FMP Programmer's Guide

DC 900-1339H

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FMP Programmer's Guide

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Preface

Purpose of Document

This document describes the operation and programming interface required to use Simpact's Financial Market Protocols (FMP) product for Simpact's Freeway communications server or embedded ICP. It is written for subscribers who receive broadcast market feeds from various stock exchanges.

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user's guide for your ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*).

Intended Audience

This document should be read by programmers who are interfacing an application program (such as a ticker plant) to one or more of the primary U.S. or international market feeds. You should understand the Freeway data link interface (DLI), as explained in the *Freeway Data Link Interface Reference Guide*, and be familiar with the message formats of the market feeds you are receiving.

Required Equipment

The FMP product requires the following two major hardware components to operate:

- a Freeway communications server or embedded ICP that runs the communications software
- a client computer that runs the following:
  - TCP/IP (for a Freeway server)
  - Freeway DLI
  - the user application program

Organization of Document

Chapter 1 is an overview of Freeway and the FMP product.

Chapter 2 summarizes the basic communication protocol formats available on the FMP software package.

Chapter 3 describes how to use the data link interface (DLI) between the client application program and the FMP communications software running on the Freeway ICP.

Chapter 4 describes the link configuration options available on the FMP software package.

Chapter 5 describes how to configure the FMP link options using the `dlicfg` program.

Appendix A describes the line control procedures for FMP.

Appendix B contains the ASCII/EBCDIC and ASCII/Baudot code translation tables.

Appendix C describes error handling and lists the error codes.

Appendix D describes the FMP loopback test program.

Simpact References

The following documents provide useful supporting information, depending on the customer's particular hardware and software environments. Most documents are available on-line at Simpact's web site, www.simpact.com.

General Product Overviews

• *Freeway 1100 Technical Overview*	25-000-0419
• *Freeway 2000/4000/8800 Technical Overview*	25-000-0374
• *ICP2432 Technical Overview*	25-000-0420
• *ICP6000X Technical Overview*	25-000-0522

Hardware Support

• *Freeway 1100/1150 Hardware Installation Guide*	DC 900-1370
• *Freeway 1200 Hardware Installation Guide*	DC 900-1537
• *Freeway 1300 Hardware Installation Guide*	DC 900-1539
• *Freeway 2000/4000 Hardware Installation Guide*	DC 900-1331
• *Freeway 8800 Hardware Installation Guide*	DC 900-1553
• *Freeway ICP6000R/ICP6000X Hardware Description*	DC 900-1020
• *ICP6000(X)/ICP9000(X) Hardware Description and Theory of Operation*	DC 900-0408
• *ICP2424 Hardware Description and Theory of Operation*	DC 900-1328
• *ICP2432 Hardware Description and Theory of Operation*	DC 900-1501
• *ICP2432 Hardware Installation Guide*	DC 900-1502

Freeway Software Installation Support

• *Freeway Release Addendum: Client Platforms*	DC 900-1555
• *Freeway User's Guide*	DC 900-1333
• *Getting Started with Freeway 1100/1150*	DC 900-1369
• *Getting Started with Freeway 1200*	DC 900-1536
• *Getting Started with Freeway 1300*	DC 900-1538
• *Getting Started with Freeway 2000/4000*	DC 900-1330
• *Getting Started with Freeway 8800*	DC 900-1552
• *Loopback Test Procedures*	DC 900-1533

Embedded ICP Installation and Programming Support

• *ICP2432 User's Guide for Digital UNIX*	DC 900-1513
• *ICP2432 User's Guide for OpenVMS Alpha*	DC 900-1511
• *ICP2432 User's Guide for OpenVMS Alpha (DLITE Interface)*	DC 900-1516
• *ICP2432 User's Guide for Solaris STREAMS*	DC 900-1512
• *ICP2432 User's Guide for Windows NT*	DC 900-1510
• *ICP2432 User's Guide for Windows NT (DLITE Interface)*	DC 900-1514

Application Program Interface (API) Programming Support

- *Freeway Data Link Interface Reference Guide* DC 900-1385
- *Freeway Transport Subsystem Interface Reference Guide* DC 900-1386
- *QIO/SQIO API Reference Guide* DC 900-1355

Socket Interface Programming Support

- *Freeway Client-Server Interface Control Document* DC 900-1303

Toolkit Programming Support

- *Freeway Server-Resident Application and Server Toolkit Programmer's Guide* DC 900-1325
- *OS/Impact Programmer's Guide* DC 900-1030
- *Protocol Software Toolkit Programmer's Guide* DC 900-1338

Protocol Support

- *ADCCP NRM Programmer's Guide* DC 900-1317
- *Asynchronous Wire Service (AWS) Programmer's Guide* DC 900-1324
- *Addendum: Embedded ICP2432 AWS Programmer's Guide* DC 900-1557
- *AUTODIN Programmer's Guide* DC 908-1558
- *Bit-Stream Protocol Programmer's Guide* DC 900-1574
- *BSC Programmer's Guide* DC 900-1340
- *BSCDEMO User's Guide* DC 900-1349
- *BSCTRAN Programmer's Guide* DC 900-1406
- *DDCMP Programmer's Guide* DC 900-1343
- *FMP Programmer's Guide* DC 900-1339
- *Military/Government Protocols Programmer's Guide* DC 900-1602
- *SIO STD-1200A (Rev. 1) Programmer's Guide* DC 908-1359
- *SIO STD-1300 Programmer's Guide* DC 908-1559
- *X.25 Call Service API Guide* DC 900-1392
- *X.25/HDLC Configuration Guide* DC 900-1345
- *X.25 Low-Level Interface* DC 900-1307

Other helpful documents:

- *General Information — Binary Synchronous Communications, IBM* GA27-3004
- *3274 Control Unit Description and Programmer's Guide, IBM* GA23-0061

Document Conventions

This document follows the most significant byte first (MSB) and most significant word first (MSW) conventions for bit-numbering and byte-ordering. In all packet transfers between the client applications and the ICPs, the ordering of the byte stream is preserved. However, FMP packed data contains word values that are not byte-swapped.

The term "Freeway" refers to any of the Freeway server models (for example, Freeway 1100/1150/1200/1300, Freeway 2000/4000, or Freeway 8800), or to the embedded ICP product (for example, the embedded ICP2432).

Physical "ports" on the ICPs are logically referred to as "links." However, since port and link numbers are usually identical (that is, port 0 is the same as link 0), this document uses the term "link."

Program code samples are written in the "C" programming language.

Revision History

The revision history of the *FMP Programmer's Guide*, Simpact document DC 900-1339H, is recorded below:

Document Revision	Release Date	Description
DC 900-1339A	June 1994	Preliminary release
DC 900-1339B	October 1994	Full release
DC 900-1339C	November 1994	• Minor modifications and updated error codes • Updated file names for software release 2.1 • Change the `usICPStatus` field to `iICPStatus` and change the `usProtModifier` field to `iProtModifier` (page 44)
DC 900-1339D	February 1995	• Minor modifications • Add the Freeway 1000 user-defined data rate (Section 4.21.2) • New FMP options in Chapter 4 and Chapter 5.
DC 900-1339E	January 1996	• Minor modifications • Add `dlControl` function (Table 3–3 on page 43) • Add Windows NT to Chapter 5 and Appendix D

Document Revision	Release Date	Description
DC 900-1339F	April 1997	• Add Simpact browser configuration information • Add normal and transparent data codes to `dlRead` responses (Table 3–8 on page 61) • Modify Table 2–1 on page 33, Section 3.4.3 on page 57, Section 3.5.1 on page 60, Table 5–1 on page 104, and Table C–1 on page 118 • Add Data Packing option (Section 4.9 on page 74) • Modify Message Blocking option (Section 4.13 on page 81)
DC 900-1339G	August 1997	• Modify the explanation of Figure 3–3 on page 62 • Correct message blocking option default (Table 4–1 on page 66) • Correct ETB enable option default (Table 5–1 on page 104) • Minor changes in Chapter 5 and Appendix D
DC 900-1339H	June 1998	• Modify Section 1.1 through Section 1.4 • Remove browser interface support • Add the Bonneville Market Feed (Section 2.1.4 on page 31, Section 4.13.6 on page 89, and Section 4.14 on page 90) • Minor changes to Section 3.1.2 on page 37 and Section 3.2 on page 40, add `dlpErrString` and `dlSyncSelect` functions (Table 3–3 on page 43) • Add 5-byte header codes to Table C–1 on page 118 • Minor changes to Chapter 5 and Appendix D

Customer Support

If you are having trouble with any Simpact product, call us at 1-800-275-3889 Monday through Friday between 8 a.m. and 5 p.m. Pacific time.

You can also fax your questions to us at (619)560-2838 or (619)560-2837 any time. Please include a cover sheet addressed to "Customer Service."

We are always interested in suggestions for improving our products. You can use the report form in the back of this manual to send us your recommendations.

Chapter

1 Introduction

1.1 Product Overview

Simpact provides a variety of wide-area network (WAN) connectivity solutions for real-time financial, defense, telecommunications, and process-control applications. Simpact's Freeway server offers flexibility and ease of programming using a variety of LAN-based server hardware platforms. Now a consistent and compatible embedded intelligent communications processor (ICP) product offers the same functionality as the Freeway server, allowing individual client computers to connect directly to the WAN.

Both Freeway and the embedded ICP use the same data link interface (DLI). Therefore, migration between the two environments simply requires linking your client application with the proper library. Various client operating systems are supported (for example, UNIX, VMS, and Windows NT).

Simpact protocols that run on the ICPs are independent of the client operating system and the hardware platform (Freeway or embedded ICP).

1.1.1 Freeway Server

Simpact's Freeway communications servers enable client applications on a local-area network (LAN) to access specialized WANs through the DLI. The Freeway server can be any of several models (for example, Freeway 1100, Freeway 2000/4000, or Freeway 8000/8800). The Freeway server is user programmable and communicates in real time. It provides multiple data links and a variety of network services to LAN-based clients. Figure 1–1 shows the Freeway configuration.

To maintain high data throughput, Freeway uses a multi-processor architecture to support the LAN and WAN services. The LAN interface is managed by a single-board computer, called the server processor. It uses the commercially available VxWorks operating system to provide a full-featured base for the LAN interface and layered services needed by Freeway.

Freeway can be configured with multiple WAN interface processor boards, each of which is a Simpact ICP. Each ICP runs the communication protocol software using Simpact's real-time operating system.

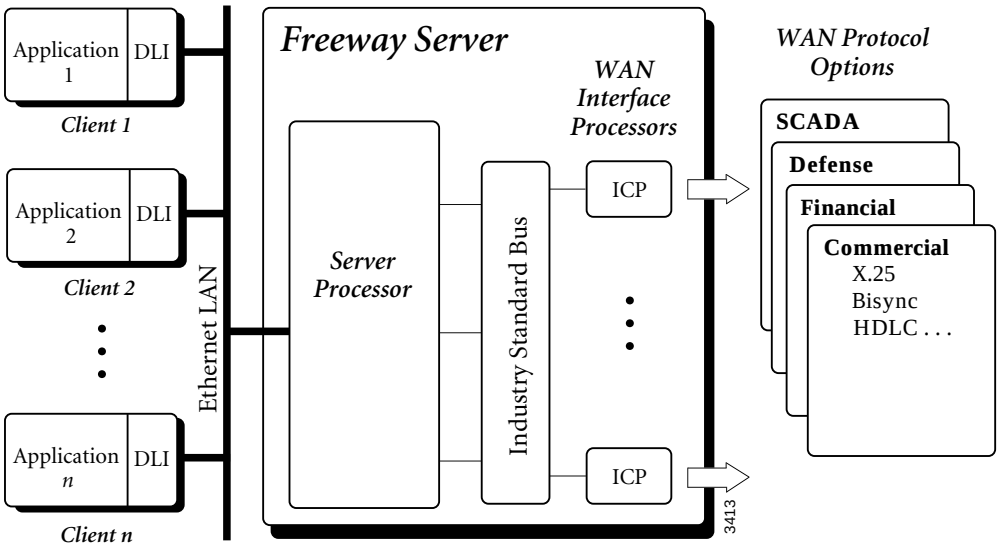


Figure 1–1: Freeway Configuration

1.1.2 Embedded ICP

The embedded ICP connects your client computer directly to the WAN (for example, using Simpact's ICP2432 PCIbus board). The embedded ICP provides client applications with the same WAN connectivity as the Freeway server, using the same data link interface. The ICP runs the communication protocol software using Simpact's real-time operating system. Figure 1–2 shows the embedded ICP configuration.

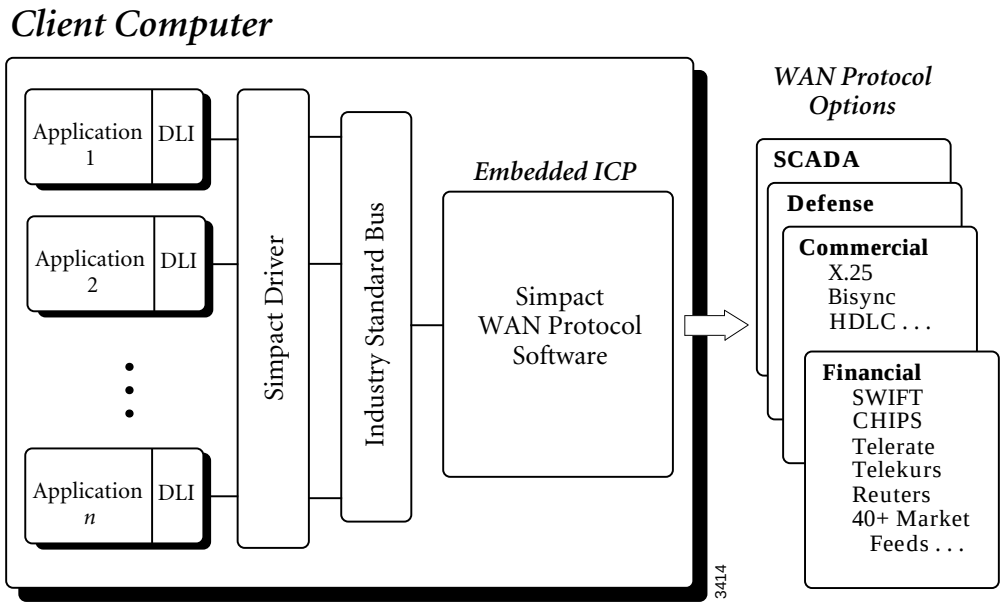


Figure 1–2: Embedded ICP Configuration

Summary of product features:

- Provision of WAN connectivity either through a LAN-based Freeway server or directly using an embedded ICP
- Elimination of difficult LAN and WAN programming and systems integration by providing a powerful and consistent data link interface
- Variety of off-the-shelf communication protocols available from Simpact which are independent of the client operating system and hardware platform
- Support for multiple WAN communication protocols simultaneously
- Support for multiple ICPs (two, four, eight, or sixteen communication lines per ICP)
- Wide selection of electrical interfaces including EIA-232, EIA-449, EIA-485, EIA-530, EIA-562, V.35, ISO-4903 (V.11), and MIL-188
- Creation of customized server-resident and ICP-resident software, using Simpact's software development toolkits
- Freeway server standard support for Ethernet and Fast Ethernet LANs running the transmission control protocol/internet protocol (TCP/IP)
- Freeway server standard support for FDDI LANs running the transmission control protocol/internet protocol (TCP/IP)
- Freeway server management and performance monitoring with the simple network management protocol (SNMP), as well as interactive menus available through a local console, telnet, or rlogin

1.2 Freeway Client-Server Environment

The Freeway server acts as a gateway that connects a client on a local-area network to a wide-area network. Through Freeway, a client application can exchange data with a remote data link application. Your client application must interact with the Freeway server and its resident ICPs before exchanging data with the remote data link application.

One of the major Freeway server components is the message multiplexor (MsgMux) that manages the data traffic between the LAN and the WAN environments. The client application typically interacts with the Freeway MsgMux through a TCP/IP BSD-style socket interface (or a shared-memory interface if it is a server-resident application (SRA)). The ICPs interact with the MsgMux through the DMA and/or shared-memory interface of the industry-standard bus to exchange WAN data. From the client application's point of view, these complexities are handled through a simple and consistent data link interface (DLI), which provides `dlOpen`, `dlWrite`, `dlRead`, and `dlClose` functions.

Figure 1–3 shows a typical Freeway connected to a locally attached client by a TCP/IP network across an Ethernet LAN interface. Running a client application in the Freeway client-server environment requires the basic steps described in Section 1.4.

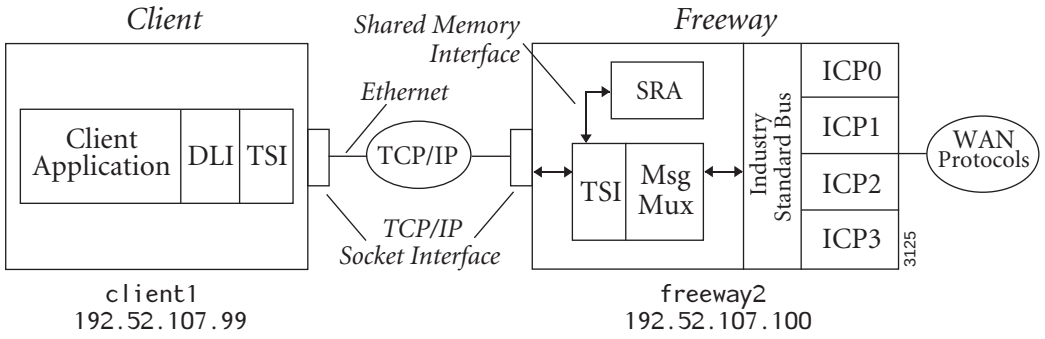


Figure 1–3: A Typical Freeway Server Environment

1.2.1 Establishing Freeway Server Internet Addresses

The Freeway server must be addressable in order for a client application to communicate with it. In the Figure 1–3 example, the TCP/IP Freeway server name is `freeway2`, and its unique Internet address is 192.52.107.100. The client machine where the client application resides is `client1`, and its unique Internet address is 192.52.107.99 . Refer to the *Freeway User's Guide* to initially set up your Freeway and download the operating system, server, and protocol software to Freeway.

1.3 Embedded ICP Environment

Refer to the user's guide for your embedded ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*) for software installation and setup instructions. The user's guide also gives additional information regarding the data link interface (DLI) and embedded programming interface descriptions for your specific embedded environment. Refer back to Figure 1–2 on page 19 for a diagram of the embedded ICP environment. Running a client application in the embedded ICP environment requires the basic steps described in Section 1.4

1.4 Client Operations

1.4.1 Defining the DLI and TSI Configuration

You must define the DLI sessions and the transport subsystem interface (TSI) connections between your client application and Freeway (or an embedded ICP). To accomplish this, you first define the configuration parameters in DLI and TSI ASCII configuration files, and then you run two preprocessor programs, `dlicfg` and `tsicfg`, to create binary configuration files (see Chapter 5). The `dlInit` function uses the binary configuration files to initialize the DLI environment.

