
Contents

Chapter 1: General Information

Introduction	1-1
Principles of Operation.....	1-1
Definitions	1-1
Modes of Operation	1-2
Physical Line Specifications & Protocol.....	1-3
Communication Parameters.....	1-4
Data Link Protocols.....	1-5
Message Format	1-6
Error Processing.....	1-7

Chapter 2: Application Level Protocol Messages and Dialogues

Application Level Protocol Messages.....	2-1
Message Priorities.....	2-1
Poll Message.....	2-2
Sample Request Message.....	2-5
No Request Message	2-10
Wait Message.....	2-11
Request Acceptance Message.....	2-12
Query Message	2-14
Result Acceptance Message.....	2-15
Result Message.....	2-16
Calibration Result Message	2-21
Result Messages	2-25
Application Level Message Dialogues.....	2-28
Timing.....	2-30

Appendix

Appendix I: Foreign Languages	A-1
German.....	A-1
Spanish.....	A-1
French	A-1
Appendix II: Table of Valid Test Names	A-2
Appendix III: Table of Valid Error Codes	A-3
Appendix IV: Error Codes Explained	A-4

Chapter 1: General Information

Introduction

This specification defines physical line connections, data link, and application level communication protocols used by the Dimension® clinical chemistry system. It also describes the interface between the Dimension® system and a Laboratory Information System.

The terms "instrument" and "computer" are used consistently throughout and refer to the respective ends of the interface.

Principles of Operation

Sample and test request data can be entered either by the instrument or the computer. Data can be entered at the instrument when the computer is busy doing other applications, is offline, or when initiation of sample processing is a priority.

Definitions

- A sample is a fluid used to determine the concentration of a particular analyte at a specific point in time. Several such tests may be performed on each sample. Due to some tests requiring sample pretreatment, a sample may require both pretreated and untreated sample cups/positions. The communication between instrument and computer organizes these requests by sample.
- Sample carriers are either known or unknown to the instrument. Sample carriers become known to the instrument by having a sample position assigned on that carrier. Sample carriers that are known to the instrument are made unknown only by user deletion of all associated sample assignment information for that carrier using instrument keyboard functions. The known or unknown status of a sample carrier is determined by its presence or absence in the poll message.
- Load lists are collated requests for sample loading on to a sample carrier. Load listed samples have their positions assigned by the computer, and must be transmitted to an "unknown" carrier.

NOTE: Sample Carriers and Load Lists are only available on the Dimension® AR instrument

- Load lists are downloaded as an unbroken communication from the computer to a single sample carrier of the instrument. Multiple load lists are allowed on the same sample carrier as long as they are communicated to the instrument in the same download, and do not exceed the number of positions available on a carrier (60). The computer breaks the communication and terminates the download by responding to the instrument poll message with the "NO REQUEST" message.

- If at least one sample carrier is known, either A or B, single sample requests have their positions assigned by the instrument.
- Single sample requests can be downloaded to either known or unknown carriers at any time there are available sample memory and positions.
- A single sample request is also the expected response to an instrument "query" when the instrument is using Send ID/Receive communication mode.

Once the computer has downloaded sample requests to the instrument, direct modification of these requests can occur only at the instrument. The computer is only able to delete an entire downloaded request prior to the start of processing. An indirect method for modification from the computer is provided by deletion followed by submission of the modified request.

Modes of Operation

All modes of operation are software selectable. Collectively, the modes of operation support downloading of sample processing requests from the computer and transmission of results from the instrument. The table details direction and information communicated for each selectable operation mode.

	Software Selectable Mode Of Operation	Direction	Information
	Off	N/A	None
Dimension® clinical chemistry system	send only	→ computer	Results
	send/receive	↔	Requests Responses Results
	send ID/receive	↔	Requests Query Responses Results

When one of the operation modes (as listed above) is selected, the sample number field on the Sample Data Entry Screen requires an entry.

Physical Line Specifications & Protocol

The instrument will conform to RS 232-C specifications. The connector on the instrument is a DB-25 (subminiature "D") style connector. All operation modes use RS 232-C DTE signal specifications.

<u>Instrument</u>	<u>Connector & Gender</u>
-------------------	-------------------------------

AR	DB-25F
XL	DB-25M
RXL	DB-25M
XPAND	DB-25M
AR ^x	DB-25M

Rear view of instrument connector



The following pins are active:

PIN	RS-232C SIGNAL NAME
1	Chassis Ground
2	TD Data Transmission Line
3	RD Received Data Line
7	Signal Ground
4	RTS (asserted high by instrument ONLINE)
20	DTR (asserted high by instrument CAN RECEIVE DATA)

RTS and DTR are not used for computer flow control, but indicate instrument readiness. Before transmitting data, the instrument does not check RTS or DTR therefore, the computer cannot flow control the instrument with these signals. Data link protocols detect physical disconnect, loss of carrier, and allow flow control by sending ACK, NAK, etc. There is a one-second delay between assertion of RTS and first transmission.

The data communication protocol is comprised of two layers of communication occurring between the computer and the instrument: data link control (DLC) and application level interaction. The DLC layer simply ensures the reliable exchange of messages across the interface. It has no knowledge of the message contents beyond that which is necessary for communication validation. The application layer functions provide message processing and acknowledgement.

Communication Parameters

- **Baud rate:** 300, 600, 1200, 2400, 4800, 9600 & 19200 (not available on AR)
- **Bit Length:** 7 or 8
- **Parity:** ODD, EVEN, NONE
- **Stop bits:** 1 or 2
- **Instrument ID:** This is set by the user to uniquely identify each Dimension® clinical chemistry system, distinguishing it from others in multi-instrument configurations. The LIS computer can use the value during initialization to identify and validate the instrument port assignments specified in the system's configuration tables.

Data Link Protocols

Data transfer is user selectable as either ASCII seven-bit or ASCII eight-bit characters. Neither the instrument nor the computer should "echo" any characters received.

STX (HEX 2) and ETX (HEX 3) will signal the start and end of a transmission, respectively. Both characters will be unique and never appear elsewhere in the data stream.

