solartron mobrey

Precision measurement solutions

5000 IMP

Isolated Measurement System

OPERATING MANUAL
50006001

CE

GENERAL SAFETY PRECAUTIONS

The equipment described in this manual has been designed in accordance with EN61010 "Safety requirements for electrical equipment for measurement, control and laboratory use", and has been supplied in a safe condition. To avoid injury to an operator or service technician the safety precautions given below, and throughout the manual, must be strictly adhered to, whenever the equipment is operated, serviced or repaired. For specific safety details, please refer to the relevant sections within the manual.

The equipment is designed solely for electronic measurement and should be used for no other purpose. Solartron accept no responsibility for accidents or damage resulting from any failure to comply with these precautions.

GROUNDING
To minimize the hazard of electrical shock it is essential that the equipment is connected to a protective ground whenever the power supply, measurement or control circuits are connected, even if the equipment is switched off.

All IMP units, including the connector block, must be connected to ground using the marked case stud before control or signal leads are connected. (Details of how to do this are contained in Chapter 3.) Where mains power supply units are used, the protective ground terminal (E) must be connected to the mains installation ground. The ground connection must have a current rating of 25A.

AC SUPPLY VOLTAGE
Never operate the equipment from a line voltage or frequency in excess of that specified. Otherwise, the insulation of internal components may break down and cause excessive leakage currents.

FUSES
Before switching on the equipment check that the fuses accessible from the exterior of the equipment are of the correct rating. The rating of the ac line fuse must be in accordance with the voltage of the ac supply.

Should any fuse continually blow, do not insert a fuse of a higher rating. Switch the equipment off, clearly label it "unserviceable" and inform a service technician.

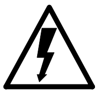
EXPLOSIVE ATMOSPHERES
NEVER OPERATE the equipment, or any sensors connected to the equipment, in a potentially explosive atmosphere. It is NOT intrinsically safe and could possibly cause an explosion.

Continued overleaf.

SAFETY PRECAUTIONS (*continued from previous page*)

SAFETY SYMBOLS

For the guidance and protection of the user, the following safety symbols appear on the equipment:

SYMBOL	MEANING
	Refer to operating manual for detailed instructions of use. In particular, note the maximum voltages permissible at the input sockets, as detailed in the Specification.
	Hazardous voltages.

NOTES, CAUTIONS AND WARNINGS

For the guidance and protection of the user, Notes, Cautions and Warnings appear throughout the manual. The significance of these is as follows:

NOTES	highlight important information for the reader’s special attention.
CAUTIONS	guide the reader in avoiding damage to the equipment.
WARNINGS	guide the reader in avoiding a hazard that could cause injury or death.

AVOID UNSAFE EQUIPMENT

The equipment may be unsafe if any of the following statements apply:

- Equipment shows visible damage.
- Equipment has failed to perform an intended operation.
- Equipment has been subjected to prolonged storage under unfavorable conditions.
- Equipment has been subjected to severe physical stress.

If in any doubt as to the serviceability of the equipment, don’t use it. Get it properly checked out by a qualified service technician.

LIVE CONDUCTORS

When the equipment is connected to its measurement inputs or supply, the opening of covers or removal of parts could expose live conductors. The equipment must be disconnected from all power and signal sources before it is opened for any adjustment, replacement, maintenance or repair. Adjustments, maintenance or repair, must be done only by qualified personnel, who should refer to the Maintenance Manual.

EQUIPMENT MODIFICATION

To avoid introducing safety hazards, never install non-standard parts in the equipment, or make any unauthorized modification. To maintain safety, always return the equipment to Solartron for service and repair.

Safety/Information Sheet

(For use with 5000 IMPs)

IMPORTANT SAFETY PRECAUTION:

Before any control or signal leads are connected, the external case of the 5000 IMP must be grounded using the M4 studs provided. The protective earth (E) terminal must be connected to the mains installation ground.

Note that the external power connections on the 5000 IMP connector block are **not** the same as those on the 3595 Series IMP connector block. In both cases they are clearly marked.

You are strongly advised to follow the relevant information regarding the installation of the 5000 IMPs contained in the 5000 IMP Operating Manual (Part No. 50006001), available from Solartron.

(Information Sheet No: 50006010)

5000 IMP Operating Manual

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Figure 1.1 The 5000 1KE Ethernet IMP.

1.1 INTRODUCTION

The 5000 IMP is based on the field-proven 3595 IMP (Isolated Measurement Pod). Each IMP is a rugged multi-channel data acquisition module designed to be sited close to the measurement point. In a typical application each IMP is configured via an RS485 port, using 5000 IMPView software. The IMPs then operate autonomously to provide measurement data on request, via either Modbus or Ethernet (10BaseT connection).

IMPs can be sited almost anywhere, and need only a 12 to 24 volt dc power supply and the communications link.

Physically, the IMP consists of two printed circuit board (pcb) assemblies, one for measurement hardware, the other for the connections, mounted within a rugged metal case with IP55 rating.

An LED display gives an external indication of the operational status of the IMP.

1.2 MEASUREMENT CAPABILITY

The 20 analog channels of the 5000 IMP can be individually configured to measure any of the inputs listed below. Note that input configuration involves both making the appropriate input connections (Chapter 4) and issuing the appropriate Modbus commands (Chapter 6). The transmission of Modbus commands is simplified by the use of 5000-IMPVIEW software (supplied).

The inputs that can be measured are: dc voltage, dc current (with shunt fitted), temperature (with thermocouple or RTD fitted), resistance (four- three- or two-wire method), logic status (TTL, 3V/9V, volt-free contact). By default, the 5000 IMP is to scan continuously every 10 seconds: the unit is thus made operational as soon as it powers up. (See Appendix B, Specification.)

1.3 COMMUNICATIONS

Communication between the controlling PC and a 5000 IMP can be conducted through either of two ports, RS485 (half-duplex) or Ethernet TCP/IP. The protocols used are Modbus and Modbus/TCP. If the PC has only an RS232 port then an RS232 to RS485 converter must be used.

IMPs can be configured from either RS485 or Ethernet. Both ports have a default setup. The default comms settings of the RS485 port are: 9600 baud; seven data bits, two stop bits, and no parity; ASCII. This setup must be used by the controlling PC in order to communicate initially with the IMP. For communication on Ethernet, the IMP has, by default, an IP address of 172.20.6.66 and a subnet mask of 255.255.0.0. The PC must be set to comply with these in order to communicate initially on the net.

Further information on RS485 and Ethernet communications networks is given in Chapter 5 of the manual. Details of the Modbus commands used are given in Chapter 6.

1.4 SYSTEM REQUIREMENTS

To successfully install and run the 5000 IMP system, you will need a PC able to run the following requisite software:

- *Windows 95, 98, or NT,*
- *VEGA, VGA, or SVGA graphics,*
- *5000 IMPVIEW (provided).*

You will also need a connection to the IMP through one or more of the following:

- *RS485 serial communication port (or RS232 port with an RS485 converter).*
- *RS485 card, half-duplex.*
- *Ethernet interface.*

1.5 ACCESSORIES

Included in the 5000 IMP pack are twenty 100Ω resistors. These are intended as load resistors for current measurements. The method of connecting these resistors is explained in Chapter 4 of the manual.

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Getting Started

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2.1 GETTING STARTED

The IMPs are among the finest products available for rugged data acquisition – an Isolated Measurement Pod (IMP) system. With a PC and suitable sensors, you will be able to monitor and log almost all physical parameters accurately and reliably.

Once you've got the system running, you can easily add more IMPs, distributed wherever you want them, hundreds of metres away if necessary - the possibilities are endless....

By following the instructions in this chapter, you will be able to install, connect and run your IMP system in about 30 minutes. You will learn:

- *What you'll need from your PC*
- *How to install the 5000 IMPVIEW software on your PC*
- *How to run 5000 IMPVIEW and start logging!*
- *What to do if things go wrong.*

This chapter is intended to help you get a ‘quick start’; it does not provide comprehensive explanations for each operation. For this, and to make the best use of the IMP and its extensive capabilities, you will need to read the full manual.

2.2 YOUR PC

To successfully install and run the 5000 IMP system, you will need a PC able to run the following requisite software:

- *Windows 95, 98, or NT,*
- *VEGA, VGA, or SVGA graphics,*
- *5000 IMPVIEW (provided).*

You will also need a connection to the IMP through one or more of the following:

- *RS485 serial communication port (or RS232 port with an RS485 converter).*
- *RS485 card, half-duplex.*

Ethernet interface.

2.3 CONNECTING THE 5000 IMP

> ***Warning:*** *Whenever making connections to the IMP, always make sure that all power is removed from the IMP and that there are no dangerous voltages present on the measurement inputs.* ***Always*** *connect the grounding studs on the case* ***and*** *the connector block to a suitable line earth (ground).*

All connections to the IMP are made via a connector block which is inserted into the housing. (See Figure 2.1.) There are the PC-IMP interface connections, 20 multi-function (analogue/status) input channels and the power connections. To obtain an actual measurement, we suggest you connect a low voltage source –for example a battery– to channel 1. The procedure for this is described in Section 2.3.1 below.

2.3.1 MAKING CONNECTIONS: GENERAL PROCEDURE

The general procedure for making connections to the connector block is:

1. Unscrew the two screws either side of the projecting rubber boots; the connector block will be released from the main IMP housing.

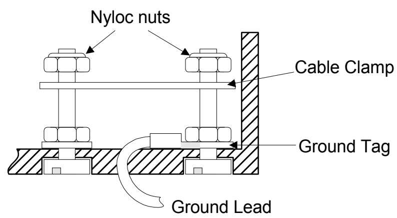
2. Withdraw the connector block carefully from the IMP housing.

3. Undo the two cover retaining screws and withdraw the cover from the rear of the connector block.

3. With a sharp blade, cut the tip off a rubber teat for each lead to be connected. (To ensure a good seal, be careful not to cut off too much in one go!)

4. Fit the prepared end of the connector block ground lead (supplied) to the lower cable clamp.

5. Push the ground lead through the lower prepared teat, ready for connecting to the IMP case.



6. Push the first lead to be connected through a prepared teat. To ease its passage the lead may be lubricated with silicone grease and, if necessary, a sleeve expansion tool used to stretch the teat slightly prior to lead insertion.

7. With multi-wire leads having a separate cover, remove just sufficient of the outer cover to allow wire separation: ensure that the outer cover remains sealed by the boot. With shielded cables remove a sufficient length of outer cover to ensure that the cable shielding makes contact with the zinc surface when clamped to the connector block case.

8. Strip off a 6mm length of insulation from each wire and connect as shown in Sections 2.3.2 through 2.3.5 in this chapter.

9. Connect the remainder of the leads, as described in Steps 7 through 9.

10. Ensure that all cable clamps are firmly tightened down.

11. Refit the connector block cover, remembering to locate the two ‘nibs’ on the rear of the cover under the pcb, before locating the screws in their respective bushes and tightening them down.

12. Push the connector block back into the IMP housing and secure with the two knurled screws.

13. Fit the ‘receptacle faston’ to the end of the ground lead protruding from the connector block. Then connect the receptacle to the grounding point on the IMP case. (See Figure 2.1.)

14. Connect the IMP grounding point to a suitable line earth (ground).

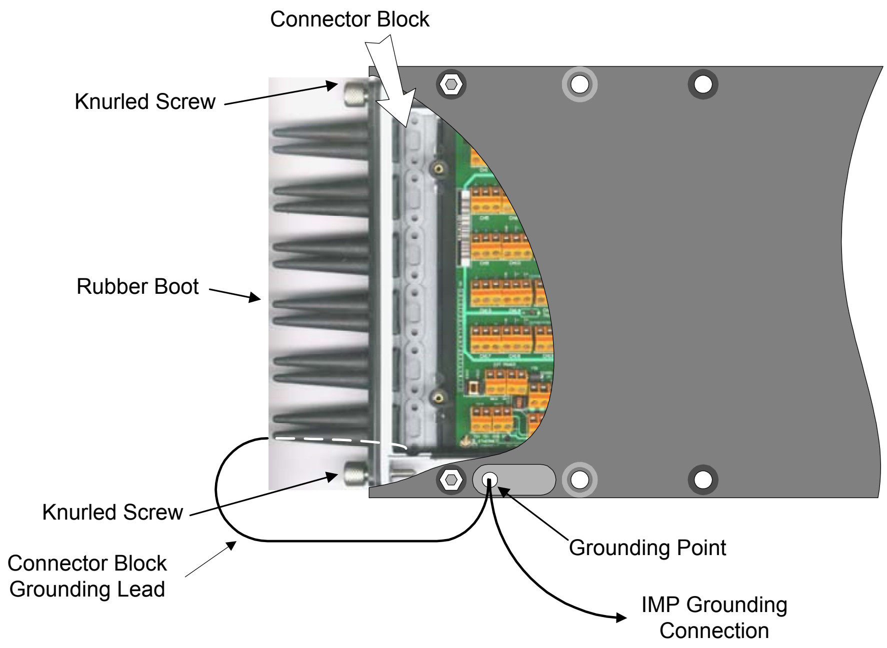


Figure 2-1   The 5000 13L IMP connector block, inserted into the main IMP housing.

2.3.2 CONNECTING THE IMP FOR ETHERNET COMMUNICATION

The Ethernet connections to the IMP are made through screw terminals, not the standard Ethernet plug-in connector. This is to avoid any disconnection problems due to vibration. (IMPs are often required to operate close to a source of vibration, such as rotating machinery.) The simplest way of obtaining a suitable cable is to cut the connector from one end of a standard 10BaseT cable. The connections to be made between the IMP and the PC are shown in Figures 2.2 and 2.3.

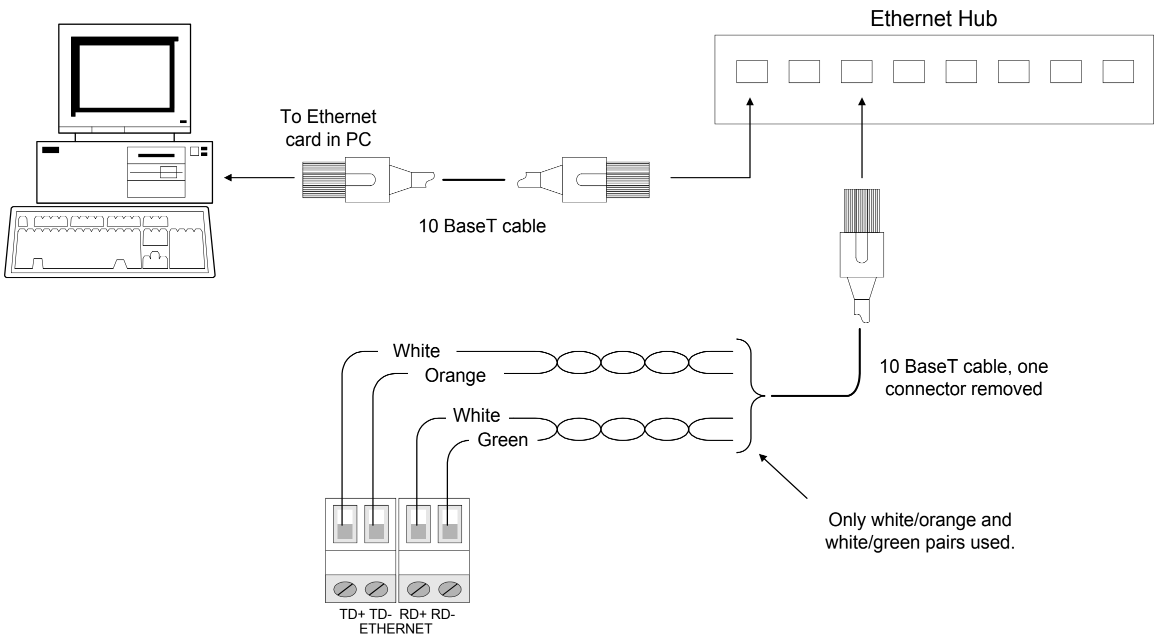


Figure 2-2   Connecting an IMP to a PC via an Ethernet hub.

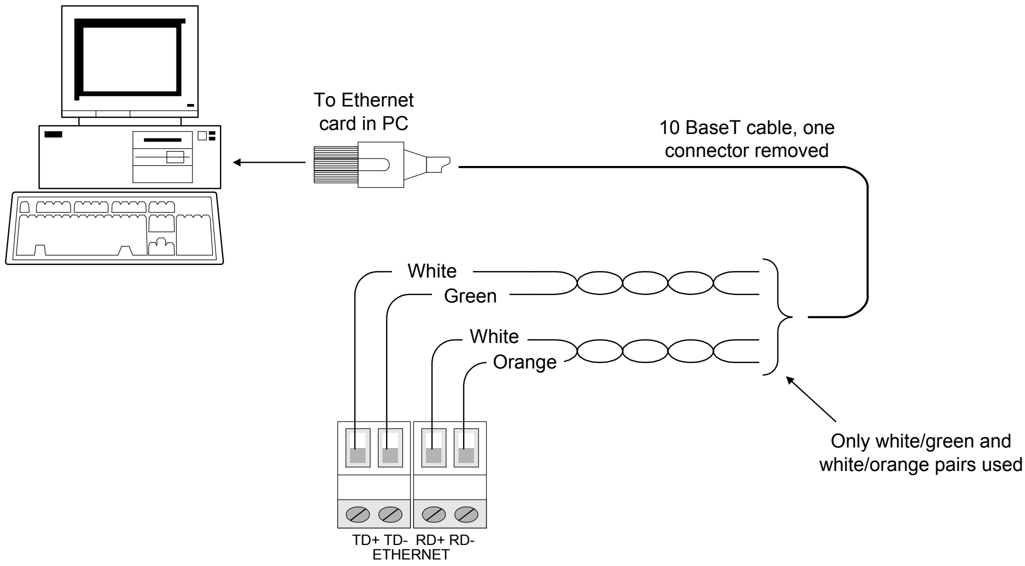


Figure 2-3 Connecting an IMP directly to the Ethernet card on a PC.

The colouring of the Ethernet wiring shown in Figures 2.2 and 2.3 assumes that the wires are coloured as shown in Figure 2.4. However, these colours may vary according to the cable manufacturer. You can find out whether or not your cable is the same as that shown in Figure 2.4 by looking through the clear plastic connector (RJ45 type). If your particular cable is different from that shown in Figure 2.4, establish the colour of the wires connected to pins 2 and 6. (As an extra check, you can do a continuity test of the pins and wires.) The new colour on pin 2 replaces 'orange' in Figures 2.2 and 2.3. Similarly, the new colour on pin 6 replaces 'green'. The wires that are twisted with the wires from pins 2 and 6 correspond to the white wires shown in Figures 2.2 and 2.3.

Having established the correspondence between the colours of the wires in your cable and those shown in Figure 2.4, connect the appropriate wires to the 5000 13L connector block. Use the same configuration as that shown in Figure 2.2 or 2.3, depending on whether or not you are making connection via an Ethernet hub.

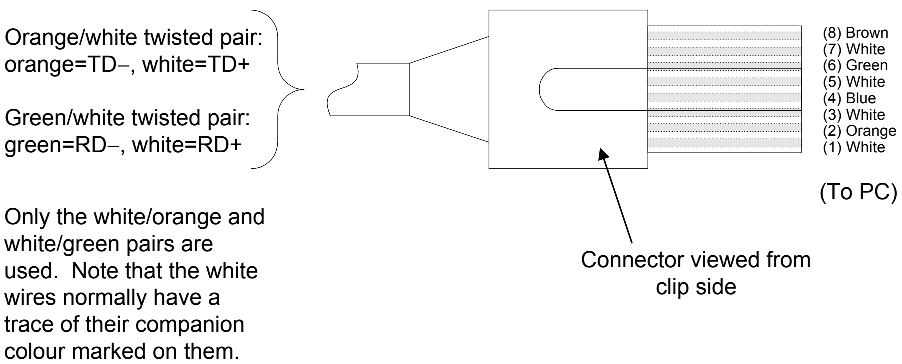


Figure 2-4 Ethernet cable connections.

2.3.3 CONNECTING THE IMP FOR RS485 COMMUNICATION

The conventional notation for RS485 signals is ‘A’, ‘B’ and ‘G’ (ground). In the ‘multidrop’ connections used on the network, you connect ‘A’ to ‘A’, ‘B’ to ‘B’, and ‘G’ to ‘G’. Some manufacturers label the ‘A’ and ‘B’ connections ‘-’ and ‘+’. Should you inadvertently reverse the connections it will cause no damage, but there will be no communication. The RS485 connections to be between the IMP and the PC are shown in Figure 2.5. Note that the host computer may require a 9-way to 25-way ‘D’ type adapter.

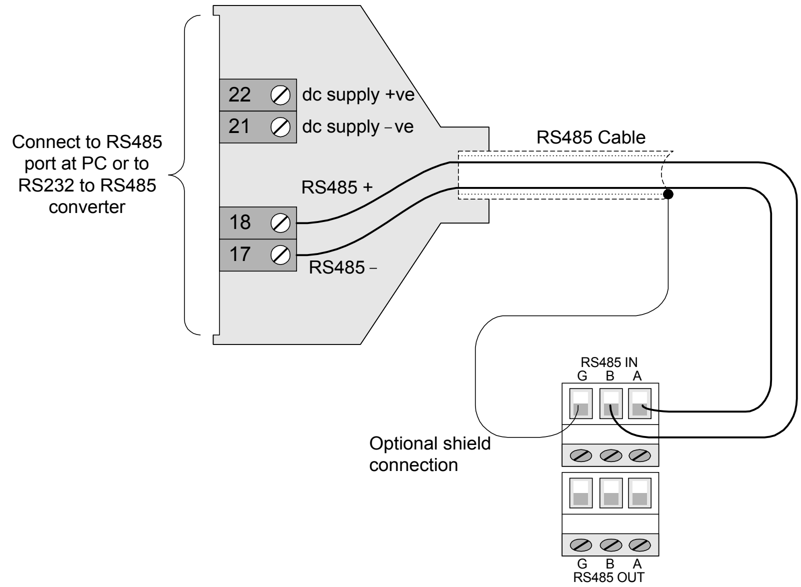


Figure 2-5 RS485 connections between an IMP and the controlling PC.

Where the PC has only an RS232 port you can plug an RS232 to RS485 converter directly into this port and connect your RS485 cable to the converter. Note that some converters work on only one Baud rate: therefore you must ensure that the PC and IMP are set to operate at this rate.

Larger networks, or networks running on low power host computers, will require an external power supply. This supply is applied via pins 22 and 21 on the RS485 connector, as shown above. For the 3593 911A RS232 to RS485 converter available from Solartron-Mobrey the supply voltage is 6V: the supply voltage for another make of converter will be stated in the converter user guide.

2.3.4 CONNECTING THE MEASUREMENT INPUTS

Signals to be measured are connected to the H (Hi) and L (Lo) input channel connections, as shown in the example in Figure 2.5.

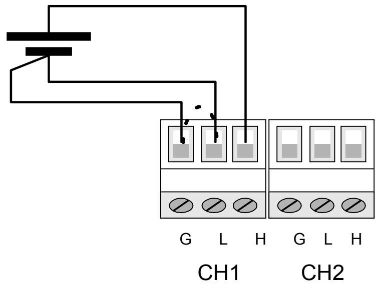
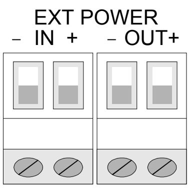


Figure 2-6 Example of measurement channel connections.

When making voltage measurements (includes thermocouples) it is imperative that terminals G and L are connected together. For best results this connection should be made at the signal source, as shown in Figure 2.5. Alternatively the connection (shown dotted) can be made at the connector block itself. It is also recommended that unused channels have H and L and G terminals linked together. See Chapter 4 (Section 4.2) and Appendix A (Section A.4.5) for guidance in connecting the cable shields.

2.3.5 CONNECTING THE IMP DC SUPPLY

Connect the IMP to the external power source, through the EXT POWER terminals on the connector block:



The power source must provide a dc voltage in the range 12V through 24V. The 'IN' and 'OUT' power terminals allow several IMPs to be 'daisy chained' to the supply lines. Connect the power terminals to terminals of the same polarity on the power supply unit. Should you inadvertently reverse the polarity of the supply the IMP will not be damaged –it is reverse polarity protected: to make the IMP work simply switch the polarity over.

2.4 INSTALLING EXPANSION CARDS IN YOUR PC

You should refer to the manufacturer's handbook for your PC for specific details on installing expansion cards. As a general guide you will need to:

1. Remove the PC's covers

2. Select a suitable blank slot for the Interface card, undo the blank panel retaining screw, remove the panel and store it.

3. Carefully insert the Interface card, ensuring that the metal panel is located where the blank panel was, and pushing firmly on the Interface to ensure it is properly seated in the edge connectors. Replace the panel retaining screw.

4. Replace the covers of the PC.

2.5 INSTALLING THE 5000 IMP SOFTWARE

1. Power up the PC and run Windows.

2. Insert the 5000 IMPVIEW disk into your floppy drive.

   (At this point you may want to run a virus check program to ensure the disk is clean. Although there virtually no risk of a virus program being present on the disk, it is good practice to virus check any new software before use.)

3. Close down any applications other than Program Manager.

4. Run the file SETUP.EXE on the floppy disk.

   (From the Program Manager 'File' menu, select 'Run...', then type 'A:\SETUP' in the command line box and choose OK. If your floppy disk has another designation, use that instead of 'A'.)

   The message 'Initialising Set-up...' will appear.

   You may see the message 'Close down VB applications?'. If this happens, choose OK.

5. Follow the displayed procedure.

   A new 5000 IMPVIEW program group is installed in Program Manager, containing one 5000 IMPVIEW icon.

You are now ready to begin making measurements! The IMP is a very versatile measurement tool, and can make direct measurements of voltage, current, resistance, temperature (thermocouples and RTDs), status. For more information, refer to Chapter 4.

2.6 RUNNING 5000 IMPVIEW WITH RS485

The following procedure assumes that a single 5000 IMP is connected to the Host, through an RS485 network. The aim is simply to get an IMP working so that you can familiarise yourself with the network operation. [To connect via Ethernet, go to Section 2.7.]

Having connected the IMP to your PC (see Section 2.3), you can start the software.

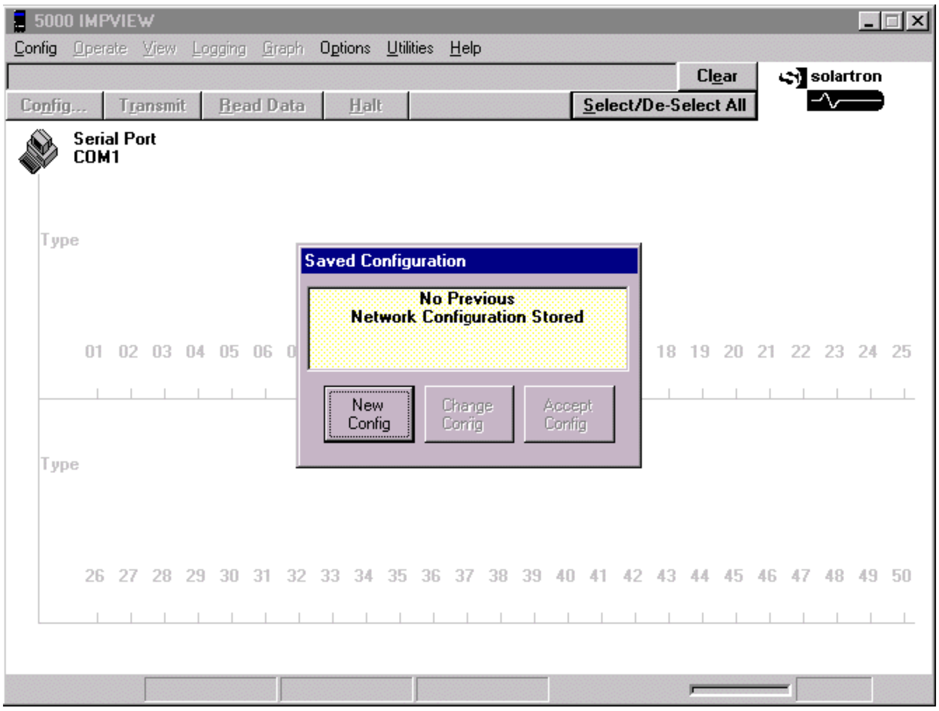
1. In Windows, locate the IMPVIEW program group, and double-click on the IMPVIEW icon.

