

SIEMENS PLC,  
Sopers Lane,  
POOLE, Dorset  
BH17 7ER

**SYSTEM/PROJECT/PRODUCT:** Siemens IMU

HANDBOOK FOR THE  
SIEMENS T400, ST700 AND ST800  
INTEGRAL MONITORING UNIT

**PREPARED:** Paul Cox

**FUNCTION:** Software Engineer

**This Document is Electronically Held and Approved in Meridian  
A 'Paper Insert' Appendix is held in the Registry – See Page 2**

<u>ISSUE:</u>	<u>CHANGE REF.:</u>	<u>DATE:</u>
01.00A		06/10/93
01.00B		29/03/94
01.00C		26/04/94
01.00D		23/09/94
01.00		24/04/95
02.00A		11/04/96
02.00B		15/08/96
02.00	ANL00311	10/12/96
03.00	ANL00760	22/08/97
04.00	TS000545	18/09/01
05.00	TS002377	09/12/04

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The document comprises the following components:

<u>Pages</u>	<u>Current Issue</u>	<u>Type</u>	<u>Part ID</u>
1 to 47	05.00	11	667/HB/22380/002
1 to 6	1	6*	667/HB/22380/002

\* TCSU Technical Instruction No. 26

## **SAFETY WARNING**

In the interests of Health and Safety, when using or servicing this equipment, the following instructions must be noted and adhered to:

- i) Only skilled or instructed personnel with relevant technical knowledge and experience, who are also familiar with the safety procedures required when dealing with modern electrical / electronic equipment are to be allowed to use and / or work on the equipment. All work shall be performed in accordance with the Electricity at Work Regulations 1989.
- ii) Such personnel must take heed of all relevant notes, cautions and warnings in this handbook and any other document or handbook associated with the Traffic Controller.
  - a) The equipment must be correctly connected to the specified incoming power supply.
  - b) The equipment must be disconnected / isolated from any incoming power supply before removing any protective covers, or working on any part from which protective covers have been removed.
  - c) The Integral Facilities PCB contains a Lithium Battery that should be disposed of in a safe manner. For further details, refer to Siemens Code of Practice CP526.

## **TELECOMMUNICATIONS APPROVAL WARNING**

The Siemens Integral Monitoring Unit connects to the PSTN using an external modem that is Approved for connection to British Telecommunications PSTN lines as defined in BS6305.

The Integral Monitoring Unit is covered by the General Approval for indirect connection of apparatus under Section 22 of the 1984 Telecommunications Act, Approval Number NS/G/1234/J/100003. The mark of approval for the external modem must not be applied to the Integral Monitoring Unit / Traffic Controller as a whole.

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# 1. INTRODUCTION

## 1.1 PURPOSE

The purpose of this document is a guide to the Siemens Integral Monitoring Unit for the T400, ST700 and ST800 Traffic Controllers. It is intended to provide professional Installation and Maintenance personnel with information on how to install, commission and maintain the Integral Monitoring Unit.

## 1.2 SCOPE

This document provides a general description of the Integral Monitoring Unit fitted to various controller outercases, along with the details required for Installation, Commissioning and Maintenance of the Unit.

## 1.3 RELATED DOCUMENTS

- a) Engineering Specification for TCSU Integral Monitoring Unit ..... 667/SA/20652/001
- b) Full Functional Specification for the TCSU T400 Pelican Integral Monitoring Unit ..... 667/UH/25073/000
- c) Full Functional Specification for the TCSU T400 Intersection Integral Monitoring Unit ..... 667/UH/25075/000
- d) Full Functional Specification for Part Time Operation on Individual Streams ..... 667/UH/25076/000
- e) Full Functional Specification for ST700 / ST800 Controllers ..... 667/UH/25083/000
- f) Circuit Diagram for T400 Integral Facilities Processor... 667/DA/25169/ETC
- g) T400 General Handbook ..... 667/HB/20200/000
- h) T400 Installation & Commissioning Handbook ..... 667/HE/20200/000
- i) T400 Maintenance Handbook..... 667/HA/20200/000
- j) T400 Handset Handbook..... 667/HH/20200/000
- k) ST800 General Handbook ..... 667/HB/27000/000
- l) ST800 Installation and Maintenance Handbook ..... 667/HE/27000/000
- m) ST700 and ST800 Handset Handbook..... 667/HH/27000/000
- n) ST700 Handbook..... 667/HB/27880/000
- o) GEMINI Traffic Outstation Handbook ..... 667/HB/30600/000

## 1.4 DEFINITIONS

DoT	Department of Transport
IMU	Integral Monitoring Unit
LGD	Last Gasp Dial
LMU	Lamp Monitor Unit
MOVA	Microprocessor Optimised Vehicle Actuation.
OMU	Outstation Monitor Unit
PSTN	Public Switched Telephone Network
PSU	Power Supply Unit
STCL	Siemens Traffic Controls Ltd
ST700	Siemens Type 700 Pedestrian Controller
ST800	Siemens Type 800 Traffic Controller
T400	STCL T400 Traffic / Pelican Controller
TCSU	Traffic Control Systems Unit
TCUG	Traffic Control User Group
TfL	Transport for London (the new name for TCSU-London)

## 1.5 ISSUE HISTORY

- 01.00A First Draft (Pelican IMU).
- 01.00B Review Draft.
- 01.00C Post review Draft.
- 01.00D Further Clarifications.
- 01.00 Incorporates comments from TCSU dated 6/2/95.
- 02.00A Document modified to include information on the intersection IMU so that the document applies to both the T400 pelican and intersection controllers.
- 02.00B Comments from STCL review included.
- 02.00 Incorporates changes requested by TCSU in FAX dated 21/11/96.
- 03.00 Incorporates changes for the Part Time on Individual Streams Facility and the new fault codes FC59 and FC60 and use of the TfL TCUG outercase.
- 04.00 Details of the ST700 and ST800 added.
- 05.00 Document modified to include information on configuring the IMU for connecting to a GEMINI Bus Processor via the modem serial link.



## 2. GENERAL DESCRIPTION

### 2.1 OVERVIEW

The Integral Monitoring Unit is used with the Siemens T400, ST700 and ST800 Traffic Controllers to perform a multitude of different monitoring and control functions such as lamp monitoring, monitoring the status of the controller for faults, modifying values of timings in the controller etc.

The IMU consists of an Integral Facilities Processor PCB, a Modem, a rechargeable Nickel-Cadmium Battery and a Mounting Panel. For a detailed description of the Integral Monitoring Unit please refer to the Full Functional Specification 667/UH/25073/000 (plus the various /UH/ supplements, see section 1.3) and the Engineering Specification for the TCSU Integral Monitoring Unit 667/SA/20652/001.

### 2.2 UTC CONTROLLERS AND 'TC8 MODE'

For UTC sites where an OTU is connected to the telephone line rather than the IMU, the IMU has a special 'TC8 Mode' (also see section 6.2 on page 35). In this mode, it no longer uses its modem or its rechargeable battery (and both should be disconnected from the IMU and removed from the controller outercase). If required, two digital outputs from the IMU can be connected to the OTU to provide two reply bits – 'lamp fault' and 'any fault' (see section 3.7.2 on page 19).

### 2.3 MODEM

An RS232 Serial Interface on the Integral Facilities Processor Card is used to communicate with a modem external to the PCB itself. This allows the IMU to use any modem suitable for the application.

### 2.4 LAMP MONITORING

On the T400, the IMU provides a Lamp Monitoring facility by means of 24 analogue inputs to the Integral Facilities Processor PCB. These allow for the connection of up to 23 Current Monitoring Torroids and 1 Voltage Monitoring Transformer.

On the ST700 and ST800, the controller provides the lamp monitoring with the information passed from the controller to the IMU over the Extended System Bus Interface. Therefore Current Monitoring Torroids and the Voltage Monitoring Transformer are no longer connected to the Integral Facilities Processor PCB.

### 2.5 LAST GASP DIAL

A Last Gasp Dial facility is available using an external Nickel Cadmium battery to provide power to the PCB. If there is a mains failure, this supports several dial attempts to inform the instation of the mains power failure. The processor is able to monitor the condition of the battery with a periodical test to ensure that it is operating correctly.

## 2.6 GENERAL PURPOSE INPUTS / OUTPUTS

The Integral Facilities Processor has four inputs and four outputs which is additional to the normal I/O available on the controller. The inputs are standard TR0141 type digital inputs and the outputs are voltage free relay contacts.

## 2.7 HANDSET ACCESS

Handset access to the Integral Monitoring Unit is carried out using an 80-character terminal. This is connected to the handset port on the controller with data passed to / from the Integral Monitoring Unit using the Extended System Bus Interface.

## 2.8 INTERFACES

The Integral Facilities Processor PCB has five connectors to provide physical connections to the following devices. Refer to Figure 1 on page 13 for the position of the connectors on the PCB.

PL1	40-way IDC Header	to Controller (Extended System Bus)
PL2	50-way IDC Header	to Lamp Monitoring Sensors
PL3	25-way D Connector	to Modem or GEMINI Bus Processor
PL4	16-way IDC Header	(Proprietary Serial Link for Future Use)
PL5	34-way IDC Header	to Power Supply and I/O Terminal block

## 2.9 POWER SUPPLY

The Integral Monitoring Unit requires the following power:

12V @ 700mA (Max)	The 12V supply is regulated on board to provide $\pm 5V$ required by the PCB circuitry (and some modems). It is also regulated to provide 8V for powering some modems.
24V @ 80mA (Max)	The 24V supply is used for powering the digital input circuits and for the Last Gasp battery charger.

The power requirements are supplied using the standard controller power supplies, although the ST700 and ST800 are fitted with a DC/DC converter on the modem-mounting panel to provide the 12V supply from the controller's 24V since the ST700/ST800 power supplies no longer provide 12V directly.

## 2.10 SIZE

The Integral Monitoring Unit is a Double Extended Euro Card size PCB (233.4mm x 220mm). It fits in a standard T400 and ST800 Logic PCB rack and has components no higher than 18mm from the surface of the PCB.

### 3. INSTALLING THE IMU RETRO-FIT KIT

Note that the normal situation would be for the controller to be delivered with the Integral Monitoring Unit already installed. However, in the event of failure in one or more of the components of the IMU, it would be necessary to replace those components. This section has therefore been written as though only the Mounting Panel for holding the Modem (modem only fitted if required) and LGD battery etc., and the LMU Current and Voltage Transformers are already fitted. To replace or install any of the other components, follow the appropriate instructions in this section.

#### 3.1 GENERAL

Installation of the Integral Monitoring Unit is carried out in the following order:

- Section 3.2: Check controller processor PCB
- Section 3.3: Configure the IMU PCB via switches / links:
  - Selection of the external modem supply (PL5 and PL9) where a modem is fitted.
  - Lithium Battery Switch (S2)
  - Last Gasp Dial Battery Switch (S3)
- Section 3.4: Install the PCB into the Controller
- Section 3.5: Install the Modem. This step is required where a modem is to be installed and not when the IMU is connected to a GEMINI Bus Processor via a direct serial link.
- Section 3.6: Install the LGD Battery
- Section 3.7: Connect the necessary cabling

#### 3.2 CHECK CONTROLLER PROCESSOR PCB

Operation of the IMU in a controller will not be possible until the correct firmwares are fitted and the correct controller configuration is loaded.

