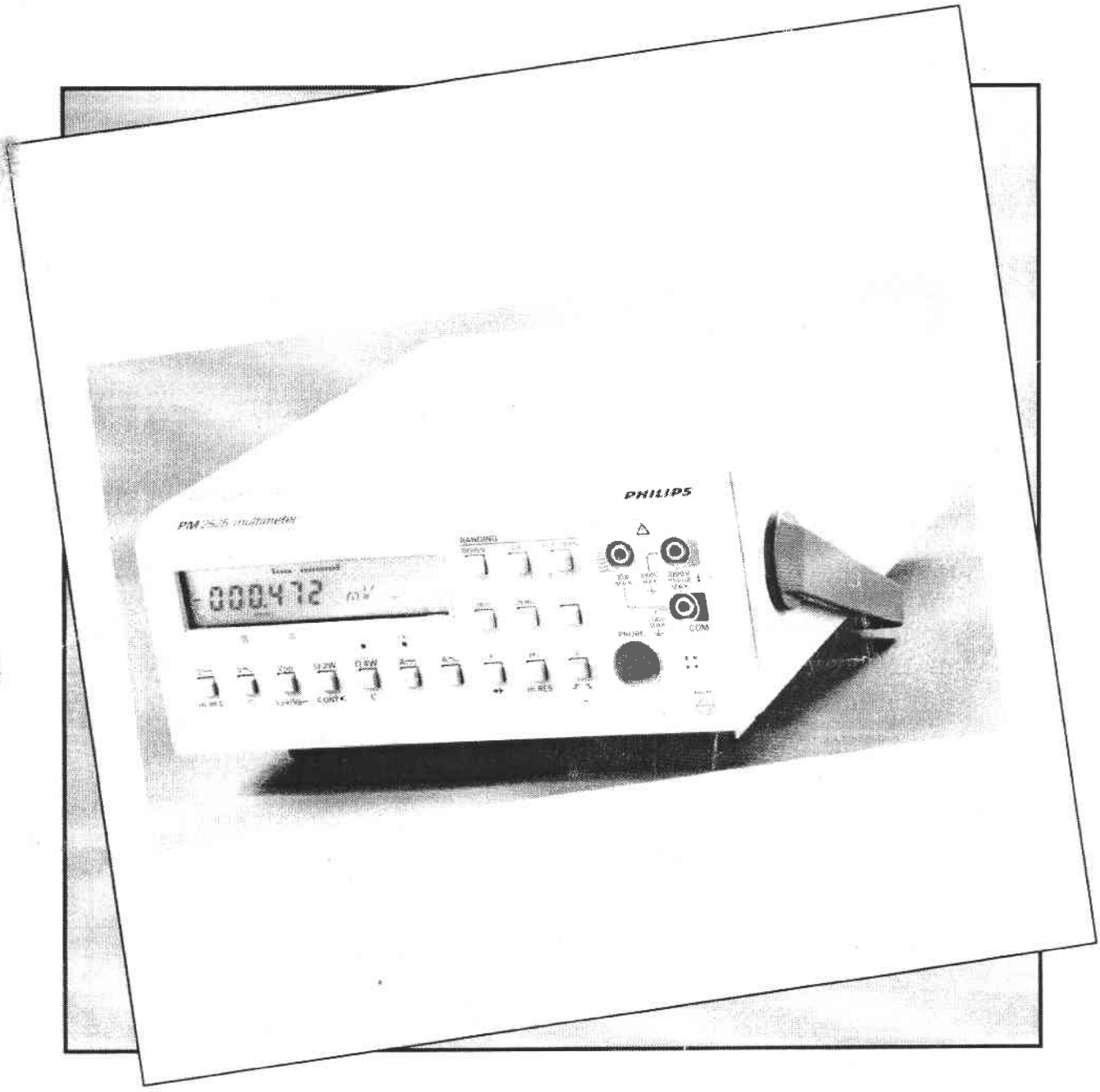
PHILIPS

Multimeter
PM2525/.3./. . .

TEST & MEASUREMENT CUSTOMER SUPPORT



4822 872 85006
930701 (all versions)

Service Manual

Multimeter
PM2525/.3./. . .

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IMPORTANT

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

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.

This service manual can be used for the following versions:

/. 3 .

- 1 standard version
  3 USA version
  4 UK version
  5 Swiss version
- 3 version (grey)
- 0 standard version
  2 battery version (plastic back panel)
  5 IEEE version (standard + PM9191)
  6 RS232C version (standard + PM9190)
  7 analog output version (standard + PM9193)

Printed in The Netherlands

CONTENTS

1 SAFETY INSTRUCTIONS

Read this page carefully before installation and use of the instrument.

The following clauses contain information, cautions and warnings which must be followed to ensure safe operation and retain the instrument in a safe condition. Adjustment, maintenance and repair of the instrument shall be carried out only by qualified personnel.

1.1 GENERAL CLAUSES

1.1.1 WARNING: The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can be dangerous to life.

1.1.2 The instrument shall be disconnected from all voltage sources before it is opened.

1.1.3 Bear in mind that capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

1.1.4 WARNING: Any interruption of the protective earth conductor inside or outside the instrument, or disconnection of protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

1.1.5 Components that are important for safety of the instrument may only be renewed by components obtained through your local Philips organisation.

1.1.6 After repair and maintenance in the primary circuit, safety inspection and tests, as mentioned in Section 7 must be performed.

2 CHARACTERISTICS

GENERAL NOTES:

1. Specification points, marked with ** apply only for the PM2525/5.. and PM2525/6...
2. This characteristics describes the overlapping specification points from the versions PM2525/0../2../5../6../7...

SAFETY CHARACTERISTICS

This apparatus has been designed and tested in accordance with Safety Class 2 Requirements for Electronic Measuring Apparatus and CSA 556B, and has been supplied in a safe condition.

REMARK: PM2525/0../2.. Safety Class 2
PM2525/5../6../7.. Safety Class 1

This manual contains information and warnings which must be followed to ensure safe operation and retain the instrument in a safe condition.

This instrument:
- satisfies the requirements of EEC Council Directive No. 73/23 EEC in that it conforms with IEC Publication 348.
- is listed by the Canadian Standard Association as certified.
- is certified by the independent German Testing and Approvals Institute VDE (and has been tested according to VDE 0411, part 1).

PERFORMANCE CHARACTERISTICS

- Properties expressed in numerical values with stated tolerance are quatanteed by PHILIPS. Specified tolerance numerical values indicate those that could be nominally expected from the mean of a range indentical instruments. This specification is valid 1 hour after power on.

Specification for Digital Multimeter PM 2525/.2.

(Terms used in these specifications are based on definitions layed down in IEC 458).

General

Manufacturer	: Philips HIG I&E
Type number	: PM 2525/.2.
Designation	: Digital Multimeter
Measured functions	: Vdc, Vac, Vac+dc, Vpeak, Adc, Aac Ohm 2W, Ohm 4W, ⊣▶⊢, cont, F, °C, Hz, s.

General notes:
1. Specification points, marked with * apply only on the /52. and /62. versions.
2. This specification describes the overlapping specification points of the versions /02., /22., /52., /62. and /72. .

Measurement performance

DC voltage measurement (VALID 1 HOUR AFTER POWER ON)

Ranges	: 200 mV - 2000V (max.input voltage 1000V)
Resolution	:*High speed mode: 100uV in 200mV range Normal mode: 10uV in 200mV range High resolution mode: 1uV in 200mV range
Number of representations units.	:*High speed mode:2100 Normal mode:21000 High resolution mode:210000
Accuracy at reference conditions speed 1+2	: ±(0.02% of reading+0.01% of range)
speed 3	: ±(0.15% of reading+0.1% of range)
Temperature coëfficiënt	: ±0.002% of reading/°C
Input impedance	: 200mV - 2V 20 MΩ // 50pF 20 V 11 MΩ // 80pF 200 V - 2000 V 10 MΩ // 90pF
Offset current in input	: < 20 pA
SMRR	: >80 dB for AC signals 50 Hz ±0.1% >60 dB for AC signals 50 Hz ±1.0%
Maximum SM signal	: 2x range except 2000 V range
CMRR	: >120 dB for DC signals >120 dB for signals 50 Hz ±0.1%
Max. CM-voltage	: 250 V RMS 350 V peak
Response time	: 0.2 /0.8 /5 s (without ranging) depending on speed. : 1 /1.5 /6 s (with ranging) depending on speed.

Maximum input voltage	:	Hi and Lo 1000 V RMS Hi and earth 1000 V RMS Lo and earth 250 V RMS
Max. V - Hz product of input signal	:	10^7
Zeroing	:	automatically
Zero point drift	:	0 - 35°C 2uV/°C 35°- 45°C 10uV/°C

dB Measurement in DC ranges

Range	:	-77...+62.2 dB (reference resistor 600Ω) Measured values less then 0.1 mV is displayed as - UL. Measured value > 1000V is displayed as OL.
0 dB reference	:	1 mV in reference resistor or when selecting the zero function with push button "zero" on/off.
Reference resistor	:	programmable between 0.0001 Ω and 9999 Ω
Resolution	:	0.1 dB for signals > 1 mV 1.0 dB for signals < 1 mV
Number of representation units	:	999 for signals > 1 mV 99 for signals < 1 mV
Accuracy signals > 5 mV; (speed 1+2)	:	± 0.1 dB
signals > 0.5 mV;< 5mV (speed 1+2)	:	± 1.0 dB
signals > 5 mV; (speed 3)	:	± 0.4 dB
Temperature coëfficiënt signals > 5 mV	:	± 0.02 dB/°C
signals < 5 mV	:	± 0.2 dB/°C
Input impedance for signals between	:	0 ..... 1.8 V 20 M // 50 pF 1.8 V.. 18 V 11 M // 80 pF 18 V .. 600 V 10 M // 90 pf
CMRR	:	> 120 dB for DC signals > 120 dB for AC signals 50 Hz ± 0.1%
Response time	:	1.5 s

AC voltage measurement

Possible measuring modes	:	AC voltages excl. DC component AC voltages incl. DC component
Ranges	:	200 mV - 2000 mV (max. input voltage 750 V RMS)
Resolution	:	*High speed mode: 100uV on 200 mV range. Normal mode 10 uV on 200 mV range Measured value under < 1% of range displayed as 0000

Number of representation units	:*High speed mode: 2100 Normal mode: 21000

Function Vac

Accuracy at reference conditions over 3% - 100% of range.

All ranges (2000V only 20 Hz ... 70Hz)	
20 Hz - 40 Hz	: ±(0.6% of reading+0.2% of range)
40 Hz - 100 Hz	: ±(0.2% of reading+0.1% of range)
100 Hz - 20 kHz	: ±(0.8% of reading+0.2% of range)
20 kHz - 50 kHz	: ±(2.5% of reading+0.5% of range)
50 kHz - 100 kHz	: ±(4.0% of reading+0.5% of range)

Function Vac/dc

Accuracy at reference conditions	: same as Vac : Additional for DC component: ±(0.2% of reading+0.1% of range)
Temperature coëfficiënt	: ±(0.025% of reading+0.005% of range)/°C
Input impedance	: 200 mV - 2V 20 M // 50 pF 20 V 11 M // 80 pF 200 V - 2000 V 10 M // 90 pF
CMRR	: >120 dB for DC signals > 60 dB for AC signals 50 Hz
Freq. range	: 20 Hz ... 100 kHz, incl. or excl. DC component, switchable on front.
DC voltage on Vac for no additional error	: 25x range
Response time	: 1.5 s (without ranging) 3.0 s (with ranging)
AC detector	: True RMS
Crest factor	: 2 at full scale, increasing down scale via 2 x full scale/ranging
Maximum input voltage	: Hi and Lo 750 V RMS Hi and earth 750 V RMS Lo and earth 250 V RMS
Maximum V - Hz product	: 10^7

dB measurements in AC ranges

Possible measuring modes	: AC voltage excl. DC component (Vac) AC voltage incl. DC component (Vac/dc)
Range	: - 51.7 + 59.7 dB (reference resistor 600 Ω) Measured value less than 2 mV is displayed as UL.
0 dB reference	: 1 mW in reference resistor or when selecting the zero function with pushbutton zero "on/off".
Reference resistor	: Programmable between 0.0001 Ω and 9999 Ω
Resolution	: 0.1 dB
Number of representation units.	: 999

Function Vac

Accuracy at reference conditions for signals

- 42.2 dB ....- 32.6 dB	: 20 Hz ...	20 kHz	± 0.8 dB
- 32.6 dB ....+ 48.2 dB	: 20 Hz ...	20 kHz	± 0.4 dB
- 32.6 dB ....+ 48.2 dB	: 20 kHz ...	100 kHz	± 1 dB

Function Vac/dc

Accuracy at reference conditions	: same as Vac additional for the DC component : ± 0.2 dB
Temperature coëfficiënt within specified range	: ± 0.02 dB/°C
Input impedance for signals between	: 0 .. 1.8 V 20 M // 50 pF 1.8 V .. 18 V 11 M // 80 pF >18 V .. 10 M // 90 pF
CMRR	: >120 dB for DC signals > 60 dB for AC signals 50 Hz ± 1%
Freq. range	: 20 Hz ... 100 kHz, incl. or excl. DC component, switchable on front.
Response time	: 3 s
AC detector	: True RMS
Crest factor	: 2
Maximum input voltage	: Hi and Lo 750 V RMS Hi and earth 750 V RMS Lo and earth 250 V RMS
Maximum V - Hz product	: 10^7

Vpeak

Possible measuring modes	: V peak-peak; V peak pos; Vpeak neg
Ranges	: 2 V ... 2000 V (max. input voltage 850 Vpeak)

Resolution	: 1 mV on 2 V range
Number of representation units	: 2100 for Vpeak neg/pos; 4200 for Vpeak-peak
Accuracy at reference conditions	
dc+ 20 Hz ... 20 kHz	: ±(1% of reading+10 digits) notes
20 kHz ... 100 kHz	: ±(5% of reading+10 digits) 1+2
Temperature coëfficiënt	: ± 0.15% of reading /°C
Input impedance	: 2 V 20 M // 50 pF 20 V 11 M // 80 pF 200 V,2000V 10 M // 90 pf
Measuring time	: 500 msec
DC voltage on Vpeak-peak for no additional error	: 25 x range
Response time p+; p-	: 1 s (without ranging) 2.5 s (with ranging)
p-p	: 1.5 s (without ranging) 5 s (with ranging)
Max.input voltage	: Hi and Lo 600 V AC or DC 850 Vpeak Hi and earth 600 V AC or DC Lo and earth 250 V AC or DC
Max. V-Hz product	: 10^7
CMRR	: >120 dB for DC signals > 60 dB for AC signals 50 Hz
Note 1	
2000 V range	: Freq. range DC + 20 Hz ... 60 Hz
Note 2	
max dV/dt 2 V range	: 2 V/us
20 V range	: 20 V/us
200 V range	: 200 V/us
2000 V range	: 0.5 V/us

DC current measurement

Ranges	: 1 µA 10A
Resolution	:*High speed mode 1 nA on 1 uA range Normal mode 0.1 nA on 1 uA range
Number of representation units	:*High speed mode: 1100 Normal mode: 11000
Accuracy	
speed 2	: ±(0.1% of reading + 0.05% of range)
speed 3	: ±(0.2% of reading + 0.2% of range)
Temperature coëfficient	: ±(0.01% of reading + 0.005% of range)/ºC
Voltage drop at end of range	: ranges 1 µA, 10 µA < 2.5 mV ranges 100 µA, 10 mA, 1 A < 40 mV ranges 1 mA, 100 mA, 10 A < 400 mV

Response time	: 0.8 s (without ranging) 2.5 s (with ranging)
Protected up to	: 250 V RMS ranges 1 uA - 100 mA Ranges 1 A ... 10 A not protected
Max. CM - voltage	: 250 V RMS, 350 V peak
Max. input - voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS

AC current measurements

Ranges	: 1 uA....10 A
Resolution	:*High speed mode: 1 nA on 1 uA range Normal mode: 0.1 nA on 1 uA range measured value under 2% of range is displayed as 0000
Number of representation units	:*High speed mode: 1100 Normal mode: 11000

Accuracy (valid between 5% and 100% of range)

Range 1 uA - 100 mA	
20 Hz - 40 Hz	: ±(0.6% of reading+0.2% of range)
40 Hz - 200 Hz	: ±(0.4% of reading+0.15% of range)
200 Hz - 500 Hz	: ±(0.6% of reading+0.2% of range)
Range 1 A - 10 A	
20 Hz - 40 Hz	: ±(0.6% of reading+0.2% of range)
40 Hz - 200 Hz	: ±(0.4% of reading+0.15% of range)
200 Hz - 500 Hz	: ±(3.0% of reading+1.0% of range)
Temperature coëfficiënt	: ±(0.04% of reading+0.015% of range)/°C
Freq. range	: 20 Hz ... 500 Hz
Voltage drop	: ranges 1 uA ... 1 mA < 2.5 mV ranges 10 mA and 1 A < 40 mV ranges 100 mA and 10 A < 400 mV
AC detector	: RMS convertor, AC coupled
Crest factor	: 4 at full scale
Responce time	: 1.5 s (without ranging) 3 s (with ranging)
Protected up to	: 250 V RMS ranges 1 uA...100 mA Ranges 1 A... 10 A not protected
Max. CM Voltage	: 250 V RMS, 350 V peak
Max. input voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS

Resistance measurement

Possible measuring modes	: two-wire configuration via Ω - 0 terminals. four-wire configuration via PROBE terminal selectable with switch on front

Ranges two-wire	: 200 Ω .....200 MΩ
Ranges four-wire	: 200 Ω ..... 2 MΩ
Maximum lead resistance on four wire configuration	: 2 Ω
Resolution	:*High speed mode: 100 mΩ on 200 Ω range Normal mode: 10 mΩ on 200 Ω range
Number of representation units	
200 Ω ... 20 MΩ	:*High speed mode: 2100 Normal mode: 21000
200 MΩ	:*High speed mode: 210 Normal mode: 2100
Accuracy	
200 Ω - 200 kΩ; speed 2	: ±(0.1% of reading+0.05% of range)
200 Ω - 200 kΩ; speed 3	: ±(0.15% of reading+0.15% of range)
2 MΩ - 20 MΩ; speed 2	: ±(0.5% of reading+0.05% of range)
2 MΩ - 20 MΩ; speed 3	: ±(0.5% of reading+0.15% of range)
200 MΩ	: ± (3% of reading+ 1% of range)
Temperature coëfficiënt	
200 Ω - 200 kΩ	: ±(0.01% of reading+0.005% of range)/°C
2 MΩ - 20 MΩ	: ±(0.05% of reading+0.01% of range)/°C
200 MΩ	: ±(0.5% of reading+0.1% of range)/°C
Measuring current	: 1 mA, 1 mA, 100 uA, 10 uA, 1 uA, 100 nA, 10nA at the separate ranges
Maximum volt at open input	: 4 V
Polarity of input socket at two-wire	: - on Hi + on Lo
Response time	
200 Ω - 200 kΩ	: 0.8 s (without ranging) 2.5 s (with ranging)
2 MΩ - 20 MΩ	: 2 s (without ranging) 3.5 s (with ranging)
200 MΩ	: 9 s (without ranging) 10 s (with ranging)
Protected up to	: 250 V RMS
Maximum input voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS

<u>Diode measurements</u>

Driving current	: 1 mA
Range	: 2000.0 mV
Resolution	: 0.1 mV
Number of representation units	: 20000
Polarity input sockets	: - on Hi + on Lo

Response time	: 0.8 s
Maximum input voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS

Continuity

Driving current	: 1 mA
Short circuit	: Audible tone from 0 ... 10 Ω
Isolation	: Resistance > 10 Ω, no tone
Response time	: < 0.15 sec.

Capacity measurement

Ranges	: 20 nF ... 2000 uF
Resolution	:*High speed mode: 10 pF in 20 nF range Normal mode: 1 pF in 20 nF range
Number of representation units	:*High speed mode: 2100 Normal mode: 21000 (20 nF .. 200 uF range) 2100 (2000 uF range)
Accuracy	
20 nF .. 200 uF range	: ±(1% of reading+0.1% of range)
2000 uF range	: ±(10% of reading+0.1% of range)
Temperature coëfficiënt:	
20 nF .. 200 uF range	: ±(0.1% of reading+0.01% of range)/°C
2000 uF of range	: ±(1 % of reading+0.1% of range)/°C
Measuring current	: 100 nA, 1 uA, 10 uA, 100uA, 1mA at the separate ranges
Maximum voltage at input	: 2.5 V
Polarity input socket	: - on Hi + on Lo
Responce time	: 1 s (without ranging) 1.5 s (with ranging)
Protected up to	: 250 V RMS
Maximum input voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS

Temperature measurements

For temperature measurements additional needed	: Pt 100 probe
Range	: - 100°C ...+ 850°C
Resolution	:* Normal mode: 1 °C High resolution mode: 0.1°C
Number of representation units	:* Normal mode: 850 High resolution mode: 8500
Accuracy(excl. probe)	: ±(0.3% of reading+0.3°C)
Temperature coefficient	: ±(0.03% of reading+0.03°C)/°C

Measuring current	: 1 mA
Response time	: 0.5 s (excl. probe)
Linearisation	: probe characteristics is linearised within limits stated in DIN 43760
Max. voltage at probe tip	: depending on probe

Frequency measurements

Ranges	: 10 kHz ...20 MHz
Resolution	: Normal mode 1 Hz in 10 kHz range High resolution mode 0.1 Hz in 10 kHz range
Number of representation units 10 kHz ... 10 MHz	: Normal mode: 10000 High resolution mode: 100000
20 MHz	: Normal mode: 2000 High resolution mode: 20000
Accuracy	: ±(0.01% of reading+2 digits range)
Temperature coëfficiënt	: ± 0.001% of reading /°C
Response time	
range 100 kHz ... 20 MHz	: Normal mode: 0.3 s (without ranging) 0.5 s (with ranging) High resolution: 2.5 s (without ranging) 3.0 s (with ranging)
range 10 kHz	: Normal mode: 1.5 s (without ranging) 2.0 s (with ranging) High resolution 13.0 s (with ranging)
Impedance	: 10 M // 50 pF
Coupling	: AC
For voltage > 5 V max. V-Hz product	: 10^7
Maximum input voltage	: Hi and Lo 250 V RMS Hi and earth 250 V RMS Lo and earth 250 V RMS
Sensitivity	: 10 Hz ... 100 Hz : 1 V peak 100 Hz ... 10 MHz : 250 mV peak 10 MHz ... 20 MHz : 500 mV peak

Time measurements

Range	: 1 ... 10^5 seconds
Resolution	: 10 us in 1 second range
Number of representation units	: 99999
Accuracy for timer measurements	: 0.01% of reading
Temperature coefficient	: ± 0.001% of reading /°C

Hold of time	: 30 us
Start	: By positive or negative slope passing the trigger level. Selectable by push button "s".
Stop	: By positive and negative slope passing the trigger level. Selectable by push button "s".
Reset	: By pushbutton on date hold probe if connected or stop pulse, if no data hold probe is connected.
Trigger level	: < 1 V
Result representation	: Old measurement are displayed at least 500 ms. Display is updated at the "stop-condition" moment.10 seconds after a "start-condition" the display starts counting the time in seconds untill the " stop condition". If measuring time > 10 seconds, the beeper will be activated by the "stop condition" for a moment. A moving baragraph indicates a measurement in progress.

External triggering (/52. and /62. version only)
Response time (single trigger, without ranging):

Function	HSM(speed 3)	NM(speed 2)	HRM(speed 1)
Vdc	0.1	0.4	4
Vac	0.25	0.55	-
Vp+, Vp-	-	0.5	-
Vpp	-	1.0	-
Adc	0.1	0.4	-
Aac	0.25	0.55	-
Ω	0.1	0.4	-
Temp	-	0.5	4.5
Freq	-	0.3	1.2 (100 kHz-20 MHz range)
Freq	-	1.5	11 (10 kHz range)
Cont	0.1	-	-
Diode	0.1	0.5	-
Cap	0.2	0.5	-

Calculate functions

a. Relative reference setting via push button "zero".
Measured value is default reference value (Can be altered manually)

b. Min/max.
Highest and lowest measured values are stored and can be displayed afterwards.

c. dB
Display = 20 log $\frac{X}{R}$ X = measured value, R = reference value
is function Vdc, Vac, Vac + Vdc

Conversion characteristics

Kind of conversion	:	lineair
Operating principle	:	Delta modulation
Basic mode of operating	:	repetitive triggered
Range setting	:	Manual - with UP and DOWN pushbutton Automatic - Upranging at 100% of scale 2000/10.000/20.000/100.000/ 200.000 Down ranging at 9.5% of scale 190/900/1900/9000/19000
Polarity setting	:	Automatic setting on Vdc, Adc,Vpeak, °C, dB, relative reference
Display Visual representation Number of digits	:	5½, 4½, 4, 3½ depending of function and range
Number of representation units	:	2100 11000 21000 210000 depending of function and range
Means of representation of output value	:	liquid crystal display Reflective Additional analog representation function by means of bargraph in LCD
Means of polarity representation	:	Automatic indication of + or - or blanked according to measuring function
Means of measuring mode representation	:	High speed mode SPEED 3 Normal mode SPEED 2 High resolution mode SPEED 1

Note: SPEED 3 available on Vdc and on versions /52. and /62. for Vdc, Vac, Ω, Cap, Adc, and Aac functions.
SPEED 2 for temperature function available only on /52. and /62. versions.

Means of decimal point representation	:	Automatic indication, depending on range
Means of functional representation	:	selected function is indicated in LCD
Means of overload representation	:	display indicates "OL"
Means of representation of exceeding crest factor	:	↑ in display
Data hold	:	By using data hold probe PM 9267
Range hold	:	possible via Auto/Man switch

Operating conditions (according to IEC 359)

a. Climatic conditions	: Group I with extension of the temperature limits
Temperature:	
Reference temperature	: + 23 °C .. ± 5 °C
Rated range of use	: 0 °C ...+40 °C
Adjustment temp. range	: + 21 °C ...+25 °C (factory only)
Limit range of operation	: 0 °C ...+55 °C
Limit range of storage and transport	: - 40 °C ...+70 °C
Humidity	
Reference rel.hum.	: 20 ...80% excluding condensation
Limit range of storage and transport	: 5 - 95% RH
Max. dew point	: 26 °C
b. Mechanical conditions	: according UN-D 1639/03 class: portable equipment subclass I
c. EMC	
Emmision	: CISPR publ. 11 and 14 VDE 871-B, VDE 875-K according Vfg. 1046/84

Line supply conditions

Group	: S2
Reference value	: 230 V ± 1%
Rated range of use	: 230 V + 12% - 15%
Note	: Instruments can be altered for nominal mains voltage of 115 V

Mains supply frequency

Reference value	: 50 Hz ± 1%
Rated range of use	: 50 Hz ± 5%
Note 1	: Instruments can be altered for nominal frequency of 60 Hz
Note 2	: Mains frequency can influence Series Mode Rejection; see specification SMR to meet same spec. for 60 Hz as for 50 Hz signals, the settings of the PM 2525 must be altered in the check function.

Mains supply interruptions

Interruption	< 30 ms	: no influence
	> 30 < 500 ms	: instrument may either restart or continue
	> 500 ms	: instrument will restart, conditions equals situation after switching on power.

Power consumption : 12 VA

Calibration

Recalibration interval : 1 year

Accessories

Supplied with instrument : Measuring leads PM9266 (incl.probes)
Main supply cable
Spare fuse
Operation manual

Optional available

Specific accessoires for PM 2525 : 4 wire Ω cable 5322 321 20506
4 wire Ω cable PM 9264/01

Universal accessoires :

High frequency probe	PM 9210
Shunt	PM 9244
Current transformer	PM 9245
EHT probe	PM 9246
Temp.probe (PT100)	PM 9249/01
Data hold probe	PM 9267/01
Current gun	PM 9101
Current probe	PM 9102
HF probe	PM 9213
Measuring leads	PM 9260
Measuring leads	PM 9266
Thermo couplerlinearizer	PM 9877/J
Thermo couplerlinearizer	PM 9877/K
19 inch rackmount	PM 2193

Miscellaneous

Dimensions : (LxBxH) 287 x 210 x 86 (excl feet)
287 x 210 x 106(incl.feet)

Weight : 2.5 kg
3.5 kg /22., /52., /62. and /72. version

Cabinet : BAYBLEND KL1441
/52., /62. and /72. version: steel plate

back

Safety

Class 2, according IEC 348

3. CIRCUIT DESCRIPTION

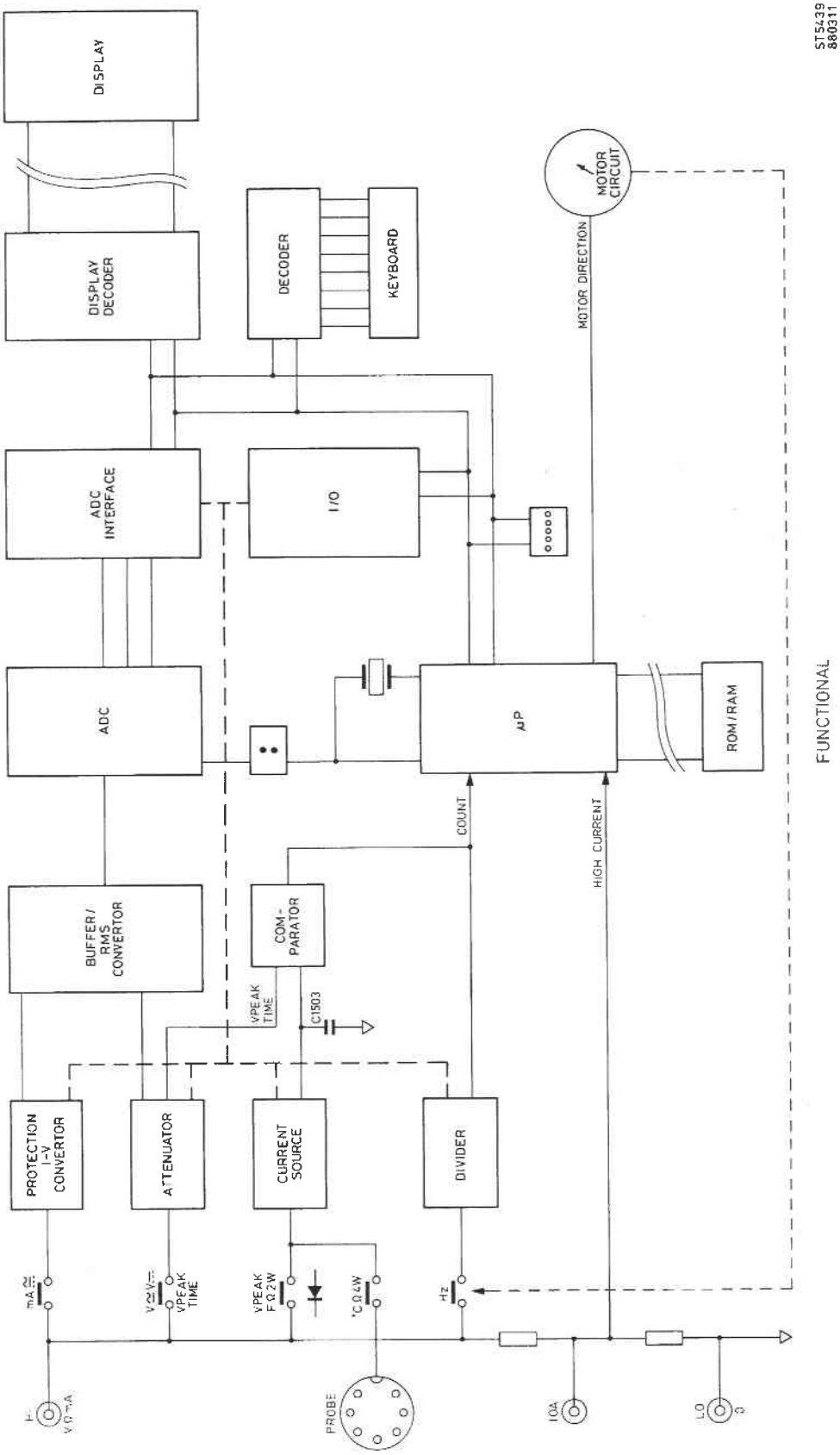
SHORT DESCRIPTION OF THE PM2525

1. General

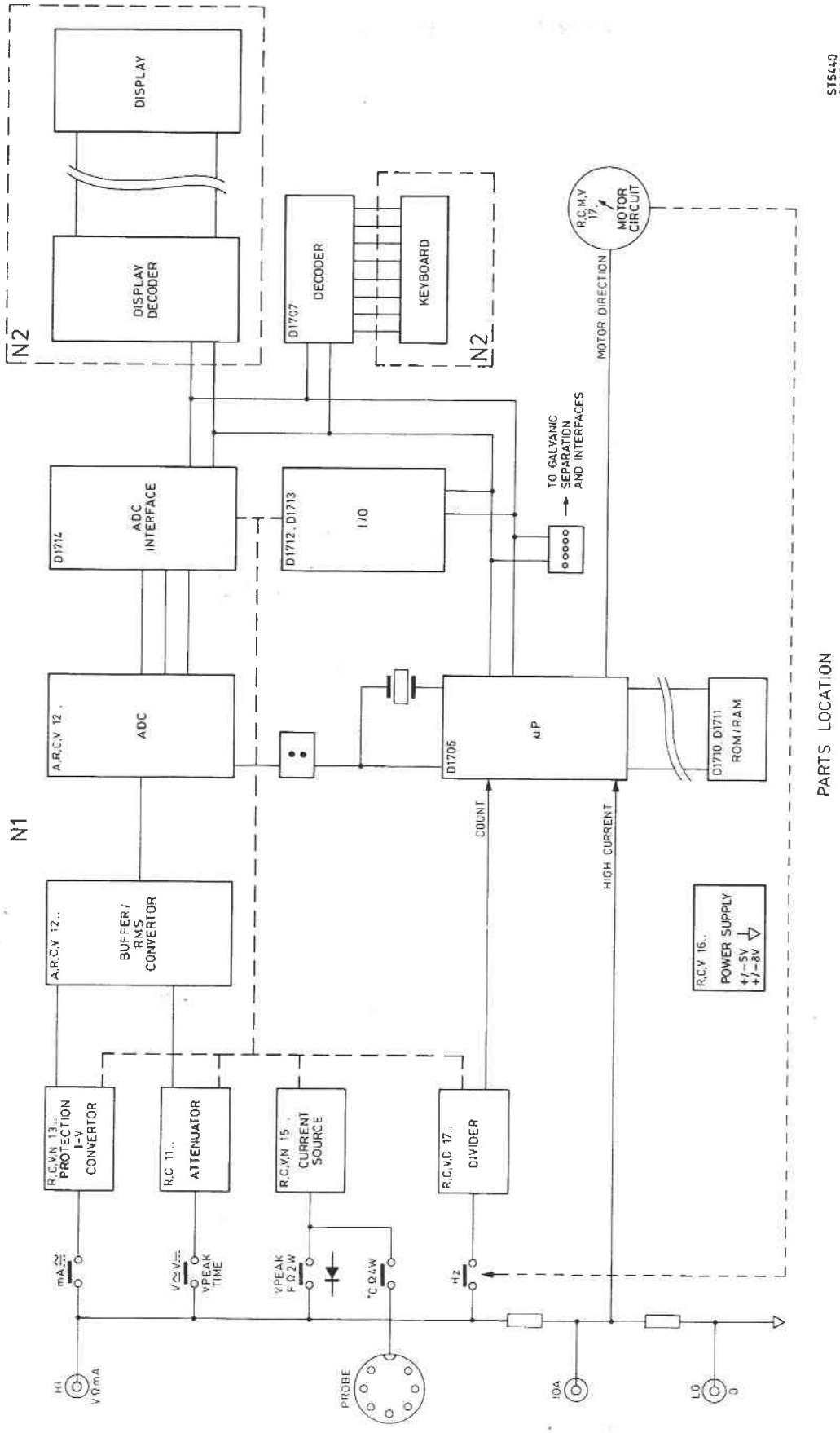
The PM2525 a multimeter ment as successor for the PM2521.
The specification has been extended on the following points:
1. Basic accuracy for DC from 0.03% to 0.02%
2. Resolution for DC from 10 uV to 1 uV.
3. AC voltage function DC coupled.
4. A peak-voltage function up to 2000 digits, 1mV resolution.
5. Four-wire resistance measurements.
6. Highest resistance range from 20 Mohm to 200 Mohm.
7. In the diode function a bleeper signal; response time <100 ms.
8. Capacity measurements from 1 pF to 2000 uF.
9. Frequency measurements from 10 kHz to 20 MHz, AC coupled.
10. To be extended as system multimeter (IEEE-488, RS232C).
11. Fully programmable (also function).
12. Min/Max function.
13. dBm for VDC.
14. Reference level programmable on front.
15. Operator friendly front with small pushbutton switches.