   A message will appear: 'Searching for Previous Network Configuration. Please wait...'. Then another: 'Checking network configuration. Please wait.'

   After a short while the Saved Configuration option box appears, in front of the main 5000 IMPVIEW screen:

Menu bar

Quick Action buttons

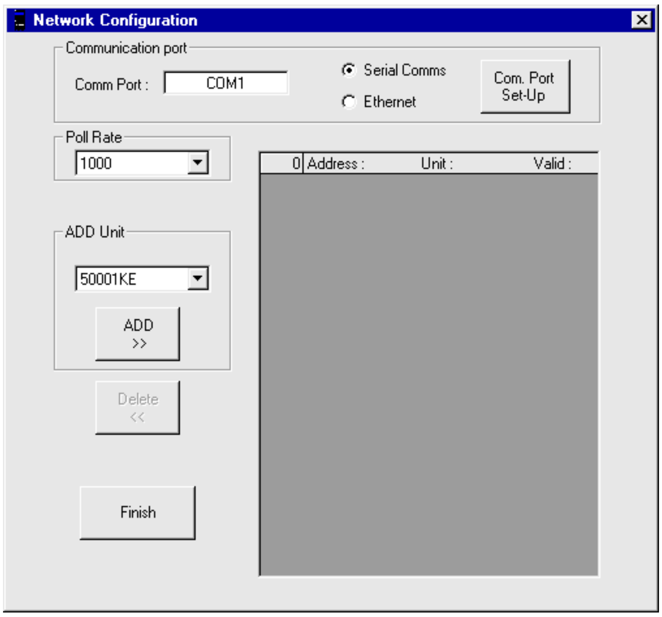


Initially, the network diagram shows only the PC (serial port). The remainder of the diagram is greyed-out, which indicates that no IMPs have yet been configured: this is reflected by the message in the Saved Configuration window, which tells you that 'No previous network configuration [is] stored'. The only option available at this time is to select ***New Configuration****.*

What IMPVIEW does on start-up is to read the last network configuration used, check that the IMP configured are present on the network, read the configuration of each IMP, and display the IMPs in their present locations on the system 'map'. With a configuration previously entered, the ***Change Config*** *and* ***Accept Config*** *options are available also. The first gives you the option of changing the present configuration to suit your present needs and the second allows you to accept the configuration as it is. Full details of these options are given in the 5000-IMPVIEW Operator Manual.*

Note that most of the menus and quick action buttons are also greyed-out to indicate that they are inactive. These items become active as soon as the first IMP is configured and selected on the map, when they will appear in bold font. The use of the menus and quick action buttons is fully explained in the 5000 IMPVIEW Operator Manual, but, where necessary, the use of some of some quick action buttons is also explained in the present procedure.

2. To begin configuring the network, click on the **New Config** button (in the Saved Configuration window) to reveal the **Network Configuration** window:

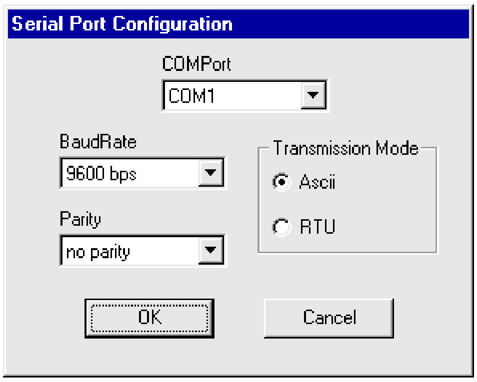


The Network Configuration window allows you to select:

- *The type of port: Serial Comms (RS485) or Ethernet.*
- *The IMP poll rate (default =1000ms).*
- *The IMP type (default =50001KE).*

For the present example it is assumed that you have selected Serial Communications and are using the default IMP type and poll rate. The next step is to check the configuration of your chosen comm port.

3. Click on the **Com. Port Set-up** button (in the Network Configuration window) to reveal the **Serial Port Configuration** window:



In the Serial Port Configuration window you select the communication parameters:

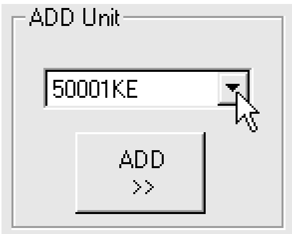
- *The RS232/RS485 communications port on your PC (e.g. COM2).*

Leave the other parameters at their default settings. (These are the settings made at the factory.):

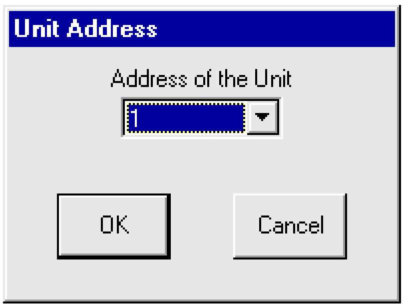
- *Baud Rate (default =9600bps)*
- *Parity (default =no parity)*
- *Transmission Mode (default =ASCII)*

4. To enter the communication parameters selected in Step 3, click on **OK** (in the Serial Port Configuration window).

5. From the **ADD Unit menu** (in the Network Configuration window) select the type of IMP that you wish to add to the network:



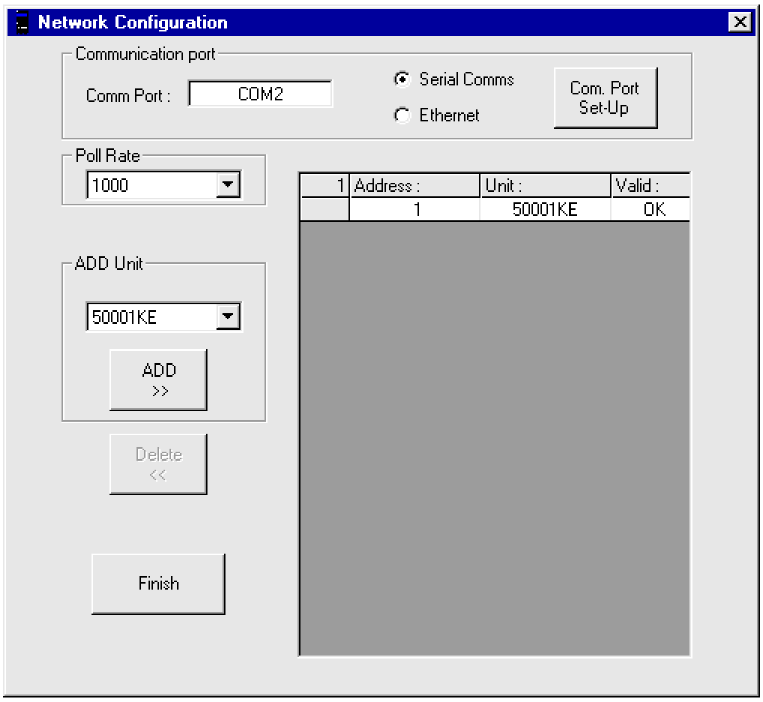
6. To add the IMP to the network, click on the **ADD** button. This opens the **Unit Address** window:



The unit address of each 5000 IMP, as supplied, is '1' by default. In the present example we have only one IMP connected to the network, therefore the address of this unit may be left as '1'. However, where several IMPs are connected to the network each must be given a unique address. Should you wish to physically connect all your IMPs to the network prior to running IMPVIEW then each IMP should have its address pre-assigned in a single network, as described in this example. Otherwise, the IMPs should be connected and ADDed to the network one at a time, a unique address being assigned in each case.

7. To enter the unit address, click on **OK**.

   The unit now appears in the list of IMPs:



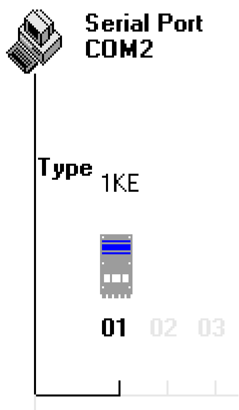
   Initially, a red 'No resp' (no response) indication appears in the Valid column. When the IMP responds to the search this changes to 'OK', which proves that the IMP is set up and responding correctly.

8. When you have finished adding units to the network –which, in the present example, is after adding the one unit– click on the **Finish** button.

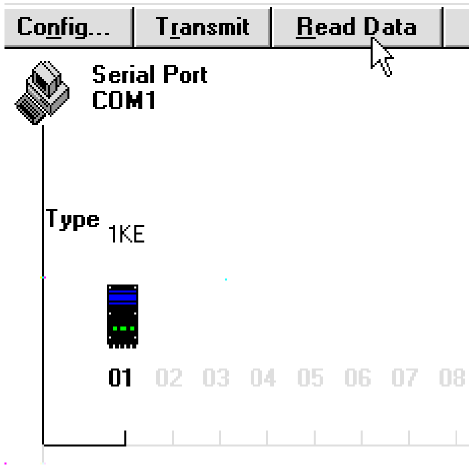
   IMPVIEW now reads the configuration of each IMP on the network -in the present example, the 50001KE IMP at address 1. This is indicated by the message:

   'Reading configuration from Unit 1. Please wait…'

   The network diagram is then updated to show the connected IMP(s):



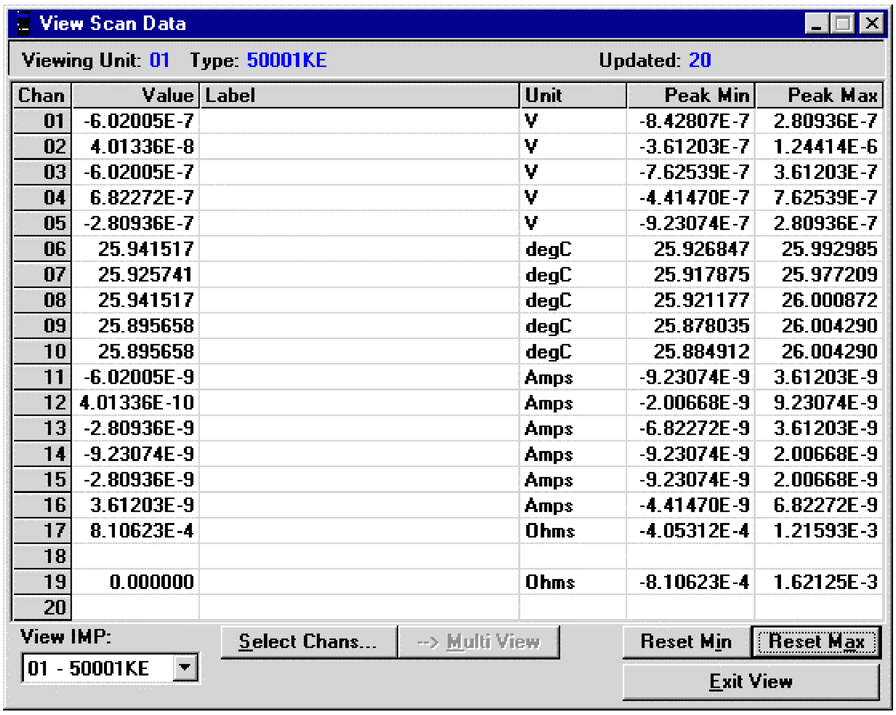
9. To read the data that the IMP is acquiring, click on the IMP icon to highlight it then click on the **Read Data** button:



The three simulated lamps on the IMP icon now change from white to green, to show that IMPVIEW is reading data.

10.To view the data being read, click on **View Data** in the **View** menu.

The data is now displayed, in the View Scan Data window:



Chan	Value	Label	Unit	Peak Min	Peak Max
01	-6.02005E-7		V	-8.42807E-7	2.80936E-7
02	4.01336E-8		V	-3.61203E-7	1.24414E-6
03	-6.02005E-7		V	-7.62539E-7	3.61203E-7
04	6.82272E-7		V	-4.41470E-7	7.62539E-7
05	-2.80936E-7		V	-9.23074E-7	2.80936E-7
06	25.941517		degC	25.926847	25.992985
07	25.925741		degC	25.917875	25.977209
08	25.941517		degC	25.921177	26.000872
09	25.895658		degC	25.878035	26.004290
10	25.895658		degC	25.884912	26.004290
11	-6.02005E-9		Amps	-9.23074E-9	3.61203E-9
12	4.01336E-10		Amps	-2.00668E-9	9.23074E-9
13	-2.80936E-9		Amps	-6.82272E-9	3.61203E-9
14	-9.23074E-9		Amps	-9.23074E-9	2.00668E-9
15	-2.80936E-9		Amps	-9.23074E-9	2.00668E-9
16	3.61203E-9		Amps	-4.41470E-9	6.82272E-9
17	8.10623E-4		Ohms	-4.05312E-4	1.21593E-3
18					
19	0.000000		Ohms	-8.10623E-4	1.62125E-3
20					

*Clicking on the **Select Chans**… button enables you to display only the channels of interest.*

Note that the default configuration of the IMP input channels is:

Channels 1-5	*volts*
Channels 6-10	*temperature (type T thermocouple)*
Channels 11-16	*current (sensing resistors are included in pack)*
Channels 17 and 19	*four-wire ohms*

11.To stop IMPVIEW reading data, click on the **Halt** quick action button.

Well done! You have now successfully installed a professional industrial measurement system and begun to take measurements. You should now take some time to read the manuals and experiment with your system in order to make the fullest use of the extensive facilities that are available to you.

One of the things you will need to do in configuring your particular system is to change the address and communications set-up of an IMP. To help you in this, the full procedure is detailed in Section 2.8.

2.7 RUNNING 5000 IMPVIEW WITH ETHERNET

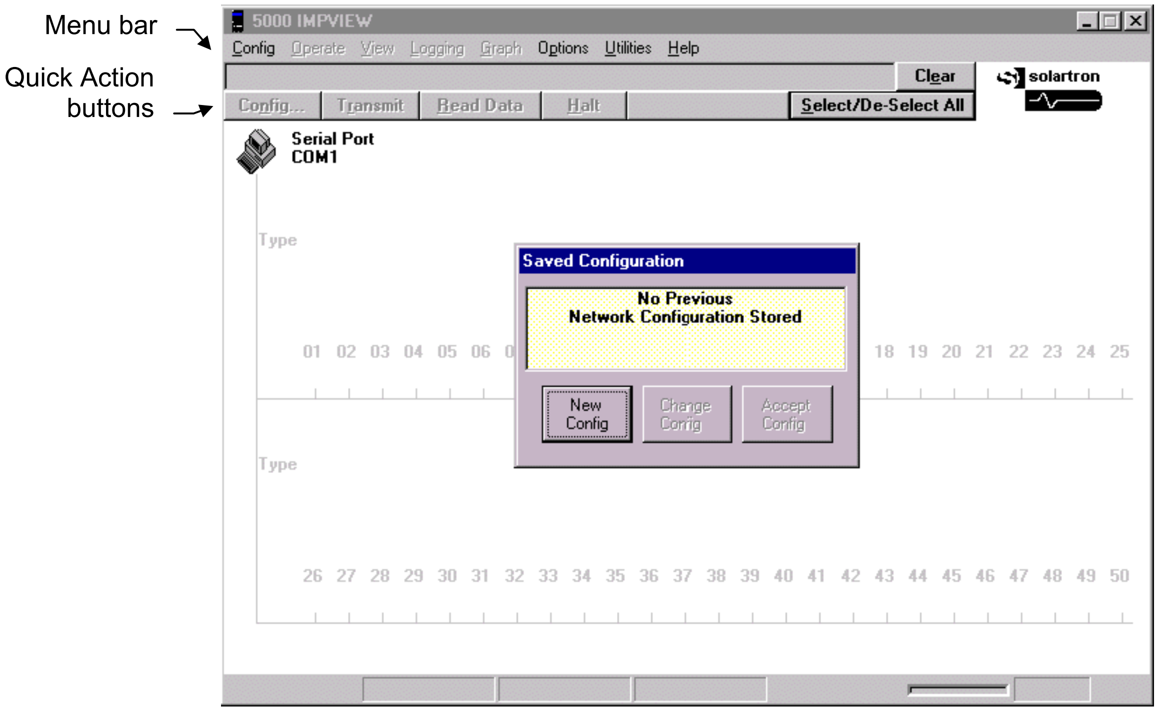
The following procedure assumes that a single 5000 IMP is connected to the Host, through Ethernet. The aim is simply to get an IMP working so that you can familiarise yourself with the network operation. [To connect via RS485, go to Section 2.6.]

Having connected the IMP to your PC (Section 2.3), check the Ethernet communications set-up of your PC. For Ethernet communications to operate successfully, the IP addresses of the PC and IMP must be compatible. The default IP address of the IMP is 172.20.6.66 and the sub-net mask 255.255.0.0 (both factory set). Therefore, a valid IP address for the PC in the present example is 172.20.6.123 and the sub-net mask 255.255.0.0. The IP address and sub-net mask of your PC are set via the PC's control panel. Once this is done, you can start the software.

1. In Windows, locate the IMPVIEW program group, and double-click on the IMPVIEW icon.

   A message will appear: 'Searching for Previous Network Configuration Please wait...'.

   After a short while an IMP network diagram appears:

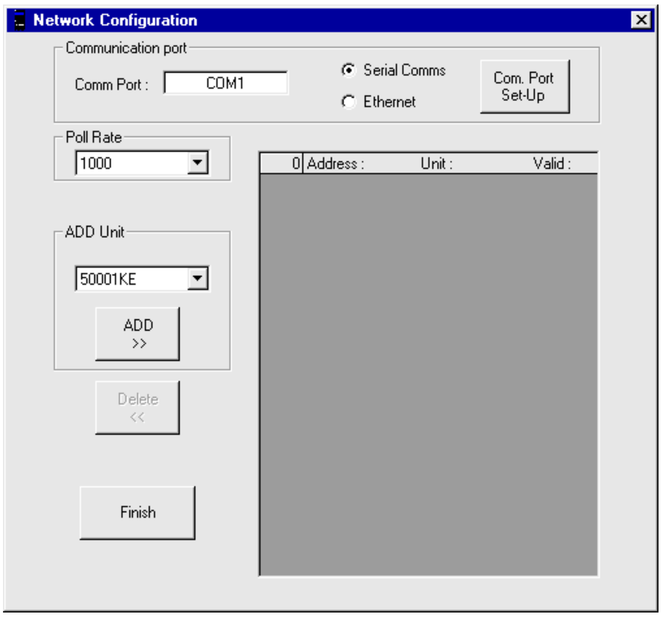


*Initially, the network diagram shows only the PC (serial port). The remainder of the diagram is greyed-out, which indicates that no IMPs have yet been configured: this is reflected by the message in the Saved Configuration window, which tells you that 'No previous network configuration [is] stored'. The only option available at this time is to select **New Configuration**.*

What IMPVIEW does on start-up is to read the last network configuration used, check that the IMP configured are present on the network, read the configuration of *each IMP, and display the IMPs in their present locations on the system 'map'. With a configuration previously entered, the* ***Change Config*** *and* ***Accept Config*** *options are available also. The first gives you the option of changing the present configuration to suit your present needs and the second allows you to accept the configuration as it is. Full details of these options are given in the 5000-IMPVIEW Operator Manual.*

Note that most of the menus and quick action buttons are also greyed-out to indicate that they are inactive. These items become active as soon as the first IMP is configured and selected on the map, when they will appear in bold font. The use of the menus and quick action buttons is fully explained in the 5000 IMPVIEW User Guide, but, where necessary, the use of some of some quick action buttons is also explained in the present procedure.

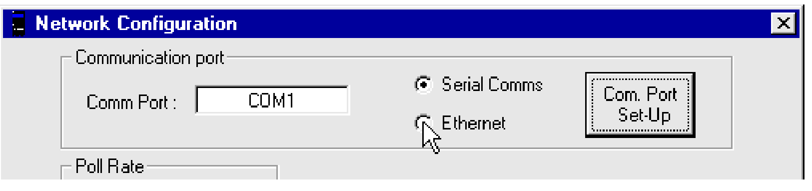
2. To begin configuring the network, click on the **New Config** button (in the Saved Configuration window) to reveal the **Network Configuration** window:



The Network Configuration window allows you to select:

- *The type of port: Serial Comms (RS485) or Ethernet.*
- *The IMP poll rate (default =1000).*
- *The IMP type (default =50001KS).*

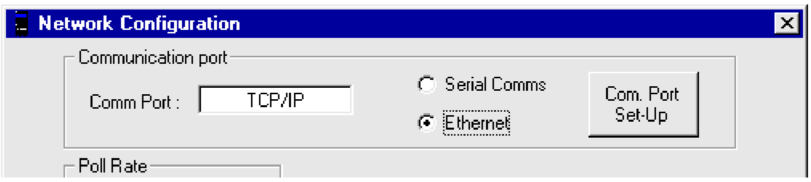
3. Click on the **Ethernet** button to select the Ethernet port:



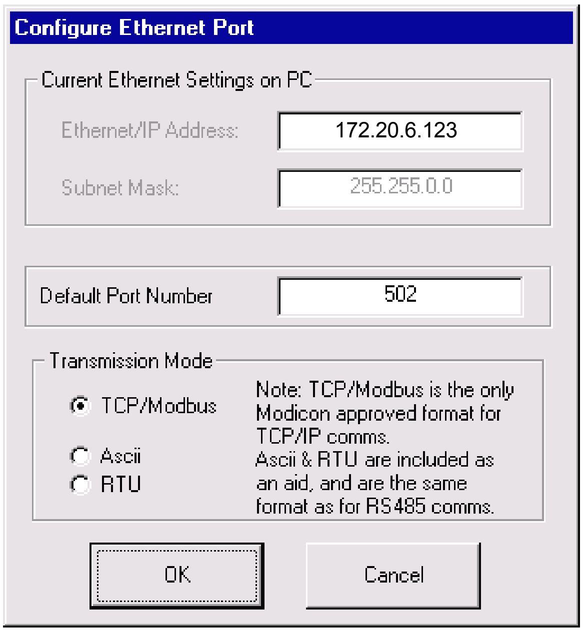
A message will appear: 'Changing the communication port INITIALISES the network configuration.'

4. Click on **OK**.

The Network Configuration window now indicates the TCP/IP comm. Port:



5. Click on the **Com. Port Set-up** button (in the Network Configuration window) to reveal the **Ethernet Configuration** window:



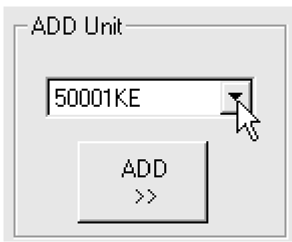
This shows the TCP/IP address and subnet mask of your PC. These can be changed only through the system settings menu of the PC.

These settings must be compatible with those of the IMP, which, by default, are:
IP address 172.20.6.66
sub-net mask 255.255.0.0

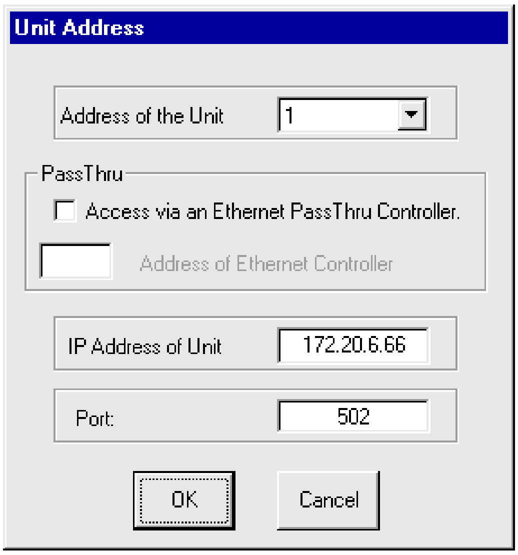
In the Ethernet Configuration window you can select the transmission mode. In the present example the preferred mode, TCP/Modbus, is used. This is the default setting.

6. To enter the communication parameters selected in Step 5, click on **OK** (in the Ethernet Configuration window).

7. From the **ADD Unit menu** (in the Network Configuration window) select the type of IMP that you wish to add to the network:

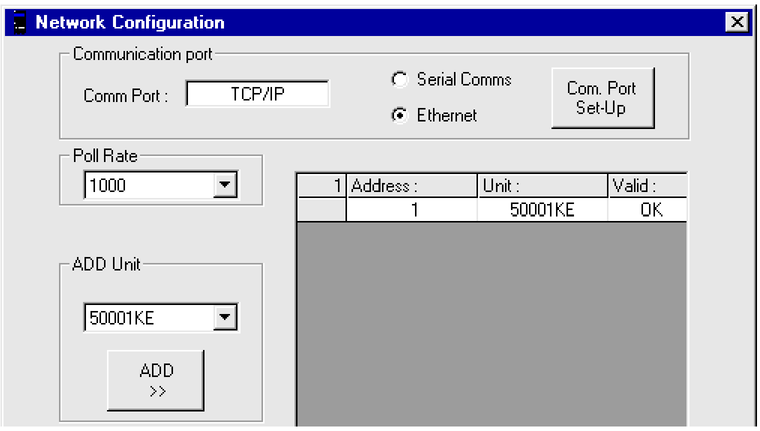


8. To add the IMP to the network, click on the **ADD** button. This opens the **Unit Address** window:



9. To enter the unit address, click on **OK**.

The unit now appears in the list of IMPs:



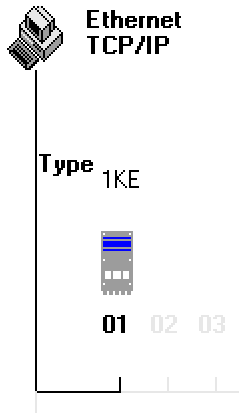
Initially, a red 'No resp' (no response) indication appears in the Valid column. When the IMP responds to the search this changes to 'OK', which proves that the IMP is set up and responding correctly.

10. When you have finished adding units to the network –which, in the present example, is after adding the one unit– click on the **Finish** button.