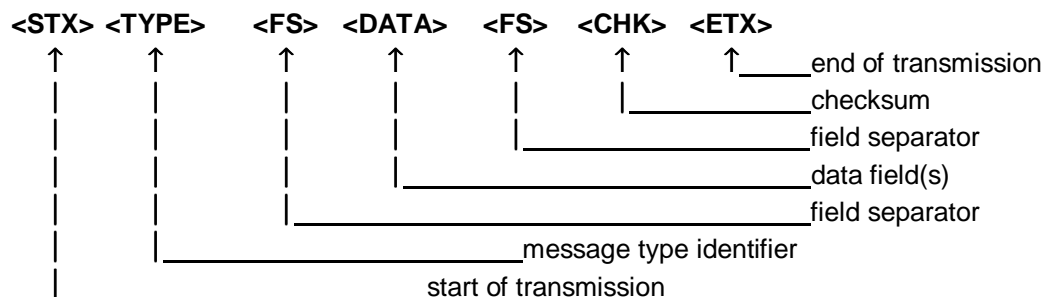
ACK (HEX 6) is always to be returned by the receiving device following correct receipt of a transmission. NAK (HEX 15) is to be returned by the receiving device following the receipt of a transmission found to have an incorrect checksum. Upon receipt of a NAK, the transmitting device retransmits the message. The message will be retransmitted in response to the NAKs for a total of four times. If an error, i.e., parity error, occurs while the receiver is expecting an ACK or NAK, the receiver transmits an ENQ to the sender, requesting a retry. The following details the use of STX-ETX, ACK-NAK, and ENQ for each mode.

Operation Mode		STX-ETX	ACK-NAK	ENQ
Dimension® clinical chemistry system	send only →	Yes	Yes	Yes
	send/receive ↔	Yes	Yes	Yes
	send ID/receive ↔	Yes	Yes	Yes
	terminal →	No	No	No
aca® discrete clinical analyzer				
	computer ↔	Yes	Yes	No

Message Format

For Dimension® clinical chemistry system mode of operation:

The general form of messages is:



Type

The "type" is a unique, 1-byte message identifier (e.g., 'P' for Poll message).

Field Delimiters

All data fields are delimited with a single field separator, <FS> (HEX 1C). <STX> and <ETX> are implied field separators. The number of fields may vary for some messages. For these cases, there is a field that specifies the number of fields or groups of fields to follow. Other fields may not contain data but their places are held by field separators.

Field Identification

The data fields do not contain any identification of the data's meaning. The field order and meaning must be known by the computer.

Field Number and Size

The number and maximum length (bytes) of the data fields are dependent on message <ETX>, and then parse the message by fields based on message type.

Field Content

Fields contain printable ASCII characters. Deviations from the ASCII set are made for foreign languages. Numbers like test results and calibration coefficients are represented in either fixed point (-dd.dd) or floating (-d.ddde-dd) point format. They are distinguished by the "e" in the floating point representation. Most other data are a combination of alphanumeric characters and other printable characters.

Checksum

The Checksum is computed on all characters, including all the <FS> characters, between <STX> and <CHK>. The Checksum is calculated by the 8-bit binary addition of all included characters with the 8th or parity bit assumed to be zero. Carries beyond the 8th bit are lost. The 8-bit result is converted into two printable ASCII Hex characters, ranging from 00 to FF, which are then inserted into the data stream as <CHK>. The Hex characters A-F are uppercase. The receiving device recalculates the checksum on the buffered message and compares it with the checksum it received. The comparison is the basis for subsequent acknowledgement (<ACK>) or negative acknowledgement (<NAK>) of the transmission.

Error Processing

When the Dimension® clinical chemistry system is unable to successfully transmit to the computer, the instrument alarm sounds and an error message appears on the screen. The instrument will continue attempts to re-establish communication until the computer interface is de-configured from the instrument communication parameters.

The following errors are possible on all Dimension® instruments

DMW/Host Communication Problem

- 316 Cannot communicate with DMW/Host
- 317 DMW/Host communication port receiver error
- 318 Received fourth NAK from DMW/Host
- 319 Received invalid message from DMW/Host
- 320 Did not receive acceptance message from DMW/Host
- 321 Did not receive ACK or NAK from DMW/Host
- 323 Received fourth ENQ from DMW/Host
- 322 DMW/Host rejected result 50 times

Chapter 2: Application Level Protocol Messages and Dialogues

Application Level Protocol Messages

Different modes use different messages as indicated by the table below:

	Operation Mode	Direction	Message
Dimension® clinical chemistry system	send only	→computer	new instrument result
	send/receive	→computer	poll
		→instrument	sample request
		→instrument	no request
		→instrument	wait
		→computer	request acceptance
		→instrument	result acceptance status
		→computer	new instrument result
		→computer	calibration result
	send ID/Receive	→computer	poll
		→instrument	sample request
		→instrument	no request
		→instrument	wait
		→computer	request acceptance
		→computer	query
		→instrument	result acceptance status
		→computer	new instrument result
		→computer	calibration result

Message Priorities

When the instrument is sending "Application Level Protocol Messages" to the Computer, it must determine a priority for each message, in the event that more than one type of message is outstanding.

The POLL message is an ongoing "background" message, and assumes the lowest priority. The QUERY and RESULT messages are driven by real time events and therefore suspend the POLL message. In terms of priority, the order is:

Priority	Message
HIGHEST	RESULT CALIBRATION RESULT QUERY
LOWEST	POLL

Poll Message

Dimension® clinical chemistry system
 send/receive mode
 send ID/receive mode

This message is sent by the instrument to inform the computer that the instrument is ready to receive the next test request. It provides information to assist the computer in sample carrier identification.

Field	Max Length	Data
TYPE	1	P
ID	5	Alphanumeric
FIRST POLL	1	1 initial poll 0 conversational poll
REQUEST	1	0 busy send no request 1 send a request
# OF CARRIERS	2	0-99
Repeated for each known carrier		
SAMPLE CARRIER ID	1	Empty(0), A or B

NOTE: The Sample Carrier ID field will be empty for all Dimension® models except the Dimension® AR instrument.

Instrument ID Field

This value is set by the customer to uniquely identify Dimension® clinical chemistry systems, distinguishing them from others in multi-instrument configurations. The computer can use the value during initialization to identify and validate the instrument/port assignments specified in the computer's configuration tables.

