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cobas bge link

Host Interface Description

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Edition notice

cobas bge link Host Interface Description

cobas bge link (formerly: *OMNILINK*) will be launched in March 2008 under the Roche Diagnostics cobas® umbrella brand.

Professional IVD users will find all of the relevant Roche Diagnostics products and services under the cobas® brand.

- Systems running software version 3.6 or up are **cobas** bge link software applications.
- Systems running software version 3.5 or below are *OMNILINK* software applications.

Every effort has been made to ensure that all the information contained in this manual is correct at the time of release. However, Roche Diagnostics GmbH reserves the right to make any changes necessary without notice as part of ongoing product development.

Software updates are done by Roche Service representatives.

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Preface

cobas bge link is a remote monitoring and maintenance software for Roche Point-of-Care-Blood gas Instruments, especially OMNI 1-9 systems, **cobas b** 121 systems (= Roche OMNI C systems) and **cobas b** 221 systems (= Roche OMNI S systems).

How to use this manual

- *Keep this manual in a safe place to ensure that it is not damaged and remains available for use.*
- *This Host Interface Description should be easily accessible at all times.*

To find information quickly, there is a table of contents at the beginning of the book and each chapter.

Where to find information

In addition to the *Host Interface Description*, the following documents are also provided to assist in finding desired information quickly:

- **cobas** bge link Instructions for Use
- **cobas** bge link Online help (accessible by the software)
- **cobas** bge link Installation manual

Conventions used in this manual

Visual cues are used to help locate and interpret information in this manual quickly. This section explains formatting conventions used in this manual.

Symbols The following symbols are used:

Symbol	Used for
►	Procedural step
•	List item
👁	Cross reference
	Note

Symbol	Used for
	Caution
	Warning

Abbreviations The following abbreviations are used:

Abbreviation	Definition
A	
ASTM	"American Society for Testing and Material"
D	
DNS	Domain Name Server
H	
HIS	Hospital Information System
L	
LIS	Laboratory Information System
M	
MAC	Media Access Control
MDAC	Data Access Components
MSDE	Microsoft SQL Desktop Engine (until version 2000)
S	
SPM	Serial Port Manager
U	
UL	Underwriters Laboratories Inc.

General descriptions A

General descriptions

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Introduction & General Information

The **cobas** bge link host communication is based upon the ASTM standard E1394, but is not a complete implementation of the standard. The actual implementation of the data transfer is described below.

Data can be transmitted via TCP/IP (following ASTM E1394) as well as via serial connection (following ASTM E1394 and E1381).

For a description of the low level protocols used, see *Low Level Protocols - ASTM 1.0* on page B-15 and *Low Level Protocols - ASTM 2.0* on page C-15.

For information of setting up the connection, see the *Appendix* on page D-3 as well as the **cobas** bge link Instructions for Use.

Restricted Characters

None of the ten transmission control characters, the form effector control or the four device control characters may appear in message text. The following characters are not permitted to appear in the message text:

Illegal Message Text Characters				
<SOH>	<STX>	<ETX>	<EOT>	<ENQ>
<LF>	<ACK>	<DLE>	<NAK>	<SYN>
<ETB>	<DC1>	<DC2>	<DC3>	<DC4>

Table A-1 Illegal Message Text Characters

ASTM 1.0 B

Message Structure – ASTM 1.0

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Explanation

Each message has a number of records. A message is a group of records that begins with a **Header Record** and ends with a **Message Terminator Record**. Each record has a number of fields. Each field is by default separated by the vertical bar | character (the actual definition of which character is used for field separation is done with the Header Record).

The table below describes the records and fields within each record:

ID	Record Types
H	Header Record
P	Patient Record
Q	Request Record
O	Test Order Record
R	Result Record
C	Comment Record
L	Message Terminator Record

Table B-1 Record Types

Note:

The record type ID is not case sensitive. However, it is suggested to always use uppercase characters.

Delimiters

Delimiters are ASCII characters used to separate fields within a record and to separate components within fields. The table below describes the delimiters and how they are commonly used:

Character	Name	Used as:
|	vertical bar	Field delimiter
\	backslash	Repeat delimiter
^	caret	Component delimiter
&	ampersand	Escape delimiter
<CR>	carriage return	Record delimiter (settings dependent)
<CR><LF>	carriage return, line feed	Record delimiter (settings dependent)

Table B-2 Delimiters

Field delimiter

Must be defined in the message header and is used to separate adjacent fields. |field|

Repeat delimiter

Must be defined in the message header and is used to separate various numbers of descriptors for the same field. E.g. a patient has two phone numbers.
|555-5555\444-4444|

Explanation

Component delimiter

Must be defined in the message header and is used to separate data elements within a field that has a hierarchical or qualifier nature. E.g. the components of an address field would be separated. |street^city^state^zip|

Escape delimiter

Must be defined in the message header and is used to identify special case operations within a text field. For example, if text were suppose to be highlighted, the field would be |&H&DoctorsName&N&|. The &H& signifies the beginning of highlighting text and the &N& signifies the start of normal text. For a full description of all possible uses of escape characters, please see the ASTM E1394 standards specification.

The application of the escape delimiter is optional and may be ignored; however, all applications must accept the escape delimiter and use it to correctly parse fields within the record.

Null values

All fields are position dependent and are obtained by counting field delimiters by their position starting from the beginning of the record. This means if a field is null (no information available), the field delimiters must be included in the record. This ensures that the n^{th} field can be identified by counting n-1 delimiters. Trailing null fields do NOT need to be included. Delimiters are not needed after the last field containing data.

Null values may be sent for the following reasons:

- The value is not known.
- The sender knows the field is irrelevant to the receiving system.
- The value has not changed since the last transmission.

A field containing only a pair of double quotes "" should be treated by the receiving system as an instruction to delete any existing contents of that field.

Note:

The receiving system may ignore any field it does not require. However, fields must always be transmitted in the order specified.

Record Termination

As an extension to the ASTM E1394 definition, records can be terminated with either <CR> or <CR><LF>, depending on the **cobas** bge link settings. To set up **cobas** bge link for using either <CR> only or <CR><LF> for record termination, please see the APPENDIX. In the following description {RT} is used for the record termination character(s).

Header Record

This record must always be the first record in a transmission. This record contains information about the sender and receiver, instruments, and computer system whose records are being exchanged. It also identifies the delimiter characters. The minimum information that must be sent in a Header record is:

H|\^&{RT}

The H corresponds to the record type, H=Header. The | (vertical bar) is used as the field delimiter. The \ (backslash) is the repeat delimiter. The ^ (carat) is the component delimiter. The & (ampersand) is the Escape delimiter. {RT} can be either <CR> or <CR><LF>, depending on the settings and signifies the end of the record.

The entire header record consists of the following fields:

1|2|3|4|5|6|7|8|9|10|11|12|13|14{RT}
H|\^&|||AVL OMNI Ser.# :1234||||||Meas|P|2.2|19940922132041{RT}

Field #	Field Name	Comment
1	Record Type ID	Required see record types, section *Explanation* on page B-3
2	Delimiter definitions	Required, see table and example above. The first character is the field delimiter, the second is the repeat delimiter, the third is the component, and the fourth is the escape character
3	Message Control ID	Not used by **cobas** bge link.
4	Access Password	Not used by **cobas** bge link.
5	Sender Name or ID	Name of manufacturer, instrument and instrument serial number.
6	Sender Street Address	Not used by **cobas** bge link.
7	Reserved Field	Not used by **cobas** bge link.
8	Sender Telephone #	Not used by **cobas** bge link.
9	Characteristic of Sender	Not used by **cobas** bge link.
10	Receiver ID	Not used by **cobas** bge link.
11	Comment or Special Instructions	Name of the report is sent here: • Meas - Patient sample • QC - Quality control • ReqP - Patient query
12	Processing ID	Indicates how message should be processed: • P - Production, use standard processing (for measurements) • Q - Quality Control, sent to identify quality control, quality assurance or regulatory data.

Table B-3 Header record

Field #	Field Name	Comment
13	ASTM Version #	Required, currently version#2.2
14	Date and Time of message	Required Format=YYYYMMDDHHMMSS Time zone may be sent optionally and appended to the data/time field in the format of +HHMM or -HHMM as appropriate. HHMM is described as time before or after Universal Coordinated Time
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-3 Header record

Patient Information Record

This record contains information about an individual patient. The Patient Information record consists of the following fields:

1|2|3|4|5|6|7|8|9|10|11|12|13|14|15|16|17|18|19|20
|21|22|23|24|25|26|27|28|29|30|31|32|33|34|35{RT}

P|1|||321225432|||||||||||||||||||{RT}

Field #	Field Name	Comment
1	Record Type ID	Required see record types, section *Explanation* on page B-3
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Practice assigned Patient ID	A unique ID assigned and used by the practice to identify the patient and his/her results. Used by practice to identify the results returned by the tester (lab). Not used with Roche Instruments and QC messages.
4	Patient ID	Laboratory assigned ID. This is a unique processing number generated by the lab, the LIS, or the HIS (bar code number). Not used with QC messages.
5	Patient ID No. 3	Used for insurance number. Not used with QC messages.