##### 3.2.1 T400 CONTROLLERS

The IMU requires a T400 Main Processor PCB that is at Issue 9 or greater. The Issue of the PCB is marked on the bottom edge of the PCB viewed from above. If the Issue of the Main Processor is 8 or less, then it must be replaced before operation of the IMU can commence.

For the Pelican IMU firmware PB580, the T400 Controller must be fitted with PB322 firmware issue 2 (or higher).

For the Pelican and Intersection IMU firmware PB581, the T400 Controller must be fitted with PB322 issue 5 (or higher).

If the Part Time on Individual Streams Facility is required then the T400 Controller must be fitted with PB322 firmware issue 7 (or higher), and the IMU must be fitted with PB581 firmware issue 2 (or higher).

**Important:** The IMU firmware PB581 issue 2 should not be used with T400 firmware issue 6 (or earlier). Other issues of PB581 can be used with these issues.

Pelican T400 Controllers must include Configuration and Conflict EPROM's that support the Integral Monitoring facility as listed below:

- DT064 and DT065 Single MCE1025 Pelican Controller (EM23208)
- DT066 and DT067 Dual MCE1025 Pelican Controller (EM23209)
- DT068 and DT069 Single MCE0145 Pedestrian Controller (EM23210)

NB: In each case, the first 'DT' number is the configuration EPROM and the second 'DT' number is the conflict EPROM.

Intersection T400 Controllers must be configured using the Configurator IC3 issue 12 (or later) and the 'Integral OMU' facility must be enabled. The Configurator IC3 Issue 14 (or higher) is required to configure the Part Time on Individual Streams Facility.

### 3.2.2 ST700 AND ST800 CONTROLLERS

The controller must be fitted with the firmware PB800 issue 18 (or higher) and the IMU must be fitted with PB581 issue 5 (or higher).

The ST700P Pedestrian and ST800 Intersection configurations require the 'London IMU' facility to be enabled and thus require IC4 version 6.2 (or later).

The TfL versions of the standard ST700P Pedestrian configurations are listed below:

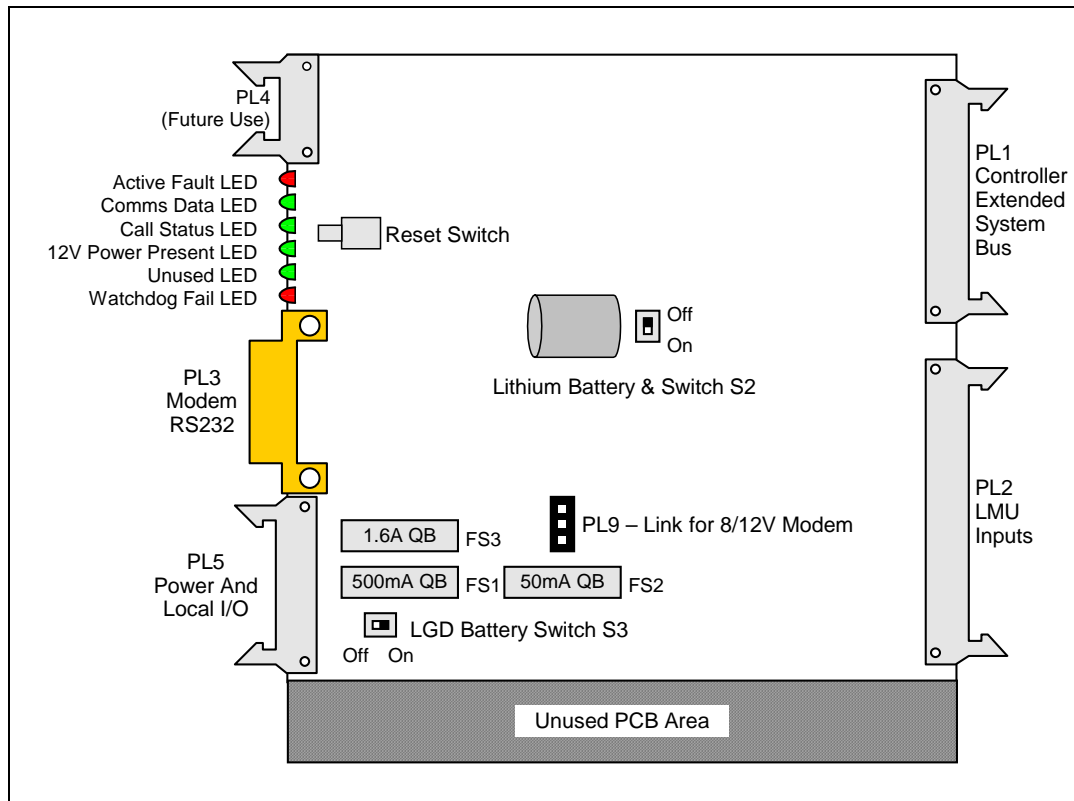
- E60710 – TfL ST700P Single or Dual Pelican
- E60711 – TfL ST700P Single or Dual Near-Side Pedestrian Crossing
- E60712 – TfL ST700P Single or Dual Pedestrian Blackout Crossing

Refer to the special instructions within these configurations for installation and commissioning details for those ST700P pedestrian controllers.

Confirm that these are the correct configurations required for the site before loading them into the ST700P.

### 3.3 CONFIGURING THE INTEGRAL FACILITIES PCB

Figure 1 below shows the layout of the Integral Facilities PCB. The position of the links, switches, fuses, connectors and status LED's is shown.



**Figure 1 – Layout of Switches and Links on Integral Facilities Processor**

Ensure that the correct variant (667/1/25169/001) of the PCB has been supplied.

For details on the connections on PL5 see Figure 6 on page 19, and for details of the connections on PL2 see section 3.7.7 (which starts on page 23). More information on the status LED's can be found in section 5.1 on page 31.

### Safety Warning

The Integral Monitoring Unit PCB contains a Lithium Battery. Care must be taken with the use and disposal of this battery. The handling precautions in Siemens code of practice CP526 must be followed.

### 3.3.1 CONFIGURING THE SWITCHES AND LINKS ON THE PCB

The voltage required by the modem is clearly labelled on the modem itself.

The IMU can supply any one of three different DC voltages 5V, 8V or 12V to the modem from the connector PL5 on the front of the IMU (see Figure 6 on page 19).

To select 5V, fit the power cable to the modem to pin 22 of PL5.

To select 8V or 12V, fit the power cable to the modem to either pin 23 or 24 and then select either 8V or 12V using PL9 below.

#### 8V / 12V Modem Supply Link (PL9)

Link PL9 is a three-way link with two positions. These are used to select 8V or 12V operation for the external modem (see Figure 2 below). The setting of this is dependent on the type of modem fitted with the Integral Monitoring Unit.

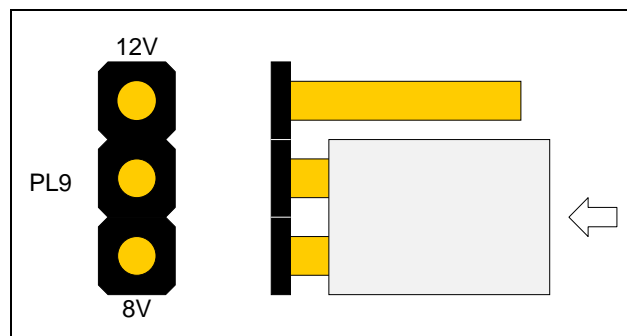


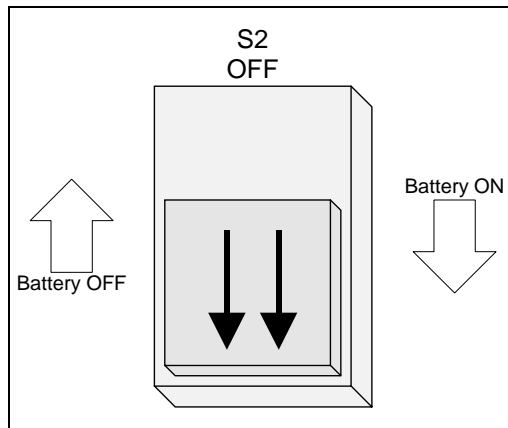
Figure 2 – 8V / 12V Links for Modem Supply

Linking the centre pin on PL9 to the pin labelled 8V or the pin labelled 12V sets the supply voltage to the external modem. This is done using the shorting link supplied on the Integral Facilities PCB. This link is normally set in the 8V position unless 12V operation is required.

#### Lithium Battery Switch (S2)

The Lithium Battery Switch S2 must be switched on to allow backup of the Data RAM in the event of a power failure. Moving Switch S2 to the “ON” position (see Figure 3 below) does this.

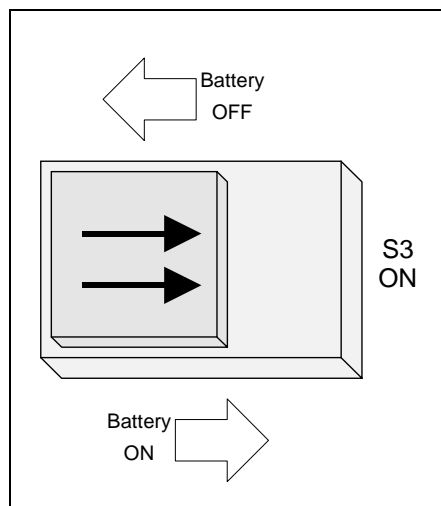
Note: Due to the position of the switch on the PCB, it is very difficult to turn this switch on after the board has been installed.



**Figure 3 – Lithium Battery Switch Setting**

### Last Gasp Dial Battery Switch (S3)

The Last Gasp Dial Battery Switch (S3) should be set to the “OFF” position for installation. It is located in the bottom left hand corner of the PCB with the “ON” position marked in the silk-screen. This switch can be operated with the board in position in the controller.



**Figure 4 – Last Gasp Dial Battery Switch**

### **3.4 INSTALLING THE INTEGRAL FACILITIES PCB**

The Controller should be switched off before any insertion / removal of PCBs takes place. It should only be switched on again after the insertion / removal is complete and all connections have been made to any PCBs that have been changed.

When all the necessary switches and links have been configured, the Integral Facilities PCB should be installed as in Figure 5 on page 17.

### **3.5 INSTALLING THE MODEM (NOT UTC CONTROLLERS)**

The Modem used in the Integral Monitoring Unit is installed on the modem panel mounted in the controller. The restraining bar should then be fastened down over the modem to secure it firmly to the panel.

Where the modem has an On / Off Switch, this should be set to the 'ON' position for normal operation. If it has a three position switch, i.e. 'On/Auto/Off', then the switch should be set to the 'auto' position.

### **3.6 INSTALLING THE BATTERY (NOT UTC CONTROLLERS)**

The Nickel-Cadmium Battery used with the Integral Monitoring Unit is also mounted on the modem panel.

The battery clamp should be removed from the panel and the battery fitted to the clamp with the battery leads freely available at the ends of the clamp. The clamp should then be replaced on the modem panel and the nuts tightened to secure the battery pack firmly to the modem panel.

Care should be taken when tightening the battery clamp to ensure that it is just sufficient to prevent the battery from moving.