2. Mechanical construction

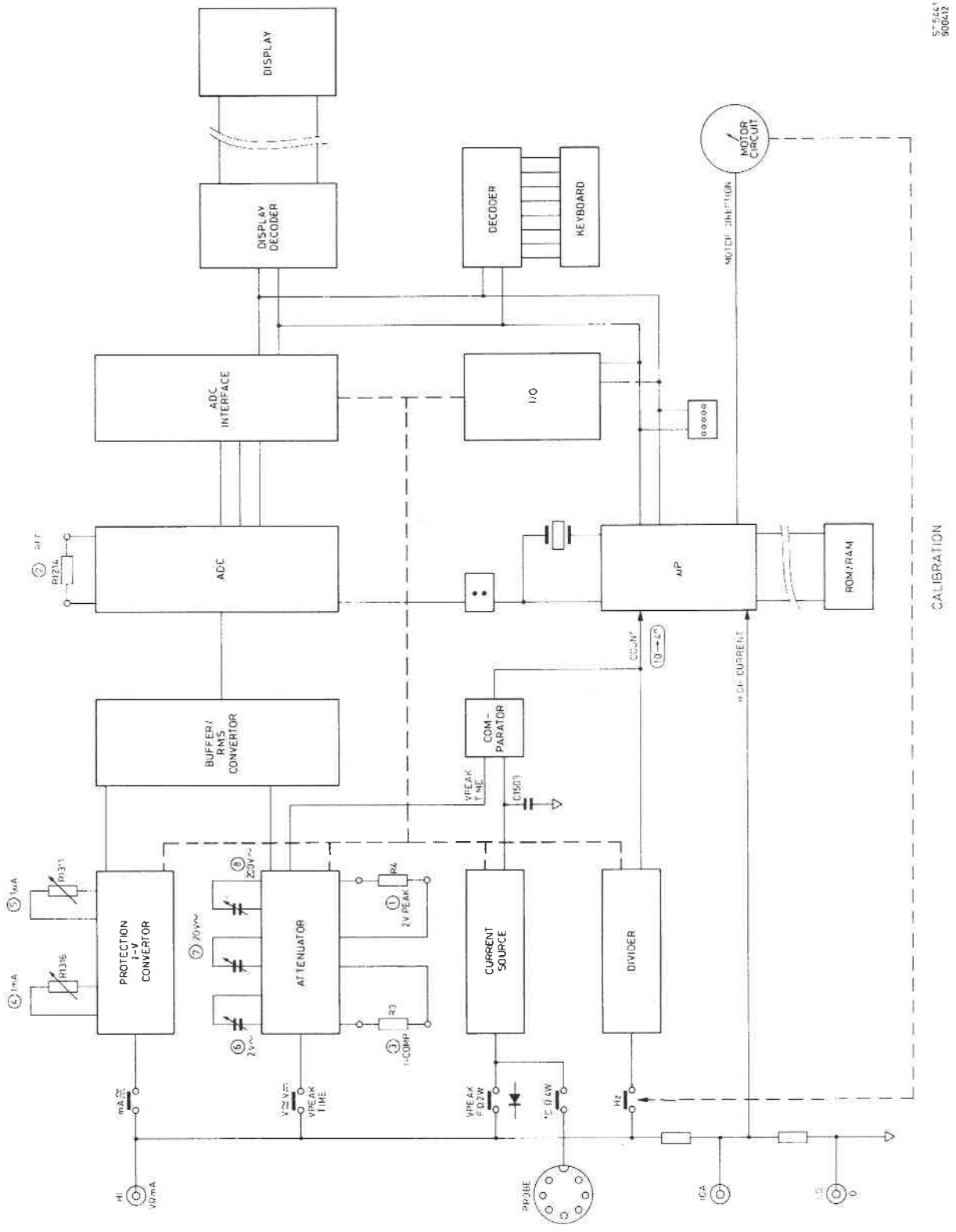
Housing of synthetic material contructed in the same way as the PM2521.
Front composition in the same way as the PM2535.
Internal built-up: One mother board and a front-display board.
In the mother board a motor controlled function switch has been incorperated.
The power supply transformer is mounted on the motherboard.
In the topcover the interfaces can be mounted.
On the front-display board the pushbutton-switches, the IC for reading the switches and LCD and LCD-driver are mounted.



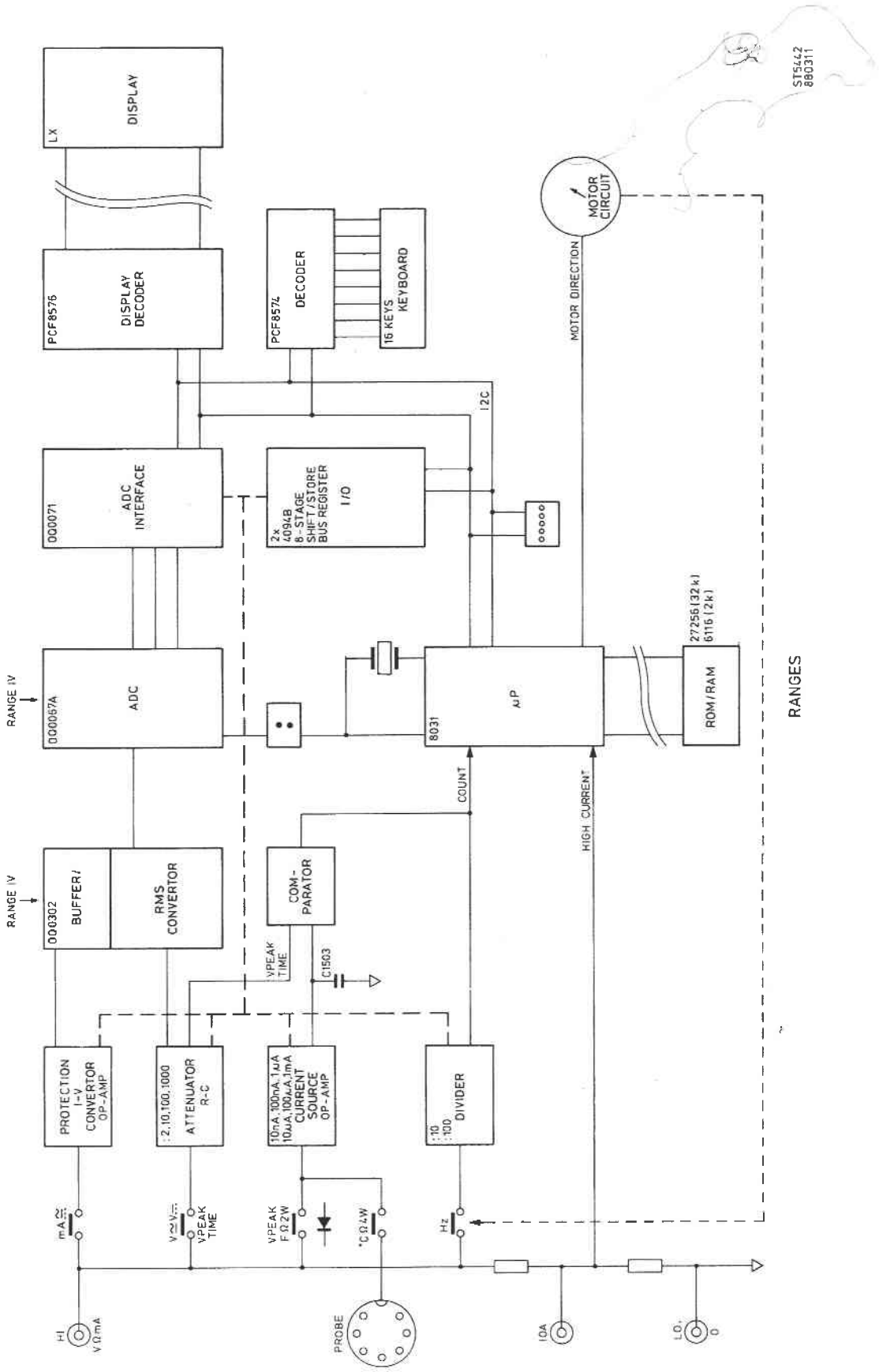
Block diagram PM2525, functional



Block diagram PM2525, parts location



Block diagram PM2525, calibration



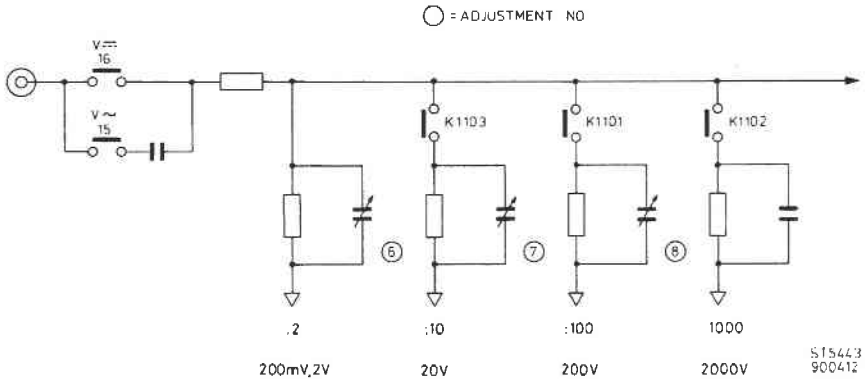
Block diagram PM2525, ranges

3. Electrical construction

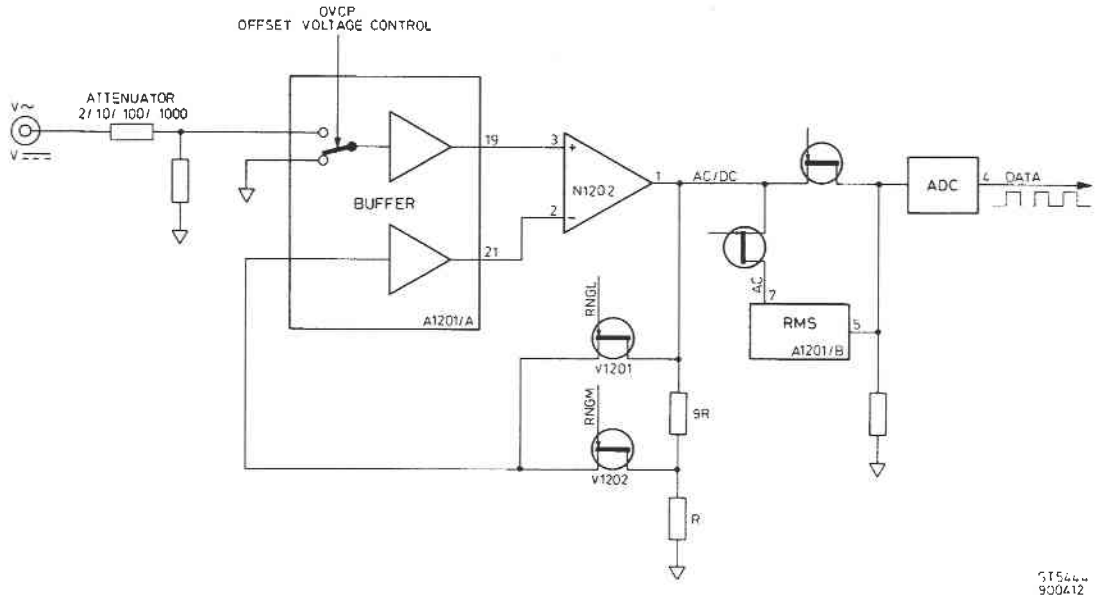
The PM2525 can be subdivided in the following parts:

a. Attenuator and voltage measurements
b. Pre-amplifier
c. Current measurement
d. RMS convertor
e. ADC
f. Peak-voltage measurement
g. Current source for resistance measurements, temperature measurements, capacity measurements, peak-voltage measurements
h. Resistance measurments
i. Temperature measurements
j. Capacity measurements
k. Frequency measurments
l. Time measurements
m. Digital control and computing
n. Power supply
o. Function-switching
p. Internal temperature measurement

3a. Attenuator



A combined frequency compensated atenuator for AC and DC is used. It is built-up of metalglass and metalfilm resistors. These resistors have the same temperature coefficient. To compensate the rest of temperature coefficient from the attenuator + pre-amplifier + ADC, an extra temperature compensation has been used.
For this reason the internal temperature of the PM2525 is measured.(transistor V1500). The temperature coefficient of the PM2525 has to be determined by a measurement at room temperature and an additional measurement at a higher temperature (over 40 deg C)
The temperature coefficient determined, is used by the micro-processor to make calculations on the ADC data.



3B. Pre-amplifier

The characteristics of the PM2525 are mainly determined by the pre-amplifier. A resolution of 10 uV resp. 1 uV (high resolution mode) for DC and 100 kHz for AC, ask for an amplifier with Auto Zero Compensation (AZC) for DC and a bandwidth equal to or better than a LF356.
A secial IC (OQ0302) has been designed for this purpose. (Refer 3d. RMS conv.)

3c. Current measurements

The current measurements can be subdivided in three parts:

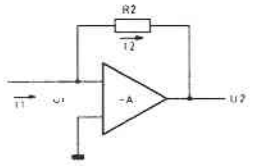
1. The low currents 1 uA to 1 mA are measured via the compensation method in two regions viz. 1 uA - 10 uA and 100 uA - 1 mA with a voltage resolution of the pre-amplifier of 10 uV and 100 uV

2. The medium currents 10 mA and 100 mA.
   Current to voltage conversion by means of a shunt of 2 ohm and fused. Voltage resolution of the pre-amplifier 2 uV resp. 20 uV.

2. The high currents 1 A and 10 A.
   Current to voltage conversion with a 20 mohm shunt and not fused. Voltage resolution of the pre-amplifier 2 uV resp. 20 uV.

Circuit element principles:

I to V convertor - This is effectively a shunt feedback amplifier based around the operational amplifier N1301. The principle is as follows:



ST3362
820503

Basic I-V convertor

The amplifier has a gain of -A (180° phase-shift) and a high input impedance.

If we assume that $U_i = \frac{U2}{A} \simeq 0$ (virtual earth point) and the input signal to be a current I_1 which is equal to I2, then the output signal will be a voltage

$$-U2 = I1 \times R2$$

In other words, the amplification is given by the resistor value of R2.

In the practical application, it means that the input currents from the shunts are converted into output voltages, the magnitude also being dependent on the values of the selected feedback resistors.

3d. PRODUCT DESCRIPTION OQ0302 (A1201)

The OQ0302 converts the RMS value of a signal into a DC value.
The circuit is split-up into two parts: the input-buffer-amplifier and the RMS-DC convertor. The offset voltage of both parts is eliminated automatically by the auto-zero-circuit. The buffer amplifier consists of four source followers to which an external dual-opamp has to be connected.

PINNING

1	VNG (-8V)	negative supply	
2	CR	crest-factor indication	
3	SWD	switch disable input	
4	CAV	averaging capacitor	
5	OUTR	output RMS-convertor	
6	NUL	analog zero	
7	INR	RMS-convertor input	
8	RCA	conversion resistor	
9	CZ1	auto-zero capacitor 1	
10	CZ2	auto-zero capacitor 2	
11	RCB	conversion resistor	
12	GND	zero	
13	IN4	input source follower	1
14	IN1A	"	2
15	IN3	"	3
16	IN1B	"	1
17	OUT3	output souce follower	3
18	OUT4	"	4
19	OUT1	"	1
20	IN2	input source folower	2
21	OUT2	output sorce follower	2
22	OVCP	zero volt pre-amplifier	
23	OVCR	auto-zero input RMS-convertor	
24	VPL (+8V)	positive supply	

THE RMS-CONVERTOR

The convertor is built-up of a voltage-current convertor, followed by a rectifier and a RMS to DC circuit.
Input-offset voltage drift is minimized by the auto-zero circuit. The offset current-drift of the output-circuit, that is not included in the auto-zero, is of non importance.

The maximum input signal will have a RMS value of 1 Volt. A crest-factor of two may not be exceeded. The signal is allowed to have a AC as well as a DC component and is connected to inputs INR and NUL.

The conversion resistor should be about 10 kohm to get a optimum crest-factor indcation.

During the auto-zero phase the input signal is switched-off and the input of the V/I-convertor is connected to zero. The SWD input must be low (GND). When the SWD input is high (open) the input signal is connected to the V-I convertor. The SWD input has an internal pull-down circuit. The offset-voltage of the pre-amplifier can be eliminated in this way if during the auto-zero phase the input of the pre-amplifier is connected to zero.
The auto-zero phase will last about 10 mili-seconds, dependent on the drift to be eliminated. During this phase the pre-amplifier has to consume of 10uA.
Every part of the symmetrical V-I convertor has a own auto-zero capacitor. The voltage over these capacitors will be nominally 0 Volt.

To realise a large frequency range, the rectifier is set to class ab. By this the rest-current in the output will cause a voltage drop of 3 mV over a 5 kohm resistor. Voltages lower than 5 mV must be displayed as zero.

The RMS value of AC and DC is determined in an analog way. In the output signal an error will occur in the shape of an average (or DC) value of a ripple. The DC error is dependent on the frequency of the signal and the value of the averaging capacitor CAV.

During the auto-zero phase the averaging capacitor CAV is discharged, but not internally disconnected. During the measuring phase this capacitor has to be charged again by the input signal. Therefore it is not possible to start a ADC-cycle immediatly after the auto-zero phase to determine the measured value. A wait-time of about 3-times the auto-zero time is needed. This wait-time can be avoided if in series with CAV a FET is switched. This FET can be controlled by signal OVCR, if the levels ly between GND and the negative supply. CAV is switched-off during the auto-zero phase.

The auto-zero input OVCR has an internal pull-down circuit by which the convertor is switched to the auto-zero position (logic 1, negative logic). If OVCR is connected to logic zero the convertor is switched in its measuring position. The input current of the auto-zero circuit is limited by an internal resistor. By the internal pull-down circuit a current of 25 uA wil flow. The switching point is at -2.5 V.

The crest-factor indication is set if the input signal is to large. The latch circuit is automatically reset by the OVCR signal.The crest-factor indication output is a open collector output to the negative supply.

The supply voltage is nominally +8 and -8 VOLT. The maximum switching is directly dependent to the negative supply voltage.

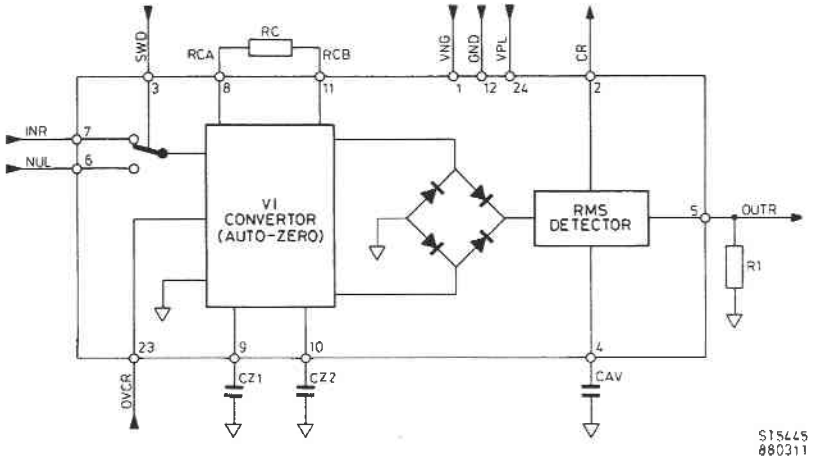
THE PRE-AMPLIFIER/BUFFER

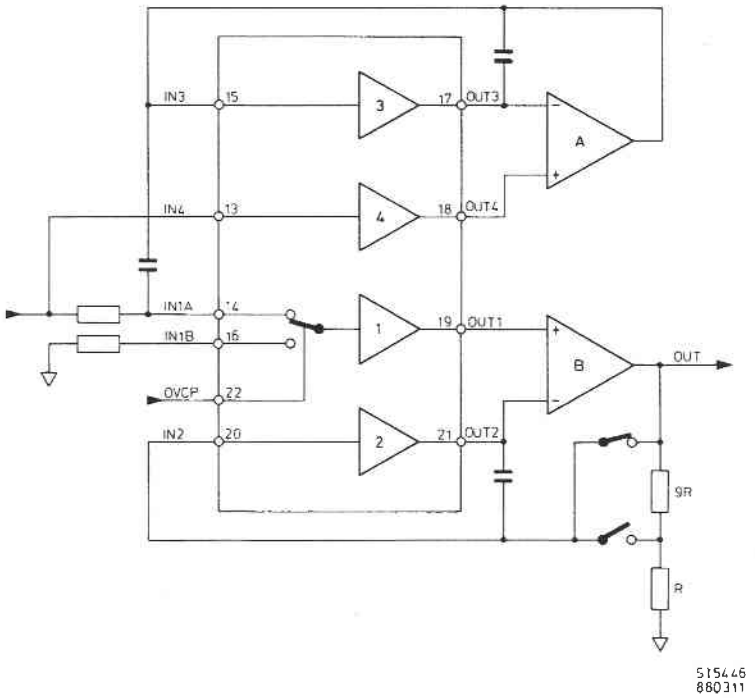
The pre-amplifier consists of four source-followers with a high input-resistance and a low bais current. To the output of the source-followers a dual op-amp has to be connected. Advised is to a NE5532. In series with input 1 of follower 1, two series switches are incorperated, of which input 1B is used as zero input. The offset-voltage of the pre-amplifier is not adjusted, but stands in series with input-offset voltage of the convertor, if input SWD is logic 1.If not, the offset-voltage drift of the pre-amplifier has to be compensated digitally. In this case a measurement has to be made with input INB to zero.

The buffer amplifier built-up around the source followers 3 and 4 takes care of the AC-path. In this way the input-signal is not attenuated by the low-pass filter (R=590 kohm in series with the input and capacitor C=10 nF in parallel with the output of the AC path). This RC-filter at the input is necessary to realise a minimum of feedback on the input (kick-back).

Input IN4 has been suplied with a protection circuit. If the input voltage is higher than 5 Vpp the input resistance drops and the current carried-off via the ground connection.

The zero input of pre-amplifier OVCP function identically to the auto-zero input of the convertor part.





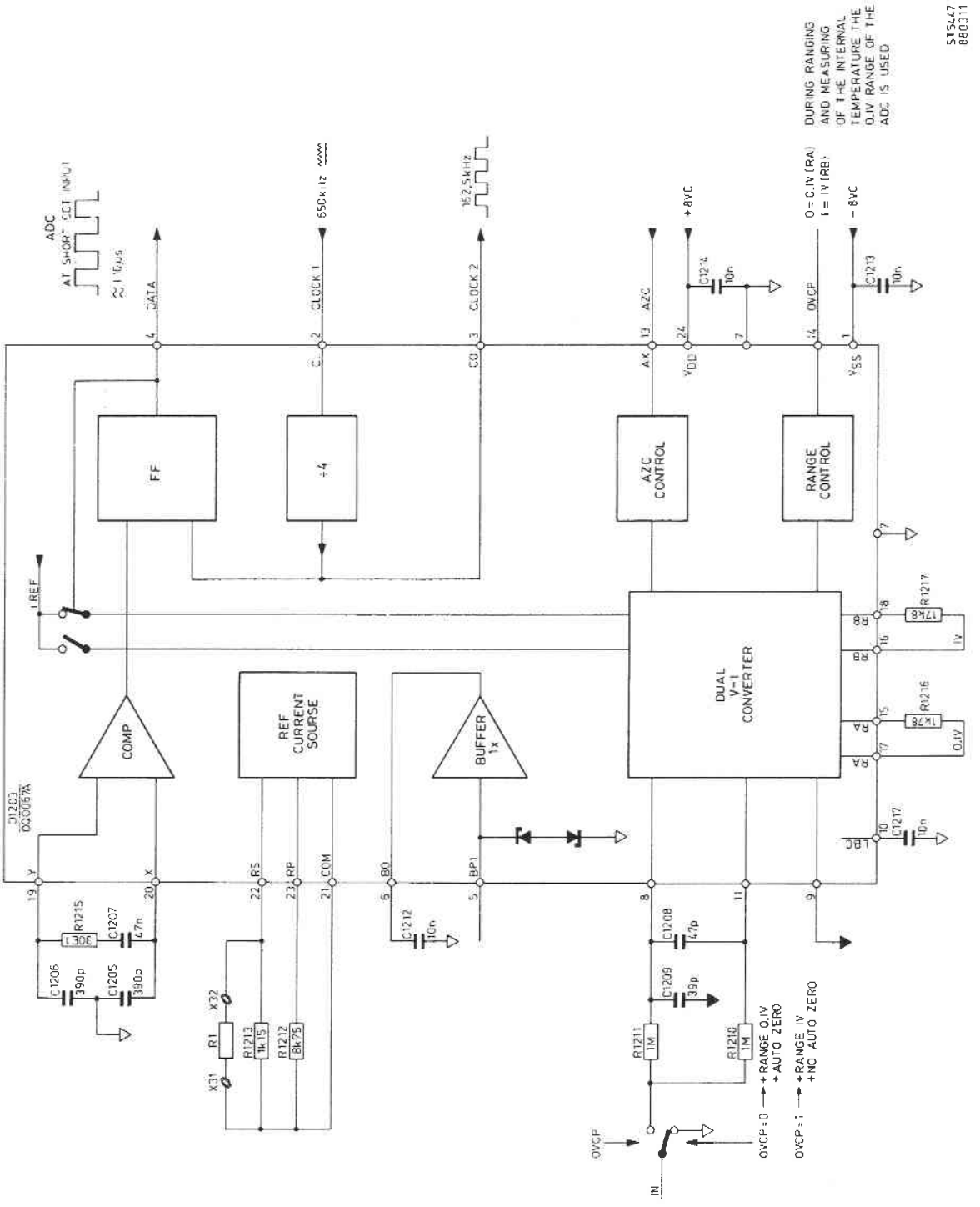
3e. Analog-to-digital converter ADC OQ0067A A1203

The ADC converts the analog signal into a digital signal by the delta modulation principle. Basically, the delta modulation ADC counts the difference in the time taken to charge and to discharge a capacitor about a fixed level, over a fixed period of time.
The number of charge/discharge cycles within this fixed time depends on the charge/discharge current which is made proportional to the unknown input voltage to the ADC. Therefore, the number of pulses counted within a fixed measuring period is proportional to the unknown voltage Vx. The obtained data signal is fed to the ADC interface D1714 where it is counted.

To obtain automatic zero i.e. counteract drift and internal offset, one complete measurement consist of two fixed measuring periods (two AZC periods).
One complete measurement is used to update the bargraph or for automatic ranging. However, a display result consist of two complete measurements.

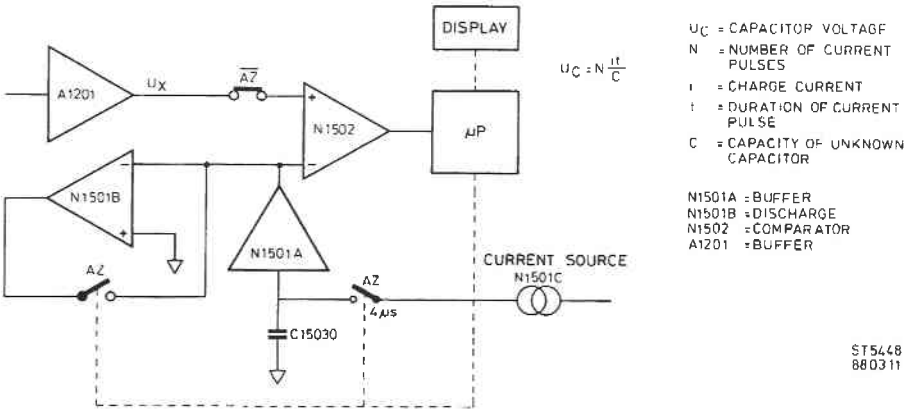
During the first period of a measurement the AZC input is low and the ADC interface counts up on each clock-edge the logical state of the data signal. The value is kept in a register. During the second period, the data signal is inverted by the ADC interface and on each clock-edge the logical state of the input signal, the register is counted down. Also the input of the ADC is inverted so that offset in the result is compensated.

The ADC has two input sensitivites 90 mV and 900 mV, selected by the signal OVCP. This signal selects either R1217 or R1216 as conversion resistor.



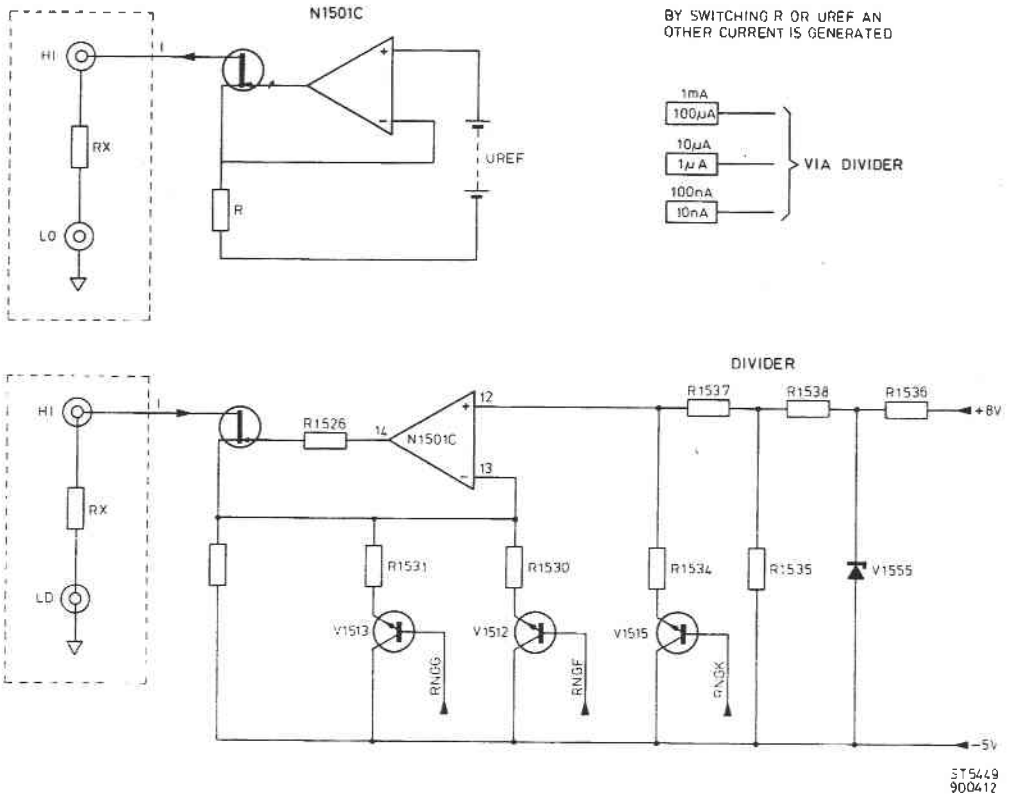
3f. Peak-voltage detector

Principle:
The unknown peak-voltage is compared by means of a comparator with a voltage in a capacitor. If Upeak > Uc then the capacitor is charged in steps.
The number of steps is counted and equals the voltage on the capacitor.



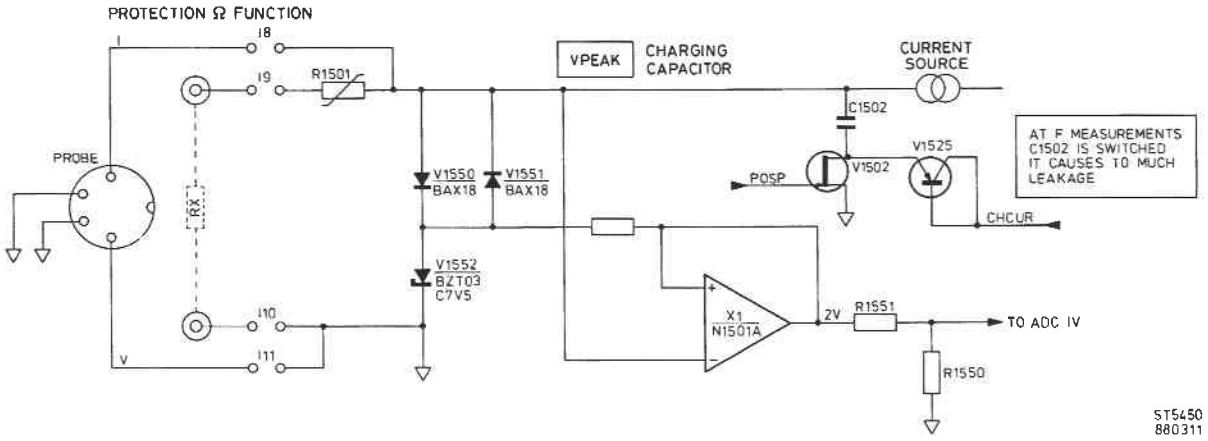
3g. Current source for resistance like measurements.

