECHARGEABLE BATTERIES WITH EXTERNAL POWER SUPPLY PM 9218



PM 2517E/01
Serial numbers DM600 – DM900



PM 2517E/01
Serial numbers DM900 and following

Fig. 1. Power supply

Technical data

Data hold	By means of slide switch on the probe.	
Maximum input voltages	Probe tip (VΩ) to common (0)	500 Vd.c. 350 Va.c. VHz product $<10^7$
	Common (0) to Mains earth	42 V
Maximum input current	200 mA	
Input capacity	300 pF	
Resistance VΩ and 0 leads	130 mΩ	
Temperature range		
Rated range of use	−10 °C . . . +55 °C	
Limit range of storage and transport	−25 °C . . . +70 °C	
Relative humidity	10% . . . 80% (excl. condensation)	

Accessories

Delivered with the PM 9263

Accessory box containing (Fig. 2)

- Zeroing lead
- 2 Marking rings (red, white, blue)
- Probe holder
- Spring loaded test clip
- Wrap pin connector
- Insulating cap
- Dual-in-line cap
- 10 Soldering test points
- 2 Spare probe tips
- Instruction manual

Optional accessories

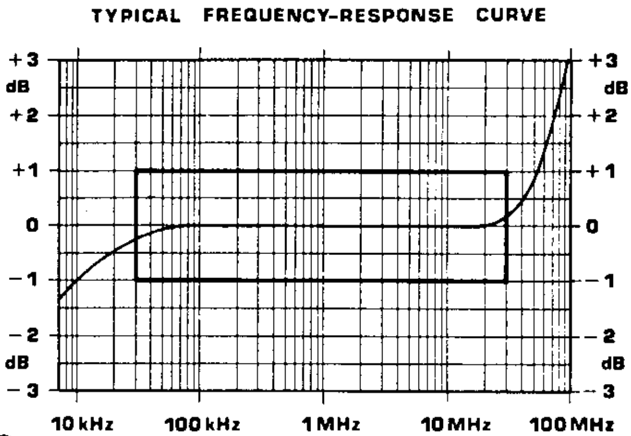
Accessories used with oscilloscope probes can be combined with this probe.

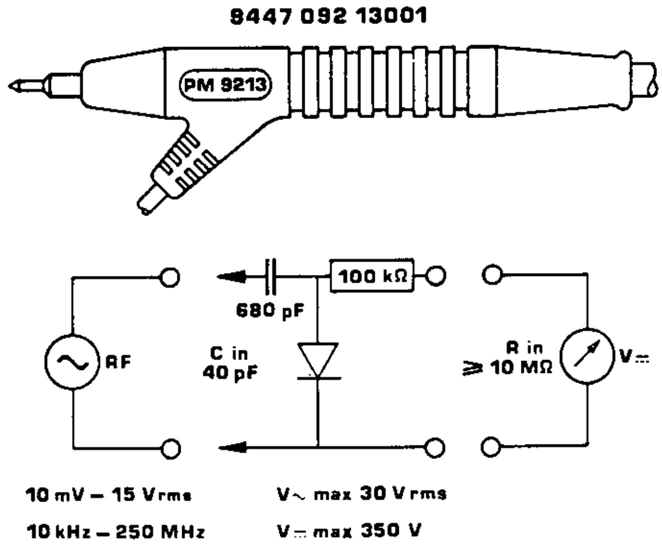
2.2.3. HF probe type PM 9210 (Fig.4) Accessory set for the probe type PM 9212 (Fig. 5)

	PM 9210	**PM 9210 + PM 9212**
Frequency range	100 kHz to 1 GHz	100 kHz to 1 GHz
Straight line within 5%	100 kHz to 6 MHz	100 kHz to 6 MHz
Maximum deviation	3 dB	3.5 dB
Voltages ranges	150 mV to 15 V	15 V to 200 V
Max. voltage a.c.	30 V	200 V
Max. voltage d.c.	200 V	500 V
Input capacitance	2 pF	2 pF
T-piece (included in PM 9212)		
Impedance		50 Ω
Standing wave ratio		1.25 at 700 MHz and 1.15 at 1 GHz with 100:1 attenuator

Probe type PM9210, in combination with the probe accessories (adjustable earthing pin and dage adaptor), is suitable for measurements up to a frequency of 100 MHz.
For measurements beyond this frequency it is advisable to use the 50 Ω T-piece and the 50 terminating resistance which are included in the PM 9212 probe accessories set.

2.2.4. RF probe PM 9213 (Fig. 6)





2.2.5. EHT probe type PM 9246 (Fig. 7)

The EHT probe PM 9246 is suitable for measuring d.c. voltages up to 30 kV. The PM 9246 can be used for measuring instruments having an input impedance of 100 MΩ, 10 MΩ or 1.2 MΩ (selectable on the probe).

Maximum voltage	30 kV
Attenuation	1000x
Input impedance	600 MΩ ± 5%
Accuracy	± 3%
Relative humidity	20% to 80%

Note: Check that earth connections are made correctly.

2.2.6. Current transformer type PM 9245 (Fig. 8)

With this transformer it is possible to measure alternating currents over 10 A up to 100 A.

Transfer factor	1000x (100 A = 100 mA)
Transfer error	± 3%
Frequency range	45 Hz to 1 kHz
Max. permissible secundary voltage loss	200 mV
Max. voltage with respect to earth	400 V a.c.

Before measuring, connect the current transformer to the instrument.
Avoid contamination of the core parts.

2.2.7. Shunt type (Fig. 9)

With this shunt it is possible to measure direct- and alternating currents (max. 1 kHz) up to 31.6 A.

Current range	10 A and 31.6 A
Output voltage	100 mV and 31.6 mV
Accuracy	100 mV : ± 1% 31.6 mV : ± 2%
Dissipation	max. 3.16 W
Dimensions	Height 55 mm Width 140 mm Depth 65 mm

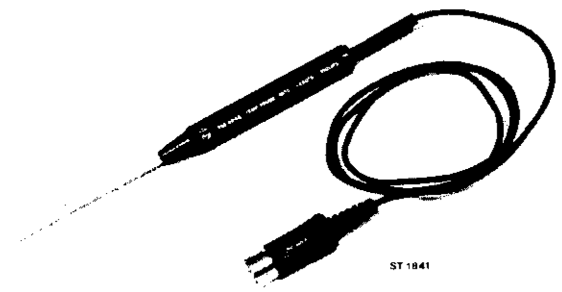


Fig. 2.

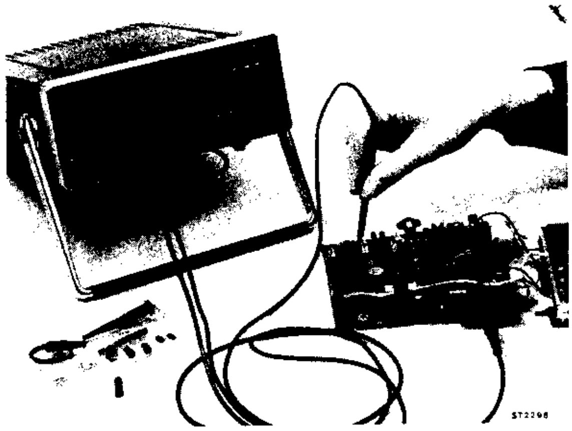


Fig. 3.

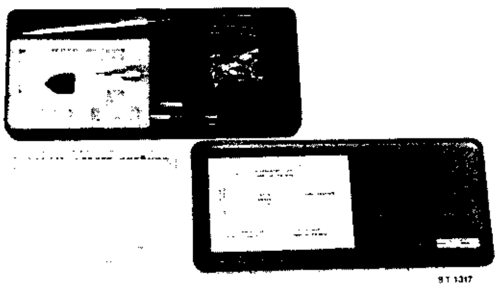


Fig. 4.

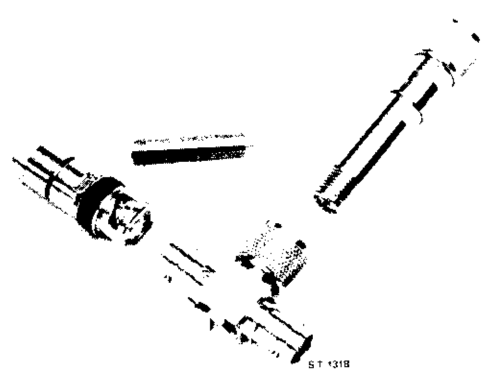


Fig. 5.

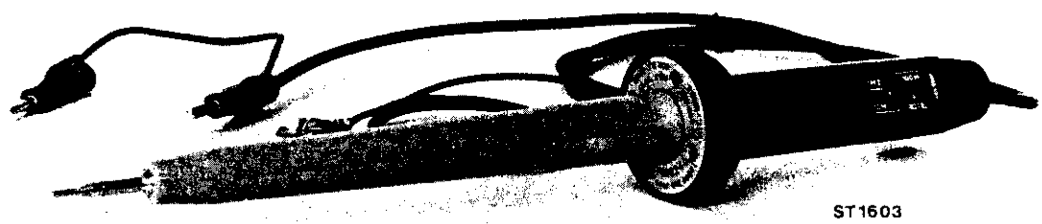


Fig. 7.

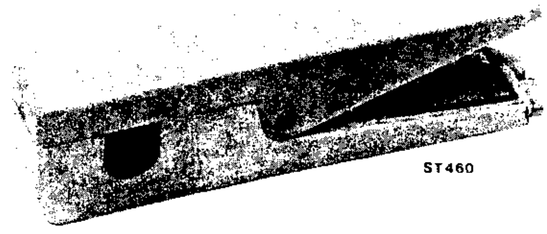


Fig. 8.

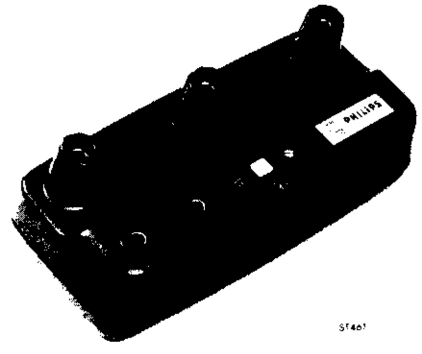


Fig. 9.

3. CIRCUIT DESCRIPTION

3.1. GENERAL

The circuit of the PM 2517 can be subdivided into three main sections:

- Analog section
- Analog to digital convertor
- Digital section

Each section is described separately with reference to the overall circuit diagram. Basic circuit diagrams of the various stages are inserted in the text wherever necessary as an aid for better understanding of the overall circuit diagram.

The circuitry of the PM 2517 consists of special made integrated circuits (LSI), discrete components and integrated circuits used for display control.

The discrete components are used:

- To convert the input signals supplied to the input terminals into suitable signals (attenuation) for the LSI circuits.
- As signal conditioning between the LSI circuits.

As LED display control IC's are used:

- HEF 4511, BCD to 7 segm^nt latch/decoder/driver
- HEF 4555, Dual 1 of 4 decoder demultiplexer.

The LSI circuits used in the PM 2517 are:

- OQ 0055, character decoder driver for LED or LC display
- OQ 0059, digital control for ADC and autoranging circuit
- OQ 0060, switching part for ADC with Delta Modulation principle (used in combination with OQ 0064)
- OQ 0061, a.c. to d.c. convertor (calculated RMS)
- OQ 0063, programmable current source for resistance measurements
- OQ 0064, voltage to current convertor for ADC with Delta Modulation principle (used in combination with OQ 0060).

From the integrated circuits the data sheets are given at the end of this chapter.

3.2. PRINCIPLE OF OPERATION (Fig. 10)

3.2.1. General

The PM 2517 consists of:

Analog section	ADC	Digital section
– Input circuits	– Switching part (OQ 0060)	– Display
– Dc attenuator	– V - I convertor (OQ 0064)	– ADC control (OQ 0059)
– Ac attenuator		– Display driver(OQ 0055)
– Ac/dc convertor (OQ 0061)		– Display control
– Shunt		
– Current source (OQ 0063)		
– Temperature bridge		

3.2.2. Analog section

3.2.2.1. Direct voltage measurements

The unknown d.c. voltage is supplied to the d.c. attenuator. Dependent on the range selected the input voltage is attenuated x10 or x1000, From the attenuator the attenuated voltage is directly supplied to the ADC which has a sensitivity of 0.1 V or 1 V.

3.2.2.2. Alternating voltage measurements

The unknown input voltage is supplied to the a.c. attenuator. Dependent on the range selected the input voltage is attenuated x10 or x1000. The attenuated signal is supplied to the RMS convertor which has a sensitivity of 0.1 or 1 dependent to the range selected. The output voltage of the RMS convertor (1 V at end of range) is supplied to the ADC.

3.2.2.3. Direct and alternating current measurement

The unknown current is supplied to the shunts. Dependent on the range selected (99.00 mA via VΩ mA socket or 9.999 A via the 10 A socket) the corresponding shunt is selected. The voltage over the shunt is in case of A⎓ measurments supplied directly to the ADC and in case A~ measurements first supplied to the ac/dc convertor and then to the ADC.

3.2.2.4. Resistance measurements

At resistance measurements a constant current flows through the unknown resistance which is connected to the input terminals of the PM 2517. The constant current is dependent on the range selected.
The voltage over R x is supplied to the ADC via the dc attenuator.

3.2.2.5. Temperature measurements

At temperature measurements the voltage drop over the resistance thermometer caused by a constant current is measured. The resistance thermometer is switched in a resistance bridge and is compensated for the resistance value at 0 ^{o}C. The voltage from the bridge is measured by the ADC.

3.2.3. Analog to digital convertor

The conversion of the analog signal into a digital signal is made according the Delta Modulation principle. The ADC system is built into two LSI circuits. The analog signal is converted into a data signal. The duty cycle of the data signal is proportional to the height of the analog input signal of the ADC system. The ADC system is also equipped with an automatic zero point correction. The ADC system has an input sensitivity of 0.1 V and 1 V dependent to the range selected.

3.2.4. Digital section

The digital section consists of 2 LSI circuits (OQ 0055 and OQ 0059), 2 integrated circuits, display and discrete components for interconnecting the integrated circuits. In the LSI circuits the complete control logic is built in (ADC control, autoranging control, data control).

Result

The data signal from the ADC, the duty cycle of which equals the input voltage of the ADC, is supplied to a counter in the OQ 0059. The result of the counter is supplied to the display

Range switching

Manual: By means of switches (UP, DOWN) up or down, commands are supplied to a range counter.
The output of the range counter switches the relevant ranges in the attenuators and the ADC.
Automatic: In the autoranging mode the output of the result counter determines the down ranging command (counter contents < 00900) and the up ranging command (counter contents > 10.000).

Overrange

When the counter contents is > 10.000 in case of manual ranging or in the highest range during autoranging then overrange is detected.

Polarity

Dependent to the polarity of the data signal from the ADC the polarity is detected.

Display

The output code from the result counter, the output code of the range counter and the polarity output of the control logic determine the indication of the display. The function indication is determined by the function code from the function switch and the range code from the range counter of the OQ 0059.
Both codes are supplied to the decoder/driver OQ 0055. The OQ 0055 determines that the correct function indication is lighted.

3.2.5. Power supply

The PM 2517 can be powered by 4 x 1.5 V batteries or external by means of the 9 V power supply PM 9218.
In case of power ON the display is continuously lighted.
In case of power STAND BY, which is only used in the PM 2517 E, the display is switched on for 40 sec. when the DISPLAY switch is pressed. When the display is switched off the PM 2517 E is still measuring so the data is immediately available when the display is lighted again.

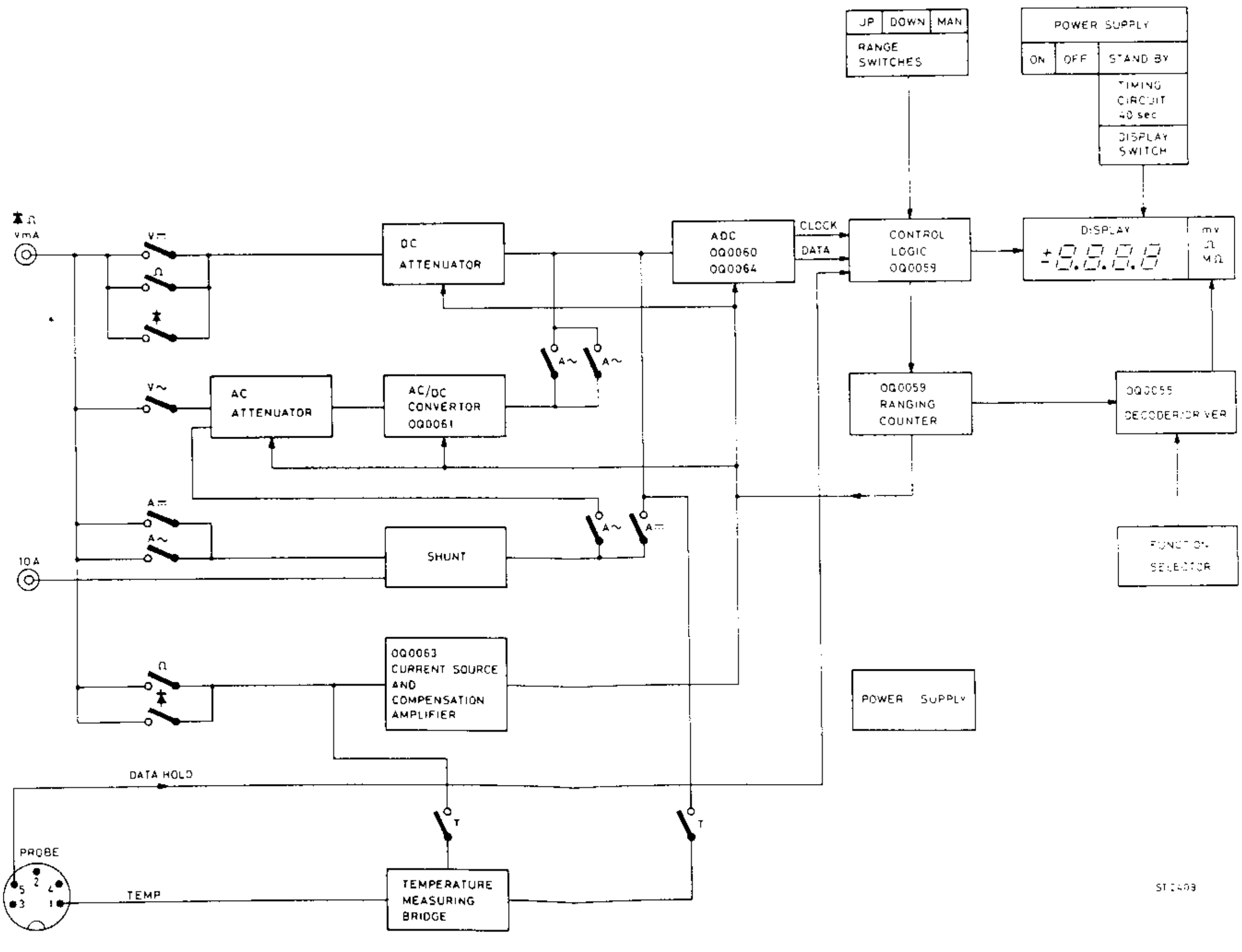


Fig. 10.

3.3. DETAILED CIRCUIT DESCRIPTION

3.3.1. General (Fig. 11)

The PM2517 is built up of the analog, ADC and digital section. All input signals are converted into a d.c. voltage signal. The d.c. voltage signal is supplied to the ADC and converted into a digital signal. In the digital section the digital signal from the ADC is used to control the analog section and ADC and to supply the counting results to the display (Fig. 11).

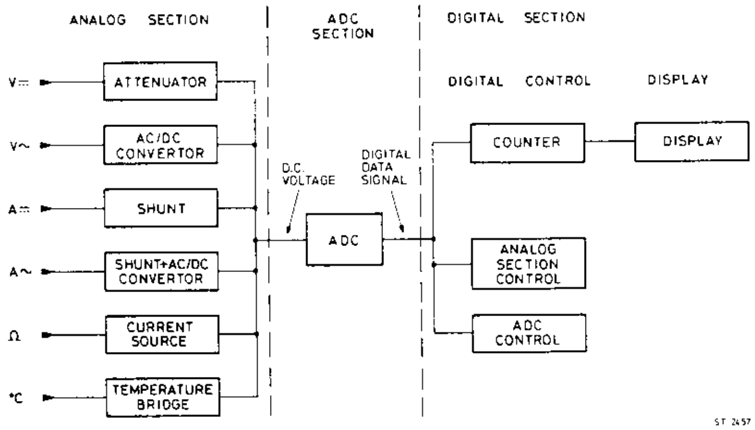


Fig. 11.

In the detailed circuit description the sections will be described separately in the order as shown in figure 11.

3.3.2. Analog section

3.3.2.1. Dc voltage measurements (Fig. 12)

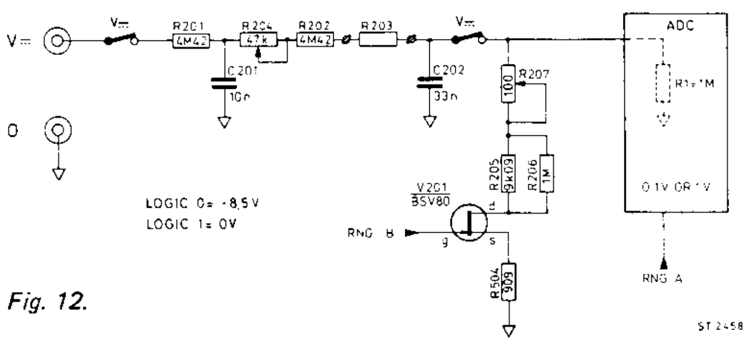


Fig. 12.

Range	Attenuation	RANGE RNGB	RNGA	Input ADC	Ri PM 2517 E	FET switch V 201
1 V⎓	10	0	0	0.1 V	10 MΩ	-•/o-
10 V⎓	10	0	1	1 V	10 MΩ	-•/o-
100 V⎓	1000	1	0	0.1 V	9 M 01	-•-o-
1000 V⎓	1000	1	1	1 V	9 M 01	-•-o-

The input circuit for d.c. voltage measurements is shown in figure 12.
In the above mentioned table, the attenuation, the input sensitivity of the ADC and the range control are given. The 10x attenuation is achieved with the voltage division of R 201 / R 204 and Ri of the ADC.
Adjusting the 10 x attenuator is made with resistor R 203 (coarse) and potentiometer R 204 (fine).
The 1000x attenuation, which is switched on by the signal RNGB, is achieved by the voltage division of R 201 / R 204 with R 205 / R 208 // Ri of the ADC.
Adjusting the 1000x attenuator is made with the cut away resistors R 206 and R 208 (coarse) and potentiometer R 207 (fine).

The a.c. signals are filtered out by the combinations R201, C201 and R202, C202.

3.3.2.2. A.c. voltage measurements (Fig. 13)

Range	Attenuation	RANGE RNGB	RNGA	Input ac/dc convertor	Ri PM 2517 E	FET switch V 301	V 302	Input ADC
1 V~	10	0	0	0.1 V	2 MΩ	-•/o-	-•/o-	1 V
10 V~	10	0	1	1 V	2 MΩ	-•/o-	-•/o-	1 V
100 V~	1000	1	0	0.1 V	1 M 802	-•-o-	-•-o-	1 V
1000 V~ *	1000	1	1	1 V	1 M 801	-•-o-	-•-o-	1 V

* max. input 600 V rms.

- The input circuit for a.c. voltage measurements is shown in figure 13. In the above mentioned table the attenuation, the range control and the input sensitivity of the ac/dc convertor and ADC are given.
- The 10x attenuation is made by the voltage division with components R 301; R 302 // C 305; C 306 and R 306 //Cp (parasitic capacitances). A d.c. voltage component is blocked by capacitor C 301.
- The 1000x attenuation as made the voltage divider R 301; R 302 // C 305; C 306 and R 305; R 315 // R 306 // C 307 and Cp (parasitic capacitances). The 1000x attenuation is switched on by FET V 301. The FET switch V 301 can be considered as an ideal switch in series with its own on resistance (Ron). The Ron of FET's switch V 301 gives an incorrect measuring result. This is compensated in the following way. The attenuated input voltage is supplied to input Vin 1 and Vin 2 (Vin 1 - Vin 2). In this way the FET switch V 301 has no influence on the 1000x attenuation.
- AC/DC convertor.
  In the ac/dc convertor the difference in voltage (Vin 1 - Vin 2) is converted into a current. The current is determined by $\frac{Vin\ 1 - Vin\ 2}{R}$, (R = R 307 or R 308 + R 316), and the state of signal RNGA (see table).

  By this the input sensitivity of the ac/dc convertor (0.1 V or 1 V) is selected. The current in the ac/dc convertor is rectified in the current rectifier and converted into a current again by the RMS section. The current from the RMS section is proportional to the RMS value of the input signal (V in 1 - V in 2). Capacitor C 302 is an integration capacitor for the RMS section. Capacitors C 303 and C 304 are used for the internal automatic zero (AZ) of the ac/dc convertor.
- Output AC/DC convertor.
  The output current from the ac/dc convertor is converted into a voltage by the resistor R 310 // R 311 + R 312. The voltage is filtered by R 313 and C 310 and then supplied to the ADC. Adjusting the output voltage is made by adjusting resistor R 311 (coarse) and potentiometer R 312 (fine).

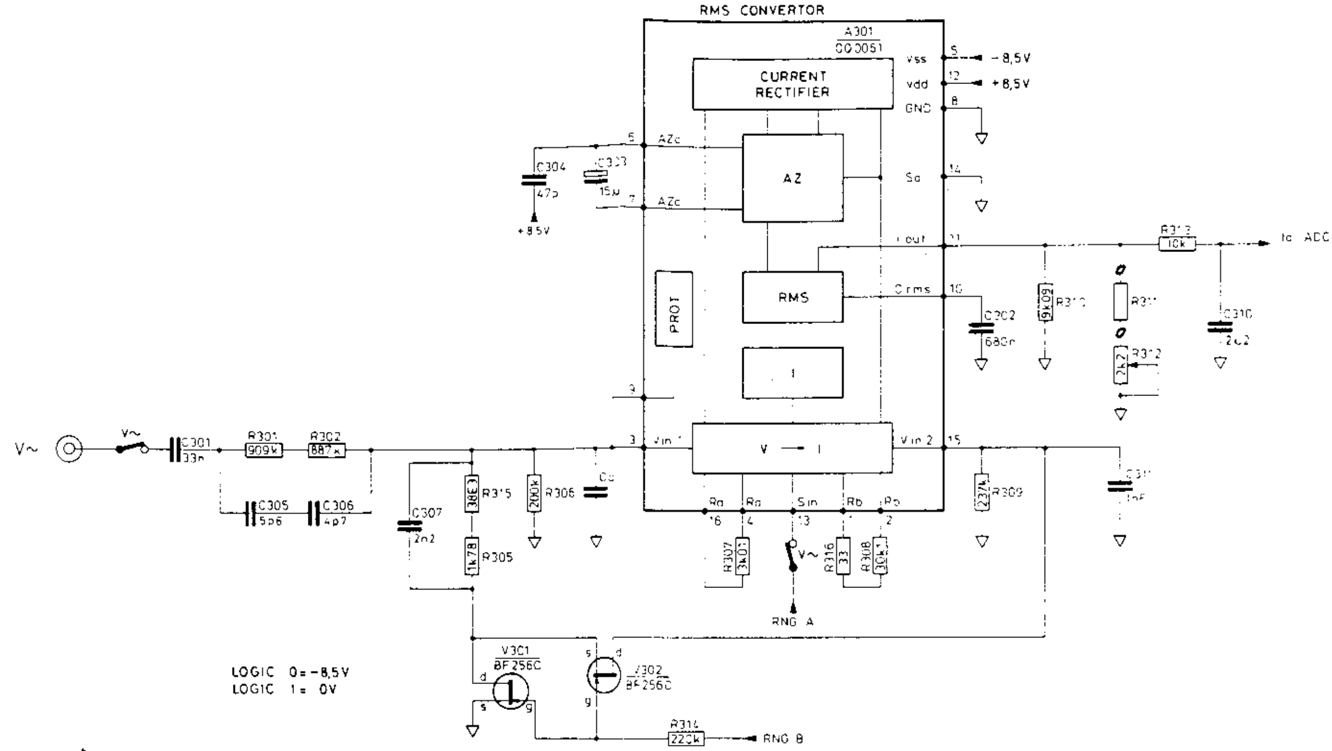

RMS CONVERTOR
A301
CURRENT RECTIFIER
AZ
RMS
PROT
V → I
-8,5V
+8,5V
to ADC
RNG A
RNG B
LOGIC 0= -8,5V
LOGIC 1= 0V
V301 BF256C
BF256C

Fig. 13.

3.3.2.3. D.c. current Measurements (Fig. 14)

- The input circuit for d.c. current measurements is shown in figure 14.
- Range 100 mA⎓.
  In the function mA⎓ only 100mA range is available. The 100 mA range is determined by shunts R 603 and R 1. Resistor R 605 is used for adjusting the 100 mA range.
- Protection
  The 100 mA range is protected by fuse F1 (315 mA quick).
  When in case of measuring in the voltage function, is switched over to the (m)A function with the voltage still on the input terminals, then due to low resistance values of the shunts a high current is switched. The high current can damage the function switch. To prevent this the (m)A range is also protected by means of a switch position (m) A'⎓. which is situated between the positions of the functions °C and (m)A⎓ in the function switch. In this case the input is first connected with NTC resistor R 601. When the input voltage at the input is too high then fuse F1 will blow.
- Range 10 A⎓
  The 10 A range is determined by shunt R1 (12 m Ω).The 10 A shunt is adjusted by resistor R608.
- In the digital section of the PM 2517 switching from the 100 mA to the 10 A range is effected in the following way:
  When a banana plug is inserted in the 10 A socket the display is switched from 100 mA to 10 A. This is done by means of the 10 A switch which is built in the 10 A socket.

Range	Input FD OQ 0055
100 mA	0
·10 A	1

- General
  Resistor R 610 is used to get an equal load in the (m)A~ and (m)A⎓ function.
  The ADC has an input sensitivity of 0.1 V in case of dc current measurements.