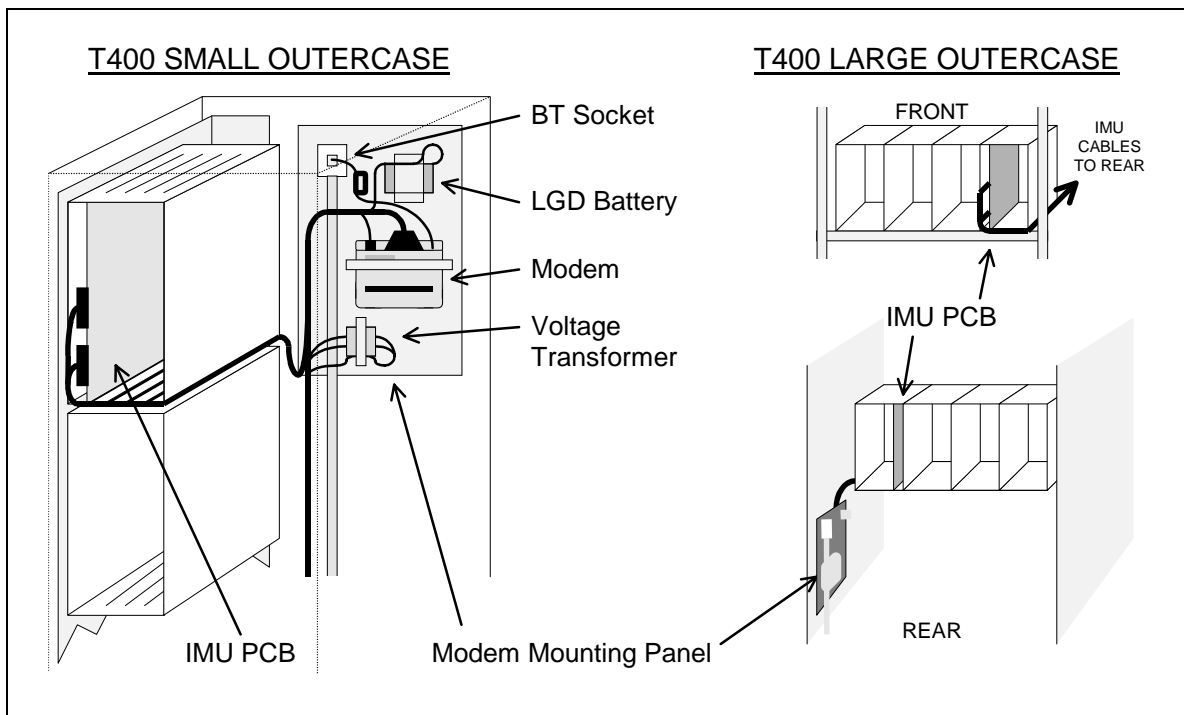


### 3.7 CONNECTING THE IMU

When the modem (as required), battery and Integral Facilities Processor have been installed into the Controller the following connections must be made:

- Section 3.7.1: Extended System Bus Cable (PL1)
- Section 3.7.2: Power and Local I/O Cable (PL5)
- Section 3.7.3: RS232 Cable (PL3)
- Section 3.7.4 and 3.7.5: Modem Connections. This step is required where a modem is installed and not when the IMU is connected to a GEMINI Bus Processor via a direct serial link.
- Section 3.7.6: Battery Connections
- Section 3.7.7: LMU Inputs (PL2)

All the cable designators given in this section refer to the connections on the Integral Facilities Processor PCB. Where appropriate, these are marked on the cableforms used.



**Figure 5 – Overview of Components**

(See overleaf for the TfL TCUG Outercases)

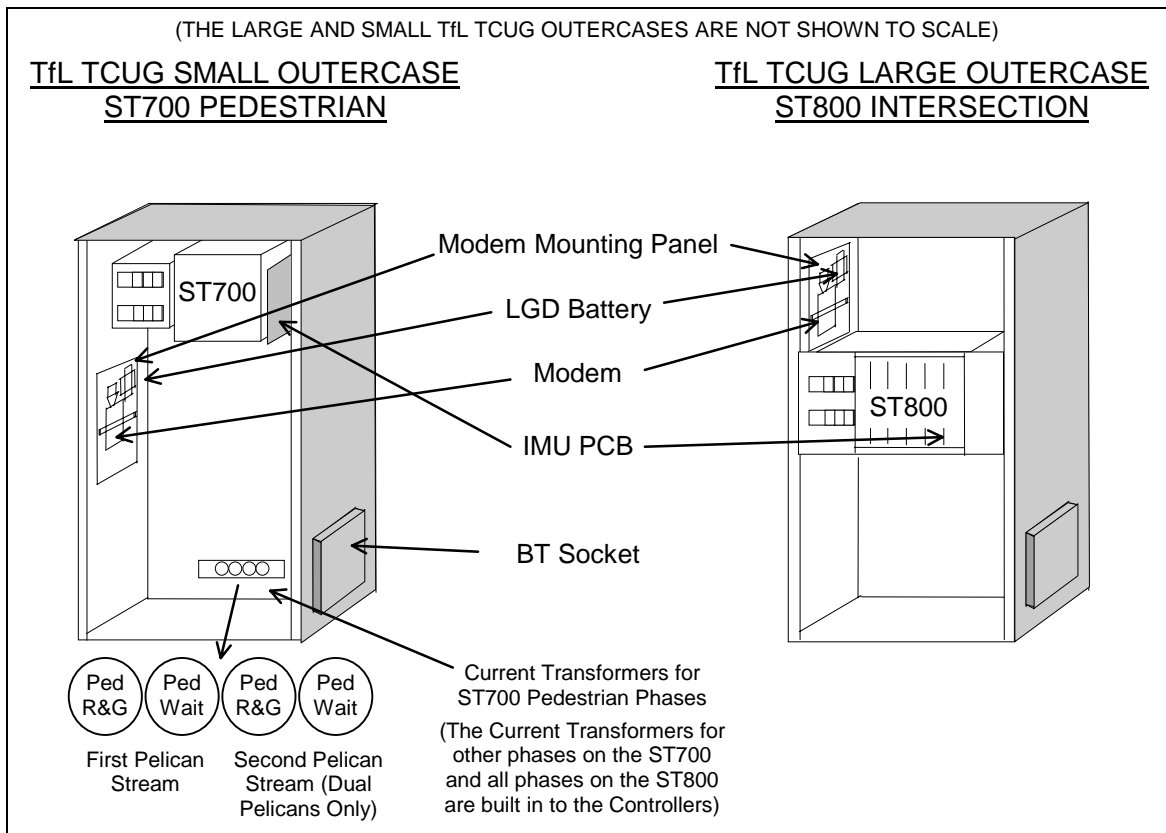
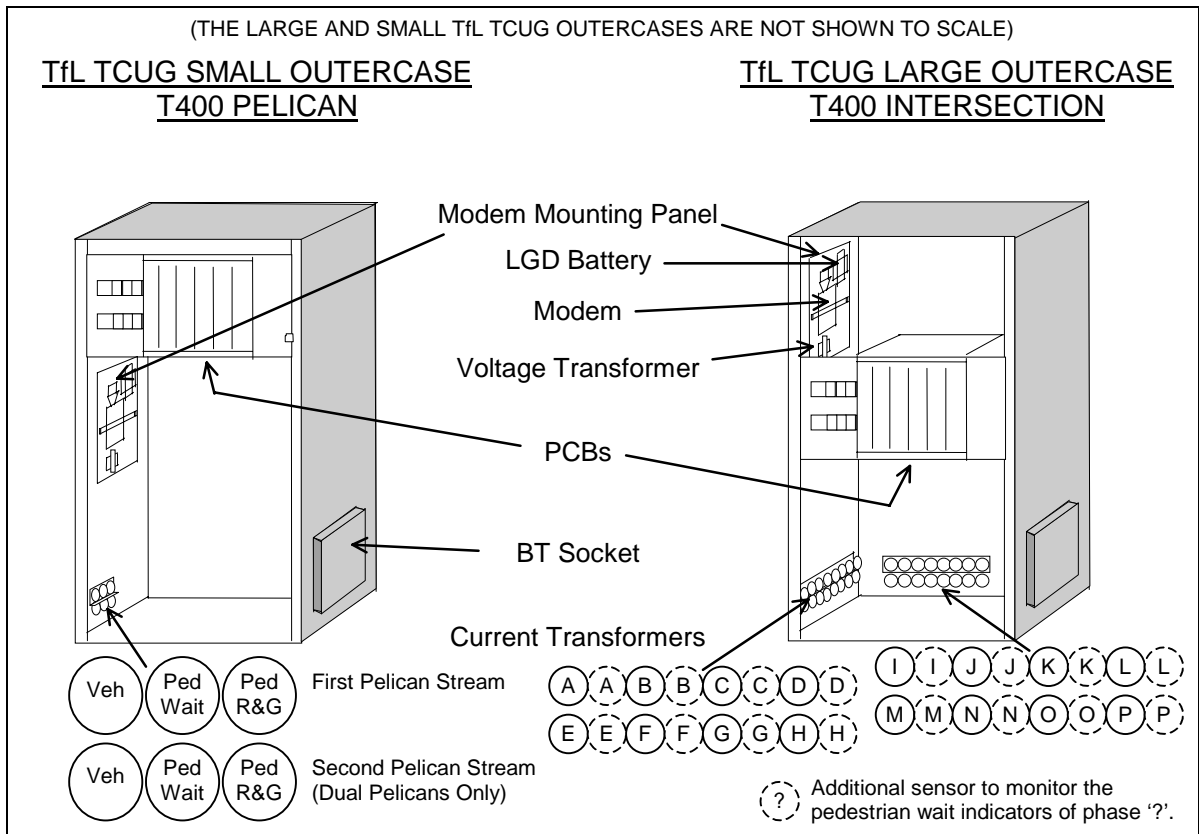


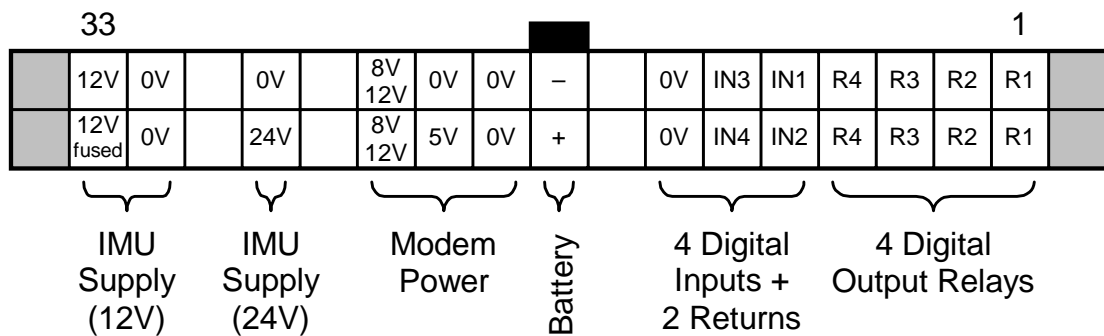
Figure 5 – Overview of Components (Continued)

**3.7.1 EXTENDED SYSTEM BUS**

The Extended System Bus is a ribbon cable that links all the logic PCBs of the controller together. This should be plugged into PL1 (see Figure 1 on page 13) and the latches closed.

**3.7.2 POWER AND LOCAL I/O CABLE**

The Power and Local I/O Cable is connected to PL5 (see Figure 1 on page 13) on the Integral Facilities PCB. The Berg Connector housing should be plugged into PL5 and the latches closed to secure it into position.



**Figure 6 – IMU Connector PL5**

See section 3.3.1 for details on the “Modem Power” connections.  
See sections 2.9 and 5.4 for details on the “IMU Supply” connections.

