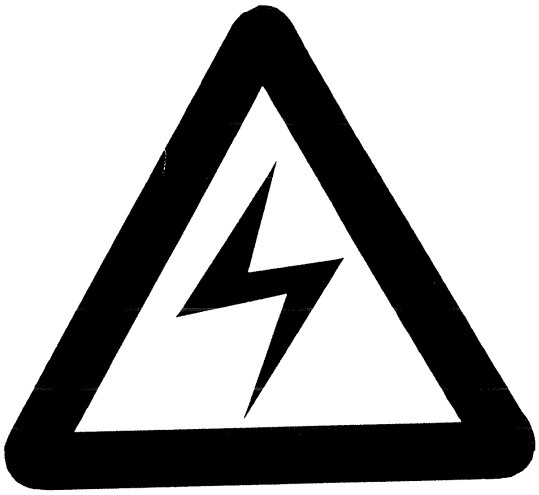
HEALTH AND SAFETY AT WORK

Electrical devices can constitute a safety hazard. It is the responsibility of the user to ensure the compliance of the installation with any local acts or bylaws in force. Only qualified personnel should install this equipment, after reading and understanding this users guide. These operating instructions should be adhered to. If in any doubt, consult with your supplier.



DANGER
ELECTRIC SHOCK RISK

PLEASE NOTE!
This equipment is supplied under warranty conditions, in force at the time of purchase at your supplier. Contact your supplier for details. Any attempt to disassemble or modify the unit will render any warranty agreement invalid.

The contents of this guide are believed to be accurate at the time of printing. The manufacturers, however, reserve the right to change the content, product specification, and performance criteria, without notice. No liability is accepted for the inappropriate, negligent, or incorrect set-up of the instrument, by the user, either by manual or automated means.

SAFETY PRECAUTIONS

1. The PM1200 is constructed in compliance with the requirements of IEC 348 Class 1 and as such ensures the safety of the meter and the user when normal precautions are followed.

2. The power plug should be inserted in a socket with a protective ground contact.

3. The power plug should be inserted before connections are made to measuring or control circuits.

4. Do not attempt to remove outer cover without first disconnecting auxiliary and test power supply.

5. This instrument must only be serviced by qualified personnel who understand the danger of shock hazards.

6. When the instrument is removed from its case hazardous voltages are present.

7. The electronic circuitry of this instrument is fully floating with respect to ground. If the instrument is opened and dangerous voltages (above 50V peak) applied to the input terminals then all the circuitry must be considered `Live'.

8. The signal leads must be in good condition with no damage.

9. NEVER remove the shorting plug from front or rear terminals while circuit under test is energised.

SECTION 1

GENERAL DESCRIPTION

1.1 Equipment Check List

The following items comprise a complete instrument:

2 x 4mm yellow Test leads
2 x 4mm black Test leads
1 x spare 20 amp fuse
1 x spare 0.315A fuse (fitted in mains connector)
1 x power lead
1 x User Manual
1 x Traceable Calibration Certificate

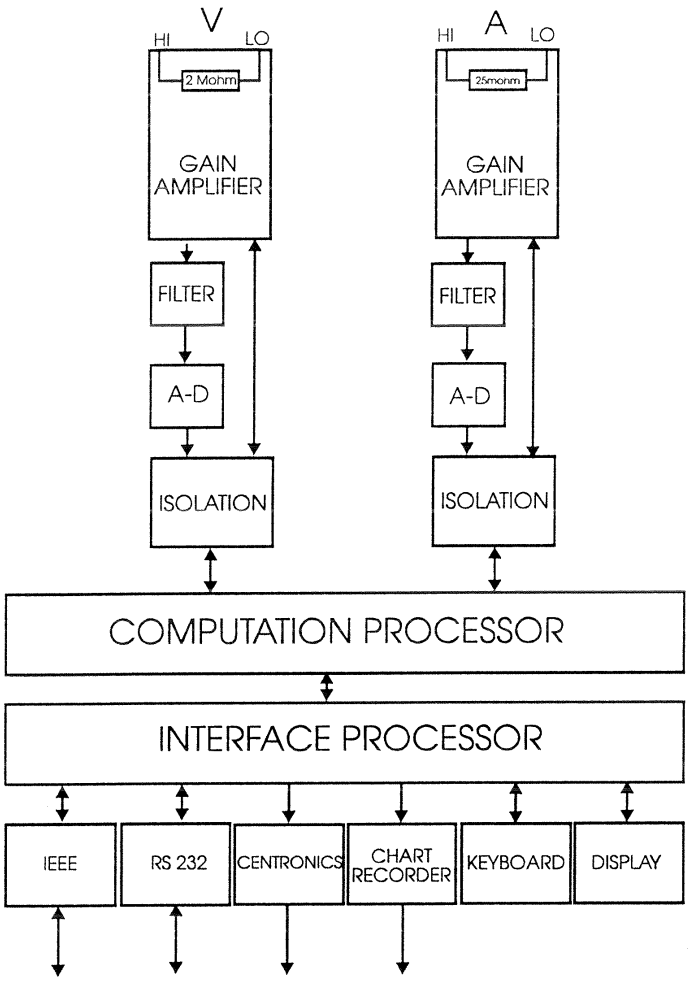
1.2 Accessories

The following options are available for the PM1200:

100:1 Current Clamp (CL100)
1000:1 Current Clamp (CL1000)
1000/100:1 Current transformer (CT1000)
Inrush Power Switch (PS1000)

1.3 Functional Description

The PM1200 is a micro-processor based instrument that effects measurements by sampling and digitizing the voltage and current waveforms and computing the value of the required measurement in the processor.



Operation is as follows:

An input attenuator (2MΩ impedance) generates a low level voltage signal and a 25mΩ current shunt generates a low level current signal. These signals are buffered by differential amplifiers, which permit the inputs to float with respect to each other and with respect to ground, greatly simplifying accurate measurements.

The signals from the differential amplifiers are amplified by programmable-gain amplifiers, the gain being selected by the processor according to the magnitude of the input voltage and current signals.

The outputs from the gain amplifiers are converted to digital information by fast A-D converters, which effect simultaneous scanning of the signals on the voltage and current channels. The rate of scanning is controlled by the processor depending on the frequency of the voltage signals.

The digital data captured by the processor is used to compute the value of the measurement selected by the keyboard, and the result is presented on the 4½ digit LED display.

SECTION 2

SPECIFICATION

2.1 Features

* IEEE488 or RS232 (150-9600 baud) remote control
* Parallel (Centronics) and RS232 printer output
* Chart Recoreder output
* Non-volatile calibration and setup data
* 16 Key keyboard
* 4.5 digit led display
* 16 led indicators
* Scaling

2.2 Functions

W	True Power
VA	Apparent Power
PF	Power Factor
VRMS	RMS Voltage
ARMS	RMS Current
VCF	Voltage Crest Factor
ACF	Current Crest Factor
AINST	Peak Inrush Current
FREQ	Frequency
HARM	Harmonic Analysis
THD	Total Harmonic Distortion
VAR	Reactive Power

2.3 Display

The display has a total of sixteen function lamps (two red, four yellow and ten green) "o" located above most of the sixteen keys and a four and a half digit led display. When lit, the "k" and "M" lamps (yellow) indicate that the value displayed is 1000 or 1,000,000 times larger than the value of the function being measured.

2.4 RMS Voltage (Vrms)

Range	2V to 1000V pk (autoranging in 7 ranges: 15V, 31V, 62V, 125V, 250V, 500V and 1000V pk
Display	4½ digits
Frequency Range	DC and 5Hz to 50kHz
Crest Factor	Up to 19.9 (limit 1000V pk)
Accuracy 23 ± 5°C Sinewave	±0.1% of reading ±0.1% of range ±0.05%/kHz ± 1 digit
Input Impedance	2MΩ and 10pF on all ranges
Peak Input Voltage	Continuous 1000V across input terminals < 1 second 2500V across input terminals

2.5 RMS Current (Arms)

Range	20mA to 20A rms (175A pk) (autoranging) in 7 ranges: 0.24A, 0.72A, 2.15A, 6.5A, 19.5A 58A and 175A peak
Display	4½ digits
Frequency Range	DC and 5Hz to 50kHz
Crest Factor	Up to 19.9 (limit 175A Pk)
Accuracy 23 ± 5°C Sinewave	±0.1% of reading ± 0.10% of range ±0.05%/kHz ±1 digit
Input Resistance	0.025Ω max inc. fuse circuit

2.6 Power (W)

Range	40mW to 13kW (autoranging) in 49 ranges corresponding to V and A ranges
Display	4½ digits with polarity according to direction of power flow
Frequency range	DC and 5Hz to 50kHz
Accuracy 23 ± 5°C Sinewave	± [(Vrdg x Aerror) + (Ardg x Verror)] ± (0.25÷PF)%/kHz ± 1 digit
Polarity	+ indicates positive power flow - indicates negative power flow

	0°	-90°	-180°	-270°	-360°
W	+	-	-	+	
PF	-	-	+	+	
VARs	+	+	-	-	

The displacement angle is the angle of the current fundamental with reference to the voltage fundamental.

2.7 Apparent Power (VA)

Range	40mVA to 13kVA (autoranging) in 49 ranges corresponding to V and A ranges
Display	4½ digits
Frequency Range	DC and 5Hz to 50kHz
Accuracy 23 ± 5°C	± [(Vrdg x Aerror) + (Ardg x Verror)] ± 1 digit

2.8 Reactive Power (VAR)

Range	40mW to 13kW (autoranging) in 49 ranges corresponding to V and A ranges.
Display	4½ digits and polarity
Frequency Range	DC and 5Hz to 50kHz
Accuracy 23 ± 5°C Sinewave	± [(Vrdg x Aerror) + (Ardg x Verror)] ± (0.25 xPF)%/kHz ± 1 digit
Polarity	+ indicates inductive load - indicates capacitive load

2.9 Power Factor (PF)

Range	+1.000 to -1.000
Display Resolution	4½ digits
Accuracy 23 ± 5°C Sinewave	± 0.001 ± (0.002 ÷ PF)/kHz
Polarity	+ indicates leading PF - indicates lagging PF

2.10 Voltage Crest Factor (Vcf)

Range	1.00 to 19.99
Display	3 digits
Accuracy 23 ± 5°C Sinewave	± 0.1% ± 1 digit

2.11 Current Crest Factor (Acf)

Range	1.00 to 19.99
Display	3 digits
Accuracy 23 ± 5°C Sinewave	± 0.1% ± 1 digit

2.12 Instantaneous Peak Current (Ainst)

Range	0.05A to 175A Pk on specified starting range or autoranging in 7 ranges comprising 0.24A, 0.72A, 2.15A, 6.5A, 19.5A, 58A, 175A.
Display resolution	4½ digits with polarity
Accuracy 23 ± 5°C Sinewave	± 2.0% of range ±1 digit
Sampling Interval	25us

2.13 AC Signal Frequency (FREQ)

Range	5Hz to 20kHz on selected channel
Display	4½ digits
Accuracy 23 ± 5°C Sinewave	± 0.2% of reading

2.14 Harmonic Analysis (HARM)

RMS Current	20mA to 20A rms (175Apk) in 7 ranges: 0.24A, 0.72A, 2.15A, 6.5A, 19.5A, 58A and 175A pk
RMS Voltage	2 to 660V rms (1000Vpk) in 7 ranges: 15V, 31V, 62V, 125V, 250V, 500V and 1000V pk
Frequency Range	DC, 5Hz to 50kHz
Display	4½ digits
Accuracy 23 ± 5°C	Fundamental: ± 0.1% of reading ± 0.1% of range ± 0.05%/kHz ± 1 digit Harmonics: ± (0.1 + 0.05/kHz)% of fundamental ± 1 digit

2.15 Total Harmonic Distortion (THD)

Range using prog 5 = 1	0.1 to 199.9%
Range using prog 5 = 0	3.0 to 199.9%
Display	4½ digits
Frequency Range	DC and 5Hz to 50 kHz
Accuracy	± 0.2% ± 0.01%/KHz ± 1 digit

2.16 Integrator

Range:	1mW.hr to 19999MW.hr
Interval:	0.001hr
Elapsed time:	0.001hr to 19999 hr or continuous.