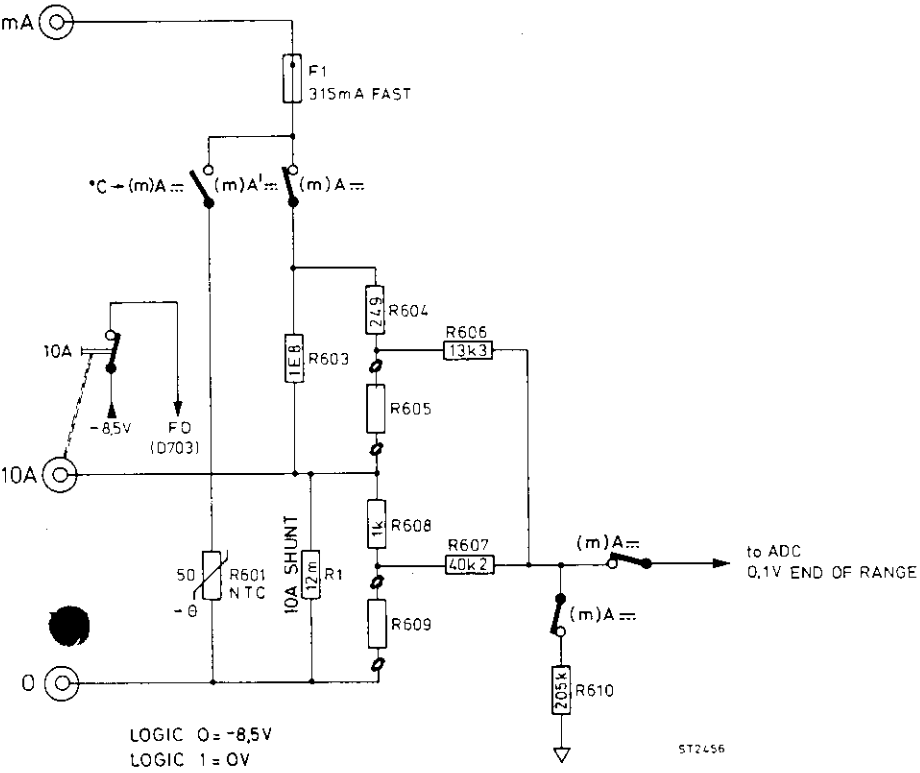
3.3.2.4. A.c. current measurements (Fig. 15)

- The input circuit for a.c. current measurements is shown in figure 15.
- The a.c. input current range 100 mA is shunted and adjusted in the same way as d.c. currents (refer to 3.3.2.3.). The voltage from the shunts (0.1V end of range) is supplied to the Vin 1 input of the a.c./d.c. convertor OQ0061 via switch mA~ and C601. Input Vin 2 of the OQ0061 is disconnected from the input circuits, by means of connecting –8.5 V supply to the gates of V 301 and V 302. Signal RNGB has no influence (also refer to a.c. voltage measurements 3.3.2.2.).

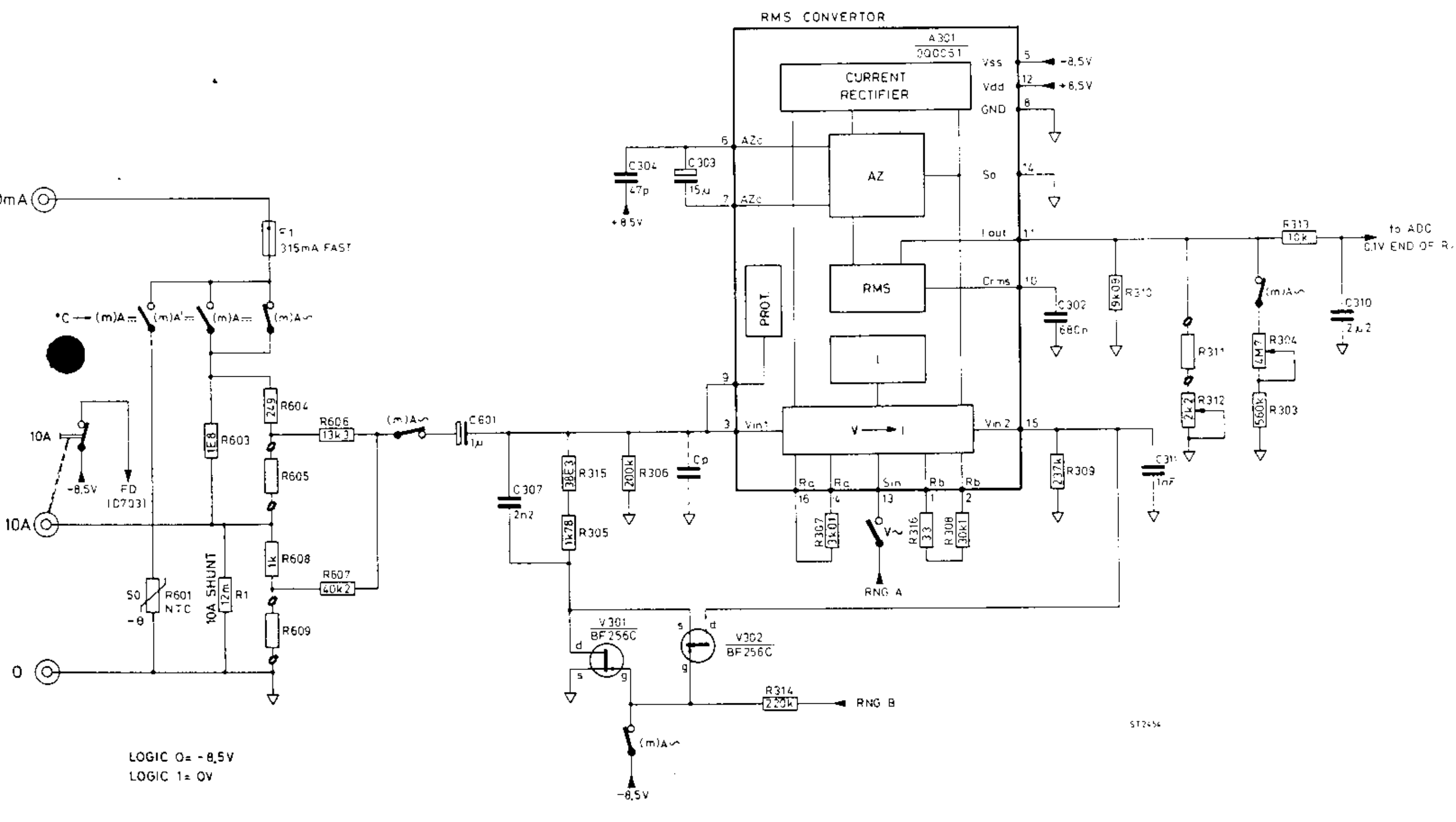
RANGE		Input	Input
RNGB	RNGA	AC/DC convertor	ADC
X	X	0.1 V	1 V

The AC/DC convertor has an input sensitivity of 0,1V in the a.c. current ranges.

- Protection
  The a.c. current ranges are protected in the same way as the d.c. current ranges.
- Adjusting
  The a.c. current ranges are adjusted by means of influencing the sensitivity of the ac/dc convertor with potentiometer R304.


mA
F1
315mA FAST
°C → (m)A ⎓
(m)A' ⎓
(m)A ⎓
10A
-8,5V
FD
(D703)
249
R604
R606
13k3
1E8
R603
R605
10A
1k
R608
R607
40k2
(m)A ⎓
to ADC
0,1V END OF RANGE
50
R601
NTC
-θ
10A SHUNT
12m
R1
R609
(m)A ⎓
0
205k
R610
LOGIC 0 = -8,5V
LOGIC 1 = 0V
ST2456

. 14.


RMS CONVERTOR
A301
OQ0051
CURRENT
RECTIFIER
Vss
Vdd
GND
-8,5V
+8,5V
AZc
AZ
So
C304
47p
C303
15µ
+8,5V
I out
R313
10k
to ADC
0,1V END OF R
RMS
Crms
C302
680n
R310
R311
R312
R304
R303
C310
2µ2
PROT.
I
Vin1
V → I
Vin2
Rc
Rc
Sin
Rb
Rb
R309
R306
Cp
R315
R305
C307
2n2
C601
1µ
R367
3k01
V~
R316
33
R308
30k1
RNG A
mA
F1
315mA FAST
°C → (m)A ⎓
(m)A' ⎓
(m)A ⎓
(m)A~
10A
-8,5V
FD
(D703)
249
R604
R606
13k3
1E8
R603
R605
10A
1k
R608
R607
40k2
50
R601
NTC
-θ
10A SHUNT
12m
R1
R609
0
V301
BF256C
V302
BF256C
R314
220k
RNG B
(m)A~
-8,5V
LOGIC 0 = -8,5V
LOGIC 1 = 0V

ı. 15.

3.3.2.5. Resistance measurements (Fig.'s 16, 17 and 18)

– The resistance measuring circuit is drawn in figure 16.

– A known constant current which is supplied by the programmable current source OQ 0063 flows through the unknown resistor RX.

Dependent to the range (manual or automatic selection) the currents are selected by the signals RNGA, RNGB and RNGC (see table).

Irx	RNGC	RNGB	RNGA	RANGE	Vx
1 mA	1	x	x	1 K	–1 V
100 μA	0	0	0	10 K	–1 V
10 μA	0	0	1	100 K	–1 V
1 μA	0	1	0	1 M	–1 V
100 nA	0	1	1	10 M	–1 V

The measuring currents in the OQ 0063 are derived from a reference current source which is adjusted with resistor R 411 and potentiometer R 403. The output current of the reference current source is supplied to the current multipliers ($\frac{1}{n}$) which gives the currents as shown in the above mentioned table, dependent to the signals RNG.
The voltage over Rx (Vx) is measured by ADC (–1V at end of range).

– To avoid incorrect reading, the input current of the ADC has to be compensated. This is done in the following way:

The voltage over (Rx Vx) is amplified 2x by the compensation amplifier in the OQ 0063 (+Vin). The amplification is determined by the resistors R 406/R 408.

The output voltage 2 Vx is supplied to one side of resistor R 409. On the other side of R 409 voltage Vx is available (from the input terminals) which means that over R 409 a voltage of 2 Vx – Vx = Vx is available. By selecting the same value for R 409 as the input resistance of the ADC (10 MΩ), the input current of the ADC is compensated.

Irx'= Irx + I adc – I comp. As I adc = I comp
Irx'= Irx (see figure 17).

– Protection
By means of the PTC resistor R 401 and the bridge rectifiers V 450 and V 451 (BY 164) the current source is protected.
The diodes start conducting at ≈ 2.4 V voltage difference between inputs VΩ mA ⯒ and 0. In case of a high voltage (current) on the input terminals PTC R 401 becomes high ohmic.
To prevent that a part of Irx (refer to figure 18) is leaking through the protection diodes, the ∿ side of the diodes of V 450 is connected to Vx. The –side of V 450 is connected via R 412 to the – Vin input of the compensation amplifier. The common point of V 450 and V 451 is connected to the output of the compensation amplifier via R414. In this way the leaking current through the diodes is compensated (refer to fig. 18) in the same way as the compensation of the I adc.

3.3.2.6. Diode measurements (semi conductors)

In the diode measuring range the OQ 0063 is set in position 1 mA. Diode measurements are performed in the same way as resistance measurements in the 1 kΩ range (refer to 3.3.2.5.).
The voltage drop over the diode is measured by the ADC.

Forward	Reversed	
Ge 100.0 . . . 300.0 Si 500.0 . . . 800.0	Ge > 0 Si > 0	Overrange

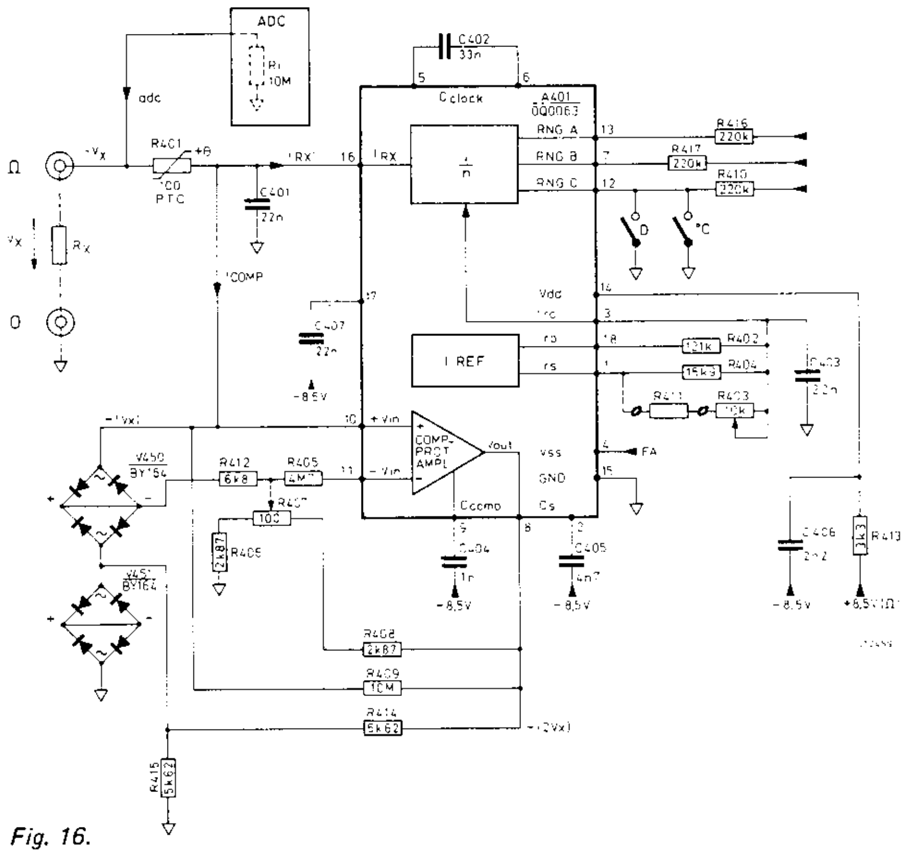


Fig. 16.

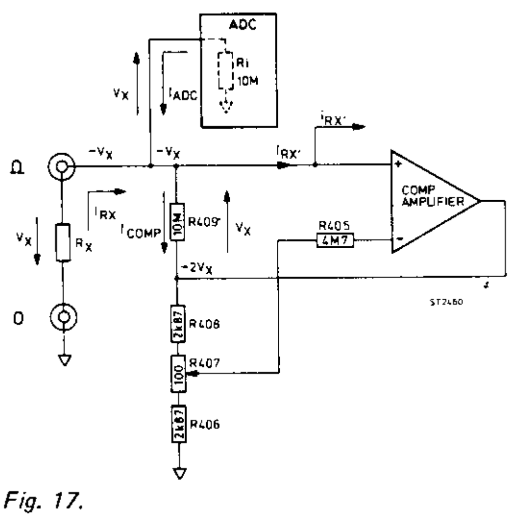


Fig. 17.

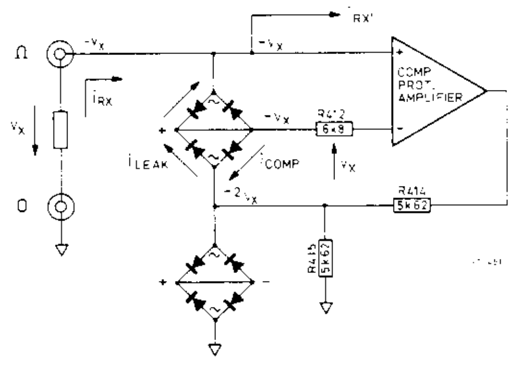


Fig. 18.

3.3.2.7. Temperature measurements

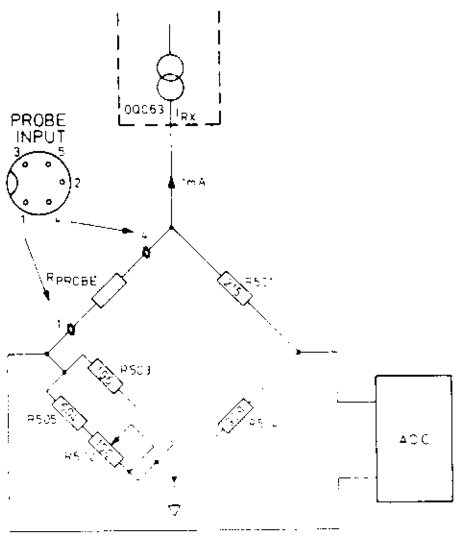


Fig. 19.

- The temperature measuring circuit is drawn in figure 19,
- The temperature probe (resistance thermometer) is mounted in a bridge circuit, which is balanced with potentiometer R 502. At 0 °C the bridge circuit is in balance (at 0 °C the probe resistance is ≈ 35 Ω).
  The voltage between R probe / R 503 and R 501 / R 504 is measured by the ADC and is proportional to the resistance of the probe. The bridge circuit is supplied with 1 mA from the programmable current source OQ 0063.

3.3.3. ADC

3.3.3.1. General (Fig. 20)

The ADC in the PM 2517 consists of a voltage to current convertor (OQ 0064) and the ADC itself (capacitor C 103 and switching part OQ 0060) according the Delta Modulation principle.
The basic of the Delta Modulation ADC is counting the difference in time, used between charging and discharging a capacitor around a fixed level during a fixed time.
The number of pulses counted during the fixed time is proportional to the unknown voltage Vx.
Each value of Vx has a certain number of charge/discharge cycles of which also the shape differs within the fixed time.

Charging/Discharging

Charging the capacitor is made with a constant reference current added with the constant current caused with Vx (I ref + ΔI).
Discharging the capacitor is made by the constant reference current substracted with the constant current caused by Vx (I ref − ΔI).
The constant reference current I ref is produced by the OQ 0064 is determined by an external resistor R range.

Fixed level

The switching level between charging and discharging is determined by the voltage between the inputs of the comparator (≈ 0 V), the flip flop and the clocksignal in the OQ 0060.
When the level is reached the comparator will switch, causing the flip flop to change its state on receipt of a clock pulse. The output of the flip flop controls the switches by which the charging current I ref + Δ I and the discharging current I ref − Δ I are connected to the capacitor.

Fixed time

The fixed time is determined by 12288 clockpulses of the clockoscillator counted by the timer in the OQ 0059 (refer 3.3.4.2. CONTROL LOGIC). One complete measurement consists of two fixed times (measuring periods).

Output

The output signal of the ADC (DATA) is a square wave which is determined by the charging/discharging times of the capacitor. Charging the capacitor will give a logic 1 and discharging will give a logic 0 of the DATA signal. In this way the analog signal is converted into a block signal which is dependent to the charging and discharging times of the capacitor.
Logic 1 of the DATA signal means up and logic 0 means down counting of clockpulses. As the charging and discharging times differ, a counting result is left in the counter after on cycle. Within one measurement (two measuring periods) a number of cycles are made. The total result of the counter after one measurement is proportional to the unknown input voltage Vx.

Note: For every value of Vx a certain number of charging/discharging cycles of which also the times are different are made within a measurement.
When measuring the DATA signal due to the varying pattern only can be seen if a data signal is present and how the counter is counting (up or down).

Example of a data signal

Note: The data signal shown in this diagram is not valid for the PM 2517, it only gives an impression of a data signal in general.
For better understanding for a measuring period of 407 clockpulses is choosen. A measuring period in the PM 2517 has 12288 clockpulses.

A

up	down	result	
101	1	100	
101	1	99	
101	1	100	1st measuring period
102	1	101	
100 ·	1	99	
102	1	102	
101	1	100	2nd measuring period
101	1	100	
	RESULT	800 : 2 = 400	

B

up		down	result
1		1	0
1	etc	1	0
1		1	0
1		1	0
	etc		
		RESULT	0

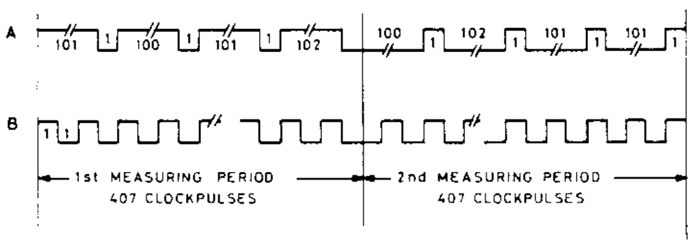


Fig. 21.

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- In the 2nd measuring period input voltage Vx of the OQ 0064 is inverted for auto zero (Refer to 3.3.3.2. OQ 0064).
- In the 2nd measuring period the up and down pulses are inverted in the OQ 0059.
- The number of clockpulses is divided by two by the up/down counter in the OQ 0059.

The displayed value can be calculated in the following way:

$$\text{Display} = \frac{\text{Vin}}{\text{I ref} \cdot \text{R range}} \cdot \frac{N}{2}$$

V in	=	Input voltage of the ADC
I ref	=	Constant reference current. Two ranges available
R range	=	Range resistor
N	=	Number of clockpulses of one measurement (2x 12288)

3.3.3.2. Voltage to current convertor OQ 0064 (Fig. 20)

General

The OQ 0064 converts the unknown input voltage into a constant current which is dependent to the height of the input voltage. By means of the selection circuit in the OQ 0064 between two input sensitivities can be selected: viz. 1 V and 0.1 V. (Refer to specification of OQ 0064) giving two different constant currents.
The voltage which is converted into a constant current, is the difference in voltage which is supplied to the two inputs of the OQ 0064. Internal offset in the OQ 0064 can influence the measuring result.
To avoid this auto zero is carried out with the aid of signals AZ and $\overline{AZ}$ from the control logic.
When a measurement is started (1st measuring period) the unknown voltage is supplied to the + input of the OQ 0064 while the – input is connected to zero. The signal which is converted will be + Vin + Voff (I + ΔI). The signal in the 2nd measuring period the input voltage is connected to the – input while the + input is connected to zero. The signal which is converted will be Vin + Voff (I – Δ). Both signals are subtrated in the ADC and the result of one measurement will be:

+ Vin + Voff	(I ref + ΔI)
– Vin + Voff	(I ref – ΔI)

The result counter in the control logic divided the number of counted pulses by two. The displayed result will be Vin without the internal offset of the OQ 0064.

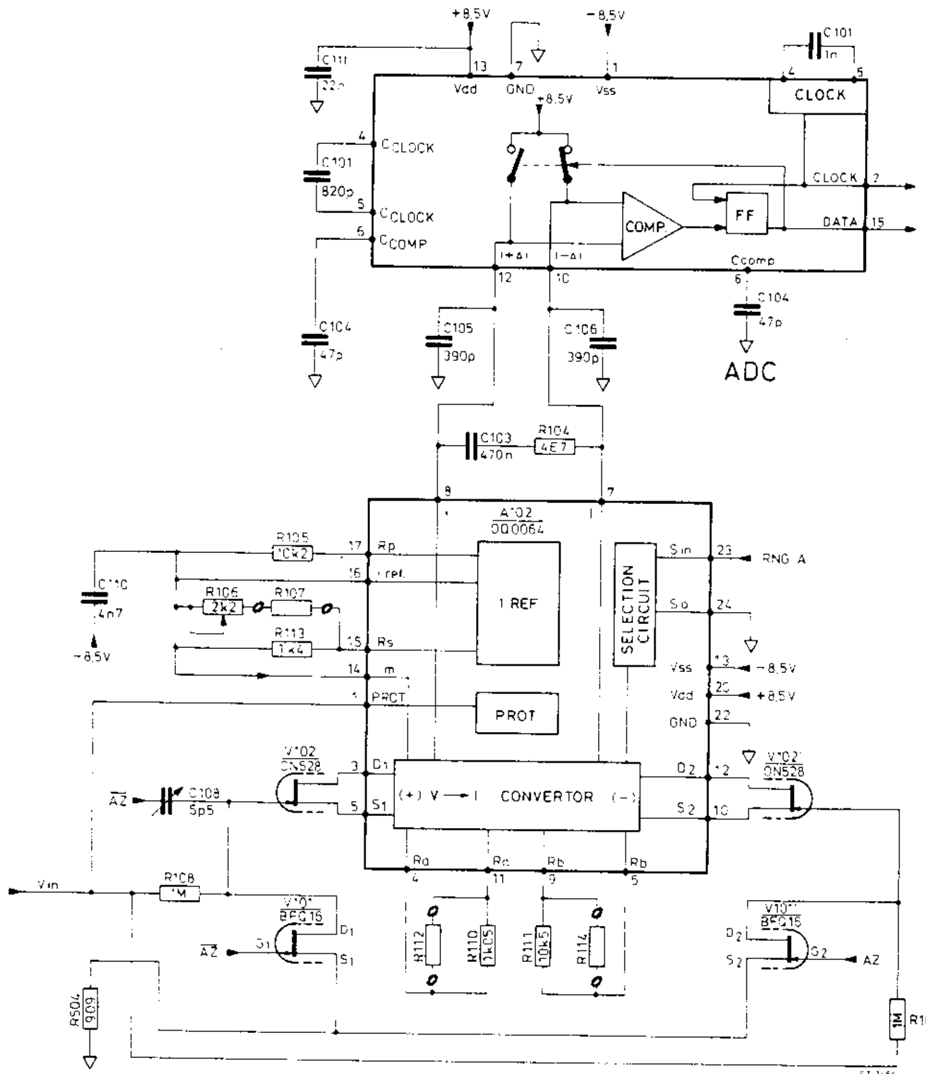
Circuit description

The unknown voltages from the RMS convertor or the attenuators are supplied to the gates of FET V102. In the OQ 0064 the voltage dependent to the selected range is switched to the range resistors Ra (R 112 // R 110) and R 6 (R 111 // R 114). The current ΔI flowing through the resistors is the variation in current which is converted into a digital up/down signal (DATA) by the ADC. The ranges Ra (input sensitivity 0;1 V) and Rb (input sensitivity 1 V) can be adjusted with resistors R 112 and R 114. To obtain a high input resistance a dual FET is used in the input circuit. The internal reference I ref is adjusted by means of R 107 (coarse) and R 106 (fine). With dual FET V 101 and the AZ signals the Input voltage is switched to the + and – input of the OQ 0064. Dependent to the AZ and $\overline{AZ}$ signals the gates of FET V 102 and V 102 are connected to zero (⏚) via R 504 or connected to the input voltage via FET switches V101 and V 101'.

Note: Measuring the I + ΔI and I – ΔI signals disturb the measuring result.

3.3.3.3. ADC switching part OQ 0060 (Fig. 20)

The ADC consist of the ADC itself (OQ 0060) and the integrating capacitance C 103 / R 104.
In the OQ 0060 the comparator, the flip flop, the charge/discharge switches and the clock is situated.
The clock in the ADC controls the timing of the PM 2517. The clock frequency may differ from 80 kHz to 100 kHz.
For further information of the OQ 0060 refer to chapter 3.4.5.



+8,5V
-8,5V
C101
1n
C111
22n
Vdd
GND
Vss
+8,5V
CLOCK
C101
820p
CCLOCK
CCLOCK
CCOMP
CLOCK
COMP
FF
DATA
I+ΔI
I-ΔI
Ccomp
C104
47p
C104
47p
C105
390p
C106
390p
ADC
C103
470n
R104
4E7
A102
OQ0064
R105
10k2
Rp
Iref
C110
4n7
R106
2k2
R107
1 REF
SELECTION CIRCUIT
Sin
RNG A
So
R113
1k4
Rs
-8,5V
m
Vss
-8,5V
PROT
Vdd
+8,5V
GND
PROT
V102
ON528
D1
D2
V102
ON528
AZ
C108
5p5
S1
(+) V → I
CONVERTOR
(-)
S2
Ra
Ra
Rb
Rb
Vin
R108
1M
V101
BFQ15
AZ
R112
R110
1k05
R111
10k5
R114
V101
BFQ15
AZ
R504
909
R109
1M

Fig. 20.

3.3.4. Digital section

3.3.4.1. General

The digital section consists of the digital control IC OQ 0059, the display control IC OQ 0055 and the display.

As control signals for the digital section are used: (Fig. 22.).

CLOCK	: from the ADC, determining the timing
DATA	: from the ADC, determining the displayed value
UP/DOWN/Ω	: determining the ranges in case of manual ranging
D H (data hold)	: from the probe input
AUT	: determining auto ranging
FA, FB, FC, FD	: function information from the function selector

As output signals for the digital section are used: (Fig. 22.).

RNG A, B, C	: range information in the different functions
AZ ($\overline{AZ}$)	: auto zero signal determining the AZ period of the ADC
OVR	: overrange for the display to give overload
DS1, DS2, LAEN	: digits select/latchenable used for serial and parallel display timing
A0, A1, A2, A3	: data information, determined by signals FA, FB, FC, FD and RNG A, B, C.
~, +, −, etc.	: unit indicaction, determined by signals FA, FB, FC, FD and RNG A, B, C, and POL
POL	: Polarity of the OQ 0059

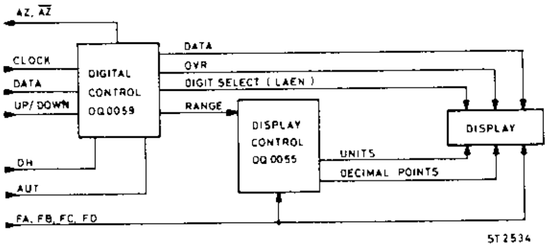


Fig. 22

For detailed information of the signals also refer to the specifications of the IC's concerning (chapter 3.4.).

3.3.4.2. Control logic (Fig. 23)

The control logic, comprising the OQ 0059 is the central processor of the PM 2517. In the flow chart abridged information is given about the timing in the OQ 0059.

When the instrument is switched on the measurements are started. After the waiting times for input settling and timing settling, the counter starts counting the result of the ADC during the first measuring period. The first measuring period is 12288 clock pulses which are counted by the timer.
The carry signal of the timer changes the state of the control logic. At the same time the input voltage of the ADC are switched with the AZ signals (refer to 3.3.3 ADC).
After the waittime which is also used for input settling, the result is counted again in the second measuring period which is also 12288 clock pulses. After the 2nd measuring period the result of the counter is displayed. The maximum contents of the counter is 20.000. If the counter result during one measurement is > 10.000, signal OVR (overrange) will become active. Dependent to the instrument settings (MAN or AUT), overrange or auto ranging will be performed when the measurement is completed.

Explanation of states

WAIT 1 = Fixed waiting, 96 clockpulses.
The time is used for input settling

WAIT 2 = Variable waiting time. The timing of the input signal has to meet a certain condition before a measurement is started. (Max. 10 clock pulses).

1st and 2nd MEASURING PERIOD = 12288 clock pulses determined by the timer

STOP = End of the measurement, reset U/D counter

RANGING COMMAND = Manual or automatic ranging command

RANGING = Selecting the correct measuring range.

3.3.4.3. Control signals (Fig. 54 and 22)

Clock

The clocksignal (80 Hz . . . 120 kHz) determines the timing in the instrument and is counted by a ÷ 12888 timer. The output of the timer is supplied to the control logic. On this signal the control logic will take action viz: switching of the signal AZ, $\overline{AZ}$ by which the input of the ADC is switched (refer to ADC 3.3.3.).