The four general purpose inputs and four outputs for the IMU are then normally available on the T400 controller I/O terminal blocks as detailed below. Note that the same terminal block names and terminal numbers are used in the T400 Outercase and the TfL TCUG Outercase.

	Single Pelican	Dual Pelican	Intersection	(TC8 Outputs*)
Input 1:	TBD 13	TBE 9	TBAA 1	–
Input 2:	TBD 14	TBE 10	TBAA 2	–
Input 3:	TBD 15	TBE 11	TBAA 3	–
Input 4:	TBD 16	TBE 12	TBAA 4	–
Output 1:	TBD 17 & 18	TBD 17 & 18	TBAA 5 & 6	–
Output 2:	TBD 19 & 20	TBD 19 & 20	TBAA 7 & 8	–
Output 3:	TBD 21 & 22	TBD 21 & 22	TBAA 9 & 10	‘Lamp Fault’
Output 4:	TBD 23 & 24	TBD 23 & 24	TBAA 11 & 12	‘Any Fault’

\* See section 2.2 on page 9

The Work Specification for the controller should be checked. It may detail any changes to this as well as identifying the terminal blocks used for the controller’s I/O.

### 3.7.3 RS232 CABLE (NOT UTC CONTROLLERS)

#### TO MODEM

The RS232 Cable to the modem is a single moulded cable (part number 667/7/25175/000).

The RS232 Cable connects the Integral Facilities Processor PCB to the modem. It connects to PL3 (see Figure 1 on page 13) on the PCB and the 25-way D Connection on the modem.

If the modem is provided with a 9-way D socket then it will have a 9-way to 25-way Converter fitted such that the RS232 cable can be plugged into the 25-way socket on the Converter.

The RS232 Cable should be connected to the Integral Facilities PCB and the upper screwlock on the right angle connector tightened to the PCB connector.

The RS232 Cable should then be connected to the modem (or Converter) and both screwlocks tightened to the modem connector (or Converter connector).

For routing of the RS232 and the Power and Local I/O Cables in the T400 cabinet, refer to Figure 5 on page 17 and the notes below.

In a small T400 outercase (i.e. a Pelican T400), the cables are routed along the side of the top PCB module to the back of the cabinet and the modem panel.

In a large T400 outercase (i.e. an Intersection T400), they are routed by the side of the PCB modules to the panel at the rear.

In the T400 and ST800 Intersection Controller Large TfL TCUG Cabinets the RS232 cable leaves the IFC and passes under the PCB rack before crossing the controller and connecting to the modem. The Power and I/O Cable is passed between the IFC and the PCB to its left, exiting the back of the PCB rack.

In the T400 Pelican Small TfL TCUG Cabinet the RS232 cable leaves the IFC and is fed through a cut-out in the right hand side of the front panel before crossing the controller to the modem. The Power and I/O Cable is passed between the IFC and the PCB to its right, exiting at the back of the PCB rack.

In the ST700 Pelican Small TfL TCUG Cabinet the IFC cables run along the top of the rack from the IFC card on the right to the modem mounting panel on the left.

All cables should be secured into position using cable ties.

## **TO GEMINI BUS PROCESSOR**

The RS232 connection to the GEMINI Bus Processor is a pair of cables. The first is the single moulded cable (part number 667/7/25175/000) used for connection to a modem. The second is a short length (15cm) ribbon cable with a 25-way D-type connector and an 18-way IDC connector at opposite ends of the cable (part number 667/1/26579/003) – see Figure 7 below.



**Figure 7 – Short Length Serial Cable to GEMINI Bus Processor**

The two cables connect the Integral Facilities Processor PCB to the GEMINI Bus Processor.

The moulded cable should be connected to the Integral Facilities PCB and the upper screwlock on the right angle connector tightened to the PCB connector.

The moulded cable should then be connected to the short length cable and both screwlocks tightened to the short length cable D-type connector.

The combined cable should initially be routed inside the cabinet in a manner that complies with a modem installation. Since there is no modem, the GEMINI Bus Processor end of the cable should be routed to the rear of the 3U rack assembly containing the GEMINI Bus Processor.

The short length cable IDC connector should be firmly inserted into the PL4 connector on the GEMINI Bus Processor PCB card. NOTE : The GEMINI Bus Processor must be unpowered before this connection can be made. The peripheral cards on the GEMINI Bus Processor must be removed to gain clear access to the PL4 connector on the PCB card. Once the connection has been made, the peripheral cards must be reattached to the GEMINI Bus Processor. See GEMINI Traffic Outstation Handbook 667/HB/30600/000 for details of Bus Processor card removal and replacement.

All cables should be secured into position using cable ties.

### 3.7.4 MODEM TELEPHONE CONNECTION (NOT UTC CONTROLLERS)

The Telephone cable supplied with the modem should be connected from the modem to the BT Socket in the controller outercase.

In controllers in TfL TCUG Outercases the BT Socket is in the BT Compartment on the side of the controller.

In other outercases, the BT socket is mounted on the modem-mounting panel.

The Telephone cable is polarised to ensure the connection can only be made in the correct manner. Any slack remaining in the telephone cable should be coiled up and secured to the modem-mounting panel.

Where an existing installation is being modified so that the IMU is connected to a GEMINI Bus Processor via a direct serial link, then the telephone cable is not required. The telephone cable should either be removed from the cabinet or disconnected from the modem. If the telephone cable is retained within the cabinet, any slack should be coiled up and secured to the modem-mounting panel.

### 3.7.5 MODEM POWER CONNECTION (NOT UTC CONTROLLERS)

The power connection to the modem is dependent on the type of modem that has been supplied.

Care should be taken to ensure that the contacts of the plug do not short with the modem mounting panel or the controller case. If the modem is removed in 'TC-8 mode' the power connector (if fitted) should be neatly insulated and tied back.

Note: Some modems have a small compartment to hold a 9v battery. This should be checked, as this battery is **not** required and should be removed. When connecting the modem power, it is advisable to have the modem switch in the 'off' position to prevent accidental blowing of the modem supply fuse, FS1 on the Integral Facilities Processor PCB.

The power connection is made using the jack plug connected to the Power and Local I/O Cable from the Integral Facilities Processor PL5, see Figure 6 on page 19.

Where an existing installation is being modified so that the IMU is connected to a GEMINI Bus Processor via a direct serial link, then the modem is not required. The modem should either be removed from the cabinet or the modem power connector be disconnected from the modem. In either case, the modem power connector should be secured to the modem-mounting panel.

### 3.7.6 BATTERY CONNECTIONS (NOT UTC CONTROLLERS)

The battery connections are made using bullet crimps installed on the battery. These are polarised and should be mated with the corresponding crimp on the Power and Local I/O Cable connection on the modem panel.

If the battery is removed in 'TC-8 Mode' the crimps on the Power and Local I/O Cable should be neatly insulated and tied back.

### 3.7.7 LAMP MONITORING INPUTS (T400 ONLY)

The LMU Inputs connect to PL2 (see Figure 1 on page 13) on the Integral Facilities Processor PCB. The LMU sensors connect to a 54-way Berg Connector Shell. This should be plugged into PL2 and the latches closed.

If the IMU is fitted to an ST700 or ST800 then the lamp monitoring is provided by the controller so PL2 on the Integral Facilities Processor card unused.

If the IMU is fitted to an Intersection T400 Controller with Red Lamp Monitoring, the LMU connector will be a 64-way Berg which should be plugged into the T400 Integral RLM card's PLB socket, with PL2 on the Integral Facilities Processor card unused. In this case, the LMU of the Integral Facilities Processor obtains information on lamp loads from the RLM card across the T400 Extended System Bus.

### Current Transformers and Voltage Monitor Connections (T400 Only)

When the controller reaches site it will normally have all its Current Transformers and the Voltage Monitor installed and connected to the appropriate positions on the Berg connector. In this case the remaining information in this section will not be required, and can be skipped. It is included here for assistance if any problems are encountered.

The IMU board contains an IDC connector that allows 23 current sensors (46 pins) and the one voltage sensor (2 pins) to be attached. The LMU sensors or 'Channels' are allocated automatically from the controller configuration PROM.

For a single / dual pelican the channels are allocated as follows:

Channel 1	PL2 Pins 1 & 2	Vehicle 1	\
Channel 2	PL2 Pins 3 & 4	Pedestrian 1	Single or Dual
Channel 3	PL2 Pins 5 & 6	Wait Indicator 1	/
Channel 4	PL2 Pins 7 & 8	Vehicle 2	\
Channel 5	PL2 Pins 9 & 10	Pedestrian 2	Dual Pelican Only
Channel 6	PL2 Pins 11 & 12	Wait Indicator 2	/
...	...	...	
Channel 24	PL2 Pins 47 & 48	Voltage Monitor	– Single or Dual

For intersection controllers, the allocation is specified when the configuration PROM is created using IC3 (the T400 configurator package). The recommended allocation is as follows. Since it is possible that controllers will be assembled before the allocation of phases is determined, the configuration will initially

default to one sensor per phase starting with sensor/channel 1, so that the first 'N' phases are monitored on the first 'N' channels as shown below:

Channel 1	PL2 Pins 1 & 2	Phase A
Channel 2	PL2 Pins 3 & 4	Phase B
Channel 3	PL2 Pins 5 & 6	Phase C
Channel 4	PL2 Pins 7 & 8	Phase D
...	...	...
...	...	...

The additional sensors for monitoring wait indicators will be added later. To facilitate the addition of new phases at a later date and to make it easier to locate the pins on connector, the 'wait sensors' will be allocated down from channel 23.

Note that the KAD handset command (see section 6.6 on page 38) will indicate the phase monitored by each sensor, including these 'wait sensors' at the end.

...	...	...
...	...	...
Channel 22	PL2 Pins 43 & 44	2nd wait indicator
Channel 23	PL2 Pins 45 & 46	1st wait indicator
Channel 24	PL2 Pins 47 & 48	Voltage monitor

For example, a complex sixteen-phase controller including six pedestrian phases should be configured with the 1st wait indicator (Phase C) on channel 23, etc.:

Phase:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Type:	V	G	P	P	V	V	P	P	P	V	V	G	V	V	V	P
LMU:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
			23	22			21	20	19							18

(Channel 17 is not required)

Phase - the 16 phases of the T400, 'A' to 'P'

Type - the phase type: V = Vehicle, P = Pedestrian or G = Green-Arrow

LMU - the channel number used to monitor the phase

(plus the channel number used to monitor wait indicators if Ped phase)



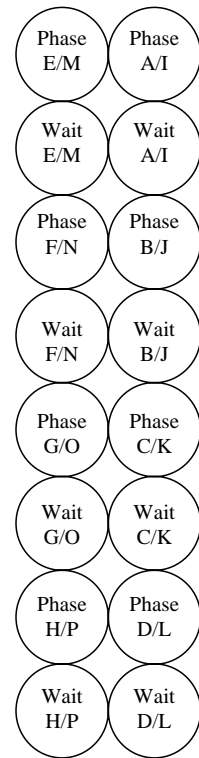
The diagram to the right shows the Positions of the Current Transformers at the back of a T400 Intersection Controller in a Large T400 Cabinet only.

See Figure 5 on page 17 for the location of the Current Transformers in other cabinets.

