Precision measurement solutions

solartron mobrey

3595 4C

PC to S-Net Interface

USER MANUAL
35952350

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, services 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-Mobrey accepts no responsibility for accidents or damage resulting from failure to comply with these precautions.

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

The electronics unit must be connected to ground using the marked case stud **before** control or signal leads are connected. The ground connections must have a current rating of 25A.

AC SUPPLY
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.

To allow the electronics unit to be isolated from the ac supply, the supply must be routed through a switch (or circuit breaker). The switch (or circuit breaker) must be within easy reach of the operator and must be clearly identified as the means of supply isolation. The maximum current drawn from the supply must be limited by a fuse or trip, to a maximum of 13A.

FUSES
Before switching on the equipment, check that the fuses accessible from the interior 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.

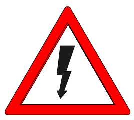
EXPLOSIVE ATMOSPHERES
NEVER OPERATE the equipment, or any sensors connected to the equipment, in a potentially explosive atmosphere. It is NOT intrinsically safe and could possibly cause an explosition

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:**
	Fault indicator. Refer to Operating Manual for detailed instructions of use.
	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 are 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 unfavourable 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' 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. Adjustment, maintenance and repairs must be must be done by qualified personnel, who should refer to the Maintenance Manual.

DO NOT OPEN THE ELECTRONICS UNIT WHEN IT IS ENERGISED.

EQUIPMENT MODIFICATION

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

About This Manual

The **3595 4C User Manual** will help you to prepare and install the interface for operation. It will also guide you through the demonstration software, which accompanies the PCI card, and then explain with an example how to program the interface.

The relevant information on interconnecting the PC and IMP can be found in the 3595 Series IMP Installation Guide. For this reason, the information on IMP networks has been kept to a minimum.

If you're not familiar with the IMP network and the 3595 4C Interface card, you are advised to read the complete manual.

If the 3595 4C Interface card is already installed, you can proceed straight to Chapter 3 which will guide you through the demonstration software.

If you are familiar with the 3595 4C Interface card and the demonstration software, you can proceed straight to Chapter 4 which deals with programming.

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EC/EEA DECLARATION OF CONFORMITY & INCORPORATION
No 84

The undersigned, representing the following manufacturer

name	**SOLARTRON MOBREY LTD**
address	**158 EDINBURGH AVENUE SLOUGH BERKSHIRE UK SL1 4UE**
tel No	**(0)1753 756600** fax No **(0)1753 823589**

herewith declares that the product

type of equipment	**3595 4C PC to S-NET INTERFACE**
type Nos.	**SERIES 3595 4C**

Minor variations in the design to suit the application and mounting requirements are identified by alpha/numeric characters in the type number where indicated * above

is in conformity with the provisions of the following EC directive(s)

reference No	title
89/336/EEC	**ELECTROMAGNETIC COMPATIBILITY**
92/31/EEC	**AMENDING 89/336/EEC**
73/23/EEC	**LOW VOLTAGE DIRECTIVE**
93/68/EEC	**AMENDING 73/23/EEC**

and that the following standards have been applied

number	subject
EN 61326:1997 +A1: 1998	**ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL AND LABORATORY USE - EMC REQUIREMENTS**
EN 61010-1: 1993 +A2: 1995	**SAFETY REQUIREMENTS FOR ELECTRICAL EQUIPMENT FOR MEASUREMENT, CONTROL AND LABORATORY USE**

the last two digits of the year in which the CE marking was first affixed is **01**

Slough UK

Date 16/11/01

Signed

Dr Rob Van Ewyk - Technical Director

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3595 4C
PC to S-Net Interface

User Manual

PART ONE
Installation and Operating Instructions
for the 3595 4C Interface card

3595 4C USER MANUAL
Part One Contents

1

Introduction: the 3595 4C Interface and facilities

Contents

1.1 THE 3595 4C INTERFACE

The **3595 4C Interface** card enables a PC, with **PCI** expansion slots, to communicate with the Solartron-Mobrey **S-Net** system. The card provides *full timing control* and *error checking*, in accordance with the S-Net communication protocol.

1.1.1 PC System Requirements

The 3595 4C Interface card is fully compatible with a PC that has:

- A free PCI expansion slot
- A minimum of 128K user memory
- Microsoft Windows (9x, 2000 or NT4)

> **Note:** The PC memory address used by the PCI card is fixed at 0xC800. You can't configure the card to use a different address.

1.2 INTERFACE ACCESSORIES

The 3595 4C Interface card is supplied with a variety of accessories:

- one 9-way D-type socket (P/N:352509060), to suit the external power connector.
- one 24 gauge S-Net cable/10m (P/N:35950203), with 9-way D-type plug to suit S-Net socket.
- one spare 9-way D-type plug (P/N:351309020) to suit the S-Net socket.
- two connector hoods (P/N:354006290).
- four screw locks, male (P/N:354005170).
- two S-Net terminators (P/N:35900222) for fitting in IMP (refer to the 3595 Series IMP Installation Guide).
- one CD-ROM (P/N:35955840) containing the software and manuals for many IMP products.

1.3 IMPVIEW SOFTWARE

IMPVIEW software is supplied on the CD-ROM that accompanies the 35954C Interface card. IMPVIEW allows you to send commands to IMP devices, and to receive data from them.

The IMPVIEW installation process will also install a (32-bit) Microsoft Windows driver.

Please refer to the "3595 74A IMPVIEW" user manual for full information on installing and using this software.

1.4 INTERFACE FACILITIES

1.4.1 IMP Commands

The IMPVIEW software communicates with the 3595 Series IMP using **commands** in the form of character strings. For example, the reset command is **RE**.

A command may need to be made more specific by using it with a number. An example of this is the command **CL2**, which means: ‘clear event totalise counter on channel 2’.

Several commands may be sent in a command string. Each command in the string is separated from it’s neighbour by a semicolon. A simple example of a command string is **ST;CL2**. This particular command tells a digital IMP to return its’ status and then clear the event totalise counter on channel 2.

IMP commands and responses are dealt with in Part two of this manual.

1.4.2 IMP Data Streams

The 3595 Series IMP is able to return **four types** of data, each data type having an individual format. S-Net protocol **segregates** these data types and returns each type on it’s own data stream. This approach allows application software to **categorise** and attach different **priorities** to data types, thus improving the speed with which high priority data (such as event timing) is handled.

The data types conveyed by each stream are as follows:

Stream 0	Scanned measurements (series of channels), or long numeric responses
Stream 1	Single channel measurement, or short numeric responses
Stream 2	Event information (3595 2A and 3595 2B only)
Stream 3	Command responses, in ASCII characters. Typical examples of this data type are status information or command confirmation.

1.4.3 IMP Addresses

Each 3595 Series IMP in the system must have a **unique address**. The IMP is assigned an address by a pair of rotary switches inside the IMP connector block. The procedure for setting these switches is as described the **“3595 Series IMP Installation Guide”**. The 3595 4C Interface card can handle up to 50 IMP devices, with addresses in the range of 1 to 50 inclusive.

1.5 3595 4C TECHNICAL SPECIFICATIONS

Connections:

124-way edge connector for PCI expansion slot bus.

9-way D-type female connector for S-Net.

9-way D-type male connector for external power.

Environment:

Temperature	Operating	0°C to 55°C (50% Relative Humidity) 0°C to 45°C (95% Relative Humidity)
	Storage	-40°C to 70°C

Communication (S-Net) capability:

Maximum of 50 IMP devices

Maximum S-Net cable length of 1500m.

S-Net Power Supply capability:

Up to 5 IMP devices (3595 Series) can be supplied, at limited distances, from the PC internal power supply.

Up to 50 IMP devices (3595 Series) can be supplied from an external power supply. The actual number depends on the voltage of the external supply and on the length and gauge of the S-Net cable. (See the “3595 IMP Installation Guide” for details)

Power Drain (on PC):

5V, 2.5W maximum

12V, 50mW maximum plus 1.2W for each 3595 Series IMP, and 1.8W for each Universal Series IMP, when powered from the internal power supply

(Up to a maximum of 5 IMP devices).

Power Drain (from external power supply, if used):

1.2W maximum per IMP.

Requirements for external power supply, if used:

12 to 50V DC, dependent on system size and S-Net wire gauge.

Supply ripple less than 100mV rms.

Physical dimensions:

Overall length	6.8in.
Overall height	4.2in.
Overall width	0.8in.
Overall weight	0.2kg/0.44lbs.

2

Preparing and Installing the 3595 4C Interface

Contents

List of Figures

List of Tables

2.1 INTRODUCTION

This chapter tells you how to set-up and install the 3595 4C Interface card. The information given here relates to card issue A and subsequent issues.

The steps to follow are:

1. Select the ‘on-card’ S-Net termination with Jumper J202. (See Section 2.2, Page 2-3.)
2. Decide on the IMP power supply option. Your decision may affect the S-Net cable required and may also make it necessary for you to remove link J201 on the Interface card. (See Section 2.3, Page 2-4.)
3. Install the 4C Interface card in the PC. (See Section 2.4, Page 2-5.)
4. Connect the 4C Interface card in the PC to S-Net. (See Section 2.5, Page 2-7.)
5. Where required, connect the 4C Interface card to an external power supply. (See Section 2.6, Page 2-12.)

PRECAUTIONS

Static Electricity

The 4C Interface card uses MOS (metal-oxide semiconductor) integrated circuits, which can be damaged by static electricity. Keep the card in the plastic packaging until it is needed for fitting. Do not touch the edge connectors. Handle the card only by the free edges.

High Voltages

Before opening the cabinet (base unit) of the PC, switch the power off and disconnect the supply lead from the mains power supply. Do not operate the PC with the cover removed.

2.2 SELECTING ON-CARD S-NET TERMINATION

To avoid signal reflections, the S-Net cable must be correctly terminated at each end. The way in which this is achieved depends on how the cable is connected between Host PC and the IMP devices. Two basic arrangements are shown in Figure 2.1.

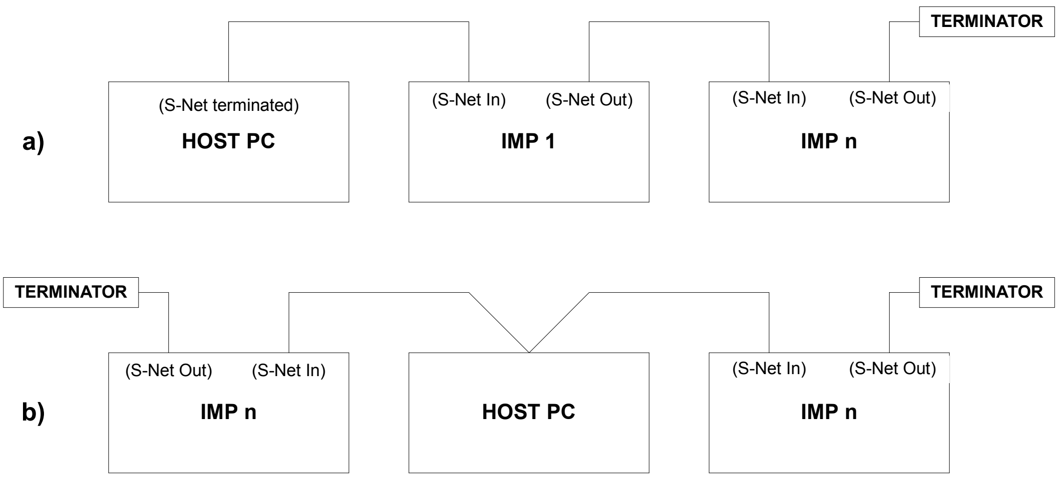


Figure 2.1: S-Net cable terminations

Where the Host PC is located at the end of S-Net (Figure 2.1a), the S-Net cable is terminated on-board the 4C Interface card. Here, connection between cable and terminator is made through 'on-card' **Jumper J202** (See Figure 2.2). The other terminator is fitted to IMP S-Net terminals at the opposite end of the cable.

Where the Host PC is located between IMP devices (See Figure 2.1), the 'on-card' termination must be disconnected. To do this, carefully remove the link on **Jumper J202**. An S-Net cable terminator is then fitted to the IMP devices at both ends of the S-Net cable.

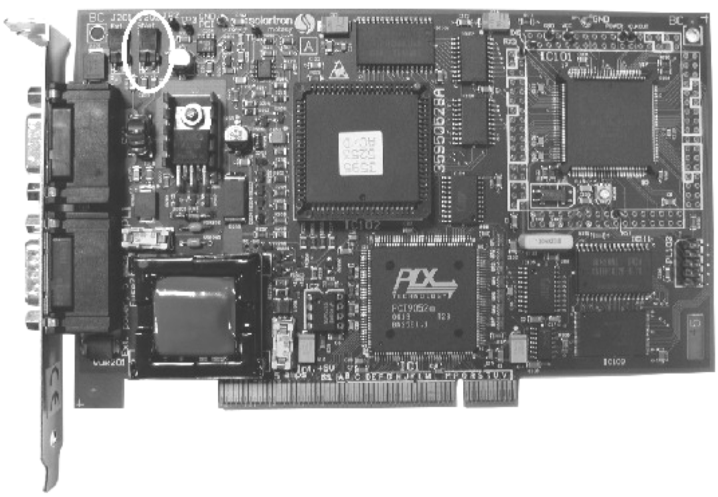


Figure 2.2: Location of S-Net termination Jumper J202

Two S-Net cable terminators for IMP devices are supplied with the 3595 4C Interface card. Instructions for fitting S-Net cables and cable terminators to an IMP are given in the "3595 Series IMP Installation Guide".

2.3 IMP POWER SUPPLY OPTIONS

IMP devices may be supplied with power from **one** of several sources:

a. From the internal power supply of the 3595 4C Interface card, via the S-Net cable. This supply can provide 12V for the S-Net system.

b. From an external 12V – 50V power supply connected to the external power supply plug on the 4C Interface card; again, via the S-Net cable. The location and pin numbering of the external power supply are detailed in Section 2.6, page 2-12. This supply allows up to 50 IMP devices to be operated with a maximum S-Net cable length of 1km.

The IMP power supply is automatically switched to the external source when a voltage of over 12V is applied to the external power plug on the 4C Interface card. Where the external source is to be used continuously, it is recommended that the 'on-card' **Jumper J201** link is removed. (See Figure 2.3)

c. Directly from a power supply that is local to the IMP(s). For further information on this, refer to the "3595 Series IMP Installation Guide".

Each IMP consumes approximately **1W** (1.2W at power-up). In some applications, the 3595 1D Analogue Output IMP can require more power. In this case, special consideration is needed. Refer to the "3595 Series IMP Installation Guide" for details.

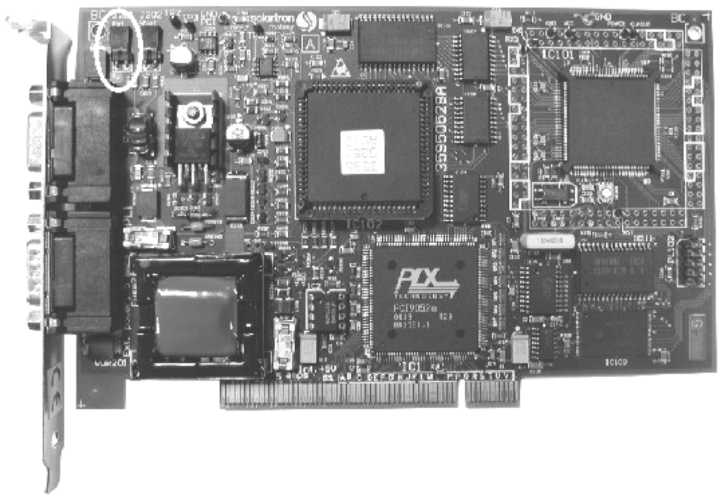


Figure 2.3: Location of external power supply Jumper J201

SUPPLY CONSIDERATIONS FOR THE VIMP

A VIMP is powered from two sources: S-Net conveys power to the communications module, whilst a 3595 95D Power Supply, local to the VIMP, supplies power to the vibration measurement front end.

Depending on the total power required from S-Net, source **a** or source **b** (as described above) can be used to provide the power for the VIMP communications module.

2.4 INSTALLING THE 3595 4C INTERFACE CARD IN THE PC

The procedure for installing the 3595 4C Interface card in the PC is as follows:

1. Set all power switches to 'off'.

2. Unplug all cables from the mains power supply.

3. Disconnect all cabling from the rear end of the Host PC.

4. Remove the Host PC casing. If you require help in doing this, refer to a PC manual.

5. Locate a free PCI expansion slot. (See Figure 2.4)

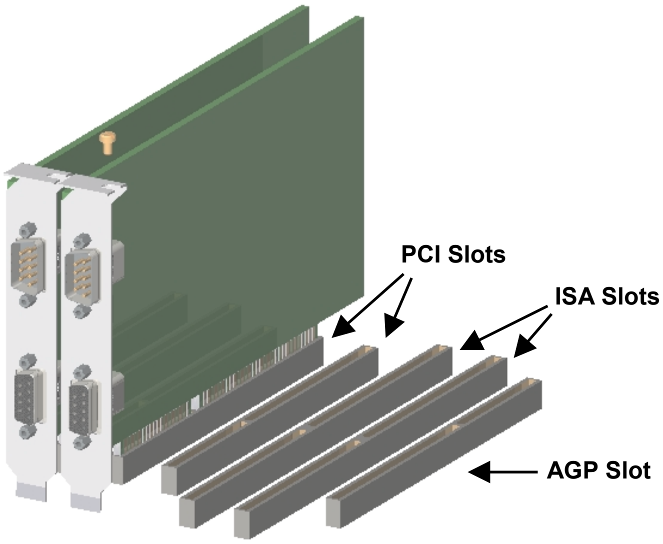


Figure 2.4: Various PC expansion slots

6. Remove the screw securing the cover of the **PCI expansion slot** in which the 4C Interface card is to be installed. Slide the cover out of the PC frame. Save the screw for securing the 4C Interface card.

7. Remove the 3595 4C Interface card from the protective cover. Check that the 'on-card' Jumpers are prepared as described in the earlier sections of this chapter.

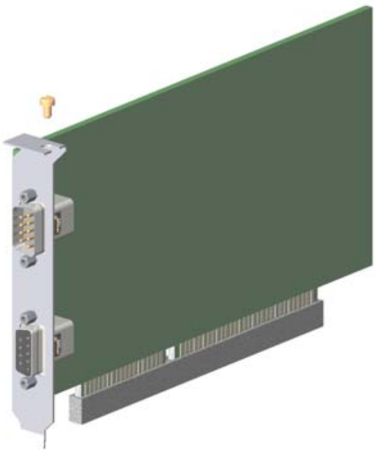


Figure 2.5: Fitting the 4C Interface card retaining screw

8. Holding the card by the corners, press it firmly into the PCI expansion slot prepared in Step 6. Align the ‘U’ shaped slot in the card-retaining bracket with the hole in the rear panel of the PC. Fit the securing screw, which should be snug against the inside of the ‘U’. Tighten the screw. (See Figure 2.5.)

9. Refit the PC casing and retaining screws. (The is the reverse of actions taken during Step 4.)

10. Refit all system cabling that was removed during Steps 2 and 3.

11. Complete the installation by connecting the S-Net cable and external power supply (as required) as described in Section 2.5 (page 2-7) and Section 2.6 (page 2-12).

2.5 CONNECTING THE 3595 4C INTERFACE CARD TO S-NET

The **S-Net cable** is connected to the Host PC through a **D-type connector** in the 4C Interface card.

Figure 2.6 shows the location of this connector when the card is already fitted in a PC. The **pin functions** of the S-Net connector as listed in Table 2.1.

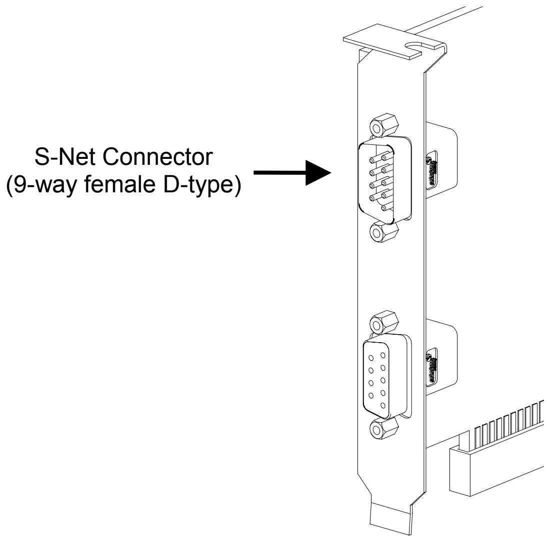


Figure 2.6: Location of S-Net connector on the Host PC rear panel

Table 2.1: S-Net Connections

Pin	Function
1, 2, 6	SHIELD
7, 8, 9	-ve S-Net line
3, 4, 5	+ve S-Net line

In applications where signals and IMP power are both delivered via the S-Net, it is important that the core of the S-Net cable is of adequate gauge. See Section 2.5.1 and 2.5.2 for details.

2.5.1 S-Net cables

3595 Series IMP devices are linked to the 3595 4C Interface card by **S-Net**, a serial communications network. The S-Net cable consists of a twisted pair of multi-stranded wires with a screen around them, and has a nominal characteristic impedance of 100Ω. Non-screened cables may be used, but S-Net signals may be subject to interference in electrically 'hostile' environments. In most applications, signals and IMP power are delivered via the S-Net cable that is connected to a D-type connector on the 4C Interface card.

Table 2.2: Cables recommended for S-Net

Cable Gauge	Brand Names	Solartron Mobrey P/N
12 AWG	Brand-Rex T12459	TBA
16 AWG	Brand-Rex T12460, Alpha 9820, Belden 9860	TBA
18 AWG	Brand-Rex CD8920251, Belden 9250	TBA
20 AWG	Brand-Rex BC 57207, Alpha 9818 Belden 9207, Belden 0915 (direct burial)	TBA
24 AWG	Brand-Rex B156641, Alpha 2400, Belden 8641	TBA

Note:

Approximately 10 metres of 24 AWG Belden 8641 cable are provided with each module. This is sufficient for small data acquisition systems or for testing purposes.

The connections are: S-Net +ve = black (or red) and S-Net –ve = white.

2.5.2 Cable selection

Cable selection depends on two cable characteristics:

1. The a.c. attenuation of the cable. This affects the digital communications that are running back and forth along the cable, between the IMP devices and the 4C Interface card. There are two specific points to consider:

   a. The high a.c. attenuation of the 24 AWG cable means that S-Net using this cable can not be longer than 660 metres.

   b. The low a.c. attenuation of the 14 and 18 AWG cables means that S-Net using these cables can extend up 1.5km. The large diameter of these cables necessitates special consideration when making connections to the IMP. For details, see the "3595 Series IMP Installation Guide" or consult Solartron Mobrey.

2. The d.c. resistance of the cable. This, and the voltage of the power supply, determines the maximum number of IMP devices that can be powered via the cable. Generally, if any IMP devices on the network are powered from the 4C Interface card via the S-Net cable, it is important that a cable of adequate gauge is used. The optimum cable size depends on the number of IMP devices to be powered via the S-Net cable, the cable length and the power supply voltage. Guidance on choosing the cable, either for power provided internally from the 4C Interface card or from an external supply via the 4C Interface card, is given in Sections 2.5.3 and 2.5.4.

2.5.3 Cable selection for IMP devices using internal supply

The internal power supply of the 4C Interface card can supply 12V to the S-Net system. For this, Table 2.3 shows the recommended maximum length for a given gauge of cable and number of IMP devices.