Data

The duty cycle of the data signal is dependent to the height of the input voltage supplied to the PM 2517 (refer to ADC 3.3.3.). The data signal is supplied via the UP/DOWN control to the UP/DOWN counter. The UP/DOWN counter is counting the clock pulses. Data signal logic 1 is count up, logic 0 is count down.
During the 2nd measuring period the DATA signal is inverted inside the OQ 0059 UP/DOWN N/Ω .
In case of manual ranging UP or DOWN pulses from the UP/DOWN circuit are supplied to the OQ 0059. In the ranging counter the pulses are converted into the range code I x depress is one range up or down. In the ranges V . . . and V ∿ the number of ranges is four. By means of signal Ω this is extended to six.

Aut

By means of a logic 1 of signal AUT (auto ranging), which is generated by the UP/DOWN/AUT circuit, the digital section is switched to auto ranging mode. When the result of the UP/DOWN counter is larger than 10.000 in a range (V⎓ , V~ or kΩ) then the control logic switched automatically to a higher range. This is repeated untill the contents of the counter is less than 10.000.
The same happens during down ranging is the automode the down level for the UP/DOWN counter is 900. Down ranging is repeat untill the contents of the counter is larger than 900.

Up/down/aut ranging circuit

For automatic or manual ranging the following conditions have to be met:

Dependent to the function selected, a specified range block is available (V ⎓ V ∿ = 4 ranges, Ω = 6 ranges) UP or DOWN pulses have no effect when the lowest or highest range is met in the specified range block. (Refer to specification of the OQ 0059, chapter 3.4.4.).
The ranging circuit consists of a switching part situated on N1 and an indication part situated on the display unit N2.

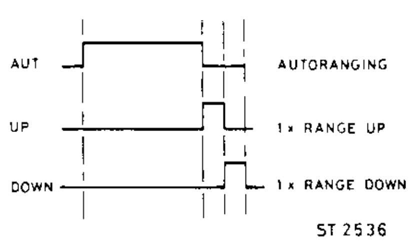


Fig. 24.

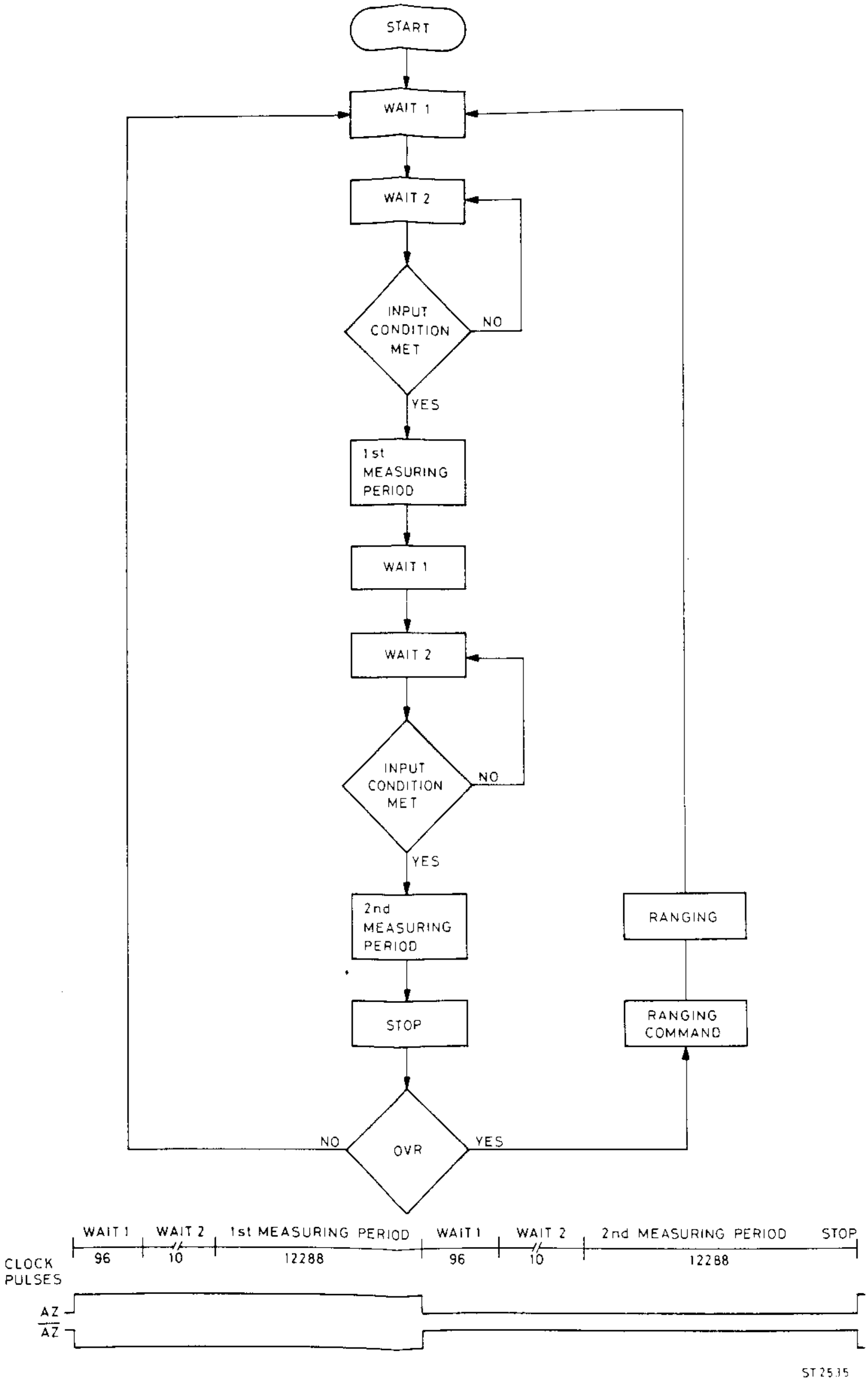

START
WAIT 1
WAIT 2
INPUT CONDITION MET
NO
YES
1st MEASURING PERIOD
WAIT 1
WAIT 2
INPUT CONDITION MET
NO
YES
2nd MEASURING PERIOD
STOP
RANGING
RANGING COMMAND
NO
OVR
YES
WAIT 1
WAIT 2
1st MEASURING PERIOD
WAIT 1
WAIT 2
2nd MEASURING PERIOD
STOP
CLOCK PULSES
96
10
12288
96
10
12288
AZ
$\overline{AZ}$
ST 2535

Fig. 23.

When switched on in a multi-range function, the instrument will be set in the manual ranging state.
This also occurs when is switched from a single-range function (⏚ °C, mA ⎓ or mA∿) to a multi-range function (V∿,V ⎓ , kΩ).
In this case the kg input of thyristor V150 is activated via the function switch and R727.
The thyristor starts conducting and a logic 0 (−8,5V) is supplied to the AUT input of the OQ 0059, which means manual ranging.
To get out of the manual ranging state the AUT switch must be depressed.

In the functions (m) A . . . , (m) A∿ °C and ⏚ no manual or auto ranging is possible. The ranges are determined by the OQ 0055 only, UP, DOWN or AUT pulses are not relevant.

Manual ranging

- When the DOWN or UP switch is depressed a logic 1 signal (⏚) will be connected to the relevant inputs of the OQ 0059. The logic 1 (⏚) pulse is also supplied to the kg input of thyristor V 150. The thyristor will start conducting and the −8.5 V (logic 0) which is supplied via the function switch to R 723 and R 724 will also be connected the AUT input of the OQ 0059 (no auto ranging).
  The thyristor will stay in this state until it is switched via the ag input. The − 8.5 level is also supplied via the thyristor to transistor V705 causing the Δ indication lamp is lighted.
- Changing the above mentioned state can only be done when switch AUT is depressed or when switching from a function with no ranging facilities to a function with ranging facilities.

Auto ranging

- When switch AUT is depressed a logic 1 (⏚) will be connected to the AUT input of the OQ 0059. Also a logic 1 (⏚) is connected to the ag input of the thyristor and the input of transistor V 705.
  The UP/DOWN inputs of the OQ 0059 are connected to logic 0 (−8.5 V) again and the lighting of the MAN indication is stopped. (or Δ indication)
- When the instrument is switched on or when it is switched from ranges (m) A ⎓ , (m) A∿, °C or to ranges V⎓, V~ or kΩ visa versa, the instrument will always start in MAN range mode.

DH

With the data hold signal is possible to hold the data.
This means that the present value of the last completed measuring will be held.
Data hold is generated in two ways viz:
- External by interconnecting point 5 of the probe input to circuit zero (⏚) or O socket
- Internal during range switching in the functions V~ and (m)A~.

Note: *Resistors R 116 and R117 are used as current limitors, so that the output of the one shot in the OQ 0059 is not short circuited in case of external data hold.*

DH logic 1 means end of measuring cycle and no transfer pulse of measured data. The control logic is waiting until DH becomes logic 0. The instrument is measuring but the data is not displayed. At the same time also signals AZ and $\overline{AZ}$ are blocked.
The DH signal is also active in the V~ and (m)A~ function when is switched from one range to another.
Via a one shot DH is active for about 480 msec. (Refer to OQ 0055, chapter 3.4.3)).

FA, FB, FC, FD

The function code is determined by the switches of the function selector.
Dependent to the function selected FA, FB, FC, FD have a certain code. (Refer to the specification of OQ 0055, chapter 3.4.3.).
In case of 10 A signal FD is switched by means of the banana plug activating the switch which is situated inside the 10 A socket.

3.3.4.4. *Output Signals (Fig. 54 and 22)*

RNG A, RNG B, RNG C

Range information from the OQ 0059 is determined by the signals UP/DOWN and Ω which are supplied to the ranging counter.
Dependent to the range selected a specified range block is available. Refer to specification of OQ 0059. Chapter 3.4.4.

AZ, $\overline{AZ}$ (Auto Zero)

The auto zero signals are switching the input voltages to the inputs of the ADC. (Refer to 3.3.3. ADC and 3.3.4.2. Control Logic).
The AZ and $\overline{AZ}$ are determined by the clock and the 12.888 timer.
One AZ period is ≈ 200 msec.

OVR

In case of overrange, which means that the result is > 10.000 counted clockpulses, signal OVR becomes active (logic 1).
When a manual range is selected, signal OVR will cause the display to be switched to overrange (display O).

DS1, DS2, LAEN

DS1, DS2 (digit select) and LAEN (latch enable) are used for timing of the display unit. (Refer Fig. 25.).
Signals DS1 and DS2 are selecting the digits for serial display.
Signal LAEN is used for latching the BCD information for a LX display.
LAEN is not used in the PM 2517 E

A0, A1, A2, A3

Signals A0, A1, A2, A3 are the data information from the OQ 0059.
The signals appear in bit parallel and word serial information.
Together with the control signals DS1, DS2 and LAEN, the data is used for serial display.

POL

The state of the polanty signal (logic 0 = –, 'og 1 = +) is determined by the state of the incoming data signal.
When more up than down pulses are counted in the 1st measuring period this means + polarity.
When more down than up pulses are counted this means – polarity.
The detection is made by the polarity detection circuit inside the OQ 0059.

3.3.5. Display unit N2 (Fig. 25 and 54)

3.3.5.1. General

The display-section consists of four 7-segment LEDs a BCD to 7-segment decoder, a dual 1 of 4 decoder/ demultiplexer for serial display and the polarity/unit indication. The display section is built on one small p.c. board N2. The interconnection between the units in the PM 2517 is made by a 29-pole interconnection strip.
Of the strip not all contacts are used in the PM 2517 E.
In the PM 2517 X all contacts of the strip are used.

3.3.5.2. Data A3, A2, A1, A0

The data bit parallel-word serial is derived from the digital control IC OQ 0059 and is supplied to the BCD to 7-segment decoder.
As a serial display is used the data is switched with the speed of clock signal DS 1 . The data is switched in the following order: 10^2, 10^3, 10^0 and 10^1. (Refer to the timing diagram Fig. 25).
The decoded data from the BCD to 7-segment decoder is supplied to the LED's. Dependent to the decoded signals DS 1 and DS 2 the correct LED's are switched on.

3.3.5.3. Blank display (40 sec. circuit)

Via the blank input of the HEF 4511 (D 701/4), it is possible to blank the data in the display. The decimal point, polarity and unit indication are not blanked. Blanking the display is used in the STAND BY position of the PM 2517E.
When push button DISPLAY is activated, signal BL becomes logic 1 and the display is allowed to light. After about 40 sec. delay is energized in the circuit built-up of V 705/706, R 719/720/721/ on unit N1.

In this circuit the RC time is determined by C 701 and R 721. C 701 is connected to +8.5 V and R 721 is connected to signal DS 1. (DS 1 ≈ 500 Hz and switching between 0 V and − 8.5 V). The resulting voltage on R 721 will be due to the resistor and capacitor about 4 V. The RC time, together with the switching point of the FET V 705 will result in a time of about 40 sec. In case of STAND BY, logic 0 (−8.5 V) will be connected to input $\overline{BL}$ of the display unit via R 720 which means blanked display. When push button DISPLAY is depressed, C 701 is discharged, FET V 705 starts conducting, causing transistor V 706 to conduct, which gives a logic 1 to the BL input which means that the display is not blanked. After 40 sec. FET V 705 switches again and the circuit is in its rest position again.

3.3.5.4. *Serial display (DS1, DS2, DS = Digit Select)*

Signals DS1 and DS2 are supplied to the dual 1 of 4 decoder D 702 (see timing diagram, Fig. 25).
The decoded signals switch the relevant LED's in the order 10^2, 10^3, 10^0 and 10^1.
In case of overrange (indication > 9999 = 0000) signal OVR is true (logic 1) and one part of the dual 1 of 4 decoder HEF 4555 is blocked (No enable). In this case only LED 10^2 is ignited as this one is switched via the other part of the HEF 4555 (enable)

3.3.5.6. *Decimal point (DP3, DP2, DP1)*

The decimal point information is directly derived from the OQ 0055 (D 703/14/15/16) and is supplied to the corresponding decimal points via a 270 Ω resistor (see table and OQ 0055 specification, chapter 3.3.5.3.).

Range	DP1	DP2	DP3
9.999	1	0	0
99.99	0	1	0
999.9	0	0	1

3.3.5.7. *Polarity and unit indication*

Unit indication

The unit indication is made with the combination of LED's and the position of the function selector switch S1. When no LED is lighted the position of the function selector determines the unit indication e.g. function kΩ and no LED indication (Ω or MΩ) means range kΩ (see table below).

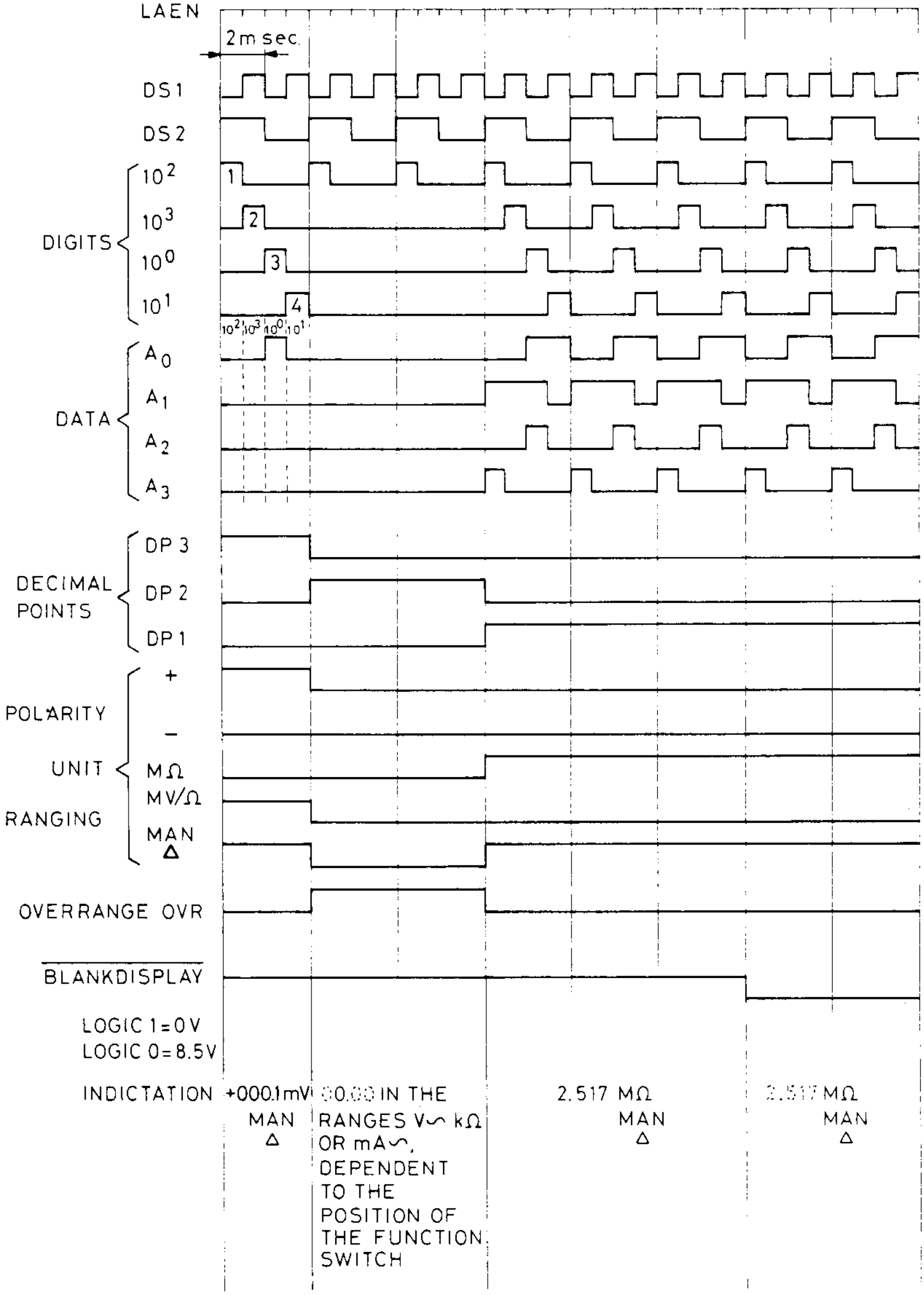
Function	Signal OQ 0055	Switches	LED lighted	Indication
V∿/V ⎓	m	V∿/V . . . (6,5)	mV/Ω	..... mV
	–	V∿/V . . . (6,5)	–	 V
kΩ	M, RNG C	kΩ	MΩ	.....MΩ
	RNG C	kΩ	mV/Ω	..... Ω
	–	kΩ	–	..... kΩ
→|	–	–	–	.....
−60...+200 °C	–	–	–	.....
(m) A ⎓	–	–	–	.....
(m) A∿	–	–	–	.....

Polarity indication (+ or −)

The polarity is indicated by means of LED's.
The information for the LED's is directly derived from the OQ 0055 (D 703/18/19).

3.3.5.8. *OVR (overrange)*

In case of overrange signal OVR becomes logic 1 causing digits 10^3, 10^1 and 10^0 to be blanked.
Only digit 10^2 is lighted.



NOTE: WHEN NO UNITS ARE INDICATED ON THE DISPLAY, THE UNITS SHOWN AT THE FUNCTION SWITCH ARE VALID.

Fig. 25.

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3.3.6. Power supply (Fig. 26 and 54)

The instrument can be powered by 4 x 1.5 V batteries of by a 9 V external power supply (PM 9218).
In the PM 2517 a stabistor BZX 75 C2VI is included in the input line of the external power input. The voltage supplied to the power circuit is in case of 9 V external power supply ≈ 7 V.
When the power is switched on, the power circuit will start oscillating. The oscillating frequency is ≈ 160 kHz. The input voltages are transferred to ≈ +8.5 V and ≈ −8.5 V. The circuit is stabelized with the feed back circuit consisting of zenerdiode V 850 (BZX 79 C10), V 852 (BAW 62), supplied to V 801 (BC 558).
The following voltages are measured in the power circuit of a PM 2517 with a 9 V external power supply PM 9218:

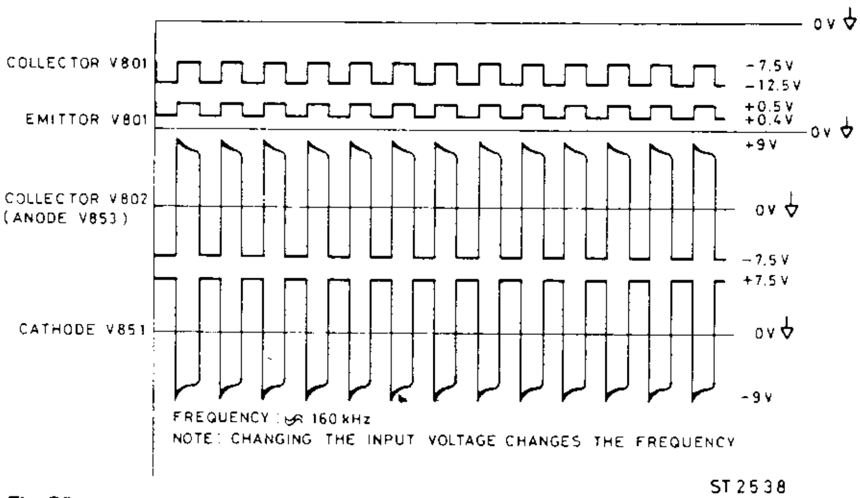


Fig. 26.

Dependent to the function selected the supply voltages are supplied via the function selecter to the integrated circuit.
The current source is only used in the functions Ω , °C and (diode symbol).
The RMS convertor is only used in the functions V~ , (m)A~ .
To avoid overloading the power supply the LED's in the PM 2517 E are directly supplied from the batteries.

3.4. SPECIFICATION OF IC'S USED IN THE PM 2517

3.4.1. HEF 4511 B BCD to 7-segment latch decoder

The HEF 4511 is a BCD to 7-segment latch/decoder/driver with four address inputs (A0-A3), an active LOW latch enable input ($\overline{EL}$), an active LOW ripple blanking input ($\overline{IB}$), an active LOW lamp test input ($\overline{ITL}$), and even active HIGH n-p-n bipolar segment outputs (O_a to O_g).
When $\overline{EL}$ is LOW, the state of the segment outputs (O_a to O_g) is determined by the data on A_0 to A_3.
When $\overline{EL}$ goes HIGH, the last data present on A_0 to A_3 are stored in the latches and the segment outputs remain stable. When $\overline{ITL}$ is LOW, all the segment outputs are HIGH independent of all other input conditions. With $\overline{ITL}$ HIGH, a LOW on $\overline{IB}$ forces all segment outputs LOW. The inputs $\overline{ITL}$ and $\overline{IB}$ do not effect the latch circuit.

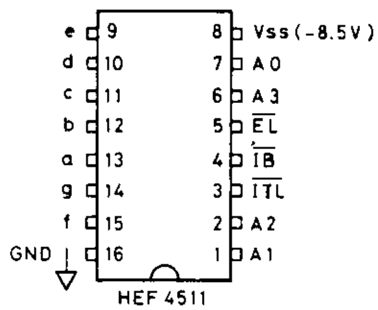


Fig. 27.

PINNING

A_0 to A_3	address (data) inputs)
$\overline{EL}$	latch enable input (active LOW)
$\overline{IB}$	ripple blanking input (active LOW)
$\overline{ITL}$	lamp test input (active LOW)
a to g	segment outputs

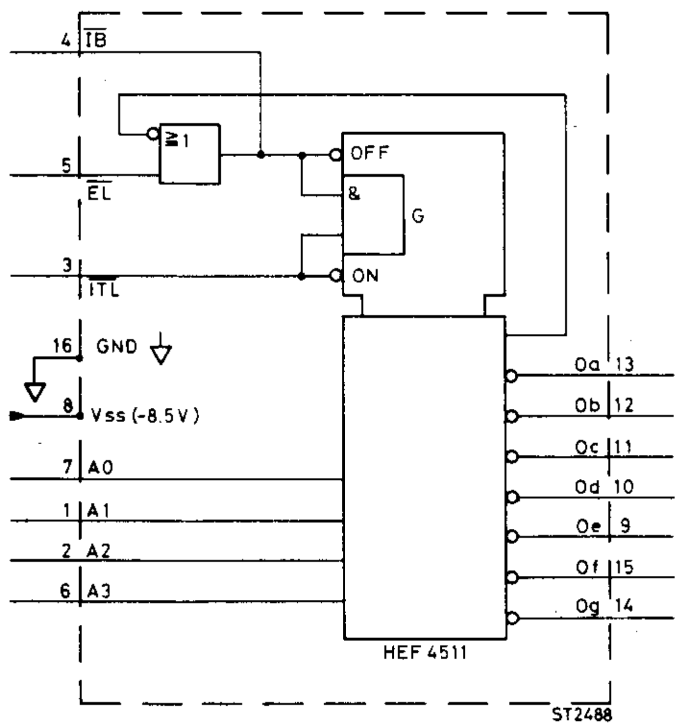


Fig. 28.

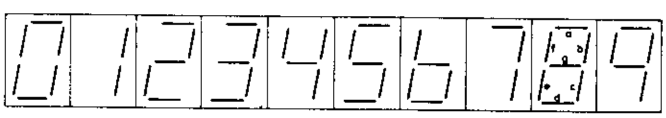
FUNCTION TABLE

inputs							outputs							
$\overline{EL}$	$\overline{IB}$	$\overline{ITL}$	A_3	A_2	A_1	A_0	a	b	c	d	e	f	g	display
X	X	L	X	X	X	X	H	H	H	H	H	H	H	8
X	L	H	X	X	X	X	L	L	L	L	L	L	L	blank
L	H	H	L	L	L	L	H	H	H	H	H	H	L	0
L	H	H	L	L	L	H	L	H	H	L	L	L	L	1
L	H	H	L	L	H	L	H	H	L	H	H	L	H	2
L	H	H	L	L	H	H	H	H	H	H	L	L	H	3
L	H	H	L	H	L	L	L	H	H	L	L	H	H	4
L	H	H	L	H	L	H	H	L	H	H	L	H	H	5
L	H	H	L	H	H	L	L	L	H	H	H	H	H	6
L	H	H	L	H	H	H	H	H	H	L	L	L	L	7
L	H	H	H	L	L	L	H	H	H	H	H	H	H	8
L	H	H	H	L	L	H	H	H	H	L	L	H	H	9
L	H	H	H	L	H	L	L	L	L	L	L	L	L	blank
L	H	H	H	L	H	H	L	L	L	L	L	L	L	blank
L	H	H	H	H	L	L	L	L	L	L	L	L	L	blank
L	H	H	H	H	L	H	L	L	L	L	L	L	L	blank
L	H	H	H	H	H	L	L	L	L	L	L	L	L	blank
L	H	H	H	H	H	H	L	L	L	L	L	L	L	blank
H	H	H	X	X	X	X				*				*

H = HIGH state (the more positive voltage)
L = LOW state (the less positive voltage)
X = state is immaterial
H = Logic 1 = 0 V
L = Logic 0 = −8.5 V

*Depends upon the BCD code applied during the LOW to HIGH transition of $\overline{EL}$.

DISPLAY



ST 2539

Fig. 29.

3.4.2. HEF 4555 B Dual 1-0f-4 decoder/demultiplixer

HEF 4555 a 1 to 4 decoder-demultiplexer is used to decode the digit select outputs DS1 and DS2 from OQ 0059.
In case of overload signal OVL becomes logic 1 and forces the outputs 4, 6 and 7 of the HEF 4555 B to low, which means that the digits 10^0, 10^1 and 10^3 are blanked.

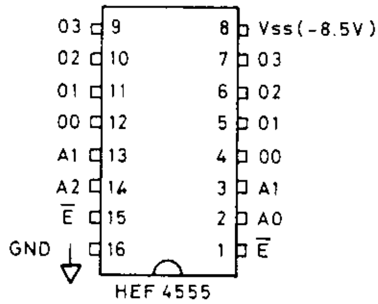


Fig. 30.

The HEF 4555 B is a dual 1 of-4 decoder/demultiplexer. Each has two address inputs (A_0 and A_1), an active LOW enable input ($\overline{E}$), and four mutually exclusive outputs which are active HIGH (O_0 to O_3). When used as a decoder, $\overline{E}$ when-HIGH, forces O_0 to O_3 LOW. When used as a demultiplexer, the appropriate output is selected by the data on A_0 and A_1. All unselected outputs are LOW.

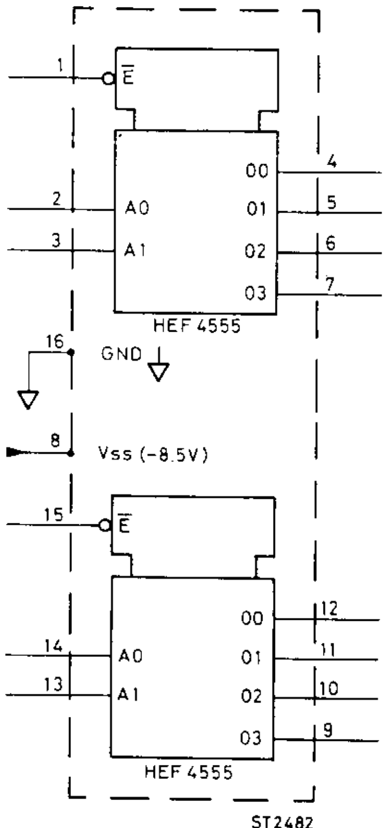


Fig. 31.

PINNING

$\overline{E}$	enable inputs (active LOW)
A_0 and A_1	address inputs
O_0 to O_3	outputs (active HIGH)

OUTPUT

A_0	A_1	O_0	O_1	O_2	O_3
0	0	1	0	0	0
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	1	1

3.4.3. OQ 0055 Character Decoder Driver

3.4.3.1. General

The OQ 0055 is a character decoder driver for Liquid Crystal Display (LX) or a LED display. Dependent on the input information (range, function, polarity) character outputs used for indication of characters +, –, ∿, m, k, M, Ω, DP1, DP2, DP3, VA are activated.

By means of a clock input the output information is made suitable for a Liquid Cristal Display.