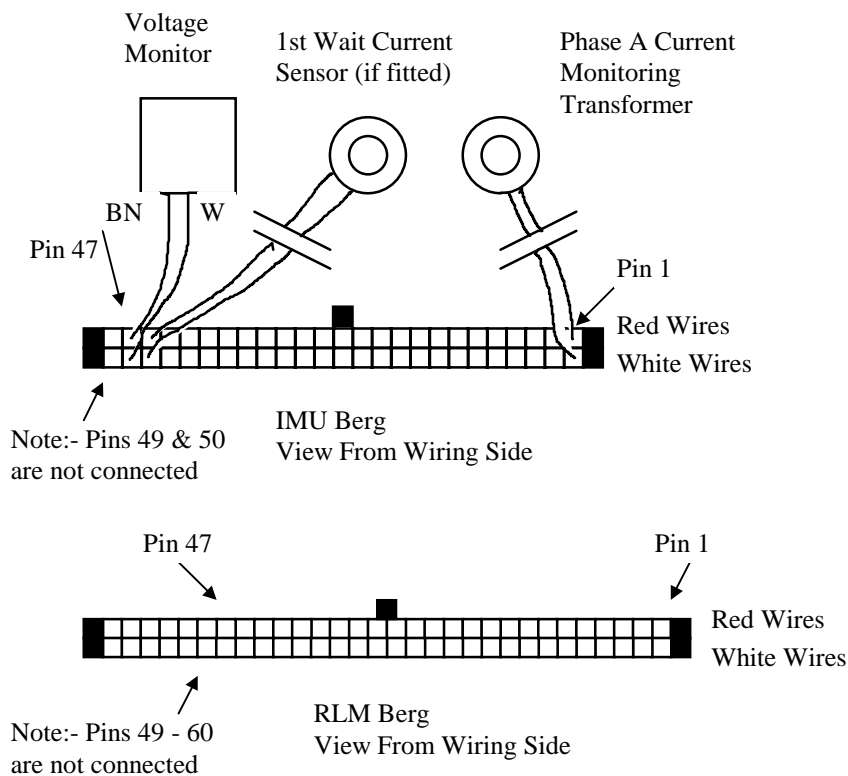
The Current Transformers for a phase are only fitted if the phase is configured.

The Current Transformers for the Wait Indicators are only fitted if it is a Pedestrian phase.

The two columns of Current Transformers will be duplicated if there are more than 8 phases. The first double column covers phases A to H and the second double column covers phases I to P.



The following diagram shows how the Current Transformers and the Voltage Monitor are connected to the Berg, in the case where the Berg is plugged into the Integral Facilities Processor PCB or into the RLM PCB.



## 4. COMMISSIONING

### 4.1 GENERAL

Commissioning of the Integral Monitoring Unit is carried out in the following order:

- Initialisation
- Configure the IMU
- Commission the IMU
- Clear Fault Log of IMU

### 4.2 INITIALISATION

#### 4.2.1 POWER ON THE CONTROLLER

#### 4.2.2 SWITCH ON THE LGD BATTERY (NOT UTC CONTROLLERS)

The LGD Battery Switch is located directly behind the Power Connector (PL5) on the Integral Facilities Processor PCB.

To switch the battery on, the Switch S3 must be moved to the position away from the front edge of the PCB (see Figure 4 on page 15). This Switch can be operated with the board in position in the controller.

#### 4.2.3 CHECK THE POWER LED ON THE IMU IS ILLUMINATED

The status LEDs are described in section 5.1 on page 31.

#### 4.2.4 OPERATE THE RESET SWITCH ON THE IMU

The RESET switch is located immediately behind the LED's and can be operated with a suitable tool such as a screwdriver or pencil.

**NOTE:** Operating the RESET switch clears the IMU fault logs, RAM code and configuration data, with the exception of the instation telephone number. 'IMU Reset to Level 1' and 'Lamp Monitor Reset' events are recorded in the IMU's fault log as NAK reports. When the reset is complete, the IMU will dial the instation, if a telephone number has been configured previously, in order to report its condition. After operation of the RESET switch, the IMU operating code and configuration will have to be downloaded from the instation.

## 4.3 CONFIGURE THE IMU

### 4.3.1 CONNECT THE MAINTENANCE TERMINAL TO THE CONTROLLER HANDSET PORT

On a T400 the Terminal should display the prompt automatically when the handset is connected. Initially connection is to the IMU rather than the T400:

```
IMU>
```

On an ST700 and ST800, the handset port 'auto-bauds' to match the baud rate used by your handset or PC (either 1200, 9600 or 19200 bps). Therefore, press [RETURN] a number of times so that the handset port can determine the required baud rate. Also note that on ST700 and ST800 controllers, the initial connection is always to the controller, unlike the T400 where the initial connection is to the IMU. Therefore, the controller prompt will always appear initially:

```
SIEMENS  
>
```

Connection to the IMU can be achieved by entering "IMU↵".

If IMU is not operating correctly, the fault log flag 'FLF59' should be set and fault log data (FLD82) can be examined to determine the cause of the IMU failure:

```
FLD 82:00000010 - IMU/Controller interface not running correctly.  
FLD 82:00010000 - Compatibility error.  
FLD 82:01000000 - Configuration PROM fault.  
FLD 82:10000000 - Compatibility error.
```

The first fault indicates a general fault with the interface between the controller and IMU, such as the IMU card is not connected to the Controller extended system bus or the IMU software is not running correctly. It will automatically clear once the IMU is connected and running correctly.

The other three faults should not normally occur and are only described for completeness. Compatibility information is passed from the IMU to the controller in order to handle future expansion. The two compatibility faults above occur when the interface across the extended system bus or the 'type' of IMU card is not what the controller is expecting. The configuration PROM fault is generated when the PROM requests the IMU facility but does not indicate that the upper 16k (where the IMU configuration resides) of the 32k device has been set-up.

**NOTE:** If the controller has not had an IMU fitted before and cannot communicate with an IMU card at all on power up, it will naturally assume that no IMU card is fitted and not log any faults. This may occur if the IMU power connector (PL5) is not connected for example. In this case, the controller handset command 'Integral OMU fitted' will still show false (OMF:0).

### 4.3.2 ENABLE TC8 MODE (AT UTC CONTROLLERS)

If TC8 mode is required, i.e. at a UTC controller where the OTU is connected to the telephone line and not the IMU, then the following IMU handset commands

(also see section 6.2 on page 35) need to be entered to initiate that mode of operation:

Use KME to get level 2 access and then enter "TCE=88" to enable the facility.

At this point the IMU will 'reboot' into 'TC8 mode'. Therefore the handset connection with the IMU will need to be re-established and KME re-entered to regain level 2 access.

The IMU will attempt to set its clock from the controller. However, since the T400 controller does not hold the date, this needs to be set-up manually in the IMU using the IMU handset command "TOD=10JAN94" for example.

Enter "TCM=1" to enable monitoring.

#### **4.3.3 INITIATE A LOCAL LOOPBACK TEST OF THE MODEM (NOT UTC CONTROLLERS)**

Use KME to get level 2 access and then set LTS=1. Check that the LTS display indicates test running (LTS:2) and then test passed (LTS:0). For more information on these handset commands, see section 6.1 on page 34.

This test is still applicable to installations where there is no modem installed and the IMU is connected directly to a suitably configured GEMINI Bus Processor. The Bus Processor emulates the modem provided that it has been configured to operate a direct serial link to an IMU.

#### **4.3.4 SWITCH TO THE CONTROLLER HANDSET COMMANDS**

Entering 'CON↵' will switch the handset from the IMU to the controller.

Upon switching to the controller for the first time, a password is requested. When the correct password is entered, the controller prompt ">" is displayed. The default password is 'ZZZZ', but consult TCSU for the current password.

Entering 'IMU↵' will switch the handset from the controller to the IMU.

#### **4.3.5 PERFORM NORMAL CONTROLLER COMMISSIONING SEQUENCE**

If the Controller firmware and configuration have not been changed and only the IMU has been modified (i.e. replaced or upgraded), then the controller does not need to be fully reset.

If the controller has been fully reset, then it must be commissioned in the usual way. This should include any special configuration requirements, as detailed in the works specification.

If the controller includes its own lamp monitor (e.g. T400 Intersection with Red Lamp Monitoring or any ST700 or ST800) then this should be commissioned as detailed in the relevant controller documentation.

#### 4.3.6 CHECK IMU CURRENT FAULT LOG

There should be no unexpected entries in the current fault log (FLC).

#### 4.3.7 LOAD IMU SOFTWARE (NOT UTC CONTROLLERS)

Dial the IMU from the Instation and carry out the following:

- a) Download the operating software
- b) Load the correct time into the IMU and Controller
- c) Download the IMU Configuration
- d) Reset IMU to Operating Level 2 (i.e. the downloaded code is executed and monitoring of the controller commences).

Note: The IMU will change automatically to operating level 2 once the call from the Instation is terminated. During the change, the IMU will perform a restart, which will re-initialise any maintenance terminal connection that was established at that time. The handset command RIR can also be checked to indicate that the IMU is in Level 2 (RIR:1).

#### 4.3.8 CONFIRM IMU OPERATION (NOT UTC CONTROLLERS)

Re-dial the IMU from the Instation and confirm that the change to operating level 2 is reported and that there are no active faults. Terminate the call to the IMU.

### 4.4 COMMISSION THE IMU

#### 4.4.1 SET COMMISSIONING FLAG ON IMU (NOT UTC CONTROLLERS)

The "Commissioning in Progress" Flag must be set on the IMU using the handset command 'CHK 2=1'. This is checked with the Instation as the IMU should dial up and inform the Instation of the change. Once the call to the Instation is completed, examine the entry in the current fault log to ensure that the NAK indication has been removed. This shows that the call was successful as the NAK indication is only removed when the fault has been acknowledged by the Instation.

#### 4.4.2 LAMP MONITORING (T400 ONLY)

Before entering KLR=1 to reset the IMU lamp monitor, check that all lamps are on and working correctly.

**Note that on an ST700 or ST800, the controller performs the lamp monitoring and this should have been checked as part of the normal controller commissioning procedure.**

Reset the IMU Lamp Monitor (KLR=1).

Note: If the IMU is fitted to an Intersection T400 Controller with Red Lamp Monitoring, ensure that the T400 Integral RLM card is functioning normally by checking the controller fault log.

Force the controller to cycle continuously and use the KAC or KES handset commands (see section 6.5 on page 37) on the IMU to check that the lamp currents and voltage are as expected.

After four controller cycles, use the KLS command to check that the LMU has learnt the lamp loads. When all the lamp loads have been learnt, all the bits in the KLS display will be cleared, i.e. KLS:00000000.

Note that if the site is fitted with dimming, then once the LMU has learnt the lamp loads in either dim or bright, it will set Bit 3 to indicate that it is waiting for a dim/bright changeover and hence commissioning is complete when the display shows KLS:00001000.

Restore the Controller to normal demand operation.

#### **4.4.3 LOCAL IMU DIGITAL INPUTS / OUTPUTS (NOT UTC CONTROLLERS)**

If any of the four digital inputs on the IMU are used, then toggle the states of the inputs and check, using the KDI command, that the IMU input port bits are updated correctly.

If any of the four digital outputs on the IMU are used, then toggle the states of the outputs using the DOP command and check that the IMU output lines change state correctly.

See section 6.3 on page 36 for more information on these handset commands.

### **4.5 CLEAR IMU FAULT LOG**

#### **4.5.1 CLEAR COMMISSIONING FLAG (NOT UTC CONTROLLERS)**

Before leaving site, the “Commissioning in Progress” flag must be cleared using the CHK command (CHK 2 = 0). The IMU will then dial the instation to report this change.