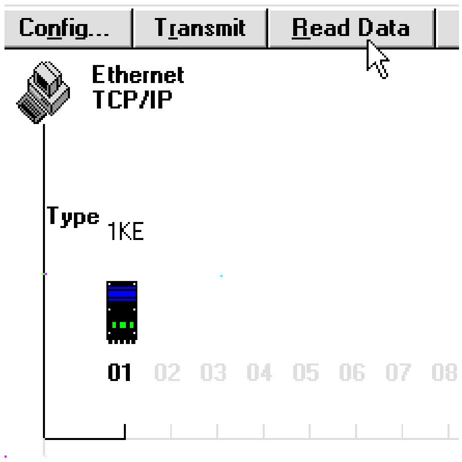
IMPVIEW now reads the configuration of each IMP on the network -in the present example, the 50001KE IMP at address 1. This is indicated by the message:

'Reading configuration from Unit 1. Please wait…'

The network diagram is then updated to show the connected IMP(s):



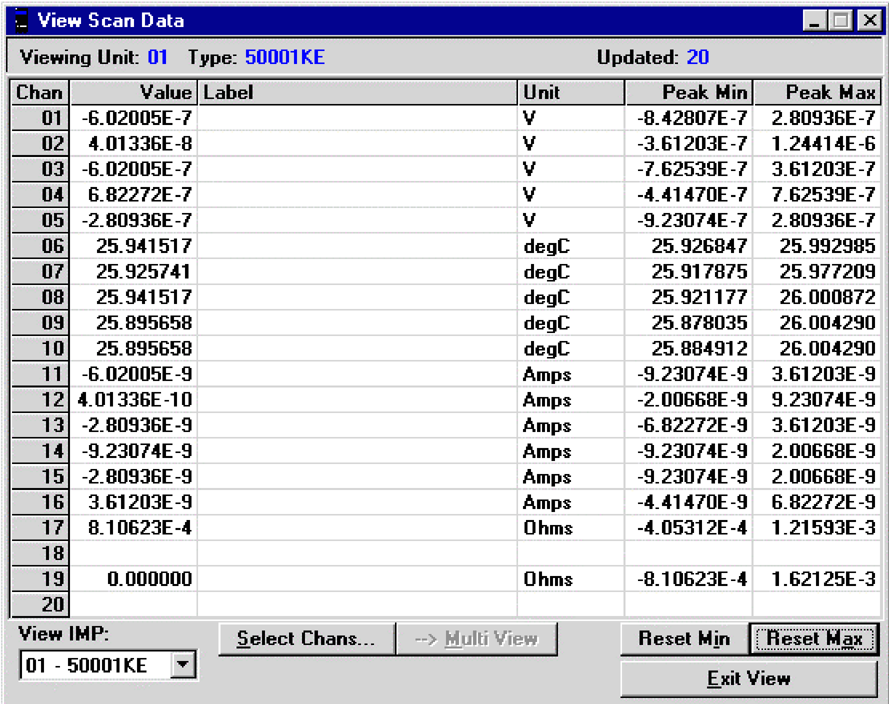
11. To read the data that the IMP is acquiring, click on the IMP icon to highlight it then click on the **Read Data** button:



The three simulated lamps on the IMP icon now change from white to green, to show that IMPVIEW is reading data.

12.To view the data being read, click on **View Data** in the **View** menu.

The data is now displayed, in the View Scan Data window:



Chan	Value	Label	Unit	Peak Min	Peak Max
01	-6.02005E-7		V	-8.42807E-7	2.80936E-7
02	4.01336E-8		V	-3.61203E-7	1.24414E-6
03	-6.02005E-7		V	-7.62539E-7	3.61203E-7
04	6.82272E-7		V	-4.41470E-7	7.62539E-7
05	-2.80936E-7		V	-9.23074E-7	2.80936E-7
06	25.941517		degC	25.926847	25.992985
07	25.925741		degC	25.917875	25.977209
08	25.941517		degC	25.921177	26.000872
09	25.895658		degC	25.878035	26.004290
10	25.895658		degC	25.884912	26.004290
11	-6.02005E-9		Amps	-9.23074E-9	3.61203E-9
12	4.01336E-10		Amps	-2.00668E-9	9.23074E-9
13	-2.80936E-9		Amps	-6.82272E-9	3.61203E-9
14	-9.23074E-9		Amps	-9.23074E-9	2.00668E-9
15	-2.80936E-9		Amps	-9.23074E-9	2.00668E-9
16	3.61203E-9		Amps	-4.41470E-9	6.82272E-9
17	8.10623E-4		Ohms	-4.05312E-4	1.21593E-3
18					
19	0.000000		Ohms	-8.10623E-4	1.62125E-3
20					

Clicking on the ***Select Chans****… button enables you to display only the channels of interest.*

13.To stop IMPVIEW reading data, ensure that the relevant IMP icon is selected and click on the **Halt** quick action button.

Well done! You have now successfully installed a professional industrial measurement system and begun to take measurements. You should now take some time to read the manuals and experiment with your system in order to make the fullest use of the extensive facilities that are available to you.

One of the things you will need to do in configuring your particular system is to change the address and communications set-up of an IMP. To help you in this, the full procedure is detailed in Section 2.8.

2.8 CONFIGURING THE COMMUNICATIONS SET-UP

One of the things you will need to do in configuring your particular system is to change the communications set-up. This involves both the IMPs and IMPVIEW, since their communication parameters must be compatible for communication to take place. The full procedure for RS485 and Ethernet communication is detailed in Sections 2.8.1 and 2.8.2 below. Note that the changes in the IMP communication parameters take effect only after the IMP has been powered off and on again.

Note: If, after changing the communications set-up, you cannot communicate with the IMP, you can reset it to its original factory setting. See Section 2.9.

2.8.1 CHANGING THE COMMS PARAMETERS IN AN RS485 SYSTEM

The procedure for changing the communications parameters is:

1. Ensure that the communication parameters of the PC and IMP are compatible.

2. Using IMPVIEW, click on the relevant IMP icon and select **Unit Setup…** from the **Config** menu. This reveals the **Configure Units** window. Now click on the **Unit RS485 Comms Port** button to reveal the **Configure Unit RS485 Communications** window.

3. Change the relevant communication parameters. These appear under four headings: **Unit Address**, **Pass Thru Mode**, **Serial/RS-485 Settings**, and **Transmission Mode**. You could, for example, change the unit address to ‘4’, the RS-485 Baud rate to 19200bps, and the transmission mode to RTU.

4. Once you have selected the required IMP communication parameters, click on **OK** in the **Configure Unit RS485 Communications** and **Configure Units** windows. A displayed message now tells you that the new configuration must be transmitted to take affect.

5. With the relevant IMP still selected, click on the **Transmit** button. A displayed message now tells you that the configuration is being transmitted.

6. Power the IMP off and on again. (IMPVIEW is now unable to communicate with the IMP at its original address.

7. Using the IMPVIEW **Config** menu, select **Network**. This reveals the **Network Configuration** window.

8. Set the network communication parameters to agree with the parameters that you have selected (in step 3) for the IMP. In the case of a changed address **ADD** a unit (e.g. 50001KE) to the network at the new address entered in step 3 (e.g. ‘4’). [You can also, if you wish, delete the IMP icon at address ‘1’.] For changes to the other communication parameters, click on the **Com. Port Set-up** button to reveal the **Serial Port Configuration** window. In the present example this applies to the **Baud Rate** and **Transmission Mode** parameters, which are set to 19200bps and RTU respectively.

9. Once you have selected the required network communication parameters, click on **Finish** in the **Network Configuration** window. A 50001KE IMP icon now

appears on the system map at the new address and the PC is able to communicate with the IMP at this address.

2.8.2 CHANGING THE COMMS PARAMETERS FOR ETHERNET

For each IMP the default IP address is 172.20.6.66 and the sub-net mask is 255.255.0.0. To set up alternative addresses, in keeping with those of your particular system, use the following procedure:

1. Set the IP address of the PC to correspond with the default IP address of the IMP. For example, use 172.20.6.123. Take care not to use the same address as the IMP.

2. Using IMPVIEW, click on the relevant IMP icon and select **Unit Setup…** from the **Config** menu. This reveals the **Configure Units** window. Now click on the **Ethernet Comms Configuration** button to reveal the window entitled '**Configure Unit Ethernet TCP/IP Communications**'.

3. Change the relevant communication parameters. These appear under four headings: **Unit Address**, **Pass Thru**, **Ethernet/IP Settings**, and **Transmission Mode**. You could, for example, change the unit address to '4', and set the IP address and Subnet Mask to work with those required by the PC.

4. Once you have selected the required IMP communication parameters, click on **OK** in the **Configure Unit Ethernet TCP/IP Communications** and **Configure Units** windows. A displayed message now tells you that the new configuration must be transmitted to take affect –click on **OK**.

5. With the relevant IMP still selected, click on the **Transmit** button. A displayed message now tells you that the configuration is being transmitted.

6. Power the IMP off and on again. (IMPVIEW is now unable to communicate with the IMP at its original address.

7. Close down IMPVIEW, set the IP address and subnet mask of the PC to the required settings, and restart IMPVIEW. (IMPVIEW will fail to connect as it is at different IP settings.)

8. Using the IMPVIEW **Config** menu, select **Network**. This reveals the **Network Configuration** window.

9. Delete the IMP icon at the original address (e.g. '1'). Set the network communication parameters to agree with the parameters that you have selected (in step 3) for the IMP. **ADD** a unit (e.g. 50001KE) to the network at the new address entered in step 3 (e.g. '4') and enter the IP address configured for the IMP (in step 3). For changes to the other communication parameters, click on the **Com. Port Set-up** button to reveal the **Configure Ethernet Port** window. In the present example this can be ignored: no settings were changed relevant to this window.

10. Once you have selected the required network communication parameters, click on **Finish** in the **Network Configuration** window. A 50001KE IMP icon now appears on the system map at the new address and the PC is able to communicate with the IMP at this address.

2.9 RETURNING THE IMP TO ITS DEFAULT SET-UP

To provide a known state from which the IMP can be configured, it is possible to return it to its default set-up. The procedure is:

1. Switch the IMP power source off.

2. Remove the IMP connector block.

3. Remove the jumper on the connector block.

4. Insert the connector block in the IMP, so that it makes good contact

5. Switch the IMP power source on. Wait for all the LEDs to be lit. (This takes between 5 and 10 seconds. Note that the LEDs light in a binary sequence: 1, 2, 1&2, 3, 3&1, etc.)

6. Switch the IMP power source off, remove the connector block and refit the jumper.

7. Insert the connector block in the IMP, and secure.

8. Switch the IMP power source on. The unit is now operating in its default set-up.

The IMP default parameters are:

Communications:
RS-485; unit address=1; pass thru mode=not enabled; serial/RS-485 settings=9600bps, no parity; transmission mode=ASCII.

Ethernet: unit address=1; pass thru mode=not enabled; IP address=172.20.6.66, subnet mask=255.255.0.0, port=502, gateway=0.0.0.0; transmission mode=Modbus/TCP.]

Channel Settings:
Chans 1-5 volts; Chans 6-10 temperature (type T thermocouple); Chans 11-16 current (sensing resistors are included in pack); Chans 17 and 19 four-wire ohms.

2.10 IF THINGS DON'T SEEM TO BE WORKING…

Although we have made every attempt to make this Getting Started procedure as straightforward and foolproof as possible, you may find that the system isn't working as it should. Here are some hints to help you.

If IMPVIEW did not install properly...
Re-boot your PC, open Windows, ensure there are no other applications running, and try again. If that fails, check that your hard disk has at least ??Mbytes of free space, and check that your floppy disk drive is working properly.

When IMPVIEW is started, no COM port is found...
This may mean that:

a) The COM port is already in use by some other device on your PC. Ensure that a serial communication port is available, i.e. not in use.

b) Ethernet not fitted to the IMP. Check the cable connections. Duplex communication between PC and IMP requires that cross-over connections are used –that is, is +TD to +RD and –TD to –RD. Where the PC is connected directly to an IMP the best way to do this is to use a standard 10BaseT cable, with the connections crossed over at the IMP. Where the PC is connected to the IMP through a hub, the hub takes care of the cross-over: so a standard 10BaseT cable can again be used, but without crossing the connections at the IMP. (See Figures 2.2 and 2.3.)

IMPVIEW finds the Interface OK, but can't find the IMP...
On the IMP the Power indicator at the opposite end of the housing should be lit. If it isn't, check that the network cable is undamaged and plugged correctly into the port connector on the PC.

Check that the IP address of the PC is compatible with the IP address and sub-net mask of the IMP. By default these are '172.20.6.66' and '255.255.0.0'.

The unit address of the IMP may be wrong. The default factory setting is '1'.

Everything seems to be OK, but I can't seem to get a sensible measurement on Channel 01...
Check that your wires to the channel 1 screw terminals are not broken, and are properly installed to the marked terminals, and that you have removed the wire link between G, H, and L.

I keep getting IMP Transmission Errors...
Try restarting IMPVIEW. Note that the RS232 to RS485 converter requires power for reliable communications.

I've done all that you say, and it still doesn't work....
Try reading the appropriate section in the manuals, which give more detail than this section.

If that doesn't solve the problem, then call Solartron-Mobrey on **+44 (0)1252 756600**.

We're here to help you!

3

Installing the 5000 IMP

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3.1 INSTALLATION SUMMARY

The installation procedure for the 5000 IMP covers three chapters in this manual. The following summary is given as a guide. Section references relate to the present chapter.

1. Choose a suitable site for the IMP. (*Section 3.2*)

2. According to site requirements, mount the IMP(s) individually (*Section 3.3*) or in a rack (*Section 3.4*).

3. Make the connections to the IMP:

    - Sensor connections (*Chapter 4*),
    - Comms connections (*Chapter 5*),
    - Power connections (*Section 3.5*). **Caution:** Do not switch on the power until installation is complete.

    General details of how to remove the connector block and make connections to it are given in Chapter 4.

4. Refit the IMP connector block.

5. Ground the IMP case. (*Section 3.6*)

3.2 CHOOSING A SITE

IMPs, typically, are distributed around the system, each IMP being mounted close to the sensors that it is to monitor. This allows the sensor leads to be kept short, which is less costly and minimises noise pick-up. In systems where there are many sensors at each measurement point, and possibly established sensor channels, several IMPs may be mounted together in a rack.

An IMP mounting site must be relatively free from moisture, vibration and corrosive substances. Where a damp site cannot be avoided, mount the IMP vertically with the connector end pointing downwards. Any excess moisture then tends to drain away from the vulnerable areas where cables enter the IMP.

In particularly hostile environments it is recommended that each IMP is mounted inside a sealed protective box and that the cables are enclosed in a sealed protective duct. See Appendix B of the manual for the IMP environmental specification.

For any mounting site ensure that there is sufficient room for the cables connected to the IMP. There should be adequate room for bending cables without straining them. There must also be sufficient room to remove the connector block from the IMP, with the IMP fixed at the mounting site. This provides for ease of access to the sensor connections.

A dc supply for the IMP must be available at the mounting site. This supply can have an output range of 12V through 24V and should be able to supply 0.5A.

CAUTION: Before connecting any power, control or signal leads to an IMP, connect the external case of the IMP to ground. See Section 3.6.

3.3 INSTALLING AN INDIVIDUAL IMP

Provision is made for fixing individual IMPs to permanent features on site, such as stanchions and bulkheads. The general approach is to use four bolts. The bolting arrangement is shown in Figure 3.1.

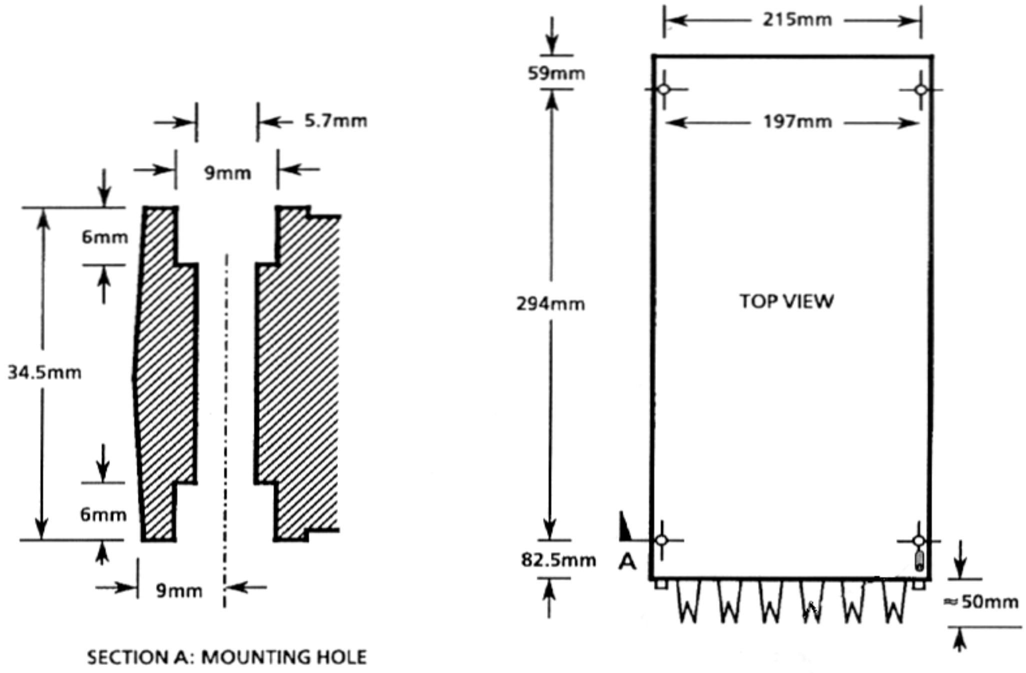

Figure 3.1 Location of bolt holes on the 5000 IMP.

3.4 INSTALLING IMPS IN A RACK

A rack mounting kit is available as an accessory, part number 359591A. Each kit allows 10 IMPs to be housed in a standard 19" rack. The overall dimensions of the assembled kit are: 483mm×510mm×266mm (19"×20"×10.5"). (See Figure 3.7.)

Each kit contains:

- two side panels,
- four support trays,
- four plastic runners,
- two rear trims,
- two front trims (one upper, one lower),
- two rack ears,
- two clamp bars (one upper, one lower),
- one pack of screws, nuts and washers,

The rack assembly procedure is:

1 Fix the support trays (four off) to the side panels (two off), using M4 pan head screws and crinkle washers. (See Figure 3.2.) Add one plain washer to fixing hole if the panel hole is a slot.

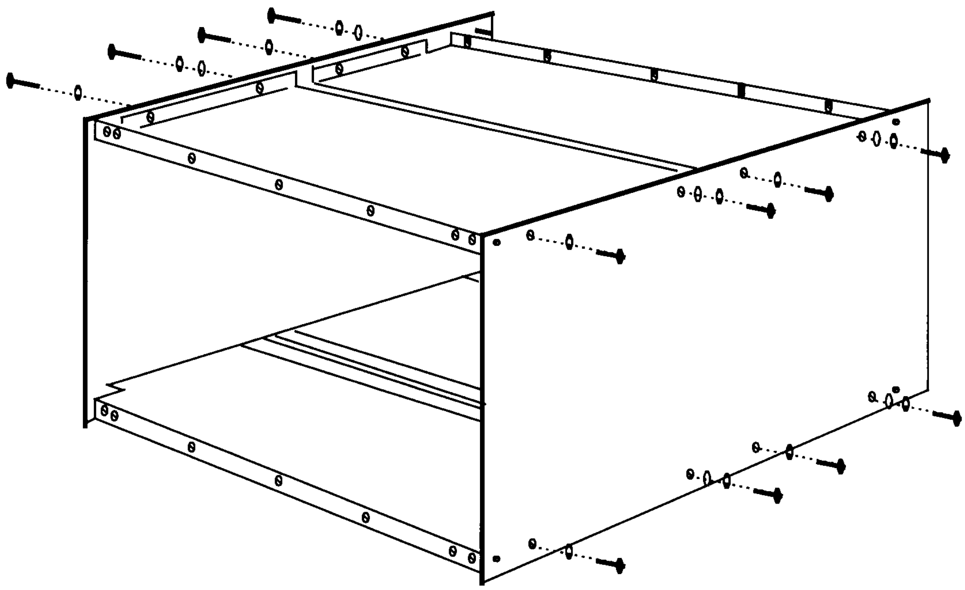

Figure 3.2 Assembly of support trays and side panels for IMP mounting frame.

2 Slide the plastic runners (four off) into the support trays. (See Figure 3.3.)

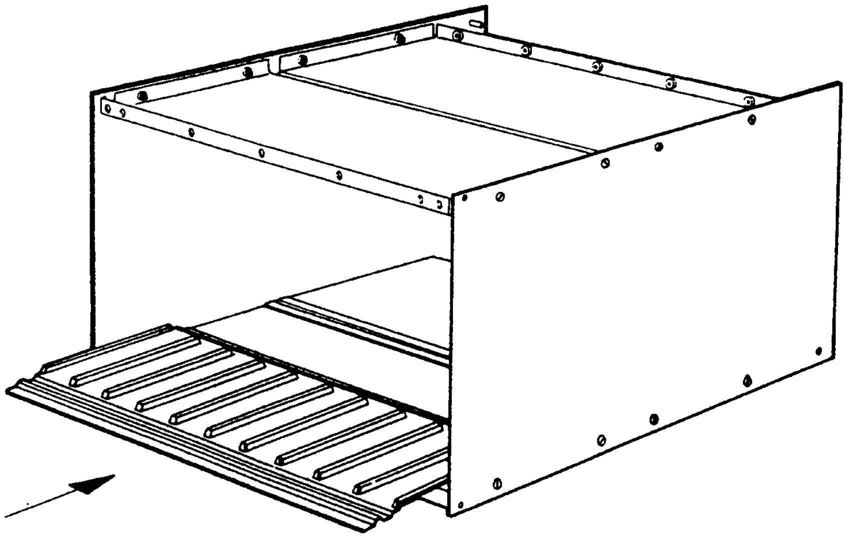

Figure 3.3 Sliding the plastic runners into the IMP mounting frame.

3 To secure the plastic runners at the rear of the mounting frame, fix the two rear trims with M4 countersunk screws. (See Figure 3.4.)

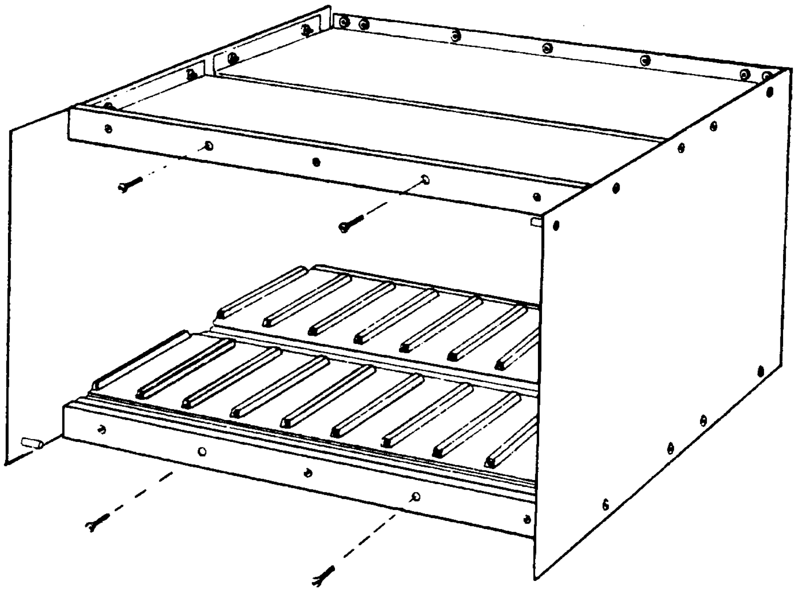

Figure 3.4 Fixing the rear trims on the IMP mounting frame.

4 To secure the plastic runners at the front of the mounting frame, fix the upper and lower front trims with M4 countersunk screws. Fix a rack ear at each side of the mounting frame, using M4 pan head screws and crinkle washers. (See Figure 3.5.)

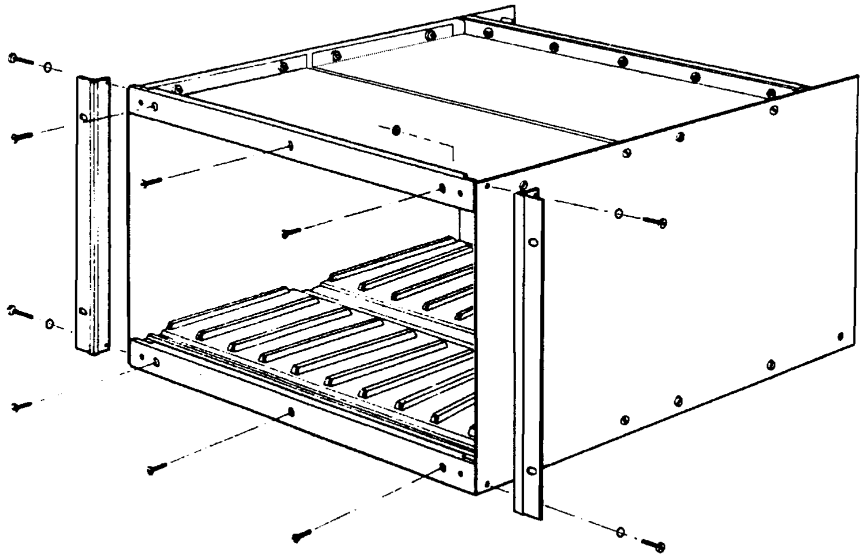

Figure 3.5 Fixing the front trims and rack ears on the IMP mounting frame.

5 At the rear of the unit fix the lower clamp bar in its lowest position, using M4 pan head screws with plain and crinkle washers. Then fix the upper clamp bar (with grounding studs) in its highest position, using M4 pan head screws with plain and crinkle washers. (See Figure 3.6.)

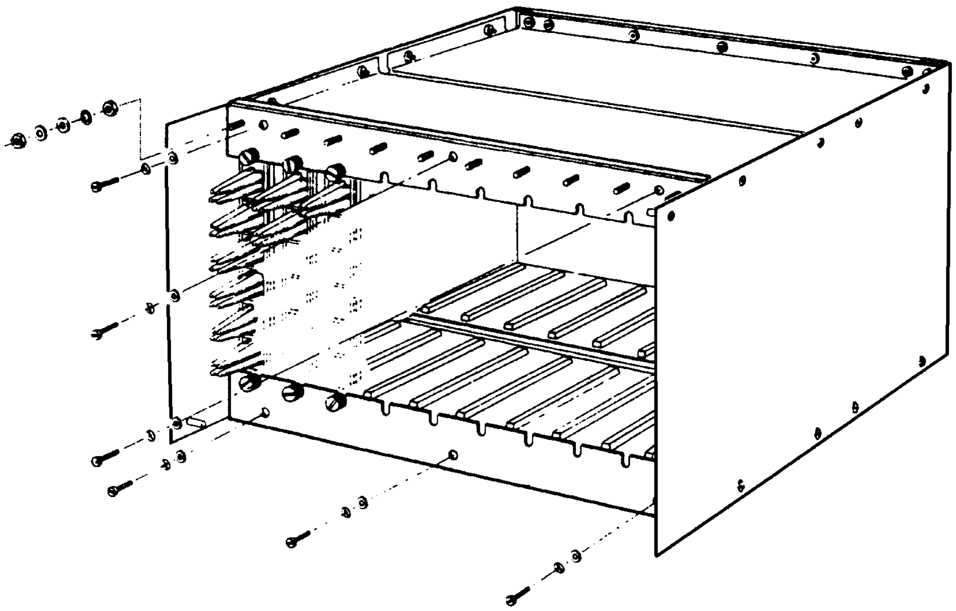

Figure 3.6 Fitting the clamp bars on the IMP mounting frame.

6 Slide all of the IMPs into the mounting frame (Figure 3.7). Then raise the lower clamping bar and lower the upper clamping bar, so that the connector block screws rest inside the open slots. Fix the clamping bars by tightening the M4 screws.

