

6108

Automatic Digital Multimeter

PM2517E DM02 4926

PM2517X DM01 3051

Service Manual

9499 475 01311

790507

S&i

Scientific & Industrial equipment division



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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

Instrument versions Documentation		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 malfunctioning 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.

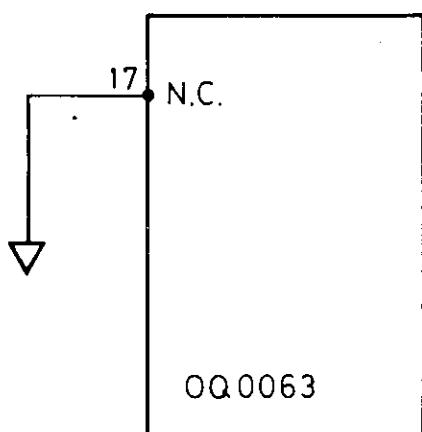
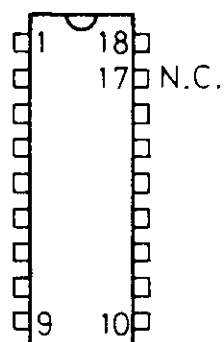
To avoid problems with the Ω -function, pin 17 of the OQ 0063 should be cut-off when using them in the earlier PM 2517.

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Old OQ 0063

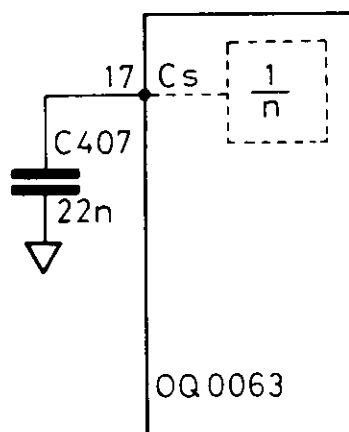
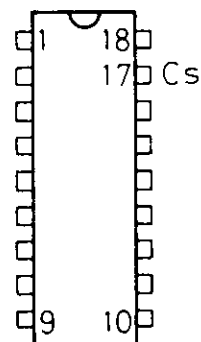
E DM01 600 - DM02 4926
X DM01 600 - DM01 3051



(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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PM2517 E/X

SME84

Already issued : SME 83

- Re : 1. Starting problems OQ0063
: 2. Battery cover
: 3. Predeflection in the mA $\overline{=}$ range
: 4. Incorrect reading in the mA ranges

1. Starting problems OQ0063.

- Error description

- If the PM2517 is switched-on in the function Ω , μ or $^{\circ}\text{C}$ with open input or $R_x > 800\Omega$, 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 $V_{\overline{=}}$, $V_{\sim}$, $\text{mA}_{\overline{=}}$ or $\text{mA}_{\sim}$ 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).

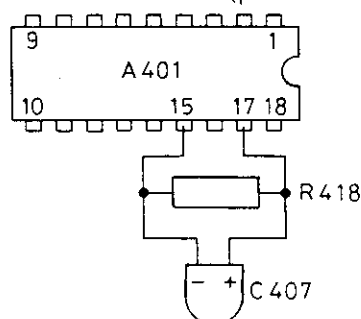
- Remedy

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 ($\downarrow$) of the OQ0063 an electrolytic capacitor of 15 μF , 10V in parallel with a resistor of 68 k Ω , CR16.
(pin 17 of the OQ0063 should be cut off, refer to SME83).



R418 = 68 k Ω , CR16 5322 111 30291

C407= 15 μF , 10V 5322 124 14036

9499 478 10811

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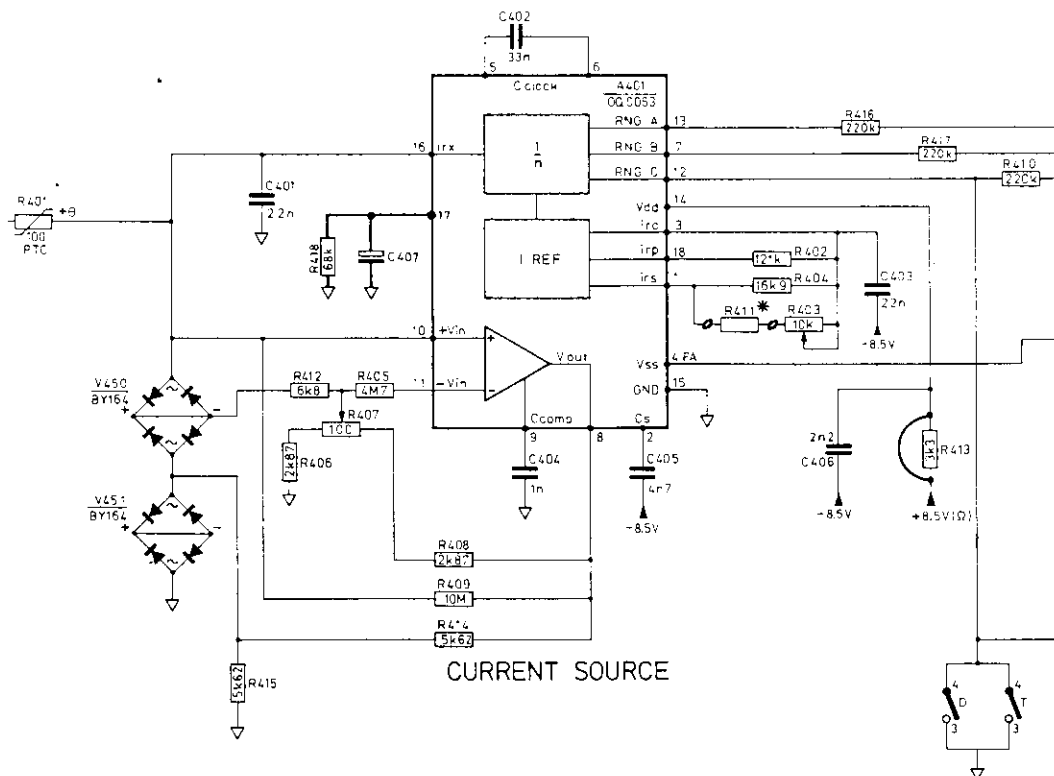
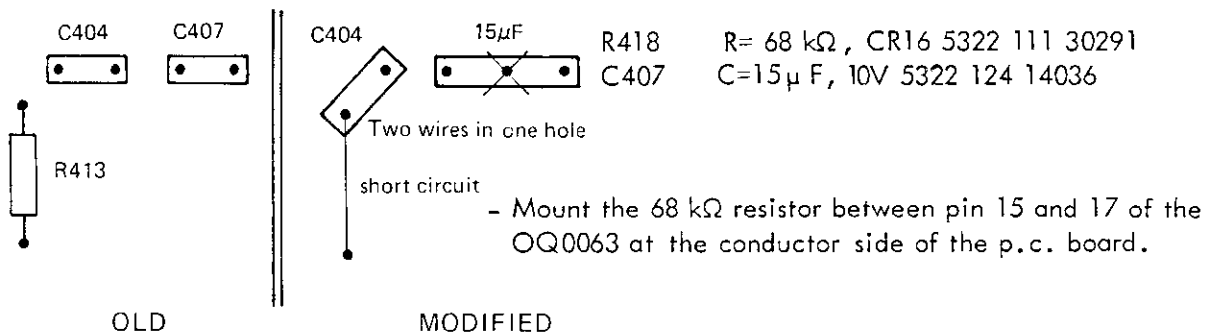
PM 2517E DM 02 4926 - DM 04 10491
PM 2517X DM 01 3051 - DM 04 8611

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 $\downarrow$ an electrolytic capacitor of $15\mu F$ in parallel with a resistor of $68 k\Omega$ 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 ($15\mu F$) on the p.c. board again (see figure).



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 circuit diagram 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 remains 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 $\rightarrow$ range.

- Error description

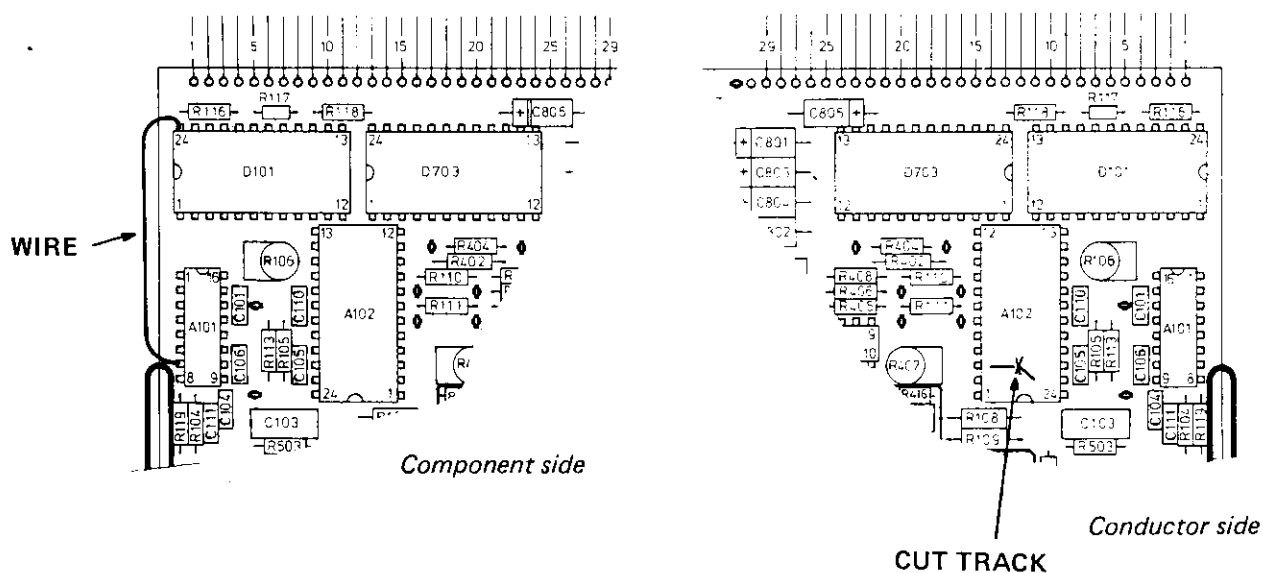
In the mA $\rightarrow$ range the PM 2517 has a predeflection of 2 digits at shortcircuited input.

- 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.





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800408

PM 2517X

SME 85

Already issued: SME 83

SME 84

Re: New LX display

— Documentation survey

Instrument versions	E DM01 600 – DM02 4926				
	X DM01 600 – DM01 3051				
Documentation	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 existing display.

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

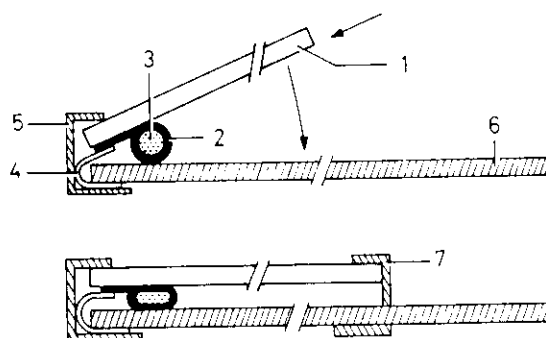
In addition to the new LX display a wire is soldered between the soldering bulb on the LX display and N1 pin 3.

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OLD SITUATION
PM2517X DM01 600 – DM07 17361

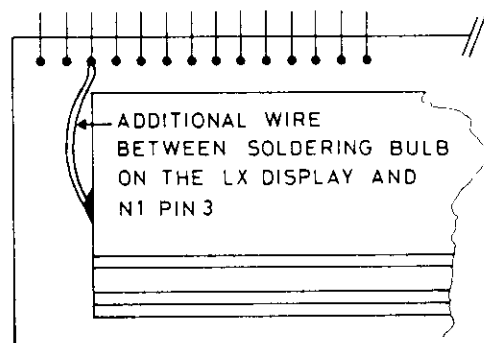
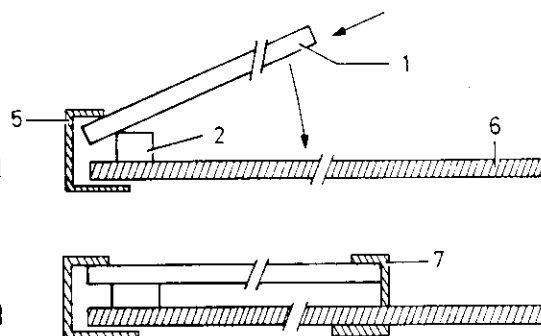
- 1= LX display (5322 130 94011 obsolete)
- 2= Flexible interconnection strip
- 3= Rubber roller
- 4= Tape
- 5= Large fixing clip
- 6= Display unit
- 7= Fixing clip 2x
- 8= Positioning hook



ST 2541

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 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

Instrument versions Documentation	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 $^{\circ}\text{C}$ with open input or $R_x > 800 \Omega$, 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 $V\text{---}$, $V\sim$, $\text{mA}\text{---}$ or $\text{mA}\sim$ 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 SME83).

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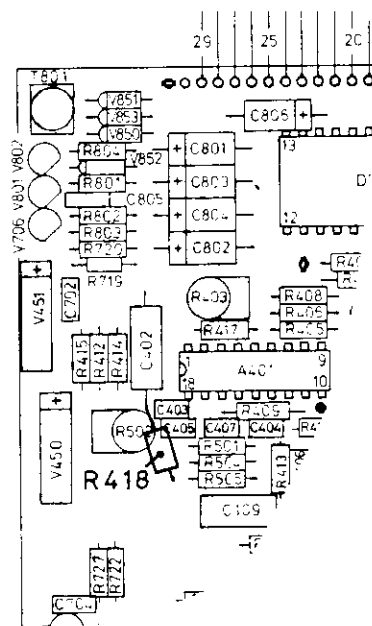
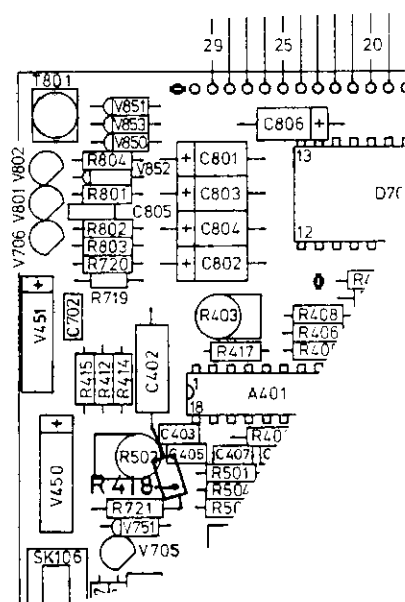
— Remedy

PM2517E DM01 600 – DM04 10491

PM2517X DM01 600 – DM04 8611

Only when the OQ0063 is replaced by a new type (weeknumber $\geq$ 7919) the following modifications must be built-in:

- Short circuit resistor R413
- Place a resistor of 220 k Ω , 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 μ F 10V 5322 124 14036 by a capacitor of 22nF, 4822 122 30103 Ceramic plate
- Place a resistor of 220 k Ω , 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 Adj. resistor R107, coarse.
changed into: (MR25, 1%, E48 series)
 Potentiometer R106, fine.

Adjustment NO.11 must be omitted.