#### **4.5.2 CHECK IMU FAULT LOG**

Check the IMU current fault log (FLC) and ensure that there are no fault entries.

## 5. MAINTENANCE

### 5.1 STATUS LED'S

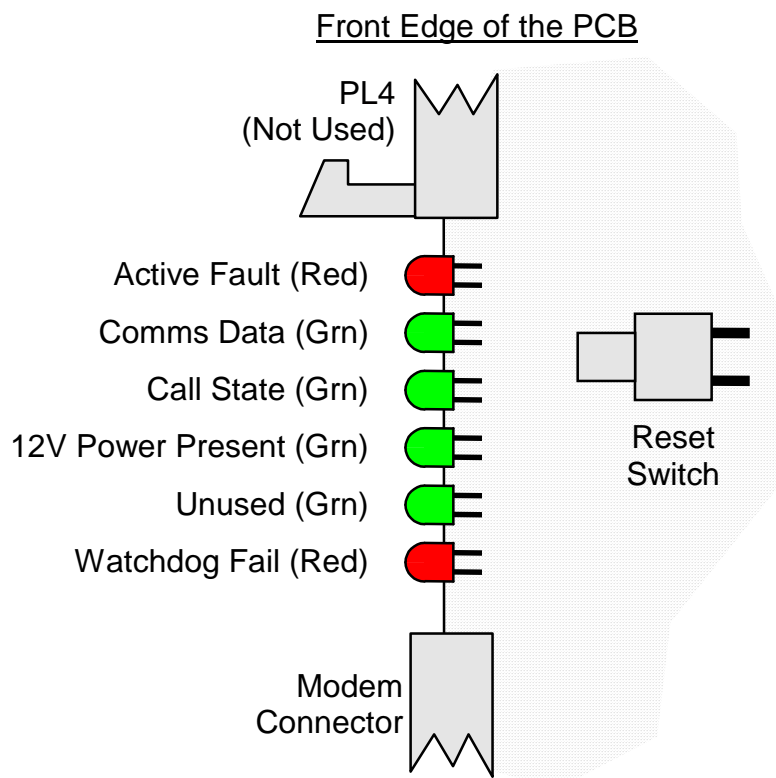
LED's are included on the front edge of the PCB to provide basic status information. The position of these LED's and their functions are detailed below...

The **Power LED** should be on, indicating the presence of +12V from the Controller.

The **Active Fault LED** is illuminated when an uncleared fault is recorded in the IMU's current Fault Log. The OMU may still be operating normally; depending on the type of failure that has been detected.

If the **Watchdog Fail LED** is illuminated the software is not running correctly. The operation of the watchdog forces the output relays to release to the non-active state and the modem to hang-up the telephone line.

The **Comms Data LED** is flashed when any data (such as modem configuration, instation message data or loopback test data) is sent from the Integral Facilities Processor PCB to the Modem. The **Call State LED** is flashed while the IMU is attempting to establish a call with the instation (either dialling out or answering). The LED is on steady while the IMU has a call successfully established with the instation.



**Figure 8 – Status LED's on the Integral Facilities Processor Card**

## 5.2 EFFECT OF INCORRECT SWITCH / LINK SETTINGS

If the **Lithium Battery Switch** (S2) is off the Active Fault LED will be illuminated and the failure recorded in the Fault Log\*.

If the **Last Gasp Dial Battery Switch** (S3) is off, the Active Fault LED will be illuminated and the failure recorded in the Fault Log\*.

\* These faults will only be recorded in the Fault Log if the IMU is operating at level 2 and is monitoring.

In the event that a modem is installed, if the modem power is set incorrectly (see section 3.3.1) there are two possible outcomes. If the modem is being supplied with a higher voltage it will probably work for a time, but the internal voltage regulator may eventually go into thermal shutdown. If the modem is supplied with a lower voltage than is nominally required, it may operate correctly. In both cases of incorrect setting, correct operation of the modem is not guaranteed and BAPT approval for the Modem is invalidated.

## 5.3 FAULT FINDING AFTER INSTALLATION

The list below details some possible faults that may occur after the Integral Monitoring Unit has been installed and commissioned, along with possible remedies for the faults.

<u>Symptom</u>	<u>Possible Reason</u>
Active Fault LED On	Use the Handset to access the Fault Log for information on the type of fault that has occurred.
Watchdog LED On	Software is not running correctly.  If the IMU cannot be accessed using the handset, use the controller OMS and OMH commands to record any error information.  Switch off the LGD battery and, if safe to do so, turn the controller power off and on again to restart the IMU software.  If the watchdog LED is still on, then Reset the Processor and clear the IMU RAM by using a suitable tool to depress the Reset Button on the front edge of the PCB behind the LED's. The IMU operating code will need to be reloaded, as described in section 3.7.7.
Inputs Not Functioning	Check Fuse protecting 24V supply on PCB (FS2)
Modem not Operating (where fitted)	Check Fuse protecting 8/12V supply to modem (FS1) and check that the RS232 cable, the Telephone Line and the Power connector to the modem are all connected properly.



## 5.4 FUSES

The Integral Facilities Processor is fitted with three fuses (FS1, FS2 and FS3) which are located just behind the Power and Local I/O Connector on the front edge of the PCB (see Figure 1 on page 13).

Fuse FS1 is used to protect the supply voltage to the modem. It is a 500mA 250V Quick Blow 20x5mm fuse - Part No: 518/4/90285/004

Fuse FS2 is used to protect the digital input supply. It is a 50mA 250V Quick Blow 20x5mm fuse - Part No: 518/4/90285/000

The IMU may be fitted with an external fuse on the +12V supply. The external fuse is included in the cableform that connects to PL5 from the Controller Power supply. This fuse is rated at 3A, Part no: 518/4/90286/006

Fuse FS3 is also available to protect the +12v supply to the PCB without requiring an external fuse. It is a 1.6A 250V Quick Blow 20x5mm fuse - Part No: 518/4/97023/009. If the on board fuse is used, the +12V supply should be connected to pin 34 rather than pin 33 of connector PL5 (see Figure 6 on page 19).

## 5.5 LITHIUM BATTERY

The Integral Monitoring Unit is fitted with a Lithium Battery (B1 - Part No: 418/4/97186/000). The position of this battery is shown in see Figure 1 on page 13.

The battery is dated on manufacture of the PCB and should be replaced six years after the date shown on the label attached to the battery.

### **Warning:**

Care should be taken when handling or disposing of Lithium Batteries. Refer to Siemens Plessey Code of Practice CP526 for full instructions.

## 5.6 NICKEL-CADMIUM BATTERY

The Integral Monitoring Unit uses a Nickel-Cadmium Battery to provide power when the mains' power fails (Part Number 667/7/25176/000).

This battery is tested approximately every 30 days by the software and should be replaced when a battery test failure is reported to the instation by the IMU (see the BTT handset command).

## 6. HANDSET COMMANDS

This section describes all of the IMU's handset commands and identifies when the commands are applicable.

The right-hand column shows the 'access level' of the handset command where R = read only, O = open access, 2 = level 2 (enabled using KME).

### 6.1 MISCELLANEOUS MAINTENANCE COMMANDS

BTT	BTT : {1 to 254, or 0 or 255} Number of days until the next Last Gasp Dial battery test. See section 6.8.1 on page 39. No function in TC8 mode since the battery is removed.	2
CHK	CHK 1 = {0 or 1} Set to '1' to suspend all monitoring, including lamp monitoring. On an ST700 or ST800, the controller continues to perform lamp monitoring but the IMU will not pick up any lamp faults or replacements until monitoring is re-enabled.	O
CHK	CHK 2 = {0 or 1} Set to '1' to indicate "commissioning is in progress" to the instation although monitoring by the IMU is unaffected. No function in TC8 mode.	O
CHK	CHK 3 = {0 or 1} Set to '1' to suspend lamp monitoring. Has no effect on an ST700 or ST800 since the controller performs lamp monitoring.	O
CON	CON Switch the handset to the controller. Also see the command "IMU".	O
FLC	FLC : fault log entry Examine the IMU Current Fault Log. See section 6.8.5 on page 43.	R
FLH	FLH : fault log entry Examine the IMU Historic Fault Log. See section 6.8.5 on page 43.	R
IMU	IMU Switch the handset to the IMU. Also see the command "CON".	O
KME	KME = {0 to 255} Controls 'Level 2' handset access.	O
LCP	LCP {0 to 23} = {0 to 255} Location for up to 24 'confirm signals' for real time green updates, see section 6.8.2 on page 40. No function in TC8 mode or on ST700 / ST800 controllers.	2

LTS	LTS : {0, 1, 2 or 255} Modem Local Loop Back Test. Use "LTS=1" to manually request a test on the modem. No function in TC8 mode since no modem is fitted. LTS:1 – Test Requested                      LTS:0 – Last Test Passed LTS:2 – Test Running                         LTS:255 – Last Test Failed	2
PIC	PIC : issue string PROM firmware identity & issue.	R
RIC	RIC : issue string Downloaded (RAM) firmware identity & issue.	R
RIR	RIR : {0 or 1} Running in RAM flag: 0 = IMU operating from PROM 1 = IMU operating from RAM.	R
TOD	TOD Shows/Sets the current date and time held in the IMU in the form "10-JAN-94 12:15:30". Also allows the date to be set in TC-8 mode, e.g. "TOD=10JAN94". For test purposes only, the time may be set, e.g. "TOD=12:15:30".	2

## 6.2 TC8 MODE HANDSET COMMANDS

TCE	TCE = {0 or 88} TC-8 Mode Enable/Disable: 0 = IRM mode, and 88 = TC8 mode. Starting or ending TC8 Mode causes complete re-initialisation of the IMU firmware - fault logs, downloaded firmware and the current time and date are all cleared.	2
TCM	TCM = 1 TC-8 Mode - Enable Monitoring. Set to '1' to enable monitoring.	2
TCR	TCR = 1 TC-8 Mode - Reset fault log (clears all events from log). Resets the 'miscellaneous monitors' causing controller fault log monitoring and dim/bright checking faults to be cleared and only re-reported when re-confirmed. Note that lamp monitoring is unaffected by TCR.	2

Also see KDL, KDM and KDP in section 6.4) Lamp Supply Monitoring Commands.

