Automatic rms multimeter
PM2528

Operating Manual/Gebrauchsanleitung/Notice d'emploi

9499 470 18101
820602

S&I
Scientific & Industrial Equipment Division

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4. OUTPUT DATA

Measurement data

The numeric representation of the decimal output data is an explicit point scaled representation, loosely called floating point.

Data examples

Char. No.	1	2	3	4	5	6	7	8	9	10	11	12 and EOI Line
Data	+	1	2	•	8	3	4	6	E	+	0	ETX ∧ END
	SP	1	2	8	•	3	4	6	E	+	3	ETX ∧ END

Device status data

DIO bits	8 (128)	7 (64)	6 (32)	5 (16)	4 (8)	3 (4)	2 (2)	1 (1)
	EX	RQS	AL	BSY	EF3	EF2	EF1	EF0

Error codes (AL = 1)

EF3	EF2	EF1	EF0	
0	0	0	1	Overload
0	0	1	0	Crest factor exceeded
0	0	1	1	Overload and crest factor exceeded
0	1	0	0	Illegal digit (Programming error)

Function codes (AL = 0)

Function	EF3	EF2	EF1	EF0
V⎓	0	0	0	0
V ~	0	0	0	1
V≂	0	0	1	0
Ω 2W	0	0	1	1
Ω 4W	0	1	0	0
A⎓	0	1	0	1
A≂	0	1	1	0
°C	0	1	1	1
Vhf	1	0	0	0
Vpeak ^	1	0	0	1
Vpeak v	1	0	1	0
Vpeak ◊	1	0	1	1

Extension bit (EX)

EX = 0 Normal mode
EX = 1 Relative reference mode

IEEE 488
IEC 625

PM2528

9499 470 18511 830330

1. PROGRAMMING THE PM2528

Function	ISO 7 bit code	Description
V⎓	F00	Function
V ~	F01	
V≂	F02	
Ω 2W	F03	
Ω 4W	F04	
A⎓	F05	
A≂	F06	
°C	F07	
Vhf	F08	
Vpeak ^	F09	
Vpeak v	F10	
Vpeak ◊	F11	
Range (see table "range code")	R0	Autoranging
	R1	Lowest range
	:	
	:	
	R8	Highest range
Data ready request	D0	- Data is output immediately after the measurement is terminated, if addressed as talker. - No request for service
	D1	- Data is not output automatically after a measurement is terminated. Output only occurs after the measurement has been ended and the PM2528 is addressed as talker. - Service Request message is sent to indicate the termination of the measurement.

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PROGRAMMING cont.

Function	ISO 7 bit code	Description
High speed mode	S∅ S1	Normal speed mode (integration time 100ms) High speed mode (integration time 20ms)
High resolution mode	H∅ H1	Normal resolution High resolution
Offset mode	 O1O1 O∅O∅	Short circuit input terminals 0 and V Ω of the PM2528. Select V⎓, autoranging, high resolution mode. Offset mode is not indicated at the front of the PM2528 or in the device status data. Input offset voltage is compensated. Offset voltage is no longer compensated. *Note: Function O1O1 is a toggle function. This means that the first time O1O1 is sent offset is compensated. The second time O1O1 is sent or O∅O∅ offset is no longer compensated.*
Relative reference mode	O1 O∅	Relative reference mode: the measured value is stored in the memory of the PM2528 once after a command. No relative reference mode. *NOTE: Relative reference mode is indicated by the offset LED.*
Start mode	T∅ T1 T2	Internal start External start via IEC-bus interface External start via IEC-bus interface or BNC on the rear of the PM2528
Start command	E1 GET	Starts a measurement Group Execute Trigger: starts a measurement

NOTE: In the programming table ∅ = zero
O = letter

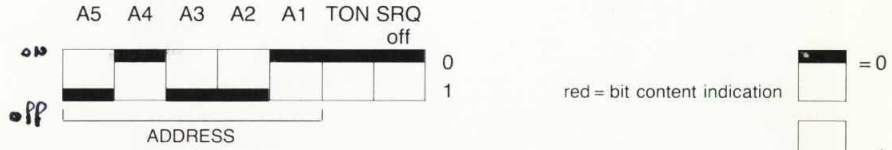
Range code		R∅	R1	R2	R3	R4	R5	R6	R7	R8
Function	Function Code									
V⎓	F∅∅					200mV	2000mV	20V	200V	2000V
V ~	F∅1	AUTO				200mV	2000mV	20V	200V	2000V
V ≂	F∅2	RANGING				200mV	2000mV	20V	200V	2000V
Ω 2W	F∅3		200Ω	2000Ω	20kΩ	200kΩ	2000kΩ	20MΩ	200MΩ	2000MΩ
Ω 4W	F∅4		200Ω	2000Ω	20kΩ	200kΩ	2000kΩ			
A⎓	F∅5			2μA	20μA	200μA	2000μA	20mA	200mA	2000mA
A ≂	F∅6			2μA	20μA	200μA	2000μA	20mA	200mA	2000mA
°C	F∅7									2000°C
Vhf	F∅8					200mV	2000mV			
Vpeak ^	F∅9						2000mV	20V	200V	2000V
Vpeak v	F1∅						2000mV	20V	200V	2000V
Vpeak ◊	F11						2000mV	20V	200V	2000V

2. DELIMITERS

Input delimiters: Not required, all delimiters are allowed

Output delimiter: ETX ∧ END

3. SETTINGS



A5 → A1 = Address 1 or 0

TON = Talk only 0 = OFF, 1 = ON

SRQ off = Service request off 0 = Service Request facility enabled, 1 = Service Request facility disabled

NOTE: The switches are located at the rear of the PM2528

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IMPORTANT

In 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.*

WICHTIG

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

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

IMPORTANT

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

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

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CONTENTS

LIST OF FIGURES

1. INTRODUCTION

The PM2528 is a microcomputer-controlled, digital, automatic rms multimeter. The type of microcomputer used is a 8035, extended with 4K external ROM. The instrument can perform the measurements as listed below.

- direct voltages (V ⎓)
- alternating voltages (V~)
- alternating voltages including direct voltage component (V $\overline{\sim}$)
- direct currents (A ⎓)
- alternating currents including direct current component (A $\overline{\sim}$)
- resistance, in two-wire (Ω 2W) and four-wire (Ω 4W) configuration
- temperature (^{o}C)
- peak voltage measurements (V peak), optional
- high frequency voltage measurements (Vhf), optional

In the functions V~ , V $\overline{\sim}$ and A $\overline{\sim}$ the true rms value is measured.
The PM2528 has a 3½, 4½ or 5½ digit display. The display length depends on the selected function and measuring mode.
Ranges can be selected manually, automatically or remote via the optional IEC-bus interface.
Measurements can be started with an internal, manual or external facility.
External starting is possible via the external start input, via the IEC-bus interface (optional) or via the BCD parallel output (optional).
The optional IEC-bus interface, BCD parallel output and analog output make the PM2528 fully system-compatible.

The measuring capabilities can be extended by using the accessories mentioned in the relevant section of this manual.

The PM2528 is equipped with an internal guard, which is external accessible.
Therefore very low level signals can be measured with high accuracy.

2. TECHNICAL DATA

This instrument has been designed and tested in accordance with IEC publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present Operating Manual contains information and warnings that shall be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

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

Manufacturer	:	N.V. Philips MIG S & I
Typenumber	:	PM2528
Designation	:	Automatic rms multimeter
Measuring quantities	:	Vdc, Vac, Vac + dc, Adc, Aac + dc, Ω 2W, Ω 4W, °C Optional: Vhf, Vpeak

2.1. MEASURING PERFORMANCE

2.1.1. Direct voltage measurements (V ⎓)

Ranges

mV	200 – 2000
V	20 – 200 – 2000

The maximum input voltage is 1000 Vdc.

Measuring modes

Normal Mode	(NM)	4½ digit display
High Resolution Mode	(HRM)	5½ digit display
High Speed Mode	(HSM)	4½ digit display

Measuring mode selection: NM and HRM with switch on the front of the PM2528 or via the optional IEC-bus interface PM9291.
HSM via the optional IEC-bus interface PM9291 only.

Measuring speed (Depending on measured value)
NM : 3.3 to 5.4 measurements/s
HRM : 1.6 to 2.7 measurements/s
HSM : 13 to 18.8 measurements/s

Resolution
NM and HSM : 10μV in range 200mV
HRM : 1μV in range 200mV

Accuracy at reference conditions: ± (0.01% of reading + 0.005% of range)

Temperature coefficient: ± (0.002% of reading + 0.0005% of range)/°C

Input impedance
In ranges 200mV and 2000mV > 1 GΩ//20pF
In other ranges 10 MΩ//20pF
At overload > 180 kΩ//20pF

Offset current at input: < 10pA, can be set to zero on front panel

Temperature coefficient of the offset current: < 1pA/°C

Series Mode Rejection

At NM	> 70dB	at 50 or 60Hz ± 0,1%
	> 50dB	at 50 or 60Hz ± 1 %
At HRM	> 80dB	at 50 or 50Hz ± 0,1%
	> 60dB	at 50 or 60Hz ± 1 %
At HSM	> 60dB	at 50 or 60Hz ± 0,1%
	> 40dB	at 50 or 60Hz ± 1 %

Maximum Series Mode signal: Peak value 180% of range.

Common Mode Rejection Ratio (CMRR) with 1kΩ unbalance and GUARD connected to Common Mode voltage.

At NM	> 140dB	for dc signals
	> 150dB	for ac signals of 50 or 60Hz ± 0,1%
	> 130dB	for ac signals of 50 or 60Hz ± 1 %

At HRM > 140dB for dc signals
> 160dB for ac signals of 50 or 60Hz ± 0,1%
> 140dB for ac signals of 50 or 60Hz ± 1 %
At HSM > 140dB for dc signals
> 140dB for ac signals of 50 or 60Hz ± 0,1%
> 120dB for ac signals of 50 or 60Hz ± 1 %

Maximum Common Mode voltage: 250V rms 400Vpeak between GUARD and earth.
60Vrms 85Vpeak between GUARD and 0

Response time: Excluding ranging:

	asynchronous start	synchronous start
NM	< 0.6 s	< 0.33 s
HRM	< 1.2 s	< 0.65 s
HSM	< 0.15 s	< 0.08 s

Including ranging:

	asynchronous start	synchronous start
NM	< 1.0 s	< 0.93 s
HRM	< 1.2 s	< 1.2 s
HSM	< 0.45 s	< 0.38 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Zero setting: Digital offset voltage compensation via front-panel push-button "OFFSET".
Compensation range approx. 80μ V

Zero point drift: Included in accuracy and temperature coefficient

Maximum input voltages:
Ranges 200mV and 2V : 1000V for 30 seconds
600V continuously
1400V peak
Ranges 20V to 2000V : 1000V continuously
1400 peak
Max. V Hz product : 10^6

2.1.2. Alternating voltage measurements (V~ and V$\overline{\sim}$)

Ranges:

mV	200 – 2000
V	20 – 200 – 2000

The maximum input voltage is 600 Vrms

Measuring function: Alternating voltage excluding direct voltage component (V~).
Alternating voltage including direct voltage component (V$\overline{\sim}$)

Measuring modes: Normal Mode (NM) 3½ digit display
High Resolution Mode (HRM) 4½ digit display

Measuring speed (depending on the measured value): 3.3 to 5.4 measurements/s, both in NM and HRM

Resolution: 10μV in the 200mV range at HRM
100μV in the 200mV range at NM

Frequency range: 30Hz up to 500kHz

Accuracy at reference conditions, valid between 1% and 100% of range

– Function V~

Range	Frequency range	Accuracy
200mV and 2000mV	30Hz – 20kHz	± (0.2% of reading + 0.07% of range)
	20kHz – 100kHz	± (0.4% of reading + 0.07% of range)
20V, 200V and 2000V	30Hz – 20kHz	± (0.1% of reading + 0.05% of range)
	20kHz – 100kHz	± (0.3% of reading + 0.05% of range)
	100kHz – 300kHz	± (1 % of reading + 0.05% of range)
	300kHz – 500kHz	± (5 % of reading + 0.05% of range)

– Function V $\tilde{=}$

AC component: same accuracy as V ~ . Additional for DC component: ± (0.05% of reading + 0.01% of range)

Temperature coefficient: ± (0.01% of reading + 0.01% of range)/°C

Input impedance: 1M Ω// 55pF

Common Mode Rejection Ratio (CMRR, 1k Ω unbalance and GUARD connected to 0)
DC signals : 120dB
AC signals of 50Hz: 80dB; decreasing with 20dB/decade

Maximum direct voltage on V$\tilde{=}$ for no additional error: 25 x range

AC detector: True RMS converter

Maximum crest factor

$$4.5 \times \frac{\text{end of range}}{\text{reading}}$$

e.g. at end of range the maximum crest factor is 4.5
Warning on the display when the crest factor is exceeded: ⊏ in the least significant digit.

Response time

Excluding ranging:

	asynchronous start	synchronous start
NM	0.8 s	0.5 s
HRM	0.7 s	0.7 s

Including ranging:

	asynchronous start	synchronous start
NM	2.5 s	2.1 s
HRM	2.6 s	2.6 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Maximum input voltage: 600 Vrms, 900 Vpeak

Maximum VHz product: 2.10^7

Maximum Common Mode voltage: 60 Vrms or 85 Vpeak between 0 and GUARD
250 Vrms or 400 Vpeak between GUARD and earth.

2.1.3. Direct current measurements (A ⎓)

Ranges

μA	2 – 20 – 200 – 2000
mA	20 – 200 – 2000

Measuring modes

Normal Mode (NM) 4½ digit display
High Resolution Mode (HRM) 5½ digit display
High Speed Mode (HSM) 4½ digit display

Measuring mode selection

NM and HRM with switch on the front of the PM2528 or via the optional IEC-bus interface.
HSM via the optional IEC-bus interface PM9291 only.

Measuring speed (depending on measured value)

NM : 3.3 to 5.4 measurements/s
HRM : 1.6 to 2.7 measurements/s
HSM : 13 to 18.8 measurements/s

Resolution

100pA in the 2μA range at NM and HSM
10pA in the 2μA range at HRM

Accuracy at reference conditions

± (0.1% of reading + 0.02% of range)

Temperature coefficient

± (0.005% of reading + 0.001% of range)/°C

Voltage drop (at end of range)

Range	Voltage drop
2μA	< 0.25mV
20μA	< 2.5 mV
200μA	< 25 mV
2000μA	< 250 mV
20mA	< 250 mV
200mA	< 250 mV
2000mA	< 500 mV

Response time

Excluding ranging

	asynchronous start	synchronous start
NM	< 0.6 s	< 0.33 s
HRM	< 1.2 s	< 0.65 s
HSM	< 0.15 s	< 0.08 s

Including ranging

	asynchronous start	synchronous start
NM	< 1.0 s	< 0.93 s
HRM	< 1.2 s	< 1.2 s
HSM	< 0.45 s	< 0.38 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Series Mode Rejection Ratio

	50 or 60Hz ± 0.1%	50 or 60Hz ± 1%
NM	> 70dB	> 50dB
HRM	> 80dB	> 60dB
HSM	> 60dB	> 40dB

Maximum Series Mode Signal

180% of range (peak value)

Influence of Common Mode Signals

The influence of Common Mode Signals is proportional to the value of the Common Mode Voltage.