Table B-4 Patient information record

Field #	Field Name	Comment
6	Patient Name	This field is the patient's name in the following format: Last^First^Middle. Each component separated by the component delimiter. Not used with QC messages.
7	Mother's Maiden Name	Generic text as entered at the instrument. Not used with OMNI 1-9 system. Not used with QC messages
8	Birth date	Format=YYYYMMDD **Note:** *For this field, time is not sent with the date.* Not used with QC messages.
9	Patient Sex	Format M or Male, F or Female, or U or Unknown, null if not entered. Not used with QC messages.
10	Patient Ethnic Origin	Transmits patient ethnic origin, generic text as entered on the instrument. Not used with OMNI 1-9 system. Not used with QC messages.
11	Patient Address	Generic text as entered at the instrument. Not used with OMNI 1-9 system. Not used with QC messages.
12	Reserved	Not used by **cobas** bge link
13	Patient Telephone #	Generic text as entered at the instrument. Not used with OMNI 1-9 system.
14	Attending Physician	Generic text as entered on the instrument. Not used with OMNI 1-9 system. Not used with QC messages.
15	Special field 1	Not used by **cobas** bge link
16	Special field 2	Not used by **cobas** bge link
17	Patient Height	Format value^unit. Not used with OMNI 1-9 system. Not used with QC messages.
18	Patient Weight	Format value^unit. Not used with OMNI 1-9 system. Not used with QC messages.
19	Known or suspected diagnosis	Generic text as entered at the instrument. Not used with OMNI 1-9 system. Not used with QC messages.

Table B-4 Patient information record

Field #	Field Name	Comment
20	Patient active medications	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
21	Patient diet	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
22	Practice field 1	Not used by **cobas** bge link
23	Practice field 2	Not used by **cobas** bge link
24	Admission and discharge data, separated by a ^	Format= YYYYMMDDHHMMSS\ YYYYMMDDHHMMSS
		Not used with OMNI 1-9 system.
		Not used with QC messages.
25	Admission status	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
26	Location	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
27	DRG or AVG	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
28	DRG or AVG #2	Not used by **cobas** bge link
29	Patient Religion	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
30	Marital Status	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
31	Isolation Status	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
32	Language	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.
33	Hospital Service	Generic text as entered at the instrument.
		Not used with OMNI 1-9 system.
		Not used with QC messages.

Table B-4 Patient information record

Field #	Field Name	Comment
34	Hospital Institution	Generic text as entered at the instrument. Not used with OMNI 1-9 system. Not used with QC messages.
35	Dosage Category	Generic text as entered at the instrument. Not used with OMNI 1-9 system. Not used with QC messages.
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-4 Patient information record

Request Information Record

This record contains a request on information about an individual patient. For **cobas** bge link it is used for querying patient demographics for the connected instruments. It is exclusively used with patient query messages.

The request information record consists of the following fields:

1|2|3|4|5{RT}

Q|1|120165||PERS{RT}

Field #	Field Name	Comment
1	Record Type ID	Required see record types, section *Explanation* on page B-3
2	Sequence#	Required, sequentially generated number identifying the number of each record. The first patient transmitted shall be 1; the second patient shall be 2.
3	Starting Range ID Number	Patient ID entered at the instrument. This is a unique processing number generated by the lab, the LIS, or the HIS (bar code number).
4	Ending Range ID Number	Not used by **cobas** bge link.
5	Universal Test ID	For **cobas** bge link always contains PERS to indicate, that personal data on the patient is requested.
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-5 Request information record

Test Order Record

The order record defines the particular type of tests run or performed for each specimen. The order record for **cobas** bge link only is transmitted to the host computer as part of a patient sample or QC result message.

The Test Order record consists of the following fields:

1|2|3|4|5|6|7|8|9|10|11|12|13|14|15|16|17|18|19|20|21|22|23|24|25|26|27|28|29|30|31{RT}

O|1|654871351A|MEASUREMENT^235||||||||||Blood^Capillary{RT}

Field #	Field Name	Comment
1	Record Type ID	Required 👁 see record types, section *Explanation* on page B-3
2	Sequence#	Required, sequential number
3	Specimen ID	Account or bar code number for patient samples, instrument QC sample number for QCs.
4	Instrument Specimen ID	A unique identifier assigned by the instrument. For patient result messages consists of the keyword MEASUREMENT followed by the instrument's running sample number separated by a component delimiter (no instrument sample number with **cobas b** 221 system data). For QC result messages consists of the keyword QC followed by the QC material LOT number separated by a component delimiter.
5	Universal Test ID	Test ID Descriptive
6	Priority	Not used by **cobas** bge link
7	Requested/ Order Date and Time	Not used by **cobas** bge link
8	Specimen collection date and time	Date and time the sample was collected. YYYYMMDDHHMM. Not used with QC messages.
9	Collection end time	Not used by **cobas** bge link
10	Collection volume	Not used by **cobas** bge link
11	Collector ID	Not used by **cobas** bge link
12	Action code	Not used by **cobas** bge link
13	Danger code	Not used by **cobas** bge link
14	Relevant clinical information	Not used by **cobas** bge link
15	Date/Time specimen received	Not used by **cobas** bge link

Table B-6 Test order record

Field #	Field Name	Comment
16	Specimen descriptor	Includes the specimen type and source, separated by a component delimiter. I.E. BLOOD^ARTERIAL for patient samples. QC material name^QC material level for QCs.
17	Ordering Physician	Not used by **cobas** bge link
18	Physician's Telephone Number	Not used by **cobas** bge link
19	User field 1	Not used by **cobas** bge link
20	User field 28	Not used by **cobas** bge link
21	Laboratory Field 1	Not used by **cobas** bge link
22	Laboratory Field 2	Not used by **cobas** bge link
23	Date/Time Results Reported or Last Modified	Not used by **cobas** bge link
24	Instrument Charge to Computer System	Not used by **cobas** bge link
25	Instrument Section ID	Not used by **cobas** bge link
26	Report Types	Not used by **cobas** bge link
27	Reserved Field	Not used by **cobas** bge link
28	Location or Ward of Specimen Collected	Not used by **cobas** bge link
29	Nosocomial Infection Flag	Not used by **cobas** bge link.
30	Specimen Service	Not used by **cobas** bge link
31	Specimen Institution	Not used by **cobas** bge link
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-6 Test order record

Result Record

The result record is used to send actual patient results that were performed on an instrument. The Result record consists of the following fields:

1|2|3|4|5|6|7|8|9|10|11|12|13|14{RT}

R|1|^^^ctHb^M|15.0|g/dL||N||F||20020922153246{RT}

Field #	Field Name	Comment
1	Record Type ID	Required see record types, section *Explanation* on page B-3
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Universal Test ID	Test name^how value was derived. Must be used as shown in example ^^^XX.X^Z XX.X=parameter ^Z=type Type: ^M=Measured ^E=Input ^S=Default ^R=Calculated ^P=Protocol ^C=Calculated ^I=Input With QC messages only measured values are transmitted.
4	Data measurement or value	Results from instruments XX.X=value
5	Units	SI or conventional.
6	Reference ranges	For patient sample messages follows the format: Reference range lower limit to upper limit, repeat delimiter, critical range lower limit to upper limit. For QC messages -2SD to +2SD.
7	Result Abnormal Flags	Errors, etc. Characters identifying these flags are: N Normal A Abnormal
8	Nature of abnormality testing	Not used by **cobas** bge link
9	Result Status	Status of the result: F Final
10	Date of Change in Instrument Normative Values	Not used by **cobas** bge link

Table B-7 Result record

Field #	Field Name	Comment
11	Operator Identification	First component identifies operator who performed the test (instrument operator), the second component identifies the verifier. **Note:** *Only transmitted in the first result record (except for **cobas b** 221 system data QC messages).*
12	Date/Time Test Started	Not used by **cobas** bge link
13	Date/Time Test Completed	The date and time instrument completed the test. **Note:** *Only transmitted in the first result record.*
14	Instrument Identification	Not used by **cobas** bge link
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-7 Result record

Comment Record

Comment records may be inserted anywhere except after the message terminator record. Each comment record applies to the first non-comment record preceding it. The Comment record consists of the following fields:

1|2|3|4|5{RT}

C|1|I||G{RT}

Field #	Field Name	Comment
1	Record Type ID	Required see record types, section *Explanation* on page B-3
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Comment Source	Always I
4	Comment Text	If comment codes are used, component delimiters ^ are used for separation
5	Comment Type	Used to qualify comment records. G Generic/Free Text I Instrument flag comment
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.

Table B-8 Comment record

Message Terminator Record

This is the last record in the message. A header record may be transmitted after this record to signify the start of another message. The Message Terminator record consists of the following:

1|2|3{RT}

L|1|N{RT}

Field #	Field Name	Comment	
1	Record Type ID	Required see record types, section *Explanation* on page B-3	
2	Sequence#	Required, sequentially generated number identifying the number of each record.	
3	Termination code	Nil, N	Normal termination
		T	Sender aborted
		R	Receiver aborted
		E	Unknown system error
		Q	Error in last request for information
		I	No information available from last query
		F	Last request for information processed
{RT}	Record Terminator	Required. Actual termination character(s) settings dependent.	

Table B-9 Message terminator record

Note

Note:

For all records, fields up to and including the last field with data needs to be transmitted. Fields not used at the end of the record may be truncated.

Low Level Protocols – ASTM 1.0

In this chapter *Chapter* **3**

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TCP/IP Connection

For TCP/IP connection, no specific low level protocol is used. Correct and complete communication is ensured by the TCP/IP protocol itself.

Serial Connection

For serial communication, the low level protocol as specified with ASTM E1381 is used. This chapter describes in detail the **cobas** bge link serial interfacing implementation.

Restricted Characters

None of the ten transmission control characters, the form effector control or the four device control characters may appear in the message text. The following characters are not permitted to appear in the message text:

Illegal Message Text Characters				
<SOH>	<STX>	<ETX>	<EOT>	<ENQ>
<LF>	<ACK>	<DLE>	<NAK>	<SYN>
<ETB>	<DC1>	<DC2>	<DC3>	<DC4>

Table B-10 Restricted Characters

Control Characters

Control characters that are used for ASTM communications:

ASCII	Decimal	Hex	Control char.	Comment
<STX>	2	0x2	^B	Start of TeXt
<ETX>	3	0x3	^C	End of TeXt
<EOT>	4	0x4	^D	End Of Transmission
<ENQ>	5	0x5	^E	ENQuiry
<ACK>	6	0x6	^F	ACKnowledge
<LF>	10	0xA	^J	Line Feed
<CR>	13	0xD	^M	Carriage Return
<NAK>	21	0x15	^U	Negative AcKnowledge
<ETB>	23	0x17	^W	End of Trans. Block

Table B-11 Control characters

Communication Phases

There are 3 distinct phases to each communication session:

- the Establishment Phase
- the Transfer Phase
- the Termination Phase

Each of these phases will be discussed in the following paragraphs.