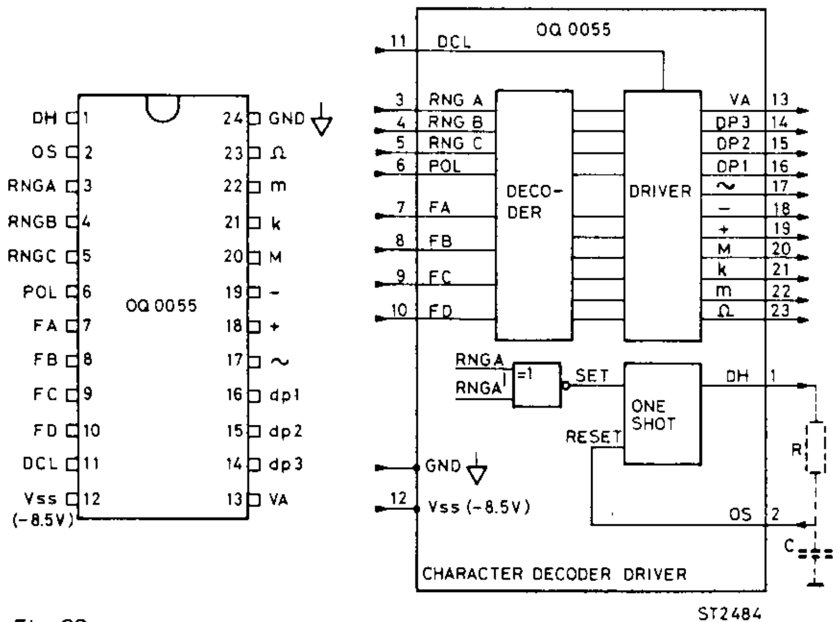


Fig. 32.

3.4.3.2. Specification of in- and outputs of the OQ 0055

Pin nr.	*Name*	*Description*	
1	DH	DATA HOLD ;	On a change of state of signal RNG a ($0 \rightleftarrows 1$) signal DH is set. By connecting the output DH to OS via a RC-network a one shot pulse DH is created, when the range information is changed. DH is used for the OQ 0059 to prevent measuring until the input amplifiers are stabilised in the functions V~ and (m)A~.
2	OS	ONE SHOT ;	OS is used in combination with signal DH to create a one shot pulse on change of range information. RC-time ≈ 480 msec.
3	RNG A	RANGE A ;	Digital range information from the OQ 0059. Together with the function indication. The range information determines the decimal point and the function indication (refer. to truth table on page 46).
4	RNG B	RANGE B	
5	RNG C	RANGE C	
6	POL	POLARITY ;	Signal POL determines the polarity sign. + or – Signal POL is generated in the OQ 0059. Logic 0 = – Polarity, Logic 1 = + Polarity.
7	FA	FUNCTION A	Digital function information from function select Together with the range information the function information determines function indication and the decimal point.
8	FB	FUNCTION B	
9	FC	FUNCTION C	
10	FD	FUNCTION D	
11	DCL	DISPLAY CLOCK ;	This signal makes the display information suitable for a liquid crystal display (Not used in PM 2517E).
12	Vss (–8,5 V)	SUPPLY ;	Negative supply voltage –8,5 V.
13	VA	VOLT/AMPERE ;	The VA signal together with the function selector determines the V or A indication on the display.
14	DP3	DECIMAL POINT 3 ;	Decimal point information for the display. The information is determined by the function- and range information.
15	DP2	DECIMAL POINT 2	
16	DP1	DECIMAL POINT 1	
17	~	A.C. SIGN ;	AC information for the display in the functions V~ and A~. (Not used in PM 2517E.)
18	–	– POLARITY	Polarity information for the display in the functions V ⎓, A ⎓, ^{o}C and The polarity signals are determined by signal POL from the OQ 0059.
19	+	+ POLARITY	
20	M	MEGA	Quantity information for the display. The information is determined by the range information and the function information
21	k	KILO	
22	m	MILI	
23	Ω	OHM	
24	GND	GROUND ⏚	Supply zero 0 V ⏚

3.4.3.3. Truth table of the OQ 0055

Function	Inputs: DCL	Inputs: FA FB FC FD	Inputs: RNGC RNGB RNGA	Inputs: POL	Outputs: m V A Ω M k	Outputs: DP0 DP1 DP2 DP3	Outputs: + − ~	Display reading
Blank	X	0 0 0 X	X X X	X	0 0 0 0 0 0	0 0 0 0	0 0 0	Blanking
V⎓ (pos.)	0	1 0 0 0	0 0 0	1	1 1 0 0 0 0	0 0 0 1	1 0 0	+ 999.9 mV
	0	1 0 0 0	0 0 1	1	0 1 0 0 0 0	0 1 0 0	1 0 0	+ 9.999 V
	0	1 0 0 0	0 1 0	1	0 1 0 0 0 0	0 0 1 0	1 0 0	+ 99.99 V
	0	1 0 0 0	0 1 1	1	0 1 0 0 0 0	0 0 0 1	1 0 0	+ 999.9 V
V⎓ (neg.)	0	1 0 0 0	0 0 0	0	1 1 0 0 0 0	0 0 0 1	0 1 0	−999.9 mV
	0	1 0 0 0	0 0 1	0	0 1 0 0 0 0	0 1 0 0	0 1 0	−9.999 V
	0	1 0 0 0	0 1 0	0	0 1 0 0 0 0	0 0 1 0	0 1 0	−99.99 V
	0	1 0 0 0	0 1 1	0	0 1 0 0 0 0	0 0 0 1	0 1 0	−999.9 V
Ω	0	0 1 0 0	1 1 1	X	0 0 0 1 0 0	0 0 0 1	0 0 0	999.9 Ω
	0	0 1 0 0	0 0 0	X	0 0 0 1 0 1	0 1 0 0	0 0 0	9.999 kΩ
	0	0 1 0 0	0 0 1	X	0 0 0 1 0 1	0 0 1 0	0 0 0	99.99 kΩ
	0	0 1 0 0	0 1 0	X	0 0 0 1 0 1	0 0 0 1	0 0 0	999.9 kΩ
	0	0 1 0 0	0 1 1	X	0 0 0 1 1 0	0 1 0 0	0 0 0	9.999 MΩ
V~	0	1 1 0 0	0 0 0	X	1 1 0 0 0 0	0 0 0 1	0 0 1	~ 999.9 mV
	0	1 1 0 0	0 0 1	X	0 1 0 0 0 0	0 1 0 0	0 0 1	~ 9.999 V
	0	1 1 0 0	0 1 0	X	0 1 0 0 0 0	0 0 1 0	0 0 1	~ 99.99 V
	0	1 1 0 0	0 1 1	X	0 1 0 0 0 0	0 0 0 1	0 0 1	~ 999.9 V
A⎓ (pos.)	0	1 0 1 0	X X X	1	1 0 1 0 0 0	1 0 0 0	1 0 0	+ 9999 mA
	0	1 0 1 0	0 0 1	1	1 0 1 0 0 0	0 0 1 0	1 0 0	+ 99.99 mA
	0	1 0 1 1	0 1 1	1	0 0 1 0 0 0	0 1 0 0	1 0 0	+ 9.999 A
A⎓ (neg.)	0	1 0 1 0	X X X	0	1 0 1 0 0 0	1 0 0 0	0 1 0	− 9999 mA
	0	1 0 1 0	0 0 1	0	1 0 1 0 0 0	0 0 1 0	0 1 0	−99.99 mA
	0	1 0 1 1	0 1 1	0	0 0 1 0 0 0	0 1 0 0	0 1 0	−9.999 A
A~	0	1 1 1 0	X X X	X	1 0 1 0 0 0	1 0 0 0	0 0 1	~ 9999 mA
	0	1 1 1 0	0 0 1	X	1 0 1 0 0 0	0 0 1 0	0 0 1	~99.99 A
	0	1 1 1 1	0 1 1	X	0 0 1 0 0 0	0 1 0 0	0 0 1	~9.999 A
(diode symbol)	0	0 1 1 0	1 X X	1	1 1 0 0 0 0	0 0 0 1	1 0 0	+ 999.9 mV
± °C	0	0 0 1 0	1 X X	1	0 0 0 0 0 0	0 0 0 1	1 0 0	+ 999.9
	0	0 0 1 0	1 X X	0	0 0 0 0 0 0	0 0 0 1	0 1 0	−999.9

Logic 1 = 0 V ⏚
Logic 0 = −8.5 V
Logic X = irrelevant

- For a liquid crystal display, signal DS2 is a square wave
- For a common cathode LED display signal DCL is Logic 0
- For a common anode LED display signal DCL is Logic 1

In function (diode symbol), the mV indication is suppressed by a switch in the PM 2517E.
In function V~ and mA~ the ~indication is not used in the PM 2517E.

3.4.4. Digital Control and Autoranging circuit OQ 0059

3.4.4.1. General

With the OQ 0059 a ADC with delta modulation principle can be controlled.
The OQ 0059 consists of:

- UP/DOWN control to determine whether incoming data should be counted up or down
- POLARITY detection circuit
- TIMER ÷ 12288
- RANGING counter for up/down ranging. From the ranging counter the digital range information is available. Number of ranges: 6.
- UP/DOWN counter for counting the result
- LATCHES and MULTIPLEXERS for controlling a LED or LX display
- LEVEL DETECTOR to determine whether should be ranged up or down in the auto range mode
- CONTROL LOGIC which generates the signals; auto zero, polarity, overload and to which the information; auto ranging and data hold can be given.

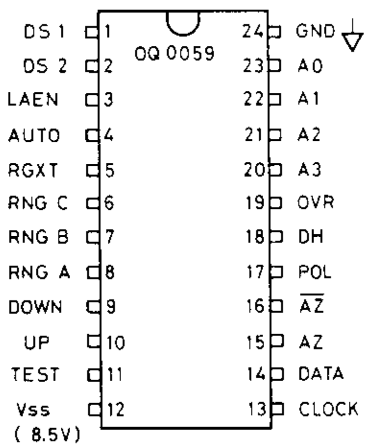


Fig. 33.

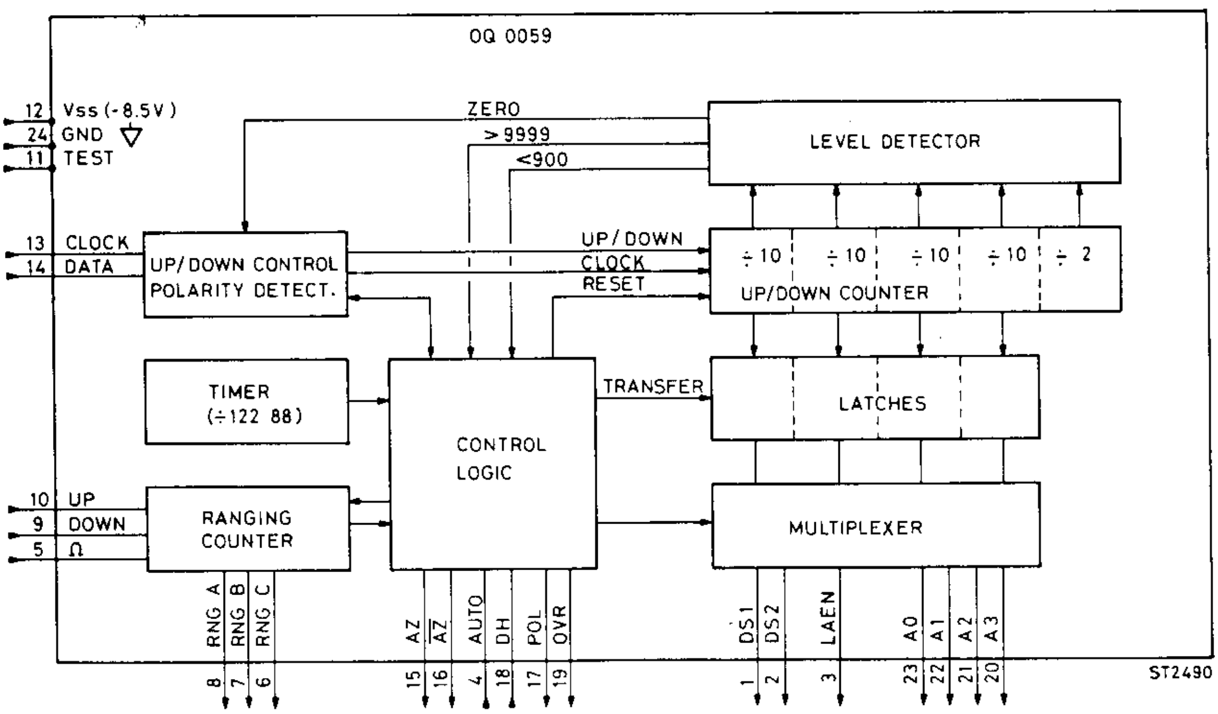


Fig. 34.

3.4.4.2. Specifications of inputs and outputs

Pin nr.	*Name*	*Description*	
1	DS1	Digit Select	Digit Select Outputs
2	DS2	Digit Select	

DS2	DS1			
0	0	10^0	LSD	Least Significant Digit
0	1	10^1		
1	0	10^2		
1	1	10^3	MSD	Most Significant Digit

One of the outputs (DS2) is used for the phase clock of the Liquid Cristal Display, for the clock-input of the OQ 0055 and for the phase inputs of the LX drivers HEF 4543.

Pin nr.	*Name*	*Description*	
3	LAEN	Latch Enable (Not used in PM 2517E)	Pulse for latching the BCD information for a LX display. The LAEN pulse is fed to a 1 of 4 decoder to disable the decoder while DS1 and DS2 are changing.
4	AUTO	Automatic Ranging	**Logic 1** is automatic ranging. The range information will be changed when the measuring result is < 900 and > 9999. < 900 = down ranging > 9999 = up ranging **Logic 0** no automatic ranging (manual ranging) Range switching can be effected by the manual range switches.
5	Ω	Range Extention	With this signal the ranges can be extended. This signal is used in the function Ω and is activated by the function switch. Logic 0 = the range switch span consists of 4 ranges. Logic 1 = the range span consists of 6 ranges.
6	RNG C	Range C	Range information
7	RNG B	Range B	
8	RNG A	Range A	

RNG C	RNG B	RNG A	RGXT	
1	1	0		1
1	1	1		1
0	0	0	0	1
0	0	1	0	1
0	1	0	0	1
0	1	1	0	1

Pin nr.	*Name*	*Description*	
9	DOWN	Manual ranging	Manual range information
10	UP	Up or down	

UP	DOWN	
0	0	no action
0	1	down ranging
1	0	up ranging
1	1	not specified

Pin nr.	*Name*	*Description*	
11	TEST	Test input	Test pin for IC testing during manufacturing. The testpin is connected to Vss −8.5 V.
12	Vss (− 8,5 V)	Supply	Negative supply voltage (−8,5 V)
13	CLOCK	Clock input	Incoming clock frequency from OQ 0060 (80 kHz ... 120 kHz)

Pin nr.	*Name*	*Description*	
14	DATA	Data input	Incoming data with a duty-cycle depending on the input voltage of the ADC. During the second measuring period the DATA signal is inverted.
15 16	AZ $\overline{AZ}$	Auto zero Inverse of auto zero	Auto zero outputs are used for commutating the input voltage of the V-I convertor for automatic zero compensation.
17	POL	Polarity	The state of signal POL is determined by the input voltage of the PM 2517, which is measured by the ADC. LOGIC 0 = – polarity LOGIC 1 = + polarity
18	DH	Data Hold	**Logic 0** normal measuring. **Logic 1** the present value of the last completed measuring cycle will be held. If DH becomes 1 the measuring cycle will be ended, there is no transfer of measured data. The control logic will be waiting until DH becomes 0, and a new measuring cycle will be started.
19	OVR	Overrange	When a measuring result is > 9999 in the highest permisseable range (in manual or automatic ranging mode) then signal OVR will become logic 1. Signal OVR is supplied to the display. In case of overload only digit 10^2 and also the corresponding decimal point is ignited.
20 21 22 23	A3 A2 A1 A0	BCD information	BCD coded result. Bit parallel-word serial. Together with the signals DS1 and DS2 (digit select) the correct digits in the correct order can be made visible.
24	GND	GROUND ⏚	Supply Zero. 0 V ⏚

3.4.5. OQ 0060 Switching part of the ADC

3.4.5.1. General

The OQ 0060 converts the current difference from the OQ 0064 (V-I convertor) to a digital output signal with a duty-cycle depending on the input voltage of the ADC.
It generates the clock for the digital section of the PM 2517: this clock-frequency is determined by external capacitors.

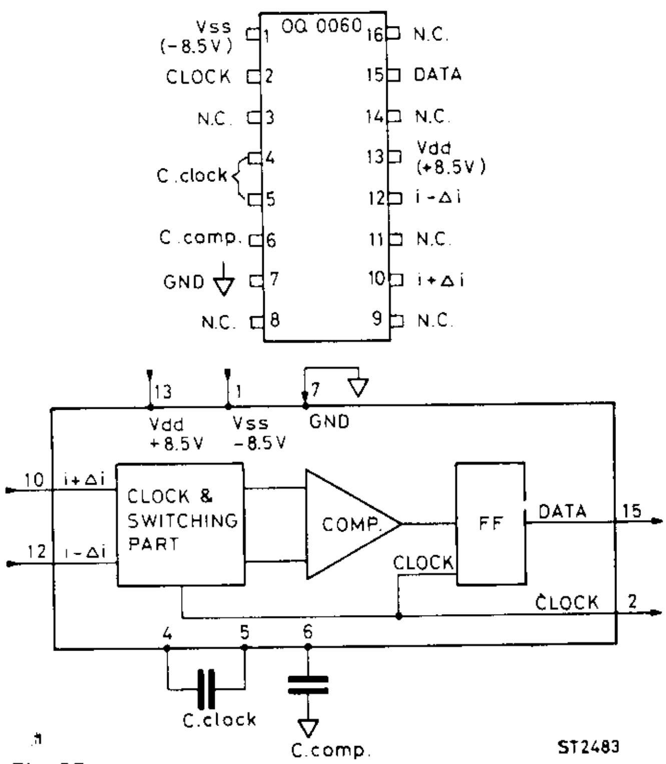


Fig. 35.

3.4.5.2. Specification of inputs and outputs

Pin nr.	*Name*	*Description*	
1	Vss	Supply (–8,5 V)	Negative supply voltage.
2	CLOCK	Clock output	Clock output for OQ 0059 (80 kHz ... 120 kHz)
3	nc	no connection	
4	C clock	Capacitor for clock	This capacitor determines the clock frequency.
5			
6	C comp.	Capacitor for compensation	Capacitor compensates internal active parts.
7	GND	Ground	Supply zero. ⏚
8	n.c.	no connection	
9	n.c.	no connection	
10	I + ΔI	Current input	Input from V-I convertor.
11	n.c.	no connection	
12	I – ΔI	Current input	Input from V-I convertor.
13	Vdd	Supply (+8,5 V)	Positive supply voltage
14	n.c.	no connection	
15	DATA	Data output	Outgoing data with a duty-cycle depending on input voltage of the ADC
16	n.c.	no connection	

3.4.6. OQ 0061 AC to DC convertor

3.4.6.1. General

The OQ 0061 is an integrated AC to DC convertor and consists of three main parts viz: a voltage to current convertor with two selectable input ranges, a current rectifier with an autozero compensation circuit and a logarithmic-antilogarithmic calculating RMS convertor.

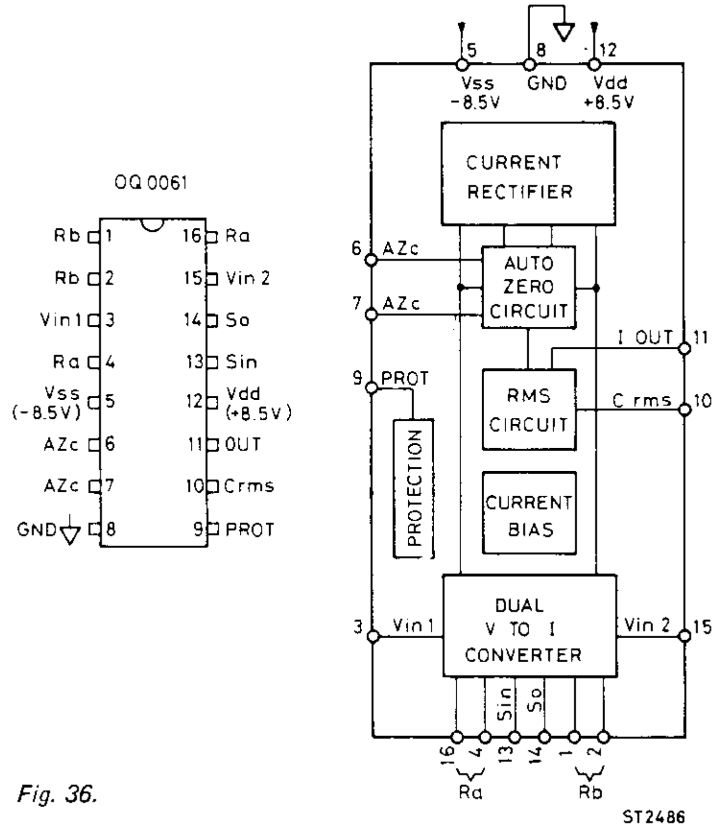


Fig. 36.

3.4.6.2. Specifications of inputs and outputs

Pin nr.	*Name*	*Description*	
1 2	Rb Rb	Range b, conversion resistor	Between inputs 1 and 2 the conversion resistor b is connected. The resistor determines the basic current of the V-I convertor Rb is R308 and R316 in the PM 2517 Rb is selected dependent to the code of Sin and So.
3	Vin 1	Voltage input 1	Input of the V to I convertor in the OQ 0061.
4	Ra	Range a, conversion resistor	Between input 4 and 16 the conversion resistor a is connected. The resistor determines the basic current of the V to I convertor. Ra is R307 in the PM 2517 Ra is selected dependent to the code of Sin and So.
5	Vss (–8,5 V)	SUPPLY	Negative supply voltage –8.5 V
6 7	AZc AZc	Auto Zero Decoupling capacitor	The auto zero decoupling capacitor C is alternating charged and discharged. When no DC offset is present, the voltage across the capacitor is zero. A DC offset causing a voltage across C, is compensated so no influence is seen upon the output signal.
8	GND	GROUND	Supply zero. ⏚
9	PROT	PROTECTION ;	Protection input.
10	Crms	RMS averaging ; capacitor	
11	I out	Current output ;	Output current of the RMS convertor. The current flowing through a known resistor gives the RMS voltage of the unknown input voltage.
12	Vdd (+8,5 V)	SUPPLY ;	Positive supply +8,5 V.
13	Sin	Range selecting ; input	By means of the Sin and So a selection can be made Ra or Rb, which determine the input sensitivity of the AD/DC conv.
14	So	Range selecting ; reference input	(see table below)

Sin	So	Ra	Rb	Range	Sensitivity
1	0	X		1V,100V	0.1 V
1	1		X	10V,1000V	1 V

Note: above mentioned table is valid for PM 2517.

Pin nr.	*Name*	*Description*	
15	Vin 2	Voltage input 2 ;	Input of the V to I convertor in the OQ 0061.
16	Ra	Range a, conversion ; resistor	Between inputs 4 and 16 the conversion resistor a is connected. The resistor determines the basic current of the V to I convertor Ra is R307 in the PM 2517. Ra is selected dependent to the code of Sin and So.

3.4.7. OQ 0063 Programmable Current Source

3.4.7.1. General

The OQ 0063 can deliver 5 programmable currents in the range 1 mA ... 10 nA with decade steps.
The OQ 0063 consist of three main parts:
a reference current source, two current multipliers and an independent operational amplifier.
The reference current source can be adjusted to 10 μA.
The current multipliers together give a multiplication range of 1/100, 1/10, 1, 10, 100 dependent to the digital input code.
The op-amp is independent of the current part and is used for compensation and protection.

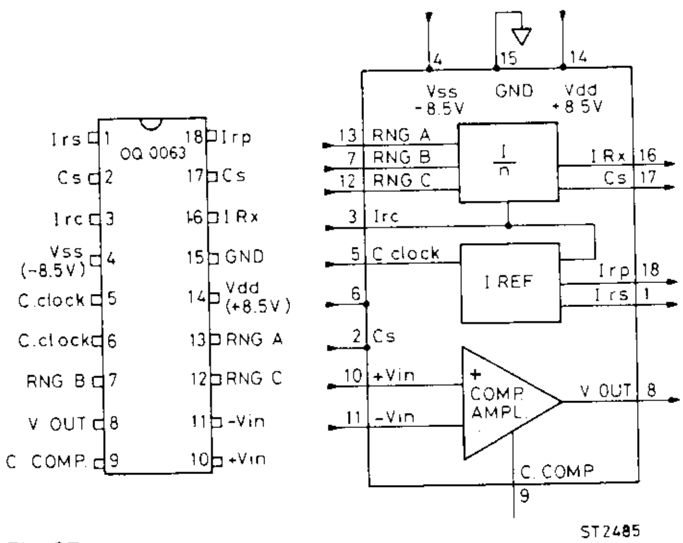


Fig. 37.

3.4.7.2. Specification of the inputs and outputs of the OQ 0063

Pin nr.	Name	Description	
1	Irs	Ref. current adjustment	With Rs the output current can be adjusted.
2	Cs	Smoothing Capacitor	Smoothing capacitor for the switched currents.
3	Irc	I Ref Common	Common connection of Rs and Rp.
4	Vss	Supply (−8,5 V)	Negative supply voltage (−8,5 V)
5 6	C clock C clock		Capacitor for the clock-oscillator
7	RNG B	Range B	Range information (see 12, 13).
8	V out	Output voltage	Output of the compensation amplifier.
9	C comp.	C. Compensation	Compensation capacitor for the compensation amplifier.
10 11	+Vin −Vin	+ Input − Input	+ and − input of the compensation/protection amplifier. **Compensation**: With the amplifier the current consumption of the ADC is compensated during Ωmeasurements. **Protection:** With the amplifier also the leak current through the protection diodes during Ω measurements is compensated.
12 13	RNG C RNG A	Range C Range A	Together with signal RNG B the signals determine the digital range information from the OQ 0059.

Range	Measuring current	RNG A	RNG B	RNG C
1 kΩ	1 mA	1	1	1
10 kΩ	100 μA	0	0	0
100 kΩ	10 μA	1	0	0
1 MΩ	1 μA	0	1	0
10 MΩ	100 nA	1	1	0

Pin nr.	Name	Description	
14	Vdd	Supply (+8,5 V)	Positive supply voltage.
15	GND	GROUND ⏚	Supply zero. ⏚
16	I out		Output current.
17	Cs		Smoothing capacitor
18	Irp		With Rp the temperature-coefficient of the reference current is determined.

3.4.8. OQ 0064 V-I convertor (ADC)

3.4.8.1. General

The OQ 0064 is an integrated Voltage to Current convertor-circuit intended for use in delta modulation ADC's. The circuit contains a voltage to current convertor with two selectable input ranges and a precision current reference source.

Two External input devices are needed (FET's). A separate input protection is provided.

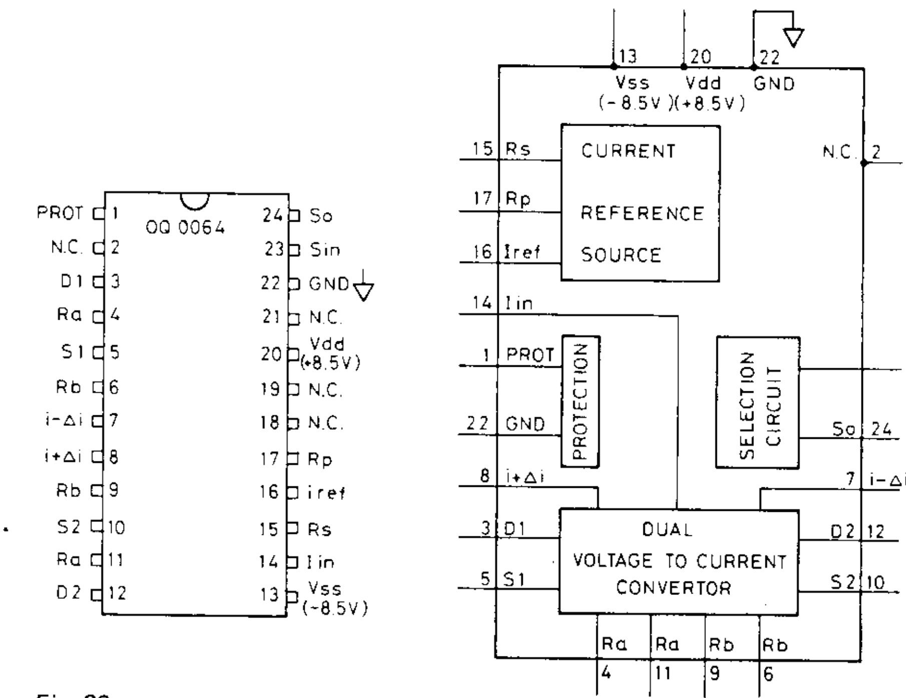


Fig. 38.

3.4.8.2. Specification of inputs and outputs

Pin nr.	*Name*	*Description*	
1	PROT	Protection input	
2	n.c.	no connection	
3	D1	Drain input for device 1	
4	Ra	Range a conversion resistor (input sensitivity 0.1 V)	
5	S 1	Source input for device 1	
6	Rb	Range b conversion resistor (input sensitivity 1 V)	
7	I	Current output	
8	I	Current output	
9	Rb	Range b conversion resistor (input sensitivity 1 V)	
10	S2	Source input for device 2.	
11	Ra	Range a conversion resistor (input sensitivity 0.1 V)	
12	D2	Drain input for device 2	
13	Vss	Negative supply voltage (−8,5 V)	
14	I in	Current input	
15	Rs	Current setting resistor	Adjustment reference current
16	I ref	Current reference output	
17	Rp	Tc setting resistor	Rp determines temperature coefficient
18	n.c.	no connection	
19	n.c.	no connection	
20	Vdd	Positive supply voltage (+8,5 V)	
21	n.c.	no connection	
22	GND	Supply Zero ⏚	
23	Sin	Range selecting input (a or b)	
24	So	Range selecting reference input	

Sin	So	Ra	Rb	Sensitivity ADC
1	0	X		0.1 V
1	1		X	1 V

4. ACCESS

4.1. GENERAL

The opening of covers or removal of parts, except those which access can be gained by hand, is likely to expose live parts and also accessible terminals may be live.
The instrument shall be disconnected from all voltage sources before any adjustment, replacement or repair during which the instrument will be opened.
If afterwards any adjustment or repair of the opened instrument under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the danger involved.
Bear in mind that capacitors inside the instrument may still be charged, even if the instrument has been separated from all voltage sources.

4.2. DISMANTLING THE PM 2517 (Figure 39)

- Remove the battery cover
- Remove the two special nuts situated under the battery cover
- The front and the rear cover can be pulled (item 1 Fig. 39) from the PM 2517 now

Note: Take care that the wiring to the battery compartment does not break. When a PM 9218 (9 V power supply) is used, the wires can be unsoldered from the battery compartment during repair of the PM 2517.