	Common Mode Signal	
Range	250Vrms, DC and AC 50 or 60Hz ± 0.1%	250Vrms AC 50 or 60Hz ± 1%
2μ A	< 2 digits at NM <20 digits at HRM	< 20 digits at NM <200 digits at HRM
20μ A to 2000mA	< 1 digit at NM <10 digits at HRM	< 10 digit at NM <100 digits at HRM

Maximum Common Mode voltage

Between 0 and GUARD : 60 Vrms, 85 Vpeak
Between GUARD and earth : 250 Vrms, 400 Vpeak

Protection

Up to 250 Vrms, 350 Vpeak. (fuse will blow)
Ceramic or glass fuse 20 x 5 mm 2.5 A-F acc to IEC 127/1.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of make-shift fuses and the short-circuiting of fuse holders are prohibited.

2.1.4. Alternating current measurements (A ~)

Ranges

μA	2 – 20 – 200 –2000
mA	20 – 200 – 2000

Measuring function
Measuring modes

Alternating current including dc component
Normal Mode (NM) 3½ digit display
High Resolution Mode (HRM) 4½ digit display

Measuring speed (depending on the measured value)

3 to 5.4 measurements/s, both at NM and HRM

Resolution

1nA in the 2μA range at NM
100pA in the 2μA range at HRM

Frequency range

30Hz to 5kHz

Accuracy at reference conditions, (valid between 1% and 100% of range)

± (0.2% of reading + 0.07% of range)

Temperature coefficient

± (0.01% of reading + 0.01% of range)/°C

AC detector

True RMS converter

Maximum allowable crest factor

$$2 \times \frac{\text{end of range}}{\text{reading}}$$

e.g. at end of range the maximum crest factor is 2.
On ranges 20mA, 200mA and 2000mA warning on display when clipping occurs.

Voltage drop (at end of range)

Range	Voltage drop
2μA	0.25mV
20μA	2.5 mV
200μA	25 mV
2000μA	250 mV
20mA	250 mV
200mA	250 mV
2000mA	500 mV

Response time

Excluding ranging:

	asynchronous start	synchronous start
NM	0.8 s	0.5 s
HRM	0.7 s	0.7 s

Including ranging:

	asynchronous start	synchronous start
NM	2.5 s	2.1 s
HRM	2.6 s	2.6 s

Synchronous start means that the input signal and the start command are given simultaneously (e.g. in EXT START mode).

Common Mode voltage influence

The Common Mode voltage influence is proportional to the Common Mode voltage.
For a Common Mode voltage of 250Vrms, DC or AC to 100Hz the influence is:

at NM	5 digits	or less
at HRM	50 digits	or less

Maximum Common Mode voltage

60 Vrms, 85 Vpeak between O and GUARD
250 Vrms, 400 Vpeak between GUARD and earth

Protection

Up to 250 Vrms, 350 Vpeak. (fuse will blow)
Ceramic of glass fuse 20 x 5 mm 2.5 A-F acc. to IEC 127/1.
Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of make-shift fuses and the short-circuiting of fuse holders are prohibited.

2.1.5. Resistance measurements (Ω2W and Ω4W)

Ranges

Ω2W

Ω	200 – 2000
kΩ	20 – 200 – 2000
MΩ	20 – 200 – 2000

Ω4W

Ω	200 – 2000
kΩ	20 – 200 – 2000

Measuring function

Two-wire (Ω2W) configuration via 0 and VΩterminal
Four-wire (Ω4W) configuration via PROBE terminal and with the 4-wire test lead.

Measuring modes

Mode	Range	Display
NM	to 200MΩ	4½ digit
	200MΩ and 2000MΩ	3½ digit
HRM	to 200MΩ	5½ digit
	200MΩ and 2000MΩ	4½ digit
HSM	to 200MΩ	4½ digit
	200MΩ and 2000MΩ	3½ digit

Measuring mode selection

NM and HRM with switch on the front of the PM2528
HSM via the optional IEC-bus interface PM9291 only.

Measuring speed (depending on measured value)

NM ; 3.3 to 5.5 measurements/s
HRM ; 1.6 to 2.7 measurements/s
HSM ; 13 to 18.8 measurements/s

Resolution

NM and HSM ; 10m Ω in range 200 Ω
HRM ; 1m Ω in range 200 Ω

Accuracy

Range	Accuracy
200 Ω to 200k Ω	± (0.03% of reading + 0.005% of range)
2M Ω to 20M Ω	± (0.1% of reading + 0.005% of range)
200M Ω	± (0.2% of reading + 0.05% of range)
2000M Ω	± (1% of reading + 0.05% of range)

Temperature coefficient

Range	Accuracy
200 Ω to 200k Ω	± 0.005% of reading/°C
2M Ω to 20M Ω	± 0.01% of reading/°C
200M Ω	± 0.02% of reading/°C
2000M Ω	± 0.1 % of reading/°C

Measuring current

Range	200 Ω	2000 Ω	20k Ω	200k Ω
Current	10mA	1mA	100μA	10μA
Range	2000k Ω	20M Ω	200M Ω	2000M Ω
Current	1μA	100nA	10nA	1nA

Maximum lead resistance on Ω4W configuration

10 Ω

Maximum voltage at input terminals (open input)

Ranges 200 Ω to 200k Ω : < 13 V
Ranges 2000k Ω to 2000M Ω: < 4.5 V

Semiconductor testing

Vforward < 2.4V

Polarity input sockets

V Ω negative
0 positive

Response time (max.)

Excluding ranging:

		Start	
Range	Mode	Asynch.	Synch.
200 Ω to 2000k Ω	NM	0.6 s	0.31 s
	HRM	1.2 s	0.61 s
	HSM	0.15 s	0.08 s
20M Ω	NM	0.6 s	0.56 s
	HRM	1.4 s	0.86 s
	HSM	0.35 s	0.34 s
200M Ω	NM	2 s	1.9 s
	HRM	2.3 s	2.2 s
	HSM	1.8 s	1.7 s
2000M Ω	NM	20 s	20 s
	HRM	20 s	20 s
	HSM	20 s	20 s

Response time (max.)

Including ranging:

		Start	
Range	Mode	Asynch.	Synch.
200 Ω to 2000k Ω	NM	1 s	0.91 s
	HRM	1.2 s	1.2 s
	HSM	0.45 s	0.38 s
20M Ω	NM	1.4 s	1.2 s
	HRM	1.7 s	1.5 s
	HSM	0.72 s	0.71 s
200M Ω	NM	2.7 s	2.6 s
	HRM	3 s	2.9 s
	HSM	2.5 s	2.4 s
2000MΩ	NM	22 s	22 s
	HRM	22 s	22 s
	HSM	22 s	22 s

NOTE: The response time in the 200M Ω and the 2000M Ω is automatically adapted to the measured resistance value.
In the EXT and MAN START mode new output values are represented after the response time.
The times mentioned above are valid at end of range. For lower resistance values the response time is shorter.

Max. Common Mode voltage

Ω2W : 60Vrms , 85Vpeak between 0 and GUARD
250Vrms , 400Vpeak between GUARD and earth
Ω4W : 30Vrms , 42Vpeak between 0 and earth
The GUARD must be connected to 0 at Ω 4W

Input protected up to

Ω2W : 250Vrms , 350Vpeak
Ω4W : 30Vrms , 42Vpeak

2.1.6. Temperature measurements (^{o}C)

Range	-220^{o}C to $+850^{o}$C
Measuring mode	Normal Mode (NM) : 3½ digit display High Resolution Mode (HRM) : 4½ digit display
Input terminals	8-pole DIN socket
Measuring principle	4-wire resistance measurement
Probe type to be used exclusively	Pt-100, acc. to DIN 43760 e.g. PM9249
Resolution	NM : 1 ^{o}C HRM : 0.1^{o}C
Measuring current	1mA
Accuracy (excluding probe)	-220^{o}C up to -100^{o}C: ± (1% of reading + 0.2^{o}C) -100^{o}C up to $+850^{o}$C: ± (0.3% of reading + 0.2^{o}C)
Linearisation	Probe characteristic is linearised within limits stated in DIN43760.
Temperature coefficient	± (0.01% of reading + 0.003% of range)/^{o}C
Response time (excluding probe)	0.5 s to 2.5 s (Depending on measured value)
Maximum voltage at the probe tip	Depending on probe type number.
Maximum voltage between 0 and earth	30Vrms, 42Vpeak.

2.1.7. Offset function

Function

- Zero point correction on V ⎓, 200mV range.
  Internal and external offset voltages can be compensated.
  All measurements are corrected.
  The correction range is ± 79 μV.
- Measurements on V ⎓, A ⎓, Ω 2W, Ω 4W and ^{o} C can be given an offset value (relative reference).
  All further measurements will be displayed with respect to this relative reference.

2.1.8. High frequency voltage measurement (Vhf, optional)

Required optional type numbers	HF plug in unit PM9258 HF probe PM9211
Ranges	200mV, 2V. 20V, 200V with attenuator supplied with PM9211.
Measuring mode	Normal mode (NM) : 3½ digit display High Resolution Mode (HRM) : 4½digit display
Measuring speed (depending on measured value)	3 to 5.4 measurements/s
Resolution	NM : 100μV in 200mV range HRM : 10μV in 200mV range
Minimum measurable voltage	5mV
Frequency range	100kHz – 700MHz
Accuracy (between 1% and 100% of range)	± (2.5% of reading + 0.1% of range) for frequency range 100kHz – 3MHz
Response time	Including ranging:

	asynchronous start	synchronous start
NM	< 2.7 s	< 2.1 s
HRM	< 2.7 s	< 2.7 s

Excluding ranging:

	asynchronous start	synchronous start
NM	< 1 s	0.7 s
HRM	< 1.1 s	0.9 s

Synchronous start means that the input signal and the start command are given simultaneously.

For further information refer to the specification of the PM9211, section 3.4.2. on page 26.

2.1.9. Peak voltage measurements (Vpeak, optional)

Ranges

mV	2000
V	20 – 200 – 2000

Max. input voltage: 600Vrms or 900V peak

Measuring modes: Normal Mode (NM) 3½ digit display; High Resolution Mode (HRM) 4½ digit display

Measuring functions:
Vpeak maximum : V ^ , highest value (DC-coupled)
Vpeak minimum : V v , lowest value (DC-coupled)
Vpeak-to-peak : V ^v , peak-to-peak value (AC-coupled)

Measuring function selection: With switch at the front of the PM2528
1 x press = V ^
2 x press = V v
3 x press = V ^v

Required optional type numbers: Peak voltage plug-in unit PM9259

Measuring speed at internal start:
V ^ and V v : 3.3 to 4 measurements/s
V ^v : 1.6 to 2 measurements/s

Resolution: 100µV in the 2000mV range at HRM
1mV in the 2000mV range at NM

Accuracy at reference conditions: Periodical signals:

DC	± (0.2% of reading + 0.2% of range)
10 Hz - 10kHz	± (0.5% of reading + 0.2% of range)
10kHz - 100kHz	± (1% of reading + 0.2% of range)

Non-periodical signals:
± (1% of reading + 0.2% of range)
See also section 6.6.1 on page 54.

Temperature coefficient: ± (0.02% of reading + 0.01% of range) /° C

Input impedance: 1MΩ/55pF

Common Mode Rejection Ratio (1kΩ unbalance and GUARD connected to 0): 120 dB for DC signals
80 dB for AC signals up to 50Hz, decreasing with 20 dB per decade

Maximum Common Mode Voltage: 60Vrms, 85Vpeak between 0 and GUARD
250Vrms, 400Vpeak between GUARD and earth.

Frequency range:
V ^ and V v : 0 - 100kHz (DC - coupled)
V ^v :10Hz - 100kHz (AC - coupled)

Maximum VHz product: 2.10^7

NOTE: The meaning of the START modes in the Vpeak functions differ from those in the other functions. Refer to section 6.6.1. on page 54.

2.2. TIME SPECIFICATION

Measuring speed

Normal Mode (NM); 3.3 to 5.4 measurements/s
High Resolution Mode (HRM); 1.6 to 2.7 measurements/s
High Speed Mode (HSM); 13 to 18 measurements/s
(The measuring speed depends on the measured value)

Input settling time

Depending on selected function and measuring speed; automatically selected.

Measuring time
Sampling time

Depending on selected function and measuring speed.

	50Hz version	60 Hz version
NM	1 x 100ms	1 x 83 1/3ms
HRM	2 x 100ms	2 x 83 1/3ms
HSM	1 x 20ms	1 x 16 2/3ms

Response time

Depending on selected function.

Range response time

Depending on selected function.

Recovery time from overload

Function	recovery time	overload
V ⎓	< 300ms < 2 s	to 200V to 1000V
V ~ , V ⎓~	< 1 s < 3 s	to 200V to 600V
A ⎓	< 300ms	to 2A
A ⎓~	< 1 s	to 2A

2.3. MAINS SUPPLY

Mains supply conditions

acc. to IEC 359 – group 2.

2.3.1. Mains supply voltage

Reference value
Rated range of use

220 V ± 1%
220 V ± 10%

NOTE: The instrument can be adapted to nominal supply voltages of 110V, 120V, 240V.
Refer to section 5.1.3. on page 41.

2.3.2. Mains supply frequency

Reference value
Rated range of use

50Hz ± 1%
50Hz ± 1%

NOTES: The instrument can be adapted to a nominal mains frequency of 60Hz.
Refer to section 5.1.3. on page 41.

2.3.3. Mains supply interruptions

Interruptions

< 30 ms : no influence
between 30ms and 500ms : instrument may either restart or continue.
> 500ms: instrument will restart. Conditions are identical to the situation after switching on.

2.3.4. Radio interference

(conducted)	K-curve according to VDE0875/6.77 and DIN57875.

2.3.5. Power consumption

30VA.

2.4. MISCELLANEOUS DATA

2.4.1. Converter characteristics (ADC)

Type of conversion	Linear
Operating principle	Integrating ADC
Basic mode of operation	– Repetitively triggered in the internal start mode. A new measurement is started automatically after completing the previous one. – Manually triggered via pushbutton "MAN" at the front. – External triggered. A measurement is started via the rear input "EXT START" (BNC) or via the options PM9291 or PM9292.
Selection of basic mode of operation	With switches at the front of the PM2528.
Range selection	Automatic in the AUTO RANGING mode: UP ranging at 110% of range DOWN ranging at 10% of range Manual with UP and DOWN switches at the front of the PM2528.
Polarity setting	Automatic in the functions V ⎓ , A ⎓, V peak, ^{o}C and OFFSET.