Establishment Phase

When **cobas** bge link is ready to send data, it transmits an <ENQ> character. After the <ENQ> is sent, the instrument waits for a maximum of 15 seconds for a response from the host. If there is no response from the host within 15 seconds, the <ENQ> is resent. This loop is repeated for a maximum of six times. If there is no response after these six retries, communication is aborted.

Sender	**Recipient**
<ENQ>	
	<ACK> or <NAK>

If an <ACK> character is received from the host, the establishment phase is successful, and the transfer phase follows. If a <NAK> character is received from the host, the instrument waits a minimum of 10 seconds, and then resends the <ENQ> after receipt of the <NAK> and repeats this loop until an ACK is received. If the host continues to respond with <NAK> after six retries, communication is aborted.

This ends the establishment phase of the communication session.

Transfer Phase

During the transfer phase the sender transmits messages to the receiver. The transfer continues until all messages have been sent.

Sender>

<STX>	FN	data	<ETB> or <ETX>	CS	<CR><LF>

Receiver<

<ACK>

Explanation of fields:

<STX>	Start of text, ASCII decimal 2. This control character identifies the starting point of the data that is being sent from the analyzer. This character must accompany all data transmissions.
FN	Frame number. A single digit field distinguishing between new and re-transmitted frames. Legal characters are ASCII '0' to '7'. The frame number must start at 1 with the first frame of the transfer phase. The frame number is incremented by one for every new frame transmitted. After '7', the frame number rolls over to '0', and continues in this fashion.
Data	Data is one of the records described in the **Message Structure** section. see chapter *Message Structure - ASTM 1.0* on page B-1

<ETB> Or <ETX>	The <ETB> character stands for End of Transmission Block and is only sent when there are multiple frames. When a message contains over 240 characters it is broken into two or more frames. The intermediate frame must be terminated with an <ETB> (end of transmission block), CS (checksum), <CR> (carriage return) and <LF> (line feed). The final frame is terminated with an <ETX> (end of text), CS (checksum), <CR> (carriage return) and <LF> (line feed). The frame structure is illustrated below. <STX> FN data <ETB> CS <CR><LF> Intermediate frame(s) <STX> FN data <ETX> CS <CR><LF> End frame
CS	The CS (checksum) is used for checking data integrity. The checksum is computed by adding the binary values of the character, keeping the lowest significant 8 bits of the result. The checksum is initialized to zero with the <STX> character. The first character used in computing the checksum is the frame number. Each character in the message text is added to the checksum (modulo 256). The calculation of the checksum does not include the <STX>, the checksum characters, or the trailing <CR> and <LF> (the <ETX>/<ETB> is included in the calculation). The checksum is transmitted as two ASCII characters (hexadecimal representation). The two characters are transmitted as the checksum, with the most significant character first (C1). For example, a checksum of 122 can be represented as 0x7A (0x stands for hexadecimal). The checksum is transmitted as the ASCII character '7' followed by the character 'A'.
<CR> <LF>	The <CR> (carriage return) and <LF> (line feed) combination is used as the end termination characters of the message text.

Acknowledgements

After each frame is sent, the sender waits up to 15 seconds for a reply. The receiver shall transmit one of three replies:

<ACK> (Decimal 06)

The <ACK> reply signifies the last frame was received and processed successfully and it is OK to send another frame. The sender increments the frame number and either sends a new frame or terminates the transmission.

see *Termination Phase* on page B-20

<NAK> (Decimal 21)

The <NAK> reply signifies the last frame was not received successfully and the receiver is prepared to receive it again. The sender will retransmit it with the same frame number.

<EOT> (Decimal 04)

The <EOT> reply signifies the last frame was received successfully and the receiver is prepared to receive another frame, but requests the sender to stop transmitting data.

see *Interrupts* on page B-20

Interrupts During the transfer phase, if the receiver responds to a frame with an <EOT> in place of an <ACK>, the sender must interpret this as an interrupt request. The <EOT> signifies the last frame was successful, but the receiver is requesting the sender to stop transmitting. If the sender chooses to ignore the <EOT>, the receiver must re-send the <EOT> for the interrupt to remain valid. If the sender chooses to honour the interrupt, the sender must enter the termination phase.

see *Termination Phase* on page B-20

The sender must not enter the establishment phase for at least 15 seconds or until the receiver has finished a message cycle (establishment, transfer, termination).

Termination Phase

The termination phase returns the communication link to the clear or neutral state. The sender notifies the receiver that all messages have been sent.

Sender	Recipient
<EOT>	
	No response

The termination phase is a sequence of conditions that will cause communication between the devices to cease. The termination phase is entered when the sender has no more data to transmit. Termination is accomplished by transmitting an <EOT>. When the <EOT> is sent, no acknowledgement is needed, do not expect an <ACK>. The receiver, upon receiving <EOT>, considers the communication to have ended and sends no further data or acknowledgements.

Error Recovery

A receiver checks every frame for valid data. To check data, the receiver calculates the checksum on the received data and compares this calculated checksum to the checksum that was transmitted by the sender and sent with the data stream. If the checksums match, the data is valid. If the checksums do not match, the data is not valid and the receiver must send a <NAK>. Upon receiving the <NAK>, the sender re-transmits the last frame with the same frame number.

A frame should be rejected for the following errors:

- Any character errors are detected (parity error, framing error, etc.).
- The calculated frame checksum does not match the checksum in the received frame.
- The frame number is not one higher than the last accepted frame.

Upon receiving a <NAK>, or any character except <ACK> or <EOT>, the sender increments a re-transmit counter and re-transmits the same frame (with the same frame number). If the counter shows the frame was not accepted after six times, the sender must abort the message and proceed immediately to the termination phase.

Time-outs

If the reply after sending an <ENQ> is not received within 15 seconds, the sender enters the termination phase.

If the receiver detects contention and no <ENQ> is received within 20 seconds, the receiver regards the data link to be in the neutral state.

If the sender receives no reply within 15 seconds after transmitting the last character of a frame, it aborts the message by entering the termination phase.

During the transfer phase, the receiver sets a timer when first entering the transfer phase or when replying to a frame. If a frame or an <EOT> is not received within 30 seconds, the receiver discards the incomplete message and regards the line to be in the neutral state.

The receiver can delay its reply for up to 15 seconds. Longer delays cause the sender to abort the message.