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PM 2517E

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PM 2517X

105

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)

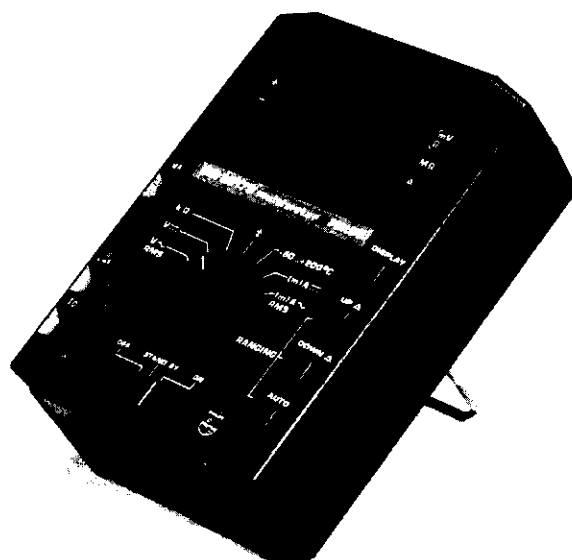
Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez TOUJOURS indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

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 continus. 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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1. TECHNICAL DATA

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

1.1. ELECTRICAL SPECIFICATIONS

1.1.1. D.C. voltage measurements

Range	100 μ V . . . 1000 V 4 sub-ranges: 999.9 mV; 9.999 V; 99.99 V; 999.9 V
Resolution	100 μ V
Accuracy	$\pm 0.2\%$ of reading $\pm 0.05\%$ of full scale
Temperature coefficient	300 ppm/ $^{\circ}$ C of reading
Input impedance	

Range	Input impedance
999.9 mV 9.999 V	10 M Ω $\pm 1\%$
99.99 V 999.9 V	9 M 01 $\pm 1\%$

Protected up to	1000 V . . . or 1000 V $\sim$ rms 1400 V peak
-----------------	--

1.1.2. A.C. voltage measurements

Range	100 μ V . . . 1000 V 4 sub-ranges: 999.9 mV; 9.999 V; 99.99 V; 999.9 V
Resolution	100 μ V
Accuracy	$\pm 0.5\%$ of reading $\pm 0.1\%$ of full scale (50Hz) Valid $> 1\%$ of range
Frequency influence	Additional error

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

Temperature coefficient	300 ppm/ $^{\circ}$ C of reading
-------------------------	----------------------------------

Input impedance	
Range	Input impedance
999.9 mV 9.999 V	2 M Ω $\pm 1\%$
99.99 V 999.9 V	1 M 802 $\pm 1\%$

AC-DC conversion	True RMS
Crest factor	2 at end of range
Protected up to	600 V $\sim$ rms + 400 V . . . 1400 V peak

1.1.3. D.C. current measurements

Range
 $10\ \mu\text{A}$ - $100\ \text{mA}$
 $1\ \text{mA}$ - $10\ \text{A}$
 2 fixed ranges with separate inputs; $99.99\ \text{mA}$
 $9.999\ \text{A}$

Resolution

Range	Resolution
$99.99\ \text{mA}$	$10\ \mu\text{A}$
$9.999\ \text{A}$	$1\ \text{mA}$

Accuracy

 $\pm 0.5\%$ of reading $\pm 0.1\%$ of full scale

Temperature coefficient

 $500\ \text{ppm}/^{\circ}\text{C}$ of reading

Voltage drop over shunt

Range	Voltage drop
$99.99\ \text{mA}$	$< 200\ \text{mV}$
$9.999\ \text{A}$	$< 150\ \text{mV}$

Protected up to

Range	Protection
$99.99\ \text{mA}$	Fuse $315\ \text{mA}$ quick $250\ \text{V rms}$
$9.999\ \text{A}$	No protection

1.1.4. A.C. current measurements

Range
 $10\ \mu\text{A}$ - $100\ \text{mA}$
 $1\ \text{mA}$ - $10\ \text{A}$
 2 fixed ranges with separate inputs; $99.99\ \text{mA}$
 $9.999\ \text{A}$

Resolution

Range	Resolution
$99.99\ \text{mA}$	$10\ \mu\text{A}$
$9.999\ \text{A}$	$1\ \text{mA}$

Accuracy

 $\pm 0.8\%$ of reading $\pm 0.1\%$ of full scale at $50\ \text{Hz}$ input signal

Temperature coefficient

 $500\ \text{ppm}/^{\circ}\text{C}$ of reading

Voltage drop over shunt

Range	Voltage drop
$99.99\ \text{mA}$	$< 200\ \text{mV}$
$9.999\ \text{A}$	$< 150\ \text{mV}$

Protected up to

Range	Protection
$99.99\ \text{mA}$	Fuse $315\ \text{mA}$ quick $250\ \text{V rms}$
$9.999\ \text{A}$	No protection

1.1.5. Resistance measurements

Range
 $0.1\ \Omega$ $10\ \text{M}\ \Omega$
 5 sub-ranges: $999.9\ \Omega$; $9.999\ \text{k}\Omega$; $99.99\ \text{k}\Omega$
 $999.9\ \text{k}\Omega$; $9.999\ \text{M}\ \Omega$

Resolution

 $0.1\ \Omega$

Accuracy

Range	$\pm\%$ of reading	$\pm\%$ of full scale
$999.9\ \Omega$	± 0.5	± 0.1
$9.999\ \text{k}\Omega$		
$99.99\ \text{k}\Omega$		
$999.9\ \text{k}\Omega$	± 1	± 0.1
$9.999\ \text{M}\ \Omega$		

Temperature coefficient

Range	Temp. coefficient
999.9 Ω	300 ppm/ $^{\circ}\text{C}$ of reading
9.999 $\text{k}\Omega$	
99.99 $\text{k}\Omega$	
999.9 $\text{k}\Omega$	
9.999 $\text{M}\Omega$	500 ppm/ $^{\circ}\text{C}$ 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 $-60^{\circ}\text{C} \dots +200^{\circ}\text{C}$ Accuracy
(Probe combined with PM 2517)

Range	$\pm$ % of reading	$\pm$ $^{\circ}\text{C}$
$-60^{\circ}\text{C} \dots +100^{\circ}\text{C}$	1	2
$+100^{\circ}\text{C} \dots +200^{\circ}\text{C}$	+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 , $\text{M}\Omega$ by LED's
V, $\text{k}\Omega$, $^{\circ}\text{C}$, (mA) by function selectorFunction indication V $\overline{\text{---}}$, V $\sim$, $\text{k}\Omega$, $^{\circ}\text{C}$, (mA) $\overline{\text{---}}$, (mA) $\sim$ by function selectorInputs Combined V, mA, Ω socket
Common socket
Special 10A input socket
Floating inputsRange selection Automatic : for function V and Ω
Manual : for all rangesSeries 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 $\overline{\dots}$, A $\overline{\dots}$, °C	max. 1 sec.
V $\sim$ A $\sim$	max. 1 sec.
Ω ∇	max. 1 sec.

With ranging

Function	Response time
V $\overline{\dots}$	max. 3 sec.
V $\sim$	max. 5 sec.
Ω	max. 6 sec.

Recovery time

max. 3 sec.

Data hold

Via probe input

Climatic conditions

Reference temperature $\pm 23\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$
 Rate range of use $-10\text{ }^{\circ}\text{C} \dots +55\text{ }^{\circ}\text{C}$
 Specified range $0\text{ }^{\circ}\text{C} \dots +45\text{ }^{\circ}\text{C}$
 Limit range of storage $-40\text{ }^{\circ}\text{C} \dots +70\text{ }^{\circ}\text{C}$
 and transport
 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 $\approx 0.7\text{ kg}$ (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.

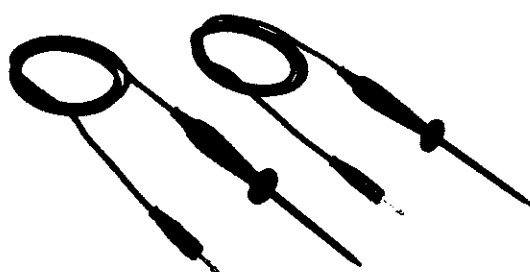
Note: Some instruments with serial numbers DM600 upto DM900 are already equipped with a voltage regulator diode as shown in figure 1. For these instruments proceed as for instruments with serial numbers greater than DM900.

- 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



SF10J8



SF10J9

- 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)**

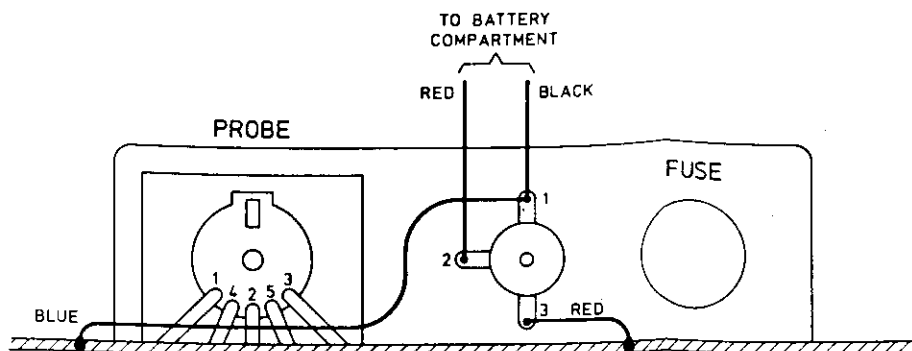
The resistance thermometer PM 9248 is a contact probe, suitable for measurement of surface temperatures between -60°C and $+200^{\circ}\text{C}$.

Range	-60°C to $+200^{\circ}\text{C}$		
Resolution	0.1°C		
Accuracy (combined with PM 2517)	— 60°C to $+100^{\circ}\text{C}$	$\pm 1\%$ of reading	$\pm 2^{\circ}\text{C}$
	+ 100°C to $+200^{\circ}\text{C}$	$+ 1\%$ to -3% of reading	$\pm 2^{\circ}\text{C}$
Permissible voltage at probe tip	60 V		

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

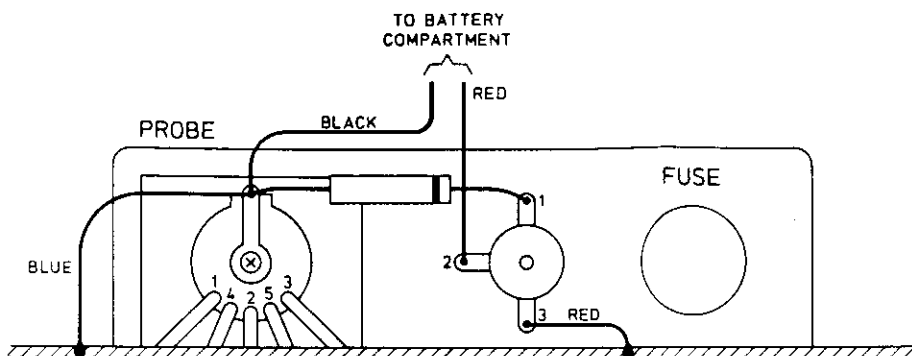
The PM 9263 is a DATA HOLD probe which can be used in combination with multimeters which have a data hold facilities on the 5-pole DIN probe input. A switch ring on the probe is pushed forward to hold the data for display. Depending on the multimeter, voltage, resistance and current measurements can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

DRY CELL BATTERIES OR 9V EXTERNAL POWER SUPPLY PM 9218



PM 2517E/01

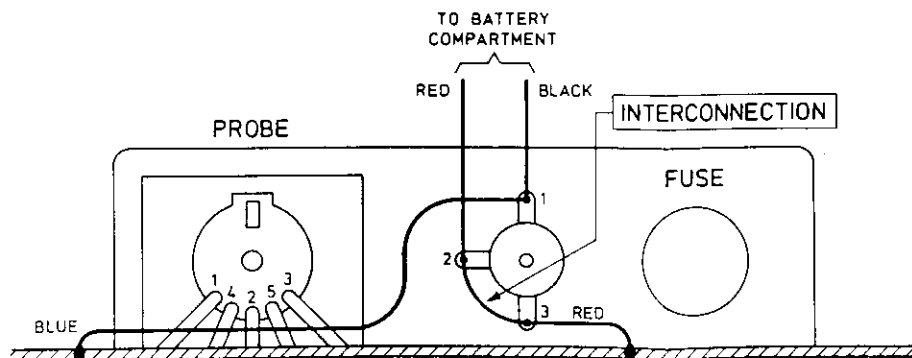
Serial numbers DM600 – DM900



PM 2517E/01

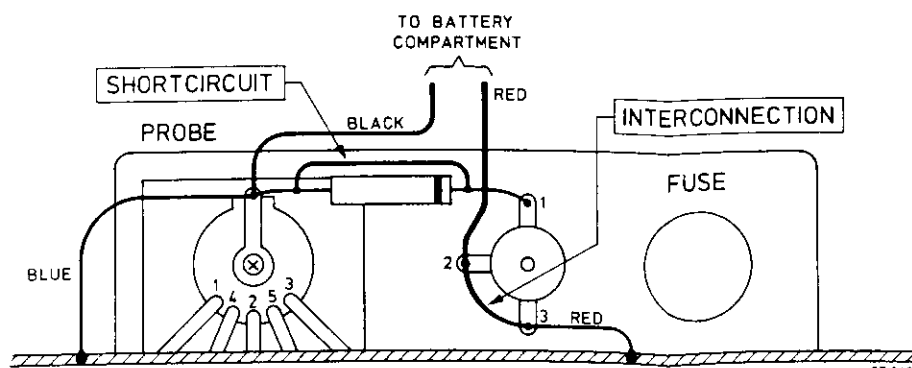
Serial numbers DM900 and following

RECHARGEABLE BATTERIES WITH EXTERNAL POWER SUPPLY PM 9218



PM 2517E/01

Serial numbers DM600 – DM900



PM 2517E/01

Serial numbers DM900 and following

ST 2465

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 V d.c. 350 V a.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.

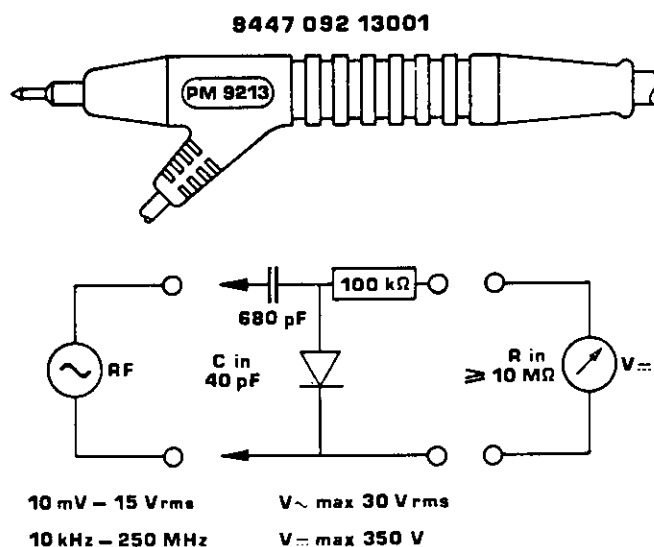
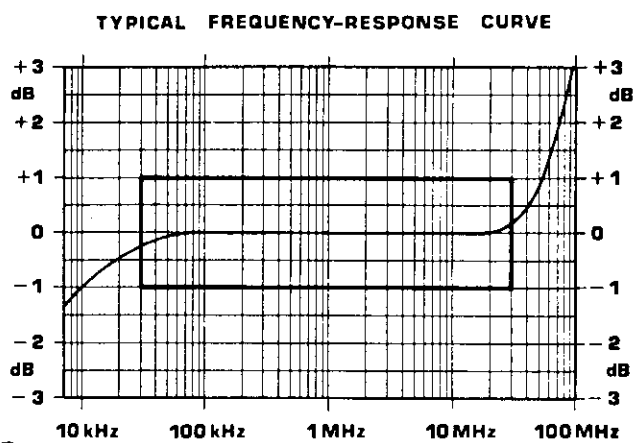
2.2.3. HF probe type PM 9210 (Fig.4) Accessory set for the probe type PM 9212 (Fig. 5)

	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
<u>T-piece (included in PM 9212)</u>		
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 daga 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 secondary 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

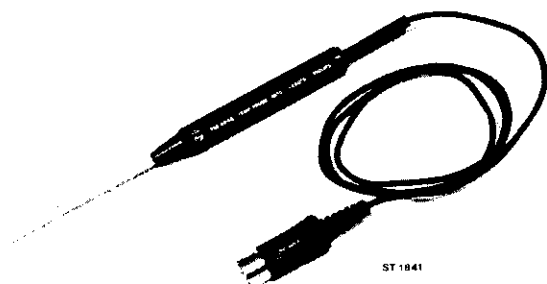


Fig. 2.

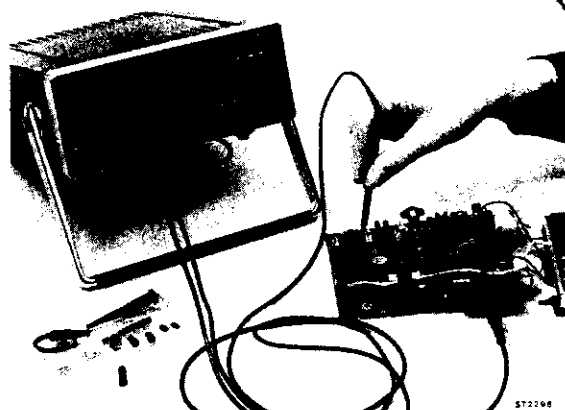


Fig. 3.

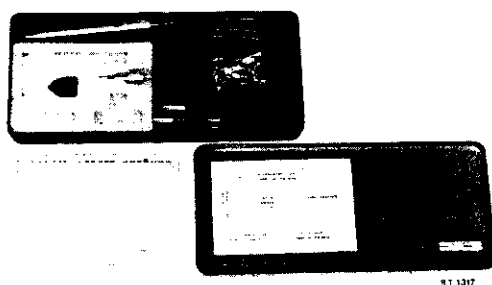


Fig. 4.

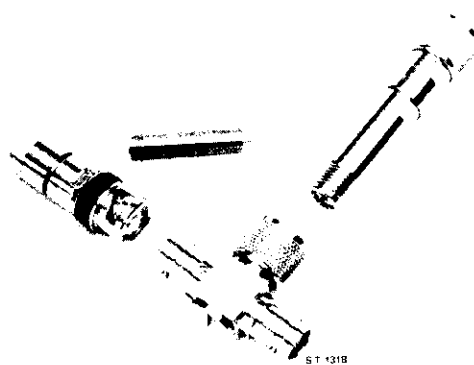


Fig. 5.



Fig. 7.

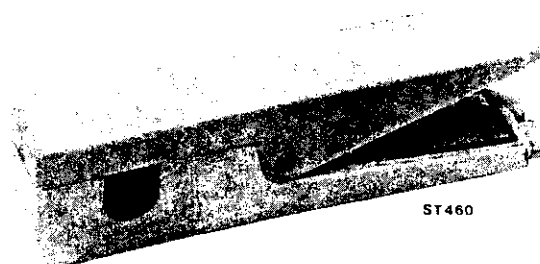


Fig. 8.

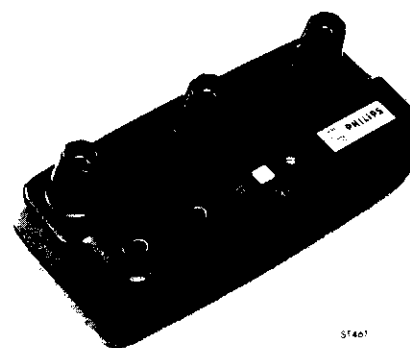


Fig. 9.

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 segment 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

- Input circuits
- Dc attenuator
- Ac attenuator
- Ac/dc convertor (OQ 0061)
- Shunt
- Current source (OQ 0063)
- Temperature bridge

ADC

- Switching part (OQ 0060)
- V - I convertor (OQ 0064)

Digital section

- Display
- ADC control (OQ 0059)
- Display driver(OQ 0055)
- Display control

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 $\times 10$ or $\times 1000$. 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 $V\Omega$ 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_{DC} measurements supplied directly to the ADC and in case A_{AC} 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 °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.