2.17 Environmental conditions

Temp	0°C to +50°C
Storage	-40°C to +70°C
Humidity	10% to 90% RH non-condensating

2.18 Overcurrent Protection

Fuse	HRC 1¼" (32mm) 20AT

2.19 Dielectric Strength

Inputs - Case	5kV AC 50/60 Hz 1 minute
Inputs - Power Supply	5kV AC 50/60 Hz 1 minute
Power Supply - Case	2kV AC 50/60 Hz 1 minute

2.20 Power Supply

AC Input Voltage	110V ac to 220V ac ± 20%
Frequency	47 to 440 Hz
Protection	Fuse 20mm 1AT
Consumption	16W, 28VA max

2.21 Physical Data

Weight	5Kg
Height	102mm
Width	215mm
Depth	360mm

2.22 Warranty

This product is warranted against defect in materials and workmanship for a period of one year from date of shipment. During warranty period, Voltech Instruments will, at its option, either repair or replace products which prove to be defective.

For repair services under warranty, the instrument must be returned to a service centre designated by Voltech. Purchaser shall pre-pay shipment charges to service centre and Voltech will pay shipment charges to return instrument to purchaser.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from unauthorized modification or misuse, or operation outside specification of instrument. No other warranty is expressed or implied.

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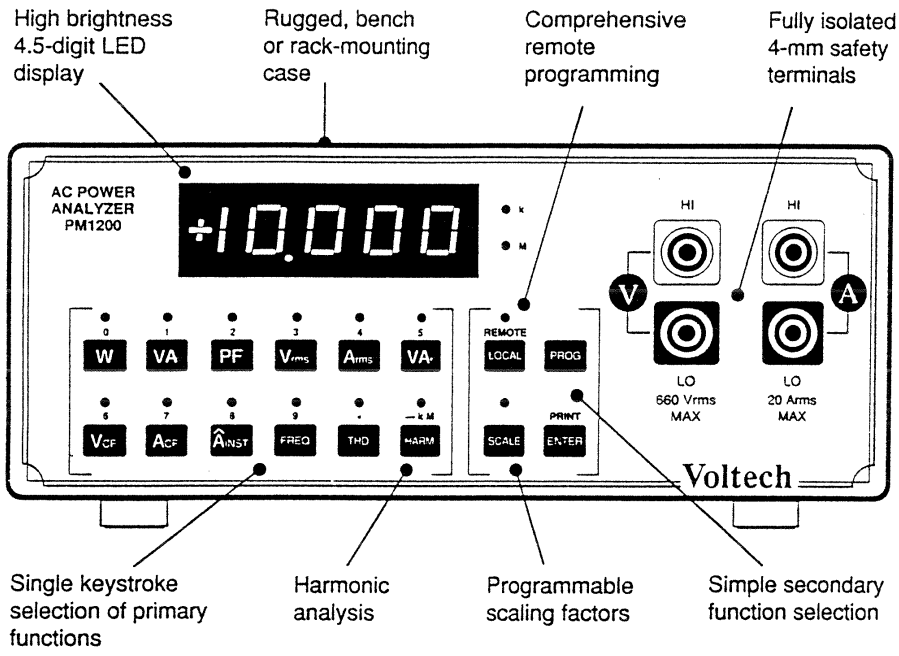
SECTION 3

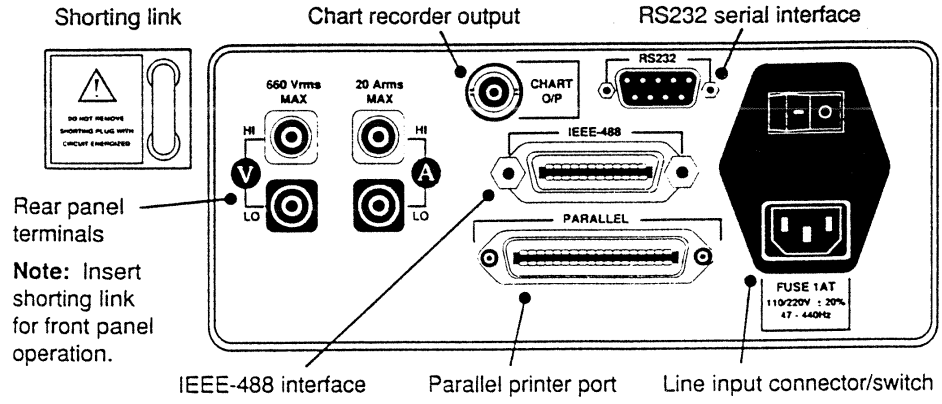
OPERATION

3 Control Function Description

The PM1200 is supplied with an amps terminal shorting plug. This is to be fitted into the amps terminal on the rear of the instrument if circuit connections are to be made via the front panel, or fitted to the amps terminal on the front of the instrument if circuit connections are to be made via the rear panel..

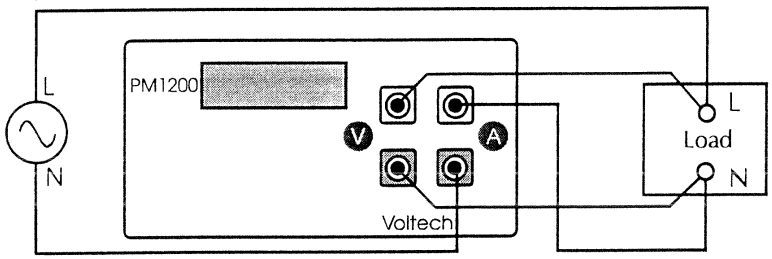
The shorting plug forms part of the external circuit current path within the instrument. **NEVER REMOVE THE PLUG FROM THE INSTRUMENT TERMINALS WHILE THE CIRCUIT UNDER TEST IS ENERGISED.**



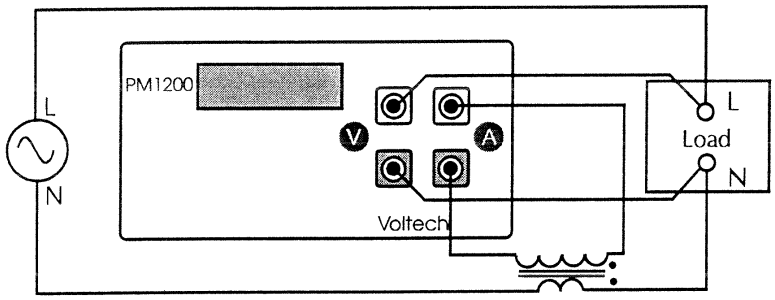


Single-Phase Measurement Connections

(i) Direct Connection (up to 20A rms)

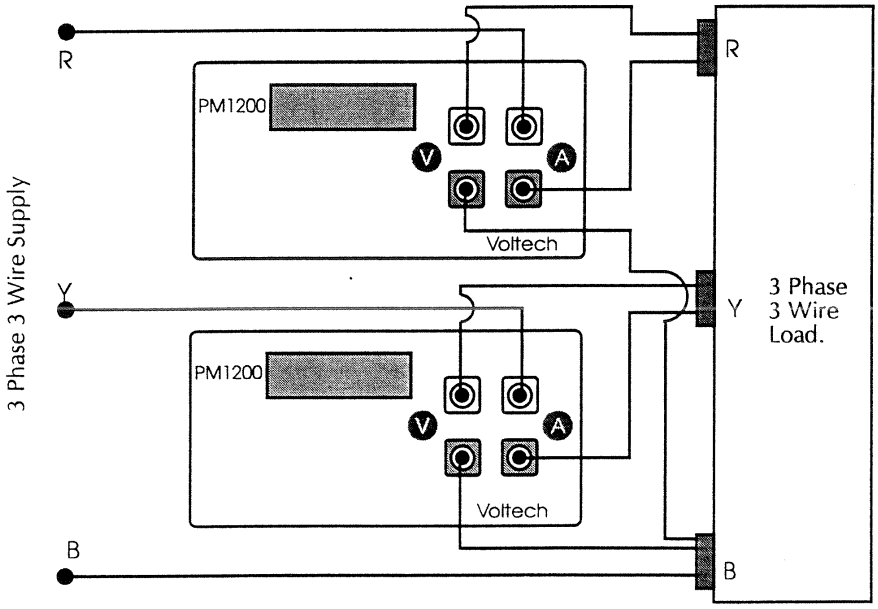


(ii) Current Transformer Connection



Three-Phase Measurement Connections

3 Phase 3 Wire (2 Readings)
P = W1 + W2
VA = (VA1 + VA2) $\sqrt{3}/2$
PF = P/VA



NOTE: For 3 Phase 4 Wire measurements - take three single-phase measurements
P = W1 + W2 + W3
VA = VA1 + VA2 + VA3
PF = P/VA

The measured functions described below are continually updated on the display when selected. A 'HOLD' function has been provided on the instrument to temporarily freeze the display value, if required. To hold the displayed value of any selected function, simply depress the [LOCAL] pushbutton. (In HOLD mode, the remote LED will flash) While in HOLD MODE it is possible to view the frozen values of other parameters by selecting the appropriate key.

Where reference in the text is made to program numbers, refer to the relevant program in section 3.18.

3.1 W - True Power

Measures accurately the power absorbed by a load or delivered from an AC source, even with distorted waveforms. The instrument is (AC + DC) coupled and therefore measures the total real power.

Connect the PM1200 as shown in the connection diagram at the front of this section and select [W]. The instrument is fully autoranging and the display will read the actual power watts.

Real power is computed as:

$$\text{Total Watts} = \frac{1}{2\pi}\int_0^{2\pi} (v \times i)\, dt$$

v represents instantaneous volts

i represents instantaneous amps

3.2 VA - Apparent Power

Determines the apparent power absorbed by a load or delivered from a source. Connect the instrument as for power measurements and select [VA]. The apparent power is displayed in volt-amperes and is calculated as

$$VA = V_{rms} \times A_{rms}$$

3.3 PF - Power Factor

Displays the true power factor of an AC load. Power factor is not cos ϕ except for undistorted waveforms; cos ϕ is merely the displacement factor of the load, a measure of the phase shift between the voltage and current waveforms. Power factor is computed as:

$$PF = \frac{\text{Watts}}{V_{rms} \times A_{rms}}$$

If the current waveform is distorted, the fundamental components of the voltage and current may well be in phase, with cos ϕ = 1, but the true power factor will be less than unity. The PM1200 computes the ratio W/VA, which is the true power factor even for distorted waveforms.

3.4 Vrms - RMS Voltage

Determines the true rms value of the input voltage, even with distorted waveforms. The input is (AC + DC) coupled, and the instrument will record the rms value of the combined AC and DC components. Only the voltage input leads need be connected for Vrms measurements. Vrms is computed as:

$$Vrms = \left[\frac{1}{2\pi}\int_0^{2\pi} v^2\, dt\right]^{1/2}$$

3.5 Arms - RMS Current

Determines the true rms value of the load current irrespective of waveform. As for Vrms, the input is (AC + DC) coupled, and displays the total RMS value. Only the current input need be connected when taking Arms measurements. Arms is computed as:

$$Arms = \left[\frac{1}{2\pi}\int_0^{2\pi} i^2\, dt\right]^{1/2}$$

3.6. VAR - Reactive Power

The PM1200 computes and displays the reactive power flow due to the phase difference between the current and voltage waveforms and due to waveform distortion. VAr is computed as:

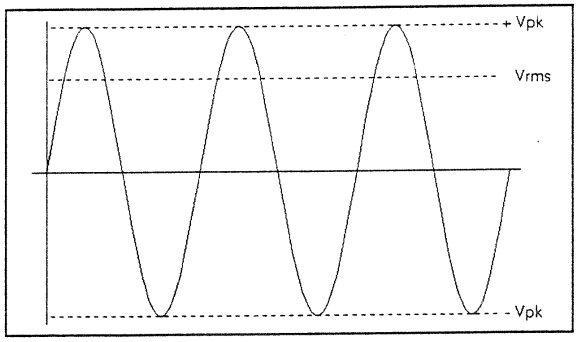
$$VAr = \left[VA^2 - Watts^2\right]^{\frac{1}{2}}$$

3.7. Vcf - Voltage Crest Factor

Displays the voltage crest factor. The value of Vcf for a pure sinewave is 1.41. A non-linear load will cause distortion of the input voltage waveform, resulting in a reduction in the value of voltage crest factor. A measurement of voltage crest factor thereby provides a useful indication of the effect of a load on the AC supply. Voltage crest factor is computed as:

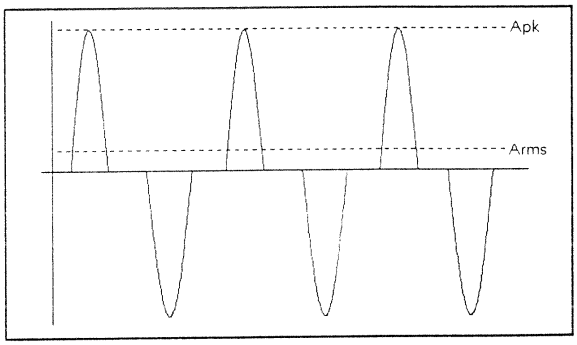
$$V_{cf} = \frac{V_{pk}}{V_{rms}}$$

.Where Vpk is the magnitude of the repetitive peak voltage, irrespective of polarity.