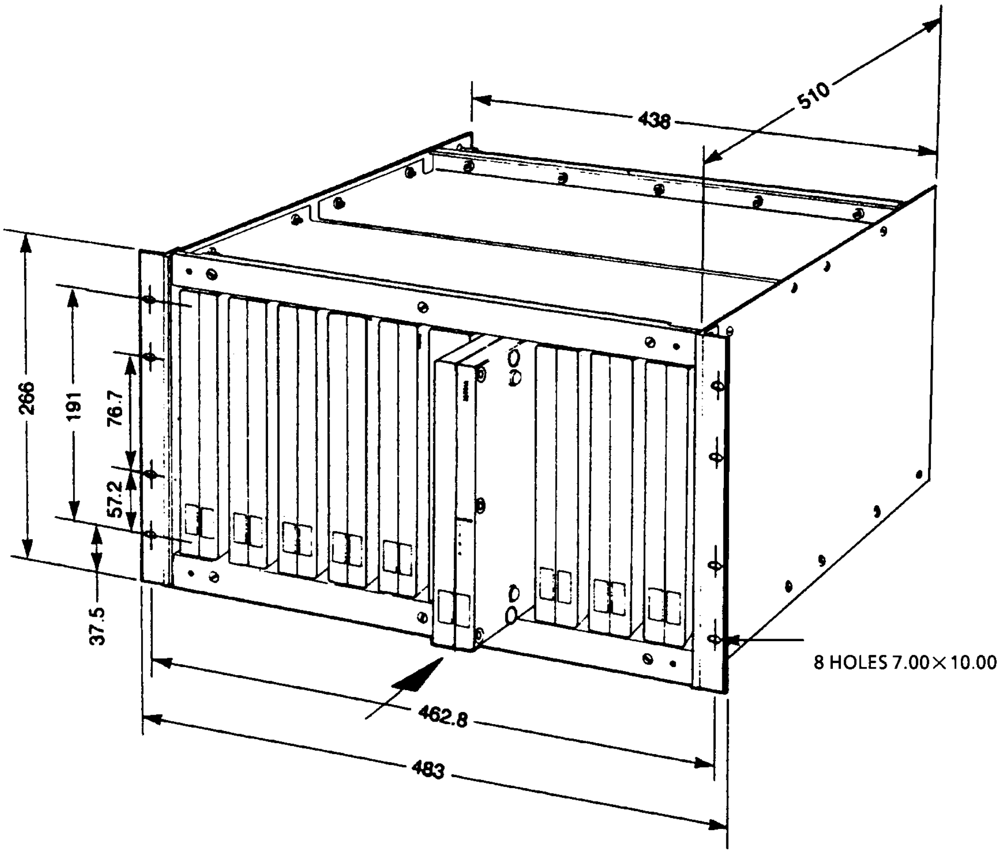

Figure 3.7 Inserting an IMP into the assembled mounting frame.

3.5 SUPPLYING POWER TO THE IMP

The 5000 IMP must be powered from a dc supply, in the range 12V through 24V. Power is connected to the EXT POWER terminals on the 5000 13L Connector Block. See Figure 3.2.

To access the EXT POWER terminals undo the two knurled screws securing the connector block and withdraw this from the IMP case. Details of how to make connections to the connector block are given in Chapter 4 (Section 4.2).

The ‘IN’ and ‘OUT’ power terminals allow several IMPs to be ‘daisy chained’ to the supply lines. Note the polarity of the power terminals and ensure that these are connected to terminals of the same polarity on the power supply unit. Should you inadvertently reverse the polarity of the supply the IMP will not be damaged –it is reverse polarity protected: to make the IMP work simply switch the polarity over.

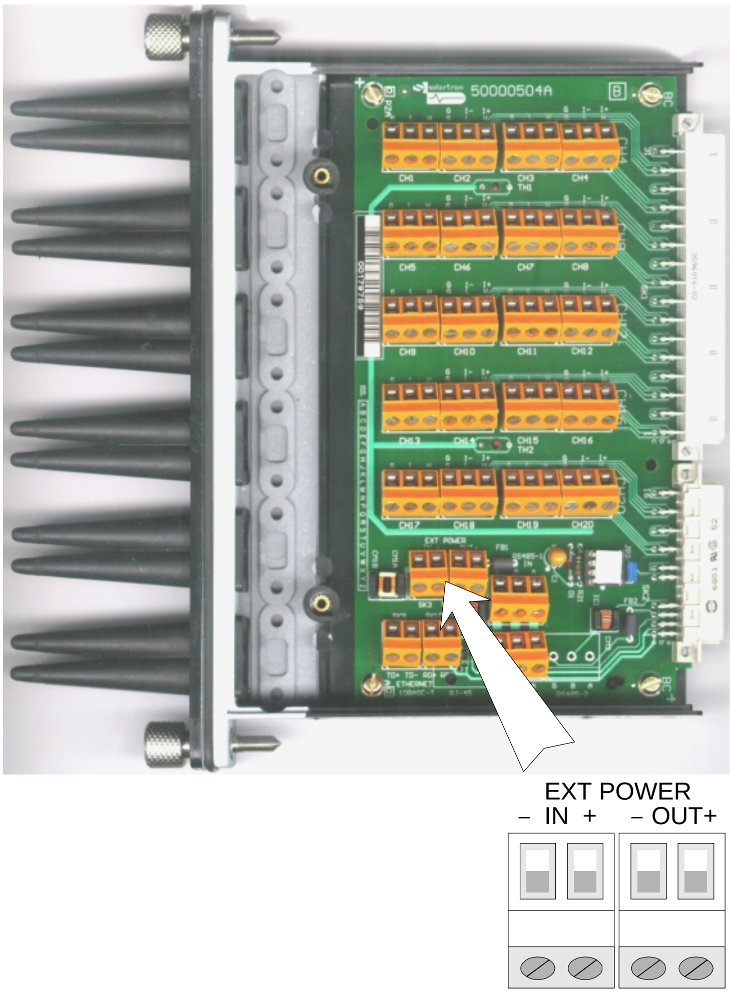

Figure 3.8 External power connectors on the 5000 13L Connector Board.

3.6 GROUNDING AN IMP

Before any power, control or signal leads are connected to an IMP its case must be connected to ground through the M4 studs provided. **Also, the protective ground terminal (E) of any ac-powered dc supply units must be connected to the ac installation ground.**

Grounding studs, threaded M4, are provided in recesses on both sides of each IMP case. (See Figure 3.9.) It is normal practice to connect one of the studs to the chassis of the equipment on which the IMP is to be mounted. Grounding enhances the screening effect of the enclosure, thus improving the IMP's immunity to electrical interference.

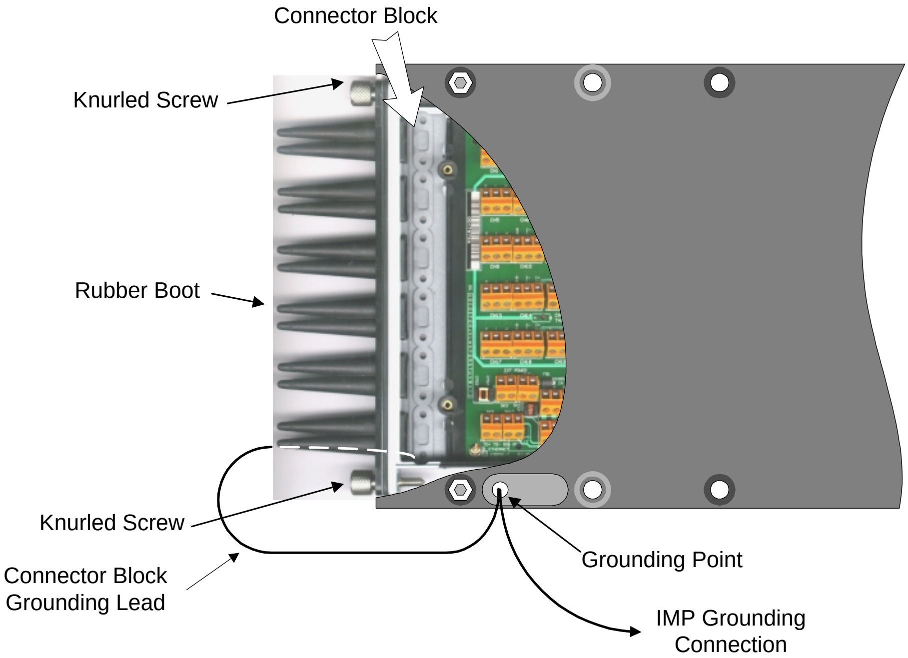

Figure 3.9 Detail of IMP grounding stud.

Where IMPs are rack mounted, grounding can be done with a short length of wire equipped with ring terminals at either end. First connect one end of the wire to the IMP enclosure grounding stud. Once the IMP has been fitted in the mounting frame, and drawn fully into place by the knurled connector block screws, the free end of the grounding wire can be fastened to the adjacent grounding stud of the upper clamp bar.

Note: the IMP case and the internal circuitry are electrically isolated from each other, and can withstand a potential difference of up to 200V.

The mounting frame must be grounded locally. Either one of two grounding points should be used. These points consist of studs (two supplied) which can be screwed into tapped bosses at the rear of the frame side panels.

3.7 MODIFYING THE IMP CONNECTIONS

Details of how to connect the sensors to the 5000 13L Connector Block are given in Chapter 4 of the manual, whilst details of the control connections are given in Chapter 5.

The connector block is removed from the IMP simply by unscrewing the two knurled retaining screws and withdrawing the block from the IMP case. This allows connections to be made or modified without removing the IMP from the installation site.

CAUTION: To avoid injury, it is advisable that connections to the block should be made only with the IMP power supply turned off. Also, before modifying the IMP connections, ensure that any signals applied on existing connections are disabled and/or are isolated from hazardous voltages.

4

Connecting the Sensors

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Table 4.1 Measurement Types 4-3

4.1 CHANNEL FUNCTIONS

Each of the 20 channels in a 5000 IMP can be set to measure a wide variety of input signals. However, setting up a channel to measure a specific signal is a two-fold process. First you must make the appropriate connections to the channel input, as described in Section 4.3 of this chapter, and then the IMP must be configured, using 5000 IMPView, to define the channel mode.

All channels (1 through 20) can each be set to measure any of the analogue or status inputs listed in Table 4.1.

Table 4.1 Measurement Types

Measurement Type	Choice of Input
DC Voltage	20mV, 200mV, 2V, 12V, auto-range.
DC Current	200mA, 2mA, 20mA, 100mA, auto-range. (This assumes that a 100Ω shunt resistor is fitted on the connector block.)
Temperature (thermocouple)	Thermocouple types E, J, K, R, S, T, B, and N, with internal or external cold (reference) junction compensation. (Open circuit detection and loop resistance measurement are available.)
Resistance	Four-wire configuration for: 25Ω, 250Ω, 2k5Ω, 25kΩ, autorange. Three-wire configuration for: 1k5Ω, 25kΩ, autorange. Two-wire configuration for: 500Ω, 25kΩ, autorange.
Temperature (RTD)	100Ω platinum, 10Ω copper.
Status	TTL, 3V/9V, volt-free contact.

4.2 THE 5000 IMP CONNECTOR BLOCK

All connections to the 5000 IMP are made through the 5000 13L Connector Block. (See Figure 4.1.) This is inserted into one end of the IMP case and is secured by two captive screws. A conductive elastomer gasket between the end cap of the connector block and the IMP case provides a weather- and RF-proof seal.

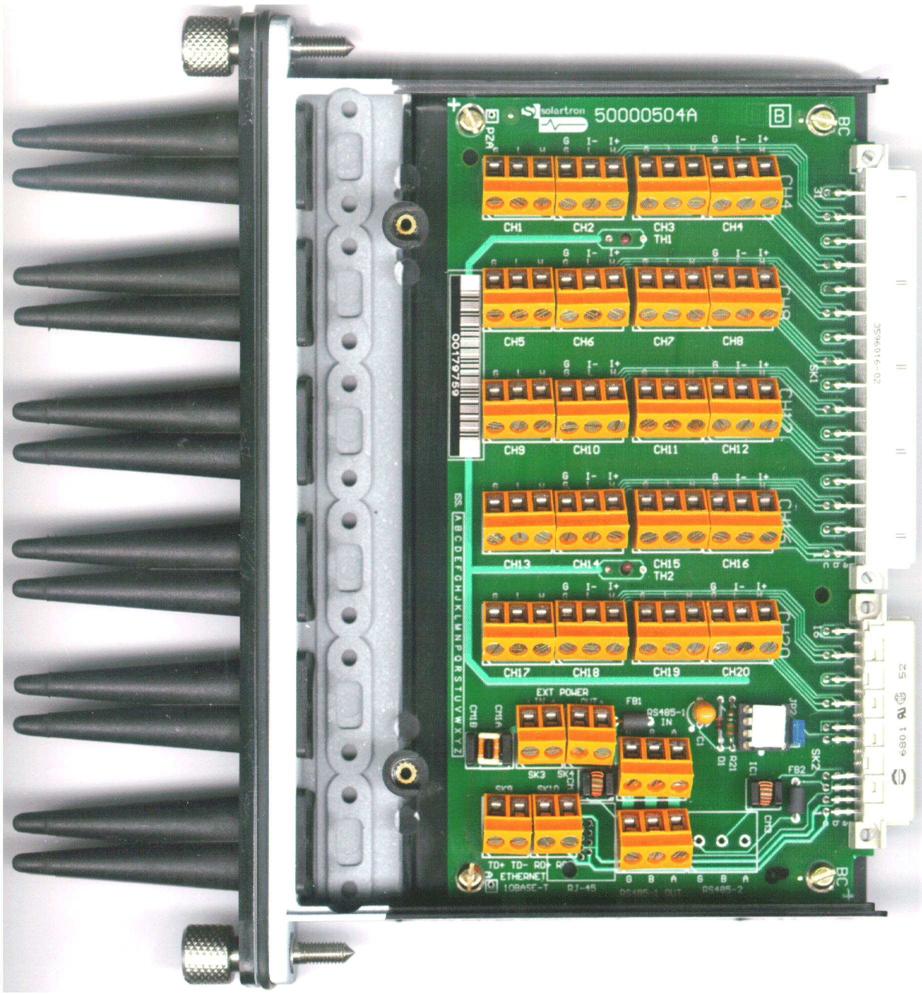


Figure 4.1 The 5000 13L Connector Block.

Six four-way PVC rubber `boots' are provided on the end cap to ensure a weatherproof seal for cable entry. Optional single-way boots can be fitted instead, for larger cables. A cable clamping and grounding facility is provided between the boots and the terminals on the pcb. Insulating covers are fitted to each side of the connector block assembly. These are for safety and prevent the wires from becoming snagged between case and end cap when the connector block is reinserted in the case.

General instructions for making IMP connections are given below. Wiring details for specific types of measurement are given in Section 4.3.

4.2.1 MAKING CONNECTIONS TO THE CONNECTOR BLOCK

To meet with the EMC standards to which the unit has been tested, it is required that all signal, power and communication cables be of a shielded type and grounded at the connector block. It is emphasised that the shielded cables must *only* be grounded at the connector block: they must *not* be grounded at the remote end as this will cause ground current loops to flow and, with common mode potentials present, may pose a safety hazard.

To maintain the environmental specification, all connections to the IMPs must be properly sealed. Protective rubber ‘boots’ are provided for this purpose and the ‘teats’ on these should be cut to a length such that leads passed through them are firmly gripped, thereby forming a seal. To effect a good seal, it is important that the cross-section of the leads is more or less circular. With twisted pairs a waterproof sealing compound such as silicone compound may be necessary.

Incoming cables are taken through the glands and connected to the Klippon connectors as required. To provide mechanical stability, the cables are clamped on entry to the box. Clamping provides not only mechanical stability but securely connects the shield of the cable to the IMP ground point. Connection is made by exposing the shield at the point that the cable is clamped. The cable clamp forces the shield into contact with the zinc arc spray surface of the connector block. The zinc surface forms a continuous conducting surface over the entry to the box and is used to make an electrical connection to the main aluminium box when the connector block is screwed into position.

For safety purposes, a fly lead is connected between the connector block and the IMP aluminium case. On the connector block, the fly lead is permanently bolted to the lower cable clamp. Should any cable screen be inadvertently grounded at the remote end, disconnection of the fly lead, with the connector block unscrewed, could result in the risk of electrical shock.

The general procedure for connecting cables to the connector block is:

The general procedure for making connections to the connector block is:

1. Unscrew the two screws either side of the projecting rubber boots; the connector block will be released from the main IMP housing.

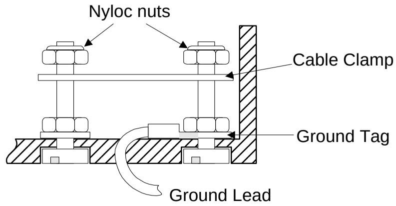
2. Withdraw the connector block carefully from the IMP housing.

3. Undo the two cover retaining screws and withdraw the cover from the rear of the connector block.

4. With a sharp blade, cut the tip off a rubber teat for each lead to be connected. (To ensure a good seal, be careful not to cut off too much in one go!)

5. Fit the prepared end of the connector block ground lead (supplied) to the lower cable clamp.

6. Push the ground lead through the lower prepared teat, ready for connecting to the IMP case.



7. Push the first lead to be connected through a prepared teat. To ease its passage the lead may be lubricated with silicone grease and, if necessary, a sleeve expansion tool used to stretch the teat slightly prior to lead insertion.

8. With multi-wire leads having a separate cover, remove just sufficient of the outer cover to allow wire separation: ensure that the outer cover remains sealed by the boot. With shielded cables remove a sufficient length of outer cover to ensure that the cable shielding makes contact with the zinc surface when clamped to the connector block case.

9. Strip off a 6mm length of insulation from each wire and connect as shown in Sections 2.3.2 through 2.3.4 in this chapter.

10. Connect the remainder of the leads, as described in Steps 7 through 9.

11. Ensure that all cable clamps are firmly tightened down.

12. Refit the connector block cover, remembering to locate the two 'nibs' on the rear of the cover under the pcb, before locating the screws in their respective bushes and tightening them down.

13. Push the connector block back into the IMP housing and secure with the two knurled screws.

14. Fit the 'receptacle faston' to the end of the ground lead protruding from the connector block. Then connect the receptacle to the grounding point on the IMP case. (See Figure 4.2.)

15. Connect the IMP grounding point to a suitable line earth (ground).

NOTE: Users who require to use multi-core, armoured, or other thick cables may choose the optional 35963 series of industrial (glanded) connectors; these offer industry standard glands as an alternative cable entry.

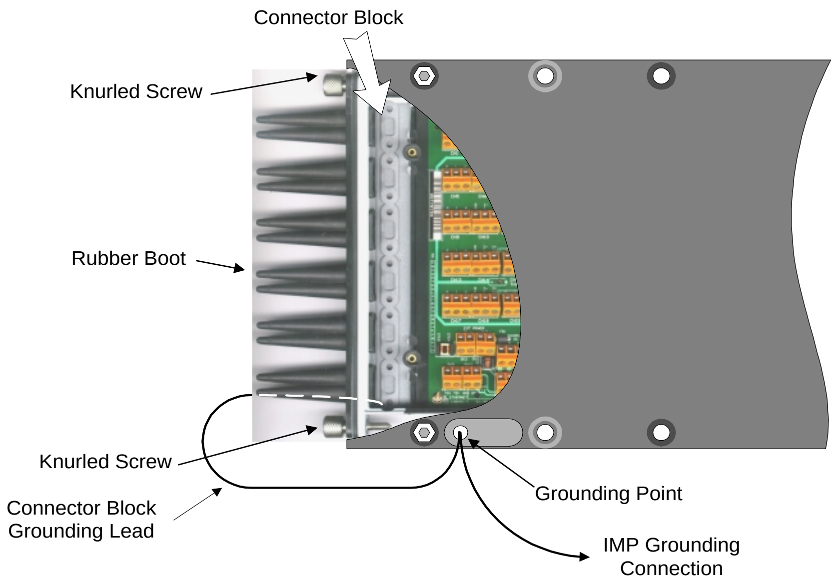


Figure 4.2 Location of IMP grounding point.

4.3 PREPARING THE MEASUREMENT CONNECTIONS

This section describes the background of each channel mode and the connections to be made for it.

4.3.1 VOLTAGE CONNECTIONS

Connect the unknown voltage to the H, L and G terminals as shown in Figure 4.3. On the even numbered channels the I+ and I- notation should be disregarded.

For the voltage measurement mode the L (Lo) and G (Guard) terminals must always be connected together. For optimum rejection of electrical interference connect the guard as shown for channel CH 1. If this is impractical connect the G and L terminals together at the terminal block, as shown for CH 2.

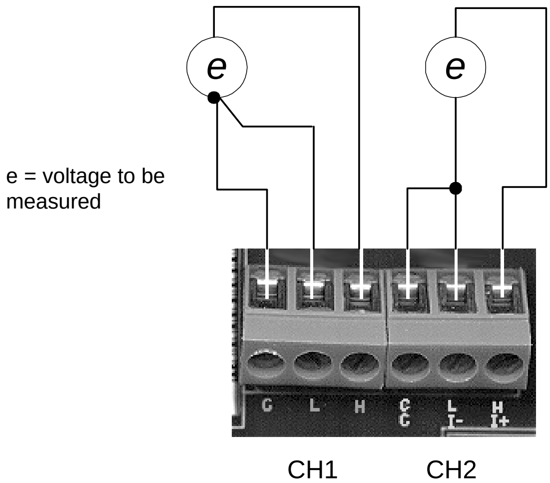


Figure 4.3 Voltage connections.

The voltage ranges available are the fixed ranges 20mV, 200mV, 2V, and 12V, and auto-range.

4.3.2 CURRENT CONNECTIONS

The IMP derives the value of current i by measuring the voltage (v) developed across a fixed precision resistor (r), then by Ohms law calculating the ratio v÷r.

Note that resistor r is fitted by the user, and must be fitted only for current measurements.

The ranges available are: 200mA, 2mA, 20mA, 100mA and auto-range. Scaling within the IMP assumes that the value of resistor r is 100Ω. Other values of resistance can be used but the results must be re-scaled accordingly. For example, if a 1000Ω resistor is used, results received by the host must be divided by 10.

The current sensing resistor is fitted between the Hi and Lo channel inputs. This is normally done at the screw terminals on the connector block, but there are sites on the reverse side of the pcb where the resistor can be soldered.

For optimum rejection of electrical interference the G (guard) terminal must be connected to L (low) at the circuit break. See the connection for channel 1 in Figure 4.4.

G (guard) must not be left disconnected since it forms an integral part of the measurement circuitry. Ideally the guard should be connected as shown for channel CH 1, but if this is impractical use the alternative guard connection shown for channel CH 2.

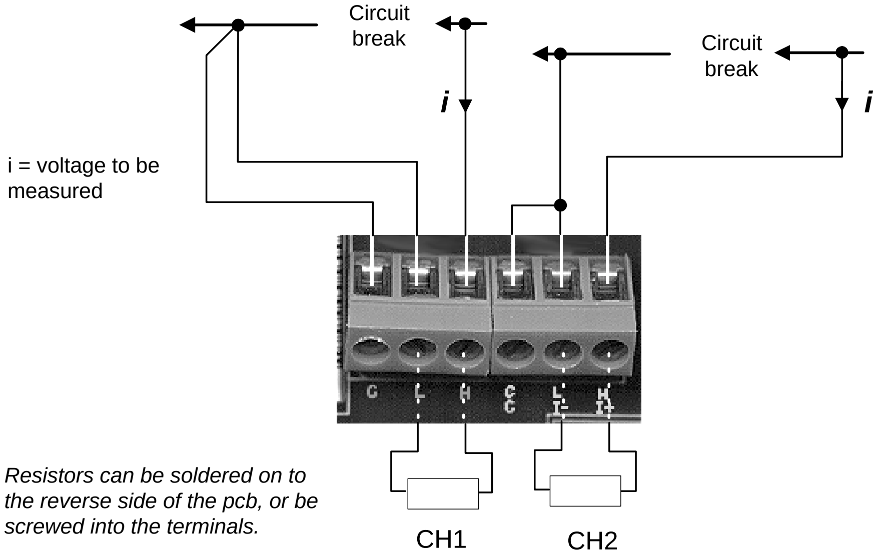


Figure 4.4 Example of current connections.

4.3.3 THERMOCOUPLE CONNECTIONS

For temperature measurements by thermocouple the IMPs can accommodate thermocouple types E, J, K, R, S, T, B and N.

The ‘cold’ (reference) junction for thermocouples can take either of the two forms shown in Figure 4.5. Channel CH 1, in this example, uses the connector block terminals. Built-in thermistors sense the temperature in the interior of the connector block and the IMP adjusts the measurement value so that it refers to 0°C. The alternative is to use an external reference unit, as shown for channel CH 2. Here, copper leads are used to join the reference junctions to the connector block. In both cases extension/compensating cables are used to connect the reference junctions to the thermocouple.

For optimum rejection of electrical interference the G (guard) terminal must be connected to L (low) at the thermocouple. See the connection for channel CH 1 in Figure 4.5.

The G terminal must not be left disconnected since it forms an integral part of the measurement circuitry. Ideally the guard should be connected as shown for channel CH 1, but if this is impractical use the alternative guard connection shown for channel CH 2.

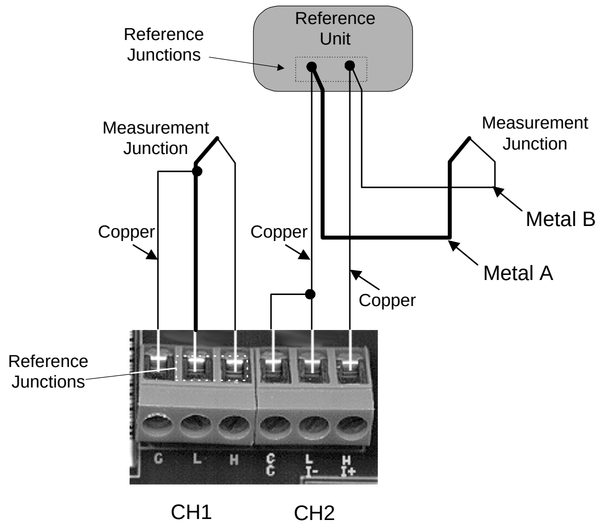


Figure 4.5 Example of thermocouple connections.

4.3.4 RESISTANCE CONNECTIONS

The resistance (r) of an external resistor is measured by passing a constant energizing current of known value (i) through the resistor and measuring the voltage v developed across it. The resistance (r) is then computed from the equation r=v÷i.

The resistance to be measured can be connected in three ways: two-wire, three-wire, or four-wire. These are shown in Figure 4.6 and their uses are described in Sections 4.3.4.1 through 4.3.4.3.

A current drive of 800mA or 80mA, dependent on range and/or mode, is supplied by the IMP. The way in which this is applied depends on the measurement connections.

