POWER-LINK

MTB1 kWh-Meter TEST UNIT

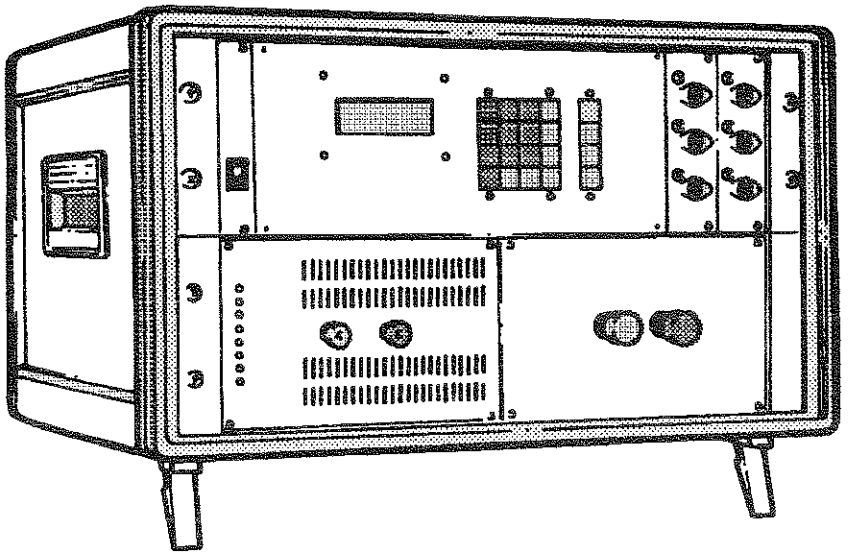
OWNER's MANUAL

Date of Issue : March 1995

Revision # : A

DEFINITION :

The **POWER LINK : MTB1** is a micro-computer controlled, stand-alone kWh-meter test and calibration set. It is able to simulate various load conditions in order to, automatically test the accuracy and print an individual test certificate for up to six kWh-meters simultaneously.



The MTB1 kWh-Meter Test Unit is supplied by :

POWER METER TECHNICS cc

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CHAPTER 1 - SAFETY PRECAUTIONS

1.1 Summary of Warnings

WARNINGS serve to attract your attention to critical procedures, situations or conditions that may lead to serious injury (or even death) of personnel if not carried out or handled correctly. The environment in which the MTB1 is used poses many potential dangers - PLEASE DO NOT IGNORE THE WARNINGS IN THIS MANUAL.

Summary :

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DO NOT CONNECT THE TEST METER TO THE MTB1 OR TOUCH THE TERMINALS WHILE THE INJECTION SET IS SWITCHED ON.
LETHAL VOLTAGE LEVELS ARE PRESENT AT THE VOLTAGE TERMINALS DURING OPERATION AND THIS POSES A SERIOUS SHOCK HAZARD.

Always ensure that the '**OFF**' indication is displayed in the LCD and that the '**HALT**' LED is illuminated before making any connections.

1.2 Summary of Cautions

CAUTIONS indicate procedures, situations or conditions that may lead to damage to the equipment if not carried out or handled correctly. To ensure cost effective and trouble-free operation of the MTB1, please do not ignore the cautions in this manual.

Summary :

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Ensure that the correct current scale is entered for the meter under test. *(E.g. Specifying a simulated output of 80A for a meter with a max. capacity of 5A, will result in complete destruction of the meter.)*

Page 6-1:

The MTB1 has no user-replaceable parts. Please do not open the housing. Please do not attempt to repair any of the internal components.

Any attempt, by the user, to open or repair the MTB1 will render the warranty nul and void.

Page B-2:

Inserting the dongle while the MTB1 is switched ON may result in damage to the parallel printer port.

CHAPTER 2 - DEFINITIONS

List of Definitions

The following meanings are intended for the definitions used in this manual :

K_h	Watt Hour per Revolution
UT	Unit under Test. The kWh meter being tested and adjusted by means of the MTB1.
INJECTION SET	The section of the MTB1 generating the simulated load for the units under test. This can also be referred to as the PHANTOM LOAD.
kWh	Kilowatt Hour

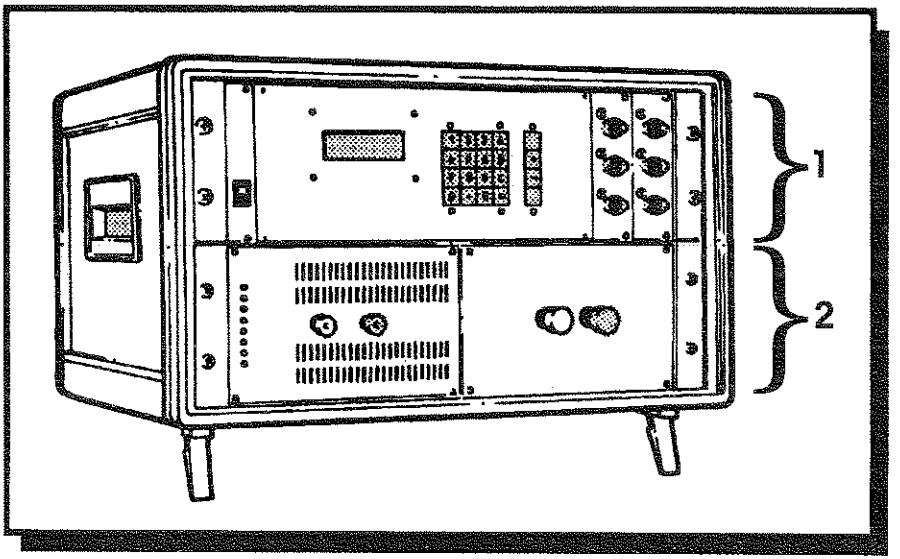

Fig. 3.1 **MTB1 Major sections**

CHAPTER 3 - GENERAL DESCRIPTION OF THE MTB1

3.1 General Overview

The MTB1 consists of two major sections : *(Refer to Fig. 3.1)*

1) **MEASUREMENT & CONTROL SET** : Controls the INJECTION SET. Counts the "rotational" or LED pulses at the meters on test. Calculates and displays the deveations from the internal sub-standard. Prints certificates for the meters tested.

2) **INJECTION SET (PHANTOM LOAD)** : Generates Voltage and Current outputs to simulate variuos load conditions to the meters on test.

The basic operation of the MTB1 is as follows:

Up to six kWh meters are connected to the Voltage and Current terminals. Various typical load conditions are simulated via the injection set to activate the meters. Optical sensors monitor the performance of each individual meter and pulses are fed back to the pulse counter.

The micro-computer uses the pulse counts received from the optical sensors as well as a generated (comparative) pulse count from an internal sub-standard to calculate the percentage deviation or fault in each meter.

The data for each meter is stored in RAM - either to print individual test certificates or to facilitate subsequent adjustments and further testing of the meters.

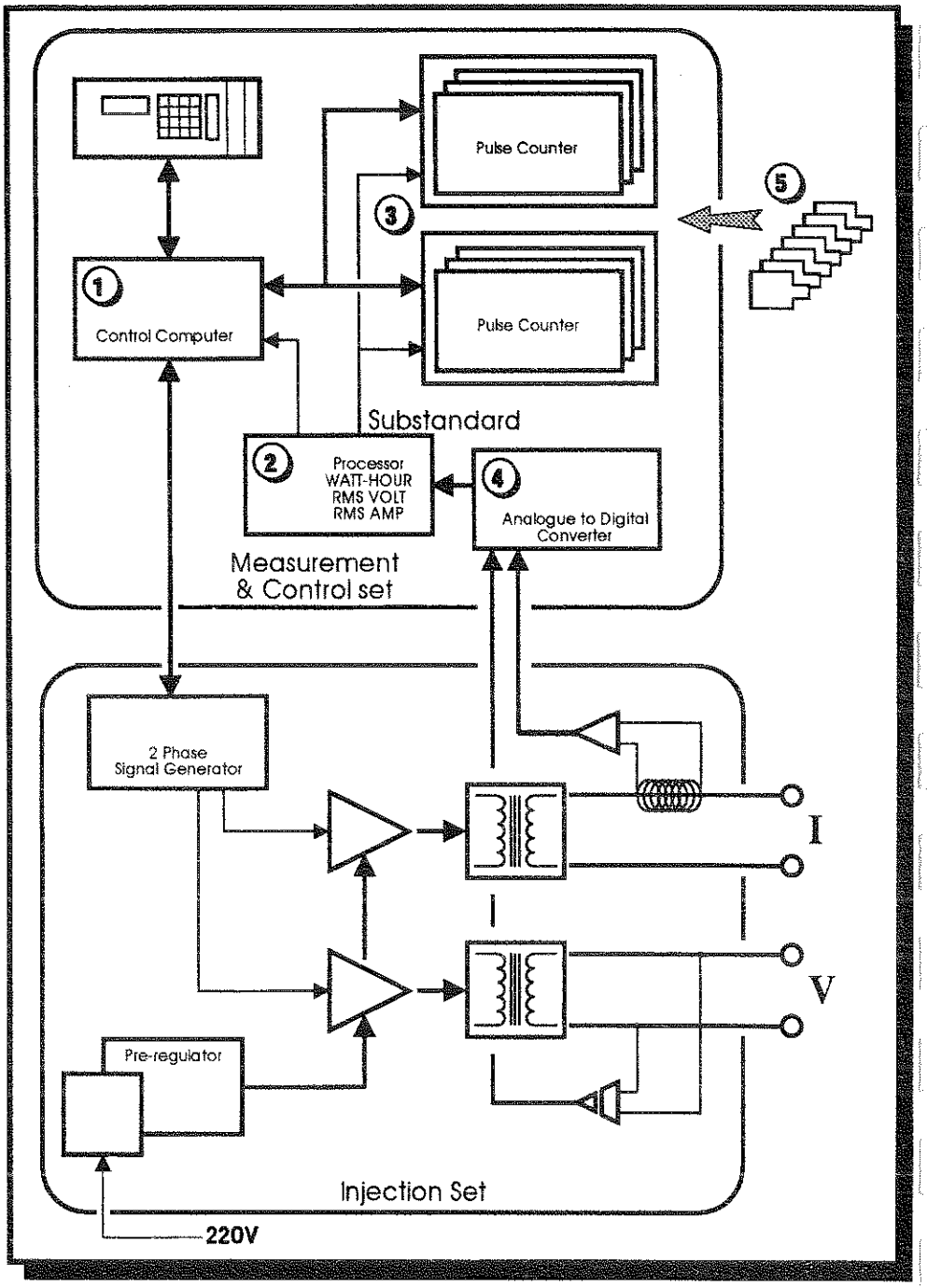

Fig. 3.2a MTB1 Measurement & Control set
(Diagrammatic Layout)

3.2 Technical Overview

MEASUREMENT & CONTROL SET : *(Refer to Fig. 3.2a)*

1. CONTROL COMPUTER

Controls the the outputs generated by the INJECTION SET. Communicates with the operator thru the LCD and KEY BOARD. Runs the test procedures instegated by the operator. Divides the meter puls counts with the internal sub-standard puls count to calculate the percentage deviation or fault of the meters on test. Displays and / or prints test results or certificates.