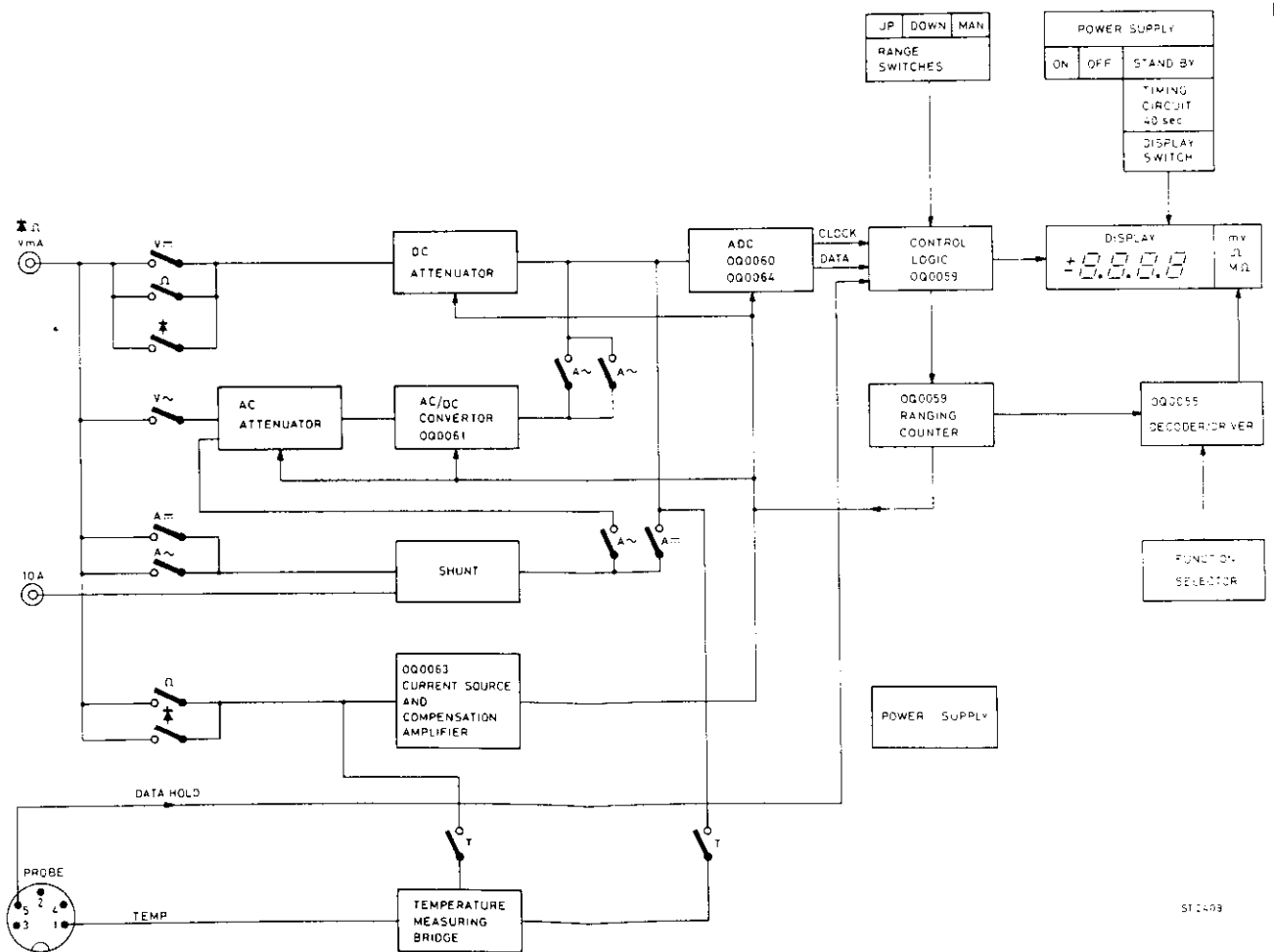


Fig. 10.

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).

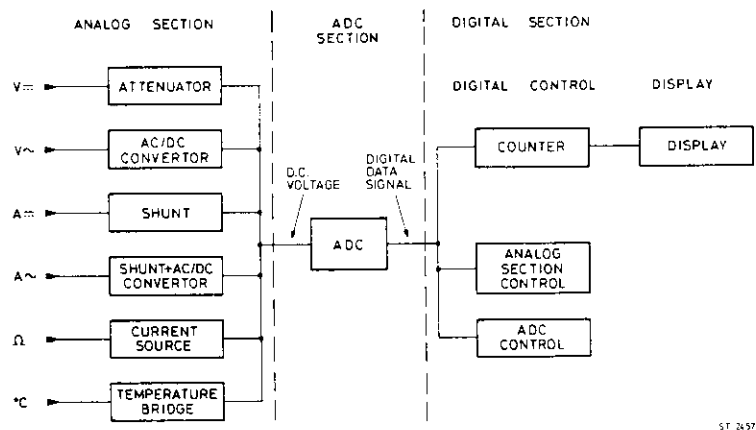


Fig. 11.

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)

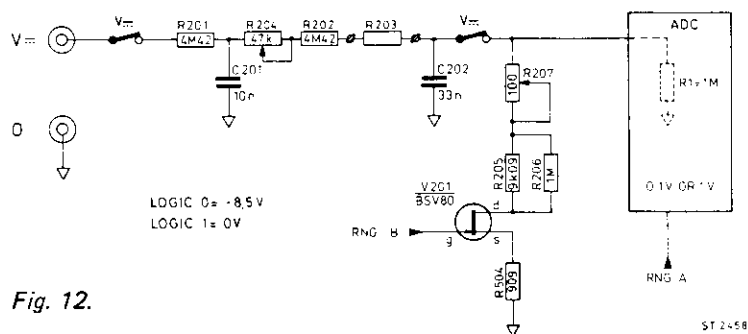


Fig. 12.

Range	Attenuation	RANGE		Input ADC	Ri PM 2517 E	FET switch V 201
		RNGB	RNGA			
1 V $\overline{\text{---}}$	10	0	0	0.1 V	10 M Ω	
10 V $\overline{\text{---}}$	10	0	1	1 V	10 M Ω	
100 V $\overline{\text{---}}$	1000	1	0	0.1 V	9 M 01	
1000 V $\overline{\text{---}}$	1000	1	1	1 V	9 M 01	

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		Input ac/dc converter	Ri PM 2517 E	FET switch V 301 V 302		Input ADC
		RNGB	RNGA			V 301	V 302	
1 V $\sim$	10	0	0	0.1 V	2 M Ω			1 V
10 V $\sim$	10	0	1	1 V	2 M Ω			1 V
100 V $\sim$	1000	1	0	0.1 V	1 M 802			1 V
1000 V $\sim$ *	1000	1	1	1 V	1 M 801			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 converter 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 converter.

In the ac/dc converter the difference in voltage (Vin 1 - Vin 2) is converted into a current. The current is determined by $\frac{V_{in 1} - V_{in 2}}{R}$. (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 converter (0.1 V or 1 V) is selected. The current in the ac/dc converter 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 converter.

– Output AC/DC converter.

The output current from the ac/dc converter 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).

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 Ω 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 $\sim$ 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 $\sim$ 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 AC/DC convertor	Input ADC
RNGB	RNGA		
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.

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 R_X .

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

I_{rx}	RNGC	RNGB	RNGA	RANGE	V_x
1 mA	1	x	x	1 K	-1 V
100 μ A	0	0	0	10 K	-1 V
10 μ A	0	0	1	100 K	-1 V
1 μ A	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 R_x (V_x) 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 ($R_x V_x$) 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 V_x is supplied to one side of resistor R 409. On the other side of R 409 voltage V_x is available (from the input terminals) which means that over R 409 a voltage of $2 V_x - V_x = V_x$ is available. By selecting the same value for R 409 as the input resistance of the ADC (10 M Ω), the input current of the ADC is compensated.

$$I_{rx}' = I_{rx} + I_{adc} - I_{comp}. \text{ As } I_{adc} = I_{comp} \\ I_{rx}' = I_{rx} \text{ (see figure 17).}$$

- 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 $V_{\Omega mA}$ 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 I_{rx} (refer to figure 18) is leaking through the protection diodes, the $\sim$ side of the diodes of V 450 is connected to V_x . 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 k Ω 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	Ge > 0
Si 500.0 ... 800.0	Si > 0 Overrange

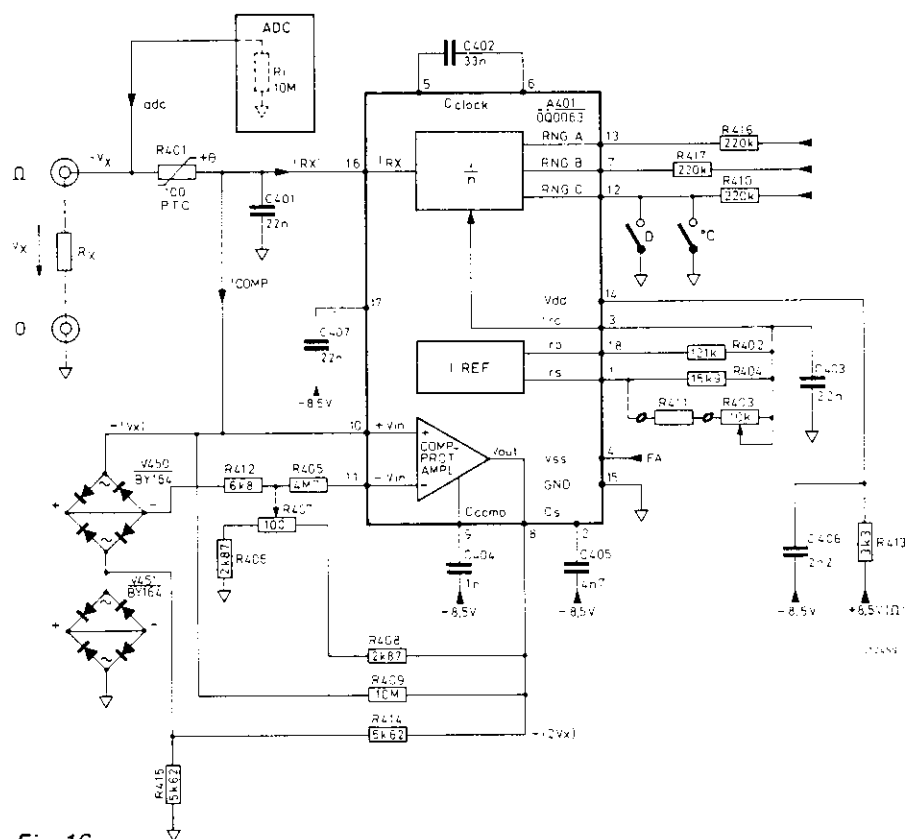


Fig. 16.

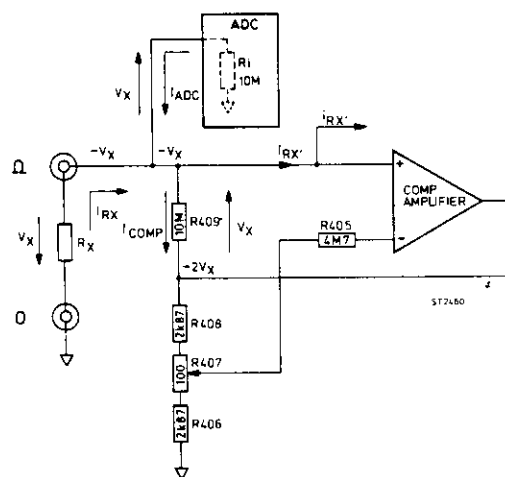


Fig. 17.

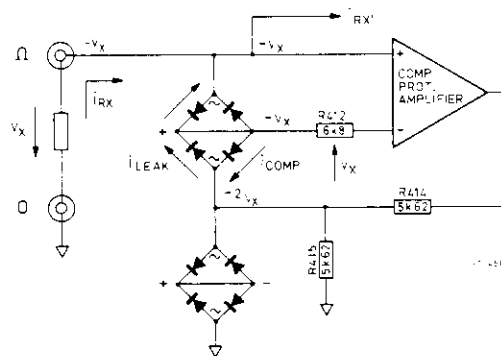


Fig. 18.

3.3.2.7. Temperature measurements

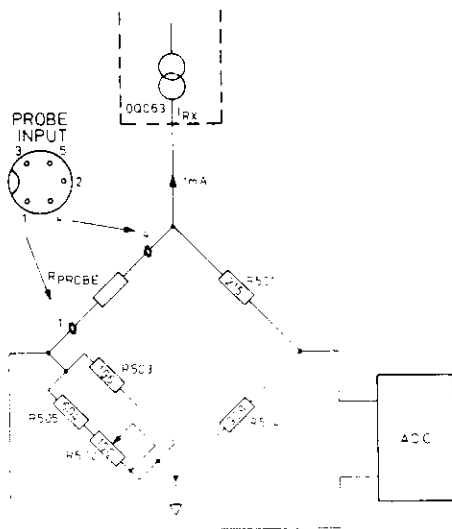


Fig. 19.

- 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 $\approx 35 \Omega$). 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 V_x .

Each value of V_x 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 V_x ($I_{ref} + \Delta I$).

Discharging the capacitor is made by the constant reference current subtracted with the constant current caused by V_x ($I_{ref} - \Delta I$).

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 ($\approx 0 V$), 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 $I_{ref} + \Delta I$ and the discharging current $I_{ref} - \Delta I$ 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 one 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 V_x .

Note: For every value of V_x 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			B		
up	down	result	up	down	result
101	1	100	1	1	0
101	1	99	1	1	0
101	1	100	etc	1	0
102	1	101			
1st measuring period					
100	1	99	1	1	0
102	1	102	1	1	0
101	1	100	etc		
101	1	100			
2nd measuring period					
RESULT 800 : 2 = 400			RESULT 0		

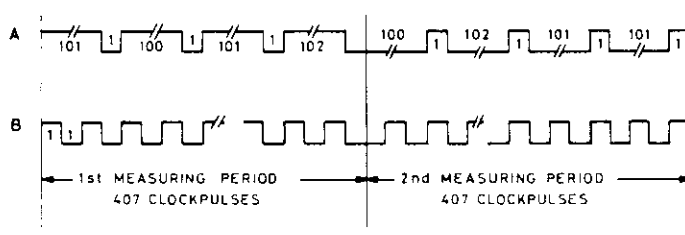


Fig. 21.

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- In the 2nd measuring period input voltage V_x 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:

$$\text{Display} = \frac{V_{in}}{I_{ref} \cdot R_{range}} - \frac{N}{2}$$

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 $+V_{in} + V_{off}$ ($I + \Delta I$). 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 $V_{in} + V_{off}$ ($I - \Delta I$). Both signals are subtrated in the ADC and the result of one measurement will be:

$$\begin{array}{ll} + V_{in} + V_{off} & (I_{ref} + \Delta I) \\ - V_{in} + V_{off} & (I_{ref} - \Delta I) \end{array}$$

The result counter in the control logic divided the number of counted pulses by two. The displayed result will be V_{in} 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 (ϕ) via R 504 or connected to the input voltage via FET switches V101 and V 101'.

Note: Measuring the $I + \Delta I$ and $I - \Delta I$ 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.

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.
$\sim$, +, -, etc.	: unit indication, determined by signals FA, FB, FC, FD and RNG A, B, C, and POL
POL	: Polarity of the OQ 0059

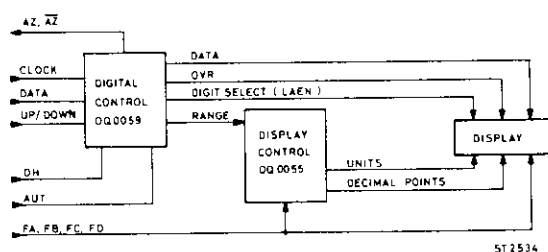


Fig. 22

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 = 12288 clock pulses determined by the timer
- MEASURING PERIOD
- 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 $\div 12888$ 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 , $A\bar{Z}$ 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 $1 \times$ depress is one range up or down. In the ranges $V \dots$ and $V \sim$ 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 ($V \dots$, $V \sim$ or $k\Omega$) 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 ($V \dots$, $V \sim$ = 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.

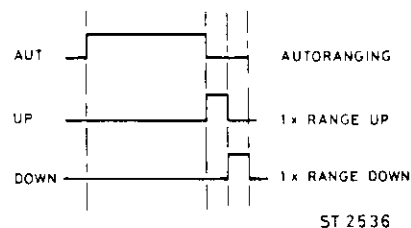


Fig. 24.