**6.3 INPUT / OUTPUT HANDSET COMMANDS**

DOP	DOP {0 to 3} = {0 or 1} Display/Change settings for the general purpose outputs where 1 is active (closed circuit). No function in TC8 mode.	2
ICC	ICC {0-11} : integer Displays the current count for each input counter. The first 'n' counters are normally configured to monitor demands from the 'n' bus priority units (if any). Note that the counters require a scaling factor set by the instation. Only available with PB581 firmware on Intersections with instation access (i.e. not TC8 mode).	R
ICL	ICL {0-11} = {0-95 / 255} Displays/Changes the input counter's input line number or 255 if the counter is unused. Also see the command ICC.	2
KDI	KDI 0 : binary Displays the IMU's digital inputs (bit 0-3) and outputs (bits 4-7). No function in TC8 mode.	R

**6.4 LAMP SUPPLY MONITORING COMMANDS**

KDB	KDB 0 : integer Displays the dim/bright state: 0=undefined, 1=dim or 2=bright.	R
KDL	KDL = {0 to 255} (Default = 64) Maximum dim/bright changes in 24-hour period. Only used in TC8 mode since this is normally configured from the instation. A fault is recorded (at the end of the 24-hour period) if the number of changes exceeds this number. Note that this check is not disabled by KDP:0.	2
KDM	KDM = {0 to 255} (Default = 1) Minimum dim/bright changes in 24-hour period. Only used in TC8 mode since this is normally configured from the instation. A fault is recorded if this number is not reached. Note that this check is disabled by KDP:0.	2
KDP	KDP = { 0 or 1} (Default = As Controller Is Configured) Controls whether dimming is present at this site. Only used in TC8 mode to inform the LMU that dimming is not present at a UTC (TC8) site, since this is normally configured from the instation. If dimming is not present, the check for KDM is not performed and the LMU does not wait for a dim/bright change when initially learning the lamp loads.	2
KEV	KEV : {Volts} Displays the lamp supply voltage in volts. Not available with PB580 IMU firmware, use KAC instead (see section 6.5).	R

**6.5 LAMP MONITORING COMMANDS – MAINTENANCE**

KAC	<p>KAC {1-23} {0-1} : integer</p> <p>Displays ADC current and volts (in ADC counts) for each sensor, e.g.  KAC 3 0 : 50 (<math>\approx 200\text{mA} \approx 50\text{W}</math>)      KAC 3 1 : 732 (<math>\approx 240\text{V}</math>).</p> <p>The handset commands KES and KEV provide this information in ‘mA’ and ‘Volts’. These are available in PB581 IMU firmware, see below...</p>	R
KAS	<p>KAS {1 to 23} {0 to 6} : binary</p> <p>Displays the lamp monitor aspect learn status for each current sensor and aspect state (i.e. colour). See section 6.8.3 on page 41.</p> <p>Use the controller handset command KAS on ST700 / ST800 controllers.</p>	R
KES	<p>KES {1 to 23} : mA + state</p> <p>Displays the current in milliamps for each sensor. Also indicates ‘ON’ if the phase monitored by the sensor is at green, otherwise it displays ‘OFF’. For sensors monitoring wait lamps, ‘ON’ indicates that the wait is illuminated.</p> <p>Not available with PB580 IMU firmware, use KAC instead. Use the controller handset command KES on an ST700 / ST800 controllers.</p>	R
KEV	See section 6.4) Lamp Supply Monitoring Commands on page 36.	R
KLM	<p>KLM 0 : {integer}</p> <p>Displays: 6 = Lamps Off, 7 = Lamps On, and 8 = change in progress.</p>	R
KLR	<p>KLR = 1</p> <p>Request lamp monitor reset and re-learn by entering “KLR=1”. This command must always be used after changing the LMU configuration using the handset. This command does not reset the controller lamp monitor.</p>	2
KLS	<p>KLS : binary</p> <p>Lamp monitor overall learn status. Section 6.8.3 on page 41 details the bits. Use the controller handset command KLS or KML on ST700 / ST800 controllers.</p>	R
LMR	<p>LMR {1 to 5} {A to P}</p> <p>Displays the record for the given ‘fault level’ (1-5) and phase (A-P) from the current profile store, see section 6.8.4 on page 42. On T400 pelicans, phases A and B apply to the first pelican and phases E and F to the second pelican of a dual.</p> <p>Not available with PB580 IMU Firmware nor on ST700 / ST800 controllers. On ST700 / ST800 controllers, use the controller command KEL which shows the learnt load in watts.</p>	R

## 6.6 LAMP MONITORING COMMANDS – CONFIGURATION

Note that these IMU handset commands are ignored on ST700 / ST800 controllers since the controller is performing the lamp monitoring, not the IMU...

KAD	KAD {1 to 23} = {0 to 255} (Default from Controller Configuration) Aspect drives for each current sensor, where 0 = Phase A, 1 = Phase B and 15 = Phase P. For sensors monitoring green arrows, add 32 to these values.	2
KLC	KLC = {1 to 255} (Default = 60) Lamp monitor 'confirm time' in seconds. Only used in TC8 mode since this limit is normally configured from the instation.	2
KLE	KLE = {0 or 1} (Default = 1) LMU enabled (KLE:1) or disabled (KLE:0). Note that the IMU handset command CHK3 (on page 34) should be used in preference to using KLE=0 to disable the lamp monitor facility.	2
KPT	KPT {1 to 23} = {0 to 255} (Default from Controller Configuration) Phase types for each current sensor:- 1: Intersection Vehicle Phase 2: MCE125 Vehicle Phase (flashing amber) 3: Intersection Pedestrian Phase 4: MCE125 Ped Phase (flashing green man) 5: 40 Watt Wait Indicators 6: 60 Watt Wait Indicators 8: Switched Bulb (used for Green Arrows) 255: Sensor Not Used	2

## 6.7 ENGINEERING HANDSET COMMANDS

KDC	KDC {0 to 3} = {0 to 255} ..... Dummy routine control	2
KEB	KEB = {0 to 2}..... Engineering display base	0
KEG	KEG {0-N} {0-255} : {0-255}..... Display/Change engineering data items	2
KER	KER {0-FFFFFF} : {0-255} ..... Display/Change engineering RAM data	2
KFE	KFE {0-3} = {0-100} ..... % Processor free time	2
KPU	KPU {0 to 5} = {0 to 255} ..... Power up data	2
KRT	KRT {0 to 7} = {0 to 255}..... Run time monitor items	2
KSC	KSC : Integer ..... Soft error current count	R
OMH	OMH : Integer ..... Hard error code	R
OMS	OMS {0 to 2} : Hex..... Soft error codes	R

## 6.8 ADDITIONAL INFORMATION ON CERTAIN HANDSET COMMANDS

### 6.8.1 BATTERY TEST TIME (BTT)

BTT [ = {0, 1 to 254, or 255} ]

Displays the time interval remaining (in days) before the next battery test for the LGD battery and can be used to force an immediate test or battery discharge cycle.

The battery test time will be 1.5 hours during which time the BTT command will show '0'. When the IMU has completed the test, the battery will be discharged to avoid any "memory" effect. The battery will be discharged for 3.5 hours (giving 5 hours total discharge time), or until the battery voltage has dropped below the test threshold.

The last battery discharge time will be stored in the IMU and made available to the operator via the KEG command (KEG 30 0). This will show the discharge time in minutes (i.e. the normal 3.5 hour discharge time would be displayed as 210 minutes).

During the battery discharge period, the BTT command will show '255'. Once the battery discharge is complete, the BTT command will return to '30', i.e. the number of days to the next battery test.

If a battery test is invoked manually, by the operator setting BTT to 0, then the 1.5 hour test is carried out as normal. However, at the end of the test no battery discharge is started and the BTT display returns to '30'.

If the operator sets the BTT command to 255, then the battery discharge cycle is invoked.

Setting the BTT command to any other value (i.e. 1 to 254) aborts a battery test or discharge cycle which may have been in progress and the IMU will perform the next automatic battery test after the set number of days (as entered by the operator). The BTT value would normally be set to 30 to resume the standard battery test interval.

## 6.8.2 GREEN STATE LOCATIONS (LCP)

The values used for the phase location handset command (LCP) identify which colour of which phase is to be returned to the instation during real time green update. The items are returned in the order in which they are defined in the LCP list. This handset command allows the engineer to alter the default settings that the IMU obtained from the controller. Note that this command is ignored on ST700 / ST800 controllers.

The basic values are as follows:

- the values 0 to 15 identify the red colour on the 16 phases A to P,
- the values 16 to 31 identify the amber colour on the 16 phases A to P,
- the values 32 to 47 identify the green colour on the 16 phases A to P,
- the value 255 marks the end of the list (see the example below).

If the colour flashes (e.g. flashing amber or green man) then three options exist:

- 'True Lamp State' - the real lamp state is sent to the instation so that the instation will 'see' the colour turning off and on repeatedly - use the numbers above,
- 'Flashing as ON' - during the flashing period, the instation will just see that the colour is on and so is indistinguishable from the steady state - add 100 to the numbers above (to give 100-115,116-131,132-147),
- 'Flashing as OFF' - during the flashing period, the instation will not see that colour on (a flashing amber will not be seen while a green man will appear to end when it starts to flash) - add 200 (to give 200-215,216-231,232-247).

For example, the default settings for a single pelican are:

LCP 0:32 Phase A green (vehicle green)  
LCP 1:233 Phase B green with flashing as OFF (steady green man only)  
LCP 2:2 Phase C red (audio confirm indicator on T400)  
LCP 3:255 End of List Marker - only 3 phases are to be sent to instation.

In addition, the following values will be defined for the second stream on a dual pelican:

LCP 12:36 Phase E green (vehicle green)  
LCP 13:237 Phase F green with flashing as OFF (steady green man only)  
LCP 14:6 Phase G red (audio confirm indicator on T400)  
LCP 15:255 End of List Marker - only 3 phases are to be sent to instation.



### 6.8.3 LEARN STATUS BITS (KAS AND KLS)

- Bit 0**      **AWAIT\_DIM** - Aspect not yet appeared in DIM:  
This bit is set if the current state is known to be Bright and Await\_Dim\_Change is set. It is cleared when dim / bright state is dim and Await\_Dim\_Change is clear.
- Bit 1**      **AWAIT\_BRIGHT** - Aspect not yet appeared in BRIGHT:  
This bit is set if the current state is known to be Dim and Await\_Dim\_Change is set. It is cleared when dim / bright state is bright and Await\_Dim\_Change is clear.  
Note: Under certain conditions both Await\_Dim and Await\_Bright can be set for an aspect. If this occurs neither bit will be cleared until the LMU has learnt the aspect in both dim and bright states.
- Bit 2**      **AWAIT\_ASPECT** - Aspect not yet appeared:  
Set on LMU Initialisation. Cleared when aspect is first learnt.
- Bit 3**      **AWAIT\_DIM\_CHANGE** - First Dim / Bright Change assessment enabled:  
Set on LMU Initialisation if dim / bright changeover monitoring is enabled. Cleared after the first dim / bright change assessment for the aspect has been completed.
- The following bits are only set in the KAS display and not the KLS display:
- Bit 4**      **CONF\_LOAD** - Aspect being assessed for load change:  
Set when either the 'rise' or 'fall' load change counter is non-zero. Cleared when both the 'rise' and 'fall' load change counters are zero. (KAS only)
- Bit 5**      **CONF\_DIM** - Aspect being assessed for dim / bright change:  
Set when either the 'dim' or 'bright' load change counter is non-zero. Cleared when both the 'dim' and 'bright' load change counters are zero. (KAS only)
- Bits 6 & 7**      Not Used

The aspect states for each type of sensor are listed here:

Vehicle Phases: 0=Red, 1=Green, 2=Amber

Pedestrian Phases: 0=RedMan, 1=GreenMan

Wait Indicators: 0=LampsOff, 1=LampsOn

Green Arrows: 0=LampsOff, 1=LampsOn

#### 6.8.4 CURRENT PROFILE STORE (LMR)

The LMU keeps a 'current profile store' for all the lamp currents of the controller. The store consists of five 'levels' starting at level 1. Level 1 of the current profile initially holds the present currents of all the lamps and is marked as 'No Fault (no more levels)'. To view all the currents, enter 'LMR 1 A' and then use the '+' key to scroll through the list.