2. SUB-STANDARD MODULE

A micro-processor unit measuring the actual voltage, current and phase angle through which the output energy of the injection set is calculated. It represents the RMS functions as well as the Watt-hour sub-standard of the MTB1.

The measurement of power is done by means of a point-to-point calculation of the Voltage and Current output waveforms.

3. PULSE COUNTER

A set of counters monitoring the pulses recieved from the internal sub-standard as well as the pulses from the optical sensors at the meters under test. Signal processing for the optical detectors is also done by the module. Allowance is made for 6 external inputs.

4. ANALOGUE to DIGITAL CONVERTER

A unit digitising the output Voltage and Current waveforms.

5. OPTICAL SENSORS

Modulated light, beam sensors monitoring the markings on the rotating disks of the mechanical kWh meters being tested.

Note : (These are optional items and are not supplied as standard equipment with the MTB1)

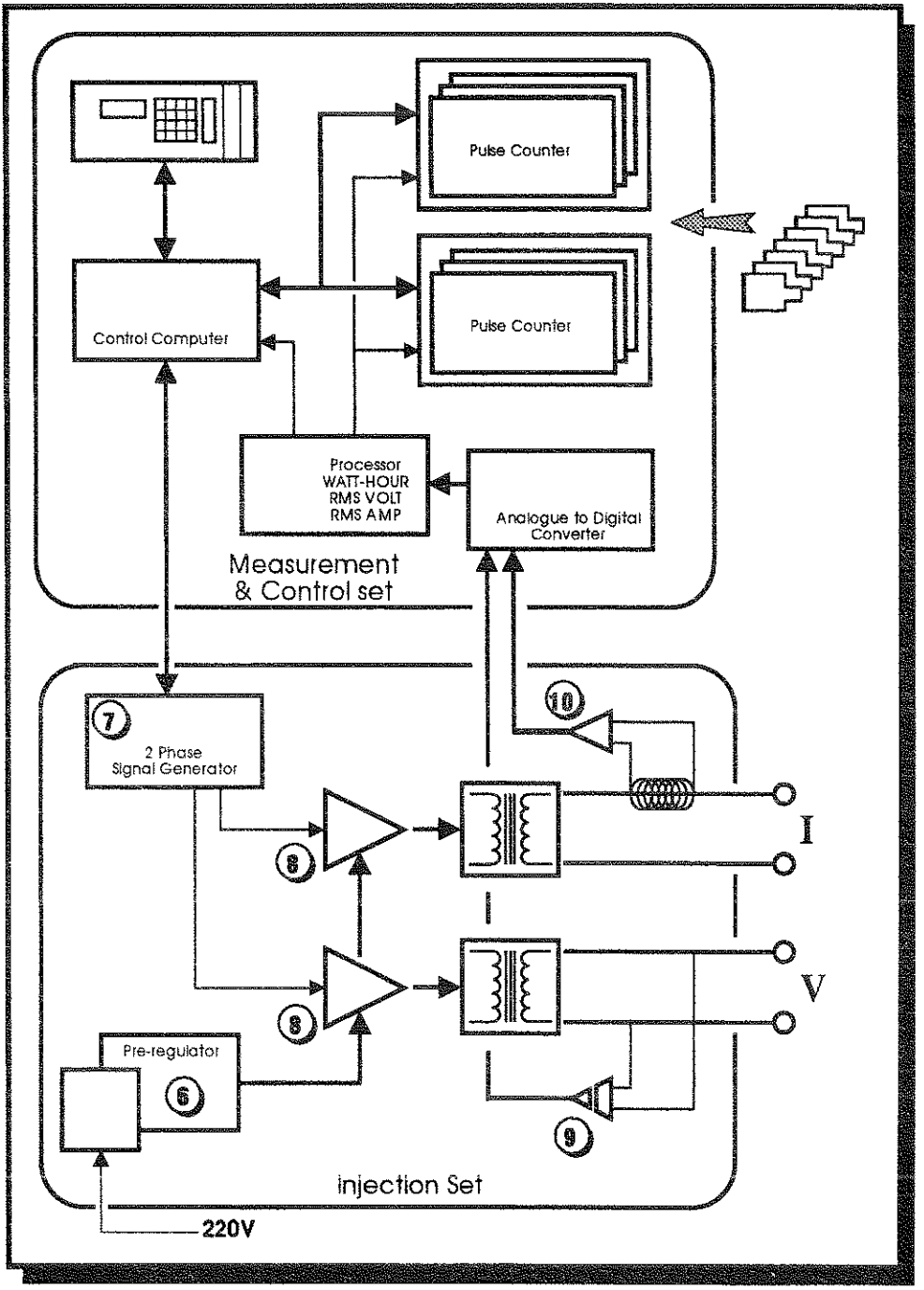

Fig. 3.2b MTB1 Injection Set (Phantom Load)
(Diagrammatic Layout)

INJECTION SET : *(Refer to Fig. 3.2b)*

6. POWER SUPPLY

A pre-regulating unit supplying power to the two amplifiers. It compensates for mains fluctuations between 200V and 250V - ensuring that the operation of the MTB1 is completely isolated from the mains supply.

7. SIGNAL GENERATOR

A generator generating the reference signals feeding the Voltage and Current apmlifiers in the Injection Set. It synthesises two waves (true sine wave or with harmonics) of which the phase angle can be adjusted digitally via the control computer. It is able to generate frequencies between 40Hz and 60Hz. The amplitude of the two reference signals are digitally adjusted and each feeds a power amplifier.

8. POWER AMPLIFIERS

Two power amplifiers consisting of high frequency pulse width, modulated bridge amplifiers, each with protection. The output of one amplifier is transformed up to nominal 220V with a range of 0V to 270V. (60VA max.). The other amplifier acts as a current source. Its output is transformed down to a nominal 5Amp (60VA max.) or 80Amp (150VA max.).

To facilitate crawl tests on electro-mechanical meters, an additional linear amplifier is used to supply a nominal 250mA output. This allows the setting of accurate and reliable currents of as low as 20mA.

Electromagnetic relays are used to connect one of the 3 current outputs to the current terminals.

9. ISOLATION AMPLIFIER

The true voltage is measured across the voltage connectors and is made available to the control computer by means of an isolation amplifier.

10. HALL-EFFECT SENSOR

The true current output is measured at the current terminal by means of a 'Hall-effect' sensor. Thus, isolation is inherent to the sensor.

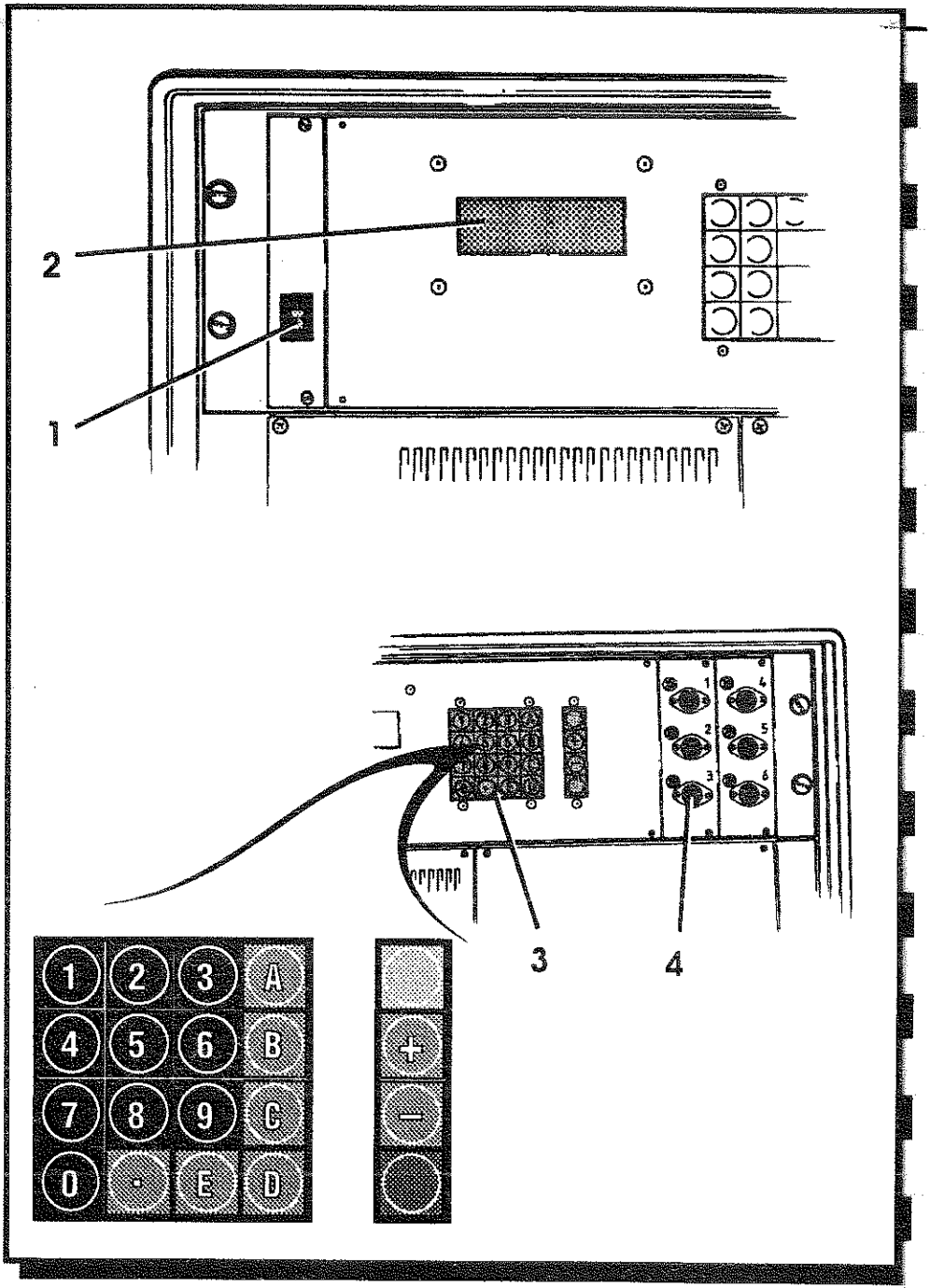

Fig. 3.3a **MTB1 Front Panel**

3.3 Front Panel

The following items are situated on the front panel of the MTB1 :
(Refer to Fig. 3.3a)

1) **Power Switch**

The switch is used to switch the mains power supply to the MTB1 ON or OFF. The switch is illuminated when switched to the ON position.