3.8. Acf - Current Crest Factor

Displays the current crest factor. If the load takes a sinusoidal current, Acf = 1.41. Many loads, such as a rectifier with capacitor filter produce a distorted current waveform (see following diagram) and Acf will be greater than 1.41. This measurement is useful in determining the repetitive peak current requirement of a power source. For example in a UPS installation the crest factor must be determined to ensure that the system can handle the repetitive peak current without being overloaded.



Current crest factor is computed as:

$$A_{cf} = \frac{A_{pk}}{A_{rms}}$$

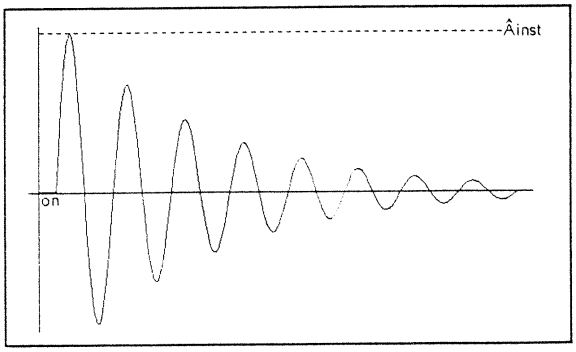
Where Apk is the magnitude of the repetitive peak current, irrespective of polarity.

3.9. Ainst - Peak Inrush Current

The PM1200 can determine the peak inrush current that flows into a load when the load is first energised. For example, an ordinary tungsten lamp passes a significantly higher current when first switched on than the current that flows when it is running.

It is useful to determine the magnitude of this current in order to correctly specify fuses and circuit breakers and to determine the effect on the AC supply feeding the load.

[Ainst] mode permits the PM1200 to work as a peak reading ammeter automatically storing the highest current peak.



To measure inrush current:

a) Connect the PM1200 in the low path of the circuit (connect the HI amps terminal to the load and the LO amps terminal to the low terminal of the source). The switch used to complete the circuit should be in the high path of the circuit.

b) Select the starting range for the inrush measurement using program 10 (PROG 10)

c) Select [Ainst]. The PM1200 is now `armed'. It is continuously scanning the signal on the current channel and is ready to display the peak value.

d) Energise AC supply by closing the switch to complete the circuit. The switch may be an electro-mechanical or a solid state switch such as the Voltech PS1000. The peak inrush current will be captured and displayed.

e) Repeat several times by de-energising the load and applying power again with the switch. Do not press the [Ainst] key: The PM1200 may have ranged upwards during the first measurement, so repeating the test ensures that the peak current is measured when set on the correct range.

3.10 FREQ - Frequency

This displays the frequency in Hz of the voltage or current input. The frequency reference is taken as the voltage input. If a voltage is not detected the current input is used. Often, the voltage and currents signals differ in frequency (e.g. PWM inverter outputs). In such cases, the frequency source can be manually selected (see PROG 26).

3.11 HARM - Harmonic Analysis

This function is used to determine the magnitude of the fundamental component and harmonics of distorted current waveforms. Many AC loads, such as DC power supplies, fluorescent lamps and thyristor convertors draw a distorted current waveform from the AC supply.

There is an increasing awareness of the need to limit the level of harmonics drawn from supply, and a number of regulatory authorities already specify limits for the harmonic content of certain loads. For example, IEC555 requires measurements to be made up to the 40th harmonic. Refer to PROG 29 for measurements to IEC552-2. In addition, the PC software supplied (PM12PC) provides a means of checking the current harmonics of a load and comparing the results with the limits set out in the IEC555 standard (Classes A, B, C and D) for steady state harmonics. Refer to section 4.6 for details.

The PM1200 will measure the harmonics of the voltage or current waveforms as follows:

a) Connect the PM1200 so that it measures the correct fundamental frequency when [FREQ] is selected.

b) Select [HARM]. The red HARM lamp will turn on to indicate that the PM1200 is in the harmonic analysis mode. The display will prompt V or A (Volts or Amps harmonics) and the VRMS and ARMS lamps will flash.

c) To determine the harmonic content of the voltage or current waveform select [VRMS] or [ARMS] respectively. The appropriate VRMS or ARMS lamp will be lit and prompt "H ___" will be displayed to indicate that the harmonic must be entered. Enter the harmonic (0-50) using the digit keys `0' to `9' and press [ENTER]. The display will show the value of the selected harmonic on the selected channel. The display flashes Hxx(harmonic number) every five seconds. Harmonic 0 (dc) will be displayed in volts or amps dc. The fundamental is displayed in volts or amps rms. Other harmonics can be displayed either in absolute units (Volts or Amps) or as a percentage depending on the selection of Program 3 (PROG 3).

d) Having obtained a selected harmonic display, other harmonics can be readily displayed by single presses of the [PROG] pushbutton (up to the maximum value of harmonic selected in PROG 7).

3.12 Harmonic Angle

To measure the phase angle of the selected harmonic, press and hold down the [SCALE] key during harmonic measurements. If both volts AC and amps AC are present at the inputs the harmonic angle is always measured relative to the voltage fundamental. Otherwise it is referenced to the current fundamental. When the [SCALE] key is released the PM1200 will return to displaying the magnitude of the selected harmonic.

3.13 THD - Total Harmonic Distortion

Determines the value of total harmonic distortion of distorted current or voltage waveforms.

a) Connect the PM1200 so that it measures the correct fundamental frequency when [FREQ] is selected. The harmonic series formula has greater accuracy at low values of THD but the computation time is longer.

b) Select the THD reference to be rms or the fundamental by means of Program 4 (see PROG 4).

c) Select the THD formula by means of Program 5 (See PROG 5).

Two formulae are available selected by Program 5

$$THD = \frac{\sqrt{rms^2 - H1^2}}{THD\ ref} \times 100\%$$

Valid 3% - 199.9%

or

$$THD = \frac{\sqrt{\sum H_2^2 \text{ to } H_N^2}}{THD\ ref} \times 100\%$$

valid 0.1% - 199.9%

Where H_N is the maximum harmonic selected in PROG 7. H_2-H_N are given in absolute values. If odd harmonics only are selected (PROG 6) then the formula only includes odd harmonics in its calculation.

d) If the sum of Harmonics formula is chosen, select the harmonics to be included in the calculation using:

PROG 6 - odd harmonics only or all harmonics
PROG 7 - Maximum harmonic number
PROG 8 - include or omit dc component

e) Select [THD]. The red THD lamp will turn on to indicate that distortion is being measured and display will prompt V or A (Volts or Amps harmonics). The VRMS and ARMS lamps will flash.

f) To determine the total harmonic distortion of the voltage or current waveform select [VRMS] or [ARMS] as appropriate. The display will show the value of total harmonic distortion on the selected channel.

g) If the series harmonic formula has been selected the instrument will display BUSY until the first value has been calculated. Reduce averaging (PROG 19), if the response time is too long.

h) If PROG 5 is set to 0 and if a printout of a series of harmonics is selected in addition to THD, the printed value of THD is automatically selected to the Harmonic series formula. If this is not desired, set PROG 5 to 2. Then the printout THD will always use the difference formula.

3.14 SCALE Key - Scale

This function scales the voltage or current reading up to a maximum value of ±19,999,000,000 : 1, and down to a minimum of ±0.001.
To scale the voltage or current reading

1. Press the [SCALE] key. The scale lamp will be lit and the display will prompt V or A (Volts or Amps harmonics). The VRMS and ARMS lamps will flash.

2. To scale the voltage or current channel select [VRMS] or [ARMS] as appropriate. The display will show the presently selected scale factor. Enter a new scale factor using the numeric keys and press [ENTER].

3. The SCALE lamp will remain lit if either the voltage or current scaling factors are not unity.

To disable scaling of voltage or current readings

1. Press the [SCALE] key.

2. Select [VRMS] or [ARMS] as appropriate. The display will show the present value Enter a scaling factor of 1.

To disable scaling of voltage and current enter a scaling factor of unity for both volts and amps.

3.15 PRINT Key - Print a Measurement

Causes the result of the next measurement to be output to the printer port. This may be Centronics or RS232 (see program 22). Refer to section 4.2 for RS232 pin configuration. The printout may be operated for either display mode or background mode according to Program 1 (PROG 1). In display mode, the print key causes the display function to be printed. In background mode, the print key initiates a series of measurements of functions selected under Program 2 (including a series of harmonics if selected), and prints out all the results together. If harmonics or THD are selected, wait until the BUSY display message has cleared, before pressing [PRINT].

3.16 LOCAL Key - Local Control

This key returns control of the PM1200 to the front panel keys when under control by a host computer via the IEEE 488 or RS232 interfaces.

3.17 ENTER Key - Terminate Numeric Entry

The ENTER key is used to enter a displayed number during programming.

3.18 PROG Key - Configuration

This function is used to configure the PM1200:

1. Press the [PROG] key. The display will clear and "P" will be displayed

2. Select the program to be defined using the digit keys and then press [ENTER]. The presently configured value will be displayed.

3. Enter the value of the function and press [ENTER] to store the new configuration. Before pressing [ENTER], the data entry may be cleared by pressing the [PROG] key. To exit the configuration function without changing the contents of the selected location press [ENTER]. If the contents of the location have been changed, the display will show BUSY while the non-volatile EEPROM is being updated.

4. If the value is invalid (eg. an IEEE address must be in the range 0 - 30) then the display will return to the presently selected value.

5. During data entry, any erroneous values can be removed by pressing [PROG key].

Program Default on Power Up:

The PM1200 programs will default to the settings given below on powering up the instrument. If the user wishes to recall the last set of program settings used before the instrument was switched off, they can be recalled by pressing [PROG] entering "99" and pressing [ENTER] (program 99) directly after power up. This will overwrite the default settings.

The Default settings are:

PROG	DEFAULT VALUE
1	0
2	Volts, Amps, Watts
3	0
4	0
5	0
6	0
7	5
8	0
9	0
10	2
11	no default
12	no default
13	no default
14	0
15	100
16	0
17	0
18	1.00
19	8
22	0
23	Autoranging
24	Autoranging
25	0
26	0
27	0
28	0
29	0

Note. Programs 11, 12 and 13 always power up as previously configured. There are no default settings.

Program menu save and load (PROG 97 & 98):

A user configuration of program settings can be saved at any time, and recalled any time later (even after an unlimited number of switch off/on cycles).

One program configuration can be stored at any one time.

To save a program configuration, select PROG 97 and press [ENTER].

To load a saved configuration, select PROG 98 and press [ENTER].

PROG 0 - Printout Configuration

Program 0 is not a location but is a command to print out the present configuration of program settings to printer.

In this printout, program 2 is shown as a 16 bit selection word eg.

0000110000011000 b
↑ ↑
bit 15 bit 0

It is coded as follows:

bit 0 W selected
bit 1 VA selected
bit 2 PF selected
bit 3 VRMS selected
bit 4 ARMS selected
bit 5 VAR selected
bit 6 VCF selected
bit 7 ACF selected
bit 8 AINST selected
bit 9 FRQ selected
bit 10 VTHD selected
bit 11 ATHD selected
bit 12 VHRM selected
bit 13 AHRM selected
bit 14 N/A
bit 15 N/A

In the example above Vrms, Arms, Vthd and Athd have been selected.