First Poll Field

A 1 (initial poll) in this field indicates that the instrument is trying to establish communication during power up, power failure recovery, selection of the computer interface by the user, or communication error recovery conditions. Until the computer replies with a sample request or no request message, the field value shall remain 1. When either of these messages are received, the field value is set to 0 (conversational poll) and remains 0 until any of the above stated conditions occur. The value is used by the computer to determine the status of the instrument during operation. This mechanism provides the computer with the information it needs to determine if the communication to the instrument was interrupted while sample requests were outstanding. The value of this field must be (0) to download a request from the LIS.

Request Field

The instrument can hold off requests for sample processing using this field, while maintaining the application level communication dialogue. It does this by setting the field value to 0, indicating "Instrument Busy" and that no requests will be accepted. The Dimension® system lengthens the poll cycle to allow the other priority processes to run. (See Section 2.12.1, Timing, Page 39 for more detail.) When the value is set to 1, requests can flow again.

of Carriers Field

This field indicates the total number of sample carriers known to the instrument. The instrument accepts one active sample carrier and one pending sample carrier at a time. The total number of sample requests using send ID/receive mode may not exceed the instrument limit of 300. The number of sample carriers will be 0 if no sample carrier is known to the instrument.

NOTE: This field is supported only by the Dimension® AR instrument.

Sample Carrier ID Fields

The number of these fields is specified in the # of Carriers field. If the number of carriers is 0, there are no Sample Carrier ID Fields and no corresponding <FS>s. Each sample carrier known to the instrument has an ID field. If the sample request is entered at the instrument, the operator specifies the sample carrier ID to the instrument. If the request is entered at the computer, the computer selects the instrument and sends the sample carrier ID to the instrument in the Sample Request message. The computer assigns the sample carrier ID only for the carriers which are unknown to the instrument. For the single sample entry at the computer (if the instrument has no known sample carrier), the computer assigns the sample carrier ID with a Loadlist ID field of 0, and the first sample transmitted as sample position 1. (See Section 2.3, Page 16, Loadlist ID Field and Section 2.3, Page 18, Sample Position Fields.)

NOTE: This function is supported only by the Dimension® AR instrument. For all other Dimension® instruments, this field will be blank.

Examples:

- First Poll, No Known Sample Carriers
<STX>P<FS>92300<FS>1<FS>1<FS>0<FS>6C<ETX>
- Conversational Poll, Sample Carrier A known to instrument
<STX> P<FS>92300<FS>0<FS>1<FS>1<FS>A<FS>C9<ETX>
- Conversational Poll, Instrument busy, send no requests
<STX>P<FS>92300<FS>0<FS>0<FS>1<FS>A<FS>C8<ETX>

Sample Request Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive mode

This message is sent to the instrument in response to the Poll [P] message and it is also used to response to a Query [I] message. Fields with Data that is empty are optional fields, all others are mandatory.

Field	Max Length	Data
TYPE	1	D
SAMPLE CARRIER ID	1	0, A or B
LOADLIST ID	2	0-99 (0 indicates single sample request)
TRANSACTION	1	Add sample (A) Delete (D),
PATIENT ID	27	Empty or alphanumeric
SAMPLE #	12	Alphanumeric
SAMPLE TYPE	1	1 to 9 or W
LOCATION	6	Empty or alphanumeric
PRIORITY	1	0-4
# OF CUPS FOR SAMPLE	1	1 to 9
Iterated # of sample cup times		
CUP POSITION	2	0 or 1-60, or "*"
DILUTION	3	1-100
# OF TESTS	2	1 to instrument limit
Iterated # of test times for each sample cup		
TEST NAME	5	Member of set of test mnemonics recognized by the instrument

Sample Carrier ID Field (Dimension® AR system only)

When the computer is sending a load list, this field contains a sample carrier ID assigned by the computer and must be currently unknown to the instrument. The carrier becomes known to the instrument upon receipt of the load list.

For single sample requests entered at the computer when one or more carriers are known to the instrument, this field contains 0 and the carrier ID is assigned by the instrument after download.

For single sample requests entered at the computer when no sample carriers are known to the instrument, this field must contain a sample carrier ID assigned by the computer. The carrier becomes known to the instrument upon receipt of this request.

Load List ID Field

The download of load list begins with the first request having a Load list ID greater than 0 and ends with the next No Requests message. Multiple load lists for the same sample carrier may be sent during the download, each with its own Load list ID. Sample requests must be grouped by load list ID. All load lists must fit completely on 1 sample carrier. The instrument will accept only downloads for an unknown sample carrier. A sample carrier becomes known to the instrument when a sample request is entered for it either at the instrument keyboard or by receiving a download of samples or a single sample request from the computer. Once the sample carrier becomes known to the instrument, any subsequent requests to it must be sent as individual samples with a Load list ID field of 0.

NOTE: This field should be zero (0) unless you wish to use the Load List function on a Dimension® AR instrument.

Transaction Field

This field indicates to the instrument the type of function to perform.

- A** Tells the instrument to add a request for samples associated with a sample number.
- D** Requests deletion of a previously downloaded sample request. Deletion cannot occur once the request has been submitted for processing by the instrument operator. If this condition exists, the request is rejected.

NOTE: To delete a sample on any Dimension® system you must download the entire request with a (D) in the Transaction field, otherwise the sample request will be rejected.

Patient ID Field

This alphanumeric field contains a character string unique to each patient. It may be a Patient Name or number. It may also be empty. An empty field consists of 2 field separators, <FS><FS>.

Sample # Field

This is a unique number for each sample request assigned by the operator, when sample data is entered at the LIS or instrument. The instrument maintains this number with the sample requests in its database.

Sample Type Field

Information about the sample type is communicated as an alpha-numeric code. The code and what is displayed on the instrument are shown below.

Alpha Numeric Code	Instrument Display
W	Whole Blood
1	Serum
2	Plasma
3	Urine
4	CSF
5	1st QC level
6	2nd QC level
7	3rd QC level
8	4th QC level
9	5th QC level

NOTE: Alpha Numeric Code 8 and 9 are used for Urine QC1 and 2

Location Field

This field's contents are decided by the laboratory. One possible use is to specify the location of the patient in the hospital. The field may be empty. An empty field consists of two fields separators, <FS><FS>.

Priority Field

Information about the sample priority is communicated as an integer code. The code and what is displayed on the instrument are shown below.

Integer Code	Instrument Display
0	Routine
1	STAT
2	ASAP
3	QC
4	XQC (Used for crossover QC)

of Sample Cups Field

A variable number of cups may be required for each sample. This number varies according to test requirements. Each test requiring pretreatment will require a separate sample cup. This field indicates the number of cups requested and defines the number of iterations of the Sample Position, Dilution, and # of Tests fields that follow in the message.