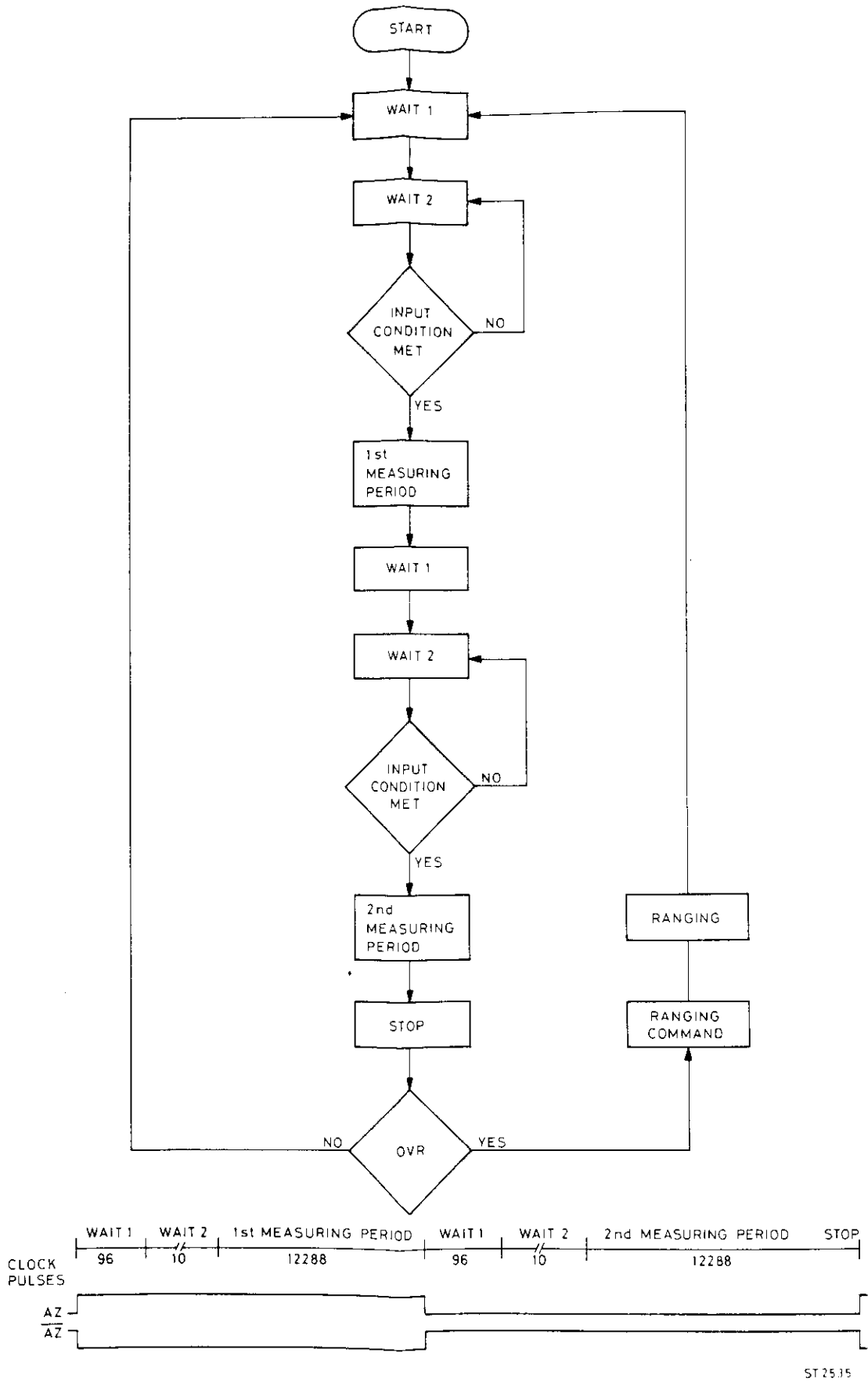


Fig. 23.

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 ($\frac{1}{\mu}\text{C}$, mA $\rightarrow$ or mA $\sim$) to a multi-range function ($V\sim$, V $\rightarrow$, k Ω).

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 $\rightarrow$, (m) A $\sim$ $^{\circ}\text{C}$ and $\frac{1}{\mu}\text{C}$ 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 ($\uparrow$) will be connected to the relevant inputs of the OQ 0059. The logic 1 ($\uparrow$) 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 ($\uparrow$) will be connected to the AUT input of the OQ 0059. Also a logic 1 ($\uparrow$) 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 $\rightarrow$, (m) A $\sim$, $^{\circ}\text{C}$ or to ranges V $\rightarrow$, V $\sim$ or k Ω 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 ($\uparrow$) or O socket
- Internal during range switching in the functions V $\sim$ and (m)A $\sim$.

Note: Resistors R 116 and R 117 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 $\overline{\text{AZ}}$ are blocked.

The DH signal is also active in the V $\sim$ and (m)A $\sim$ 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, $\overline{\text{AZ}}$ (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 $\overline{\text{AZ}}$ 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 0).

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 polarity signal (logic 0 = -, logic 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 $\approx$ 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 $270\ \Omega$ 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 $k\Omega$ and no LED indication (Ω or $M\Omega$) means range $k\Omega$ (see table below).

Function	Signal OQ 0055	Switches	LED lighted	Indication
$V\sim/V\sim\sim$	m	$V\sim/V\sim\sim (6,5)$	mV/Ω	 mV
	—	$V\sim/V\sim\sim (6,5)$	—	 V
$k\Omega$	M, RNG C	$k\Omega$	$M\Omega$	 $M\Omega$
	RNG C	$k\Omega$	mV/Ω	 Ω
	—	$k\Omega$	—	 $k\Omega$
∇	—	—	—	
$-60\dots+200\ ^\circ C$	—	—	—	
(m) A $\sim\sim$	—	—	—	
(m) A $\sim$	—	—	—	

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.

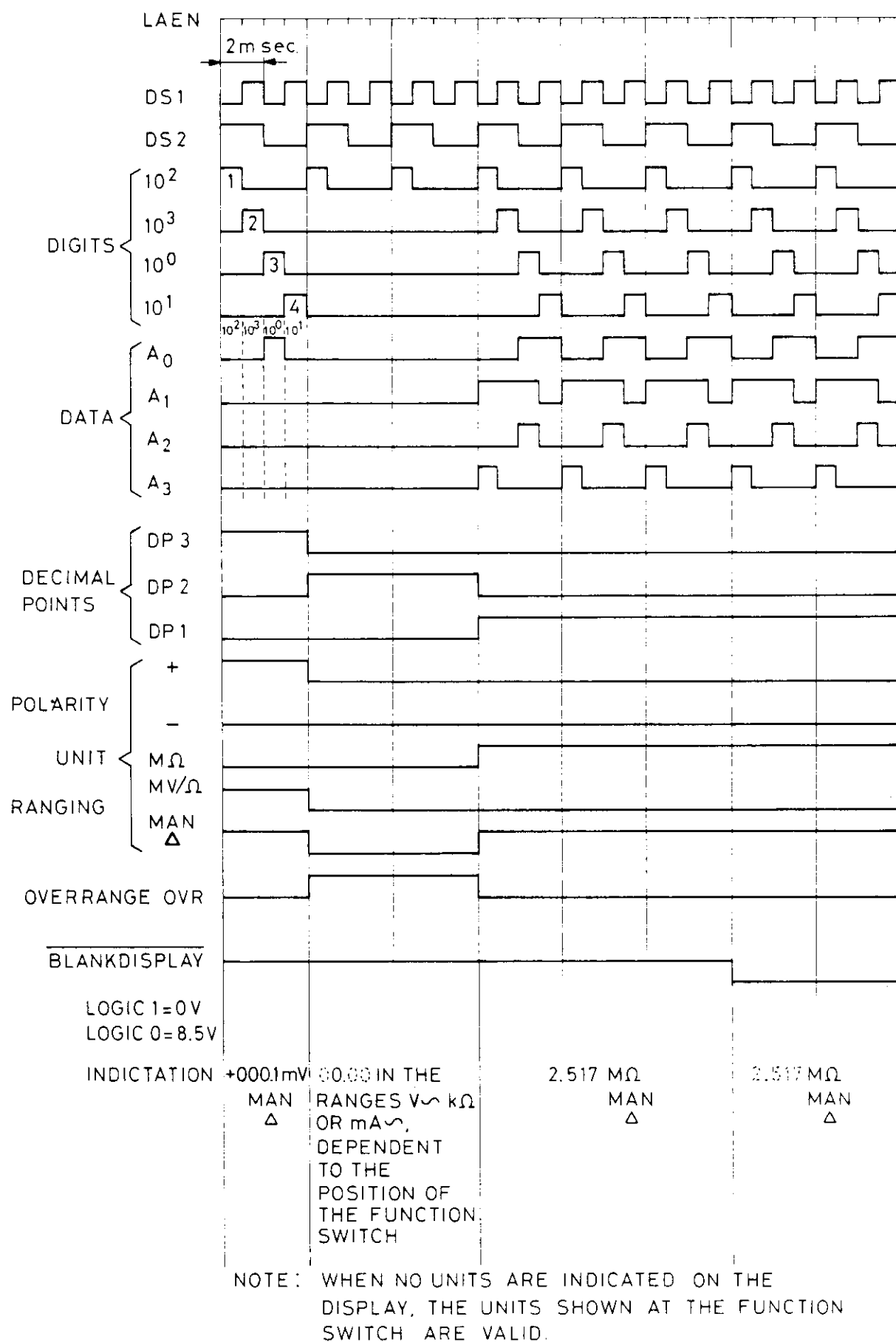


Fig. 25.

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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 or by a 9 V external power supply (PM 9218). In the PM 2517 a stabistor BZX 75 C2V1 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 $\approx +8.5$ V and ≈ -8.5 V. The circuit is stabilized 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:

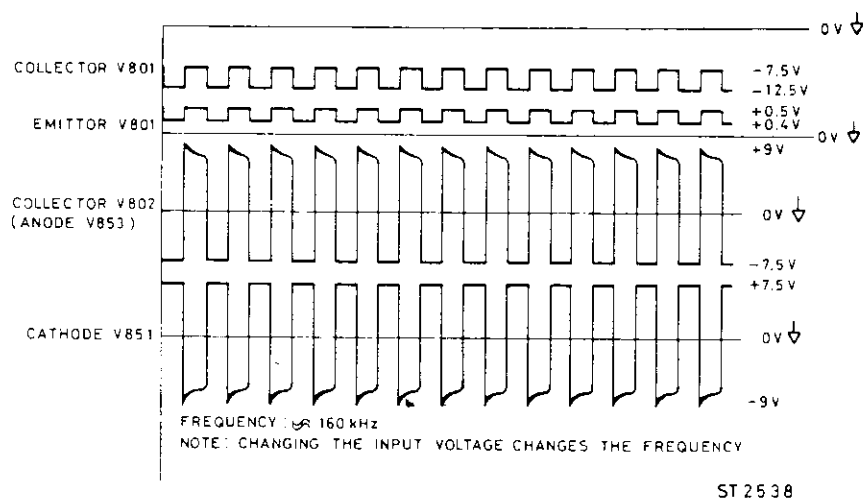


Fig. 26.

Dependent to the function selected the supply voltages are supplied via the function selector to the integrated circuit.

The current source is only used in the functions Ω , $^{\circ}\text{C}$ and ∇ .

The RMS convertor is only used in the functions $V\sim$, $(m)A\sim$.

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 (A_0 - A_3), 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 seven 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.

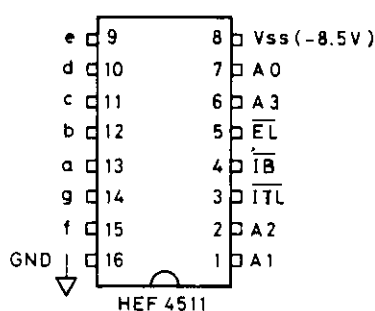


Fig. 27.

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

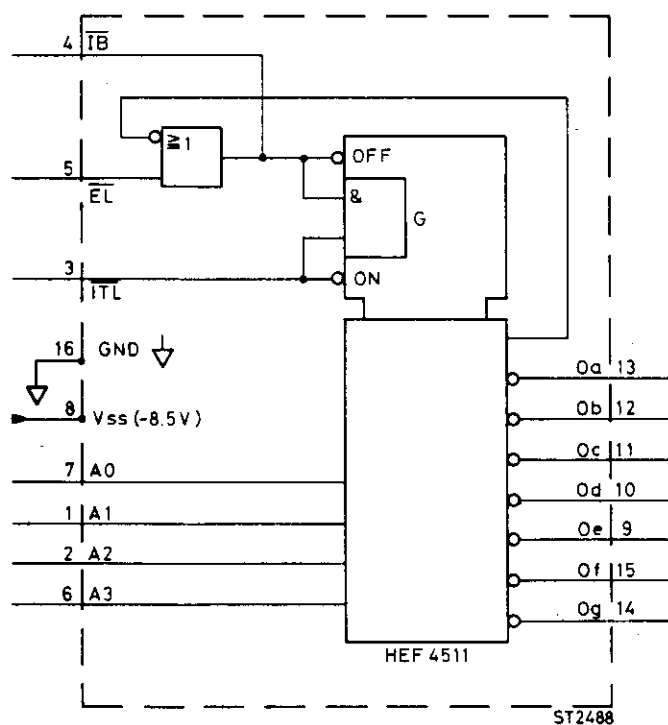


Fig. 28.

FUNCTION TABLE

inputs							outputs							display
EL	IB	ITL	A ₃	A ₂	A ₁	A ₀	a	b	c	d	e	f	g	
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	L	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)

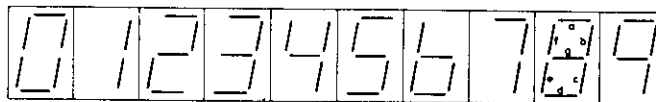
X = state is immaterial

H = Logic 1 = 0 V

L = Logic 0 = -8.5 V

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

DISPLAY



ST 2539

Fig. 29.

3.4.2. HEF 4555 B Dual 1-of-4 decoder/demultiplexer

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.

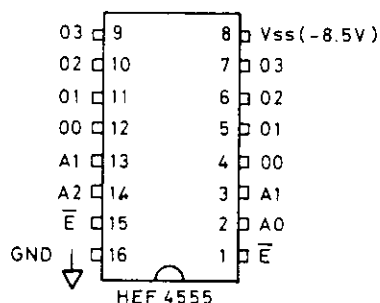


Fig. 30.

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.

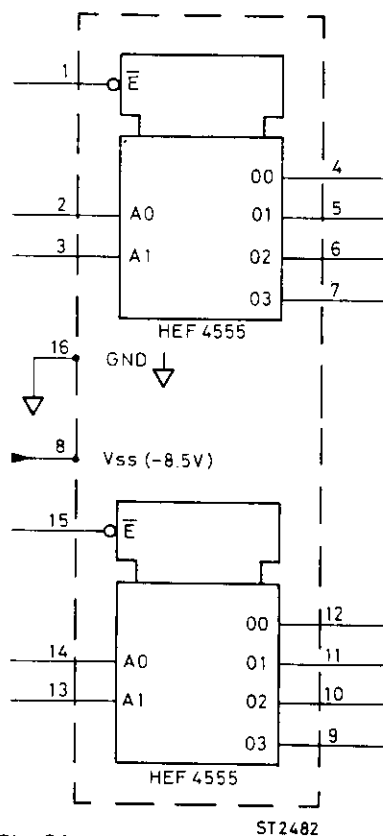


Fig. 31.

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.

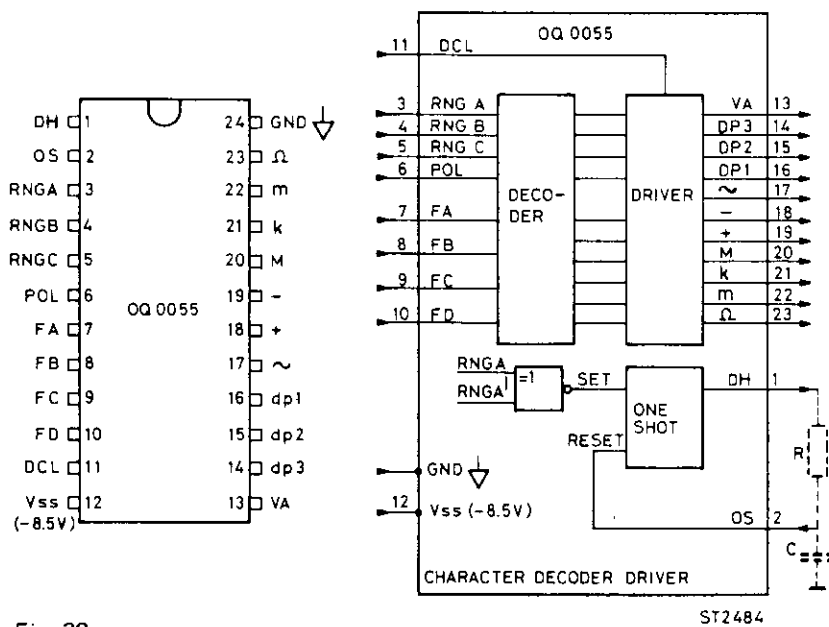


Fig. 32.

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 ($0 \rightarrow 1$) 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 $V\sim$ and $(m)A\sim$.
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	$\sim$	A.C. SIGN ;	AC information for the display in the functions $V\sim$ and $A\sim$. (Not used in PM 2517E.)
18	-	- POLARITY	Polarity information for the display in the functions $V \overline{\sim}$, $A \overline{\sim}$, $^{\circ}C$ 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								Outputs										Display reading				
	DCL	FA	FB	FC	FD	RNGC	RNGB	RNGA	POL	E	V	A	Ω	M	k	DP0	DP1	DP2		DP3	+		~
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 $\overline{\text{---}}$ (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 $\overline{\text{---}}$ (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 k Ω
	0	0	1	0	0	0	0	1	X	0	0	0	1	0	1	0	0	1	0	0	0	0	99.99 k Ω
	0	0	1	0	0	0	1	0	X	0	0	0	1	0	1	0	0	0	1	0	0	0	999.9 k Ω
	0	0	1	0	0	1	1	1	X	0	0	0	1	1	0	0	1	0	0	0	0	0	9.999 M Ω
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 $\overline{\text{---}}$ (pos.)	0	1	0	1	0	X	X	X	1	1	0	1	0	0	0	1	0	0	0	1	0	0	+ 999.9 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 $\overline{\text{---}}$ (neg.)	0	1	0	1	0	X	X	X	0	1	0	1	0	0	0	1	0	0	0	0	1	0	- 999.9 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	~ 999.9 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
$\star$	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
$\pm$ °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 $\star$, 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
- $TIMER \div 12288$
- 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.

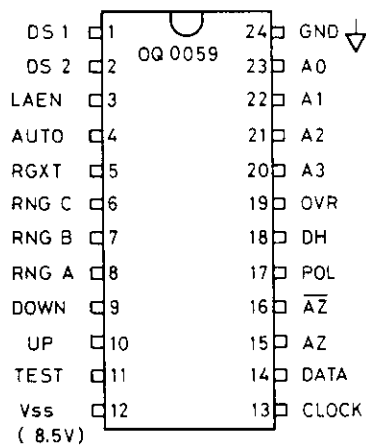


Fig. 33.