Note that Table 2.3 is based on an IBM PC with only the 3595 4C Interface card fitted. Therefore, the figures given may differ for other PCs. If additional cards using the 12V rail are fitted, the maximum number of IMP devices may decrease correspondingly.

Table 2.3: Maximum cable lengths for IMPs using 4C Interface card internal supply

No. of IMP devices	Maximum Cable Length (Metres)				
	12 AWG ($3.4mm^2$)	16 AWG ($1.3mm^2$)	18 AWG ($0.8mm^2$)	20 AWG ($0.5mm^2$)	24 AWG ($0.2mm^2$)
1	725	410	225	135	50
2	345	160	100	60	20
3	230	105	65	40	10
4	175	80	50	30	10
5	140	60	40	25	10

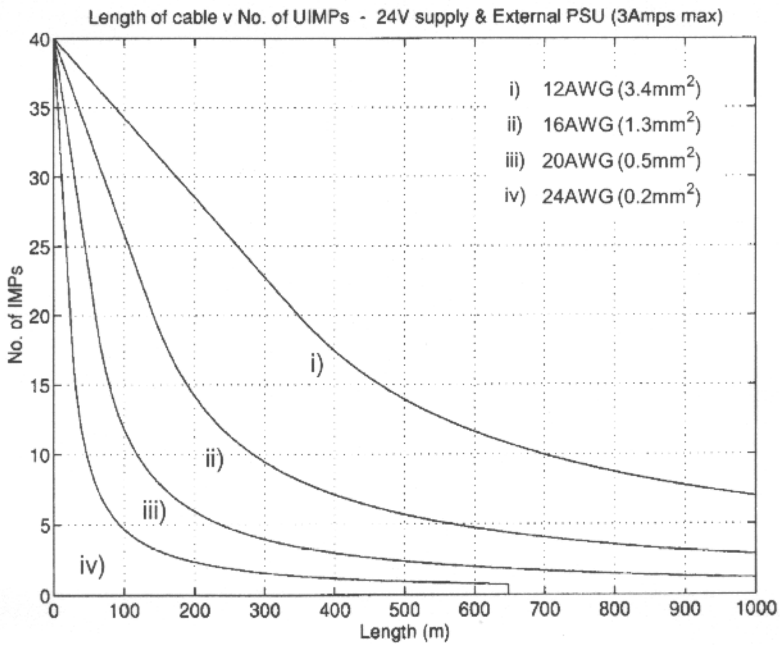
2.5.4 Cable selection for IMP devices using external supply

When IMP devices are powered from an external power supply connected to the 4C Interface card, it is possible to use longer lengths of S-Net cable than those listed in Table 2.3. It is important, however, that the core of the cable is of adequate gauge. The actual gauge required depends on the number of IMP devices to be powered, their distribution along the cable and the power supply voltage.

To select a suitable wire gauge and supply voltage for a given system, refer to the cable selection graphs (Figure 2.7 and Figure 2.8). These graphs assume the worst case distribution of IMP devices, i.e. all of them grouped at the far end of the cable, and incorporate a safety factor.

As an example of using the cable selection graphs, assume that the supply voltage has been fixed at 24V and that 10 IMP devices are to be powered by the S-Net cable. The total cable length is expected to be around 300 metres. For a 24V supply, refer to Figure 2.7 and determine the point on the graph where ’10 IMPs’ and ‘0.3km’ intersect; in this case, the 16 AWG region. This is the smallest gauge of cable that can be used. Therefore, 16, 14 or 12 AWG cables are suitable.

a)



b)

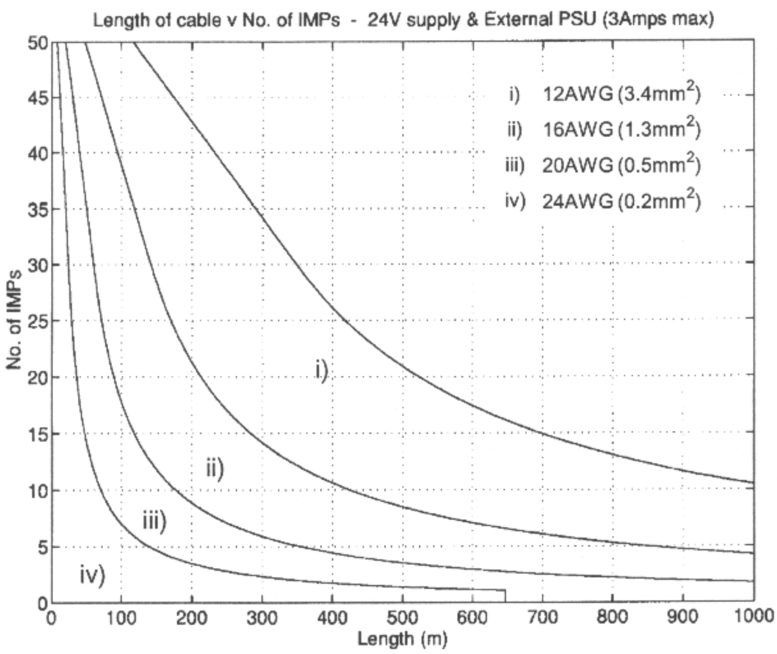
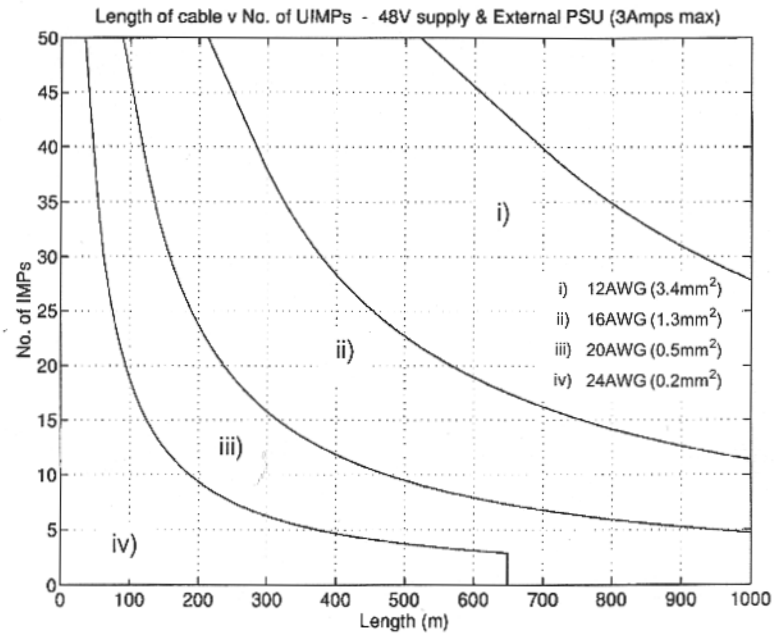


Figure 2.7: Minimum recommended wire gauge for a 24V external supply for: (a) Universal IMP and (b) Other IMP

a)



b)

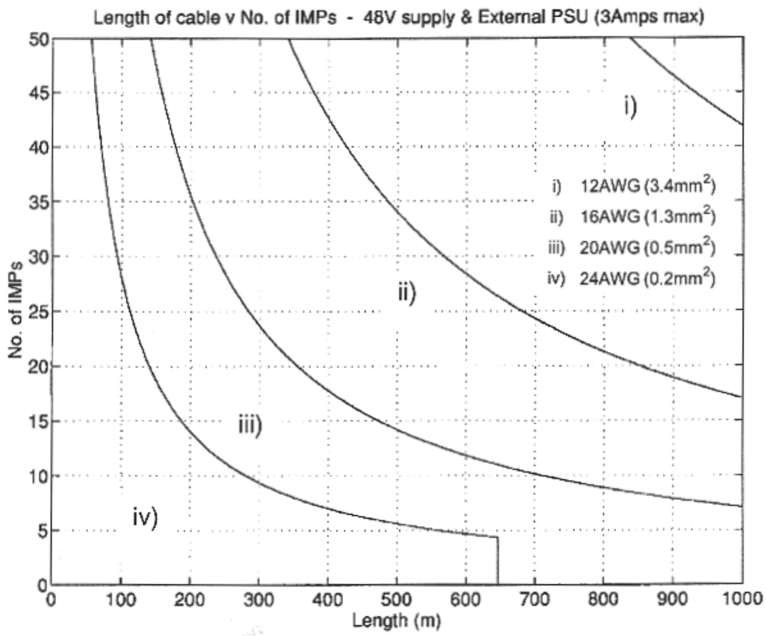


Figure 2.8: Minimum recommended wire gauge for a 48V external supply for: (a) Universal IMP and (b) Other IMP

2.6 CONNECTING AN EXTERNAL POWER SUPPLY

IMP devices can be powered from an external power supply connected to the 3595 4C Interface card. This supplies power to IMP devices through S-Net in exactly the same way as the internal power supply. However, the extra capacity provided by the external supply allows up to 50 IMP devices to be operated with a maximum cable length of 1km.

With the 'on-card' **Jumper J201** link fitted, the 4C Interface card switches from the internal supply to the external supply when the voltage of the external supply exceeds 12V. Should you wish to power IMP devices continuously from the external supply, the **Jumper J201** link must be removed. (See Section 2.3)

The external power supply connection to the Host PC is made through a D-type connector on the 3595 4C Interface card. The location of this D-type connector is shown in Figure 2.9.

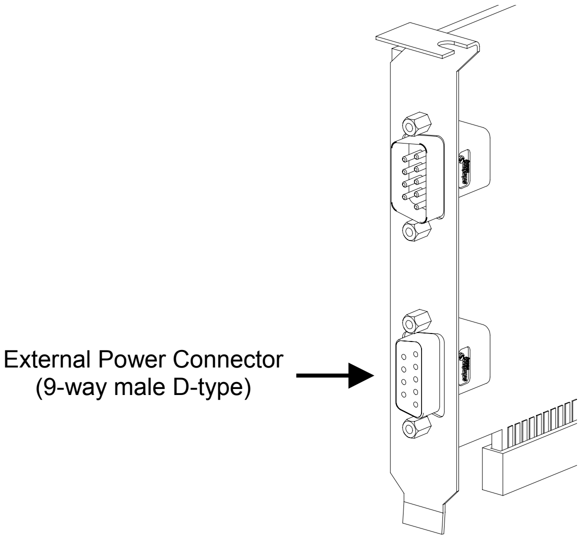


Figure 2.9: Location of the external power connector on the PC rear panel

Table 2.4: External Power Connector

Pin	Function
6, 7, 8, 9	+ve 12059V, 1A max.
1, 2, 3, 4, 5	-ve

2.6.1 External power supply requirements

An external power source must fulfil the following requirements:

- Current limited to 1.5A - 5A, or protected by 5A fuse.
- Voltage 12V to 50V. This depends on the wire gauge, the cable length and the number of IMP devices connected to the cable.
- Supply ripple of less than 100mV rms.

It is permissible for a battery-powered S-Net system to have a charger permanently connected. Batteries generally provide sufficient output smoothing. A battery-powered system must be protected by a fuse (~5A).

A suitable supply, the 3595 95A 48V System PSU, is available from Solartron-Mobrey.

3

Programming the 3595 4C Interface card

Contents

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3.1 INTRODUCTION

This chapter describes how the Host PC can be made to control IMP devices on S-Net by accessing a **64K dual-port RAM** on the 3595 4C Interface card. The information is intended for users who wish to write their own software drivers: if your system uses Solartron-Mobrey software then the dual-port RAM is 'transparent' and you need not get involved with it.

3.2 ADDRESSING THE 4C INTERFACE CARD MEMORY

By accessing the 3595 4C Interface card memory, the Host PC is able to communicate with both the card and the IMP devices under it's control.

Figure 3.1 shows how the 64K dual-port RAM is divided up into **512-byte pages**, each page dealing with a particular aspect of IMP operation.

Communication control is managed through **RAM Page 0**. On this page, the Host PC controls such elements as:

- IMP command transmission,
- The polling of IMP devices for data,
- measurement data and message reception, on the IMP data streams,
- real-time calendar and clock control of the 4C Interface card,
- S-Net power on/off.

IMP commands to be transmitted are written by the Host PC into **RAM Page 1**.

Measurement results from the IMP devices are received on **RAM Pages 2** through **51**, which are assigned to IMP devices 1 through 50.

3.2.1 Addressing the RAM locations

The Host PC accesses the dual-port RAM of the 4C Interface card through the *RAM page window* (Figure 3.1). This window is **0x200** locations wide. **It resides at a *base address* that is <u>always</u> 0xC800**.

The width of the window allows it to encompass one complete RAM page. Initially, the page accessed is RAM Page 0. Any other page can be accessed from this by writing the appropriate page number into the *page select* location (byte) on RAM Page 0.

The address of the *page select* location (byte) is *base address* + 0xFF = 0xC8FF.

A return to RAM Page 0, from the page in use, is made by reading the *page select* location (byte). The data read is the actual data at this location (a measurement data byte on RAM Page 2 for example). On RAM Page 0, however, the page select byte contains the number of the page last visited. This number can be saved, should the page returned from need to be restored (See Section 3.2.2). Zero should be written into the *page select* byte to indicate that the RAM Page 0 is selected.

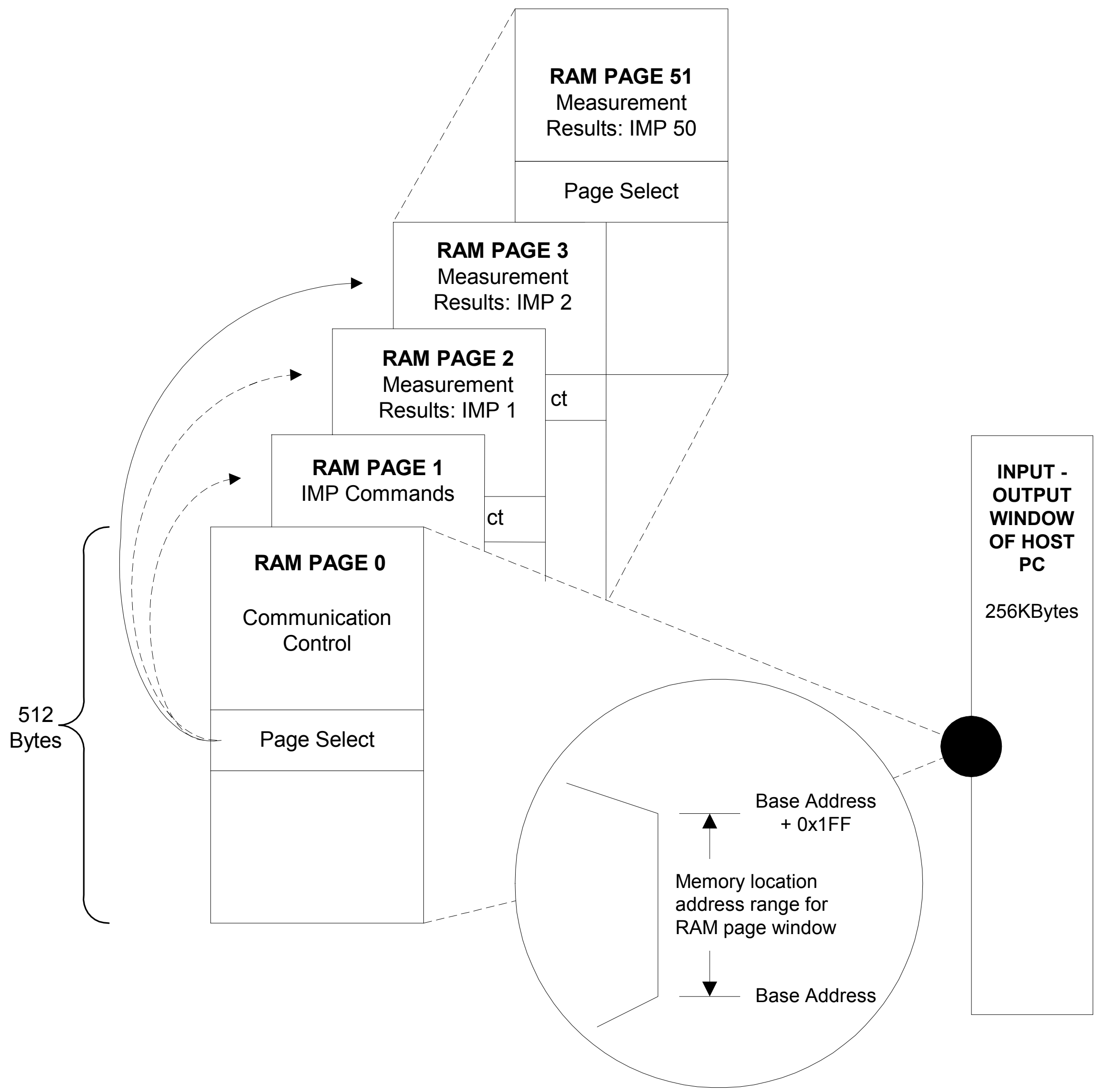

Figure 3.1: RAM page access by the HOST PC

3.2.2 Restoring a previously selected RAM Page

In a multi-tasking application, it may be necessary to restore a RAM page from, say, 'Task A' on completion of, say, 'Task B'. The routine for doing this is as follows:

1. Use Task B to read the page select byte on the page presently used by Task A
2. Read the page select byte again. This will contain the number of the page used by Task A
3. Save this page number
4. Write zero to the page select byte, to indicate that RAM Page 0 is now selected. (Note: This ensures that RAM Page 0 will be restored for Task B, should it be interrupted whilst using Page 0)
5. On completion of Task B, select RAM Page 0 by reading the Page Select byte on the page in use.
6. Get the page number saved in step 3
7. Write this page number into the page select byte. The RAM Page previously selected for Task A is now restored.

During the above sequence, interrupts should be masked. This masking is to handle the period when RAM Page 0 is selected but the *page select* byte still contains the previous page number.

3.3 CONTROLLING IMP COMMUNICATION

The Host PC controls IMP communication by accessing RAM Page 0. This page holds 512 bytes of control and status information for up to 50 IMP devices. Table 3.1 lists the control facilities on RAM Page 0 and the range of location addresses used for each one. The use of these facilities is described in Section 3.3.1. The bit functions are described in Section 3.4.

Table 3.1: Control and status areas of RAM Page 0

Location Addresses *	Function
000 – 0C7 (r/w)	Receive Table
0C8 – 0CE (r/w)	Poll Table (Receive Enable)
0CF – 0E7 (r/w	Receive Interrupt Table
0E8 – 0ED (r/w)	Transmit Control Registers
0EE – 0F7 (r/w)	Real-time Calendar and Clock
0F8 – 0FE (r/w)	Reserved
0FF (r/w)	Page Select
100 – 1FF (w)	Interface Control Register
101 – 103	Reserved
102	Unallocated
103	Reserved
104 (r)	Operating Mode
105 (r)	Extended Error Codes
106 – 10F	Unallocated
110 (r)	Boot Software Status (in ASCII, e.g. 'A')
111 (r)	Boot Software Status (in ASCII, e.g. 'B')
112 (r)	Boot Software Status (in ASCII, e.g. 'C')
113 (r)	Boot Software Status (in ASCII, e.g. 'D')
114 – 11F	Reserved for extra software information
120 – 128 (r)	Flash Checksum
129 – 140	Reserved
141 – 1FF	Unallocated

* To obtain the actual location addresses used, add these hexadecimal addresses to the base address

3.3.1 Initialising the system

To initialise the system, the Host PC must set up:

- The **INTERFACE CONTROL REGISTER** (Section 3.4.1, Page 3-9). This provides for:

  — powering-up S-Net (where IMP devices are powered from the 4C Interface card) and indirectly resetting the IMP devices,

  — resetting the 4C Interface card,

  — reprogramming the 4C Interface card in-situ,

  — reading an error code.

- The **REAL-TIME CALENDAR AND CLOCK** (Section 3.4.5, Page 3-11). Once this is done, the time is transmitted to all IMP devices on the S-Net once every second. This maintains the time in all IMP devices, accurate to within ±1ms of the time in the 4C Interface card.

- The **POLL TABLE** (Section 3.4.6, Page 3-12). In this table, a bit should be set for each IMP device from which data is required. Alternatively, the Poll Table may be set later, when reception is required.

> **NOTE: Power-up Settling Delay**
>
> After power has been applied to the S-Net, the IMP devices take time to become operational. For 50V at the IMP, this time could be up to 1 second, whereas for 10V, it is up to 3 seconds. The voltages quoted are those actually at the IMP, not those applied to the S-Net at the Controller. The times quoted apply to IMP devices other than the Universal IMP (UIMP): for UIMP devices, the times should be doubled.
>
> Setting poll bits before the power-up time has elapsed can result in poll errors being generated. Therefore, it is necessary to delay setting up the Poll Table by a time slightly in excess of the power-up time.

The 4C Interface card can now be used to command the IMP devices on S-Net and receive from them. Sections 3.3.2 through 3.3.4 tell you how.

3.3.2 Transmitting a command message

To make an IMP do something, the Host PC sends it a command message. This is loaded into **RAM Page 1**, which can hold up to **256 bytes**. (Details of the IMP commands are given in Part 2 of this manual.)

To control message transmission, the Host PC uses the **TRANSMIT REGISTERS** (Section 3.4.8, Page 3-13). These allow the Host PC to:

- specify the number of bytes to be transmitted,
- specify the address of the IMP to which the message is to be sent,
- communicate with the 4C Interface card regarding:
  - — transmission requests,
  - — transmission errors,
  - — transmission busy, and
  - — 'break' character transmission (for resetting locally powered IMP devices).
- specify whether it wants to be interrupted at the end of transmissions.

3.3.3 Receiving measurement results

Measurement data is received only from those IMP devices selected in the **POLL TABLE** (Section 3.4.6, Page 3-12). The 4C Interface card polls each of these IMP devices in turn.

When an IMP has data ready to send back to the 4C Interface card, it responds to a poll by placing the data on the S-Net. If the data is received successfully, the card places it in the RAM Page for measurement results relating to the IMP. The 4C Interface card then sets the Data Ready (DR) bit and Data Offset for that IMP and stream, in the **RECEIVE TABLE** (Section 3.4.9, Page 3-15). If the Data Offset in this table is multiplied by four, it gives the address with the IMP's data page at which the data is to be found.

When measurement data has been read by the PC, the relevant entry in the RECEIVE TABLE should be cleared. This allows the 4C Interface card to receive further measurement data from the IMP and stream.

Data can be received on four streams from each IMP and should reception fail on any stream then the 4C Interface card tries three more times to receive data before reporting an error. The card reports errors by setting the Receive Data Error bit (RXE) in the RECEIVE TABLE for each active stream of the IMP that is being polled.

For all IMP devices, the Host PC can enable interrupts on selected data streams by setting the relevant bits in the RECEIVE INTERRUPT TABLE (Section 3.4.10, Page 3-16). On data streams, for which interrupts are enabled, an interrupt is generated by the 4C Interface card either when data is successfully received or when a 'receive error' is reported.

3.3.4 Using interrupts

The 4C Interface card is able to interrupt the Host PC for the following things:

- transmit complete,
- calendar access granted, and
- measurement data received, for each of four streams on up to 50 IMP devices.

Whilst any of these conditions exists, and an interrupt is enabled, the 4C Interface card continues to interrupt the PC. Therefore, special processing of interrupts may be necessary if the Host PC is able to service *all* sources of interrupts, and not just one or two busy ones.

It is recommended that, once a source of interrupt has gained the attention of the Host PC, any further interrupts from the same source are inhibited until other equally important interrupts have been attended to.

3.4 INTERFACE CONTROL

3.4.1 Interface Control Register

The Interface Control (IC) register (Figure 3.2) appears on two RAM pages, Page 0 and Page 255. On both pages, the register is located at address 0x100.