1.4.2 Opening a Session

After the DLI and TSI configurations are properly defined, your client application uses the `dlOpen` function to establish a DLI session with an ICP link. As part of the session establishment process, the DLI establishes a TSI connection with the Freeway MsgMux through the TCP/IP BSD-style socket interface for the Freeway server, or directly to the client driver for the embedded ICP environment.

1.4.3 Exchanging Data with the Remote Application

After the link is enabled, the client application can exchange data with the remote application using the `dlWrite` and `dlRead` functions.

1.4.4 Closing a Session

When your application finishes exchanging data with the remote application, it calls the `dlClose` function to disable the ICP link, close the session with the ICP, and disconnect from Freeway (or the embedded ICP).

1.5 FMP Overview

Simpact's Financial Market Protocols (FMP) data feed receiver is a software product that allows financial analysis programs to receive information from one or more of the available primary market feeds. Primary market feeds are financial information data feeds that are digitally broadcast from the world's stock exchanges. The FMP product consists of communications software that runs on Simpact's Freeway platform.

The communications software on Freeway handles the low-level protocol interface requirements of the market feed, thus freeing clients from this CPU-intensive activity. The FMP software presents packets of market data to your application program through the Freeway DLI.

Each serial link on the FMP ICP can be configured as a receiver of one of several defined market feeds. Each link operates independently of the other links on the same ICP and can be configured with different communication options.

Data messages on the primary market feeds are broadcast using bisynchronous, asynchronous, or isochronous frames. To receive the bisynchronous information, the Simpact FMP product uses a variation of IBM's 2780 or 3780 BSC protocol as described in the document, *General Information — Binary Synchronous Communications, IBM*. To receive the asynchronous and isochronous information, the Simpact FMP product uses various settings of the FMP asynchronous communication capabilities. Refer to Chapter 4 for more information about the FMP protocol options.

1.5.1 Software Description

Simpact's FMP product includes the following major software components:

- A group of communications software downloadable images:
    1. Freeway server or embedded ICP software
    2. Real-time operating system (OS/Impact)
    3. FMP communications software
- DLI library for linking with client applications
- A loopback test program (`fmpalp.c`) to check product installation (see Appendix D)
- An interactive demonstration program (`bscdemo`) that allows a user to send individual commands to the FMP software on Freeway. The `bscdemo` program is described in the *BSCDEMO User's Guide*.

The *Freeway User's Guide* or the user's guide for your particular embedded ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*) describes the software installation procedures. The DLI provides an interface by which data is

exchanged between the client application and Freeway; refer to the *Freeway Data Link Interface Reference Guide*.

1.5.2 Hardware Description

A typical Freeway configuration of Simpact's FMP product requires the following hardware:

- Communications server processor (for example, Freeway 1100, Freeway 2000, Freeway 4000 or Freeway 8800) or an embedded ICP (for example, the PCIbus ICP2432)
- Ethernet connection to a client running TCP/IP (for a Freeway server)

Chapter

2 FMP Protocol Summary

2.1 Message Formats

Although the text message format of each primary market feed is unique, the protocols used to frame the text fall into three general categories: bisynchronous, asynchronous, and isochronous. This chapter describes these three protocol categories. Information regarding the protocol framing of your feed can be found in the digital feed specification document supplied by the stock exchange or feed provider. This information is usually a one-page description called "line characteristics" located near the front of the specification.

The line mode option of the FMP product is used to configure communication links on the FMP ICP for different protocol categories. The line mode option (described in Section 4.18 on page 92) allows the FMP software to receive a large number of the world's primary digital feeds. Refer to your feed specification to determine what general protocol category it fits into. Next, read the following sections to determine what line mode option setting to use. Finally, refer to Chapter 4 for any additional options required for your feed.

All of the feeds described in this chapter are simplex; that is, they are one-way digital broadcasts. There are no protocol-level acknowledges for received blocks. Retransmission of data blocks for some feeds may be accomplished by telephone. The subscriber tells the exchange which block was missed (by sequence number) and the exchange retransmits the block when there is time on the link. Since the repeated block is transmitted to all subscribers, it is usually marked with a retransmission flag so that it will be ignored by the subscribers who don't need it.

2.1.1 Bisynchronous Market Feeds

Most of the U.S. primary feeds use the bisynchronous (BSC) method of transmission to broadcast data. BSC market feeds require the presence of a clock signal to receive the feed. Clock signals are usually supplied externally by the synchronous modem. FMP receives BSC-type framing when the line mode option is set to *bisynchronous*.

2.1.1.1 BSC 2780 Frame Structure

The BSC 2780 frame structure provides a method of transmitting individually block-checked messages. Each data message is placed into a single record within the BSC frame. Several records can be included in the frame until the specified maximum size of the data frame is reached. The diagram below outlines the normal BSC 2780 text frame. It begins with a start-of-header (SOH) character or a start-of-text (STX) character and ends with an end-of-transmission-block (ETB) or an end-of-text (ETX) character. Each data record within the text block ends with a unit separator character (US in ASCII, IUS in EBCDIC), except the last record of the block. Each record is followed by a block check character (BCC) that is a redundancy check (CRC-16 or LRC-8) of the characters in that record, including the US or ETB/ETX character. The number of synchronization (SYN) characters are described in Section 4.3 on page 70. PAD characters ensure complete transmission of the data block.

SYN	SYN	SOH	record	US	BCC	record	US	BCC	record	ETX	BCC	PAD

SIAC's Consolidated Tape System (CTS) and Consolidated Quote System (CQS), and NASDAQ's Level 2 are among the market feeds that use BSC 2780 framing.

2.1.1.2 BSC 3780 Frame Structure

When the BSC 3780 frame is used, data is broadcast with one message per block instead of one message per record. The diagram below shows the normal BSC 3780 text block. It begins with a start-of-header (SOH) or a start-of-text (STX) character and ends with

an end-of-text (ETX) character. Each text block is followed by a block check character (BCC) that is a redundancy check (CRC-16 or LRC-8) of the characters in the entire block starting with the first character following SOH or STX and ending with the ETX character. The number of SYN characters are described in Section 4.3 on page 70. PAD characters ensure complete transmission of the data block.

SYN	SYN	SOH	text message	ETX	BCC	PAD

An example of a market feed that uses normal BSC 3780 framing is the New Market Reporting System from the Tokyo Stock Exchange.

The diagram below shows the same BSC 3780 message received in transparent BSC mode. Each block starts with a data-link-escape (DLE) STX character pair (DLE STX character combination) and ends with a DLE ETX character combination. Data within the block can appear as any bit combination. Transparency of data is maintained by the insertion of an additional DLE character after each DLE bit combination within the data stream. The FMP software removes the additional DLE characters before sending the message to the client application.

SYN	SYN	DLE	STX	transparent text message	DLE	ETX	BCC	PAD

The Osaka Stock Exchange is one of the market feeds that uses transparent BSC 3780 framing.

2.1.2 Asynchronous Market Feeds

There are two basic types of asynchronous feeds: structured and unstructured. Structured feeds broadcast one text message in each block. Unstructured feeds can consist of almost any format (or none at all). Asynchronous market feeds do not require external clock signals to be received. However, the proper data rate option setting must be used for each asynchronous line whether or not a modem is used. FMP handles these types

of frames when the line mode option is set to one of the *asynchronous* settings (see Chapter 4 for more information on these option settings).

2.1.2.1 Structured Asynchronous Frame

A structured asynchronous frame is similar to a BSC frame containing one message. The diagram below shows the structured asynchronous text frame which is identical to a normal BSC 3780 frame without leading SYN or trailing PAD characters. The frame begins with an STX (or SOH) character and ends with an ETX character. Each text block is followed by a BCC character (usually LRC-8) that is a redundancy check of the characters in the entire block starting with the first character following SOH or STX and ending with the ETX character.

The London International Financial Futures Exchange (LIFFE) is an example of a market feed using a structured asynchronous frame.

2.1.2.2 Unstructured Asynchronous Frame

The most common method of broadcasting information on an asynchronous line is to use an unstructured frame. In this format, no start-of-text or end-of-text characters are broadcast. Characters are received as one continuous stream of information. On some feeds, a terminating character (TC) can be used to signify the end of a received block as shown below:

FMP uses the terminating character to divide messages into separate buffers before sending them to the client. If your feed does not specify a distinct character for message termination, a common recurring character (such as a carriage return or line feed) can be used as a message break.

An example of an unstructured asynchronous feed is SIAC's Ticker A feed.

2.1.3 Isochronous Market Feeds

The isochronous protocol is asynchronous character framing that is clocked by an external source (such as a modem). FMP receives these feeds in the same manner as the unstructured asynchronous feeds except that the line mode option must be set to *isochronous* and the clock source option must be set to *external*. See the diagram in Section 2.1.2.2.

2.1.4 Bonneville Market Feed

The Bonneville feed is an 8-bit asynchronous broadcast feed generated by the Bonneville Telecommunications Company. Each incoming packet starts with a fixed size header that contains the count of the data bytes in the packet. The following is an example of a Bonneville feed packet:

Start Flag	Address Flag	Byte Count	VCN High	VCN Low	Data Bytes	FCS1	FCS2	End Flag

The frame check sequence (FCS) for each packet consists of two bytes. The first FCS byte is calculated by taking the "exclusive or" of every other byte beginning with the byte count field. The second FCS byte is calculated by taking the "exclusive or" of every other byte beginning with the VCN high byte. For more information about the Bonneville packet format, refer to the *Packet Definition and Description* document available from the Bonneville Telecommunications Company.

2.1.5 Character Codes

The Simpact FMP software can transmit and receive data in either the American Standard Code for Information Interchange (ASCII) character set, Extended Binary Coded Decimal Interchange (EBCDIC), or five-level or six-level Baudot code depending on the setting of the data translation option. The data transferred between the client pro-

gram and the Freeway server or embedded ICP is always in ASCII and is translated by the FMP software as required.

2.1.6 Message Transmission

In addition to receiving the market feeds, the FMP product can transmit data in the same format. This capability is not usually used during normal operations; however, it can be used for port-to-port loopback testing.

The client sends data to the FMP software as a complete message. A message consists of one buffer of text data. The FMP control characters are not included in the message. The control characters are inserted by FMP before transmitting the data except when the message blocking option (Section 4.13 on page 81) is set to *no blocking*. Once in memory, FMP may transmit the messages in smaller blocks, called transmission blocks, to provide more accurate and efficient error control. The FMP software begins each transmission block with a start-of-header (SOH) control character and ends each message with an end-of-text (ETX) character. All data blocking and deblocking is transparent to the user; however, the ICP message buffer size (Section 3.4.1.3 on page 48) and transmission block size (Section 4.7 on page 72) must be defined by the user before a communication link is placed in operation (if other than the default values are required).

2.2 FMP Access Modes

Each FMP session on a link can be set to one of the following access modes: *Manager*, *Shared Manager*, *User*, or *Control*. The access mode is defined in the DLI configuration file (Chapter 5) using the client-related "`mode`" parameter (described in the *Freeway Data Link Interface Reference Guide*).

When several sessions have access to a link, each non-*Control* session receives a copy of any message listed in Table 2–1. A maximum of six non-*Control* sessions may register on any one link. Only one *Control* session is allowed per link.

Table 2–1: Messages Duplicated for all Non-*Control* Sessions on a Link

Response Codes	Usage	Reference Section
DLI_PROT_RECV_PACKED_DATA	Received packed data	Section 3.5.1 on page 60
DLI_PROT_RECV_PACKED_DATA_EOM	Received packed data (EOM)	Section 3.5.1 on page 60
DLI_PROT_RESP_ERROR	Error reports	Section 3.5.2 on page 63
DLI_PROT_SEND_NORM_DATA	Received normal data	Section 3.5.1 on page 60
DLI_PROT_SEND_NORM_DATA_EOM	Received normal data (EOM)	Section 3.5.1 on page 60
DLI_PROT_SEND_TRANS_DATA	Received transparent data	Section 3.5.1 on page 60
DLI_PROT_SEND_TRANS_DATA_EOM	Received transparent data (EOM)	Section 3.5.1 on page 60

The valid FMP access modes are defined in Table 2–2. Table 2–3 shows the required access modes for various FMP operations.

Table 2–2: FMP Session Access Modes

Mode	Usage
Manager	Set *Manager* mode for a session by setting the DLI "mode" configuration parameter to "mgr." *Manager* mode gives the client the right to issue any command or request. There can be only one *Manager* session per link.
Shared Manager	*Shared Manager* mode works the same as the *Manager* mode except that the exclusive access of *Manager* mode is not enforced. Set *Shared Manager* mode for a session by setting the DLI "mode" configuration parameter to "shrmgr." *Shared Manager* mode gives the client the right to issue any command or request. There can be up to six *Shared Manager* sessions per link.
User	Set *User* mode for a session by setting the DLI "mode" configuration parameter to "user." *User* mode allows clients to receive all messages listed in Table 2–3. *User* mode does not allow the client to issue any command that would modify or change the operational status of the link.
Control	Set *Control* mode for a session by setting the DLI "mode" configuration parameter to "control." The *Control* session may not transmit data and does not receive incoming data. Any other non-*Control* sessions for the link with the active *Control* session will not receive copies of responses to commands sent by the *Control* session. There can be only one *Control* session per link.

Table 2–3: FMP Access Modes for Various Operations

Operation	Access Mode Required	Reference Section
Set Translation Table	*Manager* or *Shared Manager*	Section 3.4.1.1
Clear Statistics	*Manager* or *Shared Manager*	Section 3.4.1.2
Change Buffer Size	Any mode	Section 3.4.1.3
Configure Link	*Manager* or *Shared Manager*	Section 3.4.1.4
Start Link	*Manager* or *Shared Manager*	Section 3.4.1.5
Stop Link	*Manager* or *Shared Manager*	Section 3.4.1.6
Buffer Report	Any mode	Section 3.4.2.1
Configuration Report	Any mode	Section 3.4.2.2
Statistics Report	Any mode	Section 3.4.2.3
Status Report	Any mode	Section 3.4.2.4
Translation Table Report	Any mode	Section 3.4.2.5
Software Version Report	Any mode	Section 3.4.2.6
Data Transmit (`dlWrite`)	*Manager* or *Shared Manager*	Section 3.4
Data Receive (`dlRead`)	Any mode	Section 3.5

Chapter

3 FMP DLI Functions

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user's guide for your ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*).

This chapter describes how to use the data link interface (DLI) functions to write client applications interfacing to the Freeway FMP protocol software. You should be familiar with the concepts described in the *Freeway Data Link Interface Reference Guide*; however, some summary information is provided in Section 3.1.

The following might be helpful references while reading this chapter:

- Section 3.2 compares a typical sequence of DLI function calls using blocking versus non-blocking I/O.
- Appendix C explains error handling and provides a summary table for FMP error codes. The *Freeway Data Link Interface Reference Guide* gives complete DLI error code descriptions.
- The *Freeway Data Link Interface Reference Guide* provides a generic code example which can guide your application program development, along with the programs described in Appendix D of this manual.

3.1 Summary of DLI Concepts

The DLI presents a consistent, high-level, common interface across multiple clients, operating systems, and transport services. It implements functions that permit your application to use data link services to access, configure, establish and terminate sessions, and transfer data across multiple data link protocols. The DLI concepts are described in detail in the *Freeway Data Link Interface Reference Guide*. This section summarizes the basic information.

3.1.1 Configuration in the Freeway Environment

Several items must be configured before a client application can run in the Freeway environment:

- Freeway server configuration
- data link interface (DLI) session configuration
- transport subsystem interface (TSI) connection configuration
- protocol-specific ICP link configuration

The Freeway server is normally configured only once, during the installation procedures described in the *Freeway User's Guide*. DLI session and TSI connection configurations are defined by specifying parameters in DLI and TSI ASCII configuration files and then running two preprocessor programs, `dlicfg` and `tsicfg`, to create binary configuration files. Refer to Chapter 5 of this document, as well as the *Freeway Data Link Interface Reference Guide* and the *Freeway Transport Subsystem Interface Reference Guide*.

ICP link configuration can be performed using any of the following methods:

- The `dlOpen` function can configure the ICP links during the DLI session establishment process using the default ICP link configuration values provided by the protocol software.

- You can specify ICP link parameters in the DLI ASCII configuration file and then run the `dlicfg` preprocessor program (see Chapter 5). The `dlOpen` function uses the resulting DLI binary configuration file to perform the link configuration during the DLI session establishment process.

- You can perform ICP link configuration within the client application (described in Section 3.4.1.4). This method is useful if you need to change link configuration without exiting the application.

3.1.2 Normal versus Raw Operation

There are two choices for the `protocol` DLI configuration parameter:

- A session is opened for *Normal* operation if you set `protocol` to a specific protocol (for example, "`FMP`"); then the DLI software configures the ICP links using the values in the DLI configuration file and transparently handles all headers and I/O.

- A session is opened for *Raw* operation if you set `protocol` to "`raw`"; then your application must handle all configuration, headers, and I/O details. Refer to the *Freeway Data Link Interface Reference Guide* if you need to use *Raw* operation.

To read and write using *Normal* operation, your client application typically interacts with Freeway only for the purpose of exchanging data with the remote application. The `writeType` DLI configuration parameter (Table 5–1 on page 104) specifies the type of data (normal or transparent).

However, if your client application needs to interact with Freeway to obtain status or reports, or to provide Freeway with protocol-specific information relating to the data exchange, *Normal* and *Raw* operation can be mixed. The client application session should be configured for *Normal* operation (allowing DLI to handle some of the headers), but the write and read requests (Section 3.4 and Section 3.5) can use *Raw* operation by including the optional arguments structure (Section 3.3) containing the protocol-specific information.

Note

For most applications, the FMP protocol requires *Raw* read and write requests to specify protocol-specific information.

3.1.3 Blocking versus Non-blocking I/O

Note

Earlier Freeway releases used the term "synchronous" for blocking I/O and "asynchronous" for non-blocking I/O. Some parameter names reflect the previous terminology.

Non-blocking I/O applications are useful when doing I/O to multiple channels with a single process where it is not possible to "block" on any one channel waiting for I/O completion. Blocking I/O applications are useful when it is reasonable to have the calling process wait for I/O completion.

In the Freeway environment, the term blocking I/O indicates that the `dlOpen`, `dlClose`, `dlRead` and `dlWrite` functions do not return until the I/O is complete. For non-blocking I/O, these functions might return after the I/O has been queued at the client, but before the transfer to Freeway is complete. The client must handle I/O completions at the software interrupt level in the completion handler established by the `dlInit` or `dlOpen` function, or by periodic use of `dlPoll` to query the I/O completion status.

The `asyncIO` DLI configuration parameter specifies whether an application session uses blocking or non-blocking I/O. The `alwaysQIO` DLI configuration parameter further qualifies the operation of non-blocking I/O activity. Refer to the *Freeway Data Link Interface Reference Guide* for more information.