PROG 1 - Print Mode

Program 1 selects "display mode" or "background mode" for printout. It only has an effect when [PRINT] key is pressed. The PM1200 always powers up in display mode.

0 - display mode
1 - background mode

PROG 2 - Background Functions Selection

Program 2 allows any combination of measurement functions to be selected in the background averaging for printout. Once program 2 has been selected the display shows P2. The functions may then be selected by

pressing the individual function keys. When selecting harmonic analysis or THD, either, or both, voltage and current may be selected in the usual way. When the selection is complete, press [ENTER]. The detailed selection of THD formula and the number of harmonics is chosen using programs 4-8.

The new selection is stored in non-volatile memory.

PROG 3 - Display Harmonics as Absolute or Percentage Values.

Program 3 selects the display units of the harmonics.

0 - display as percentage of reference (PROG 4)
1 - display as absolute value (Volts or Amps)

The selected value is stored in non-volatile memory.

PROG 4 - THD Reference

Program 4 selects the reference for the THD calculation, and harmonic percentage.

0 - reference is fundamental
1 - reference is rms value

The selected value is stored in non-volatile memory.

PROG 5 - THD Formula

Program 5 selects the formula for the THD calculation.
(see section 3.13 THD key)

0 - difference between rms and fundamental. (If a printout is selected containing harmonics, the thd will automatically change to series formula on the printout only. The display still use the same formula).
1 - harmonic series
2 - difference between rms and fundamental. (If a printout is selected containing harmonics, the difference formula will still be applied on the printout of thd. It is not automatically changed, as in setting 0);

The selected value is stored in non-volatile memory.

PROG 6 - Enable Even Harmonics

Program 6 selects if even harmonics are to be included in the harmonic series (printout or series THD).

0 - only odd harmonics
1 - even harmonics included

The selected value is stored in non-volatile memory.

PROG 7 - Maximum Harmonic

Program 7 contains a value up to a maximum of 50 which limits the maximum harmonic in a harmonic series (printout or series THD). The display prompts "H xx" where xx is the presently selected value.

The selected value is stored in non-volatile memory.

PROG 8 - Enable dc Component

Program 8 selects if harmonic zero (dc) is to be included in the harmonic series (printout or series THD).

0 - dc component excluded
1 - dc component included

The selected value is stored in non-volatile memory.

PROG 9 - Disable Auto Averaging

Program 9 selects if the averaging auto resets for significant changes of the input levels. When auto averaging is selected, the averaging will reset if consecutive input values indicate that the

input has changed significantly. This speeds up the response of the PM1200 to changes in the load conditions.

If fixed averaging is selected, the measurement value will take time to response to a significant change of input, until the averaging has revised its full store of data to the new conditions presented to it. Fixed averaging is useful when sudden load surges would normally reset the averaging and delay printouts (for example).

0 - auto averaging enabled
1 - fixed averaging

The selected value is stored in non-volatile memory.

PROG 10 - Inrush Current Start Range

Program 10 selects the current range on which the inrush current measurement starts. As changing range involves a small delay during which current peaks may be missed, it is best to start on the correct range for the peak current.

Gain Range	Peak Current
1	0.24 A
2	0.72 A
3	2.15 A
4	6.5 A
5	19.5 A
6	58 A
7	175 A

The selected value is stored in non-volatile memory.

PROG 11 - RS232 Baud Rate

Program 11 holds the selected baud rate for the RS232 interface. The following baud rates are available:

150
300
600
1200
2400
4800
9600

The selected value is stored in non-volatile memory.

PROG 12 - Computer Control Mode

Program 12 selects either RS232 or IEEE remote control operation.

0 - IEEE 488.1
1 - RS232
2 - IEEE 488.2

The selected value is stored in non-volatile memory.

PROG 13 - IEEE Address

Program 13 holds the address to which the PM1200 will respond over the IEEE. The address must be between 1 and 30.

The selected value is stored in non-volatile memory.

PROG 14 - Chart Recorder Minimum

Program 14 holds the minimum value for the selected chart recorder output. A measured value at or below this minimum will generate a chart recorder output of 0V. Values may be entered in the range -19,999,000,000 to +19,999,000,000 using the numeric keys.

The selected value is stored in non-volatile memory.

PROG 15 - Chart Recorder Maximum

Program 15 holds the maximum value for the scaled chart recorder output. A measured value at, or above, the maximum will generate a chart recorder output of 2.5V. Values may be entered in the range -19,999,000,000 to 19,999,000,000 using the numeric keys.

The selected value is stored in non-volatile memory.

PROG 16 - Chart Recorder Enable

Program 16 enables the chart recorder output. When disabled the output remains at the previous level until the PM1200 has been powered off and on again.

0 - chart recorder disabled
1 - chart recorder enabled

The selected value is stored in non-volatile memory.

PROG 17 - Integrator Enabled

Program 17 enables the integrator function of the PM1200. When enabled with PROG 17 and initiated with [PRINT], the PM1200 displays accumulated Watt hours. To cancel an initiated integration press any key. Before starting the integrator, select watts.

During integration, the elapsed integration time can be monitored momentarily by depressing the [SCALE] pushbutton.

0 - Integrator disabled
1 - Integrator enabled

The selected value is stored in non-volatile memory.

PROG 18 - Integrator Stop Time

Program 18 contains the duration in hours for which the integrator function is to run. On completion of the time, the PM1200 displays the accumulated Watt hours up to the stop time.

The selected value is stored in non-volatile memory.

PROG 19 - Averaging Depth

Program 19 contains the number of measurement cycles up to a maximum of 16 to be taken for background or display averaging.

The selected value is stored in non-volatile memory.

PROG 20 - Calibration

The PM1200 is electronically calibrated by storing calibration constants in non-volatile memory for each voltage and current channel gain range. There are no mechanical adjustments necessary for calibration.

If the PM1200 determines that any of the 14 voltage and current ranges are not calibrated when it is powered on the message "UCAL" will be displayed until the user presses any key. The PM1200 can be then used in an uncalibrated, or partially calibrated state. For example, if only voltage range 1 is calibrated then voltage measurements (VRMS, THD, FREQ, VCF and HARM V) within specified voltage levels for range 1 will be measured accurately.

PROG 21 - Print full scale calibration values.

Program 21 prints out the peak values of voltage and current for each range. Voltages are shown in the first column, current in the second column.

PROG 22 - Printer Outlet Port.

Program 22 selects the outlet port for printer.

0 = Centronics port.
1 = RS232 port.

The selected value is stored in non-volatile memory.

PROG 23 - Manual Voltage Range.

Allows manual selection of voltage range from r1 to r7. Enter the range number required and press [ENTER]. To reset to autoranging, set program 23 to r0 and press [ENTER].

The selected value is stored in non-volatile memory.

PROG 24 - Manual Current Range.

As above for manual current ranges.

PROG 25 - Digital Filter for PWM Motor Applications.

In all measurements on the PM1200 it is essential to capture the frequency measurement to ensure accurate and stable readings. For PWM applications, in which the voltage waveform contains a significant proportion of high switching frequencies, it is difficult to obtain the frequency. In the first instance try to source frequency from current (which has less associated distortion) by using program 26. If this is not fully sucessful, use the digital filter for this situation.

To use the function:

1) Select the frequency reference to be current (if possible), otherwise select voltage. Set P26=2 (or P26=1).

2) Ensure the filter is deselected to allow autoranging. (The instrument will lock the voltage and current ranges when the filter is applied). Set P25=0 to deselect the filter

3) Once the instrument has settled on voltage and current ranges, select the required PWM filter 1 to 9. 1 is the weakest filter and 9 is the most powerful. The object is to obtain;

    1. A frequency measurement of the fundamental
    2. Current and voltage measuements corresponding to the fundamental values.

As and example, the table below is a guide to the choice of filter level and motor frequency selected, and for a PWM switching frequency between 2 and 12 kHz.

Motor frequency	Filter
10Hz	filter 5
25Hz	filter 4
50Hz	filter 3
100Hz	filter 2

4) The values of Vrms and Arms displayed will be the filtered values of the voltage and current. Their value is dependent on the level of filtering.
   Choose the lowest level of filtering to enable the frequency to be measured. Then obtain the fundamental values (AH01 and VH01) using the [HARM] key. These are the values which generate power at the motor. The total Watts displayed is the power supplied to the motor.

5) If motor frequency or load conditions change to affect the level of current significantly, repeat steps 2 and 3 to ensure correct range selection.

Note: The operation of the filter can be set over the IEEE bus using,

- Q command to set the frequency source.
- V0 and W0 to allow autoranging; Vf and Wf to lock the ranges once the instrument has settled.
- X00 to deselect the filter (for autoranging); X01 to X09 for the filter level.
- B1 to inhibit low value blanking if required. (see PROG 27)

PROG 26 - Frequency Reference Source

The instrument normally operates in AUTO frequency source select. If a voltage input (with frequency) is connected, voltage is automatically selected as the frequency source. If no voltage input is connected, current is automatically selected as the frequency source. Program 26 allows the user to select voltage or current source manually.

0 - Autoselect
1 - Voltage source
2 - Current source

The selected value is stored in non-volatile memory.

PROG 27 - Display Blanking Disable

The instrument exercises a blanking of the measured value if the value becomes too low in a given range to be able to meet the specified accuracy. For example, the blanking level on the lowest voltage range is set at 2.0 volts.

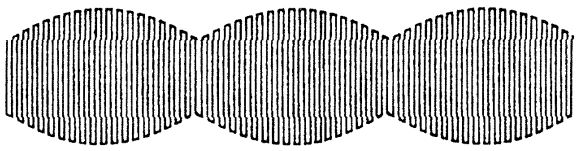
Program 27 allows you to remove this blanking.

0 - Blanking enabled
1 - Blanking disabled

The selected value is stored in non-volatile memory.

PROG 28 - Ballast Output Mode

In situations where voltage and current waveforms at high frequencies are heavily modulated by mains borne frequencies, it is difficult to make accurate measurements as the sampling is not synchronised to the 50/60 Hz modulation. This occurs frequently with lighting ballast power measurements.



20 kHz waveform, 50/60 Hz modulation

This configuration provides the option to lock to data acquisition to the 50 Hz or 60Hz line frequency. The resulting measurements are then extremely stable. Note that in this mode, the frequency displayed will be the selected line frequency of 50Hz or 60Hz (the carrier frequency is not measured). for more detailed information, refer to our Application Note 101

0 - Ballast mode disabled
1 - Ballast mode (50Hz line frequency)
2 - Ballast mode (60Hz line frequency)

The selected value is stored in non-volatile memory.

PROG 29 - IEC555-2 Measurement Mode.

The IEC555-2 Standard specifies the maximum limits for the harmonic currents taken by equipment connected to a line supply, and consuming less than 16A. The Standard states that harmonics up to the 40th should be measured.

This measurement mode uses a high speed data sampling rate (130kHz) and digital filtering. It eliminates any effects that higher frequency components in the current signal might have on the measurement of the first 40 harmonics (for example, the high frequency switching components of a PFC Boost Converter).

The available parameters for measurement are limited to Arms, Acf, Athd, Aharm and frequency. Programs P17 and P28 are not available in this mode.

Program 29 is set as follows:

0 - Disabled
1 - Enabled

The selected value is stored in non volatile memory.

Individual harmonics can be displayed in this mode by pressing [HARM] and selecting the desired harmonic number.

To print out a list of all harmonic values from H1 to H40: Select PROG 1 to 1 for background mode, and then pressing the [ENTER] key automatically prints out harmonics to the 40th. If printout of any other allowed parameter is required, it must be selected via PROG 2 (background selection).

SECTION 4

COMPUTER OPERATION

4.1 Introduction

The PM1200 is provided with serial (RS232), parallel (Centronics), IEEE488, and chart recorder interfaces as standard. The interface sockets are fitted on the rear panel of the instrument and can be used to output data. The instrument can also be configured to send data to, and be controlled by a computer fitted either with RS232 or IEEE488 interfaces.

4.2 RS232 Interface

RS232 operation is selected by setting PROG 12 to 1. The RS232 baud rate is selectable from 150 baud to 9600 baud (PROG 11).