Bit 7							Bit 0
PWR	**RST**	**X**	**X**	**PRG**	◄ **ERROR CODE** ►		

(X = Do not care)

Figure 3.2: Interface Control Register

To ensure software compatibility with the original 3595 Host PC to S-Net Interface card (4A), the only function that can be controlled from RAM Page 0 is the PWR function (bit 7). On RAM Page 255, *all* functions can be controlled. On both RAM pages the state of all bits in the IC register may be read.

The bit functions of the IC register are listed in Table 3.2.

Table 3.2: Bit functions of the IC register

Function *	Description
PWR	Power to S-Net: ‘1’ = power on; ‘0’ = power off IMP devices can be reset by switching the power off and then on again. To ensure that power is completely removed from IMP devices, insert a 250ms delay between these two actions. Note that locally powered IMP devices can be reset by sending a ‘Break’ command from the Transmit Control Register (Section 3.3.2) Allow a delay of 3 seconds after power-up before attempting to communicate with an IMP. For the Universal IMP (UIMP), allow a delay of 6 seconds.
RST	Interface reset: ‘0’ = reset and ‘1’ = no reset.
PRG	Not supported at present.
ERROR CODE	The meanings of the error codes that may appear in bits ‘0’ thorough ‘2’ are as follows: 0 = No Error. 1 = Dual Port RAM Error. 2 = Local RAM error. 3 = Boot code ROM error. 4 = Main code ROM error. 5 = Firmware failure. (Watchdog has reset the 4C Interface card.) 6 = Host PC software failure. 7 = General error. (See Section 3.4.2 for extended error codes.) Error codes 1 through 5 indicate that an error has occurred on the 4C Interface card. Therefore, you should return the card for repair. (Please mention the error code detected as this will help in the faultfinding process.)

* See Figure 3.2 for illustration of the IC register

3.4.2 Extended error codes

The extended error codes stored in RAM location 0x105 consist of the same error codes that appear in the Interface Control Register, and some extra ones.

The error codes and their meanings are:

00 = No Error.
01 = Dual Port RAM Error.
02 = Local RAM error.
03 = Boot code ROM error.
04 = Main code ROM error.
05 = Firmware failure. (Watchdog has reset the 4C Interface card.)
06 = Host PC software failure.
07 = Not applicable
08 = Programming: Bad S-record – does not start with 'S'
09 = Programming: Bad S-record checksum
10 = Programming: ROM (IC) failed to programme
11 = Programming: ROM (IC) failed to programme
12 = Programming: S-record data was not word aligned.

RAM location 0x105 and the Interface Control (IC) Register are located in different areas of hardware. This allows a fault in one area to be reported in the other: for example, a RAM error may make location 0x105 inaccessible, but the relevant error code could still be read from the Interface Control (IC) Register.

3.4.3 Software status and issue

RAM locations 0x110 and 0x111 hold the status of the Boot software currently installed in the 4C Interface card. Similarly, RAM locations 0x112 and 0x113 hold the status and issue of the Main software. Should new software be installed, the status and issue are updated automatically.

3.4.4 Flash Checksum registers

The Flash Checksum Registers allow the Host PC to check the correct loading of the 4C Interface card software. Locations 0x121 through 0x128 hold the even and odd checksums for Sectors 0 and 1, as shown in Table 3.3. Locations 0x129 through 0x140 are reserved for the checksums of Flash Sectors 2 through 7, which are assigned in the same way.

Location 0x120 holds the flash checksum summary. Bits 0 and 1 in this location indicated the checksum status for Sectors 0 and 1: '1' = checksum okay; '0' = checksum error. Bits 2 through 7 are reserved for the checksum summaries of Flash Sectors 2 through 7.

Table 3.3: Flash Checksum Registers

RAM location	Checksum
0x121	Flash Sector 0: even checksum (m.s)
0x122	Flash Sector 0: even checksum (l.s)
0x123	Flash Sector 0: odd checksum (m.s)
0x124	Flash Sector 0: odd checksum (l.s)
0x125	Flash Sector 1: even checksum (m.s)
0x126	Flash Sector 1: even checksum (l.s)
0x127	Flash Sector 1: odd checksum (m.s)
0x128	Flash Sector 1: odd checksum (l.s)

"m.s" = most significant byte; "l.s". = least significant byte

3.4.5 Real-time calendar and clock

The 4C Interface card maintains a real-time calendar and clock (Figure 3.3) for timing and the IMP functions.

Real-time Calendar and Clock (Bit 7 … Bit 0):

0xEE	Calendar Synchronise
0xEF	CGT, CIE, …, CRQ ← Calendar Set
0xF0	Year
0xF1	Month
0xF2	Day
0xF3	Hour
0xF4	Minutes
0xF5	Seconds
0cF6	Millisecs (100's), Millisecs (10's)
0xF7	Millisecs (1's)

Figure 3.3: Real-time calendar and clock

The on-card calendar and clock are set by the Host PC and can be left to run with an accuracy determined by the on-card crystal (error less than 2.5 seconds a day). Alternatively, it is possible to synchronise the 4C Interface card clock to the Host PC clock. Access to the on-card calendar and clock is requested by the PC, and granted by the card, through the Calendar Set Register. The on-card calendar and clock are set by writing an eight-byte time value into locations 0xF0 through 0xF7. Each byte is expressed in the binary-coded decimal format. Synchronisation to the Host PC clock is maintained through the Calendar Synchronise Register.

Synchronising the clock

If software synchronisation is to be used for the real-time clock, the byte at location 0xEE should be set non-zero on the second boundary. The 4C Interface card clears this byte ready for the next synchronisation.

Accessing the calendar

Access to the real-time calendar by the Host PC is requested and granted through the Calendar Set Register, at location 0xEF. The bit functions of this register are as follows:

- CGT — Bit 7: Calendar Grant. The ‘1’ state indicates to the Host PC that access to the calendar is granted
- CIE — Bit 6: Calendar Interrupt Enable. When set to ‘1’, causes Host PC to be interrupted when calendar access is granted.
- CRQ — Bit 0: Calendar Request. When set to ‘1’, requests access to the calendar by the PC

Setting up the calendar and clock

To set-up the real-time calendar and clock, the procedure is as follows:

1. Request access to the calendar and clock by setting the Calendar Request bit (CRQ) in the Calendar Set Register. In addition, set the Interrupt Enable bit (CIE) if an interrupt is required when access is granted.

2. Wait either for the Calendar Grant bit (CGT) to be set, or for the interrupt that indicates this has happened.

3. Write the present Host PC operating system time into the calendar registers.

4. Clear the Calendar Set byte to release access to the calendar.

Once initialised, the calendar and clock can be left to run free at the accuracy determined by the on-card crystal (error < 2.5 s/day). Alternatively, to synchronise the clock to the PC system clock, a non-zero value should be written to the Calendar Synchronise byte at the “roll-over” of each second. Note that it is essential to keep the interval between each write to the Calendar Synchronise byte as close to one second as possible, so that the phase-locking process can maintain a regular real-time clock.

3.4.6 Selecting IMP devices for polling

By setting the appropriate bits in the Poll Table (Figure 3.4), the Host PC tells the 4C Interface card which IMP devices are to be polled for data. Throughout the table, each bit represents a specific IMP. Bit 0 of location 0xC8 through bit 1 of location 0xCE represents IMP 1 through IMP 50, respectively.

Poll Table (Receive Enable)

	Bit 7							Bit 0
0xC8								**1**
0xC9								**9**
0xCA								**17**
0xCB								**25**
0xCC								**33**
0xCD								**41**
0xCE							**50**	**49**

Each bit represents a specific IMP, as indicated by the IMP numbers. When a bit is set, the corresponding IMP is polled for data.

Figure 3.4: Poll Table

In general, a bit should be set for each IMP from which measurement data is required. (See note on power-up settling delay below.) Immediately the poll bits are set by the PC, the 4C Interface card begins to poll the corresponding IMP device(s), checking for data, and reporting communication errors.

The Poll Table set-up can be altered at any time without re-initialising the 4C Interface card. However, once a bit is set, it should not be cleared unless communication errors occur. Errors may be due, for example, to IMP removal or ‘not present’.

NOTE: Power-up Settling Delay

After power has been applied to the S-Net, the IMP devices take time to become operational. For 50V at the IMP, this time could be up to 1 second, whereas for 10V, it is up to 3 seconds. The voltages quoted are those actually at the IMP, not those applied to the S-Net at the Controller. The times quoted apply to IMP devices other than the Universal IMP (UIMP): for UIMP devices, the times should be doubled.

Setting poll bits before the power-up time has elapsed can result in poll errors being generated. Therefore, it is necessary to delay setting up the Poll Table by a time slightly in excess of the power-up time.

3.4.7 Selecting the RAM pages

The **Page Select Register**, at location 0xFF, allows the Host PC to select another RAM page from RAM Page 0. When the number of the required page is written into this register, the 4C Interface card moves the RAM window to allow access to this page. A Page Select Register on the selected page, when read, returns to RAM window to RAM Page 0. (See Section 3.2 page 3-3.)

3.4.8 Transmitting data to the IMP

The **Transmit Register** (Figure 3.5) allows the Host PC to communicate with the 4C Interface card when it wishes to transmit data to an IMP. The data to be transmitted is written by the Host PC into RAM Page 1. Sections X through Y describe the function of each Transmit Register.

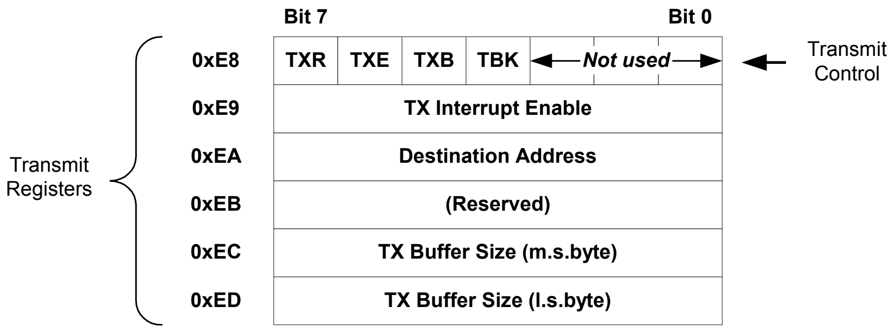

Figure 3.5: Transmit Register

Transmission control

The **Transmit Control Register** is used to control and give the status of transmissions made by the 4C Interface card. The bit functions are as follows:

TXR Transmit Request. The Host PC sets the TXR bit to tell the 4C Interface card that the data on RAM Page 1 is to be transmitted. Another transmit can be requested only when the TXB bit is cleared by the card.

On completion of the transmission, the TXB bit is cleared. (This is a more precise indication of transmission complete than the clearance of the TXB bit.)

TXE Transmit Error Flag. The 4C Interface card sets the TXE bit to indicate a transmission error.

TXB Transmit Busy. The 4C Interface card sets the TXE bit to indicate that transmission has started. The bit is cleared after transmission ends; another transmit can then be requested.

TBK Transmit Break. The Host PC sets this bit to tell the 4C Interface card to transmit a break character on the S-Net.

The break character resets every IMP on the network. It is primarily intended for resetting every locally powered IMP, although it also resets those powered via the S-Net. When every IMP is reset, the TBK bit state returns to ‘0’. A break character can be used to re-establish correct system operation when there are transmit or receive errors.

Transmit or receive errors may be caused by removing an IMP, or replacing one, in an operational system. Although this activity is sometimes necessary, and certainly will not damage the IMP hardware, it is not recommended.

Transmission interrupts

An interrupt is generated if the byte at location 0xE9 is non-zero and TXR in the Transmit Register is clear.

Destination addressing

The **Destination Address Register**, in location 0xEA, holds the address of the IMP that is to receive the data on RAM Page 1. The destination address is written into this register by the Host PC.

A message may be ‘broadcast’ to every IMP on the S-Net by making the destination address a zero. This facility is intended primarily as a means of synchronising the time between the 4C Interface card and every IMP on S-Net: time is sent to every IMP simultaneously so that they can operate in a common timeframe. Other messages, such as a measure command, may also be broadcast, which gives a marginal increase in data throughput. With a broadcast message, however, message reception goes unchecked and no indication is given to the PC. Therefore, it is not recommended for messages in a secure environment, i.e. where the function of every IMP is critical and the failure of any IMP to respond must be reported to the PC. [1]

Transmit buffer size

Two bytes are used to hold the number of bytes that are to be transmitted. The maximum number is 256 bytes, which is the capacity of the transmit buffer on RAM Page 1.

Transmit sequence

To transmit a message to an IMP, the Host PC must take the following steps:

1. Write the message onto RAM Page 1, starting at address 0x00.
2. On RAM Page 0, set-up the Transmit Registers as follows:
   - **a.** Specify the number of bytes to be transmitted by writing this into the **Tx Buffer Size Register**
   - **b.** Specify the IMP that is to receive the command by writing it’s address into the Destination Address Register.
   - **c.** Initiate the transmission by setting the TXR (Transmit Request) bit in the Transmit Register.
   - **d.** Set the Tx Interrupt Enable byte to non-zero (only if a transmit-complete interrupt is required.)

When the Transmit Request (TXR) bit has been recognised by the 4C Interface card, the card itself sets the Transmit Busy (TXB) bit and the message is then transmitted on the S-Net. If a message is sent to a specific IMP, i.e. the destination address is not zero, the IMP is polled immediately after the message is sent. This poll is for verifying correct message reception. If an acknowledgement of the message is not received, up to three re-tries are performed before an error is reported to the user.

When transmission is complete, the 4C Interface card sets the Transmit Control Register as follows:

Transmit Request (TXR)	- clear.
Transmit Error (TXE)	- sets only if transmission has failed.
Transmit Busy (TXB)	- clear.

If the Interrupt Enable byte was set, the 4C Interface card generates a ‘transmission complete’ interrupt.

[1] In the case of time broadcasts, acknowledgement of reception is of no consequence. The time is broadcast at regular intervals and any IMP not receiving the time, due to being busy, should receive the time data on a subsequent broadcast. A total failure of an IMP to receive data will be reported to the Host PC when that IMP is normally polled.

3.4.9 Reading the received data status

The **Receive Table** has the format shown in Figure 3.6. Four consecutive bytes are assigned to each IMP, and these contain the receive status for data streams 0 through 3. For each IMP and data stream, the table tells the Host PC whether the data transmitted by the IMP is ready in the 'on-card' RAM, or whether the card has failed to receive this data. Each receive status byte also contains an address offset, which tells the Host PC where to start reading the data stream on the relevant page of RAM.

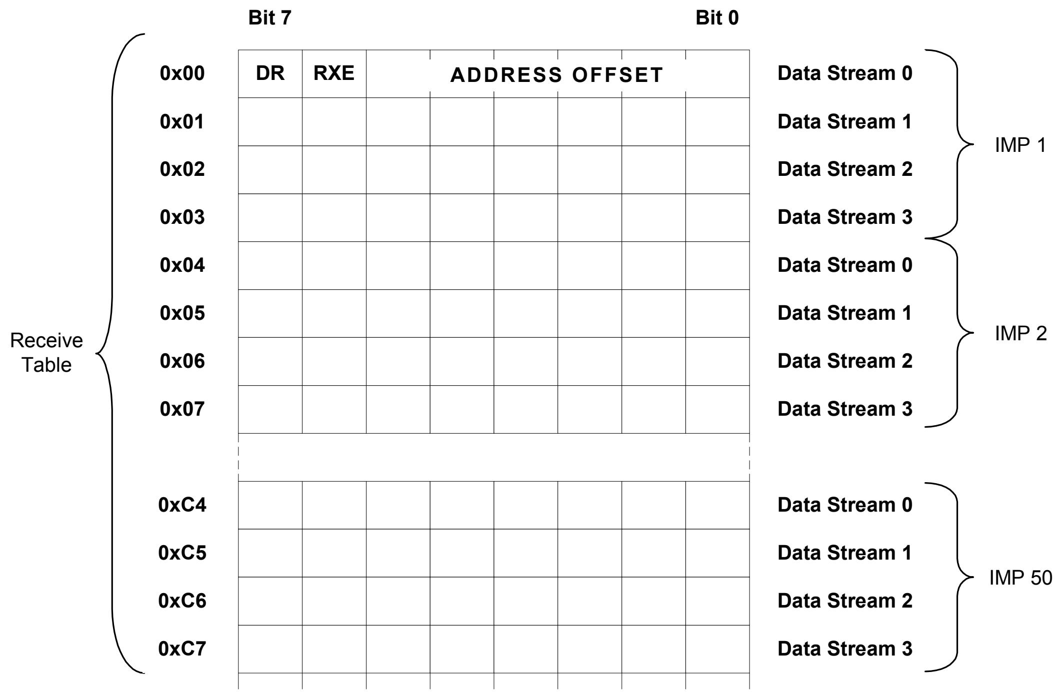

Figure 3.6: Receive Table

For each receive status byte, the bit functions are:

DR	Data Ready. When set, this bit indicates that some new data has been received and is ready on the RAM page assigned to storing IMP measurement results.
RXE	Receive Data Error. When set, this bit indicates that the 4C Interface card has failed after three attempts to receive data transmitted by an IMP.
Address Offset	Bits 0 through 5 contain a RAM location offset (divided by 4). This points to the location in RAM where the first byte of the data stream is located. All data starts on long word boundaries (four bytes). (The measurement results received from IMP 1 through IMP 50 are stored on RAM pages 2 through 51.)

3.4.10 Setting receive interrupts

The **Receive Interrupt Table** (Figure 3.7) is intended for use in 'task programming'. It allows a Host PC, by setting the relevant bits, to select the data streams for which it is to be interrupted on completion of a receive operation.

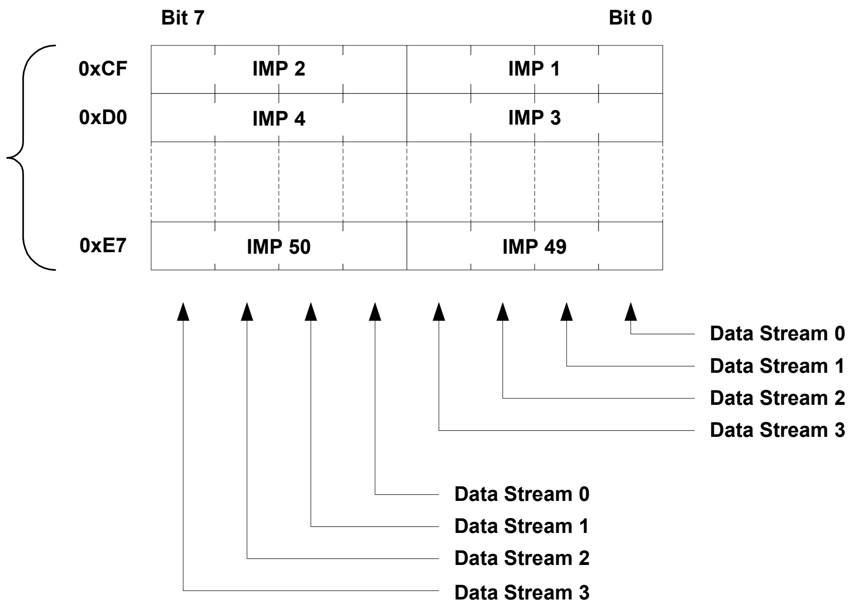

Figure 3.7: Receive Interrupt Table

Each of the four-bit bytes, into which the table is divided, is assigned to a specific IMP. Within each of those bytes, each bit is assigned to a specific data stream. When the Host PC sets a bit in this table, the 4C Interface card generates an interrupt either when measurement data is ready in the on-card RAM or when the card has failed to receive measurement data. An indication of either occurrence is given by the Data Ready and Receive Data Error bits in the relevant byte of the Receive Table (Section 3.4.9).

3.5 Receiving IMP results and responses

Measurement results from IMP devices are received on RAM pages 2 though 51, which are assigned to IMP 1 through 50 respectively. Each of these pages contains the data, organised as shown in Table 3.1. Sections 3.5.1 through 3.5.4 describe each type of data.

Table 3.4: Content of RAM pages 2 through 51

Location Addresses *	Function
000 – 04F (r/w)	Data stream 0 (80 bytes)
070 – 073 (r/w)	Data stream 1 (4 bytes)
080 – 0EF (r/w)	Data stream 2 (112 bytes)
0F0 – 0FB (r/w)	Data stream 3 (12 bytes)
0FC – 0FF (r)	Unallocated
0FF (w)	Page address
100 – 101 (r/w	Stream 0 size
102 – 103 (r/w)	Stream 1 size
104 – 105 (r/w)	Stream 2 size
106 – 107 (r/w)	Stream 3 size
108 – 109 (r/w)	Stream 0 time tag
110 – 117 (r/w)	Stream 1 time tag
118 – 11F (r/w)	Stream 2 time tag
120 – 127 (r/w)	Stream 3 time tag
128 (r/w)	Unallocated
129 (r/w)	Transmit retry count
12A – 1FF (r/w)	Unallocated

* Remember to add the *base address* of card to these hexadecimal numbers.

3.5.1 Data streams

IMP devices are able to return four types of data, each type having a particular format. To allow application software to categorise and attach different priorities to the data types, the S-Net protocol segregates them into four data streams. The data-to-stream assignments are listed in Table 3.5, together with size of the buffers that accommodate them.

Table 3.5: Data-to-Stream assignments

Stream No.	Data Conveyed	Buffer Size
0	Measurement scan or long numeric response	80 bytes
1	Single channel measurement or short numeric response	4 bytes
2	Event information (3595 2A and 3595 2B IMP only)	112 bytes
3	Command responses in ASCII	12 bytes

NOTE: In response to the **SA** command (‘Save set-up data’ – see Chapter 1 in Part 2 of this manual), more than 80 bytes *may* be sent in Stream 0 by an IMP. This *may* overwrite the boundaries of the area reserved for Stream 0 in the (on-card) buffer space. Stream 0 for the 3595 2B switch-pod is 128 bytes wide. (Therefore, this pod does not use Stream 1.)

3.5.2 Stream size

The size (number of bytes) of each data stream is stored in locations 0x100 to 0x107. (See Figure 3.8)

	Bit 7 Bit 0
0x100	**Data Stream 0 Size (m.s.byte)**
0x101	**Data Stream 0 Size (l.s.byte)**
0x102	**Data Stream 1 Size (m.s.byte)**
0x103	**Data Stream 1 Size (l.s.byte)**
0x104	**Data Stream 2 Size (m.s.byte)**
0x105	**Data Stream 2 Size (l.s.byte)**
0x106	**Data Stream 3 Size (m.s.byte)**
0x107	**Data Stream 3 Size (l.s.byte)**

Figure 3.8: Stream size locations

3.5.3 Stream time tags

A time tag is stored for each stream of data received. This includes the date and the time at which the reception of data, at the 4C Interface card, was completed. For the location of the various date and time elements, see Figure 3.9.

Data Streams:

0	1	2	3	Bit 7	Bit 0
0x108	0x110	0x118	0x120	**Year**	
0x109	0x111	0x119	0x121	**Month**	
0x10A	0x112	0x11A	0x122	**Day**	
0x10B	0x113	0x11B	0x123	**Hour**	
0x10C	0x114	0x11C	0x124	**Minutes**	
0x10D	0x115	0x11D	0x125	**Seconds**	
0x10E	0x116	0x11E	0x126	**Millisecs (100's)**	**Millisecs (10's)**
0x10F	0x117	0x11F	0x127	**Millisecs (1's)**	

Figure 3.9: Stream time tag locations

3.5.4 Transmit retry count

The transmit retry count (stored at location 0x129) indicates the quality of transmission on S-Net, from the 4C Interface card to the IMP devices.