The effects on different DLI functions, resulting from the choice of blocking or non-blocking I/O, are explained in the *Freeway Data Link Interface Reference Guide* and throughout this chapter as they relate to FMP.

3.1.4 Buffer Management

Currently the interrelated Freeway, DLI, TSI and ICP buffers default to a size of 1024 bytes.

Caution

If you need to change a buffer size for your application, refer to the *Freeway Data Link Interface Reference Guide* for explanations of the complexities that you must consider.

3.2 Example FMP Call Sequences

Table 3–1 shows the sequence of DLI function calls to send and receive data using blocking I/O. Table 3–2 is the non-blocking I/O example. The remainder of this chapter and the *Freeway Data Link Interface Reference Guide* give further information about each function call. Section 3.1.3 on page 38 describes blocking and non-blocking I/O.

Note

The example call sequences assume that the `cfgLink` and `enable` DLI configuration parameters are both set to "yes" (the defaults). This means that `dlOpen` configures and enables the ICP links. Figure 5–2 on page 103 shows an example DLI configuration file.

Table 3–1: DLI Call Sequence for FMP (Blocking I/O)

1. Call `dlInit` to initialize the DLI operating environment.
   The first parameter is your DLI binary configuration file name.
2. Call `dlOpen` for each required session (link) to get a session ID.
3. Call `dlBufAlloc` for all required input and output buffers.
4. Call `dlWrite` to send requests and data to Freeway (Section 3.4 on page 45).
5. Call `dlRead` to receive responses and data from Freeway (Section 3.5 on page 60).
6. Repeat Step 4 and Step 5 until you are finished writing and reading.
7. Call `dlBufFree` for all buffers allocated in Step 3.
8. Call `dlClose` for each session ID obtained in Step 2.
9. Call `dlTerm` to terminate your application's access to Freeway.

Note

When using non-blocking I/O, a `dlRead` request must always be queued to avoid loss of data or responses from the ICP (see Step 5 of Table 3–2).

Table 3–2: DLI Call Sequence for FMP (Non-blocking I/O)

1. Call `dlInit` to initialize the DLI operating environment.
   The first parameter is your DLI binary configuration file name.
2. Call `dlOpen` for each required session (link) to get a session ID.
3. Call `dlPoll` to confirm the success of each session ID obtained in Step 2.
4. Call `dlBufAlloc` for all required input and output buffers.
5. Call `dlRead` to queue the initial read request.
6. Call `dlWrite` to send requests and data to Freeway (Section 3.4 on page 45).
7. Call `dlRead` to queue reads to receive responses and data from Freeway (Section 3.5 on page 60).
8. As I/Os complete and the I/O completion handler is invoked, call `dlPoll` to confirm the success of each `dlWrite` in Step 6 and to accept the data from each `dlRead` in Step 7.
9. Repeat Step 6 through Step 8 until you are finished writing and reading.
10. Call `dlBufFree` for all buffers allocated in Step 4.
11. Call `dlClose` for each session ID obtained in Step 2.
12. Call `dlPoll` to confirm that each session was closed in Step 11.
13. Call `dlTerm` to terminate your application's access to Freeway.

3.3 Overview of DLI Functions for FMP

This section summarizes the DLI functions used in writing a client application. An overview of using the DLI functions is:

- Start up communications (`dlInit`, `dlOpen`, `dlBufAlloc`)
- Send requests and data using `dlWrite`
- Receive responses using `dlRead`
- For blocking I/O, use `dlSyncSelect` to query read availability status for multiple sessions
- For non-blocking I/O, handle I/O completions at the software interrupt level in the completion handler established by the `dlInit` or `dlOpen` function, or by periodic use of `dlPoll` to query the I/O completion status
- Monitor errors using `dlpErrString`
- If necessary, reset and download the protocol software to the ICP using `dlControl`
- Shut down communications (`dlBufFree`, `dlClose`, `dlTerm`)

Table 3–3 summarizes the DLI function syntax and parameters, listed in the most likely calling order. Refer to the *Freeway Data Link Interface Reference Guide* for details.

Caution

When using non-blocking I/O, there must always be at least one `dlRead` request queued to avoid loss of data or responses from the ICP.

Table 3–3: DLI Functions: Syntax and Parameters (Listed in Typical Call Order)

DLI Function	Parameter(s)	Parameter Usage

`int dlInit`	`(char *cfgFile,`
	`char *pUsrCb,`
	`int (*fUsrIOCH)(char *pUsrCb));`
		DLI binary configuration file name
		Optional I/O complete control block
		Optional IOCH and parameter

`int dlOpen`[a]	`(char *cSessionName,`
	`int (*fUsrIOCH)`
	`(char *pUsrCB, int iSessionID));`
		Session name in DLI config file
		Optional I/O completion handler
		Parameters for IOCH

`int dlPoll`	`(int iSessionID,`
	`int iPollType,`
	`char **ppBuf,`
	`int *piBufLen,`
	`char *pStat,`
	`DLI_OPT_ARGS **ppOptArgs);`
		Session ID from `dlOpen`
		Request type
		Poll type dependent buffer
		Size of I/O buffer (bytes)
		Status or configuration buffer
		Optional arguments

`int dlpErrString`	`(int dlErrNo);`	DLI error number (global variable `dlerrno`)
`char *dlBufAlloc`	`(int iBufLen);`	Minimum buffer size

`int dlRead`	`(int iSessionID,`
	`char **ppBuf,`
	`int iBufLen,`
	`DLI_OPT_ARGS *pOptArgs);`
		Session ID from `dlOpen`
		Buffer to receive data
		Maximum bytes to be returned
		Optional arguments structure

`int dlWrite`	`(int iSessionID,`
	`char *pBuf,`
	`int iBufLen,`
	`int iWritePriority,`
	`DLI_OPT_ARGS *pOptArgs);`
		Session ID from `dlOpen`
		Source buffer for write
		Number of bytes to write
		Write priority (normal or expedite)
		Optional arguments structure

`int dlSyncSelect`	`(int iNbrSessID,`
	`int sessIDArray[],`
	`int readStatArray[]);`
		Number of session IDs
		Packed array of session IDs
		Array containing read status for IDs

`char *dlBufFree`	`(char *pBuf);`	Buffer to return to pool
`int dlClose`	`(int iSessionID,` `int iCloseMode);`	Session ID from `dlOpen` Mode (normal or force)
`int dlTerm`	`(void);`	

`int dlControl`	`(char *cSessionName,`
	`int iCommand,`
	`int (*fUsrIOCH)`
	`(char *pUsrCB, int iSessionID));`
		Session name in DLI config file
		Command (*e.g.* reset/download)
		Optional I/O completion handler
		Parameters for IOCH

[a] It is critical for the client application to receive the `dlOpen` completion status before making any other DLI requests; otherwise, subsequent requests will fail. After the `dlOpen` completion, however, you do not have to maintain a one-to-one correspondence between DLI requests and `dlRead` requests.

3.3.1 DLI Optional Arguments

Section 3.4 and Section 3.5 describe the `dlWrite` and `dlRead` functions for an FMP application. Both functions can use the optional arguments parameter to provide the protocol-specific information required for *Raw* operation (Section 3.1.2). The "C" definition of the optional arguments structure is shown in Figure 3–1.

```
typedef struct      _DLI_OPT_ARGS
{
    unsigned short  usFWPacketType;     /* FW_CONTROL or FW_DATA          */
    unsigned short  usFWCommand;        /* FW_ICP_WRITE, FW_ICP_WRITE_EXP */
                                        /*   or FW_ICP_READ               */
    unsigned short  usFWStatus;
    unsigned short  usICPClientID;
    unsigned short  usICPServerID;
    unsigned short  usICPCommand;       /* Required for start/stop cmds   */
    short           iICPStatus;         /* ICP return error code (dlRead) */
    unsigned short  usICPParms[3];
    unsigned short  usProtCommand;      /* Required field (dlWrite)       */
    short           iProtModifier;
    unsigned short  usProtLinkID;
    unsigned short  usProtCircuitID;    /* Used for translation tables    */
    unsigned short  usProtSessionID;
    unsigned short  usProtSequence;
    unsigned short  usProtXParms[2];
}   DLI_OPT_ARGS;
```

Figure 3–1: "C" Definition of DLI Optional Arguments Structure

3.4 Overview of FMP Requests using dlWrite

For FMP the `dlWrite` function supports three `dlWrite` categories: commands, information requests, and data transfer, which are discussed in detail in Section 3.4.1 through Section 3.4.3. Whether you use blocking or non-blocking I/O, each `dlWrite` request must be followed by a `dlRead` request to receive the command confirmation, information requested, or acknowledgment of the data transfer. Section 3.5 discusses these different responses received using `dlRead`.

In a typical FMP application, most `dlWrite` requests use *Raw* operation; that is, the optional arguments structure (page 44) is required to specify protocol-specific information.

If your application is limited to interacting with Freeway only to exchange data with the remote application, you can read and write using *Normal* operation. The `writeType` DLI configuration parameter (Table 5–1 on page 104) specifies the type of data to be exchanged. If `writeType` is set to "`normal`," normal data with EOM is used (Section 3.4.3.1); if `writeType` is set to "`transparent`," transparent data with EOM is used (Section 3.4.3.2).

Caution

Take care not to confuse the terms "*Normal* operation" and "normal data." Normal data can be sent using either *Normal* or *Raw* operation.

Table 3–4 shows the FMP DLI request codes for different categories of the `dlWrite` function. Each request is explained in the following sections.

In addition to the command-specific error codes listed in the following sections, an unsuccessful `dlWrite` function can return one of the following error codes in the `dlRead` `pOptArgs.ilCPStatus` field (see Appendix C for error handling):

DLI_ICP_ERR_INBUF_OVERFLOW	Input buffer overflow
DLI_ICP_ERR_OUTBUF_OVERFLOW	Output buffer overflow

Table 3–4: Categories for FMP dlWrite Requests

Category	DLI Request Code	Usage
Commands to ICP	DLI_PROT_CFG_LINK	Configure link
	DLI_PROT_CLR_STATISTICS	Clear statistics
	DLI_PROT_SEND_BIND	Start link
	DLI_PROT_SEND_UNBIND	Stop link
	DLI_PROT_SET_BUF_SIZE	Set ICP message buffer size
	DLI_PROT_SET_TRANS_TABLE	Set translation table
Report Requests	DLI_PROT_GET_BUF_REPORT	Request buffer report
	DLI_PROT_GET_LINK_CFG	Request link configuration report
	DLI_PROT_GET_SOFTWARE_VER	Request software version ID
	DLI_PROT_GET_STATISTICS_REPORT	Request statistics report
	DLI_PROT_GET_STATUS_REPORT	Request status report
	DLI_PROT_GET_TRANS_TABLE	Request translation table
Data Transfer	DLI_PROT_SEND_NORM_DATA	Transmit normal data
	DLI_PROT_SEND_NORM_DATA_EOM	Transmit normal data with EOM[a]
	DLI_PROT_SEND_TRANS_DATA	Transmit transparent data
	DLI_PROT_SEND_TRANS_DATA_EOM	Transmit transparent data with EOM[a]

[a] If you use dlWrite without optional arguments, one of the EOM types is used, depending on the writeType DLI configuration parameter (Table 5–1 on page 104). If writeType is set to "normal," DLI_PROT_SEND_NORM_DATA_EOM is used; if it is set to "transparent," DLI_PROT_SEND_TRANS_DATA_EOM is used.

3.4.1 Commands using Raw dlWrite

Section 3.4.1.1 through Section 3.4.1.6 explain how to issue specific commands to the FMP software using the `dlWrite` function. Call `dlRead` to receive the command confirmation response (the `dlRead` `pOptArgs.usProtCommand` field is set by the DLI).

3.4.1.1 Set Translation Table Command

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_SET_TRANS_TABLE` to set translation table 1 or 2 (translation table 3 cannot be changed). Use the MSB of the `pOptArgs.usProtCircuitID` field to specify the translation table to be set (1 or 2). Each link can use any of the three tables for character translation. After Freeway startup, the tables contain the default values shown in Appendix B. Use the data area of the buffer pointed to by the `pBuf` parameter to send the translation table values. The first 256 bytes of data are the conversion values for the ASCII-to-new character set translation. The next 256 bytes are the conversion values for the new character set-to-ASCII translation.

An unsuccessful Set Translation Table command can return one of the following error codes in the `dlRead` `pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_BAD_MODE`	The function request is not available for the requested access mode; see Table 2–2 on page 33.
`DLI_ICP_ERR_BAD_PARMS`	The parameter value(s) used for the function call are illegal.

3.4.1.2 Clear Statistics Command

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_CLR_STATISTICS` to clear the link statistics report. The link statistics are cleared as soon as this command is received. The statistics are automatically cleared when a Start Link command (Section 3.4.1.5) is issued.

An unsuccessful Clear Statistics command can return the following error code in the `dlRead` `pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_BAD_MODE`	The function request is not available for the requested access mode; see Table 2–2 on page 33.

3.4.1.3 Set ICP Message Buffer Size Command

The ICP message buffer size applies to all links on the ICP. The DLI sets the ICP message buffer size as part of the configuration process during the `dlOpen` command. The default ICP message buffer size of 1024 is used in the following situations:

- If the buffer size is not changed when the very first `dlOpen` is issued, immediately after the FMP software is downloaded (the `dlOpen` function uses the value specified in the `msgBlkSize` parameter value, page 104)
- If you specify an invalid buffer size for the Set ICP Message Buffer Size command

If your application must set the ICP message buffer size itself (see the caution previously mentioned in Section 3.1.4), it must set the `cfgLink` and `enable` DLI configuration parameters to "no" (Section 5.2 on page 102) and perform the following procedure:

First, download the FMP software and send a `dlOpen` request for one link on the ICP. Second, send a `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_SET_BUF_SIZE`. Set the `iBufLen` parameter to 2, and set the write buffer to the maximum data size (in bytes) for any single transfer to or from the ICP. The valid range is 256 to 8192 bytes and must be less than or equal to the `maxBufSize` parameter in the TSI configuration file (the default value is 1024).

An unsuccessful Set ICP Message Buffer Size command can return one of the following error codes in the `dlRead` `pOptArgs.iICPStatus` field (see Appendix C for error handling):

DLI_ICP_ERR_BAD_MODE	The function request is not available for the requested access mode; see Table 2–2 on page 33.
DLI_ICP_ERR_BAD_PARMS	The parameter value(s) used for the function call are illegal.
DLI_ICP_ERR_LINK_ACTIVE	The link is already started.

3.4.1.4 Configure Link Command

You can define the ICP link configuration by setting parameters in the DLI text configuration file and running the dlicfg preprocessor program as described in Chapter 5; however, if your application must perform link configuration, set both the cfgLink and enable DLI configuration parameters to "no" for that link and then perform the configuration as follows:

Use the dlWrite function with the pOptArgs.usProtCommand field set to DLI_PROT_CFG_LINK to set the link configuration options. The buffer pointed to by the pBuf parameter contains a string of 16-bit words containing link configuration information. The string consists of a variable number of two-word configuration option/value pairs ending with a zero word. The iBufLen field equals the number of bytes in the configuration string including the zero terminator word. Figure 3–2 gives an example of the link configuration string.

Each option number corresponds to a software-selectable option of the FMP software. The configuration value is used to set that option. Table 4–1 on page 66 lists the available options and values for the FMP protocol.

All valid parameters are set by the ICP. If invalid parameters are requested, the ICP lists them in the data area of the response, but no error code is returned. Customers who want to know if all their link parameters were set can check the data area of the response. This approach enables applications to set hardware-dependent options on startup without being concerned about receiving an error. For example, the Electrical

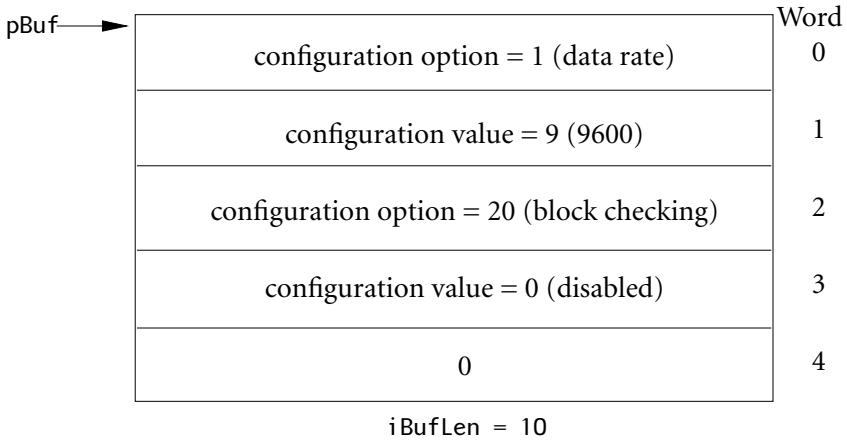


Figure 3–2: Link Configuration Block with Two Options

Interface option (Section 4.22 on page 95) is valid only on the Freeway 1000, not the Freeway 2000 or 4000.

An unsuccessful Configure Link command can return one of the following error codes in the `dlRead` `pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_LINK_ACTIVE`	The link is already started.
`DLI_ICP_ERR_BAD_MODE`	The function request is not available for the requested access mode; see Table 2–2 on page 33.
`DLI_ICP_ERR_BAD_PARMS`	The parameter value(s) used for the function call are illegal.

3.4.1.5 Start Link Command

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_SEND_BIND` and the `pOptArgs.usICPCommand` field set to `DLI_ICP_CMD_BIND` to start a link after issuing a Stop Link command (Section 3.4.1.6). After receiving this command, the FMP software turns on the DTR modem control signal and prepares the

link to transmit and receive data according to the current configuration settings. After a link starts, data transmission can begin on the line.

For blocking I/O, a successful Start Link command returns zero, but you must call `dlRead` to receive the `DLI_PROT_RESP_BIND_ACK` response indicating that the FMP software has received a data set ready (DSR) signal from the remote end. The link is not considered started until this signal is received; however, DSR can be ignored by using certain settings of the modem control option (Section 4.11 on page 80). If you are using non-blocking I/O, you must also make a `dlRead` request to read the completion status.

An unsuccessful Start Link command can return one of the following error codes in the `dlRead pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_LINK_ACTIVE`	The link is already started.
`DLI_ICP_ERR_BAD_MODE`	The function request is not available for the requested access mode; see Table 2–2 on page 33.
`DLI_ICP_ERR_BAD_PARMS`	The parameter value(s) used for the function call are illegal.

3.4.1.6 Stop Link Command

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_SEND_UNBIND` and the `pOptArgs.usICPCommand` field set to `DLI_ICP_CMD_UNBIND` to stop a link without ending your session with Freeway. This command turns off the DTR modem control signal and shuts down the link transmitter and receiver. A Stop Link command can be sent to a link that is active or already inactive.