2) **LCD display**

The operator interface of the MTB1 is an LCD display with LED backlight for optimal visibility in daylight conditions. It has a display capacity of 4 lines consisting of 20 characters each.

3) **Key Pad**

The key pad is a 16 key matrix (4 x 4) as well as a column of 4 keys with the following functions :

Black keys : Entering numeric values in the various data entry fields.

Zero (0) key : Returning to the previous menu level.

Grey keys : Making menu selections.
Alternative function for **E** = ENTER
Alternative function for **D** = Delete (Backspace)

Yellow key : Starting a test.

Plus (+) key : Entering positive values in the various data entry fields.
Selecting different modes of operation.
(ie. Single / Multi-mode or Start / Stop mode)

Minus (-) key : Entering negative values in the various data entry fields.
Selecting of different modes of operation.
(ie. Single / Multi-mode or Start / Stop mode)

Red key : Switching the output of the injection set between ON and OFF.

4) **Sensor Sockets** (1 - 6)

Standard DIN (5 pin) sockets for connecting up to 6 optical sensors to the MTB1. Each socket is supplied with a 3-colour LED which indicates whether the sensor is operational as well as reflects the current test status for the particular meter tested.

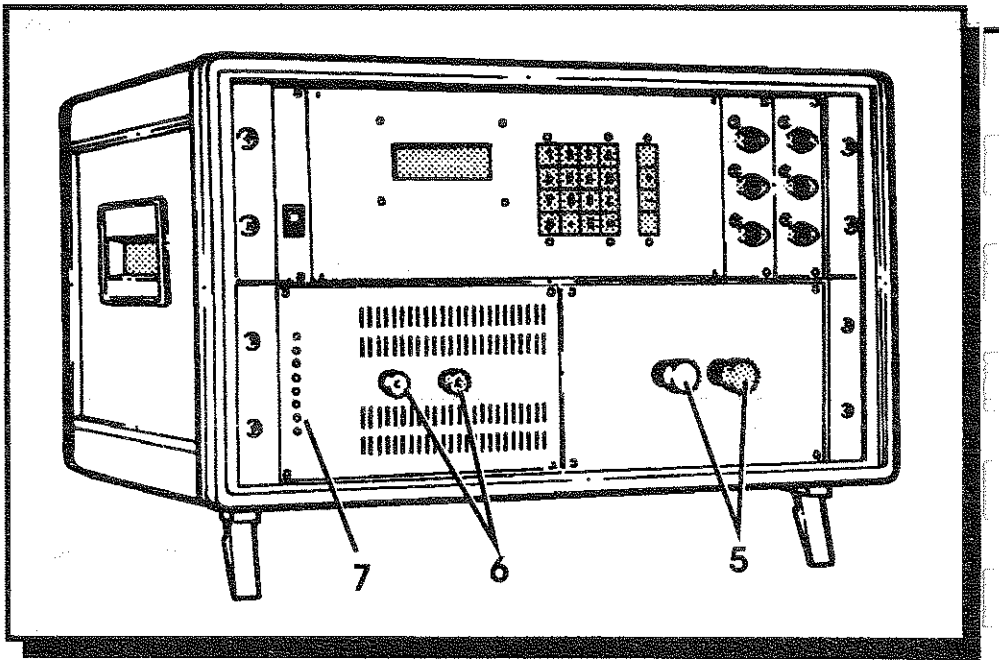

Fig. 3.3b **MTB1 Front Panel**

5) **Current Terminals** *(Refer to Fig. 3.3b)*

These terminals are the connectors for the current output of the injection set. (Left = BLACK ; Right = RED) The output is selectable as follows :

I	@	V
80A		2V
5A		12V
0,1A to 0,25A		0,1V

The terminals are fully open circuit protected.

6) **Voltage Terminals**

These terminals are the connectors for the Voltage output of the injection set and are fully short circuit protected.

7) **Status LEDs**

These LEDs are indicators for the following :

* Whether the Injection Set is switched, logically, ON or OFF.
* Correct operation of the power source of the Injection Set.
* The current scale the Injection Set is configured to. (80A or 5A or 0,1A)

The 8 LEDs are marked as follows :

- **VOLT. OVL.**
- **CUR. OVL.**
- **SYS. READY**
- **DC. READY**
- **HALT**
- **80 AMP**
- **5 AMP**
- **0,1 AMP**

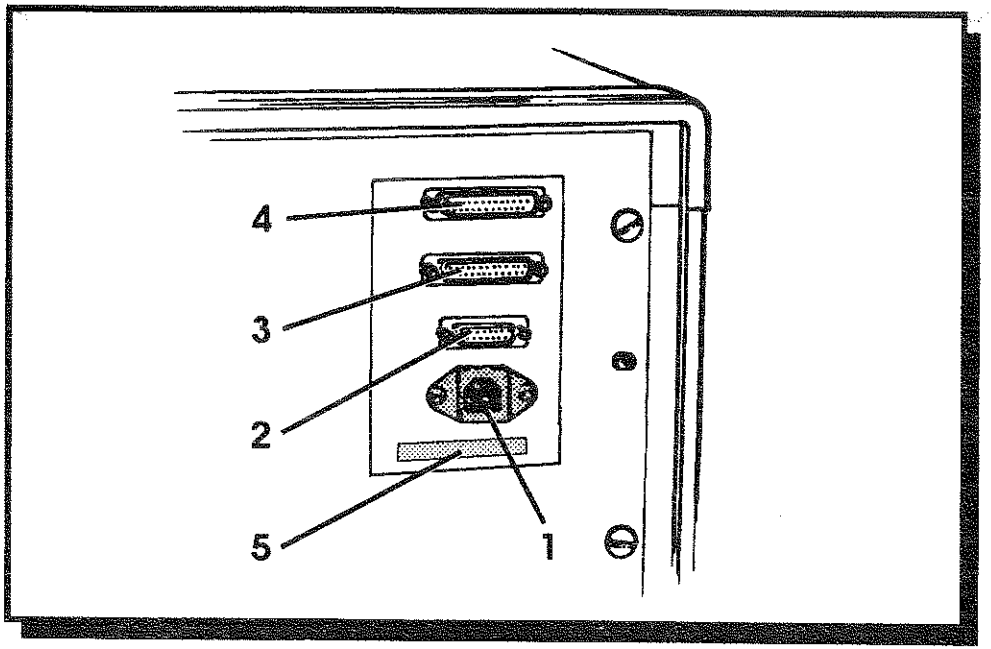

Fig. 3.4 **MTB1 Back Panel**

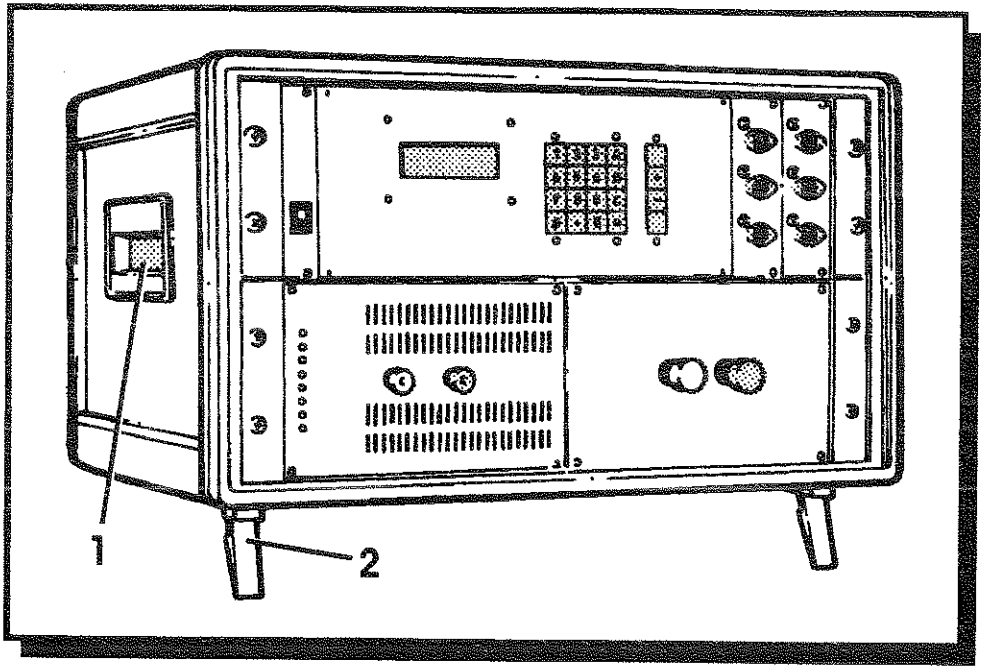

Fig. 3.5 **MTB1 Housing**

3.4 Back Panel

The following items are situated on the MTB1 back panel : *(Refer to Fig. 3.4)*

1) **AC Power Socket**
Standard IEC power connector. (Kettle plug)

2) **Options Connector**
Standard 15 pin D SUB MIN socket where the energy pulses of the internal sub-standard may be accessed.

3) **Parallel Printer Port**
Standard IBM compatible parallel port for connecting a dot matrix printer to the MTB1 for printing test certificates as well as the results of the automatic test procedures.

4) **Serial Communications Port**
Standard RS232 port for connecting the MTB1 to a PC for external manipulation of test parameters and sequences.

5) **Serial Number**

3.5 Unit Housing

The following items are fitted to the MTB1 housing : *(Refer to Fig. 3.5)*

1) **Carrying handles**

Convenient fold-away carrying handles for transportation of the MTB1.

2) **Tilt feet**

Convenient fold-away feet for tilting the MTB1 to a more user friendly angle during operation.