For each character that the 4C Interface card transmits to an IMP, it expects a response: this is part of the S-Net protocol. Should an IMP fail to respond, three retries are made before an error is reported. In many cases where the quality of the transmission is marginal, the transmission may succeed after several attempts. This is where the transmit retry count can provide a useful check.

Retries should be kept to a minimum since they increase the time taken to transmit data streams. Where the count is particularly high, the serviceability of equipment on S-Net should be investigated.

3595 4C
PC to S-Net Interface

User Manual

PART TWO
IMP Commands and Responses

3595 4C USER MANUAL
Part Two Contents

1

IMP Commands

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1.1 INTRODUCTION

This chapter provides information on the use of IMP commands, a summary of commands, a detailed command directory, and suggested command procedures.

> **NOTE:** Details of the Vibration IMP (VIMP) commands are given in the SI3595 1F&G VIMP Programmer's Manual (P/N: 35952200)

1.1.1 Command Strings

The following rules apply to command strings:

a. They **must not** contain more than 256 characters (bytes).

b. They may contain a number of individual commands, as long as they are separated by semicolons. Commands are executed in order, left-to-right across the string, and responses are returned in order.

c. They must not contain unnecessary spaces or lower case characters.

d. If a command includes some binary-coded information, all bytes of this data must be included. Omissions can cause both the command involved, and subsequent commands, to be misinterpreted.

1.1.2 IMP Command Types

Command strings are built from two basic command types:

General Commands - *applicable to most IMP types*

Specific Commands - *applicable to a particular type of IMP. For example, the **EV** command applies only to the digital and switch IMP devices.*

Note: IMP addressing is dealt with in Part 1 of this manual.

1.1.3 Numbers in commands

The majority of commands require one or more numbers to further specify the command. For example, the **ME** (measure) command must be specified with a channel number. Unless otherwise stated in the command directory, these numbers are ASCII (keyboard) characters and not numeric variables.

1.1.4 Examples of command strings

A string of two or more commands may be sent by inserting semicolons between individual commands. On receipt of a command string, the IMP executes each command in turn, left-to-right. Each command string should not exceed 256 characters (bytes) in length, including semicolons.

As an example, the command sequence SE;TR provides a quick measurement set-up:

1. On an IMP *other* than the Universal IMP '1H and '1J, it selects 'volts dc auto-ranging' (for analogue versions) or 'digital status' (for digital and switch versions).

   On the UIMP, it sets analogue channels 1 through 18 to 'volts dc auto-ranging' and digital channels 19 and 20 to 'digital status'.

2. It arms the IMP to make measurements.

3. It tells the IMP to take a scan – that is, measure on all channels.

Other useful command sequences are:

a. **RE** ; **CH***n***MO**103 ; **ME***n* (For analogue IMP and Universal IMP)

This command resets previous settings, sets channel *n* to 'volts dc 2V range', and tells the IMP to take a measurement on channel *n*.

(On an IMP other than the UIMP, channel *n* can be any channel; on the UIMP, channel *n* can be any channel from 1 through 18)

b. **RE** ; **CH***n***MO**902; **ME***n* (For digital IMP and Universal IMP)

This command resets previous settings, sets channel *n* to 'frequency measurement – gate time 1 second', and then tells the IMP to take a measurement on channel *n*.

(On an IMP other than the UIMP, channel *n* can be any channel; on the UIMP, channel *n* can be any channel from 19 or channel 20)

c. **SE** ;**CO** ; **TR**(For any IMP)

This command sets every IMP (all channels) to either 'volts dc auto-ranging' (analogue IMP) or 'digital status' (digital or switch IMP) and enables measurements, enables continuous measurement scanning, and then starts the scanning (measuring on all channels). Scans will continue being made until the buffers available are full or until the **HA** (halt) command is issued.

d. Examples (**a.**) and (**b.**) can be extended to setting up every channel on an IMP and begin scanning. To do this, use **CH MO** entry in the Command Directory to decide the required function of each channel. Then string together all the appropriate **CH MO** commands (one for each channel). As an example, IMP type 1A would have twenty **CH MO** commands sent to it in order to configure every channel:

RE ; **CH**1**MO**100 ; **CH**2**MO**500 ;……; **CH**20**MO**310 ; **AR** ; **TR**

e. **RE** ; **CH**1**MO**600 ; **CH**1**GA**$n_1n_2n_3n_4$; **IN**1 ; **ME**1 (For analogue IMP 1B only)

Where: $n_{1...}n_4$ = IEEE 754 floating-point number
n_1 = most significant byte

For a strain gauge factor of, say, 2.25,

First byte	n_1	= 01000000_2 equivalent to 64_{10}
Second byte	n_2	= 00010000_2 equivalent to 16_{10}
Third byte	n_3	= 00000000_2 equivalent to 0
Fourth byte	n_4	= 00000000_2 equivalent to 0

This command sequence:

- resets previous settings,
- sets channel 1 to measure strain using a ½-bridge (4mA) configuration on auto-ranging,
- uses a strain gauge factor of 2.25 in strain calculations,
- initialises the strain gauge, and
- tells the IMP to take a measurement on Channel 1.

A detailed explanation of how to convert the decimal number '2.25' into a binary number in IEEE 754 floating-point format is given in Chapter 2.

1.1.5 Incorrect commands

The IMP checks command strings for correct syntax. If it finds a command that it does not understand, it ignores the command and moves on to the set of characters after the next semicolon (or the next command string if the message ends before a semicolon occurs).

For example, if the following command string is sent to an IMP:

HELLO; **TR**

The first five characters, **HELLO**, mean nothing to an IMP and it will ignore these. The command **TR** will then be processed and executed.

However, it is possible to send an IMP a command that it understands, *but can't obey*. For example, the command may specify an invalid mode or range. In such a case, the IMP stores an appropriate error code and returns this when it next receives a measure or trigger command for the affected channel(s). Thus, when the command string does not instruct an immediate response, the error is not immediately reported; this may lead to confusion.

Therefore, it is important that the application software checks that each command sent has the correct syntax and that the parameters as valid.

1.1.6 Command delays

To ensure that an IMP correctly executes commands, it is good practice to insert a delay of 100ms between command strings and a delay of 500ms after each of the following commands: **RE**set, **TR**igger and **HA**lt.

1.2 COMMAND SUMMARY

Table 1.1: IMP Command Summary

Command	Applicable to … (3595 1A, 1B, etc)									Purpose	Sect.
	1A	1B	1C	1D	1E	1H	1J	2A	2B		
AR	*	*	*		*	*	*	*	*	Arms an IMP.	3.1
CH MO	*	*	*		*	*	*	*	*	Sets channel mode.	“
CO	*	*	*		*	*	*	*	*	Continuously scan channels.	“
DI	*	*	*		*	*	*	*	*	Cancels the AR command.	“
HA	*	*	*		*	*	*	*	*	Halts all measurements.	“
LO	*	*	*		*	*	*	*	*	Loads saved set-up information.	“
ME	*	*	*		*	*	*	*	*	Takes a single measurement	“
RE	*	*	*	*	*	*	*	*	*	Sets all IMP settings to default.	“
SA	*	*	*		*	*	*	*	*	Store set-up data.	“
SE	*	*	*		*	*	*	*	*	Quick set-up of all IMPS.	“
SP	*	*	*		*	*	*	*	*	Set scan period.	“
ST	*	*	*	*	*	*	*	*	*	Request information on IMP.	“
TR	*	*	*		*	*	*	*	*	Request data from (armed) IMP.	“
CA	*	*	*		*	*	*			Calibration on specific ranges.	3.2
DR	*	*	*		*	*	*			For test purposes only.	“
FR	*	*	*		*	*	*			Sets the integration time.	“
KA	*	*	*	*	*	*	*			Calibrate ON.	“
UN	*	*	*		*	*	*			Selects units of Temperature	“
AM	*		*		*	*	*			Ambient temperature reference.	3.3
TE	*		*		*	*	*			Sets reference temperature.	“
TC	*		*		*	*	*			Sets thermocouple check for o/c	“
CH GA		*								Loads IMP with gauge factor.	3.4
CH OF		*								Sets the strain gauge offset.	“
IN		*								Sets strain gauge parameters.	“
CH RA						*	*	*		Sets the sample rate.	3.4
CH TI						*	*	*		Sets the time-out period.	“
CL						*	*	*		Clear event-totalling counter.	“
EV								*	*	Enables event capture.	“
ES								*	*	Event status.	“
HW						*	*		*	Enable/Disable hardware w/dog.	“
SF									*	Status format, IEEE/compressed	“
SW						*	*		*	Enable/Disable software w/dog.	“
CH VO				*						Sets channel to voltage	3.6
CH IO				*						Sets channel to current.	“
CH CV				*						Calibrates voltage channel.	“
CH CI				*						Calibrates current channel.	“
OS				*						Request info. on o/p channels.	“

Abbreviations used: “w/dog” = watchdog, “o/c” = open-circuit, “o/p” = output, “info.” = information

Table 1.2: Additional commands for the 3595 1H and 1J IMP

Command	Purpose
CH LR	Returns the loop resistance of a thermocouple
CH UC	Converts a measured parameter into alternative units, with the function $y = mx + c$.
UT	Defines a set of coefficients to be used for thermocouple linearisation. (These are applied by selecting the appropriate channel mode.)
CH PL	Enables a measured parameter to be linearised into alternative units
PL	Defines coefficients of the polynomial applied by CH PL.
CH HL	Defines a high limit for channel alarm checking.
CH LL	Defines a low limit for channel alarm checking
CH GO	Defines a group of alarm channels to be used with a digital output channel.
AS	Enables an IMP to start automatically after a hard reset.
RM	Selects the result mode from real-time, time tagged, historical.
FB	Flushes the historical results buffer.
SD	Saves the database in the IMP flash PROM.
RD	Restores the database in the flash PROM to the database proper.

1.3 COMMAND DIRECTORY

In this directory, the IMP commands are classified under the following headings:

Commands for Analogue and Digital Measurements

Commands for Analogue Measurements Only

Commands for Thermocouple Measurements

Commands for Strain Gauge Measurements

Commands for Digital Measurements Only

Commands for Analogue Outputs

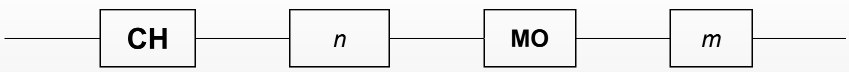
Additional Commands for the Universal IMP

In each section, commands appear in alphabetical order.

Each command description is headed with the command code and the command title in brackets.
For example:

CH MO (Set **CH**annel **MO**de)

The command syntax is shown by a flow diagram, which includes any command variables.
For example:



Where:

n is an integer that defines the channel number:

in the range 1 ≤ n ≤ 20 for IMP types 3595 1A, 1C, 1E, 1H, 1J and 2A,
in the range 1 ≤ n ≤ 10 for IMP type 3595 1B, and
in the range 1 ≤ n ≤ 32 for IMP type 3595 2B

m is a 3-digit code which defines the channel mode

Note that the command codes are shown in bold UPPER CASE characters and variables in *lower case* Italics. Only the items in boxes form part of the command string. A description of each command variable, and the variable limits, appear under the flow diagram as illustrated above. Following the flow diagram, the following information is given:

Note Detailing specific IMP devices when appropriate.

Function Description of command function.

Response What the IMP transmits to the PC in response to the command

See also Other related commands.

In some cases, an example of use is given also.

1.3.1 Commands for analogue and digital measurements

AR (ARm)

— **AR** —

Note This command does not apply to IMP types with analogue outputs (i.e. the 3595 1D).

Function Arms an IMP. Only an armed IMP can respond to a TR (Trigger) command for scanning all channels. This allows individual IMP devices to be armed and only they will then respond to broadcast TR (Trigger) command. Once an IMP is armed, it will continue to respond to a TR command until disarmed with DR command.

Response None.

See also **TR** and **DI**

CH MO (set CHannel MOde)

— CH — *n* — MO — *m* —

Note This command does not apply to IMP types with analogue outputs (i.e. the 3595 1D).

Function Sets the channel mode (measurement function and range) on specified channel. See Table 1.3 through Table 1.7 for encoding details.

Response If an IMP is given a channel mode command with which it is unable to comply, it will return the error message ‘unknown mode, type or range’, but only when instructed to measure.

Any channel can be set to ‘skip’. The channel is then not measured and returns the error message ‘not measured’, instead of any data requested. Channels set to ‘skip’ can be left without termination. Channels set to a particular mode (other than ‘skip’), but not used, should be shorted-out at the connector block.

Note By using an HV connector block (type ‘3D), the 10V range can be converted into a 250V range. If the HA (attenuated) input is used, results from the IMP must be multiplied by 50

Example The command **CH**1**MO**330 configures channel 1 of an addressed IMP type 3595 1A (or 1C) to measure K type thermocouples.

Table 1.3: Mode Codes for IMP Types 1A, 1C and 1E

Code, *m*	Mode Set	Comments
000	Skip	
100	Volts, dc, auto-ranging	
101	Volts, dc, 20mV range	
102	Volts, dc, 200mV range	The ‘10V range’ can extend to 12V
103	Volts, dc, 2V range	
104	Volts, dc, 10mV range	
310 – 314	Thermocouple type E	The third digit sets the range:
320 – 324	Thermocouple type J	0 = auto-ranging,
330 – 334	Thermocouple type K	4 = least sensitive range (10V)
340 – 344	Thermocouple type R	
350 – 354	Thermocouple type S	
360 – 364	Thermocouple type T	* Type B and N thermocouples may be used only
370 – 374	Thermocouple type B *	with an IMP marked with product status C3
380 – 384	Thermocouple type N *	onwards
500	Current, dc, auto-ranging	
501	Current, dc, 200µA	Channels used for current measurements require the
502	Current, dc, 2mA	fitting of a 100Ω shunt. (See IMP Installation Guide.)
503	Current, dc, 20mA	
504	Current, dc, 100mA	

Table 1.4: Mode Codes for IMP type 1B (Strain)

Code, *m*	Mode Set	Comments
000	Skip	
100	Volts, dc, auto-ranging	There is no ‘10V range’.
101	Volts, dc, 20mV range	
102	Volts, dc, 200mV range	
103	Volts, dc, 2V range	
	Resistance, 4-terminal,	
200	0.8mA drive, auto-ranging	
201	0.8mA drive, 25Ω range,	
202	0.8mA drive, 250Ω range,	
203	0.8mA drive, 2k5Ω range	
	Resistance, 3-terminal,	
210	0.8mA drive, auto-ranging	* Only an IMP with a product status of C6 (or higher) are able to comply with an auto-ranging command.
211	0.8mA drive, 25Ω range,	
212	0.8mA drive, 250Ω range,	
213	0.8mA drive, 2k5Ω range	
	RTD/PRT, 100Ω, 4-terminal,	
400	“ auto-ranging	
411	“ 20mV range	
412	“ 200mV range	
413	“ 2V range	
	RTD/PRT, 100Ω, 3-terminal	
410	“ auto-ranging *	* Only an IMP with a product status of C6 (or higher) are able to comply with an auto-ranging command.
411	“ 20mV range	
412	“ 200mV range	
413	“ 2V range	
	Strain Gauges:	
600 – 603	½-bridge, 4mA dual current.	The last digit in the code sets the range:
610 – 613	½-bridge, 0.8mA dual current.	0 = auto-ranging,
620 – 623	¼-bridge, 4mA dual current.	1 = 200mV range,
630 – 633	¼-bridge, 0.8mA dual current.	2 = 200mV range,
640 – 643	Full-bridge, 8mA drive	3 = 2V range.
650 – 653	Full-bridge, 1.6mA drive	
660 – 663	Three-wire, 4mA drive	
670 - 673	Three-wire, 0.8mA drive.	

Table 1.5: Mode Codes for IMP type 2A (Digital)

Code, *m*	Mode Set	Comments
000	Skip	
700	Digital status	
	Event count totalise:	
740	-ve going edge.	On receipt of a measurement trigger, keeps a continuous count of events. This count may be cleared either by the CL command or by setting the channel mode again to event count totalise.
741	+ve going edge.	
742	+ve or -ve going edge.	
	Event count increment:	
750	-ve going edge.	A continuous count of events is kept since the last trigger. On receipt of the next trigger, the event count is stopped, the result is sent to the PC, and another event count is begun.
751	+ve going edge.	
752	+ve or -ve going edge.	
	Event capture:	
760	-ve going edge.	Enabled by EV command only.
761	+ve going edge.	
762	+ve or -ve going edge.	
800	Switch output off (high)	For digital output, sets channel to logic '1' or '0'.
801	Switch output on (low)	
	Frequency Measurement:	
900	gate time = 10ms.	
901	gate time = 100ms.	
902	gate time = 1s.	
903	gate time = 10s.	
	Multiple periods:	
910	1 period.	Returns the time over which periods are counted. Measurement starts on the negative-going edge.
911	10 periods.	
912	100 periods.	
913	10000 periods.	
	'One-shot' time:	
920	-ve going start, +ve going stop.	Measures -ve pulse width.
921	+ve going start, -ve going stop.	Measures +ve pulse width

Note: -ve edge refers to a negative-going edge, a transition from high to low.
+ve edge refers to a positive-going edge, a transition from low to high.

Event Count

This facility permits a number of events to be counted. The events (transitions) to be included in the count can be +ve, -ve or both. Two types of count are offered: increment or totalise. These operate as follows:

Increment. On receipt of a measurement trigger, an event count is started. Then on receipt of another measurement trigger, the event count is stopped. The result is sent to the 3595 4C Interface card and another count begins.

Totalise. On receipt of a measurement trigger, events are counted until an HA (halt) command is received or until the channel mode is set to Event Count Increment. In the latter case, the counter is cleared prior to starting the incremental count. If a CL (clear) command is received at any time, the event counter is reset to zero. A new count is started on receipt of the next measurement trigger. The event counter of a particular channel is also cleared when that channel is set again to the totalise mode.

The maximum number of events that can be recorded per channel by the event-counting circuitry is 16,777,215, after which the rolls over to zero. No indication of this is given.

Table 1.6: Mode Codes for IMP type 2A (Switch IMP)

Code, *m*	Mode Set	Comments
000	Skip	
700	Digital status	
	Event capture:	
760	-ve going edge.	Enabled by EV command only.
761	+ve going edge.	
762	+ve or -ve going edge	
800	Switch output off (high)	For digital output, sets channel to logic ‘1’ or ‘0’.
801	Switch output on (low)	

Note: -ve edge refers to a negative-going edge, a transition from high to low.
+ve edge refers to a positive-going edge, a transition from low to high.

Channels 29 to 32 are digital input/output channels. Digital outputs are set when the IMP devices receive the relevant CH MO command. For more details on each individual mode, refer to the IMP Installation Guide.

Table 1.7: Mode Codes for IMP type 1H and 1J

Code, *m*	Mode Set	Comments
000	Skip	
100	Volts, dc, auto-ranging.	
101	Volts, dc, 20mV range.	
102	Volts, dc, 200mV range.	
103	Volts, dc, 2V range.	
104	Volts, dc, 10V range.	
200	800/80μA drive, auto-ranging.	Three-wire resistance ranges. ☞
201	800μA drive, 25Ω range.	
202	800μA drive, 250Ω range.	
203	800μA drive, 2k5Ω range.	
204	80μA drive, 25kΩ range.	
210	800/80μA drive, auto-ranging.	Two-wire resistance ranges. ☞
211	Not Used	
212	Not Used	
213	800μA drive, 1k5Ω range.	
214	80μA drive, 25kΩ range.	
220	800/80μA drive, auto-ranging.	Two-wire resistance ranges.
221	Not Used	
222	Not Used	
223	800μA drive, 500Ω range.	
224	80μA drive, 25kΩ range.	
310 – 314	Thermocouple, type E.	Same modes as for 1A, 1C and 1E.
320 – 324	Thermocouple, type J.	
330 – 334	Thermocouple, type K.	The third digit sets the range:
340 – 344	Thermocouple, type R.	0 = auto-ranging,
350 – 354	Thermocouple, type S.	4 = least sensitive range (10V).
360 – 364	Thermocouple, type T.	
370 – 374	Thermocouple, type B.	
380 – 384	Thermocouple, type N.	
390 – 394	Thermocouple, User TC 1.	User defined linearisation. (See UT description in
3A0 – 3A4	Thermocouple, User TC 2.	Section 1.3.7, page 1-45)
400	800μA drive, auto-ranging *.	Four-wire, 100Ω, RTD/PRT ranges. ☞
401	800μA drive, -200°C to -180°C	
402	800μA drive, -200°C to +400°C	
403	800μA drive, -200°C to +600°C	
410	800μA drive, auto-ranging *.	Three-wire, 100Ω, RTD/PRT ranges. ☞
411	*Do not use*	*(One useful range.)*
412	*Do not use*	
413	800μA drive, -200°C to +600°C	* Auto-ranges to code 413
420	800μA drive, auto-ranging *.	Four-wire, 100Ω, RTD/PRT ranges. ☞
421	800μA drive, -200°C to -180°C	*(One useful range.)*
422	*Do not use*	
423	*Do not use*	* Auto-ranges to code 421
430	800μA drive, auto-ranging *.	Three-wire, 100Ω, RTD/PRT ranges. ☞
431	*Do not use*	*(One useful range.)*
432	*Do not use*	
433	800μA drive, -200°C to +150°C	* Auto-ranges to code 433

☞ Three-wire and four-wire resistance and temperature measurements use a pair of channels (connected as shown in Chapter 12 of the 3595 Series IMP Installation Guide). The channel mode is configured for the odd numbered channel (e.g. channel 1). Any configuration set-up for the companion even numbered channel (e.g. channel 2) is ignored, but, for good practice, it is recommended that this channel is configured for 'skip' (code 000)

Code, *m*	Mode Set	Comments
500	Current, dc, auto-ranging.	Channels used for current measurements require the fitting of a 100Ω shunt. (See IMP Installation Guide.)
501	Current, dc, 200µA.	
502	Current, dc, 2mA.	
503	Current, dc, 20mA.	
504	Current, dc, 1mA.	(Same modes as for 1A, 1C and 1E)
700	TTL logic levels.	Digital status inputs
701	12V (3V/9V) logic levels.	(Codes 701 and 702 apply only to channels 1 through 18.
702	Two-wire, 25kΩ measurement.	1 = high (V or Ω) measured. 0 = low (V or Ω) measured. (For channel 19 and 20, the only logical level mode applicable is mode 700. Selection of the TTL or 12V logic levels is made by split pads in the connector block)
710	Reserved for internal use.	
720	Reserved for internal use.	
740	-ve going edge	Event count totalise.
741	+ve going edge	A continuous count of events is kept, reset only by the CL command.
742	+ve or -ve going edge	(Same modes as for 2A)
750	-ve going edge	Event count increment.
751	+ve going edge	A continuous count of events is kept since the last trigger.
752	+ve or -ve going edge	(Same modes as for 2A)
800	Switch output off (high)	For digital output, set channel to logic '1' or '0;
801	Switch output on (low)	Similar modes to 2A, except: (a) Status of channel can be read back. (b) Outputs default to Off on power-up.
900	Gate time = 10ms.	Frequency Measurement.
901	Gate time = 100ms.	
902	Gate time = 1s.	
903	Gate time = 10s.	
910	1 period	Multiple period measurement
911	10 periods.	Returns the time for one period, in seconds.
912	100 periods.	(Same modes as for 2A)
913	1000 periods.	