4.3. REPLACING PARTS

4.3.1. Slide switch ON/STAND BY/OFF S2 (Figure 40)

4.3.1.1. Printed circuit board part of S2

Remove the two retaining rings from the slide bodies (item 1 Fig. 40). The slide switch consists of two bodies. In the bottom body the switch contacts are situated. A switch contact consists of a spring and a slider.

*Note: All parts of slide switch S2 are in stock separately.
When a complete switch has to be replaced all parts should be ordered. When mounting the slide switch again, push both bodies slightly on the p.c. board and slide the retaining rings on the pins again.*

4.3.1.2. Topcover part of S2 (Figure 41 and 42)

- Remove the screening plate situated inside the topcover
- Remove the locking spring by bending out the two lips (item 1 Fig. 41)
- When mounting the switch again, take care that the locking spring in not fit too tight (Fig. 42)

4.3.2. Function switch S1 (Figure 41)

4.3.2.1. Topcover part S1

Remove the screening plate situated inside the top cover. The function switch (item 3) and the two leaf springs (item 2) are accessible and can be replaced without any trouble.

4.3.2.2. Printed circuit board part S1 (Figure 40)

- The p.c. board part of function switch S1 consists of:
  - 2 slide bodies
  - 8 springs
  - 8 switch contacts
- Remove the screws and nuts from the slide bodies (item 3). The bodies can be lifted from the p.c. board now.

Note: From function switch only the separate parts are in stock. When the complete switch has to be replaced all parts should be ordered.

4.3.3. Window (Figure 41)

Remove the two selftapping screws (item 4) which are situated inside the topcover. The window can be lifted out of the topcover now.

4.3.4. Battery springs (Figure 39)

- Remove the screening plate which is situated in the bottom cover
- Unsolder the wires from the battery springs
- Pull the battery springs out of the battery compartment

Note: *Only the double battery springs are in stock. A single one can be obtained by cutting the double one in two pieces.*

4.3.5. Display unit N2 (Figure 40)

- Unsolder the wiring from the display unit

Note: *In stock a 29 pole wiring strip is available.*

- Remove the nuts and screws (item 4) from the display unit
- The display p.c. board can be lifted from the bottom p.c. board

Note: *When components have to be unsoldered from the display unit then it is not neccessary to unsolder the wiring.*

4.3.6. Shunt R 602 (Figure 40, item 5)

- Unsolder the input socket 10A (X1) and O (X3) from the bottom p.c. board together with the shunt
- Unsolder the shunt from the socket and replace it by a new shunt
- Solder the sockets on the p.c. board again.

4.3.7. 10A switch S7 (Figure 43, item 1)

- From the rear of the bottom p.c. board the contact spring of the 10A switch can be removed. The 10A switch is situated inside the 10A socket. The 10A switch consists of a contact spring and a switch block.
- When the contact spring is removed the switch block in the 10A socket can also be removed.

Note: *– When mounting a new switch, take care that the contact spring switches properly*
– When a banana plug is inserted in the 10 socket the contact of the switch are opend.

Test: Switch on the 10A range. The display should be 00.00.
Insert a banana plug in the 10A socket.
The decimal point should switch to the 10A position; display 0.000.

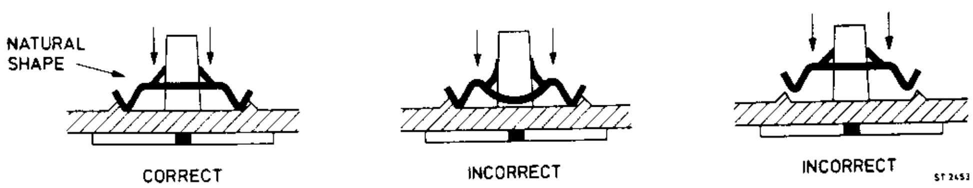


Fig. 42.

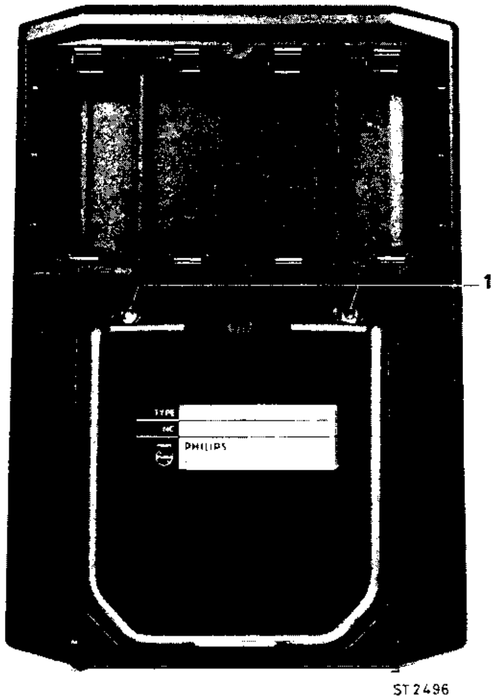


Fig. 39.

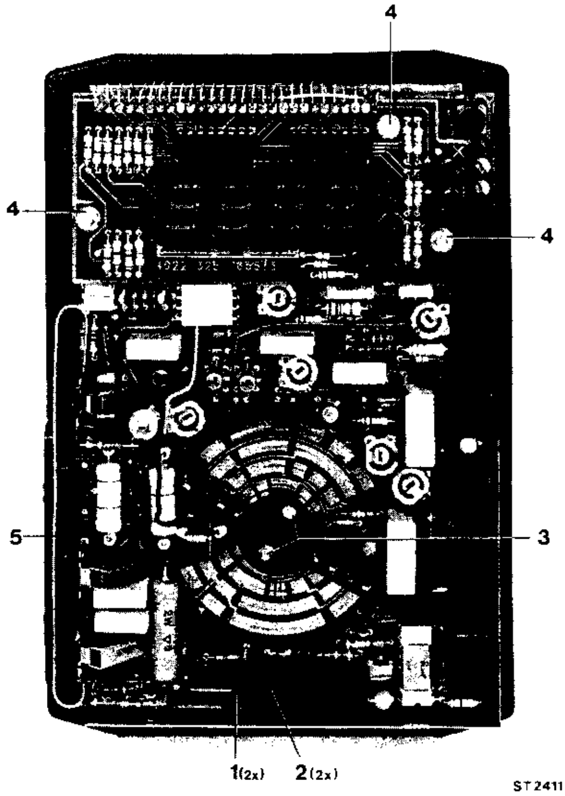


Fig. 40.

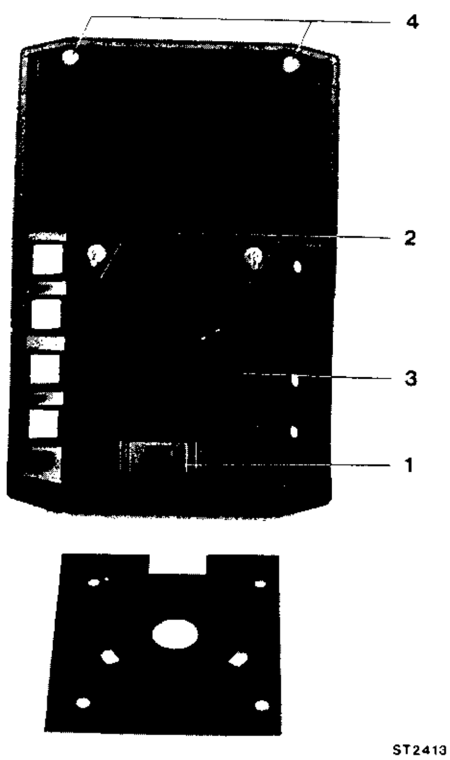


Fig. 41.

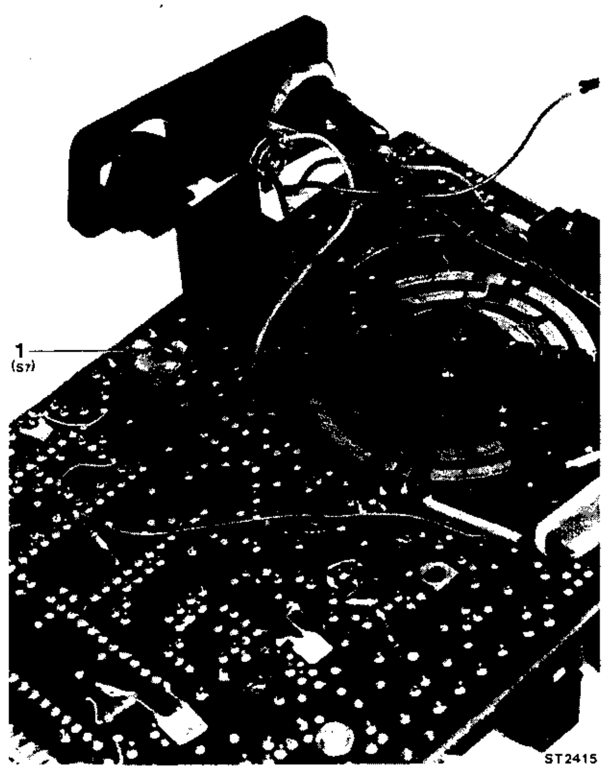


Fig. 43.

5. CHECKING AND ADJUSTING

5.1. GENERAL

The tolerances in this chapter correspond to the factory data, which only apply to a completely re-adjusted instrument. These tolerances may deviate from those mentioned in the Technical Data (Chapter 1).

For a complete re-adjustment of the instrument the sequence in this chapter should be adhered too. When individual components, especially semi-conductors are replaced, the relevant section should be completele re-adjusted.

To calibrate this measuring instrument only reference voltages and measuring equipment with the required accuracy should be applied. If such equipment is not available, comparative measurements can be made with another calibrated PM 2517. However, theoretically the tolerances may be doubled in the extreme case.

The measuring arrangement should be such that the measurement cannot be affected by external influences. Protect the circuit against temperature variations (fans, sun).

With all the measurements the cables should be kept as short as possible; at higher frequencies co-axial leads should be used.
Non-screened measuring cables act as serials so that the measuring instrument will measure HF voltage values or hum voltages.

Before checking and adjusting remove bottom cover. For calibrating the instrument the adjusting elements are reacheable at the back of the bottom p.c. board N1. In case of a complete adjusting of the instrument it may also be necessary to replace the adjusting resistors, which are reacheable at the front of the bottom p.c. board. In this case the top- and bottom cover should be removed.

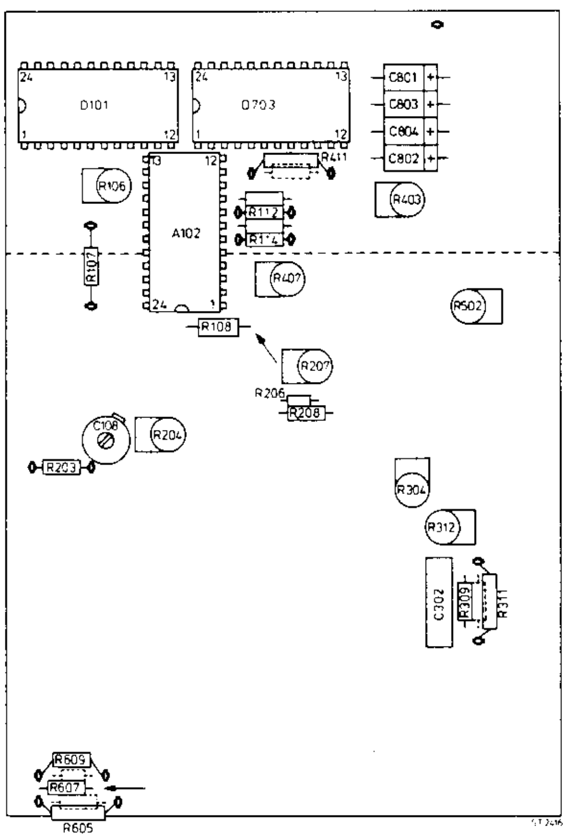
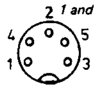


Fig. 44.

5.2. Adjusting Table

NO.	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNALS	ADJUSTING DATA	MEASURING POINTS
	General					
1	Check					
	– Power supply	–	Instrument switched on Power; 4x1.5V batteries ; PM 9248 (9V)	–	+ 8.5V – 8.5V	C802 (+) and 0 socket C804 (–) and 0 socket
	– Current consumption	–	"		< 120 mA	In battery wire
	– Low battery	–	Instrument switched on Power; + 3.6V		Voltage drop < 0.5V opposite + 8.5V < 0.5V opposite – 8.5V	C802 (+) and 0 socket C804 (–) and 0 socket
2	Reference current for the ADC (OQ 0064)	Adj. resistor R107 (MR25, 1%, E48 series)	Instrument set in position; V ⎓ ,AUTO	–	+ 120 μA ± 0.01%	A102/14 (OQ0064) and C802 (–8,5V)
3	Zero ADC	Trimmer C108	Instrument set in position; V ⎓ ,AUTO	VΩ and 0 socket shortcircuited	00.00 mV ± 1 digit	Display
4	Range 2 of the ADC	Adj. resistor R114, **coarse** (MR25, 1%, E48 series) Potentiometer R106; **fine**	Instrument set in position; V ⎓ ,AUTO	+ 0.9V ± 0.001% supplied to R108 rightside and 0 socket	+ 9.000V ± 1 digit	Display
5	Range 1 of the ADC	Adj. Resistor R112 (MR25, 1%, E48 series)	Instrument set in position; V ⎓ ,AUTO	+ 0.09V ± 0.001% supplied to R108,rightside and 0 socket	+ 900.0 mV ± 2 digits	Display
	Dc. volt. ranges					
6	Calibration range 9.999V ⎓	Adj. resistor R203; **coarse** (MR25, 1%, E48 series) Potentiometer R204; **fine**	Instrument set in position; V ⎓ ,AUTO	+ 9V ± 0.001% supplied to VΩ and 0 socket	+ 9.000V ± 1 digit	Display
7	Calibration range 99.99V ⎓	Adj. resistors R206, R208 (MR25, 1%, E48 series)**coarse** Potentiometer R207, **fine** *Note: Coarse adjustment;* *– deviation > 80 digits < 160 digits cut away R206* *– deviation > 160 digits < 178 digits cut away R208* *– deviation > 178 digits cut away R206 and R208*	Instrument set in position, V ⎓ ,AUTO	+ 90V ± 0.001% supplied to VΩ and 0 socket	90.00V ± 1 digit	Display
8	Checks V ⎓ ranges Range 999.9V ⎓	–	Instrument set in position; V ⎓ ,AUTO	+ 900V ± 0.001% supplied to VΩ and 0 socket	+ 900.0V ± 6 digits	Display
9	Linearity	–	Instrument set in position; V ⎓ , Range 9.999V	a. + 9 V ± 0.001% b. + 0.9 V ± 0.001% c. + 0.09V ± 0.001% supplied to VΩ and 0 socket	a. + 9.000V ± 2 digits b. + 0.999V ± 2 digits c. + 0.090V ± 2 digits	Display
	Ac volt.ranges					
10	Calibration range 999.9 mV~	Adj. resistor R311; **coarse** (MR25, 1%, E48 series) Potentiometer R312; **fine**	Instrument set in position; V~,AUTO	0.9V 60 Hz ± 0.01% supplied to VΩ and 0 socket	900.0 mV ± 2 digits	Display
	Dc current ranges					
11	Calibration range 10 A ⎓	Adj. resistor R609 (MR25, 1%, E48 series)	Instrument set (m)A ⎓ ,10A ⎓ supplied to 10A and 0 socket	9A ⎓ ± 0.2% Supplied to 10A and 0 socket	+ 9.000 A ± 30 digits	Display

NO.	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNALS	ADJUSTING DATA	MEASURING POINTS
13	Calibration range 99.99 mA⎓	Adj. resistor R605 (MR25, 1%, E48 series)	Instrument set in position; (m)A⎓	90 mA⎓ ± 0.2% Supplied to VmA and 0 socket	+ 90.00 mA ± 30 digits	Display
	Resistance ranges					
14	Reference current of OQ 0063	Adj. resistor R411, **coarse** (MR25, 1%, E48 series) Potentiometer R403; **fine**	Instrument set in position kΩ 999.9Ω	900Ω ± 0.01% Supplied to VΩ and 0 socket	900.0 ± 1 digit	Display
15	Compensation amplifier of OQ 0063	Potentiometer R407	Instrument set in position kΩ, Range 9.999 MΩ	9 MΩ ± 0.01% Supplied to VΩ and 0 socket	9.000 MΩ ± 5 digits	Display
16	Checks resistance ranges					
	Range 9.999 MΩ	–	Instrument set in position kΩ, Range 9.999 MΩ	a. 3MΩ ± 0.01%	a. 3.000 MΩ ± 20 digits	Display
	Range 9.999 kΩ	–	Instrument set in position kΩ, Range 9.999 kΩ	b. 9 kΩ ± 0.01%	b. 9.000 kΩ ± 20 digits	Display
	Range 99.99 kΩ	–	Instrument set in position kΩ, Range 99.99 kΩ	c. 90kΩ ± 0.01%	c. 90.00 kΩ ± 20 digits	Display
	Range 999.9 kΩ	–	Instrument set in position kΩ, Range 999.9 kΩ	d. 900 kΩ ± 0.01% Supplied to VΩ and 0 socket	d. 900.0 kΩ ± 50 digits	Display
	Temperature ranges					
17	0°C calibration	Potentiometer R502	Instrument set in position – 60... + 200°C	35.34Ω ± 0.1%	± 000.0°C ± 1 digit	Display
18	Check temp ranges					
	+ 100°C	–	Instrument set in position – 60... + 200°C	49.99Ω ± 0.1%	between + 099.8 and + 100.8	Display
	– 50°C	–	Instrument set in position – 60...+ 200°C	27.84Ω ± 0.1% *Note: The resistance should be connected to points 1 and 3 of the probe input*  *Front view*	– 050.0°C ± 2 digits	Display
	Ac current ranges					
19	Calibration range 99.99 mA~	Potentiometer R304	Instrument set in position (m)A~	90.68mV 60 Hz ± 0.01% Supplied to R607, rightside and the 0 socket 90.83 mV DM 01 1715 onwards	90.00 ± 5 digits	Display

*ADJUSTING RESISTORS		
ITEM	VALUE	SERIES
R107	9k53 - 16k2	MR 25, 1% E 48 SERIES
R112	9k53 - 12k4	
R114	95k - 124k	
R203	20k5 - 205k	
R311	24k9 - 42k2	
R411	68k1 - 562k	
R605	806 - 1k96	
R609	187 - 14k7	

6 FAULT FINDING

General

Service hints

If servicing has to be carried out the following points should be taken into account in order to avoid damaging the instrument.

— Take care to avoid short-circuits with measuring clips and hooks if the instrument is switched-on, especially near the input terminals when high-voltages are present.

— Use miniature soldering iron (35 W max.) with a tin cleaner or a vacuum soldering iron.

— Use an acid-free solder.

— When fault-finding, dismantle the instrument, unsolder the battery wires and loosen the display board
— As the dismantled instrument is not very stable it is advised to use a work fixing clamp, when measuring or replacing parts.

— After repair the instrument should be calibrated again.

Fault-finding procedure

In this chapter a genera' fault-finding table is given to locate the incorrect section in the instrument. From this general procedure the incorrect parts can be found by using the detailed fault-finding tables.

Note: The fault-finding procedure is meant as an aid for fault-finding. This means that the incorrect component cannot be found in every case.

Measuring instruments used:
- 9V external power supply PM9218
- Analog multimeter PM2503 unless otherwise stated
- Oscilloscope PM3231 or PM3232
- Digital multimeter PM 2524

Note: This fault-finding procedure is based on instruments from serial number DM01 1715 onwards. Instrument with lower serial numbers can have deviations, especially in different values of components.
In this case also refer to the survey of modifications given in Chapter 7.3.

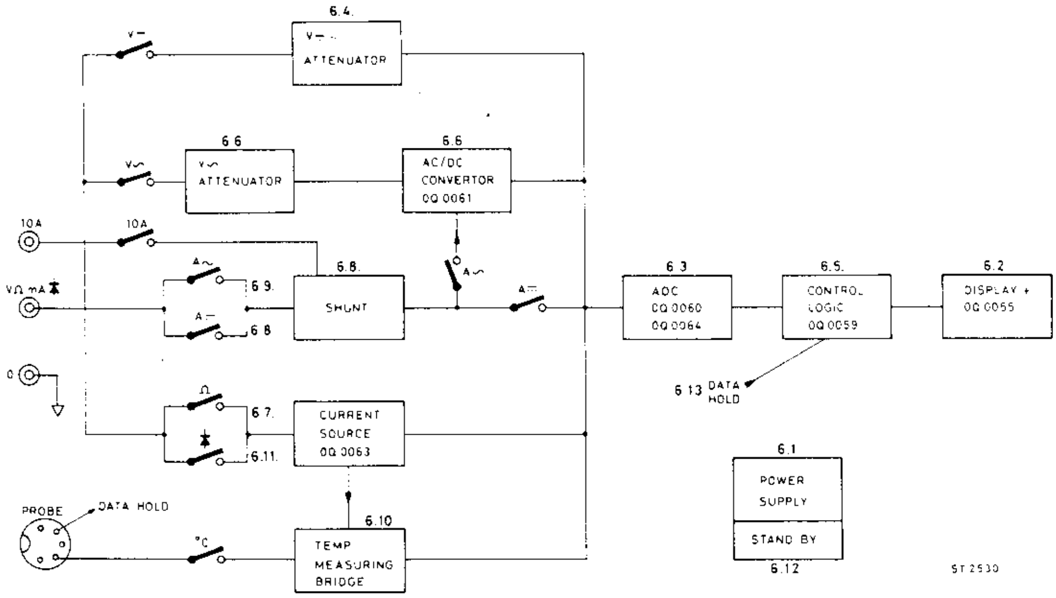
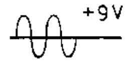
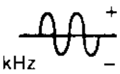
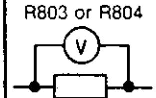


Fig. 45.

	Error in	Errors	Refer to	Instrument settings	Comments
6.1.	POWER SUPPLY	- If problems with the instrument check power supply first	6.1.1.	Function V ⎓ No input voltage Autoranging	- Check if batteries are empty - Check if 9V EXT power supply is correct
6.2.	DISPLAY	- No LED is lighted - Only indication LED's are lighted (+, −, MAN, MΩ, mVΩ) - LED MAN is not lighted - One 7 segment LED is lighted very bright - Two 7 segment LED's are blanked - One 7 segment LED is blanked - One 7 segment LED is incorrect - One segment of a LED is incorrect	6.2.1. 6.2.2. 6.2.3. 6.2.4. 6.2.5. 6.2.6. 6.2.7. 6.2.8.	Function V ⎓ No input voltage Auto ranging	- Check if the display is misshaped
6.3.	ADC (without input attenuators)	- Display constant 0000 - Display constant 0 (overrange) - Display will not become 0000 - No adjustment of display possible - Difference at + and − display - Unstable display - ADC not linear	6.3.1. 6.3.2. 6.3.3. 6.3.4. 6.3.5. 6.3.6. 6.3.7.	Function V ⎓ Input voltage directly supplied to input of ADC 0, ± 90mV, ± 900mV Hi = R108 right side Lo = 0 socket ⏚	- If adjustments 4 and 5 (Chapter 5.2.) cannot be made range 1 and 2 of ADC, then the error is likely in the ADC - The ADC is used in all functions
6.4.	V ⎓ ATTENUATOR	- Display cannot be adjusted to zero - Range 1V ⎓ and 10V ⎓ cannot be adjusted (Adj. 3, 4, 5) - Range 100V ⎓ and 1000V ⎓ cannot be adjusted (Adj. no. 6, 7) - V ⎓ ranges not linear	6.4.1. 6.4.2. 6.4.3. 6.4.5.	Function V ⎓ Input voltage VΩ/0 Manual ranging	- If error is only in V ⎓ funtion, then the error is likely in the V ⎓ attenuator
6.5.	RANGING	- No manual ranging - No auto ranging - Incorrect ranging (decimal point incorrect) - Oscillating between two V~ ranges	6.5.1. 6.5.2. 6.5.3. 6.5.4.	Function V ⎓, V~, or kΩ Input; not important Manual/Auto ranging	- Ranging part is built in the control logic and is used in all functions
6.6.	V~ RANGES (RMS convertor)	- Display constant 0000 - Display will not become zero, VΩ/0 shortcircuited - Adjustment cannot be made (Adj. no. 10) - Incorrect measured value	6.6.1. 6.6.2. 6.6.3. 6.6.4.	Funtion V~ Input voltage supplied to VΩ/0 Manual ranging	- The AC/DC convertor is also used in the A~ funtion
6.7.	Ω RANGES (Current source)	- Display constant 0000 - Range 1000 Ω cannot be adjusted (Adj. no. 14) - Range 10 MΩ cannot be adjusted (Adj. no. 15) - Deviation in the measered value - 10M~ range not linear	6.7.1. 6.7.2. 6.7.3. 6.7.4. 6.7.5.	Function Ω Resistance supllied to VΩ/0 Manual ranging	- The current source OQ0063 is also used in the functions °C and
6.8.	A ⎓ RANGES (Shunts)	- Display constant 0000 in range 10A ⎓ - Range 10A ⎓ cannot be adjusted (Adj. no. 12) - Display constant 0000 in range 100mA ⎓ - Range 100mA ⎓ cannot be adjusted (Adj. no. 19)	6.8.1. 6.8.2. 6.8.3. 6.8.4.	Funtion A ⎓ Current supplied to VΩ/0 and 10A/0	Combined shunt A ⎓, A~
6.9.	A~ RANGES (Shunts)	- Display constant 0000 - Range 100mA~ cannot be adjusted (Adj.no. 19)	6.9.1. 6.9.2	Function A~ Current supplied to VΩ/0 and 10A/0	Combined shunt A ⎓, A~
6.10.	°C RANGES (Temp. bridge)	- Display constant 0000 - °C range cannot be adjusted (Adj. no. 17)	6.10.1 6.10.2	Function °C Input; Probe or resistor (Adj. no. 17)	Combined ~, °C and ⯆ range
6.11.	⯆ RANGE	- Incorrect functionning	6.11.1	Function ⯆ Input; Diode between VΩ/0	Combined current source Ω, °C and ⯆ (2kΩ range)
6.12.	STAND BY (40 sec.)	- Stand by time is too long - Stand by time is too short	6.12.1 6.12.2	STAND BY (40 sec)	
6.13.	DATA HOLD	- Data hold does not function	6.13.1	Use data hold probe PM9263 or interconnect probe input socket point 5 and 0 socket ⏚	

6.1. POWER SUPPLY

6.1.1. No or incorrect power

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A.		Supply voltage + an – (across C804, C802)	Hi = C804 (+) Hi = C802 (–) Lo = 0-socket ⏚	+ 8V .... + 9V – 8V .... – 9V	Power supply okay	Both incorrect, Refer to B. + V not present, – V≈ Vbatt Refer to H
B.	A	Ripple on the supply voltage + and –	Hi = C804 (+) Hi = C802 (–) Lo = 0-socket ⏚ With oscilloscope	< 10mV	Refer to C	Refer to E
C.	B	Too high or too low supply voltage	Hi = C804 (+) Hi = C802 (–) Lo = 0-socket ⏚	> + 9V < + 8V > – 9V < – 8V		> Refer to D < Refer to F
D.	C	Convertor frequency (Supply voltage > + 9V, > – 9V)	Hi = Coil V802 Lo = 0-socket ⏚ With oscilloscope Vary the battery voltage between 6 and 9V ext.	Changing of frequency Normal at 9V ext or 6V batt ≈160kHz  + 9V – 9V When varying Vbatt. the frequency should change	V850 defect	V801 defect or R802 to small (560kΩ)
E.	B	Ripple on supply voltage >10mV	Hi = C804 (+) Lo = 0-socket ⏚ With oscilloscope	50 Hz 80 .... 100 kHz 4 Hz 100 Hz	Defect in power supply Defect in control clock, refer to 6.5. Defect in AZ signal refer to 6.5. Defect in display control, refer to 6.5.	
F.	C	Convertor frequency (Supply voltage < + 8V, <—8V	Hi = C804 (+) Lo = 0-socket ⏚ With oscilloscope Vary the battery voltage between 6 and 9V ext.	Changing of frequency Normal at 9V ext or 6V batt  + 9V ≈160 kHz – 9V When varying V batt. the frequency should change	Defect V850	Refer to G
G.	F	Voltage over R803/804	R803 or R804 	R803≈165mV ⎓ ± 25% R804≈265mV ⎓ ± 25%	–	**Too small:** Check; R801, V852, V801 or Trackinterruption **Too large:** Too much current consumption by the instrument. e.g. One LED lights too much
H.	A	+ V supply not present – V supply ≈Vbatt	Hi = C804 (+) Hi = C802 (–) Lo = 0-socket ⏚	+ V supply not present – V supply ≈Vbatt	Convertor is not running. Check; R802 V802 and T801	

6.2. DISPLAY

6.2.1. No LED Lighted

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Supply voltage	Hi = C804 (+) Hi = C802 (−) Lo = 0-socket ⏚	+8V .... +9V −8V .... −9V	—	Check power, supply Refert to 6.1.1.

6.2.2. Only indication LED's are lighted (+, −, MAN, MΩ, mVΩ)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Supply voltage	Hi = C804 (+) Hi = C802 (−) Lo = 0-socket ⏚	+8V .... +9V −8V .... −9V	Refer to B	Check power, supply Refert to 6.1.1. The indication LED's are supplied from the batteries directly
B	A	Blank display	Hi = D701/4 Lo = 0-socket ⏚	Logic 1 = display (0V) Logic 0 = blank display (−8.5V)	Check D701	Check display 40 sec. circuit

6.2.3. Indication LED MAN is not lighted

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	LED MAN	Display	Instrument set in manual ranging	—	No LED MAN lighted. − V supply is short circuited Refer to 6.1.1.