A call to `dlClose` (described in the *Freeway Data Link Interface Reference Guide*) also stops the link, but terminates the session as well. This is the normal method to terminate a session at the end of a client application. The Stop Link command is useful for temporarily stopping the link without terminating the session (for example, to recon-

figure the link using the Link Configuration command). The link is restarted again by issuing a Start Link command.

For blocking I/O a successful Stop Link command returns zero, but you must call `dlRead` to receive the `DLI_PROT_RESP_UNBIND_ACK` response indicating the link is deactivated. If you are using non-blocking I/O, you must also make a `dlRead` request to read the completion status.

An unsuccessful Stop Link command can return one of the following error codes in the `dlRead pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_BAD_MODE`	The function request is not available for the requested access mode; see Table 2–2 on page 33.
`DLI_ICP_ERR_BAD_PARMS`	The parameter value(s) used for the function call are illegal.

3.4.2 Information Requests using Raw dlWrite

Section 3.4.2.1 through Section 3.4.2.6 explain how to issue specific information requests to the FMP software using the `dlWrite` function. You must then make a *Raw* `dlRead` request to receive the report information (the `dlRead pOptArgs.usProtCommand` field is set by the DLI to reflect the type of report, and the `iBufLen` parameter indicates the size of the message).

Caution

The `dlWrite iBufLen` parameter must specify a buffer size large enough for the requested report; otherwise, the `dlRead` function truncates the text to the size indicated by the `dlWrite iBufLen` parameter.

3.4.2.1 Request Buffer Report

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_BUF_REPORT` to request a buffer report. The `dlRead` buffer report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_BUF_REPORT` by the DLI) consists of 20 words (40 bytes) of buffer information as described in Table 3–5.

Table 3–5: Buffer Report Definition

Word	Parameter
1	ICP message buffer size
2	Number of free ICP message buffers
3	Total number of ICP message buffers
4	Transmission buffer size
5	Number of free transmission buffers
6	Total number of transmission buffers
7	Total number of links
8–20	Reserved for Simpact diagnostics

3.4.2.2 Request Configuration Report

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_LINK_CFG` to request the current configuration option settings for a link. The `dlRead` configuration report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_LINK_CFG` by the DLI) consists of a sequence of 16-bit word pairs containing the option number in the first word and the option setting in the second. The report format is identical to that used by the `dlWrite` Configure Link command (Section 3.4.1.4).

3.4.2.3 Request Statistics Report

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_STATISTICS_REPORT` to request link statistics. The FMP software maintains a set of link statistics. The report consists of 8 words (16 bytes) of statistics. Link statistics keep track of events specific to a physical link on the ICP. The format of the `dlRead` statistics report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_STATISTICS_REPORT` by the DLI) is shown in Table 3–6.

Table 3–6: Statistics Report Definition

Word	Statistic
1	Block check errors
2	Parity errors
3	Receive overrun errors
4	Queue limit errors
5	Messages sent
6	Messages received
7	Buffer not available
8	Buffer overrun errors

3.4.2.4 Request Status Report

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_STATUS_REPORT` to request the current link status. The status report returned by `dlRead` is a snapshot of the link's hardware and software condition. The `dlRead` status report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_STATUS_REPORT` by the DLI) is an eleven-word report containing the current link status as shown in Table 3–7.

Table 3–7: Status Report Definition

Word	Description	Value	Setting
1	Link status	0	off
		1	on
		2	starting
2	Current operation mode	0	idle
		1	DSR off
3	DTR	0	off
		1	on
4	DCD	0	off
		1	on
5	RTS	0	off
		1	on
6	CTS	0	off
		1	on
7	Receiver	0	off
		1	on
8	Transmitter	0	off
		1	on
9	Reserved		
10	Reserved		
11	DSR	0	off
		1	on

Link status indicates whether the link is *on*, *off*, or *starting*. *Starting* indicates that a connection command was received, but the link did not start because it did not receive the data set ready (DSR) signal from the remote station. A line is *off* until it is started and the DSR signal has been received from the remote station.

Current operation mode settings indicate whether the line can operate. A line is *idle* when data transmission or reception can occur. The setting is *DSR off* if the DSR signal is off.

The signals DTR, DSR, DCD, RTS, and CTS are reported *on* when the link detects them.

The transmitter or receiver is *on* while the link is actually transmitting or receiving data. The transmitter is also reported as *on* if the link is attempting (unsuccessfully) to transmit data on the line. This situation can occur if the transmit clock signal is not present.

3.4.2.5 Request Translation Table Report

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_TRANS_TABLE` to request any of the three translation tables. Use the MSB of the `pOptArgs.usProtCircuitID` field to specify the translation table to be read (1, 2, or 3).

The `dlRead` translation table report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_TRANS_TABLE` by the DLI) has the same format as the `dlWrite` Set Translation Table command (Section 3.4.1.1).

An unsuccessful translation table report request can return the following error code in the `dlRead` `pOptArgs.iICPStatus` field (see Appendix C for error handling):

`DLI_ICP_ERR_BAD_PARMS`	The parameter value(s) used for the function call are illegal.

3.4.2.6 Request Software Version ID

Use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_GET_SOFTWARE_VER` to request the software version ID. The `dlRead` software version report response (the `pOptArgs.usProtCommand` field is set to `DLI_PROT_GET_SOFTWARE_VER` by the DLI) is a one-line report such as the following:

```
@(#) Simpact FMP for Freeway 2000 - V01.15a 16-May-94 OS/Impact Version V1.5
```

3.4.3 Data Transfer using Raw dlWrite

FMP provides two write types for sending data: Normal Data and Transparent Data. The FMP software also provides two command variations (EOM and non-EOM) for each type of write. These variations are meaningful only when receiving data. When sending data, they both result in sending a block of data which starts with SOH and ends with ETX (for BSC and Structured Async lines). This block structure is the most widely used for BSC type feeds (i.e., feeds from SIAC, OPRA, NASDAQ, etc.). If the transparent data commands are used, the sent block starts with DLE SOH and ends in DLE ETX. The FMP software has an ETB Switch option (Section 4.16 on page 92) that allows sent data blocks to end with ETB instead of ETX in limited situations. More write format options are available using the Message Blocking option (Section 4.13 on page 81).

Each `dlWrite` consists of a data buffer containing *n* bytes of data, where *n* is a number from 0 to the maximum data size specified by the Set ICP Message Buffer Size command (Section 3.4.1.3). The ICP response to each `dlWrite` is a data acknowledge which is also called a local ack (`DLI_PROT_RESP_LOCAL_ACK`). The client application program can process the local acks itself with `dlRead` or have the DLI process it automatically (see below). If an application writes a data message that is larger than the configured ICP message buffer size, Freeway returns the data message with the `DLI_ICP_ERR_BUF_TOO_SMALL` error code instead of the data acknowledge (local ack) response.

If the localAck DLI configuration parameter is set to "no" (see the *Freeway Data Link Interface Reference Guide*), the client application must make a dlRead request to receive the data acknowledge response for each dlWrite data transfer request (the dlRead pOptArgs.usProtCommand field is set to DLI_PROT_RESP_LOCAL_ACK by the DLI). One DLI_PROT_RESP_LOCAL_ACK response (with the dlRead pOptArgs.iICPStatus field set to 1, signifying that one block of data was sent) is sent to the client computer after each data block has been successfully transmitted to the remote computer, and can be treated by the client program as the remote acknowledgment. Data acknowledgments are also used to report transmission errors (as a response to a dlRead request as described in Section 3.5.2). The client application can use the data acknowledge response to monitor the success or failure of transmitted data messages, or for regulating the number of outbound messages that the FMP software has pending transmission at any one time.

If the DLI localAck configuration parameter is set to "yes" (which is the default), the data acknowledge response is implied by a successful dlWrite.

An unsuccessful dlWrite data transfer request can return one of the following error codes in the dlRead pOptArgs.iICPStatus field (see Appendix C for error handling):

DLI_ICP_ERR_LINK_INACTIVE	The link is stopped.
DLI_ICP_ERR_BAD_MODE	The function request is not available for the requested access mode; see Table 2–2 on page 33.
DLI_ICP_ERR_XMIT_TIMEOUT	The protocol software was unable to transmit the data. This error occurs when some or all of the modem signals are not present.

3.4.3.1 Send Normal Data

If your application needs to perform a *Raw* dlWrite, use the dlWrite function with the pOptArgs.usProtCommand field set to DLI_PROT_SEND_NORM_DATA or DLI_PROT_SEND_NORM_DATA_EOM to send normal data.

To automatically send normal data with EOM, set `writeType = "normal"` in the DLI configuration file (Table 5–1 on page 104).

3.4.3.2 Send Transparent Data

If your application needs to perform a *Raw* `dlWrite`, use the `dlWrite` function with the `pOptArgs.usProtCommand` field set to `DLI_PROT_SEND_TRANS_DATA` or `DLI_PROT_SEND_TRANS_DATA_EOM` to send transparent data. The client can send transparent data in either ASCII or EBCDIC mode. In either mode, the data is not code-converted. The blocks are transmitted with DLE SOH and terminated with DLE ETX. The DLE characters are not counted in the block size. FMP performs all the required DLE insertion and deletion for transparent data streams.

To automatically send transparent data with EOM, set `writeType = "transparent"` in the DLI configuration file (Table 5–1 on page 104).

3.5 Overview of FMP Responses using Raw dlRead

Table 3–8 shows the valid FMP codes sent to your application in response to a *Raw* `dlRead` request; the returned `dlRead pOptArgs.usProtCommand` field indicates the response code. If the `dlRead` return value is zero or positive, it indicates the number of bytes read; if it is less than zero, an error has occurred. FMP error codes that can be associated with the responses are described in Appendix C.

Note

The use of *Normal* `dlRead` requests (that is, without the optional arguments parameter) is not recommended for FMP since error reports would be indistinguishable from data received from the remote application.

The following types of data can be returned from the ICP:

- Normal, transparent, and packed received data
- Error and confirmation responses
- Acknowledgments (if the `localAck` DLI configuration parameter is set to "no")
- Reports in response to `dlWrite` information requests

3.5.1 Received Data

FMP provides three read types for receiving data: Normal Data, Transparent Data, and Packed Data. Data blocks received from the serial line are sent to the client with the `dlRead pOptArgs.usProtCommand` field set to one of these data types (see Table 3–8). Note that the word "`SEND`" is used in some of the receive command types. This is because the same command code is used to both send and receive these data types.

The FMP software also provides two command variations (EOM and non-EOM) for each type of read. When a data block ending with ETX is received on the serial line (BSC and Structured Async lines), the ICP uses the EOM variation of the data type. This is

Table 3–8: FMP Response Codes

Category	DLI Response Code in pOptArgs.usProtCommand Field	Usage	Section
Received Data	DLI_PROT_RECV_PACKED_DATA	Normal or transparent data with header	
	DLI_PROT_RECV_PACKED_DATA_EOM	Normal or transparent data with header (end of message)	
	DLI_PROT_SEND_NORM_DATA	Normal data	Section 3.5.1
	DLI_PROT_SEND_NORM_DATA_EOM	Normal data (EOM)	
	DLI_PROT_SEND_TRANS_DATA	Transparent data	
	DLI_PROT_SEND_TRANS_DATA_EOM	Transparent data (EOM)	
Errors[a]	DLI_PROT_RESP_ERROR	Error report; the dlRead pOptArgs.ilCPStatus field contains more information.	Appendix C
Acknowledgments	DLI_PROT_RESP_LOCAL_ACK	Acknowledgment that a transmission buffer has been sent (if the pOptArgs.ilCPStatus field = 1). If it is less than zero, an error has occurred.	Section 3.4.3.1 and Section 3.4.3.2
	DLI_PROT_RESP_BIND_ACK	Acknowledgment of Start Link command	Section 3.4.1.5
	DLI_PROT_RESP_UNBIND_ACK	Acknowledgment of Stop Link command	Section 3.4.1.6
Command Confirmations	DLI_PROT_SET_TRANS_TABLE	Set Translation Table confirmation	Section 3.4.1.1
	DLI_PROT_CLR_STATISTICS	Clear Statistics confirmation	Section 3.4.1.2
	DLI_PROT_SET_BUF_SIZE	Set ICP Message Buffer Size confirmation	Section 3.4.1.3
	DLI_PROT_CFG_LINK	Configure Link confirmation	Section 3.4.1.4
Reports	DLI_PROT_GET_BUF_REPORT	Buffer report	Section 3.4.2.1
	DLI_PROT_GET_LINK_CFG	Link configuration report	Section 3.4.2.2
	DLI_PROT_GET_STATISTICS_REPORT	Statistics report	Section 3.4.2.3
	DLI_PROT_GET_STATUS_REPORT	Link status report	Section 3.4.2.4
	DLI_PROT_GET_TRANS_TABLE	Translation table report	Section 3.4.2.5
	DLI_PROT_GET_SOFTWARE_VER	Software version ID report	Section 3.4.2.6

[a] All of the responses, as well as the error report, can return an error code in dlRead pOptArgs.ilCPStatus field

the most widely used format for BSC type feeds (i.e., feeds from SIAC, OPRA, NASDAQ, etc.). When a data block ending with ETB is received or if the ICP must split a single block in order to fit the records into a smaller message buffer, the ICP uses the non-EOM variation. For most data feed applications, both variations should be treated as the same.

If the Message Blocking option (Section 4.13 on page 81) is set to 0, 1, or 2 (*Raw Blocks*, *Data Records*, or *Single Records*), the ICP uses the Normal Data types. If the ICP receives a transparent data block on the line, (i.e., a block starting with DLE SOH or DLE STX and ending with DLE ETB or DLE ETX), the Transparent Data types are used for those blocks.

If the Message Blocking option is set to 3 or 4 (*Data Records with Header* or *Raw Blocks with Header*), the ICP uses the Packed Data types for all received data blocks, normal or transparent. The Packed Data type indicates the presence of 5-byte ICP-generated record or block headers within the data. Each header consists of a 16-bit count, a 16-bit sequence number, and an 8-bit error code, as shown in Figure 3–3. The 5-byte header error code values are listed in Appendix C.

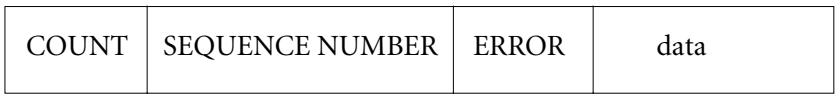


Figure 3–3: Packed Data with 5-Byte Header Format

The two-byte count includes the sequence number, error byte, and the size of the data in bytes. Depending on the type of data block received, the 5-byte header can occur multiple times within a single received data buffer. The client application must be able to search through the received buffer for multiple records or blocks until the byte count from the `dlRead` call is reached.

Caution

The 16-bit header fields are not byte-swapped by the FMP software. The client application must perform any necessary swapping. Additionally, packed data headers might not start on word boundaries. The packed data is in most significant byte (MSB) first order in the data area.

3.5.2 Error, Confirmation, and Acknowledgment Responses

Table 3–8 lists the possible FMP error, confirmation, and acknowledgment response codes returned in the `dlRead` `pOptArgs.usProtCommand` field. All of the responses, as well as the `DLI_PROT_RESP_ERROR` error report, can return an error code in the `dlRead` `pOptArgs.ilCPStatus` field to indicate failure. Section 3.4.3 on page 57 gives more information about the data acknowledgment response (`DLI_PROT_RESP_LOCAL_ACK`).

3.5.3 Reports in Response to dlWrite Information Requests

After issuing a `dlWrite` information request (Section 3.4.2 on page 53), a `dlRead` request must be issued to receive the report information. The reports are listed in Table 3–8 on page 61.

Chapter

4 FMP Link Configuration Options

This chapter describes the various link configuration options that can be defined using the DLI configuration file described in Section 5.2 on page 102. Alternatively, the link options can be set using the `dlWrite` Configure Link command as described in Section 3.4.1.4 on page 49.

Table 4–1 lists all the available options in numerical order along with the allowed settings and defaults. The defaults are in effect immediately after the protocol software is downloaded to the ICP. They remain in effect until you either modify the DLI configuration file and redownload the ICP, or send a `dlWrite` Configure Link command.

Note

Link configuration options can be set only when the link being configured is stopped.

Some of the possible error conditions are discussed in the following sections, as they relate to using each configuration option. Appendix C explains FMP error handling and gives a list of errors.

Table 4–1: FMP Default Options and Settings

Option	Number	Value	Default (✓)	Setting
Data Rate	1	0		75 bits/second
		1		110
		2		135
		3		150
		4		300
		5		600
		6		1200
		7		2400
		8		4800
		9	✓	9600
		10		19200
		11		38400
		12		56000
Clock Source	2	0	✓	External
		1		Internal
Number of Leading Sync Characters	4	*n*	3	*n* = sync chars ($2 \leq n \leq 8$)
Protocol	5	2	2	FMP
Parity	6	0		None
		1	✓	Odd
		2		Even
Character Set	7	0	✓	ASCII/LRC-8
		1		EBCDIC/CRC-16
		2		ASCII/CRC-16
		3		ASCII/LRC-8 OR'd with 0x40 hex
		4		EBCDIC/CCITT-0
		5		ASCII/CCITT-0
Transmission Block Size	8	*n*	512	*n* = size in bytes ($64 \leq n \leq 4096$)

Table 4–1: FMP Default Options and Settings *(Cont'd)*

Option	Number	Value	Default (✓)	Setting
Data Translation	10	0		Disable
		1	✓	Table 1 (default is EBCDIC)
		2		Table 2 (default is Baudot level 6)
		3		Table 3 (default is Baudot level 5)
Data Packing	12	0		Disable
		1	✓	Enable
Buffer Timer	15	*n*	0	*n* = delay in tenths of seconds ($0 \leq n \leq 8000$)
Modem Control	16	0		HDX-1
		1	✓	FDX-1
		2		HDX-2
		3		FDX-2
		4		HDX-3
		5		FDX-3
		6		HDX-4
		7		FDX-4
Feed ID	18	*n*	0	*n* = 0–999 (defined by user)
Message Blocking	19	0		Raw Blocks
		1		Data Records
		2		Single Records
		3	✓	Data Records with Header
		4		Raw Blocks with Header
Block Checking	20	0		Disable
		1	✓	Exclude first byte
		2		Include first byte
Queue Limit	21	0	✓	No limit
		n		Buffer limit ($0 \leq n \leq 4096$)
ETB Switch	24	0	✓	Disable
		1		Enable
DSR Delay	30	*n*	3	*n* = delay in seconds ($1 \leq n \leq 127$)

Table 4–1: FMP Default Options and Settings *(Cont'd)*

Option	Number	Value	Default (✓)	Setting
Line Mode	33	0	✓	Bisynchronous
		1		Structured Asynchronous
		2		8-bit Unstructured Asynchronous
		3		7-bit Unstructured Asynchronous
		4		6-bit Unstructured Asynchronous
		5		5-bit Unstructured Asynchronous
		6		8-bit Isochronous
		7		Bonneville Asynchronous Feed
Asynchronous Terminating Characters	34	A	3	A = ASCII character code (0–255)
Number of Terminating Characters	38	0		No terminating character
		1	✓	One terminating character (as defined by option 34)
User-defined Data Rate	39	0	✓	Disable
		n		Time Constant ($0 \leq n \leq 4096$)
Electrical Interface (Freeway 1000 only)	40	0	✓	EIA-232
		1		EIA-485
		2		EIA-530/EIA-449 (balanced, EIA-422)
		3		V.35
		4		EIA-449 (unbalanced, EIA-423)
		5		EIA-562

4.1 Data Rate Option (1)

The data rate can be set by the client for installations where the FMP software must generate the data clocking signal. If external clocking is provided by a modem or modem eliminator, the configuration of the data rate is not required. However, when transmitting data, the data rate setting is used to calculate the amount of time to wait before aborting a transmission with the `DLI_ICP_ERR_XMIT_TIMEOUT` transmit timeout error.