State Diagram

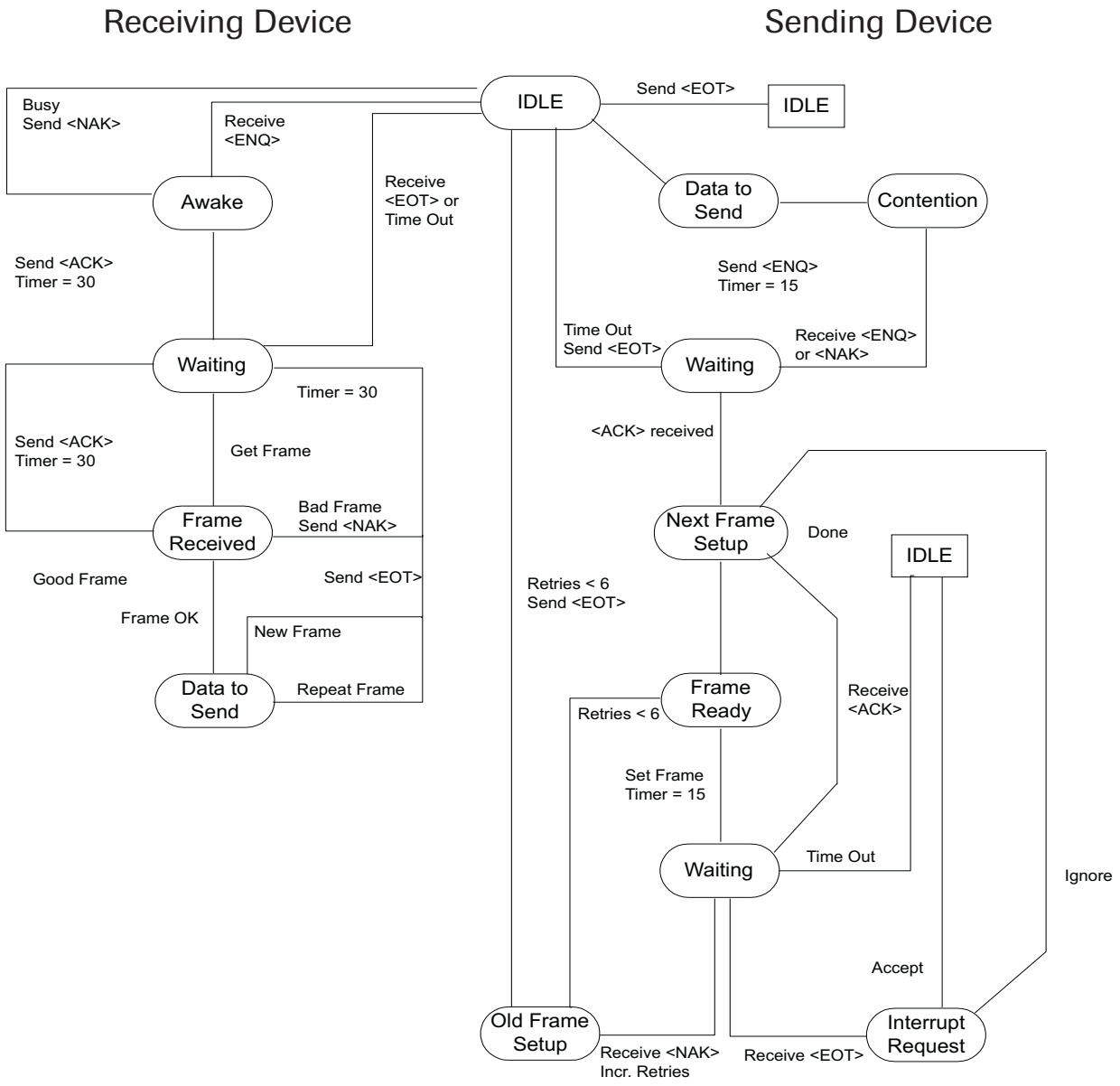

Figure B-1 State Diagram

Data Examples – ASTM 1.0

In this chapter *Chapter* **4**

Measurement Report

```
H|\^&|||Roche OMNI-C Ser.# :1003||||||Meas|P|2.2|20040823085623
P|1|382548345238|123123123123||Sample^Joe^X||19790813|M|||||||185^cm|88^kg||||||00000000000000/
00000000000000
O|1||MEASUREMENT^30|||||||||||Blood^Arterial
C|1|I||G
R|1|^^^pH^M|7.410||7.350 to 7.450\7.200 to 7.600|N||F||||20040813083246
R|2|^^^PCO2^M|44.3|mmHg|35.0 to 45.0\20.0 to 60.0|N||F|
R|3|^^^PO2^M|132.9|mmHg|80.0 to 100.0\60.0 to 800.0|A||F|
R|4|^^^Na^M|133.8|mmol/l|135.0 to 148.0\125.0 to 160.0|A||F|
R|5|^^^K^M|4.58|mmol/l|3.50 to 4.50\2.80 to 6.00|A||F|
R|6|^^^Cl^M|92.1|mmol/l|98.0 to 107.0\80.0 to 115.0|A||F|
R|7|^^^iCa^M|1.124|mmol/l|1.120 to 1.320\1.050 to 1.500|N||F|
R|8|^^^tHb^M|14.3|g/dl|13.6 to 17.2\8.0 to 23.0|N||F|
R|9|^^^SO2^M|94.9|%|75.0 to 99.0\60.0 to 100.0|N||F|
R|10|^^^Hct^M|-|%|35.0 to 50.0\25.0 to 65.0|A||X|
R|11|^^^Temperature^I|37.0|C||N||F|
R|12|^^^Baro^M|726.7|mmHg||N||F|
R|13|^^^cHCO3^C|27.5|mmol/l||N||F|
R|14|^^^ctCO2(P)^C|28.8|mmol/l||N||F|
R|15|^^^SO2(c)^C|99.0|%||N||F|
R|16|^^^BE^C|2.3|mmol/l||N||F|
R|17|^^^BEecf^C|2.8|mmol/l||N||F|
R|18|^^^BB^C|50.1|mmol/l||N||F|
R|19|^^^ctO2^C|19.3|vol%||N||F|
R|20|^^^ctCO2(B)^C|24.0|mmol/l||N||F|
R|21|^^^pHst^C|7.439|||N||F|
R|22|^^^cHCO3st^C|26.1|mmol/l||N||F|
R|23|^^^HbI^C|0.048|||N||F|
R|24|^^^PAO2^C|132.9|mmHg||N||F|
R|25|^^^AaDO2^C|0.0|mmHg||N||F|
R|26|^^^a/AO2^C|100.0|%||N||F|
R|27|^^^avDO2^C|-|%||A||X|
R|28|^^^RI^C|0|%||N||F|
R|29|^^^niCa^C|1.130|mmol/l||N||F|
R|30|^^^AG^C|18.8|mmol/l||N||F|
R|31|^^^pHt^C|7.410|||N||F|
R|32|^^^H+t^C|38.935|nmol/l||N||F|
R|33|^^^PCO2t^C|44.3|mmHg||N||F|
R|34|^^^PO2t^C|132.9|mmHg||N||F|
R|35|^^^PAO2t^C|132.9|mmHg||N||F|
R|36|^^^AaDO2t^C|0.0|mmHg||N||F|
R|37|^^^a/AO2t^C|100.0|%||N||F|
R|38|^^^RIt^C|0|%||N||F|
R|39|^^^Hct(C)^C|43.0|%||N||F|
R|40|^^^MCHC^C|-|g/dl||A||X|
R|41|^^^BO2^C|-|||A||X|
R|42|^^^BEact^C|2.6|mmol/l||N||F|
R|43|^^^Osm^C|267.3|mOsm/kg||N||F|
```

```
R|44|^^^OER^C|-|%||A||X|
R|45|^^^Qs/Qt^C|-|%||A||X|
R|46|^^^Qt^C|-|%||A||X|
R|47|^^^PFIndex^C|632.6|mmHg||N||F|
R|48|^^^ALLEN Flag ^I|unknown|||N||F|
R|49|^^^A/F^I|adult|||N||F|
R|50|^^^P50^I|26.7|mmHg||N||F|
R|51|^^^R ^I|0.840|||N||F|
R|52|^^^FIO2 ^I|0.210|||N||F|
L|1|N
```

QC Report

```
H|\^&|||Roche OMNI-S Ser.# :115||||||QC|Q|2.2|20040823083110
P|1
O|1||QC^21723102|||||||||||AUTO-TROL PLUS B^2
C|1|I| (8/23/2004 08:28:20) remmy demmy|G
R|1|^^^Bili^M||µmol/L|193 to 227|A||F||4711||20040614175358
R|2|^^^Ca^M||mmol/l|1.050 to 1.250|A||F||4711
R|3|^^^Cl^M||mmol/l|98.0 to 106.0|A||F||4711
R|4|^^^COHb^M||%|8.6 to 13.6|A||F||4711
R|5|^^^Glu^M||mmol/l|1.8 to 2.8|A||F||4711
R|6|^^^Hct^M||%|36.0 to 46.0|A||F||4711
R|7|^^^HHb^M||%|6.6 to 10.6|A||F||4711
R|8|^^^K^M||mmol/l|4.60 to 5.00|A||F||4711
R|9|^^^Lac^M||mmol/l|1.4 to 2.4|A||F||4711
R|10|^^^MetHb^M||%|4.5 to 7.5|A||F||4711
R|11|^^^Na^M||mmol/l|136.0 to 144.0|A||F||4711
R|12|^^^O2Hb^M||%|70.2 to 78.2|A||F||4711
R|13|^^^PCO2^M||mmHg|39.0 to 45.0|A||F||4711
R|14|^^^pH^M|||7.390 to 7.450|A||F||4711
R|15|^^^PO2^M||mmHg|78.0 to 102.0|A||F||4711
R|16|^^^SO2^M||%|86.9 to 92.2|A||F||4711
R|17|^^^tHb^M||g/dl|11.2 to 13.2|A||F||4711
L|1|N
```

Patient Query

```
H|\^&|||AVL OMNI Ser.# :1028||||||ReqP|P|2.2|19981027100820
Q|1|120165||PERS
L|1
```

ASTM 2.0 C

Message Structure – ASTM 2.0

In this chapter *Chapter* **5**

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Explanation

Each message has a number of records. A message is a group of records that begins with a **Header Record** and ends with a **Message Terminator Record**. Each record has a number of fields. Each field is by default separated by the vertical bar | character (the actual definition of which character is used for field separation is done with the Header Record). Following is a description of the records and the fields within each record:

ID	Record Types
H	Header Record
P	Patient Record
O	Test Order Record
R	Result Record
M	Manufacturer Record
Q	Request Information Record
L	Message Terminator Record

Table C-1 Record Types

Note:

The record type ID is not case sensitive. However, it is suggested to always use uppercase characters.

Delimiters

Delimiters are ASCII characters used to separate fields within a record and to separate sub-components within fields. The table below describes the records and fields within each record:

Character	Name	Used as:
|	vertical bar	Field delimiter
\	backslash	Repeat delimiter
^	caret	Component delimiter
&	ampersand	Escape delimiter
<CR>	carriage return	Record delimiter

Table C-2 Delimiters

Field delimiter

Separates adjacent fields. |field|

Repeat delimiter

Must be defined in the message header and is used to separate various numbers of descriptors for the same field. I.E. multiple range information |7.350^7.450^reference\7.200^7.600^critical|

Component delimiter

Used to separate data elements within a field that has a hierarchical or qualifier nature. I.E. The components of a name field would be separated.
|Sample^Josephine^X^jr.^M.D.|

Escape delimiter

The escape delimiter is used to identify special case operations within a text field. For example, if text were to be highlighted, the field would be |&H&DoctorsName&N&|. The &H& signifies the beginning of highlighting text and the &N& signifies the start of normal text.

The application of the escape delimiter is optional and may be ignored; however, all applications must accept the escape delimiter and use it to correctly parse fields within the record.

Null values

All fields are position dependent and are obtained by counting field delimiters by their position starting from the beginning of the record. This means if a field is null (no information available), the field delimiters must be included in the record. This ensures that the n^{th} field can be identified by counting n-1 delimiters. Trailing null fields do NOT need to be included. Delimiters are not needed after the last field containing data.

Null values may be sent for the following reasons:

- The value is not known.
- The sender knows the field is irrelevant to the receiving system.
- The value has not changed since the last transmission.

A field containing only a pair of double quotes "" should be treated by the receiving system as an instruction to delete any existing contents of that field.

Note:

The receiving system may ignore any field it does not require. However, fields must always be transmitted in the order specified.