6.2.4. One 7. segment is lighted very bright

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Supply voltage	Hi = C804 (+) Hi = C802 (−) Lo = 0-socket ⏚	+8V .... +9V −8V .... −9V	Refer to B	Check power, supply Refert to 6.1.1.
B	A	Clocksignal OQ0060 (A101)	Hi = A101/2 Lo = 0-socket ⏚ With oscilloscope	 0 / −8.5V 80kHz ... 120kHz	Refer to F	Refer to C
C	B	Supply voltage of OQ0060 (A101)	Hi = A101/13 (+) Hi = A101/1 (−) Lo = 0-socket ⏚	+8V ... −8V −8V ... −9V	Refer to D	Trackinterruption
D	C	Data signal OQ0059 (D101)	Hi = D101/14 Lo = 0-socket ⏚ a. Open input (V and 0) b. Short circuit input (V and 0) With oscilloscope	a. Block signal varying with input signal b. Block signal ½x clock signal OQ0060 Logic 0 = −8.5V, Logic 1 = 0V	Refer to E	· No signal Track shortcircuit · Too small signal (200mV) Defect OQ0059
E	D	Voltage over C101 (OQ0060, A101)	Hi = A101/4 Hi = A101/5 Lo = 0-socket ⏚	5 ... 6V ⎓ 5 ... 6V ⎓ equal	Defect OQ0060	Trackinterruption

F	B	Digit Select DS 1/2 OQ0059 (D101)	Hi = D101/1 (DS1) Hi = D101/2 (DS2) Lo = 0-socket With oscilloscope	0 − 8.5V ≈500Hz 0 − 8.5V ≈250Hz	Refer to I	Refer to G
G	F	Clock OQ0059 (D101)	Hi = D101/13 Lo = 0-socket ⏚ With oscilloscope	o − 8.5V 80 . . . 120k Hz	Refer to H	No signal Trackinterruption A101/2 - D101/13
H	G	Supply voltage OQ0059 (D101)	Hi = D101/12 (−) Lo = 0-socket ⏚	− 8V . . . 9V	Defect OQ0059	Trackinterruption
I	F	Supply volly voltage OQ0059 (D101)	Hi = D101/12 (−) Lo = 0-socket	− 8V . . . − 9V	Defect OQ0059	Trackinterruption
I	F	Supply voltage HEF 4555 (D702)	Hi = D702/8 Lo = 0-socket ⏚	− 8V . . . − 9V	Defect D702	Trackinterruption shortcircuit

6.2.5. Two 7. segment LED's are blanked

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Digit Select DS 1/2 OQ0059(D101)	Hi = D101/1 (DS1) Hi = D101/2 (DS2) Lo = 0-socket ⏚ With oscilloscope	o − 8.5V ≈500Hz o − 8.5V ≈250Hz	Refer to B	Defect OQ0059
B	A	Digit Select DS1/2 HEF 4555 (DS702)	Hi = D702/2 (DS1) Hi = D702/3 (DS2) Lo = 0-socket ⏚ With oscilloscope	o − 8.5V ≈500Hz o − 8.5V ≈250Hz	Defect D702	Trackinterruption

6.2.6. One 7. segment LED is blanked

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	V bais of the cathode switches of the LED's concerning	Hi = bais V701/702/703 or V704 Lo = 0-socket ⏚ With oscilloscope	Block signal, ≈3Vp.p. Division of the signals DS1 and DS2 Refer to Fig. 25	Defect transistor V701/702/703 or V704	Refer to B
B	A	Outputs of HEF 4555 (D702)	Hi = D702/4/5/6 or 7 Lo = 0-socket ⏚ With oscilloscope	Block signal, ≈8Vpp Division of signals DS1 and DS2 Refer to Fig. 25	Defect resistor R715/716/717 or R718 Track interruption	Defect D702

6.2.7. One segment of all LED's is incorrect

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	LED segment	Display	Constant lighting	Defect D701	
B	—	LED segment	Display	Constant missing	Refer to C	
C	B	Output of HEF 4511 (D701)	Corresponding output (a/g) Hi = D701/9 . . . 15 Lo = 0-socket ⏚ With oscilloscope	Blocksignal 8Vp.p. Division of signals A0, A1, A2, A3 Refer to Fig. 25	Defect resistor R703/709 Track interruption	Defect D701

6.2.8. One segment of one LED is missing

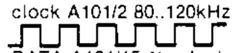
Defect LED

6.3. ADC

6.3.1. Display constant 0000

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Input signal supplied directly to ADC	Display **Input voltage;** a. shortcircuit b. ± 90mV c. ± 900mV **Supplied to; ADC** Hi = R108 right hand side Lo = 0-socket ⏚ **Function;** V ⎓ **Range;** a.b. 999.9mV c. 9.999V	a. ± 0000 mV b. ± 90.00 mV c. ± 9.000 V	—	Refer to B
B	A	Data signal OQ0059 (D101)	Hi = D101/14 Lo = 0-socket ⏚ With oscilloscope **Input voltage;** + 90mV supplied to ADC, refer to: A	a. Assymetrical block voltage b. Symetrical block voltage c. No signal	a. Refer to C b. Refer to H c. Refer to I	
C	B	Data hold DH OQ0059 (D101)	Hi = D101/18 Lo = 0-socket ⏚	Logic 0 (− 8.5V)	Refer to F	Refer to D
D	C	Data hold DH OQ0055 (D703)	Hi = D703/1 Lo = 0-socket ⏚	Logic 0 (− 8.5V)	Refer to E	- Defect OQ0055 - Trackinterruption in DH line
E	D	Data hold DH OQ0059 (D101)	Connect D101/18 to − 8.5V (C802 —)	a. Instrument functions again b. Error still in instrument	a. Track interruption in DH line b. Defect OQ0059	
F	C	Autozero AZ OQ0059 (D101)	Hi = D101/15 AZ Hi = D101/16 AZ Lo = 0-socket ⏚ With oscilloscope	200m sec. AZ ⌐⌙ 0 − 8.5V $\overline{AZ}$ ⌙⌐ 0 − 8.5V	Refer to G	- Trackinterruption - Defect OQ0059
G	F	Auto zero AZ on FET V102/V102[1]	Hi = gate V101/V101 Lo = 0-socket ⏚ With oscilloscope **Input voltage;** supplied to ADC + 90mV and + 900mV, refer to A	200m sec. AZ ⌐⌙ G or B 0 a. 90 mV in range 99.99mV b. 900mV in range 9.999V	Defect OQ0059	- Check R504 - Check tracks - If correct defect FET V101/101[1]
H	B	Conversion resistors Ra and Rb of OQ0064 (A102)	a. A102/4/11 b. A102/9/6	a. ≈1kΩ b. ≈10kΩ	Defect OQ0060 (A101)	- Trackinteruption Ra, Rb - Defect resistors Ra, Rb
I	B	Track A101/15 to D101/14	A101/15 − D101/14	Shortcircuit to or − 8.5V supply	No shortcircuit; refer to J	Shortcircuit
J	I	Input of ADC Switching part OQ0060 (A101)	Hi = A101/12 Hi = A101/10 Lo = + 8.5V (C804 +)	− 2.6V . . . − 3.2V Both signals should be equal	Defect OQ0060	Refer to K
K	J	Data output OQ0060 (A101)	Hi = A101/15 Lo = 0-socket ⏚ With oscilloscope Load A101/15 with the multimeter in both directions. The multimeter should be in its lowest Ω range (PM2503)	The measurements with the multimeter should influence the data signal	Refer to L	(No reaction) Defect OQ0060
L	K	Source voltage of FET V102/102[1]	Hi = A102/5 (V102) Hi = A102/10 (V102[1]) Lo = 0-socket ⏚	+ 0.4V . . . + 3V Both signals should be equal	Defect OQ0064	- V source <0V; Defect OQ0064 - V source ≈ Vdrain Defect V102/102[1]

6.3.2. Display constant 0 (Overrange)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A		Overrange (OVR) HEF 4555 (D702)	Hi = D702/1 Lo = 0-socket ⏚ Shortcircuit ADC input	Logic 0 (−8.5V)	Defect HEF 4555 (D702)	Refer to B
B	A	Overrange (OVR) OQ0059	Hi = D101/19 Lo = 0-socket ⏚ Shortcircuit ADC input	Logic 0 (−8.5V)	Trackint702)	Refer to B
B	A	Overrange (OVR) OQ0059 (D101)	Hi = D101/19 Lo = 0-socket ⏚ Shortcircuit ADC input	Logic 0 (−8.5V)	Trackinterruption	Refer to C
C	B	Data signal OQ0060 (A101)	Hi = A101/15 Lo = 0-socket ⏚ Shortcircuit ADC input Input ADC; Hi = R108 right hand side Lo = 0-socket ⏚	clock A101/2 80..120kHz  DATA A101/15 ½xclock  symmetrical	Defect OQ0059	—

6.3.3. Display will not become zero with shorcircuited ADC input

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A		Iref OQ0064 (A102)	Hi = A102/14 Lo = 0-socket ⏚ Short circuit ADC input	+ 120μA ⎓	Refer to C	Refer to B
B	A	Check adjustments; - Reference current ADC (adj. no. 2) - Range 2 of ADC (adj. no. 4)	R107 R106 Short circuit ADC input	R107 adjusting resistor 9k53 . . . 16k2 Potentiometer 2k2 R105 = 10k2 R113 = 1k4	Defect OQ0064	Make adjustment
C	A	Iref OQ0064 (A102)	Hi = A102/14 Lo = 0-socket ⏚ With oscilloscope Short circuit ADC input	Oscillations	Check capactor C110	Refer to D
D	C	Input of ADC Switching part OQ0060A(101)	Hi = A101/10 Hi = A101/12 Lo = 0-socket ⏚ Input ADC; Hi = R108 right hand side Lo = 0-socket	 >10mV	Defect OQ0060	Check; C103, R104 Track interruption

6.3.4. No adjustment of instrument possible, stable display, input voltage supplied to ADC

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Iref OQ0064 (A102)	Hi = A102/14 Lo = 0-socket ⏚ Short circuit ADC input	+ 120μA	Refer to C, D, E, F	Refer to B
B	A	Check R105, R106, R107 and R113	R105, R106, R107, R113	R105 = 10k2 R106 = 2k2 potentiometer R107 = Adjusting resistor 9k53...16k2 R113 = 1k4	Defect OQ0064	Replace resistors
C	A	Adjustment Range 1 of ADC (adj. no. 5)	Check R110, R112	R110 = 1k05 R112 = Adjusting resistor 9k53 . . . 12k4 R110/R112 ≈1kΩ)	Refer to D	Replace resistors
D	C	Range selecting input (Sin) OQ0064 (A102)	Hi = A102/23 Lo = 0-socket ⏚ Instrument set in function V ⎓	Logic 0 (−8.5V)	Refer to G	Check OQ0059 ranging counter
E	A	Adjustment Range 2 Of ADC (adj. no. 4)	Check R111, R114	R111 = 10k5 R114 = adjusting resistor 95k . . . 124k R111//R114 = ≈10k	Refer to F	Replace resistors

F	E	Range selecting input (Sin) OQ0064 (A102)	Hi = A102/23 Lo = 0-socket ⏚ Instrument set in function V ⎓	Logic O (−8.5V)	Refer to G	Check OQ0059 ranging counter
G	D F	Adjustments Range 1 and 2 of ADC (adj. no. 5 and 4)	Display	≈45mV instead of 90mV ≈450mV instead of 900mV (≈½x supplied voltage)	Refer to H	Defect OQ0064 (correct value)
H	G	Signal Auto Zero (AZ) V101	Hi = gates V101/V101[1] Lo = 0-socket ⏚	Square wave 0 −8.5V 200 msec	Refer to J	Refer to I
I	H	Signal Auto Zero (AZ) OQ0059	Hi = D101/1 Lo = 0-socket ⏚	Square wave 0 AZ −8.5V 0 AZ −8.5V 200msec	Trackinterruption Track interruption V101/D101	Defect OQ0059 Defect OQ0059
J	H	Drain V101/V101[1]	Hi = drain V101/V101[1] Lo = 0-socket ⏚ measure with Ω-meter in 1MΩ range (PM2503) Short circuit ADC input Input ADC: Hi = R108 right hand side Lo = 0-socket ⏚	≈0.5MΩ fluctuating	—	**Constant 0**; Short circuit in V101/V101 **Constant 1MΩ**: Interruption in V101/V101[1] >**1MΩ**: Check R108, R109, tracks

6.3.5. Difference at + and − display in function V ⎓

If the difference is > 2 digits defect OQ0064 or V101

6.3.6. Unstable display

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Input of ADC switching part OQ0060 (A101)	Hi = A101/12 Hi = A101/10 Lo = 0-socket ⏚	−2.6V . . . −3.2V Both signals should be equal	Refer to B	Defect OQ0060
B	A	Check C104, C105, C106	C104, C105, C106	C104 = 47pF C105 = 390pf C106 = 390pf	Refer to C	Replace capicitors
C	B	Iref OQ0064 (A102)	Hi = A102/14 Lo = 0-socket ⏚ With oscilloscope	Oscillations	Check C110 (4n7)	Refer to D
D	C	Iref OQ0064 (A102)	Hi = A102/14 Lo = 0-socket ⏚	+120μA	Refer to F	Refer to E
E	D	Check R105, R106 R107, R113	R105, R106 R107, R113	R105 = 10k2 R106 = 2k2 potentiometer R107 = Adjusting resistor 9k53 . . 16k2 R113 = 1k4	Defect OQ0064	Replace resistor
F	D	Clock frequency OQ0060 (A101)	Hi = A101/2 Lo = 0-socket ⏚	0 −8.5V 80kHz . . . 100kHz	Defect OQ0060	Refer to G
G	F	Check C101 and tracks	C101	C101 = InF	Defect OQ0060	Replace to C101

6.3.7. ADC not linear

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Linearity	Display **Input voltage;** +30mV supplied to ADC Hi = R108 right hand side Lo = 0-socket ⏚ Select; Range 999.9mV	On display 300.0mV	Defect OQ0064	Refer to B
B	—	Replace V102		If ADC is stil not linear		Defect OQ0060

6.4. V ⎓ ATTENUATOR

6.4.1. Display cannot be adjusted to zero

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check if the p.c. board is clean	Open input			
B	—	Check C108	Open input	C108 = 5p5 trimmer	Refer to C	Replace C108
C	B	Display	Display Open input Range 999.9mV ⎓ Insulate selectors witch part V ⎓ 1/2 with a piece of insulating material, shifted under the sliding contact. (Refer to Fig.)	Display ± 000.0mV	Defect V201	refer to D
D	C	Display	Display Cut track from R204 to A102/1 (OQ0064) The track is situated at the conductorside Range 999.9mV ⎓ Open input	Display ± 000.0mV	Defect OQ0064	Defect V102. if still incorrect replace V101

6.4.2. Range 1V ⎓ cannot be adjusted (adj. no. 3, 4, 5.)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Instrument stays on zero	Display	Refer to Adj. no. 3, 4, 5	**Check;** R204 = 47k pot. meter Trackinterruptions Function selector C201 = 10nF } short C202 = 33nF } circuit R201 = 4M2 } Inter- R202 = 4M2 } ruption	
B	—	Instrument stays on a certain value	Display	refer to Adj. no. 3, 4, 5	**Check;** R201 = 4M2 R202 = 4M2 R108 = 1M R109 = 1M	

6.4.3. Range 10V ⎓ and 100V ⎓ cannot be adjusted (adj. no. 6, 7)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	**Range deviates with a factor of 100** Check; R205, R206 R207 and R208	R205, R206, R207 and R208	R205 = 9k09 R206 = 1M R207 = 100Ωpot. meter R208 = 820k	Refer to B	Replace resistors
B	A	Check; Track interruptions Selector switch (clean!)			Refer to C	Repair
C	B	R on V201 Range 10V ⎓	Hi = V201 drain Lo = V201 source Ω-meter	<60Ω	Track interruption	Refer to D
D	C	Gate voltage V201 Range 10V ⎓	Hi = gate V201 Lo = source V201	0V	Defect V201	Refer to E
E	D	Is the decimal point in correct position	—	—	Trackinterruption	Check ranging counter OQ0059

		Range deviates				
A	—	Check; R205, R206 R207 and R208	R205, R206, R207 and R208	R205 = 9k09 R206 = 1M R207 = 100Ω pot. meter R208 = 820k	Refer to B	Replace resistor
B	A	Check; Selector switch (clean!)			Refer to C	Repair
C	B	R on V201 Range 100V	Hi = V201 drain Lo = V201 source Ω-meter	<60Ω	—	Defect V201

6.4.4. V⎓ ranges not linear

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check linearity of ADC, Refer to 6.2.7.	—	—	Refer to B	Repair
B	A	Linearity of V⎓ range	Display **Select;** 999.9mV Insulate selector switch part V⎓ 1/2 with a piece of insulating material, shifted under the sliding contact	Check if the V⎓ range is linear	Refer to C	Defect 0064
C	B	Gate of V201	Hi = V201 gate Lo = 0-socket ⏚ Select; Range 999.9mV⎓	Logic 0 (−8.5V)	Defect V201	Trackinterruption or Refer to 6.5 RANGING

6.5. RANGING

6.5.1. No manual ranging

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Auto ranging signal (AUT) OQ0059 (D101)	Hi = D101/4 Lo = 0-socket ⏚	Logic 0 (−8.5V)	Refer to E	Refer to B
B	A	Anode voltage V150	Hi = V150 anode Lo = 0-socket ⏚	Logic 0 (−8.5V)	Trackinterruption	Refer to C
C	B	Kathode voltage V150	Hi = V150 kathode Lo = 0-socket ⏚	Logic 0 (−8.5V)	Refer to D	Trackinterruption Check switch AUTO
D	C	Anode voltage V150	Hi = V150 anode Lo = 0-socket ⏚ Connect the kathode of V150 via a 100kΩ resistor to the 0-socket	Logic 0 (−8.5V)	Check R722 Tracks	Defect V150
E	A	Signal UP/DOWN OQ0059 (D101)	Hi = D101/9 DOWN Hi = D101/10 UP Lo = 0-socket ⏚	Depress switch UP D101/10 = Logic 1 Release switch UP D101/10 = Logic 0 Depress switch DOWN D101/9 = Logic 1 Release switch DOWN D101/9 = Logic 0 Logic 0 = −8.5V Logic 1 = 0V	Refer to F, G	Track interruption Check switches UP; DOWN
F	E	Signal RNG A OQ0059 (D101)	Hi = D101/8 Lo = 0-socket ⏚ Select ranges in function V⎓ with MAN switch	Logic 0 or 1 Range Logic 1V 0 10V 0 100V 1 1000V 1	ADC cannot be adjusted Refer to 6.4.2.	Defect OQ0059

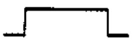
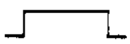
6.5.2. No auto ranging

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check if manual ranging functions	Display	Refer to truth table OQ0055	Refer to B	Refer to 6.5.1. No manual ranging
B	A	Ranging	Hi = A102/1 Lo = 0-socket ⏚ **Select;** Range 1V ⎓ manual **Supply;** 100V ⎓ to VΩ and 0	+ 2V . . . + 3V	Defect OQ0059	>3V defect OQ0064 ≤≈0V Track interruption

6.5.3. Incorrect ranging (decimal point incorrect)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signals RNG A, RNG B, RNG C Check if these signals are correct on OQ0055 and OQ0059 (D101)	Hi = D101/8 - D703/3 Hi = D101/7 - D703/4 Hi = D101/6 - D703/5 Lo = 0-socket ⏚ **Select;** Function V ⎓ Manual ranging	Range C B A 1V 0 0 0 10V 0 0 1 100V 0 1 0 1000V 0 1 1 Logic 0 = − 8.5V Logic 1 = 0V Refer to truth table of OQ0055	Refer to B	Trackinterruption
B	A	Signals FA, FB, FC, FD, OQ0055 (D703)	Hi = D703/7 FA Hi = D703/8 FB Hi = D703/9 FC Hi = D703/10 FD Lo = 0-socket ⏚	Function FD FC FB FA V~ 0 0 1 1 V ⎓ 0 0 0 1 Ω 0 0 1 0 ⯈| 0 1 1 0 °C 0 1 0 0 mA ⎓ 0 1 0 1 mA~ 0 1 1 1 10A ⎓ 1 1 0 1 10A~ 1 1 1 1 Logic 0 = − 8.5V Logic 1 = 0V Refer to truth table of OQ0055	Refer to C Defect switch	Track interruption
C	B	Incorrect decimal points			Defect OQ0055	
	B	No decimal points Check signals DP1, DP2, DP3 OQ0055 (D703)	Hi = D703/16 DP1 Hi = D703/15 DP2 Hi = D703/14 DP3 Lo = 0-socket ⏚ **Select;** Function V ⎓ Manual ranging	Range DP3 DP2 DP1 1V 1 0 0 10V 0 0 1 100V 0 1 0 1000V 1 0 0 Logic 0 = − 8.5V Logic 1 = 0V Refer to truth table of OQ0055	Refer to D	Defect OQ0055
D	C	Decimal points on LED's	Hi = V758/9 Hi = V756/9 Hi = V757/9 Lo = 0-socket ⏚	Range V758/9 V756/9 V757/9 1V 1 0 0 10V 0 0 1 100V 0 1 0 1000V 1 0 0 Logic 0 = − 8.5V Logic 1 = 0V	—	Trackinterruption Defect LED

6.5.4. Oscillating between two V~ ranges

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signal DH OQ0059 (D101)	Hi = D101/18 Lo = 0-socket ⏚ Switch from one V~ to another V~ range with the manual range push buttons Measure with oscilloscope	0  − 8.5V Pulse of 200msec	Refer to Chapter 6.13 DATA HOLD	Refer to B
B	A	Check R118, C109 and tracks	R118, C109	R118 = 2M2 C109 = 220nF	Refer to C	Repair
C	B	Signal DH OQ0055 (D703)	Hi = D703/1 Lo = 0-socket ⏚ Switch from one V~ to another V~ range with the manual range buttons Measure with oscilloscope	0  − 8.5V Pulse of 200msec	Check R117 and tracks	Refer to D
D	C	Range switching	Display Switch ranges with the manual range pushbuttons	Check if the decimal point is changing	Defect OQ0055	Refer to 6.5.3. Decimal point incorrect

6.6. V~ RANGES (ATTN + AC/DC CONV,)

6.6.1. Display constant 0000

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Input signal	Hi = Connection C301/R301 Lo = 0-socket ⏚ **Select;** Range IV~ Manual ranging **Supply;** ≈0.5V~(VΩ-O) Measure with oscilloscope	Its there a signal present	Refer to B	No signal; Check C301, Selector switch tracks
B	A	Signal Vin1 of OQ0061 (A301)	Hi = A301/3 Lo = 0-socket ⏚ **Select;** Range IV~ Manual ranging **Supply;**≈0.5V~ (VΩ-O) Measure with oscilloscope	≈0.5V:10	Refer to I	Refer to C — No signal — :1000 signal
C	B	No signal	**Supply;** 900mV, 1kHz to A301/3 Lo = 0-socket ⏚	Display?	Display Defect A301 Track shortcircuit	No display Defect R301/R302 Trackinterruption
	B	:1000 signal	Hi = A301/3 Lo = 0-socket **Settings;** refer to B	≈0.5V:1000	Refer to D	—
D	C	Check track R315, V301/V302	R310 V301/V302	No short circuit	Refer to E	Repair tracks
E	D	Gate voltage V301/V302	Hi = gate V301/V302 Lo = O-socket ⏚ **Select;** Function V~ Manual ranging	Range Logic 1V 0 10V 0 100V 1 1000V 1 Logic 0 = − 8.5V Logic 1 = 0V	Defect V301	Refer to F
F	E	Signal RNG B or R314	Hi = R314 right hand side Lo = 0-socket ⏚ **Select;** Function V ~ Manual ranging	See E	Refer to G	Refer to H

G	F	Check R314 and tracks			Defect V301/V302	Repair
H	F	Signal RNG B on D101	Hi = D101/7 Lo = 0-socket ⏚ **Select;** Function V~ Manual ranging	See E	Trackinterruption	Refer to 6.5. Ranging errors
I	B	Signal Vin2 OQ0061 (A301)	Hi = A301/15 Lo = 0-socket ⏚ **Select;** Range 1V~ Manual ranging	0V~	Refer to J	Defect V302 Control of V302
J	I	Signal I out OQ0061 (A301)	Hi = A301/11 Lo = 0-socket ⏚ **Select;** Range 1V~ Manual-ranging	≈1V ⎓	Defect R313 Selector switch Tracks	No voltage Refer to K
K	J	Resistors Ra and Rb OQ0061 (A301)	R307 = Ra R308, R316 = Rb Ω meter	≈3kΩ ≈30kΩ	Refer to L	Defect R307 R308 or R316
L	K	Signal AZc OQ0061 (A301)	Place a capitor of 15μF in paralell to C303 (A301/6/7)	Display correct again when measuring	Defect C303 Tracks	Defect A301

6.6.2. Display will not become zero with VΩ/O short circuited (V~ function)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Ripple on power supply of OQ0061 (A301)	Hi = A301/12/5 +8.5V Lo = 0-socket ⏚ **Select;** Function V~, AUT ranging Shortcircuit VΩ/0 With oscilloscope	∿∿ <5mV	Refer to B	Refer to POWER SUPPLY 6.1.
B	A	Signals Vin1 and Vin2 OQ0061 (A301)	Hi = A301/3 (Vin1) Hi = A301/15 (Vin2) Lo = 0-socket ⏚ **Select;** Function V~, AUT ranging Shortcircuit VΩ/0	<10mV Both signals should be equal	Refer to D	Refer to C
C	B	Check R306 and R309 Trackinterruption	R306, R309	R306 = 200k R309 = 237k	Defect A301	Repair
D	B	Diode measurement between AZc inputs of OQ0061 (A301)	Hi = A301/6 Lo = A301/7 **Select;** Function V~, AUT ranging Shortcircuit VΩ/0	≈0.6V	Refer to E	Defet C303 Track short circuit
E	D	Resistors Ra and Rb OQ0061 (A301)	R307 = Ra R308, R316 = Rb Select; Function V~, AUT ranging Shortcircuit VΩ/0	≈ 3kΩ ≈30kΩ	Refer to F	Repair
F	E	Signal I out OQ0061 (A301)	Hi = A301/11 Lo = 0-socket ⏚ Instrument switched off Ω meter	≈10k when R311 is removed ≈7k5 when R311 is fitted	Defect A301	Check; R310/R311 and R312 Tracks

6.6.3. Adjustments cannot be made (Adj. no. 10)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signal Vin1 OQ0061 (A301)	Hi = A301/3 Lo = 0-socket ⏚ **Select;** Function V~ AUT ranging **Supply;** 9V~ to VΩ/0 Measured with PM2524	685mV~ . . . 699mV~ Note down the measured value	Refer to E	Refer to B
B	A	Drain V301	Hi = V301 drain Lo = 0-socket ⏚ **Instrument settings;** Refer to A Measured with PM2524	0,2% lower as value measured under A	Refer to D	Refer to C a. Voltage = ≈0V~ b. Voltage = ≈50% lower as measured under A

C	B	a, Voltage ≈0V~	Hi = gate V301 Lo = 0-socket ⏚ **Instrument settings;** Refer to A Measured with PM2524	Logic 0 (− 8.5V)	Defect V301 Track shortcircuit	0V, Refer to 6.6.1.
	B	b. Voltage ≈50% lower as measured under A	Hi = Gate V302 Lo = 0-socket ⏚ **Instrument settings;** Refer to A Measured with PM2524	Logic 0 (− 8.5V)	Defect V302 Track shortcircuit	0V, Trackinterruption
D	B	Check R301, R302, R306	R301, R307, R306	R301 = 909k R302 = 887k R306 = 200k	Defect OQ0061	Repair
E	A	Signal Sin OQ0061 (A301)	Hi = A301/13 Lo = 0-socket ⏚ **Select;** Range 1V~	Logic 0 (− 8.5V)	Refer to F	Track shortcircuit If not refer to 6.5. Ranging
F	E	Resistors Ra and Rb OQ0061 (A301)	R307 = Ra R308, R316 = Rb **Select;** Range 1V~	3k01 ± 0.1% 30k ± 0.1%	Refer to G	Repair
G	F	Check R310, R313, tracks at R311, R312	R310, R313	R310 = 10k5 R313 = 48k7	Defect OQ0061	Repair

6.6.4. Incorrect measured value

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Range 10V~deviates Range 100V~deviates	—	—	Refer to B Refer to G	—
B	A A	Range 10V~ deviates with a factor of 10 Range 10V~ deviates (not with a factor of 10)	—	—	Refer to C Refer to F	—
C	B	Range 10V~, deviation factor 10 Signal Sin OQ0061 (A301)	Hi = A301/13 Lo = 0-socket ⏚ **Select;** Range 10V~	Logic1 (0V)	Refer to E	Refer to D
D	—	Signal RNG A OQ0059 (D101)	Hi = D101/8 Lo = 0-socket ⏚ **Select;** Range 10V~	Logic 1 (0V)	Trackinterruption V~ switch (7-8)	Refer to 6.5 RANGING
E	C	Resistors Rb OQ0061 (A301)	R308, R316 = Rb	30k1 ± 0.1%	Defect OQ0061	Repair
F	B	Resistors Rb OQ0061 (A301)	R308, R316 = Rb	30k1 ± 0.1%	Refer to 6.6.3.	Repair
G	A	·Range 100V~ deviates with a factor of 100 ·Range 100V~ deviates not with a factor of 100	— a	— factor	Refer to H Refer to K of	— 100
H	G	Gate voltage of V301	Hi = gate V301 Lo = 0-socket ⏚ **Select;** Range 100V~	Logic 1 (0V)	Refer to J	Refer to I
I	G	Signal RNG B OQ0059 (D101)	Hi = D101/7 Lo = 0-socket ⏚ **Select;** Range 100V~	Logic 1 (0V)	Check R314 Track	Refer to 6.5. RANGING
J	G	Drain voltage V301	Hi = drain V301 Lo = 0-socket ⏚ **Select;** Range 100V~	<50mV~	Check R305, R315 Tracks	Defect V301

6.7. Ω RANGES

6.7.1. Display constant 0000

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Supply voltage OQ0063 (A401)	Hi = A401/14 Lo = 0-socket ⏚	+ 6V	Refer to C	Refer to B
B	A	Check R413 Power supply tracks	R413	R413 = 3k3	Defect OQ0063 (A401)	Repair
C	A	Current Irx OQ0063 (A401)	Hi = A401/16 Lo = 0-socket ⏚ **Select;** Function kΩ AUTO ranging	≈ + 1mA	Refer to D	Refer to E
D	C	Check R401, track A401/16 to V/Ω input	R401	R401 = 100Ω PTC	Check switches	Repair
E	C	Current Irc OQ0063 (A401)	Hi = A401/3 Lo = 0-socket ⏚ **Select;** Function kΩ AUTO ranging	≈ + 10μA	Refer to G	Refer to F
F	E	Check R402, R404	R402, R404	R402 = 121k R404 = 16k 9	Defect OQ0063	Repair
G	E	Check track shortcircuits			Defect OQ0063	Repair