Principle:
The voltage over a resistor is made equal to a reference voltage by an operational amplifier. The current needed will be constant and is the same current as needed for the current source.



3h. Resistance measurements RTW RFW ^{o}C

The current from the current-source is supplied through Rx.
The voltage drop is measured by the ADC.



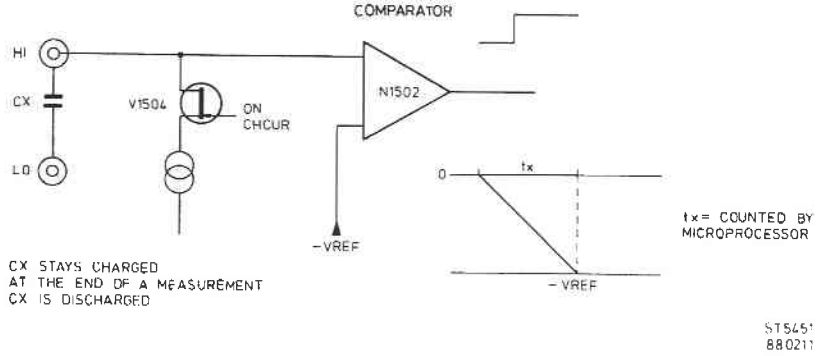
3i. Temperature measurements (refer to 3h.)

Principle:
4-wire resistance measurements on a Pt100 element (e.g. PM9249)
The micro-processor compensates the zero degrees (100 ohm). The micro-processor also carries out the wanted accuracy and linearity calculations.

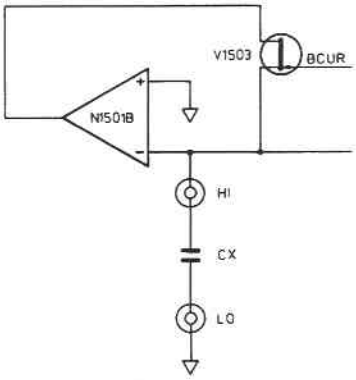
3j. Capacity measurements

Principle:
Through the unkown capacitor a constant current is fed: $Cx = \frac{iT}{Ucx}$

The voltage over the capacitor is compared with a reference voltage. The time needed to charge the capacitor to the level of Uref., is measured by the micro- processor. It is related to the capacitance. The reference voltage is generated by the constant-current i, fed through a known resistor. The voltage over R is stored in the auto-zero capacitor of the preamplifier.



DISCHARGING CX



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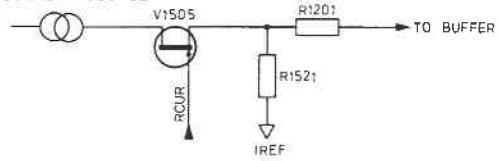
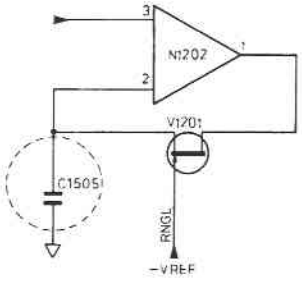
-VREF

CURRENT SOURCE



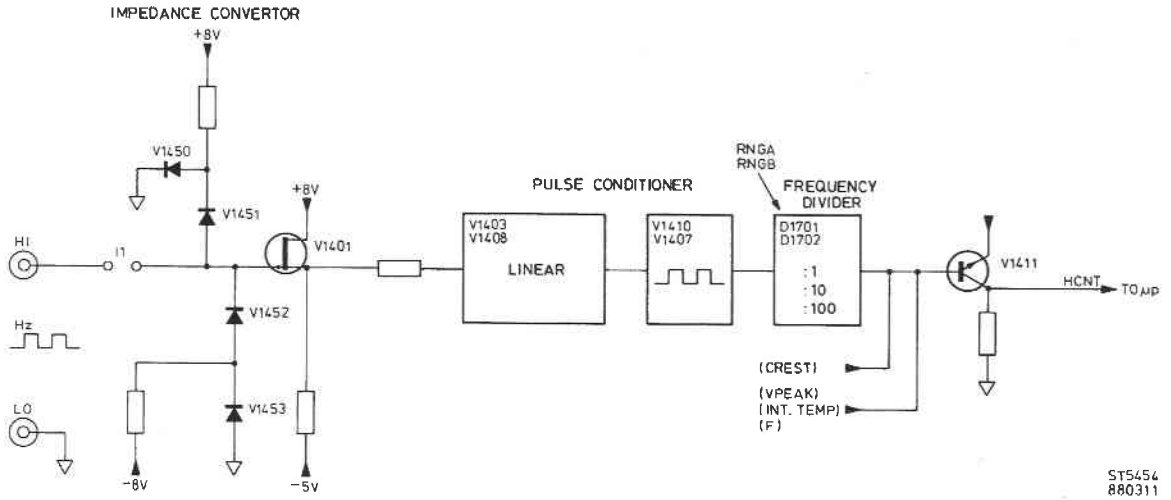
DURING DISCHARGING OF CX AT THE END OF A MEASUREMENT V R1521 IS CHARGED IN CAPACITOR C1505



STS453
880211

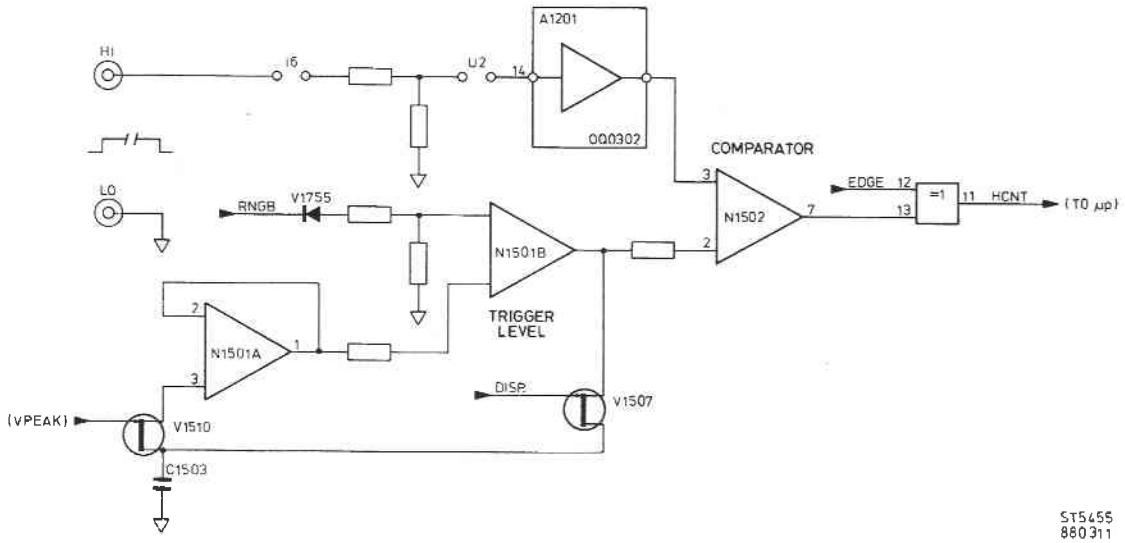
3k. Frequency measurements

Principle:
The incoming signal is amplified and set to a correct level with two invertors. It is supplied to a hardware circuit that attenuates 1, 100, 1000 dependent on the measuring range. The signal is processed by the internal counter of the micro-computer.



31. Time measurements

In the time measurements function the signal may be inverted or directly supplied to the internal timer of the micro-processor. The inversion of the signal enables starting on respectively stopping on a positive or negative level.



3m. Digital control and computing

The heart is a 8031 micro computer with a ROM and RAM
Links to the analog section are made via an OQ0071 and two 8-stage shift registers.

SWITCHING TABLE (1-2)

	DSHF00									DSHF01									OQ071									P4		
	SHIFT-REGISTERS																													
	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		0	5	4
	OVCR	DISP	TMPM	STOP	FILT	RNGC	RNGE	RNGD		FCAP	RNGB	VPEAK	RNGF	RNGA	RNGG	MDIR	RNGK		ACDC	OVCP	POSP	NEGP	RNGM	RNGL	CHCHR	RCUR		BEDGE	BCUR	CRST
V^																											(inv)			
2V	0	0*	0	1	0	0	0	0	10	0	1	1	1	1*	0	1	0	7A	1	1	1*	1	1	0	0	0	07	0	1*	0*
20V	0	0*	0	1	0	1	0	0	14	0	1	1	1	1*	0	1	0	7A	1	1	1*	1	1	0	0	0	07	0	1*	0*
200V	0	0*	0	1	0	0	0	1	11	0	1	1	1	1*	0	1	0	7A	1	1	1*	1	1	0	0	0	07	0	1*	0*
2000V	0	0*	0	1	0	0	1	0	12	0	1	1	1	1*	0	1	0	7A	1	1	1*	1	1	0	0	0	07	0	1*	0*
V~																														
2V	0	0*	0	1	0	0	0	0	10	0	1	1	1	1*	0	1	0	7A	1	1	1	1*	1	0	0	0	07	0	1*	0*
20V	0	0*	0	1	0	1	0	0	14	0	1	1	1	1*	0	1	0	7A	1	1	1	1*	1	0	0	0	07	0	1*	0*
200V	0	0*	0	1	0	0	0	1	11	0	1	1	1	1*	0	1	0	7A	1	1	1	1*	1	0	0	0	07	0	1*	0*
2000V	0	0*	0	1	0	0	1	0	12	0	1	1	1	1*	0	1	0	7A	1	1	1	1*	1	0	0	0	07	0	1*	0*
V ⎓																														
200mV	0	1	1	1	1	0	0	0	78	0	1	1	0	0	0	1	0	62	0	1	1	1	0	1	0	0	8B	1	1	0
2V	0	1	1	1	1	0	0	0	78	0	1	1	0	0	0	1	0	62	0	1	1	1	1	0	0	0	87	1	1	0
20V	0	1	1	1	1	1	0	0	7C	0	1	1	0	0	0	1	0	62	0	1	1	1	1	0	0	0	87	1	1	0
200V	0	1	1	1	1	0	0	1	79	0	1	1	0	0	0	1	0	62	0	1	1	1	1	0	0	0	87	1	1	0
2000V	0	1	1	1	1	0	1	0	7A	0	1	1	0	0	0	1	0	62	0	1	1	1	1	0	0	0	87	1	1	0
V ⎓																														
200mV	1*	1	1	1	0	0	0	0	F0	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	0	1	0	0	0B	1	1	0
2V	1*	1	1	1	0	0	0	0	F0	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
20V	1*	1	1	1	0	1	0	0	F4	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
200V	1*	1	1	1	0	0	0	1	F1	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
2000V	1*	1	1	1	0	0	1	0	F2	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
V ⎓																														
200mV	1*	1	1	1	0	0	0	0	F0	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	0	1	0	0	0B	1	1	0
2V	1*	1	1	1	0	0	0	0	F0	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
20V	1*	1	1	1	0	1	0	0	F4	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
200V	1*	1	1	1	0	0	0	1	F1	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
2000V	1*	1	1	1	0	0	1	0	F2	0	1	1	0	1*	0	1	0	6A	1	1*	1	1	1	0	0	0	07	1	1	0
Ω 2W																														
200Ω	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	0	1	1	0	A9	1	0	0
2kΩ	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	1	0	1	0	A5	1	0	0
20kΩ	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	1	51	0	1	0	1	1	0	1	0	A5	1	0	0
200kΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	1	0	0	44	0	1	0	1	1	0	1	0	A5	1	0	0
2MΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	1	0	1	45	0	1	0	1	1	0	1	0	A5	1	0	0
Ω 4W																														
200Ω	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	0	1	1	0	A9	1	0	0
2kΩ	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	1	0	1	0	A5	1	0	0
20kΩ	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	1	51	0	1	0	1	1	0	1	0	A5	1	0	0
200kΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	1	0	0	44	0	1	0	1	1	0	1	0	A5	1	0	0
2MΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	1	0	1	45	0	1	0	1	1	0	1	0	A5	1	0	0
20MΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	0	0	0	40	0	1	0	1	1	0	1	0	A5	1	0	0
200MΩ	0	0	0	1	0	0	0	0	10	0	1	0	0	0	0	0	1	41	0	1	0	1	1	0	1	0	A5	1	0	0

SWITCHING TABLE (2-2)

	DSHF00									DSHF01									OQ071									P1		
	SHIFT-REGISTERS																												
	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0		0	5	4
	OVCR	DISP	TMPM	STOP	FILT	RNGC	RNGE	RNGD		FCAP	RNGB	FPEAK	RNGF	RNGA	RNGG	MDIR	RNGK		ACDC	OVCP	POSP	NEGP	RNGM	RNGL	CHCHR	RCUR		BEDGE	BCUR	CRST
A ⎓																											(inv)			
1uA	0	1	1	1	0	0	0	0	70	0	1	1	1	0	0	1	0	72	0	1	1	1	0	1	0	0	8B	1	1	0
10uA	0	1	1	1	0	0	0	0	70	0	1	1	1	0	0	1	0	72	0	1	1	1	1	0	0	0	87	1	1	0
100uA	0	1	1	1	0	1	0	0	74	0	1	1	1	0	0	1	0	72	0	1	1	1	0	1	0	0	8B	1	1	0
1mA	0	1	1	1	0	1	0	0	74	0	1	1	1	0	0	1	0	72	0	1	1	1	1	0	0	0	87	1	1	0
10mA	0	1	1	1	0	0	0	0	70	0	1	1	1	0	0	1	0	72	0	1	1	1	0	1	0	0	8B	1	1	0
100mA	0	1	1	1	0	0	0	0	70	0	1	1	1	0	0	1	0	72	0	1	1	1	1	0	0	0	87	1	1	0
1A	0	1	1	1	0	0	0	0	(70)	0	1	1	1	0	0	1	0	72	0	1	1	1	0	1	0	0	8B	1	1	0
10A	0	1	1	1	0	0	0	0	(70)	0	1	1	1	0	0	1	0	72	0	1	1	1	1	0	0	0	87	1	1	0
A ⎓																														
1uA	1*	1	1	1	0	0	0	0	F0	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	0	1	0	0	0B	1	1	0
10uA	1*	1	1	1	0	0	0	0	F0	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	1	0	0	0	07	1	1	0
100uA	1*	1	1	1	0	1	0	0	F4	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	0	1	0	0	0B	1	1	0
1mA	1*	1	1	1	0	1	0	0	F4	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	1	0	0	0	07	1	1	0
10mA	1*	1	1	1	0	0	0	0	F0	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	0	1	0	0	0B	1	1	0
100mA	1*	1	1	1	0	0	0	0	F0	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	1	0	0	0	07	1	1	0
1A	1*	1	1	1	0	0	0	0	(F0)	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	0	1	0	0	0B	1	1	0
10A	1*	1	1	1	0	0	0	0	(F0)	0	1	1	1	1*	0	1	0	7A	1	1*	1	1	1	0	0	0	07	1	1	0
										1 ms high																				
S all	0	1	0	1	0	0	0	0	50	0	1*	1	0	1*	0	0	01	09	1	1	0	1	1	0	0	0	27	0*	1	0
										1 ms high																				
F																														
20nF	0	0	0	1	0	0	1	1	13	1	1	0	0*	1*	0*	0	0*	C8	0	1*	1	0	1	1*	0*	0*	93	0	1*	0
200nF	0	0	0	1	0	0	1	1	13	1	1	0	0*	1*	1*	0	1*	CD	0	1*	1	0	1	1*	0*	0*	93	0	1*	0
2uF	0	0	0	1	0	0	1	1	13	1	1	0	0*	1*	1*	0	0*	CC	0	1*	1	0	1	1*	0*	0*	93	0	1*	0
20uF	0	0	0	1	0	0	1	1	13	1	1	0	1*	1*	0*	0	1*	D9	0	1*	1	0	1	1*	0*	0*	93	0	1*	0
200uF/ 2000uF	0	0	0	1	0	0	1	1	13	1	1	0	1*	1*	0*	0	0*	D8	0	1*	1	0	1	1*	0*	0*	93	0	1*	0
	For speed 3, shift one range									Range 200uF and 2000uF will be deleted.									Range 20nF will become settings of range 200nF etc.											
Hz																														
10kHz	0	1	1	1	0	1	0	0	74	0	1	1	0	1	0	0	1	69	1	0	1	1	1	0	0	0	47	1	1	0
100kHz	0	1	1	1	0	1	0	0	74	0	1	1	0	1	0	0	1	69	1	0	1	1	1	0	0	0	47	1	1	0
1MHz	0	1	1	1	0	1	0	0	74	0	1	1	0	0	0	0	1	61	1	0	1	1	1	0	0	0	47	1	1	0
10MHz	0	1	1	1	0	1	0	0	74	0	0	1	0	0	0	0	1	21	1	0	1	1	1	0	0	0	47	1	1	0
20MHz	0	1	1	1	0	1	0	0	74	0	0	1	0	0	0	0	1	21	1	0	1	1	1	0	0	0	47	1	1	0
°C 2kΩ-4W	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	1	0	1	0	A5	1	0	0
⊣⊢ 2kΩ-2W	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	1	0	1	0	A5	1	0	0
🔊 200Ω-2W	0	0	0	1	0	0	0	0	10	0	1	0	1	0	0	0	0	50	0	1	0	1	0	1	1	0	A9	1	0	0
										remains in the same position																				
int.tmp.	0	0*	1	1	0	a	a	a	3B	0	1	1	1	1*	0	1	0	7A	1	0	1	1*	a	a	0	0	4F	0	1*	0*
null 200mV	a	a	1	1	0	a	x	x		0	a	a	a	a	a	a	a		0	0	1	1	1	0	a	0		a	a	a
null 20V	a	a	1	1	1	a	x	x		0	a	a	a	a	a	a	a		0	0	1	1	1	0	a	0		a	a	a
										remains in same position except in function F.																				

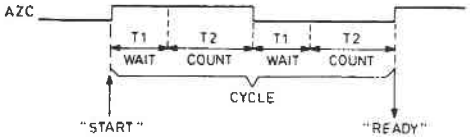
a = don't care

* = toggles during measurement

ADC interface OQ0071 D1714

The information transport to this device is by means of an I^2C compatible interface.
This ADC interface is activated by a start condition so that it first reads an eight bit address. The four most-significant bits contain the group address, and the four least-significant bits contain a command to be executed by the device. This is in contradiction to the I^2C specification where these bytes are reserved for the device address.

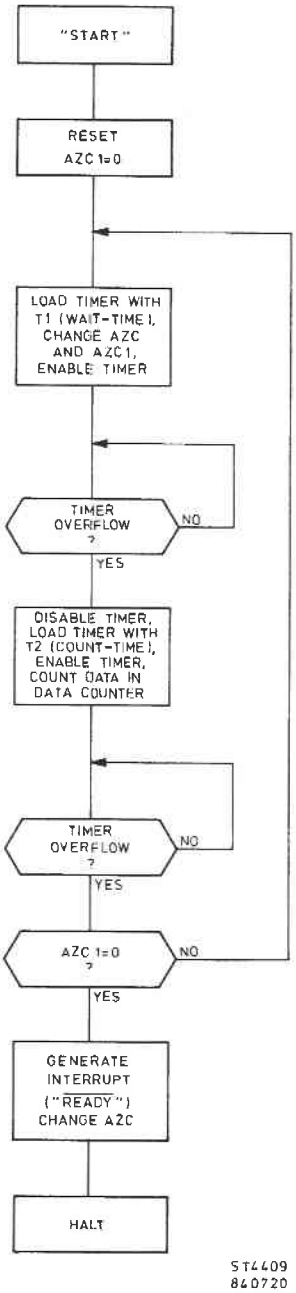
The main purpose of the ADC interface is to count the number of clock-pulses within a given time period (T2, the measuring time) in which the data input is opposite to the AZC signal has been inverted. The time periods are preceded by a waiting time T1 (setting time). The figure below explains this sequence.

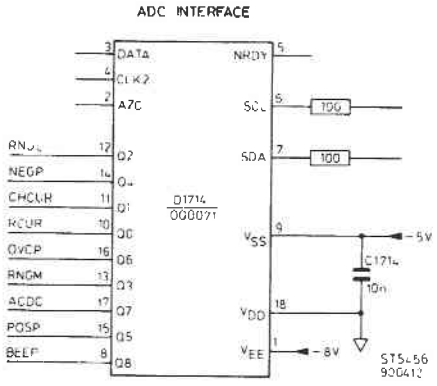


ST4408
840720

At the end of this cycle the device generates a ready (READY) which interrupts the microcomputer.
It instructs the microcomputer to read the internal counter of the ADC interface.
The organisation should be such that when data continuously high and the number in T2 is N, that at the end of the count-time the contents of the counter are also N.

Flow-chart of the sequence:





Besides these functions, the ADC interface has eight output latches to control to analog section (input sensitivities) .One of the latches is used to give an a.c. signal which is used for the bleeper.

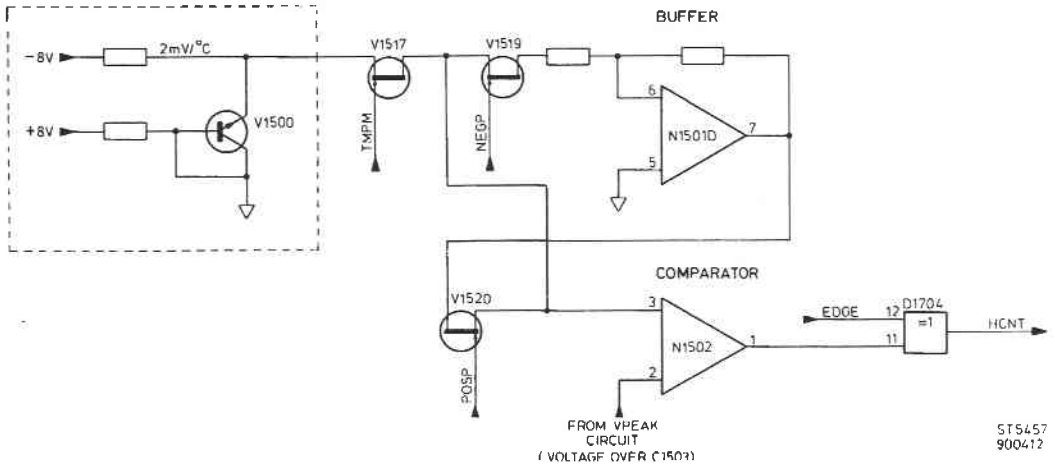
3n. Power supply

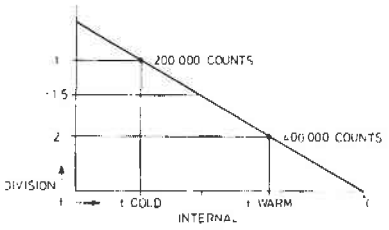
The PM2525 is suitable for mainssuply of 115 V and 230 V. The altering from 230 V to 115 V can be made on the pc-board.

3o. Function-switching

The function switch consists of a motor driven printed switch. Dependent on the function selected on the keyboard,the motor forces the switch to the correct position. The position is detected by the micro-processor.

3p. Internal temperature (A Vpeak measurement)





With t internal is is determined with what figure the result has to be divided.
tc and tw are relative.
tc = temperature for cold calibration
tw = temperatur for warm calibration

When calibrating:
Cold : Once a year to meet specification
Warm : In case of new ADC, Vpeak circuit, defect RAM

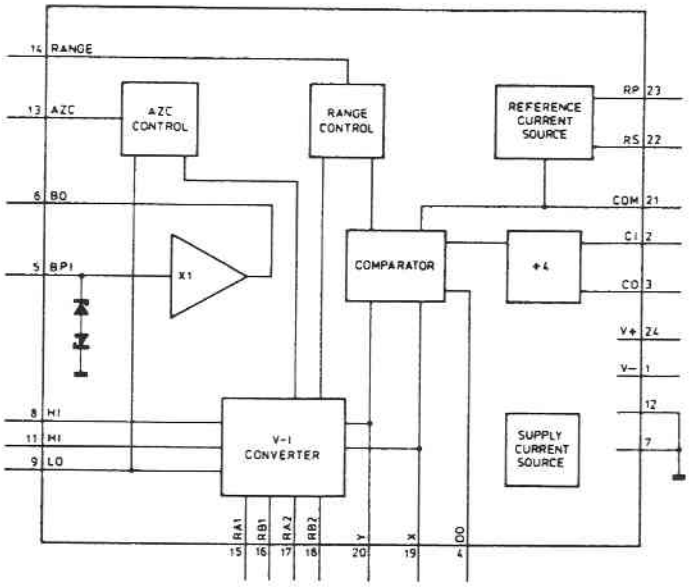
DISPLAY/KEYBOARD

The PCF 8576 is a circuit designed to drive a Liquid Crystal Display with up to 160 segments. A 2-line I^2C bus structure enables serial data transfer with the microcomputer.
A LCD is an AC device. Therefore, for multiplexing, the information of the segment line is imortant for each segment that will be driven by that line.
The reference voltage for the driver is obtained from transistor V2101 and zener diode V2101.
To change the viewing angle the reference voltage can be adjusted with potentiometer R2105.

On the same PCB the keyboard is situated. Pushing a switch will be read by the microcomputer via the I^2C bus. This is done by scanning lines P0 to P7 to obtain which switch is pressed.

COMPONENT DATA

OQ0067A BI-FET input ADC



Block diagram OQ0067A

DESCRIPTION

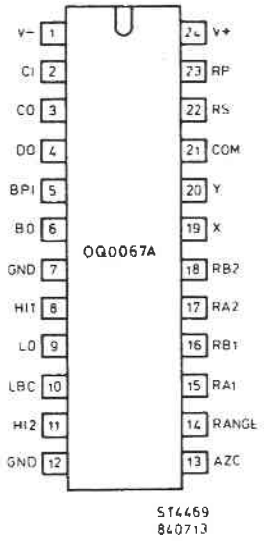
The OQ0067 is an ADC according to the Delta Modulator principle. It contains all the parts for a ADC. The output signal is an synchronus datasignal, which can be clocked in a microprocessor with a present clock. The display result is:

$$Disp = \frac{N \times Vin}{\frac{Iref}{2} \times Rconv}$$

N= the number of clockperiods during a measurement. The formule shows that the result will be more accurate with more clockperiods. This can be achieved with a longer measuring period or more clockpulses. To prevent offset voltages a AZC (auto zero compensation) input is available.

Every measuring period consists of two AZC periods. During the first AZC period the AZC input is logic low and the up counts the logic value of the datasignal on every edge of the clock. In the second AZC period the datasignal is inverted by the up. The up subtracts the logic value of the datasignal on every clock edge. At the same time the inputs of the ADC are interchanged. By this the input offset-voltage is eliminated. Via the range input a selection can be made between the two conversion resistors (input sensitivity 0.1V/1V).

PINNING & PIN FUNCTIONS



PIN NUMBER	NAME	DESCRIPTION
1	V -	Most negative supply & substrate
2	C1	Clock input
3	CO	ADC clock input
4	DO	ADC data output
5	BPI	Buffer & protection input
6	BO	Buffer output
8, 11	HI1,2	ADC HI inputs
9	LO	ADC LO input
10	LBC	Low buffer capacitor
7, 12	GND	Digital ground
13	AZC	AZC input
14	RANGE	Range input
15, 17	RA1,2	Range resistor A
16, 18	RB1,2	Range resistor B
19, 20	X, Y	Integrator capacitor
21	COM	Common point for current souce resistor
22	RS	Series resistor Current source
23	RP	Parallel resistor
24	V^+	Most positive supply

NOTE: pin numbers 7 and 12 are not connected together internally

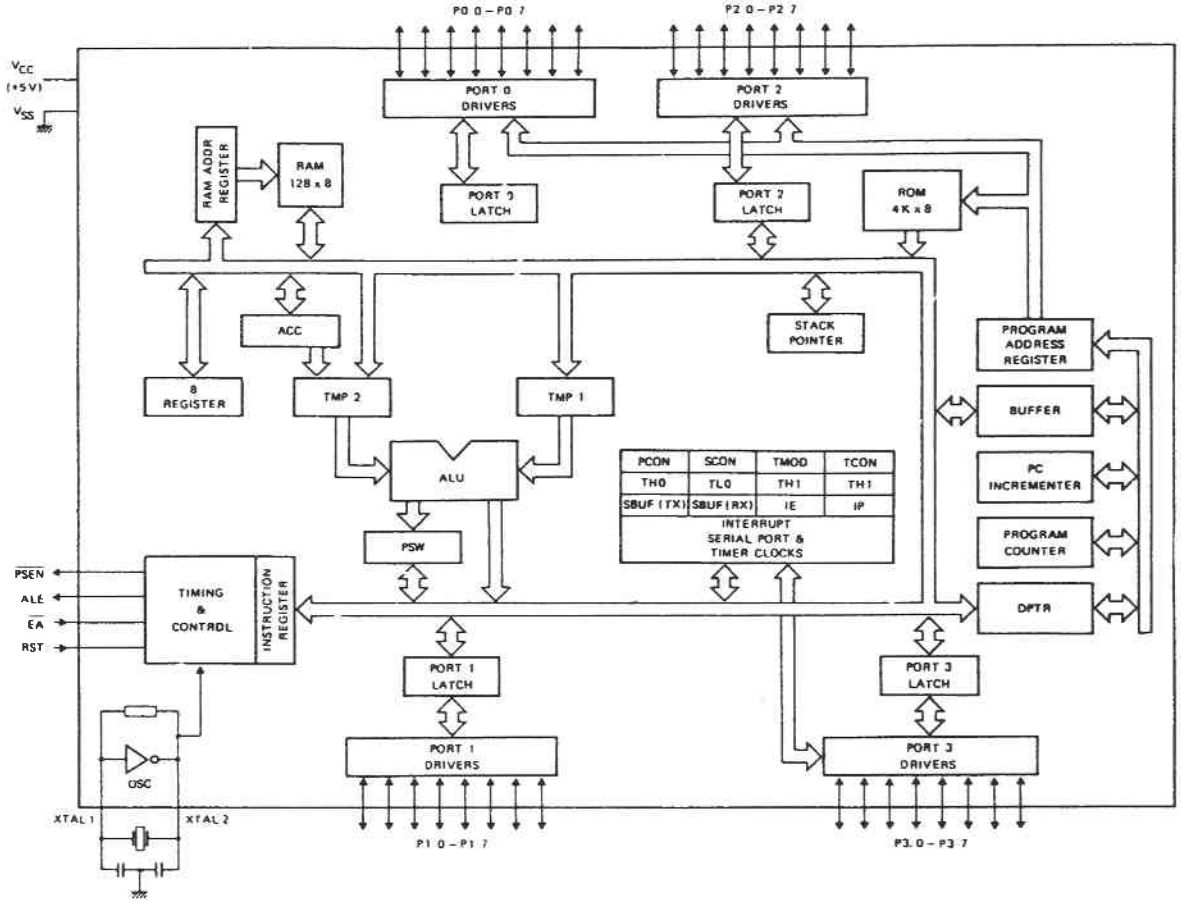
Pinning OQ0067A

8031AH single-component 8-bit microcomputer

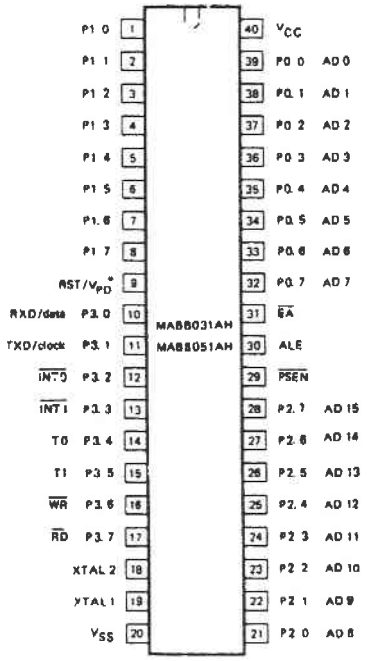
- 8031AH - Control-Oriented CPU with RAM and I/O
- 128K Accessible External Memory
- 218 User Bit-Addressable Locations
- 128 x 8 RAM
- 32 I/O Lines (Four 8-bBit Ports)
- Two 16-Bit Timer/Counters
- Programmable Full-Duplex Serial Channel

The 8031AH is Intel's HMOS version of the High performance 8-bit 8031 microcomputer. While the 8031AH features the same powerful architecture and instruction set as its HMOS predecessor, it offers the additional benefit of lower powerd supply current.

The 8031AH provides a cost-effective solution for those controller applications requiring up to 64 Kbytes of program and/or 64 Kbytes of data storage. Specifically, the 8031AH contains 128 bytes of read/write data memory; 21 I/O lines configured as four 8-bit parallel prots; two 16-bit timer/counters.



Block Diagram



Pin configuration

8031AH PIN DESCRIPTIONS

V_{SS}
Circuit ground potential.

V_{CC}
5V power supply input for normal operation and program verification.

Port 0
Port 0 is an 8-bit open drain bidirectional I/0 port. It is also the multiplexed low-order address and data bus when using external memory. It is used for data output during program verification. Port 0 can sink (and in bus operations can source) eight LS TTL loads.

Port 1
Port 1 is an 8-bit quasi-bidirectional I/0 port. It also emits the high-order address byte when accessing external memory. It is used for the high-order address and the control signals during program verification. Port 2 can sink/source for LS TTL loads.

Port 3
Port 3 is and 8-bit bidirectional I/= port with internal pullups. It also serves the functions of various spcial features of the MCS-51 Family, as listed below:

Port Pin	Alternate Function
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	INT0 (external interrupt)
P3.3	INT1 (external interrupt)
P3.4	T0 (Timer/counter 0 external input)
P3.5	T1 (Timer/counter 1 external input)
P3.6	WR (external Data Memory write strobe)
P3.7	RD (external Data Memory read strobe)

The output latch corresponding to a seconary function must be programmed to a one (1) for that function to operate. Port 3 ca- sink/source four LS TTL loads.