Sample Cup Position Fields

The number of these fields is specified in the # of Cups field. There must be at least 1. This field is part of the iterated group consisting of Sample Position, Dilution and # of Tests fields. Sample positions on the sample carriers known to the instrument are assigned by the instrument. Sample positions on sample carriers which are unknown to the instrument are assigned by the computer. The Sample Position field in this message contains a positive value only if the computer is assigning sample positions, otherwise it is 0. Samples that will be identified by their bar coded labels will contain a "***" for this field. This indicates that no cup position assignment will occur until the sample has been identified by the instrument.

NOTE: You can only assign a cup position on the Dimension® AR instrument

Dilution Fields

The number of these fields is specified in the # of Cups field. There will be at least 1, and the default value of the field is 1. This field is a part of the iterated group consisting of Sample Position, Dilution, and # of Tests fields. The 3-digit dilution number is the value the measured result is multiplied by to compensate for a dilution of the sample. The range is 0 to 10 0.

Example:	Measured result	=	1.0
	Dilution	=	10.0
	Reported result	=	10.0

of Tests Fields

The number of these fields is specified in the # of Sample Cups field. There will be at least 1. This field is a part of the iterated group consisting of Sample Position, Dilution, and # of Tests fields. A variable number of tests can be requested for each sample cup. This field indicates the number of tests being requested and defines the number of iterations of the Test Name field that will follow in the message.

Test Name Fields

The number of these fields per sample is specified in the # of Tests field. There will be at least 1. The instrument must be configured to have positions uniquely for sample cup placement. Due to the flexible nature of the chemistry reagents associated with the Dimension® system, the test library is large and will change as new methods are made available to the customer. For this reason it is suggested that the test library be in the hands of the customer. Appendix II provides a table of those tests that may currently be part of the analyzer test library.

NOTE: All test name fields must be in upper case

Examples:

- Sample request for a barcoded tube.

<STX>D<FS>0<FS>0<FS>A<FS>106<FS>0305041<FS>1

<FS><FS>1<FS>1<FS>*<FS>1<FS>1<FS>GLU<FS>94<ETX>

No Request Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive

This data stream is sent by the LIS to indicate that there are no test requests to be downloaded. It is the computer response to the poll message which indicates the end of a download, and also is the computer response to the query message which indicates no sample found. It is the computer default response to the initial and conversational poll of the instrument.

Message Fields

Field	Max Length	Data
TYPE	1	N
No data fields		

Example:

- Only possible message

<STX>N<FS>6A<ETX>

Wait Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive mode

This message is sent by the computer when an "instrument busy" poll message is received during a load list download or to prevent termination of the download by a rejected request. The wait message is sent so the instrument will not terminate the load list, but will allow the load list to continue when the instrument is able to accept more requests, or the rejected request has been corrected or bypassed.

Message Fields

Field	Max Length	Data
TYPE	1	W
No data fields		

Example:

- Only possible message

<STX>W<FS>73<ETX>

NOTE: This message should only be used on the Dimension® AR instrument.

Request Acceptance Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive mode

This message is the instrument response to the computer Sample Request message.

Message Fields

Field	Max Length	Data
TYPE	1	M
STATUS	1	Accept (A), Reject (R)
REASON	2	Accept (empty field), Reject (1-8)
SAMPLE CARRIER ID	1	0, A or B
# OF SAMPLE CUPS	1	1 to 9
Repeated # of sample cup times		
SAMPLE POSITION	2	0, 1-60, or "*"

Status Fields

The status simply indicates acceptance or rejection of last request. If one sample cup of the several in the request has a problem, the whole request is rejected. There are no partial requests accepted.

Reason Field

For rejected requests, the Reason field gives one of the following reason codes for rejection; otherwise, it is empty. An empty field consists of two field separators, <FS><FS>.

Code	Reason
1	Request in process
2	Result no longer available
3	Sample carrier in use
4	No memory to store request
5	Error in test request
6	(Reserved)
7	Sample Carrier full
8	No known carriers
9	Incorrect Fluid Type

Sample Carrier ID Field

For an accepted request, this field indicates the carrier ID which the request was assigned. For a rejected request this field will always be 0.

of Sample Cups Field

A variable number of sample cups may be required for each sample. This number varies according to test requirements. Pretreated tests will require separate sample cups. This field indicates the number of sample cups being requested and the number of Sample Position fields that follow in the message. For rejected requests, this field will always be 1.

Sample Position Fields

The number of these fields is specified in the # of Sample Cups field. There will be at least 1. For requests associated with bar coded tubes the position will be a "*". The sample cup order in these fields may be affected by the instrument configuration. For rejected requests, this field will always be 0.

Sample positions on the sample carriers known to the instrument are assigned by the instrument. Sample positions on sample carriers which the instrument knows nothing about are assigned by the computer. The Sample Position field value is either assigned by the instrument or a copy of the value is sent in the sample request message.

Examples:

- Accept. Two sample cups associated with the request.

```
<STX>M<FS>A<FS><FS>A<FS> 2<FS>2<FS>3<FS>2A<ETX>
```

- Accept. Barcoded sample tube.

```
<STX>M<FS>A<FS><FS>A<FS>1<FS><FS>D2<ETX>
```

- Reject due to of error in request.

```
<STX>M<FS>R<FS> 5<FS>0<FS>1<FS>0<FS>0D<ETX>
```

- Reject due to incorrect fluid type.

```
<STX>M<FS>R<FS>9<FS> 0<FS>1<FS> 0<FS> 0F<ETX>
```

Query Message

Dimension® clinical chemistry system
send ID/receive mode

This message is sent by the instrument to query the computer for a specific sample request. It provides the sample ID only, and expects either a Sample Request Message with valid sample data, or a No Request Message indicating no sample found with matching ID. The Sample ID must match the sample ID field in the Sample Request or the message will be rejected.

Message Fields

Field	Max Length	Data
TYPE	1	I
SAMPLE ID	12	Alphanumeric

Example:

- Query for sample ID 043092011.
<STX>I<FS>043092011<FS>45<ETX>

Result Acceptance Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive mode

This is the computer response to the instrument Result and Calibration Result Messages. Upon receiving this message from the computer, the instrument marks the result as having been sent successfully.