Header Record

This record must always be the first record in a transmission. This record contains information about the sender and receiver, instruments and computer systems whose records are being exchanged. It also identifies the delimiter characters. The minimum information that must be sent in a Header record is:

H|\^&<CR>

The H corresponds to the record type, H=Header. The | (vertical bar) is used as the field delimiter. The \ (backslash) is the repeat delimiter. The ^ (caret) is the component delimiter. The & (ampersand) is the Escape delimiter. The <CR> is identified as a Carriage Return (ASCII decimal 13). The Carriage Return signifies the end of the record.

The entire header record consists of the following fields:

Field #	Field Name	Comment
1	Record Type ID	Required, always H
2	Delimiter definitions	Required, see the table in Delimiters. see section *Delimiters* on page C-5 The first character is the field delimiter, the second is the repeat delimiter, the third is the component and the fourth is the escape character
3	Message Control ID	Not used by **cobas** bge link.
4	Access Password	Not used by **cobas** bge link.
5	Sender Name or ID	Instrument ID, manufacturer name, instrument type, software version, protocol version, serial number and IP address; separated by component delimiters.
6	Sender Street Address	Not used by **cobas** bge link.
7	Reserved Field	Not used by **cobas** bge link.
8	Sender Telephone #	Not used by **cobas** bge link.
9	Characteristic of Sender	Not used by **cobas** bge link.
10	Receiver ID	Receiving application name and IP address; separated by component delimiters.
11	Comment or Special Instructions	Message type. • M = measurement results, • QC = quality control results, • SR^REAL = calibration results, • LSU^U12 = maintenance data, • PQ = patient information query.
12	Processing ID	Indicates how message should be processed: P-Production, use standard processing
13	ASTM Version #	Required, currently 1394-97
14	Date and Time of message	Required Format=YYYYMMDDHHMMSS
<CR>	Carriage return	Required. Record Terminator

Table C-3 Header Record

Example

H|\^&|||GSS^Roche^OMNI S^V5.0^1^115^10.124.67.88|||||
LSU^U12|P|1394-97|20040615164743<CR>

Patient Information Record

This record contains information about an individual patient. Patient information records are only actively used in a Measurement Report and a Patient Information Query. A QC Report contains a Patient Information Record without data due to ASTM standard compliance necessities.

The Patient Information record consists of the following fields:

Field #	Field Name	Comment
1	Record Type ID	Required, always P
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Practice assigned Patient ID	A unique ID assigned and used by the practice to identify the patient and his/her results. Used by practice to identify the results returned by the tester (lab).
4	Laboratory Patient ID	Laboratory assigned ID. This is a unique processing number generated by the lab, the LIS, or the HIS (bar code number).
5	Patient ID No. 3	Used for transmitting the patient's insurance number.
6	Patient Name	This field is the patients name in the following format: Last^First^Middle^Suffix^Title. Each component separated by the component delimiter.
7	Mother's Maiden Name	Generic text (as entered at the instrument).
8	Date of Birth	Format=YYYYMMDD
9	Patient Sex	Format M (male), F (female), or U (unknown), null if not entered.
10	Patient Race	Patient ethnic origin. Generic text (as entered at the instrument).
11	Patient Address	Generic text (as entered at the instrument).
12	Reserved	Not used by **cobas** bge link.
13	Patient Telephone #	Generic text (as entered at the instrument).
14	Attending Physician	ID of the attending physician.
15	Special field 1	Not used by **cobas** bge link.
16	Special field 2	Not used by **cobas** bge link.
17	Patient Height	Format value^unit.
18	Patient Weight	Format value^unit.
19	Known or suspected diagnosis	Generic text (as entered at the instrument).
20	Patient active medications	Generic text (as entered at the instrument).
21	Patient diet	Generic text (as entered at the instrument).
22	Practice field 1	Not used by **cobas** bge link.

Table C-4 Patient Information Record

Field #	Field Name	Comment
23	Practice field 2	Not used by **cobas** bge link.
24	Admission and discharge data and time	Format= YYYYMMDDHHMMSS\ YYYYMMDDHHMMSS
25	Admission status	Generic text (as entered at the instrument).
26	Location	Generic text (as entered at the instrument).
27	Diagnostic Code	Generic text (as entered at the instrument).
28	Alternative Diagnostic Code	Not used by **cobas** bge link.
29	Patient Religion	Generic text (as entered at the instrument).
30	Marital Status	Generic text (as entered at the instrument).
31	Isolation Status	Generic text (as entered at the instrument).
32	Language	Generic text (as entered at the instrument).
33	Hospital Service	Generic text (as entered at the instrument).
34	Hospital Institution	Generic text (as entered at the instrument).
35	Dosage Category	Generic text (as entered at the instrument).
<CR>	Carriage Return	Required. Record terminator

Table C-4 Patient Information Record

Example

P | 1 | | 123456 | Amex123 | Sample^Josephine^X^jr.^M.D. | Good | 20691202 | Female | Caucasian | 1 Draft Avenue, Omah | |+43 316 27787-7349|Trapper John, M.D.| | |169.0^cm|72.0^kg|Birth | None | Steak and Gravy| | |20030427103200|Admitted |Third Floor, Delivery|Diag Code123| |Catholic|Separated |Isolation 123|Estonian|Intensive|Maternity Clinic|Dosage 123<CR>

Test Order Record

The order record defines the particular type of tests run or performed for each specimen. The order record for **cobas** bge link is only transmitted to the host computer as part of the measurement report.

The Test Order record consists of the following fields:

Field #	Field Name	Comment
1	Record Type ID	Required, always O
2	Sequence#	Required, sequential number
3	Specimen ID	Account or bar code number
4	Instrument Specimen ID	Order ID^Measurement ID^^^^Sample Container.
5	Universal Test ID	Not used by **cobas** bge link.
6	Priority	Not used by **cobas** bge link.

Table C-5 Test Order Record

Field #	Field Name	Comment
7	Requested /Order Date and Time	Not used by **cobas** bge link.
8	Specimen collection date and time	Not used by **cobas** bge link.
9	Collection end time	Not used by **cobas** bge link.
10	Collection volume	Not used by **cobas** bge link.
11	Collector ID	Not used by **cobas** bge link.
12	Action code	Not used by **cobas** bge link.
13	Danger code	Generic text (as entered at the instrument).
14	Relevant clinical information	Clinic Info. Generic text (as entered at the instrument).
15	Date/Time specimen received	Not used by **cobas** bge link.
16	Specimen descriptor	For measurement: Sample type, blood type and puncture site; separated by component delimiters. For quality control: Material name, level, lot number and material base; separated by component delimiters.
17	Ordering Physician	Not used by **cobas** bge link.
18	Physician's Telephone Number	Not used by **cobas** bge link.
19	User field 1	Not used by **cobas** bge link.
20	User field 2	Not used by **cobas** bge link.
21	Laboratory Field 1	Not used by **cobas** bge link.
22	Laboratory Field 2	Not used by **cobas** bge link.
23	Date/Time Results Reported or Last Modified	Not used by **cobas** bge link.
24	Instrument Charge to Computer System	Not used by **cobas** bge link.
25	Instrument Section ID	Not used by **cobas** bge link.
26	Report Types	Not used by **cobas** bge link.
27	Reserved Field	Not used by **cobas** bge link.
28	Location or Ward of Specimen Collected	Not used by **cobas** bge link.
29	Nosocomial Infection Flag	Not used by **cobas** bge link.
30	Specimen Service	Not used by **cobas** bge link.
31	Specimen Institution	Not used by **cobas** bge link.
<CR>	Carriage Return	Required. Record Terminator

Table C-5 Test Order Record

Example

O | 1 | spec123 | order123^33^^^^Syringe| | | | | | | | danger123 | Clinic123 | | Aqueous solution^Arterial^A. femoralis l.<CR>

Result Record

The result record is used to send actual patient results and quality control results, that were performed on an instrument.

The Result record consists of the following fields:

Field #	Field Name	Comment
1	Record Type ID	Required, always R.
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Universal Test ID	^^^Test name^^^how value was derived (M-Measured, C-Calculated, I-Input)
4	Data measurement or value	Result value (Cut-off index not used)
5	Units	Same as selected for instrument display.
6	Reference ranges	Reference range of the analyte. Format is lower limit^upper limit^limit name. Multiple ranges are separated by repeat delimiters.
7	Result Abnormal Flags	N Normal A Abnormal L Below reference range H Above reference range LL Below critical range HH Above critical range < Off low scale of instrument > Off high scale of instrument
8	Nature of abnormality testing	A, S, N or empty.
9	Result Status	F Final
10	Date of Change in Instrument Normative Values	Not used by **cobas** bge link.
11	Operator Identification	Identifies operator who performed the test (instrument operator). **Note:** *Only transmitted in the first result record.*
12	Date/Time Test Started	Not used by **cobas** bge link.
13	Date/Time Test Completed	The date and time the instrument completed the test. Format=YYYYMMDDHHMMSS **Note:** *Only transmitted in the first result record.*
14	Instrument Identification	Not used by **cobas** bge link.
<CR>	Carriage Return	Required. Record Terminator

Table C-6 Result Record

Example

R | 1 | ^^^pH^^^M^1 | 7.185 | | 7.350^7.450^reference
\7.200^7.600^critical | LL | | F | | oper123 | | 20040615183711<CR>

Request Information Record

The Request Information Record is used for querying a host system for patient demographics. The response message to an information request has to consist of a Header Record, a Patient Information Record and Message Terminator Record. The Message Terminator Record in this case has to end with one of the query response codes.