RST
A high on this pin for two machine cycles while the oscillator is running resets the device. A small external pulldown resistor (8.2k) from RST to V_{SS} permits power on reset when a capacitor (10uF) is also connected from this pin to V_{CC}.

ALE
Address Latch Enable output for latching the low byte of the address during accesses to external memory. ALE is activated at a constant rate of 1/6 the oscillator frequency except during an external data memory access at which time one ALE pulse is skipped. ALE can sink/source 8 LS TTL inputs.

PSEN
The Program Store Enable output is a control signal that enables the external Program Memory to the bus during external fetch operations. It is activated every six oscillator periods except during external data memory access. PSEN remains high during internal program execution.

EA
When held at a TTL high level, the 8051AH executes instructions from the internal ROM when the PC is less than 4096. When held at a TTL-low level, the 8031AH/8051AH fetches all instructions from external Program Memory. Do not float EA during normal operation.

XTAL 1
Input to the inverting amplifier that forms part of the oscillator. This pin should be ¡connected to ground when an external oscillator is used.

XTAL 2
Output o the inverting amplifier that forms part of the oscillator, and input to the oscillator signal when an external oscillator is used.

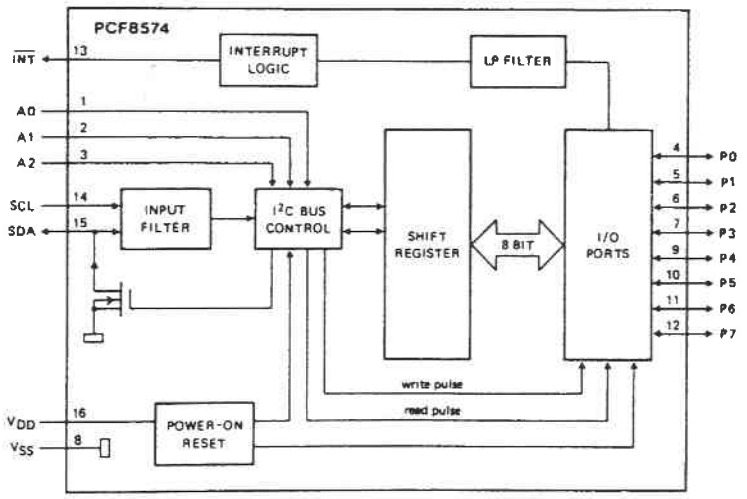
PCF8574 remote 8-bit I/O for I^2C bus

DESCRIPTION

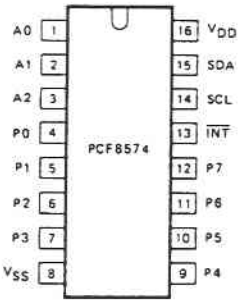
The PCF8574 is a single-chip silicon gate CMOS circuit. It provides remote I/O expansion for the MAB8400 and PCF8500 microcomputer families via the two-line serial bidirectional bus (I^2C). The device consists of an 8-bit quasi-bidirectional port and an I^2C interface. The PCF8574 has low current consumption and includes latched outpus with high current drive capability for directly driving LEDs.

Features

- Operating supply voltage 2,5 V to 6 V
- Biderectional expander
- Open drain interrupt output
- 8-bit remote I/O port for the I^2C bus
- Latched outputs with high current drive capability for directly driving LEDs
- Address by 3 hardware address pins for the use of up to 8 devices (up to 16 possible with mask option)



Block diagram

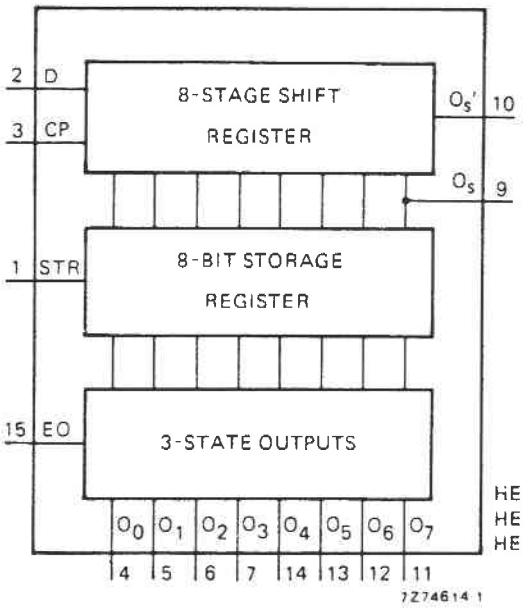


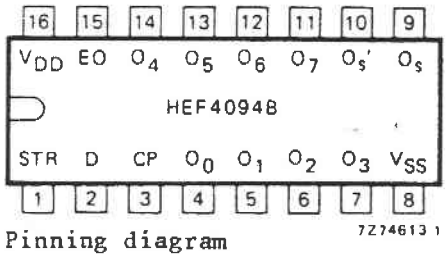
1 to 3	A0 to A2	address inputs
4 to 7	P0 to P3	8-bit quasi-bidirectional I/O
9 to 12	P4 to P7	port
8	V_{SS}	negative supply
13	INT	interrupt output
14	SCL	serial clock line
15	SDA	serial data line
16	V_{DD}	positive supply

Pinning diagram

8-STAGE SHIFT-AND-STORE BUS REGISTER

The HEF4094B is an 8-stage serial shift register having a storage latch associated with each stage for strobing data from the serial input to parallel buffered 3-state oupus O_0 to O_7. The parallel outputs may be connected directly to common bus lines. Data is shifted on positive-going clock transitions. The data in each shift register stage is transferred to the storage register when the strobe (STR) input is HIGH. Data in the storage register appears at the outputs whenever the output enable (EO) signal is HIGH.
Two serial outputs (O_s and O_s') are available for cascading a number of HEF4094B devices. Data is available at O_s on positive-going clock edges to allow high-speed operation in cascaded systems in which the clock rise time is fast. The same serial information is available at O_s' on the next negative-going clock edge and provides cascading HEF4094B devices when the clock rise time is slow.





Pinning diagram

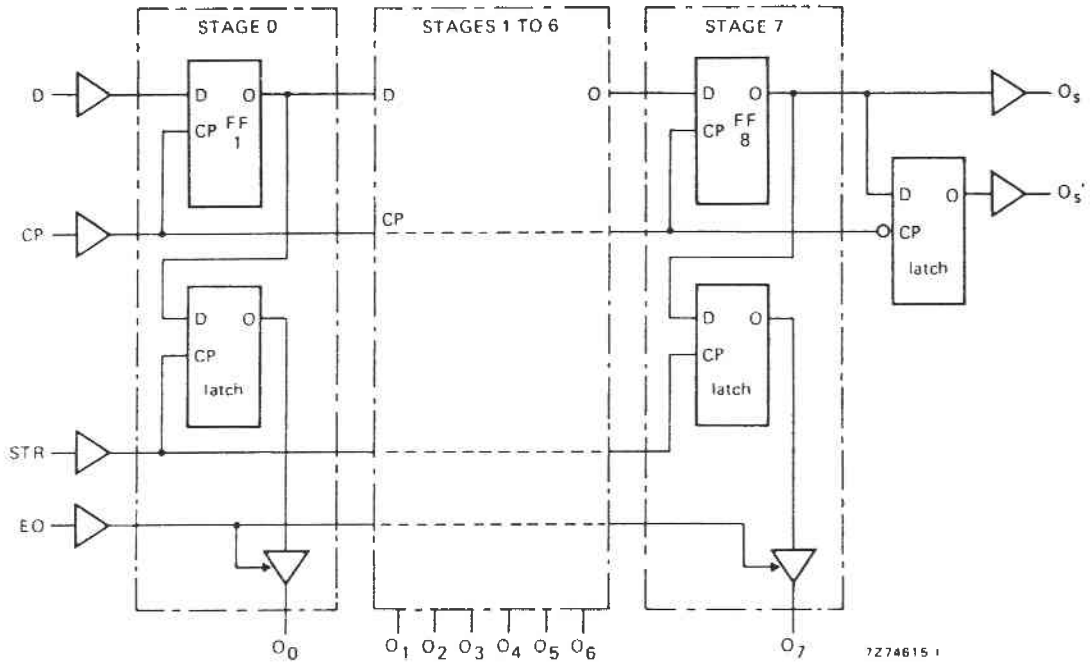
HEF4094BP : 16-lead DIL; plastic (SOT-38Z).
HEF4094BD: 16-lead DIL; ceramic (cerdip) (SOT-74).
HEF4094BT : 16-lead mini-pack; plastic (SO-16; SOT-109A).

Functional diagram

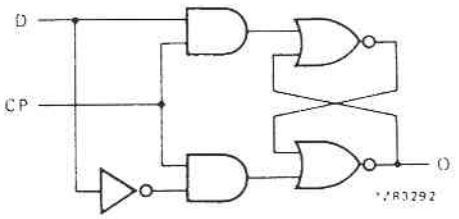
PINNING

D	data input	EO	output enable input
CP	clock input	O_s, O_s'	serial outputs
STR	strobe input	O_0 to O_7	parallel outputs

FAMILY DATA
I_{DD} LIMITS category MSI } see Family Specifications



Logic diagram



One D-latch

FUNCTION TABLE

inputs				parallel outputs		serial outputs	
CP	EO	STR	D	O_0	O_n	O_s	O_s'
⌐	L	X	X	Z	Z	O_6'	nc
⌙	L	X	X	Z	Z	nc	O_7
⌐	H	L	X	nc	nc	O_6'	nc
⌐	H	H	L	L	$O_{n\,1}$	O_6'	nc
⌐	H	H	H	H	O_{n-1}	O_6'	nc
⌙	H	H	H	nc	nc	nc	O_7

H = HIGH state (the more positive voltage)
L = LOW state (the less positive voltage)
X = state is immaterial
⌐ = positive-going transition
⌙ = negative-going transition
Z = high impedance off state
nc = no change
O_6' = the information in the seventh shift register stage

At the positive clock edge the information in the 7th register stage is transferred to the 8th register stage and the O_s output.

A.C. CHARACTERISTICS

V_{SS} = 0 V, T_{amb} = 25 °C; input transition times ≤ 20 ns

	V_{DD} V	typical formula for P (μW)
Dynamic power dissipation per package (P)	5	2100 f_i + $\Sigma(f_oC_L) \times V_{DD}^2$
	10	9700 f_i + $\Sigma(f_oC_L) \times V_{DD}^2$
	15	26 000 f_i + $\Sigma(f_oC_L) \times V_{DD}^2$

where
f_i = input freq. (MHz)
f_o = output freq. (MHz)
C_L = load capacitance (pF)
$\Sigma(f_oC_L)$ = sum of outputs
V_{DD} = supply voltage (V)

4. DISMANTLING THE INSTRUMENT

GENERAL INFORMATION

This section provides the dismantling procedures required for the removal of components during repair operations. All circuit boards removed from the instrument must be adquately proteced against damage, and all normal precautions regarding the use fo tools must be observed. During dismantling a careful note must be made of all disconnected leads so that they can be reconnected to their correct terminals during re-assembly.

CAUTION: Damage may result if:
- the instrument is switched on when a circuit board has been removed.
- a circuit board is removed within one minute after switching-off the instrument.

Disconnect measuring terminals before opening.

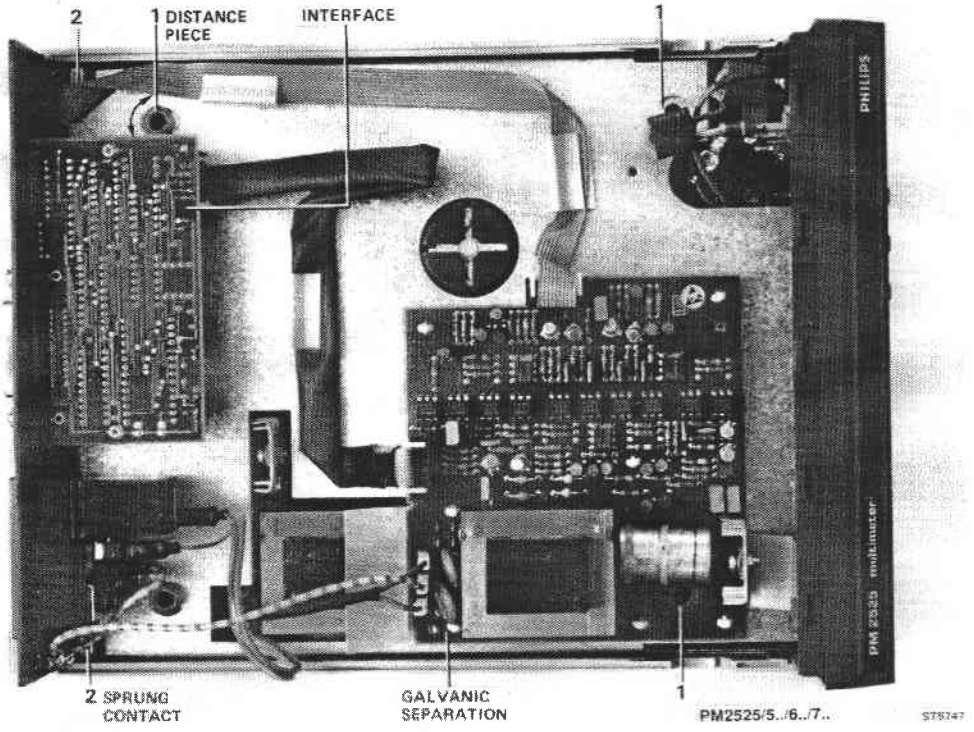
4.1 REMOVING THE TOPCOVER

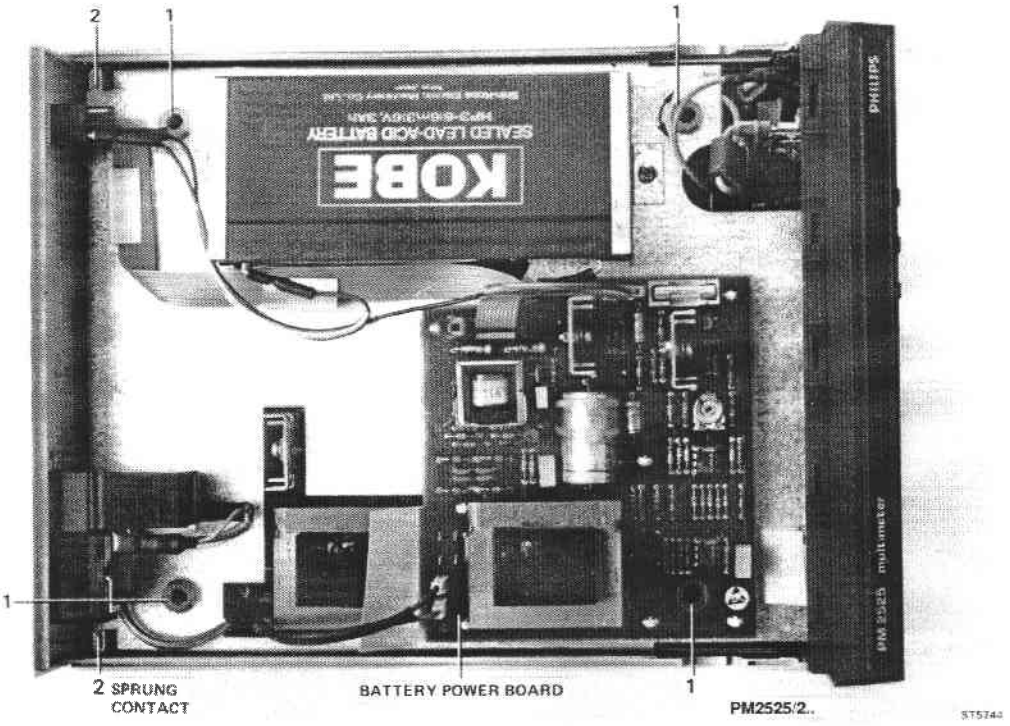
- Place the carrying handle in the bottom position.
- Loosen the four fixing screws (torx screws) that are situated in the four feet.

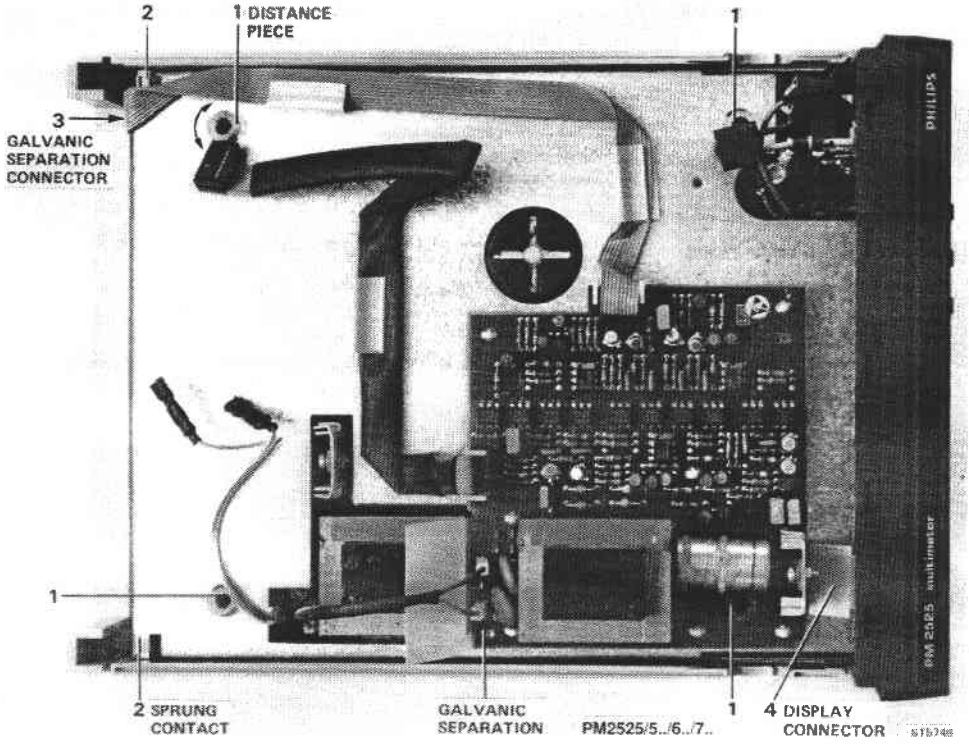
  Remark: The fixing screws can be loosened with a TORX screwdriver, size T10.

- Lever the topcover and pull it upwards.

4.2 REMOVING THE TOP-SCREENING

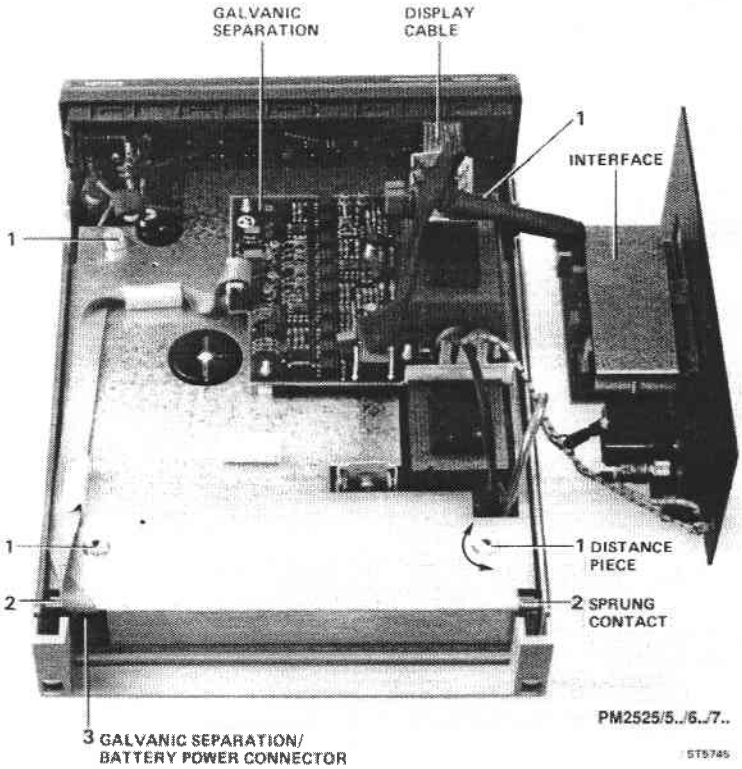






PM2525/5../6../7..

ST5744



PM2525/5../6../7..

ST5745

- Remove the topcover.
- Remove the wiring from the backplate.

  Remark: For version /02 there is only mains power wiring.

- Loosen the display cable from the display board.
- Turn the distance pieces (1).
- Lift the screening out-off the instrument.

  Remarks: The display cable is connected to the mother board (4).

  The galvanic separation is connected to the mother board (3).

  When mounting the top screening first make the connections (3) (4) and make sure that the sprung contacts (2) are fitted well.

4.3 REMOVING THE BOTTOMCOVER

- Remove the topcover.
- Remove the top-screening.
- The mother board including the front assembly is fixed with one Phillips screw to the bottom cover. The screw is situated near the mains-transformer.
- Pull the bottom cover from the instrument.

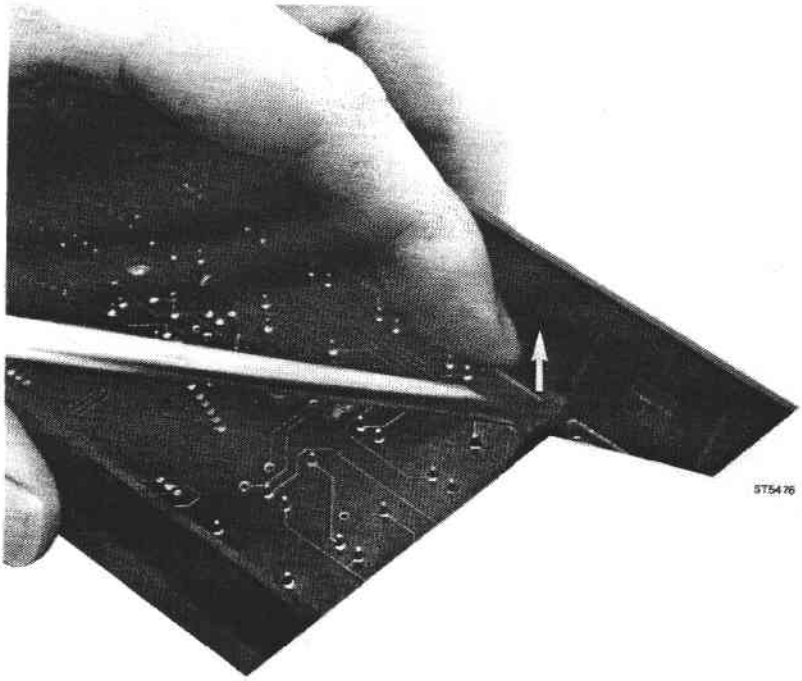
4.4 REMOVING THE FRONT-ASSEMBLY

- Remove the topcover.
- Remove the top-screening.
- Remove the bottom cover.
- Bend-out the two hooks of the front-assembly.
  The two plastic clip-hooks can be reached at the component side of the mother board near the front.
- Pull the front from the mother board.

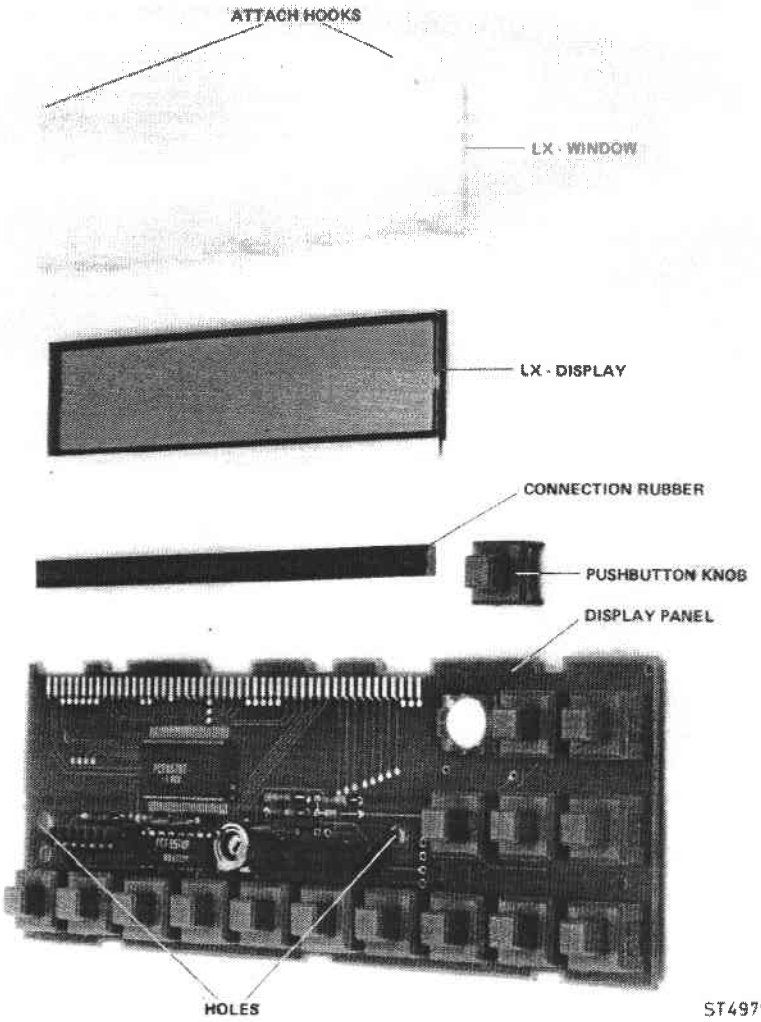
4.5 LX- DISPLAY, WINDOW AND INTERCONNECTION RUBBER

- Dismantle.
- Remove screening.
- Remove front assembly.
- Bend out the six hooks and lift the PCB out of the front assembly.

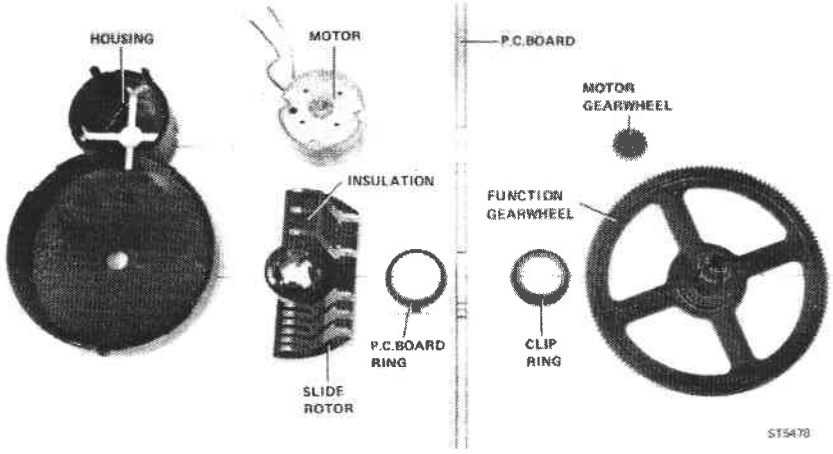
- Push the attach hooks out of the holes at the component side of the PCB and lift the LCD display from the PCB.



The assembly of the display consists of four main parts. All parts can be replaced seperately.



4.6 REPLACING THE FUNCTION SELECTOR



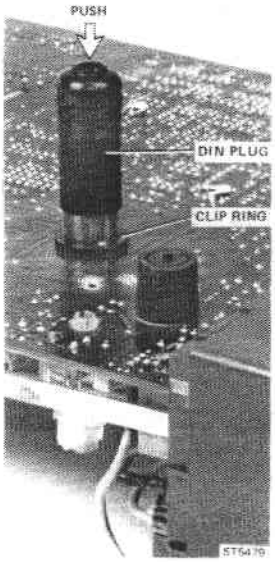
- Remove the topcover.
- Remove the top-screening

Replace of the function gearwheel
- Use a M5.5mm Box-spanner to press the gearwheel out of the function selector housing. A box-spanner is used to compress the retaining lugs of the gearwheel simultaneously.

  The gearwheel is keyed so no erroneous mounting is possible.

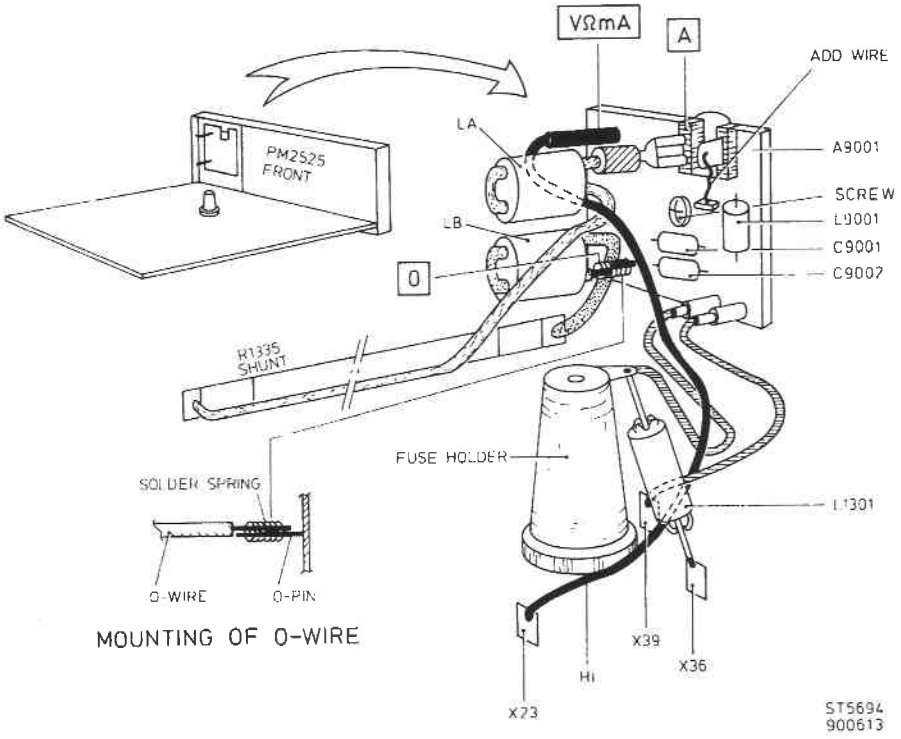
Replace of function selector housing assembly.
(Housing, motor, motor gearwheel)
- Remove function gearwheel.
- The function selector housing including motor assembly can be pressed out of the p.c. board from the bottom side on. (three lugs)
- The motor gearwheel can be pulled of the motor pinion.
- The motor can be pulled out of the housing with a screwdriver.

Replace of the function slide-rotor assembly
- Remove function gearwheel.
- Remove function selector housing assembly.
- The function selector assembly consists of a clipring, a p.c. board ring, slide rotor assembly (rotor + insulation)
- Push the rotor out of the clipring with a screwdriver or a DIN-plug at the conductor-side of the mother p.c. board.



4.7 REPLACING THE SMALL RESET PC BOARD

Replace of the small reset p.c. board onto the input sockets
- Solder the 0-wire from the 0-pin and remove the wire and the solder-spring.
- Pull all the interconnection wires from the small p.c. board.
- Remove the ADDitional piece of wire between the A-socket and the testpin on the small p.c. board.
- Loosen the screw and remove the p.c. board.



MOUNTING OF 0-WIRE

5. CHECKING AND ADJUSTING THE PM2525 (all versions)

5.1 GENERAL INFORMATION

The following information provides the complete checking and adjusting procedures for the instrument. As various control functions are interdependent, a certain order of adjustment is necessary. The procedure is , therefore, presented in a sequence which is best suited to this order, cros-reference being made to any circuit which may affect a particular adjustment.
Before any check or adjustment, the instrument must attain its normal operating temperature.

- Where possible, instrument performance should be checked before any adjustment is made. (refer PERFORMANCE TEST 5.2)
- All limits and tolerances given in this section are calibration guides, and should be not interpreted as instrument specifications unless they are also published in section 2.
- Tolerances given are for the instrument under test and do not include test equipment error.
- All controls which are mentioned without item numbers are located on the outside of the instrument.

WHY CALIBRATING AT TWO TEMPERATURES

Calibration will be made to get exact values without tolerances. Measuring at various temperatures will give different measuring data. Hot calibration will take care of the compensation of the different measuring data which originate by temperature variations.

THE CALIBRATION CAN BE SUBDIVIDED INTO:

5.3	Preparations	
5.4	Manual course adjustment	,open instrument
5.5	Manual fine adjustment	,open instrument
5.6.1	Electronic calibration COLD	,closed instrument
5.6.3	Electronic calibration HOT	,closed instrument

The coarse/fine adjustment and the calibration hot have to be
---
carried out only when components have been replaced.

IMPORTANT: IN CASE OF N.C. (NO CAL) ON THE DISPLAY IN ALL RANGES THERE IS ONLY ONE WAY TO CALIBRATE THE PM 2525 AND THAT IS FIRST THE COMPLETE COLD CALIBRATION AND THEN THE COMPLETE HOT CALIBRATION !

If the following components have been replaced, parts or the complete hot calibration has to be made.

Component	Hot calibration number
R1334 R1337	NO 42 100 mADC
R1532	NO 19 200 MΩ NO 40 20 MΩ
C1503 R1203, R1204 R1212, R1213 R1216, R1217 R1530, R1533 R1535, R1536 R1537, R1538 R1548.	ALL
N1202 N1501C N1502	
V1500, V1555	
D1201 00302 A1203 0Q0067 D1711 RAM	

In case of hot calibration, the cold calibration has to be done first, in the sequence which is given in section 5.5.7.
After this the hot calibration can be made in the same sequence.

The cold calibration has to be made once a year to quaranty the specification.

YEARLY CALIBRATION
- Performance test
- Calibration cold (complete or parts)

5.2 PERFORMANCE TEST

The meter should be calibrated and in operating condition when you receive it.

The following performance tests are provided to ensure that the meter is in a proper operating condition. If the instrument fails any of the performance tests, then calibration adjustments and / or repair is needed.

To perform these tests, you will need a:

- Fluke 5100B Multifunction Calibrator (or equivalents).
- Philips PM5390 Frequency Generator
- Resistor of 1 MΩ 0.1%.
- Capacitor of 20 nF 0.5%.
- Capacitor of 2 µF 0.5%.
- Philips PM9264/01 four-wire OHM cable.

Each of the measurements listed in the following steps assume the instrument is being tested after a one-hour warmup, in an environment with an ambient temperature of 18 to 28°C, and a relative humidity of less than 80%.

NOTE: All measurements listed in the performance tests tables are made in the initial measuring speeds. These speeds are automatically switched on when the functions are selected (unless otherwise stated).
The ranges of the meter must be selected in the manual ranging mode.