ST2487

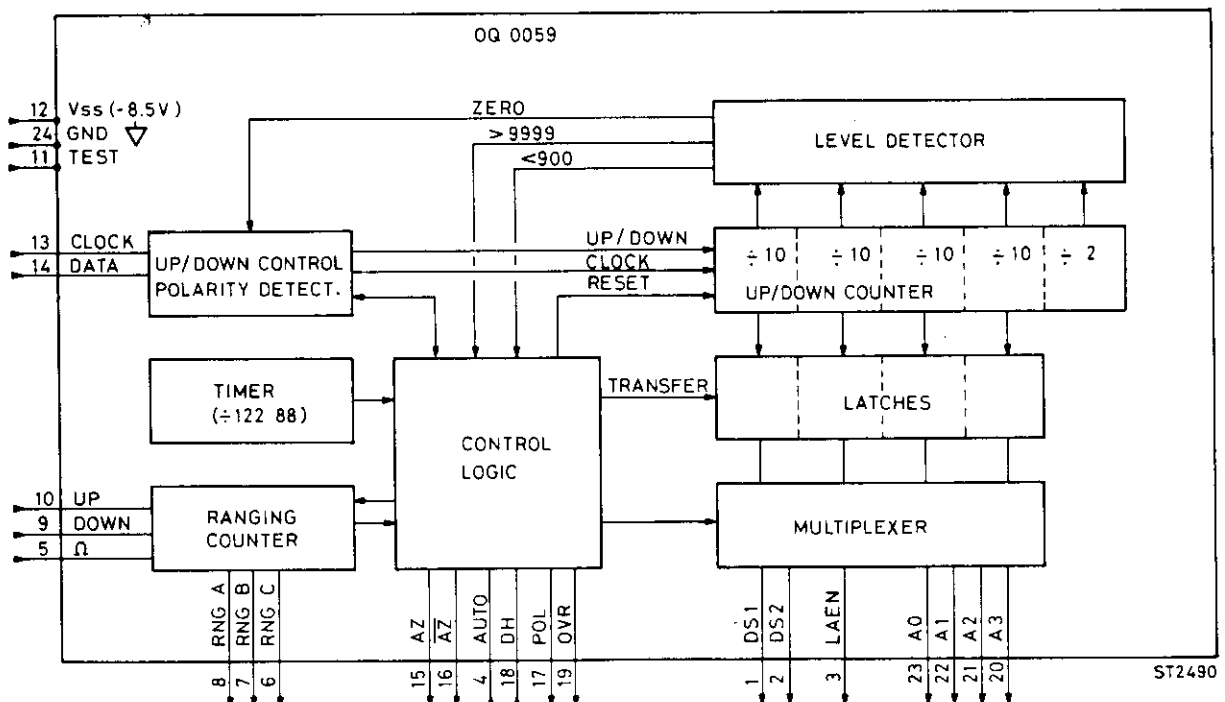


Fig. 34.

ST2490

3.4.4.2. Specifications of inputs and outputs

Pin nr.	Name	Description																													
1	DS1	Digit Select	Digit Select Outputs																												
2	DS2	Digit Select	<table><tr><th>DS2</th><th>DS1</th><th></th><th></th><th></th></tr><tr><td>0</td><td>0</td><td>10^0</td><td>LSD</td><td>Least Significant Digit</td></tr><tr><td>0</td><td>1</td><td>10^1</td><td></td><td></td></tr><tr><td>1</td><td>0</td><td>10^2</td><td></td><td></td></tr><tr><td>1</td><td>1</td><td>10^3</td><td>MSD</td><td>Most Significant Digit</td></tr></table> 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.	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			
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																											
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	<table><tr><th>RNG C</th><th>RNG B</th><th>RNG A</th><th>RGXT</th></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>0</td><td>0 1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0 1</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0 1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0 1</td></tr></table>	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
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																												
9	DOWN	Manual ranging	Manual range information																												
10	UP	Up or down	<table><tr><th>UP</th><th>DOWN</th><th></th></tr><tr><td>0</td><td>0</td><td>no action</td></tr><tr><td>0</td><td>1</td><td>down ranging</td></tr><tr><td>1</td><td>0</td><td>up ranging</td></tr><tr><td>1</td><td>1</td><td>not specified</td></tr></table>	UP	DOWN		0	0	no action	0	1	down ranging	1	0	up ranging	1	1	not specified													
UP	DOWN																														
0	0	no action																													
0	1	down ranging																													
1	0	up ranging																													
1	1	not specified																													
11	TEST	Test input	Test pin for IC testing during manufacturing. The testpin is connected to $V_{ss} - 8.5$ V.																												
12	$V_{ss} (-8,5$ 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	AZ	Auto zero	Auto zero outputs are used for commutating the input voltage of the V-I convertor for automatic zero compensation.
16	$\overline{\text{AZ}}$	Inverse of auto zero	
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 permissible 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	A3	BCD information	BCD coded result.
21	A2		Bit parallel-word serial.
22	A1		Together with the signals DS1 and DS2 (digit select) the correct digits in the correct order can be made visible.
23	A0		
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.

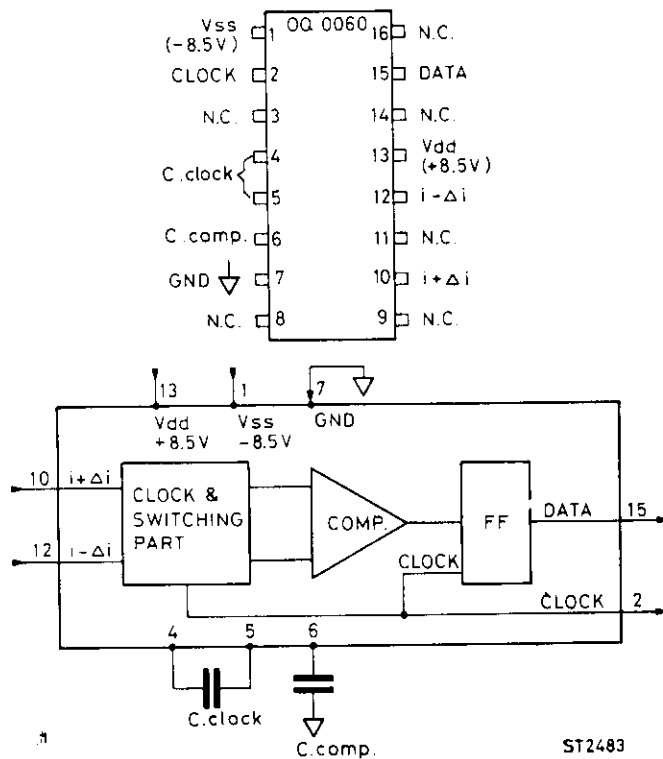


Fig. 35.

ST2483

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 converter with two selectable input ranges, a current rectifier with an autozero compensation circuit and a logarithmic-antilogarithmic calculating RMS convertor.

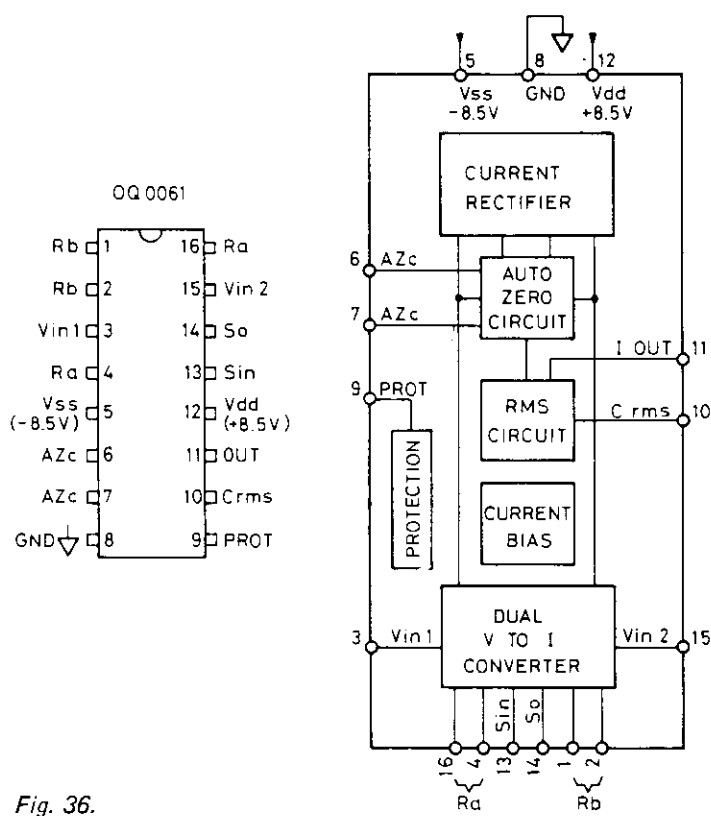


Fig. 36.

ST2486

3.4.6.2. Specifications of inputs and outputs

Pin nr.	Name	Description																			
1	Rb	Range b, conversion resistor	Between inputs 1 and 2 the conversion resistor b is connected.																		
2	Rb		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	AZc	Auto Zero	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.																		
7	AZc	Decoupling capacitor																			
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	<table><tr><th>Sin</th><th>So</th><th>Ra</th><th>Rb</th><th>Range</th><th>Sensitivity</th></tr><tr><td>1</td><td>0</td><td>X</td><td></td><td>1V,100V</td><td>0.1 V</td></tr><tr><td>1</td><td>1</td><td></td><td>X</td><td>10V,1000V</td><td>1 V</td></tr></table> <i>Note: above mentioned table is valid for PM 2517.</i>	Sin	So	Ra	Rb	Range	Sensitivity	1	0	X		1V,100V	0.1 V	1	1		X	10V,1000V	1 V
Sin	So	Ra	Rb	Range	Sensitivity																
1	0	X		1V,100V	0.1 V																
1	1		X	10V,1000V	1 V																
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 μ A.

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.

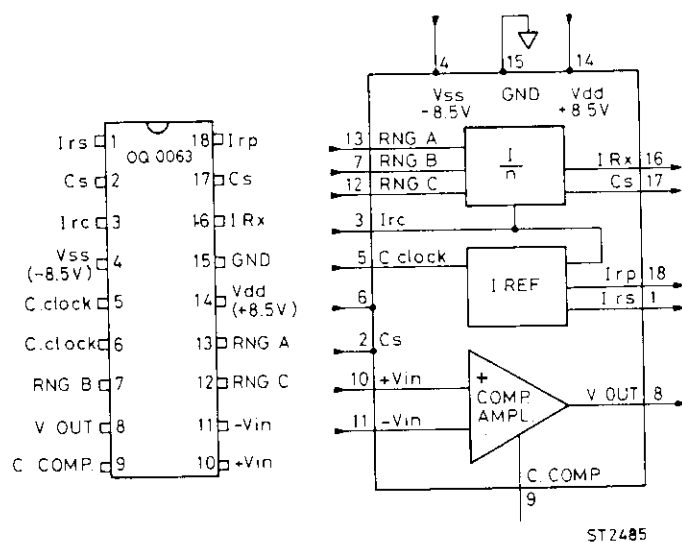


Fig. 37.

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	C clock		Capacitor for the clock-oscillator																													
6	C clock																															
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	+Vin	+ Input	+ and − input of the compensation/protection amplifier.																													
11	−Vin	− Input	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	RNG C	Range C	Together with signal RNG B the signals determine the digital range information from the OQ 0059.																													
13	RNG A	Range A																														
		<table><tr><th>Range</th><th>Measuring current</th><th>RNG A</th><th>RNG B</th><th>RNG C</th></tr><tr><td>1 kΩ</td><td>1 mA</td><td>1</td><td>1</td><td>1</td></tr><tr><td>10 kΩ</td><td>100 μA</td><td>0</td><td>0</td><td>0</td></tr><tr><td>100 kΩ</td><td>10 μA</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1 MΩ</td><td>1 μA</td><td>0</td><td>1</td><td>0</td></tr><tr><td>10 MΩ</td><td>100 nA</td><td>1</td><td>1</td><td>0</td></tr></table>		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
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																												
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.

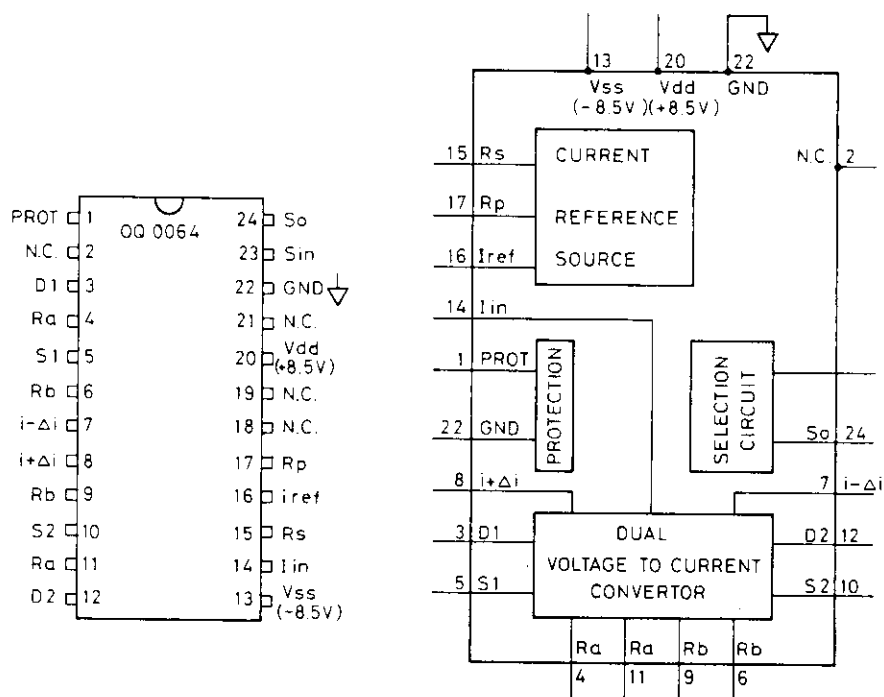


Fig. 38.

ST2489

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
16	I ref	Current reference output
17	Rp	Tc setting resistor
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 $\downarrow$
23	Sin	Range selecting input (a or b)
24	So	Range selecting reference input

Adjustment reference current

Rp determines temperature coefficient

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 is 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 necessary 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 open.

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.

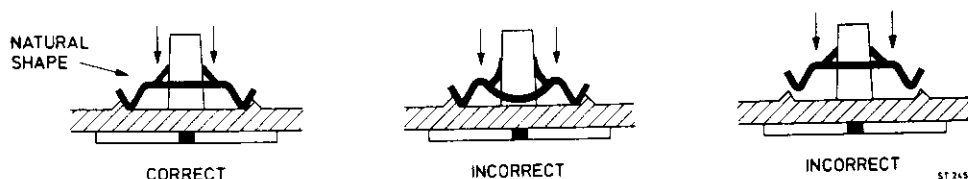


Fig. 42.

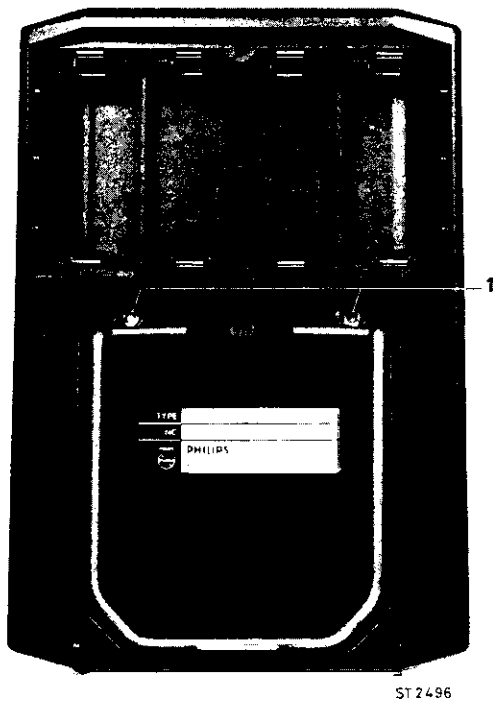


Fig. 39.

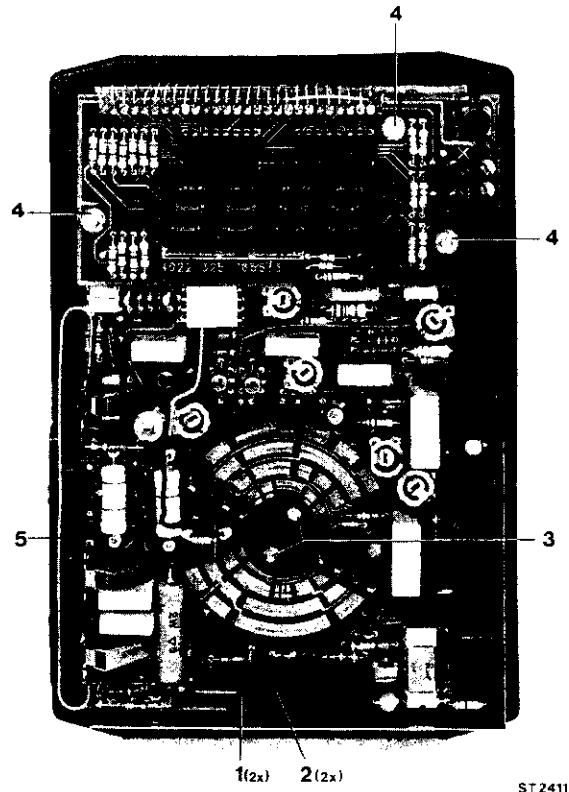


Fig. 40.