Therefore, if FMP is being used to transmit data, the data rate should be set to match, or be slower than, the modem clock rate.

The data rate on a link can be set from 75 through 56,000 bits/second. When using data rates above 19,200 bits/second, be careful not to overload the communications server processor. Freeway supports up to16 links per ICP, and the maximum link data rates are:

- 1 link at 56,000 b/s
- 4–8 links at 19,200 b/s
- 16 links for a 16-port ICP at 9,600 b/s

To set this option using the DLI configuration file, use the `dataRate` parameter; for example, `dataRate = 9600`. See Table 5–1 on page 104.

4.2 Clock Source Option (2)

The clock source option determines the source of the data clock signals for a link. Data clocking can be provided by the FMP software or received from an external source.

To set this option using the DLI configuration file, use the `clockSource` parameter; for example, `clockSource = "external"`. See Table 5–1 on page 104.

4.2.1 External

Simpact recommends the *external* clock setting for most communications applications that involve a cable length greater than 25 feet. With the external setting, the clock generator is disabled, and data clocking must be supplied by an external source such as a modem or modem eliminator. Receive clocking is input through the receiver timing signal (EIA-232 pin 17), and transmit clocking is input through the transmitter timing signal (EIA-232 pin 15). Your Freeway server is factory configured for *external* clocking using a hardware jumper.

4.2.2 Internal

When the *internal* clock setting is used, the clock signal is generated at the rate specified in the data rate option (Section 4.1). The generated clock signal is used for transmit clocking and is output on the terminal timing signal (EIA-232 pin 24). Receive clocking is input through the receiver timing signal (EIA-232 pin 17). The transmitter timing signal (EIA-232 pin 15) is not used. Your Freeway server is factory configured for *external* clocking using a hardware jumper. If you need to set internal clocking, call the Simpact customer support number given in the *Preface*.

4.3 Number of Leading SYN Characters Option (4)

This option specifies the number of SYN characters to precede all transmitted data blocks. Certain links may require more SYN characters to ensure synchronization on poor-quality lines. The minimum number of leading SYN characters is two; the maximum number is eight. SYN characters are not added to unstructured asynchronous transmissions.

To set this option using the DLI configuration file, use the `numLeadSync` parameter; for example, `numLeadSync = 3`. See Table 5–1 on page 104.

4.4 Protocol Option (5)

This option indicates the protocol used on the ICP and has only one setting (FMP). This setting is reported in the configuration report (Section 3.4.2.2 on page 54) which may be used by client application programs to verify the protocol running on the ICP.

The DLI configuration program (Chapter 5) considers this protocol option to be protocol-independent, but it must be set to "`FMP`" in order to select the FMP protocol. This parameter must be set prior to any attempt to assign another FMP configuration option within a session definition (see Figure 5–2 on page 103); otherwise the DLI configuration program will fail.

To set this option using the DLI configuration file, use the `protocol` parameter; for example, `protocol = "FMP"`. See Figure 5–1 on page 104.

4.5 Parity Option (6)

When using the ASCII/LRC-8 character set, this option controls the setting of bit 7 of each character. Parity can be set to *odd*, *even*, or *none* (space parity for bisynchronous). Any transmission containing a parity error is detected by the receiver hardware, and the appropriate error recovery is taken by the FMP software. If no parity is selected, bit 7 is set to zero for all transmitted characters when using bisynchronous line mode. Parity is automatically disabled when the *EBCDIC/CRC-16, ASCII/CRC-16, EBCDIC/CCITT-0* or *ASCII/CCITT-0* character set is used. The parity used for bisynchronous transmission is normally *odd*.

To set this option using the DLI configuration file, use the `parity` parameter; for example, `parity = "odd"`. See Table 5–1 on page 104.

4.6 Character Set Option (7)

This option determines the character code for the FMP control sequences used on the transmission line. It also determines what type of block checking is done on data blocks. The character set option is valid only for the bisynchronous and structured asynchronous line modes. The FMP software transmits all control characters on the line with space parity when *no parity* is selected (Section 4.5).

To set this option using the DLI configuration file, use the `charSet` parameter; for example, `charSet = "asciilrc8"`. See Table 5–1 on page 104.

4.6.1 ASCII/LRC-8

When this setting is used, the FMP control sequences are transmitted in 7-bit ASCII format, and LRC-8 block checking is performed.

4.6.2 EBCDIC/CRC-16

When this setting is used, the FMP control sequences are transmitted in 8-bit EBCDIC format, and the CRC-16 block check polynomial is performed. The parity option is ignored when using EBCDIC/CRC-16.

4.6.3 ASCII/CRC-16

When this setting is used, the FMP control sequences are transmitted in 7-bit ASCII (space parity) format, and the CRC-16 block check polynomial is performed. Data parity checking is disabled when using ASCII/CRC-16.

4.6.4 ASCII/LRC-8 OR'd with 0x40 Hex

This setting is used with the Hong Kong Foreign Exchange feed. The FMP control sequences are transmitted in 7-bit ASCII format with LRC-8 block checking OR'd with 0x40 hex.

4.6.5 EBCDIC/CCITT-0

When this setting is used, the FMP control sequences are transmitted in 8-bit EBCDIC, and the CCITT-0 block check polynomial ($X^{16} + X^{12} + X^5 + 1$) is used. The parity option is ignored when using EBCDIC/CCITT-0.

4.6.6 ASCII/CCITT-0

When this setting is used, the FMP software uses the CCITT-0 block check polynomial ($X^{16} + X^{12} + X^5 + 1$) on all input and output ASCII data blocks. The parity option is ignored when using ASCII/CCITT-0

4.7 Transmission Block Size Option (8)

The transmission block size is selectable from 64 through 4096 bytes. This value controls the size of the data blocks transferred over the data link. The size of the transmission block includes the bisynchronous text control characters as well as the data

characters. For example, a transmission block size of 512 bytes consists of 510 bytes of data plus two control characters (SOH and ETX). SYN, DLE, PAD, and BCC characters are not included in the transmission block size count. The FMP software automatically inserts all control characters in the blocks sent and removes them from blocks received. If the remote station sends a transmission block that is larger than the configured size, the FMP software sends the `DLI_ICP_ERR_BUF_OVERFLOW` buffer overrun error to the client with all the data that was received.

The size of message buffers from the client is independent of the transmission block size. The ICP message buffer size is controlled by the Set ICP Message Buffer Size command (Section 3.4.1.3 on page 48). Messages to be transmitted that are greater than the transmission block size are broken into smaller messages and sent separately. See Section 2.1.6 on page 32 for more information on transmission blocks.

For messages received on the communication line, the ICP message buffer size is the maximum size that can be received; otherwise, the `DLI_ICP_ERR_BUF_OVERFLOW` error code is sent to the client application.

To set this option using the DLI configuration file, use the `transBlkSize` parameter; for example, `transBlkSize = 512`. See Table 5–1 on page 104.

4.8 Data Translation Option (10)

This option invokes transmit and receive data translation using one of the three onboard ASCII translation tables described in Appendix B.

When one of the translation tables is selected, data translation is enabled. Data blocks from the client are treated as ASCII data and are translated into EBCDIC or Baudot code before they are transmitted on the communication line. Conversely, data blocks received from the line are treated as EBCDIC or Baudot code and are translated to ASCII before they are sent to the client. No translation is done on transparent data blocks.

If this option is set to *disable*, no data translation is performed. In this case, the client application program is responsible for performing any necessary data translation.

The 5-bit Baudot-to-ASCII and ASCII-to-Baudot data translation using Translation Table 3 does not work in the same way as data translation using Translation Table 1. ASCII values that are to be translated to 5-bit Baudot code are evaluated to see whether a figure-shift or letter-shift character should be inserted in front of the character. A character that requires a figure-shift character inserted before it has the high bit of its Baudot table value set. For example, if ASCII value 33 (hexadecimal) is translated to its Baudot code equivalent, the value in the translation table would appear as 81 (hexadecimal). The value 81 (hexadecimal) is the Baudot 01 value with the high bit set indicating that the character is to be preceded by a figure shift. It is the 01 value that is sent out on the link.

On inbound data, the letter-shift and figure-shift characters are stripped from the data, and all Baudot characters are translated to their ASCII equivalents. All figure-shift characters are listed in the last 128 bytes, and all letter-shift characters are listed in the first 128 bytes of the Baudot-to-ASCII translation tables. Only data translation using Translation Table 3 employs this method; data translation using Translation Table 1 or 2 uses one-to-one correspondence. See Appendix B for the translation tables and for an example of data translation using Translation Table 1 or 2.

To set this option using the DLI configuration file, use the `dataTranslation` parameter; for example, `dataTranslation = "table1"`. See Table 5–1 on page 104.

4.9 Data Packing Option (12)

This option controls the packing of multiple incoming records or blocks into a single buffer. Data packing is especially useful when receiving a burst of small data blocks from the serial line (such as test messages). In this situation the data packing feature of FMP conserves buffer space on Freeway by packing as many of these small blocks as will

fit in one buffer. Data packing also helps move data from Freeway to the client more efficiently over the Ethernet.

The default for this option is *enabled*. To disable this option using the DLI configuration file, use the `dataPacking` parameter; for example, `dataPacking = "no"`. See Table 5–1 on page 104.

Note

Earlier versions of the BSCDEMO interactive program might display this option as "space compression"; however, you can still use this option to turn data packing on or off. For more information, refer to the *BSCDEMO User's Guide*.

4.9.1 How Data Packing Works

When data packing is *enabled*, the FMP software starts packing incoming messages when it detects that the message buffers are not being read by the client fast enough; i.e., unread buffers start collecting on the Freeway ICP board. When this happens, the FMP software attempts to put any newly received data into the previous waiting message buffer. This happens only if the previous message buffer has enough free space to hold the new data. If it does, FMP copies the new data into the previous buffer, placing it behind the data already in the buffer. The data size of the previous buffer is updated to reflect the number of bytes added to the buffer. Finally, the ICP buffer that contained the new data is released to the ICP free pool to be reused.

Note

Data packing takes place only when the client cannot read the incoming data fast enough. If the client application is keeping up with the flow of incoming data, it might never see a packed data buffer, even though the data packing option is *enabled*.

Data Message Types: Only data buffers are packed. If a non-data buffer (such as a data acknowledgment or report) is placed on the waiting queue, data packing is temporarily interrupted. Data packing resumes when two sequential data type buffers appear on the queue. The buffer retains the command code of the first message in a packed buffer. For example, if an ETB block (`DLI_PROT_SEND_NORM_DATA`) was on the queue and an ETX block (`DLI_PROT_SEND_NORM_DATA_EOM`) was packed into it, the packed buffer would retain the ETB command code (`DLI_PROT_SEND_NORM_DATA`).

Buffer Reporting: The link buffer request (Section 3.4.2.1 on page 53) reports the number of buffers in the ICP waiting queue (HOSTOQ) at any one time. For best results on an active link, the buffer request should be issued through the control access mode (Section 2.2 on page 32). Because the ICP always posts two writes to the Freeway server, data packing normally does not start until after the third buffer arrives on the queue.

Sequence Number Field: When the data packing option *enabled*, the Simpact assigned sequence numbers for packed buffers become meaningless for obvious reasons. As such, the sequence number field in the optional arguments structure (Section 3.3.1 on page 44) is used for a different purpose when data packing is *enabled*. With data packing *enabled*, the sequence number field contains the number of messages (whole buffers) that were packed into this buffer. Incoming data buffers that do not remain in ICP memory long enough to pack have a 1 in the sequence number field. On Freeway record types with a 5-byte header, (see Section 4.13.4 on page 87 and Section 4.13.5 on page 88), the sequence number appears in bytes 4 and 5 of the record header even though packing is *enabled*.

4.9.2 Data Packing Examples

Figure 4–1 through Figure 4–5 give examples of how data is packed for the various Message Blocking options (Section 4.13 on page 81). Compare these with the examples of unpacked data in Figure 4–7 on page 83 through Figure 4–14 on page 89. Both series of

figures show how the three example data blocks shown in Figure 4–6 on page 82 would be received for each option setting

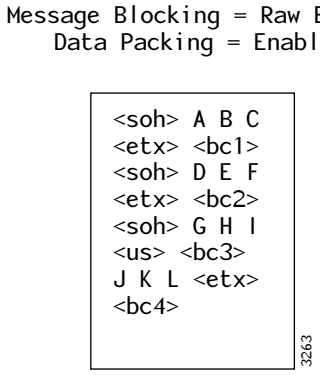


Figure 4–1: Data Packing *Enabled* (Message Blocking = *Raw Blocks*)

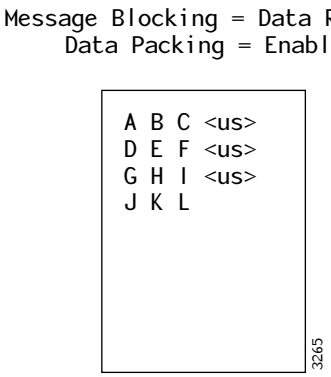


Figure 4–2: Data Packing *Enabled* (Message Blocking = *Data Records*)

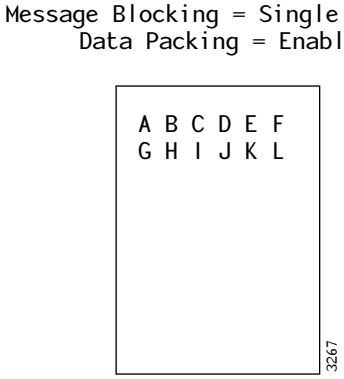


Figure 4–3: Data Packing *Enabled* (Message Blocking = *Single Records*)

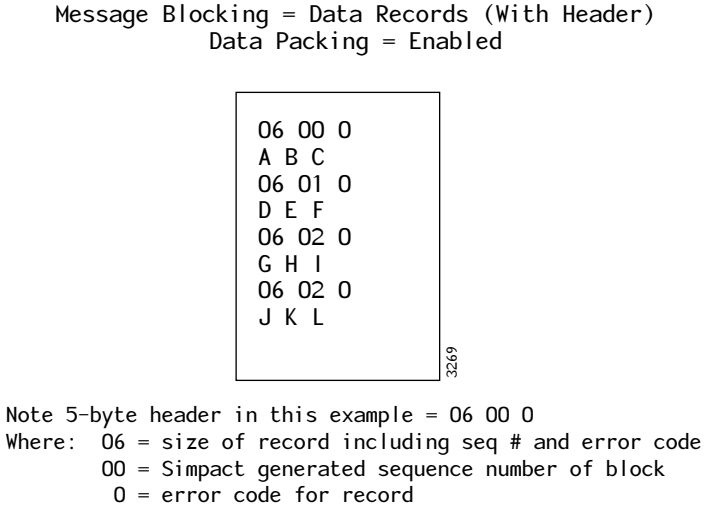
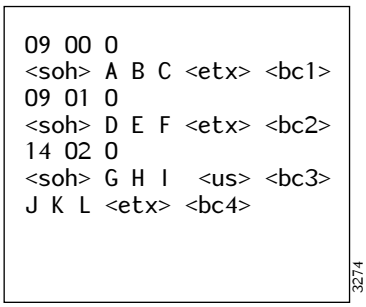


Figure 4–4: Data Packing *Enabled* (Message Blocking = *Data Records with Header*)

```
Message Blocking = Raw Blocks (With Header)
          Data Packing = Enabled
```




```
Note 5-byte header in this example: 09 00 0
Where: 09 = size of block including seq # and error code
       00 = Simpact generated sequence number of block
        0 = error code for block
```

Figure 4–5: Data Packing *Enabled* (Message Blocking = *Raw Blocks with Header*)

4.10 Buffer Timer Option (15)

This option allows you to control the amount of time the FMP software holds a buffer containing data while waiting for additional data. The Buffer Timer interval is specified in tenths of seconds and can range from 0 (infinite delay) to 8000 (800 seconds). This option prevents you from waiting indefinitely for a terminating character that does not arrive. This option applies only when line mode is asynchronous or isochronous; that is, the line mode option is set to a value greater than or equal to 2. If the interval expires, the current buffer, if it has data, is sent to the client with the error field marked with `DLI_ICP_ERR_NO_TERM_CHAR`. All buffers marked with `DLI_ICP_ERR_NO_TERM_CHAR` are sent to the client with the `dlRead optArgs.usProtCommand` field set to `DLI_PROT_RECV_PACKED_DATA`. The asynchronous terminating character option is described in Section 4.19.

To set this option using the DLI configuration file, use the `bufferTimer` parameter; for example, `bufferTimer = 0`. See Table 5–1 on page 104.

4.11 Modem Control Option (16)

This option determines two things: the operation of the request to send (RTS) output modem signal and the detection of the data set ready (DSR) and data carrier detect (DCD) input modem signals. Table 4–2 lists the possible settings for this option.

Table 4–2: Modem Control Option Settings

Value	Setting	Description
0	HDX-1	Half duplex, detect DSR
1	FDX-1	Full duplex, detect DSR
2	HDX-2	Half duplex, ignore DSR and DCD
3	FDX-2	Full duplex, ignore DSR and DCD
4	HDX-3	Half duplex, detect DCD
5	FDX-3	Full duplex, detect DCD
6	HDX-4	Half duplex, detect DSR and DCD
7	FDX-4	Full duplex, detect DSR and DCD

To set this option using the DLI configuration file, use the `modemControl` parameter; for example, `modemControl = "FDX1"`. See Table 5–1 on page 104.

4.11.1 RTS Signal

When the modem control option is set to any *half-duplex* setting (HDX), the RTS signal is turned on when FMP is ready to transmit and turned off when transmission is complete. For any *full-duplex* setting (FDX), the RTS signal is turned on when the link is started and stays on until the link is stopped. In all cases, transmission does not start until a clear to send (CTS) signal is received by the FMP software.

4.11.2 DSR and DCD Signals

Line activity ceases when the signal on the DSR pin is lost. With either the HDX-2 or FDX-2 setting, the incoming DSR signal is ignored by the FMP software. This setting is useful when DSR may not be present.