1 Power-up the meter and allow it to stabilize for one hour.

2. Connect a cable from the Output HI and LO connectors of the Fluke 5100B to the V-Ω-mA and 0 connectors on the PM2525.
   Select the function and range on the PM2525 and the input level from the Fluke 5100B using the values listed in the tables. The display should read between the minimum and maximum values listed in the tables.

3. In some cases another calibrator source is needed.
   This is clearly mentioned in the tables.

Performance test 1 PM2525

DC volts

FUNCTION	RANGE (SPEED 2)	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
V ⎓	200 mV	short	-	- 000.02	+000.02
	200 mV	+199.999 mV	-	+199.94	+200.06
	200 mV	- 199.999 mV	-	- 200.06	- 199.94
	2 V	+1.99999 V	-	+1.9994	+2.0006
	2 V	- 1.99999 V	-	- 2.0006	+1.9994
	20 V	+10.0000 V	-	+09.996	+10.004
	20 V	+15.0000 V	-	+14.995	+15.005
	20 V	+19.9999 V	-	+19.994	+20.006
	20 V	- 10.0000 V	-	- 10.004	- 09.996
	20 V	- 15.0000 V	-	- 15.005	- 14.995
	20 V	- 19.9999 V	-	- 20.006	- 19.994
	200 V	+199.999 V	-	+199.94	+200.06
	200 V	- 199.999 V	-	- 200.06	- 199.94
	2000 V	+0990.00 V	-	+0989.6	+0990.4
	2000 V	- 0990.00 V	-	- 0990.4	- 0989.6

Performance test 2 PM2525

AC volts

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
V ~	200 mV	short	-	-	<000.16
	200 mV	199.999 mV	60 Hz *	199.40	200.60
	200 mV	199.999 mV	300 Hz	198.00	202.00
	200 mV	199.999 mV	1 kHz	198.00	202.00
	200 mV	199.999 mV	20 kHz	194.00	206.00
	200 mV	199.999 mV	50 kHz	194.00	206.00
	2 V	1.99999 V	60 Hz *	1.9940	2.0060
	2 V	1.99999 V	300 Hz	1.9800	2.0200
	2 V	0.50000 V	1 kHz	0.4920	0.5080
	2 V	1.00000 V	1 kHz	0.9880	1.0120
	2 V	1.99999 V	1 kHz	1.9800	2.0200
	2 V	1.99999 V	20 kHz	1.9800	2.0200
	2 V	1.99999 V	50 kHz	1.9400	2.0600
	20 V	07.0000 V	60 Hz *	06.966	07.034
	20 V	10.0000 V	60 Hz *	09.960	10.040
	20 V	19.9999 V	60 Hz *	19.940	20.060
	20 V	19.9999 V	300 Hz	19.980	20.200
	20 V	19.9999 V	1 kHz	19.980	20.200
	20 V	19.9999 V	20 kHz	19.980	20.200
	20 V	19.9999 V	50 kHz	19.400	20.600
	200 V	199.999 V	60 Hz *	199.40	200.60
	200 V	199.999 V	300 Hz	198.00	202.00
	200 V	199.999 V	1 kHz	198.00	202.00
	200 V	199.999 V	20 kHz	198.00	202.00
	2000 V	0600.00 V	60 Hz *	0596.8	0603.2
V $\overline{\sim}$	2 V	+1.99999 V	-	+1.9940	+2.0060
	2 V	- 1.99999 V	-	- 2.0060	- 1.9940
	2 V	1.99999 V	60 Hz *	1.9940	2.0060
	2 V	1.99999 V	20 kHz	1.9800	2.0200

*If the PM2525 is used in a 60 Hz line power environment, use a 70 Hz input level signal.

Performance test 3 PM2525

Vpeak

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
VPU^	2 V	SHORT	-	- 0.002	+0.002
	2 V	+1.99999 V		+1.970	+2.030
	20 V	+19.9999 V	-	+19.70	+20.30
VPLv	2 V	-1.99999 V	-	- 2.030	- 1.970
	20 V	-19.9999 V	-	- 20.30	- 19.70
VPU^	2 V	+1.41400 V	70 Hz	+1.970	+2.030
	2 V	+1.41400 V	50 kHz	+1.890	+2.110
VPLv	2 V	-1.41400 V	70 Hz	- 2.030	- 1.970
	2 V	-1.41400 V	50 kHz	- 2.110	- 1.890
VPU^	200 V	+199.999 V	-	+197.0	+203.0
	2000 V	+0500.00 V	-	+0485	+0515

Performance test 4 PM2525

RTW (Resistance Two-Wire) and RFW (Resistance Four-Wire)

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
Ω2W	200 Ω	100 Ω	-	099.80	100.20
	2 kΩ	1 kΩ	-	0.9980	1.0020
	20 kΩ	10 kΩ	-	09.980	10.020
	200 kΩ	100 kΩ	-	099.80	100.20
	2 MΩ	1 MΩ	-	0.9940	1.0060
	20 MΩ	10 MΩ	-	09.940	10.060
	200 MΩ	100 MΩ*	-	095.0	105.0

*The Fluke 5100B cannot deliver 100MΩ. Use another external source.

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
Ω4W**	200 Ω	SHORT	-		<000.08
	200 Ω	100 Ω	-	099.80	100.20
	2 kΩ	1 kΩ	-	0.9980	1.0020
	20 kΩ	10 kΩ	-	09.980	10.020
	200 kΩ	100 kΩ	-	099.80	100.20
	2 MΩ	1 MΩ	-	0.9940	1.0060

**Use the four-wire OHM cable PM9264/01.
Connect the PM9264/01 to the PROBE connector of the PM2525 and the HI and LO connectors of the Fluke 5100B.
Remove the leads from the V-Ω-mA and 0 connector of the PM2525.

Performance test 5 PM2525

IDC (DC currents) and IAC (AC currents)

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
A ⎓	1 µA	open	-	- 0.0005	+0.0005
	1 µA	+1 µA*	-	+0.9985	+1.0015
	1 µA	-1 µA*	-	- 1.0015	- 0.9985
	10 µA	+10 µA*	-	+09.985	+10.015
	100 µA	open	-	- 000.04	+000.04
	100 µA	+100 µA	-	+099.85	+100.15
	100 µA	-100 µA	-	- 100.15	- 099.85
	1 mA	+1 mA	-	+0.9985	+1.0015
	10 mA	+10 mA	-	+09.985	+10.015
	100 mA	+100 mA	-	+099.85	+100.15
	1 A	+1 A	-	+0.9985	+1.0015
	10 A	+1.99999 A	-	+01.993	+02.007

*The Fluke 5100B cannot deliver 1 µA and 10 µA accurate enough. To check the ranges connect a 1 MΩ resistor of 0.1 % in series with the HI output of the calibrator.
For 1 µA set the calibrator to +1 V.
For 10 µA set the calibrator to +10 V.

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY	
				MIN	MAX
A ~	10 µA	10 µA	60 Hz *	09.945	10.055
	100 µA	100 µA	60 Hz*	099.45	100.55
	1 mA	1 mA	60 Hz*	0.9945	1.0055
	1 mA	1 mA	200 Hz	0.9945	1.0055
	10 mA	10 mA	60 Hz*	09.945	10.055
	1 A	50 mA	60 Hz*	0.0483	0.0517

*If a PM2525 is used in a 60Hz line power environment, use a 70 Hz input level signal.

Performance test 6 PM2525

CONT (Continuity), F (Capacitance), °C (Temperature) and Hz (Frequency).

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY MIN	DISPLAY MAX
Cont	CONT	short	-	closed +audible tone	
	CONT	open	-	open	

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY MIN	DISPLAY MAX
F	20 nF	20 nF *	-	19.780	20.220
	2 µF	2 µF *	-	1.9780	2.0220

*Connect external capacitors to the PM2525.
-20 nF 0.5%
-2 µF 0.5%

FUNCTION	RANGE	INPUT LEVEL	FREQUENCY	DISPLAY MIN	DISPLAY MAX
°C	°C	100 Ω**	-	-000.3	+000.3

**Use the four-wire OHM cable PM9264/01.
Connect the P9264/01 to the PROBE connector of the PM2525
and the HI and LO connectors of the Fluke 5100B.
Remove the leads from the V-Ω-mA and 0 connector of the PM2525.

FUNCTION	RANGE (Speed2)	INPUT LEVEL	FREQUENCY	DISPLAY MIN	DISPLAY MAX
Hz	100 kHz	2 Vpp***	100 kHz	099.97	100.03
	1 MHz	2 Vpp***	1 MHz	0.9997	1.0003
	1 MHz	2 Vpp***	10 MHz	00.997	01.003

***Use the PM5390 Frequency Generator as calibrator.

5.3 PREPARATIONS FOR CALIBRATION

5.3.1 Preparations for manual adjustment.

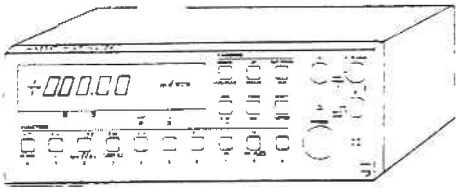
Hardware adjustments only must be made if components have been replaced.
For hardware adjusting No 1 to 9, the instrument must be opened (see chapter 4).
Before starting measuring and adjusting the diodes V1354,V1355,V1350 and V1351 must be covered because the light has influence on the measuring data.
For adjusting No 2 use a measuring lead with an build-in resistor of 14 kohm.

5.3.2 Preparations for electronic calibration.

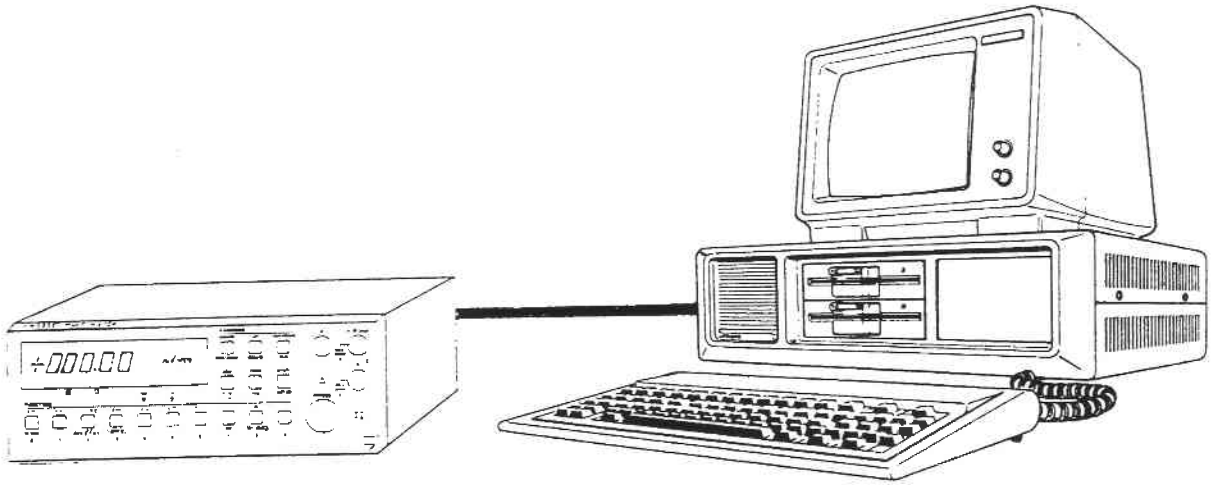
In case of cold calibration the ambient temperature and the temperature of the instrument must be between +20 and +26°C +/-1°C
In case of hot calibration the ambient temperature and the temperature of the instrument must be between +33 and +40°C +/-5°C
Be sure the instrument is closed. In fig. 5.3 examples are shown to control the instrument.

5.3.3 Following instruments and accesories can be used for calibration.

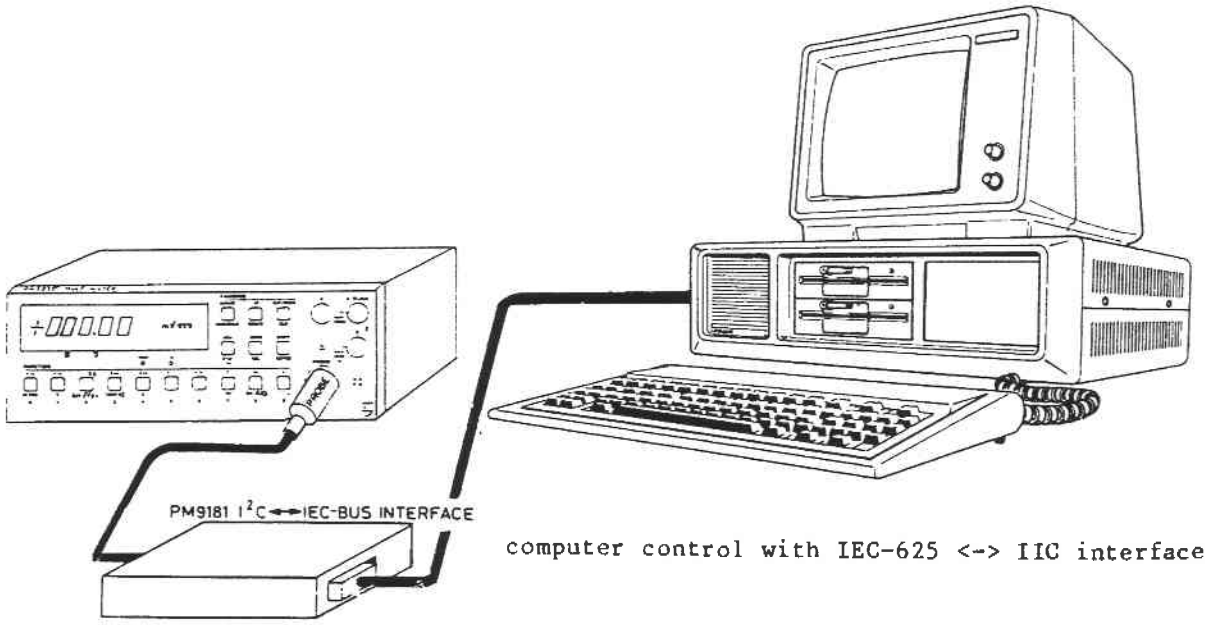
Calibrator	(eg. FLUKE 5100)
Frequency generator	(eg. PM5390)
Interface IEC-625 <-> IIC	(eg. PM9181)
Four wire measuring lead	(eg. PM9264/01)
Calibrator for 100Mohm	(eg. FLUKE 5700)
Resistor 1 Mohm +/-0.1%	
Oven for hot calibration	



Manual control



Computer control with IEC-625 or RS232C/V24 interface.



computer control with IEC-625 <-> IIC interface.

Different ways of how to control the PM2525

5.4 COARSE ADJUSTMENTS (open instrument, only if components have been replaced)

Overview

Adj.number	Adjustment	
1	2 Vpp	R4
2	Iref. ADC 0Q0067A	R1214
3	I compensation	R3
4	1 mA ...	R1316
5	1 uA	R1311
6	2 V ~	C1105
7	20 V ~	C1108
8	200 V ~	C1111

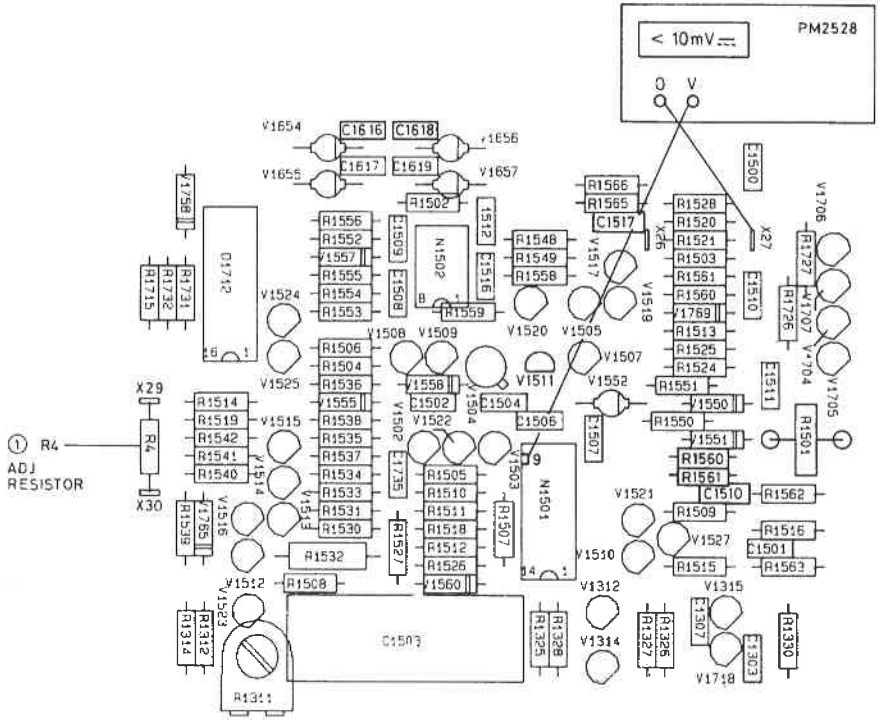
5.4.1 Adjusting of 2 VPP

No	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNAL	MEASURING DATA	MEASURING POINT
1	VPP range 2V	R4 adjust resistor (MR25 1% E48 series)	Instrument set in position VPP. 2V. Use a PM2528.	Short circuited input.	< 10 mV ⎓ ± 0.1%	HI = N1501/9 LO = X 27

U N1501/9-X27 R4

>= 3.....< 5 mV	3M6
>= 5.....< 7 mV	2M4
>= 7.....< 9 mV	1M8
>= 9.....< 11 mV	1M5
>= 11.....< 13 mV	1M2
>= 13.....< 15 mV	1M
>= 15.....< 17 mV	909k
>= 17.....< 19 mV	825k
>= 19.....< 21 mV	750k
>= 21.....< 23 mV	681k
>= 23.....< 25 mV	619k

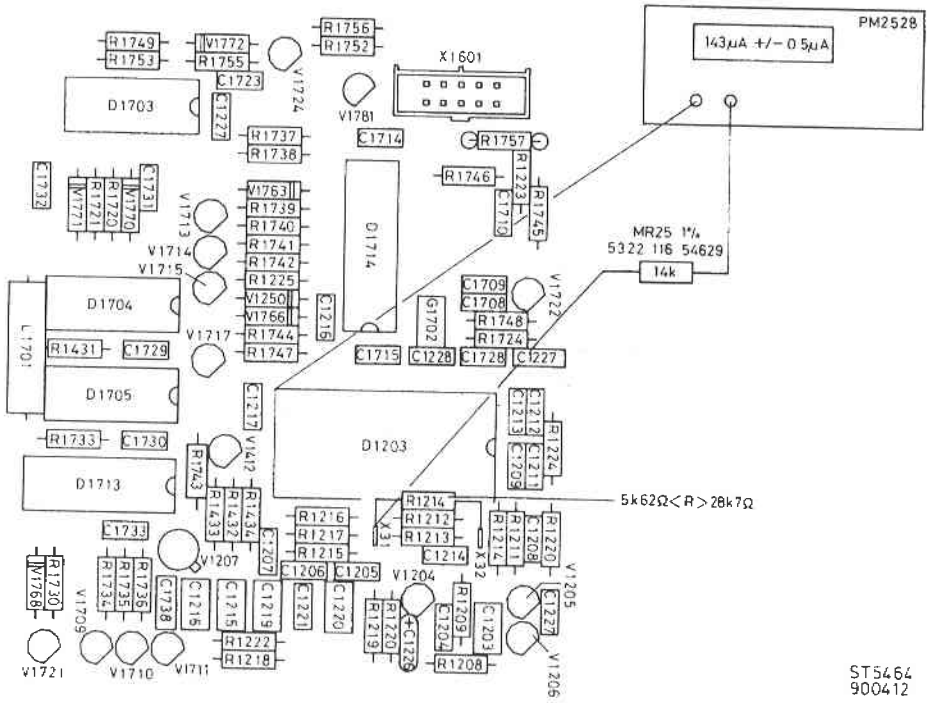
NOTE: When measuring and adjusting in an open instrument the diodes V1354, V1355, V1350, V1351 must be covered, to eliminate the influence of light.



ST5463
900412

5.4.2 Adjusting the OQ0067A

No	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNAL	MEASURING DATA	MEASURING POINT
2	Reference current ADC OQ 0067A	R1214 adjust resistor 5k62 < R > 28k7 (MR25 1% E48 series)	Instrument set in position V ⎓ AUT Use PM2528 and a help resistor,	Open input	+143uA +/- 0.5uA	HI = X31 LO = D1203/12



NOTE: When measuring and adjusting in an open instrument the diodes V1354, V1355, V1350, V1351 must be covered, to eliminated the influence of light.

5.4.3 Input current compensation

No.	ADJUSTMENT	ADJUSTMENT ELEMENT	PREPARATION	INPUT SIGNAL	MEASURING DATA	MEASURING POINT
3	I input	R3 adjust resistor (MR25 1% E48 series) 150kΩ < R < 1MΩ	Select Vdc Range 200 mV Speed 2 Shortcircuit input Press ZERO	- Shortcircuit input - Open input	$U_{shortcircuit\ input}$ $U_{open\ input}$	Display Display

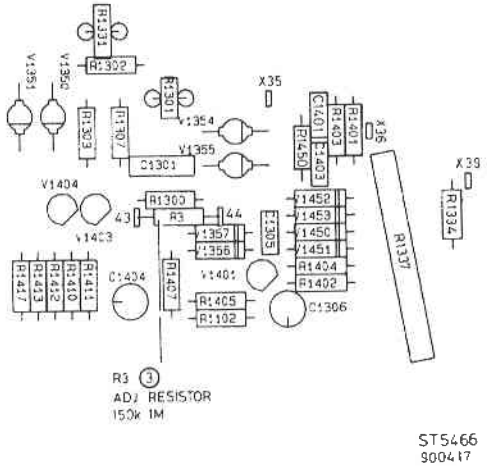
$$R3 = \frac{200}{U_{sh.\ input} - U_{open\ input}} \times 100k\Omega$$

$[U_{shortcircuit\ input}] = mV$

$[U_{open\ input}] = mV$

If R3 > 1 MΩ, no resistor should be installed

NOTE: When measuring and adjusting in an open instrument the diodes V1350, V1351, V1355, V1354, must be covered to eliminate the influence of light



5.5.2 Fine adjustment AC voltage

No	ADJUSTMENT	ADJUSTING ELEMENT	PREPARATIONS	INPUT SIGNAL	MEASURING DATA	MEASURING POINT
6	VAC range 2 V	Trimmer C1105 Removable capacitor see table 1	Instrument set in position 2 V.	1.7 V 60 Hz +/- 0.08%	xxxxx	See display
				1.7 V 2 kHz +/- 0.08%	xxxxx + 40 dig.*	See display
7	VAC range 20 V	Trimmer C1108 Removable capacitor see table 2	Instrument set in position 20 V.	17 V 60 Hz +/- 0.2%	xxxxx	See display
				17 V 1 kHz +/- 0.2%	xxxxx + 40 dig.*	See display
8	VAC range 200 V	Trimmer C1111 Removable capacitor see table 3	Instrument set in position 200 V.	170 V 60 Hz +/- 0.2%	xxxxx	See display
				170 V 1 kHz +/- 0.2%	xxxxx	See display

NOTE: make the two values (xxxxx) the same with the adjusting elements

* = without the screening

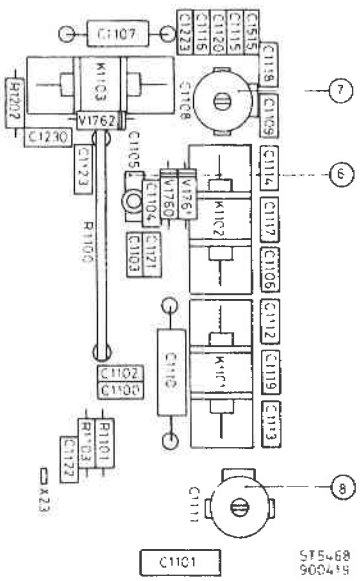


TABLE 1 (1.7V)	
TRIMMER C 1105	
C1106	DEVIATION IN COUNTS
X	0---623 624---1400

X = REMOVE

TABLE 2 (17V)		
TRIMMER C 1108		
C1118	C1109	DEVIATION IN COUNTS
		0---420
	X	421---812
X		813---1223
X	X	1224---1710

X = REMOVE

Note: Before using table 3 check C1223. It must be 1.5 nF. C1125 must be mounted.

NOTE: When measuring and adjusting in an open instrument the diodes V1354, V1355, V1350, V1351 must be covered, to eliminated the influence of light.

TABLE 3					
TRIMMER C 1111					
C1117	C1119	C1114	C1113	C1112	DEVIATION IN DIGITS
					0---39
				X	40---76
			X		77---112
			X	X	113---153
		X			154---195
		X		X	196---231
		X	X		232---268
		X	X	X	269---297
		X	X	X	298---326
		X		X	327---363
	X		X		364---400
	X		X	X	401---443
	X	X			444---486
	X	X		X	487---524
	X	X	X		525---562
	X	X	X	X	563---612
X					613---663
X				X	664---702
X			X		703---741
X			X	X	742---785
X		X			786---805
X		X		X	806---870
X		X	X		871---909
X		X	X	X	910---940
X	X				941---972
X	X			X	973---1012
X	X		X		1013---1052
X	X		X	X	1053---1099
X	X	X			1100---1145
X	X	X		X	1146---1186
X	X	X	X		1187---1227
	X	X	X	X	1228---1274

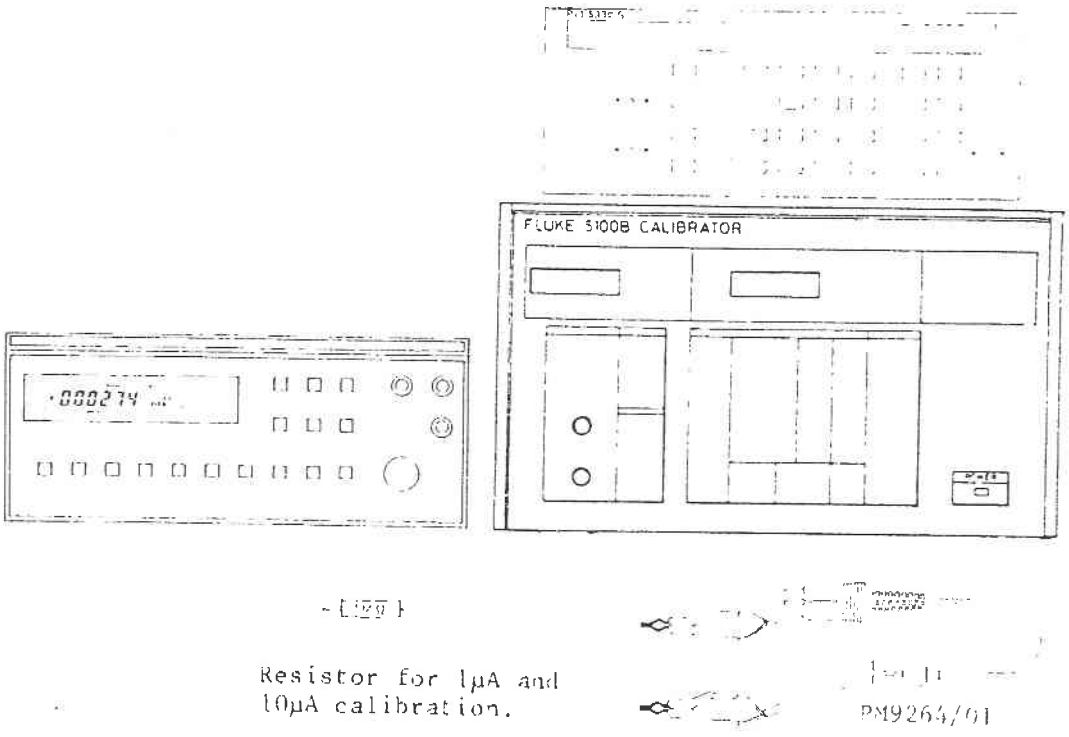
5.6 ELECTRONIC CALIBRATION COLD AND HOT.

5.6.1 How to switch on the cold calibration mode by manual control.

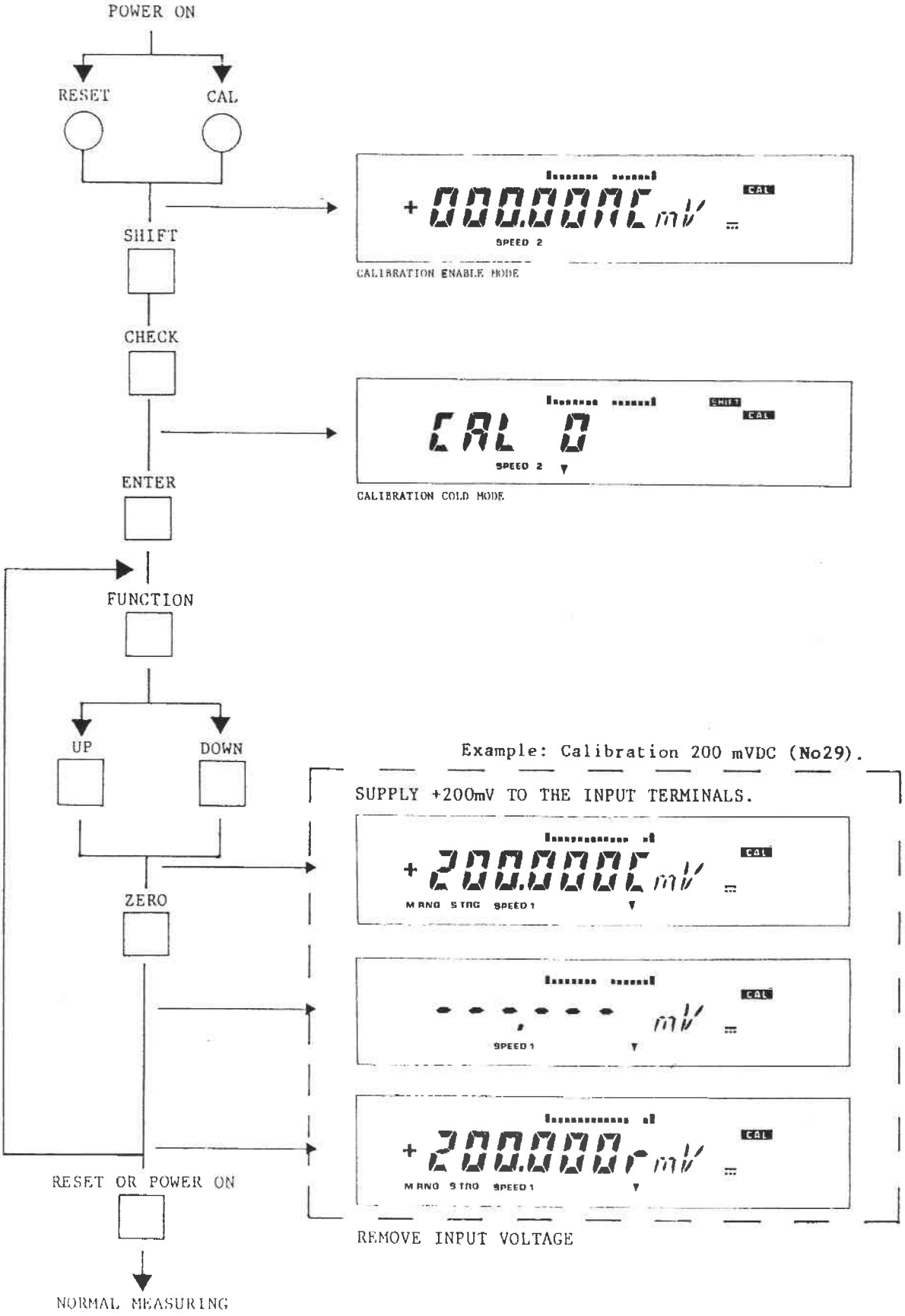
Cold calibration has to be made at a room temperature of +20 to +26°C +/-1°C. Before calibrating the instrument check if the instrument mains frequency is set correct.

How to select the calibration enable mode.

To make it possible to calibrate the instrument it has to be set in the calibration enable mode. This may be done by pressing the switch "CAL" and "RESET"(pencil-point operation) simultaneously and then release the "RESET" switch before releasing the "CAL" switch. Now the instrument is set in the calibration enable mode. In the display CAL appears.Press "SHIFT CHECK 0 ENTER".
Now the instrument is set in the mode "CAL 0" which means calibration cold.
Select the range and function which need to be calibrated.
When the display shows a value followed by "nA" this means, this range cannot be calibrated (not applicable).
After supplying the signal to the input terminals, start calibration by pressing the "ZERO" key. In a few seconds appears on the diplay the calibrated value followed by "r", this means, calibration ready.
If "FAIL" is shown, the calibration has failed and has to be repeated.
Pressing the "RESET" switch or POWER ON/OFF will return to normal measuring.
See also next page: Flowchart for electronic calibration by manual control.



Example of instruments and accessories for cold calibration by manual control.



Flow-chart for electronic calibration by manual control

5.6.2 How to switch on the cold calibration mode by computer control

Cold calibration must be made at a temperature of +20 to +26°C +/- 1°C.
Selecting of range and function must be done by a controller with IEEE-488 interface (IBM compatible e.g. P3100)
When using an PM9181 as IEEE-488 interface for the PM2525, make a help set (see page 5-31) to connect the interface plug and the four wire ohm cable at the same time to the instrument.
Before calibrating the instrument check if the instrument mains frequency is set correct.
To make it possible to calibrate the instrument, it has to be set in the calibration enable mode.
This may be done by pressing the switch "CAL" and "RESET" (pencil-point operation) simultaneouly and then release the "RESET" switch before releasing the "CAL" switch.
Now the instrument is set to the calibration enable mode. In the display "CAL" appears.

COMMANDS

CAL_ON,0	select calibration cold
CAL_OFF	switch off the cal mode,back to cal enable *
CAL_OFF (second)	switch off cal enable mode, back to normal measuring.
CAL_?	gives the actual cal mode (eg CAL ON,0 or CAL OFF)

After sending the command "CAL_ON ,0" the instrument is set in the mode calibration cold.
Now select the range and function which need to be calibrated by sending the corresponding commands.
If the display shows a value followed by "nA " this means this range cannot be calibrated (not applicable).
After supplying the signal to the input terminals, send the command "TRG_B,X". This command will start the calibration.
In a few seconds on the display appears the calibrated value followed by "r ", which means calibration ready.
If "FAIL" is shown the calibration has failed and has to be repeated.
Sending the command "CAL_OFF" once, will set the instrument in the calibration enable mode. Sending the command "CAL_OFF" the second time, the instrument will disable the calibration enable mode and return to normal measuring.
Page 5-23 shows an example of an calibration set-up.
See also page 5-22: Flow-chart calibration by computer control.