3.6 Optional Items

1) **Optical Sensor**

A modulated light, beam sensor for monitoring the markings on the rotating disk of the mechanical kWh meter being tested. With this type of sensor it is not necessary to remove the front cover of the meter under test during testing.

2) **Dongle**

A device fitted to the Parallel Port of the MTB1 to facilitate access to the calibration figures. *(The dongle is only available to centres authorised to calibrate and certify the MTB1 test unit.)*

CHAPTER 4 - FUNCTIONAL DESCRIPTION

4.1 Functional Overview

The MTB1 is normally used as the processing centre of a typical test bench setup. It may be operated in two modes : AUTO MODE and MANUAL MODE. Each of these modes may be used for single meter testing (Single mode) or multiple meter testing (Multi mode).

In **AUTO** mode 11 pre-programmed tests, each customised to suit a specific type or make of kWh meter, may be executed by merely entering a few test parameters. In **MANUAL** mode the test parameters and field values may be altered to suit various applications or test conditions.

Manual mode is also used during remote control of the MTB1 by means of an external PC. During 'external' operation, the components of the MTB1 are available to be used individually to measure any specific value or execute any specific test or task - even for applications other than the testing of kWh meters.

The operation of the MTB1 is controlled by a micro-computer and is completely menu driven. *(Refer to the schematic layout of the software menu structure)* The various functions are executed by selecting menu options and entering data into data fields. The operator interface is a 4 line LCD display and a 20-key key pad.

With the use of a dongle it is also possible to calibrate the various internal values to National standards.

4.2 Main Menu Structure

The functions of the MTB1 are completely menu-driven. For normal operation, the following Main Menu items are available :

A :	**MANUAL**	(Used to manually set the test conditions of the injection set)
B:	**SETUP**	(Used to pre-set the parameters of the kWh meter to be tested)
C :	**AUTO**	(Used to execute the automatic tests on a kWh meter or group of meters)
D :	**CALIBRATE**	(Used to calibrate the parameters of the MTB1)

4.3 Main Menu Items

The four Main Menu items have the following sub-menus and data fields :

A : MANUAL

This menu item is used to manually manipulate and set-up the test conditions of the injection set.

The following data fields are available :

A: V = 0.0	To enter the value of the test voltage (in Volts) required at the Voltage terminals of the Injection Set.
B: I = 0.0	To enter the value of the test current (in Ampere) required at the Current terminals of the Injection Set.
C: P = +0.00	To enter the value of the power factor for the load conditions where 1 = UNITY POWER FACTOR or 0^{o} phase shift, and 0,5 = 0,5 POWER FACTOR or 60^{o} phase shift. (ie. enter Cos Φ) This represents the phase of the Voltage & Current output to be delivered by the Injection Set.
R: (Red key)	Toggles the outputs of the injection set ON / OFF. *(Activates the outputs of the Injection Set to deliver the pre-set Voltage & Current.)*
E: R=	To enter the number of disc revolutions used in the test.
Y: (Yellow key)	To start a test using the number of revolutions entered in the field E : R=..... .
+ Key	To select normal calibration with error in percentage.
- Key	To select Start / Stop mode used for adjustments.
0 (Zero)	To return to the main menu.

The following additional special functions are available :

Key **1:**	To print the current setup of the injection set on an external printer connected to the parallel port. *(ie. the set of values entered in the various fields)*
Key **2:**	To print the actual measured values. *(ie. the actual values measured at the Voltage & Current terminals of the Injection Set.)*

Key **5:**	To toggle the current scale between 80A, 5A and 0,1A.
Key **6:**	To toggle the addition of a third harmonic distortion on the current wave ON or OFF.
Key **9:**	To enable the pulse test.
Key **.** :	To enable the entering the required frequency in Hz. *(Range between 40Hz and 60Hz)*

The following values are displayed under this menu item :

NOTE : When the Injection Set is OFF, the 'SETUP' (or required) values are displayed. When the Injection Set is ON, the 'Actual measured' values are displayed.

A:	Indicates the measured potential difference over the voltage terminals. (in Volts)
B :	Indicates the measured current through the current terminals. (in Ampere)
C :	Indicates the measured power factor. (Cos Φ)
W =	Indicates the currently imitated Watts.
%	Indicates the last measured percentage error value.

B : SETUP

This menu item is used to pre-set the parameters defining the kWh meter to be tested as well as the sub-standard (reference meter) used.

The following data fields are available :

Ref **A:** 00.0	To enter the 'KH' constant of the reference meter (sub-standard). *(Positive value = KH constant = W_h / Rev) Negative value = Revs. per kWh)*
Tst **B:** 00.0	To enter the value of the 'KH' constant of the test meter. *(Positive value = KH constant Negative value = Revs. per kWh)*
C: 00.0	To enter the number of pulses for 1 disc revolution of the reference meter (sub-standard).
D: 00.0	To enter the number of pulses for 1 disc revolution of the test meter.

Ref ▪: 0.0	To select the counter channel where the sub-standard pulses should be counted. (0 = Internal; 1,2,3 = External)
Tst E: -00.0	To select the counter input channel where the sensor monitoring the meter under test is connected. *(This field is applicable to single mode operation.)*
+ : *Plus key*	To select multi-mode. (E = Multi)
- *Minus key*	To select single-mode. (E = 1)

The following options are available under multi mode:

Tst E: Multi	To select the counter channels where the sensors monitoring the meters under test are connected. The 6 available channels are indicated as selectable options in tabular form.
Keys **1** to **6**	To select a particular channel.
+ Key	To activate the selected channel for Light / Dark transition sensitivity.
- Key	To activate the selected channel for Dark / Light transition sensitivity.
▪ Key	To disable the selected channel.
0 (Zero key)	To return to the previous menu level.
0 (Zero)	To return to the main menu

The following additional special functions are available at B: SETUP menu level :

Key **1:**	To print the current set of values entered in the various fields.

C : AUTO

This menu item is used to execute the automatic tests on a meter (or group of meters). There are 11 pre-programmed tests available. *(Please refer to Appendix A for information on the 11 sets of standard test parameters.)*

NOTE : Additional, customised test may be executed by means of the PC Interface.

The following data fields are available :

A: Test #	To enter the number of the specific, desired test (#1 to #11 may be entered).
B: Date	To enter the date on which the test is executed. This is a normal ten character text field e.g. : **01-06-1994** The format of the date entered has no effect on the test.
C: Ser#	To enter the Serial Number(s) of the meter(s) to be tested. This is a normal ten character text field e.g. : **A123-B456C** The format of the number entered has no effect on the test. All the **numeric keys** as well as the **A**, **B** and **C** key may be used. The +, - and . keys may be used as symbols.

The following Sub-menu is available under C (if in MULTI-MODE) to enter the serial numbers for up to 6 meters to be tested.

A :	Number of channel. (1 to 6)
B :	Serial number for the particular channel.

D: Print	To print a hard copy of the test parameters of the selected test sequence (1 to 11).
Y: Run	To start the selected test sequence - with the sub-sequent printing of a test certificate. *(In Multi-mode the test certificates will be printed only after all the test have been completed)*
E: Copy	To print a copy of the previous test certificate(s).
0 (Zero)	To return to the main menu.

The following additional special function is available at A : AUTO menu level :

Key 1:	To print the current set of values entered in the displayed fields.

D : CALIBRATE

This function is used to pre-set or calibrate the values of the Voltage, Current and Wattmeter to the National standards. Please note that the MTB1 may only be calibrated by a **Certified Electrical Metrology Laboratory**.

THIS FUNCTION IS NOT AVAILABLE TO NORMAL USERS.
Access to this menu is dongle protected since accidental erasure or alteration of the calibrated values renders the MTB1 useless.

The message : **CALIBRATE : NO SOFTWARE KEY** is displayed when D : CALIBRATE is selected without a proper dongle inserted into the MTB1 parallel port.

The following keys will be active and available without the use of a dongle :

Key **1** To print a hard copy of the current calibration parameters.

Key **0** To return to the Main Menu.

For information on D : CALIBRATE, please contact the manufacturer.

4.4 PC Interface

The PC interface allows full control over the functions of the individual components of the MTB1 (ie. independent control of the Voltage current source). It is used to execute test sequences with complex or unique parameters. (E.g. to plot an error curve of a kWh meter)

Please refer to Appendix B for the following information :

* *An example of a basic, 'Customised test sequence' program*
* *The MTB1 / PC Interface pin connections*
* *The PC Interface programming protocol*

CHAPTER 5 - OPERATING INSTRUCTIONS

5.1 Operating Conventions

In this chapter certain commands are given to describe and explain the menu-driven operation of the MTB1. The following commands are most commonly used :

Making a menu item selection

To select a menu item, press the key indicated for the specific item.
E.g. to select **B : SETUP** from the Main Menu, press the **B** key once.
The SETUP menu will be displayed.

Opening a data field

To open a data field, press the key indicated for the specific field.
E.g. to open the Voltage field, **A : .....** , from the Setup Menu, press the **A** key once. *The open field with a text cursor will be displayed.*

Entering data into a data field

To key in the required data into a data field, proceed as follows :

* Open the field and ensure that the text cursor is displayed.
* Press the required sequence of numerical keys followed by the E key to enter the data into the system.
  (E.g. to enter a value of 220, press **2 2 0 E**)
  (E.g. to enter a value of 0,5 press **0 . 5 E**)
* Observe that the entered value is displayed in the data field.

Editing existing field data

To edit the existing data in a data field, proceed as follows :

* Open the field and ensure that the text cursor is displayed.
* Press the **D** key *once* to delete the last digit in the field. Continue pressing **D** to delete all the digits from right to left until the field is clear.
* Enter the new value as described above.
* Observe that the entered value is displayed in the data field

Aborting a field entry during entry of data

To abort an uncompleted entry of data, proceed as follows :

* Press the **D** key to delete all the incorrect digits from the data field.
* Ensure that the field is empty and press the **E** key. *Entering an empty data field will abort the entry and accept the previous value for the field.* Please note that entering a value of **0** will not abort the entry but will result in a field value of 0.

Returning to the previous menu level

To return to the previous menu level, press the **0** key. To return to the Main Menu, press the **0** key repeatedly from anywhere in the menu structure.

Aborting a test sequence

To abort a test sequence and return to the previous menu level, press the **0** key.

An audible 'BEEP'

An audible 'BEEP' will be heard when any fault condition is encountered or when an incorrect key is pressed. This does not indicate damage to the system or loss of data. Merely correct the fault condition or press the correct key to continue the operation.