The Request Information Record consists of the following fields:

Field #	Field Name	Comment
1	Record Type ID	Required, always is Q.
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Starting Range ID Number	Laboratory Patient ID, entered during measurement.
4	Ending Range ID Number	Not used by **cobas** bge link.
5	Universal Test ID	Not used by **cobas** bge link.
6	Nature of Request Time Limits	Not used by **cobas** bge link.
7	Beginning Request Results Date and Time	Not used by **cobas** bge link.
8	Ending Request Results Date and Time	Not used by **cobas** bge link.
9	Requesting Physician Name	Not used by **cobas** bge link.
10	Requesting Physician Telephone Number	Not used by **cobas** bge link.
11	User Field No. 1	Not used by **cobas** bge link.
12	User Field No. 2	Not used by **cobas** bge link.
13	Request Information Status Codes	D - Requesting demographics only
<CR>	Carriage Return	Required. Record Terminator

Table C-7 Request Information Record

Example

Q | 1 | 123456 | | | | | | | | | D<CR>

Comment Record

Comment records may be inserted anywhere except after the message terminator record. Each comment record applies to the first non-comment record preceding it. The Comment record consists of the following fields:

1 | 2 | 3 | 4 | 5<CR>

Field #	Field Name	Comment
1	Record Type ID	Required, always is R.
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Comment Source	I Clinical Instrument
4	Comment Text	For comment codes used, the format is code^comment.
5	Comment Type	Used to qualify comment records.
		G Generic/Free Text
		I Instrument flag comment
<CR>	Carriage Return	Required. Record Terminator

Table C-8 Comment Record

Example

C | 1 | I | The Remark | G<CR>

Message Terminator Record

This is the last record in the message. A header record may be transmitted after this record to signify the start of another message. The Message Terminator record consists of the following:

Field #	Field Name	Comment
1	Record Type ID	Required, always is L.
2	Sequence#	Required, sequentially generated number identifying the number of each record.
3	Termination code	N normal termination
		T sender aborted
		E unknown system error
		Q error in last request for information
		I no information available from last query
		F last request for information processed
<CR>	Carriage Return	Required. Record Terminator

Table C-9 Message Terminator Record

Example

L | 1 | N<CR>

Note

Note:

For all records, fields up to and including the last field with data needs to be transmitted. Fields not used at the end of the record may be truncated.

Low Level Protocols – ASTM 2.0

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TCP/IP Connection

For TCP/IP connection, no specific low level protocol is used. Correct and complete communication is ensured by the TCP/IP protocol itself.

Serial Connection

For serial communication, the low level protocol as specified with ASTM E1381 is used. A detailed description of the **cobas** bge link implementation can be found in the following.

Control Characters

Control characters that are used for ASTM communications:

ASCII	Decimal	Hex	Control char.	Comment
<STX>	2	0x2	^B	Start of TeXt
<ETX>	3	0x3	^C	End of TeXt
<EOT>	4	0x4	^D	End Of Transmission
<ENQ>	5	0x5	^E	ENQuiry
<ACK>	6	0x6	^F	ACKnowledge
<LF>	10	0xA	^J	Line Feed
<CR>	13	0xD	^M	Carriage Return
<NAK>	21	0x15	^U	Negative AcKnowledge
<ETB>	23	0x17	^W	End of Trans. Block

Table C-10 Control characters

Communication Phases

There are 3 distinct phases to each communication session:

- Establishment phase,
- Transfer phase and the
- Termination phase.

Each of these phases will be discussed in the following paragraphs.

Establishment Phase

When **cobas** bge link is ready to send data, it transmits an <ENQ> character. After the <ENQ> is sent, the instrument waits for a maximum of 15 seconds for a response from the host. If there is no response from the host within 15 seconds, the <ENQ> is resent. This loop is repeated for a maximum of six times. If there is no response after these six retries, communication is aborted.

Sender	Recipient
<ENQ>	
	<ACK> or <NAK>

If an <ACK> character is received from the host, the establishment phase is successful, and the transfer phase follows. If a <NAK> character is received from the host, **cobas** bge link waits a minimum of 10 seconds, then resends the <ENQ> after receipt of the <NAK> and repeats this loop until an ACK is received. If the host continues to respond with <NAK> after six retries, the communication is aborted.

This ends the Establishment phase of the communication session.

Transfer Phase

During the transfer phase the sender transmits messages to the receiver. The transfer continues until all messages have been sent.

Sender>

<STX>	FN	data	<ETB> or <ETX>	CS	<CR><LF>

Receiver<

<ACK>

Explanation of fields:

<STX>	Start of text, ASCII decimal 2. This control character identifies the starting point of the data that is being sent from **cobas** bge link. This character must accompany all data transmissions.
FN	Frame number. A single digit field distinguishing between new and re-transmitted frames. Legal characters are ASCII '0' to '7'. The frame number must start at 1 with the first frame of the transfer phase. The frame number is incremented by one for every new frame transmitted. After '7', the frame number rolls over to '0', and continues in this fashion.
Data	Data is one of the records described in the **Message Structure** section. see chapter *Message Structure - ASTM 2.0* on page C-3
<ETB> Or <ETX>	The <ETB> character stands for End of Transmission Block and is only sent when there are multiple frames. When a message contains over 240 characters it is broken into two or more frames. The intermediate frame must be terminated with an <ETB> (end of transmission block), CS (checksum), <CR> (carriage return) and <LF> (line feed). The final frame is terminated with an <ETX> (end of text), CS (checksum), <CR> (carriage return) and <LF> (line feed). The frame structure is illustrated below. <STX> FN data <ETB> CS <CR><LF> Intermediate frame(s) <STX> FN data <ETX> CS <CR><LF> End frame

CS	The CS (checksum) is used for checking data integrity. The checksum is computed by adding the binary values of the character, keeping the lowest significant 8 bits of the result. The checksum is initialized to zero with the <STX> character. The first character used in computing the checksum is the frame number. Each character in the message text is added to the checksum (modulo 256). The calculation of the checksum does not include the <STX>, the checksum characters, or the trailing <CR> and <LF> (the <ETX>/<ETB> is included in the calculation). The checksum is transmitted as two ASCII characters (hexadecimal representation). The two characters are transmitted as the checksum, with the most significant character first (C1). For example, a checksum of 122 can be represented as 0x7A (0x stands for hexadecimal). The checksum is transmitted as the ASCII character '7' followed by the character 'A'.
<CR> <LF>	The <CR> (carriage return) and <LF> (line feed) combination is used as the end termination characters of the message text.

Acknowledgements

After each frame is sent, the sender waits up to 15 seconds for a reply. The receiver shall transmit one of three replies:

<ACK> (Decimal 06)

The <ACK> reply signifies the last frame was received and processed successfully and it is OK to send another frame. The sender increments the frame number and either sends a new frame or terminates the transmission.

see *Termination Phase* on page C-20

<NAK> (Decimal 21)

The <NAK> reply signifies the last frame was not received successfully and the receiver is prepared to receive it again. The sender will retransmit it with the same frame number.

<EOT> (Decimal 04)

The <EOT> reply signifies the last frame was received successfully and the receiver is prepared to receive another frame, but requests the sender to stop transmitting data.

see *Interrupts* on page C-19

Interrupts

During the transfer phase, if the receiver responds to a frame with an <EOT> in place of an <ACK>, the sender must interpret this as an interrupt request. The <EOT> signifies the last frame was successful, but the receiver is requesting the sender to stop transmitting. If the sender chooses to ignore the <EOT>, the receiver must resend the <EOT> for the interrupt to remain valid. If the sender chooses to honour the interrupt, the sender must enter the termination phase.

see *Termination Phase* on page C-20

The sender must not enter the establishment phase for at least 15 seconds or until the receiver has finished a message cycle (establishment, transfer, termination).

Termination Phase

The termination phase returns the communication link to the clear or neutral state. The sender notifies the receiver that all messages have been sent.

Sender	Recipient
<EOT>	
	No response

The termination phase is a sequence of conditions that will cause communication between the devices to cease. The termination phase is entered when the sender has no more data to transmit. Termination is accomplished by transmitting an <EOT>. When the <EOT> is sent, no acknowledgement is needed, do not expect an <ACK>. The receiver, upon receiving <EOT>, considers the communication to have ended and sends no further data or acknowledgements.

Error Recovery

A receiver checks every frame for valid data. To check data, the receiver calculates the checksum on the received data and compares this calculated checksum to the checksum that was transmitted by the sender and sent with the data stream. If the checksums match, the data is valid. If the checksums do not match, the data is not valid and the receiver must send a <NAK>. Upon receiving the <NAK>, the sender re-transmits the last frame with the same frame number.

A frame should be rejected for the following errors:

- Any character errors are detected (parity error, framing error, etc.).
- The calculated frame checksum does not match the checksum in the received frame.
- The frame number is not one higher than the last accepted frame.

Upon receiving a <NAK>, or any character except <ACK> or <EOT>, the sender increments a re-transmit counter and re-transmits the same frame (with the same frame number). If the counter shows the frame was not accepted after six times, the sender must abort the message and proceed immediately to the termination phase.

Time-outs

If the reply after sending an <ENQ> is not received within 15 seconds, the sender enters the termination phase.

If the receiver detects contention and no <ENQ> is received within 20 seconds, the receiver regards the data link to be in the neutral state.

If the sender receives no reply within 15 seconds after transmitting the last character of a frame, it aborts the message by entering the termination phase.

During the transfer phase, the receiver sets a timer when first entering the transfer phase or when replying to a frame. If a frame or an <EOT> is not received within 30 seconds, the receiver discards the incomplete message and regards the line to be in the neutral state.

The receiver can delay its reply for up to 15 seconds. Longer delays cause the sender to abort the message.