Message Fields

Field	Length	Data
TYPE	1	M
STATUS	1	Accept (A), Reject (R)
REASON	2	Accept (empty field), Reject (1)

Status Field

The status simply indicates acceptance or rejection of last result.

Reason Field

For rejected requests, the Reason field gives the following reason code for rejection; otherwise, it is empty. An empty field consists of two field separators, <FS><FS>.

<u>Code</u>	<u>Reason</u>
1	computer out of memory

Examples:

- Accept.

<STX>M<FS>A<FS><FS>E2<ETX>

- Reject because computer is out of memory.

<STX>M<FS>R<FS>1<FS>24<ETX>

Result Message

Dimension® clinical chemistry system

send receive

send ID/receive mode

send only mode

This message is sent to the computer when all tests for a sample request have been processed on the instrument. The message contains results or error information for all tests requested.

When an instrument establishes communication with a computer, it scans its data base for all completed sample requests that have not been transmitted to the computer. The instrument communicates these results as part of the automatic recovery procedure, taking advantage of the instrument's battery support during power failure and its data storage capacity.

If a result is rejected by the computer with a Result Acceptance message, the instrument keeps trying to send the result and does not send any poll messages to solicit sample requests. The instrument signals the user that the computer will not accept results. The user must clear the situation at the computer. If not cleared and after 50 attempts (at 15-second intervals) to transmit a result, the instrument stops communication. Communication must be restored by the operator.

Field	Max Length	Data
TYPE	1	R
LOADLIST ID	2	0-99, "*"
PATIENT ID	27	alphanumeric
SAMPLE #	12	Empty, alphanumeric
SAMPLE TYPE	1	1 to 9 or W
LOCATION	6	Empty, alphanumeric
PRIORITY	1	0-4
DATE TIME	12	ssmmhhddmmyy
# OF SAMPLE CUPS	1	1 to 9
Iterated # of sample cup times		
DILUTION	3	1-100
# OF TESTS	2	1 to instrument limit
Iterated # of test times for each sample cup		
TEST NAME	5	Member of set of test mnemonics recognized by the instrument
TEST RESULT	10	Alphanumeric, ".", "-", "e"
UNITS	10	Empty, alphanumeric, "/", "%", "_"
ERROR CODE	2	Alphanumeric

Loadlist ID Field

Results for requests that originated on the instrument (i.e., not entered through the computer), have a Loadlist ID equal to " ". Single sample requests transmitted by the computer have a Loadlist ID equal to zero (0). A value greater than zero (0) indicates that the result is part of a Loadlist.

NOTE: Supported by Dimension® AR instrument only.

Patient ID Field

This alphanumeric field contains a character string unique to each patient. It may be a Patient Name or number. It may also be empty. An empty field consists of 2 field separators, <FS><FS>.

Sample # Field

This is a unique number for each sample request assigned by the operator, when sample data is entered at the LIS or instrument. The instrument maintains this number with the sample requests in its database.

Sample Type Field

Information about the sample type is communicated as an alphanumeric code. The code and what is displayed on the instrument are shown below.

Location Field

This field's contents are decided by the laboratory. One possible use is to specify the location of the patient in the hospital. The field may be empty. An empty field consists of two fields separators, <FS><FS>.

Priority Field

Information about the sample priority is communicated as an integer code. The code and what is displayed on the instrument are shown below.

Date Time Field

The time and date when the request is submitted to the instrument. The ssmmhhddmmyy format is interpreted as character pairs representing in sequence: seconds, minutes, hours, days, month, and year.

of Sample Cups Field

A variable number of sample cups may be required for each sample. This field indicates the number of sample cups requested and defines the number of iterations of: Dilution, # of Tests, Test Name, Test Results, Units, and Error Code fields that follow in the message.

Dilution Field

The number of these fields is specified in the # of Sample Cups field. There will be at least one. This field is part of the iterated group of fields consisting of: Dilution, # of Tests, Test Name, Test Results, Units, and Error Code fields.

The 3-digit dilution number is the value the measured result is multiplied by the Dimension® to compensate for a dilution of the sample.

of Tests Field

The number of these fields is specified in the # of Sample Cups field. There will be at least one. This field is a part of the iterated group of fields consisting of: Dilution, # of Tests, Test Name, Units, Test Results, and Error Code fields.

A variable number of tests can be requested for each sample cup. This field indicates the number of tests being requested and defines the number of iterations of the Test Name field that will follow in the message.

Test Name Field

The number of these fields per sample cup is specified in the # of Tests field. There will be at least one.

The instrument must be configured to have positions uniquely for sample cup placement. Due to the flexible nature of the chemistry reagents associated with the Dimension® system, the test library is large and will change as new methods are made available to the customer. For this reason it is suggested that the test library be in the hands of the customer. APPENDIX II provides a table of those tests that may currently be part of the analyzer test library.

Test Result Field

The number of these fields per sample cup is specified in the # of Tests field. There will be at least one.

The test result is contained in this field unless an error occurs causing the result to be suppressed.

The result is a 1-10 character string. It may contain alphanumeric characters, the digits, 0-9, negative sign, "-", "e", and a decimal point, or period, as appropriate, to represent the result value in either fixed or floating point format. See Chapter 1: *General Information*, "Message Format".

For errors that suppress the result, the result field is empty. The error code will be in the Error Code field.

NOTE: Certain methods that are calibrated for Qualitative results will report out as POS. or NEG. depending on the concentration level.

Units Field

Units of measure used in reporting test results.

Error Code Field

Because of the flexible nature of the chemistry reagents associated with the Dimension® system the error codes are varied and will change as new methods are made available to the customer. For this reason it is suggested that the error code library be in the hands of the customer. APPENDIX III provides a table of those errors that may currently be part of the analyzer error code library.