Entering the kH Constant or Revs. per Watt Hour

The energy constant stated on the name plate of various kWh meters is either expressed as **kH Constant** *(Wh / Rev.)* or **Revs. per Watt Hour** . In essence these two formats describe the same constant in the meter. It is calculated as follows : 1 000 divided by Revs. / Kwh = kH Constant The MTB1 is programmed to accommodate both formats. It distinguishes between the two formats by means of a positive or negative value.

To enter the **kH constant** in the Ref. A: 00.0 and Tst B: 00.0 fields (under B : SETUP) enter the constant as a **positive** value. (e.g. .....)

To enter the **Revs. per Watt hour** in the Ref. A: 00.0 and Tst B: 00.0 fields (under B : SETUP) enter the constant as a **negative** value.(e.g. - .....)

5.2 Pre-operational requirements

The following are important operational criteria :

1) Positive insulation of all cables and wires are imperative. *(Dangerous voltage levels are generated during testing.)*

2) Current wires should have sufficient cross-sectional area to carry a 80A current without heat build-up. *(20 mm^2 wire recommended.)*

3) A mains AC power supply with a capacity of at least 5A is required.

4) An open space of at least 200mm is required behind the unit to ensure an unobstructed air flow. *(Also, please remove loose objects, paper, etc. from behind the unit as it sucks in air at the back.)*
The unit should not be operated in an area containing excessive dust.

5) To facilitate ease of operation it is recommended that the MTB1's LCD and the meter under test are visible simultaneously.
(The best visibility on the LCD is achieved with the display window just below eye level.)

5.3 Calibrating the MTB1

THIS FUNCTION IS NOT AVAILABLE TO NORMAL USERS.
Access to this menu is dongle protected since accidental erasure or alteration of the calibrated values renders the MTB1 useless.

The message : **CALIBRATE : NO SOFTWARE KEY** is displayed when D : CALIBRATE is selected without a proper dongle inserted into the MTB1 parallel port.

The following keys will be active and available without the use of a dongle :

Key **1** To print a hard copy of the current calibration parameters

Key **0** To return to the Main Menu.

For information on the menu items under D : CALIBRATE, please refer to Appendix B.

5.4 Manual Operation (MANUAL MODE)

Manual operation is used to set the Voltage and Current to be applied to the meter under test to determine the accuracy of the meter at that particular load condition. Subsequent adjustments to the meter under test may be made until the desired accuracy is achieved.

5.4.1 Single meter calibration

To calibrate a single power meter *(Typical, 80A @ 1 pulse per rev.)* proceed as follows :

1) Ensure that all the safety precautions and pre-test procedures, as prescribed by the local authorities, have been adhered to.

2) Switch the MTB1 power switch to the **ON** position.
   * The Power ON / OFF switch will be illuminated
   * A series of 'beeps' will be heard
   * The probe indicator LEDs will be illuminated in a sequence of red, yellow and green
   * The MAIN MENU will be displayed

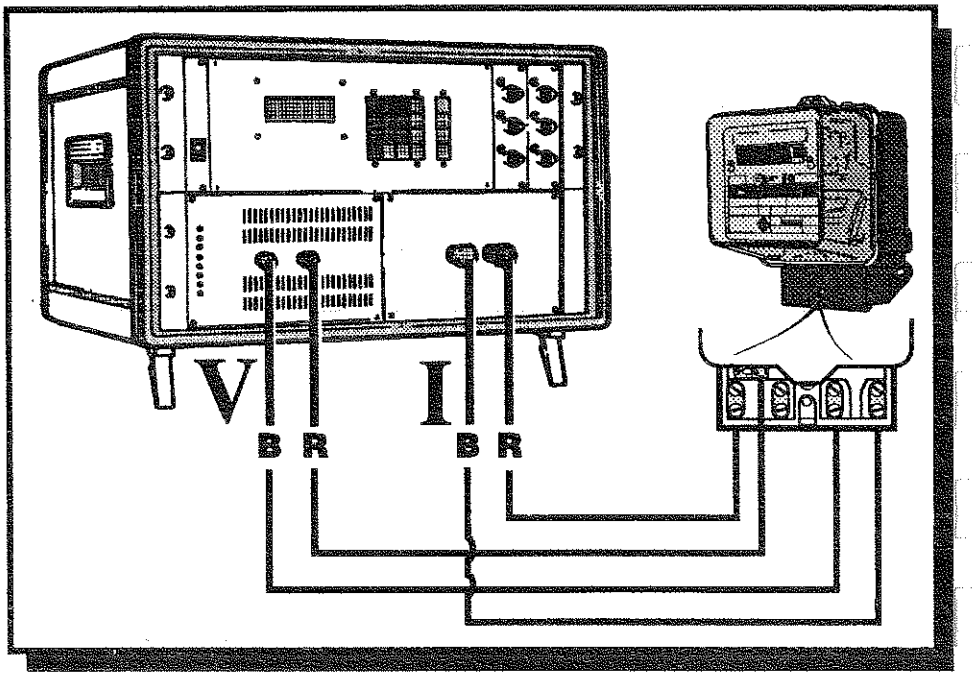

Fig. 5.4.1 **Connection of a single kWh meter**

3) Ensure that the MTB1 Injection Set is switched **OFF**. Ensure that the '**HALT**' LED is illuminated.

4) Mount the UT properly onto the test bench *(Level & Vertical)*. Ensure that the optical sensor is positioned correctly.

WARNING : DO NOT CONNECT THE TEST METER TO THE MTB1 OR TOUCH THE TERMINALS WHILE THE INJECTION SET IS SWITCHED ON.

Lethal voltage levels are present at the voltage terminals during operation and this poses a serious shock hazard.

5) Connect the UT to the MTB1 as indicated in Fig. 5.4.1
(Since only one meter is being tested, it is not necessary to remove the IP link on the line side of the meter.)

NOTE : ENSURE THAT THE CURRENT TERMINALS ARE FIRMLY TIGHTENED.

6) Press **B** to select **SETUP** from the Main Menu.

7) Press the ▪ key to select **SINGLE mode**.

8) Press **B** to open the **kH data field.** Acquire the Energy Constant of the UT from the UT name plate.

NOTE : If the **kH Constant** is given - enter it as a positive value.
If the **Revs. per kWh** is given - enter it as a negative value.

Enter the value in the field and press **E** to close the data field.

9) Press ▪ to open the **sub-standard data field**. Enter a value of **0** and press **E** to close the data field. *(0 activates the internal sub standard.)*

NOTE : The values in fields A and C are calculated automatically.

10) Connect the optical sensor cable to the connector for channel 1.

11) Press **E** to open the **sensor # field**. Enter the selected channel number **1** and press **E** to close the data field.

12) Press **D** to open the **pulse # field**. Enter the pulse count per rev. e.g. **1** and press **E** to close the data field.

13) Press **0** to return to the **Main Menu**.

NOTE : This concludes the SETUP phase of the procedure.

14) Press **A** to select **MANUAL** mode.

15) Press **A** to open the **voltage field**. Enter the nominal voltage (e.g. 220V) as indicated on the UT name plate. Press **E** to close the data field.

16) Press **B** to open the **current field**. Enter the nominal running current (e.g. 5A) as indicated on the UT name plate. Press **E** to close the data field.

CAUTION : Ensure that the **correct current scale** is entered for the meter under test. *(E.g. Specifying a simulated output of 80A for a meter with a max. capacity of 5A, will result in complete destruction of the meter.)*

17) Press **C** to open the **power factor field**. Enter unity power factor **1** and press **E** to close the data field. *It is recommended that a series of tests is always started at unity power factor.*

18) Press and briefly hold the **RED key** to switch the Injection Set logically **ON**.

* The indicator LEDs will indicate a change in status.
(HALT = off SYSTEM READY = on)

WARNING : DO NOT CONNECT THE TEST METER TO THE MTB1 OR TOUCH THE TERMINALS WHILE THE INJECTION SET IS SWITCHED ON.
LETHAL VOLTAGE LEVELS ARE PRESENT AT THE VOLTAGE TERMINAL DURING OPERATION AND THIS POSES A SERIOUS SHOCK HAZARD.

Always ensure that the '**OFF**' indication is displayed in the LCD and that the '**HALT**' LED is illuminated before making any connections.

19) Observe that the specified current and voltage levels are displayed in the display window. Also observe that the rotating disk of the UT is turning from left to right. *(If the disk is turning the other way round, please ensure that the UT is connected as indicated in Fig. 5.4.1)*

20) Press **9** to activate the **pulse test**. Align the optical sensor to achieve a constant pulse count. *(The LED at channel 1 should indicate a constant single red pulse, corresponding with the mark on the turning disk.)*

21) Press **0** to return to the **previous menu level.**

22) Press **E** to open the **rev. count field**. Enter the required amount of revolutions for the test (e.g. **5**). Press **E** to close the data field.

23) Press the **YELLOW key** to **start the test**.

* The test will start.
* The decreasing number of revolutions will be displayed.
* The previous menu will be displayed when the test is finished.
* The % accuracy of the UT will be displayed.

NOTE : A negative value indicates that the UT is turning too slow.
A positive value indicates that the UT is turning too fast.

24) Record the % fault of the UT.

25) Press **B** to open the **current field**. Enter the full load current (e.g. 40A) and press **E** to close the data field.

CAUTION : Ensure that the **correct current scale** is entered for the meter under test. *(E.g. Specifying a simulated output of 80A for a meter with a max. capacity of 5A, will result in complete destruction of the meter.)*

26) Press the **YELLOW key** to **start the test** to acquire a full load accuracy measurement.

* The test will be executed and the subsequent % fault will be displayed.

27) Adjust the full load setting on the UT and repeat the test to determine the impact of the adjustment on the accuracy. Continue testing and adjusting until the required accuracy is achieved. *(An error of less than 0,5% is normally acceptable.)*

28) Repeat steps 26 & 27 with different values for Power Factor and Current to simulate different load conditions.

NOTES :
* Due to the slow turning speed of the UT disk at light load conditions, a rev. count of 1 or 2 is recommended.
* Pressing **0** during the execution of a test, will abort the test and the previous menu will be displayed.
* Increasing the number of revolutions for a test (e.g. 20) will result in a better resolution in the % error.

29) Press the **RED** key to switch the Injection Set logically **OFF**. Ensure that the OFF status is reflected in the display window and that the HALT LED is illuminated.

NOTE : The UT may be disconnected at this stage if required.

30) Press **0** to return to the **main menu**.