For status measurements in channels 1 through 18, the logic levels applicable are:

Mode 700 (TTL)	*m* < 0.8V	= '0';	*m* > 2.4V	= '1'
Mode 701 (3V/9V)	*m* < 3V	= '0';	*m* > 9V	= '1'
Mode 702 (25kΩ)	*m* < 100Ω)	= '0';	*m* > 1kΩ	= '1'

In each of the above modes, the last value measured is maintained during the intermediate region (for example, in Mode 700, where 0.8V < *m* < 2.4V).

For frequency and period measurements on channels 19 and 20 (modes 900 – 903 and 910 – 913), the following conditions apply:

- **For continuous scans**, a 3595 1H and 1J type IMP does not wait for a measurement to complete, but returns the error code 0xFF8D (*measurement pending*) for all scans until a result is available. When the measurement is complete, the result is returned in the next scan.
- **For a single scan**, the results are not returned until the measurement is complete.

EXAMPLE:

1. Assume that the measured input is a 20Hz (nom.) square wave, and that mode 902 has been selected. This means that the frequency of the square wave is to be measured for 1 second (the ‘gate’ time).

   For continuous scanning, with a scan period of 100ms, error code 0xFF8D is returned in place of each of the first nine results. On the tenth scan, a valid measurement result (≈20Hz) is returned. This sequence is repeated whilst continuous scanning is in operation.

   For a single scan, the result (≈20Hz) is returned on completion of the one-second (1s) ‘gate’ time.

2. Assume that the measured input is a 200Hz (nom.) square wave and that mode 901 has been selected. This means that the frequency of the square wave is to be measured for 100ms.

   For continuous scanning, with a scan period of 100ms, a valid measurement result (≈200Hz) is returned for each scan.

   For continuous scanning, with a scan period of 1s, a valid measurement result of the same accuracy is returned every second.

   For a single scan, the result (≈200Hz) is returned on completion of the 100ms ‘gate’ time.

CO (**CO**ntinuous measurement)

CO

Note: This command does not apply to a type 1D IMP.

Function: Instructs an **AR**med IMP, upon receiving a **TR**igger, to continuously scan all channels and return data.

An IMP can hold the measurement results of two complete scans in a pair of output buffers. When continuous measurement starts, the IMP puts the result of the first scan in the first buffer and then puts the results of the second scan in the second buffer. If the scan period is set to 0ms (default value) and the PC is able to read the results of the first scan by the time the second scan is complete, the results are placed in the first buffer. This sequence continues and allows the IMP to continuously scan inputs, without waiting for scan data to be read by the PC. If the scan period is defined, the start points of successive scans are separated by this period. Also, if the PC is unable to read the scan data as fast as the IMP provides it, the IMP 'hangs' whilst to PC catches up.

Note that Universal IMP type 1H and 1J do not 'hang' in the historical mode, but continues scanning even when the output buffer is full. This is to allow the alarm inputs to continue to be monitored. Until the PC reads the data from the buffer, the data presently stored is not overwritten and the most recent results are discarded.

For more information in buffering, refer to part 1 of this manual.

Response: As **TR**igger, subsequent scans are loaded into the IMP output buffer as previous scans are accepted by the PC.

See also: TR, AR, SP and RM

DI (**DI**sarm)

DI

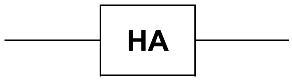
Note: This command does not apply to type 1D IMP devices.

Function: Cancels the **AR**m command.

Response: None.

See also: AR

HA (**HA**lt)



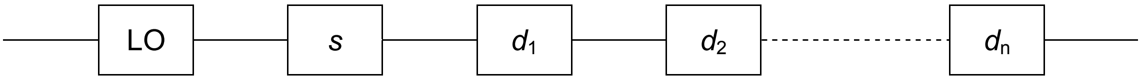
Note: This command does not apply to type 1D IMP devices.

Function: Cancels the continuous measurement mode. If an IMP is making measurements when the **HA** command is received, it completes the scan and sends the results to the PC before halting. If no measurements are made, the IMP halts immediately.

The HA command does not alter the scan period (set with the SP command).

Response: Stream 3. Single character 'H' confirms that measurement has stopped.

LO (**LO**ad set-up data to IMP)



Where:

s is the database:

- 1, 2 or 3 for IMP types 1A, 1B, 1C, 1E, 2A and 2B, and
- 1, 2, 3, …, 7 for the Universal IMP (UIMP) types 1H and 1J.

d_1, $d_{2, \ldots,}$ d_n are n data bytes where n is dependent on the IMP type and on the database.

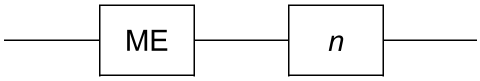
Note: This command does not apply to type 1D IMP devices.

Function: Loads previously **SA**ved set-up information into the database of the IMP. This allows the same channel configurations and values to be used after an IMP is powered-down.

Response: None.

See also: SA, (and for 1H and 1J IMP types) SA and RD

ME (**ME**asure a channel)



Where: *n* is an integer which defines the channel number:

- in the range 1 ≤ *n* ≤ 20 for IMP types 1A, 1C, 1H, 1J and 2A, or
- in the range 1 ≤ *n* ≤ 10 for IMP types 1D or 2B

Note: This command does not apply to type 1D IMP devices.

Function: Instructions an IMP to take a single measurement on a specified channel. On IMP types other than the 1H and 1J, the channels set for event capture, skip, or digital output are not affected by this command, but returns the error message 'not measured' instead. However, the digital channels (19 and 20) on the 1J and 1H IMP types, when set for digital output, respond to a **ME** command by returning the present status.

MEasure starts the counting on a single channel set to 'event count increment' or 'event count totalise', provided that counting has not already started. An initial result of zero is then returned. If counting has already started, the result returned is the number of events the IMP has recorded in that channel so far. **ME**asure does not reset any counters.

Response: Stream 1, one 4-byte result.

See also: RM (for the 1H and 1J IMP types)

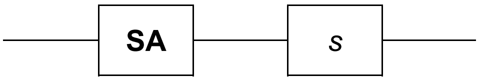
RE (**RE**set)

Function: Sets all IMP settings to their default values – this *normally* assumed on first power-up:

- **CO**ntinuous 'off'.
- Not armed.
- Defined scan period set to 0ms.
- **KA**libration 'on'.
- **DR**ift correct 'on'.
- External temperature 'on'.
- **AM**bient temperature reference 'on'.
- All channels to 'skip'.
- Time-out 2 seconds.
- Temperatures returned in °C.
- Integration time set to 20ma (FR0).
- Voltage and current outputs set to default values (see installation guide).
- Sets scan to be sent over stream 0.
- Sets digital sample rate to default.
- Event counters cleared.
- User conversions cleared and disabled.
- Both user thermocouples cleared.
- Both user post linearisations cleared.
- All channel alarm conditions cleared and disabled.

Response: None

SA (**SA**ve set-up)



Where: *s* is the database:

- 1, 2 or 3 for IMP types 1A, 1B, 1C, 1E, 2A and 2B, and
- 1, 2, 3, …, 7 for the Universal IMP (UIMP) types 1H and 1J.

Note: This command does not apply to type 1D IMP devices.

Function: On IMP types other than the 1H and 1J, the set-up data (mode, strain gauge data, etc.) is stored in one of three databases in the IMP.

Database **1** contains the set-up data selected by the **AR**, **CO**, **UN**, **DR**, **KA**, **AM**, **FR**, and **TE** commands. Database **2** contains the set-up data for individual channels mode, strain gauge values, etc. Database **3** contains the scan period defined by the **SP** command.
(Note that when the scan period is loaded by the **IO** command, with the IMP in continuous scanning mode, the new scan period takes effect from the beginning of the next scan.)

On the 1H and 1J Universal IMP, the set-up data is stored in seven databases. This is described in Appendix A of Part 2.

SA instructs the IMP to transmit this data to the PC. The complete output buffer capability of the IMP is needed to transmit this data. Therefore, the user must ensure that no data is waiting (for transmission) at the IMP. In addition, if two **SA** commands are sent in quick succession, the IMP may ignore the second one due to shortage of buffer space. This problem can be overcome by putting another command, for example STATUS, between the two **SA** commands.

If the IMP is powered-down, it loses the contents of the databases. The **LO**ad command, in conjunction with previously **SA**ved data, allows set-up data to be quickly reloaded into an IMP database.

The general procedure for storing and loading an IMP database is:

1. Stop all measurements in progress by the IMP
2. Read all data available
3. Send a **SA** command
4. Store the next stream 0 response from the IMP
5. Repeat steps 3 and 4 for each database to be saved
6. Power-down and, if required, disconnect the IMP
7. Power-up and, if required, reconnect the IMP
8. Send the following string to the IMP: ‘LO*n*’ + bytes originally returned by **SA***n* command
9. Repeat step 8 for each database to be loaded into the IMP.

Response: Stream 0, *n* bytes of data.

See also: **SD** and **RD**.

Table 1.8: Database bytes (1A, 1B, 1C, 1E, 2A and 2B IMP types)

IMP Type	No. of bytes in Database 1	No. of bytes in Database 2	No. of bytes in Database 3
1A, 1C & 1E (Thermocouple)	11	63	80
1B (Strain)	6	163	80
2A (Digital)	2	100	80
2B (Switch)	2	97	80

Table 1.9: Database bytes (1H and 1J IMP types)

IMP Type	Number of bytes in Database D*n*						
	D1	D2	D3	D4	D5	D6	D7
1H and 1J (Universal)	12	86	165	146	182	180	180

SE (**SE**t-up to test condition and arm)

Note: This command does not apply to type 1D IMP devices.

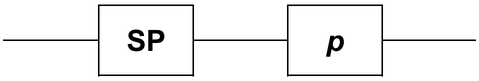
Function: Quick set-up of most IMP devices in the system, for test purposes:

- All analogue input channels are set to ‘volts DC auto-ranging’.
- All digital channels are set to ‘digital status’.
- The IMP is armed.

When all channels are set-up in this way, unused channels should be shorted-out at the connector block,

Response: None.

SP (Scan Period)



Where: *p* is a 4-byte floating-point number that defines the scan period in the range 0ms through 16777215ms.

Note: This command does not apply to type 1D IMP devices.

Function: The **SP** command defines the period between start points of successive scans in the continuous measurement mode and this allows scan data to be sent to the PC at a defined rate.

Defined scan periods are intended for an IMP in the fast scanning mode. (See entry for the **FR** command.) For example, a 3595 1A IMP could be set to make a fast scan of 20 thermocouples every second, the duration of each scan being 300ms (FR2):

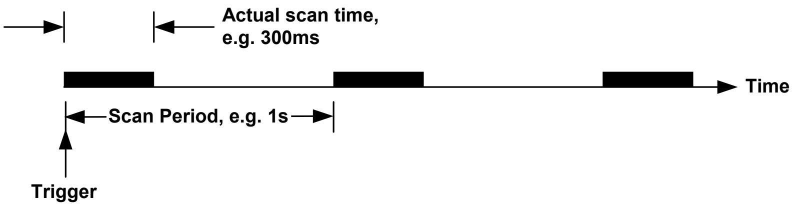


Figure 1.1: Scan Period Command

Defining the scan period gives two advantages: (a) it provides a manageable amount of useful data for the PC, and (b) the data becomes 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 rate possible. With this, however, the intervals at which data becomes available are unpredictable and, if the PC is unable to cope with the large amount of data produced, the system may hang. To make scanned data more manageable and predictable, the scan period defined by the SP command should also allow the PC enough time to process each block of scan data as it occurs. For a guide, the average scan times for the various types of IMP and their measurement modes are listed in Table 1.10.

The scan period may be re-defined at any time. If a defined scan period is in operation, the new period effectively merges with the old one. (See **note** on exception to this.) For example, consider a scan with a defined period of 5 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, 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 the inherent measurement rate. If the defined scan period is less than the actual scan time, 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 analogue type IMP has its' internal calendar clock synchronised to the time in the 4C Interface card. Synchronisation occurs every second. (Due to the uncertainty of the clock in the PC/4C Interface card, a small number of scans may be lost or gained over a 24-hour period. This number is ≤ 2500÷*scan period*, where the scan period is in milliseconds.)

Table 1.10: Average scan times for Fast Integration IMP devices

IMP Type	Measurement mode	Average * Scan Time (ms)			
		FR2	FR3	FR4	FR5
3595 1A	Voltage	189	159	81	71
3595 1B	Voltage	176	155	95	84
3595 1C/1E	Voltage	225	196	112	111
3595 1A	Thermocouple	300	292	270	269
3595 1C/1E	Thermocouple	337	328	311	309
3595 1A	Thermocouple with OCTD	403	385	338	335
3595 1C/1E	Thermocouple with OCTD	474	454	408	408
3595 1B	Strain	360	328	238	221
3595 1B	Resistance	284	254	168	151
3595 1B	Temperature (PRT)	355	322	234	121

Notes on Autoscan Firmware

1. IMP types not fitted with Autoscan firmware will ignore the **SP** command.

2. IMP types that have the Autoscan firmware are:

3595 1A/3595 51A	Mod. Strikes C13/A9
3595 1B/3595 51B	Mod. Strikes C17/10
3595 1C/3595 51C	Mod. Strikes C16/A9
3595 2A/3595 52A	Mod. Strikes B12/A10
3595 1E/3595 51E	Mod. Strikes A1
3595 2B/3595 52B	Mod. Strikes A1
3595 1H	Mod. Strikes A1
3595 1J	Mod. Strikes A1

3. IMP devices that may be fitted retrospectively with the Autoscan firmware are:

35952A	Mod. Strike B11, Issue X
359552A	Mod. Strike A9. Issue X

4. All IMP interfaces must be fitted with the correct issue of firmware – that is, firmware to issue AE. To get the firmware updated for types 3595 4A, 6A or 8A, contact Solartron Mobrey. The type 4B and types 9A/9B/9D will always have the correct issue of firmware fitted.

Example: An example of a command string, in IMPVIEW, using the SP command is:

AR;SP’100’;CO;TR

Where: AR arms the IMP,
SP’100’ sets a scan period of 100ms,
CO enables the continuous mod, and
TR triggers the IMP

This command string instructs the IMP to scan all channels of the IMP, continuously every 100ms.

SCAN SYNCHRONISATION OF THE 1H AND 1J IMP types

To make it possible for scans to be synchronised, the 1H and 1J IMP types are able to delay the start of a scan from the trigger. This is so that, in each IMP, the scan begins at a pre-defined subdivision boundary of a second, minute or hour. Each IMP clock is synchronised to that of the PC. Therefore, all scans will start at the same point in time. The time subdivision used for scan synchronisation equals the scan period, where this is an integral sub-multiple of 100ms (1s), 60000ms (1m) or 3600000 (1h).

The algorithm that each 1H and 1J IMP uses for scan synchronisation operates as shown in Figure 1.2.

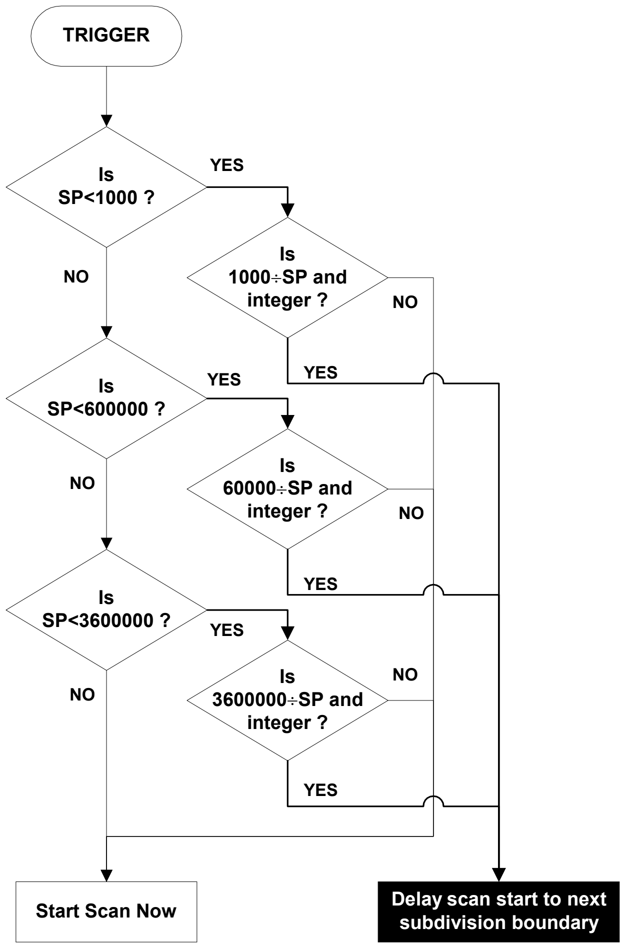


Figure 1.2: Scan synchronisation of 1H and 1J IMP types

Example: The command SP '250' is given, which specifies a scan every 250ms.

1000÷250 = 4 (remainder 0). Therefore, depending on the time at which the trigger occurs, the scan is delayed until 0ms, 250ms, 500ms or 750ms past the second:

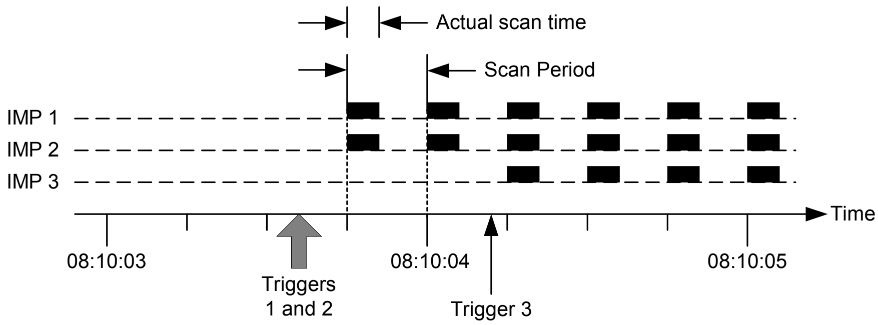


Figure 1.3: SP '250' Command Example

A scan starts within 50ms (worst case) of the required time.

Only the first scan is aligned. Thereafter, scans are started at the beginning of each scan period - unless the system runs out of output buffers, in which case scan alignment will be lost.

ST (STatus)

ST

Function: Instructs the IMP to respond with information on type of IMP, connector block, and firmware fitted.

Response: Stream 3, 12 characters:

x	***x***	***b***	***c***		***r***	***f***		***n***	***n***	***y***	***z***

Where:

xx IMP code; indicates IMP type (See Table 1.11)

b Connector block code; indicates connector block type. (See Table 1.12)

c Bit function depends on the type of IMP. For the 35951D Analogue Output IMP, *c* indicates the minimum output current, ‘0’ for 0A or ‘4’ for 4mA. For all other IMP types, *c* is set to ‘A’ if the IMP is capable of responding to a **SP** command.

r binary counter of the number of communication retries.

f If *f* = F, the IMP is capable of responding to an **FR**0 or **FR**1 command.

nnyz The software number, status and issue. The software numbers are related to the IMP type and are listed in Table 1.11.

Example: A response of 1CDA—F-03FB indicates a ‘3595 1G reed relay thermocouple’ IMP with a ‘3595 3D attenuator’ connector block and firmware version 03FB. The IMP can respond both to the **SP** command and to the **FR** command.

Table 1.11: IMP Codes

IMP Code (xx)	Software No. (nn)	IMP Type	Software IMP Part Number
1A	01	Solid State (thermocouple).	3595 1A
1B	02	Strain Gauge.	3595 1B
1C	03	Reed Relay (thermocouple).	3595 1C
1D	11	Analog Output.	3595 1D
1E	25	500V Reed Relay (thermocouple).	3595 1E
1H	30	Universal IMP (200V ch-ch isol.).	3595 1H
1J	30	Universal IMP (500V ch-ch isol.).	3595 1J
2A	04	Digital.	3595 2A
2B	18	Switch.	3595 2B

Table 1.12: Connector block codes

Connect Block Code (*b*)	Connector Block Type	Connector Block P/N	
		Standard Block	Glanded Block
A	Thermocouple	3595 3A	3596 3A
B	Strain Gauge.	3595 3B	3596 3B
C	Digital.	3595 3C	3596 3C
D	Reed Relay Attenuator.	3595 3D	-
E	Analogue Output.	3595 3E	-
F	Switch.	3595 3F	-
J	Universal.	3595 3J	-
W	Universal Calibration.	3595 3W	-
Y	Analogue Output Calibration.	3595 3Y	-
Z	Calibration.	3595 3Z	-
?	Unknown.	-	-

TR (TRigger scan)

TR

Notes: This command does not apply to type 1D IMP devices.

If trigger 'broadcasting' is to be used, please read the relevant sub-section in Chapter A of the 3595 4A, 3595 4B, or 3595 9A/9B/9D Operating Manual, before implementation.

Function: Instructs an ARmed IMP to make a measurement scan. An IMP must already be ARmed to respond. If CO has already been transmitted, continuous scanning will be started by the TR command.

On IMP types other than the 1H and 1J, the channels set for event capture, skip, or digital output, are not affected by this command, but return 'not measured' instead. However, the digital channels (19 and 20) on the 1H and 1J IMP types, when set for digital output, respond to an ME command by returning the present status.

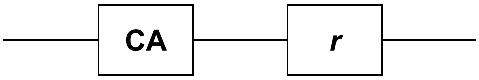
TRigger will start counting on all channels set to 'event count increment' or 'event count totalise', provided counting has not already started. If counting has already started, TRigger will return to number of events recorded so far; additionally, channels set to 'event count increment' will begin counting from zero.

Response: Stream 0. Each IMP transmits a 4-byte result for each of its' channels. If the status-data-format command instructs the Switch type IMP for compressed data, this data will appear over stream 3 as a 9-byte quantity.

See also: AR, EV, SF and (for 1H and 1J IMP types) RM.

1.3.2 Commands for analogue measurements only

CA (CAlibrate)



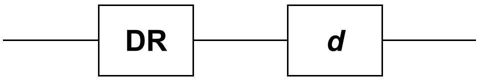
Where: *r* is an integer (1 ≤ *r* ≤ 8) which defines the analogue input range to be calibrated.

Note: This command does not apply to 1D, 2A or 2B IMP types.

Function: Allows calibration of a specified measurement range on an IMP. Calibration should normally be left to Solartron Mobrey or to those users with specialist reference equipment.

Equipment and Procedure: These are detailed in the operating manual entitled 'Calibration of the 3595 Series Analog IMPs' (P/N: 35952233).

DR (DRift correct)



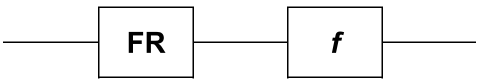
Where: *d* = 0, continuous update (default setting)
d = 1, fixes drift correct value to existing setting
d = 2, sets drift correct value to a nominal test value

Note: This command does not apply to 1D, 2A or 2B IMP types.

Function: This command is intended for diagnostic and test purposes only. An analogue 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.

Response: None.

FR (Set integration time)



Where:

f = 0	20.00ms	integration time for 50Hz (or 400Hz supply areas).
f = 1	16.67ms	integration time for 60Hz supply areas.
f = 2	5.00ms	integration time for 400Hz supply areas.
f = 3	4.17ms	integration time.
f = 4	1.25ms	integration time.
f = 5	1.04ms	integration time.

Note: This command does not apply to 1D, 2A or 2B IMP types. Furthermore, IMP types 1A and 1C must have software status 'E' onwards and IMP type 1B must have software status 'C' onwards to be able to comply with the commands FR2, FR3, FR4 and FR5.