The PM1200 will work in the local mode until it receives a valid command from the RS232 interface (if enabled) and thereafter it will only work via the RS232 until "LOCAL" is pressed.
It is possible to configure the PM1200 to print via the RS232 port, this is selected using program 22.

The RS232 connector is a 9 way male plug located on the rear panel.

RS232 9 Way `D' Plug

Pin Number	PM1200 Function	RS232 Definition
1	Unused	(CD)
2	RX	Received data
3	TX	Transmit data
4	Unused	(DTR)
5	SG	Signal ground
6	Unused	(DSR)
7	RTS	Request to send
8	CTS	Clear to send
9	Unused	(RI)

Protocol

The PM1200 can be controlled by a PC over the RS232 interface using simple text commands.

The RS232 obeys the same commands as the IEEE (488.1 command set). It uses 8 data bits, no parity, 1 stop bit and RTS/CTS handshaking.

The PM1200 operates with a simple ASCII protocol where any received characters are echoed back to the sender. On receipt of a carriage return, the command is processed and any reply is returned terminated with an idle prompt, ">". Note that this means that all commands return some character (only the idle prompt if no other data). If the PM1200 is unable to receive characters due to internal operations it will de-assert the RTS handshaking line. Due to delays in responding to the RTS line, the preferred method of communicating with the PM1200 is to wait for the echoed data before sending the next character.

The complete protocol then becomes

DO	
	send a character
	wait for echo
UNTIL	all string sent
send	carriage return ('\r' or OD, hex or 13 decimal)
DO	receive data
UNTIL	'>' received

4.3 IEEE488 Capability

The PM1200 supports both IEEE 488.1 and IEEE 488.2 operation. Refer to section 4.4 for IEEE 488.1 and section 4.5 for IEEE 488.2 guidance of use.

Select PROG 12 to 0 for IEEE 488.1 operation, or 2 for IEEE 488.2 operation. IEEE488.2 commands can be used with IEEE488.1 protocol (see 4.6.2)

The IEEE 488 interface is address selectable using PROG 13 and the address is stored in EEPROM (factory set to address 10). The IEEE functions supported are:

- Talker/listener
- Serial Poll
- Device clear
- Remote/local capability with local lockout

Response to IEEE bus messages:

A DEVICE CLEAR places the PM1200 into its power on routine. The REMOTE message allows the PM1200 to be controlled over the IEEE488 bus. In remote operation the front panel buttons, except "LOCAL" are disabled.

A LOCAL LOCKOUT message disables all front panel buttons including "LOCAL". A serial poll (spoll) will cause the PM1200 to return a status byte. This is bit-encoded:

bit 0 data ready
bit 1 background averaging full
bit 2 display averaging full
bit 3
bit 4
bit 5 uncalibrated
bit 6
bit 7

When performing background averaging of a number of functions, the spoll byte will be 0 until the averaging is full, then it will read as 2. Data may now be requested using the Read command which sets up the data to be read and sets spoll to 3. After all data has been read (last message = END OF DATA) the spoll byte will again be 2. The same data may be re-read using the Read command or new data may be acquired using the Trigger command.

The IEEE connector is a standard 24 way female amphenol socket mounted on the rear panel.

The PM1200 can be controlled over the IEEE488 bus using simple text commands. See the following section.

4.4 IEEE 488.1 Operation

4.4.1 Overview of Operation

1. Enable IEEE 488.1 control mode by selecting 0 on program 12.

2. Obtain IEEE bus address of PM1200 on Program 13. Change, if required, by entering appropriate digits. Press Enter.

3. Clear the IEEE busline and initialise PM1200 with DEVICE CLEAR command.

   Using IOTECH IEEE card example:-

   "CLEAR"

4. Select the PM1200 for computer communication by giving the REMOTE command.

   IOTECH example:-

   "REMOTE 10" (where 10 is PM1200 address).

   The PM1200 "REMOTE" L.E.D will now illuminate.

5. OUTPUT the selection of commands as given in the following pages of commands.

   IOTECH example:
   -
   "OUTPUT 10; F01"

6. A serial poll (spoll) will cause the PM1200 to return a status byte. This is bit-encoded:

   bit 0 data ready
   bit 1 background averaging full
   bit 2 display averaging full
   bit 3
   bit 4
   bit 5 uncalibrated
   bit 6
   bit 7

   When performing background averaging of a number of functions, the spoll byte will be 0 until the averaging is full, then it will read as 2. Data may now be requested using the read command which sets up the data to be read and sets spoll to 3. After all data has been read (last message = END OF DATA) the spoll byte will again be 2. The same data may be re-read using the Read command or new data may be acquired using the Trigger command.

7. Once data has been sent to the output buffer, it can be read by the computer using the READ command.

   IOTECH example:-

   "ENTER 10"

4.4.2 Example: IEEE Data Acquisition

The following example program is written for an IOTECH bus card, and PM1200 address 10. It returns data for Vrms, Arms, Vharm and Aharm (to the fifth harmonic) using the background averaging.

```
'     open ieee 488 input and output files
start:  CLS
        OPEN "\dev\ieeeout" FOR OUTPUT AS #1
        IOCTL #1, "BREAK"
        PRINT #1, "RESET"
        OPEN "\dev\ieeein" FOR INPUT AS #2
'-------------------------------------------------------
'  program setup, send commands for selection required
'
        PRINT #1, "CLEAR 10"          (resets the IEEE bus and PM1200)
        GOSUB delay1
        PRINT #1, "REMOTE 10"         (selects the PM1200 for computer communication)
        PRINT #1, "OUTPUT 10;M1"      (sets up a single shot trigger)
        PRINT #1, "OUTPUT 10;L050"    (max. harmonic = 5, odd only)
        PRINT #1, "OUTPUT 10;S00"     (resets background selection list)
        PRINT #1, "OUTPUT 10;S04"     (selects Vrms)
        PRINT #1, "OUTPUT 10;S05"     (selects Arms)
        PRINT #1, "OUTPUT 10;S20"     (selects V Harmonic)
        PRINT #1, "OUTPUT 10;S21"     (selects A Harmonic)
        PRINT #1, "OUTPUT 10;A04"     (averaging depth 4)
        PRINT #1, "OUTPUT 10;T"       (triggers the values to be captured)
        GOSUB spoll
        PRINT #1, "OUTPUT 10;R"       (read results onto output buffer)
        GOSUB spoll1
        WHILE a$ <> "END OF DATA!"
        PRINT #1, "ENTER 10;"; "LF"
        INPUT #2, a$
        LPRINT ; a$
        GOSUB delay1
        WEND
        END
'-------------------------------------------------------
spoll:  spoll = 0
        WHILE spoll <> 2
        PRINT #1, "SPOLL 10"  (serial poll - wait for spoll = 2)
        INPUT #2, spoll
        spoll = spoll AND 2
        WEND
        RETURN
'-------------------------------------------------------
spoll1: spoll = 0
        WHILE spoll <> 3
        PRINT #1, "SPOLL 10"
(serial poll - wait for spoll = 3)
        INPUT #2, spoll
        spoll = spoll AND 3
        WEND
        RETURN
'-------------------------------------------------------
delay1: t1 = TIMER
1       t2 = TIMER
        IF t2 - t1 < 1 THEN GOTO 1
        RETURN
```

Results:

```
Vrms   2.52190 V
Arms   0.05027 A
VH1    2.51940 V      100.00%        0.0 deg
VH3    0.00543 V        0.20%      - 13.0 deg
VH5    0.00137 V        0.04%      - 45.4 deg
AH1    0.05023 A      100.00%      -359.9deg
AH3    0.00008 A        0.16%      - 45.0 deg
AH5    0.00005 A        0.09%      - 56.4 deg
END OF DATA!
```

4.4.3. Commands

The IEEE488.1 commands are listed below.

Axxy: Background Averaging (P19/P9)

Sets the background averaging to the required depth from 1 - 16. Higher values take longer before results are ready but give more stable values

xx = 2 digits 01 - 16
y = A (or no entry)

leading zero is required. A00 = autoaveraging with depth 16. The y extension sets the averaging as auto or fixed (prog 9). Set y = A (or `a') for auto, otherwise it is fixed.

Bx: Display Blanking Disable (P27)

Enables/disables display blanking

x = 1 digit 0 or 1

Dx: THD Formula (P5)

Sets the THD formula

x = 1 digit 0 or 1

0 = difference between rms and H1
1 = harmonic series

Fxx: Set and Return Display Function

Sets the displayed function and returns the selected data.

xx = 2 digits 01 - 24, as shown below.
The leading zero is required

Format command	Return String
01	Watts
02	VA
03	VAr
04	Vrms
05	Arms
06	PF
08	Inrush Current
09	VCF
10	ACF
12	watt hours
20	Voltage Harmonics
21	Current harmonics
22	Voltage THD
23	Current THD
24	Frequency

Note 1: For WATT HOURS, it is necessary to set up the INTEGRATOR (I command) and send trigger (T command) before the F command.

example:
output 10 ; I1
output 10 ; T
output 10 ; F12

If required, preset the integration time with the P command.

Note 2: For voltage and current harmonics, (F20 and F21), it is necessary to send the S and H commands prior to the F command.

example:
output 10; S20
output 10; H20
output 10; F20

Note 3: For voltage THD and current THD (F22 and F23) it is necessary to send the S command prior to the F command

example:
output 10; S22
output 10; F22

Gx: THD Reference (P4)

Sets the THD reference

x = 1 digit 0 or 1

0 = fundamental
1 = rms

Hxx: Harmonic Number (before F20/21)

Sets the harmonic number prior to an F command to read a single harmonic.

xx = 2 digits 01 - 50

Ix: Integrator Enable (P17)

Enables or disables integrator mode. (Needs to be followed by trigger command to set watt-hours mode).

x = single digit0 or 1

0 = Integrator disabled
1 = Integrator enabled

Jxxxxx: Current Scaling

Sets CURRENT scaling

xxxxx = combination of digits, +, - and.
19999000000 to 0.001

(no restriction to number of digits entered).

Kxxxxx: Voltage Scaling

Sets VOLTAGE scaling

xxxxx = combination of digits, +, - and.
19999000000 to 0.001
(no restriction to number of digits entered).

Lxxy: Harmonic Analysis Setup (P6/P7)

Sets up the harmonic analysis for a series of harmonics.

xx = 01 to 50
y = 0 or 1

Maximum harmonic is set from 1 to 50. Odd or even harmonics are selected by the y value (y = 0, only odd value, y = 1, even values included).

Mx: Operational Mode (P1)

Sets the operational mode of the instrument - Mode 0 is display mode, Modes 1 and 2 are background modes. In Mode 1, a trigger command starts the background averaging which on completion, stores the results to be read (R command). In Mode 2, after the first trigger command the unit continually retriggers and stores the latest data to be read (R command). Thus in Mode 1, the data which will be read is the data available at the time of the trigger command. In Mode 2, the data which will be read is the data present at the time of the read command.

x = Single digit 0 - 2

0 = display mode
1 = single shot background
2 = repeat background

Nx: Enable DC Component (P8)

Selects the DC component in the harmonic series.

x = Single digit 0 or 1

0 = ac coupled
1 = ac and dc coupled

Pxxxxx: Integrator Run Time (P18)

Sets the integrator run time in hours

xxxxx = combination of digits, and "."

Qx: Frequency Reference (P26)

Sets the frequency reference source

x = single digit 0, 1 or 2

0 = auto
1 = voltage source
2 = current source

R: Read Data

Return background averaging data. Selected combination of data returned (refer to S command)

Reads the data from the background averaging (if available) into the output buffer. The SPOLL byte should be checked for available data before attempting to read using the R command. (The spoll byte should be 2 before the read command, and 3 after the read command).

Note: Once the data has been read to the output buffer (SPOLL = 3), the data can be transferred to the computer, one parameter at a time. To read all parameters selected to the computer, repeat the computer read command until "END OF DATA".

Sxx: Sets Background Selection (P2)

Sets the displayed function and enters the parameter to the background averaging selection list.

xx = 2 digits 00 - 24

Leading zero is required. Assigned parameters as in F command.

Note: S00 resets the selection by clearing the background list. If this is not entered, the S commands will add to those already existing in the background list.

T: Trigger

Initiates a background analysis of S commands, or the integrator. It is not valid after F commands or in mode 0 (M = 0).