Examples:

- Sample requested at instrument

```
<STX>R<FS><FS>279-38-000<FS>043092005<FS>1<FS><FS>  
0<FS>174513190302<FS>1<FS>1<FS>2<FS>GLU<FS>85.00<FS>  
mg/dL<FS>  
<FS>BUN<FS>7<FS>mg/dL<FS><FS>0C<ETX>
```

- Sample requested at instrument (when error code suppresses the result)

<STX>R<FS><FS><FS>1596<FS>1<FS><FS>0<FS>420111230702<FS>1<FS>

1<FS>5<FS>NA<FS><FS><FS>11<FS>K<FS><FS><FS>11<FS>CL<FS><FS><FS>11

<FS>TCO2<FS><FS><FS>11<FS>CREA<FS>0.2<FS>mg/dl<FS>3<FS>CB<ETX>
- Sample requested at instrument (when error code does not suppress the result)

<STX>R<FS><FS><FS>1519<FS>1<FS><FS>0<FS>594513230702<FS>1<FS>

1<FS>1<FS>CK<FS>2590<FS>U/L<FS>3<FS>AE<ETX>

Calibration Result Message

Dimension® clinical chemistry system

send/receive mode

send ID/receive mode

This data is sent to the computer when a calibration is obtained.

Field	Max Length	Data
TYPE	1	C
TEST NAME	5	Member of set of test mnemonics recognized by the instrument
UNITS	10	alphanumeric, "/" and "%"
LOT NUMBER	10	alphanumeric
CALIBRATOR	10	Member of set of calibrators and verifiers recognized by the instrument
CALIBRATOR LOT NUMBER	10	Alphanumeric
OPERATOR	10	Alphanumeric
DATE TIME	12	ssmmhddmmyy
SLOPE	10	Numeric, ".", "-", "e"
INTERCEPT	10	Numeric, ".", "-", "e"
# OF COEFFICIENTS	2	2-5
Repeated # of coefficients times		
COEFFICIENTS	10	Numeric, ".", "-", "e"
# OF BOTTLE VALUES	2	3-5
Repeated # of bottle value times		
BOTTLE VALUE	10	Numeric, ".", "-", "e"
# OF RESULTS	2	2-3
Repeated # of results x # of bottle value times		
RESULT	10	Numeric, ".", "-", "e"

Test Name Field

The number of these fields per sample is specified in the # of Tests field. There will be at least 1. The instrument must be configured to have positions uniquely for sample cup placement. Due to the flexible nature of the chemistry reagents associated with the Dimension® system, the test library is large and will change as new methods are made available to the customer. For this reason it is suggested that the test library be in the hands of the customer. APPENDIX II provides a table of those tests that may currently be part of the analyzer test library.

Units Field

Units of measure used in reporting test results.

Lot Number Field

The lot number of the reagent being calibrated is contained in this field.

Calibrator Field

Calibrators and verifiers are instrument-type dependent. Some of the most common calibrator mnemonics are listed below and are among those communicated in the Calibrator field.

<u>Calibrator</u>	<u>Mnemonic</u>
CK Verifier	CK-V
CKMB Verifier	CKMB-V
T4 Calibrator	T4-C
TU Calibrator	TU-C
CHOL Calibrator	CHOL-C
HDL Calibrator	HDL-C
TBIL/DBIL Calibrator	TBIL/DBIL-C
CHEM I Calibrator	CHEM-C
Enzyme Verifier	ENZ-V
IRN/TIBC Calibrator	IRN/TIBC-C
Drug Calibrator	DRUG-C
ACP Verifier	ACP-V
AMON Calibrator	AMON-C

Calibrator Lot Number Field

The lot number for the calibrator or verifier product used for this calibration is transmitted in this field.

Operator Field

The name or code for the operator performing the calibration is put in this field.

Date Time Field

The time and date when the request is submitted to the instrument. The ssmmhddmmyy format is interpreted as character pairs representing in sequence: seconds, minutes, hours, days, month, and year.

Slope Field

The Slope field contains the slope of the linear regression line, plotting bottle values versus measured concentrations. For format of numeric data, see Chapter 1: *General Information*, “Message Format”.

Intercept Field

The intercept field contains the intercept of the linear regression line. For format of numeric data, see Chapter 1: *General Information*, “Message Format”.

of Coefficients Field

This field specifies the number of Coefficient Fields to follow.

Coefficient Fields

The new coefficients computed from the calibration calculations are communicated in these fields. For format of numeric data, see Chapter 1: *General Information*, “Message Format”.

of Bottle Values Field

For each bottle value there exists 2 to 3 results and residuals. Each bottle value has a group of associated fields, consisting of a Bottle Value, # of Results, and Result fields. This field specifies the number of field groups to follow.

Bottle Value Fields

The calibrator/verifier product is packaged as 3 to 5 levels to generate several known concentrations or bottle values. These values are specified in the Bottle Value fields. For format of numeric data, see Chapter 1: *General Information*, “Message Format”.

of Results Field

This field specifies the number of results for the current Bottle Value field.

Result Field

For format of numeric data, see Chapter 1: *General Information*, “Message Format”.

There are no error messages in this field as there are for the Test Result field.

Example:

- Three Bottle Values with two tests per Bottle Value.

<STX>C<FS>GLU<FS>MG/DL<FS>FA3406<FS>CHEM-C<FS>
CC2456<FS>

GEORGE<FS>053121100386<FS>1.05<FS>0.35<FS>2<FS>0.768
<FS>1.2E-5

<FS>3<FS>10<FS>2<FS>9.5<FS>9.6<FS>50<FS>2<FS>50.2<FS>
49.9<FS>90

<FS>2<FS>91.2<FS>91.3<FS>FB<ETX>

Result Messages

aca® discrete clinical analyzer

simulated mode

When the Dimension® clinical chemistry system is simulating the aca® discrete clinical analyzer, the result messages are test oriented one message per test result. The computer must collate these results according to sample, as indicated by the Sample Cup field. The instrument does not transmit a result until all results for tests associated with the sample are ready.

Message fields are fixed length. The following table gives the character positions for aca® analyzer Terminal Mode. In aca® analyzer Computer Mode, the positions increase by one to reflect the STX prefix with ETX as the final character.

Character Position	aca® IV, V analyzer or Dimension® system
1-4	Instrument ID
5	Space
6	Space
7-9	Sample Cup Number
10	Space
11-14	Result Sequence Number
15	Space
16	Space
17	Space
18-19	Dilution Factor (not used)
20	Space
21-29	Sample ID Number
30	Space
31-32	Method Number
33	Space
34-38	Method mnemonic
39	Space
40	A
41	Space
42	Minus sign or space
43-48	Test Result
49	Space
50-51	Error Code
52-58	Spaces
59-60	Checksum
61	Carriage return
62	Line feed

Instrument ID Field

This value is set by the customer to uniquely identify Dimension® clinical chemistry systems, distinguishing them from others in multi-instrument configurations. The computer can use the value during initialization to identify and validate the instrument/port assignments specified in the computer's configuration tables.