* In the calibration enable mode the display shows processed zero point calibration values for test purposes. Refer to chapter 6.3 Trouble shooting.

5.6.3 How to switch on the hot calibration by manual control

Hot calibration have to be made at a temperature of +33 to +40°C +/-5°C. The best way is to do this in an oven.
The warming-up time for hot calibration is one hour (instrument in the oven at the correct temperature, power on).
During calibration,keep the door of the oven closed as much as possible, otherwise there is a lot of temperature loss every time the oven will be opened.

Before calibrating the instrument check if the instrument mains frequency is set correct.

To make it possible to calibrate the instrument, it has to be set in the calibration enable mode.
This may be done by pressing the switch "CAL" and "RESET"(pencil-point operation) simultaneouly and then release the "RESET" switch before releasing the "CAL" switch.
Now the instrument is set in the calibration enable mode. In the display "CAL" appears.

Press "SHIFT CHECK 1 ENTER" and the instrument is set in the mode "CAL 1" which means calibration hot.

Select range and function which need to calibrate, when the display will show a value followed by "nA "this means not applicable.

After supplying the signal to the input terminals press the ZERO key, and calibration is started.
In a few seconds on the display appears the calibrated value followed by "r ", which means calibration ready.
If "FAIL" is shown the calibration has failed and has to be repeated.

Select next function and range and calibrate as above described.

5.6.4 How to switch on the hot calibration by computer control

Hot calibration has to be made at a temperature of +33 to +40°C +/-5°C. The best way is to do this in an oven.
The warming-up time for hot calibration is one hour (instrument in the oven at the correct temperature, power on).
During calibration, keep the door of the oven closed as much as possible, otherwise there is a temperature loss every time the oven will be opened.
Selecting of range and function may by done by controller with a IEEE-488 interface (IBM compatible eg P3100).
When using an PM 9181as IEEE-488 interface for the PM2525, make a help set (see page 5-31) to connect the interfase plug and the 4 wire ohm cable at the same time to the instrument.

Before calibrating the instrument check if the instrument mains frequency is set correct.
To make it possible to calibrate the instrument, it has to be set in the calibration enable mode.
This may be done by pressing the switch "CAL" and "RESET" (pencil-point operation) simultaneouly and then release the "RESET" switch before releasing the "CAL" switch.
Now the instrument is set to the calibration enable mode. In the display "CAL" appears.

COMMANDS

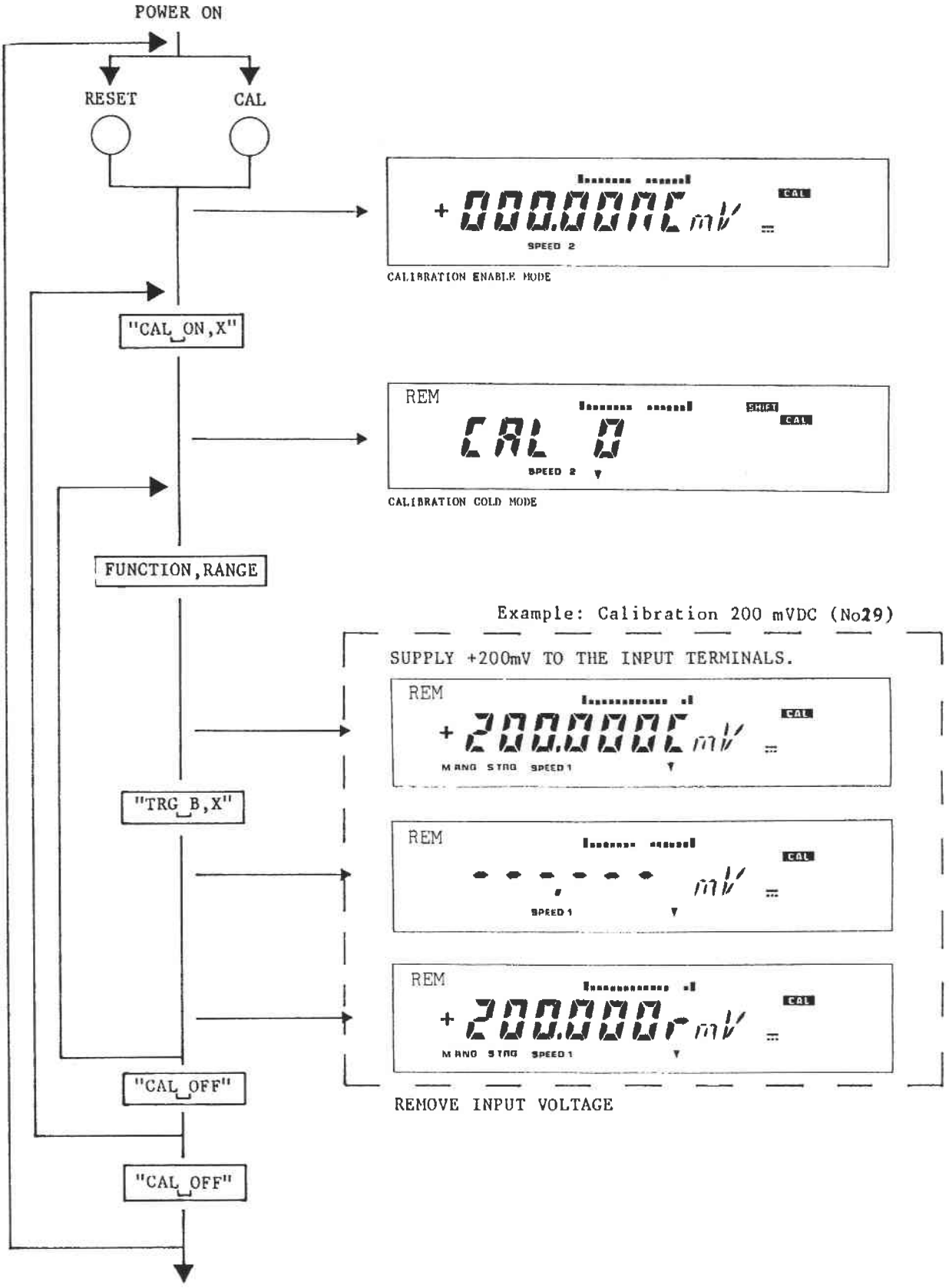
CAL_ON,1	select calibration hot
CAL_OFF	switch off the cal mode,back to cal enable *
CAL_OFF (second)	switch off cal enable mode, back to normal measuring.
CAL_?	gives the actual cal mode (e.g. CAL_0 or CAL_OFF)

After sending the command "CAL_ON,1" the instrument is set in the mode calibration hot.
Now select the range and function which need to calibrated by sending the corresponding commands.
If the display shows a value followed by "nA " this means this range cannot be calibrated (not applicable).

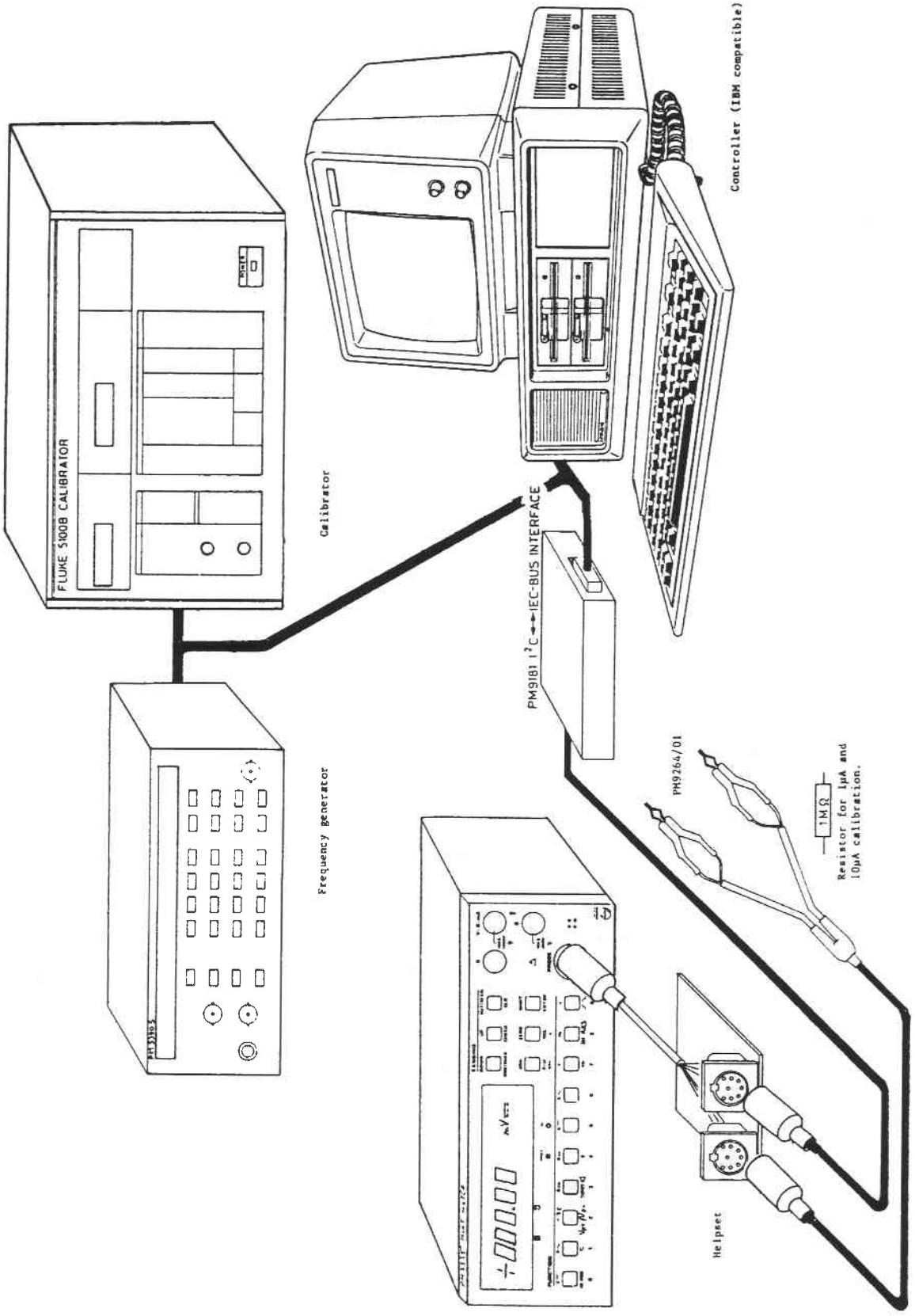
After supplying the signal to the input terminals, send the command "TRG_B,X". This command will start calibration.
In a few seconds appears on the display the calibrated value followed by "r ", which means calibration is OK.
If "FAIL" is shown the calibration has failed and has to be done again.

Sending the command "CAL_OFF" once, the instrument is set in the calibration enable mode. Sending the command "CAL_OFF" the second time, the instrument will disable the calibration enable mode and returns to normal measuring.
See also page 5-22: Flow-chart calibration by computer control.

* In the calibration enable mode the display shows proccessed zero point calibration values for test purposes. Refer to chapter 6.3 Trouble shooting.



Flow-chart for electronic calibration by computer control



Example of instruments and accesories for cold calibration by computer control

5.6.5 Calibration of the 1 uA and 10 uA ranges

The DC current ranges 1 uA and 10 uA of the FLUKE 5100 B calibrator are not accurate enough to calibrate the PM2525
To calibrate these two uA ranges connect a resistor of 1 M between the HI output of the FLUKE 5100 B en the HI input of the PM2525.
Connect the low output of the FLUKE 5100 B to the LO input of the PM2525.
Use undermentioned table for correct input signals.

No	PREPARATION	CALIBRATING RANGE	OUTPUT SIGNAL 5100 B	INPUT SIGNAL PM2525	DISPLAY AFTER CALIBRATION
11		1 uA		open input	0.000 ruA
20	1 MΩ	1 uA	+ 1 V	1 uA	1.0000 ruA
21	1 MΩ	10 uA	+10 V	10 uA	10.000 ruA

Calibration table for DC uA ranges.

5.6.6 Calibration overviews

5.6.6.1 Cold/Hot calibrations

Adj.No	Adj		Cold	Hot
10	1 MHz	f.s.	x	-
11	1 uA DC	zero (open)	x	x
12a	100 uA DC	zero (open)	x	x
12b	1 A DC	zero (open)	x	x
13	20 nF	zero (open)	x	-
14a	200 ΩTW	zero	x	x
14b	2 kΩTW	zero	x	x
14c	200 ΩTW	zero	x	x
15	2 kΩFW	1 kΩ	x	x
16	20 kΩFW	10 kΩ	x	x
17	TDC	0 Ω	x	x
18	TDC	100 Ω	x	x
19	200 MΩTW	100 MΩ	x	x
20	1 uADC	1 uA	x	x
21	10 uADC	10 uA	x	x
22	1 ADC	1 A	x	x
23	200 m VDC	zero	x	x
24	2 VDC	zero	x	x
25	20 VDC	zero	x	x
26	200 VDC	zero	x	x
27	2 VPU	zero	x	x
28	2 VPL	zero	x	x
29	200 mVDC	200 mV	x	x
30	2 VDC	2 V	x	x
31	20 VDC	20 V	x	x
32	20 VDC	-20 V	x	-
33	2 VPU	2 V	x	x
34	2 VPL	-2 V	x	x
35	200 mVAC	200 mV/60Hz	x	-
36	2 VAC	2 V /60Hz	x	x
37	20 VAC	20 V /60Hz	x	-
38	200 kΩ	100 kΩ	x	x
39	2 MΩ	1 MΩ	x	x
40	20 MΩ	10 MΩ	x	x
41	1 mADC	1 mA	x	x
42	100 mADC	100 mA	x	x
43	1 mAAC	1 mA /60Hz	x	x
44	200 VAC	200 V /60Hz	x	-
45	2000 VAC	600 V /60Hz	x	-
46	200 VDC	200 V	x	-
47	2000 VDC	1000 V	x	-

5.6.6.2 Calibration cross-reference of related ranges

Nr.	Function	Range	Cold Zero scale	Cold Full scale	Hot Zero scale	Hot Full scale
23/29	VDC	200 mV	x	x	x	x
24/30	VDC	2 V	x	x	x	x
25/31	VDC	20 V	x	x	x	x
32	VDC	-20 V	.	x	.	.
26/46	VDC	200 V	x	x	x	.
47	VDC	2000 V	.	x!	.	.
35	VAC	200 mV	.	x	.	.
36	VAC	2 V	.	x	.	x
37	VAC	20 V	.	x	.	.
38	VAC	200 V	.	x	.	.
45	VAC	2000 V	.	x!	.	.
28/34	VPL	2 V	x	x	x	x
2733	VPU	2 V	x	x	x	x

! Input value is not full scale.

Nr.	Function	Range	Cold Zero scale	Cold Full scale	Hot Zero scale	Hot Full scale
14c	RFW	200Ω	x	.	x	.
15	RFW	2 kΩ	.	x!	.	x!
16	RFW	20 kΩ	.	x!	.	x!
14a	RTW	200Ω	x	.	x	.
14b	RTW	2 kΩ	x	.	x	.
38	RTW	200 kΩ	.	x!	.	x!
39	RTW	2 MΩ	.	x!	.	x!
40	RTW	20 MΩ	.	x!	.	x!
19	RTW	200 MΩ	.	x!	.	x!
17/18	TDC	-100.°C +850°C	x	x!	x	x
11/20	IDC	1 uA	x	x	x	x
21	IDC	10 uA	.	x	.	x
12a	IDC	100 uA	x	.	x	.
41	IDC	1 mA	.	x	.	x
42	IDC	100 mA	.	x	.	x
22/12b	IDC	1 A	x	x	x	x
43	IAC	1 mA	.	x	.	x
13	CAP	20 nF	x	.	.	.

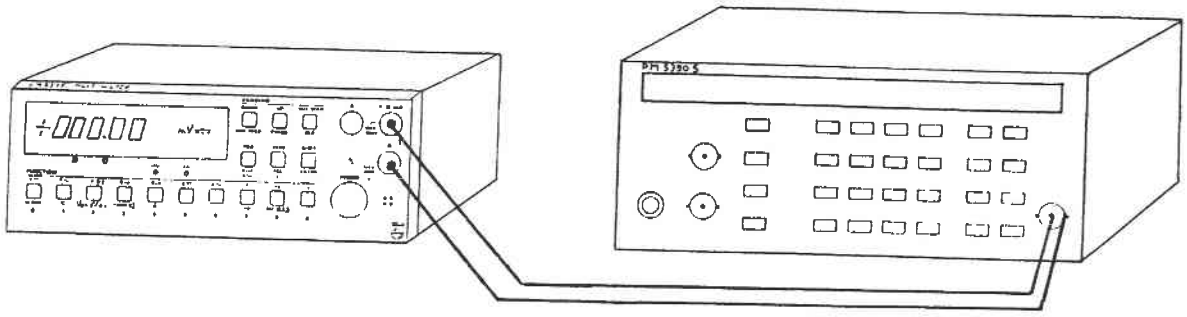
! Input value is not full scale.

5.6.7 Calibrationtable

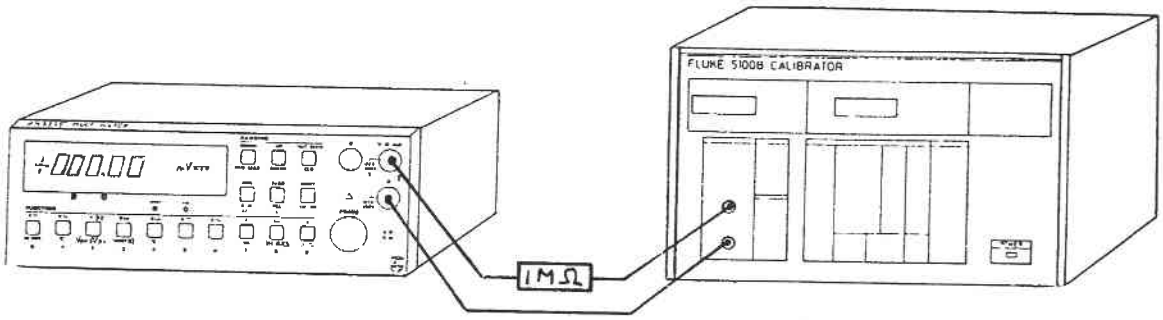
Nr.	Function	Range	Input signal	Display before calibration	Display before calibration	Remarks
10*	Hz (only cold)	1 MHz	1 MHz 2 Vpp ±2 Hz	1.00000 CMHz	1.00000 rMHz	
11	IDC	1 µA	open input	1.0000 CµA	0.0000 rµA	
12a	IDC	100 µA	open input	100.00 CµA	000.00 rµA	
12b	**IDC**	**1 A**	**open input**	**1.0000 CA**	**0.0000 rA**	
13*	F (only cold)	20 nF	open input	20.000 CnF	00.000 rµF	
14a	RFW	200 Ω	0 Ω	200.00 CΩ	000.00 rΩ	Use 4 wire cable
14b	**RTW**	**2 kΩ**	**0 Ω**	**1.0000 CkΩ**	**0.0000 rkΩ**	
14c	**RFW**	**200 Ω**	**0 Ω**	**200.00 cΩ**	**000.00 rΩ**	
15	RFW	2 kΩ	1 kΩ ±0.04%	1.0000 CkΩ	1.0000 rkΩ	Use 4 wire cable
16	RFW	20 kΩ	10 kΩ ±0.04%	10.000 CkΩ	10.000 rkΩ	Use 4 wire cable
17	TDCΩ	- 246°C	0 Ω	000.0 C°C	-246.8 r°C	Use 4 wire cable
18	TDCΩ	0 °C	100 Ω ±0.1%	000.0 C°C	000.0 r°C	Use 4 wire cable
19	**RTW**	**200 MΩ**	**100 MΩ ±1%**	**100.0 MΩ**	**100.0 rMΩ**	■
20	IDC	1 µA	1 µA ⎓ ±0.03%	1.0000 CµA	1.0000 rµA	
21	IDC	10 µA	10 µA ⎓ ±0.03%	10.000 CµA	10.000 rµA	
22	IDC	1 A	1 A ⎓ ±0.03%	1.0000 CA	1.0000 rA	
23	VDC	200 mV	0	200.000 CmV	000.00 rmV	
24	VDC	2 V	0	2.00000 CV	0.00000 rV	
25	VDC	20 V	0	20.00000 CV	00.0000 rV	
26	VDC	200 V	0	200.000 CV	000.000 rV	
27	VPU	2 V	0	2.000 CVP~	0.000 rVP~	
28	VPL	2 V	0	2.000 CVP~	0.000 rVP~	
29	VDC	200 mV	200 mV ⎓ ±0.006%	200.000 CmV	+200.000 rmV	
30	VDC	2 V	2 V ⎓ ±0.006%	2.00000 CV	+2.00000 rV	
31	VDC	20 V	20 V ⎓	20.0000 CV	+20.0000 rV	
32*	VDC (only cold)	20 V	-20 V ⎓ ±0.006%	20.0000 CV	-20.0000 rV	
33	VPU	2 V	2 V ⎓ ±0.3%	2.000 CVP^	2.000 rVP^	
34	VPL	2 V	-2 V ⎓ ±0.3%	2.000 CVPv	2.000 rVPv	
35*	VAC (only cold)	200 mV	200 mV 60 Hz ±0.08%	200.00 CmV~	200.00 rmV~	

■ connect 100MΩ via an external source (Fluke 5700)

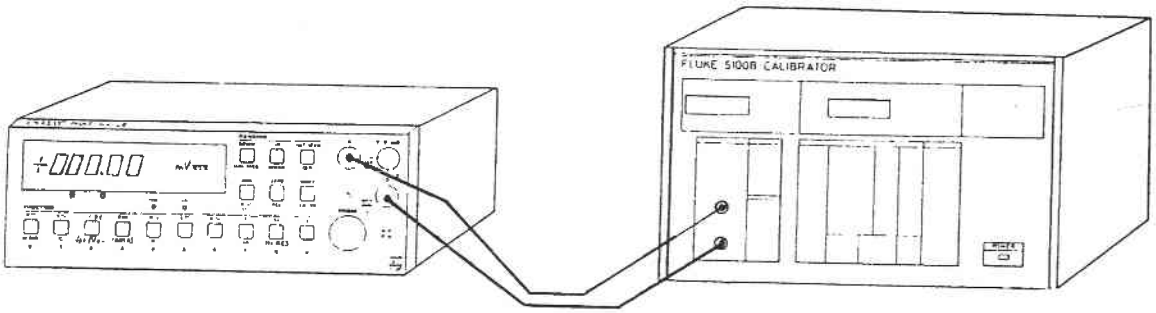
Nr.	Function	Range	Input signal	Display before calibration	Display after calibration	Remarks
36	VAC	2 V	2 V 60 Hz ± 0.08%	2.0000 CV ~	2.0000 rV ~	
37*	VAC (only cold)	20 V	20 V 60 Hz ± 0.08%	20.000 CV ~	20.000 rV ~	
38	RTW	200 kΩ	100 kΩ ± 0.04%	100.00 CkΩ	100.00 rkΩ	
39	RTW	2 MΩ	1 MΩ ± 0.14%	1.0000 CMΩ	1.0000 rMΩ	
40	RTW	20 MΩ	10 MΩ ± 0.14%	10.000 CMΩ	10.000 rMΩ	
41	IDC	1 mA	1 mA ⎓ ± 0.03%	1.0000 CmA	1.0000 rmA	
42	IDC	100 mA	100 mA ± 0.03%	100.00 CmA	100.00 rmA	
43	IAC	1 mA	1 mA 60 Hz ± 0.11%	1.0000 CmA	1.0000 rmA	
44	VAC	200 V	200 V 60 Hz ± 0.08%	200.00 CV	200.00 rV	
45*	VAC (only cold)	2000 V	600 V 60 Hz ± 0.1266%	0600.0 CV	0600.0 rV	
46*	VDC (only cold)	200 V	200 V ⎓ ± 0.006%	200.000 CV	200.000 rV	
47*	VDC (only cold)	2000 V	1000 V ⎓ ± 0.008%	1000.00 CV	1000.00 rV	



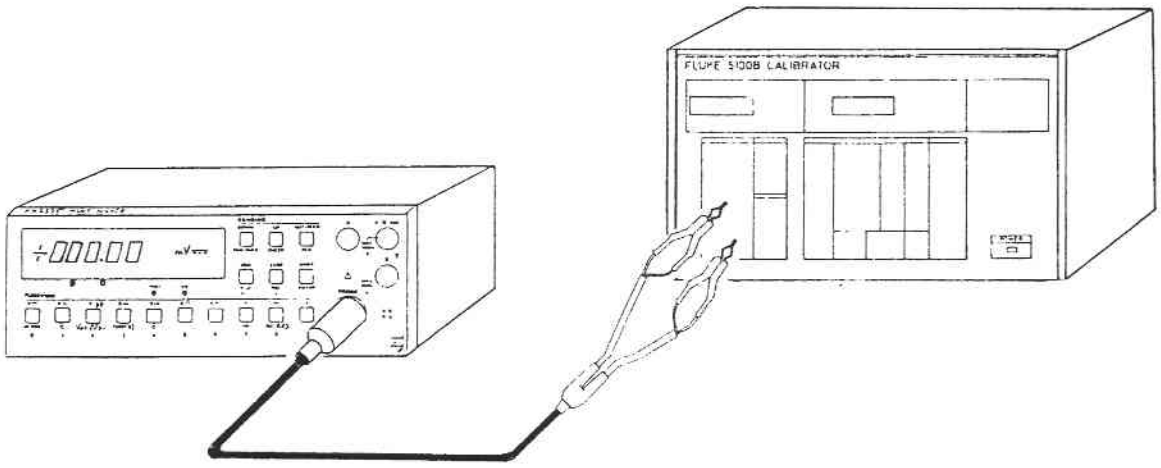
Example of calibration set up for Hz



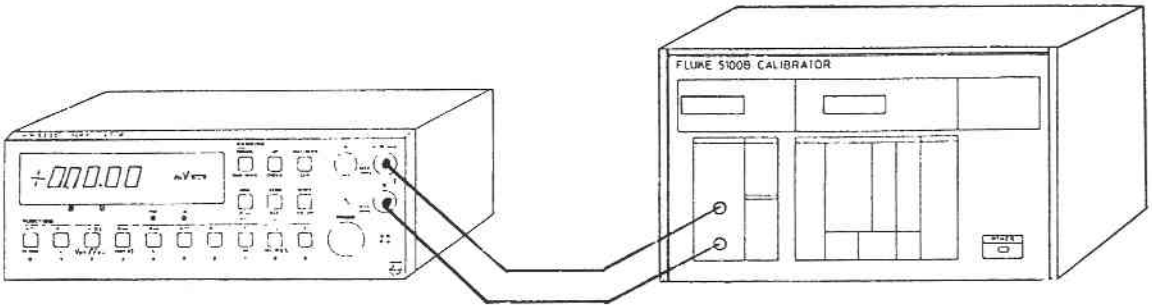
Example of calibration set up for 1 ua DC and 10 ua DC



Example of calibration set up for 1 A DC



Example of calibration set up for RFW and TDC

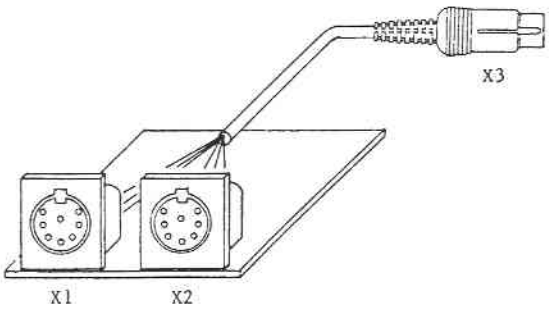


Example of calibration set up for VDC,VP+,VP-,VAC,RTW,IAC and some ranges of IDC

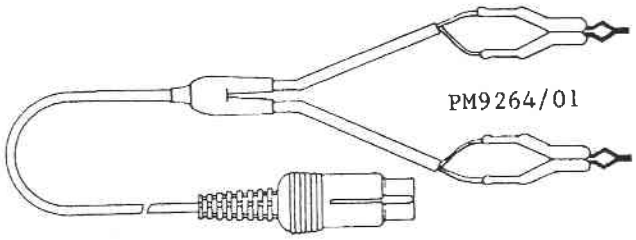
5.6.8 Calibration accessories

Connections of the help set

pin 1 of X3 to pin 1 of X1 and X2
pin 2 of X3 to pin 2 of X1 and X2
pin 3 of X3 to pin 3 of X1 and X2
pin 4 of X3 to pin 4 of X1 and X2
pin 5 of X3 to pin 5 of X1 and X2
pin 6 of X3 to pin 6 of X1 and X2
pin 7 of X3 to pin 7 of X1 and X2
pin 8 of X3 to pin 8 of X1 and X2



Helpset



Measuring cable for RFW (Resistance Four Wire) and TDC (Temperature Degree Celcius).

5.7 ADJUSTING THE LIQUID CRYSTAL DISPLAY

The PCF 8576 is a circuit designed to drive a Liquid Crystal Display with up to 160 segments. A 2-line IIC bus structure enables serial data transfer with the microcomputer.
A LCD is a AC device. Therefore, for multiplexing, the information of the segment line is important for each segment that will be driven by thet line.
The reference voltage for the driver is obtained from transistor V 2102 and zener diode V 2101.
To change the viewing angle the reference voltage can be adjusted with potentiometer R 2105.

6. CORRECTIVE MAINTENANCE

6.1 SPECIAL PARTS

In addition to the standard electronic components, some special components are used:
- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument.

ATTENTION: Both type of components may only be replaced by components obtained through your local Philips organisation or representative. These components have been marked in the Parts List by a *.

6.2 TROUBLESHOOTING

BUILT IN TESTS

TEST 1 Direct measuring mode without processing of the measuring results.

Description: In the normal measuring mode the measuring results are processed.
In the direct measuring mode the following process functions are left out.
- Calibration values are not processed.

Remark: The measuring result is not accurate.

- No auto zero of the analog to digital convertor. Signal AZC (A1203/13) on the ADC is not active.
- No offset control of the pre-amplifier/bufffer (signal OVCP A1201/22) and offset control of the RMS-convertor (signal A1201/23).
- No measuring of the internal temperature after xmeasurements.
  The internal temperature is measured in the Vpeak configuration via transistor V1500.

How to switch on the test: Press push button S1701 while measuring.
The switch is situated on the mother board (little white knob).

When to use the test: Use the test when the PM2525 has a hang-up.
All the important conditional jumps are skipped.

TEST 2 Show deviation in processed zero point calibration values.

Description : At shortcicuited input the PM2525 will show the processed zero point calibration values. These values may have positive or negative polarity sign, also for not polarity related functions such as function OHM.
Example: Suppose the zero point of OHM is calibrated with +10 digits due to a bad connection, and this is accepted by the PM2525 (calibration passed) In the normal measuring mode this +10 digits is calculated in the measuring result and not shown. In TEST 2 the PM2525 does not calculate with the zero point calibration value.
At a correct zero point connection the display will show in this case -10 digits in thefunction OHM.

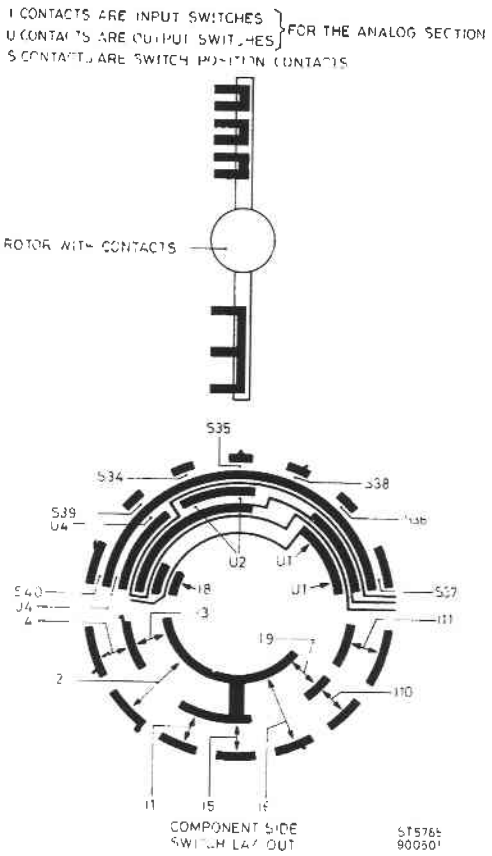
How to switch: on the test The test is active in the CALibration enable mode. With the two switches on the front (CAL and RESET) the CALibration enable mode is switched on.

WARNING: DONOT USE THE MEASURING RESULTS IN THE CALIBRATION ENABLE MODE AS NORMAL MEASURING RESULTS FOR E.G. A CALIBRATION LIST PRINT-OUT.

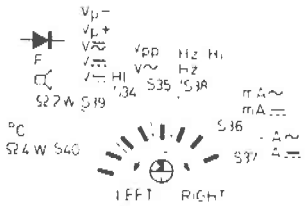
When to use : the test. Alinearity errors may be caused by a incorrect zero point calibration. Test 2 allows to trace this.

Alinearity may be caused in the following functions: OHM-2W, OHM-4W, Vp+, Vp-, Vpp, F, Vac, Vac+dc, Aac.

TEST 3 Testing the motor circuit



FUNCTION	SWITCH CONTACT	NAME	SWITCH CONTACT POSITION
Hz, Hz H RES	I1	-	FHRZ	S38
V~, Vpp	I5	U2	FVAC	S35
V⎓, V⎓ HI RES	I6	U2	FVDC	S34
V≂, Vp+, Vp−				
Ω2W, ⏚, F, ▶|	I4, I10	U4	FRTW	S39
Ω4W, °C	I8, I11	U4	FRTW	S40
A~, A⎓	I7, I4	U1	FIH	S37
mA~, mA⎓	-	U1	FILO	S36

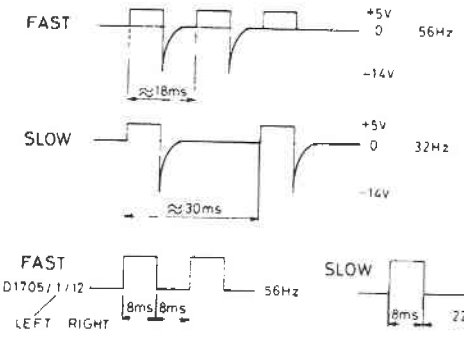


MOTOR SWITCH POSITION

The motor can run on two speeds:

SPEED 1 = FAR FROM THE SELECTED FUNCTION
SPEED 2 = CLOSE TO THE DESIRED FUNCTION

If the motor is forced by hand to the left, it will try to run to the right.
If far from the selected function: (Measured on motor RED=HI, BLUE=LO)



7. SAFETY IN SPECTION TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

7.1 GENERAL DIRECTIVES

- Take care that the creepage distance and clearances have not been reduced.
- Before soldering, the wires should be bent through the holes of solder tags, or wrapped around the tag in the form of an open U, or Wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and plates.