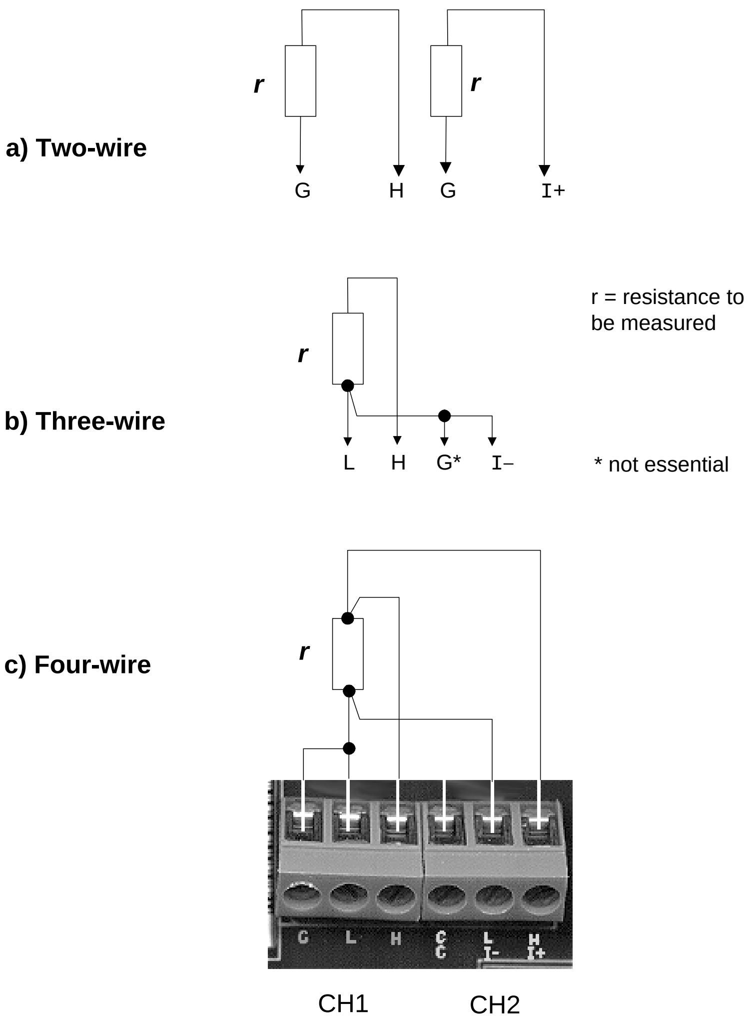


Figure 4.6 Resistance connections.

4.3.4.1 Two-wire Resistance Measurement

Two-wire resistance measurement is the least accurate and is intended primarily for use in volt-free contact status applications. The ranges are: 500Ω, 25kΩ, and auto-range. The current drive is supplied through the H and G terminals of the measurement channel. Therefore all channels from 1 through 20 can be used for two-wire resistance measurements.

The two-wire method is not recommended for value measurement. However, if only two wires are available for this purpose, it is possible to use the four-wire method, connected as shown in Figure 4.7. With this application the resistance value of the leads ($2R_L$) must be subtracted from the measurement result.

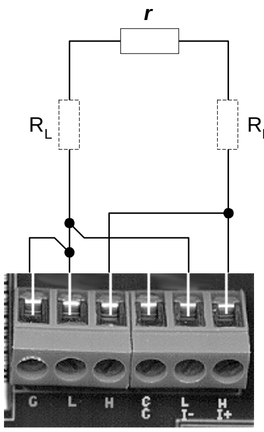


Figure 4.7 Four-wire connections for two-wire source.

4.3.4.2 Three-wire Resistance Measurement

Three-wire resistance measurement is sometimes preferred to the four-wire method, because three-core cable is cheaper than four-core. The results, however, are less accurate than with the four-wire method and have a reduced thermal stability. Also, for the resistance of the leads to be effectively nulled, the three conductors must be identical. The ranges are: 1.5kΩ, 25kΩ, and auto-range.

On Channels 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20 the I- terminal is used for the current return. To compensate for the resistance of the input connection cables the current drive is applied alternately to the H and L terminals of Channels 1, 3, 5, 7, 9, 11, 13, 15, 17 and 19. These are the only channels on which a measurement result is obtained.

4.3.4.3 Four-wire Resistance Measurement

Four-wire resistance measurement has greater thermal stability than the three-wire method, and gives a more accurate measurement. The ranges are: 25Ω, 250Ω, 2.5kΩ, 25kΩ, and auto-range. The wires from the H and L terminals must be connected as close as possible to the body of the unknown resistance. The guard connection is not essential as the I- terminal provides interference rejection, but it is still good practice to use it.

The current drive is supplied by the I+ and I- terminals on Channels 2, 4, 6, 8, 10, 12, 14, 16, 18 and 20. Again, the only channels on which a measurement result is obtained are Channels 1, 3, 5, 7, 9, 11, 13, 15, 17 and 19.

4.3.5 RTD CONNECTIONS

Temperature measurements by an RTD (resistance thermometer device) rely on the predictable variation, with temperature, in the resistance of a platinum or copper wire element. The IMP can work with three-wire or four wire RTDs and the connections are exactly the same as for three- and four-wire resistance measurements. (See Figure 4.8.) For improved interference rejection connect the Lo terminal to ground at source.

The IMP linearises temperature measurements by RTD to IEC 751. Linearisation can be selected either for a 100Ω RTD or for a 10Ω one.

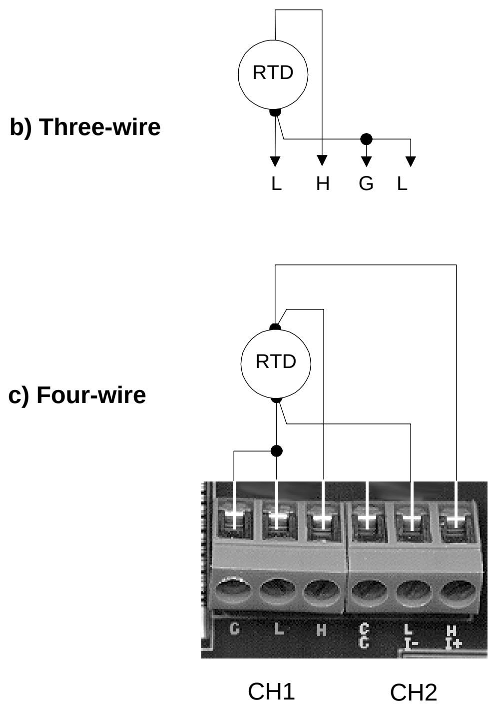


Figure 4.8 RTD connections.

Many different colour codes are used by the manufacturers of RTDs, therefore a standard colour code scheme cannot be defined. For the colour codes of a specific RTD refer to the manufacturer's specification.

The three-wire method of connecting an RTD is sometimes preferred to the four-wire method, due to the saving in sensor cable cost. The three-wire method does, however, give a less accurate signal, with reduced thermal stability, than the four-wire method. For the resistance of the leads to be effectively nulled, the conductors should be identical.

The four-wire method has greater thermal stability, and enables a more accurate measurement to be obtained. Any differences in lead resistance have no effect on the measurement.

In the three-wire mode the Guard connection is not essential: the circuitry associated with the I- terminal automatically provides interference rejection, as well as acting as current return. However it is still good practice to make this connection.

4.3.6 STATUS CONNECTIONS

The purpose of status measurement is to ascertain the logic state of a signal. Inputs are interpreted as logic ‘1’ or logic ‘0’.

Signal compatibility is offered for:

- TTL levels,
- 12V (nominal) levels,
- Two-wire voltage-free contact status.

The logic levels that the IMP interprets as a ‘1’ or a ‘0’ are shown in Figure 4.9. To avoid errors, ensure that the input signal always occurs outside the Indeterminate region: within this region a signal may be interpreted as either logic ‘0’ or logic ‘1’. (To determine the status of voltage-free contacts the IMP measures the resistance between them.)

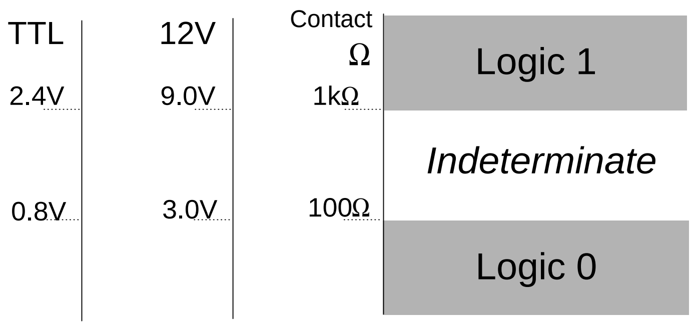


Figure 4.9 Logic level interpretation.

The rate at which signal status is determined depends upon the frequency at which the host issues status measurement commands.

The connections for status measurements are shown in Figure 4.10. (Note the difference between the connections for voltage logic and those for voltage-free contact logic.)

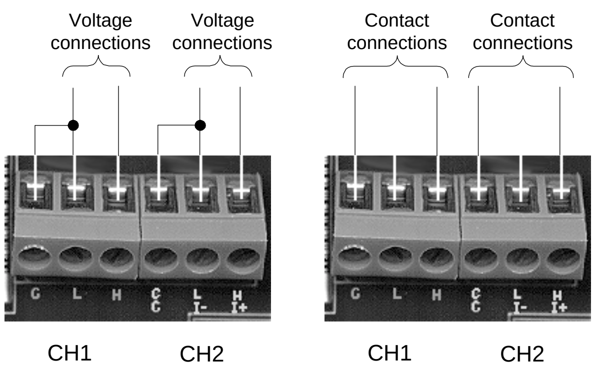


Figure 4.10 Example of status input connections.

4.4 UNDERSTANDING THE LED DISPLAY

Four LEDs on the end face of the IMP convey the following user confidence information, when illuminated. See Figure 4.11. The LED functions are:

Power Power is applied to the IMP.

Cal Error The IMP has a calibration error: contact a Solartron Service agent to have it re-calibrated.

ADC Error The IMP has an ADC error: contact a Solartron Service agent to get it checked out.

Scan The IMP is actively scanning predefined input channels.

For normal operation the state of the LEDs should be:

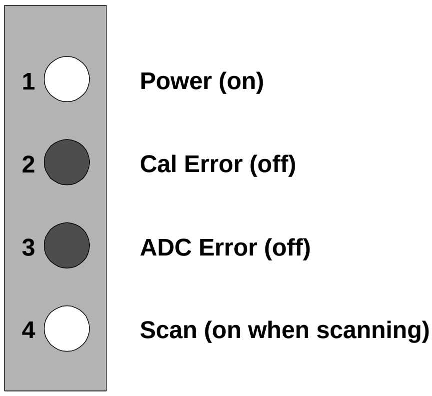


Figure 4.11 Normal state of LED status indicators.

5

Connecting the IMP to the Communications Network

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5.1 USING THE COMMUNICATION NETWORKS

To provide for a wide range of communication requirements the 5000 IMP has two ports: Serial (RS485) and Ethernet. Both of these use the Modbus protocol, as described in Chapter 6.

Introductions to the use of RS485 and Ethernet are given in Sections 5.2 through 5.4 in this chapter.

5.2 USING RS485

5.2.1 NETWORK TOPOLOGY

The topology of an RS485 network is shown in Figure 5.1. 5000 IMPs use the two-wire system, which provides for half-duplex communication.

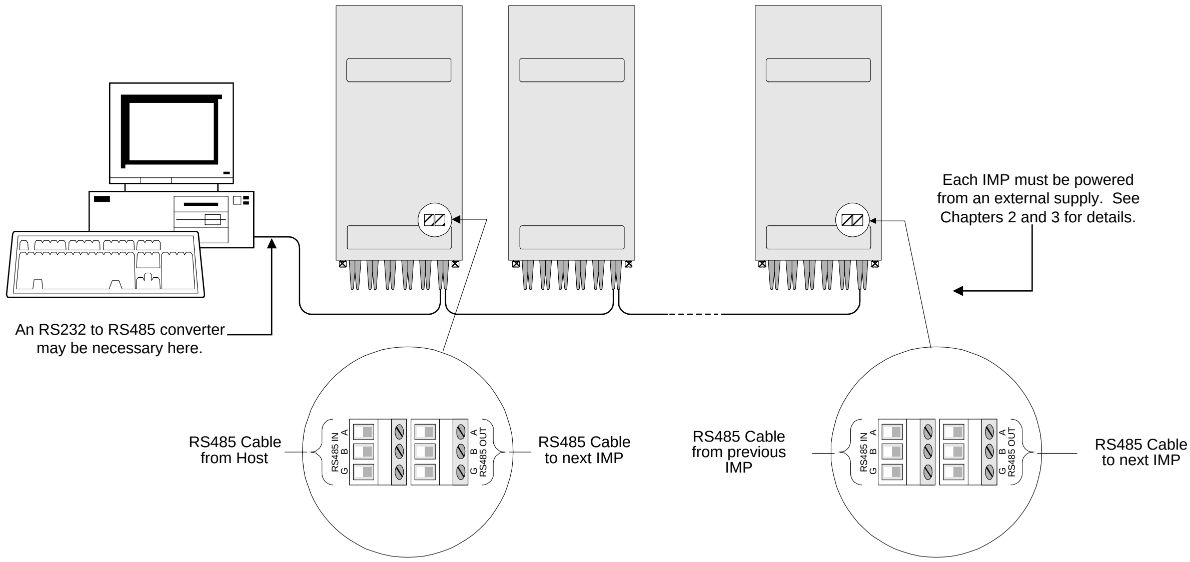

Figure 5.1 RS485 topology for 5000 IMPs.

5.2.2 MULTIPLE IMP CONNECTIONS

The conventional notation for RS485 signals is ‘A’, ‘B’ and ‘G’ (ground). In the ‘multidrop’ connections used on the network, you connect ‘A’ to ‘A’, ‘B’ to ‘B’, and ‘G’ to ‘G’. [*Some manufacturers label the ‘A’ and ‘B’ connections ‘–’ and ‘+’. Should you reverse the connections it will cause no damage, but there will be no communication.*]

Referring to Figure 5.1, the ‘A’, ‘B’ and ‘G’ wires from the Host are connected to the corresponding RS485 IN terminals on the first IMP in the chain. Connections for the second IMP in the chain are made between the RS485 OUT terminals on the first IMP and the RS485 IN terminals on the second IMP. Subsequent IMPs in the chain are connected in the same way as the first and second IMPs.

5.2.3 HOST PORT CONNECTION

If you intend to use an RS485 connection then you should have an RS485 card fitted to your PC.

Alternatively, you can use the RS232 port with an RS232 to RS485 converter fitted. This device plugs directly into the serial port of the host computer. Note that the host computer may require a 9-way to 25-way 'D' type adapter.

The RS485 connections to be made at the host computer are shown in Figure 5.2.

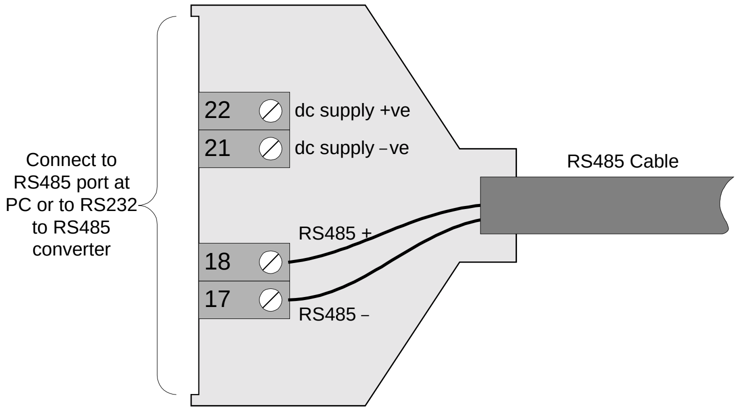

Figure 5.2 RS485 connections at the Host computer.

Larger networks, or networks running on low power host computers, will require an external power supply. This supply is applied via pins 22 and 21 on the RS485 connector, as shown above. For the 3593 911A RS232 to RS485 converter available from Solartron the supply voltage is 6V: the supply voltage for another make of converter will be stated in the converter user guide.

5.2.4 RS485 CABLE LENGTH

RS485 provides for communication with up to 32 IMPs, at half-duplex, at distances of up to 1200 metres (4000 feet) between the Host and the last IMP in the chain. The length of the cable and the number of IMPs can easily be extended by using a repeater.

5.2.5 RS485 CABLE TERMINATION

Depending on the length of cable used and the data rate, it may be necessary to terminate the RS485 cable. The object of this is to avoid signals being reflected back from a mismatched load impedance and causing data errors.

Termination becomes increasingly necessary as the cable length and data rate increase. Guidance on when to use termination, and which type, is contained in National Semiconductor Application Note 903, "A Comparison of Differential Termination Techniques" by Joe Vo. This is available on-line at *http://www.national.com*. A quick search facility allows you to search for available topics. Enter '485' as the search pointer for a list of related notes.

5.2.6 IMP ADDRESSES

The address of each 5000 IMP, as supplied, is '1' by default. Where several IMPs are connected to the network each must be given a unique address. This is done with Modbus commands, issued from IMPVIEW or the user software. Should you wish to physically connect all your IMPs to the network prior to running IMPVIEW then each IMP should have its address pre-assigned in a single network, as described in Chapter 2. Otherwise, the IMPs should be connected and ADDed to the network one at a time, a unique address being assigned in each case.

5.2.7 CONFIGURING THE SERIAL PORT PARAMETERS

The default serial port parameters of an IMP are:

Baud rate	9600bps
Parity	no parity
Transmission mode	ASCII

Initially, the PC must use these same parameters to be able to communicate with the IMP. (Accordingly, IMPVIEW has the same default.) Alternative parameters, e.g. the RTU mode, can be selected by modbus command and take effect when the IMP is next powered off and on again.

5.3 USING THE ETHERNET

5.3.1 NETWORK TOPOLOGIES

The 5000 IMP works on the UTP/10Base-T ethernet standard as this is the most common in terms of available equipment (repeaters etc). IMPs are intended to be connected to main networks via a hub. The hub has two purposes: a) it facilitates the connection of multiple IMPs to the network in a particular geographical region, and b) it can provide an interface with other types of network (e.g. coax or fibre). In large industrial sites the network backbone tends to be either 10Base-5 (Thick coax and AUI) or 10Base-F (optical fibre). Backbone implementation using a number of bridges gives good performance and is useful for connecting geographically separated segments.

Figure 5.3 shows a simple 10Base-T network, which connects three IMPs to the Host PC via a 10Base-T hub.

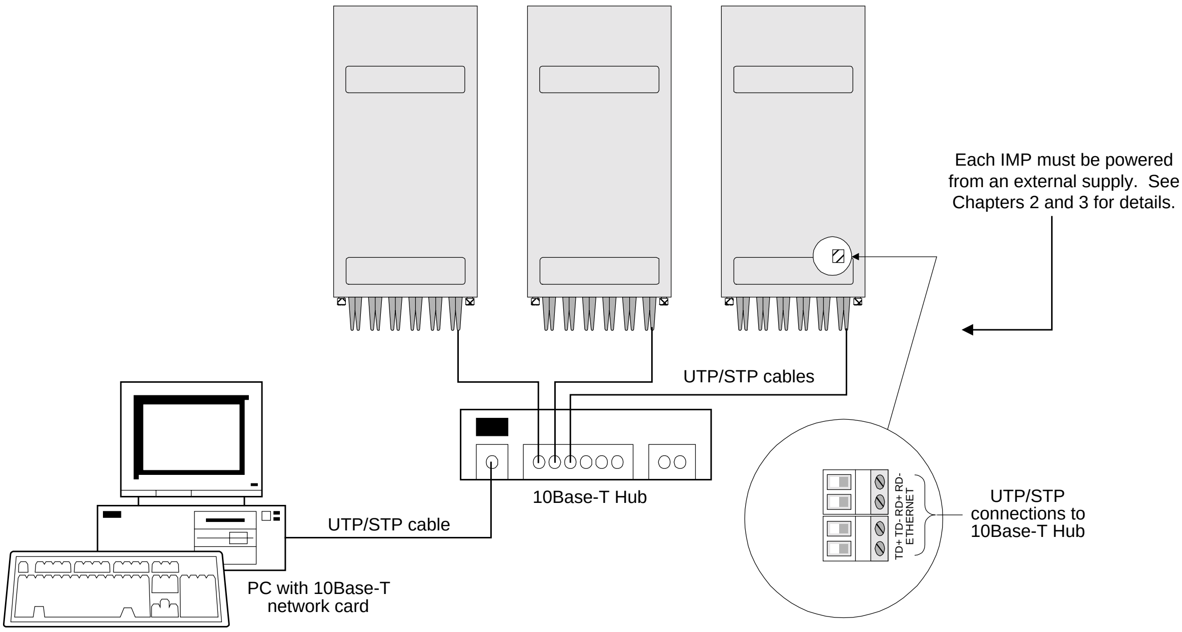

Figure 5.3 Simple 10Base-T network.

Figure 5.4 shows an example of network interfacing. The hub, in this particular case, is providing an interface between: a) the transceiver connection from the coaxial cable backbone and b) the UTP connections to the IMPs.

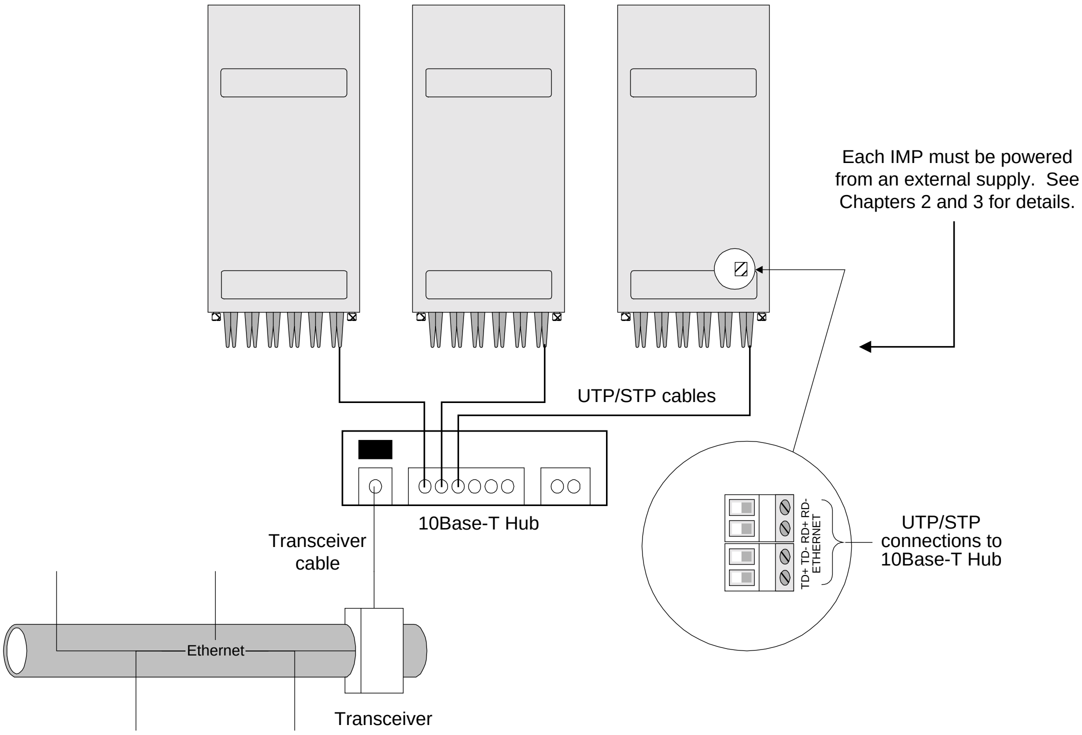

Figure 5.4 10Base-T network off coax. backbone.

5.3.2 CONNECTING THE IMP TO ETHERNET

The Ethernet connections to the IMP terminal block are made through screw terminals, not the standard Ethernet plug-in connector (RJ45). This is to avoid any disconnection problems due to vibration. (IMPs are often required to operate close to a source of vibration, such as rotating machinery.) The simplest way of obtaining a suitable cable is to cut the RJ45 connector from one end of a standard 10BaseT cable. Use the cut end for making the IMP connections.

Where the PC is connected directly to an IMP the connections are crossed at the screw terminals, i.e. +TD to +RD and –TD to –RD. Where the PC is connected to the IMP through a hub, however, the hub takes care of the cross-over, so the connections at the IMP are not crossed.

The general procedure for making connections to the IMP connector block is given in Chapter 4, Section 2.3.2.

5.3.3 SETTING UP THE IP ADDRESSES

For each IMP the default IP address is 172.20.6.66 and the sub-net mask is 255.255.0.0. Alternative addresses, in keeping with those of the user's system, can be set up through either the RS485 port or the Ethernet port.

To set up the IP address of an IMP over Ethernet, use the following procedure:

1. Set the IP address of the PC to correspond with the default IP address of the IMP. For example, use 172.20.1.123. Take care not to use the same address as the IMP.
2. Having established communication with the IMP, configure the IMP with an IP address acceptable to the application network.
3. Set the IP address of the PC back to its original value.
4. To implement the IMP's new IP address, switch the power to the IMP off and on again.

5.3.4 USING PASS THROUGH CONTROL

Pass through control is a very convenient and cost effective way of integrating Modbus devices into the plant network. (Pass thru' control is similar to an Ethernet-RS485 'gateway'.) One IMP is configured as a Pass Through Controller. This IMP is then able to relay communication between the controlling PC on Ethernet and IMPs and other Modbus devices connected to its Serial (RS485) Port. IMPs connected to this port must be configured to access the Ethernet through the Pass Through Controller. These IMPs/units are thus acting as slaves to the Pass Through Controller. (See the example system in Figure 5.6.)

Note that a Pass Through Controller is still able to act as an Isolated Measurement Pod, when it receives Modbus commands addressed to itself. Guidance on configuring pass through control is given in the 5000-IMPVIEW Operating Manual. The relevant Modbus commands are detailed in Chapter 6.

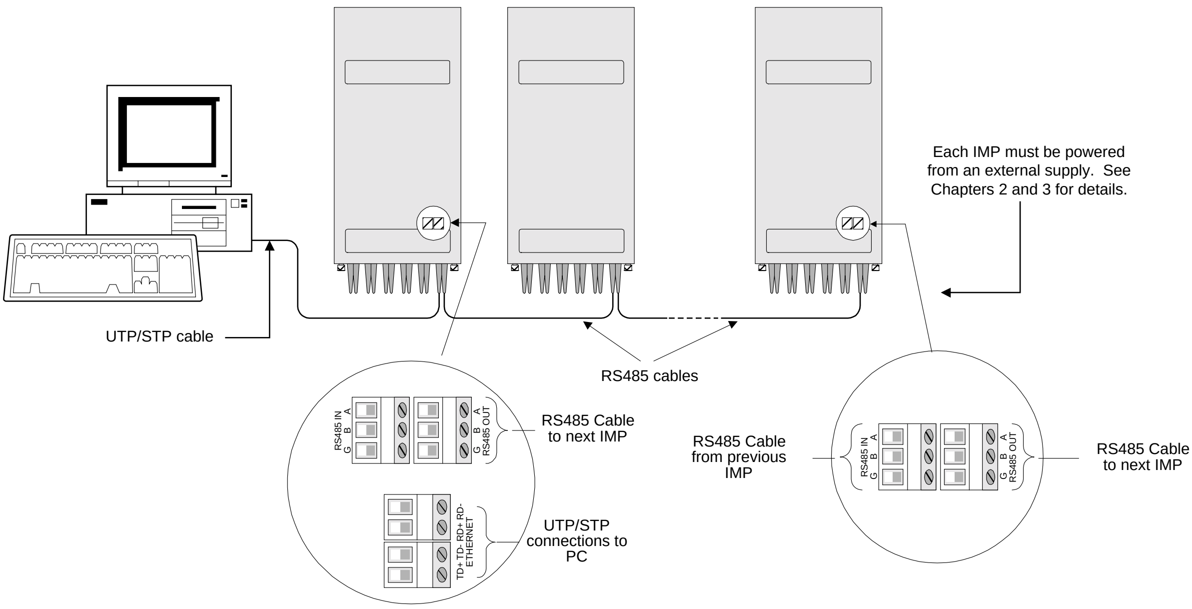

Figure 5.5 Pass-through control connections.

6

Modbus Commands

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6.1 MODBUS PROTOCOL

Modbus protocol defines a recognisable message structure that can be used by controllers, regardless of the type of networks over which they communicate. The protocol describes:

- the process by which a controller requests access to other devices,
- the response of the controller to requests from other devices, and
- how any errors are detected and reported.