The following error conditions may occur during testing :

* A 'TRIP' message will be displayed in the display window under the following conditions :

  (TRIP 1) = Shorts on the voltage cables
  (TRIP 2) = Open circuits on current cables

* To reset a trip condition, rectify the fault condition and press and hold the RED key briefly.

* To switch the system OFF in case of a more serious fault condition, press and hold the RED key intil R = OFF is displayed and the HALT LED is illuminated.

* A series of lines (dashes) will be displayed if the % error of the UT is not measurable. This indicates that the disk of the UT is not turning at all or that the kH has been entered incorrectly.

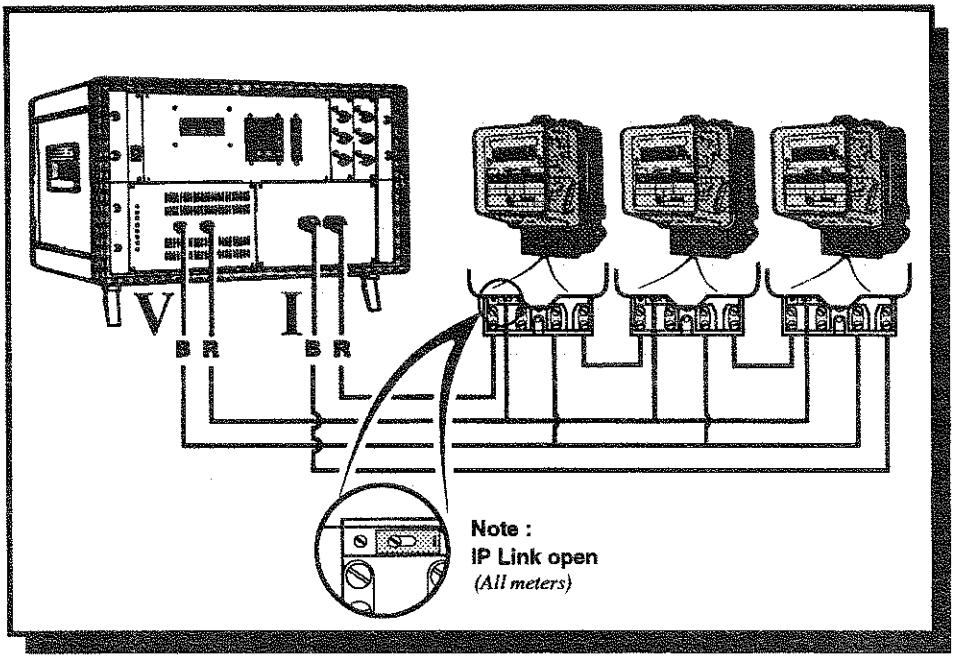

Fig. 5.4.2 Connection of multiple kWh Meters

5.4.2 Multiple meter calibration

To calibrate multiple, power meters *(Typical, 80A @ 1 pulse per rev.)* proceed as follows :

1) Ensure that all the safety precautions and pre-test procedures, as prescribed by the local authorities, have been adhered to.

2) Switch the MTB1 power switch to the **ON** position.
   * The Power ON / OFF switch will be illuminated
   * A series of 'beeps' will be heard
   * The probe indicator LEDs will be illuminated in a sequence of red, yellow and green
   * The MAIN MENU will be displayed

3) Ensure that the MTB1 Injection Set is switched **OFF**. Ensure that the '**HALT**' LED is illuminated

4) Mount the UTs *(Units under Test)* properly onto the test bench *(Level & Vertical)*. Ensure that the optical sensors are positioned correctly.

> **WARNING : DO NOT CONNECT THE TEST METERS TO THE MTB1 OR TOUCH THE TERMINALS WHILE THE INJECTION SET IS SWITCHED ON.**
> **LETHAL VOLTAGE LEVELS ARE PRESENT AT THE VOLTAGE TERMINAL DURING OPERATION AND THIS POSES A SERIOUS SHOCK HAZARD.**
>
> Always ensure that the '**OFF**' indication is displayed in the LCD and that the '**HALT**' LED is illuminated before making any connections.

5) Connect the UTs to the MTB1 as indicated in Fig. 5.4.2.
(Ensure that the IP link on the line side of all the meters are open. If the links are left closed, the voltage coil of a meter will be shunted by the current coil of the preceding meter.)

NOTE : ENSURE THAT ALL THE CURRENT TERMINALS ARE FIRMLY TIGHTENED.

6) Press **B** to select **SETUP** from the Main Menu.

7) Press the **+** key to select **MULTI mode**.

8) Press **E** to open the **Multi channel setup menu**. Press **1** to select channel number 1. Press **+** to activate the channel for 'light-to-dark' transition sensitivity. Activate all the required channels in a similar way. Press **0** to return to the previous menu.

NOTE : * Pressing **.** after a channel number will disable the channel.
* Pressing **=** after a channel number will activate the channel for 'dark-to-light' transition sensitivity.

9) Press **.** to open the **sub-standard data field**. Enter a value of **0** and press **E** to close the data field. *(0 activates the internal sub standard.)*

NOTE : The values in fields A and C are calculated automatically.

10) Connect the optical sensor cables to the channel connectors.

11) Press **D** to open the **pulse # field**. Enter the pulse count per rev. - e.g. **1** and press **E** to close the data field.

12) Press **0** to return to the **Main Menu**.

NOTE : This concludes the SETUP phase of the procedure.

13) Press **A** to select **MANUAL** mode.

14) Press **A** to open the **voltage field**. Enter the nominal voltage (e.g. 220V) as indicated on the UT name plates. Press **E** to close the data field.

15) Press **B** to open the **current field**. Enter the nominal running current (e.g. 5A) as indicated on the UT name plates. Press **E** to close the data field.

CAUTION : Ensure that the **correct current scale** is entered for the meters under test. *(E.g. Specifying a simulated output of 80A for a meter with a max. capacity of 5A, will result in complete destruction of the meter.)*

16) Press **C** to open the **power factor field**. Enter unity power factor **1** and press **E** to close the data field. *It is recommended that a series of tests is always started at unity power factor.*

17) Press and briefly hold the **RED key** to switch the unit logically ON.

* The indicator LEDs will indicate a change in status.
(HALT = off SYSTEM READY = on)

WARNING : DO NOT CONNECT THE TEST METERS TO THE MTB1 OR TOUCH THE TERMINALS WHILE THE INJECTION SET IS SWITCHED ON.
LETHAL VOLTAGE LEVELS ARE PRESENT AT THE VOLTAGE TERMINAL DURING OPERATION AND THIS POSES A SERIOUS SHOCK HAZARD.

Always ensure that the **'OFF'** indication is displayed in the LCD and that the **'HALT'** LED is illuminated before making any connections.

18) Observe that the specified current and voltage levels are displayed in the display window. Also observe that the rotating disks of all the UTs are turning from left to right. *(If a disk is turning the other way round, please ensure that the UT is connected as indicated in Fig. 5.4.2)*

19) Press **9** to activate the **pulse test**. Align the optical sensors to achieve a constant pulse count at all channels. *(The channel LED for each channel should indicate a constant single red pulse, corresponding with the mark on each turning disk.)*

20) Press **0** to return to the **previous menu level.**

21) Press **E** to open the **rev. count field**. Enter the required amount of revolutions for the test (e.g. **5**). Press **E** to close the data field.

22) Press the **YELLOW key** to **start the test**.

* The test will start.
* The decreasing number of revolutions, for each UT in turn, will be displayed.
* The previous menu will be displayed when the test is finished.
* A % accuracy table for all the UTs will be displayed.

NOTE : A negative value indicates that the UT is turning too slow.
A positive value indicates that the UT is turning too fast.

23) Record the % fault of each UT.

24) Press **0** to return to the **previous menu level.**

25) Press **B** to open the **current field**. Enter the full load current (e.g. 40A) and press **E** to close the data field.

CAUTION : Ensure that the **correct current scale** is entered for the meters under test. *(E.g. Specifying a simulated output of 80A for a meter with a max. capacity of 5A, will result in complete destruction of the meter.)*

26) Press the **YELLOW key** to **start the test** to acquire a full load accuracy measurement.

* The test will be executed and the subsequent % faults will be displayed.

27) Adjust the full load setting on each UT and repeat the test to determine the impact of the adjustment on the accuracy. Continue testing and adjusting until the required accuracy is achieved. *(An error of less than 0,5% is normally acceptable.)*

28) Repeat steps 26 & 27 with different values for Power factor and Current to simulate different load conditions.

NOTES :
* Due to the slow turning speed of the UT disk at light load conditions, a rev. count of 1 or 2 is recommended.
* Pressing **0** during the execution of a test, will abort the test and the previous menu will be displayed.
* Increasing the number of revolutions for a test (e.g. 20) will result in a better resolution in the % error.

29) Press the **RED** key to switch the Injection Set logically **OFF**. Ensure that the OFF status is reflected in the display window and that the HALT LED is illuminated.

NOTE : The UTs may be disconnected at this stage if required.

30) Press **0** to return to the **main menu**.

The following error conditions may occur during testing :

* A 'TRIP' message will be displayed in the display window under the following conditions :

  (TRIP 1) = Shorts on the voltage cables
  (TRIP 2) = Open circuits on current cables

* To reset a trip condition, rectify the fault condition and press and hold the RED key briefly.

* To switch the system OFF in case of a more serious fault condition, press and hold the RED key intil R = OFF is displayed and the HALT LED is illuminated.

* A series of lines (dashes) will be displayed if the % error of a UT is not measurable. This indicates that the disk of the UT is not turning at all or that the kH has been entered incorrectly.

5.5 Automatic Operation (AUTO MODE)

Auto Mode is used to execute the automatic tests on a meter (or group of meters) and print a test certificate. There are 11 pre-programmed tests available. *(Please refer to Appendix A for information on the 11 sets of standard test parameters.)*

5.5.1 Single meter automatic test

To execute one of the automatic test sequences for a single power meter *(Typical, 80A @ 1 pulse per rev.)* proceed as follows :

1) Complete steps 1 to 13 of the SETUP sequence for a single meter, as described on page 5-3 & 5-4. Ensure that the UT is connected properly. Do at least one Manual test to ensure that the system is connected and set-up correctly.

2) Press **A** to select **MANUAL Mode**.

3) Press **A** to open the **Voltage Field**. Enter the required Voltage (e.g. 230V) at which the tests have to be executed. Press **E** to close the field.

NOTE : The nominal Voltage at which the test will be executed, is not part of the automatic test parameters.