4.12 Feed ID Option (18)

This option lets the application program assign a number to a configuration. For example, if an application program services a given number of multiple links or communications servers, the configuration feed ID is used to determine what market feed that line is configured for. In other words, the user application assigns unique feed IDs to every different market feed. The user application can then identify the market feed by using the feed ID option. This option has no effect on the FMP software.

To set this option using the DLI configuration file, use the `feedID` parameter; for example, `feedID = 0`. See Table 5–1 on page 104.

4.13 Message Blocking Option (19)

This option controls the logical blocking and deblocking of data between ICP message buffers (Section 3.4.1.3 on page 48) and transmission blocks (Section 4.7 on page 72) during normal link operation. See Section 2.1.6 on page 32 for more information on message buffers and transmission blocks. This option, in conjunction with the Data Packing option (Section 4.9 on page 74), determines how received data is formatted in an FMP buffer. Table 4–3 summarizes the Message Blocking option settings for received data.

Before determining which setting is best for your application, it is important to know the difference between a data block and a data record. A data block starts with STX or SOH and ends with ETB or ETX followed by a BCC (block check character). A block can contain one or more records. Multiple records within a block are separated by unit separator (US) or record separator (RS) characters. Data feeds that use US characters to

Table 4–3: Message Blocking Option Settings for Received Data

Value	Setting	Description	Freeway Data Codes
0	*Raw Blocks*	Block is received with SOH, US, and BCC characters left in	DLI_PROT_SEND_NORM_DATA DLI_PROT_SEND_NORM_DATA_EOM DLI_PROT_SEND_TRANS_DATA DLI_PROT_SEND_TRANS_DATA_EOM
1	*Data Records*	BSC control chars are removed, US chars are left in to separate records	DLI_PROT_SEND_NORM_DATA DLI_PROT_SEND_NORM_DATA_EOM DLI_PROT_SEND_TRANS_DATA DLI_PROT_SEND_TRANS_DATA_EOM
2	*Single Records*	All control chars are removed, one record per message buffer	DLI_PROT_SEND_NORM_DATA DLI_PROT_SEND_NORM_DATA_EOM DLI_PROT_SEND_TRANS_DATA DLI_PROT_SEND_TRANS_DATA_EOM
3	*Data Records with Header*	All control chars are removed and a 5-byte header before each record	DLI_PROT_RECV_PACKED_DATA DLI_PROT_RECV_PACKED_DATA_EOM
4	*Raw Blocks with Header*	Same as '0' but with a 5-byte header before each block	DLI_PROT_RECV_PACKED_DATA DLI_PROT_RECV_PACKED_DATA_EOM

separate records also place a BCC for that record after each US character as well as after the ETB or ETX.

To illustrate the effects of the Message Blocking option on received data, Figure 4–7 on page 83 through Figure 4–14 on page 89 graphically represent how the data looks when received with each of the Message Blocking option settings (when the Data Packing option is *disabled*). Compare these with the examples of Data Packing *enabled* in Figure 4–1 on page 77 through Figure 4–5 on page 79. Both series of figures show how the three example data blocks of Figure 4–6 would be received for each option setting:

```
<syn> <syn> <soh> A B C <etx> <bcc> <pad>
<syn> <syn> <soh> D E F <etx> <bcc> <pad>
<syn> <syn> <soh> G H I <us>  <bcc> J K L <etx> <bcc> <pad>
```

Figure 4–6: Received Data Used in Message Blocking and Data Packing Examples

To set this option using the DLI configuration file, use the `messageBlocking` parameter; for example, `messageBlocking = "DataHdr"`. See Table 5–1 on page 104.

4.13.1 Raw Blocks

On inbound messages with Message Blocking set to *Raw Blocks*, FMP strips any leading PAD or SYN characters from the message. The FMP software also strips any trailing PAD characters from the message. The message is sent to the client with all bisynchronous control characters and all block check characters (BCCs) present. Figure 4–7 is an example of the *Raw Blocks* setting using the sample received data blocks shown in Figure 4–6 on page 82.

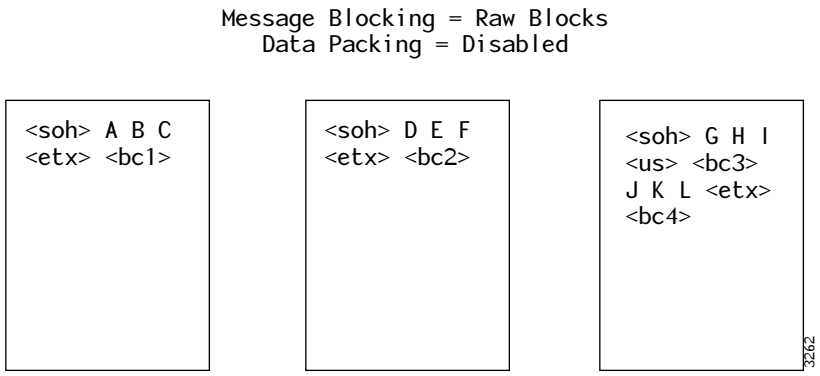


Figure 4–7: Message Blocking Example (*Raw Blocks*)

An outbound message with Message Blocking set to *Raw Blocks* must be sent to FMP with any necessary control characters (that is, SOH, ETB, or ETX) embedded in the message. In front of the message, FMP inserts a PAD character followed by the number of SYN characters specified by the number of leading SYN characters option (Section 4.3). The message is followed by a PAD character. Figure 4–8 is an example of an outbound message with the *Raw Blocks* option.

SOH	data A	US	BCC	data B	ETX	BCC

User's Outbound Message as Sent to FMP using the *Raw Blocks* Option

PAD	SYN	SYN	SYN	SOH	data A	US	BCC	data B	ETX	BCC	PAD

Same Message with Characters Added by FMP Using the *Raw Blocks* Option

Figure 4–8: Example of User's Outbound Message (*Raw Blocks* Option)

The *Raw Blocks* option is always used on asynchronous lines (line mode options 2–6). The *Raw Blocks* option can be used in bisynchronous mode if explicit control is needed for message enveloping.

4.13.2 Data Records

On inbound messages with Message Blocking set to *Data Records*, FMP strips out block check characters and all control characters except unit separators (which are used to separate individual records). If a BCC error or other receive error is detected within any record in a block, an error code is placed in the Freeway error field of the received buffer. Figure 4–9 is an example of the *Data Records* setting using the sample received data blocks shown in Figure 4–6 on page 82. There is no data blocking on unstructured asynchronous lines.

On outbound messages, the client application places individual records in the write buffer separated by US characters. The FMP software adds all the BSC control characters necessary to send the records in one block. In addition, FMP generates the block check character for each record. Figure 4–10 is an example of the *Data Records* setting for transmitted data.

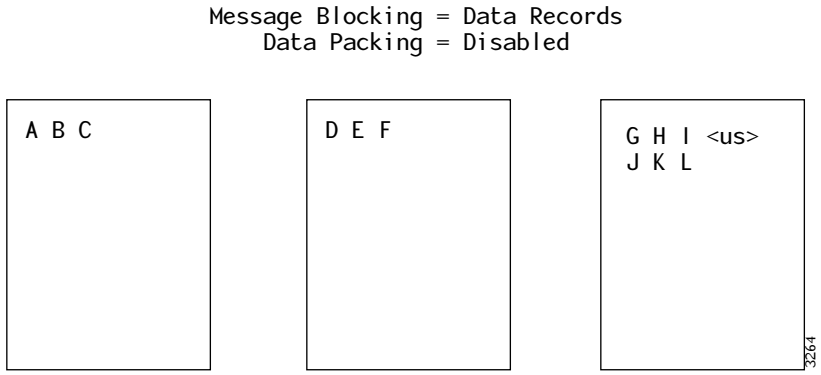


Figure 4–9: Message Blocking Example (*Data Records*)

data A	US	data B

User's Outbound Message as Sent to FMP using the *Data Records* Option

PAD	SYN	SYN	SYN	SOH	data A	US	BCC	data B	ETX	BCC	PAD

Same Message with Characters Added by FMP Using the *Data Records* Option

Figure 4–10: User's Non-transparent Outbound Message (*Data Records* Option)

4.13.3 Single Records

Note

The *Single Records* setting was added for compatibility with older versions of FMP on embedded ICP boards. This setting is not recommended for high-speed or multiple-line use on Freeway devices, as it generates more overhead on the Ethernet LAN.

On inbound messages with the Message Blocking option set to *Single Records*, FMP strips out block check characters and all control characters including unit separators. Also, each individual record is placed in a separate message buffer. This means that the client program must issue a `dlRead` for each record received. If a BCC error or other receive error is detected within the record, an error code is placed in the Freeway error field of the received buffer. Figure 4–11 is an example of the *Single Records* setting using the sample received data blocks shown in Figure 4–6 on page 82.

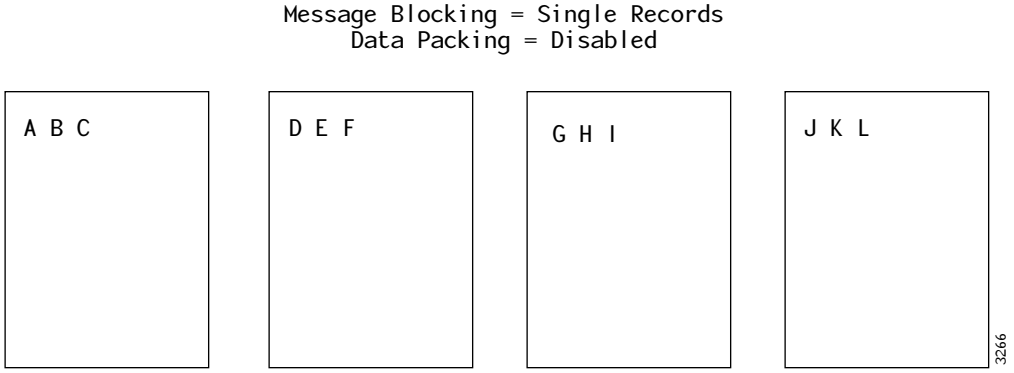


Figure 4–11: Message Blocking Example (*Single Records*)

The *Single Records* setting is not applicable to outbound messages. Messages that are sent with this setting are formatted the same way as with the *Data Records* setting (Section 4.13.2).

4.13.4 Data Records with Header

On inbound messages with Message Blocking set to *Data Records with Header*, FMP strips out block check characters and all control characters including unit separators. Each individual record is preceded by a 5-byte header that contains information about the record. Figure 4–12 shows the format of the record header. The first two bytes contain a 16-bit count of the number of record bytes that follow it (including the rest of the record header). The next two bytes contain a 16-bit FMP-generated block sequence number. If multiple records are received in the same block, they will have the same sequence number. The last header byte contains an 8-bit error code pertaining to that record (see Appendix C for the error code values). If the record contains no errors, this field is zero. If a BCC error or other receive error is detected within the record, an error code is placed in this field. Figure 4–13 is an example of the *Data Records with Header* setting using the sample received data blocks shown in Figure 4–6 on page 82.

PAD	SYN	SYN	SYN	DLE	SOH	data	DLE	ETX	BCC	PAD

Message as received by FMP

count	sequence number	error	data

(DLI_PROT_RECV_PACKED_DATA_EOM)

User's inbound message from FMP

Figure 4–12: Example of a User's Transparent Inbound Message

On outbound messages, the client application places individual records in the write buffer separated by US characters (as in the *Data Records* setting). The FMP software adds all the BSC control characters necessary to send the records in one block. In addition, FMP generates the block check character for each record. No header is required on outbound messages. See Figure 4–10 on page 85 for an example of transmitted data for this setting.

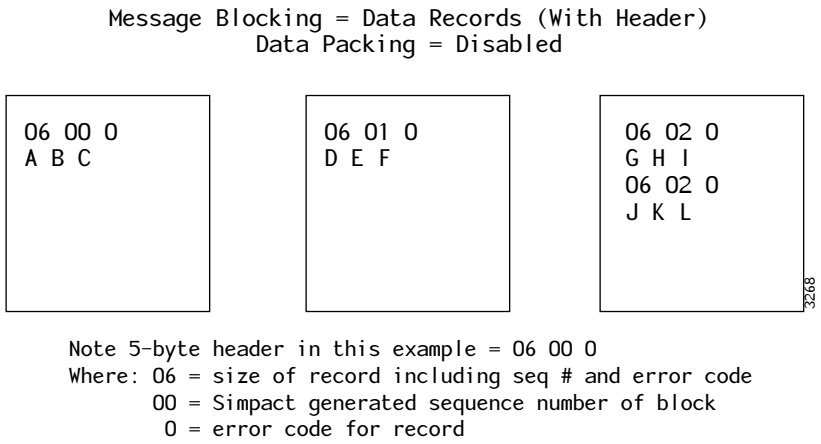


Figure 4–13: Message Blocking Example (*Data Records with Header*)

4.13.5 Raw Blocks with Header

On inbound messages with Message Blocking set to *Raw Blocks with Header*, FMP strips any leading PAD or SYN characters and trailing PAD characters from the message. The message is sent to the client with all BSC control characters and BCC characters present. This is the same format as in the *Raw Blocks* setting except that each block is preceded by a 5-byte header that contains information about the block (see Appendix C for the error code values). Figure 4–12 on page 87 shows the format of the record header. The first two bytes contain a 16-bit count of the number of bytes that follow it (including the rest of the block header). The next two bytes contain a 16-bit FMP-generated block sequence number. The last header byte contains an 8-bit error code pertaining to that block. If the block contains no errors, this field is zero. If a BCC error or other receive error is detected in any record within the block, an error code is placed in this field. Figure 4–14 is an example of the *Raw Blocks with Header* setting using the sample received data blocks shown in Figure 4–6 on page 82.

On outbound messages, the client application places all the control characters (except SYN and PAD) into the block before sending it to Freeway (as in the *Raw Blocks* setting).

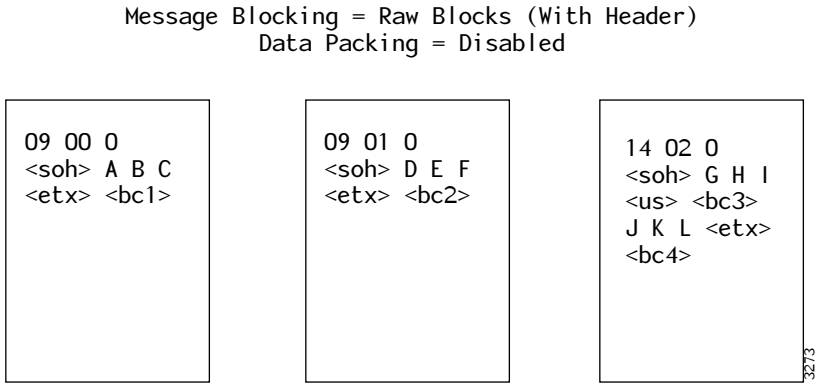


Figure 4–14: Message Blocking Example (*Raw Blocks with Header*)

No header is required on outbound messages. See Figure 4–8 on page 84 for an example of transmitted data for this setting.

4.13.6 Message Blocking for the Bonneville Feed

If the line mode option (Section 4.18 on page 92) is set for the Bonneville feed, the following apply for transmitting and receiving packets.

For transmit: If message blocking is set to one of the raw modes, the user must supply the entire Bonneville packet including the correct frame check sequence to the FMP software. For all other modes, the user must supply only the bytes from the VCN high field to the last data byte. The FMP software adds the start and end flags, address, byte count, and FCS bytes to the packet before transmitting it.

For receive: If message blocking is set to one of the raw modes, the user receives the entire Bonneville packet including the frame check sequence from the FMP software. For all other modes, the user receives only the bytes from the VCN high field to the last data byte. The FMP software removes the start and end flags, address, byte count, and FCS bytes to the packet before transmitting. If there is an error on the received FCS, the FMP software sets the `DLI_ICP_ERR_BAD_BCC` error code in the appropriate header field.

4.14 Block Checking Option (20)

This option determines what characters are included in the block check character (BCC) calculation on transmitted and received data blocks. If the received block check character does not match the BCC value calculated by FMP, the `DLI_ICP_ERR_BAD_BCC` error code is returned to the client application. Block checking can be set to include or exclude the leading FMP control character or can be disabled completely. It does not apply to unstructured asynchronous lines (line mode options 2–5).

If the option is set to *exclude*, the BCC calculation starts with the first data character following SOH. This is the normal FMP mode of BCC calculation.

If the option is set to *include*, the SOH is included in the BCC calculation for transmitted and received data blocks.

If the option is set to *disable*, a block check character is still generated on transmit and expected on receive, but the receive BCC comparison is not performed and each received data block is sent to the client without regard to any possible error. The BCC calculation is done on transmitted blocks as if the option is set to *exclude*.

If the line mode option (Section 4.18 on page 92) is set for the Bonneville feed, the FMP software calculates the special two-byte Bonneville frame check sequence (FCS) whether this option is set for *include* or *exclude*. However, if this option is set to *disable*, the FMP software will not check the FCS of incoming packets and pass every packet to the user without block check error.

Note

When transmitting non-transparent text, embedded SYN characters are not included in the outbound BCC calculation.

To set this option using the DLI configuration file, use the `blockChecking` parameter; for example, `blockChecking = "exclFirst"`. See Table 5–1 on page 104.

4.15 Queue Limit Option (21)

The queue limit option is used to prevent the ICP message buffer pool from being exhausted. Message buffers for all links on the ICP are taken from the same memory pool. This method allows each link to draw buffers as demand increases. However, if a process on the client were to stop reading on one link without disabling the link, incoming messages could deplete the buffer supply and the other links would not be able to obtain buffers.

To prevent this from occurring, a queue limit can be placed on the FMP-to-client message queue for a particular link. When the queue limit is reached, the last buffer on the queue is marked with the `DLI_ICP_ERR_QFULL` error code, and all subsequent blocks from the link are discarded until the client program begins reading messages from the queue. Control blocks such as status report, that cannot be placed on the queue, are discarded. When the client program receives the `DLI_ICP_ERR_QFULL` error, it should check the sequence number to determine how much data, if any, was lost.

The client program specifies the maximum number of buffers to be placed in the FMP-to-client queue for a particular link. The queue limit applies to all sessions for a given link. For example, if a queue limit of ten is set on a link that has a *Manager* and a *Control* session established (Section 2.2 on page 32), the FMP software will queue ten master buffers and ten control buffers. The queue limit is also independent for each type of session; for example, if the *Manager* session has all ten buffers queued and waiting to be read, this will not affect the *Control* session's ten-buffer limit.

Specify a zero value to disable queue limiting for that link.

To set this option using the DLI configuration file, use the `qLimit` parameter; for example, `qLimit = 0`. See Table 5–1 on page 104.