Function: Sets the integration time of all analogue measurements. It provides for optimum rejection of 50Hz, 60Hz or 400Hz supply frequencies. Also allows a shorter integration time to be selected for increased scan rates, at the expense of reduced interference rejection. (Note: A 'scan' refers to the series of measurements made on all IMP channels and obtained on data stream 0.) Typical scan rates (scans per second) obtained with shorter integration times are show in Table 1.13.

The scan rates shown in Table 1.13 are for individual IMP devices on a fixed voltage range. (See SP command for further information.) Mixing fast and slow IMP devices in a large system may result in the fast IMP being slowed down.

xxxxxx shows the effect on the overall scan rate of increasing the number of fast IMP devices (types 1A and 1B) in a five-IMP system. With a small system, such as this, the fast IMP devices are not slowed down by the slow IMP devices. Actual throughputs are also dependent on the PC and the application software.
xxxxxx shows the effect on the overall scan rate of increasing the number of fast IMP devices (types 1A and 1B) in a five-IMP system. With a small system, such as this, the fast IMP devices are not slowed down by the slow IMP devices. Actual throughputs are also dependent on the PC and the application software.

Response: Error FF87 'Unknown mode, type or range' is returned instead of a measurement value when an unsupported integration time is requested.

See also: SP

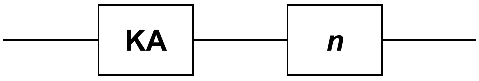
Table 1.13: Scan rates V integration times for totally fast IMP system

Integration Time	Scans per second		
	3595 1A	3595 1B	3595 1C
20ms (FR0)	1.56	2.01	1.48
16.67ms (FR1)	1.88	2.38	1.78
5.00ms (FR2)	5.41	5.85	4.48
4.17ms (FR3)	6.45	6.63	5.16
1.25ms (FR4)	12.95	11.33	9.10
1.04ms (FR5)	14.83	12.50	9.38

Table 1.14: Scan rate (scan/sec) v no. of fast five-IMP system

No. of Fast IMPs (FR2)	No. of Fast IMPs (FR4)	Combined Scan Rate of Fast IMPs	No. of Slow IMPs (FR0)	Combined Scan Rate of Slow IMPs	Overall Scan Rate
1	-	5	4	4	5+4=9
2	-	10	3	3	10+3 = 13
3	-	15	2	2	15+2=17
4	-	20	1	1	20+1=21
5	-	25	0	0	25+0=25
-	1	10	4	4	10+4=14
-	2	20	3	3	20+3=23
-	3	30	2	2	30+2=32
-	4	40	1	1	40+1=41
-	5	50	0	0	50+0=50

KA (calibration off)



Note: This command does not apply to the digital IMP (types 2A and 2B).

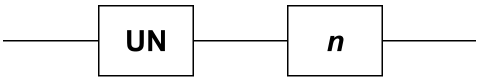
Function: With calibration 'on', measurements are corrected with the offset and scale factors kept in EEPROM. These factors are determined during factory calibration, or changed by the calibrate command (CA, CH CV or CH CI), and suit the individual IMP. This function defaults to 'on'.

With calibration 'off', the correction factors used assume perfect components. This provides the user with a reference or a means to operate with a missing, corrupted, or non-programmed non-volatile memory.

Response: None.

See also: CA, CH CV and CH CI

UN (UNits of temperature)



Note: This command does not apply to IMP types 1D, 2A and 2B.

Function: Decides the units of temperature used for:

1. Temperature measurement results (thermocouple and RTD).
2. Setting the external reference temperature with the TR command.

The IMP default is °C (on power-up).

Response: None.

1.3.3 Commands for thermocouple measurements

AM (AMbient temperature reference)

Note: This command applies only to IMP types 1A, 1C, 1E, 1H and 1J.

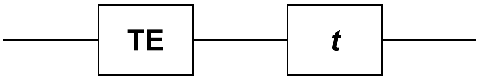
Function: Instructs the IMP to use the ambient temperature as a reference for those channels set for thermocouple measurement. The ambient temperature is sensed by a thermistor in the IMP connector block. This is the default (power-up) condition.

To set an external temperature reference, use the **TE** command.

Response: None.

See also: TE

TE (set external temperature reference)



Where: *t* is the external reference junction temperature, defined by an IEEE 754 floating-point number in the range:

-30°C/-22°F ≤ t ≤ 80°C/177°F

Note: This command applies only to IMP types 1A, 1C, 1E, 1H and 1J.

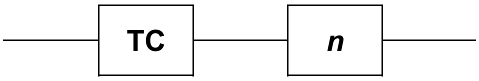
Function: Sets the value of the external temperature reference into the IMP. For use only when an external reference [1] junction is to be used. The units used for temperature results and references are set by the **UN** command.

Response: None.

See also: **AM** and **UN**

[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.

TC (set **T**hermocouple **C**hecking for open circuit)



Where: *n* = 0, thermocouple checking off
n = 1, thermocouple checking on

Note: This command applies only to IMP types 1A, 1C, 1E, 1H and 1J.

Function: With checking enabled, a second measurement follows the thermocouple measurement; this is to confirm thermocouple integrity. Note that this may slow down the data acquisition rate to less than 1 per second. When an open circuit is detected, the measurement result is replaced with the error code. (See Chapter 2.)

Response: None.

1.3.4 COMMANDS FOR STRAIN GAUGE MEASUREMENTS

CH GA (set CHannel GAuge factor)

— CH — *n* — GA — *g* —

Where: *n* is an integer that defines the channel number, in the range 1 ≤ *n* ≤ 10
g is an IEEE 754 floating-point number defining the strain gauge factor

Note: This command applies only to IMP type 1B with strain gauge(s).

Function: Loads the IMP database with the gauge factor required for a specified channel. A strain gauge channel can't perform measurements until it has been **IN**itialised and the gauge factor sent to the IMP.

Response: None.

See also: **IN**, **CH OF**, **LO** and **SA**

CH OF (set CHannel OFfset and initial voltage)

— CH — *n* — OF — *o* — *p* —

Where: n is an integer that defines the channel number, in the range 1 ≤ *n* ≤ 10
o is an IEEE 754 floating-point number defining the offset in volts
p is an IEEE 754 floating-point number defining the initial gauge voltage

Note: This command applies only to IMP type 1B with strain gauge(s).

Function: Sets the strain gauge offset and initial voltage values used by an IMP to calculate strain results. These values will have been returned by the **IN**itialise command and should be stored in the PC. After an IMP has been powered-down, this command can be used to set up a strain gauge channel to the original condition set by the previous **IN** command.

This must be used in conjunction with the **CH GA** command before the strain gauge can return data.

Response: None.

IN (INitialise strain gauge parameters)

— **IN** — ***n*** —

Where: *n* is an integer that defines the channel number, in the range 1 ≤ *n* ≤ 10

Note: This command applies only to IMP type 1B with strain gauge(s).

Function: Before a strain gauge channel can be used, the IMP must first know the initial voltage of a gauge connected to a specified channel, to store this, and also transmit this data to the PC. The IMP must then be informed of the gauge factor using the CH GA command. The IMP uses these parameters to calculate strain results and unless the IMP holds these parameters, it will return the error ‘strain gauge not initialised’ when commanded to measure.

The PC should be programmed to store the strain gauge data as a string and later (if necessary) send it back to the IMP using the **LO** or **CH OF** commands. This allows a re-start after the IMP has been powered down.

Response: Stream 1, 8 bytes

o	*o*	*o*	*o*	*r*	*r*	*r*	*r*

oooo = out-of-balance voltage, represented by 4 bytes.
r r r r = initial gauge voltage, represented by 4 bytes.

See also: **CH GA**, **CH OF**, **SA** and **LO**

1.3.5 COMMANDS FOR DIGITAL MEASUREMENTS ONLY

CH RA (set CHannel sample RAte)

CH — *n* — RA — *d*

Where: *n* is an integer that defines the channel number, in the range $1 \le n \le 20$
d is an integer that defines the sample rate, in the range $1 \le d \le 4$

Note: This command applies only to IMP types 1H, 1J and 2A. In the case of the 1H and 1J IMP types, the command applies only to channels 19 and 20.

Function: Sets the sample rate for the specified channel. The sample rates selectable are listed in Table 1.15. On power-up, the IMP selects the default sample rate. This rate is suited to mode of operation, as shown in Table 1.16.

At the sample rates of 20Hz and 1kHz, a level change is detected only if four consecutive samples are the sample value. This improves immunity against contact bounce and similar effects. Note, however, that the time recorded for event capture is four sample periods 'late' at the lower sample rates.

Response: None.

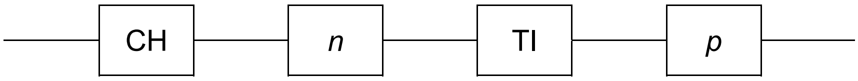
Table 1.15: Sample rate settings

Rate setting (d)	Sample rate selected
0	Default (as on power-up)
1	20Hz
2	1kHz
3	10kHz
4	100kHz

Table 1.16: Default sample rates

Mode	Default Sample Rate
Digital status	20Hz
Event counting	1Hz
Event capture	1kHz
Frequency	100kHz
Period	100kHz
One-shot time	100kHz

CH TI (set CHannel TIme-out)



Where: *n* is an integer that defines the channel number, in the range 1 ≤ *n* ≤ 20
p is an integer that defines the time-out code, in the range 0 ≤ *p* ≤ 5

Note: This command applies only to IMP types 1H, 1J and 2A.

Function: For a specific channel, sets the time-out period for period measurements. The settings available are listed in Table 1.17. The default period is 2 seconds (p = 1)

The time-out period is the maximum time any period or 'one-shot' measurement is allowed to take. If the period to be measured exceeds this time, the error 'period time-out' is returned instead of a result. For single period measurement of cyclic signals, the time-out period must be at least twice that of the measured signal. This ensures both edges of the signal are within the time-out period.

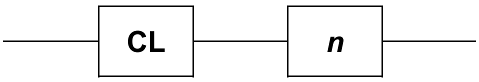
Response: None

Table 1.17: Time-out periods

Time-out Code	Time-out Period
0	200ms
1	2s
2	20s
3	50s
4	70s*
5	130s*

* Available on 1H and 1J IMP types only.

CL (CLear event totalis counter)



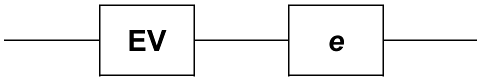
Where: *n* is an integer that defines the channel number, in the range 1 ≤ *n* ≤ 20

Note: This command applies only to the digital IMP (type 2A) and the Universal IMP (types 1H and 1J).

Function: Instructs the IMP to clear its' event totalise counter and to inhibit counting until the next **ME** or **TR** command, for a specified channel only. The event totalise counter keeps a continuously updated record of the number of events that have occurred since an initial **ME** or **TR** command. It can only be cleared by a power-down or the **CL** command. Maximum count value = 16,777,215.

Response: None.

EV (enable EVent capture)



Where: e = 0, stop event capture
e = 1, enable event capture

Note: This command applies only to the digital IMP (types 2A and 2B).

Function: Enables event capture on any channels in the IMP already set to ‘event capture mode’. Event capture can be enabled or stopped only by this command.

TRigger, **AR**m or **ME**easure commands have no effect on event capture.

Response: Event data is sent to stream 2. For a detailed explanation on event result formats, see Chapter 2.

See also: **CH MO** and **ES**

ES (Event Status)

Note: This command applies only to digital IMP (types 2A and 2B)

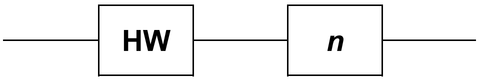
Function: This command checks the configuration for channels selected for event capture, and for each one, inserts an event status result with time tag into the event buffer. This command operates independently, whether events are enabled or not. If the event buffer is full, this command, in part or in full, is ignored. It will not affect the events lost count.

Note: Only a digital IMP with a product status marked B4 onwards and the Switch IMP are able to comply with this command.

Response: Event Status data is sent in stream 2. For a detailed explanation on event status formats, see Chapter 2.

See also: **CH MO** and **EV**

HW (Hardware Watchdog)



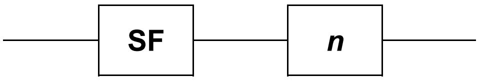
Where: *n* = 0, to disable the watchdog
n = 1, to enable the watchdog

Note: This command applies only to the Universal IMP (types 1H and 1J), and digital IMP type 2B.

Function: Enables or disables the hardware watchdog. Once the watchdog is enabled, the watchdog output channel (channel 20 for UIMP or 32 for digital IMP) goes from a ‘0’ state to a ‘1’ (no alarm) state. If a time-out period passes without the IMP being ‘patted’, the output is set to a ‘0’ (alarm) state. The IMP is reset into the power-up state. The watchdog can then be re-enabled by sending the **HW1** command. Disabling causes the output to go into the ‘0’ state. Once the watchdog is enabled, power-down forces the output into the ‘0’ (alarm) state. The **RE** command does not disable the watchdog.

Response: None.

SF (Status data Format)



Where: *n* = 0, for IEEE 754 floating-point format
n = 1, for binary compressed format

Note: This command applies only to the Switch IMP type 2B.

Functions: Command **SF** defines whether scan data is supplied as IEEE 754 floating-point numbers (128 bytes) in stream 0 or as a binary compressed quantity (9 bytes) in stream 3, for the single trigger or continuous mode of operation. The default value is for IEEE 754 floating-point format.

The binary format consists of:

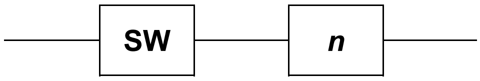
Byte 1 ASCII character ‘%’ (37 decimal)

Bytes 2-5 Binary inputs from channels 1 to 32, starting from bit 7 of byte 2 to bit 0 of byte 5 for channels.

Bytes 6-9 Control bytes (one bit per channel). A bit value of ‘0’ indicates that the channel is set to status input. A bit value of ‘1’ indicates the channel is ‘Not measured’ or ‘Unknown mode, type or range’.

Response: None.

SW (Software Watchdog)



Where: *n* = 0, to disable the software watchdog
n = 1 to 255, to set the software watchdog time-out (in seconds)

Note: This command applies only to the Universal IMP (types 1H and 1J), and digital IMP type 2B.

Function: Enables or disables the software watchdog. Once the watchdog is enabled, the watchdog output channel (channel 20 for UIMP or 32 for digital IMP) goes from a ‘0’ state to a ‘1’ (no alarm) state. The IMP then expects the ST command to be sent within every ‘n’ seconds. If a time-out period passes without a ST command being received, the output is set to a ‘0’ (alarm) state. (The IMP is not reset.) Disabling causes the output to go into the ‘0’ state. The **RE** command does not disable the watchdog.

Note: Enabling either watchdog causes the output to go into the ‘1’ (no alarm) state. For the output to be disabled from the watchdog, both the hardware and software watchdogs need to be disabled.

Response: None.

1.3.6 COMMANDS FOR ANALOGUE OUTPUTS

CH VO (CHannel Voltage Output)

CH — *n* — **VO** — *x*

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 4$
x is the output voltage in 4-byte floating-point format, in the range $-10 \leq x \leq +10$

Note: This command applies only to IMP type 1D.

Function: Sets the specified channel to the specified voltage.

Response: None.

See also: OS.

CH IO (CHannel Current)

CH — *n* — **IO** — *x*

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 4$
x is the output current (amps) in 4-byte floating-point format:

- in the range $0.000 \leq x \leq 0.02$, or
- in the range $0.004 \leq x \leq 0.02$, if the split pad on the converter block is made. (See the IMP Installation Guide)

Note: This command applies only to IMP type 1D.

Function: Sets the specified channel to the specified current in amps.

Response: None.

See also: OS.

CH CV (CHannel Calibrate Voltage)

CH — ***n*** — **CV** — ***x*** — ***y***

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 4$
x = the measured voltage value, corresponding to an non-calibrated 0V output
y = the measured voltage value, corresponding to an non-calibrated 10V output

Values *x* and *y* are both in volts, in floating-point format.

Note: This command applies only to an IMP type 1D with a '3595 3Y' connector block.

Function: Allows voltage calibration of a specific output channel. This should normally be left to Solartron Mobrey, or those users with specialist reference equipment.

Response: Stream 3, 4 characters **C*n*V*e***, where: *n* is the channel number and ***e*** represents the calibration response, as shown in Table 1.18.

Equipment: The calibration equipment required for IMP type 1D is:

a. An 'analogue output' connector block (P/N: 35953Y). This allows the IMP to recognise the calibrate commands

b. A stable temperature environment of 20°C±3°C. The IMP should be powered-up and allowed to stabilise at this temperature, ideally for 24 hours

c. An accurate multimeter to measure the output channels.

Procedure: The procedure for calibrating the output voltage of a type 1D IMP is:

1. Fit all cables to the '3595 3Y' connector block. PCB terminal connectors are as shown in Figure 1.4.

   a. The S-Net cable is connected to the 'COMMS IN' terminals. Strictly observer + to + and - to – polarity, and the S (screen) to S connections throughout the network.

   b. The multimeter is connected to the channel to be calibrated.

   Note: To avoid signal reflections, a terminator connector (P/N: 35900222) must be connected across the 'COMMS OUT' terminals of the last IMP in the system. (The terminator connector is supplied with the S-Net host interface package.)

2. Set the rotary address switches on the '3595 3Y' connector block PCB to a number between 01 and 50.

3. Insert the '3595 3Y' connector block into the IMP to be calibrated

4. Power-up the PC.

5. Turn the calibration mode off by sending the **KA1** command to the IMP.

6. Using the **CH VO** command, set the channel output voltage first to 0V and second to 10V, and in each case, measure the voltage actually output by the IMP.

7. Using the measurements obtained in Step 6, send the channel calibrate voltage command **CH*n*CV*xy***. In this command, *x* is the actual voltage measured when 0V was requested and *y* is the actual voltage measured when 10V was requested.

8. Check the calibration response in stream 3 (see Table 1.18 on page 1-42) to ensure that the IMP channel has been successfully calibrated.

Table 1.18: Calibration responses

e Code	Meaning
0	Calibration completed.
1	Invalid range. *
2	EEPROM fault: missing or not working.
3	'35953Y' calibration connector not fitted.

* e = 1 is caused either by an arithmetic error in calculating the calibration coefficients or by the same coefficients not allowing the full range of the channel to be utilised. Either an incorrect measurement was made or there is faulty circuitry in the IMP.

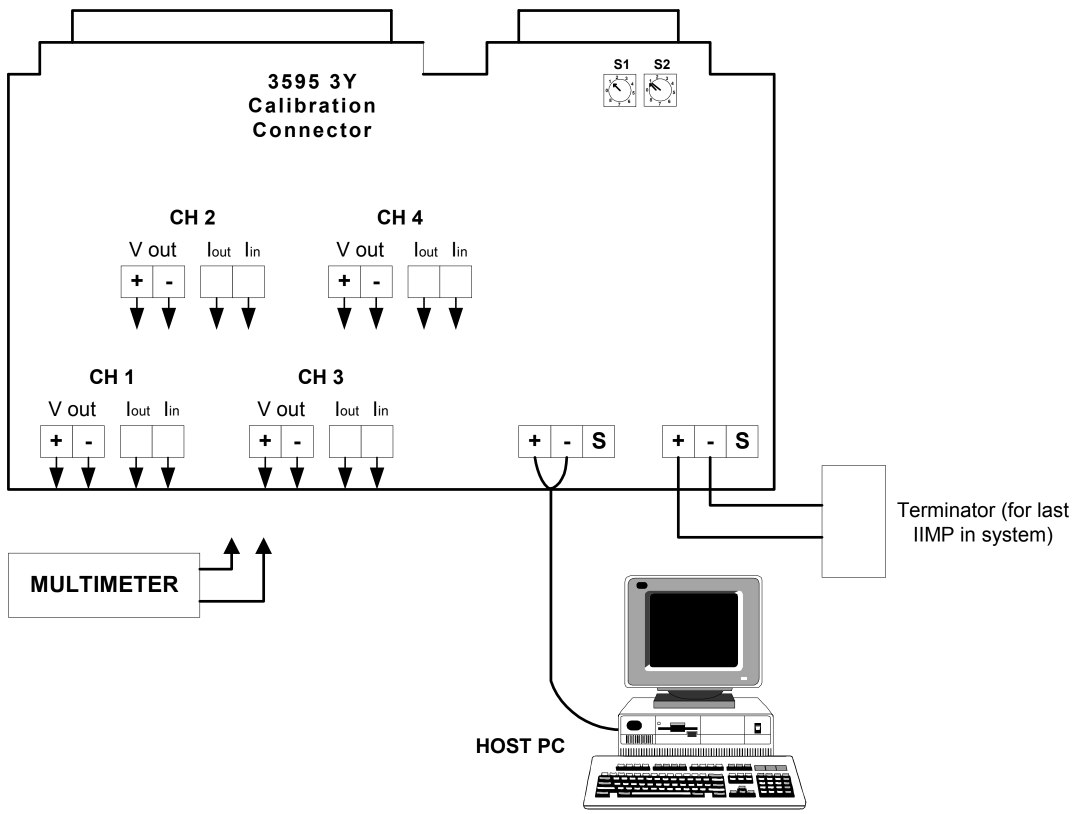


Figure 1.4: Connections to '3595 3Y' calibration block connector

CH CI (CHannel Calibrate current)

CH — *n* — **CI** — *x* — *y*

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 4$
x = the measured current value, corresponding to an non-calibrated 0.004A output
y = the measured current value, corresponding to an non-calibrated 0.02A output

Values *x* and *y* are both in amps, in floating-point format.

Note: This command applies only to an IMP type 1D with a '3595 3Y' connector block.

Function: Allows current calibration of a specific output channel. This should normally be left to Solartron Mobrey, or those users with specialist reference equipment.

Response: Stream 3, 4 characters **C*n*I*e***, where: *n* is the channel number and *e* represents the calibration response, as shown in Table 1.18.

Equipment: Same as for **CH CV** command.

Procedure: The procedure for calibrating the output current of a type 1D IMP is:

1 – 5 Same as for **CH CV** command.

6. Using the **CH VO** command, set the channel output current first to 0.004A and second to 0.02A, and in each case, measure the current actually output by the IMP.

7. Using the measurements obtained in Step 6, send the channel calibrate current command **CH*n*CI*xy***. In this command, *x* is the actual current measured when 0.004A was requested and *y* is the actual voltage measured when 0.02A was requested.

8. Check the calibration response in stream 3 (see Table 1.18 on page 1-42) to ensure that the IMP channel has been successfully calibrated.

OS (**O**utput **S**tatus)

OS

Note: This command applies only to IMP type 1D.

Function: This command returns the status of the analogue channels.

Response: Stream 3, 12 characters:

3	0			d_1	e	d_2	e	d_3	e	d_4	e

Where:

digits d_1 d_2 d_3 d_4 relate to channels 1, 2, 3 and 4; they are either 'V' or 'I', depending on whether the last command sent to that channel was **CH***n***VO***x* or **CH***n***CI***x*.

e represents the output status code as shown in Table 1.19.

For example, '30 V0V0I0I0' shows that channels 1 and 2 have been correctly set for 'voltage output' and channels 3 and 4 have been correctly set for 'current output'

Table 1.19: Analogue Output status codes

e Code	Meaning
0	OK (channel is correctly set)
1	Calibration mode 'on' but calibration data corrupt. (* and **)
2	Value requested is out of range. (**)

* EEPROM not fitted or IMP not yet calibrated.

** The last channel output command sent to that channel was not executed.

1.3.7 ADDITIONAL COMMANDS FOR 3595 IMP TYPES 1H AND 1J

Definition of terms:

Physical Channel
These are the twenty channels present on the IMP connector block, in the range of one through twenty.