2.4.2. Visual representation of measuring results (display)

Number of digits	5½, 4½, 3½, depending on selected function, range and mode.
Number of representation units	2,400 24,000 240,000 } depending on function, range and mode
Means of representing:	
– output value	6 x 7 segment LED display, 11m, red
– polarity	Automatic indication of + or –.
– decimal point	Automatic indication, depending on range.
– function	By a LED in the function switch. On display ^ , and ˅ for V peak .
– unit	mV, V, Ω , kΩ , MΩ , µA, mA, ^{o}C, on the display
– overload	Display indicates "OL".
– excessive crest factor	⌐ in least significant digit; measured value remains on display.
Data hold	Possible via START MAN switch or by using Data-Hold probe PM9263.
Range hold	Possible via RANGING (AUTO) switch.

2.4.3. Electrical representation of measuring results

Digital output (optional)

Output system	IEC-Bus interface PM9291 Parallel BCD output PM9292
Output	Galvanically separated from input
Maximum voltage between 0 terminal and output	250Vrms, 350Vpeak

For detailed specifications of the PM9291 and PM9292 refer to section 3.7 (page 31) and section 3.5 (page 28) respectively.

Analog output (optional)

Output system	Analog output PM9254, digital to analog converter
Output	Galvanically separated from the input
Output voltage	0 – 1V
Maximum voltage between 0 terminal and output	250Vrms, 350Vpeak

For detailed specifications of the PM9254 refer to section 3.6 (page 30).

2.4.4. Remote control

Via IEC-bus interface PM9291 (optional)	All functions, ranges and modes can be controlled via the PM9291
Via BCD parallel output PM9292 (optional)	A start command to start a measurement can be given via the PM9292
Via BNC at rear side of PM2528	A start command to start a measurement can be given via the BNC (START EXT) connector

For detailed information on the PM9291 and PM9292 refer to section 3.7 (page 31) and section 3.5 (page 28) respectively.

2.4.5. Warm-up time

Warm-up time	30 minutes to reach specified accuracy 2 hours before calibration

2.4.6. Calibration

Recalibration interval	180 days

2.4.7. Input terminal arrangement

Number of input terminals	Four x 4 mm terminals: GUARD, 0, VΩ and A One x 8-pole DIN socket: PROBE
Input	Asymmetrical, floating, guarded.
Impedance between the input terminals	GUARD - earth ; > 10GΩ // < 1000pF GUARD - 0 ; > 10GΩ // < 1000pF 0 - earth ; > 20GΩ // < 500pF 0 - VΩ } Depending on the selected 0 - A } function and range. Refer to the relevant specification parts.
Maximum voltages between the input terminals	GUARD - earth ; 250Vrms, 350Vpeak GUARD - 0 ; 60Vrms, 85Vpeak 0 - earth ; 250Vrms, 350Vpeak VΩ - earth ; 1000Vrms, 1400Vpeak A - 0 ; 250Vrms, 350Vpeak (fuse will blow) VΩ - 0 ; depending on the selected function and range. Refer to the relevant specification parts.

2.5. ENVIRONMENTAL CONDITIONS (in accordance with IEC359)

2.5.1. Climatic conditions

In accordance with Group 1 of IEC359 with extension of the temperature limits.

Temperature

Reference temperature	+23°C ± 1°C
Rated range of use	0°C ... +50°C
Limit range of operation	0°C ... +55°C
Limit range of storage and transit	−40°C ... +70°C

Humidity

Reference relative humidity	45% ... 75% RH
Rated range of use	20% ... 80% RH
Limit range of use	20% ... 80% RH
Limit range of storage and transit	5% ... 95% RH
Maximum dew-point	25°C

2.5.2. Mechanical conditions

In accordance with Group 2 of IEC359

2.6. SAFETY

Class 1, according to IEC348.

2.7. MECHANICAL

Dimensions	Height 90 mm Width 280 mm Depth 328 mm
Weight	approx. 5.3 kg
Cabinet	Metal housing

3. ACCESSORIES

3.1. ACCESSORIES SUPPLIED WITH THE PM2528 (Fig. 1.)

				Item
– 4-wire test-lead				1
– Measuring lead with test-probes PM9260				2
– Shielded measuring cable				3
– Mains cable				4
– Spare fuses:	2 x	250 mA – T	110/120V mains	5
	2 x	2.5 A – F	current measurements low breaking capacity	5
	2x	2.5 A – F	current measurements high breaking capacity non-transparant fuse link	5
– Operating manual				6

NOTE: The spare fuse for the set mains voltage is situated in the combined mains-socket/fuse-holder.

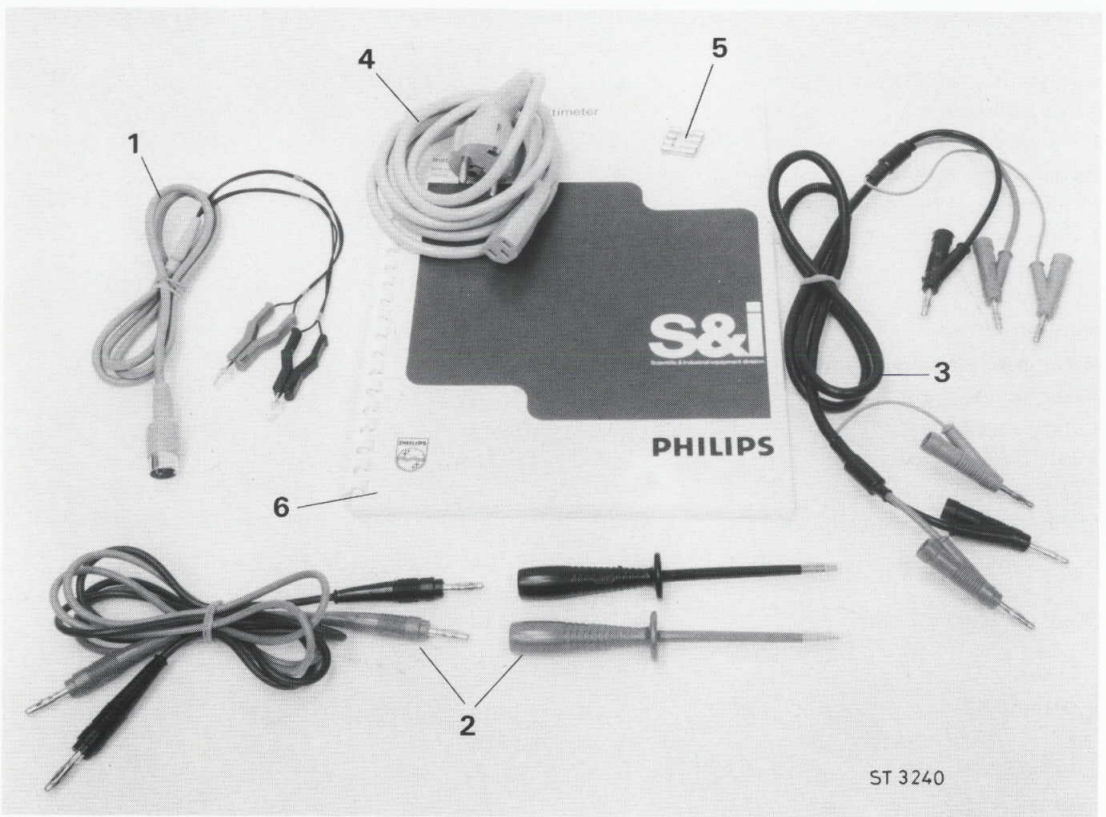


Fig. 1. Accessories supplied with the PM2528.

3.2. SUMMARY OF OPTIONAL ACCESSORIES

Extended measuring capabilities
- Extremely high tension measurement with EHT probe PM9246.
- High current measurements with shunt PM9244.
- High current measurements with current transformer PM9245.
- Data Hold measurements with probe PM9263.
- Temperature measurements with Pt-100 probe PM9249.

Additional measuring functions
- Peak voltage measurements with PM9259.
- High frequency measurements with PM9258 and HF probe PM9211.

Electrical representation
- BCD parallel output PM9292.
- Analog output PM9254.

IEC-bus interface PM9291

Rack-mounting set for 19-inch rack PM9669/03

NOTE: Either the PM9291 or the PM9292 can be installed in the PM2528. A combination of both is not possible.

3.3. EXTENDED MEASURING CAPABILITIES

3.3.1. Extremely High Tension (EHT) probe PM9246

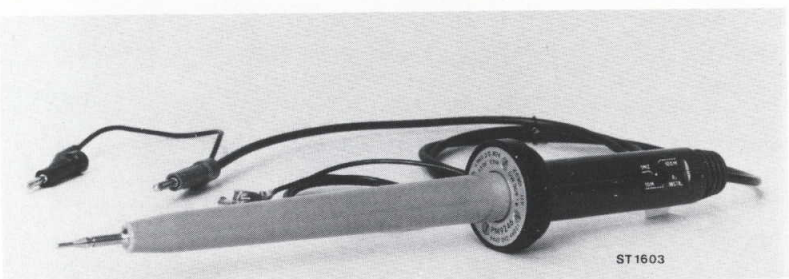


Fig. 2. EHT probe PM9246

The EHT probe PM9246 is suitable for measuring direct voltages up to 30kV. The PM9246 may be used for measuring instruments with an input impedance of 100MΩ, 10MΩ or 1.2MΩ (selectable on the probe).

Maximum voltage	30kV
Attenuaton	1000 x
Input impedance	600MΩ ± 5%
Accuracy	± 3% (Excluding accuracy of PM2528)
Relative humidity	20% ... 80%

NOTE: Pay attention to safe earth connections.

3.3.2. Shunt PM9244

With the PM9244 it is possible to measure direct and alternating currents (max. 1kHz) up to 31.6A.

Current range	10A and 31.6A
Output voltage	100mV and 31.6mV
Accuracy	100mV ± 1% 31.6mV ± 2% (Excluding accuracy of PM2528)
Max. voltage	250V with respect to earth. (PM9244 + PM2528)
Dissipation	Max. 3.16W
Dimensions	Height 55 mm Width 140 mm Depth 65 mm

Fig. 3. Shunt PM9244.

3.3.3. Current transformer PM9245

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

Transfer factor	1000 x (100A = 100mA)
Accuracy	± 3% (excluding accuracy of PM2528)
Frequency range	45Hz to 1kHz
Maximum secondary voltage loss	200mV
Maximum voltage with respect to earth	400V

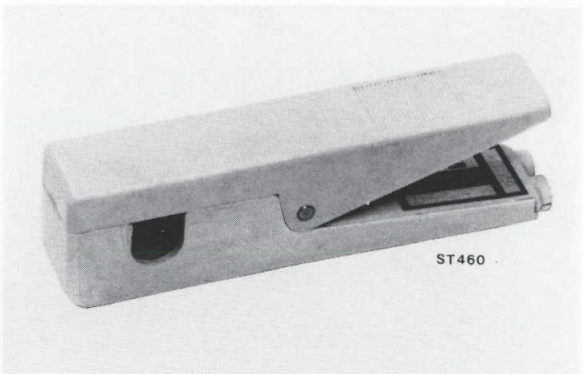


Fig. 4. Current transformer PM9245.

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

3.3.4. Data -hold probe PM9263

The PM9263 is a data-hold probe which can be used in combination with multimeters which have data-hold facilities on the DIN probe input.
A switch ring on the probe is pushed forward to hold the data for display. Depending on the multimeter voltage, resistance and current measurements can be made in combination with the probe.

Max input voltages:

– test voltage	500Vac
– probe tip (V Ω) to common (0)	30Vrms VHz product $< 10^7$
– common (0) to earth	30Vrms

Maximum input current	200mA
Input capacity	300pF
Resistance of V Ω leads and 0 leads	130mΩ
Data hold	by means of slide switch on the probe
Temperature range:	
– rated range of use	–10°C ... +55°C
– limit range of storage and transit	–25°C ... +70°C
Relative humidity	10% ... 80% (non-condensing)

Accessories delivered with the PM9263 (fig. 5):

	item
– Zeroing lead	3
– 6 marking rings (red, white, blue)	4
– probe holder	5
– spring-loaded test clip	6
– wrap pin connector	7
– insulation cap	8
– dual-in-line cap	9
– 10 soldering test points	10
– 2 spare probe tips	11
– instruction manual	

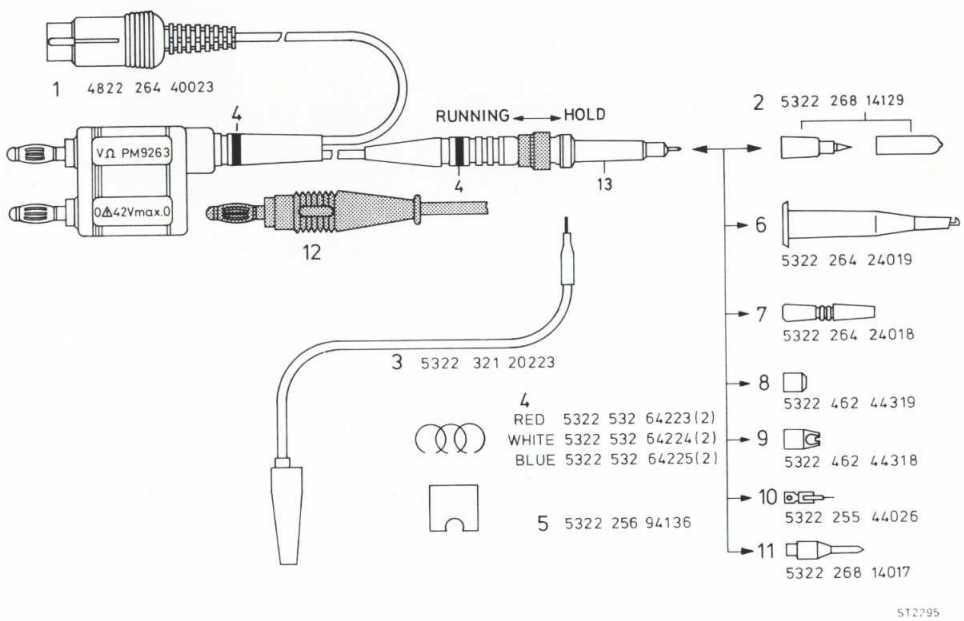


Fig. 5. Data-hold probe PM9263.