Vx: Sets Manual Voltage Range (P23)

Sets the manual (or automatic) voltage range.

x = Single digit 0-7, or F (or f)

Enter value 1 to 7 according to manual range required. Enter 0 to reset to autoranging. If F (or f) is selected it locks the existing range.

Wx: Sets Manual Current Range (P24)

Sets the manual (or automatic) current range.

x = single digit 0-7, or F (or f)

Enter value 1 to 7 according to manual range required. Enter 0 to reset to autoranging. If F (or f) is selected, it locks the existing range.

Xxx: Digital Filter (P25)

Sets the level of the digital filter for PWM analysis.

xx = 2 digits 00 to 01

00 = Filter disabled
01 - 09 = Level of filtering

Z: Serial Number Send

Sends the instrument serial number to the P.C.

4.5 IEEE 488.2 Operation

4.5.1 Selection

To enable IEEE 488.2 control mode, select 2 on program 12.

4.5.2.Command structure

Commands and replies are passed as a sequence of ASCII letters and numbers terminated by either a line feed or an EOI (hardware signal for 'end of instruction').
Upper and lower case letters are treated equally and all white-space characters are ignored. Thus to set manual voltage range 6:

```
output 09; :RNG:VLT:FIX 6
output 09; :rng:vlt:fix6
output 09; :Rng :Vlt :Fix     6
```

all have exactly the same effect (although it takes longer to transmit strings with more characters).

Commands may be one of two types- common or device. Common commands (and common '*' character eg.

```
output 09; *TRG
```

Device commands are defined by the manufacturer of each instrument, and Voltech instruments' device commands are preceded by a ':' character eg.

```
output 09; :RNG:VLT:FIX 6
```

This allows the instrument to continue to support the IEEE 488.1 command set alongside the new IEEE488.2 command set and automatically distinguish between the commands. Where there is a direct incompatibility (such as in the status reporting) the instrument must be configured for IEEE488.2 operation (select 2 on program 12).

Commands may be cascaded if separated by ';'. If a reply is waiting to be read, further commands are received and buffered but will not be executed until the reply buffer has been read.

Data replies may only be sent in response to a query message which ends with a question mark. The data is returned either as an integer (NR1 numeric response type) or in scientific format with 4½ digit signed mantissa and 2 digit signed exponent (NR3 numeric response type). Data may be entered as integer, integer with decimals, or scientific eg. to set target power factor, the following commandshave the same effect:

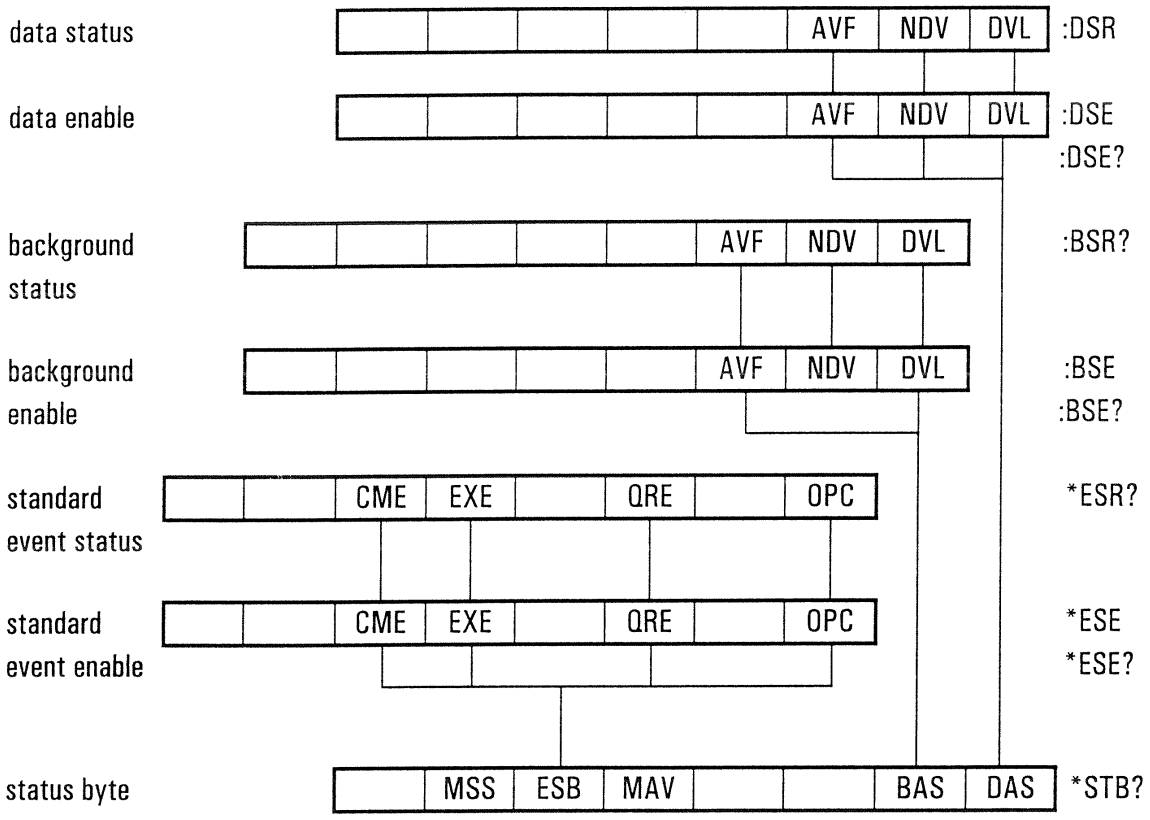
```
output 09; :cfg 2, 1
output 09; :cfg 2, 1.00
output 09; :cfg 2, 1.0000E+00
```

Program examples are given in details for the :BRD? and :FRD? commands which follow.

4.5.3. Status reporting

The IEEE488.2 status byte contains the mandatory MSS, ESB and MAV bits with two instrument specific summary bits, BAS and DAS.

The enable registers are set by the user, and act as a mask to reflect chosen elements of the appropriate status registers to the Status Byte Register. Transparency is set by setting the appropriate bit of the enable register to 1. If any of the status registers are read, the register is reset to zero.



4.5.3.1 Status byte register

Read by *STB? or serial poll

	MSS	ESB	MAV			BAS	DAS

DAS summary bit to show display data available

BAS summary bit to show background data available

MAV set whenever there is a message available in the output buffer

ESB summary bit to show standard event status

MSS master summary status set as a result of the logical bitwise AND of the status byte register with the service request enable register.

Note that the serial poll register is the same as the status byte register except that bit 6 (MSS in stb, RQS in serial poll) is controlled in order to generate the service request.

4.5.3.2 Background status

Read by :BSR? or in summary by *STB? BAS bit

					AVF	NDV	DVL

DVL set to indicate the availability of data

NDV set to indicate that new data has become available since the last :BSR? command

AVF set to indicate that the averaging is full to the specified depth

4.5.3.3 Display Data status

Read by :DSR? or in summary by *STB? DAS bit

					AVF	NDV	DVL

DVL set to indicate the avaliability of data

NDV set to indicate that new data has become available since the last :DSR? command

AVF set to indicate that the averaging is full to the specified depth

4.5.3.4 Standard event status

Read by *ESR? on in summary by *STB? ESB bit

		CME	EXE		QRE		OPC

OPC operation complete (data available)

QRE unterminated query error

EXE execution error

CME command error

4.5.4 Available commands

:AVG	set averaging
Class	device command
Return type	none
Format	:AVG :FIX depth AUT
Options	:FIX set fixed averaging :AUT set auto averaging depth 1-16
Example	CMD > output 10; :AVG:FIX 16

:BAL	Set ballast/ultrasonic mode
Class	device command
Return type	none
Format	:BAL:50H 60H
Options	:50H set ballast mode for lock to 50Hz :60H set ballast mode for lock to 60Hz
Example	CMD > output 10; :BAL:50H

:BRD?	Read background data
Class	device query
Return type	arbitrary ASCII response data
Format	:BRD?
Options	none
Return format	sequence of data strings terminated by "END"
Example	1. Select the functions you want to read. OUTPUT 10; :SEL:CLR; :SEL:VLT; :SEL:AMP OUTPUT 10; :SEL:VHM 2. Select the averaging depth. OUTPUT 10; :AVG:FIX 16 3. Select all harmonics (odd and even) and set maximum harmonic to 7. OUTPUT 10; :HMX:ALL 7 4. Enable checking for AVG(bit 2). OUTPUT 10; :BSE 4 5. Select background mode. OUTPUT 10; :MOD 1 6. Send a trigger. OUTPUT 10; *TRG 7. Repeatedly check the spoll byte until BAS(bit 1) goes high. SPOLL 10 SPOLL 10 SPOLL 10

.
.
.
SPOLL 10

8. Request the data to be read.
OUTPUT 10; :BRD?

All results are comma separated and up to 8 are returned on any one line. Any extra will be sent on subsequent lines until all results have been sent. At this point an "END" string is sent signifying the end of the results block.

In the above example, the following would be returned:-
ENTER 10
2.460E2,2.236E-1,2.458E2,1.0000E2,0.000E-1,2.046E-1,8.000E-2,-3.181E2
ENTER 10
2.203E0,8.900E-1,-2.431E2,1.3089E-1,5.000E-2,-2.710E1,8.027E0,3.260E0
ENTER 10
0.000E-1,2.070E-2,0.000E-1,-1.7230E2,2.134E0,8.600E-1,-8.500E0
ENTER 10
"END"
Where,

VRMS = 2.460E2	ARMS = 2.236E-1
VH1_MAG = 2.458E2	VH1_REF = 1.0000E2
VH2_MAG = 2.046E-1	VH2_REF = 8.000E-2
VH3_MAG = 2.203E0	VH3_REF = 8.900E-1
VH4_MAG = 1.3089E-1	VH4_REF = 5.000E-2
VH5_MAG = 8.027E0	VH5_REF = 3.260E0
VH6_MAG = 2.070E-2	VH6_REF = 0.000E-1
VH7_MAG = 2.134E0	VH7_REF = 8.600E-1
VH1_LAG = 0.000E-1	VH2_LAG = -3.181E2
VH3_LAG = -2.431E2	VH4_LAG = -2.710E1
VH5_LAG = 0.000E-1	VH6_LAG = -1.7230E2
VH7_LAG = -8.500E0	

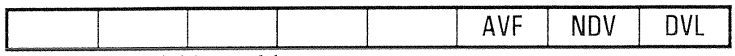
Notes

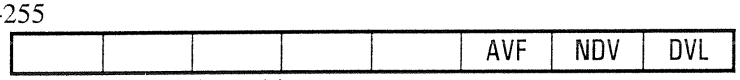
This command reads data which has been previously prepared by a trigger command.

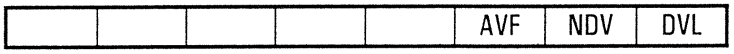
Functions in :BRD? are returned in the following order. (If the function is not selected, then it does not appear).
1. WATTS 2. VA 3. PF 4. VRMS 5. ARMS
6. VAR 7. VCF 8. ACF 9. FREQ 10. VTHD
11. ATHD 12. VHARM (magnitude) 13. VHARM (%ref)
14. VHARM (phase angle) 15. AHARM (magnitude)
16. AHARM(%ref) 17. AHARM (phase angle)

Harmonics retrieved using :BRD?

H0	Magnitude only
H1-H49	Magnitude, % of reference & phase angle.

:BSE	Set background data status enable register
Class	device command
Return type	none
Format	:BSE data
Options	none
Data format	0-255
	
	DVL - data available enable NDV - new data available enable AVF - averaging full enable
Example	CMD> output 10; :BSE 4
Notes	The BAS bit in the serial poll status byte is set according to the logical bitwise AND of the background data status register and the background data status enable register.

:BSE?	Read background data status enable register
Class	device query
Return type	NR1 numerical response data
Format	:BSE?
Options	none
Return format	0-255
	
	DVL - data available enable NDV - new data available enable AVF - averaging full enable
Example	CMD> output 10; :BSE? CMD> enter 10 4
Notes	The BAS bit in the serial poll status byte is set according to the logical bitwise AND of the background data status register and the background data status enable register.