Only the first four characters of the instrument ID are transmitted.

Sample Cup Number Field

The Sample Cup Number is sample positions on the sample carriers which are assigned by the instrument. The number is right justified in the field with leading zeros, and ranges 1 to 60.

Result Sequence Number Field

The Result Sequence Number increments for every new result. When the number reaches 9999 it resets to 0000 automatically. It also can be reset to zero by using the system Configuration routine. The number is right justified in the field with leading zeros.

Sample ID Number Field

The Sample ID Number is the first nine digits of the Dimension® clinical chemistry system twelve-digit Sample number, See Section 2.3, Sample # Field. The number is left justified with padding space.

Method Number and the Method Mnemonic Fields

The mnemonics are given in Appendix II. The method number is filled with zeros. The mnemonic is left justified with padding space.

Test Result Field

The test result is left justified in the field. Only six characters are available for five digits and a decimal point; therefore, results may be reported with fewer significant digits than when in a New Instrument communication mode.

Error Code Field

Because of the flexible nature of the chemistry reagents associated with the Dimension® system the error codes are varied and will change as new methods are made available to the customer. For this reason it is suggested that the error code library be in the hands of the customer. Appendix III provides a table of those errors that may currently be part of the analyzer error code library.

Examples:

- Sample requested at instrument

```
<STX>R<FS><FS>279-38-000<FS>043092005<FS>  
1<FS><FS>
```

```
0<FS>174513190302<FS>1<FS>1<FS>2<FS>GLU<FS>85.00  
<FS>mg/dL<FS>
```

```
<FS>BUN<FS>7<FS>mg/dL<FS><FS>0C<ETX>
```

- Sample requested at instrument (when error code suppresses the result)

<STX>R<FS><FS><FS>1596<FS>1<FS><FS>0<FS>420111230702
<FS>1<FS>

- 1<FS>5<FS>NA<FS><FS><FS>11<FS>K<FS><FS><FS>11<FS>CL
<FS><FS><FS>11

<FS>TCO2<FS><FS><FS>11<FS>CREA<FS>-0.2<FS>mg/dl<FS>
3<FS>CB<ETX>

- Sample requested at instrument (when error code does not suppress the result)

<STX>R<FS><FS><FS>1519<FS>1<FS><FS>0<FS>594513230702
<FS>1<FS>

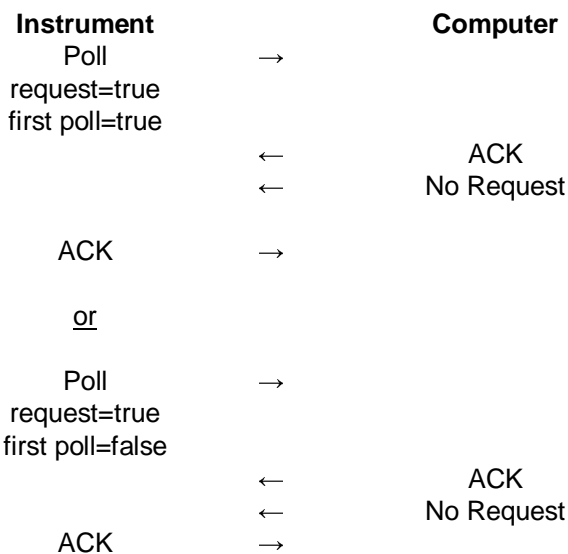
1<FS>1<FS>CK<FS>2590<FS>U/L<FS>3<FS>AE<ETX>

Application Level Message Dialogues

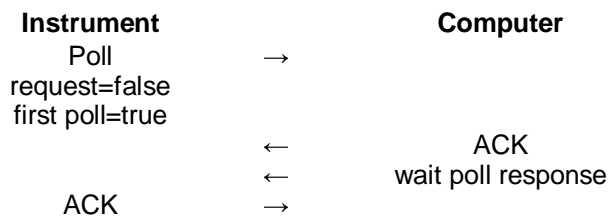
All messages must be acknowledged, either ACK'd or NAK'd by the receiver. The application level control functions exchange messages to maintain logical contact between the instrument and the computer regardless of the acknowledgements (ACK) that occur at the data link control layer.

The several basic dialogues or message exchanges are diagrammed below.

- Instrument is ready to receive sample download (polling) while the computer is idling with no sample to download.

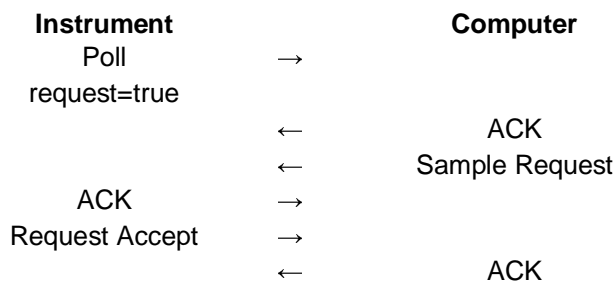


- Instrument is unable to receive additional sample download, but computer has sample download to send



Sequence repeats **every 15 seconds** while link is active.

- Instrument is in ready-to-receive state and the computer is in sample-download-ready state.



- Poll cycle is set to 1 second after a sample download has been received.



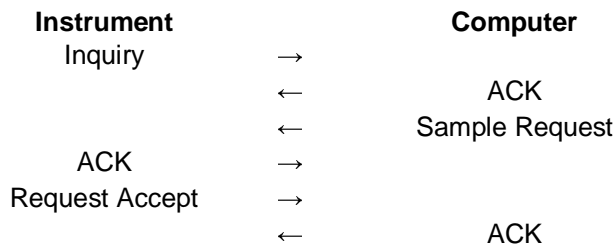
- Poll cycle reset to 15 seconds when Loadlist download terminated by the no request poll response.

- Instrument is in the result transmit state.



- Sequence repeats until all buffered test results have been transmitted to the computer.

- Instrument has found unknown sample with query mode activated.