3.3.5. Pt-100 temperature probe PM9249

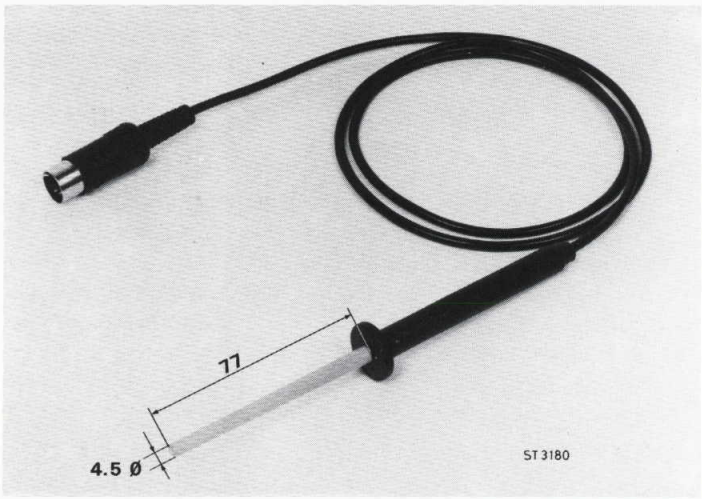


Fig. 6. Pt-100 temperature probe PM9249.

The Pt-100 temperature probe PM9249 is a contact probe suitable for measurements of surface temperatures.

Range	$-60^{o}C$ ... $+200^{o}C$
Accuracy	According to DIN 43760
(excluding PM2528)	$-\ 60^{o}C$ ... $+100^{o}C$ $\pm 0.55^{o}C$
	$+100^{o}C$ ... $+200^{o}C$ $\pm 1\ ^{o}C$

3.4. ADDITIONAL MEASURING FUNCTIONS

3.4.1. Peak voltage measurements with the PM9259

The PM9259 is an optionally available plug-in card which enables the PM2528 to measure the peak or peak-to-peak value of a voltage.

For technical data refer to section 2.1.9 on page 17.

3.4.2. High frequency voltage measurements with the PM9258 and probe PM9211

The PM9258 is an optionally available plug-in card which enables the PM2528 to perform high frequency voltage measurements with the use of the H.F. probe PM9211.

– For specifications of the PM9258 see section 2.1.8. on page 16.

– The H.F. probe PM9211 is suitable for measuring hf voltages from 5mV up to 2V in combination with digital multimeter PM2528. For voltages from 2V up to 200V a capacitive voltage attenuator with a division ratio of 100:1 is provided.

Specification of the PM9211:

Probe	
Voltage range	5mV~ ... 2V~
Frequency range	up to 100MHz (up to 1.2 GHz with 50Ω T-piece)
Accuracy	± 3% of range at 100kHz (23°C)
Input capacity	less than 2pF
Frequency characteristics	< 3dB at 10kHz and 1GHz (see graph, figure 7)
Max. input voltage	30Vrms superimposed on 200Vdc
100:1 Attenuator	
Attenuation	100:1
Voltage range	2V~ ... 200V~
Additional error	< 3dB at 100kHz and 1GHz
Input capacity	less than 2pF
Max. input voltage	200Vrms superimposed on 500Vdc
50 Ohm T-piece	
Impedance	50Ω
Frequency range	100kHz ... 1.2GHz
Standing wave ratio	1.25 at 500MHz with the probe inserted
	1.15 at 1GHz with attenuator inserted

NOTE: Remove the H.F. probe when functions other than Vhf are selected. Refer to section 6.6.2. on page 58.

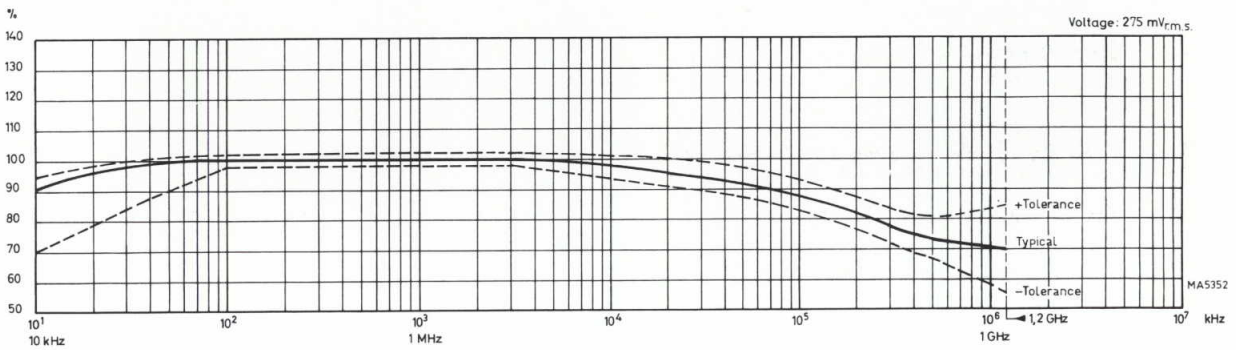


Fig. 7. Frequency characteristic of PM9211 (without attenuator).

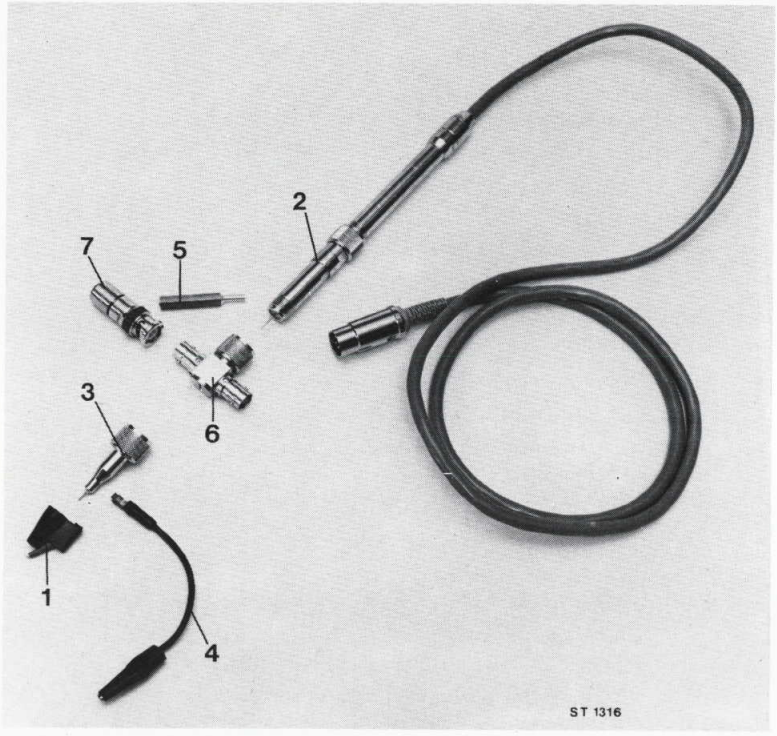


Fig. 8. HF probe PM9211 with accessories.

– Adjustable earthing pin	1
– 100:1 attenuator	2
– Dage adapter	3
– Earth lead	4
– Adjustment key	5
– 50 Ω T-piece	6
– 50 Ω terminating resistance	7

3.5. BCD PARALLEL OUTPUT PM9292

The PM9292 consists of two cards, the galvanic separation card and the interface card. With these cards it is possible to output the measuring results, range code, function code and polarity of the measured signal. Via the output an outgoing start command for a printer is given automatically after each measurement. The PM2528 can be started via the PM9292.

Output system	Word parallel-bit parallel	
Output code	Positive BCD	
	"0" level	: 0V ... +0.4V
	"1" level	: +5V at delivery +15V via external supply and a jumper-setting on the PM9292
	I sink	: 5mA
	R out	: 8.2k Ω

Result

Digit 10^0, 10^1, 10^2, 10^3, 10^4 in BCD

Digit 10^5 :

Binary code 8 4 2 1	Decimal
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
1 0 1 0	10

At 3½ and 4½ digit display 2 or 1 digits are blanked.
The blanked digits represent 1 1 1 1.

Range code

V ⎓, V~ V ≂, Vpeak	A ⎓, A ≂	Ω	HF	°C	Binary code 8 4 2 1	Decimal
		200 Ω			1 0 0 1	9
	2μA	2000 Ω			1 0 0 0	8
	20μA	20k Ω			0 1 1 1	7
200mV *	200μA	200k Ω	200mV		0 1 1 0	6
2000mV	2000μA	2000k Ω	2000mV		0 1 0 1	5
20V	20mA	20M Ω**			0 1 0 0	4
200V	200mA	200M Ω**			0 0 1 1	3
2000V	2000mA	2000M Ω**		−200...+850°C	0 0 1 0	2

* not for Vpeak ** not for Ω 4W

Function code

Function	Binary code 8 4 2 1	Decimal
V≂	0 0 0 0	0
Ω	0 0 0 1	1
A≂	0 0 1 0	2
A⎓	0 0 1 1	3
V~, Vhf	0 1 0 0	4
V⎓	0 1 0 1	5
°C	0 1 1 0	6
Vpeak	0 1 1 1	7

Polarity indication

Polarity	Binary code 8 4 2 1	Decimal
+	1 0 1 1	11
−	1 1 0 1	13
none	1 1 1 1	15

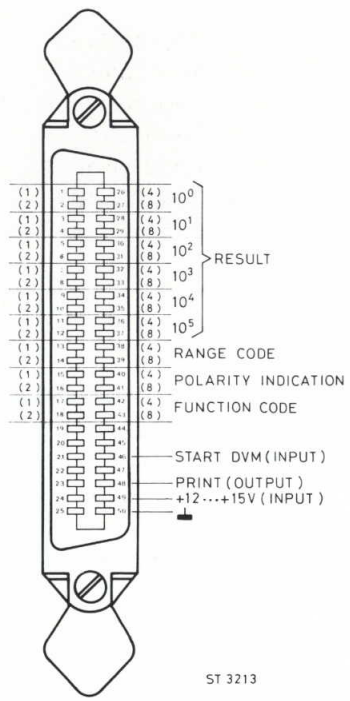
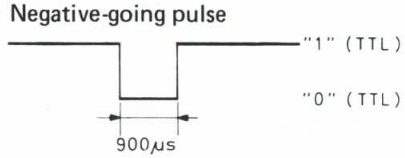


Fig. 9. BCD parallel output connector.

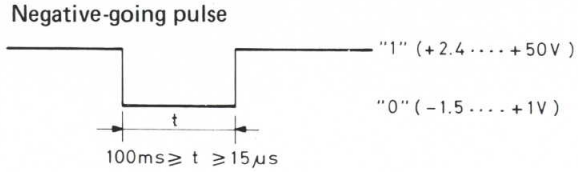
Print command (output)

Negative-going pulse



Start command (for PM2528, input)

Negative-going pulse



3.6. ANALOG OUTPUT PM9254

The analog output PM9254 offers the possibility to monitor a part of the displayed value. The output voltage sweep corresponds with a selectable number of digits of the display, and is galvanically separated from the input. The analog output PM9254 consists of two plug-in cards.

Output voltage	0 – 1 V
Accuracy	± (0.2% of reading + 0.1% of range) excluding PM2528.
Temperature coefficient	± (0.025% of reading + 0.005% of range) per ^{o}C, excluding PM2528.
Output sockets	HI and LO; LO connected to earth
Output protection	Short circuit protected Max. input voltage 15V.
Output system	Digital-to-Analog Converter.
Output resistance	200Ω
Maximum voltage between input (0 terminal) and output	250Vrms, 350Vpeak
Response time	< 0.5 s, excluding PM2528

Output modes

mode	selected digits	range for output voltage 0V – 1V
A	D5 D4 D3 D2 . .	0000 . . – 2500 . .*
B	. D4 D3 D2 . .	. 000 . . – . 999 . .
C	. D4 D3 D2 . .	. 500 . . – . 499 . .
D	. . D3 D2 D1 .	. . 000 . – . . 999 .
E	. . D3 D2 D1 .	. . 500 . – . . 499 .
F	. . . D2 D1 D0	. . . 000 – . . . 999
G	. . . D2 D1 D0	. . . 500 – . . . 499

D5 = most-significant digit
D0 = least-significant digit

* scale length is 2400

Output mode selection	via switch at the rear of the PM2528.
Resolution	mode A 1:2500 other modes 1:1000

3.7. IEC-BUS INTERFACE PM9291

Via the IEC-bus interface, the PM2528 can be fully remote controlled, enabling the measuring result, including the polarity, to be read out. The PM9291 consists of a galvanic separation plug-in card and an interface card.

Interface function repertoire

Interface function	identification	description
Talker function	T5	Serial poll possible Function Talk only possible Automatic unaddress possible
Listener function	L4	Basic listener Unaddress if MTA
Service Request	SR1	Complete service request capability (can be switched off via switsch "SRQ off")
Remote Local	RL1	No local Lock-out "Return to local" (rtl) always false
Device Trigger	DT1	Complete device trigger capability; trigger is also possible via data byte E1

Code specifications

Used code	ISO – 7 – bit code (ISO 646)
Delimiters	Input delimiter: Optional Not required, all delimiters are allowed.
	Output delimiter: ETX ^ END

Bus driver specification

E1	Open-collector I sink 48mA

Settings (Fig. 10)

Address settings	The five least significant bits of the address are switch-selectable
Talk-only mode	Switch-selectable by "TON"
Service request	Switch-selectable by "SRQ off"

The switches are situated on the interface card at the rear of the PM2528.

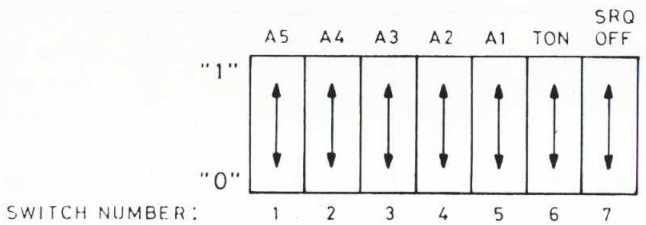


Fig. 10. Settings on IEC-bus interface.

Mechanical

Type of connector	25-pin female connector; contact assignment acc. to IEC 625

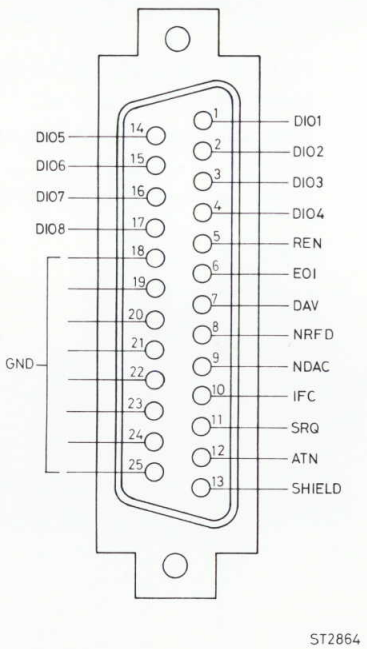


Fig. 11. IEC bus connector.