6.7.2. Range 1000Ω cannot be adjusted (Adj. no. 14)

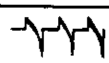
No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Current Irc OQ0063 (A401)	Hi = A401/3 Lo = 0-socket ⏚ **Select;** Function kΩ Range 1000Ω	≈ + 10μA Check if current can be adjusted with R411	Refer to C	Refer to B
B	A	Check R402, R404, R403 and tracks	R402, R404, R403	R402 = 121k R403 = 10k pot.meter R404 = 16k9	Defect OQ0063	Repair
C	A	Current Irx OQ0063 (A401)	Hi = A401/16 Lo = 0-socket ⏚ **Select;** Function kΩ Range 1000Ω	≈ + 1mA	Refer to D	Defect OQ0063
D	C	Voltage on Irx input OQ0063 (A401)	Hi = A402/16 Lo = 0-socket ⏚ **Select;** Function kΩ Range 1000Ω Shortcircuit VΩ and 0	≈ + 100mV	Defect OQ0063	Check R401 switches

6.7.3. Range 10MΩ cannot be adjusted (Adj. no. 15)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Vout OQ0063 (A401)	Hi = A401/8 Lo = 0-socket ⏚ **Select;** Range 1kΩ, 1kΩ connected to VΩ/0 (full scale)	− 2V Can be adjusted with R407 (Note down!)	Refer to F	V = positief, defect OQ0063 V = negative but incorrect. Refer to B
B	A	Voltage on slider contact of potentiometer R407	Hi = R407 slider contact Lo = 0-socket ⏚ **Select;** Range 1kΩ 1kΩ connected to VΩ/0 (full scale)	½ voltage measured at A (Note down!)	Refer to E	Refer to C
C	B	Check R406, R407, R408 and tracks	R406, R407, R408	R406 = 2k87 R407 = 100Ω pot.meter R408 = 2k87	Refer to D	Repair
D	C	Voltage on connection of R414, R415	Hi = Connection R414 R415 Lo = 0-socket ⏚ **Select;** Range 1kΩ, 1kΩ connected to VΩ/0 (full scale)	+ 0.9 . . . . + 1V	Refer to E	Defect V451 BY164

E	D	– Vin OQ0063 (A401)	Hi = A401/11 Lo = 0-socket ⏚ **Select;** Range 1kΩ, 1kΩ connected to VΩ/0 (full scale)	⅔ of voltage measured under B	Defect OQ0063	Check R405 and tracks
F	A	Voltage on connection of R412, R450 and OQ0063/10	Hi = A104/10 Lo = Connection R412, V450 **Select;** Range 1kΩ, 1kΩ connected to VΩ/0 (full scale)	≈0V	Defect OQ0063	Refer to G
G	F	Voltage on connection R414, R415	Hi = Connection R414, Lo = 0-socket ⏚ **Select;** Range 1kΩ, 1kΩ connected to VΩ/0 (full scale)	+ 0.9V . . . + 1V	Check; R405, tracks	Check; R414, R415, tracks ≈ + 0.5V; Defect V451, BY164

6.7.4. Deviation in the measured value

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Clock signal OQ0063 (A401)	Hi = A401/5 Lo = 0-socket ⏚ **Select;** kΩ function With oscilloscope	 ≈400mV 3kHz . . . 4kHz Note: In instruments with serialnumber DM 01 601 up to DM 01 1715 the clock signal is ≈1,3kHz	Refer to B	Refer to C
B	A	Deviation	Display	Factor 10 Small deviation	Refer to C Defect OQ0063	
C	B	Range information RNG A, RNG B, RNG C OQ0063	Hi = A401/13, RNG A Hi = A401/7 , RNG B Hi = A401/12, RNG C Lo = 0-socket ⏚ **Select;** Function kΩ MAN.ranging	RNG C B A 1k 1 1 1 10k 0 0 0 100k 0 0 1 1000k 0 1 0 10M 1 0 0 Logic 0 = – 8.5V Logic 1 = 0V ⏚	Defect OQ0063	Refer to D
D	C	Range information RNG A, RNG B, RNG C OQ0059	Hi = D101/8 RNG A Hi = D101/7 RNG B Hi = D101/6 RNG C Lo = 0-socket ⏚ **Select;** Function kΩ MAN. ranging	RNG C B A 1k 1 1 1 10k 0 0 0 100k 0 0 1 1000k 0 1 0 10M 1 0 0 Logic 0 = – 8.5V Logic 1 = 0V ⏚	Defect R401, R416, R417 or OQ0063 or tracks	Refer to 6.5. RANGING

6.7.5. 10MΩ range not linear

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	10kΩ range	Display **Select;** Range 10kΩ **Supply;** 1kΩ to VΩ/0	1000kΩ	Refer to 6.7.4.	Refer to 6.3.7. ADC

6.8. A ⎓ RANGES

6.8.1. Display constant 0000 in range 10A

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check switch (m)A ⎓ 15/16 and R603, R604, R607, R608	R603, R604, R607, R608 and switch (m)A ⎓ 15/16	R603 = 1,6Ω R604 = 249Ω R507 = 40kΩ R608 = 1kΩ	Check tracks	Repair

6.8.2. Range 10A ⎓ cannot be adjusted (Adj. no. 12)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check shunt R1 and soldering spots	R1	R1 = ≈ 12mΩ	Refer to B	Repair
B	A	Check R603, R604, R606 R607, R608, R610	R603, R604, R606, R607, R608, R610	R603 = 1.8Ω R604 = 249Ω R606 = 13k3 R607 = 40k2 R608 = 1kΩ R610 = 205k	Check tracks	Repair

6.8.3. Display constant zero in range 100mA

Check fuse F1 (315 mA) and the wiring

6.8.4. Range 100mA ⎓ cannot be adjusted (Adj. no. 19)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check R603	R603	1.8Ω ± 10%	Refer to B	Repair
B	A	Check R604, R606, R607, R608, R610	R604, R606, R607 R608, R610	R604 = 249Ω R606 = 13k3 R607 = 40k2 R608 = 1k R610 = 205k	Check tracks	Repair

6.9. A~ RANGES

6.9.1. Display constant 0000

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check ranges 100mA ⎓ Refer to 6.8.4.	—	—	Refer to B	Refer to 6.8. A ⎓ RANGES
B	A	Vin 1 of OQ0061 (A301)	Hi = A301/3 Lo = 0-socket ⏚ **Select;** Range 100mA~ **Supply;** 90.83 mV 60Hz to connection point of R606 / R607 and the 0-socket ⏚	90.83mV	Refer to C	Check C601 and switch (m)A~ 11/12
C	B	Check R303, R304 and tracks	R303, R304	R303 = 560k R304 = 4M7 pot. meter	Refer to 6.6 V~ RANGES	Repair

6.9.2. Range 100mA~ cannot be adjusted (Adj. no. 19)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check R610, R306, R303 and R304	R610, R306, R303, and R304	R303 = 560k R304 = 4M7 pot. meter R306 = 200k R610 = 205k	Defect C601	Repair

6.10. °C RANGE

6.10.1. Display constant 0000

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check the 1kΩ range	—	—	Check switches T1/2 and T11/12 and tracks	Refer to 6.7. Ω RANGES

6.10.2. °C range cannot be adjusted

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signal RNG C of OQ0063 (A401)	Hi = A401/12 Lo = 0-socket ⏚ **Select;** °C range	Logic 1 (0V)	Refer to B	Check switch T3/4 and tracks
B	A	Check the 1kΩ range	—	—	Refer to C	Refer to 6.7. Ω RANGES
C	B	Check R501, R502, R503, R504 and R505	R501, R502, R503, R504, R505	R501 = 215Ω R502 = 100Ω pot. meter R503 = 196Ω R504 = 909Ω R505 = 604Ω	Check tracks	Repair

6.11. ⏚ RANGE

6.11.1. Incorrect functionning

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check 1kΩ range	—	—	Refer to B	Refer to 6.7. Ω RANGES
B	A	Signal RNG C of OQ0063 (A401)	Hi = A401/12 Lo = 0-socket ⏚	Logic 1 (0V)	Check switch D13/14	Check switch D3/4 and tracks

6.12. STAND BY (40 sec.)

6.12.1. Stand by time is too long

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signal DS1 of OQ0059 (D101) and on R721	Hi = D101/1 Hi = R721, left hand side Lo = 0-socket ⏚ With oscilloscope	≈500Hz 0 −8.5V	Refer to B	Track interruption
B	A	Blank	Supply −8.5V to the cathode of diode V751 (logic 0) c a	Display should blank	Defect V705	Refer to C
C	B	Collector of transitor V706	Collector C706	Logic 0 (−8.5V)	Refer to E	Refer to D
D	C	Check R719, R720 and tracks to	R719, R720	R719 = 68k R720 = 82k	Defect V706	Repair
E	C	Blank signal ($\overline{BL}$) of HEF 4511 (D701)	Hi = 701/4 Lo = 0-socket ⏚	Logic 0 (−8.5V)	Defect D701	Trackinterruption

6.12.2. Stand by time is too short

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	On time	Display	t = 0 t = >0 but too short	Refer to B Check R721 (33M) C701 (680nF)	
B	A	Base transistor V706	Hi = V706 base Lo = 0-socket ⏚ **Depress;** Push button DISPLAY	0V	Refer to C	Defect V705 or track short-circuit
C	B	Check R719, R720 and tracks	R719, R720	R719 = 68kΩ R720 = 82kΩ	Defect V706 or tracks	Repair

6.13. DATA HOLD

6.13.1. Data hold does not function

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Signal DH OQ0059 (D101)	Hi = D101/18 Lo = 0-socket ⏚ Data hold function should be used (Interconnect point 5 of the probe input and the 0-socket ⏚)	Logic 1 (0V)	Defect OQ0059	Check R116, R117 and tracks

7. PARTS LIST

7.1. MECHANICAL

Description	*Ordering number*	*Qty.*	*Item*	*Fig.*
TOPCOVER	5322 447 94558	1	1	46
Window	5322 459 24094	1	2	46
Knob for power switch S2	5322 414 64098	1	3	46
Lock spring S2	5322 492 64675	1	4	46
Knob for function switch S1	5322 414 64099	1	5	46
Leaf spring S1	5322 492 64676	2	6	46
BOTTEM COVER (complete with screening)	5322 447 94492	1	7	47
Battery spring double	5322 492 64672	3	8	47
Special nut M3x6	5322 505 10574	2	9	47
Stand-up bracket	5322 405 94164	1	10	47
Rubber foot	5322 462 44148	2	11	47
BATTERY COVER (without feet)	5322 443 64026	1	–	
Rubber foot	5322 462 44148	2	11	47
INPUT BLOCK	5322 466 94555	1	12	48
Shutter	5322 443 64025	1	13	48
Spring	5322 492 64674	1	14	48
Fuseholder X4	5322 256 40017	1	15	48
Power input X6	4822 265 20051	1	16	48
PRINTED CIRCUIT BOARD				
Display board N2 (complete)	5322 216 94208	1	17	49
Power switch S2				
Body	5322 278 54001	2	18	49
Segment	5322 492 64628	2	19	49
Spring	5322 492 54291	2	20	49
Ring	4822 530 70122	2	21	49
Function switch S1				
Body	5322 405 94155	2	22	49
Segment	5322 492 64628	8	19	49
Spring	5322 492 54291	8	20	49
10 A Switch S7 (situated in 10 A socket)				
Switch block	5322 405 94163	1	23	49
Contact spring	5322 492 64673	1	24	49
Switch up/down/aut/displ S3/S6				
Switch	5322 276 14338	4	25	49
Switch knob	5322 414 26305	4	26	49
Input socket 0/VΩ/10 A, X1/X3	5322 268 24109	3	27	49
Shunt R1	5322 405 94165	1	28	49
Soldering pin 1 mm	5322 290 34004	20	29	49
Contact strip 29 pole	5322 265 54047	1	30	49
Transformer T801	5322 144 14011	1	31	49
Test pin red	5322 264 24013	1	–	–
Test pin black	5322 264 24014	1	–	–
Fuse 315 mA FAST SAND FILLED	5322 253 24009	1	–	–

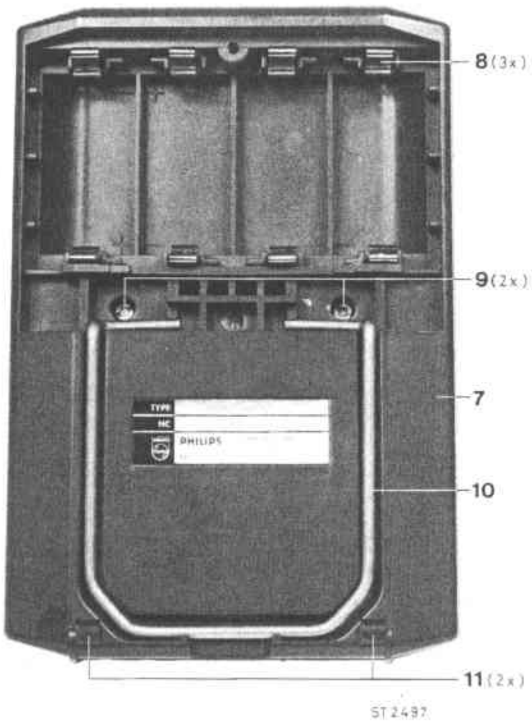


Fig. 46.

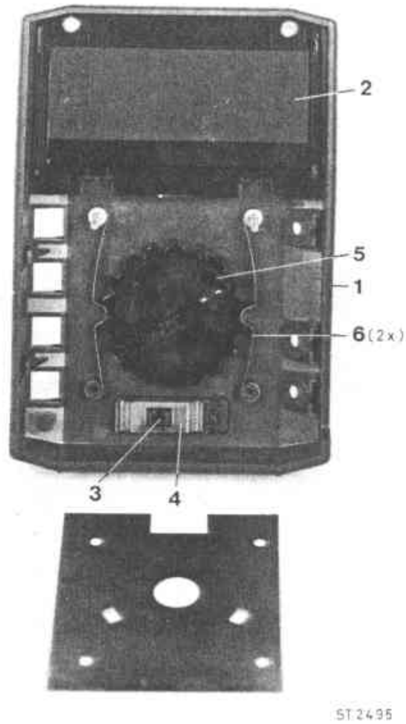


Fig. 47.

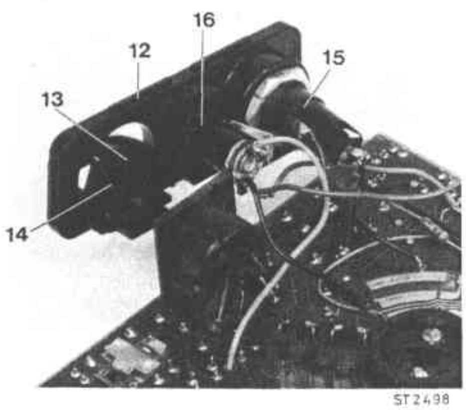


Fig. 48.

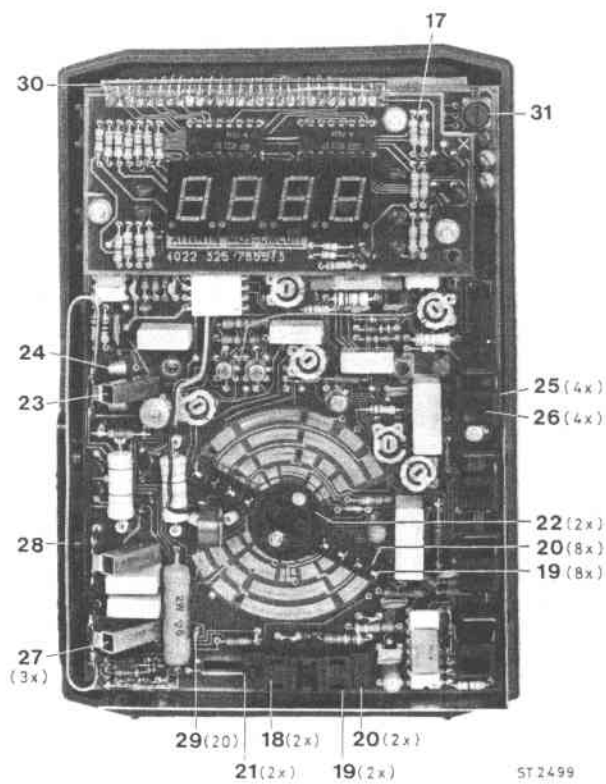


Fig. 49.

7.2. ELECTRICAL

7.2.1. Resistors

Item	*Ordering number*	*Ohm*	*Tol. (%)*	*Type*	*Remarks*
R104	4822 110 63045	4,7	5	CR25	Carbon
R105	5322 116 55266	10,2 k	0,1	MR24E	Metal film
R106	4822 100 10029	2.2 k	20	0.05 W	Trimming potm.
R108	5322 116 54188	1 M	0,5	MR30	Metal film
R109	5322 116 54188	1 M	0,5	MR30	Metal film
R110	5322 116 54552	1,05 k	1	MR25	Metal film
R111	5322 116 50731	10,5 k	1	MR25	Metal film
R113	5322 116 50749	1,4 k	0,5	MR24E	Metal film
R116	4822 110 63134	10 k	5	CR25	Carbon
R117	4822 111 30333	1 M	10	CR16	Carbon
R118	4822 110 63196	2,2 M	5	CR25	Carbon
R119	4822 110 63134	10 k	5	CR25	Carbon
R120	4822 111 30304	150 k	5	CR16	Carbon
R121	4822 110 63078	82	5	CR25	Carbon
R201	5322 111 34167	4,42 M	1	Spec.	Carbon
R202	5322 111 34167	4,42 M	1	Spec.	Carbon
R204	4822 100 10079	47 k	20	0.05 W	Trimming potm.
R205	5322 116 54615	9,09 k	0,5	MR25	Metal film
R206	4822 111 30333	1 M	10	CR16	Carbon
R207	4822 100 10075	100	20	0.05 W	Trimming potm.
R208	4822 110 63185	820 k	5	CR25	Carbon
R301	5322 116 55211	909 k	0,5	MR30	Metal film
R302	5322 116 55265	887 k	0,5	MR30	Metal film
R303	5322 111 30261	560 k	10	CR16	Carbon
R304	5322 101 14099	4,7 M	20	0.05 W	Trimming potm.
R305	5322 116 54228	1,78 k	0,1	MR24C	Metal film
R306	5322 116 54892	200 k	0,1	MR34E	Metal film
R307	5322 116 54218	3,01 k	0,1	MR24C	Metal film
R308	5322 116 54191	30,1 k	0,1	MR24C	Metal film
R309	5322 116 54732	237 k	1	MR25	Metal film
R310	5322 116 54619	10 k	1	MR25	Metal film
R312	4822 100 10029	2,2 k	20	0.05 W	Trimming potm.
R313	5322 116 54696	100 k	1	MR25	Metal film
R314	4822 111 30302	220 k	5	CR16	Carbon
R315	5322 116 50954	38,3 k	1	MR25	Metal film
R316	4822 110 63067	33	5	CR25	Carbon
R401	4822 116 40006	100	20	265 V	PTC
R402	5322 116 54072	121 k	0,1	MR34E	Metal film
R403	4822 100 10035	10 k	20	0.05 W	Trimming potm.
R404	5322 116 54833	16,9 k	0,5	MR24E	Metal film
R405	4822 110 63205	4,7 M	10	CR25	Carbon
R406	5322 116 55279	2,87 k	0,5	MR25	Metal film
R407	4822 100 10075	100	20	0.05 W	Trimming potm.
R408	5322 116 55279	2,87 k	0,5	MR25	Metal film
R409	4822 110 42214	10 M	1	VR37	Carbon
R410	4822 110 30302	220 k	5	CR16	Carbon
R412	4822 110 63129	6,8 k	5	CR25	Carbon
R413	4822 111 30263	3,3 k	5	CR16	Carbon
R414	4822 111 30313	5,62 k	5	CR16	Carbon
R415	4822 111 30313	5,62 k	5	CR16	Carbon
R416	4822 111 30302	220 k	5	CR16	Carbon
R417	4822 111 30302	220 k	5	CR16	Carbon

Item	*Ordering number*	*Ohm*		*Tol. (%)*	*Type*	*Remarks*
R501	5322 116 50457	215		0,5	MR25	Metal film
R502	4822 100 10075	100		20	0.05 W	Trimming potm.
R503	5322 116 50676	196		0,5	MR25	Metal film
R504	5322 116 54545	909		0,5	MR25	Metal film
R505	5322 116 54528	604		1	MR25	Metal film
R601	4822 116 30008	50		20	1 W	NTC
R602	5322 405 94165	12	m			Shunt
R603	5322 113 60097	1,8		10	2 W	Wire-wound
R604	5322 116 54499	249		1	MR25	Metal film
R606	5322 116 54627	13,3	k	1	MR25	Metal film
R607	5322 116 54665	40,2	k	1	MR25	Metal film
R608	4822 111 30269	1	k	5	CR16	Carbon
R610	5322 116 54727	205	k	1	MR25	Metal film
R701	4822 110 63103	680		5	CR25	Carbon
R702	4822 111 30308	120	k	5	CR16	Carbon
R703	4822 110 63092	270		5	CR25	Carbon
R704	4822 110 63092	270		5	CR25	Carbon
R705	4822 110 63092	270		5	CR25	Carbon
R706	4822 110 63092	270		5	CR25	Carbon
R707	4822 110 63092	270		5	CR25	Carbon
R708	4822 110 63092	270		5	CR25	Carbon
R709	4822 110 63092	270		5	CR25	Carbon
R710	4822 110 63103	680		5	CR25	Carbon
R711	4822 110 63103	680		5	CR25	Carbon
R712	4822 110 63092	270		5	CR25	Carbon
R713	4822 110 63092	270		5	CR25	Carbon
R714	4822 110 63092	270		5	CR25	Carbon
R715	4822 110 63103	680		5	CR25	Carbon
R716	4822 110 63103	680		5	CR25	Carbon
R717	4822 110 63103	680		5	CR25	Carbon
R718	4822 110 63103	680		5	CR25	Carbon
R719	4822 110 63156	68	k	5	CR25	Carbon
R720	4822 110 63158	82	k	5	CR25	Carbon
R721	4822 110 42227	33	M	5	VR37	Carbon
R722	5322 111 30291	68	k	5	CR16	Carbon
R723	4822 111 30274	12	k	5	CR16	Carbon
R724	4822 111 30274	12	k	5	CR16	Carbon
R725	4822 110 63163	120	k	5	CR25	Carbon
R726	4822 110 63069	39		5	CR25	Carbon
R727	4822 111 30333	1	M	10%	CR16	Carbon
R801	4822 110 63116	2,2	k	5	CR25	Carbon
R802	4822 110 63181	560	k	5	CR25	Carbon
R803	4822 110 63081	100		5	CR25	Carbon
R804	4822 110 63081	100		5	CR25	Carbon

7.2.2. Capacitors

Item	*Ordering number*	*Farad*	*Tol. (%)*	*Volts*	*Remarks*
C101	4822 122 31175	1 nF	10	100	Ceramic plate
C103	4822 121 40175	470 nF	10	100	Polyester foil
C104	4822 122 31072	47 pF	2	100	Ceramic plate
C105	4822 122 31176	390 pF	10	100	Ceramic plate
C106	4822 122 31176	390 pF	10	100	Ceramic plate
C108	4822 125 50077	5,5 pF		250	Trimmer
C109	4822 121 40232	220 nF	−20+80	100	Polyester foil
C110	4822 122 31125	4,7 nF	−20+80	40	Ceramic plate
C111	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C201	5322 121 44201	10 nF	10	630	Polyester foil
C202	5322 121 44025	33 nF	10	400	Polyester foil
C301	5322 121 44025	33 nF	10	400	Polyester foil
C302	5322 121 40233	680 nF	10	100	Polyester foil
C303	5322 124 14036	15 μF	−10+50	10	Electrolytic
C304	4822 122 31072	47 pF	2	100	Ceramic plate
C305	4822 122 31191	5,6 pF	0,25 pF	500	Ceramic plate
C306	4822 122 31189	4,7 pF	0,25 pF	500	Ceramic plate
C307	4822 122 31116	2,2 nF	10	500	Ceramic plate
C308	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C309	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C310	5322 121 40281	220 nF	10	400	Polyester foil
C311	4822 122 31175	1 nF	−20 +80	40	Ceramic plate
C ·01	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C402	4822 121 40238	33 nF	10	100	Polyester foil
C403	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C404	4822 122 30027	1 nF	−20+80	40	Ceramic plate
C405	4822 122 31125	4,7 nF	−20+80	40	Ceramic plate
C406	4822 122 30114	2,2 nF	−20+80	40	Ceramic plate
C407	4822 122 30114	2,2 nF	−20 + 80	40	Ceramic plate
C601	5322 124 14075	1 μF	−10+50	63	Electrolytic
C701	5322 121 40233	680 nF	10	100	Polyester foil
C702	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C703	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C704	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C705	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C706	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C707	4822 122 30103	22 nF	−20+80	40	Ceramic plate
C801	4822 124 20459	22 μF	−10+50	10	Electrolytic
C802	4822 124 20459	22 μF	−10+50	10	Electrolytic
C803	4822 124 20459	22 μF	−10+50	10	Electrolytic
C804	4822 124 20459	22 μF	−10+50	10	Electrolytic
C805	4822 122 31072	47 pF	2	100	Ceramic plate
C806	4822 124 20459	22 μF	−10+50	10	Electrolytic

7.2.3. Semi conductors

Item	Ordering number	Type/Description
V101	5322 130 44509	BFQ16
V102	5322 130 44405	ON528
V150	5322 130 40482	BRY39
V201	5322 130 34044	BSV80
V301	5322 130 44744	BF256B
V302	5322 130 44744	VF256B
V350	5322 130 34174	BZX79-C4V7
V450	4822 130 30414	BY164
V451	4822 130 30414	BY164
V701	4822 130 40938	BC548
V702	4822 130 40938	BC548
V703	4822 130 40938	BC548
V704	4822 130 40938	BC548
V705	5322 130 44418	BF256A
V706	4822 130 40941	BC558
V707	4822 130 40941	BC558
V750	4822 130 30914	CQY54
V751	4822 130 30613	BAW62
V752	4822 130 30914	CQY54
V753	4822 130 30914	CQY54
V754	4822 130 30914	CQY54
V755	4822 130 30914	CQY54
V756	5322 130 34737	HP5082 - 7760
V757	5322 130 34737	HP5082 - 7760
V758	5322 130 34737	HP5082 - 7760
V759	5322 130 34737	HP5082 - 7760
V760	4822 130 30613	BAW62
V761	4822 130 30613	BAW62
V801	4822 130 40941	BC558
V802	4822 130 44246	BC549C
V850	5322 130 34297	BZX79 - B10
V851	4822 130 30613	BAW62
V852	4822 130 30613	BAW62
V853	4822 130 30613	BAW62
V001	5322 130 34049	BZX75-C2V1

7.2.4. Integrated circuits

Item	Ordering number	Type/Description
D101	5322 209 85853	OQ 0059
D703	5322 209 85852	OQ 0055
D702	5322 209 14188	HEF4555BP
D701	5322 209 14122	HEF4511BP
A101	5322 209 85884	OQ0060
A102	5322 209 85887	OQ0064
A301	5322 209 85885	OQ0061
A401	5322 209 85886	OQ0063

7.3. MODIFICATIONS IN PM2517E

Between DM01 601 and DM01 1715	Replaced	C101	820p	100V	10%	4822 122 30031 replaced by
			1n	100V	10%	4822 122 31175
		C402	100n	100V	10%	4822 121 40036 replaced by
			33n	100V	10%	4822 121 40238
	Added	C406	2n2	40V	−20+80	4822 122 30114
	Cancelled	V452	BZX79	C13		5322 130 34195
	Replaced	V802	BC548			4822 130 40938 replaced by
			BC549C			4822 130 44246
		R118	1M	CR25	10%	4822 110 63187 replaced by
			2M2	CR25	10%	4822 110 63196
	Replaced	R310	10k5	MR25	1%	5372 116 50731 replaced by
			9k09	MR25	1%	5322 116 54615
		R313	48k7	MR25	1%	5322 116 50442 replaced by
			10k	MR25	1%	5322 116 54619
DM01 900 onwards	Added	Stabistor V001 = BZX75C2V1, 5322 130 34049				
	Reason	Drifting of OQ0046 due to heath. From the 9V of the external power supply ≈ 3V is dissipated in the power supply, causing heath near the OQ0064. By means of the stabistor about 2V is already dissipated near the power input terminal.				
DM01 1715 onwards	Replaced	R610	249k	MR25	1%	5322 116 54734 replaced
			205k	MR15	1%	5322 116 54/27
		C305	3.9p	500V± 0.25p		4822 122 31217 replaced by
			5.6p	500V± 0.25p		4822 122 31191
		C306	3.9p	500V± 0.25p		4822 122 31217
			4.7p	500V± 0.25p		4822 122 31189
		C307	1.2n	500V, 10		4822 122 31171 replaced by
			2.2n	500V, 10		4822 122 31116
	Change	Track C601 to A301/15 is cut C601 is connected to A301/9 V350 is not needed anymore				
	Reason	Pickup (hand) when measuring mains currents (AC).				
	Replaced	R104	10 Ω	CR25		4822 110 63054 replaced by
			4.7Ω	CR25		4822 110 64045
		C103	220nF	100V± 10		4822 121 30031 replaced by
			470nF	100V± 10		5322 122 40175
	Reason	Overloading of OQ0060				
	Replaced	R406	13k3	MR25	0.5%	5322 116 54627 replaced by
			2k87	MR25	0.5%	5322 116 55279
		R407	470 Ω	0.05W	20%	4822 100 10038 replaced by
			100 Ω	0.05W	20%	4822 100 10075
		R408	13k3	MR25	0.5%	5322 116 54627 replaced by
			2k87	MR25	0.5%	5322 116 55279
		R412	47k	CR25		4822 110 63152 replaced by
			6k8	CR25		4822 110 63129
	Add	R414	5k62	CR16	5%	4822 111 30313
		R415	5k62	CR16	5%	4822 111 30313
	Reason	Leakage of safety rectifiers V450/V451 causing deviation in 10 MΩ range.				