Timing

The Dimension® clinical chemistry system uses the poll message to flow control the computer. The poll interval is set to either 1 second or 15 seconds. This means that 1 second or 15 seconds after the last message of the previous transaction, the instrument sends out the next poll message. When no sample requests are being transmitted by the computer or the instrument is too busy (see Section 2.2, Request Field, Page 13) to accept new sample requests, the interval is set to 15 seconds. When Sample Requests are sent by the computer and the instrument is not busy, the poll interval is reduced to 1 second to expedite sample request downloading.

After transmitting the poll message or result message, the instrument sets a 1-second ACK/NAK timer. When the ACK/NAK times elapses with no ACK/NAK received, the instrument tries to reestablish communications, either by reverting to an initial poll, or in limited cases by re-transmitting the result message. This communication recovery is attempted three times before declaring an interruption, and displaying a visible and audible alarm to the operator.

After transmitting the result and receiving the ACK from the computer, the instrument sets another 1-second response timer. If no Result Acceptance Message is received, the instrument tries to reestablish communications, either by reverting to an initial poll, or in limited cases by re-transmitting the result message. This communication recovery is attempted three times before declaring an interruption, and displaying a visible and audible alarm to the operator.

If a Result Acceptance Message rejects a Result Message, the instrument continues to transmit the result at 15-second intervals until accepted or 50 attempts are counted. The computer can use the Result Acceptance Message to flow control the instrument. Since 50 rejections are made before global communication error recovery is attempted, transmission of new results from the instrument can be suspended for approximately 30 minutes until fixed, or declared an error.

When transmitting the QUERY message and receiving the ACK from computer, the instrument will set only ONE 15-second response timer. No retransmissions occur for the QUERY message.

Appendix

Appendix I: Foreign Languages

The following tables, one for each language, specify the ASCII codes required to communicate language dependent characters to the instrument. All characters not specified below are standard ASCII.

German

ASCII Character	ASCII Code	Language Character
[5b	Ä (A umlaut)
{	7b	ä (a umlaut)
~	7e	ß (Beta)
\	5	Ö (O umlaut)
	7c	ö (o umlaut)
}	7d	ü (u umlaut)
]	5d	Ü (U umlaut)

Spanish

ASCII Character	ASCII Code	Language Character
?	?	~ (tilde)
"	7e	¨ (umlaut)
unavailable		´ (accent acute)
\	5c	ç (c with cedilla)
:	a4	Ñ (N with tilde)
;	c4	ñ (n with tilde)
@	40	à (a accent grave)
	7c	ù (u accent grave)

French

ASCII Character	ASCII Code	Language Character
	7c	ù (u accent grave)
@	40	à (a accent grave)
{	7b	é (c accent acute)
}	7d	(c accent grave)
\	5c	ç with cedilla
	ba	¨ umlaut

ASCII Character	ASCII Code	Language Character
	40	à (a accent grave)
\	5c	ç (c with cedilla)
}	7d	(c accent grave)
	7c	ù (u accent grave)
{	7b	é (c accent acute)
J	58	ò (o accent grave)

Appendix II: Table of Valid Test Names

ACP	DBIL	MYO
ACTM	DGNA	NA
AHDL	DGTX	OPI
ALB	ECO2	PALB
ALC	FERR	PCHE
ALDL	FPSA	PCP
ALP	FT4	PHNO
ALT	GENT	PHOS
AMON	GGT	PSA
AMPH	GLU	PTN
AMY	HA1C	RCRP
AST	HCG	SAL
BARB	HDL	T4
BENZ	IBCT	TBIL
BUN	IGA	TCO2
C3	IGG	TGL
C4	IGM	THC
CA	IRN	THEO
CHOL	K	TIBC
CK	LA	TOBR
CKMB	LDH	TP
CL	LHCG	TPSA
COC	LI	TRIG
CRBM	LIP	TRNF
CREA	LMMB	TSH
CRP	LTNI	TU
CSA	METH	UCFP
CTNI	MG	URCA
	MMB	VALP
		VANC

The following tests are calculated and are uploaded by the Dimension® instrument only. They cannot be downloaded.

%ISAT	FTI	RISK
%MB	GLOB	
%FPSA	IBIL	
A/G	LDL	
AGAP	OSMO	
BN/CR	UIBC	

Appendix III: Table of Valid Error Codes

Error Code	Suppress Result	Error Interpretation
1	NO	Temperature out of range
2	NO	Calibration expired
3	NO	Assay out of range
4	NO	Absorbance
5	NO	Measurement system (noise, cuvette, etc.)
6	NO	Reagent QC
7	YES	Arithmetic error
8	YES	Never calibrated
9	YES	No reagent
10	YES	Aborted test
11	YES	Processing error
12	YES	Software error
13	NO	"Hemoglobin"
14	NO	Abnormal reaction
15	NO	Diluted
16	YES	Below assay range
17	YES	Above assay range

Appendix IV: Error Codes Explained

Code	Error	Explanation	Results Suppressed
12	Software error	Software error exists on the instrument	YES
11	Process error	A system processing error occurred that prevented the system from the determined result.	YES
10	Aborted test no aliquots	A system action (by user or system) aborted this test.	YES
9	No reagent	The system lacked sufficient reagent for this test or a hydration of a reagent failed.	YES
8	Not calibrated	The reagent cartridge lot for this method was never calibrated.	YES
7	Arithmetic	The result was not able to be calculated using the current coefficients for that method.	YES
17	Above assay range	Above current assay range for non-linear methods.	YES
16	Below assay range	Below current assay range for non-linear methods	YES
6	Reagent QC Abnormal Assy	Assay is out of the established range for the specified method. See release notes.	NO
14	Abnormal reaction	Indicates the abnormal reaction conditions, i. e., foaming, air bubbles or turbidity problems are present in the mixture in the cuvette.	NO
4	Absorbance	The photometric reading was out of acceptable range. See "Chemistry Troubleshooting".	NO
	antigen excess assy rng/dilu low 'A' error high 'A' error subst deplet'n	These errors are reported out as code (4)	
13	Hemoglobin	The sample contained enough hemoglobin to interfere with system DBIL results. However, this will not affect the TBIL results	NO
5	Measurement	During photometric measurement, the system detected some noise or variances in the absorbance.	NO
3	Assay range/diluted	The result for this test was out of assay range defined for the linear method.	NO
2	Calibration expired	The reagent cartridge lot for this test had an EXPIRED calibration status.	NO
15	Diluted	The test has been autodiluted by the instrument.	NO
1	Temperature	The cuvette temperature was out of acceptable range.	NO