Programming the PM2528 via the IEC-bus interface

Function	ISO-7-bit code	description
V ⎓ V~ V⎓~ Ω2W Ω4W A⎓ A⎓~ °C Vhf Vpeak ^ Vpeak v Vpeak ^v	F00 F01 F02 F03 F04 F05 F06 F07 F08 F09 F10 F11	Function
Range (see table)	R0 R1 R8	autoranging lowest range highest range
Data ready request	D0 D1	SRQ disable (no SRQ after a measurement) SRQ enable (SRQ after a measurement)
High speed mode	S0 S1	normal speed mode (integration time 100ms) high speed mode (integration time 20ms)
High resolution	H0 H1	normal resolution high resolution
Offset	O1O1 O0O0 O1 O0	input offset voltage is compensated input offset voltage is not compensated *NOTE: short-circuit the input terminals 0 and VΩof the PM2528.* *Select V⎓, autoranging, high resolution mode.* Relative reference mode: the measured value is stored in the memory of the PM2528 after a command O1. No relative reference mode.
Start mode	T0 T1 T2	internal start external start via IEC-bus interface external start via IEC-bus interface or BNC on the rear of the PM2528
Start command	E1 GET	starts a measurement Group Execute Trigger: starts a measurement

RANGE CODE		R0	R1	R2	R3	R4	R5	R6	R7	R8
Function	Function Code									
V ⎓	F00	AUTO RANGING				200mV	2000mV	20V	200V	2000V
V~	F01					200mV	2000mV	20V	200V	2000V
V⎓~	F02					200mV	2000mV	20V	200V	2000V
Ω2W	F03		200 Ω	2000 Ω	20k Ω	200k Ω	2000k Ω	20M Ω	200M Ω	2000M Ω
Ω4W	F04		200 Ω	2000 Ω	20k Ω	200k Ω	2000k Ω			
A ⎓	F05			2μA	20μA	200μA	2000μA	20mA	200mA	2000mA
A⎓~	F06			2μA	20μA	200μA	2000μA	20mA	200mA	2000mA
°C	F07									2000°C
Vhf	F08					200mV	2000mV			
Vpeak ^	F09						2000mV	20V	200V	2000V
Vpeak v	F10						2000mV	20V	200V	2000V
Vpeak ^ v	F11						2000mV	20V	200V	2000V

Range codes and function codes of the PM2528 + IEC-bus interface.

NOTE: After wrong programming the last programmed function is maintained. Programming-errors are specified in the device status data.

Output data

The output format meets the code and format conventions of the IEC625–2 document.
The numeric representation of the decimal output data is an explicit point scaled representation, loosely called floating point form.

– Measurement data

The polarity and measured value are transmitted as decimal data.

Examples: + 1 2 . 8 3 4 6 E + 0 ETX ^ END (+12.8346 .10^0)
1 2 8 . 3 4 6 E + 3 ETX ^ END (128.346 .10^3)

At a 3½ and 4½ digit display the blanked digits are represented as 0 (zero).
When no polarity is represented, the first character is a space.

Example: 1 2 8 3 . 0 0 E – 3 ETX ^ END (1.283 .10^{-3})

– Device status data

The device status data is available in the addressable mode (not in talk only mode).
The device status data of the PM2528 is represented in one status (8 bits) word.
The status word is built-up as follows:

DIO8	DIO7	DIO6	DIO5	DIO4	DIO3	DIO2	DIO1
EX	RQS	AL	BSY	EF3	EF2	EF1	EF0

EX – Extension
EX = 0 Bits EF3 – EF0 contain the normal function code
EX = 1 Bits EF3 – EF0 contain the extended function code (Relative reference mode)
If the AL bit is 1 then bits EF3 – EF0 contain the error codes.

RQS – Request for service, interface status bit
RQS = 1 PM2528 asks for service in case of:

Programming errors
– illegal digit (out of range)
PM2528 warnings
– exceeding the crest factor
– overload
– exceeding the crest factor and overload
If programmed via the IEC-BUS interface
– when data is available

RQS = 0 PM2528 asks no service

AL – Alarm bit
AL= 1 The PM2528 is in an erroneous or alarm condition. The condition is specified in the bits EF3 – EF0.
AL= 0 No erroneous or alarm condition.
Bits EF3 – EF0 contain the function code.
The function code is extended if EXT is 1.

BSY – Busy bit
Busy = 1 The PM2528 is measuring
Busy = 0 The PM2528 is not measuring

EF3 – EF0 Error codes if the alarm bit AL is 1.

	EF3	EF2	EF1	EF0	
Programming error	0	1	0	0	– illegal digit
PM2528 warnings	0	0	0	1	– overload
	0	0	1	0	– crest factor exceed
	0	0	1	1	– overload and crest factor exceed

EF3 – EF0 Function codes (Alarm bit AL is 0)

Function	EF3	EF2	EF1	EF0
V ⎓	0	0	0	0
V ~	0	0	0	1
V ≂	0	0	1	0
Ω 2W	0	0	1	1
Ω 4W	0	1	0	0
A ⎓	0	1	0	1
A ≂	0	1	1	0
°C	0	1	1	1
Vhf	1	0	0	0
Vpeak ^	1	0	0	1
Vpeak v	1	0	1	0
Vpeak ^ v	1	0	1	1

3.8. RACK-MOUNTING SET FOR 19-INCH RACK PM9669/03

The PM9669/03 is a rack-mounting set for mounting the PM2528 into a 19-inch rack.

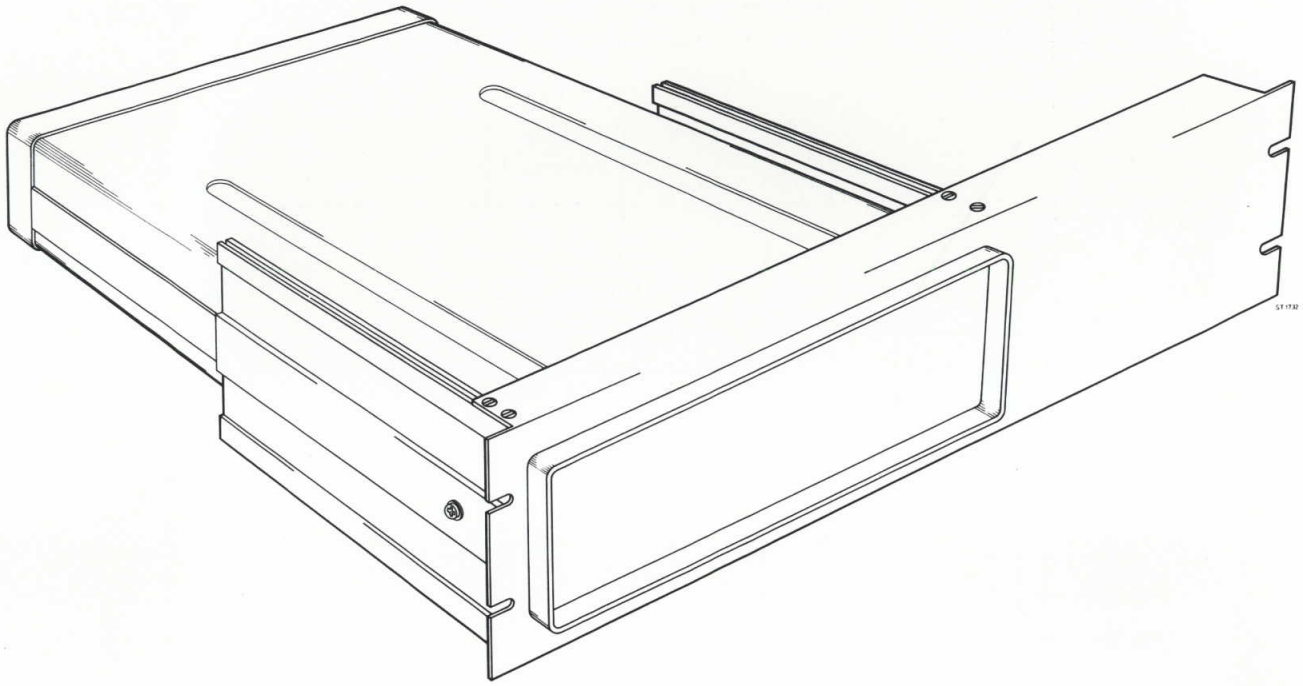


Fig. 12. Rack-mounting set PM9669/03.

4. PRINCIPLE OF OPERATION

The PM2528 is subdivided into four functional parts: Analog Section, Analog Digital Converter, Control Section and Display Keyboard Section. The basic build-up of the PM2528 is shown in fig. 13.

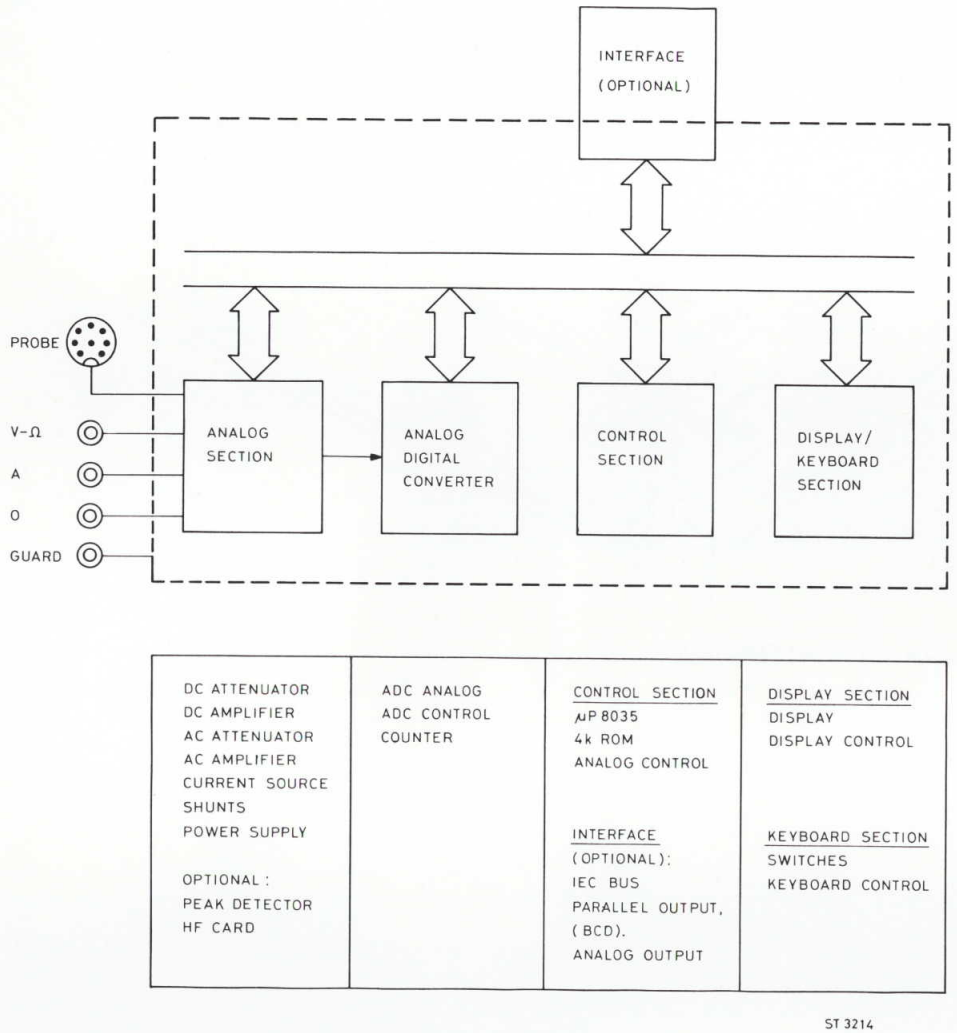


Fig. 13. Basic build-up of the PM2528.

4.1. ANALOG SECTION

In the analog section all quantities to be measured are converted into voltages. These voltages are supplied to the Analog Digital Converter (ADC) via the ADC input control.

4.1.1. Standard measurements

V ⎓ measurements

Direct voltages (V ⎓) are attenuated by a dc attenuator or amplified by a chopper stabilised dc amplifier.

V~ and V≂ measurements

Alternating voltages can be measured excluding or including a dc component. The input voltage is attenuated by an ac attenuator or amplified by an ac amplifier. The rms value is then determined by the rms converter.

Ω2W and Ω4W measurements

The unknown resistance is connected to a current source via the V-Ω socket (Ω 2W) or via the PROBE input (Ω 4W). The current depends on the selected range. The voltage across the unknown resistance is measured via the ADC.

A ⎓ and A≂ measurements

In the ranges 2000mA, 200mA and 20mA the current is converted into a voltage via shunt resistors. This voltage is measured like direct voltages (V ⎓) or alternating voltages including dc component (V≂). In the ranges up to 20mA the current is supplied to the virtual ground of the dc amplifier. As the output of the amplifier compensates this current, the output voltage is proportional to the input current.
Both, A ⎓ and A≂ are measured in this way.
For alternating currents (A≂), the rms value is also determined.

°C measurements

Temperatures are measured with a Pt-100 resistor – e.g. the temperature probe PM9249 – via the PROBE input. The resistance of the Pt-100 element is measured in the Ω4W configuration.
This resistance is proportional to the temperature of the probe tip.
Linearisation and conversion into °C takes place in the control section, via a software routine.

Offset function (relative reference).

A correction register in the PM2528 is loaded with the value of an input voltage. Measurements are corrected with the contents of the correction register.

4.1.2. Optional measurements

Vpeak measurements

In the function Vpeak, the input voltage is supplied via the ac amplifier to a peak detector. The peak detector determines the maximum value (V^) or the minimum value (V˅) of the input signal. The peak-peak value (V ⇕) is computed by the microcomputer in the control section. It adds the result of a V^ and V˅ measurement.

Vhf measurements

In the function Vhf, a high frequency voltage can be measured according to the compensation principle, with the high frequency probe PM9211. The hf voltage is rectified in the probe. A 100kHz signal is generated on the hf plug-in card in the PM2528. This signal is supplied to the probe and also rectified. The difference between the two rectified signals is supplied to the dc amplifier input. The output voltage of the dc amplifier controls the amplitude of the 100kHz oscillator voltage. This 100kHz signal is controlled until it compensates the hf voltage. The output voltage of the oscillator is then proportional to the hf input voltage and is measured via the ac amplifier and rms converter.

4.1.3. ADC input control

The ADC input control is an analog multiplexer consisting of a number of analog switches. Using these switches, one of the input signals of the ADC input control can be connected to the ADC. The switches are controlled by the control section.

4.2. ANALOG DIGITAL CONVERTER (ADC)

The conversion of analog signals into a digital code is based on the dual-slope integration principle.
The conversion consists of two states: the ramp-up state and the ramp-down state.
During the ramp-up state the analog input signal is supplied to an integrator for a definite time. This time is determined by a fixed number of clock pulses. During this state an integration capacitor is charged to a voltage which is proportional to the input voltage.
During the ramp-down state the integration capacitor is discharged by a constant current. The discharging time is proportional to the voltage on the integration capacitor. It is measured by counting the number of clock pulses during this time.
The output code of the counter at the end of the ramp-down state is the value of the input signal.
The ADC control is responsible for the communication between the analog part of the ADC, the counter and the control section.