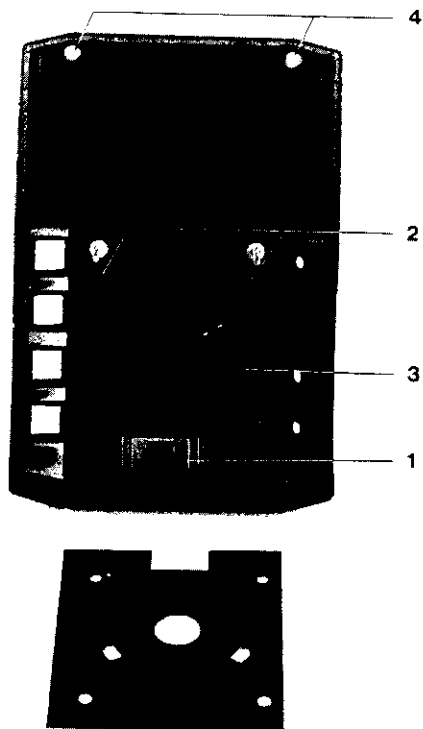


Fig. 41.

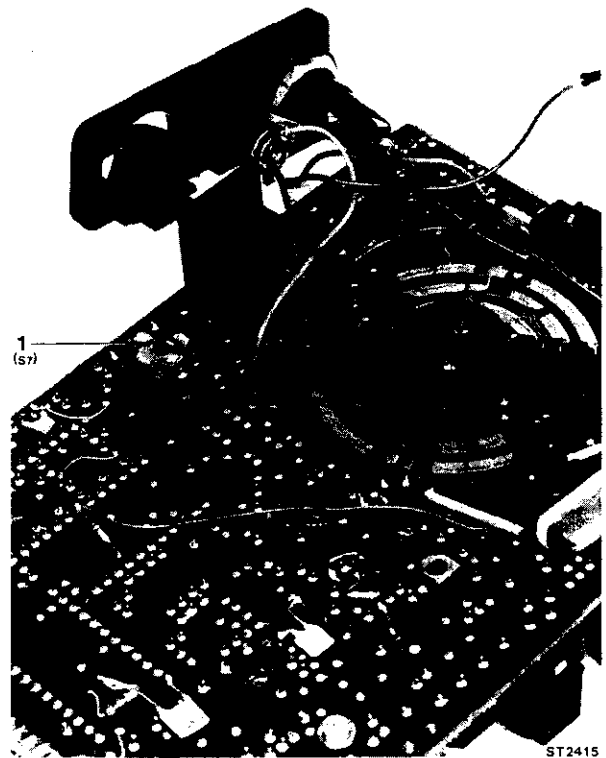


Fig. 43.

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 complete 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 reachable 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 reachable at the front of the bottom p.c. board. In this case the top- and bottom cover should be removed.

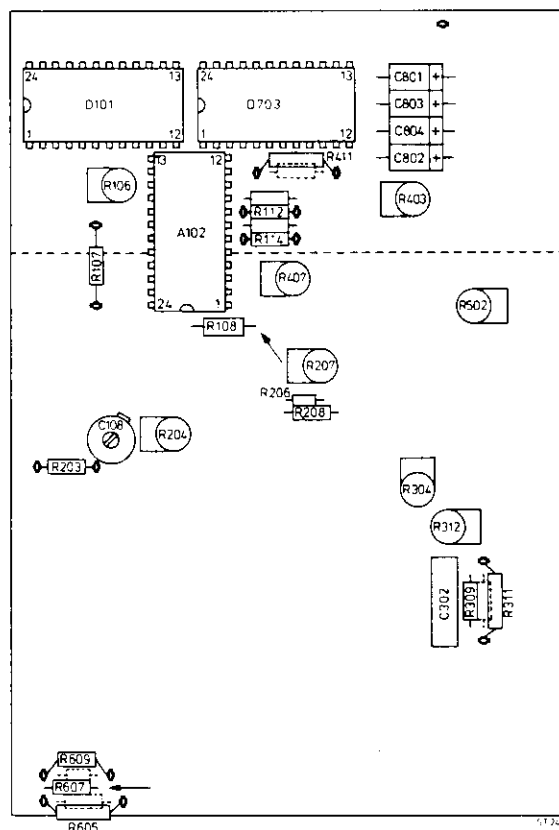


Fig. 44.

NO.	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNALS	ADJUSTING DATA	MEASURING POINTS
13	Calibration range 99.99 mA $\approx$	Adj. resistor R605 (MR25, 1%, E48 series)	Instrument set in position; (m)A $\approx$	90 mA $\approx \pm 0.2\%$ Supplied to VmA and 0 socket	+ 90.00 mA $\pm$ 30 digits	Display
14	<u>Resistance ranges</u> Reference current of OQ 0063	Adj. resistor R411, coarse (MR25, 1%, E48 series) Potentiometer R403; fine Potentiometer R407	Instrument set in position k Ω 999.9 Ω	900 $\Omega \pm 0.01\%$ Supplied to V Ω and 0 socket	900.0 $\pm$ 1 digit	Display
15	Compensation amplifier of OQ 0063		Instrument set in position k Ω , Range 9.999 M Ω	9 M $\Omega \pm 0.01\%$ Supplied to V Ω and 0 socket	9.000 M $\Omega \pm 5$ digits	Display
16	<u>Checks resistance ranges</u>					
	Range 9.999 M Ω		Instrument set in position k Ω , Range 9.999 M Ω	a. 3M $\Omega \pm 0.01\%$	a. 3.000 M $\Omega \pm 20$ digits	Display
	Range 9.999 k Ω		Instrument set in position k Ω , Range 9.999 k Ω	b. 9 k $\Omega \pm 0.01\%$	b. 9.000 k $\Omega \pm 20$ digits	Display
	Range 99.99 k Ω		Instrument set in position k Ω , Range 99.99 k Ω	c. 90k $\Omega \pm 0.01\%$	c. 90.00 k $\Omega \pm 20$ digits	Display
	Range 999.9 k Ω		Instrument set in position k Ω , Range 999.9 k Ω	d. 900 k $\Omega \pm 0.01\%$ Supplied to V Ω and 0 socket	d. 900.0 k $\Omega \pm 50$ digits	Display
17	<u>Temperature ranges</u> 0°C calibration	Potentiometer R502	Instrument set in position - 60... + 200°C	35.34 $\Omega \pm 0.1\%$	$\pm 000.0^\circ\text{C} \pm 1$ digit	Display
18	<u>Check temp ranges</u> + 100°C	-	Instrument set in position - 60... + 200°C	49.99 $\Omega \pm 0.1\%$	between + 099.8 and + 100.8	Display
	- 50°C	-	Instrument set in position - 60... + 200°C	27.84 $\Omega \pm 0.1\%$ <i>Note: The resistance should be connected to points 2 1 and 3 of the probe input</i>  Front view	- 050.0°C ± 2 digits	Display
19	<u>Ac current ranges</u> Calibration range 99.99 mA $\sim$	Potentiometer R304	Instrument set in position (m)A $\sim$	90.68mV 60 Hz $\pm 0.01\%$ 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 general 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.

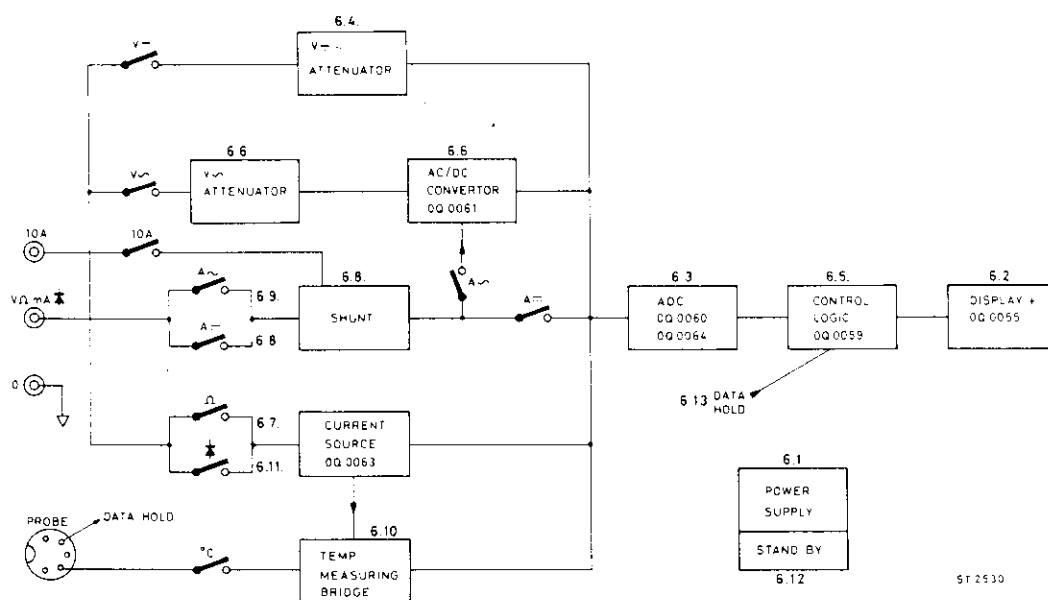
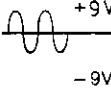
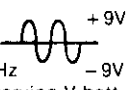
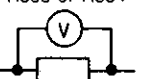


Fig. 45.

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 ≈ V _{batt} 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	Converter 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 When varying V _{batt} , 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	Converter 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  ≈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 Track interruption Too large: Too much current consumption by the instrument. e.g. One LED lights too much
H.	A	+V supply not present –V supply ≈ V _{batt}	Hi = C804 (+) Hi = C802 (–) Lo = 0-socket ↓	+V supply not present –V supply ≈ V _{batt}	Converter 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 Refer to 6.1.1.

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

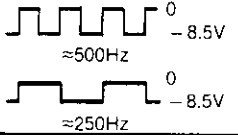
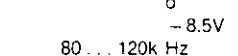
No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Supply voltage	Hi = C804 (+) Hi = C802 (-) Lo = 0-socket ↓	+8V ... +9V -8V ... -9V	Refer to B	Check power, supply Refer to 6.1.1. The indication LED's are supplied from the batteries directly
B	A	Blank display	Hi = D701/4 Lo =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

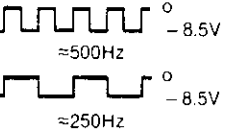
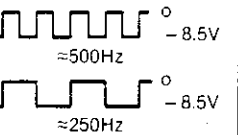
No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	LED MAN	Display	Instrument set in manual ranging	—	No LED MAN lighted. - V supply is short circuited Refer to 6.1.1.

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 Refer 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	Track interruption
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 1/2 x 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  equal 5 ... 6V 	Defect OQ0060	Track interruption

F	B	Digit Select DS 1/2 OQ0059 (D101)	Hi = D101/1 (DS1) Hi = D101/2 (DS2) Lo = 0-socket With oscilloscope		Refer to I	Refer to G
G	F	Clock OQ0059 (D101)	Hi = D101/13 Lo = 0-socket ↓ With oscilloscope		Refer to H	No signal Track interruption A101/2 - D101/13
H	G	Supply voltage OQ0059 (D101)	Hi = D101/12 (-) Lo = 0-socket ↓	-8V ... -9V	Defect OQ0059	Track interruption
I	F	Supply volly voltage OQ0059 (D101)	Hi = D101/12 (-) Lo = 0-socket	-8V ... -9V	Defect OQ0059	Track interruption
I	F	Supply voltage HEF 4555 (D702)	Hi = D702/8 Lo = 0-socket ↓	-8V ... -9V	Defect D702	Track interruption 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		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		Defect D702	Track interruption

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

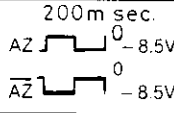
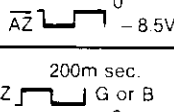
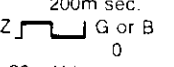
No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	LED segment	Display	Constant lighting	Defect D701	
B	—	LED segment	Display	Constant missing	Refer to C	
C	B	Output of HEF 4511 (D701)	Corresponding output (a/g) Hi = D701/9 ... 15 Lo = 0-socket ↓ With oscilloscope	Blocksignal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

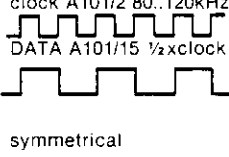
6.2.8. One segment of one LED is missing

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. $\pm 90\text{mV}$ c. $\pm 900\text{mV}$ Supplied to: ADC Hi = R108 right hand side Lo = 0-socket $\downarrow$ Function; V $\overline{\text{---}}$ Range; a.b. 999.9mV c. 9.999V	a. $\pm 0000\text{ mV}$ b. $\pm 90.00\text{ mV}$ c. $\pm 9.000\text{ V}$	—	Refer to B
B	A	Data signal OQ0059 (D101)	Hi = D101/14 Lo = 0-socket $\downarrow$ 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 $\downarrow$	Logic 0 (-8.5V)	Refer to F	Refer to D
D	C	Data hold DH OQ0055 (D703)	Hi = D703/1 Lo = 0-socket $\downarrow$	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 $\downarrow$ With oscilloscope	200m sec. AZ  -8.5V AZ  -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 $\downarrow$ With oscilloscope Input voltage; supplied to ADC +90mV and +900mV, refer to A	200m sec. AZ  G or B 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. $\approx 1\text{k}\Omega$ b. $\approx 10\text{k}\Omega$	Defect OQ0060 (A101)	- Trackinterruption 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 +)	$-2.6\text{V} \dots -3.2\text{V}$ Both signals should be equal	Defect OQ0060	Refer to K
K	J	Data output OQ0060 (A101)	Hi = A101/15 Lo = 0-socket $\downarrow$ 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/V102 ¹	Hi = A102/5 (V102) Hi = A102/10 (V102 ¹) Lo = 0-socket $\downarrow$	+0.4V ... +3V Both signals should be equal	Defect OQ0064	- V source $<0\text{V}$; Defect OQ0064 - V source $\approx V_{\text{drain}}$ Defect V102/V102 ¹

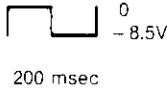
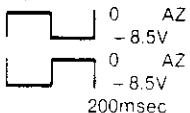
No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A		Overrange (OVR) HEF 4555 (D702)	Hi = D702/1 Lo = 0-socket ↓ Shortcircuit ADC input	Logic 0 (– 8.5V)	Defect HEF 4555 (D702)	Refer to B
B	A	Overrange (OVR) OQ0059	Hi = D101/19 Lo = 0-socket ↓ Shortcircuit ADC input	Logic 0 (– 8.5V)	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 shortcircuited 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 capacitor C110	Refer to D
D	C	Input of ADC Switching part OQ0060A(A101) 1	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 $\overline{\text{---}}$	Logic 0 (−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 (≈ 1/2 x 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  200 msec	Refer to J	Refer to I
I	H	Signal Auto Zero (AZ) OQ0059	Hi = D101/1 Lo = 0-socket ↓	Square wave  200msec	Track interruption 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 1M Ω range (PM2503) Short circuit ADC input Input ADC: Hi = R108 right hand side Lo = 0-socket ↓	≈0.5M Ω fluctuating	—	Constant 0: Short circuit in V101/V101 Constant 1MΩ: Interruption in V101/V101 ¹ >1M Ω : Check R108, R109, tracks

6.3.5. Difference at + and − display in function V $\overline{\text{---}}$

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 capacitors
C	B	Iref OQ0064 ¹ (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 ↓	+ 120 μ A	Refer to F	Refer to E
E	D	Check R105, R106, R107, R113	R105, R106, R107, R113	R105 = 10k Ω R106 = 2k Ω potentiometer R107 = Adjusting resistor 9k53 ... 16k Ω R113 = 1k4	Defect OQ0064	Replace resistor
F	D	Clock frequency OQ0060 (A101)	Hi = A101/2 Lo = 0-socket ↓	 80kHz ... 100kHz	Defect OQ0060	Refer to G
G	F	Check C101 and tracks	C101	C101 = 1nF	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 still not linear		Defect OQ0060

6.4. V $\overline{\text{---}}$ 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 $\overline{\text{---}}$ Insulate selectors switch part V $\overline{\text{---}}$ 1/2 with a piece of insulating material, shifted under the sliding contact. (Refer to Fig.)	Display $\pm 000.0\text{mV}$	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 $\overline{\text{---}}$ Open input	Display $\pm 000.0\text{mV}$	Defect OQ0064	Defect V102. if still incorrect replace V101

6.4.2. Range 1V $\overline{\text{---}}$ 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 Track interruptions 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 $\overline{\text{---}}$ and 100V $\overline{\text{---}}$ cannot be adjusted (adj. no. 6, 7)