:BSR?	Read background data status register
Class	device query
Return type	NR1 numerical response data
Format	:BSR?
Options	none
Return format	0-255
	
	DVL - data available NDV - new data available AVF - averaging full
Example	CMD> output 10; :BSR? CMD> enter 10 7

Notes	This command clears the background data status register. The BAS bit in the serial poll status byte is set according to the logical bitwise AND of the background data status register and the background data status enable register.

:CAL	Calibrate
Class	device command
Return type	none
Format	:CAL:PWD pass :CAL:VLT range, value AMP :CAL:END pass
Options	:PWD enter password to start calibration :VLT calibrate voltage :AMP calibrate current :END end calibration and save values in EEPROM pass calibration password 0-9999 range range to be calibrated 1-7 value measured value
Return format	none
Example	CMD> output 10; :CAL:PWD 1234 CMD> output 10; :CAL:VLT 3, 1.2345 CMD> output 10; :CAL:END 1234

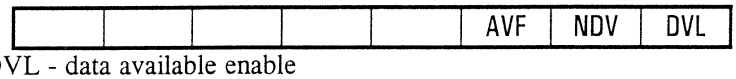
:CAL?	Read calibration values
Class	device query
Return type	NR3 numerical response data or string response data
Format	:CAL:VLT? range AMP
Options	:VLT read voltage calibration :AMP read current calibration range range calibrated 1-7
Return format	4½ digit signed mantissa with 2 digit exponent "** UNCAL **"
Example	CMD> output 10; :CAL:VLT? 3 CMD> enter 10 +0.0673E00
Notes	This represents the calibration correction for the given channel. The calibrated value of an input is given by: actual value = measured value x (1 + calibration)

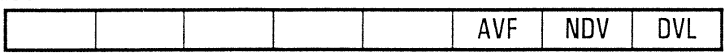
:CFG	Configure
Class	device command
Return type	none
Format	:CFG prog, data
Options	prog integer program location 0-29 data appropriate integer of floating point data
Return format	none
Example	CMD> output 10; :CFG 6, 1

Notes	The prog number is the program selected from the configurable list (eg 6 will select P6 for harmonic calculations). See section 4.5.5 for full listing of configurable programs.

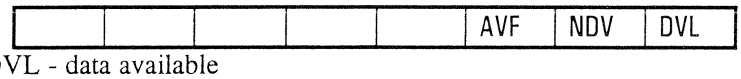
:CFG?	Read configuration
Class	device query
Return type	NR1 numerical response data or NR3 numerical response data
Format	:CFG? prog
Options	prog integer program location 0-29
Return format	integer or floating point data as appropriate
Example	CMD > output 10; :CFG? 6 CMD > enter 10 1

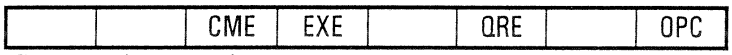
*CLS	Clear standard event status register
Class	common command
Return type	none
Format	*CLS
Options	none
Return format	none
Example	CMD > output 10; *CLS

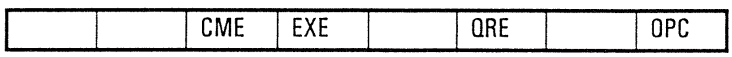
:DSE	Set data status enable register
Class	device command
Return type	none
Format	:DSE data
Options	none
Data format	0-255
	
	DVL - data available enable NDV - new data available enable AVF - averaging full enable
Example	CMD > output 10; :DSE 2
Notes	The DAS bit in the serial poll status byte is set according to the logical bitwise AND of the data status register and the data status enable register.

:DSE?	Read data status enable register
Class	device query
Return type	NR1 numerical response data
Format	:DSE?
Options	none
Return format	0-255
	
	DVL - data available enable NDV - new data available enable AVF - averaging full enable
Example	CMD > output 10; :DSE? CMD > enter 10 2

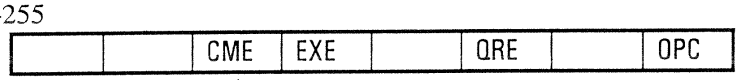
Notes	The DAS bit in the serial poll status byte is set according to the logical bitwise AND of the data status register and the data status enable register.

:DSR?	Read data status register
Class	device query
Return type	NR1 numerical response data
Format	:DSR?
Options	none
Return format	0-255
	
	DVL - data available NDV - new data available AVF - averaging full
Example	CMD> output 10; :DSR? CMD> enter 10 7
Notes	This command clears the data status register. The DAS bit in the serial poll status byte is set according to the logical bitwise AND of the data status register and the data status enable register.

*ESE	Set standard event status enable register
Class	common command
Return type	none
Format	*ESE flags
Data format	0-255
	
	OPC - operation complete QRE - unterminated query error EXE - execution error CME - command error
Example	CMD> output 10; *ESE 32
Notes	The ESB bit in the serial poll status byte is set according to the logical bitwise AND of the standard event status register and the standard event status enable register.

*ESE?	Read standard event status enable register
Class	common query
Return type	NR1 numeric response data
Format	*ESE?
Options	none
Return format	0-255
	
	OPC - operation complete QRE - unterminated query error EXE - execution error CME - command error

Example	CMD > output 10; *ESE? CMD > enter 10 32
Notes	The ESB bit in the serial poll status byte is set according to the logical bitwise AND of the standard event status register and the standard event status enable register.

*ESR?	**Read standard event status register**
Class	common query
Return type	NR1 numeric response data
Format	*ESR?
Options	none
Return format	0-255  OPC - operation complete QRE - unterminated query error EXE - execution error CME - command error
Example	CMD > output 10; *ESR? CMD > enter 10 1
Notes	The ESB bit in the serial poll status byte is set according to the logical bitwise AND of the standard event status register and the standard event status enable register.

:FNC?	**Read function data**
Class	device query
Return type	NR3 numerical response data
Format	:FNC function? :FNC:WAT? Watts VAS VA VAR VArs VLT Volts AMP Amps PWF Powerfactor VPK Volts peak APK Amps peak VCF Volts Crestfactor ACF Amps Crestfactor WHR Watt-Hrs VHM Voltage Harmonic AHM Current Harmonic VDF Volts Distortion ADF Current distortion FRQ Frequency
Return format	4½ digit mantissa with 2 digit exponent ±x.xxxE±xx ±1.xxxxE±xx
Example	CMD > output 10; :FNC:VLT? CMD > enter 10 +2.395E+02

Notes	Data read can be synchronised to new data values by using the NDV bit in the data status register (see :DSR?), or via the SPOLL register if the appropriate enable register is set (see :DSE)

:FRD?	**Read foreground data**
Class	device query
Return type	multiple NR3 numerical response data separated by commas, terminated by string response data, "END"
Format	:FRD?
Options	none
Return format	NR3,NR3,NR3..... (maximum 8 on one line)
Example	1 Select the functions you want to read. OUTPUT 10; :SEL:CLR; :SEL:VLT; :SEL:AMP OUTPUT 10; :SEL:PWF; :SEL:FRQ; :SEL:VAR OUTPUT 10; :SEL:VAS 2 Select the averaging depth. OUTPUT 10; :AVG:FIX 16 3. Enable checking for AVG(bit 2). OUTPUT 10; :DSE 4 4. Reset averaging. OUTPUT 10; :RAV 5. Repeatedly check the spoll byte until DAS(bit 0) goes high. SPOLL 10 SPOLL 10 SPOLL 10 . . . SPOLL 10 6. Request the data to be read. OUTPUT 10; :FRD? All results are comma separated and up to 8 are returned on any one line. Any extra will be sent on subsequent lines until all results have been sent. At this point an "END" string is sent signifying the end of the results block. In the above example, the following would be returned:- ENTER 10 5.471E1,-8.534E-1,2.448E2,2.235E-1,2.851E1,5.006E1 ENTER 10 "END" Where, VAS = 5.471E1 PF = -8.534E-1 VRMS = 2.448E2 ARMS = 2.235E-1 VAR = 2.851E1 FREQ = 5.006E1

Notes	The data to be sent is determined by the previously stored selection (see :SEL). No more than 8 values are sent on an individual line. Functions in :FRD? are returned in the following order. (If the function is not selected, then it does not appear). 1. WATTS 2. VA 3. PF 4. VRMS 5. ARMS 6. VAR 7. VCF 8. ACF 9. FREQ 10. VTHD 11. ATHD 12. VHARM (magnitude) 13. VHARM (%ref) 14. VHARM (phase angle) 15. AHARM (magnitude) 16. AHARM(%ref) 17. AHARM (phase angle) **Harmonics retrieved** H0 Magnitude only H1 Magnitude and phase angle H2-H49 Depends on the setting of P3 (Harmonic Display Mode). If P3 = 0(% of ref) then, % of reference & phase angle If P3 = 1(absolute value) then, Magnitude & phase angle.
:FSR	**Set frequency source**
Class	device command
Return type	none
Format	:FSR:VLT AMP AUT
Options	:VLT set voltage frequency source :AMP set current frequency source :AUT auto select frequency source
Return format	none
Example	CMD> output 10; :FSR:VLT
:HRM	**Set single harmonic**
Class	device command
Return type	none
Format	:HRM harm
Options	harm integer harmonic number 0-50
Return format	none
Example	CMD> output 10; :HRM 3
:HMX	**Set maximum harmonic for series**
Class	device command
Return type	none
Format	:HMX:ODD harm ALL
Options	:ODD only odd harmonics :ALL use both odd and even harmonics harm integer maximum harmonic 0-50
Return format	none
Example	CMD> output 10; :HMX:ODD 39

*IDN?	Identify
Class	common query
Return type	arbitrary ASCII response data
Format	*IDN?
Options	none
Return format	VOLTECH,PM1200,1234,version
Example	CMD> output 10; *IDN? CMD> enter 10 VOLTECH,PM1200,1234,v1.31

:IEC	Set IEC555 harmonics mode
Class	device command
Return type	none
Format	:IEC:ENB DIS
Options	:ENB enable IEC555 mode :DIS disable IEC555 mode
Return format	none
Example	CMD> output 10; :IEC:ENB
Notes	Only current parameters are valid in IEC555 mode. In background mode, a series of harmonics up to and including the 39th will be computed following a trigger.

:INT	Set up integrator
Class	device command
Return type	none
Format	:INT:ENB DIS :INT:RUN time
Options	:ENB enable integrator :DIS disable integrator :RUN enable integrator and set stop time time run time in hours
Return format	none
Example	CMD> output 10; :INT:ENB

:MOD	Set operating mode
Class	device command
Return type	none
Format	:MOD mode
Options	0 display mode 1 single shot trigger (background mode) 2 multiple shot trigger (background mode)
Return format	none
Example	CMD> output 10; :MOD 1
Note	The default value is MOD 0 This command sets the mode of data acquisition command which follows (eg :FRD? or *TRG).

*OPC	Initialise operation complete function
Class	common command
Return type	none
Format	*OPC
Options	none
Return format	none
Example	CMD > output 10; *OPC

*OPC?	Flag when operation complete
Class	common query
Return type	NR1 numeric response data
Format	*OPC?
Options	none
Return format	1
Example	CMD > output 10; *OPC CMD > output 10; *OPC? CMD > enter 10 1

:RAV	Reset averaging
Class	device command
Return type	none
Format	:RAV
Options	none
Return format	none
Example	CMD > output 10; :RAV
Notes	This command can be used to speed up the response of fixed averaging

:RNG	Set ranging
Class	device command
Return type	none
Format	:RNG:VLT:FIX range AMP :RNG:VLT:AUT AMP
Options	:VLT set voltage ranging :AMP set current ranging :FIX fixed ranging :AUT autoranging range integer range 1-7
Return format	none
Example	CMD > output 10; :RNG:AMP:FIX 5

*RST	Reset device
Class	common command
Return type	none
Format	*RST
Options	none
Return format	none
Example	CMD > output 10; *RST

:RTR	Set retrigger mode
Class	device command
Return type	none
Format	:RTR:ENB DIS
Options	:ENB retrigger after completion of next trigger :DIS do not retrigger
Return format	none
Example	CMD > output 10; :RTR:ENB
Notes	If retrigger is selected then background data will repeatedly be updated and the latest data will be sent when read (see :BRD?). If retrigger is not selected then the background data will be stored and may be read sometime later.