4.3. CONTROL SECTION

In the control section, both input and output data are processed.
Input data are derived from:

keyboard	– function selection, ranging commands, start mode and start commands, offset mode, high resolution mode or normal mode.
interfaces	– IEC-bus interface (control commands) BCD parallel output (start command)
ADC	– measured value
external start input	– start commands

Output data are sent to:

keyboard	– LED's in push-buttons
display	– measuring result, unit indication
interfaces	– IEC-bus interface and BCD parallel output (measuring result, etc.) analog output (measuring result)
analog section	– relays, multiplexer.
ADC	– start command etc.

The control section consists of a 8035 microcomputer, 4k EPROM and a number of I/O ports (analog control).
Input commands are recognised on an interrupt basis. The priority of the interrupts is software controlled.
When an interrupt is caused e.g. by pressing one of the front-panel push-buttons of the PM2528, the microprocessor detects which command has been given and takes the desired action.

4.4. DISPLAY AND KEYBOARD SECTION

The display section consists of six 7-segment LED displays, a unit-indication part and the display control.
Data which have to be displayed are sent in a serial form from the microprocessor to the display control.
In the display control serial data are converted in bit-parallel data that is suitable for the display.
The keyboard section consists of 18 push-button switches and a keyboard control. Via the keyboard control an activated push-button is detected.

5. INSTALLATION

5.1. MAINS SUPPLY

5.1.1. Safety instructions

- Before any other connection is made the protective earth shall be connected to a protective conductor (see section 5.1.2. Earthing).
- Before inserting the mains plug into a mains socket ensure that the instrument is set for the correct local mains voltage.
- Adaption to the local mains voltage or the correct mains frequency may be performed only by a skilled person who is aware of the risks involved.
  When a fuse is to be replaced the instrument must be disconnected from all voltage sources.

5.1.2. Earthing

Before switching on, the instrument shall be connected to a protective earth conductor in one of the following ways:

- Via the three-core mains cable. The mains plug shall only be inserted into a socket outlet provided with an earth contact. The protective action shall not be made ineffective by the use of an extension lead without protective conductor. Replacing the mains plug is at the users own risk.
- Via the protective earth terminal at the rear

WARNING: **Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.**
When an instrument is brought from the cold into a warm environment, condensation may cause a hazardous condition. Therefore, make sure that the earthing requirements are strictly adhered to.

5.1.3. Adaption to the mains voltage and mains frequency

The PM2528 can be adapted to a mains voltage of 100V, 120V, 220V or 240V and to a mains frequency of 50Hz or 60Hz.
When this is necessary please contact your local dealer.

5.1.4. Replacing the mains fuse

The mains fuse is situated in the mains socket at the rear of the instrument.
Also the spare fuse for the set mains voltage is situated in the combined mains-socket/fuse-holder.

Mains voltage	Required fuse
220V – 240V	125mA T (slow blow)
100V – 120V	250mA T (slow blow)

Make sure that only fuses with the required rated current and of the specified type are used. The use of make shift fuses and the short-circuiting of fuse holders are prohibited.

5.2. INSTALLATION OF THE ACCESSORIES IN THE PM2528

The details for building in the accessories are outlined in the relevant "Operating manuals" delivered with the accessories.
The apparatus shall be disconnected from all voltage sources before it is opened for building in the accessories.

6. OPERATION

6.1. SWITCHING ON

The instrument is ready for use after earthing and connecting it to the mains. It is switched on by means of the push-button switch "POWER". A warming-up time of approx. 30 minutes should be taken into account to meet the specified accuracy.
When the PM2528 is brought from a cold into a warm environment condensation can cause incorrect readings.

NOTE: Before connecting an input signal to the PM2528 select the correct function and range.

6.2. CONTROLS, CONNECTORS AND DISPLAY

6.2.1. Front panel

Description	Application
POWER	Power-on switch
Ranging	
UP	Up-ranging: 1 x press UP gives next higher range.
DOWN	Down-ranging: 1 x press DOWN gives next lower range.
AUTO	○ Automatic ranging: ranges are selected automatically.
	NOTE: ○ LED in push-button lights at AUTO RANGING.
Start	
INT	○ Measurements are started internally.
EXT	○ Measurements can be started externally via BNC or interface.
MAN	○ Measurements can be started by pressing the push-button MAN.
	NOTE: ○ *LED in selected START mode lights.*
Function	
V ⎓	○ Direct voltage measurements.
V~	○ Alternating voltage measurements.
V~⎓	○ Alternating voltage measurements including direct voltage component.
Ω2W	○ Two-wire resistance measurements.
Ω4W	○ Four-wire resistance measurements, possible with 4-wire test lead
A ⎓	○ Direct current measurements.
A~	○ Alternating current measurement including dc component.
Vpeak	○ Peak voltage measurements. Only possible with peak voltage option PM9259.
Vhf	○ High frequency voltage measurements. Only possible with HF option PM9258 and HF probe PM9211.
°C	○ Temperature measurements. Possible with Pt-100 probe e.g. PM9249.
	NOTE: ○ *Function is switched on when LED in push-button lights.*

OFFSET	⊗ The PM2528 measures in the relative reference mode. ○ The PM2528 does not measure in the relative reference mode. The input offset voltage can be compensated in this mode.
HIGH RES	⊗ HIGH RESOLUTION mode. The display is extended with one digit. ○ Normal mode. *NOTE:* – ⊗ means: LED in push-button lights. – Selecting or switching off the relative reference mode and the HIGH RES mode becomes effective only when a measurement is performed.

NOTE: Switching to another function and up-ranging or down-ranging in the external or manual start mode will cause a displayed value in which the digits are replaced by dashes, e.g. ———.—— kΩ, to prevent wrong intepretation of the measured value.
After performing a measurement, initiated by a start command, the new measurement value will be displayed.

Front panel input sockets

PROBE — 8-pole DIN socket which can be used for
– Pt-100 temperature probe e.g. PM9249
– 4-wire resistance measurement test lead.
– Data hold probe PM9263
– Vhf measurements with probe PM9211 and HF option PM9258.

GUARD — Guard socket. The guard socket is connected to an internal shield (guard) between the 0 (LO) of the PM2528 and ground. In this way the impedance between the 0 and earth is increased to improve the common mode rejection.

0 — Combined LO socket.

V-Ω — HI socket for the functions V ⎓, V~, V⎓~, Vpeak and Ω2W.

A — HI socket for the functions A ⎓ and A⎓~.

FUSE — 2.5 A-F fuse for protection in the functions A ⎓ and A⎓~.

Input current — Screwdriver-adjustment of the input current via the hole adjacent to the 2.5A fuse. Refer to page 45.

Display

– polarity indication — + or – in the functions V⎓, Vpeak, A ⎓, °C, OFFSET

– result of a measurement

Function	Normal Mode	High Resolution Mode
V ⎓, A ⎓ Ω2W ⩽ 20MΩ Ω4W	4½ digit	5½ digit
V~, V⎓~, Vpeak Vhf, A⎓~, °C Ω2W ⩾ 200MΩ	3½ digit	4½ digit

– decimal-point representation ●

– unit representation

Display (units)	Function
mV, V Ω, kΩ, MΩ μA, mA °C ^, v, ^v	V ⎓, V~, V ⎓~, Vpeak, Vhf Ω 2W, Ω 4W A ⎓, A⎓~ °C Vpeak: ^ highest value v lowest value ^v peak-to-peak value

– overload indication OL

– crest factor indication (in functions V~, V ⎓~, V peak and A ⎓~) ⌐ in the least significant digit shows that the input circuit is overloaded due to an input signal with an excessive crest factor.

6.2.2. Rear panel

Analog output (optional)

A galvanically-separated analog output signal, which is proportional to the input signal, is available when the analog output option PM9254 is used.

Digital interface (optional)

– PM9291: IEC625 interface

The PM2528 can be remotely controlled on all functions, ranges and modes and the measuring result can be read out via the bus.

– PM9292: parallel output.

The measuring result and the function code are available in BCD parallel format. Also a start command can be given.

Ext. start (BNC)

A measuring cycle can be started by supplying a logic "0" level to this input or by short-circuiting when the EXT START mode is selected.

Mains socket

The PM2528 is provided with a combined mains socket and fuse holder, in which also a spare fuse is situated.

Earth terminal

Protective earth terminal. Refer to section 5.1.2. on page 41.

6.3. GUARD

The digital multimeter PM2528 is equipped with a GUARD. This GUARD is a shield between LO and earth which increases the leakage impedance.
Increasing the leakage impedance improves the common mode rejection.
The GUARD may be connected to the circuit via a separate lead.
Proper use of the GUARD provides a better common mode rejection and a higher measuring accuracy, especially in the most sensitive ranges.

For an optimum GUARD connection, the following rules should be taken into account:

– Connect the voltage to be measured to the PM2528 by means of a shielded measuring cable.This cable should not run parallel to heavy current cables.
– Connect the GUARD to the same potential as the 0 input terminal.
– Connect the GUARD in such a way that no common mode current flows through any source impedance.

6.4. LOCAL CONTROL

6.4.1. Function selection

The measuring functions are set by pressing the FUNCTION push-buttons. When a function is selected the corresponding LED in the push-button lights. Vpeak measurements can be made only if the peak voltage option PM9259 installed in the PM2528.
Vhf measurements can be made only if the Vhf option PM9258 is installed.

6.4.2. Zeroing the offset voltage and the input current

Input offset voltage
Due to a thermal emf at the input sockets an offset voltage can arise. This offset voltage is compensated in the following way. Short-circuit the input terminals 0 and V-Ω (0 interconnected to GUARD).
Select the **HIGH RES** mode, **INT START** mode, **AUTO RANGING** and **FUNCTION V ⎓** .
The displayed value is the offset voltage. By pressing the push-button OFFSET twice the offset voltage is compensated. When the push-button OFFSET is pressed twice again (under the above-mentioned conditions) the offset voltage, which can be changed due to warming up, is displayed. This offset can be compensated by pressing the push-button OFFSET twice again. The compensation is maintained for all measurements.
The maximum offset voltage which can be compensated is 80μV.
The LED in the OFFSET push-button is not lighted during zeroing of the input offset voltage.

Input current (only in the 200MΩ and 2000MΩ range)
Whenever the input current of the PM2528 is very low it can influence the measuring result at very high resistance measurements (200MΩ and 2000MΩ range).
An input current of 10pA will cause an additional error of 1% in the 2000MΩ range and an additional error of 0.1% in the 200MΩ range.
In the other ranges and functions the error caused by the input current is negligible.
To reach a very high measuring-accuracy in the 200MΩ and 2000MΩ range the input current can be adjusted. For zeroing the input current proceed as follows:

- Select the function V ⎓ and the modes AUTO RANGING, HIGH RES and INT START.
- Short-circuit the 0 and V-Ω terminal and zero the input offset voltage as described above.
- Remove the short-circuit. The displayed value will increase or decrease continuously. The reason is that the input capacitance is charged by the input current. Therefore the input voltage slopes up or slopes down. The input current can be adjusted with the potentiometer mounted behind a hole in the front panel of the PM2528. This hole is situated between the 2.5 A FUSE and the V ⎓ push-button.
- Turn the potentiometer clockwise when the displayed value decreases (becomes more negative) or counter clockwise when the displayed value increases (becomes more positive).
  Continue until the displayed value neither increases nor decreases (average) more than 1mV per measurement.

6.4.3. Relative reference mode

In the relative reference mode the difference between a predetermined value and a measured value is displayed. This mode can be used in the functions V ⎓, Ω2W, Ω4W, A ⎓ and °C only, within one range (autoranging and manual UP and DOWN ranging are not permitted).
Supply the predetermined value (offset value) to the input terminals (V⎓ and Ω2W to the 0 and V-Ω socket, A ⎓ to the 0 and A socket, Ω4W and °C to the PROBE input). Press push-button OFFSET (LED must ignite, when LED is already on, switch it off before by pressing OFFSET). After one measuring cycle, which can be started internally, manually or externally, the predetermined value is stored in the memory of the PM2528. At the following measuring cycles, the value of the input signal is compared to the predetermined (offset) value. The difference is displayed, including its polarity. When the input value is higher than the offset value a + is displayed, otherwise a – is displayed. The relative reference mode is switched off by pressing one of the OFFSET, RANGING or FUNCTION push-buttons. By using the relative reference mode, the ranges are not extended. Overload occurs when the input signal exceeds end of normal range.

Example:

- Select FUNCTION Ω2W
- Select START INT
- Select range 200Ω at manual ranging
- Select HIGH RES mode (LED on)
- Switch the OFFSET mode off (LED off)
- Connect a resistor R (see table below) between the O and V-Ω socket

Offset	R	Display value	Remarks
OFF	100Ω	100.000Ω	
ON	100Ω	+ 000.000Ω	press OFFSET, LED lights
ON	50Ω	− 050.000Ω	value 50 Ω below reference value
ON	160Ω	+ 060.000Ω	value 60 Ω above reference value
ON	300Ω	+ OL	range is 200Ω
ON	100Ω	+ 000.000Ω	
OFF	100Ω	100.000Ω	press OFFSET, LED off

6.4.4. High resolution mode (HIGH RES)

By pressing the push-button HIGH RES the PM2528 is switched into or out of the high resolution mode. In the HIGH RES mode the display is extended by one digit. In the table below the display length is given.

Function	Normal mode digits	HIGH RES mode digits	
V ⎓	4½	5½	
V~	3½	4½	
V⎓~	3½	4½	
A ⎓	4½	5½	
A⎓~	3½	4½	
Ω2W	4½	5½	ranges up to and including 20 MΩ
Ω2W	3½	4½	ranges 200MΩ and 2000MΩ
Ω4W	4½	5½	
°C	3½	4½	
Vpeak	3½	4½	
Vhf	3½	4½	

6.4.5. Ranging

By pressing the push-button AUTO the auto ranging mode can be switched on and off. The ranges are set automatically by the PM2528 in the auto ranging mode (the LED in the push-button is on). Ranges can be set manual by pressing the push-button UP (higher range) or DOWN (lower range).
Depending on the selected function, a fixed block of ranges is available (see table below).

Function	V ⎓, V~ V⎓, Vpeak	A ⎓, A⎓	Ω2W	Ω4W	Vhf	°C
Ranges	200mV*	2μA	200 Ω	200 Ω	200mV	−250°C
	2000mV	20μA	2000 Ω	2000 Ω	2000mV	up to
	20 V	200μA	20k Ω	20kΩ		+850°C
	200 V	2000μA	200k Ω	200kΩ		
	2000 V	20mA	2000k Ω	2000kΩ		
		200mA	20MΩ			
		2000mA	200MΩ			
			2000MΩ			

* Not in Vpeak function

In the auto ranging mode up-ranging occurs at 110% of range and down ranging starts at 10% of range.