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

A	—	Range deviates	R205, R206, R207 and R208	R205 = 9k09 R206 = 1M R207 = 100Ω pot. meter R208 = 820k	Refer to B	Replace resistor
		Check; R205, R206 R207 and R208				
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. $V_{\text{---}}$ 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 $V_{\text{---}}$ range	Display Select: 999.9mV Insulate selector switch part $V_{\text{---}}$ 1/2 with a piece of insulating material, shifted under the sliding contact	Check if the $V_{\text{---}}$ range is linear	Refer to C	Defect 0064
C	B	Gate of V201	Hi = V201 gate Lo = 0-socket ↓ Select: Range 999.9m $V_{\text{---}}$	Logic 0 (– 8.5V)	Defect V201	Track interruption 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)	Track interruption	Refer to C
C	B	Kathode voltage V150	Hi = V150 kathode Lo = 0-socket ↓	Logic 0 (– 8.5V)	Refer to D	Track interruption 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 $V_{\text{---}}$ 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 IV --- 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 $\overline{\text{---}}$ Manual ranging	<table><tr><td>Range</td><td>C</td><td>B</td><td>A</td></tr><tr><td>1V</td><td>0</td><td>0</td><td>0</td></tr><tr><td>10V</td><td>0</td><td>0</td><td>1</td></tr><tr><td>100V</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1000V</td><td>0</td><td>1</td><td>1</td></tr></table> Logic 0 = -8.5V Logic 1 = 0V Refer to truth table of OQ0055	Range	C	B	A	1V	0	0	0	10V	0	0	1	100V	0	1	0	1000V	0	1	1	Refer to B	Track interruption																														
Range	C	B	A																																																					
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10V	0	0	1																																																					
100V	0	1	0																																																					
1000V	0	1	1																																																					
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 ⬇	<table><tr><td>Function</td><td>FD</td><td>FC</td><td>FB</td><td>FA</td></tr><tr><td>V~</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>V $\overline{\text{---}}$</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>Ω</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>★</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>°C</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>mA $\overline{\text{---}}$</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>mA~</td><td>0</td><td>1</td><td>1</td><td>1</td></tr><tr><td>10A $\overline{\text{---}}$</td><td>1</td><td>1</td><td>0</td><td>1</td></tr><tr><td>10A~</td><td>1</td><td>1</td><td>1</td><td>1</td></tr></table> Logic 0 = -8.5V Logic 1 = 0V Refer to truth table of OQ0055	Function	FD	FC	FB	FA	V~	0	0	1	1	V $\overline{\text{---}}$	0	0	0	1	Ω	0	0	1	0	★	0	1	1	0	°C	0	1	0	0	mA $\overline{\text{---}}$	0	1	0	1	mA~	0	1	1	1	10A $\overline{\text{---}}$	1	1	0	1	10A~	1	1	1	1	Refer to C Defect switch	Track interruption
Function	FD	FC	FB	FA																																																				
V~	0	0	1	1																																																				
V $\overline{\text{---}}$	0	0	0	1																																																				
Ω	0	0	1	0																																																				
★	0	1	1	0																																																				
°C	0	1	0	0																																																				
mA $\overline{\text{---}}$	0	1	0	1																																																				
mA~	0	1	1	1																																																				
10A $\overline{\text{---}}$	1	1	0	1																																																				
10A~	1	1	1	1																																																				
C	B B	Incorrect decimal points 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 $\overline{\text{---}}$ Manual ranging	<table><tr><td>Range</td><td>DP3</td><td>DP2</td><td>DP1</td></tr><tr><td>1V</td><td>1</td><td>0</td><td>0</td></tr><tr><td>10V</td><td>0</td><td>0</td><td>1</td></tr><tr><td>100V</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1000V</td><td>1</td><td>0</td><td>0</td></tr></table> Logic 0 = -8.5V Logic 1 = 0V Refer to truth table of OQ0055	Range	DP3	DP2	DP1	1V	1	0	0	10V	0	0	1	100V	0	1	0	1000V	1	0	0	Defect OQ0055 Refer to D	Defect OQ0055																														
Range	DP3	DP2	DP1																																																					
1V	1	0	0																																																					
10V	0	0	1																																																					
100V	0	1	0																																																					
1000V	1	0	0																																																					
D	C	Decimal points on LED's	Hi = V758/9 Hi = V756/9 Hi = V757/9 Lo = 0-socket ⬇	<table><tr><td>Range</td><td>V758/9</td><td>V756/9</td><td>V757/9</td></tr><tr><td>1V</td><td>1</td><td>0</td><td>0</td></tr><tr><td>10V</td><td>0</td><td>0</td><td>1</td></tr><tr><td>100V</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1000V</td><td>1</td><td>0</td><td>0</td></tr></table> Logic 0 = -8.5V Logic 1 = 0V	Range	V758/9	V756/9	V757/9	1V	1	0	0	10V	0	0	1	100V	0	1	0	1000V	1	0	0	—	Track interruption Defect LED																														
Range	V758/9	V756/9	V757/9																																																					
1V	1	0	0																																																					
10V	0	0	1																																																					
100V	0	1	0																																																					
1000V	1	0	0																																																					

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	Is 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 Track interruption
	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 = 0-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	Track interruption	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/O 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/O	<10.nV Both signals should be equal	Refer to D	Refer to C
C	B	Check R306 and R309 Track interruption	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/O	≈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/O	≈ 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/O 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 $\approx 0V \sim$	Hi = gate V301 Lo = 0-socket $\downarrow$ 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 $\approx 50\%$ lower as measured under A	Hi = Gate V302 Lo = 0-socket $\downarrow$ Instrument settings; Refer to A Measured with PM2524	Logic 0 ($-8.5V$)	Defect V302 Track shortcircuit	0V, Track interruption
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 $\downarrow$ Select; Range 1V $\sim$	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 $\sim$	3k01 $\pm 0.1\%$ 30k $\pm 0.1\%$	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 $\sim$ deviates Range 100V $\sim$ deviates	—	—	Refer to B Refer to G	—
B	A A	Range 10V $\sim$ deviates with a factor of 10 Range 10V $\sim$ deviates not with a factor of 10)	—	—	Refer to C Refer to F	—
C	B	Range 10V $\sim$, deviation factor 10 Signal Sin OQ0061 (A301)	Hi = A301/13 Lo = 0-socket $\downarrow$ Select; Range 10V $\sim$	Logic 1 (0V)	Refer to E	Refer to D
D	—	Signal RNG A OQ0059 (D101)	Hi = D101/8 Lo = 0-socket $\downarrow$ Select; Range 10V $\sim$	Logic 1 (0V)	Track interruption V $\sim$ switch (7-8)	Refer to 6.5 RANGING
E	C	Resistors Rb OQ0061 (A301)	R308, R316 = Rb	30k1 $\pm 0.1\%$	Defect OQ0061	Repair
F	B	Resistors Rb OQ0061 (A301)	R308, R316 = Rb	30k1 $\pm 0.1\%$	Refer to 6.6.3.	Repair
G	A	-Range 100V $\sim$ deviates with a factor of 100 -Range 100V $\sim$ 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 $\downarrow$ Select; Range 100V $\sim$	Logic 1 (0V)	Refer to J	Refer to I
I	G	Signal RNG B OQ0059 (D101)	Hi = D101/7 Lo = 0-socket $\downarrow$ Select; Range 100V $\sim$	Logic 1 (0V)	Check R314 Track	Refer to 6.5. RANGING
J	G	Drain voltage V301	Hi = drain V301 Lo = 0-socket $\downarrow$ Select; Range 100V $\sim$	<50mV $\sim$	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 I _{rx} OQ0063 (A401)	Hi = A401/16 Lo = 0-socket ↓ Select ; Function k Ω AUTO ranging	$\approx$ + 1mA	Refer to D	Refer to E
D	C	Check R401, track A401/16 to V/ Ω input	R401	R401 = 100 Ω PTC	Check switches	Repair
E	C	Current I _{rc} OQ0063 (A401)	Hi = A401/3 Lo = 0-socket ↓ Select ; Function k Ω AUTO ranging	$\approx$ + 10 μ A	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 1000 Ω cannot be adjusted (Adj. no. 14)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Current I _{rc} OQ0063 (A401)	Hi = A401/3 Lo = 0-socket ↓ Select ; Function k Ω Range 1000 Ω	$\approx$ + 10 μ A 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 I _{rx} OQ0063 (A401)	Hi = A401/16 Lo = 0-socket ↓ Select ; Function k Ω Range 1000 Ω	$\approx$ + 1mA	Refer to D	Defect OQ0063
D	C	Voltage on I _{rx} input OQ0063 (A401)	Hi = A402/16 Lo = 0-socket ↓ Select ; Function k Ω Range 1000 Ω Shortcircuit V Ω and 0	$\approx$ + 100mV	Defect OQ0063	Check R401 switches

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

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	V _{out} OQ0063 (A401)	Hi = A401/8 Lo = 0-socket ↓ Select ; Range 1k Ω , 1k Ω connected to V Ω /0 (full scale)	- 2V Can be adjusted with R407 (Note down!)	Refer to F	V = positif, 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 1k Ω 1k Ω connected to V Ω /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 = 100 Ω 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 1k Ω , 1k Ω connected to V Ω /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)	2/3 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	<table><tr><th>RNG</th><th>C</th><th>B</th><th>A</th></tr><tr><td>1k</td><td>1</td><td>1</td><td>1</td></tr><tr><td>10k</td><td>0</td><td>0</td><td>0</td></tr><tr><td>100k</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1000k</td><td>0</td><td>1</td><td>0</td></tr><tr><td>10M</td><td>1</td><td>0</td><td>0</td></tr></table> Logic 0 = –8.5V Logic 1 = 0V ↓	RNG	C	B	A	1k	1	1	1	10k	0	0	0	100k	0	0	1	1000k	0	1	0	10M	1	0	0	Defect OQ0063	Refer to D
RNG	C	B	A																											
1k	1	1	1																											
10k	0	0	0																											
100k	0	0	1																											
1000k	0	1	0																											
10M	1	0	0																											
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	<table><tr><th>RNG</th><th>C</th><th>B</th><th>A</th></tr><tr><td>1k</td><td>1</td><td>1</td><td>1</td></tr><tr><td>10k</td><td>0</td><td>0</td><td>0</td></tr><tr><td>100k</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1000k</td><td>0</td><td>1</td><td>0</td></tr><tr><td>10M</td><td>1</td><td>0</td><td>0</td></tr></table> Logic 0 = –8.5V Logic 1 = 0V ↓	RNG	C	B	A	1k	1	1	1	10k	0	0	0	100k	0	0	1	1000k	0	1	0	10M	1	0	0	Defect R401, R416, R417 or OQ0063 or tracks	Refer to 6.5. 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																											

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 $\rightarrow$ RANGES

6.8.1. Display constant 0000 in range 10A

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

6.8.2. Range 10A $\rightarrow$ cannot be adjusted (Adj. no. 12)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check shunt R1 and soldering spots	R1	R1 = $\approx$ 12m Ω	Refer to B	Repair
B	A	Check R603, R604, R606, R607, R608, R610	R603, R604, R606, R607, R608, R610	R603 = 1,8 Ω R604 = 249 Ω R606 = 13k3 R607 = 40k2 R608 = 1k Ω 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 $\rightarrow$ cannot be adjusted (Adj. no. 19)

No.	From	Measurement	Measuring points	Measuring data	Correct	Incorrect
A	—	Check R603	R603	1,8 Ω $\pm$ 10%	Refer to B	Repair
B	A	Check R604, R606, R607, R608, R610	R604, R606, R607, R608, R610	R604 = 249 Ω R606 = 13k3 R607 = 40k2 R608 = 1k R610 = 205k	Check tracks	Repair

6.9. A $\sim$ RANGES

6.9.1. Display constant 0000

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

6.9.2. Range 100mA $\sim$ 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 functioning

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 	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 transistor 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 (BL) of HEF 4511 (D701)	Hi = 701/4 Lo = 0-socket ↓	Logic 0 (-8.5V)	Defect D701	Track interruption

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

<i>Description</i>	<i>Ordering number</i>	<i>Qty.</i>	<i>Item</i>	<i>Fig.</i>
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/V Ω /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	—	—

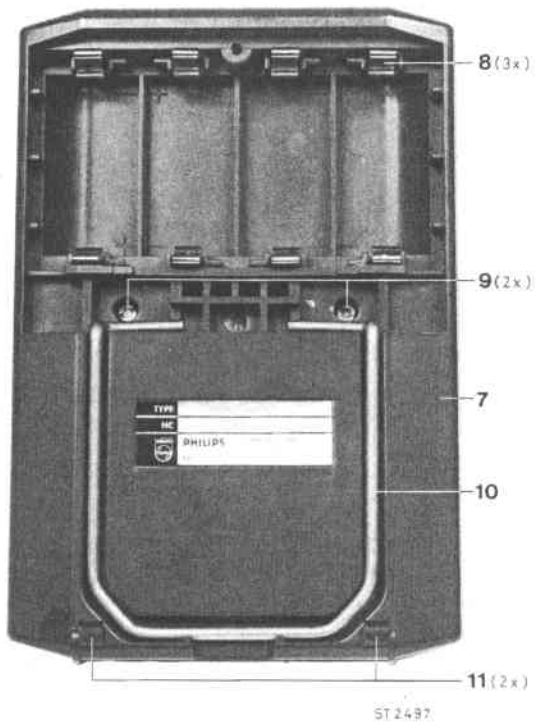


Fig. 46.

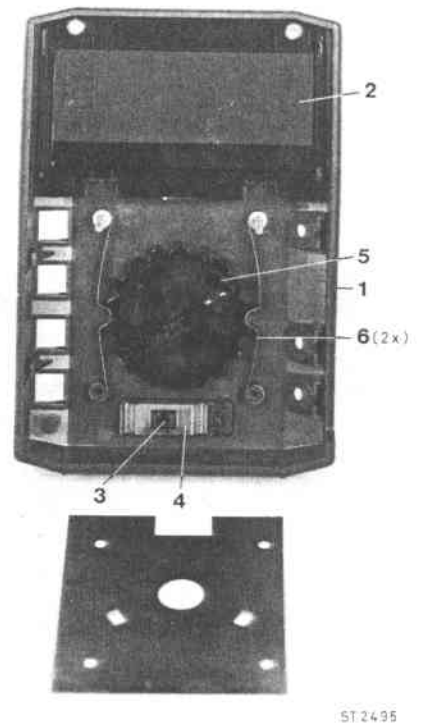


Fig. 47.

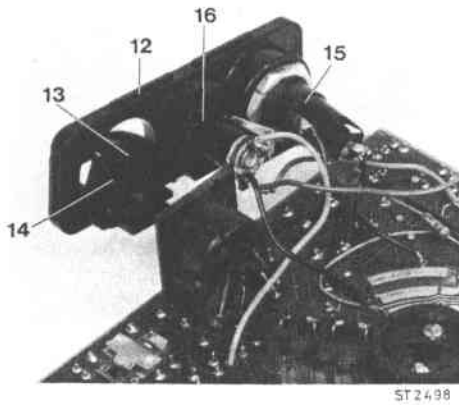


Fig. 48.

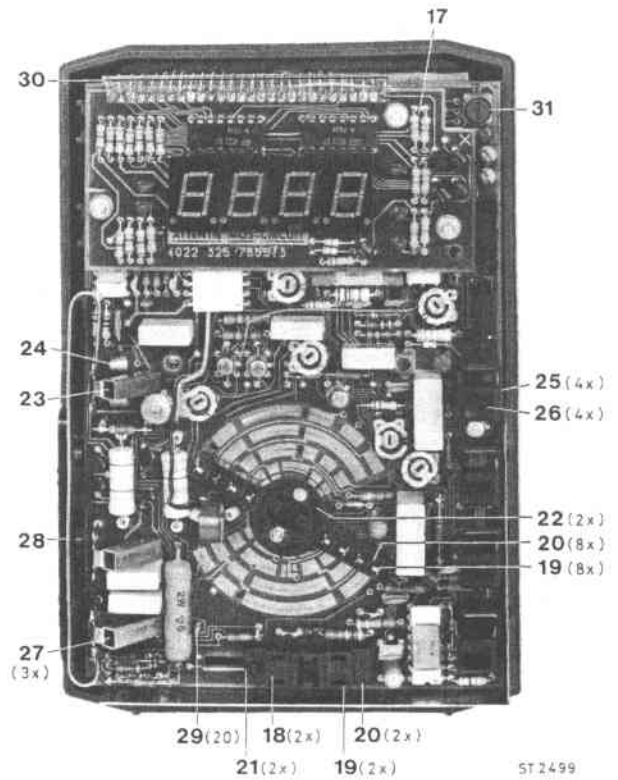


Fig. 49.

7.2. ELECTRICAL

7.2.1. Resistors

<i>Item</i>	<i>Ordering number</i>	<i>Ohm</i>	<i>Tol. (%)</i>	<i>Type</i>	<i>Remarks</i>
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

<i>Item</i>	<i>Ordering number</i>	<i>Ohm</i>	<i>Tol. (%)</i>	<i>Type</i>	<i>Remarks</i>
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

<i>Item</i>	<i>Ordering number</i>	<i>Farad</i>	<i>Tol. (%)</i>	<i>Volts</i>	<i>Remarks</i>
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 μ F	-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
C401	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 μ F	-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 μ F	-10+50	10	Electrolytic
C802	4822 124 20459	22 μ F	-10+50	10	Electrolytic
C803	4822 124 20459	22 μ F	-10+50	10	Electrolytic
C804	4822 124 20459	22 μ F	-10+50	10	Electrolytic
C805	4822 122 31072	47 pF	2	100	Ceramic plate
C806	4822 124 20459	22 μ F	-10+50	10	Electrolytic

<i>Item</i>	<i>Ordering number</i>	<i>Type/Description</i>
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7.2.3. Semi conductors

V101	5322 130 44509	BFQ16
V102	5322 130 44405	ON528
V150	5322 130 40482	BRV39
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

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%	5322 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 $\approx$ 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 54727
		C305	3.9p	500V $\pm$ 0.25p		4822 122 31217 replaced by
			5.6p	500V $\pm$ 0.25p		4822 122 31191
		C306	3.9p	500V $\pm$ 0.25p		4822 122 31217
			4.7p	500V $\pm$ 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
			4.7 Ω	CR25		4822 110 64045
		C103	220nF	100V $\pm$ 10		4822 121 30031 replaced by
			470nF	100V $\pm$ 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 M Ω range.				

DM01 2000 onwards	Replaced : C303 15 μ 4V -10+50 4822 124 20579 replaced by 15 μ 10V -10+50 5322 124 14036 Reason : Better quality of electrolytic capacitors
DM02 4926 onwards	New p.c. board N1 Replaced : C601 1 μ 63V -10+50 4822 124 20624 replaced by 1 μ 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 k Ω , D,T function switch. Reason : The OQ0063 is only switched on now in the k Ω , 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 $\downarrow$
	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 until
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 $\downarrow$
The ordering number of the OQ0063 remains 5322 209 85886.