State Diagram

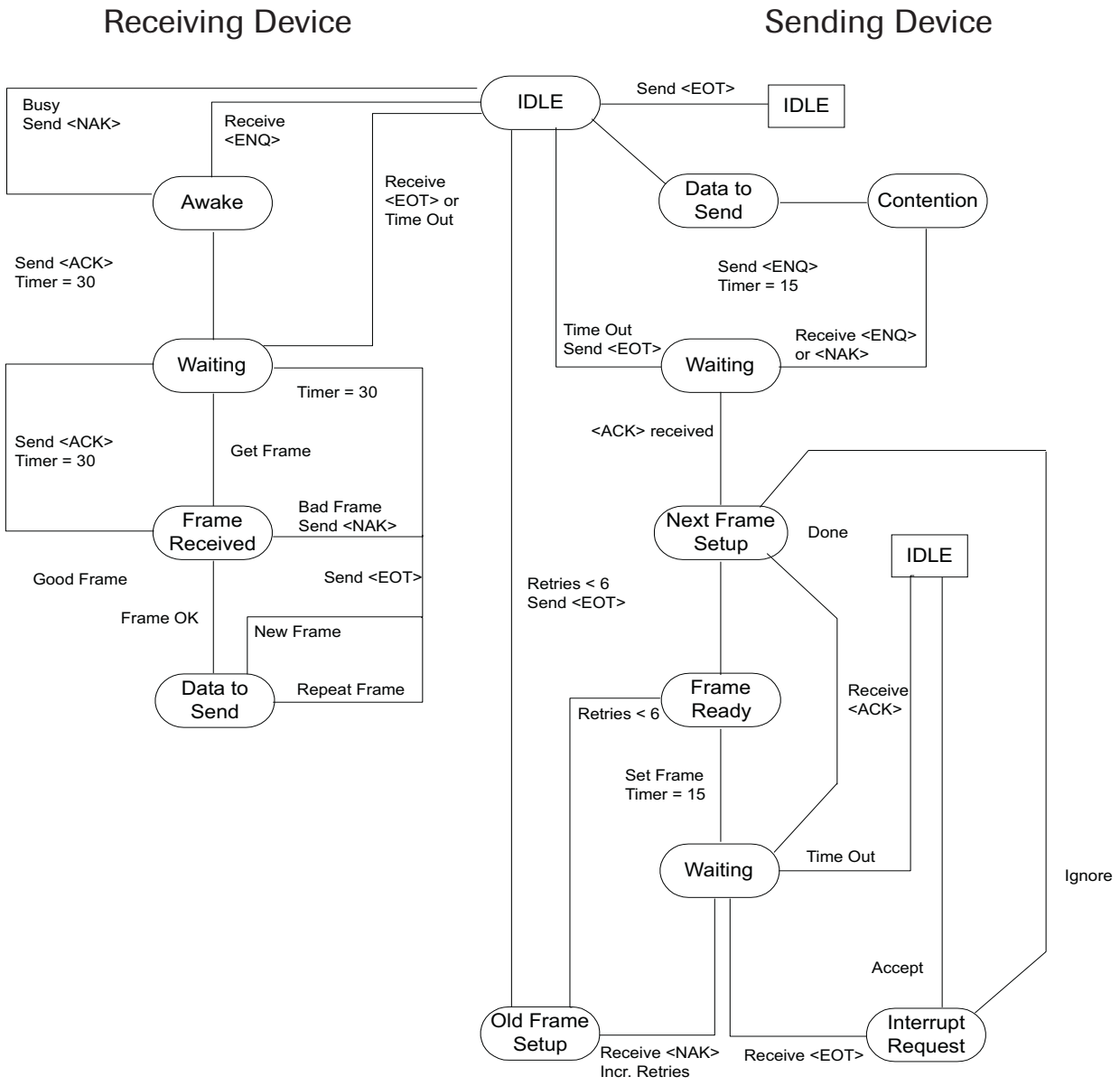

Figure C-1 State Diagram

Data Examples – ASTM 2.0

In this chapter *Chapter* **7**

Measurement Report

```
H|\^&|||GSS^Roche^OMNI S^V5.0^1^115^10.124.67.88||||||M|P|1394-97|20040615184647
P|1||123456|Amex123|Sample^Josephine^X^jr.^M.D.|Good|20691202|Female|Caucasian|1 Draft Avenue,
Omah||+43 316 27787-7349|Trapper John, M.D.|||169.0^cm|72.0^kg|Birth|None|Steak and
Gravy|||20030427103200|Admitted|Third Floor, Delivery|Diag Code123||Catholic|Separated|
Isolation 123|Estonian|Intensive|Maternity Clinic|Dosage 123
O|1|spec123|order123^33^^^^Syringe|||||||||danger123|Clinic123||Aqueous solution^Arterial^A.
femoralis l.
R|1|^^^pH^^^M^1|7.185||7.350^7.450^reference\7.200^7.600^critical|LL||F||oper123||20040615183711
R|2|^^^PO2^^^M^3||mmHg|80.0^100.0^reference\60.0^800.0^critical|A||F
R|3|^^^PCO2^^^M^4||mmHg|35.0^45.0^reference\20.0^60.0^critical|A||F
R|4|^^^Hct^^^M^5||%|35.0^50.0^reference\25.0^65.0^critical|A||F
R|5|^^^Na^^^M^6|118.7|mmol/l|135.0^148.0^reference\125.0^160.0^critical|LL||F
R|6|^^^K^^^M^7||mmol/l|3.50^4.50^reference\2.80^6.00^critical|A||F
R|7|^^^Ca^^^M^8||mmol/l|1.120^1.320^reference\1.050^1.500^critical|A||F
R|8|^^^Cl^^^M^9|85.1|mmol/l|98.0^107.0^reference\80.0^115.0^critical|L||F
R|9|^^^tHb^^^M^10||g/dL|11.5^17.4^reference\8.0^23.0^critical|A||F
R|10|^^^SO2^^^M^11|29.5|%|75.0^99.0^reference\60.0^100.0^critical|LL||F
R|11|^^^O2Hb^^^M^12|48.1|%|95.0^99.0^reference\80.0^100.0^critical|LL||F
R|12|^^^COHb^^^M^13||%| 0.5^ 2.5^reference\ 0.0^10.0^critical|A||F
R|13|^^^MetHb^^^M^14||%| 0.4^ 1.5^reference\ 0.0^ 5.0^critical|A||F
R|14|^^^HHb^^^M^16||%| 1.0^ 5.0^reference\ 0.0^20.0^critical|A||F
R|15|^^^Bili^^^M^17||umol/L| 24^ 149^reference\ 0^ 256^critical|A||F
R|16|^^^Glu^^^M^18|5.4|mmol/l| 3.3^ 6.1^reference\ 2.8^ 7.8^critical|N||F
R|17|^^^Lac^^^M^19|9.5|mmol/l| 0.4^ 2.2^reference\ 0.2^ 5.0^critical|HH||F
R|18|^^^Urea^^^M^24||mmol/l| 2.5^ 6.4^reference\ 0.5^35.7^critical|A||F
R|19|^^^Baro^^^M^31|727.8|mmHg||N||F
R|20|^^^H+^^^C^50|65.3|nmol/L||N||F
R|21|^^^cHCO3^^^C^51||mmol/l||A||F
R|22|^^^ctCO2(P)^^^C^52||mmol/l||A||F
R|23|^^^BE^^^C^53||mmol/l||A||F
R|24|^^^BE(act)^^^C^54||mmol/l||A||F
R|25|^^^BEecf^^^C^55||mmol/l||A||F
R|26|^^^BB^^^C^56||mmol/l||A||F
R|27|^^^SO2(c)^^^C^58||%||A||F
R|28|^^^P50^^^C^59||mmHg||A||F
R|29|^^^FO2Hb^^^C^89|0.481|||N||F
R|30|^^^ctO2^^^C^60|8.3|vol%||N||F
R|31|^^^ctCO2(B)^^^C^61||mmol/l||A||F
R|32|^^^pHst^^^C^62||||A||F
R|33|^^^cHCO3st^^^C^63||mmol/l||A||F
R|34|^^^PAO2^^^C^64||mmHg||A||F
R|35|^^^AaDO2^^^C^65||mmHg||A||F
R|36|^^^a/AO2^^^C^66||%||A||F
R|37|^^^avDO2^^^C^67||vol%||A||F
R|38|^^^RI^^^C^68||%||A||F
R|39|^^^Qs/Qt^^^C^69||%||A||F
R|40|^^^OER^^^C^83||%||A||F
R|41|^^^niCa^^^C^70||mmol/l||A||F
R|42|^^^AG^^^C^71||mmol/l||A||F
R|43|^^^pht^^^C^72|7.185|||N||F
R|44|^^^cHt^^^C^73|65.3|nmol/L||N||F
R|45|^^^PCO2t^^^C^74||mmHg||A||F
```

```
R|46|^^^PO2t^^^C^75||mmHg||A||F
R|47|^^^PAO2t^^^C^76||mmHg||A||F
R|48|^^^AaDO2t^^^C^77||mmHg||A||F
R|49|^^^a/AO2t^^^C^78||%||A||F
R|50|^^^RIt^^^C^79||%||A||F
R|51|^^^Hct(c)^^^C^80||%||A||F
R|52|^^^MCHC^^^C^81||g/dL||A||F
R|53|^^^Osm^^^C^82|262|mOsm/kg||N||F
R|54|^^^BO2^^^C^84||vol%||A||F
R|55|^^^BUN^^^C^85||mg/dL||A||F
R|56|^^^Qt^^^C^86||vol%||A||F
R|57|^^^PFIndex^^^C^88||mmHg||A||F
R|58|^^^ALLEN test^^^I^152|On|||N||F
R|59|^^^Pat.Temp^^^I^155|37.0|C||N||F
R|60|^^^R^^^I^157|0.84|||N||F
R|61|^^^FIO2^^^I^158|0.21|||N||F
R|62|^^^tHb(e)^^^I^171|12.0|g/dL||N||F
R|63|^^^Hb Factor^^^I^172|3.0|||N||F
R|64|^^^24h Urine^^^I^159||ml||N||F
R|65|^^^Vent Mode^^^I^160||||N||F
R|66|^^^VT^^^I^161||l||N||F
R|67|^^^MV^^^I^162||l||N||F
R|68|^^^PIP^^^I^163||cmH2O||N||F
R|69|^^^Ti^^^I^164||s||N||F
R|70|^^^Te^^^I^165||s||N||F
R|71|^^^SRATE^^^I^166||||N||F
R|72|^^^ARATE^^^I^167||||N||F
R|73|^^^PEEP^^^I^168||cmH2O||N||F
R|74|^^^MAP^^^I^169||cmH2O||N||F
R|75|^^^Flow^^^I^170||l/min||N||F
R|76|^^^Age (A/F)^^^I^110|> 1 year|||N||F
R|77|^^^Date drawn^^^I^145|20040615|||N||F
R|78|^^^Time drawn^^^I^146|182500|||N||F
R|79|^^^Date changed^^^I^138|20040615|||N||F
R|80|^^^Time changed^^^I^137|184645|||N||F
R|81|^^^Department^^^I^174|Alpha|||N||F
R|82|^^^Accepted by^^^I^144|Acceptor|||N||F
R|83|^^^Billing code^^^I^173|bill123|||N||F
R|84|^^^Remark^^^I^140|A Remark|||N||F
L|1|N
```