DM01 2000 onwards	Replaced : C303 15μ 4V −10+50 4822 124 20579 replaced by 15μ 10V −10+50 5322 124 14036 Reason : Better quality of electrolytic capacitors
DM02 4926 onwards	**New p.c. board N1** Replaced : C601 1μ 63V −10+50 4822 124 20624 replaced by 1μ 63V −10+50 5322 124 14075 Reason : Better quality of electrolytic capacitors
	Modified : RANGING circuit; Resistor R724 is connected to logic 0 (−8,5V) Signal FC is connected to the kg input of V150 via the new resistor R727. Reason : PM2517 is set to manual ranging, when the instrument is switched-on or switched from a single-range function to a multi range function
	Modified : OQ0065 power supply; Vss C (pin 4) is connected to −8,5V via the kΩ, D,T function switch. Reason : The OQ0063 is only switched on now in the kΩ, D and T function
	Added : R416 and R417 220k 5% CR16 4822 111 30302
	Replaced : R310 9k09 MR25 1% 5322 116 54615 is replaced by 10k MR25 1% 5322 116 54619 R313 10k MR25 1% 5322 116 54619 is replaced by 100k MR25 1% 5322 116 54696
	Added : C311 1nF 40V −20+80 4822 122 31175
	Modified : C304 is connected to +8,5V instead of ⏚
	Replaced : V850 BZX79-C10 5322 130 34297 is replaced by BZX79-B10 5322 130 34297
DM03 572	Wire from p.c. board to screening is replaced by a spring
DM03 6131	Replaced : Topcover 5322 447 94493 is replaced by 5322 447 94558 Window 5322 459 24086 is replaced by 5322 459 24094 Reason : New text lay-out, MAN replaced by Δ

GENERAL

OQ0064 Drift

Tempory solution : Change adjustments.
All adjusting data have to be changed from 9000 to 8990 digits untill ceramic IC's is used.

Final solution : Ceramic OQ0064

Flash over }
Short circuit } **Between PTC R401 and screening in the Ω ranges**

Tempory solution : Insulation tape glued on the screening above the PTC and input terminals (DM01 1800 onwards).

Final solution : PTC mounted lower (on p.c. board) from DM01 4926 on. Insulation tape.

New OQ0063 Pin 17 is internally interconnected now Capacitor C407 22nF 4822 122 30114 is added and connected to pin 17 and ⏚
The ordering number of the OQ0063 remains 5322 209 85886.

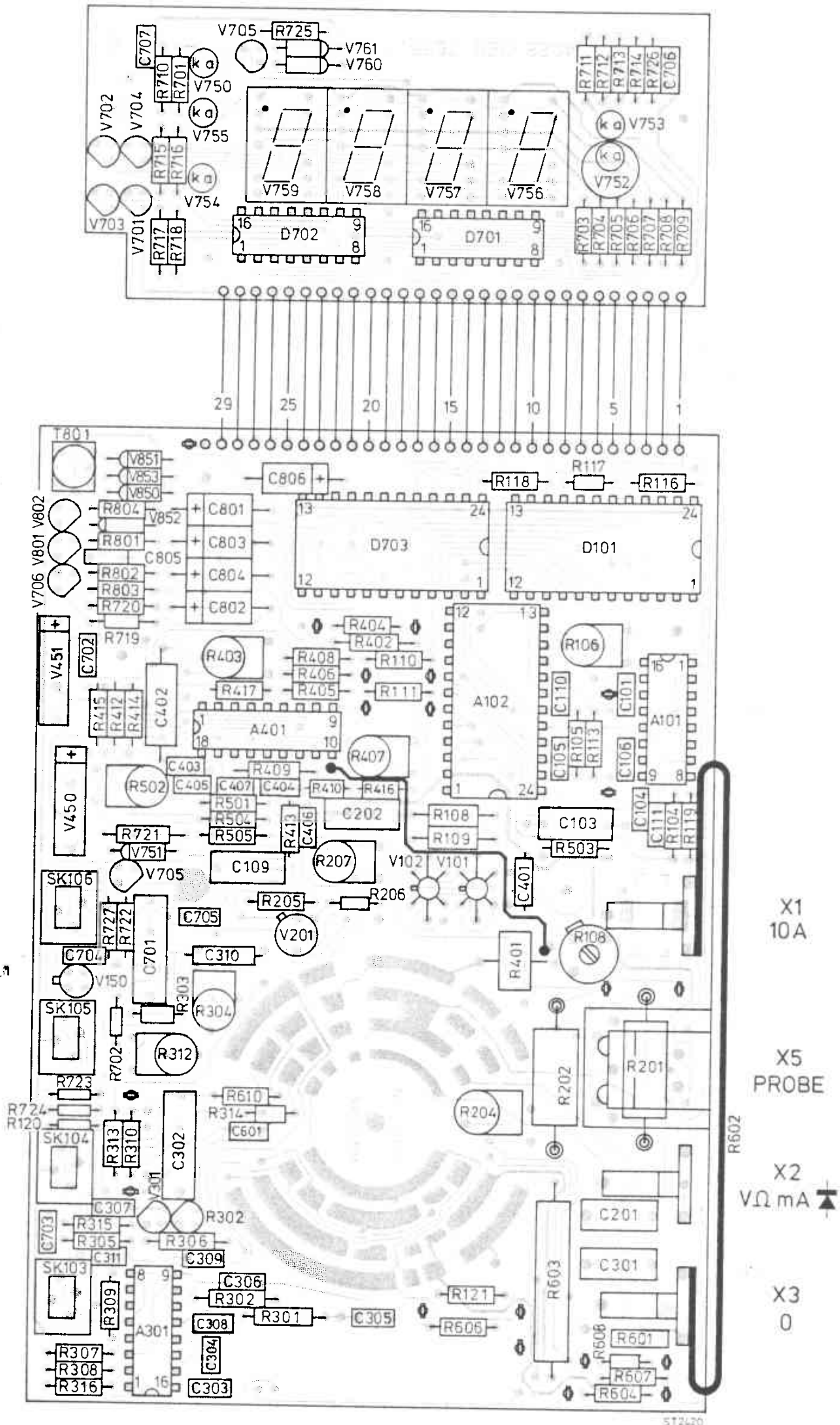


Fig. 51. P.c. boards conductor side

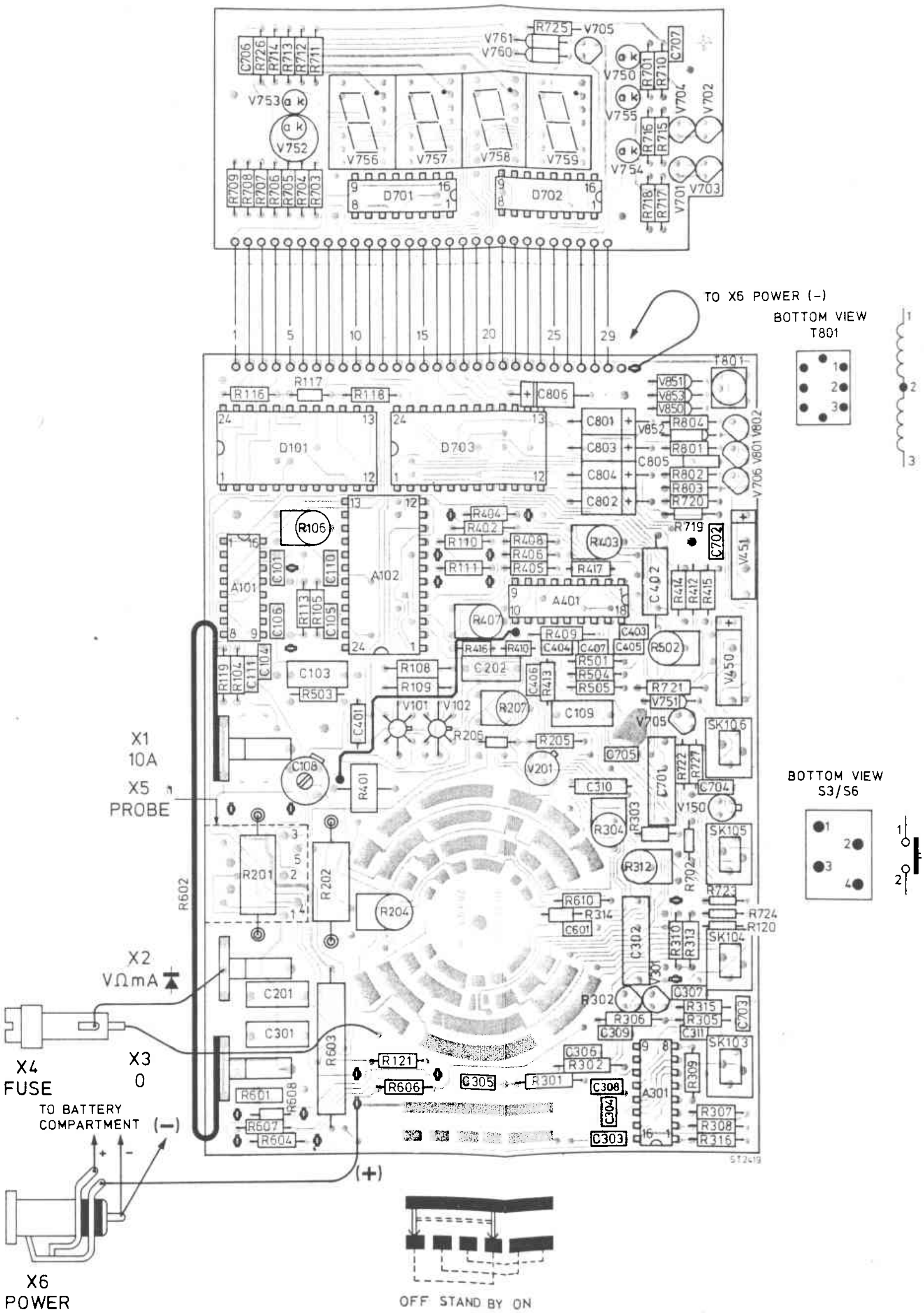


Fig. 50. P.c. boards component side

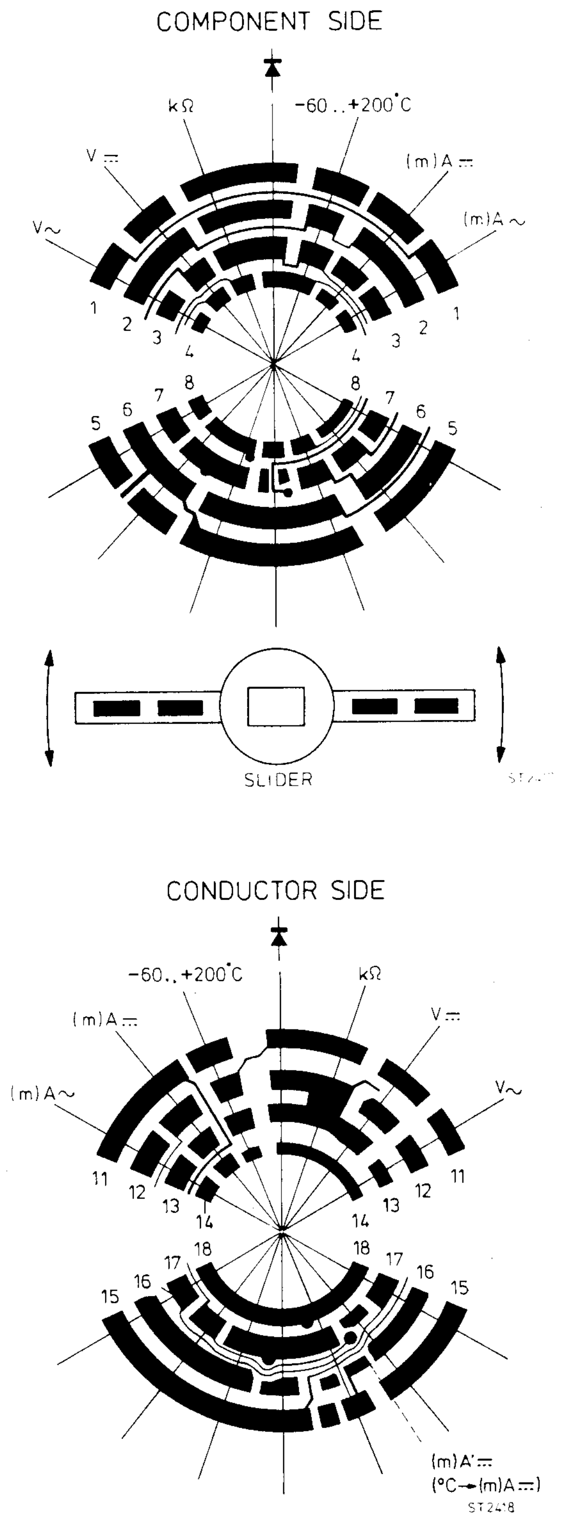


Fig. 52. Function switch lay-out

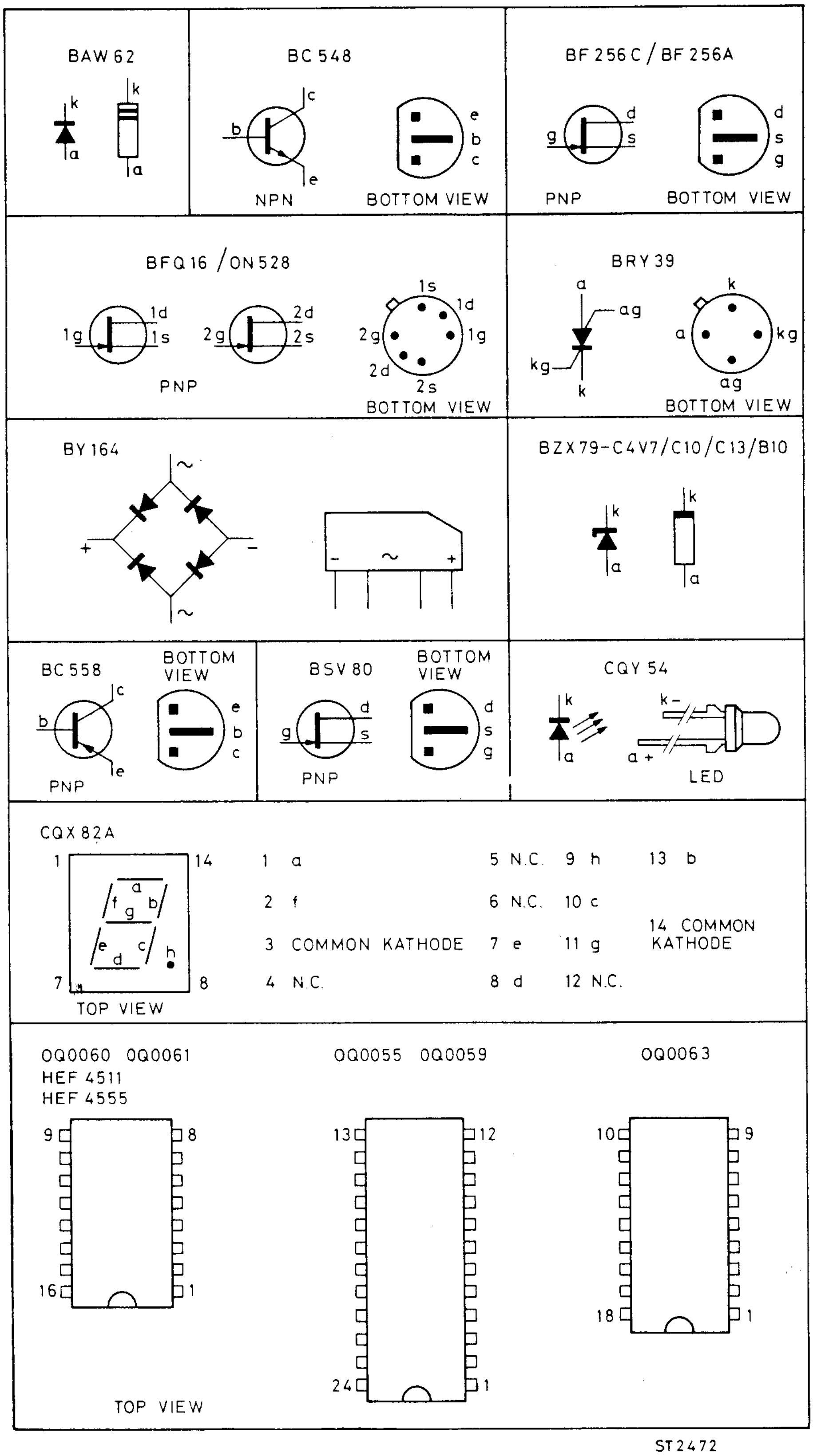
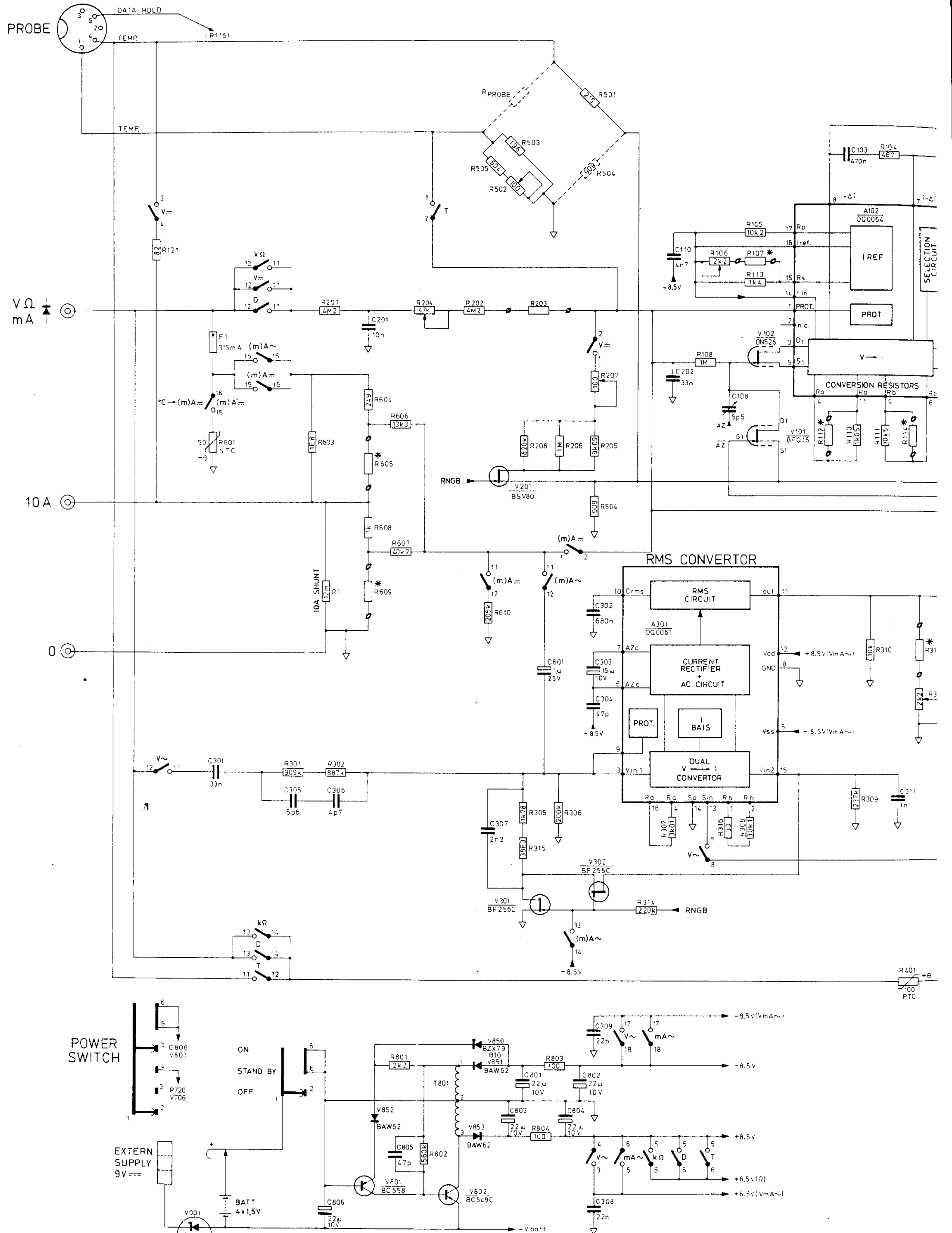
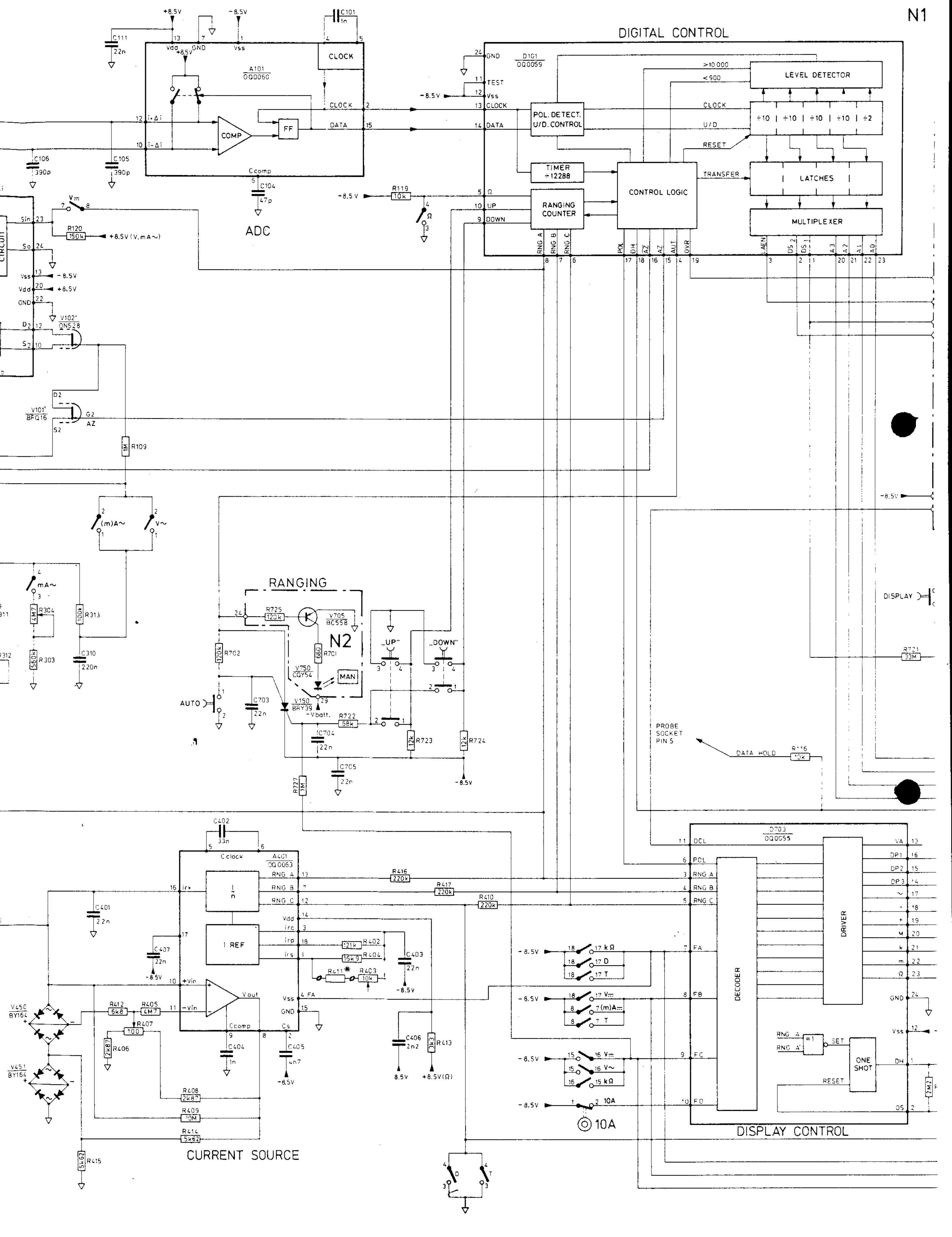


Fig. 53. Survey of used components in the PM 2517



PROBE
DATA HOLD
(R116)
TEMP
TEMP
RPROBE
R501
R503
R505
R502
R504
R121
VΩ
mA
10 A
0
F1
3'5mA
(m)A~
(m)A⎓
°C → (m)A⎓
(m)A'⎓
R601
NTC
R603
R604
R606
R605
R608
R607
R609
10A SHUNT
R1
R201
C201
R204
R202
R203
R207
R208
R206
R205
RNGB
V201
BSV80
R504
R610
C601
C110
R105
R106
R107
R113
R108
C202
V102
ON528
C108
V101
BFQ16
C103
R104
A102
OQ0064
IREF
PROT
V → I
CONVERSION RESISTORS
SELECTION CIRCUIT
R112
R110
R111
R114
RMS CONVERTOR
RMS CIRCUIT
A301
OQ0061
CURRENT RECTIFIER + AC CIRCUIT
PROT.
I BAIS
DUAL V → I CONVERTOR
C302
C303
C304
R310
R309
C311
C301
R301
R302
C305
C306
C307
R305
R306
R315
R307
R316
R308
V302
BF256C
V301
BF256C
R314
RNGB
R401
PTC
POWER SWITCH
C806
V801
R720
V706
ON
STAND BY
OFF
EXTERN SUPPLY 9V⎓
BATT 4x1,5V
V001
BZX75 C2V1
V850
BZX79 B10
V851
BAW62
R801
R803
T801
C801
C802
C803
C804
V852
BAW62
V853
BAW62
R804
C805
R802
V801
BC558
V802
BC549C
C806
C309
C308
-8,5V(VmA~)
-8,5V
+8,5V
+8,5V(Ω)
+8,5V(VmA~)
-Vbatt


N1
DIGITAL CONTROL
CLOCK
A101
OQ0060
COMP
FF
ADC
D101
OQ0059
LEVEL DETECTOR
POL. DETECT.
U/D. CONTROL
TIMER
÷12288
CONTROL LOGIC
RANGING
COUNTER
LATCHES
MULTIPLEXER
TRANSFER
RESET
RANGING
N2
MAN
AUTO
"UP"
"DOWN"
PROBE
SOCKET
PIN 5
DATA HOLD
DISPLAY
A401
OQ0063
1 REF
CURRENT SOURCE
D703
OQ0055
DECODER
DRIVER
ONE
SHOT
DISPLAY CONTROL
10A

1 N2

LOGIC 0= -8.5V
LOGIC 1 = 0V
WITH RESPECT
to ⏚

PART NUMBERS
100 .. 199 = ADC
200 .. 299 = V⎓INPUT CIRCUIT
300 .. 399 = V~INPUT CIRCUIT+RMS CONVERTOR
400 .. 499 = Ω INPUT CIRCUIT
500 .. 599 = °C INPUT CIRCUIT
600 .. 699 = A⎓, A~INPUT CIRCUIT
700 .. 799 = DIGITAL PART
800 .. 899 = POWER SUPPLY

*

ADJUSTING RESISTORS		
ITEM	VALUE	SERIES
R107	9k53 .. 16k2	MR25, 1%, E48 SERIES
R112	9k53 .. 12k4	
R114	95k .. 124k	
R203	20k5 .. 205k	
R311	24k9 .. 42k2	
R411	68k1 .. 562k	
R605	806 .. 1k96	
R609	187 .. 14k7	

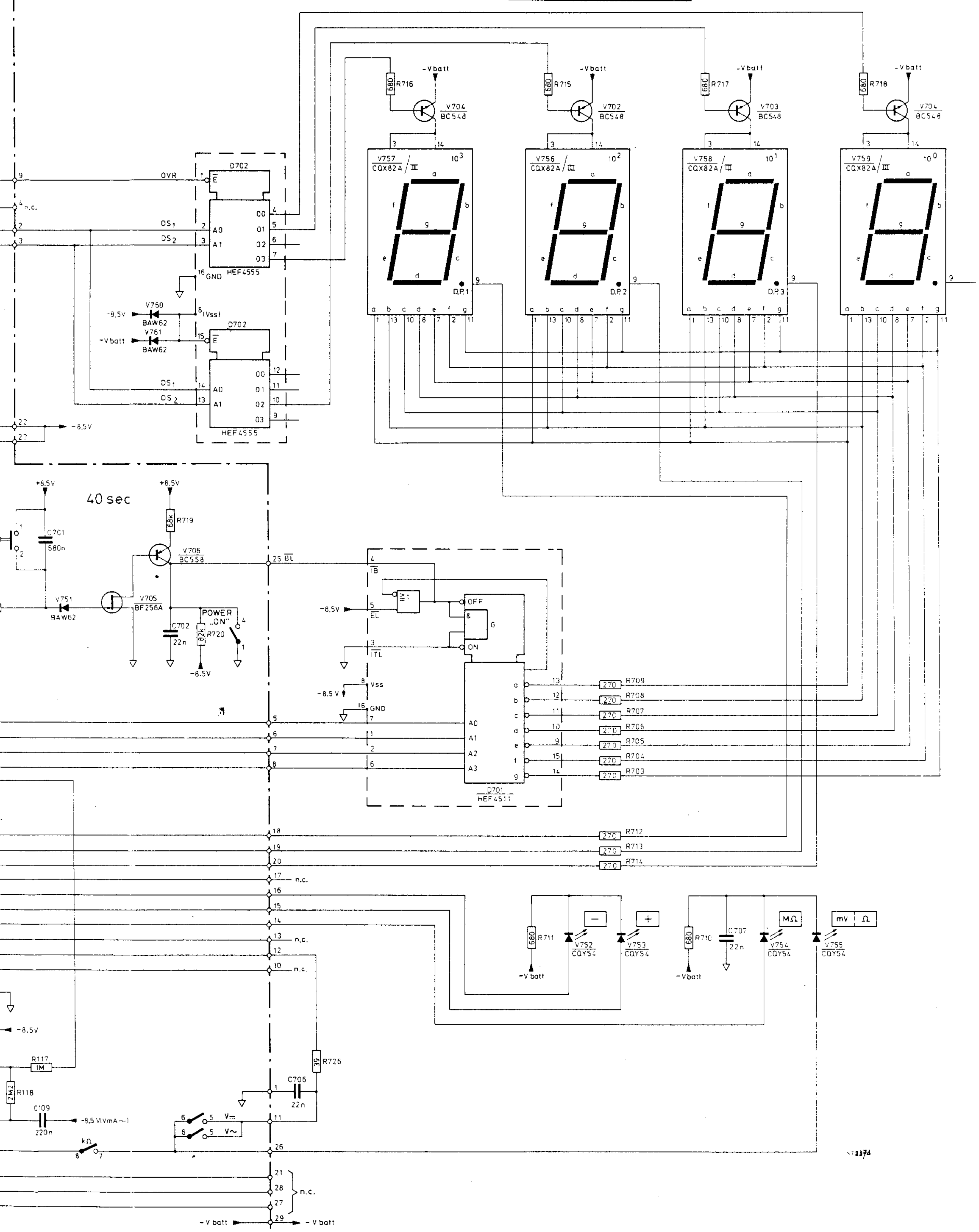


Fig. 54. Circuit diagram. **Note:** The circuit diagram shows the PM 2517E from serial number DM01 4926 onwards. For modifications in the earliar instruments refer to chapter 7.3.