4) Press **0** to return to the **Main Menu**.

5) Press **C** to select **AUTO Mode**.

6) Press **A** to open the **Test # Field**. Enter the number of the test to be executed. *(Refer to Appendix A, for a list of all the available automatic test sequences.)* Press **E** to close the field.

7) Press **B** to open the **Date Field**. Enter the required date. Press **E** to close the field.

NOTE : The Date field is merely a text field. The format of the date has no effect on the test. (D = Backspace and E = Enter)

8) Press **C** to open the **Serial # Field**. Enter the serial number of the UT. Press **E** to close the field.

NOTE : The Serial # field is merely a text field. The format of the number has no effect on the test. All the **numeric keys** as well as the **A**, **B** and **C** key may be used. The +, - and . keys may be used as symbols. (D = Backspace and E = Enter)

9) Ensure that the **printer is connected** to the parallel port. Ensure that the printer is **ON** and **On-line**. Press **D** to print a copy of the test parameters of the selected test.

NOTE : A number of 'beeps' will be heard if the printer is not connected or ready.

10) Press the **Yellow Key** to start the selected test sequence. A test certificate will be printed as the test progresses.

NOTE : The test sequence may be aborted by pressing the **0** key repeatedly until the Main Menu is displayed.

11) Press **E** to print an **additional copy** of the test certificate, if required.

12) Press **0** to return to the **main menu**.

5.5.2 Multiple meter automatic test

To execute one of the automatic test sequences for multiple power meters *(Typical, 80A @ 1 pulse per rev.)* proceed as follows :

1) Complete steps 1 to 12 of the SETUP sequence for multiple meters, as described on page 5-8 & 5-9. Ensure that the UTs are connected properly. Do at least one Manual test to ensure that the system is connected and set-up correctly.

2) Press **A** to select **MANUAL Mode**.

3) Press **A** to open the **Voltage Field**. Enter the required Voltage (e.g. 230V) at which the tests have to be executed. Press **E** to close the field.

NOTE : The nominal Voltage, at which the tests will be executed, is not part of the automatic test parameters.

4) Press **0** to return to the **Main Menu**.

5) Press **C** to select **AUTO Mode**.

6) Press **A** to open the **Test # Field**. Enter the number of the test to be executed. *(Refer to Appendix A, for a list of all the available automatic test sequences.)* Press **E** to close the field.

7) Press **B** to open the **Date Field**. Enter the required date. Press **E** to close the field.

NOTE : The Date field is merely a text field. The format of the date has no effect on the test. (D = Backspace and E = Enter)

8) Press **C** to open the **Multi Serial # field**. Press **A** to open the channel number field. Enter the **channel number**. Press **E** to close the field. Press **B** to open the **Serial # field**. Enter the serial number of the UT connected to the particular channel. Press **E** to close the field. *(Enter all the required serial numbers in the same way.)*

NOTE : The Serial # field is merely a text field. The format of the number has no effect on the test. All the **numeric keys** as well as the **A**, **B** and **C** key may be used. The +, - and . keys may be used as symbols. (D = Backspace and E = Enter)

9) Press **0** to return to the **Auto Mode** menu.

10) Ensure that the **printer is connected** to the parallel port. Ensure that the printer is **ON** and **On-line**. Press **D** to print a copy of the test parameters of the selected test.

NOTE : A continuous 'beep' will be heard if the printer is not connected or ready.

11) Press the **Yellow Key** to start the selected **test sequence**.

NOTE :
* The test certificates will only be printed after completion of all the tests.
* The test sequence may be aborted by pressing the **0** key repeatedly until the Main Menu is displayed.

12) Press **E** to print an **additional copy** of all the test certificates, if required.

13) Press **0** to return to the **main menu**.

CHAPTER 6 - FAULT-FINDING ANALYSIS

CAUTION : The MTB1 has no user-replaceable parts. Please do not open the housing. Please do not attempt to repair any of the internal components.

Any attempt, by the user, to open or repair the MTB1 will render the warranty null and void.

If any difficulties arise during the operation of the MTB1 unit, the following table may be used to identify a probable cause :

Problem	**Suggested solution** *(In sequential order.)*
No audible 'beeps' or display when the unit is switched ON. Still no reaction after checking mains.	* Check mains supply * Check power cable & kettle plug * Contact supplier to report a faulty power supply or system fault.
DC Ready LED does not illuminate after automatic power-up sequence is completed.	* Retry to power-up a few times. *(e.g. Switch the MTB1 OFF and ON again.)* * Contact supplier to report a system fault
TRIP 1 message when switching the Injection Set logically **ON**, in Manual mode. *(e.g. Pressing RED key)*	* Ensure that the Voltage terminals are connected correctly and tightened firmly. * Check for any 'Short Circuit' condition in the test bench setup. * Contact supplier to report a system fault
TRIP 2 message when switching the Injection Set logically **ON**, in Manual mode. *(e.g. Pressing RED key)*	* Ensure that the Current terminals are connected correctly and tightened firmly. * Check for any 'Open Circuit' condition in the test bench setup. * Contact supplier to report a system fault
TRIP 3 message when switching the Injection Set logically **ON**, in Manual mode. *(e.g. Pressing RED key)*	* Ensure that the conditions for both TRIP 1 and TRIP 2 are in order. * Contact supplier to report a system fault

To keep a record of operational errors occurring during testing, it is suggested that the following sheets are copied and completed for future reference :

Report #	Date	Short description of error	Sign

Report # : ..... Date : ..... Technician : .....

Serial # of MTB1 unit : *(Refer to back panel)* .....

Description of error : .....

.....

.....

.....

Description of solution : .....

.....

.....

.....

.....

.....

.....

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CHAPTER 7 - MTB1 TECHNICAL DATA SHEET

OUTPUT TO KWh METERS :

VOLTAGE :	0 - 260 V	(200 mV steps)
CURRENT :	0 - 80 A	(100 mA steps)
	0 - 5 A	(5 mA steps)
	0 - 250 mA	(1 mA steps)
PHASE ANGLE :	- 180 to + 180	(0,3 dg steps)
FREQUENCY :	40 - 62 Hz	(0,1 Hz steps)

MEASUREMENT :

VOLTAGE : 12 bit resolution with true RMS calculation.

CURRENT : 12 bit resolution with true RMS calculation and phase sensing.

WATT - HOUR SUBSTANDARD :

Automatic selection of kh to suit selected current range and ensure short test runs.

For 80 A range : ≃ 50 000 pulses / kwh

For 5 A range : ≃ 400 000 pulses / kwh

PULS INPUT :

6 Inputs.
Weak pull up to 12 V.
Drive with contact closure or open collector output.

MAINS INPUT :

Fully isolated from mains.
Not dependend on mains 50 Hz
Supply 210 to 240 V AC
Load less than 600 VA

CHAPTER 8 - EXAMPLE PRINT-OUTS

Typical Test Result

POWER-LINK
Demo by Power Meter Technics
Tel : (011) 466-1632

Date : 94 . 01 . 01 Meter serial number : 1234567

230.0 volt	80.0 amp	pf = 1.0	0.63 %
230.0 volt	40.0 amp	pf = 1.0	0.40 %
230.0 volt	1.0 amp	pf = 1.0	1.10 %
230.0 volt	40.0 amp	pf = 0.5	- 0.70 %
= = = = = = = = = = = = = = =		Average error	0.71 %

Appendix A - AUTO Test Parameters

NOTE : The Voltage at which the tests are to be executed is not included in the Auto Test Parameters. In all cases the required Voltage must be specified in the **MANUAL MENU** under field **A : V =**.

TEST 1 :

TEST SEQUENCE # 1

Step	Amp	Pf	Rev
1	80.0	1.0	5
2	40.0	1.0	5
3	1.0	1.0	1
4	40.0	0.5	5

TEST 2 :

TEST SEQUENCE # 2

Step	Amp	Pf	Rev
1	80.0	1.0	10
2	40.0	1.0	10
3	1.0	1.0	2
4	40.0	0.5	10

TEST 3 :

TEST SEQUENCE # 3

Step	Amp	Pf	Rev
1	2.50	1.0	5
2	5.00	1.0	5
3	2.50	0.5	5
4	0.20	1.0	1

TEST 4 :

TEST SEQUENCE # 4			
Step	Amp	Pf	Rev
1	2.50	1.0	10
2	5.00	1.0	10
3	2.50	0.5	10
4	0.20	1.0	2

TEST 5 :

TEST SEQUENCE # 5			
Step	Amp	Pf	Rev
1	50.0	1.0	5
2	50.0	0.5	5
3	80.0	1.0	5
4	2.0	1.0	1

TEST 6 :

TEST SEQUENCE # 6			
Step	Amp	Pf	Rev
1	50.0	1.0	10
2	50.0	0.5	10
3	80.0	1.0	10
4	2.0	1.0	2

TEST 7 :

TEST SEQUENCE # 7			
Step	Amp	Pf	Rev
1	0.50	1.0	5
2	0.50	0.5	5
3	1.00	1.0	5
4	0.10	1.0	1

TEST 8 :

TEST SEQUENCE # 8			
Step	Amp	Pf	Rev
1	0.50	1.0	10
2	0.50	0.5	10
3	1.00	1.0	10
4	0.10	1.0	2

TEST 9 :

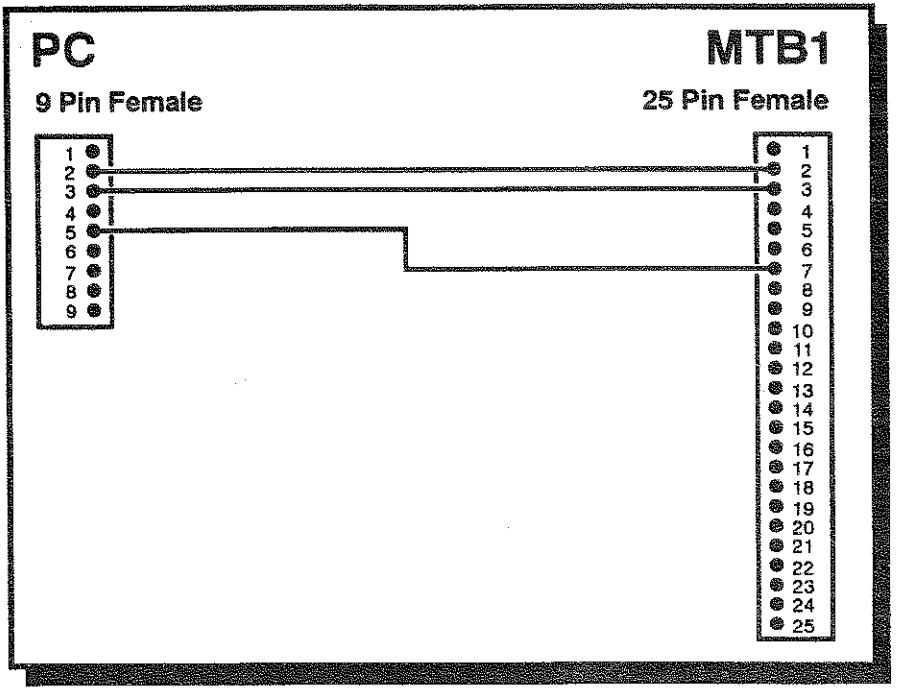
TEST SEQUENCE # 9			
Step	Amp	Pf	Rev
1	80.0	1.0	20
2	20.0	1.0	20
3	20.0	0.5	15
4	1.0	1.0	10