In the table below the upranging limits and downranging limits are given for a 5½, 4½ and 3½ digit display.

UPranging			DOWNranging		
2.20000	2.2000		0.20000	0.2000	
22.0000	22.000	22.00	02.0000	02.000	02.00
220.000	220.00	220.0	020.000	020.00	020.0
2200.00	2200.0	2200.	0200.00	0200.0	0200.

In the automatic ranging mode up-ranging and down-ranging can also be done manually, as can be seen in the following example.

- Select AUTO RANGING; LED in AUTO push-button lights.
- Select V ⎓ by pressing V ⎓ .
- Select HIGH RES; LED in HIGH RES push-button lights.
- Select INT START; LED in INT push-button lights.
- Supply a voltage V to the input sockets 0 and V Ω Change V as listed below.

Input voltage V	Displayed value	Ranging	Resolution
2 V	2000.00mV		10μV
2.3V	02.3000 V	AUTO UP	100μV
2.2V	02.2000 V		100μV
2 V	2200.00mV	MAN DOWN (press DOWN)	10μV

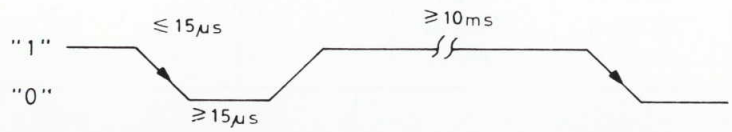
In this way a high resolution can be reached between the ranging-limits.

6.4.6. Starting

The start mode is selected by pressing one of the START push-buttons. A LED in the push-button knob indicates which start mode is selected. The following start modes are possible.

INT START : a measurement is started automatically after completing the previous one.
EXT START : a measurement can be started externally via the
- BNC connector at the rear of the PM2528
- A measurement is started by making this input low (see fig. 14)
  The EXT start input is galvanically separated from the measuring circuit.
- IEC-bus interface PM9291 (see relevant specification, page 31).
- BCD parallel output PM9292 (see relevant specification, page 28).

MAN START: By pressing the push-button MAN once, one measurement is performed. At AUTO RANGING first the correct range is selected and then a new measurement is performed and displayed.



"0" = –20 V .... +1V or short-circuited BNC input.
"1" = +2.4V ... 20V or open BNC input.

Fig. 14. Start pulse for EXT START input.

Remarks

- Notice the different meaning of START INT and START EXT in the V ^ and V v function (page 55).
- Switching to another function and up-ranging or down-ranging in the EXT and MAN start mode will cause a displayed value in which the digits are replaced by dashes e.g. ————.—— kΩ.
  After performing a measurement the measured value will be displayed.
- Selecting or switching off the OFFSET and HIGH RES mode becomes effective only after performance of a measurement.

6.5. STANDARD MEASUREMENTS

6.5.1. Voltage measurements (V⎓, V ~ , V ≂)

- Select the INT, EXT or MAN start mode.
- Select the desired function.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the input signal to the 0 and V-Ω socket.

Remarks

- When only dashes are displayed (e.g. ———.—— V) in the EXT or MAN start mode press START INT or MAN
- In the function V ⎓ the relative reference mode can be used.
- The maximum input voltages are:

V ⎓	1000V
V~ , V≂	600Vrms, 900Vpeak

- In the 2000V range overload (OL) is indicated at an input voltage of 2000V.
  Pay attention to the maximum input voltages.
- Indication ⌐ in the least significant digit of the display means that the input circuit is overloaded. This occurs in the V~ and V≂ function when the crest factor of the input signal is too high. It results in an error in the measured value.
- Voltages up to 30kV ⎓ can be measured with the aid of the Extremely High Tension probe PM9246.
- In the table below, the ranges, ranging limits and display lengths are represented.

V ⎓ High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.000mV	220.000		240.000
2000.00mV	2200.00	0200.00	2400.00
20.0000 V	22.0000	02.0000	24.0000
200.000 V	220.000	020.000	240.000
2000.00 V		0200.00	2400.00

V~, V≂ High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.00mV	220.00		240.00
2000.0mV	2200.0	0200.0	2400.0
20.000 V	22.000	02.000	24.000
200.00 V	220.00	020.00	240.00
2000.0 V		0200.0	2400.0

6.5.2. Resistance measurements (Ω2W, Ω4W)

- Select the INT, EXT or MAN start mode.
- Select the function Ω2W or Ω4W.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or normal resolution mode.
- Connect the resistance to be measured to the correct input sockets.

Ω2W	– 0 (positive) and V-Ω (negative)
Ω4W	– PROBE

Remarks

- When only dashes are displayed (e.g. ———.–– k Ω) in the EXT or MAN start mode press START INT or MAN.
- In the Ω4W function the 0 and the GUARD must be interconnected.
- In the Ω4W function the 4-wire test lead can be used. For connector data, see fig. 15.
- When very high resistances must be measured with high accuracy the input current has to be adjusted. Refer to section 6.4.2. on page 45.

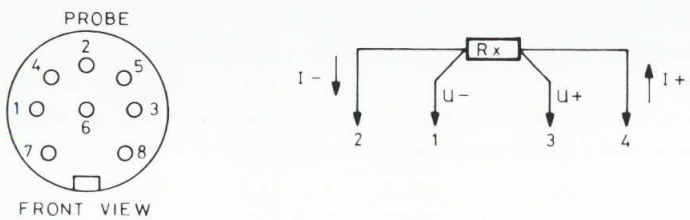


Fig. 15. Connection of the PROBE input for Ω4W measurements.

- The relative reference mode can be used.
- Use shielded cables in the high ranges to prevent errors in the measurements due to external influences.
- In the 200M Ω and 2000M Ω range the response time increases proportional to the measured value and can be 22 seconds.
- Overload is indicated with OL in the display.
- In the table below, the ranges, ranging limits, scale lengths and measuring currents are represented.

Ω2W High resolution mode

Range	AUTO UP ranging	AUTO DOWN ranging	display length	measuring current
200.000 Ω	220.000		240.000	10mA
2000.00 Ω	2200.00	0200.00	2400.00	1mA
20.0000k Ω	22.0000	02.0000	24.0000	100μ A
200.000k Ω	220.000	020.000	240.000	10μ A
2000.00k Ω	2200.00	0200.00	2400.00	1μ A
20.0000MΩ	2200.00	02.0000	24.0000	100n A
200.00MΩ	220.00	020.00	240.00	10n A
2000.0MΩ		0200.0	2400.0	1n A

Ω4W High resolution mode

Range	AUTO UP ranging	AUTO DOWN ranging	display length	measuring current
200.000 Ω	220.000		240.000	10mA
2000.00 Ω	2200.00	0200.00	2400.00	1mA
20.0000k Ω	22.0000	02.0000	24.0000	100μ A
200.000k Ω	220.000	020.000	240.000	10μ A
2000.00k Ω		0200.00	2400.00	1μ A

6.5.3. Testing semiconductors

Semiconductors can be tested in the Ω 2W function.
The output current of the PM2528 causes a voltage drop across the semiconductor under test. This voltage drop is measured by the PM2528.
The display length corresponds in every range with a voltage of 2.4 Volt.
When the voltage drop across the semiconductor becomes higher than 2.4 Volt, the PM2528 indicates "OL" (e.g. measuring diodes in reverse direction).

- Select the INT, EXT or MAN start mode.
- Select function Ω2W.
- Select a range in the manual ranging mode, according to the desired measuring current (see table below).
- Select the HIGH RES mode or the normal resolution mode.
- Connect the semiconductor to the 0 and V-Ωsocket.

Remarks

- When only dashes are displayed (————.—— Ω) press START INT or MAN.
- The maximum output voltage at the terminals is 13V.
- Vforward must be lower than 2.4V.
- In the table below the ranges and measuring currents are listed.
- The relative reference mode can be used (e.g. comparative measurements)
- By measuring the forward voltage in all ranges (measuring currents), the characteristic of a diode can easily be measured.

High resolution mode

Range	display length	measured voltage at end of display	measuring current	max. reverse voltage
200.000 Ω	240.000	2.4V	10mA	13 V
2000.00 Ω	2400.00	2.4V = (2400.00mV)*	1mA	13 V
20.0000k Ω	24.0000	2.4V	100μ A	13 V
200.000k Ω	240.000	2.4V	10μ A	13 V
2000.00k Ω	2400.00	2.4V = (2400.00mV)*	1μ A	4.5V
20.0000M Ω	24.000	2.4V	100n A	4.5V
200.00M Ω	240.00	2.4V	10n A	4.5V
2000.0M Ω	2400.0	2.4V = (2400.0mV)*	1n A	4.5V

* Direct reading in mV.

6.5.4. Current measurements (A ⎓, A ~).

- Select the INT, EXT or MAN start mode.
- Select the desired function.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the current source to the 0 and A socket.

Remarks

- When only dashes are displayed (e.g. ————.—— μA) press START INT or MAN.
- In the A ⎓ function the relative reference mode can be used.
- The maximum permissible input current is 2A.
- Currents up to 31.6A ⎓ can be measured with shunt PM9244 (refer to section 3.3.2.).
- Currents up to 100A ~ can be measured with current transformer PM9245 (refer to section 3.3.3.).
- Overload is indicated with OL in the display.
- Fuses (at front).
  At delivery a 2.5 A -F low breaking capacity fuse is installed in the PM2528.
  Whenever currents are measured in circuits with high dc voltages, which can cause high overload currents, the high breaking capacity (sand filled) shall be used, to prevent the generation of an arc in the fuse.
  The high breaking capacity fuse causes a maximum additional voltage drop of 200mV at a current of 2A.
- Indication ⊏ in de least significant digit of the display means that input circuit is overloaded. It results in an error in the measured value. This only counts fot the ranges 20mA, 200mA and 2000mA of the A~ function.
- In the table below, the ranges, ranging limits, scale lengths and voltage drops are represented.

A.⎓. ▒ High resolution mode

Range	AUTO UP-ranging	AUTO DOWN-ranging	display length	voltage drop at full scale	
				low breaking fuse	high breaking fuse
2.00000 μA	2.20000		2.40000	< 0.25mV	< 0.25mV
20.0000 μA	22.0000	02.0000	24.0000	< 2.5 mV	< 2.5 mV
200.000 μA	220.000	020.000	240.000	< 25 mV	< 25 mV
2000.00 μA	2200.00	0200.00	2400.00	<250 mV	<250 mV
20.0000mA	22.0000	02.0000	24.0000	<250 mV	<252 mV
200.000mA	220.000	020.000	240.000	<250 mV	<270 mV
2000.00mA		0200.00	2400.00	<500 mV	<700 mV

Range	AUTO UP-ranging	AUTO DOWN-ranging	display length	voltage drop at full scale	
				low breaking fuse	high breaking fuse
2.0000 μA	2.2000		2.4000	< 0.25mV	< 0.25mV
20.000 μA	22.000	02.000	24.000	< 2.5 mV	< 2.5 mV
200.00 μA	220.00	020.00	240.00	< 25 mV	< 25 mV
2000.0 μA	2200.0	0200.0	2400.0	<250 mV	<250 mV
20.000mA	22.000	02.000	24.000	<250 mV	<252 mV
200.00mA	220.00	020.00	240.00	<250 mV	<270 mV
2000.0mA		0200.0	2400.0	<500 mV	<700 mV

6.5.5. Temperature measurements (^{o}C)

- Select the INT, EXT or MAN start mode.
- Select the function ^{o}C.
- Select the HIGH RES mode or the normal resolution mode.
- Connect a temperature probe e.g. PM9249 or Pt-100 resistor to the PROBE input.

Remarks

- When only dashes are displayed (e.g. ———.—— ^{o}C) press START INT or MAN.
- In the ^{o}C function the Pt-100 probe PM9249 can be used. For connection of a Pt-100 element see fig. 16.

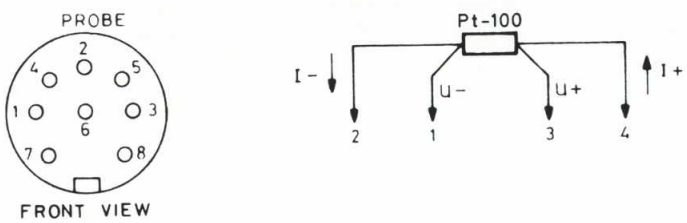


Fig. 16. Connector data of the PROBE input (^{o}C).

- The measuring ranges of the PM2528 and the temperature probe PM9249 are listed below. The correct measuring range is automatically selected by the PM2528.
  HIGH RES mode —0220.0^{o}C . . . . +0850.0^{o}C
  normal mode —0220. ^{o}C . . . . +0850. ^{o}C
  PM9249 — 60 ^{o}C . . . . + 200 ^{o}C
- The relative reference mode can be used.
- Linearisation and probe characteristics according to DIN 43760.

6.6. ADDITIONAL MEASUREMENTS

6.6.1. Peak voltage measurements (Vpeak, optional with PM9259)

Definition of V ^ , V ˅ and V ^˅ (fig. 17)

In the Vpeak function the highest (V ^), lowest (V ˅) and peak-peak (V ^˅) value of a signal can be measured. In the V ^˅ mode only the ac component is measured. In the V ^ and V ˅ mode the dc and ac component are measured and also the polarity is displayed.

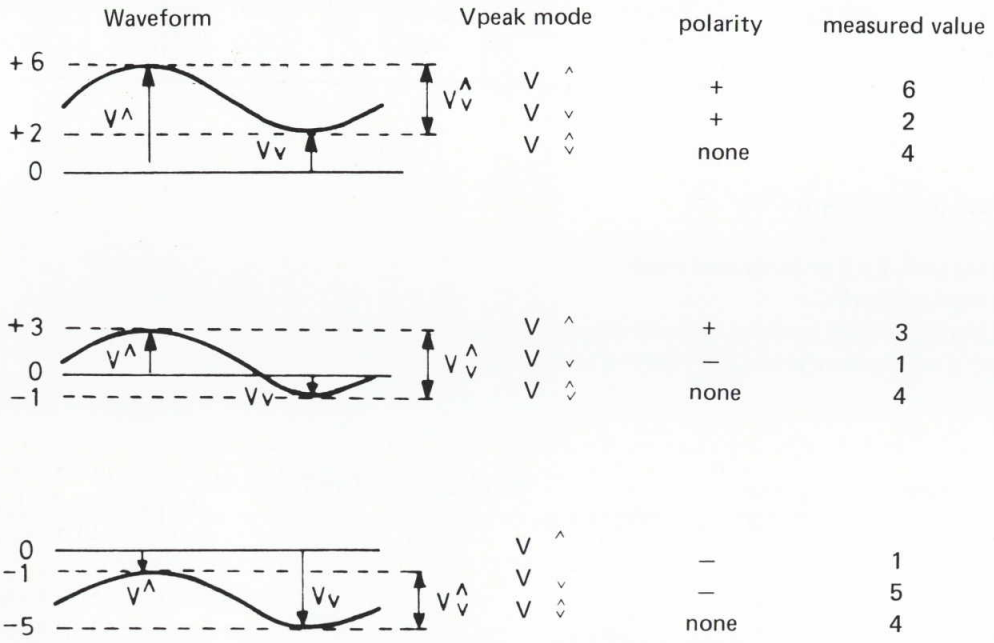


Fig. 17. Definition of V ^ , V ˅ and V ^˅

The peak function can manually only be selected if the peak unit is mounted. However via de IEC-bus interface PM9291, the peak function can be selected without a mounted peak unit.