User Unit Conversion
A simple first-order conversion of the measurement unit (resulting from CHannel MOde) to required unit.

User Linearisation
A fifth-order linearisation from the measurement unit (resulting from CHannel MOde) to required unit.

Real-time Mode
An IMP outputs data in this ‘standard’ mode. The messages are streamed and real-time results appear without a timestamp in Stream 0. For IMP types 1A, 1B, 1C, 1D, 1E, 2A and 2B, this is the only mode available. The same mode can also be selected for IMP types 1H and 1J, but there are two additional modes available: *time tag* mode and *historical* mode. (See below)

Time Tag Mode
Same as real-time mode with an extended Stream 0 that includes a time tag.

Historical Mode
This mode is unique to IMP types 1H and 1J and does not use Streams 0 and 1. Stream 2 is enlarged to fill the first 240 bytes of the receive page. All results, alarms, etc. from the IMP are passed through with a timestamp. This mode must be used if buffering of IMP data during S-Net downtime is required. Stream 3 is preserved to return status and error information. (*Do not use the SA command while in continuous historical mode, since this command uses Stream 0 and overlaps the same data space on the 3595 4C Interface card*.)

Logic States
When channels 19 and 20 are used for ‘digital status’ inputs, the logic states recognised are:

- logic 1 = switch open (off) = high impedance
- logic 0 = switch closed (on) = low (zero) impedance

When the IMP is powered off, the switch is high impedance and is read as a ‘1’ by another IMP. The digital channel output maintains this state until changed by a set-up command.

CH LR (CHannel Loop Resistance)

CH	*n*	LR

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 18$

Function: Reports the loop resistance, between *high* and *low*, of a thermocouple on channel n. Channel *n* must be configured as a thermocouple type (**MO**de 310 – 3A4). If *n* is out of range, the command does not return an error and is ignored.

Response: In Stream 3:

CH*n***LR** <4-byte result>

The result is in kohms – no time lag.

CH UC (CHannel Unit Conversion)

CH	*n*	UC	*m*	*c*	*e*

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 18$
m is an IEEE 754 floating-point number defining the slop of a line,
c is an IEEE 754 floating-point number defining a constant (y-axis catersian intersection)
e is an enable flag (1 = enable, 0 = disable)

Function: Used to convert a measured parameter into alternative units with the function:

$$y = mx + c$$

Where *x* is the *input* parameter and *y* is the *output*.

Notes:

1. The *input parameter* is post Channel Mode. Therefore, if the required *output* is pressure and the *input* is measured from a 4-20mA transmitter, two conversions are possible:

   a. From a measured voltage across a precision resistor, through which the current flows (unit conversion is post CHannel MOde voltage).

   b. From a measured current, through a 100Ω precision resistor (unit conversion is post CHannel MOde current).

2. Once the measured parameter has been converted, it is no longer available (as current or voltage for example)

UT (User Thermocouple linearisation)

UT — **I** — ***$a_5 – a_0$*** — ***$b_5 – b_0$***

Where: < *I* > defines the user thermocouple as Thermocouple ‘1’ or ‘2’

$a_5 – a_0$ are IEEE 754 floating-point numbers for the coefficients of a fifth-order polynomial

$b_5 – b_0$ are IEEE 754 floating-point numbers for the coefficients of a fifth-order polynomial, but are the inverse of the $a_5 – a_0$ polynomial.

Function: This command is used to apply a user-defined linearisation to a thermocouple measurement. The aim is to cover any thermocouple type not covered by the polynomials available in 3595 IMP types 1H and 1J). (Channel modes 390 – 394 use the coefficients defined by **UT1**. Modes 3A0 – 3A4 use coefficients defined by **UT2**.)

The computation of reference junction [2] compensation requires both the linearisation polynomial and its’ inverse. User-defined thermocouple linearisation acts in the same way as predefined thermocouple linearisation with respect to the **AM**, **TR** and **TC** commands. (See mode codes 310 – 3A4 in Table 1.7, page 1-14)

Notes: If a thermocouple is measured and the corresponding linearisation equation has not been defined, the error code FF82*xxxx* is returned instead of the 4-byte result.

See also: **CH MO**

CH PL (Post Linearisation)

CH — ***n*** — **PL** — ***I***

Where: *n* is an integer that defines the channel number, in the range $1 \le n \le 18$

< *I* > defines the user-defined linearisation equation to use, ‘1’ or ‘2’ (‘0’ disables post linearisation on channel n)

Function: Enables conversion of a measured parameter into alternative units, with the linearisation function:

$$y = a_5 x^5 + a_4 x^4 + a_3 x^3 + a_2 x^2 + a_5 x^5 + a_0$$

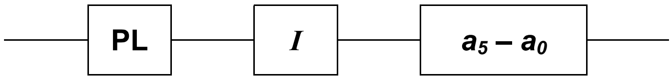
Where *x* is the *input* parameter and *y* is the *output*. The coefficients used are those defined by the **PL** command.

Note: The **CH PL** command can be used with channel unit conversion. Post linearisation is applied first and then the unit conversion.

See also: **PL**

[2] Historically, called the ‘cold’ junction. Now known more accurately as the *reference* junction. Similarly, the ‘hot’ junction is now known as the *measurement* junction.

PL (Post Linearisation)



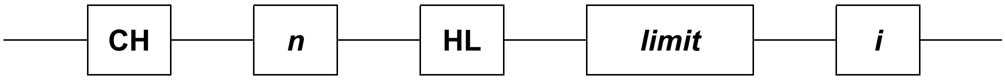
Where < *I* > defines the linearisation equation to use, ‘1’ or ‘2’

$a_5 – a_0$ are IEEE 754 floating-point numbers for the coefficients of a fifth-order polynomial

Function: Defines the coefficients of the polynomial that is applied by a **CH PL** command. If the polynomial is undefined, the result returned is zero and not an error code

See also: **CH PL**

CH HL (CHannel High Limit)



Where: *n* is an integer that defines the channel number, in the range $1 \le n \le 18$

<*limit*> is an IEEE 754 floating-point number that defines the limit in channel units

< *i* > is an IEEE 754 floating-point number that defines the limits for hysteresis (in units)

Function: Defines the high limit for alarm checking on a channel. This is used only in conjunction with the **CH GO** command.

The effect of hysteresis is described in the following example:

1. The limit for a thermocouple is set to 100°C.
2. Hysteresis is set to 3.
3. With a rising temperature, an alarm is signalled at 113°C. The signal remains until the temperature falls below 107°C.

See also: **CH LL** and **CH GO**

CH LL (CHannel Low Limit)

CH — ***n*** — **LL** — ***limit*** — ***i***

Where: *n* is an integer that defines the channel number, in the range $1 \leq n \leq 18$

<*limit*> is an IEEE 754 floating-point number that defines the limit (in channel units)

< *i* > is an IEEE 754 floating-point number that defines the limits for hysteresis (in units)

Function: Defines the low limit for alarm checking on a channel. This is used only in conjunction with the **CH GO** command.

The effect of hysteresis is described in the following example:

1. The limit for a thermocouple is set to 10°C.
2. Hysteresis is set to 3.
3. With a falling temperature, an alarm is signalled at 7°C. The signal remains until the temperature rises above 13°C.

See also: **CH HL** and **CH GO**

CH GO (CHannel Group alarm Output)

CH — ***n*** — **GO** — ***string***

Where: *n* is an integer that defines the digital output channel number, 19 or 20

<*string*> is a string defining on which the analogue channels an alarm check is required.

The format for <*string*> is:

$$pA_1A_2A_3\ldots A_{36}$$

p defines the output state of channel *n* for alarm detected:

- *p* = 2, disable alarm checking on channel n
- *p* = 1, FET on: switch closed, i.e. as MODE 801
- *p* = 0, FET off: switch closed, i.e. as MODE 800

A_n is the identity of an alarm check and consists of an analogue channel number, in the range 1 through 18, and the character H or L. The 'H' specifies a high limit alarm check (See **CH HL**); 'L' specifies the low limit alarm check (See **CH LL**).

Function: Defines the group of alarms to be associated with a digital output. If any of the alarms are active (OR logic), the digital output will be active. Only the channels specified in the last **CH GO** command are checked.

The **CH GO** command provides for alarm checking on all 18 analogue channels. Checking is against the high and low limits defined by the **CH HL** and **CH LL** commands. On all analogue channels, it is possible to specify a high limit alarm check, or a low limit alarm check, or both. Specifying both alarm limit checks is equivalent to specifying an 'out-of-window' check. (Note that it is not possible to specify an 'in-window' check by specifying a high limit that is less than the low limit.)

See also: CH HL and CH LL.

Notes:

1. If *n* = 20, Watchdogs are disabled.

2. Alarm checking operates only for scanned channels, NOT for single measurements.

3. The **CH GO** command stays in operation, unless:

a. it is overridden by a **CH MO** command, or
b. another **CH GO** command is received, or
c. the Watchdog is enabled (channel 20 only). This command sets the MOde database to MO*80x*, where *x* = the 'Go' state for the channel.

4. The state of the digital output may be read at any time by measuring or scanning the channel.

5. The group may consist of one alarm element only. If *p* = 2, no alarms need be specified – alarm checking is disabled for all alarms previously specified.

6. On alarm, the defined digital output is active. 'Active' can be defined as 'switch closed' or 'switch open', depending on the value of *p* in the command string. This gives the option of an active alarm when the IMP is non-functional.

Consider a requirement to disable a machine when off-limit readings are obtained for oil temperature, oil pressure, or both, or monitoring equipment is non-functional. The oil temperature should be in the range –10 to +95°C. The oil pressure should be in the range 1 to 3bar. The channel definitions for this scenario could be:

a. Minimum acceptable oil temperature on channel 1 (low limit): CH1LL-10.

b. Maximum acceptable oil temperature on channel 1 (high limit): CH1HL95.

c. Minimum acceptable oil pressure on channel 2 (low limit): CH2LL1.

d. Maximum acceptable oil pressure on channel 2 (high limit): CH2HL3.

e. Define channel 19 associated with the above alarm group: CH19GO001L01H02L02H.

(Note that alarms use data post-unit conversion or post-linearisation.)

While the IMP is powered-down, the digital output is open, thus disabling the machine. When the IMP first powers-up, the machine remains disabled. When CH19GO command is sent, the output is switched into the alarm state (i.e. no change in this case) thus disabling the machine. Once the IMP has read the machine parameters and determined that none are in alarm, it closes the output switch and, thus, enables the machine.

AS (**A**uto **S**tart)

AS — ***n***

Where: *n* = 0 = False – do not auto-start (default)
n = 1 = True – do auto-start

Function: When auto-start is set to *true*, the IMP automatically begins operations after a hard reset (power-up or a hardware watchdog timeout).

After a hardware reset, and just before entering an idle loop, the IMP checks the value of *n* in its' non-volatile database. If *n* is true, the non-volatile database is restored to the database proper, as if the **RD** command had been issued. A check is then made on the CONTINUOUS_SCANNING Boolean variable: if this is true, a scan is triggered automatically; if it is false, no further action is taken.

When auto-start is set to *false*, no action is taken.

Example: A typical AS command sequence is:

1. **SE** (set-up the IMP to default mode)
2. **CO** (set continuous triggering)
3. **AS1** (set auto-start to true)
4. **SD** (save settings in non-volatile memory)

These commands prepare an IMP to respond to a hard reset by restoring its' database amd issuing a trigger command to itself.

RM (**R**esult **M**ode)

RM — ***n***

Where: *n* = 0 = Real-time mode (default)
n = 1 = Real-time mode with time-tagging. (See page 1-45)
n = 2 = All results returned in Stream 2 (historical)

Function: Mode 0 outputs data on Stream 0 in the same format as for all IMP devices. Mode 1 outputs the same data but with a time-tag. Mode 2 outputs historical data on Stream 2 and allows all 960 buffers to be used. Each buffer holds a scan of 20 channels. If, for example, the scan period is set to 10s with the SP command, the 960 buffers will be filled in 9,600 seconds (= 2hrs 40mins).

Historical mode buffering operates on a first-in, first-out basis (FIFO). If the IMP is measuring faster than the PC can read results, the results are stacked in the FIFO buffer (queue). When the buffer is full, the IMP continues measuring so that it can monitor alarm inputs, but does not store new results in the buffer until space becomes available.

FB (**F**lush **B**uffers)

FB

Function: Flushes the historical results (FIFO buffer) and returns the FIFO buffer to the 'free buffer list'. **FB** is a 'one-shot' command and has no persistent effect. For further flushing, another **FB** command must be sent.

SD (**S**ave **D**atabase) and RD (**R**estore **D**atabase)

SD **RD**

Function: The SD and RD commands provide for a quick set-up.

The SD command saves the database of a previously configured IMP into a **Flash PROM**. Later, the RD command can be used to load the current contents of the Flash PROM into the same database.

When the database is restored, two things happen:

1. The watchdogs are disabled and
2. If the channel mode is 80x, the output is set accordingly.

(Refer to Appendix A for details of the database format.)

Compared with the PC saving and restoring the IMP database over S-Net, the above method is more convenient, but less flexible.

Response: Stream 3. Single character 'H' (**SD** command only). This response confirms that the database has been written.

Note: Before storing the database in the Flash PROM, the **SD** command generates an internal HA (halt) command. This does not change the state of the COntinuous Scan Parameter.

While the database is being restored, there is no communication with the IMP and S-Net. This causes polling errors, which stop when storage is complete.

It can take up to three seconds for the IMP database to be restored. Therefore after sending the SD command, any software application should wait three seconds, then clear the error flags from the 3595 4C Interface card, and then read Stream 3 for an 'H' character. Once this is received, the IMP is ready to resume normal operations.

1.4 SUGGESTED COMMAND PROCEDURES

Before an IMP can take a measurement, it must first be assigned a task and enabled (set-up). Only then can an IMP be instructed to take a measurement. Each result must then be read, otherwise buffer space will be filled until the IMP no longer has room to store new data and measurements will stop.

The command language used by the IMP is very versatile, allowing great flexibility in the way each channel can be configured and used. To assist in preparing a software application, suggested command procedures are outlined overleaf. The detailed function and syntax of each command is documented in the Command Directory (page 1-8 onwards). Once familiar with commands, procedures can be tailored to suit a particular requirement.

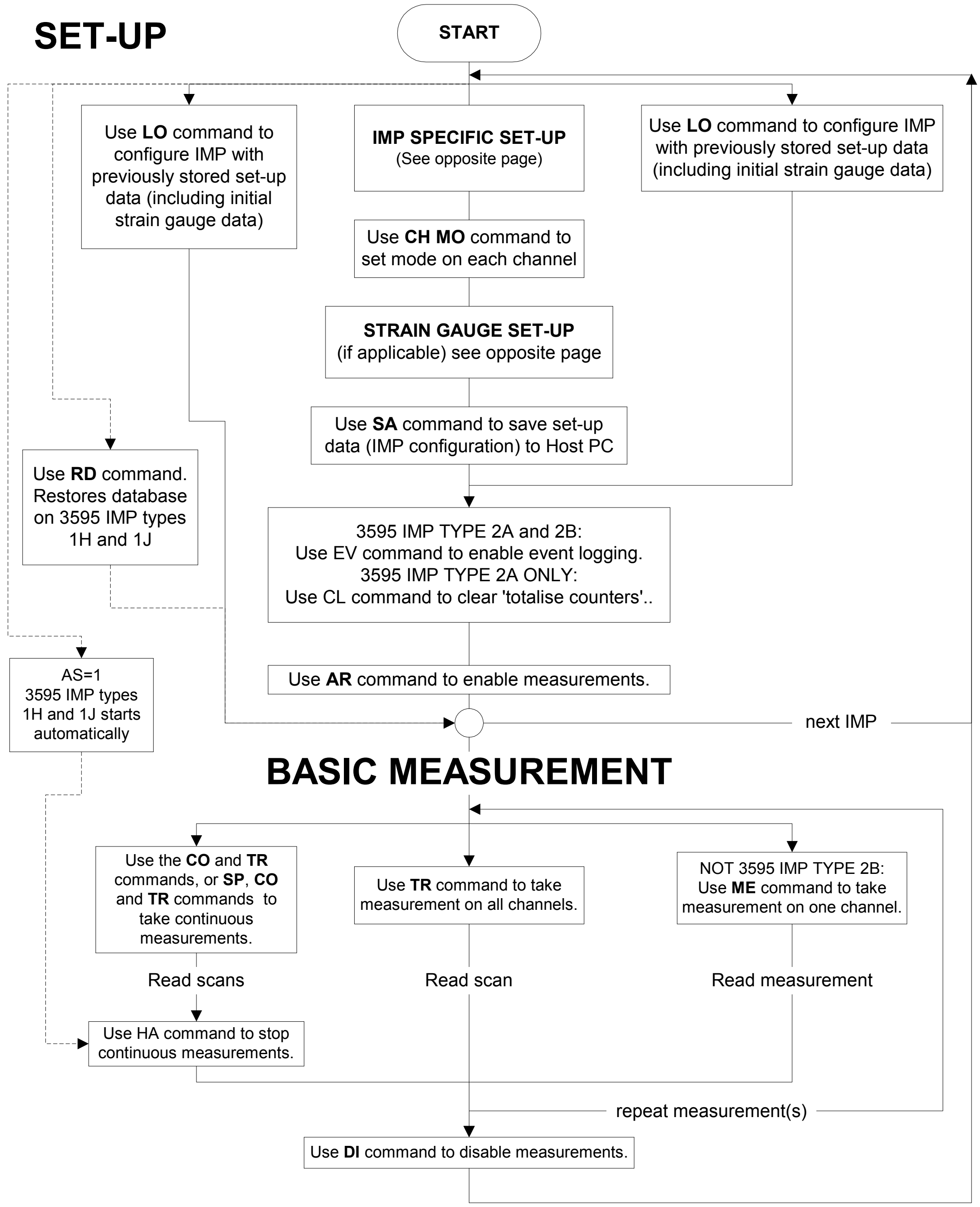


Figure 1.5: Set-up and basic measurement

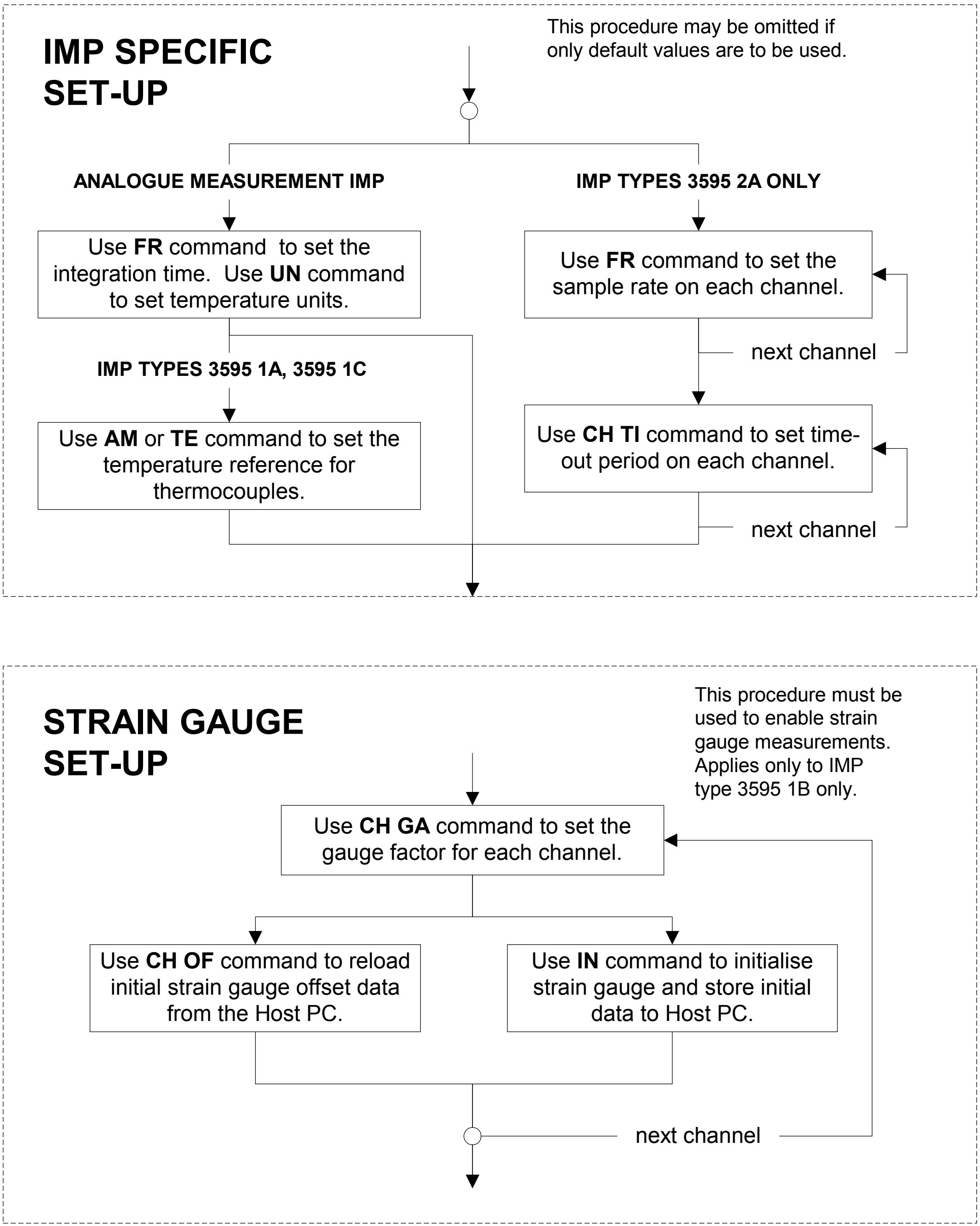


Figure 1.6: IMP Specific Set-up and Strain Gauge Set-up

2

Result and Error Formats

Contents

List of Tables

2.1 INTRODUCTION

Table 2.1 summarises the **result formats** applicable to 3595 Series IMP types 1A, 1B, 1C, 1D, 1E, 2A and 2B.

For IMP types 3595 1H and 1J, the same formats apply. However, depending on the **result mode** selected, the results may be time-tagged.

The three result modes of IMP types 3595 1H and 1J are:

- *Real-time* –exactly the same format as for all other IMP types.
- *Time-tagged* –each scan data block, or single measurement result, has a *bookmark* and *time-tag* appended.
- *Historical* – allows the IMP to pass historical time-tagged results back to the Host PC.

The formats of the bytes appended in the *time-tagged* and *historical modes* are described in Sections 2.5 and 2.6.

The error messages that may be returned by any IMP are listed in Section 2.7, together with their meanings.

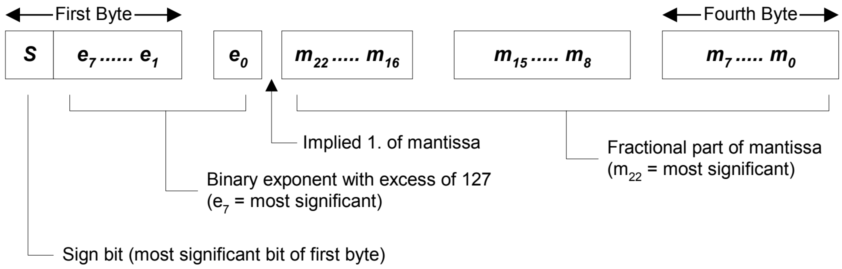
Table 2.1: IMP Result Formats

IMP Result	Stream	Format
Scan data of all measurements, except ‘event totalise’ and ‘event increment’.	0	4-byte floating-point number. (See page 2-5)
Scan data of ‘event totalise’ and ‘event increment’ measurements.	0	IEEE 754 floating-point number. (See page 2-4)
Single measurement.	1	4-byte floating-point number. (See page 2-5)
Events capture. From 3595 2A and 2B IMP types only)	2	Event capture results are returned in the form of bookmarks, event tags, event status, end tags and lost events. Each of these has an individual format, which is described in Section 2.4.
IMP status and Command responses	3	ASCII characters.
Response to a SA (SAve set-up data) command.	0	Command format. (See Chapter 1, ‘IMP Commands’.)