:SCL	Set scaling
Class	device command
Return type	none
Format	:SCL:VLT scale AMP
Options	:VLT set voltage scaling :AMP set current scaling
Return format	none
Example	CMD > output 10; :SCL:AMP 99.34

:SEL	Select function list
Class	device command
Return type	none
Format	:SEL:CLR WAT Watts VAS VA VAR VAr VLT Volts AMP Current PWF Powerfactor VPK Volts peak APK Current peak VCF Voltage crestfactor ACF Current crestfactor WHR Watt-Hrs VHM Voltage harmonic AHM Current harmonic VDF Volts distortion ADF Current distortion FRQ Frequency
Options	:CLR clears entire selection others set selection for that function
Return format	none
Example	CMD > output 10; :SEL:CLR CMD > output 10; :SEL:VLT; :SEL:WAT; :SEL:AMP

Do not work.

4.6 Voltech PM12PC IEEE software with IEC555 current limit checking

4.6.1 Introduction

This software is designed to run with an IBM compatible PC fitted with an IEEE interface card suchas IOTECH 488B or NATIONAL PCII/IIA (see appendix note for setup details). It allows you to configure and run the PM1200 for harmonic analysis from your PC, storing the measured results in files which can be viewed from the main menu. The harmonic data can be easily viewed as bargraphs and reconstructed into current and voltage waveforms.

A special feature of this software is its IEC555 current harmonic limit checking. The setup menu allows you to select class A,B,C or D as the IEC555 standard against which the results are compared:

- The PC displays a banner message to advise pass/fail status compared to the chosen standard when the results are returned to the PC.
- The filed harmonic results are listed against the IEC limits, and individual harmonics are verified as passed or failed.
- The bargraphs display the harmonics and the chosen IEC555 limits for an overview of the harmonic performance of the load under test.

An additional useful feature is the ability to playback acquired measurement data at any time, with or without a different IEC555 class limit, to review data and graphs. In addition, external data files obtained from the PM1200 (suchas from a datatracker) can be easily imported into the software using this mode to allow limit checking and waveform synthesis.

4.6.2 Installing, startup and the main menu

We recommend that the software is run from the hard disk drive for speed and performance. To install, insert the disk and type "install" after the drive prompt. Screen prompts will guide you to execute the procedure. To start the program, type "run". This presents you with the main menu page supplying the following options:

Select options
Run options
View results file
Display harmonics
Print results file
Play Back data file
EXit to Dos

Options are selected using the cursor controlled by the
arrowed keys, or by using the highlighted hotkeys. A brief
description of each option is given below.

4.6.3 Demonstration example

An example set of results is stored on this software to demonstrate its use. You will find this data in the file PM12PC.DAT, derived from running the setup file PM12PC.IEE. The load under test was a switched mode power supply. From the main menu, you can view the results, display the graphs and use the playback function to re-analyse the data under different IEC555 class limits by following the guidance given below.

4.6.4 Select options

This option allows you to set up configuration of the PM1200. Press ENTER (or S) to select. A window appears with previous setup programs and "New File". Use the cursor to select an existing file that you want to edit, or select New File to create one.

If New File is selected, the display will prompt for a filename. Eight character names with a .IEE extension are allowed. You do not need to type the extension.

The display then presents the PM1200 setup menu. The menu is conveniently set up for standard IEC555 current harmonic measurements to class A. Note the controls at the bottom of the screen, which are accessed by the cursor or hotkeys. Select EDIT to change PM1200 configuration or IEC class.

The cursor moves into the setup field. To adjust any parameter, use the spacebar to change it, and the number keys for data entry. Pressing ENTER when the cursor is over "Function Select" will reveal a window for function measurement selection.

To exit the setup, press the ESCAPE key and select SAVE.

4.6.5 Run options

On selecting this option, a window is revealed with program files available to be run (the list may be longer than the available window - to access the hidden files run the cursor down the list). Choose the file to be run with the cursor and press ENTER.

The program first offers you the choice of changing the data file to which the results will be sent. This allows you to rerun the same setup file and retain the data for each
run in separately named files. The filename can be up to eight characters, terminated with a .DAT extension. You do not need to type the extension.

Thereafter, the program continues automatically, advising status on the PC screen. On completion,the program returns to the main menu page.

4.6.6 View results file

You can view the last set of readings obtained from the PM1200 by entering this option. Alternatively, you can view previous data by the Playback option (see later).

The file presents the following information:

- The returned data from the PM1200.
- A table comparing the measured harmonic data with the selected IEC class limits. See the attached example.

To exit this option press the ESC key.

4.6.7 Display harmonics

The harmonic results stored in the Viewdata file can be examined graphically, and reconstructed into current and voltage waveforms in this option. The graphs can be printed by using the PRINT SCREEN key if you are operating your PC on DOS 5.0 or higher.

The software will normally recognise the type of graphics adapter you are using on your PC. If you experience difficulty in obtaining graphic displays it is because it has failed to recognise the adapter. In this case, you will need to set up the CONFIG.VPM file on this disk to correct this situation. See the appendix note for details.

The harmonic bargraphs display the harmonics and the IEC limits if selected. If the current bargraph values are very small compared to the displayed IEC limits, you can obtain better resolution by rerunning the data through the Playback option with no limits set.

4.6.8 Print results file

The results currently stored in the Viewdata file can be printed using this option.

4.6.9 Play back data file

This option allows you to rerun data obtained from either the PM1200 directly or imported from a datatracker, with an option to reselect the IEC 555 limits applied.

Press ENTER to select the option and a window appears containing all data files with .DAT extensions. In addition the Newfile option allows you to select a data file for review which does not have this extension (eg from a datatracker). Choose the file to run with the cursor, and then you are given the option to change the limits applied. The program will reprocess the chosen data into the Viewdata file and graphic displays, and then returns to the main menu. You can then use the View results file and Display options to inspect the data.

Note that to review a data file under IEC classes C and D limits, the file must contain power factor data and power data respectively.

4.6.10: The CONFIG.VPM File

As described in Display Harmonics, you can use this file to set up for graphic display in cases of difficulty.

Exit to DOS from the main menu and type

ed config.vpm

and press ENTER. Now type into the file the # command for screen type. For example, for an ega screen adapter;

#screen = ega

Now press ALT X,enter,followed by Y to save the changes.

Return to the main menu and use Playback to rerun the data into the Viewdata file. You should now be able to view the graphs in the Display option. Once this has been set up for your PC, there will be no further need to adjust the software.

4.6.11: Setup of IEEE interface cards

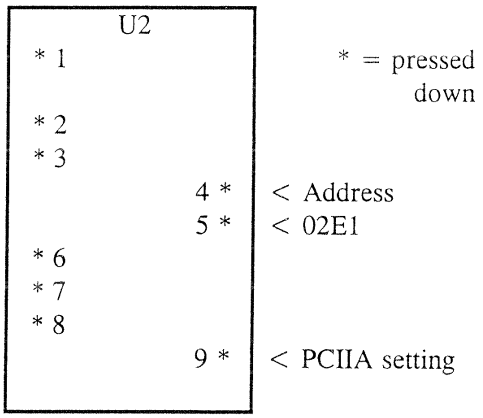
This software will operate with a wide range of IEEE interface cards, provided that they are set up correctly. The RUN.BAT file sets up the IEEE card as a system controller (SC) on bus address 21 (B21) with DMA transfers set for channel 1. Its I/O port address is set at A&H02E1.

It is generally only necessary to change the I/O address to obtain successful communication. Details of settings are outlined below for two popular cards, IOTECH 488B and NATIONAL PCII/IIA.

IOTECH 488B: There is no need to make any adjustments to the standard factory default settings on this card.

NATIONAL PCII/IIA: This needs to be set for address 02E1 and PCIIA operation as below. The jumper settings are;

IRQ7.....interrupt level 7
DRQ1 and DRCK1.....DMA channel 1



SECTION 5

CALIBRATION

5.1 Equipment Required for Calibration

1. Multimeter 5½ digit minimum Vac, Vdc, Aac ±0.01%.
2. Variable Voltage Source 0 - 500 Vac RMS, 50/60Hz
   (If it is necessary to check the instrument at any other frequency then suitable variable frequency voltage and current generator is required).
3. Variable current source 0 - 18 Amps ac RMS, 50/60Hz.
4. Precision current shunts 20A ±0.01%.

Apply mains power and leave for a minimum of 20 minutes for unit to adjust to room temperature. Ambient must be between 19 and 23 degrees Celsius. Should a parameter be out of limits refer to the adjustment section of this manual.

5.2 VRMS Functions

Select VRMS. Connect AC voltage generator to `V' terminals of PM1200. Leave the `A' terminals unconnected. Apply the following voltages at 50/60 Hz and allow reading to settle before taking results.

7.7	Vac RMS
15	Vac RMS
30	Vac RMS
60	Vac RMS
120	Vac RMS
245	Vac RMS
500	Vac RMS

Accuracy should be ±0.1% of reading ±0.1% of range ± 1 digit.

5.3 ARMS Function

Select ARMS. Remove voltage generator from `V' terminal and link Vhi and Vlo together. Connect AC current generator to the current terminal. Inject the following currents at 50/60 Hz and allow readings to settle before taking results.

120	mA	RMS
40	mA	RMS
1	A	RMS
3	A	RMS
9	A	RMS
18	A	RMS

Accuracy should be ±0.1% of reading ±0.1% range ± 1 digit.

5.4 Watts, VA and PF Functions

Apply the following voltages and currents at 50/60 Hz with voltages in phase with current. (Power Factor = 1.000). Allow reading to settle before taking results.

a)	250V	Vac	RMS
	80mA	Aac	RMS
b)	5.5V	Vac	RMS
	10A	Aac	RMS

Take measurements of watts, VA and PF.

Watts and VA accuracy should be better than a) ±140mW b) ±370mW.
PF accuracy should be ± 0.001 of reading ± 1 digit.

5.5 Frequency Function

Apply 15V ac at 50/60 Hz into "V" terminals. Select Freq and take measurement when reading has settled. Accuracy should be ± 0.2% of reading.

5.6 Other Functions

All other functions are computed from same data used to calculate Vrms and Arms. As they are mathematically derived it is unnecessary to calibrate these functions separately.

5.7 Calibration Procedure

The PM1200 is electronically calibrated by storing calibration constants in non-volatile memory for each voltage and current channel gain range. There are no mechanical adjustments necessary for calibration.

Apply ac power and leave for a minimum of 20 minutes for the unit to adjust to room temperature. Ambient temperature should be between 19 and 23 degrees Celsius.

1. After selecting PROG 20, the message "CALP" is displayed briefly followed by the prompt "---". Enter the calibration password (factory set to 1200).

   The calibration password may be changed at this point by pressing [SCALE]. Otherwise press [ENTER] twice.

   If the [SCALE] key was pressed the prompt "---" is displayed. Enter a new password and press [ENTER] twice. If the password is changed ensure that a note of the new password is made. If the new password is lost or forgotten then a master password held at Voltech will allow access.

2. The display will prompt V or A and the VRMS and ARMS lamps will flash. Select the channel to be calibrated by pressing [VRMS] or [ARMS], or press the [PROG] key to finish calibration.

3. Apply a 120 Hz sinusodial ac voltage or current signal at the appropriate level (±5%) for the selection.

Gain Range	RMS Voltage	RMS Current
1	7.7 V	120 mA
2	15 V	340 mA
3	30 V	1 A
4	60 V	3 A
5	120 V	9 A
6	245 V	18 A
7	500 V	18 A

4. The message "r x" will be displayed where x is the range selected by the PM1200. If the correct input has been applied then x will be the required range and [ENTER] should be pressed. The range may be forced to another value using the numeric keys before pressing [ENTER] (this is necessary to calibrate the maximum current range).

5. The PM1200 will display BUSY until the averaging is complete, then the message will be displayed. Using a precision voltmeter measure the applied voltage or current and enter the true value of the applied signal.

6. The PM1200 will average 16 readings of the signal applied to the input terminals and use this average to compute a calibration constant.

7. If the calibration was successful the message "PASS" will be displayed. If the calibration was not successful the message "FAIL" will be displayed indicating that the fault has occurred during calibration of the selected range. On pressing ENTER the PM1200 will return to stage 2 above.

8. The calibration full scale values may be printed at any time by selecting PROG 21.