Measuring modes on V ^ and V ˅ :

– Internal starting of measurements (INT START, fig. 18).

Measurements are continuously repetitively started by the PM2528.
The displayed value is the highest (V ^) or lowest (V ˅) value of a signal over a fixed period of about 200ms. In this mode, periodical signals with a frequency between 10Hz and 100kHz can be measured.

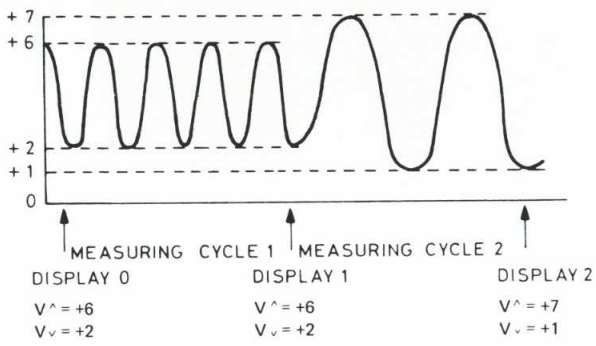


Fig. 18. V ^ and V ˅ measurement in INT START mode.

– External or manual starting and stopping of a measurement (fig. 19).
The displayed value is the highest (V ^) or lowest (V ˅) value of the input signal. Commands are given in the EXT or MAN start mode. At the first (start) command the measurement is started. At the second (stop) command the measurement stops. The peak value, measured in the preceding measuring period, is displayed. During this measuring period the displayed value is the peak value found until that moment.
The LED in the EXT or MAN push-button blinks during a measurement. In this mode it is possible to measure the maximum or minimum value of a signal during a time determined by the user. In this way, low frequency signals can be measured.

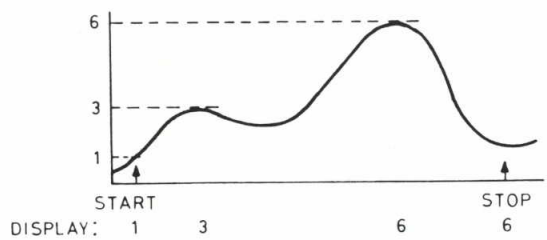


Fig. 19. V ^ measurement in MAN or EXT START mode.

Measuring modes on V $\hat{\ }$ (fig.20)

– Internal starting of measurements (INT START).

Measurements are continuously repetitively started by the PM2528.
The displayed value is the peak-peak (V $\hat{\ }$) value of a signal over a fixed period (400ms approx.). In this mode, periodic signals with a frequency between 10Hz and 100kHz can be measured (see below).

– External or manual starting of a measurement

The displayed value is the peak-peak value of a signal over one fixed period (400ms approx.). The measuring period is started via START MAN or START EXT in the MAN or EXT start mode. Periodic signals with a frequency between 10Hz and 100kHz can be measured.

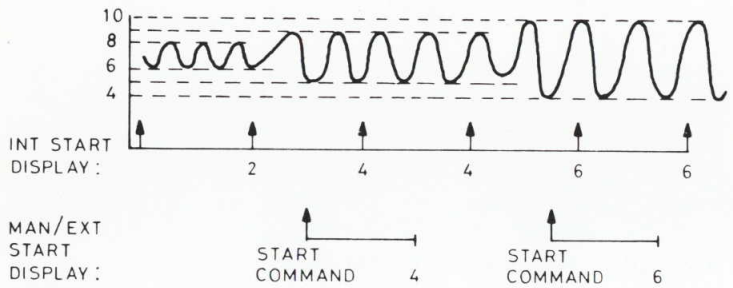


Fig. 20. V $\hat{\ }$ measurement.

Time relation of input signals

To determine the peak or peak-peak value of an input signal, a capacitor in the PM2528 has to be loaded, which requires a certain time.
A signal can be measured with full accuracy when its slew-rate is lower than 7 digits per µs in normal mode or 70 digits per µs in high resolution mode. When the slew-rate of the input signal is higher, this signal must be present for more periods (fig. 21).

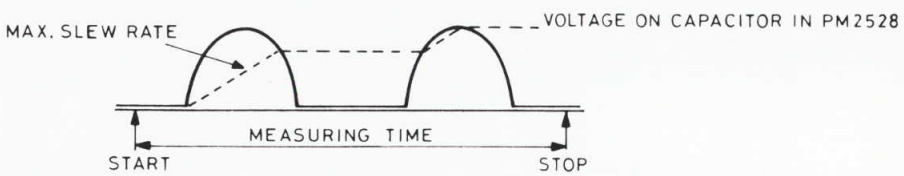


Fig. 21. Slew-rate of input signal at Vpeak measurements.

For input signals with high slew-rates, such as pulses, the peak value has to be present over at least 1ms. In case of a periodic signal this time may be split up as shown in fig. 22.

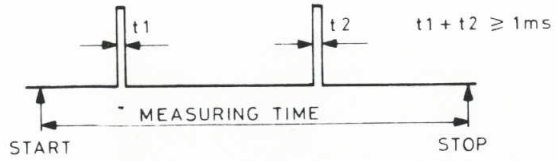


Fig. 22. Measuring the peak value of pulses.

Sine-waves and triangular-waves up to 100kHz can be measured with full accuracy.

Operation

- Select function V ^ , V ˅ or V ⇕
  - V ^ : 1 x press Vpeak
  - V ˅ : 2 x press Vpeak
  - V ⇕ : 3 x press Vpeak
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal mode.
- Select a start mode by pressing:
  - INT — measurements are started continuously repetitive.
  - MAN — a measurement can be started by pressing MAN.
    In the V ⇕ function a measurement stops at the end of a measuring cycle (400ms approx.)
    In the V ^ and V ˅ function, a measurement can only be stopped by pressing MAN again.
    In the V ^ and V ˅ function, the LED in the MAN push-button blinks during a measurement.
  - EXT — a measurement is started via the EXT START input or one of the interfaces PM9291 (IEC-bus) or PM9292 (BCD parallel).
    In the V ⇕ function a measurement stops at the end of a measuring cycle (400ms approx.)
    In the V ^ and V ˅ function a measurement can be stopped via the EXT START input or one of the interfaces ("stop" command). During a measurement in the V ^ and V ˅ function the LED in the EXT push-button blinks. The minimum time between a start command and a "stop" command is 400ms.
- Connect the input signal to the 0 and V-Ω socket.

Remarks

- For Vpeak measurements the optional plug-in card PM9259 must be installed in the PM2528.
- When the display shows dashes (e.g. ———.—— V) press START INT or MAN.
- In the table below, the ranges, ranging limits and scale lengths are represented.
- At MAN and EXT START in the V ^ and V ˅ mode, a measurement is stopped at overload.

High resolution mode.

range	AUTO UP ranging	AUTO DOWN ranging	scale length
2000.0mV	2200.0		2400.0
20.000 V	22.000	02.000	24.000
200.00 V	220.00	020.00	240.00
2000.0 V*		0200.0	2400.0

* Maximum voltage is 600Vrms and 900Vpeak.

- For technical data refer to page 17.
- Application
  - periodic signals from 10Hz up to 100kHz
    highest value: V ^ ; INT START
    lowest value: V v ; INT START
    peak-peak value: V ⇕ ; INT START
    MAN START
    EXT START
  - aperiodic signals and periodic signals up to 100kHz
    highest value: V ^ ; MAN START
    EXT START
    lowest value: V v ; MAN START
    EXT START
    peak-peak value: V ⇕ add the result of a V ^ and V v measurement.
    For aperiodic signals, the signal has to be reproduced.

6.6.2. High frequency voltage measurements (Vhf, optional with PM9258)

- Select the INT, EXT or MAN start mode.
- Select the function Vhf.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Connect the HF probe PM9211 to the PROBE input.

Remarks

- When only dashes are displayed (e.g. ————.——mV) press START INT or MAN.
- To perform HF measurements, insertion of the optional plug-in card PM9258 is required.
- Consult the instruction manual of the PM9211 for further information.
- In the table below, the ranges, ranging limits and scale lengths are listed.

High resolution mode

range	AUTO UP ranging	AUTO DOWN ranging	display length
200.00mV	220.00		240.00
2000.0mV		0200.0	2400.0

- Ranges 20V and 200V with the attenuator delivered at the PM9211.
- Remove the HF probe when other functions are selected, when using the INT. START mode.
  The probe will force the PM2528 into the data hold mode.
  By this it is possible to leave the HF probe in the PM2528 in the EXT/MAN START mode and measure in another function. The PM2528 will not be forced to data hold.
  This makes continuous measuring possible in every function, which is very usefull if the PM2528 is controlled via the IEC-bus.

NOTE: When the HF probe stays connected, the following must be observed:

- *– The LO of the probe is connected to the LO-input of the PM2528 and is raised with the same potential.*
- *– In range 200mVdc a measuring error can occur, if the LO of the probe and the LO of the PM2528 are connected to each other via an impedance in the circuit to be measured.*

- For technical data of the PM2528 refer to page 16.
  For technical data of the probe PM9211 and HF plug-in card PM9258, refer tot page 26.
- The VHF function can manually only be selected if the HF unit is mounted. However via the IEC-bus interface PM9291 the HF function can be selected without a mounted HF unit.

6.6.3. High tension measurements

Direct voltages up to 30kV can be measured by using the optional EHT probe PM9246.

– Select function V⎓
– Select the manual ranging mode.
– Select the correct range and switch the probe to the correct impedance, according to the table below.

range PM2528	probe switch	range including probe
200mV	100MΩ	200 V
2000mV	100MΩ	2000 V
20 V	10MΩ	20kV
200 V	10MΩ	200kV*

* Maximum voltage on the probe tip is 30kV.

– Select the INT, EXT or MAN start mode.
– Select the HIGH RES mode or the normal resolution mode.
– Connect the probe to the PM2528 input sockets O (LO) and VΩ (HI).

NOTE: pay attention to safe earth conditions. The crocodile clip of the PM9246 has to be connected to the mains earth.

Remarks

- AUTO RANGING is permitted. As can be seen in the table above the PM9246 has to be switched to another impedance if automatic up-ranging (from 2000mV to 20V) or down-ranging (from 20V to 2000mV) occurs.
- When the display shows dashes, press START INT or MAN.
- For technical data refer to page 23.

6.6.4. High current measurements (optional with PM9245 or PM9244)

By means of the optional current transformer PM9245, alternating current with a value between 10A and 100A can be measured with the PM2528. The frequency range of the current transformer is 45Hz – 1kHz.

Direct currents and alternating currents up to 31.6A can be measured by using the optional shunt PM9244. The maximum frequency of the current to be measured is 1kHz.

High Current measurements with the current transformer PM9245

- Select function A$\tilde{=}$
- Select a range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT, EXT or MAN start mode.
- Connect the PM9245 to the 0 and A terminal of the PM2528.

Remarks

- When the display shows dashes (e.g. ————.—— μA) press START INT or MAN.
- The transfer factor of the PM9245 is 1000:1 (100A = 100mA).
- The measuring range of the PM9245 is 10A up to 100A. The frequency range is 45Hz up to 1kHz.
- For technical data of the PM9245, refer to page 24.

High current measurements with the shunt PM9244

- Select one of the functions V ⎓, V~ or V$\tilde{=}$.
- Select the correct range or the AUTO ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT, EXT or MAN start mode.
- Connect the PM9244 to the O and VΩterminal of the PM2528.

Remarks

- There are two current ranges possible on the PM9244, viz, 10A or 31.6A. In both ranges the full-scale output voltage can be switched to a value of 100mV or 31.6mV.

switch on PM9244	range PM9244	output voltage of PM9244
100 mV	10 A	100 mV
100 mV	31.6A	100 mV
31.6mV	10 A	31.6mV
31.6mV	31.6A	31.6mV

- The frequency range is from dc up to 1kHz.
- When the display shows dashes, press START INT or MAN.
- For technical data refer to page 24.

6.6.5. Measurements with the optional data-hold probe PM9263

- Select one of the functions V ⎓, V ~, V ≂, A ⎓, A ~, Ω 2W or Vpeak
- Select a range or the automatic ranging mode.
- Select the HIGH RES mode or the normal resolution mode.
- Select the INT START mode.

NOTE: Data hold is only possible in the INT START mode.

- Select the INT, EXT or MAN START mode.
- Connect the data hold probe to the PM2528 as follows:
  the DIN plug to the probe input
  the V Ω banana plug to the V Ω input terminal
  the O banana plug to the O input terminal
- Select the most suitable test pin for the probe.
- Connect the probe to zero with the zeroing lead or with a separate banana plug lead.
- Push the slide switch (white ring) on the probe to the RUNNING position (away from the probe tip). Place the probe tip on the measuring spot and push the slide switch to the HOLD position (towards the probe tip). The data on the display is now held (frozen).
  Meanwhile the PM2528 carries on measuring and new data will be displayed when the slide switch on the data hold probe is pushed to the RUNNING position.

Remarks

- The maximum voltage on the probe tip is 30Vrms.
- The maximum input current of the probe is 200mA.
- For technical data refer to page 24.

7. FIRST AID SERVICING

7.1. BREAK DOWN

Since the PM2528 has been designed and assembled with utmost care, the risk of breakdown is small. Nevertheless, if a breakdown occurs, it is possible at all times to contact your nearest Philips Organisation. However, in case of simple breakdowns, the user can remedy the breakdowns himself, by reference to the hints below.
When it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

Breakdown	Possible cause	Measures
The PM2528 does not function at all. No display	Defective mains fuse or mains lead.	Replace mains fuse (refer to section 5.1.4. on page
The PM2528 does not function properly	Confused control logic	Switch off the PM2528 and switch it on again
The PM2528 does not measure currents	Defective fuse in current input	Replace fuse at the front (refer to section 6.5.4. on page 52)

7.2. INCORRECT HANDLING

Symptom	Possible cause	Measures
Display shows dashes (——.————)	Switching to another function of range in EXT or MAN start mode	Give a start command Refer to section 6.4.6., page 48.
Display can not be refreshed in functions other than Vhf	HF probe is connected to PROBE input. This forces the PM2528 into the data-hold mode.	Disconnect HF probe.