7.2 SAFETY COMPONENTS

Components in the primary circuit may only be replaced by components selected by Philips.

7.3 CHECKING THE PROTECTIVE EARTH CONNECTION

The correct connection and condition is checked by visual control and by measuring the resistance between the protective lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0,5 Ohm. During measurements the mains cable should be removed. Resistance varations indicate a defect.

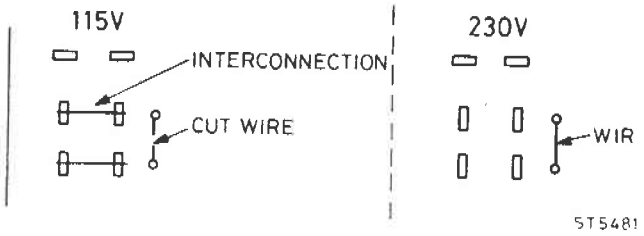
7.4 ADAPTION TO THE LOCAL MAINS VOLTAGE (115/230V)

The PM2525 can be altered to another mains voltage.
To alter proceed as follows:

- Remove the topcover and top screening (Refer to chapter 4)

PM2525/0..	ONE MAINS TRANSFORMER
PM2525/2.. /5.. /6.. /7..	TWO MAINS TRANSFORMERS

Place jumpers and short-circuitwire in the correct position.



Remark: For both 115 V and 230 V the same mains fuse can be used. 630 mAT/250 V DIN 41571.

7.5 ADAPTION TO THE LOCAL MAINS FREQUENCY (50/60 Hz)

In the "CHECK" function the instrument can be adapted to the local mains frequency.

Proceed as follows:

50 Hz to 60 Hz

Press	SHIFT CHECK	1	ENTER
Display action	60 H0	60 H1	Measuring

60 Hz to 50 Hz

Press	SHIFT CHECK	0	ENTER
Display action	60 H1	60 H0	Measuring

8. PARTS LIST

Different type numbers PM2525.

/. . .

- 1 standard version
  3 USA version
  4 UK version
  5 Swiss version
- 2 version (mushroom)
  3 version (grey)
- 0 standard version
  2 battery version (plastic back panel)
  5 IEEE version (standard + PM9191)
  6 RS232C version (standard + PM9190)
  7 analog output version (standard + PM9193)

8.1 MECHANICAL PARTS

Description	Serv. Code	QTY.	FIG.	ITEM
8.1.1 POWER				
MAINS INPUT CONNECTOR 2P	5322 265 51192	1	D	24
MAINS INPUT CONNECTOR 2P+EARTH	5322 265 20372	1	D	24
FUSE 630MAF FOR MAINS	4822 070 36301	1	D	4
MAINS TRANSFORMER (T301,T401, T1601)	5322 146 10241	1	D	23
THERMAL FUSE	5322 252 20117	1	D	5
MAINS CABLE 2P	5322 321 23296	1		
MAINS CABLE 2P+EARTH	5322 321 23297	1		
MAINS CABLE USA 2P	5322 321 10643	1		
MAINS CABLE USA 2P+E	5322 321 10644	1		
MAINS CABLE CH 2P	5322 321 10682	1		
MAINS CABLE CH 2P+E	5322 321 10679	1		
MAINS CABLE UK 2P+E	5322 321 10681	1		
8.1.2 MOTOR ASSEMBLY				
COVER GEARWHEEL	5322 447 91791	1	C	14
ROTOR INSULATION	5322 466 91519	1	C	15
SLIDE ROTOR ASSEMBLY	5322 362 20226	1	C	17
ROTOR CLIP RING	5322 532 60932	1	C	16
PC BOARD RING	5322 532 51932	1	C	18
MOTOR GEARWHEEL (small)	5322 522 32384	1	C	19
GEAR WHEEL (big)	5322 522 32463	1	C	20
MOTOR	5322 361 21338	1	C	21
8.1.3 FLAT CABLES				
GALVANIC SEPARATION TO INTERFACE PCB	5322 321 60666	1	D	25
DISPLAY PCB TO MAIN PCB	5322 321 21307	1	D	7
MAIN PCB TO GALVANIC SEP. OR BATTERY BOARD	5322 321 21585	1	D	31
CONNECTOR CLAMP	5322 401 11156	4	D	26
8.1.4 DISPLAY				
WINDOW	5322 450 60633	1	B	11
LCD INTERCON.RUBBER	5322 267 50753	1	B	12
LCD	5322 130 90454	1	B	13
8.1.5 CABINET				
DISTANCE PIECE PLASTIC	5322 535 92416	4	D	10
FOOT-BOTTOM	5322 462 41278	4	A	9
FOOT-REAR	5322 462 41201	2	D	8
GREY:				
TOPCOVER	5322 447 91905	1	A	29
BOTTOM COVER	5322 447 91899	1	A	28
FRONT ASSEMBLY	5322 447 91901	1	A	30

HANDLE ASSEMBLY	5322 498 50323	1	A	31
PUSHBUTTON WHITE	5322 414 60738	5	B	26
PUSHBUTTON GREY	5322 414 20315	10	B	26
PUSHBUTTON YELLOW	5322 414 60741	1	B	26
REAR PLATE BATTERY VERSION	5322 447 92085			
MUSHROOM:				
TOPCOVER	5322 447 91527	1	A	29
BOTTOM COVER	5322 447 91447	1	A	28
FRONT ASSEMBLY	5322 447 91446 VERV.	1	A	30
HANDLE ASSEMBLY	5322 498 54105	1	A	31
PUSHBUTTON DARK	5322 414 20031	15	B	26
PUSHBUTTON GREY	5322 414 60146	1	B	26
USA /02:				
TOPCOVER	5322 447 91528	1	A	29
BOTTOM COVER	5322 447 91525	1	A	28
FRONT ASSEMBLY	5322 447 91524	1	A	30
HANDLE ASSEMBLY	5322 498 50306	1	A	31
PUSHBUTTON WHITE	5322 414 20263	10	B	26
PUSHBUTTON GREY	5322 414 20244	5	B	26
PUSHBUTTON DARK GREY	5322 414 20245	1	B	26

8.1.6 MISCELLANEOUS

IC SOCKET 24-P	5322 255 40248	1
IC SOCKET 28-P	5322 255 44047	2
IC SOCKET 40-P	5322 255 44217	1
SCREWDRIVER TORX T10	5322 395 50381	
SCREW BOTTOM TORX	5322 502 50017	4

8.2 ELECTRICAL PARTS

8.2.1 Motherbaord A1000

FUSE HOLDER A-FUNCTION	5322 256 34102
CAP FUSE HOLDER A-FUNCTION	5322 462 44478
FUSE 630MAT FOR A-FUNCTION	4822 070 16301

CAPACITORS

C 1100	CAP.	2% 56PF	5322 122 32982
C 1101	CAP.FOIL	400V 10% 33NF	5322 121 44025
C 1102	CAP.	2% 56PF	5322 122 32982
C 1103	CAP.	2% 56PF	5322 122 32982
C 1104	CAP.CERAMIC	2% 33PF	4822 122 32193
C 1105	CAP.TRIMMER	160V 5PF	5322 125 50352
C 1106	CAP.CERAMIC	0.25PF 3.9PF	5322 122 34107
C 1107	CAP.FOIL	250V 1% 1NF	4822 121 50566
C 1108	CAP.TRIMMER	300V 4/40PF	5322 125 50058
C 1109	CAP.CERAMIC	2% 27PF	4822 122 30045
C 1110	CAP.FOIL	63V 1% 10NF	5322 121 54154
C 1111	CAP.TRIMMER	300V 4/40PF	5322 125 50058
C 1112	CAP.CERAMIC	2% 27PF	4822 122 30045
C 1113	CAP.CERAMIC	2% 56PF	4822 122 32027
C 1114	CAP.CERAMIC	2% 120PF	4822 122 31348

C 1115	CAP.FOIL	63V 10% 100NF	5322 121 42386
C 1116	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1117	CAP.CERAMIC	10% 470PF	5322 122 32311
C 1118	CAP.CERAMIC	2% 56PF	4822 122 32027
C 1119	CAP.CERAMIC	2% 220PF	5322 122 32346
C 1120	CAP.CERAMIC	10% 4.7NF	4822 122 31125
C 1121	CAP.	2% 56PF	5322 122 32982
C 1122	CAP.FOIL	63V 10% 220NF	4822 121 42408
C 1123	CAP.CERAMIC	10% 1.5NF	5322 122 31169
C 1124	CAP.	2% 56PF	5322 122 32982
C 1125	CAP.	2% 12PF	4822 122 31196
C 1200	CAP.CERAMIC	2% 220PF	5322 122 32346
C 1201	CAP.FOIL	100V 10% 33NF	5322 121 42489
C 1202	CAP.CERAMIC	2% 100PF	4822 122 31316
C 1203	CAP.FOIL	63V 10% 470NF	4822 121 51252
C 1204	CAP.FOIL	63V 10% 100NF	5322 121 42386
C 1205	CAP.CERAMIC	2% 390PF	4822 122 32121
C 1206	CAP.CERAMIC	2% 390PF	4822 122 32121
C 1207	CAP.FOIL	100V 10% 47NF	4822 121 43526
C 1208	CAP.CERAMIC	2% 47PF	4822 122 31072
C 1209	CAP.CERAMIC	2% 33PF	5322 122 32072
C 1210	CAP.CERAMIC	2% 10PF	4822 122 32185
C 1211	CAP.CERAMIC	2% 33PF	5322 122 32072
C 1212	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1213	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1214	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1215	CAP.FOIL	63V 10% 470NF	4822 121 51252
C 1216	CAP.FOIL	63V 10% 470NF	4822 121 51252
C 1217	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1218	CAP.CERAMIC	2% 100PF	4822 122 31316
C 1219	CAP.FOIL	63V 10% 680NF	5322 121 42498
C 1220	CAP.FOIL	63V 10% 680NF	5322 121 42498
C 1221	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1223	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1224	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1225	CAP.TANTAL	20% 10µF	5322 124 10675
C 1226	CAP.TANTAL	20% 10µF	5322 124 10675
C 1227	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1228	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1229	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1230	CAP.	100V 10% 10NF	4822 121 41857
C 1300	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1302	CAP.ELECTROLYT.	20% 1µF	5322 124 41098
C 1303	CAP.FOIL	63V 10% 100NF	5322 121 42386
C 1304	CAP.CERAMIC	100V 2% 100PF	4822 122 31316
C 1305	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1306	CAP.FOIL	20% 100µF	5322 124 41383
C 1307	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1401	CAP.CERAMIC	10% 1NF	5322 122 32127

C 1402	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1403	CAP.CERAMIC	2% 33PF	4822 122 31202
C 1404	CAP.FOIL	20% 33µF	5322 124 41378
C 1405	CAP.FOIL	20% 33µF	5322 124 41378
C 1407	CAP.FOIL	20% 100µF	5322 124 41383
C 1408	CAP.FOIL	20% 33µF	5322 124 41378
C 1409	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1410	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1411	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1500	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1501	CAP.CERAMIC	10% 1NF	5322 122 32127
C 1502	CAP.FOIL	250V 5% 4.7NF	4822 121 43856
C 1503	CAP.FOIL	100V 5% 4.7µF	4822 121 41975
C 1504	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1505	CAP.	63V 10% 1µF	5322 121 42114
C 1506	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1507	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1508	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1509	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1510	CAP.CERAMIC	0.25PF 2.7PF	4822 122 31038
C 1511	CAP.CERAMIC	2% 220PF	5322 122 32346
C 1512	CAP.CERAMIC	2% 33PF	5322 122 32072
C 1513	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1514	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1515	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1516	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1517	CAP.CERAMIC	2% 100PF	4822 122 31316
C 1602	CAP.ELECTROLYT.	-10+50% 220µF	4822 124 20717
C 1603	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1604	CAP.ELECTROLYT.	20% 1µF	5322 124 41098
C 1605	CAP.ELECTROLYT.	-10+50% 330µF	4822 124 20705
C 1606	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1607	CAP.ELECTROLYT.	20% 1µF	5322 124 41098
C 1609	CAP.ELECTROLYT.	-20+20% 6800µF	4822 124 20783
C 1611	CAP.ELECTROLYT.	-10+50% 470µF	4822 124 20695
C 1612	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1613	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1614	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1615	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1616	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1617	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1618	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1619	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1701	CAP.TANTAL	20% 10µF	5322 124 11083
C 1702	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1704	CAP.CERAMIC	2% 33PF	5322 122 32072
C 1705	CAP.CERAMIC	2% 33PF	5322 122 32072
C 1706	CAP.ELECTROLYT.	20% 10µF	5322 124 21731
C 1707	CAP.CERAMIC	-20+50% 10NF	4822 122 31414

C 1708	CAP.CERAMIC	2% 100PF	4822 122 31316
C 1709	CAP.CERAMIC	2% 100PF	4822 122 31316
C 1710	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1711	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1712	CAP.ELECTROLYT.	20% 1µF	5322 124 41098
C 1713	CAP.ELECTROLYT.	20% 10µF	5322 124 21731
C 1714	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1715	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1716	CAP.CERAMIC	10% 2.2NF	5322 122 32818
C 1717	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1718	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1719	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1720	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1721	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1722	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1723	CAP.FOIL	63V 10% 220NF	4822 121 42408
C 1724	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1725	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1726	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1727	CAP.FOIL	63V 10% 220NF	4822 121 42408
C 1728	CAP.CERAMIC	2% 47PF	4822 122 31072
C 1729	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1730	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1731	CAP.CERAMIC	10% 1NF	5322 122 32331
C 1732	CAP.FOIL	63V 10% 100NF	5322 121 42386
C 1733	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1734	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1735	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1736	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1737	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1738	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 1739	CAP.FOIL	63V 10% 220NF	4822 121 42408
C 1740	CAP.CERAMIC	100V -10% 560PF	5322 122 32336
C 1741	CAP.CERAMIC	40V -20+80% 22NF	4822 122 30103
C 1742	CAP.CERAMIC	40V -20+80% 22NF	4822 122 30103
C 1743	CAP.CERAMIC	40V -20+80% 22NF	4822 122 30103

DIGITAL INTEGRATED CIRCUITS

D 1203	INTEGR.CIRCUIT	OQ0067A	5322 209 81883
D 1701	INTEGR.CIRCUIT	PC74HC132P PEL	5322 209 11194
D 1702	INTEGR.CIRCUIT	PC74HC4518P PEL	5322 209 11736
D 1703	INTEGR.CIRCUIT	PC74HC132P PEL	5322 209 11194
D 1704	INTEGR.CIRCUIT	PC74HC86P PEL	5322 209 11473
D 1705	I.C. DIGITAL	PC74HC27P PEL	5322 209 11333
D 1706	MICROPROCESSOR	P80C31BH INT	5322 209 73932
D 1707	INTEGR.CIRCUIT	PC74HC165P PEL	5322 209 11531
D 1709	INTEGR.CIRCUIT	PC74HC373P PEL	5322 209 11366
D 1710	INTEGR.CIRCUIT	EPROM /02, /03	5322 209 51849
D 1711	INTEGR.CIRCUIT	2KX8 SRAM HM6116LP-2	5322 209 12568

D 1712	INTEGR.CIRCUIT	PC74HC4094P PEL	5322 209 11532
D 1713	INTEGR.CIRCUIT	PC74HC4094P PEL	5322 209 11532
D 1714	INTEGR.CIRCUIT	OQ0071	5322 209 81901

MICELLANEOUS

G 1701	CRYSTAL	12000 KHZ	5322 242 71226
G 1702	CRYSTAL	650 KHZ MUR	5322 242 71888
G 1703	LITHEUM BATTERY	5322 138 10263	
H 1701	BUZZER	PS20-01-0	5322 280 10148
L 0700	COIL	100MC 3B	5322 158 10052
L 0701	COIL	100MC 3B	5322 158 10052
L 1301	COIL	50MC 3B	5322 158 10052
L 1701	COIL	27µH	4822 158 10551

ANALOG INTEGRATED CIRCUITS

A 1201	INTEGR.CIRCUIT	OQ 0302A	5322 209 11657
N 1202	INTEGR.CIRCUIT	LT1057CN8 L.T	5322 209 73385
N 1301	INTEGR.CIRCUIT	OP-07CZ PMI	5322 209 83268
N 1501	INTEGR.CIRCUIT	AD713JN NSC	9322 006 83682
N 1502	INTEGR.CIRCUIT	LM311N NSC	5322 209 85503
N 1601	INTEGR.CIRCUIT	LM78L05ACZ N.S	5322 209 80903
N 1602	INTEGR.CIRCUIT	LM79L05ACZ NSC	5322 209 86434
N 1603	INTEGR.CIRCUIT	LM358N NSC	4822 209 70672

RESISTORS

R 1100	RES.NETWERK	OM551	5322 209 72563
R 1101	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1102	RES.METAL FILM	MRS25 1% 24E9	4822 050 22499
R 1103	RES.METAL FILM	MRS25 1% 61K9	4822 050 26193
R 1200	RES.HI-TENSION	VR25 5% 10M	4822 053 20106
R 1201	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1202	RES.METAL FILM	MRS25 1% 590K	4822 050 25904
R 1203	RES.METAL FILM	MRS25 1% 90K9	4822 050 29093
R 1204	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1205	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1206	RES.METAL FILM	MRS25 1% 90K9	4822 050 29093
R 1207	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1208	RES.METAL FILM	MRS25 1% 178K	4822 050 21784
R 1209	RES.METAL FILM	MRS25 1% 36K5	4822 050 23653
R 1210	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1211	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1212	RES.METAL FILM	1/4W 0.1% 8K76	5322 116 52117
R 1213	RES.METAL FILM	MRS25 1% 1K15	4822 050 21152
R 1214	RES.HI-TENSION	VR25 5% 8M2	4822 053 20825
R 1215	RES.METAL FILM	MRS25 1% 30E1	4822 050 23019
R 1216	RES.METAL FILM	1/4W 0.1% 2K26	5322 116 80649
R 1217	RES.METAL FILM	1/4W 0.1% 16K9	5322 116 52116
R 1218	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1219	RES.METAL FILM	MRS25 1% 5K11	4822 050 25112
R 1220	RES.METAL FILM	MRS25 1% 1M	4822 050 21005

R 1221	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1222	RES.METAL FILM	MRS25 1% 4K87	4822 050 24872
R 1223	RES.METAL FILM	MRS25 1% 20E5	4822 050 22059
R 1224	RES.METAL FILM	MRS25 1% 20E5	4822 050 22059
R 1225	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1226	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1227	RES.METAL FILM	MRS25 1% 332K	4822 050 23324
R 1228	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1300	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1301	RES.P.T.C.	245V 750E-1K5	5322 116 44006
R 1302	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1303	RES.METAL FILM	MRS25 1% 750E	4822 050 27501
R 1304	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1305	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1306	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1308	RES.P.T.C.	265V 20% 100E	4822 116 40006
R 1309	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1310	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1311	POTM.CERMET	OMP10 20% 100K	5322 101 10508
R 1312	RES.HI-TENSION	VR25 5% 10M	4822 053 20106
R 1313	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1314	RES.METAL FILM	MRS25 1% 12K1	4822 050 21213
R 1315	RES.METAL FILM	MRS25 1% 40K2	4822 050 24023
R 1316	POTM.CERMET	OMP10 20% 100K	5322 101 10508
R 1317	RES.HI-TENSION	VR25 5% 10M	4822 053 20106
R 1318	RES.METAL FILM	MRS25 1% 681E	4822 050 26811
R 1319	RES.METAL FILM	MRS25 1% 59K	4822 050 25903
R 1320	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 1321	RES.METAL FILM	MRS25 1% 464K	4822 050 24644
R 1322	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 1323	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1324	RES.METAL FILM	MRS25 1% 90K9	4822 0mx 29093
R 1329	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1330	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1331	RES.P.T.C.	S233	5322 116 40192
R 1332	RES.METAL FILM	MRS25 1% 20K5	4822 050 22053
R 1333	RES.METAL FILM	MRS25 1% 20K5	4822 050 22053
R 1334	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1337	RES.	2R00 1% 1W	5322 116 82983
R 1401	RES.HI-TENSION	VR25 5% 10M	4822 053 20106
R 1402	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1403	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1404	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1405	RES.METAL FILM	MRS25 1% 2K26	4822 050 22262
R 1407	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1409	RES.METAL FILM	MRS25 1% 3K01	4822 050 23012
R 1410	RES.METAL FILM	MRS25 1% 7K5	4822 050 27502
R 1411	RES.METAL FILM	MRS25 1% 15K4	4822 050 21543
R 1412	RES.METAL FILM	MRS25 1% 365E	4822 050 23651

R 1413	RES.METAL FILM	MRS25 1% 487E	4822 050 24871
R 1414	RES.METAL FILM	MRS25 1% 10E	4822 050 21009
R 1416	RES.METAL FILM	MRS25 1% 348E	4822 050 23481
R 1417	RES.METAL FILM	MRS25 1% 140E	4822 050 21401
R 1418	RES.METAL FILM	MRS25 1% 1K1	4822 050 21102
R 1419	RES.METAL FILM	MRS25 1% 2K61	4822 050 22612
R 1420	RES.METAL FILM	MRS25 1% 402E	4822 050 24021
R 1421	RES.METAL FILM	MRS25 1% 402E	4822 050 24021
R 1422	RES.METAL FILM	MRS25 1% 10E	4822 050 21009
R 1424	RES.METAL FILM	MRS25 1% 127E	4822 050 21271
R 1425	RES.METAL FILM	MRS25 1% 10E	4822 050 21009
R 1426	RES.METAL FILM	MRS25 1% 909E	4822 050 29091
R 1427	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1428	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1429	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1430	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1431	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1432	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1433	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1434	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1450	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1501	RES.P.T.C.	265V 20% 100E	4822 116 40006
R 1502	RES.METAL FILM	MRS25 1% 162K	4822 050 21624
R 1503	RES.METAL FILM	MRS25 1% 23K7	4822 050 22373
R 1504	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1505	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 1506	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1507	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1508	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1509	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1510	RES.METAL FILM	MRS25 1% 649K	4822 050 26494
R 1511	RES.METAL FILM	MRS25 1% 51K1	4822 050 25113
R 1512	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1513	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1514	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1515	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1516	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1518	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1519	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1520	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1521	RES.METAL FILM	1/4W 0.1% 511E	5322 116 80468
R 1524	RES.METAL FILM	MRS25 1% 205K	4822 050 22054
R 1525	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1526	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1527	RES.METAL FILM	MRS25 1% 1K78	4822 050 21782
R 1528	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1530	RES.METAL FILM	MRS25 1% 1K62	4822 050 21622
R 1531	RES.METAL FILM	MRS25 1% 162K	4822 050 21624
R 1532	RES.HI-TENSION	VR37 5% 16M	4822 053 21166

R 1533	RES.METAL FILM	MRS25 1% 249K	4822 050 22494
R 1534	RES.METAL FILM	MRS25 1% 19K6	4822 050 21963
R 1535	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1536	RES.METAL FILM	MRS25 1% 3K01	4822 050 23012
R 1537	RES.METAL FILM	MRS25 1% 169K	4822 050 21694
R 1538	RES.METAL FILM	MRS25 1% 30K1	4822 050 23013
R 1539	RES.METAL FILM	MRS25 1% 3K83	4822 050 23832
R 1540	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1541	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1542	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1548	RES.METAL FILM	MRS25 1% 365K	4822 050 23654
R 1549	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1550	RES.METAL FILM	MPR24 0.1% 174K	
R 1551	RES.METAL FILM	MPR24 0.1% 174K	
R 1552	RES.METAL FILM	MRS25 1% 5K62	4822 050 25622
R 1553	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1555	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1556	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1557	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1558	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1559	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1560	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1561	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1562	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1563	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1565	RES.METAL FILM	MRS25 1% 2K05	4822 050 22052
R 1566	RES.METAL FILM	MRS25 1% 383K	4822 050 23834
R 1601	RES.METAL FILM	MRS25 1% 90K9	4822 050 29093
R 1602	RES.METAL FILM	MRS25 1% 2K49	4822 050 22492
R 1603	RES.METAL FILM	MRS25 1% 17K8	4822 050 21783
R 1604	RES.METAL FILM	MRS25 1% 1K62	4822 050 21622
R 1605	RES.METAL FILM	MRS25 1% 51E1	4822 050 25119
R 1606	RES.METAL FILM	MRS25 1% 3K65	4822 050 23652
R 1607	RES.METAL FILM	MRS25 1% 1K96	4822 050 21962
R 1608	RES.METAL FILM	MRS25 1% 3K48	4822 050 23482
R 1609	RES.METAL FILM	MRS25 1% 348E	4822 050 23481
R 1611	RES.METAL FILM	MRS25 1% 1K27	4822 050 21272
R 1614	RES.METAL FILM	MRS25 1% 464E	4822 050 24641
R 1615	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1700	RES.METAL FILM	MRS25 1% 2K05	4822 050 22052
R 1704	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1705	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1706	RES.METAL FILM	MRS25 1% 205K	4822 050 22054
R 1707	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1708	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1709	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1710	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1711	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1712	RES.METAL FILM	MRS25 1% 100E	4822 050 21001

R 1713	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1714	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1715	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1716	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1717	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1718	COMBINATION,RC	-105-103 10K	5322 111 90473
R 1719	COMBINATION,RC	-105-103 10K	5322 111 90473
R 1720	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1721	RES.METAL FILM	MRS25 1% 147K	4822 050 21474
R 1722	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1723	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1724	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 1725	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1726	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1727	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1728	RES.METAL FILM	MRS25 1% 22E6	4822 050 22269
R 1729	RES.METAL FILM	MRS25 1% 287E	4822 050 22871
R 1730	RES.METAL FILM	MRS25 1% 3K32	4822 050 23322
R 1731	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1732	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1733	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1734	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1735	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1736	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1737	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1738	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 1739	RES.METAL FILM	MRS25 1% 22K6	4822 050 22263
R 1740	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1741	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1742	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1743	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1744	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1745	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 1746	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1747	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1748	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 1749	RES.METAL FILM	MRS25 1% 5K11	4822 050 25112
R 1750	RES.METAL FILM	MRS25 1% 4K64	4822 050 24642
R 1751	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1752	RES.METAL FILM	MRS25 1% 10E	4822 050 21009
R 1753	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1754	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1755	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1756	RES.METAL FILM	MRS25 1% 332E	4822 050 23321
R 1757	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1758	RES.METAL FILM	MRS25 1% 1K54	4822 050 21542
R 1759	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 1760	RES.METAL FILM	MRS25 1% 825K	4822 050 28254
R 1761	RES.METAL FILM	MRS25 1% 100K	4822 050 21004

R 1762	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 1763	RES.METAL FILM	MRS25 1% 348K	4822 050 23484
R 1780	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 1781	RES.METAL FILM	MRS25 1% 5K11	4822 050 25112

SEMI CONDUCTORS

V 1201	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1202	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1203	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1204	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1205	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1206	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1207	TRANSISTOR,FET	BSV80 PEL	5322 130 34044
V 1208	TRANSISTOR,FET	BSV80 PEL	5322 130 34044
V 1250	DIODE	BAW62 PEL	4822 130 30613
V 1303	TRANSISTOR	BC549C PEL	4822 130 44246
V 1304	TRANSISTOR	BC559B PEL	4822 130 44358
V 1305	TRANSISTOR	BC559B PEL	4822 130 44358
V 1306	TRANSISTOR,FET	BF256B PEL	5322 130 44744
V 1307	TRANSISTOR,FET	BF256B PEL	5322 130 44744
V 1309	TRANSISTOR	BC549C PEL	4822 130 44246
V 1310	TRANSISTOR	BC549C PEL	4822 130 44246
V 1315	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1354	DIODE	BYW56 PEL	5322 130 34973
V 1355	DIODE	BYW56 PEL	5322 130 34973
V 1356	DIODE	BAT8[illegible] PEL	4822 130 31983
V 1357	DIODE	BAT85 PEL	4822 130 31983
V 1370	TRANSISTOR,FET	BSV80 PEL	5322 130 34044
V 1401	TRANSISTOR,FET	BF256B PEL	5322 130 44744
V 1403	TRANSISTOR	BF199 PEL	4822 130 44154
V 1404	TRANSISTOR	BF199 PEL	4822 130 44154
V 1405	TRANSISTOR	BF324 PEL	4822 130 41448
V 1406	TRANSISTOR	BF324 PEL	4822 130 41448
V 1407	TRANSISTOR	BF324 PEL	4822 130 41448
V 1408	TRANSISTOR	BC547B PEL	4822 130 40959
V 1410	TRANSISTOR	BSX20 PEL	4822 130 41705
V 1411	TRANSISTOR	BC549C PEL	4822 130 44246
V 1412	TRANSISTOR	BC559B PEL	4822 130 44358
V 1450	DIODE	BAT85 PEL	4822 130 31983
V 1451	DIODE	BAW62 PEL	4822 130 30613
V 1452	DIODE	BAW62 PEL	4822 130 30613
V 1453	DIODE	BAT85 PEL	4822 130 31983
V 1500	TRANSISTOR	BC549C PEL	4822 130 44246
V 1502	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1503	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1504	TRANSISTOR,FET	BSV80 PEL	5322 130 34044
V 1505	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1507	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1508	TRANSISTOR,FET	BF245A PEL	5322 130 61605

V 1509	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1510	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1511	TRANSISTOR	BST70A PEL	5322 130 42709
V 1512	TRANSISTOR	BC337 PEL	4822 130 40855
V 1513	TRANSISTOR	BC549C PEL	4822 130 44246
V 1514	TRANSISTOR	BC549C PEL	4822 130 44246
V 1515	TRANSISTOR	BC549C PEL	4822 130 44246
V 1516	TRANSISTOR	BC549C PEL	4822 130 44246
V 1517	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1518	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1519	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1520	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1521	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1522	TRANSISTOR	BC549C PEL	4822 130 44246
V 1523	TRANSISTOR,FET	BF245A PEL	5322 130 61605
V 1524	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1525	TRANSISTOR	BC549C PEL	4822 130 44246
V 1526	TRANSISTOR,FET	BF256A PEL	5322 130 44418
V 1527	TRANSISTOR	BC549C PEL	4822 130 44246
V 1550	DIODE	BAX18 PEL	4822 130 34121
V 1551	DIODE	BAX18 PEL	4822 130 34121
V 1552	DIODE,REFERENCE	BZT03-C7V5 PEL	4822 130 31913
V 1555	DIODE,REFERENCE	1N821/HR PEL	5322 130 83423
V 1557	DIODE	BAW62 PEL	4822 130 30613
V 1558	DIODE	BAT85 PEL	4822 130 31983
V 1560	DIODE	BAW62 PEL	4822 130 30613
V 1570	DIODE	BAX18 PEL	4822 130 34121
V 1571	DIODE	BAX18 PEL	4822 130 34121
V 1601	TRANSISTOR	BC549C PEL	4822 130 44246
V 1602	TRANSISTOR	BD139 PEL	4822 130 40823
V 1650	DIODE	BYW56 PEL	5322 130 34973
V 1651	DIODE	BYW56 PEL	5322 130 34973
V 1652	DIODE	BYW56 PEL	5322 130 34973
V 1653	DIODE	BYW56 PEL	5322 130 34973
V 1654	DIODE	BYW56 PEL	5322 130 34973
V 1655	DIODE	BYW56 PEL	5322 130 34973
V 1656	DIODE	BYW56 PEL	5322 130 34973
V 1657	DIODE	BYW56 PEL	5322 130 34973
V 1658	DIODE,REFERENCE	BZX79-B3V3 PEL	5322 130 31504
V 1659	DIODE,REFERENCE	BZX79-B3V3 PEL	5322 130 31504
V 1660	DIODE,REFERENCE	BZX79-B3V3 PEL	5322 130 31504
V 1661	DIODE,REFERENCE	BZX79-B3V3 PEL	5322 130 31504
V 1662	DIODE	BAW62 PEL	4822 130 30613
V 1663	DIODE	BAT85 PEL	4822 130 31983
V 1664	DIODE	BAT85 PEL	4822 130 31983
V 1665	DIODE	BAX18 PEL	4822 130 34121
V 1666	DIODE,REFERENCE	BZX79-B3V3 PEL	5322 130 31504
V 1667	DIODE	BAW62 PEL	4822 130 30613
V 1703	TRANSISTOR	BC549C PEL	4822 130 44246