Modbus also specifies a common format for the layout and content of message fields.

The Modbus protocol is by the Modicon Standard PI-MBUS-300 for serial communications (RS485) and the Modbus/TCP Specification for Ethernet. Both of these documents can be found at the following website:

http://www.modicon.com/OPENMBUS/standards/standards.htm.

6.1.1 MODBUS COMMUNICATION ON AN RS485 NETWORK

The Modbus protocol provides the internal standard that a controller uses to parse messages. During communications on an RS485 network, the protocol determines how an IMP will recognise its device address, comprehend a message addressed to it, determine the action to be taken, and extract the information contained in the message. Should a reply be called for, the IMP constructs an appropriate message and sends it in accordance with Modbus protocol.

The RS485 Modbus modes used by 5000 IMPs are listed in Table 6.1.

Table 6.1 RS485 Modbus mode

Component	Example	ASCII	RTU
Message delimiter		:	None
Address	Unit 1	0 1	01
Function code	Read Holding Registers	0 3	03
Data	Start register HI	0 0	00
	Start register LO	0 0	00
	No. of registers to read HI	0 0	00
	No. of registers to read LO	0 1	01
Checksum.		LRC HI (2 chars)	CRC (16 bits)
		LRC LO	None
End delimiter		0D 0A (CR, LF)	None

6.1.2 MODBUS COMMUNICATION ON ETHERNET

On Ethernet, messages in Modbus/TCP binary format, using Modbus protocol, are imbedded into the TCP packet structure used on Ethernet.

Conversion of the messages extends to resolving node addresses, routing paths, and error-checking. For example, Modbus device addresses contained in the Modbus protocol are converted into node addresses prior to message transmission. Error-checking fields are also be applied to message packets, consistent with TCP protocol. At the final point of delivery –for example, an IMP– the contents of the imbedded message, written in accordance with Modbus protocol, define the action to be taken.

The Ethernet Modbus/TCP modes used by 5000 IMPs are listed in Table 6.2.

Table 6.2 Ethernet Modbus/TCP mode

Component	Example	Modbus/TCP
Message delimiter	Response values same as sent (usually 0)	00 00
	Reserved	00 00
	Byte Count of remainder of message.	00 06
Address	Unit 1	01
Function code	Read Holding Registers	03
Data	Start register HI	00
	Start register LO	00
	Number of registers to read HI	00
	Number of registers to read LO	01

Note: The format is similar to RS485 RTU (binary) format, but has another six bytes at the beginning and no checksum at the end.

6.1.3 ALTERNATIVE MODBUS FORMATS OVER ETHERNET

The RS485 message format is also available for use on Ethernet. This facility is not covered by any standard, but it does provide an intermediate step in converting from RS485 to Ethernet use. First get the PC to IMP communications working, in ASCII, on RS485. Then send the same commands, in ASCII, over Ethernet. This proves the use of Ethernet with the familiar RS485 Modbus command format. The last step is to convert your IMP commands to Modbus/TCP format, as per the standard. This latter format has the advantage that it is more compact than the RS485 format.

Note: To use this facility, switch the Ethernet transmission mode from the default TCP/Modbus setting to ASCII.

6.1.4 SUPPORTED MODBUS FUNCTIONS

Each 5000 IMP acts as a Modbus ‘slave’, under the control of a PC ‘master’. The Modbus functions supported in control and data communication between PC and IMPs are listed in Table 6.3.

Table 6.3 IMP Modbus Functions

Code	Function
03	Read Holding Registers
04	Read Input Registers
06	Preset Single Register
08	Diagnostics
16	Preset Multiple Registers

All commands received are checked for validity and, if required, the appropriate exception code is returned in the response, as defined in the Modbus protocol.

The information and actions associated with the Modbus functions are shown in Sections 6.1.4.1 through 6.1.4.4.

6.1.4.1 Function 03 (0x03) Read Holding Register

Reads the binary contents of holding registers (4x references) in the unit. Broadcast is not supported.

Table 6.4 Function 03: Read Holding Register

ASCII mode	Code
Address	01
Function code	03
Start register HI	00
Start register LO	00
No. of registers to read HI	00
No. of registers to read LO	01

6.1.4.2 Function 04 (0x04) Read Input Register

Reads the binary contents of the input registers (3x references) in the unit. Broadcast is not supported.

Table 6.5 Function 04: Read Input Register

ASCII mode	Code
Address	01
Function code	04
Start register HI	00
Start register LO	00
No. of registers to read HI	00
No. of registers to read LO	01

6.1.4.3 Function 06 (0x06) Preset Single Register

Presets a value into a single holding register (4x references). When broadcast, the function presets the same register reference in all attached slave units.

Table 6.6 Function 06: Preset Single Register

ASCII mode	Code
Address	01
Function code	06
Register HI	00
Register LO	00
Data HI	12
Data LO	34

6.1.4.4 Function 16 (0x10) Preset Multiple Register:

Presets values into a sequence of holding registers (4x references). When broadcast, the function presets the same register references in all attached slave units.

Table 6.7 Function 16: Preset Multiple Register

ASCII Mode	Code
Address	01
Function code	10
Start register HI	00
Start register LO	00
Number of registers to write HI	00
Number of registers to write LO	02
Byte Count	04
Data (as number of registers to write)	
Data (as number of registers to write)	
Data (as number of registers to write)	
Data (as number of registers to write)	

6.1.5 ERROR REPORTING

In a normal response the unit echoes the function code of the original query in the function code field of the response. All function codes have their most significant bit (MSB) set to 0, i.e. are below 0*x*80. If an exception has occurred, the function code is returned with the MSB set. The standard error codes are shown in Table 6.9. For the Modbus IMP, only codes 01,02,03 and 06 are used.

Table 6.8 Standard Error Codes

Code	Name	Description
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the slave.
02	ILLEGAL DATA ADDRESS	The data address received is not valid for the slave.
03	ILLEGAL DATA VALUE	The data value contained in the query data field is not an allowable value for the slave.
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred while the slave was attempting to perform the requested action.
05	ACKNOWLEDGE	The slave has accepted a request and is processing it, but a long duration of time is required. This response is returned to prevent a timeout error in the master.
06	SLAVE DEVICE BUSY	The slave is processing a long duration request. The master should retransmit the message later.
07	NEGATIVE ACKNOWLEDGE	The slave cannot perform the program function received in the query.
08	MEMORY PARITY ERROR	The slave attempted to read extended memory, but detected a parity error.

6.1.6 CHECKSUMS

In either of the two serial transmission modes (ASCII or RTU), a Modbus message is transmitted within a frame that has a known beginning and end point. An IMP is thus allowed to begin receiving at the start of a message, read the address portion and determine if it is the addressee. Also, by detecting the end point, an IMP knows when the message is complete. Partial messages can thus be detected and any errors reported back to the controlling PC.

6.1.6.1 ASCII Mode

The ASCII mode checksum is a Longitudinal Redundancy Check (LRC). This checksum is the twos complement of the sum of all the bytes in the message. The checksum is calculated before the message is converted to ASCII hexadecimal and does not include the start delimiter or the ending delimiter of the carriage return line feed combination.

The following routine gives an example of how the LRC may be calculated.

```
unsigned char lrc(unsigned char * msg, int len)
{
    unsigned char cksum = 0;

    while(len--)
        cksum += *msg++;

    return(cksum);
}
```

6.1.6.2 RTU Mode

The checksum in this mode is a 16 bit Cyclic Redundancy Check with the polynomial:-

$$a^{15} + a^{13} + a^{0}$$

The following routine gives an example of how the 16bit CRC may be calculated.

```
unsigned short crc16(unsigned char * msg, int len)
{
    unsigned short cksum = 0xffff;
    int i;

    while(len--)
    {
        cksum ^= *msg++;
        for(i = 0; i < 8; i++)
        {
            if(cksum & 1)
            {
                cksum = cksum >> 1;
                cksum ^= 0xa001;
            }
            else
            {
                cksum = cksum >> 1;
            }
        }
    }
    return(cksum);
}
```

6.2 MODBUS REGISTER USAGE

Inputs are addressed using Modbus 3x references (registers in the range 0x0000-0xFFFF). The user can read fixed point value, as is most common, or read the values in IEEE floating point form. Each floating point value requires the use of two consecutive registers. All values are stored in big endian format.

6.2.1 INPUT (RESULT) REGISTER

These read only registers hold the current measurement results. This data is converted as described in Table 6.9.

Table 6.9 Modbus Register Reference 3 Usage

Register	Description
0x0000 to 0x0013	Input registers Channel 1 to Channel 20. 16 bit fixed point result values to be converted as per the input range used by the host (Tables 6.16 - 6.18). Channel errors are reported using a number in excess of the maximum valid value (Table 6.19).
0x0020 to 0x0047	Input registers Channel 1 to Channel 20 in floating point format. These results have been converted for the input range and the linearisation coefficients. Channel errors are reported using a number in excess of the maximum valid value (Table 6.20). (Note: two registers per channel)
0x0050 (&0x0051)	Temperature of unit (the average reading of the two thermistors in the connector block). This reading is updated when ‘Ambient Temperature’ compensation is enabled (holding register 0x0070) and at least one channel mode is set as a thermocouple.

6.2.2 HOLDING (SET-UP) REGISTERS

These read/write registers hold the unit configuration commands. These commands are listed in Table 6.10. A description of each command is given in Section 6.3.

Table 6.10 Modbus Register Reference 4 Usage

Register	Description
0x0000 to 0x0013	Input Range Channel 1 to Channel 20: (See Section 6.2.3, ‘Mode and Range Registers’.)
0x0020 to 0x0033	Mode/Type Channel 1 to Channel 20: (See Section 6.2.3, ‘Mode and Range Registers’.)

0x0040 to 0x0053	Integration time per channel: Channel 1 to 20. Integration time 50Hz related: 0x0000 = 80ms (reserved) 0x0001 = 20ms (default 50Hz) 0x0002 = 5.00ms 0x0003 = 1.25ms Integration time 60Hz related: 0x0100 = 66.67ms (reserved) 0x0101 = 16.67ms (60Hz) 0x0102 = 4.17ms 0x0103 = 1.04ms
0x0068	Scan Period - Unsigned 16 bit integer in tenths of a second. Setting the register to 0xFFFF will turn continuous scanning off, i.e. single measurement mode. (Note, zero is flat out).
0x006C	Drift correct. 0x0000 = continuous update (default) 0x0001 = fixes to current value 0x0002 = nominal test value
0x006E	Temperature units Centigrade = 0x0000 (default setting) Fahrenheit = 0x0001
0x0070	Reference temperature x 100 (fixed-point format range -30°C /-22°F to 80°C/177°F) Set to 0x7FFF for Ambient Temp Reference using the connector block thermistor. (default setting)
0x0078	Open-Circuit Thermocouple Detection (OCTD). (For settings, see the TC command.) 0x0000 Disabled (default) 0x0001 Enabled
0x0100 to 0x0113 0x0120 to 0x012B	Post Linearisation Channels on which linearisation is to be applied. Register per channel: 0 - linearisation disabled on channel. (default) 1 - linearise channel results. (floating point only) Coefficients to be applied to the floating point results (specified in floating point form). $a_0+a_1x+a_2x^2+a_3x^3+a_4x^4+a_5x^5$ Default values: a_1 is 1.0, the rest are 0.0: therefore, if enabled before coefficients set, the result will be unchanged. (a_0 is loaded into register 0x020 and 0x0121, etc.)

0xF000 to 0xF0FF 0xF000 0xF002 0xF004 0xF005 to 0xF007 0xF010 0xF012	Status information. (Character string spaces where not specified) Read only. Software version. Main code. Main unit identity. (Ends with query (?) if error detected in reading identity.) Connector block identity. (Ends with query (?) if error detected in reading connector block type and/or communications type. The first query is for the connector block type and the second query is for the communications type.) FPGA version. Boot software version.
0xF100	RS485 Port 1: Baud rate, parity, mode. Default = 0x0002 (9600bps, no parity, ASCII mode) 0xXXX0 2400bps 0xXXX1 4800bps 0xXXX2 9600bps (Default) 0xXXX3 19200bps 0xXXX4 38400bps 0xXX0X no parity (2 stop bits) (default) 0xXX1X odd parity (1 stop bit) 0xXX2X even parity (1 stop bit) 0xX0XX ASCII mode (7 data bits) (default) 0xX1XX RTU mode (8 data bits)
0xF101	Unit address on RS485 port 1. Default = 01.
 0xF400 to 0xF403 0xF410 to 0xF413 0xF420 to 0xF423 0xF430 0xF433	Ethernet: IP address: default 172.20.6.66 Subnet mask: default 255.255.0.0 Gateway Address: default 0.0.0.0 Port number: default 502 0x0000 ASCII mode 0x0100 RTU mode: 0x0200 Modbus/TCP (default)
 0xF440 to 0xF446 0xF448 to 0xF449	Unit MAC and serial numbers. (Read only) MAC/OUI number used by the unit, byte per register. Serial number of unit/pcb MAC error: if not zero, the MAC number stored has been corrupted –the unit need s to be returned for service.
0xF480	Ethernet "Pass-Thru" mode: 0x0000 disabled 0x0001 enabled
0xFFFE	Writing 0x0D1E (decimal +3358) to this register causes the unit to restart (similar effect to powering the unit off and on). **Note**: The unit allows a short time for the response, before resetting. Allow about two seconds for the unit to restart.
0xFFFF	Save Setting: Writing 0xFEED (decimal: unsigned 65261, equivalent to signed -275) to this register causes the unit to save the current settings in non-volatile memory. (Copies IMP set-up from RAM to flash memory, ready for use on power up.)

6.2.3 MODE AND RANGE REGISTERS

Table 6.11 Voltage Readings

Mode Register	Range Register	Measurement Range	Comment
0x00	0	Skip	
0x10	0	Volts, dc auto-ranging	Uses 12V range scaling
	1	22mV	
	2	220mV	
	3	2.2V	
	4	12V	

Table 6.12 Resistance readings

Mode Register	Range Register	Measurement Range	Comment
0x20	0	800/80µA drive autoranging	4 wire Ω*
	1	800µA drive, 25Ω	
	2	800µA drive, 250Ω	
	3	800µA drive, 2k5Ω	
	4	80µA drive, 25kΩ	
0x21	0	800/80µA drive autoranging	3 wire Ω*
	1	not used	
	2	not used	
	3	800µA drive, 1k5Ω	
	4	80µA drive, 25kΩ	
0x22	0	800/80µA drive autoranging	2 wire Ω*
	1	not used	
	2	not used	
	3	800µA drive, 500Ω	
	4	80µA drive, 25kΩ	

***Note that** 4-wire Ω readings require two measurements, 3-wire Ω readings require four measurements and 2-wire Ω readings require two measurements.

Table 6.13 Thermocouple readings

Mode Register	Range Register	Measurement Range	Comment
0x31	0 - 4	Thermocouple type E	
0x32	0 - 4	Thermocouple type J	
0x33	0 - 4	Thermocouple type K	
0x34	0 - 4	Thermocouple type R	
0x35	0 - 4	Thermocouple type S	
0x36	0 - 4	Thermocouple type T	
0x37	0 - 4	Thermocouple type B	
0x38	0 - 4	Thermocouple type N	

Table 6.14 RTD/PRT readings

Mode Register	Range Register	Measurement Range	Comment
0x40	0	800µA drive, autoranging	Four-wire 100Ω RTD/PRT*
	1	25Ω, 800µA drive, -200°C to -180°C	“
	2	250Ω, 800µA drive, -200°C to +400°C	“
	3	2k5Ω, 800µA drive, -200°C to +850°C	“
0x41	0	800µA drive, autoranging	Three-wire 100Ω RTD/PRT*
	1	not used	“
	2	not used	“
	3	1k5Ω, 800µA drive, -200°C to +600°C	“
0x42	0	800µA drive, autoranging	Four-wire 10Ω RTD/PRT*
	1	25Ω, 800µA drive, -100°C to +810°C	“
	2	not used	“
	3	not used	“
0x43	0	800µA drive, autoranging	Three-wire 10Ω RTD/PRT*
	1	not used	“
	2	not used	“
	3	1k5Ω, 800µA drive, -100°C to +810°C	“

***Note that** four-wire RTD/PRT readings require two measurements and three-wire RTD/PRT readings require two measurements.

Table 6.15 Current Readings

Mode Register	Range Register	Measurement Range	Comment
0x50	0	Current, dc auto-ranging	Uses 120mA range scaling
	1	220µA	
	2	2.2mA	
	3	22mA	
	4	120mA	

Table 6.16 Digital Status

Mode Register	Range Register	Measurement Range	Comment
0x70	0	autoranging	TTL levels: ‘0’ if <0.8V; ‘1’ if >2.4V
	1	not used	“
	2	not used	“
	3	not used	“
	4	10V	“
0x71	0	autoranging	3V/9V levels: ‘0’ if <3V; ‘1’ if >9V
	1	not used	“
	2	not used	“
	3	not used	“
	4	10V	“
0x72	0	autoranging	2-wire Ω: ‘0’ if <100Ω; ‘1’ if >1kΩ
	1	not used	“
	2	not used	“
	3	not used	“
	4	25kΩ	“

6.2.4 REGISTER RANGE SCALING

The modbus registers (reference 3) 0 to 19 hold an integer representing the actual value scaled as shown in Tables 6.17 through 6.20 below. To get the actual value, read the scaled value from the register and then divide by the scaling factor specified.

Note: Post linearisation is NOT applied to the fixed point register values, as this could cause the values to go outside their possible range.

Table 6.17 Scaling Factor for Volts

Range	**Scaling Factor** (Decimal)
12V (and auto-range)	1.0E3
2.2V	1.0E4
220mV	1.0E5
22mV	1.0E6

Table 6.18 Scaling Factor for Ohms

Range	**Scaling Factor** (Decimal)
25kΩ (and auto-range)	1
2.5kΩ	10
250Ω	100
25Ω	1000

Table 6.19 Scaling Factor for Current

Range	**Scaling Factor** (Decimal)
120mA (and auto-range)	100
22mA	1000
2.2mA	10000
220µA	100000

Table 6.20 Scaling Factor for Temperature (RTD/PRT Thermocouples)

Range	**Scaling Factor** (Decimal)
Thermocouple °C	10
Thermocouple °F	1

6.3 MODBUS COMMAND FUNCTIONS

Listed below are descriptions of the commands issued to the IMPs on Modbus. The numbers in brackets are the command codes.

6.3.1 INTEGRATION TIME (0x0040 - 0x0053)

Sets the integration time of all analog measurements. Provides for optimum rejection of 50Hz, 60Hz or 400Hz supply frequencies. Also allows a shorter integration time to be selected, at the expense of reduced interference rejection, for increased scan rates.

Note: a ‘scan’ refers to the series of measurements made on all IMP channels.

6.3.2 SCAN PERIOD (0x0068)

The Scan Period command defines the period between the start points of successive scans in the continuous measurement mode and thus allows scan data to be sent to the host at a defined rate.

Defining the scan period gives two advantages: (a) it provides a manageable amount of useful data for the host, and (b) the data become available at predictable intervals, thus simplifying the reading of the data.

On power up the scan period is set to the default value of 0ms, which allows the IMP to output scan data at the fastest possible rate. With this, however, the intervals at which the data become available are unpredictable and, if the host is unable to cope with the large amount of data produced, the system may hang. To make the scanned data manageable and predictable the scan period defined by the SP command should be at least as long as the actual scan time and should also allow the host time to process each block of scan data as it occurs.

The scan period may be re-defined at any time. If a defined scan period is in operation then a new period effectively merges with the old one. For example, consider a scan with a defined period of five seconds that has been running for one second. Commanding a new scan period of four seconds causes the next scan to start in three seconds.

Conversely, if the new scan period is one second or less then the next scan starts immediately on completion of the present scan. Note that a scan is never terminated by re-definition of the scan period.

Note: When a new scan period is loaded with the LO command (with continuous scanning) the new period takes effect from the beginning of the next scan.

An IMP can not be made to output data faster than its inherent measurement rate. If the defined scan period is less than the actual scan time then the IMP outputs the scan data at the maximum, uncontrolled, rate.

The defined scan period is not effective for single scans. With the continuous mode inoperative, scans start immediately on trigger. To ensure long term repeatability of the defined scan period, the IMPs have their internal calendar clocks synchronised to the time in the host adapter. Synchronisation occurs every second.

6.3.3 DRIFT CORRECT (0x006C)

This command is intended for diagnostic and test purposes only. An analog IMP continuously corrects for drift in between measurements. By using the **DR** command the correction may be continuously updated, frozen at the last value or set to a specific test value.

6.3.4 TEMPERATURE UNITS (0x006E)

Decides the units of temperature used for:

1. Temperature results (thermocouple and RTD).

2. Setting the external reference temperature with the reference temperature command.

The IMPs default to °C (on power-up).

6.3.5 REFERENCE TEMPERATURE (0x0070)

Instructs the IMP to use the ambient temperature as the reference for those channels set for thermocouple measurement. The ambient temperature is sensed by a thermistor in the IMP connector block. This is the default (power-up) condition.

Also sets the value of the external temperature reference into the IMP. For use only when an external reference[1] junction is to be used. The units used for temperature results and references are set by the UN command.

6.3.6 OPEN-CIRCUIT THERMOCOUPLE DETECTION (0xOO78)

With checking enabled, a second measurement follows the thermocouple measurement: this is to confirm thermocouple integrity. Note: this adds 5ms per thermocouple channel to the data acquisition time. When an open circuit is detected, the measurement result is replaced with the error code.

6.3.7 POST LINEARISATION (0x0100 - 0x012B)

Converts a measured parameter into alternative units, with the function

$$y = a_5x^5 + a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0$$

where x is the measured input and y the linearised output.

The user is able to specify the coefficients a_5 through a_0 and to select which channels are to be linearised.

[1] Historically, called the `cold' junction –now known, more accurately, as the *reference* junction. Similarly, the `hot' junction is now known as the *measurement* junction.

6.4 ERROR REPORTING

Channels in error return an error code in the Input Result Registers:

1. The Integer Result Registers (reference 3: 0x0000 - 0x0013) return a reading in the range 0x7F80 to 0x7FFF.

2. The floating-point Result Registers (reference 3: 0x0020 - 0x0047) repeat the error code with the MSB set, i.e. using the range 0xFF80 to 0xFFFF in the top two bytes.

Table 6.21 Integer Register Error Values

Error Code in Integer Result Register	Error Code in Floating Point Result Register	Description of Error
0x7F81	0xFF81	Analog overload
0x7F82	0xFF82	User thermocouple undefined.
0x7F83	0xFF83	Out of linearisation range.
0x7F84	0xFF84	Ambient measurement range
0x7F85	0xFF85	Transducer error.
0x7F86	0xFF86	Open circuit thermocouple error.
0x7F87	0xFF87	Unknown mode type or range.
0x7F88	0xFF88	Unassigned
0x7F89	0xFF89	Invalid Register.
0x7F8A	0xFF8A	System zero error.
0x7F8B	0xFF8B	System calibration corrupt.
0x7F8C	0xFF8C	Measurement Error
0x7F8D	0xFF8D	reserved
0x7F8E	0xFF8E	reserved
0x7FFF	0xFFFF	Not measured.

A

Measurement Techniques

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A.1 INTRODUCTION

This chapter is intended mainly for newcomers to data logging, or for those whose data logging experience is limited to making a few simple measurements. To give you an idea of what is going on behind the scenes the chapter introduces the simple theory behind the measurement of various physical quantities, such as voltage, current and resistance. It then progresses to more advanced measurements, such as strain gauging. The intention is to give a clear understanding of all features of the Series 5000 IMPs, so that you can use these to solve your data logging problems.

The further aim of this chapter is to ensure that your measurement results, obtained with a Series 5000 IMP, truly reflect the system being monitored. Although an IMP is capable of making extremely accurate measurements, it can measure only what is applied to its inputs. This chapter instructs you how to use the interference rejection abilities of the IMPs to full advantage. Some simple rules are included also, which ensure that the signals applied to the input channels are as clean as possible.

A.2 INPUT DATA

Series 5000 IMPs can measure both analog signals and digital signals. Digital signals are read directly into the logic circuitry. Analog signals, however, are converted into digital form by an Analog-to-Digital Converter (ADC) within the IMP.

Analog signals represent a continuously variable physical quantity. Some quantities, such as voltage and current, may be measured directly, whilst others, such as temperature and strain, must be converted to electrical form with a transducer. Typical transducers are thermocouples and platinum resistance thermometers (PRTs) for temperature monitoring.

Digital signals are those that are switched between two distinct logic states, for example +5V for logic ‘1’ and 0V for logic ‘0’. This type of signal is often derived from switch contacts on the system being monitored and represents status and event conditions. These signals may be monitored singly or in groups, and compared with preset conditions.

A.3 MEASUREMENT CONCEPTS

For each type of measurement that an IMP can make, this section introduces you to the simple theory behind it and guides you in using the technique best suited to your application.

A.3.1 VOLTAGE MEASUREMENT

The ADC within a Series 5000 IMP responds to dc voltages. Therefore dc voltages, and transducers which produce dc voltage outputs, may be measured directly. Other electrical quantities - current and resistance - are measured indirectly, as described in Sections A3.2 and A3.3.

A.3.2 CURRENT MEASUREMENT

A dc current (i) is measured by passing it through a resistor of known value (r). By Ohms law, the voltage (v) developed across the resistor is directly proportional to the current. (See Figure A.1.) This allows the value of current (i) to be computed from the simple equation $i = v \div r$. Assuming that the value of the known resistor is 100Ω, the range of dc current measured is 0mA through 20mA. For channels that are to measure current a 100Ω precision resistor must be fitted to the appropriate terminals of the connector block.

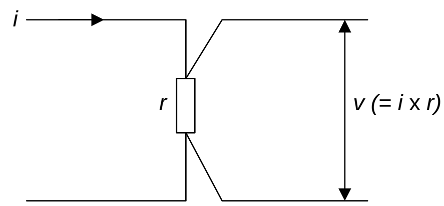

Figure A.1 Principle of current measurement

A.3.3 RESISTANCE MEASUREMENT

The resistance (r) of an external resistor is measured by passing a constant energizing current of known value (i) through the resistor and measuring the voltage developed across it. Again from Ohms law, the resistance (r) is computed from the equation $r = v \div i$. (See Figure A.2.)

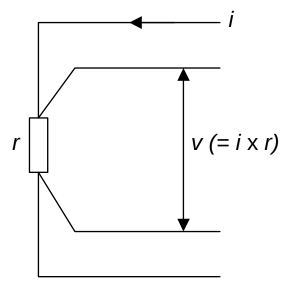

Figure A.2 Principle of resistance measurement

With a Series 5000 IMP operating in four-wire mode there are four nominal measurement ranges available: 25Ω, 250Ω, 2.5kΩ, 25kΩ and autorange. A current drive of 0.8mA is automatically supplied by the IMP via the I_A and and I_R terminals. On all ranges the results are output in kohms.

Resistance can be measured using the four-wire or three-wire method. The four-wire method is the more accurate of the two and has greater thermal stability.