4.16 ETB Switch Option (24)

The end of text block (ETB) switch option is normally set to *disable*, and all message blocks end in ETX. If you need blocks to end with ETB instead of ETX, enable this option. Then when a text block is too large and must be divided into smaller blocks, all blocks end in ETB except for the final block, which ends with ETX.

To set this option using the DLI configuration file, use the `etbEnable` parameter; for example, `etbEnable = "no"`. See Table 5–1 on page 104.

4.17 DSR Delay Option (30)

This option determines the delay in seconds between the time FMP detects a loss of the data set ready (DSR) modem signal and the time this loss is reported to the client application program. This option is designed for use in systems where momentary losses of the DSR signal are common.

When the FMP software detects a loss of the DSR signal, it delays for the specified number of seconds before reporting the loss with the `DLI_ICP_ERR_DSR_DOWN` error report. If the DSR signal returns before the delay time expires, the timer is reset and no report is made.

To set this option using the DLI configuration file, use the `dsrDelay` parameter; for example, `dsrDelay = 3`. See Table 5–1 on page 104.

4.18 Line Mode Option (33)

The value you use for the line mode option determines the general protocol category (bisynchronous, asynchronous, or isochronous) of the communication line. Table 4–1 at the beginning of this chapter lists the available line mode settings and their values. Note that there are multiple settings of the asynchronous line mode, including one especially for the Bonneville market feed. Refer to the protocol descriptions in Chapter 2 if you are unsure of which line mode to use for your market feed.

To set this option using the DLI configuration file, use the `lineMode` parameter; for example, `lineMode = "bsc"`. See Table 5–1 on page 104.

4.19 Asynchronous Terminating Character Option (34)

The asynchronous terminating character option allows you to define the terminating character for asynchronous communication. This configuration option is used only when the line mode is set to asynchronous or isochronous. See also Section 4.18.

To set this option using the DLI configuration file, use the `asyncTermChar` parameter; for example, `asyncTermChar = 3`. See Table 5–1 on page 104.

4.20 Number of Terminating Characters Option (38)

The number of terminating characters option allows you use the asynchronous terminating character option. The current allowed values are 0 (no terminating character) or 1 (one terminating character as defined by the asynchronous terminating character option, Section 4.19).

To set this option using the DLI configuration file, use the `numTermChar` parameter; for example, `numTermChar = 1`. See Table 5–1 on page 104.

4.21 User-defined Data Rate Option (39)

The user-defined data rate option overrides the data rate option (Section 4.1). The value for this option can be determined from the formula:

$$V = \frac{1}{R} \times \left(\frac{f}{32}\right) - 2$$

where

V is the time constant and must be an integer value

R is the data rate

f is the PCLK frequency

Note

This option applies only to asynchronous lines.

To set this option using the DLI configuration file, use the `usrDataRate` parameter; for example, `usrDataRate = 14`. See Table 5–1 on page 104.

4.21.1 Example for Platforms other than the Freeway 1000

The Freeway PCLK frequency equals 7.3728×10^6.

An example follows for 14400 bits per second:

$$V = \frac{7372800}{14400 \times 32} - 2$$

$$V = 16 - 2$$

$$V = 14$$

4.21.2 Example for the Freeway 1000 Platform

The Freeway PCLK frequency equals 3.6864 x 10^6 for the Freeway 1000.

An example follows for 14400 bits per second:

$$V = \frac{3684400}{14400 \times 32} - 2$$

$$V = 8 - 2$$

$$V = 6$$

4.22 Electrical Interface Option (40)

The electrical interface option applies to the Freeway 1000 model only and allows the electrical interface for each link to be set. The valid values are EIA-232 (default), EIA-485, EIA-530/EIA-449 (balanced, EIA-422), V.35, EIA-449 (unbalanced, EIA-423), and EIA-562. Refer to the *ICP2424 Hardware Description and Theory of Operation* guide for more information on electrical interfaces and cabling options.

To set this option using the DLI configuration file, use the `elecInterface` parameter; for example, `elecInterface = "EIA232"`. See Table 5–1 on page 104.

Chapter

5 FMP Link Configuration Using dlicfg

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user's guide for your ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*).

5.1 Configuration Overview

Section 3.1.1 on page 36 summarized your choices for performing ICP link configuration. This chapter describes the FMP link configuration process using the DLI text configuration file as input to the `dlicfg` preprocessor program to produce a binary configuration file which is used by the `dlInit` and `dlOpen` functions.

If you use the DLI configuration file to define link configuration, and later need to change a link parameter value, you must shut down your application, modify the DLI text configuration file, rerun `dlicfg`, and then restart your application using the updated binary configuration file (you do not have to rebuild your application). If you need to make changes to link configuration frequently, consider using the Configure Link command (Section 3.4.1.4 on page 49) in your application.

Even if you choose not to use the DLI configuration file to define the FMP links, you still must configure DLI sessions and TSI connections. You should be familiar with the protocol-independent configuration procedures described in the *Freeway Data Link Interface Reference Guide* and the *Freeway Transport Subsystem Interface Reference Guide*.

The DLI and TSI configuration process is a part of the loopback testing procedure described in Appendix D and the installation procedure described in the *Freeway User's Guide*. During your client application development and testing, you might need to perform DLI and TSI configuration repeatedly.

The DLI and TSI configuration procedures are summarized as follows:

1. Create or modify a TSI text configuration file specifying the configuration of the TSI connections (for example, `fmpaltcfg` in the `freeway/client/test/fmp` directory).

2. Create or modify a DLI text configuration file specifying the DLI session configuration and optional ICP link configurations for all ICPs and serial communication links in your Freeway system (for example, `fmpaldcfg` in the `freeway/client/test/fmp` directory).

3. If you have a UNIX or Windows NT system, skip this step. If you have a VMS system, run the `makefc.com` command file from the `[FREEWAY.CLIENT.TEST.FMP]` directory to create the foreign commands used for `dlicfg` and `tsicfg`.

   `@MAKEFC` <*tcp-sys*>

   where <*tcp-sys*> is your TCP/IP package:

`MULTINET`	(for a Multinet system)
`TCPWARE`	(for TCPware system)
`UCX`	(for a UCX system)

   VMS example: `@MAKEFC UCX`

4. From the `freeway/client/test/fmp` directory, execute `tsicfg` with the text file from Step 1 as input. This creates the TSI binary configuration file in the same directory as the location of the text file (unless a different path is supplied with the optional filename). If the optional filename is not supplied, the binary file is given the same name as your TSI text configuration file plus a `.bin` extension.

`tsicfg` *TSI-text-configuration-filename [TSI-binary-configuration-filename]*

VMS example: `tsicfg fmpaltcfg`

UNIX example: `freeway/client/`*op-sys*`/bin/tsicfg fmpaltcfg`

NT example: `freeway\client\`*op-sys*`\bin\tsicfg fmpaltcfg`

5. From the `freeway/client/test/fmp` directory, execute `dlicfg` with the text file from Step 2 as input. This creates the DLI binary configuration file in the same directory as the location of the text file (unless a different path is supplied with the optional filename). If the optional filename is not supplied, the binary file is given the same name as your DLI text configuration file plus a `.bin` extension.

   `dlicfg` *DLI-text-configuration-filename [DLI-binary-configuration-filename]*

   VMS example: `dlicfg fmpaldcfg`

   UNIX example: `freeway/client/`*op-sys*`/bin/dlicfg fmpaldcfg`

   NT example: `freeway\client\`*op-sys*`\bin\dlicfg fmpaldcfg`

Note

You must rerun `dlicfg` or `tsicfg` whenever you modify the text configuration file so that the DLI or TSI functions can apply the changes. On all but VMS systems, if a binary file already exists with the same name in the directory, the existing file is renamed by appending the `.BAK` extension. If the renamed file duplicates an existing file in the directory, the existing file is removed by the configuration preprocessor program.

6. If you have a UNIX system, move the TSI and DLI binary configuration files that you created in Step 4 and Step 5 into the appropriate `freeway/client/`*op-sys*`/bin` directory where *op-sys* indicates the operating system: `sunos`, `hpux`, `solaris`, `rs_aix`, `osf1`.

   UNIX example:
   ```
   mv fmpaldcfg.bin /usr/local/freeway/client/hpux/bin
   mv fmpaltcfg.bin /usr/local/freeway/client/hpux/bin
   ```

7. If you have a VMS system, run the `move.com` command file from the `[FREEWAY.CLIENT.TEST.FMP]` directory. This moves the DLI and TSI binary configuration files you created in Step 4 and Step 5 into the `bin` directory for your particular TCP/IP package.

   `@MOVE` *filename* <*tcp-sys*>

   where *filename* is the name of the binary configuration file and <*tcp-sys*> is the TCP/IP package:

   `MULTINET` (for a Multinet system)

   `TCPWARE` (for TCPware system)

   `UCX` (for a UCX system)

   VMS example: `@MOVE FMPALDCFG.BIN UCX`

8. If you have a Windows NT system, move the TSI and DLI binary configuration files that you created in Step 4 and Step 5 into the appropriate `freeway\client\`*op-sys*`\bin` directory where *op-sys* indicates the operating system: `ant` or `int`.

   NT example:
   ```
   copy fmpaldcfg.bin \freeway\client\ant\bin
   copy fmpaltcfg.bin \freeway\client\ant\bin
   ```

When your application calls the `dlInit` function, the DLI and TSI binary configuration files generated in Step 4 and Step 5 are used to configure the DLI sessions and TSI connections. Figure 5–1 shows the configuration process.

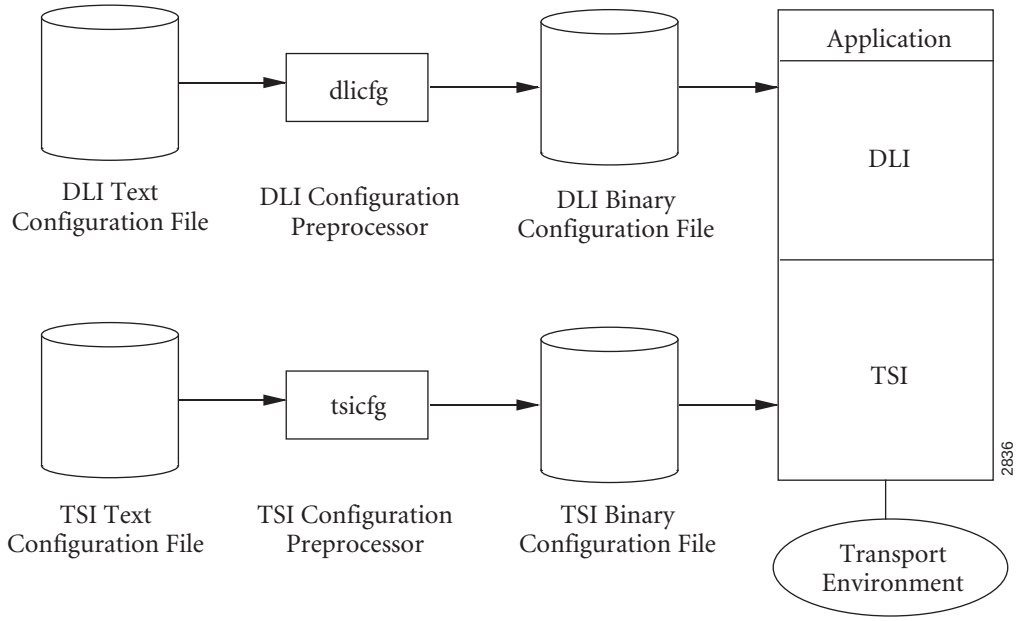


Figure 5–1: DLI and TSI Configuration Process

5.2 DLI Session Configuration

The DLI text configuration file used by the `dlicfg` program consists of the following sections:

- A "main" section which specifies the DLI configuration for non-session-specific operations (described in the *Freeway Data Link Interface Reference Guide*)
- One or more additional sections, each specifying a protocol-specific session associated with a particular Freeway serial communication link (port). Each link can be configured independently of the other links. The FMP protocol allows multiple sessions per link.

The protocol-specific session parameters can be divided into two groups:

- Client-related parameters are described in the *Freeway Data Link Interface Reference Guide*. For example, each session has an associated TSI connection name which you also specify in your TSI configuration file, though multiple sessions can use the same TSI connection.
- Protocol-specific link parameter values which are different from the defaults shown in Table 5–1. These parameters are optional in the DLI text configuration file. The `dlWrite` Configure Link command described in Section 3.4.1.4 on page 49 also can perform protocol-specific configuration.

Figure 5–2 is an example DLI configuration file showing the "main" section and two FMP sessions. The DLI client-related parameters are shown in `typewriter type`. The protocol-specific parameters are shown in **`bold typewriter type`**. You need to include only those parameters whose values differ from the defaults. Chapter 4 describes the link configuration options in detail.

The syntax for the FMP link configuration parameters is shown in Table 5–1, along with the defaults. The parameter names are case independent but are shown in upper and lower case for readability.

```
main                                // DLI "main" section:          //
{
    asyncIO = "no";                 // Use blocking I/O             //
    tsiCfgName = "fmpaltcfg.bin";   // TSI binary config file       //
}

ICPOlink0                           // First session name:          //
{                                   // Client-related parameters:   //
    asyncIO = "no";                 //   Use blocking I/O           //
    boardNo = 0;                    //   First ICP is zero          //
    portNo = 0;                     //   First ICP link is zero     //
    protocol = "FMP";               //   Session protocol           //
    transport = "client1";          //   TSI connection name specified//
                                    //     in TSI configuration file  //
    // Optional protocol parameters (different from defaults)://
    dataRate = 4800;                // 4800 bits/second             //
    qLimit = 10;                    // 10-buffer queue limit        //
}

ICPOlink1                           // Second session name:         //
{                                   // Client-related parameters:   //
    asyncIO = "no";                 //   Use blocking I/O           //
    boardNo = 0;                    //   First ICP is zero          //
    portNo = 1;                     //   Second ICP link is one     //
    protocol = "FMP";               //   Session protocol           //
    transport = "client1";          //   TSI connection name specified//
                                    //     in TSI configuration file  //

    // Optional protocol parameters (different from defaults)://
    transBlkSize = 1024;            // 1024-byte transmit blocks    //
    dataTranslation = "Table2";     // Data translation table       //
}
```

Figure 5–2: Example DLI Configuration File for Two Links

Table 5–1: FMP ICP Link Parameters and Defaults for Using dlicfg

dlicfg Option Name	Default	Valid Values
dataRate	9600	75, 110, 135, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 or 56000
clockSource	"external"	"external" or "internal"
numLeadSync	3	2–8
protocol	"FMP"	"FMP"
parity	"odd"	"none", "odd", or "even"
charSet	"asciilrc8"	"asciilrc8", "ebcdiccrc16", "asciicrc16", "asciilrc8bit6", "ebcdicccitt0" or "asciiccitt0"
transBlkSize	512	64–4096
dataTranslation	"table1"	"disable", "table1", "table2" or "table3"
dataPacking	"yes"	"yes" or "no"
bufferTimer	0	0–8000
modemControl	"FDX1"	"HDX1", "FDX1", "HDX2", "FDX2", "HDX3", "FDX3, "HDX4" or "FDX4"
feedID	0	0–999
messageBlocking	"DataHdr"	"RawBlk", "DataBlk", "SingleRec", "DataHdr" or "RawHdr"
blockChecking	"exclFirst"	"disable", "exclFirst" or "inclFirst"
qLimit	0	0–4096
etbEnable	"no"	"yes" or "no"
dsrDelay	3	1–127
lineMode	"bsc"	"bsc", "structAsync", "unstructAsync8", "unstructAsync7", "unstructAsync6", "unstructAsync5", "iso8" or "bonneville"
asyncTermChar	3	0–255
numTermChar	1	0 or 1
usrDataRate	0	0–4096
elecInterface	"EIA232"	"EIA232", "EIA485", "EIA530", "V35", "unbEIA449" or "EIA562"
msgBlkSize[a]	1024	256–8192
writeType[b]	"normal"	"normal" or "transparent"

[a] The msgBlkSize parameter allows the DLI to configure the ICP message buffer size (equivalent to the Set ICP Message Buffer Size command in Section 3.4.1.3 on page 48).

[b] If you use dlWrite without optional arguments, one of the EOM types is used, depending on the writeType DLI configuration parameter. If writeType is set to "normal," DLI_PROT_SEND_NORM_DATA_EOM is used; if it is set to "transparent," DLI_PROT_SEND_TRANS_DATA_EOM is used.

Appendix

A Line Control Procedures

This appendix defines line control procedures for the FMP package.

A.1 DSR Up/Down Reporting

If the data set ready (DSR) signal is lost while a link is active, FMP suspends line operations for that link and notifies the client with the `DLI_PROT_RESP_ERROR` error report containing the `DLI_ICP_ERR_DSR_DOWN` error code. At that time, all ICP message buffers that are queued for transmission are discarded. The client receives the `DLI_PROT_RESP_LOCAL_ACK` data acknowledge with the `DLI_ICP_ERR_DSR_DOWN` error code for each discarded message buffer (if the `localAck` DLI configuration parameter is set to "no").

When the DSR signal returns, FMP sends the client the `DLI_PROT_RESP_ERROR` error report containing the `DLI_ICP_ERR_DSR_UP` information code, and normal line operation resumes.

DSR up/down reporting is disabled when the modem control option is set to HDX-2 or FDX-2 (Section 4.11 on page 80).

A.2 Freeway/Line Interface

Freeway communicates to remote devices through serial connectors. The ports can be connected to standard modem cables.

A.3 Modem Control Lines

Table A–1 lists the EIA-232 modem control lines used by the FMP software.

Table A–1: EIA-232 Modem Control Lines

Signal	Pin	Direction	Description
RTS	4	Output	For half-duplex, RTS is turned on just before transmission is started and turned off when transmission is complete.
CTS	5	Input	CTS is checked after RTS is turned on but prior to transmit. If CTS is on at this point, transmit is started and further changes in the CTS pin are ignored until the next block is ready to be transmitted. If CTS is off at this point, transmission is delayed until the CTS pin is turned on.
DSR	6	Input	DSR is monitored by the protocol software, and its status is reported in the link status report.
DCD	8	Input	DCD status is reported in the link status report.
DTR	20	Output	DTR is turned on when the link is started and turned off when the link is stopped.

A.4 Clock Signals

The FMP communication interface is designed to use either externally or internally generated clock signals. Clocking is selected through the clock source option (Section 4.2 on page 69). The FMP software always uses receive clocking provided by the receive data source. Under external clocking, FMP receives its transmit clocks from the remote computer. Under internal clocking, the transmit clock is internally generated and also output to the remote computer. You must also set the hardware clock jumper for each link. Refer to the *Freeway ICP6000R/ICP6000X Hardware Description* manual. If you need to set internal clocking, call the Simpact customer support number given in the *Preface*. For the Freeway 1000, refer to the *ICP2424 Hardware Description and Theory of Operation*.

Table A–2 defines the EIA-232 clock signals used by the FMP software.