2.2 IEEE 754 FLOATING-POINT NUMBER FORMAT

The IEEE 754 floating-point number format is used for the ‘event totalise’ and ‘event increment’ results, as returned by the 3595 IMP types 2A and 2B. It is also used for the response to the IN command, and for the set-up parameters in several IMP commands.

To represent a number in IEEE 754 format, four bytes are used:



The S (sign) bit is one if the number is negative and zero if the number is positive. The binary exponent has an excess of 127_{10}. This means that it consists of the sum of the true exponent with 127_{10}. This allows a range of exponent values from -127_{10} to 128_{10}. To retrieve the true exponent, subtract 127_{10}. The mantissa has an ‘implied one’. Only the fractional part of the mantissa is actually written. When the number is converted to IEEE format, the exponent is adjusted until there is only a single binary one to the left the binary zero. This binary one is then omitted and becomes ‘implied’.

Example: To convert a decimal number of 2.25

$$2.25_{10} = 10.01_2 = 10.01 * 2^0 = 1.001 * 2^1$$

Mantissa (with implied 1)	= .001
Exponent	= 1
with excess of 127	= 127+1 = 128

This gives the result:

0	1000000	0	0010000	00000000	00000000

The result breaks down into:

Sign bit = 0, therefore the number is positive.

An exponent with the excess of $127_{10} = 10000000_2 = 128_{10}$, the true binary exponent is 1_{10}.

Mantissa with implied 1 = 001…., a true mantissa of 1.001_2.

The four bytes there represent:

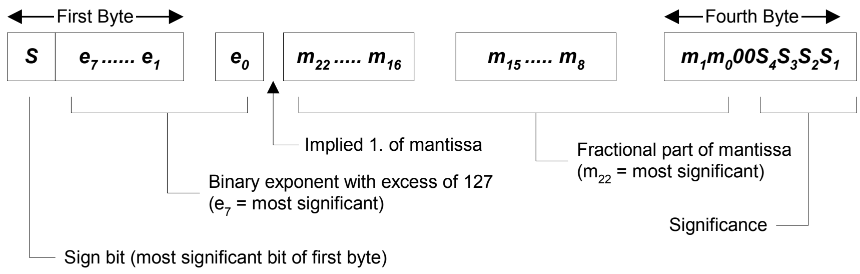
$$1.001_2 * 2^1 = 10.01_2 = 2.25_{10}$$

Note: Zero is represented by all four bytes being ‘all zeroes’.

2.3 FOUR-BYTE RESULT FORMAT

Analogue and digital data are sent in a 4-byte result format that closely resembles the IEEE 754 format.

The 4-byte format differs from IEEE 754 in having a shorter mantissa, that is 17 bits rather than 23. Four of the six bits are thus freed and are used to hold information on the significance of the result, as follows:



The significance is the number of valid decimal places in the result. This is decided by the range selected in the IMP.

2.4 EVENT RESULT FORMAT

Event results are obtainable only from digital IMP type 3595 2A and switch IMP type 3595 2B, set-up for 'events capture'. The 3595 2A IMP can store up to 6000 bytes of event data, whilst the 3595 2B can store up to 512 bytes. Both types can transmit up to 112 bytes of event data at a time.

Event data carries information on the time and directional change of a digital signal. The time of a detected event is referenced to the IMP internal calendar and clock, which is regularly synchronised from the 3595 4C Interface card. Synchronisation is performed regularly and it does not affect measurement integrity.

Event data is transmitted in Stream 2. If the on-card input buffer for Stream 2 and the relevant IMP is empty, the event data is transmitted as soon as it occurs. However, if the input buffer already holds unread data, the IMP stores results and transmits the event data when the buffer is free.

Event data consists of:

Bookmarks. Four bytes containing the calendar month, day, hour and minute.

Event tags. Four bytes containing the channel number, direction of transition, calendar seconds and milliseconds. One event tags is sent per event.

End tags. Four bytes containing only binary zeroes. This indicates the end of a set of event data, and is used when less than 112 bytes of event data is transmitted.

Lost event results. When the event storage area of the IMP and *on-card* input buffer are full, the IMP has nowhere to send or store event results. Instead, it counts the number of events that occur. This data is stored in a 4-byte result and loaded into the output buffer when space is available. Up to 65535 lost events can be counted.

Event data transmitted by an IMP can consist of a number of bookmarks, event tags and one end tag. Only a single bookmark is sent per calendar minute (and this is only if an event occurs). A bookmark gives the most significant calendar data for all event tags sent after it, until the next bookmark is sent.

If event data is sent to a free buffer (on the 4C Interface card), data for only one result is sent: this consists of a bookmark, an event tag and an end tag. Subsequent data is sent only if the application software reads the initial data. The IMP, whilst waiting for the buffer to become free, stores any new event tags and bookmarks. This new data is sent when the buffer is free. An end tag is added if the stream of event data is less than 112 bytes long, but this tag can be replaced by a lost event tag if one is to be sent.

Event status responses also go into Stream 2. In this case, the event tag is replaced by the 'event status format'.

2.4.1 Bookmark format

A bookmark contains the calendar month, day, hour and minute, in the following format:

← First Byte →			← Fourth Byte →
0 0 0 X_4..... X_0	***D_7...... D_0***	***H_7...... H_0***	***M_7...... M_0***

most significant bit of first byte

All numbers are in binary coded decimal:

X_4	months, tens
$X_3 \ldots X_0$	months, units
$D_7 \ldots D_4$	days, tens
$D_3 \ldots D_0$	days, units
$H_7 \ldots H_4$	hours, tens
$H_3 \ldots H_0$	hours, units
$M_7 \ldots M_4$	minutes, tens
$M_3 \ldots M_0$	minutes, units

2.4.2 Event tag format

An event tag contains the channel number, direction of transition, and the calendar seconds and milliseconds, in the following format:

← First Byte →			← Fourth Byte →
1 0 T C_4..... C_0	***S_7...... S_0***	***R_7...... R_0***	***P_7...... P_4 0 0 0***

most significant bit of first byte

T = transitions:	if T = 1, event is positive-going (low to high) if T = 0, event is negative-going (high to low)
$C_4 \ldots C_0$	channel number in binary (C_4 is most significant)

Note: Channel numbers entered for the 3595 2A IMP correspond exactly with the physical channels: 1 = Channel 1, 2 = Channel 2, etc. With the 3595 2B IMP, however, channel numbers 0 through 31 represent the physical channels 1 through 32.

All remaining numbers are in binary-coded decimal:

$S_7 \ldots S_4$	seconds, tens
$S_3 \ldots S_0$	seconds, units
$R_4 \ldots R_7$	milliseconds, hundreds
$R_3 \ldots R_0$	milliseconds, tens
$P_7 \ldots P_4$	milliseconds, units

2.4.3 Event status format

Event status information is similar to that contained in an event flag. The only difference is that the event status contains the event level instead of the event transition; all other information is the same.

←First Byte→			←Fourth Byte→
0 1 L C_4..... C_0	***S_7...... S_0***	***R_7...... R_0***	***P_7...... P_4 0 0 0***

└most significant bit of first byte

L = status level: if L = 1, status = high
if L = 0, status = low

$C_4 \ldots C_0$ channel number (in binary, C_4 = most significant bit)

Note: Channel numbers entered for the 3595 2A IMP correspond exactly with the physical channels: 1 = Channel 1, 2 = Channel 2, etc. With the 3595 2B IMP, however, channel numbers 0 through 31 represent the physical channels 1 through 32.

All remaining numbers are in binary-coded decimal:

$S_7 \ldots S_4$ seconds, tens
$S_3 \ldots S_0$ seconds, units

$R_4 \ldots R_7$ milliseconds, hundreds

$R_3 \ldots R_0$ milliseconds, tens
$P_7 \ldots P_4$ milliseconds, units

2.4.4 End tag format

An end tag indicates the end of a set of event data. It is used when less than 112 bytes are transmitted. The format is as follows:

←First Byte→			←Fourth Byte→
0 0 0 0 0 0 0 0	***X_7...... X_0***	***X_7...... X_0***	***X_7...... X_0***

└most significant bit of first byte

2.4.5 Lost event result format

The 'lost event' result contains the number of events lost due to the 4C Interface card input buffer being full. The format is as follows:

←First Byte→			←Fourth Byte→
1 1 1 1 1 1 1 1	***X .... X***	***N_{15}...... N_8***	***N_7...... N_0***

└most significant bit of first byte

$N_{15} \ldots N_0$ = Number of event results lost (in binary, N_{15} = most significant bit)

X = any number (0 or 1)

2.5 TIME TAG FORMATS (FOR 3595 1H AND 1J IMPS)

With the result format set to *time-tag*, results from the 3595 1H and 1J IMP types are returned with a bookmark and time-tag, appended. These appear at the end of each scan and at the end of each single measurement. The formats of the bookmark and time-tag are in Sections 2.5.1 and 2.5.2.

2.5.1 Bookmark format

A bookmark contains the calendar month, day, hour and minute. The format is:

◄─First Byte─►			◄─Fourth Byte─►
0 0 0 X_4 ***.....*** X_0	D_7 ***......*** D_0	H_7 ***......*** H_0	M_7 ***......*** M_0

most significant bit of first byte

All numbers are in binary coded decimal:

X_4	months, tens
$X_3 \ldots X_0$	months, units
$D_7 \ldots D_4$	days, tens
$D_3 \ldots D_0$	days, units
$H_7 \ldots H_4$	hours, tens
$H_3 \ldots H_0$	hours, units
$M_7 \ldots M_4$	minutes, tens
$M_3 \ldots M_0$	minutes, units

2.5.2 Time-tag format

The time-tag contains the calendar seconds and milliseconds, in the following format:

◄─First Byte─►			◄─Fourth Byte─►
1 0 X_5 ***.......*** X_0	S_7 ***......*** S_0	R_7 ***......*** R_0	P_7 ***......*** P_4 ***0 0 0***

most significant bit of first byte

$X_5 \ldots X_0$	don’t care

All remaining numbers are in binary-coded decimal:

$S_7 \ldots S_4$	seconds, tens
$S_3 \ldots S_0$	seconds, units
$R_4 \ldots R_7$	milliseconds, hundreds
$R_3 \ldots R_0$	milliseconds, tens
$P_7 \ldots P_4$	milliseconds, units

2.6 HISTORICAL DATA FORMATS (FOR 3595 1H AND 1J)

With the result format set to *historical*, results from 3595 Series IMP types 1H and 1J are preceded with a *bookmark* and *time-tag*. These are described in Section 2.6.2 and 2.6.3.

In addition, to increase data throughput, and thus allow the historical buffer to be emptied quickly after a temporary loss of S-Net, the data streaming is completely reorganised. This allows up to 240 bytes of scan or single measurement data to be passed back in Stream 2 to the Host PC, for every poll. Data streaming for historical results is described in Section 2.6.1. The end of useful data in Stream 2 is defined by an *end-tag*. This is described in Section 2.6.4.

2.6.1 Historical data stream

Historical data is carried on Stream 2. This is enlarged to 240 bytes so that more than one scan, and possibly some single measurements, can be returned every poll.

After a temporary loss of S-Net, the enlarged Stream 2 allows the Host PC to extract data from the **historical data buffer** as quickly as possible. The Host PC can then get up-to-date with real-time measurements as they are made. (Unwanted historical data may be flushed out.)

Stream 0 is not used (except for the special case of SA) and Stream 1 is not used. Stream 3 is retained; it resides at the top of the data page.

Stream 2 never splits scan result blocks across a data page. Therefore, after a loss in communications, and while extracting buffered scans, Stream 2 contains one or two full data scans (and possibly measurement results). The end of useful data is marked with an end-tag. Note that this does not imply that there is no more historical data to extract; it does imply that the last piece of useful data has been read from the data page.

2.6.2 Bookmark format

A bookmark contains the calendar month, day, hour and minute. The format is:

◄— First Byte —►			◄— Fourth Byte —►
0 0 0 X_4 ..... X_0	***D_7 ...... D_0***	***H_7 ...... H_0***	***M_7 ...... M_0***

most significant bit of first byte

All numbers are in binary coded decimal:

X_4	months, tens
$X_3 \ldots X_0$	months, units
$D_7 \ldots D_4$	days, tens
$D_3 \ldots D_0$	days, units
$H_7 \ldots H_4$	hours, tens
$H_3 \ldots H_0$	hours, units
$M_7 \ldots M_4$	minutes, tens
$M_3 \ldots M_0$	minutes, units

2.6.3 Time-tag format

The time-tag contains an indication of whether the following data is a scan or a single measurement, the channel number, and the calendar seconds and milliseconds. It has the following format:

← First Byte →			← Fourth Byte →
1 0 M X_4..... X_0	***S_7...... S_0***	***R_7...... R_0***	***P_7...... P_4 0 0 0***

most significant bit of first byte

M	if M = 0, a single measurement follows the time-tag if M = 1, a scan follows the time-tag
$C_4 \ldots C_0$	channel number (in binary). Not used if M = 1 (a scan)

All remaining numbers are in binary-coded decimal:

$S_7 \ldots S_4$	seconds, tens
$S_3 \ldots S_0$	seconds, units
$R_4 \ldots R_7$	milliseconds, hundreds
$R_3 \ldots R_0$	milliseconds, tens
$P_7 \ldots P_4$	milliseconds, units

2.6.4 End-tag format

An *end-tag* in historical data indicates that there is no more data following it in the data page. The format is as follows:

← First Byte →			← Fourth Byte →
0 0 0 0 0 0 0 0	***X_7...... X_0***	***X_7...... X_0***	***X_7...... X_0***

most significant bit of first byte

Note that the *end-tag* does not imply that there is no more historical data to extract; it does imply that the last piece of useful data has been read from the data page.

2.7 IMP ERROR MESSAGES

Error messages are transmitted by an IMP instead of a 4-byte result. They occur only in response to a **ME** or **TR** command.

An error message is in the form of a 4-byte analogue result with a negative sign and an exponent of 255. In hexadecimal format, this is represented by any number in excess of 'FF800000'. In IEEE 754 floating-point format, this is equivalent to 'Not a number'.

FF81 xxxx	Analogue overload. The input to an analogue measurement channel has exceeded the maximum value of the present range.
FF82 xxxx	User thermocouple undefined. Returned when a channel mode is set to 39x or 3Ax, but the corresponding thermocouple has not been defined. (3595 1H and 1J only)
FF83 xxxx	Out of linearisation range. Returned by a thermocouple channel when the temperature is out of measurable range.
FF84 xxxx	Ambient temperature range. The IMP has been instructed to use a temperature reference outside the permitted range (-30°C to +80°C).
FF85 xxxx	Transducer error. The IMP analogue-to-digital converter is unable to decide a value. This error is commonly due to an open-circuit input or a large over-voltage.
FF86 xxxx	Open-circuit thermocouple error. Open-circuit thermocouple checking is enabled and the IMP detected a failure.
FF87 xxxx	Unknown mode, type or range. The IMP has been instructed to select an inapplicable channel mode or an unsupported integration time.
FF88 xxxx	This error code is unassigned.
FF89 xxxx	Channel number out of range. A channel number, n, outside the permitted range has been specified. The permitted range is $1 \leq n \leq 10$ (for IMP type 3595 1B) or $1 \leq n \leq 20$ (for IMP types 3595 1A, 1C, 1H, 1J and 2A).
FF8A xxxx	System zero error. The IMP is unable to perform a drift correction.
FF8B xxxx	System calibration corrupt. The calibration constants (including backup values) held in non-volatile memory show 'read errors'. Non-volatile memory is either corrupted or not fitted.
FF8C xxxx	Strain gauge not initialised. The IMP database must be loaded with the gauge offset resistance and factor. See the 'Command Directory' entry for **IN**. (Relevant only to IMP type 3595 1B.)
FF8D xxxx	Digital result pending. (Relevant only to IMP types 3595 1H and 1J.)
FF8E xxxx	Period time-out. The IMP has tried to measure a time period but took longer than the maximum time allowed (as set by the **CH TI** command).
FFFF xxxx	Not measured. The channel has been set to 'skip', 'digital output' or 'event capture'.

The remainder of possible error codes are unassigned.

A

Database Structure (3595 1H and 1J IMP)

Contents

A.1 DATABASE STRUCTURE

The IMP uses a floating point format similar to IEEE, but not Quite. It is as Follows:

¦SEEEEEEE¦MMMMMMMM¦MMMMMMMM¦MMMMMMMM¦

S = sign bit
E = 7 bit exponent – excess 64
M = 24 bit mantissa - *no hidden bits.*

Note: Where a parameter is stated as being a value, 0,1, 2 and so on, it is stored in the database in binary code, not ASCII.

```
#define TRUE                    1           /* define Boolean Constants */
#define FALSE                   0
#define CA_DISABLED             2           /* Disable Alarm Checking*/
#define CA_ASSERT               1           /* Turn Fet On, AS Mode 801 (Logic 0)*/
#define CA_DISASSERT            0           /* Turn Fet Off, As Mode 800 (Logic I)*/


typedef unsigned char BYTE;
typedef unsigned char BOOL;
typedef float IMPFP


/****** Typedefs for DATABASE 1 - 12 Bytes *******/

typedef struct
{
   BOOL                 Armed;              /* AR Pod Armed */
   BOOL                 Cont;               /* CO Continuous Scanning */
   BYTE                 Driff,              /* DR 0, 1 or 2 */
   BYTE                 Cali;               /* KA 0 or 1 */
   BYTE                 Units;              /* UN 0 or 1 */
   BYTE                 UK_USA;             /* FR - See Below */
   IMPFP                Ex_ref[4];          /* TE in IMPFP Format */
   BOOL                 Tcref,              /* TRUE if TE, FALSE if AM */
   BYTE                 ResultMode;         /* RM 0,1 or 2)
}DBI, *DB1_PTR;


/* The FR value is obtained by shifting the binary argument one place to the right
 * and inserting the carry bit into bit 4.*/


/****** Typedefs for DATABASE 2 - 86 Bytes *******/

typedef struct
{
/* Post Linearisation Enabled */
   BYTE num[18];
/* num = 0,1 or 2 */
}POSTLIN, *PL_PTR;


typedef struct
{
   BYTE val[21];  /* Byte 0 for Internal Use */
}MODE, *MD_PTR;


typedef struct
{
```

```
  BOOL          AutoStart;            /* Set by AS Command */
  BYTE          Dbncel9;              /* CH n RAte Setting */
  BYTE          Dbnce20;
  BYTE          Timeout19;            /* CH n TImeout setting */
  BYTE          Timeout20;
  POSTLIN       PostLin;              /* Post linearisation Enabled */
  MODE          Type;                 /* Components of the .. */
  MODE          Mode;                 /* CH n MO command */
  MODE          Range;
}DB2, *DB2_PTR;


/* Type is the First parameter, Mode the Second, and Rate the Third parameter of the
 * CH n MO TMR command. Exceptions are noted below.
 *
 * 1) Range = Parameter -1, Except for 0 (Autorange, which is 0x82)
 * 2) Modes 701 & 702 are stored as 7,1,82 & 7,2,82 respectively.
 * 3) 'A' for User defined Thermocouple is OxOa
 */


/******* Typedefs for DATABASE 3 - 165 Bytes ******/

typedef struct
{
  BOOL Enabled;
  IMPFP m;
  IMPFP c;
}UC, *UC_PTR;


typedef struct
{
  BYTE       ScanPeriod[3];                  /* Integer Milliseconds */
  UC         Conversions[ 18];
}DB3, *DB3_PTR;



/****** Typedefs for DATABASE 4 - 146 Bytes ******/

typedef struct
{
  BOOL   DEFINED; /* This thermocouple is defined*/

/* Volts to temperature equation*/

   IMPFP    VT_PWR_5;                 /* Multiplication Factor for x^5*/
   IMPEP    VT_PWR_4;                 /* Multiplication Factor for x^4*/
   IMPFP    VT_PWR_3;                 /* Multiplication Factor for x^3*/
   IMPFP    VT_PWR_2;                 /* Multiplication Factor for x'2*/
   IMPFP    VT_PWR_1;                 /* Multiplication Factor for x^1*/
   IMPFP    VT_C;                     /* Constant addition*/

/* Temperature to volts equation for cold junction compensation */

   IMPFP    TV_PWR_5                  /* Multiplication Factor for x^5*/
   IMPFP    TV_PWR_4;                 /* Multiplication Factor for x^4*/
   IMPFP    TV_PWR_3;                 /* Multiplication Factor for x^3*/
   IMPFP    TV_PWR_2;                 /* Multiplication Factor for x^2*/
   IMPFP    TV_PWR_1;                 /* Multiplication Factor for x^1 */
   IMPFP    TV_C                      /* Constant addition*/

}UThermo, *UThermo_ptr;




/* Channel Post Linearisation equations*/
typedef struct
{
   IMPFP        PL_PWR_5;          /* Multiplication Factor for x^5*/
   IMPFP        PL_PWR_4;          /* Multiplication Factor for x^4*/
   IMPFP        PL_PWR_3;          /* Multiplication Factor for x^3*/
```

```
   IMPFP        PL_PWR_2;          /* Multiplication Factor for x^2*/
   IMPFP        PL_PWR_1;          /* Multiplication Factor for x^1*/
   IMPFP        PL_C;              /* Constant addition*/
}PL_eqn, *PL_eqn_ptr;

typedef struct
{
    UThermo TCs[2];                /* User Thermocouples*/
    PL_eqn Lins[2];                /* Post Linearisation equations*/
}DB4, *DB4_PTR;


/****** Typedefs for DATABASE 5,(182 Bytes) 6 & 7 (Both 180 Bytes)

typedef struct                     /* Channel alarm structure*/
{
    IMPFP       HIGH;                /* Channel High limit*/
    IMPFP       HI_HYSTER;           /* Hysteresis value*/
    IMPFP       HI_COMPARE;          /* Current compare limit*/
    IMPFP       LOW;                 /* Channel Low limit*/
    IMPFP       LO_HYSTER;           /* Hysteresis value*/
    IMPFP       LO_COMPARE;          /* Current compare limit*/
    BOOL        IN_HIGH;             /* IN_HIGH-ALARM*/
    BOOL        IN_LOW;              /* IN_LOW_ALARM*/
    BOOL        C19_HI_ALARM;        /* True if HI is in CH 19 alarm group*/
    BOOL        CH20_HI_ALARM;       /* True if HI is in CH 20 alarm group*/
    BOOL        CH19_LO_ALARM;       /* True if LO is in CH 19 alarm group*/
    BOOL        CH20_LO_ALARM;       /* True if LO is in CH 20 alarm group*/
}CA, *CA_PTR;

typedef struct
{
    BYTE        CH 19_GO_STATE;      /* CA_DISABLED, CA_ASSERT or
                                        CA_DISSASERT*/
    BYTE        CH20_GO_STATE;
    CA          Alarms[6];

}DB5, *DB5_PTR;

typedef struct
{
    CA   Alarms[6];
}DB6_7, *DB6-7_PTR;
```

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