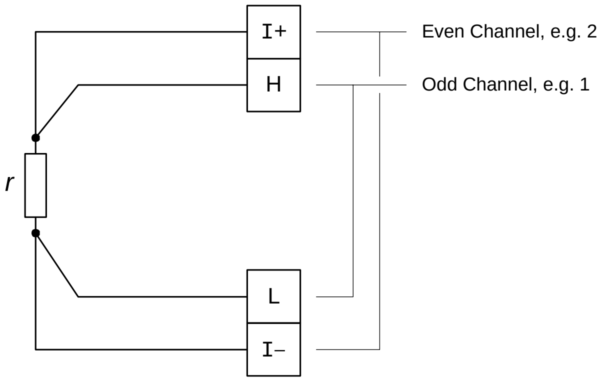

Figure A.3 Resistance measurement connections, four-wire

The connections for the four-wire method are shown in Figure A.3. To avoid errors due to lead resistance, the wires from the H and L terminals should be connected as close as possible to the body of the unknown resistance. No guard connection is needed: the circuitry associated with the I_R terminal automatically provides interference rejection, as well as acting as current return.

The connections for three-wire resistance measurement are shown in Figure A.4. In this case two fixed ranges, 1.5kΩ and 25kΩ, are provided, plus autorange. This method is sometimes preferred because three-core cable is cheaper than four-core.

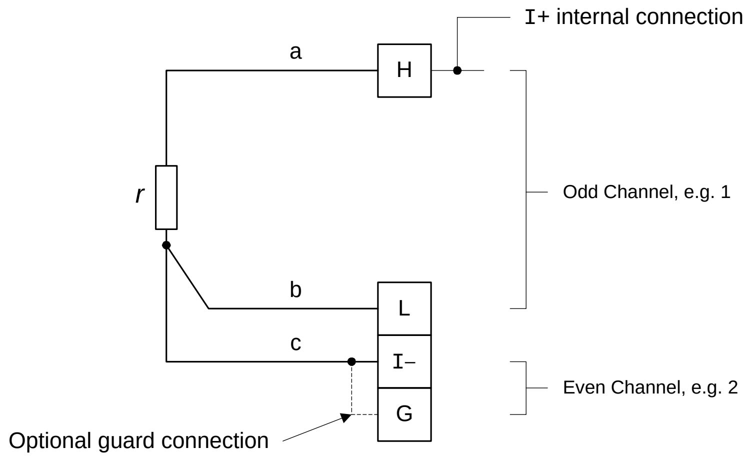

Figure A.4 Resistance measurement connections, three-wire

The three-wire method does, however, rely on wires *a* and *b* (Figure A.4) being identical. (The precise value of resistance of wire c is not critical.) Since this ideal is rarely achieved in practice, the three-wire method is less accurate than the four-wire method and has less thermal stability.

A.3.4 TEMPERATURE MEASUREMENT

To enable temperature to be measured, a temperature sensor must be used. This converts the thermal energy into an electrical signal that an IMP can recognise. Series 5000 IMPs allow you to measure temperature with either a thermo-couple or a platinum resistance thermometer (PRT). To help you decide which type of sensor to use, Table A.1 compares their overall performances. Note that PRTs are also known as RTDs (resistance thermometer devices).

Table A.1 Performance Comparison: PRTs v Thermocouples

Aspect	Resistance Thermometer	Thermocouple
Range	-200ºC to 850ºC	-250ºC to 2000ºC
Accuracy	±0.1ºC to ±1ºC	±0.5ºC to ±5ºC
Stability	Excellent: output consistent with temperature over very long periods.	Tendency to drift - type K in particular.
Response time	1 second to 50 seconds.	0.05 seconds to 5 seconds.
Vibration tolerance	Not as tolerant of vibration as thermocouples generally, but ‘supported’ types are available for industrial use.	Mineral insulated types are suitable for arduous operation.
Noise susceptability	Less susceptible to electrical interference than thermocouples.	More susceptible to electrical interference than PRTs.
Size	Resistance thermometers, generally, are larger than thermocouples.	Some very small thermocouples are available.
Cost	A PRT normally costs between two and three times as much as a thermocouple of similar performance.	Thermocouples are cheaper: see opposite column.
Leads required	Ordinary copper leads.	To ensure accurate results the leads between the measuring junction and the reference junction(s) should be of the same (or similar) metals as those used in the thermocouple.

A wide selection of temperature sensors is available, to suit all measurement environments. Full details can be obtained from the sensor manufacturers. Most manufacturers will also provide you with detailed information on how to install and use your chosen sensor to get the most accurate results. Sections A3.4.1 and A3.4.2 give basic guidance on the use of PRTs and thermocouples.

A.3.4.1 Using a PRT

A PRT uses the principle that the resistance of a platinum wire varies predictably with temperature. Therefore the connections made to the IMP are the same as those for resistance measurement. The PRT is energized by the module’s integral dc supply.

To ensure an accurate result, four-wire PRTs should be used. The color coding of the leadwires shown in Figure A.5 is that recommended by the British Standard BS1904:1984. However, not all manufacturers adhere to this standard, so be careful. If in doubt, refer to the manufacturer's data sheet. Do not use four-wire *compensated* PRTs: these have leadwires color-coded blue, blue, red, and white and are *not* suitable for use with Series 5000 IMPs.

For a PRT to give a true indication of temperature it should be placed in good thermal contact with the substance being investigated. Insertion probes should be inserted in a fluid to the distance recommended by the manufacturer. Surface probes should be mounted with a small amount of heat sink compound between the probe and the surface. See Figure A.6.

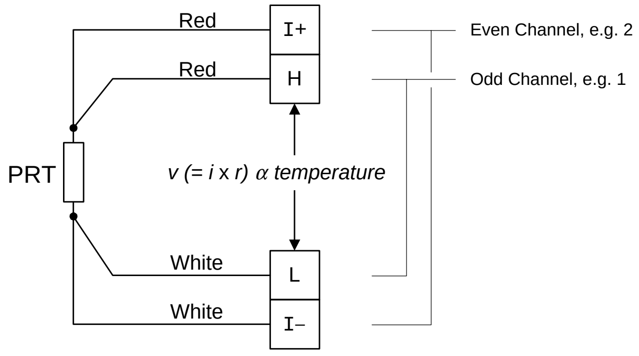

Figure A.5 Temperature measurement with a PRT

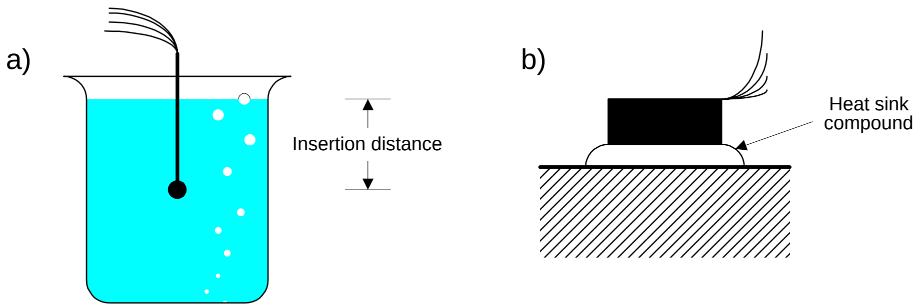

Figure A.6 Installing a PRT: (a) insertion type; (b) surface mounted type

The three-wire method of connecting a PRT is sometimes preferred to the four-wire method, due to the saving in sensor cable cost. However, the three-wire method gives a less accurate result than the 4-wire method and has less thermal stability. An example of the three-wire connection is shown in Figure A.7. For the lead resistances to be effectively nulled, conductors ‘a’ and ‘b’ should be identical.

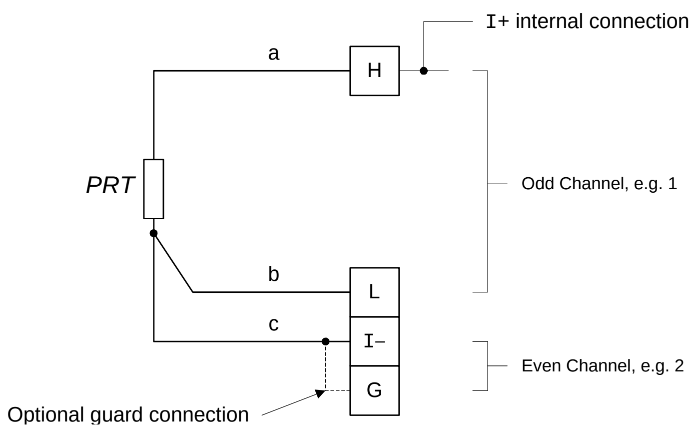

Figure A.7 PRT connections, three-wire method

The comparison between the four-wire and three-wire connections is exactly the same for PRTs as it is for resistance measurements. For the principle of three-wire resistance measurement see Section A3.3 in this chapter.

Series 5000 IMPs provide for the linearization of a PRT output to conform with the IEC 751 Standard. PRT temperature readings are available over two ranges, -200°C to 490°C and 490°C to 600°C, with the sensitivity and limits of error specified in Appendix B of the manual.

A.3.4.2 Using a Thermocouple

A thermocouple is simply a junction between two dissimilar metals, which develops an emf proportional to its temperature. A simple thermocouple can be made by twisting two suitable wires together, but, generally, it is best to use one of the purpose-built temperature sensors available from thermocouple manufacturers.

The principle of thermocouple measurement is illustrated in Figure A.8. Here it can be seen that a thermocouple circuit consists basically of a pair of thermocouple junctions connected in opposition. (The two emfs produced by the junctions act against each other). Since the two junctions are of the same type they produce equal emfs when held at the same temperature - in which case the resultant emf is zero. If the measurement junction is now heated (to 100°C for example) whilst the reference junction is maintained at 0°C, then the resultant emf is a function of the two temperatures. This principle applies for all thermocouple measurements and a wide selection of temperature sensors allows you to measure temperatures in the range -250°C through 2000°C.

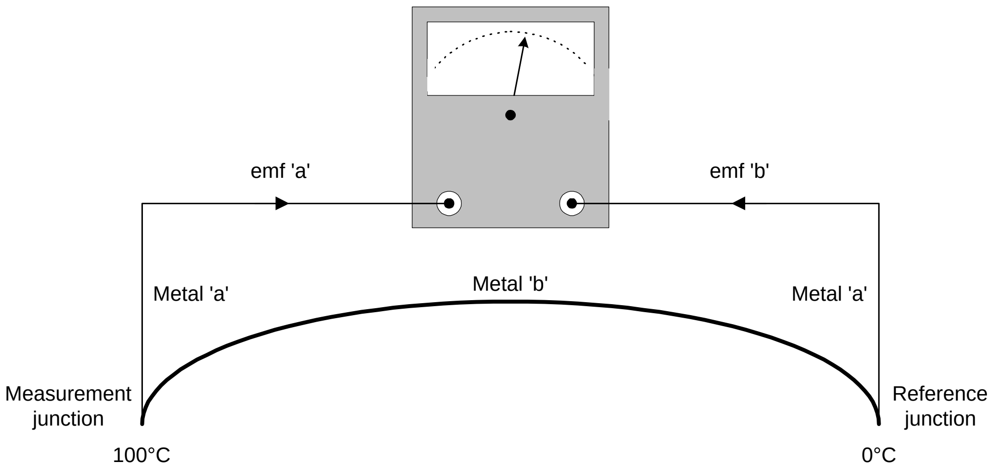

Figure A.8 Thermocouple principle

Historically, the two thermocouple junctions are known as the ‘hot’ and ‘cold’ junctions, the cold junction being maintained at 0°C by a flask of melting ice. Recently, however, the two junctions have come to be known, more correctly, as the ‘measurement’ and ‘reference’ junctions. (When temperatures lower than 0°C are being measured the ‘hot’ junction is cooler than the ‘cold’ junction!)

Thermocouples may be connected to an IMP connector block in two different ways. One of these (Figure A.9) uses an external reference unit, whilst the other (Figure A.10) uses the IMP input connections themselves as reference junctions. In the latter case the ambient temperature of the input terminals is monitored in the connector block and temperature compensation is applied automatically. (In these practical measuring circuits there are, of course, two reference junctions, one at the Hi input terminal and one at the Lo; but, since these two closely located terminals have a common temperature, they act as a single junction.)

Note the use of compensating/extension cables to connect the thermocouple sensor to the reference junctions. These cables contain single or multiple pairs of wires whose composition is the same as, or similar to, that of the sensor metals and this allows the measurement and reference junctions to be situated a suitable distance from each other. Use only those cables recommended by the thermocouple manufacturer, and make sure that they are connected the right way round. Most cables are color-coded to allow you to identify the positive and negative wires, but, be careful, the color codes vary from country to country. Thermocouple terminations are either color-coded in the same way or marked '+' and '–'.

Series 5000 IMPs are able to operate with eight different types of thermocouple: B, E, J, K, N, R, S, and T. All measurement results are linearized to comply with the IEC 584 and BS 4937 Standards. The different temperature ranges thus made available are listed in Table A.2.

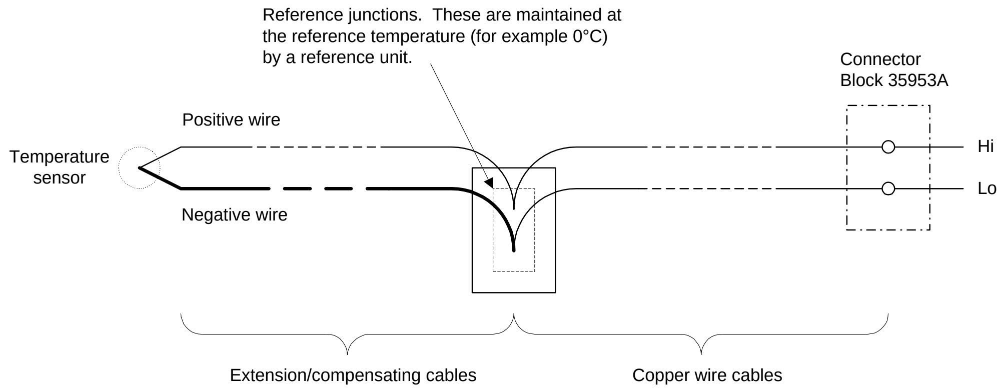

Figure A.9 Thermocouple connections made through reference unit

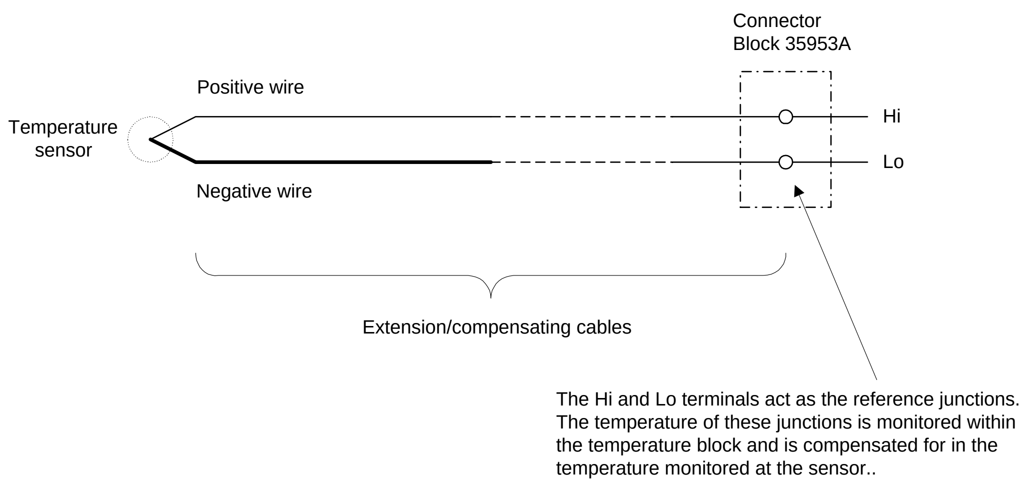

Figure A.10 Thermocouple connections made direct to the connector block

Table A.2 Thermocouple Ranges

Thermocouple Type	Overall Temp. Range (°C)
B	80 to 1820
E	-200 to 1000
J	-210 to 1200
K	-210 to 1370
N	-210 to 1300
R	-50 to 1760
S	-50 to 1760
T	-200 to 400

Full details of the individual temperature ranges are specified in Appendix B of the manual.

A.3.5 QUALITY OF MEASUREMENT

The quality of a measurement is expressed in terms of resolution and accuracy. To appreciate the measurement ability of the Series 5000 IMPs it is important not to confuse these two terms. Therefore, a concise definition of each one is now given. Also defined is the term ‘repeatability’, which is another important aspect of measurement quality.

A.3.5.1 Resolution

Resolution describes the ‘fineness’ of a measurement. In other words, it is the smallest amount by which your measurement result can change. As an example, an IMP is able, on its 20mV dc input range, to measure dc voltages with a resolution of 1mV (one millionth of a volt). Thus you can measure voltages of 0.001mV, 0.002mV, 0.003mV, and so on, up to around 20.001mV. Similarly, on the 12V dc range voltages can be measured with a resolution of 1mV, for example 5.001V, 5.002V, and so on. (These figures assume an integration time of 20ms.)

A.3.5.2 Accuracy

Accuracy describes how closely the measured value approaches the actual value of a physical quantity. Accuracy is quoted in the IMP specifications in terms of ‘Limits of Error’ and, for this reason, it is sometimes known as the ‘uncertainty’ of a measurement. As an example, the limits of error on the 20mV range, with a 20ms integration period, are specified as ‘±(0.02% rdg+5mV)’. This means that if your measurement result (measured on the 20mV range, with an integration time of 20ms) is 10mV then the actual value is somewhere in the range of values 9.993mV to 10.007mV. (The limits of error are ±7mV.)

A.3.5.3 Repeatability

Repeatability is an aspect of measurement quality that is particularly important when measurements are being compared with each other, rather than against an absolute standard such as the Standard Volt. Repeatability means that successive measurements of a stable physical quantity remain substantially the same over long periods, assuming a stable ambient temperature. This ensures that, even if an IMP is slightly out of calibration (after periods in excess of one year) the results of differential measurements are valid.

A.4 COMBATING INTERFERENCE

Interference is a general term for anything that influences a signal being measured to give a false result. Usually the interference takes the form of an extraneous signal, which combines with the signal being measured at the ADC input. Sometimes, however, errors in the result may be caused by a variation in performance with temperature (also known as 'drift').

Depending on the type of measurement being made, an IMP is able to reject specific types of interference, whilst accepting the signal to be measured. It is still an advantage, however, to ensure that the signal being measured is as free of interference as possible. This is achieved by careful installation of sensors and input leads, as outlined in Section A4.5 in this chapter.

A.4.1 TYPES OF INTERFERENCE

Interference can be classified as follows:

a) in the way it appears at the input terminals, common mode or series mode, and

b) the interference content, dc or ac.

Common mode interference occurs when the interference source e_{cm} is common to the Hi and Lo inputs of the IMP. See Figure A.11.

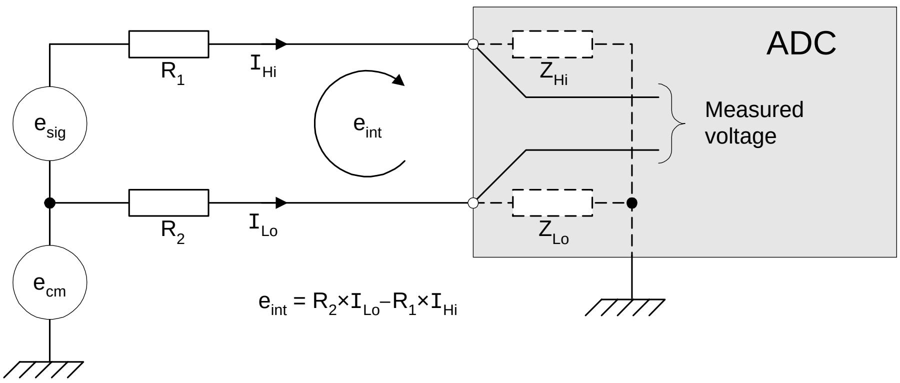

Figure A.11 Common mode interference

Common mode interference does not affect the measurement directly. If the input impedances Z_{Hi} and Z_{Lo} were equal, and the lead resistances R_1 and R_2 equal also, common mode interference would have no effect: the lead and input impedances would form a balanced bridge and, therefore, no voltage due to the interference e_{cm} would appear across the Hi and Lo inputs. In practice, however, the input impedances Z_{Hi} and Z_{Lo} are different, Z_{Lo} generally being the lowest. This imbalance results in an interference signal e_{int} ($=R_2 \times I_{Lo}$ - $R1 \times I_{Hi}$) across the Hi and Lo inputs, and common mode interference is thus converted into *series mode* interference. A high resistance in the Lo input lead generally aggravates the problem. In the IMPs the problem of common mode interference has largely been solved by using floating inputs. Section 4.2 gives the details.

Series mode interference acts in series with the signal being measured (the 'wanted' signal e_{sig}). This type of interference may be due either to common mode interference, as explained above, or to interference mixed with e_{sig}. The way in which series mode interference is dealt with is explained in Sections A4.3 and A4.4.

A.4.2 COMMON MODE REJECTION

IMPs reject common mode interference by using a floating analog-to-digital converter (ADC) as shown in Figure A.12.

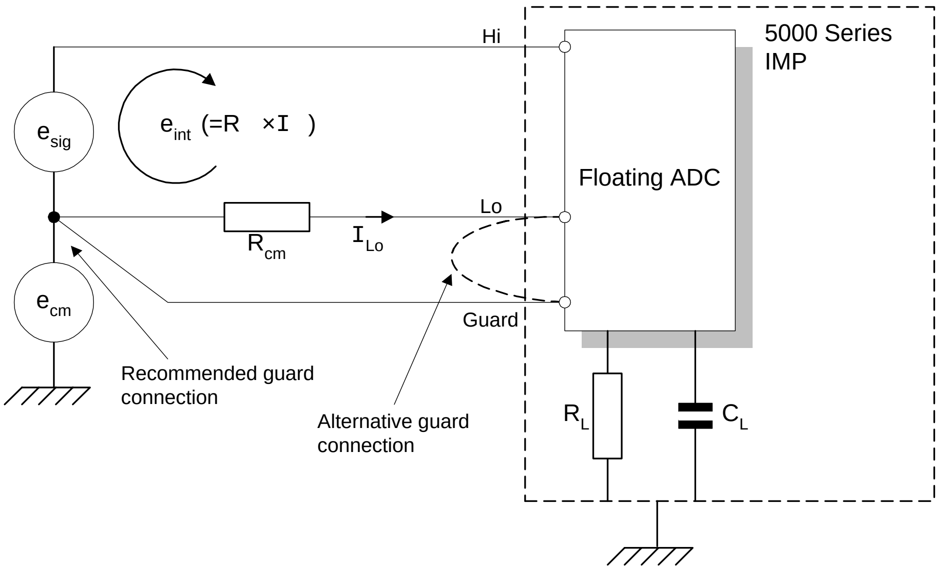

Figure A.12 The use of a floating ADC for common mode rejection

The best rejection of common mode interference is obtained with Guard connected to the source of common mode. Should this be impractical then guard must be connected to Lo. With the latter method, common mode and series mode rejection is slightly degraded, due to the leakage through R_L and C_L (the leakage resistance and stray capacitance).

Note that the maximum value of common mode voltage between the IMP inputs and communications lines is specified as 200V, which implies a maximum common mode voltage of 200V between the inputs and ground. Within this limitation, any leakage to ground should be negligable, but it depends on the number of IMPs in the system and on their individual common mode voltages.

As explained in Section A4.1, common mode interference is measurable only when converted to series mode interference. It is standard practice, therefore, to deliberately insert a resistance R_{cm} of known value into the Lo input lead when common mode rejection is measured during tests on the IMP's ADC. The common mode rejection figures for the various IMPs (see Table A.3) are specified for an R_{cm} value of 1kΩ. Usually, the resistance of the Lo input lead is much less than 1kΩ, in which case the rejection is correspondingly greater. (Conversely, the common mode rejection will be less than that specified if the resistance of the low input lead is greater than 1kΩ!)

Table A.3 Common Mode Rejection*

IMP and Type of Interference	Rejection at 20ms integration	Rejection at 5ms/4.17ms/ 1.25ms/1.04ms
IMPs 35951A, C, and E, and IMCs 359551A, C, and E		
dc	>140dB	>140dB
50Hz/60Hz	>140dB	>80dB
50Hz/60Hz	>120dB	-
IMPs 35951C and E, with HV connector block 35953D		
dc	>100dB	>100dB
50Hz/60Hz	>100dB	-
IMPs 35951B and IMC 359541B		
dc	>120dB	>140dB
50Hz/60Hz	>120dB	>80dB
50Hz/60Hz	>100dB	-

* These figures assume that the guard terminal is connected to source and that there is a 1kΩ imbalance in the input leads.

Note the reduced rejection of 50Hz (60Hz) for integration periods other than 20ms. The reason for this is that the rejection specified for 20ms integration period includes 60dB of series mode rejection, which is not obtained for other integration periods. Note also that the common mode rejection of ac signals decreases as the frequency increases.

A.4.3 AC SERIES MODE REJECTION

The term *series mode rejection* (also known as ‘normal’ mode rejection) is generally applied to the rejection of line frequency interference, when this is acting in series with a ‘wanted’ dc signal. An IMP rejects series mode interference by *integrating* each dc measurement over a complete number of cycles of interference. Integration means continuously monitoring the input signal over the measurement period and computing the mean value. During this process the ac interference averages to zero.

Ac series mode rejection is effective only when the integration period of the IMP analog-to-digital converter is set to cover the period of the line voltage fundamental frequency, see Figure A.13. By default, the integration period is set to 20ms to reject 50Hz interference. Two other integration periods can be selected by remote command: 16.67ms for 60Hz supplies and 5ms for 400Hz supplies.

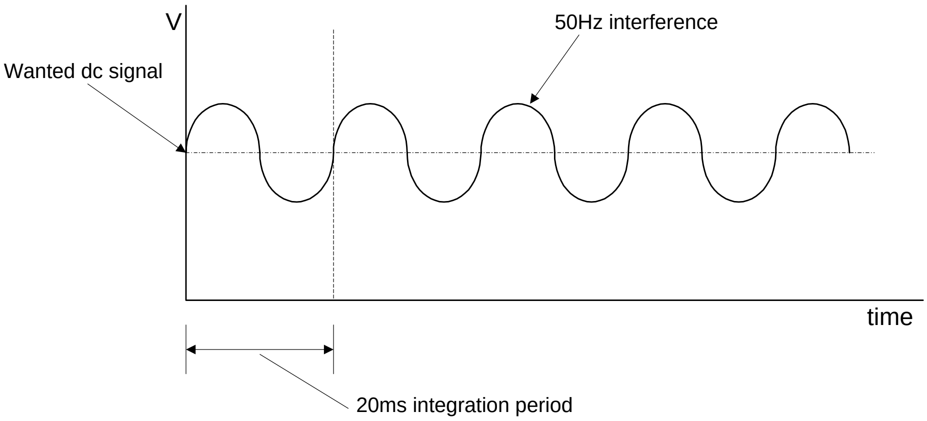

Figure A.13 The rejection of ac series mode interference at 50 Hz

An integration period that is suited to the ac supply (for example 20ms for 50Hz or 16.67ms for 60Hz) gives a series mode rejection of >60dB at the fundamental supply frequency and its harmonics. Series mode rejection is not effective for the ‘fast'' integration periods (4.17ms, 1.25ms and 1.04ms). Therefore, in electrically noisy environments it is essential to use an effective integration period.

A.4.4 DRIFT COMPENSATION

Variations in measurement results, known as ‘drift’, can be caused by changes in the internal temperature an IMP, which in turn affect the performance of the ADC. To compensate for this, the IMP periodically measures two reference inputs and calculates from the results actually obtained the compensation to be applied for all readings.

Drift compensation measurements have very little effect on the input measurement rate and are transparent to the user.

A.4.5 AVOIDING INTERFERENCE

Interference in your measurement results will be largely avoided, and certainly minimized, if you follow the simple installation rules given below.