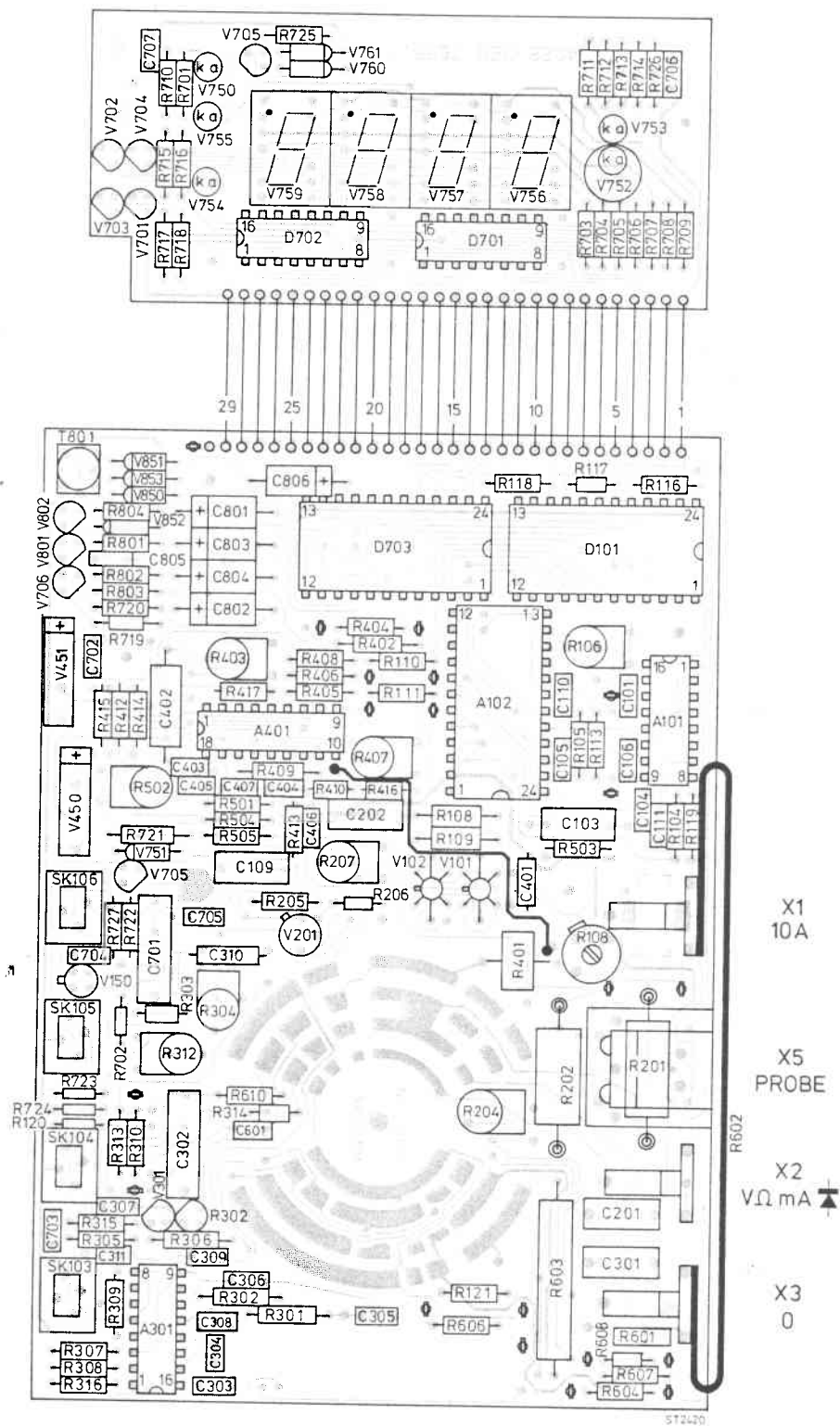


Fig. 51. P.c. boards conductor side

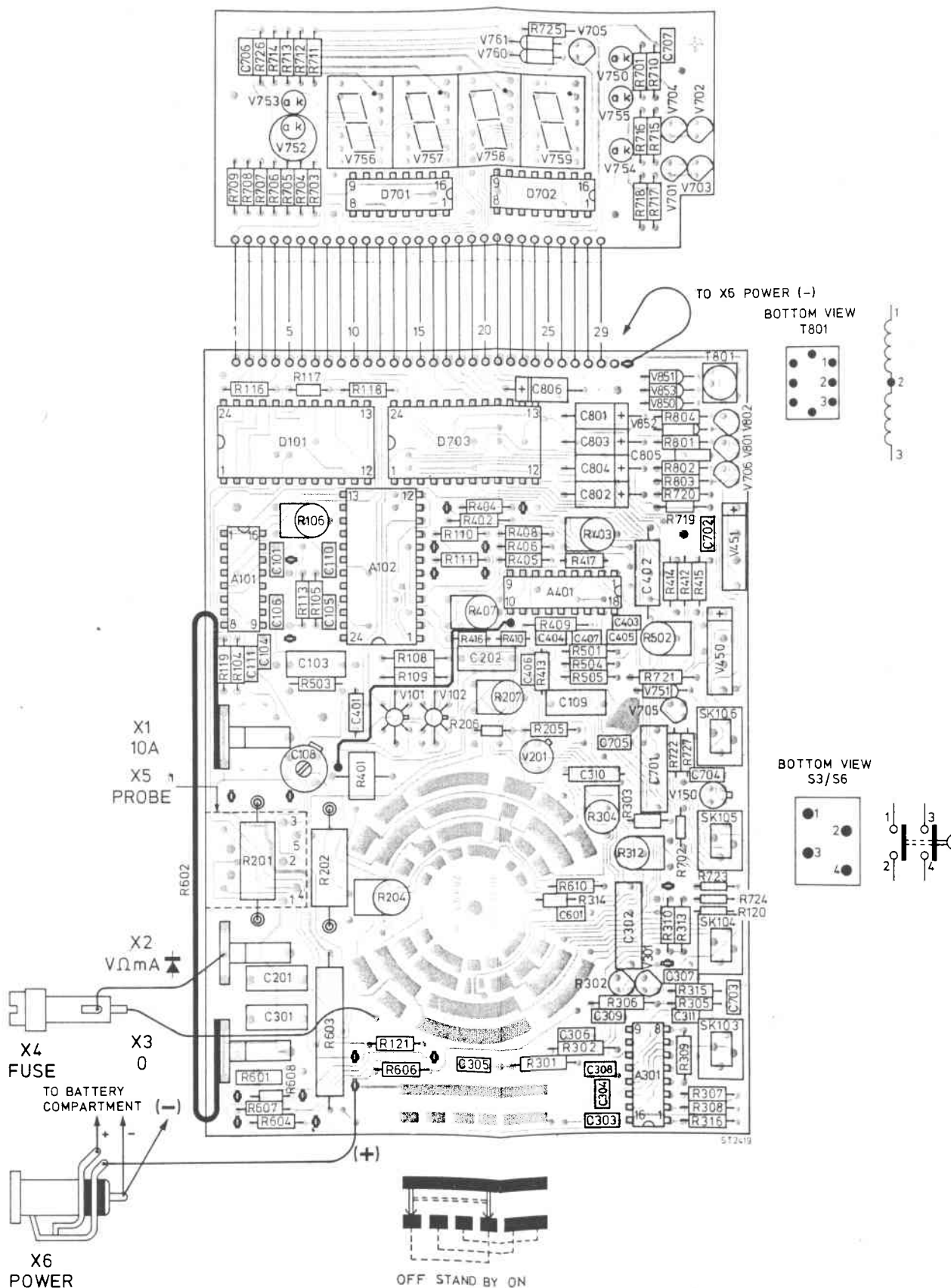


Fig. 50. P.c. boards component side

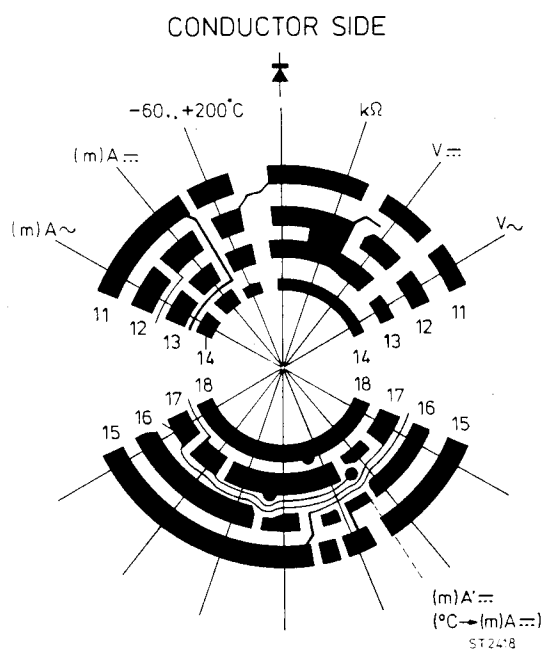
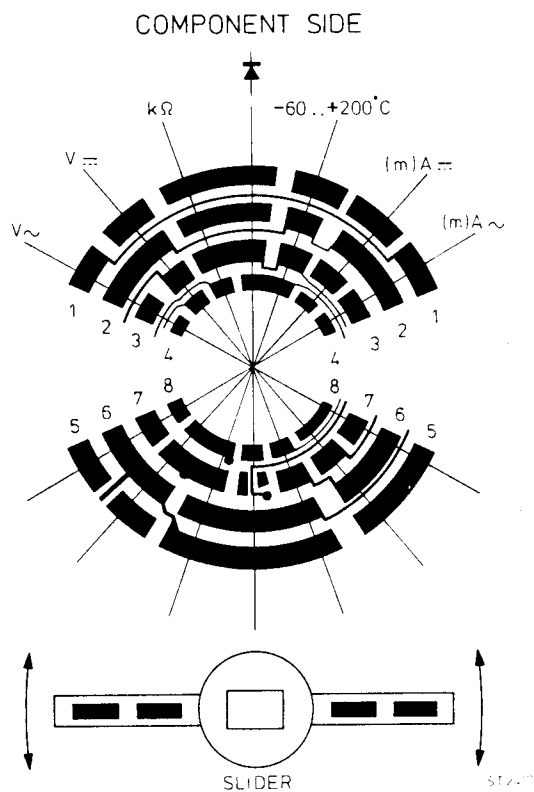
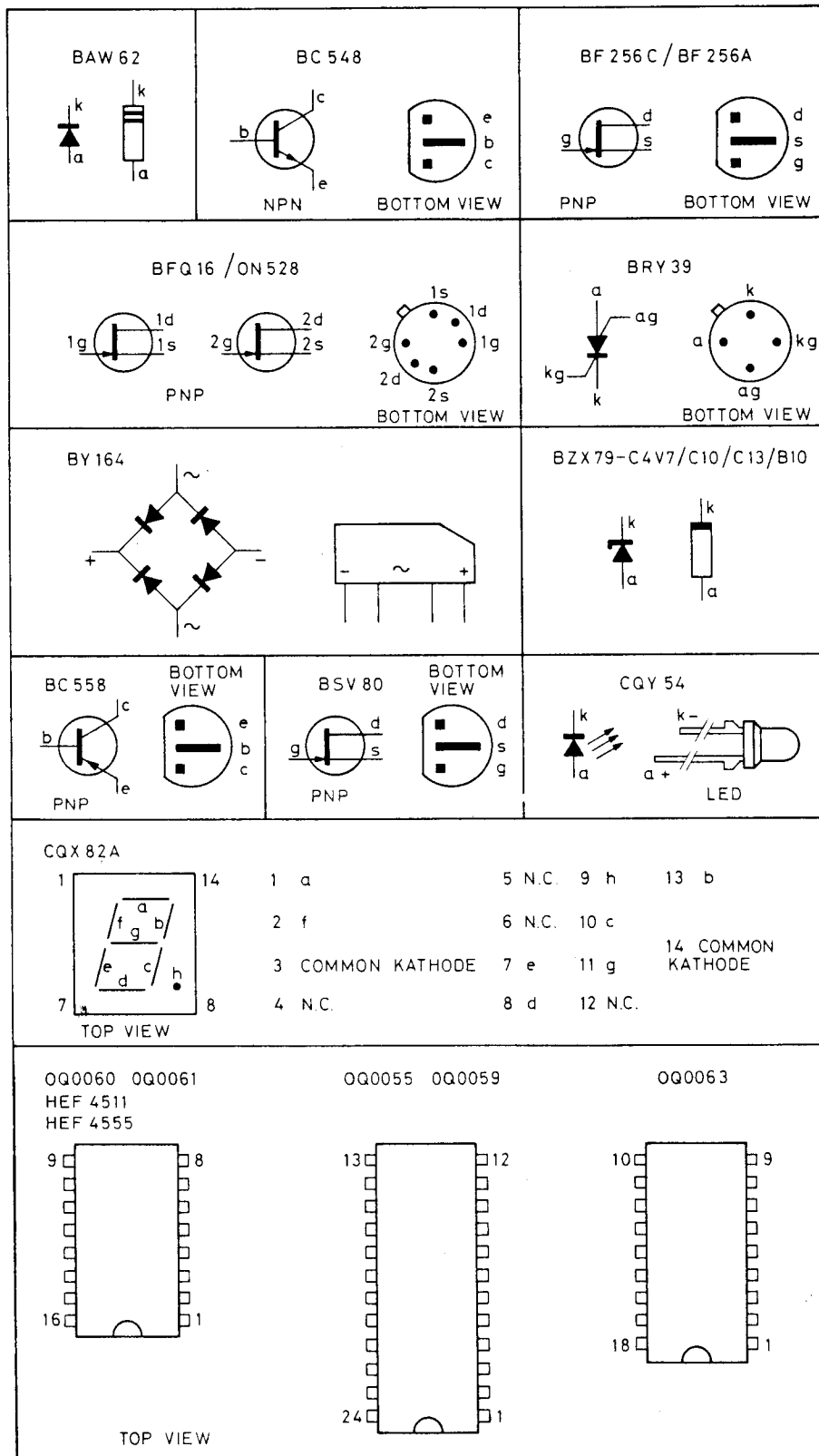
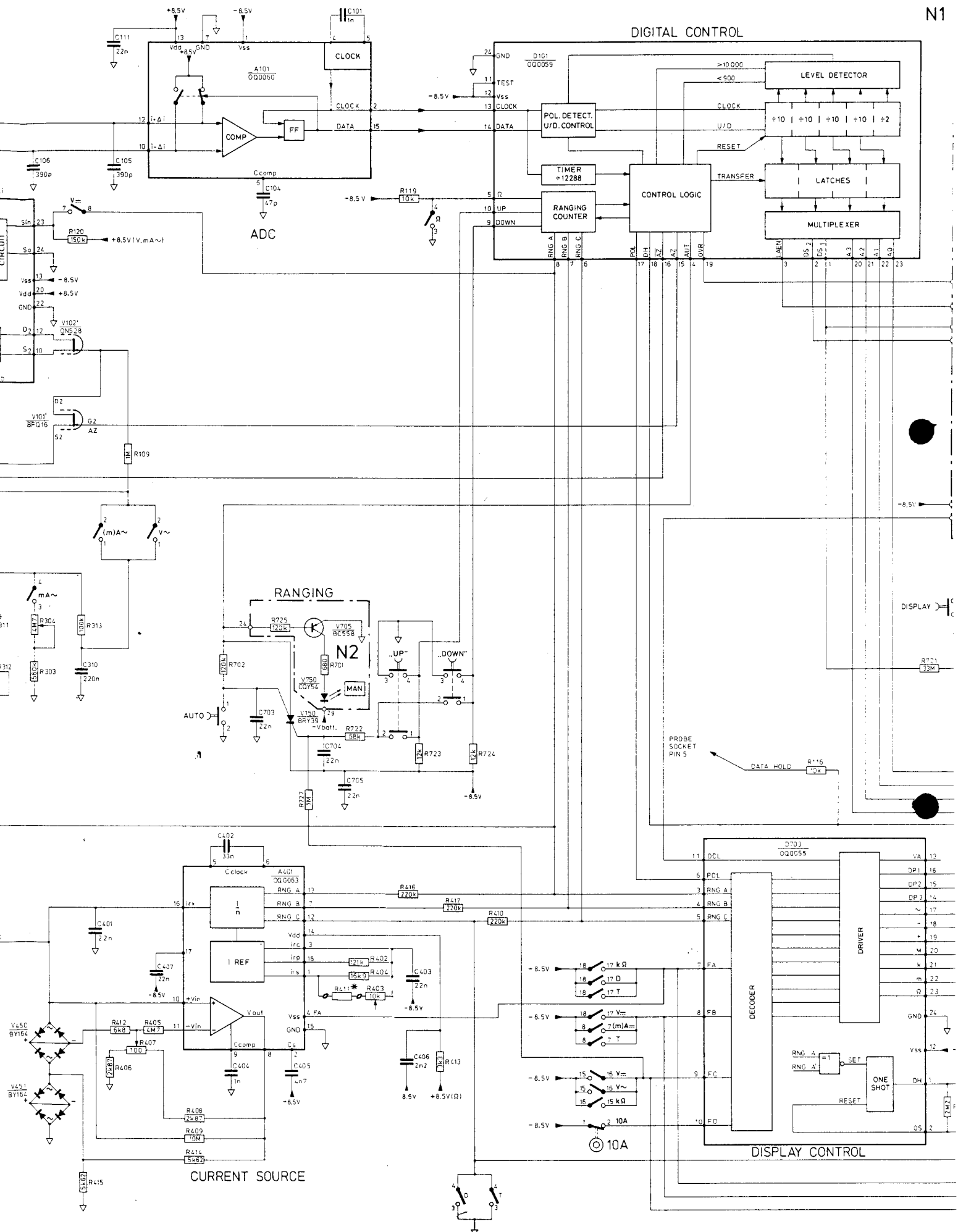


Fig. 52. Function switch lay-out



ST2472

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



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 earlier instruments refer to chapter 7.3.