V 1704	TRANSISTOR	BC327 PEL	4822 130 40854
V 1705	TRANSISTOR	BC337 PEL	4822 130 40855
V 1706	TRANSISTOR	BC327 PEL	4822 130 40854
V 1707	TRANSISTOR	BC337 PEL	4822 130 40855
V 1708	TRANSISTOR	BC327 PEL	4822 130 40854
V 1709	TRANSISTOR	BC549C PEL	4822 130 44246
V 1710	TRANSISTOR	BC549C PEL	4822 130 44246
V 1711	TRANSISTOR	BC549C PEL	4822 130 44246
V 1712	TRANSISTOR	BC549C PEL	4822 130 44246
V 1713	TRANSISTOR	BC549C PEL	4822 130 44246
V 1714	TRANSISTOR	BC549C PEL	4822 130 44246
V 1715	TRANSISTOR	BC549C PEL	4822 130 44246
V 1716	TRANSISTOR	BC559B PEL	4822 130 44358
V 1717	TRANSISTOR	BC549C PEL	4822 130 44246
V 1718	TRANSISTOR	BC549C PEL	4822 130 44246
V 1719	TRANSISTOR	BC559B PEL	4822 130 44358
V 1720	TRANSISTOR	BC327 PEL	4822 130 40854
V 1721	TRANSISTOR	BC559B PEL	4822 130 44358
V 1722	TRANSISTOR	BC549C PEL	4822 130 44246
V 1724	TRANSISTOR	BC549C PEL	4822 130 44246
V 1725	TRANSISTOR	BC559B PEL	4822 130 44358
V 1750	THYRISTOR	BRY39 PEL	5322 130 40482
V 1751	DIODE	BAT85 PEL	4822 130 31983
V 1752	DIODE	BAT85 PEL	4822 130 31983
V 1753	DIODE	BAT85 PEL	4822 130 31983
V 1754	DIODE	BAT85 PEL	4822 130 31983
V 1757	DIODE	BAT85 PEL	4822 130 31983
V 1758	DIODE	BAT85 PEL	4822 130 31983
V 1759	DIODE	BAT85 PEL	4822 130 31983
V 1760	DIODE	BAW62 PEL	4822 130 30613
V 1761	DIODE	BAW62 PEL	4822 130 30613
V 1762	DIODE	BAW62 PEL	4822 130 30613
V 1763	DIODE	BAW62 PEL	4822 130 30613
V 1765	DIODE	BZV86-C1V4 PEL	4822 130 81423
V 1766	DIODE	BZV86-C2V0 PEL	4822 130 81424
V 1768	DIODE	BZV86-C1V4 PEL	4822 130 81423
V 1769	DIODE	BAT85 PEL	4822 130 31983
V 1770	DIODE	BAW62 PEL	4822 130 30613
V 1771	DIODE	BAW62 PEL	4822 130 30613
V 1772	DIODE,REFERENCE	BZX79-C3V9 PEL	4822 130 31981
V 1773	DIODE	BAT85 PEL	4822 130 31983
V 1780	TRANSISTOR	BC547B PEL	4822 130 40959
V 1781	TRANSISTOR	BC557B PEL	4822 130 44568
V 1782	DIODE	BAW62 PEL	4822 130 30613
V 1783	DIODE	BAW62 PEL	4822 130 30613
V 1784	TRANSISTOR	BC557B PEL	4822 130 44568
V 1785	DIODE	BAW62 PEL	4822 130 30613

8.2.2 DISPLAY BOARD, A2000

		DISPLAY PCB	5322 218 61097
CAPACITORS			
C 2101	CAP.CERAMIC	100V 10% 22NF	5322 122 10457
INTEGRATED CIRCUITS			
D 2101	INTEGR.CIRCµIT	PCF8576T PEL	5322 209 11129
D 2201	INTEGR.CIRCµIT	PCF8574P PEL	5322 209 10883
RESISTORS			
R 2101	RES.METAL FILM	MRS25 1% 196K	4822 050 21964
R 2102	RES.METAL FILM	MRS25 1% 3K48	4822 050 23482
R 2103	RES.METAL FILM	MRS25 1% 3K32	4822 050 23322
R 2104	RES.METAL FILM	MRS25 1% 590E	4822 050 25901
R 2105	POTM.TRIMMER	OCP10 20% 220E	4822 100 10019
R 2201	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
SWITCHES			
S 2201	SWITCH	1-P	4822 276 11076
S 2202	SWITCH	1-P	4822 276 11076
S 2203	SWITCH	1-P	4822 276 11076
S 2204	SWITCH	1-P	4822 276 11076
S 2205	SWITCH	1-P	4822 276 11076
S 2206	SWITCH	1-P	4822 276 11076
S 2207	SWITCH	1-P	4822 276 11076
S 2208	SWITCH	1-P	4822 276 11076
S 2209	SWITCH	1-P	4822 276 11076
S 2210	SWITCH	1-P	4822 276 11076
S 2211	SWITCH	1-P	4822 276 11076
S 2212	SWITCH	1-P	4822 276 11076
S 2213	SWITCH	1-P	4822 276 11076
S 2214	SWITCH	1-P	4822 276 11076
S 2215	SWITCH	1-P	4822 276 11076
S 2216	SWITCH	1-P	4822 276 11076
S 2217	SWITCH,PUSHBUT.	1-P	5322 276 11577
S 2218	SWITCH,PUSHBUT.	1-P	5322 276 11577
SEMI CONDUCTORS			
V 2101	DIODE	BZV86-C1V4 PEL	4822 130 81423
V 2102	TRANSISTOR	BC547B PEL	4822 130 40959

8.2.3 BATTERY BOARD

CAPACITORS			
C 0403	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0404	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0405	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0406	CAP.CERAMIC	-20+50% 10NF	4822 122 31414

C 0407	CAP.ELECTROLYT.	16V 20% 4700UF	4822 124 40706
C 0410	CAP.	63V 10% 1UF	5322 121 42114
C 0411	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0412	CAP.ELECTROLYT.	40V -10+50% 10UF	4822 124 20708
C 0413	CAP.ELECTROLYT.	ELCAP 10V 330UF	5322 124 22095
C 0414	CAP.ELECTROLYT.	ELCAP 10V 330UF	5322 124 22095
C 0415	CAP.	63V 10% 1UF	5322 121 42114
C 0416	CAP.CERAMIC	2% 100PF	4822 122 31316
C 0419	CAP.CERAMIC	-20+50% 10NF	4822 122 31414

FUSES

F 0401		THERMAL FUSE	5322 252 20117
F 0402	FUSE	T 5X20 1A	4822 070 31002

ANALOG INTEGRATED CIRCUITS

N 0401	INTEGR.CIRCUIT	LM358N NSC	4822 209 70672
N 0402	INTEGR.CIRCUIT	LM358N NSC	4822 209 70672

RISISTORS

R 0401	RES.METAL FILM	MRS25 1% 46K4	4822 050 24643
R 0402	RES.METAL FILM	MRS25 1% 316E	4822 050 23161
R 0403	RES.METAL FILM	MRS25 1% 1M	4822 050 21005
R 0404	RES.METAL FILM	MRS25 1% 4E87	4822 050 24878
R 0405	RES.METAL FILM	MRS25 1% 4E87	4822 050 24878
R 0406	RES.METAL FILM	MRS25 1% 36K5	4822 050 23653
R 0407	RES.METAL FILM	MRS25 1% 2K26	4822 050 22262
R 0408	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 0409	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 0410	RES.METAL FILM	MRS25 1% 6K49	4822 050 26492
R 0411	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 0412	RES.METAL FILM	MRS25 1% 6K49	4822 050 26492
R 0413	RES.METAL FILM	MRS25 1% 4K87	4822 050 24872
R 0414	POTM.TRIMMER	OMP10 20% 2K2	5322 101 14008
R 0415	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 0416	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 0417	RES.METAL FILM	MRS25 1% 6K49	4822 050 26492
R 0418	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 0419	RES.METAL FILM	MRS25 1% 22K6	4822 050 22263
R 0420	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 0421	RES.METAL FILM	MRS25 1% 4K42	4822 050 24422
R 0422	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 0423	RES.METAL FILM	MRS25 1% 22K6	4822 050 22263
R 0424	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 0425	RES.METAL FILM	MRS25 1% 1K	4822 050 21002
R 0426	RES.METAL FILM	MRS25 1% 2E15	4822 050 22158

TRANSFORMERS

T 0401	MAINS TRANSFORMER	5322 146 10241
T 0402	TRANSFORMER	5322 148 60267

SEMICONDUCTOR

V 0401	DIODE	BYV10-40 PEL	4822 130 32245
V 0402	DIODE	BYV10-40 PEL	4822 130 32245
V 0403	DIODE	BYV10-40 PEL	4822 130 32245
V 0404	DIODE	BYV10-40 PEL	4822 130 32245
V 0405	DIODE	BAW62 PEL	4822 130 30613
V 0406	DIODE,REFERENCE	BZX79-C12 PEL	4822 130 34197
V 0407	DIODE	BAX18 PEL	4822 130 34121
V 0408	DIODE	BAX18 PEL	4822 130 34121
V 0409	DIODE	BAW62 PEL	4822 130 30613
V 0410	DIODE	BAW62 PEL	4822 130 30613
V 0411	DIODE	BAW62 PEL	4822 130 30613
V 0412	DIODE	BAW62 PEL	4822 130 30613
V 0413	DIODE	BAW62 PEL	4822 130 30613
V 0414	DIODE	BAW62 PEL	4822 130 30613
V 0415	DIODE	BAW62 PEL	4822 130 30613
V 0416	DIODE	BAW62 PEL	4822 130 30613
V 0417	DIODE	BAW62 PEL	4822 130 30613
V 0418	DIODE	BAW62 PEL	4822 130 30613
V 0419	TRANSISTOR	BC557B PEL	4822 130 44568
V 0420	TRANSISTOR	BC368 PEL	5322 130 44647
V 0421	TRANSISTOR	BC557B PEL	4822 130 44568
V 0422	TRANSISTOR	BD139 PEL	4822 130 40823
V 0423	TRANSISTOR	BC547B PEL	4822 130 40959
V 0424	TRANSISTOR	BC547B PEL	4822 130 40959
V 0425	TRANSISTOR	BC547B PEL	4822 130 40959
V 0426	TRANSISTOR	BD139 PEL	4822 130 40823
V 0427	TRANSISTOR	BC557B PEL	4822 130 44568
V 0428	DIODE	BYV10-40 PEL	4822 130 32245
V 0429	DIODE	BYV10-40 PEL	4822 130 32245
V 0430	DIODE	BAW62 PEL	4822 130 30613
V 0431	DIODE	BAW62 PEL	4822 130 30613

8.2.4 GALVANIC SEPARATION BOARD, A300

	GALVANIC SEPARATION P.C.B.	5322 218 61098

CAPACITORS

C 0301	CAP.ELECTROLYT.	20%	10UF	5322 124 21731
C 0302	CAP.ELECTROLYT.	20%	10UF	5322 124 21731
C 0303	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 0304	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 0305	CAP.ELECTROLYT.	20%	10UF	5322 124 21731
C 0306	CAP.FOIL	10% 63V	100NF	5322 121 42386
C 0307	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 0309	CAP.CERAMIC	-20+50%	10NF	4822 122 31414
C 0311	CAP.CERAMIC	10% 100V	100NF	5322 122 10468
C 0312	CAP.ELECTROLYT.	20%	10UF	5322 124 21731

C 0313	CAP.ELECTROLYT.	20%		4700UF	4822 124 40706
C 0314	CAP.FOIL	10% 63V		100NF	5322 121 42386
C 0320	CAP.CERAMIC	20% 400V		1NF	5322 122 40364
C 0321	CAP.CERAMIC	20% 400V		1NF	5322 122 40364
C 0322	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 0323	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 0324	CAP.CERAMIC	-20+50%		10NF	4822 122 31414
C 0325	CAP.CERAMIC	-20+50%		10NF	4822 122 31414

OPTO DEVICES

H 0301	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0302	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0303	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0304	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0306	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0307	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0308	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0309	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112
H 0310	TRANSIST,PHOTO	CNX36U PEL			5322 130 91112

ANALOG INTEGRATED CIRCUITS

N 0301	INTEGR.CIRCUIT	LM393N NSC			4822 209 80797
N 0302	INTEGR.CIRCUIT	LM393N NSC			4822 209 80797
N 0303	INTEGR.CIRCUIT	LM393N NSC			4822 209 80797
N 0304	DIODE	ICL7660CPA G.E			4822 130 32961
N 0321	INTEGR.CIRCUIT	LM7805CT N.S			5322 209 86445

RESISTORS

R 0301	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0302	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0303	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0304	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0305	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0306	RES.METAL FILM	MRS25	1%	226E	4822 050 22261
R 0307	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0308	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0309	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0310	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0311	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0312	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0313	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0314	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0315	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0316	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0317	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0318	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0319	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0320	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0321	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0322	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652

R 0323	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0325	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0326	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0327	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0329	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0330	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0331	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0332	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0333	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0334	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0335	RES.METAL FILM	MRS25	1%	2K49	4822 050 22492
R 0336	RES.METAL FILM	MRS25	1%	3K65	4822 050 23652
R 0343	RES.METAL FILM	MRS25	1%	14E7	4822 050 21479
R 0344	RES.METAL FILM	MRS25	1%	10K	4822 050 21003
R 0345	RES.METAL FILM	MRS25	1%	10K	4822 050 21003
R 0346	RES.METAL FILM	MRS25	1%	10K	4822 050 21003
R 0347	RES.METAL FILM	MRS25	1%	10K	4822 050 21003
R 0348	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0349	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0350	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0351	RES.METAL FILM	MRS25	1%	8K25	4822 050 28252
R 0352	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0353	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0354	RES.METAL FILM	MRS25	1%	2K87	4822 050 22872
R 0355	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0356	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0357	RES.METAL FILM	MRS25	1%	2K87	4822 050 22872
R 0358	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0359	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0360	RES.METAL FILM	MRS25	1%	2K87	4822 050 22872
R 0361	RES.METAL FILM	MRS25	1%	287E	4822 050 22871
R 0362	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0363	RES.METAL FILM	MRS25	1%	2K87	4822 050 22872
R 0364	RES.METAL FILM	MRS25	1%	100E	4822 050 21001
R 0365	RES.METAL FILM	MRS25	1%	249E	4822 050 22491
R 0366	RES.METAL FILM	MRS25	1%	301K	4822 050 23014

SEMI CONDUCTORS

V 0301	TRANSISTOR	BC559B PEL	4822 130 44358
V 0302	TRANSISTOR	BC547B PEL	4822 130 40959
V 0303	TRANSISTOR	BC547B PEL	4822 130 40959
V 0304	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0305	TRANSISTOR	BC559B PEL	4822 130 44358
V 0306	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0307	TRANSISTOR	BC559B PEL	4822 130 44358
V 0308	TRANSISTOR	BC559B PEL	4822 130 44358
V 0309	TRANSISTOR	BC547B PEL	4822 130 40959
V 0310	TRANSISTOR	BC547B PEL	4822 130 40959
V 0311	TRANSISTOR	BC559B PEL	4822 130 44358

V 0312	TRANSISTOR	BC547B PEL	4822 130 40959
V 0313	TRANSISTOR	BC547B PEL	4822 130 40959
V 0314	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0316	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0318	TRANSISTOR	BC559B PEL	4822 130 44358
V 0319	TRANSISTOR	BC547B PEL	4822 130 40959
V 0320	TRANSISTOR	BC547B PEL	4822 130 40959
V 0321	DIODE	BAT85 PEL	4822 130 31983
V 0322	DIODE	BYV27-150 PEL	4822 130 31628
V 0323	DIODE	BYV27-150 PEL	4822 130 31628
V 0324	DIODE	BYV27-150 PEL	4822 130 31628
V 0325	DIODE	BYV27-150 PEL	4822 130 31628
V 0330	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0331	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0332	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0333	TRANSISTOR	BSX20 PEL	4822 130 41705
V 0334	TRANSISTOR	BC547B PEL	4822 130 40959

8.2.5 RS232C/V24 INTERFACE BOARD

CAPACITORS

C 1001	CAP.CERAMIC	10NF -20+50% 100 V	4822 122 31414
C 1002	CAP.ELECTROLYTE.	100NF 10% 63 V	5322 124 21959
C 1003	CAP.CERAMIC	10PF 2% 100 V	4822 122 32185
C 1004	CAP.CERAMIC	10PF 2% 100 V	4822 122 32185
C 1005	CAP.SOLID ALU	22UF 20% 6.3 V	4822 124 20943
C 1007	CAP.CERAMIC	10NF -20+50% 100 V	4822 122 31414
C 1008	CAP.HI-TENSION	15UF 20% 10 V	5322 124 10665
C 1009	CAP.HI-TENSION	15UF 20% 10 V	5322 124 10665
C 1010	CAP.HI-TENSION	15UF 20% 10 V	5322 124 10665
C 1011	CAP.HI-TENSION	15UF 20% 10 V	5322 124 10665
C 1012	CAP.HI-TENSION	15UF 20% 10 V	5322 124 10665
C 1013	CAP.SOLID ALU	6.8UF 20% 16 V	5322 124 21763
C 1014	CAP.CERAMIC	10NF -20+50% 100 V	4822 122 31414
C 1015	CAP.CERAMIC	10NF -20+50% 100 V	4822 122 31414
C 1016	CAP.CERAMIC	10NF -20+50% 100 V	4822 122 31414

INTEGRATED CIRCUITS

D 1001	µ-PROCESSOR	PCF84C41AP/089	5322 209 52236
D 1002	DUART	SCC2692AC1N28	5322 209 61496
D 1003	INTEGR.CIRCUIT	DS14C88J	5322 209 11659
D 1004	INTEGR.CIRCUIT	DS14C89AJ	5322 209 11661

RESISTORS

R 1001	COMBINATION,RC	RES.NETW.10K	5322 111 90473
R 1002	RES.METAL FILM	100E 1%	4822 050 21001
R 1003	RES.METAL FILM	100E 1%	4822 050 21001
R 1004	RES.METAL FILM	100K 1%	4822 050 21004
R 1005	RES.METAL FILM	1M 1%	4822 050 21005
R 1006	RES.METAL FILM	5K9 1%	4822 050 25902
R 1007	RES.METAL FILM	215E 1%	4822 050 22151

R 1008	RES.METAL FILM	5K9 1%	4822 050 25902
R 1009	RES.METAL FILM	196E 1%	4822 050 21961
R 1010	RES.METAL FILM	1M 1%	4822 050 21005

SEMI CONDUCTORS

V 1001	DIODE	BAW62	4822 130 30613
V 1002	DIODE	BAW62	4822 130 30613
V 1003	DIODE	BAW62	4822 130 30613
V 1004	DIODE	BAW62	4822 130 30613
V 1005	DIODE	BAW62	4822 130 30613
V 1006	DIODE	BAW62	4822 130 30613
V 1007	DIODE	BAW62	4822 130 30613
V 1009	DIODE	BAW62	4822 130 30613
V 1010	DIODE	BAW62	4822 130 30613
V 1011	DIODE	BAW62	4822 130 30613
V 1012	DIODE	BAW62	4822 130 30613
V 1013	DIODE	BAW62	4822 130 30613
V 1014	DIODE	BAW62	4822 130 30613
V 1015	TRANSISTOR	BC549C	4822 130 44246
V 1016	DIODE	BAW62	4822 130 30613
V 1019	DIODE,REFERENCE	BZX79-C6V2	4822 130 34167
V 1020	TRANSISTOR	BC559B	4822 130 44358
V 1021	TRANSISTOR	BC337	4822 130 40855
V 1022	DIODE	BAX12	5322 130 34605
V 1023	DIODE,REFERENCE	BZX79-C11	4822 130 34488
V 1024	TRANSISTOR	BC549C	4822 130 44246
V 1025	TRANSISTOR	BC327	4822 130 40854
V 1026	DIODE	BAX12	5322 130 34605

MISCELLANEOUS

G 1001	CRYSTAL	CRYSTAL 3686.4KHZ	5322 242 70764
T 1001	COIL	TRANSFORMER	5322 138 54250
T 1002	COIL	TRANSFORMER	5322 138 54250
S 1001	SWITCH.SLIDE	DIL SWITCH	5322 127 00208
X 1001	CONNECTOR	CONNECTOR 10P	5322 265 51188
X 1002	CONNECTOR	CONNECTOR 25P	5322 267 60192
	SOCKET.IC	IC SOCKET 28P	5322 255 44047

8.2.6 IEEE INTERFACE BOARD

		IEEE INTERFACE P.C.B.	5322 218 61099
C 0601	CAP.SOLID ALU.	20% 22UF	4822 124 20989
C 0602	CAP.	10% 100NF 63V	5322 121 42386
C 0603	CAP.SOLID ALU.	20% 22UF	4822 124 20989
C 0604	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0605	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0606	CAP.CERAMIC	-20+50% 10NF	4822 122 31414
C 0607	CAP.SOLID ALU.	20% 22UF	4822 124 20989
C 0608	CAP.CERAMIC	0.25PF 5.6PF	5322 122 32163
C 0609	CAP.CERAMIC	0.25PF 5.6PF	5322 122 32163

IGITAL INTEGRATED CIRCUITS

D 0601	INTEGR.CIRCUIT	PCF 84C41AP/089	5322 209 52236
D 0602	INTEGR.CIRCUIT	DS75161AN	4822 209 63506
D 0603	INTEGR.CIRCUIT	DS75160AN	4822 209 63507
D 0604	INTEGR.CIRCUIT	HEF40245BP PEL	5322 209 10867
D 0605	INTEGR.CIRCUIT	N74LS02N PEL	5322 209 81624
D 0606	INTEGR.CIRCUIT	N74LS05N PEL	5322 209 84994

CRYSTAL

G 0601	CRYSTAL	6.0MHZ PEL	4822 242 70392

RISISTORS

R 0601	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 0602	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 0603	RES.METAL FILM	MRS25 1% 100E	4822 050 21001
R 0604	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 0605	RES.METAL FILM	MRS25 1% 100K	4822 050 21004
R 0607	RES.METAL FILM	MRS25 1% 2K74	4822 050 22742
R 0608	RES.METAL FILM	MRS25 1% 4K64	4822 050 24642
R 0609	RES.METAL FILM	MRS25 1% 8K66	4822 050 28662
R 0610	RES.METAL FILM	MRS25 1% 10K	4822 050 21003
R 0612	RES.METAL FILM	MRS25 1% 10K	4822 050 21003

SEMI CONDUCTORS

V 0606	DIODE	BAT85 PEL	4822 130 31983

8.2.7 ANALOG OUTPUT BOARD

CAPACITORS

C 1001	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1002	CAP.SOLID ALU.	25V	20%	1µF	4822 124 20944
C 1003	CAP.CERAMIC	100V	2%	33PF	5322 122 32072
C 1004	CAP.CERAMIC	100V	2%	33PF	5322 122 32072
C 1005	CAP.SOLID ALU.	6.3V	20%	22µF	4822 124 20989
C 1006	CAP.SOLID ALU.	6.3V	20%	22µF	4822 124 20989
C 1007	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1008	CAP.CERAMIC	40V	22NF		4822 122 30103
C 1009	CAP.ELECTROLYTE	25V	1PF		5322 124 21959
C 1010	CAP.SOLID ALU.	40V	680NF		4822 124 21317
C 1011	CAP.CERAMIC	100V	470PF		4822 122 30034
C 1012	CAP.CERAMIC	100V	390PF		4822 122 32121
C 1013	CAP.CERAMIC	40V	22NF		4822 122 30103
C 1014	CAP.CERAMIC	100V	6.8NF		4822 122 31429
C 1015	CAP.CERAMIC	40V	22NF		4822 122 30103
C 1016	CAP.SOLID ALU.	16V	6.8NF		5322 124 21763
C 1017	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1018	ELECTROLYTE	25V	10%	2.2µF	5322 124 22097
C 1019	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1020	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1021	CAP.CERAMIC	100V	10NF		4822 122 31414
C 1022	CAP.CERAMIC	100V	390PF		4822 122 32121

C 1023	CAP.CERAMIC	100V	390PF		4822 122 32121
INTEGRATED CIRCUITS					
D 1001	INTEGR.CIRCUIT	MAB8401B 8BIT MCU			5322 209 11719
D 1002	INTEGR.CIRCUIT	HEF4066BP 4xDIL.SWITCH			5322 209 10357
D 1003	INTEGR.CIRCUIT	HEF4049BP 4xINV.BUFFER			4822 209 10306
D 1004	INTEGR.CIRCUIT	SAM PROM			5322 310 10453
ANALOG INTEGRATED CIRCUITS					
N 1001	INTEGR.CIRCUIT	LM388N 2X OP.AMP.			4822 209 70672
N 1002	INTEGR.CIRCUIT	OQ 0051 AMPLIFIER			5322 209 84444
RESISTORS					
R 1001	RES.METAL FILM	1%	10K		4822 050 21003
R 1002	RES.METAL FILM	1%	100E		4822 050 21001
R 1003	RES.METAL FILM	1%	100E		4822 050 21001
R 1004	RES.METAL FILM	1%	10K		4822 050 21003
R 1005	RES.METAL FILM	1%	100K		4822 050 21004
R 1006	RES.METAL FILM	1%	1M		4822 050 21005
R 1007	RES.METAL FILM	1%	10K		4822 050 21003
R 1008	RES.METAL F8LM	1%	10K		4822 050 21003
R 1009	RES.METAL FILM	1%	10K		4822 050 21003
R 1010	RES.METAL FILM	1%	10K		4822 050 21003
R 1011	RES.METAL FILM	1%	10K		4822 050 21003
R 1012	RES.METAL FILM	1%	121K		4822 050 21214
R 1013	RES.METAL FILM	1%	162K		4822 050 21624
R 1014	RES.METAL F8LM	1%	162K		4822 050 21624
R 1015	RES.METAL FILM	1%	787K		4822 050 27874
R 1016	RES.METAL FILM	1%	464E		4822 050 24641
R 1017	RES.METAL FILM	1%	100E		4822 050 21001
R 1018	RES.METAL FILM	1%	100E		4822 050 21001
R 1019	RES.HI-TENSION	5%	10M		4822 053 20106
R 1020	RES.METAL FILM	1%	15K4		4822 050 21543
R 1021	RES.METAL FILM	1%	100E		4822 050 21001
R 1022	RES.METAL FILM	1%	100E		4822 050 21001
R 1023	RES.METAL FILM	1%	787K		4822 050 27874
R 1024	RES.METAL FILM	1%	15K4		4822 050 21543
R 1025	RES.METAL FILM	1%	14E7		4822 050 21479
R 1026	RES.METAL FILM	1%	4K87		4822 050 24872
R 1027	POTM.TRIMMER	POTM	20%	47K	4822 100 10598
R 1028	POTM.TRIMMER	POTM	20%	1K	4822 100 10254
SEMI CONDUCTORS					
V 1002	DIODE	BAW62			4822 130 30613
V 1003	DIODE	BAW62			4822 130 30613
V 1004	DIODE	BAW62			4822 130 30613
V 1005	TRANSISTOR,FET	BFQ12			5322 130 44248
V 1006	DIODE,REFERENCE	BZX79-C5V6			4822 130 34173
V 1007	DIODE,REFERENCE	BZX79-C5V6			4822 130 34173

MISCELLANEOUS

G 1001	CRYSTAL	6.0MHZ X-TAL	4822 242 70392
S 1001	SWITCH,SLIDE	SWITCHES	5322 277 21196
X 1001	CONNECTOR	DIN PLUG MALE 10-P	5322 265 51188
X 1002	PLUG	INPUT SOCKET RED	5322 267 34057
X 1003	PLUG	INPUT SOCKET BLACK	5322 267 30527

FIG. A

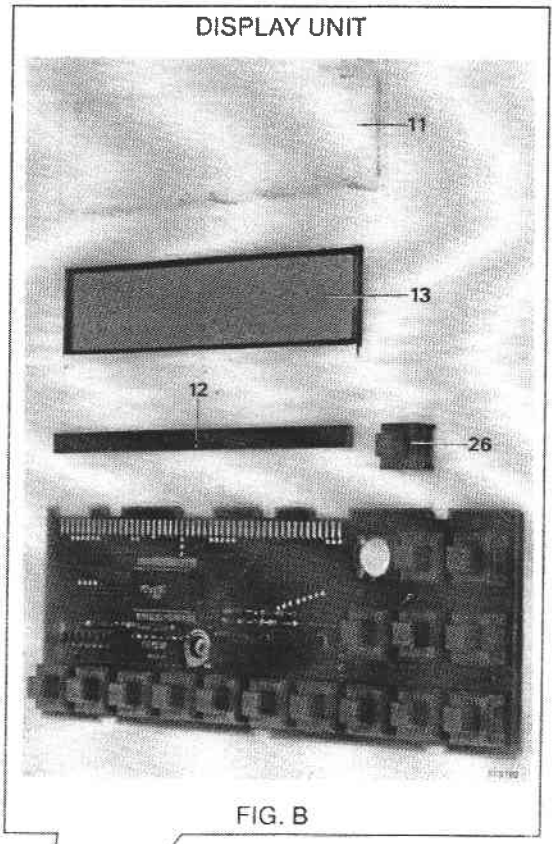


FIG. B

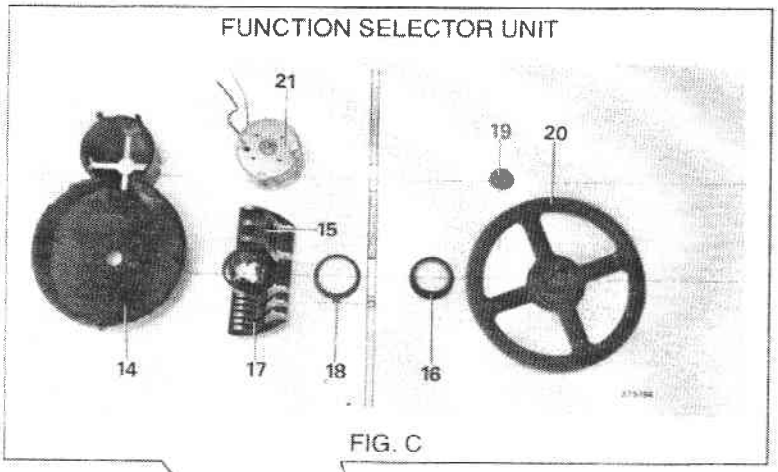


FIG. C

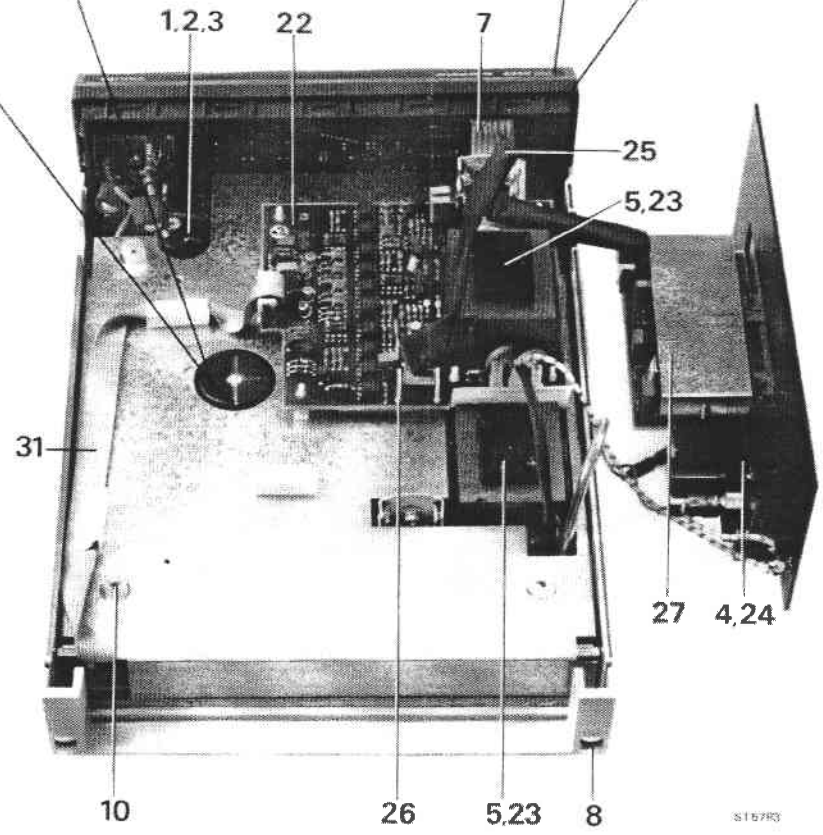
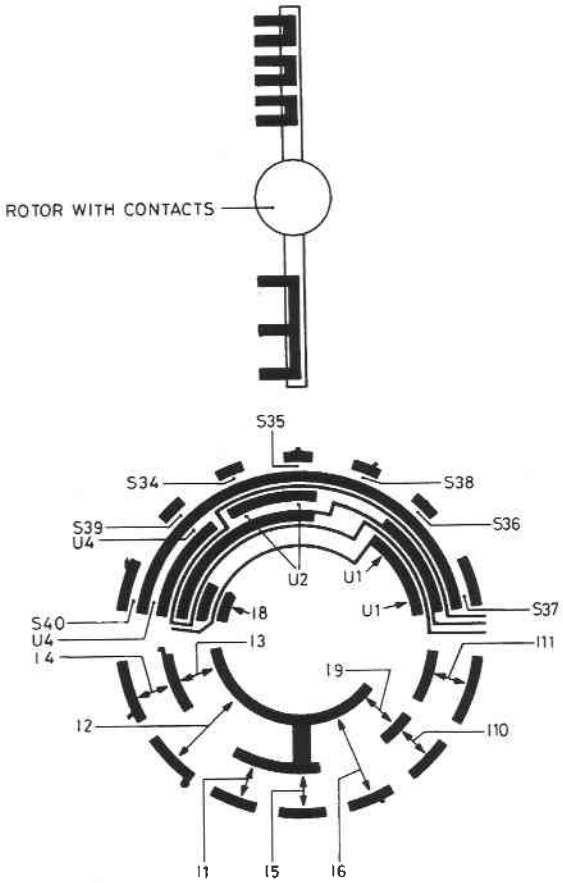


FIG. D

9. CIRCUIT-DIAGRAMS PRINT LAY-OUTS

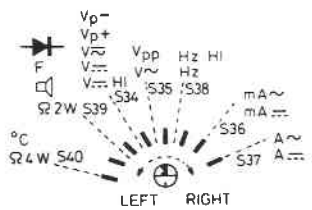
I CONTACTS ARE INPUT SWITCHES
U CONTACTS ARE OUTPUT SWITCHES } FOR THE ANALOG SECTION
S CONTACTS ARE SWITCH POSITION CONTACTS



COMPONENT SIDE
SWITCH LAY-OUT

ST5785
900501

FUNCTION	SWITCH CONTACT		NAME	SWITCH CONTACT POSITION
Hz . Hz HI RES	I1	-	FHRZ	S38
V~ . V_{pp}	I5	U2	FVAC	S35
V⎓ . V⎓ HI RES	I6	U2	FVDC	S34
V≂ . V_p+ . V_p− . S				
Ω 2W . 🔊 . F. ⊣▶	I9 . I10	U4	FRTW	S39
Ω 4W . °C	I8 . I11	U4	FRFW	S40
A~ . A⎓	I3 . I4	U1	FIHI	S37
mA~ . mA⎓	I2	U1	FILO	S36



MOTOR SWITCH POSITION

ST5470
900419

X9 = RAM BAT−
X10 = RAM BAT+
X12 = MOTOR RED
X13 = MOTOR BLUE
X16 = MAINS
X17 = MAINS
X23 = HI BUS

X29 = R4 VPP
X30 = R4 VPP
X31 = R1214 ADC
X32 = R1214 ADC
X35 = A-FUSE
X36 = A-FUSE
X39 = A-SENSE

X40 = MAINS
X43 = R3
X44 = R3