To avoid ac interference:

- Use twisted pairs or screened leads to connect the sensor to the connector block terminals.
- Avoid running the input leads near other cables carrying heavy ac currents or high ac voltages.

To avoid dc interference:

- Try to avoid sources of thermal emf, such as nickel-iron relay contacts with copper connections.
- Avoid high humidity, which can cause leakage across nominally good insulators.

- Avoid moisture on exposed terminals, which may cause emfs to be generated by a corrosion process.
- Do not fix cables to vibrating equipment, otherwise electrostatic potentials may be generated.
- To avoid ac and dc interference:
- Always connect Guard (Sense) to the Lo line: never leave it open-circuit.
- Never leave unused channels open-circuit: always fit a Hi-Lo-Guard shorting link.
- Always connect the IMP case to a local ground point.

A.4.5.1 Preferred Guarding Connections

Figure A.14 below shows the preferred guarding arrangements for voltage- and current-based sensor connections to the IMP input terminals.

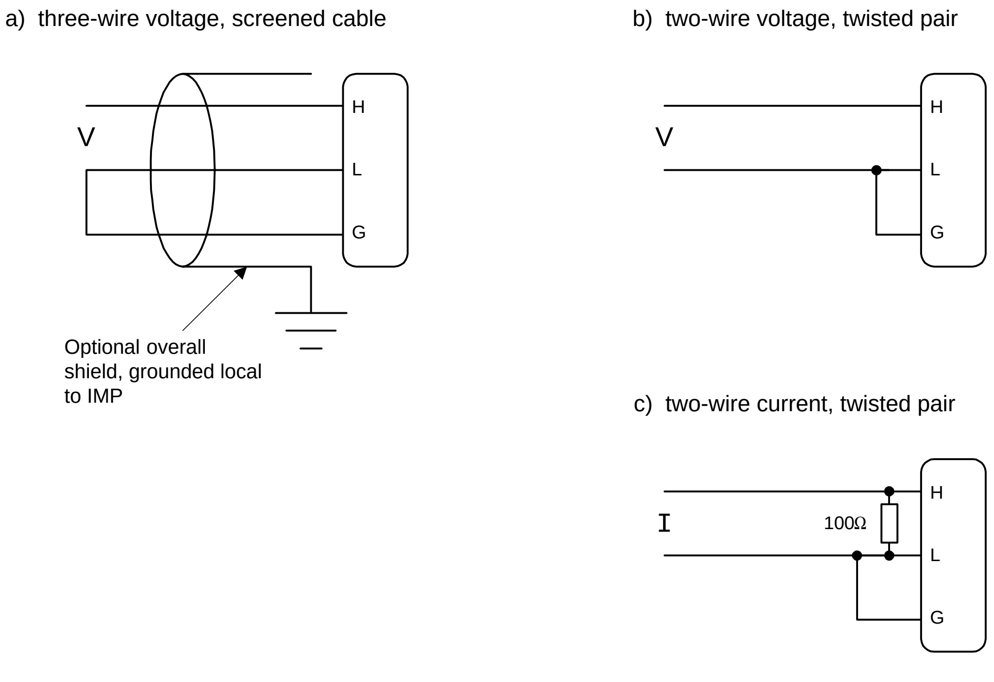

Figure A.14 Preferred guarding arrangments

A twisted pair is recommended for the Hi and Lo leads as it is less susceptible to interference. The three-wire arrangement (a) extends the guard circuit out to the sensor: this arrangement is particularly effective when used with a screened cable, grounded at the IMP.

A.4.5.2 Grounded Signal Guarding

Where one side of the sensor output is referred to ground (for example as in a ‘grounded tip’ thermocouple) use the guarding arrangement shown in Figure A.15. Remember, however, that the sensor is always the source of common mode interference and defines the measurement reference.

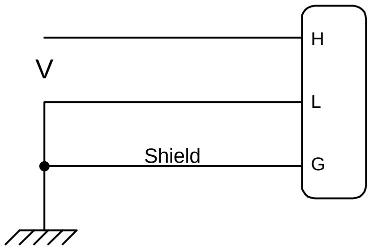

Figure A.15 Grounded signal guarding

The shield connection shown in Figure A.15 extends the guard circuit to the local ‘ground’ (at the sensor) which may or may not be at actual ground potential. By allowing the guard to float at the common mode potential (the potential of the local ground) this guarding arrangement minimizes common mode interference, but certain limitations are imposed on ground connections at the IMP:

- The guard terminal must not be linked to Lo at the IMP, or to another ground point.

- With respect to the IMP's inter-channel isolation it is important to ensure that other sensors connected to the same IMP are all at a ground potential which does not exceed the maximum inter-channel voltage specified for the IMP.

Note that the IMP to IMP isolation is >200V. Therefore grounded sensor connections on one IMP should not effect other IMPs on the same network.

A.5 EFFECT OF PARALLEL INSTRUMENTATION

It is sometimes required for IMP input channels to be connected in parallel with those of other instruments, typically when measuring thermocouples. The purpose of this section is to remind the reader of the effect of this, and to offer some broad guidelines.

Voltage inputs only are considered. (If a 4-20mA transmitter is to be monitored by two instruments, IMPs or otherwise, the error imposed by the additional circuit is negligable. This is due to the relatively high voltage backing a 4mA to 20mA loop.)

In parallel instrumentation there are generally two scenarios:

- The IMP channel is connected to an existing measurement circuit, which has a sensor already connected to it, for example a chart recorder.

- Two IMP channels, usually from different IMPs, are connected to the same sensor for redundancy purposes.

In these two cases an error voltage is developed, which is a product of the second instrument's input leakage current and the sensor impedance.

A.5.1 INPUT LEAKAGE CURRENT

Input leakage current, rather than input impedance, is the best parameter to use when considering the effect of one instrument's input circuit on that of another.

Leakage current is a function of the input impedance of a measuring device, but there are other factors, for example input amplifiers and multiplexer circuits in particular. Therefore the fact that an ADC has a high input impedance, in the order of GΩ, often has little bearing on the actual input leakage. However, if the precise value for the leakage current is not available then the effective leakage current may be estimated by dividing the measured voltage by the ADC input impedance. For example, with a thermocouple output of around 200mV and an ADC input impedance of 100MΩ the leakage current approximates to 20nA.

The input impedance of the ADC within an analog IMP is 10GΩ, but this is degraded by the multiplexer circuitry so that the input leakage current is higher than expected, at 15nA. This is the case with all multi-channel instruments and is not always quoted - so beware!

Two examples of measurement errors due to leakage are given on the next page.

Example 1
An existing measurement system has a thermocouple connected to a Series 5000 IMP. The user wishes to connect a Phillips PM8238 30 channel chart recorder to the IMP measurement circuit. The measurement error due to leakage is approximately:

input leakage of chart recorder × thermocouple impedance

$$=100\text{pA} \times 300\Omega=3\text{nV}$$

in terms of °C this error is too small to consider.

Example 2
Two IMPs are connected to the same sensor for redundancy purposes. (This example also applies for an IMP connected in parallel to any existing measurement system.) The error due to leakage that is seen at each IMP is approximately:

IMP input leakage current × thermocouple impedance

$$=15\text{nA} \times 300\Omega = 4.5\mu\text{V}$$

in terms of °C this represents an error of 0.1°C, which is significant when added to the overall uncertainty and is probably worth considering.

Note: When measuring thermocouples in this way always disable the IMP's open-circuit thermocouple detection facility.

A.5.2 ACCUMULATED CHARGE

In addition to the errors caused by input leakage current, errors may arise due to charge injection from the other instrument during channel scanning. This occurs when the other scanner has just measured a high voltage and insufficient settling time has been allowed for the accumulated charge in the ADC to discharge.

It is recommended that instruments which have channels connected in parallel with another instrument are used to monitor sensors with similar output levels: do not mix high and low voltage sensors in this situation. Also, the timing should be arranged such that the two instruments do not scan together: leave an adequate settling time (>10ms) between channels measurements and thus allow any charge on the measurement circuit to decay away.

B

5000 IMP Specification

Contents

B.1 CHANNEL SPECIFICATIONS B-3

B.2 GENERAL SPECIFICATIONS B-10

All limits of error are for 1 year at 20°C±3°C.

B.1 CHANNEL SPECIFICATIONS

Number of analog channels ....20 (Channels 1 through 20)

Switching................................. reed relay, three-pole (or six-pole using two channels)

Reed-relay life .... >10^8 operations

Maximum signal measured..±12V

Maximum input voltage ....±14V

Overload protection, continuous 50V

Maximum voltage between any two inputs: 200V

Common mode, between IMPs... 200V

Analog to Digital Conversion

Analog to digital converter.. 15 bits + sign, integrating

Analog scanner leakage currents at 25°C±3°C: ....<15nA

Analog channel crosstalk ....>120dB

ADC input impedance ....>10GΩ

Interference Rejection

(Specifications are for 1kΩ imbalance in Hi and Lo leads)

20ms/16.67ms Integration time:

Normal mode, 50 or 60Hz ±0.1% ....>60dB

Effective common mode rejection,

dc ....>140dB

50 or 60Hz...>140dB

5ms/4.17ms/1.25ms/1.04ms Integration times:

Normal mode, 50 or 60Hz ....>0dB

Effective common mode rejection, 50 or 60Hz ....>80dB

Continued on next page

Three-pole Measurement

Voltage dc, without optional connector ....0 to ±12V

Current dc (assuming 100W shunt).. 0 to 20mA

Resistance (two-terminal) .... 0 - 25kΩ

Status.. TTL, 3/9V, or volt-free contact
(volt-free uses two-terminal resistance measurement)

Thermocouple types...B,E,J,K,N,T,R,S and user-defined
(user can define two fifth-order polynomials)

Thermocouple Cold Junction ....External or Automatic

Thermocouple open circuit detection...programmable on/off
(threshold 1.9kΩ ± 0.1kΩ)

Six-pole Measurement

Resistance, three- and four-terminal.. 0 to 25kΩ

Resistance Thermometer (RTD) ....100Ω PRT (three- and four-terminal)
10Ω copper (four-terminal)

DC Voltage

20ms/16.67ms Integration time:

Range	Full Scale	Sensitivity	Limits of Error
20mV	22.000	1µV	±(0.02%rdg+5µV)
200mV	220.00	10µV	±(0.02%rdg+0.01%fs)
2V	2.2000	100µV	±(0.01%rdg+0.01%fs)
12V	12.000	1mV	±(0.05%rdg+0.01%fs)

5ms/4.17ms Integration time:

Range	Full Scale	Sensitivity	Limits of Error
20mV	22.000	2µV	±(0.02%rdg+20µV)
200mV	220.00	20µV	±(0.02%rdg+0.04%fs)
2V	2.2000	200µV	±(0.01%rdg+0.04%fs)
12V	12.000	2.5mV	±(0.05%rdg+0.04%fs)

1.25ms/1.04ms Integration time:

Range	Full Scale	Sensitivity	Limits of Error
20mV	22.000	8µV	±(0.02%rdg+80µV)
200mV	220.00	80µV	±(0.02%rdg+0.16%fs)
2V	2.2000	800µV	±(0.01%rdg+0.16%fs)
12V	12.000	8µV	±(0.05%rdg+0.16%fs)

DC Current

Sensitivity, (assuming 100Ω shunt) 10nA

Error as for DC Voltage +error of shunt resistor + leakage currents.

Thermocouples

The following temperature ranges are based on 20ms/16.67ms Integration times. All values are specified in degrees Celsius.

Error quoted is conformity to IEC584 (BS4937)

Type	Mid Range	Error	Full Range	Error
B (Pt-30% Rh/Pt-6%Rh)	400 to1820	<0.3	80 to 1820	<2.0
E (Ni-Cr/Cu-Ni)	-100 to 250	<0.3	-210 to 1000	<0.5
J (Fe/Cu-Ni)	-100 to 350	<0.3	-210 to 1200	<0.7
K ((Ni-Cr/Ni-Al)	-100 to 450	<0.3	-200 to 1370	<1.0
N (Nicrosil/Nisil)	-180 to 1280	<0.3	-250 to 1300	<0.8
T (Cu/Cu-Ni)	-100 to 400	<0.3	-200 to 400	<0.5
R (Pt-13%Rh/Pt)	0 to 1600	<1.0	-50 to 1760	<2.0
S (Pt-10%Rh/Pt)	0 to 1760	<1.0	-50 to 1760	<1.5

Sensitivity, Types B,E,J,K,N,T .... 0.1°C

Sensitivity, Types R,S .... 0.2°C

Total thermocouple error equals Conformity plus voltage errors.

Additional error when using automatic Cold Junction Compensation:

Range -15 to 60°C .... <0.4°C

-20 to 70°C .... <0.6°C

External Cold Junction range ....-30°C to +80°C

Open circuit detection threshold 2kΩ

Resistance, Four-wire

Temperature Coefficient .... <0.003%rdg per°C

20ms/16.67ms Integration time:

Range	Sensitivity	Limits of Error
25Ω	1.25mΩ	±[0.03%rdg + 6mΩ]
250Ω	12.5mΩ	±[0.03%rdg + 0.01%fs]
2.5kΩ	125mΩ	±[0.02%rdg + 0.01%fs]
25kΩ	1.25Ω	±[0.02%rdg + 0.04%fs]

5ms/4.17ms Integration time

Range	Sensitivity	Limits of Error
25Ω	2.5mΩ	±[0.03%rdg + 24mΩ]
250Ω	25mΩ	±[0.03%rdg +0.04%fs]
2.5kΩ	250mΩ	±[0.02%rdg +0.04%fs]
25kΩ	2.5Ω	±[0.02%rdg + 0.04%fs]

1.25ms/1.04ms Integration time

Range	Sensitivity	Limits of Error
25Ω	10mΩ	±[0.02%rdg + 96mΩ]
250Ω	100mΩ	±[0.02%rdg + 0.16%fs]
2.5kΩ	1Ω	±[0.02%rdg + 0.16%fs]
25kΩ	10Ω	±[0.02%rdg + 0.16%fs]

Resistance, Three-wire

Temperature Coefficient<[0.003%rdg + 0.03Ω] per°C (In three-wire configurations any lead resistance imbalance should be added to the error.)

20ms/16.67ms Integration time:

Range	Sensitivity	Limits of Error
1.5kΩ	125mΩ	±[0.02%rdg + 0.2Ω + 0.017%fs]
25kΩ	1.25Ω	±[0.02%rdg + 0.2Ω + 0.01%fs]

5ms/4.17ms Integration time

Range	Sensitivity	Limits of Error
1.5kΩ	250mΩ	±[0.02%rdg + 0.2Ω + 0.07%fs]
25kΩ	2.5Ω	±[0.02%rdg + 0.2Ω + 0.04%fs]

1.25ms/1.04ms Integration time

Range	Sensitivity	Limits of Error
1.5kΩ	1Ω	±[0.02%rdg + 0.2Ω + 0.3%fs]
25kΩ	10Ω	±[0.02%rdg + 0.2Ω + 0.16%fs]

Resistance, Two-wire

20ms/16.67ms Integration time:

Range	Sensitivity	Limits of Error
500Ω	125mΩ	±[0.02%rdg + 50Ω + 0.05%fs]
25kΩ	1.25Ω	±[0.02%rdg + 50Ω + 0.01%fs]

5ms/4.17ms Integration time

Range	Sensitivity	Limits of Error
500Ω	250mΩ	±[0.02%rdg + 50Ω + 0.02%fs]
25kΩ	2.5Ω	±[0.02%rdg + 50Ω + 0.04%fs]

1.25ms/1.04ms Integration time

Range	Sensitivity	Limits of Error
500Ω	1Ω	±[0.02%rdg + 50Ω + 0.8%fs]
25kΩ	10Ω	±[0.02%rdg + 50Ω + 0.16%fs]

Resistance Thermometer Device (100Ω platinum), Four-wire

Conformity for 100Ω PRT (RTD) is to IEC 751

Temperature coefficient ....<0.03°C per °C

20ms/16.67ms Integration time

Range	Sensitivity	Limits of Error
-200 to 490°C	0.1°C	±0.4°C
490 to 600°C	0.2°C	±1.2 °C

Resistance Thermometer Device (100Ω platinum), Three-wire

Temperature coefficient ....<0.2°C per °C

In three-wire configurations any lead resistance imbalance should be added to the error.

20ms/16.67ms Integration time

Range	Sensitivity	Limits of Error
-200 to 600°C	0.2°C	±2°C

Resistance Thermometer Device (10Ω copper), Four-wire

Temperature coefficient (over -100 to +150°C) ....<0.02°C per °C

20ms/16.67ms Integration time

Range	Sensitivity	Limits of Error
-100 to +150°C	0.1°C	±0.3°C

B.2 GENERAL SPECIFICATIONS

Isolation

IMP to IMP, IMP to S-Net, IMP to ground 200V

Power Supply

Power supply.. 12V to 24V d.c.

Power feed ....via IMP terminals

Power consumption of each IMP..4W

IMP Environment

Storage temperature...-25°C to 75°C

Operating temperature: ....-20°C to 70°C

Humidity, at 40°C (non-condensing): 95%

Vibration: operating for 2 hours: ....5g, 11Hz to 500Hz

Otherwise, to Def. Std 66/31 Issue 01 Cat. IV.

IMP Packaging

Sealed aluminium casting to BS5490, IP55 (IEC 529) and NEMA ICS6 Class 4.

Dimensions...435mm×215mm×34.5mm (17.1"×8.5"×1.4")

Protrusion of cable boots .... 50mm (2")

Weight 2.5kg (5.5lbs)

Electromagnetic Compatibility

Complies with ....EN50081-2 and EN50082-2

Note: High levels of radiated or conducted radio frequency interference, as defined in EN50082-2, may reduce the accuracy of low level measurements.

C

OPC Server

Contents

C.1 THE OPC SERVER FACILITY........C-3
C.1.1 IMP REGISTERS SUPPORTED........C-4
C.1.2 SETTING UP THE OPC INI FILE........C-4
C.1.3 INI FILE EXAMPLES........C-5

Table C.1 IMP Registers Accessible by OPC Server C-4

C.1 THE OPC SERVER FACILITY

Users can communicate directly with an IMP, via Serial RS485 or Ethernet, using Modbus protocol. This form of communication allows the user to program the operation of the IMP to fit his needs precisely. It does, however, require a programming skill that the user may not have or may involve expensive programming effort.

An alternative is to use 5000-IMPVIEW. This provides a user-friendly interface and enables the user to familiarise with IMP operation and also to in the initial communication parameters of the IMP. However, 5000-IMPVIEW is intended mainly as a tutorial aid and may prove cumbersome in some applications.

A third option is to use the OPC server (500075A, 5000-IMPserver), which can be used with Windows 95/98/NT. This server acts as an intermediary between the user's OPC client and the IMP. Communication is conducted through the IMP's Modbus registers, most of which an OPC client can access via the OPC server.

The OPC interface options supported are:

IOPCCommon
IOPCServer
IOPConnectPointContainer
IOPCItemProperties
IOPCBrowseServerAddressSpace

To install the OPC server, load the 500075Adisk (50005802) containing the 5000-IMP Server, double-click on the setup application, and follow the on-screen instructions.

For Windows 95 systems the DCOM95 (Distributed COMs support) needs to be added prior to installation. DCOM95 for Windows 95 can be downloaded from the Microsoft website free of charge and should be added as specified. When complete, install the 5000-IMP Server as described above. Windows 98 and NT systems do not require DCOM95.

The installation of the 5000-IMP Server should register this OPC server. However, if there are any problems the server can be registered (and unregistered) manually as follows:

> To register the server, double click on the MS-DOS Batch File 'Register5000_IMPServer' in the directory containing 5000_lMPserve.exe. To remove the registration double-click on the MS-DOS Batch File 'UnRegister5000_IMPServer'.
>
> (Alternatively, you can register the server by entering: "5000_lMPServer regserver" in an MS-DOS window in the directory containing 5000_lMPserve.exe. Similarly you can remove the registration by entering "5000_IMPServer unregserver".)

Having registered the server (performed by the installation) and set-up the 5000_IMPServer.INI file (see Section C.1.2) the 5000-IMP OPC server is ready for the client to be started. The client looks for the OPC servers registered. Having connected to the server, a 5000_lMPServer window pops up showing the status of reads between the server and the IMPs.

C.1.1 IMP REGISTERS SUPPORTED

The IMP Modbus registers accessible via the OPC server are listed in Table C.1.

Table C.1 IMP Registers Accessible by OPC Server

Register Function	Write/Read
Input Registers	
Fixed point	Read only
Floating Point	"
Holding Registers	
Channel Range	Read/Write
Channel Mode/Type	"
Channel Integration Time	"
Device Settings:	
Scan Period	"
Drift Correct	"
Temperature Units	"
Reference Temperature	"
OCTD (Open Circuit Thermocouple Detect)	"
Store Configuration	Write only
Communication Config. Registers	
RS485 settings	Read Only
Slave Address	"
IP Address (Hi and Lo)	"
Subnet Mask (Hi and Lo)	"
IP Port Number	"
IP Communications Mode	"
Ethernet Modbus pass-through mode	"

C.1.2 SETTING UP THE OPC INI FILE

The 5000_IMPServer is configured by the file 5000_IMPServer.INI, which specifies the PC's communications and the IMPs to be connected and their addresses. This file must be in the windows directory (e.g. WinNT for Windows NT). An example INI file has been placed in the windows directory. The example 5000_IMPServer.INI file configuration is for one IMP at address '1'. This IMP is accessed via serial comm port 2 (C0M2), at a Baud rate of 9600. (These settings match the factory settings of the IMP for serial RS-485 communications.) If the 5000_lMPServer cannot find the .INI file in the windows directory, then the error: "Ini file error 09" is reported when the client tries to start the IMP Server.

For any other configuration the 5000_IMPServer.INI file must be modified to match the required configuration.

C.1.2.1 Pass Thru' Mode

To configure the pass thru' mode, when enabled on the system, set the INI file for Ethernet and set the IP address of the slave unit(s) (e.g. Unit 2) to be the same as that of the pass thru' controller (e.g. Unit 1). The OPC server then sends Unit 2 requests to Unit 1 IP address. Unit 1 recognises that the requests are for Unit 2 and passes them down the RS485 link to Unit 2.

C.1.3 INI FILE EXAMPLES

The format of INI file is shown in the following examples. At the beginning of each example is stated the object of the file and additional comments have been inserted, in italics, where necessary. Comment lines actually included in the INI file are preceded by a semicolon (;). Note that lines not required for a particular communication mode are 'commented out': that is, they are each preceded by a semicolon to make them inactive.

C.1.3.1 INI File Example 1

This INI file specifies the parameters of the Serial communication (RS485) to be used between the PC and a single IMP.

File	Comments
[Communication]	
;Transport layer: Serial | Ethernet	
;Communication type: ASCII | RTU | TCP	
Transport=Serial	*Communicate on RS485),*
Type=ASCII	*in ASCII transmission mode….*
[SerialSettings]	
;Comm Port: COM1 | COM2	
;Baud rate	
;Parity: Even | Odd | None	
;Flow control: XonXoff | Hardware | None	
Port=COM1	*…through RS485 port COM1;*
Baud=9600	*…at a Baud rate of 9600;*
Parity=None	*…with no parity check*
Flow=None	*…and no flow control…*
[Ethernet]	
;No items	
[Devices]	
;Number of devices attached	
Number=1	*…with one device…*
[Device1]	
;Slave address of the device	
;IP Addr	
;IP Port	
SlaveAddress=1	*…whose slave address is '1'.*
;IPAddr=172.20.6.66	
;IPPort=502	
[Recent File List]	
File1=D:\WINNT\system32\Solartron	
File2=D:\WINNT\Profiles\system\Desktop\server	

C.1.3.2 INI File Example 2

This INI file specifies the parameters of the Ethernet communication to be used between the PC and a single IMP.

File	Comments
[Communication]	
;Transport layer: Serial | Ethernet	
;Communication type: ASCII | RTU | TCP	
Transport=Ethernet	*Communicate on Ethernet,*
Type=TCP	*using TCP transmission mode...*
[SerialSettings]	
;Comm Port: COM1 | COM2	
;Baud rate	
;Parity: Even | Odd | None	
;Flow control: XonXoff | Hardware | None	
;Port=COM2	
;Baud=9600	
;Parity=None	
;Flow=None	
[Ethernet]	
;No items	
[Devices]	
;Number of devices attached	
Number=1	*...with one device...*
[Device1]	
;Slave address of the device	
;IP Addr	
;IP Port	
SlaveAddress=1	*...whose slave address is '1'...*
IPAddr=172.20.6.66	*...IP address is 172.20.6.66...*
IPPort=502	*...and IP port is 502.*
[Recent File List]	
File1=D:\WINNT\system32\Untitled	
File2=D:\WINNT\Profiles\system\Desktop\server	

C.1.3.3 INI File Example 3

This INI file specifies the parameters of the Serial communication (RS485) to be used between the PC and two IMPs.

File	**Comments**
[Communication]	
;Transport layer: Serial | Ethernet	
;Communication type: ASCII | RTU | TCP	
Transport=Serial	*Communicate on RS485),*
Type=RTU	*in ASCII transmission mode….*
[SerialSettings]	
;Comm Port: COM1 | COM2	
;Baud rate	
;Parity: Even | Odd | None	
;Flow control: XonXoff | Hardware | None	
Port=COM1	*…through RS485 port COM1;*
Baud=9600	*…at a Baud rate of 9600*
Parity=None	*…with no parity check*
Flow=None	*…and no flow control…*
[Ethernet]	
;No items	
[Devices]	
;Number of devices attached	
Number=2	*…with two devices….*
[Device1]	
;Slave address of the device	
;IP Addr	
;IP Port	
SlaveAddress=1	*…the first addressed as slave '1…*
;IPAddr=172.20.6.66	
;IPPort=502	
[Device2]	
SlaveAddress=4	*…and the second addressed as slave '2'.*
;IPAddr=172.20.6.4	
;IPPort=502	
[Recent File List]	
File1=D:\WINNT\system32\Solartron	
File2=D:\WINNT\Profiles\system\Desktop\server	

C.1.3.4 INI File Example 4

This INI file specifies the parameters of the Ethernet communication to be used between the PC and the first of two IMPs (slave 1). This IMP is acting as a pass-through controller for the second IMP (slave 4).

File	Comments
[Communication]	
;Transport layer: Serial | Ethernet	
;Communication type: ASCII | RTU | TCP	
Transport=Ethernet	*Communicate on Ethernet,*
Type=TCP	*using TCP transmission mode…*
[SerialSettings]	
;Comm Port: COM1 | COM2	
;Baud rate	
;Parity: Even | Odd | None	
;Flow control: XonXoff | Hardware | None	
;Port=COM1	
;Baud=9600	
;Parity=None	
;Flow=None	
[Ethernet]	
;No items	
[Devices]	
;Number of devices attached	
Number=2	*…with two devices…*
[Device1]	
;Slave address of the device	
;IP Addr	
;IP Port	
SlaveAddress=1	*…slave 1, the pass thru' controller,*
IPAddr=172.20.6.66	*whose IP address is 172.20.6.66,*
IPPort=502	*and IP port is 502…*
[Device2]	
SlaveAddress=4	*…and slave 4, addressed via slave 1,*
IPAddr=172.20.6.66	*whose IP address*
IPPort=502	*and IP port are the same as for slave 1.*
[Recent File List]	
File1=D:\WINNT\system32\Solartron	
File2=D:\WINNT\Profiles\system\Desktop\server	

D

5000-IMP Server Licence

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October 1999

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