Table A–2: EIA-232 Clock Signals

Signal	Pin	Direction	Description
XMT CLK	15	Input	External clocking: transmit clock Internal clocking: not used
RCV CLK	17	Input	External clocking: receive clock Internal clocking: receive clock
EXT CLK	24	Output	External clocking: not used Internal clocking: server-generated Clock signal to be connected to the XMT CLK of the local interface and the RCV CLK pin of the remote interface.

A.5 Idle Line Condition

When no data is being transmitted on a full-duplex circuit, the transmit line is held in a marking condition (all one-bits are transmitted).

Appendix

B ASCII Translation Tables

The FMP software contains ASCII/EBCDIC, ASCII/Baudot level-5, and ASCII/Baudot level-6 translation tables. Each table may be modified using software commands. Table B–1 through Table B–6 show the contents of the three translation tables immediately after the communications server download.

Table B–1: ASCII to EBCDIC Translation Table 1

		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	20	45	2F	41	70	53	49	55	77	44	52	4A	4E	46	43	4B
1	54	5A	4C	57	48	59	50	51	4F	42	47	26	4D	58	56	72
2	2E	35	63	31	2E	73	67	00	30	34	74	79	00	36	33	2E
3	7C	7D	74	7B	38	5D	73	5B	00	32	37	42	53	7E	5E	00
4	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
5	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
6	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
8	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
9	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
A	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
E	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
F	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Example: 6-level Baudot code 25 translates to ASCII character 73.																

Table B–2: EBCDIC to ASCII Translation Table 1

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	00	01	02	03	9C	09	86	7F	97	8D	8E	0B	0C	0D	0E	0F
1	10	11	12	13	9D	85	08	87	18	19	92	8F	1C	1D	1E	1F
2	80	81	82	83	84	0A	17	1B	88	89	8A	8B	8C	05	06	07
3	90	91	16	93	94	95	96	04	98	99	9A	9B	14	15	9E	1A
4	20	A0	A1	A2	A3	A4	A5	A6	A7	A8	5B	2E	3C	28	2B	21
5	26	A9	AA	AB	EC	AD	AE	AF	B0	B1	5D	24	2A	29	3B	5E
6	2D	2F	B2	B3	B4	B5	B6	B7	B8	B9	7C	2C	25	5F	3E	3F
7	BA	BB	BC	BD	BE	BF	C0	C1	C2	60	3A	23	40	27	3D	22
8	C3	61	62	63	64	65	66	67	68	69	C4	C5	C6	C7	C8	C9
9	CA	6A	6B	6C	6D	6E	6F	70	71	72	CB	CC	CD	CE	CF	D0
A	D1	7E	73	74	75	76	77	78	79	7A	D2	D3	D4	D5	D6	D7
B	D8	D9	DA	DB	DC	DD	DE	DF	E0	E1	E2	E3	E4	E5	E6	E7
C	7B	41	42	43	44	45	46	47	48	49	E8	E9	EA	EB	EC	ED
D	7D	4A	4B	4C	4D	4E	4F	50	51	52	EE	EF	F0	F1	F2	F3
E	5C	9F	53	54	55	56	57	58	59	5A	F4	F5	F6	F7	F8	F9
F	30	31	32	33	34	35	36	37	38	39	FA	FB	FC	FD	FE	FF

Example: EBCDIC character 26 translates to ASCII character 17.

Table B–3: ASCII to 6-bit Baudot Translation Table 2

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
1	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
2	00	00	00	00	00	00	1B	00	00	00	00	00	00	00	20	02
3	28	23	39	2E	29	21	2D	3A	34	00	00	00	00	00	00	00
4	00	03	19	0E	09	01	0D	1A	14	06	0B	0F	12	1C	0C	18
5	16	17	0A	05	10	07	1E	13	1D	15	11	37	00	35	3E	00
6	00	03	19	22	09	01	0D	26	25	06	0B	0F	12	1C	0C	18
7	04	17	1F	36	32	07	1E	08	1D	2B	2A	33	30	31	3D	00
8	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
9	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
A	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
E	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
F	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Example: ASCII character 42 translates to 6-level Baudot code 19.																

Table B–4: 6-bit Baudot to ASCII Translation Table 2

		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	20	45	2F	41	70	53	49	55	77	44	52	4A	4E	46	43	4B
1	54	5A	4C	57	48	59	50	51	4F	42	47	26	4D	58	56	72
2	2E	35	63	31	2E	73	67	00	30	34	74	79	00	36	33	2E
3	7C	7D	74	7B	38	5D	73	5B	00	32	37	42	53	7E	5E	00
4	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
5	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
6	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
8	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
9	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
A	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
E	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
F	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
Example: 6-level Baudot code 25 translates to ASCII character 73.																

Table B–5: ASCII to 5-bit Baudot Translation Table 3

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	00	00	00	00	00	00	00	87	00	00	00	02	00	08	00	00
1	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
2	04	00	13	00	9A	8D	00	85	8F	92	00	91	8C	83	9C	00
3	96	97	93	81	8A	90	95	87	86	98	8E	00	00	9E	00	9D
4	00	03	19	0E	09	01	0D	1A	14	06	0B	0F	12	1C	0C	18
5	16	17	0A	05	10	07	1E	00	1D	15	11	00	00	00	00	00
6	00	03	19	0E	09	01	0D	1A	14	06	0B	0F	12	1C	0C	18
7	16	17	0A	05	10	07	1E	00	1D	15	11	00	00	94	00	00
8	80	00	00	00	00	00	00	87	00	00	00	82	00	88	00	00
9	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
A	84	00	13	00	9A	8D	00	85	8F	92	00	91	8C	83	9C	00
B	96	97	93	81	8A	90	95	87	86	98	8E	00	00	9E	00	9D
C	00	03	19	0E	09	01	0D	1A	14	06	0B	0F	12	1A	0B	18
D	16	17	0A	05	10	07	1E	00	1D	15	11	00	00	00	00	00
E	00	03	19	0E	09	01	0D	1A	14	06	0B	0F	12	1C	0C	18
F	16	17	0A	05	10	07	1E	00	1D	15	11	00	00	94	00	00

Example: ASCII 41 (hex) translates to 5-level Baudot code 03 (hex). This example assumes that a letter-shift character precedes the 03 (hex). See Section 4.8 on page 73.

Table B–6: 5-bit Baudot to ASCII Translation Table 3

		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E
0	00	45	0B	41	20	53	49	55	0D	44	52	4A	4E	46	43	4B
1	54	5A	4C	22	48	59	50	51	4F	42	47	00	4D	58	56	00
2	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
3	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
4	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
5	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
6	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
7	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
8	00	33	0B	2D	20	27	38	37	0D	00	34	07	2C	25	3A	28
9	35	2B	29	32	23	36	30	31	39	3F	24	00	2E	2F	3D	00
A	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
B	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
C	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
D	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
E	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00
F	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00

Example: After receiving a figure-shift character, Baudot code 01 (hex) shifts to row 08 and translates to ASCII 33 (hex). See Section 4.8 on page 73.

Appendix

C Error Codes

There are several methods used by the DLI and FMP software to report errors (Table C–1 lists the FMP errors).

1. The error code can be returned directly by the DLI function call. Typical errors are those described in the *Freeway Data Link Interface Reference Guide*.

2. The FMP errors listed in Table C–1 can be returned in the global variable `iICPStatus`. The `DLI` constants are defined in the file `dlicperr.h`.

3. The FMP errors listed in Table C–1 can also be returned in the `dlRead pOptArgs.iICPStatus` field of the response to a `dlWrite` request. The DLI sets the `dlRead pOptArgs.usProtCommand` field to the same value as the `dlWrite` request that caused the error. An example of this type of error is the `DLI_ICP_ERR_BAD_MODE` invalid mode error.

4. The FMP error can be reported in an error report response to a `dlRead` request. The returned `dlRead pOptArgs.usProtCommand` field is set to `DLI_PROT_RESP_ERROR`, and the `dlRead pOptArgs.iICPStatus` field is set to the actual error code. An example of this type of error is the `DLI_ICP_ERR_DSR_DOWN` error.

5. The FMP errors can also be returned in the error code byte within the 5-byte header in data blocks that contain a 5-byte header (see Section 4.13.4 on page 87 and Section 4.13.5 on page 88). The error code values are listed in the "**5-byte Header Code**" column of Table C–1.

6. Under certain communication line conditions that cause queued transmission buffers to be discarded (such as losing the DSR signal while transmitting data), the FMP error can be reported in a data acknowledgment response to a `dlRead` request. In this case, the returned `dlRead pOptArgs.usProtCommand` field is set to `DLI_PROT_RESP_LOCAL_ACK`, and the `dlRead pOptArgs.iICPStatus` field is set to the actual error code. An example of this type of error is the `DLI_ICP_ERR_XMIT_TIMEOUT` transmit timeout error.

Table C–1: FMP Error Codes

5-byte Header Code	Freeway Code	DLI Constant Name	Meaning
0	0	`DLI_ICP_ERR_NO_ERR`	A data block has been successfully transmitted or received on the line or a command has been successfully executed.
75	1	`DLI_ONE_BLOCK`	One block of data has been sent.
16	–103	`DLI_ICP_ERR_NO_CLIENT`	The protocol software has the maximum number of clients registered for that link.
71	–104	`DLI_ICP_ERR_MASTER_IN_USE`	The *Manager* or *Control* session is already in use.
78	–105	`DLI_ICP_ERR_BAD_CMD`	The command from the client program is not a legal value.
1	–106	`DLI_ICP_ERR_BAD_BCC`	The received block check character does not match the BCC value calculated by the protocol software.
6	–107	`DLI_ICP_ERR_NO_TERM_CHAR`	A terminating character was not received in the time specified by the buffer timer option (Section 4.10 on page 79). This error occurs only when the line mode option (Section 4.18 on page 92) is set to one of the unstructured asynchronous settings.
7	–108	`DLI_ICP_ERR_QFULL`	The ICP message buffer queue limit (Section 4.15 on page 91) has been reached. This error usually occurs when the client fails to make `dlRead` requests frequently enough to read incoming messages.

Table C–1: FMP Error Codes *(Cont'd)*

5-byte Header Code	Freeway Code	DLI Constant Name	Meaning
9	–109	DLI_ICP_ERR_XMIT_TIMEOUT	The protocol software was unable to transmit the data. This error occurs when some or all of the modem signals are not present.
10	–110	DLI_ICP_ERR_DSR_UP	The protocol software has received a positive data set ready (DSR) signal from the remote station.
11	–111	DLI_ICP_ERR_DSR_DOWN	The data set ready (DSR) signal from the remote station was lost. All polling and data transfer operations are stopped.
23	–112	DLI_ICP_ERR_BAD_PARITY	The protocol software has detected a parity error or errors.
25	–113	DLI_ICP_ERR_RCV_OVERFLOW	The protocol software did not process a character before the next character was received. This can be caused by high data rates on several of the links.
27	–114	DLI_ICP_ERR_BUF_OVERFLOW	A message larger than the transmission/receive buffer (Section 4.7 on page 72) was received. Some data was lost.
43	–115	DLI_ICP_ERR_BUF_TOO_SMALL	The ICP message buffer size (Section 3.4.1.3 on page 48) is smaller than the buffer received from the client.
77	–117	DLI_ICP_ERR_LINK_ACTIVE	The link is already started.
79	–118	DLI_ICP_ERR_LINK_INACTIVE	The link is stopped.
74	–119	DLI_ICP_ERR_BAD_SESSID	If this error occurs, please call Simpact.
—	–120	DLI_ICP_ERR_LINK_NOT_CONFIG	The device is not owned; no legal operations.
72	–121	DLI_ICP_ERR_NO_SESSION	No more clients are available on this ICP. This error should never occur; if it does, please call Simpact.
76	–122	DLI_ICP_ERR_BAD_PARMS	The parameter value(s) used for the function call are illegal.
73	–123	DLI_ICP_ERR_BAD_MODE	The function request is not available for the requested access mode; see Table 2–2 on page 33.

Table C–1: FMP Error Codes *(Cont'd)*

5-byte Header Code	Freeway Code	DLI Constant Name	Meaning
45	–125	DLI_ICP_ERR_NO_CTRL_SESS	No non-*Control* session is registered for this link. The operation is not allowed.
—	–145	DLI_ICP_ERR_INBUF_OVERFLOW	Input buffer overflow
—	–146	DLI_ICP_ERR_OUTBUF_OVERFLOW	Output buffer overflow
54	–150	DLI_ICP_ERR_DATA_LOST	Data was dropped by the ICP (sequence number gap)
55	–151	DLI_ICP_ERR_BCC_PARITY	BCC and parity errors were detected

Appendix

D FMP Loopback Test Program

Note

In this document, the term "Freeway" can mean either a Freeway server or an embedded ICP. For the embedded ICP, also refer to the user's guide for your ICP and operating system (for example, the *ICP2432 User's Guide for Windows NT*).

D.1 Loopback Test Programs

The FMP loopback test programs and test directories are listed in Table D–1, according to operating system (UNIX, VMS, or Windows NT). This section provides a summary of the steps required to run the loopback test; see the *Loopback Test Procedures* document for the details and an example output (this information was previously in the *Freeway User's Guide*). The loopback program uses non-blocking I/O, meaning that the `asyncIO` DLI configuration parameter (described in the *Freeway Data Link Interface Reference Guide*) must be set to "yes" (the default is "no" for blocking I/O).

Table D–1: Loopback Test Programs and Directories

Operating System	Loopback Program	Test Directory
UNIX	`fmpalp.c`	`usr/local/freeway/client/test/fmp`
VMS	`FMPALP.C`	`SYS$SYSDEVICE:[FREEWAY.CLIENT.TEST.FMP]`
Windows NT	`fmpalp.c`	`c:\freeway\client\test\fmp`

To run the test program, perform the following steps:

1. Make sure the `server` TSI configuration parameter is correctly defined in the TSI text configuration file for each TSI connection definition. Refer to the *Freeway Transport Subsystem Interface Reference Guide*.

2. Make any required changes to the DLI text configuration file for DLI session parameters or ICP link parameters whose values differ from the defaults (for example, the `elecInterface` parameter for a Freeway 1000). Refer to the *Freeway Data Link Interface Reference Guide* and to Chapter 5 of this guide.

3. Be sure you are in the correct directory.

   For UNIX: `cd /usr/local/freeway/client/test/fmp`
   For VMS: `SET DEF SYS$SYSDEVICE:[FREEWAY.CLIENT.TEST.FMP]`
   For NT: `cd c:\freeway\client\test\fmp`

4. Run the make file provided in the test directory.

   For UNIX: `make -f makefile.`<*op-sys*> `all`
   where <*op-sys*> is the operating system:
   `sun` (for a Sun system)
   `hpux` (for an HP/UX system)
   `sol` (for a Solaris system)
   `aix` (for an RS6000/AIX system)
   `osf1` (for an OSF1 system)
   UNIX example: `make -f makefile.sol all`

   For VMS: `@MAKEVMS "" `<*tcp-sys*>
   where <*tcp-sys*> is the TCP/IP package:
   `MULTINET` (for a Multinet system)
   `TCPWARE` (for TCPware system)
   `UCX` (for a UCX system)
   VMS example: `@MAKEVMS "" UCX`

For NT: `nmake -f makefile.<op-sys> all`

where <*op-sys*> is the operating system:

`ant` (for Alpha NT)

`int` (for Intel NT)

NT example: `nmake -f makefile.ant all`

The make file automatically performs the following:

- In VMS systems only, creates the foreign commands used for the `dlicfg` and `tsicfg` configuration preprocessor programs. (This is not necessary for UNIX and NT systems.)

- Runs the `dlicfg` and `tsicfg` configuration preprocessor programs. These programs process the appropriate DLI and TSI text configuration files to create the DLI and TSI binary configuration files. The text configuration files provided for non-blocking I/O are:

  DLI: `fmpaldcfg`
  TSI: `fmpaltcfg`

  The resulting binary configuration files have the same names with a `.bin` extension. For example, `fmpaldcfg.bin`.

- Copies the DLI and TSI binary configuration files to the appropriate `bin` directory.

  UNIX example: `freeway/client/`*op-sys*`/bin`
  VMS example: `[FREEWAY.CLIENT.`<*vms_platform*>`_tcp-sys.BIN]`
  where <*vms_platform*> is `VAX` or `AXP`
  for example, `[FREEWAY.CLIENT.VAX_UCX.BIN]`
  NT example: `freeway\client\`*op-sys*`\bin`

- Compiles and links the loopback test program and copies it to the same `bin` directory.

5. Boot the Freeway server and load the FMP protocol software onto the ICP (refer to the *Freeway User's Guide*).

6. Connect two ICP links with loopback cables (refer to the *Loopback Test Procedures* document).

7. Execute the test program from the directory where the *binary* DLI and TSI configuration files reside (that resulted from Step 4 above).

In Step 4 above, the make file runs the `dlicfg` and `tsicfg` preprocessor programs *and* compiles and links the test program. If you already compiled and linked the test program, you can avoid recompiling and relinking it by running `dlicfg` and `tsicfg` yourself instead of running the make file. However, note the following if you do.

In a UNIX system, if you run `dlicfg` and `tsicfg` instead of running the make file, you must manually move the resulting DLI and TSI binary configuration files to the appropriate `freeway/client/`*op-sys*`/bin` directory where *op-sys* indicates the operating system: `sunos`, `hpux`, `solaris`, `rs_aix`, `osf1`.

UNIX example:
```
mv fmpaldcfg.bin usr/local/freeway/client/hpux/bin
mv fmpaltcfg.bin usr/local/freeway/client/hpux/bin
```

In a VMS system, if you run `dlicfg` and `tsicfg` instead of running the make file, you must do the following:

- *Before* you run `dlicfg` and `tsicfg`, run the `makefc.com` command file to create the foreign commands used for `dlicfg` and `tsicfg`.

  `@MAKEFC` <*tcp-sys*>

  where <*tcp-sys*> is your TCP/IP package:

  `MULTINET` (for a Multinet system)
  `TCPWARE` (for TCPware system)
  `UCX` (for a UCX system)

  VMS example: `@MAKEFC UCX`

- *After* you run `dlicfg` and `tsicfg`, run the `move.com` command file which moves the DLI and TSI binary configuration files to the `bin` directory for your TCP/IP package.

  `@MOVE` *filename* <*tcp-sys*>

  where *filename* is the name of the binary configuration file and <*tcp-sys*> is your TCP/IP package as shown above.

  VMS example: `@MOVE FMPALDCFG.BIN UCX`

In a Windows NT system, if you run `dlicfg` and `tsicfg` instead of running the make file, you must manually move the resulting DLI and TSI binary configuration files to the appropriate `freeway\client\`*op-sys*`\bin` directory where *op-sys* indicates the operating system: `ant` or `int`.

NT example:
```
copy fmpaldcfg.bin \freeway\client\ant\bin
copy fmpaltcfg.bin \freeway\client\ant\bin
```

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