When the LMU confirms a lamp fault (or colour conflict), it records the current from before the failure occurred in level 1 of the current profile and marks that level with either 'Fault (see next level)' or 'Conflict (see next level)'. In other words, the currents in level 1 remain at the initial level, i.e. are 'frozen' and the status changed to indicate that a fault has occurred. Now level 2 will show a status of 'No Fault (no more levels)' and the new present current, which will be lower in the case of lamp failure and higher in the case of a colour conflict.

For example:

```
LMR 1 A: Fault      (see next level) R:0.51 A:0.52 G:0.50 W:-.--
LMR 1 B: No Fault  (no more levels) R:-.-- A:-.-- G:0.26 W:-.--
LMR 1 C: Conflict  (see next level) R:0.51 A:-.-- G:0.50 W:0.40

LMR 2 A: No Fault  (no more levels) R:0.25 A:0.52 G:0.24 W:-.--
LMR 2 B: No Fault  (no more levels) R:-.-- A:-.-- G:0.26 W:-.--
LMR 2 C: No Fault  (no more levels) R:0.51 A:-.-- G:1.01 W:0.40
```

In this example, Phase A is a vehicle phase with lamp failures on both red and green. Phase B is a green arrow (hence no red or amber currents). Phase C is a pedestrian phase with a large current increase (colour conflict) on the green man (e.g. the red man is stuck on).

Note that failures on different colours of the same phase are 'combined' in the same level (see phase A). If the failure on the green had been a colour conflict (current increase), then the fault status would show 'Conflict' and not 'Fault' since the fault status displayed is for the last colour with a fault reading left to right, and so the fault status for the green is shown.

If a second lamp failure (or colour conflict) is confirmed on the same phase and colour, the currents in level 2 are 'frozen' and the status changed accordingly. Now level 3 will show the new even lower (or higher) current. This process continues until level 4 indicates a fault. After that, no more 'old' currents are stored and level 5 always shows 'No fault (no more levels)' and the present currents.

### 6.8.5 FAULT LOG COMMANDS (FLC AND FLH)

The current fault log contains entries for currently active faults (and those events not yet reported to the instation). If the IMU is running firmware PB580 in TC8 mode, events remain in the current fault log until cleared by TCR=1.

The historic fault log holds all fault occurrences and clearances and all events in the order that they occurred.

There are three alternative ways of initially entering the handset commands that display the current and historic fault log as described below:

- FLC** Entering the command with no index displays the most recent entry from the current fault log.
- FLH** Entering the command with no index displays the most recent entry from the historic fault log.
- FLC n** On entering "FLC n", entry number "n" from the current fault log is displayed, where 0 is the most recent entry and 31 is the oldest. If the log is not full, entering FLC 31 will display the oldest existing entry in the current fault log.  
**(where n = 0 to 31)**
- FLH n** On entering "FLH n", entry number "n" from the historic fault log is displayed, where 0 is the most recent entry and 255 is the oldest. If the log is not full, entering FLH 255 will display the oldest existing entry in the historic fault log.  
**(where n = 0 to 255)**
- FLC ?** The entry being viewed when the FLC command was last used is re-displayed. This allows the user to use other handset commands and then re-enter the fault log at the same point.
- FLH ?** The entry being viewed when the FLH) command was last used is re-displayed. This allows the user to use other handset commands and then re-enter the fault log at the same point.

Whichever command option is used, the "+" key can be used to step back through the log, displaying older entries. When the end of the log is reached, using the "+" key re-displays the last entry. The "-" key can be used to step forward again, displaying more recent entries.

The fault log command will return "FAULT LOG IS EMPTY" if there are no entries to be displayed.

The display format which is used for the maintenance terminal connected to the IMU is:

```
DD-MMM-YY HH:MM:SS Code:F/C <fault entry text> NAK
```

where:

- DD = day of month: 00 to 31
- MMM = month: JAN, FEB etc.
- YY = year: 00 to 99 (99 = 1999, 00 = 2000 etc.)
- HH = hours: 00 to 23
- MM = minutes: 00 to 59
- SS = seconds: 00 to 59
- F/C = Fault Code 1 to 255 as defined by TCSU
- <fault entry text> = Text description of fault, see below
- NAK = 'NAK' for an unacknowledged fault or blank.

The report for a red lamp fail on the vehicle phase of the first pelican, where this report has not yet been acknowledged by the instation, would therefore appear as follows:

```
10-MAR-93 08:44:03 Code 41: Lamp failure - vehicle red, ctrl 1 NAK
```

A complete list of fault log codes and displays is given in section 6.9 starting on page 45.

## 6.9 FAULT DISPLAY CODES AND TEXT

This section contains all the fault log codes and associated text, as seen when using the FLC and FLH commands.

The variable values used in the reports are explained below:

level 'n'	The new operating level:- 1 = running from PROM 2 = running from downloaded code in RAM
'colour'	The failed lamp colour: Red, Amber, Green, or Wait.
Phase 'x'	The phase on which the colour has failed (Phases A to P)
ctrlr 'n'	The controller reference:- 1 = first pelican, 2 = second pelican of a dual
Changes='n'	The number of dim/bright changes in the 24-hour period.
line 'n'	The failed detector number (controller input line number 0 to 95).
CHK 'n'	Maintenance flag number:- 1 = monitoring suspended 2 = monitoring enabled (but commissioning in progress) 3 = lamp monitoring suspended
Input 'n'	The IMU general-purpose digital input number, range 1 to 4.
stream 'n'	Stream number where 'n' denotes stream 0 onwards.

This table details the Fault codes and the text associated with the faults. Note that the inverted commas shown around 'n' and 'x' etc. in the tables are for clarity and are not displayed on the handset.

Code 1	IMU has been reset to level 'n'
Code 3	Lamp monitor has been reset
Code 5	IMU is not monitoring (TCM:0)
Code 6	IMU is running normally (TCM:1)
Code 9	Controller has been reset to PROM
Code 11	Controller fault log has been reset
Code 13	Detector monitor has been reset
Code 15	Telephone communications fault
Code 16	Telephone communications fault clear
Code 15	Modem configuration fail
Code 16	Modem configuration successful
Code 17	Link level communications failure
Code 18	Link level communications failure cleared
Code 17	Periodic local loopback test failed
Code 18	Periodic local loopback test passed
Code 17	Bad message received
Code 18	Bad message fault cleared
Code 21	IMU RAM configuration area sum check fail
Code 23	IMU RAM instruction area sum check fail
Code 25	IMU PROM instruction area sum check fail
Code 27	Software logical check fail (soft error)
Code 29	Watchdog check fail
Code 31	Miscellaneous monitor has been reset
Code 39	Outstanding fault in log

Code 40	Outstanding fault cleared
Code 41	Lamp failure - veh 'colour' - ctrl 'n'
Code 41	Lamp failure - ped 'colour' - ctrl 'n'
Code 41	Lamp failure - phase 'x', 'colour'
Code 42	Lamp replaced - veh 'colour' - ctrl 'n'
Code 42	Lamp replaced - ped 'colour' - ctrl 'n'
Code 42	Lamp replaced - phase 'x', 'colour'
Code 43	Colour conflict - veh 'colour' - ctrl 'n'
Code 43	Colour conflict - ped 'colour' - ctrl 'n'
Code 43	Colour conflict - phase 'x', 'colour'
Code 44	Colour conflict clear - veh 'colour' - ctrl 'n'
Code 44	Colour conflict clear - ped 'colour' - ctrl 'n'
Code 44	Colour conflict clear - phase 'x', 'colour'
Code 45}* Code 46}	Undecided lamp failure - phase 'x'
Code 46}	Undecided lamp fail clear - phase 'x'
Code 59}† Code 60}	Lamps off, 2nd RL fail, stream 'n'
Code 60}	Lamps on, 2nd RL fail - clear, stream 'n'
Code 61	Lamp supply failed, ctrl 'n'
Code 62	Lamp supply restored, ctrl 'n'
Code 63	Mains power failed
Code 64	Mains power restored
Code 65	LGD battery supply failed
Code 66	LGD battery supply restored
Code 65	RAM battery supply failed
Code 66	RAM battery supply restored
Code 67	Dimmer sequence failed: Changes = 'n'
Code 68	Dimmer sequence restored: Changes = 'n'
Code 69	Veh detector DFM fail - line 'n'
Code 69	Ped push-button DFM fail - line 'n'
Code 70	Veh detector DFM restored - line 'n'
Code 70	Ped push-button DFM restored - line 'n'
Code 71	Audio tone inoperable fault
Code 72	Audio tone inoperable fault clear
Code 131	FLF nn: 'Controller FLF fault'
Code 132	FLF nn: 'Controller FLF fault' - clear
Code 133	Controller communications failed
Code 134	Controller communications restored
Code 135	Controller invalid reply
Code 139}‡ Code 140}	Controller time check failed
Code 139}	Controller time failure cleared
Code 140}	Clock fault - IMU is 'fast by HH:MM:SS'
Code 140}	Clock fault - cleared
Code 141	Controller clock data changed
Code 141	Controller fixed veh periods changed
Code 141	Controller min times changed

\* 'Undecided lamp faults' are only reported on ST800 Controllers when the Controller and the IMU are unable to determine whether the confirmed lamp fault is a pedestrian red lamp or a pedestrian wait lamp.

† Indications of 'Lamps off due to second red lamp failures' are not provided before T400 firmware PB322 issue 7 and IMU firmware issue 2.

‡ PB581 firmware displays the time discrepancy held within the fault data. PB580 firmware did not.

Code 141	Controller max times changed
Code 141	Controller ext times changed
Code 141	Controller all red times changed
Code 141	Controller ped green times changed
Code 141	Controller phase delay periods changed
Code 141	Controller ped black-out changed
Code 141	Controller conditioning timers changed
Code 141	Controller intergreen times changed
Code 141	Controller misc intergreen data changed
Code 141	Controller SDE/SA data changed
Code 141	Controller hurry delay periods changed
Code 141	Controller hurry hold periods changed
Code 141	Controller hurry prevent periods changed
Code 141	Controller call delay periods changed
Code 141	Controller cancel delay periods changed
Code 141	Controller bus extension periods changed
Code 141	Controller bus maximum periods changed
Code 141	Controller bus inhibit periods changed
Code 141	Controller bus priority demands changed
Code 141	Controller bus revertive demands changed
Code 141	Controller bus revertive inhibits changed
Code 141	Controller bus allowed VA demands changed
Code 141	Controller bus enforced demands changed
Code 141	Controller bus compensation data changed
Code 141	Controller bus miscellaneous data changed
Code 141	Controller detector data changed
Code 141	Controller timetable data changed
Code 141	Controller plan 0 data changed
Code 141	Controller plan 1 data changed
Code 141	Controller plan 2 data changed
Code 141	Controller plan 3 data changed
Code 141	Controller plan 4 data changed
Code 141	Controller plan 5 data changed
Code 141	Controller plan 6 data changed
Code 141	Controller plan 7 data changed
Code 141	Controller plan miscellaneous data changed
Code 141	Controller fault log reset
Code 141	Controller DFM reset
Code 141	Controller plan influence data changed
Code 141	Controller fixed time data changed
Code 141	Controller general data changed
Code 141	Controller local link data changed
Code 149	Site engineer logged on - CHK 'n'
Code 150	Site engineer logged off - CHK 'n'
Code 151	Input monitor alarm - Input 'n'
Code 152	Input monitor alarm clear - Input 'n'
Code 153	Input monitor overload
Code 154	Input monitor overload clear