TEST 10 :

TEST SEQUENCE # 10			
Step	Amp	Pf	Rev
1	80.0	1.0	30000
2	40.0	1.0	30000
3	40.0	0.5	30000
4	5.0	1.0	30000

TEST 11 :

TEST SEQUENCE # 11			
Step	Amp	Pf	Rev
1	30.00	1.0	70
2	60.00	1.0	70
3	1.00	1.0	15
4	30.00	0.5	70



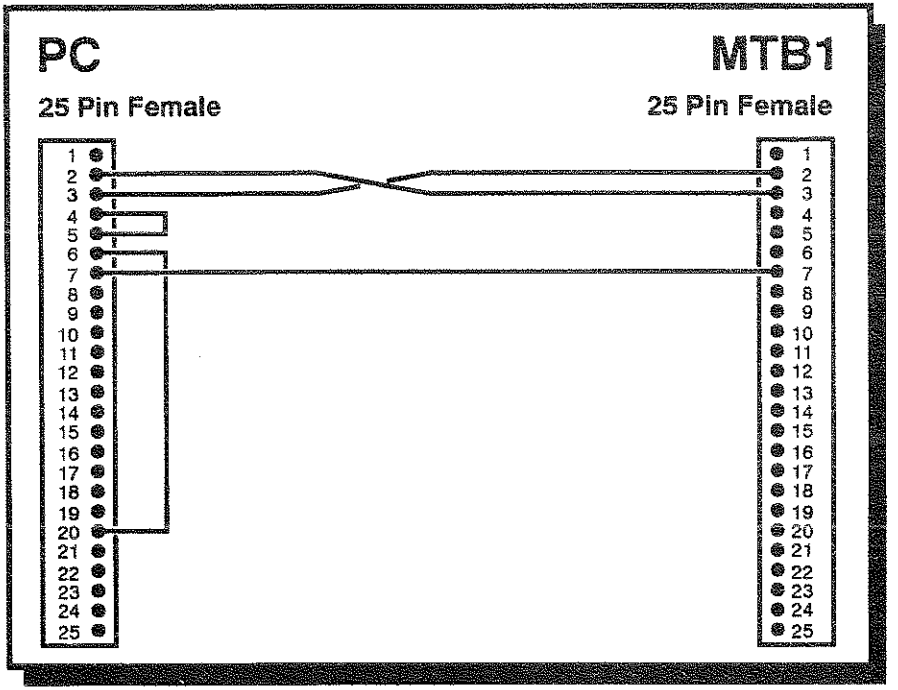


Fig. B.1 PC Interface pin connections

APPENDIX B - PC INTERFACE INFORMATION

B.1 PC Interface pin Connections

The pin connections of the RS232 cable between the PC and the MTB1 Serial port are as indicated if Fig. B.1

B.2 PC Interface Protocol

The following protocol is applicable to custom programming of the MTB1 :

* Serial port set for 2400 Baud, 8 bits, no parity, 1 stop.
* Set PC serial port to 2 stop bits.
* All commands must end with [CR].
  ([LF] may be sent but will be ignored)
* After the command is processed, it will be echoed. The read back commands will return the data after the command letter.
* Unknown commands will return " **? ! ?** " or " *** ? ! ?** ".
  If the command letter was recognised but the data part was incorrect, it will echo the command letter followed by " **?** ".
* Some commands take a while to execute. Therefore, the echo will be delayed until after completion.
* All commands will send [CR] at completion. *(No* [LF] *is sent)*

B.3 MTB1 Command List from RS232 Port.

Set parameter

Fnn.n	FREQUENCY in Hz	40.0	...	60.9
Vnnn.n	VOLTS	0	...	270.0
Inn.nn	AMPS	0	...	99.9
P+n.nn	POWER FACTOR	-1.0	...	+2.9
D+nnn	DEGREES PHASE	-180	...	+180
An	CURRENT RANGE	0 = 80A; 1 = 5A; 2 = 0.1A		
Sn	POWER ON / OFF	0 / 1		
Z	RESET FILTERS			
U	UPDATE OUTPUT	(correct outputs to set values)		
C r t p	COUNT PULSES			

r = channel reference (0 = internal sub-standard)
t = channel for meter under test
p = number of pulses / revolutions of meter under test reply with =nnnnn giving the number of pulses from ref. meter

Read parameter (Actual value measured)

v	Volts (rms)	(V)		
i	Amps (rms)	(A)		
p	Power factor			
d	Phase angle	(deg)		
f	Frequency	(Hz)		
s	Status			
k	kH factor of internal sub-standard			
a	V source control value	(0	...	4095 steps)
b	I source control value	(0	...	4095 steps)
c	Phase control value	(0	...	1023 steps)

ALPHABETICAL LIST OF ALL COMMANDS

A : Select current range 0 = 80A
1 = 5A
2 = 0.1A

B : ----

C : count pulses ref test revolutions ; R n T n P nnnn = xxxx

D : phase angle (power factor) in degrees

E : enable servo loop 0 = off 1 = on

F : frequency nn.n

G : ----

H : Select harmonics on current : 0 = off 1 = on

I : current nnn.nn

J : ----

K : ----

L : ----

M : count multi channel ref revolutions : R n P nnnn = xxxx

N : ----

O : ----

P : power factor +n.nn

Q : ----

R : ----

S : switch power : 0 = off 1 = on

T : enable channels for multi : T n n n n n n / n = 1 + edge
0 disable
- 1 - edge

U : update outputs (run servo)

V : volts nnn.nnn

W : ----

X : select phase in 3 phase mode : Xn / n = 1,2,3

Y :

Z : zero RMS filters

ALPHABETICAL LIST OF ALL COMMANDS (Cont'd)

a : V signal amplitude (0.. 4095)

b : I signal amplitude (0.. 4095)

c : Phase setting (0..1023) 512 = 0 degrees

d : Degrees measured

e : servo loop state 0 = off 1 = on

f : frequency

g : ----

h : ----

i : current

j : ----

k : actual kh

l : ----

m : ----

n : ----

o : ----

p : power factor

q : ----

r : ----

s : status 0 = 80A + 4 if switched on / + 8 if tripped
1 = 5A
2 = 0.1A

t : test channels for multi T 1x 2x 3x 4x 5x 6x / x = + + edge
= . disabled
= - - edge

u : ----

v : volts

w : watts

x : phase selected (3 phase only)

y : VA

z :

ALPHABETICAL LIST OF ALL COMMANDS (Cont'd)

* : direct control of internal values

- I current (0.. 4095)
- P power factor (0.. 1023)
- V volts (0.. 4095)

: readback of internal values

- i current rms measured (7.07 volt max)
- v voltage rms measured (7.07 volt max)
- w watt measured

? : display text from eerom

- 1 first line
- 2 second line
- 3 third line
- S serial number and version of MTB
- C current checksum

LIST OF CONTENTS

PROGRAM 2

Test of one meter :

```
10    REM DEMO2.bas
20    FALSE = 0 : TRUE = NOT FALSE
30    ' ---- open serial port and disable all handshake -----
40    OPEN "COM2:2400,n,8,2,cs,ds,rs" AS #1
50    PRINT#1,              ' get MTB in known state
60    TT=2 : GOSUB 410
70    ' set voltage , current , power factor
80    ' then turn power on and run a test on meter in channel 1
90    V=220
100   I=40
110   PF = 1
120   NREV = 5          ' number of disk revolutions to use
130   KH = 6.666        ' kh of meter to be tested
140   NPR = 500         ' ALWAYS constant for internal substandard
150   TT=5
160   PRINT#1,"V";V    : GOSUB 410
170   PRINT#1,"A0"     : GOSUB 410
180   PRINT#1,"I";I    : GOSUB 410
190   PRINT#1,"P";PF   : GOSUB 410
200   PRINT#1,"S1"     : GOSUB 410
210   ' ------- get the actual kh of internal reference
220   PRINT#1,"k"      : GOSUB 410
230   PRINT X$
240   KHR = VAL(MID$(X$,2))      ' skip the command echo at start
250   PREF = KH * NREV * NPR / KHR  ' expected reference puls count
260   TSEC = KH*(NREV+1)*3600/(V*I*PF) ' expected time to complete
270   ' ---- now start the test
280   PRINT#1,"C 0 1";NREV   : TT=TSEC * 1.5   : GOSUB 410
290   X%=INSTR(X$,"=") + 1   ' skip all till after =
300   PCNT = VAL(MID$(X$,X%))  ' get the actual puls count
310   CERR = (PREF-PCNT)/PREF*100
320   PRINT "Error =",CERR
330   ' --- turn power off at end
340   PRINT#1,"S0"     : GOSUB 410
350   STOP
360   '
370   ' ---------------------------------------------------------------
380   ' ---- wait for respnse from MTB , terminate when CR recieved  ---
390   ' ---- timeout value in TT  exit if timeout before CR          ---
400   ' ---- return response in X$ .                                  ---
410   XX=TIMER : X$ = "" : TIMEOUT = FALSE
420   BUSY = TRUE : IF TT < .1 THEN TT = .1
430   WHILE BUSY
440   IF TIMER > XX + TT THEN BUSY = FALSE : SOUND 200,2 : TIMEOUT = TRUE
450   IF LOC(1) = 0 THEN X$=X$+INPUT$(LOC(1),#1)
460   IF RIGHT$(X$,1)=CHR$(13) THEN BUSY = FALSE
470   WEND
480   RETURN
490   ' ---------------------------------------------------------------
```