QC Report

```
H|\^&|||GSS^Roche^OMNI S^V5.0^1^115^10.124.67.88||||||QC|P|1394-97|20040615183318
P|1
O|1|||||||||||||||AUTO-TROL PLUS B^1^21723202^aqueous
C|1|I|The Remark|G
R|1|^^^Bili^^^M^615|104|umol/L| 87^ 115|N||F||oper123||20040615182731
R|2|^^^Ca^^^M^603|1.797|mmol/l|1.420^1.720|H||F
R|3|^^^Cl^^^M^601|84.0|mmol/l|81.0^89.0|N||F
R|4|^^^COHb^^^M^611|22.9|%|20.8^25.8|N||F
R|5|^^^Glu^^^M^616|5.5|mmol/l| 4.7^ 6.5|N||F
R|6|^^^Hct^^^M^609|53.6|%|50.0^60.0|N||F
R|7|^^^HHb^^^M^614|18.1|%|16.3^20.3|N||F
R|8|^^^K^^^M^604||mmol/l|2.80^3.20|A||F
R|9|^^^Lac^^^M^617|9.4|mmol/l| 7.2^11.2|N||F
R|10|^^^MetHb^^^M^612|12.0|%|10.6^13.6|N||F
R|11|^^^Na^^^M^600|121.7|mmol/l|117.0^125.0|N||F
R|12|^^^O2Hb^^^M^610|47.0|%|42.2^50.2|N||F
R|13|^^^PCO2^^^M^606||mmHg|61.0^69.0|A||F
R|14|^^^pH^^^M^602|7.201||7.150^7.210|N||F
R|15|^^^PO2^^^M^605||mmHg|39.0^63.0|A||F
R|16|^^^SO2^^^M^608|72.3|%|67.5^75.5|N||F
R|17|^^^tHb^^^M^607|7.8|g/dL|6.9^8.3|N||F
R|18|^^^Urea^^^M^619||mmol/l|20.0^26.0|A||F
L|1|N
```

Patient Demographics Query

By Patient ID

A sample patient information query sent trough **cobas** bge link:

```
H|\^&|||Roche OMNI S Ser.# :119||||||QReq|P|2.2|20071109125601
Q|1|999|||||||||||D
L|1|N
```

A sample answer from the LIS/HIS system to the patient information query:

```
H|\^&|||^LISHIS^1.2^1^0001|||||||P|1394-97|200711091256
P|1||999||Lastname_PatID999^Firstname^Middle||19711111|M|||||||180^cm|80.5^kg
O|1|999|||R|||||||||||||||||||Q
L|1|N
```

By Specimen ID (also known as Sample ID or Accession Number)

A sample patient information query sent trough **cobas** bge link:

```
H|\^&|||Roche OMNI S Ser.# :119||||||PQ|P|2.2|20071109130016
Q|1|^1000|||||||||||D
L|1|N
```

A sample answer from the LIS/HIS system to the patient information query:

```
H|\^&|||^LISHIS^1.2^1^0001||||||PQ|P|1394-97|200711091300
P|1||70555||Lastname_PatID70555^Firstname||19660225|M|||||||174^cm|84.5^kg
O|1|1000|||R|||||||||||||||||||Q
L|1|F
```

Appendix D

Appendix

In this chapter *Chapter* **8**

Table of contents

TCP/IP Connection Settings

Figure D-1 **cobas** bge link status overview window

The TCP/IP connection settings are accessed through the header of the **cobas** bge link status overview window, clicking on Setup, then LIS/HIS connection.

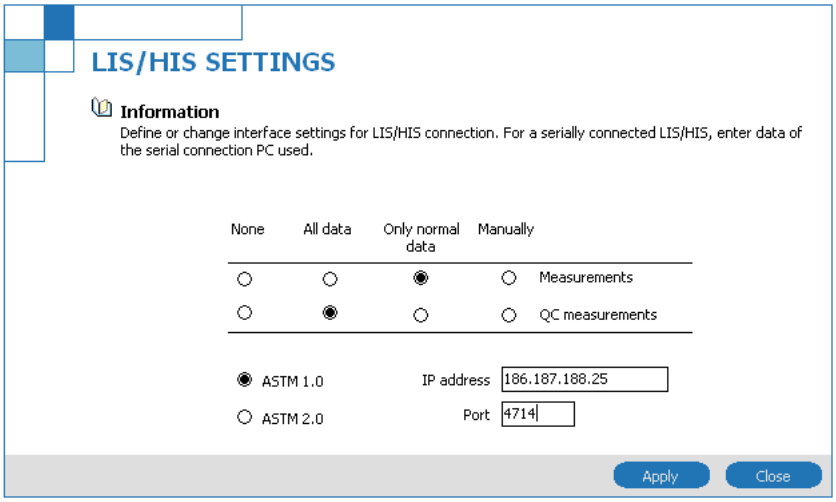

Figure D-2 LIS/HIS settings

The data transmission options can be set as following:

Option	Meaning
None	Data will not be transmitted.
All data	All data will be transmitted automatically.
Only normal data	Only data marked as normal will be transmitted automatically, data marked as abnormal (values out of range/ no values) are sent manually only.
Manually	Data will be transmitted manually only.
ASTM 1.0/2.0	ASTM version selection.

Table D-1 Data transmission options

Note:

To enable the transmission of patient demographic queries and patient demographic data between the connected instruments and the LIS or HIS, at least one option button has to be set to something different than None.

The **IP Address** field contains the IP address of the LIS or HIS host.
The **Port field** contains the IP port number dedicated for the **cobas** bge link message traffic.

After clicking the <Apply> button, the settings are immediately applied. If the IP address and port are correct, the LIS/HIS connection indicator on the Status Overview window will show a checkmark:

Figure D-3 LIS/HIS connection indicator

Otherwise, the "X" will be displayed (no LIS/HIS connection).

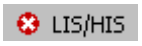

Figure D-4 LIS/HIS connection indicator

Serial Connection Settings

Figure D-5 **cobas** bge link status overview window

From the header of the **cobas** bge link status overview window, click on Setup, then LIS/HIS connection.

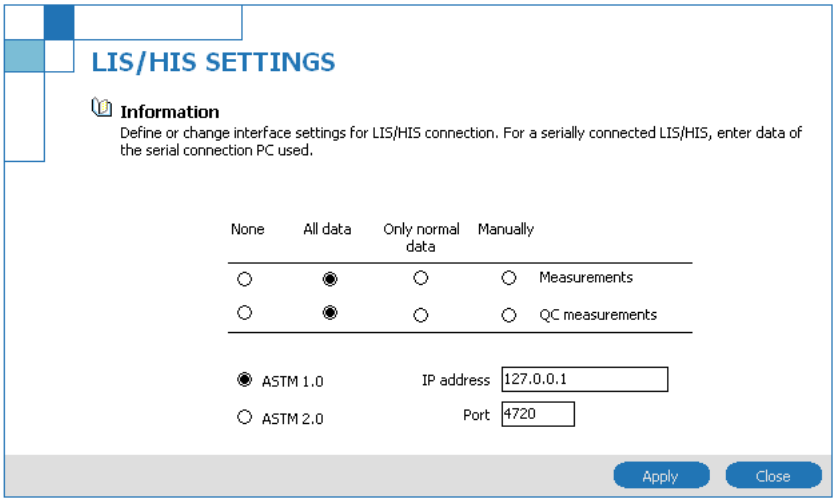

Figure D-6 LIS/HIS settings

The data can be transmitted using the following options:

Option	Meaning
None	Data will not be transmitted.
All data	All data will be transmitted automatically.
Only normal data	Only data marked as normal will be transmitted automatically, data marked as abnormal (values out of range/ no values) are sent manually only.
Manually	Data will be transmitted manually only.
ASTM 1.0/2.0	ASTM version selection.

Table D-2 Data transmission options

Note:

To enable the transmission of patient demographic queries and patient demographic data between the connected instruments and the LIS or HIS, at least one option button has to be set to something different than None.

The **IP Address** field contains the IP address of the PC running the **cobas** bge link Serial Connection Module dedicated for the LIS or HIS host.
The **Port** field has to contain 4720, (SPM port).

After clicking the <Apply> button, the settings are immediately applied.

As the serial connection has not yet been set up on the Serial Connection PC, the LIS/HIS connection indicator on the Status Overview window will show the following symbol:

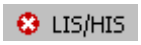

Figure D-7 LIS/HIS connection indicator

At the serial connection PC, double-clicking the Serial Connection icon (see below) in the system tray will open the Serial Port Manager window.

Figure D-8 Serial Connection icon

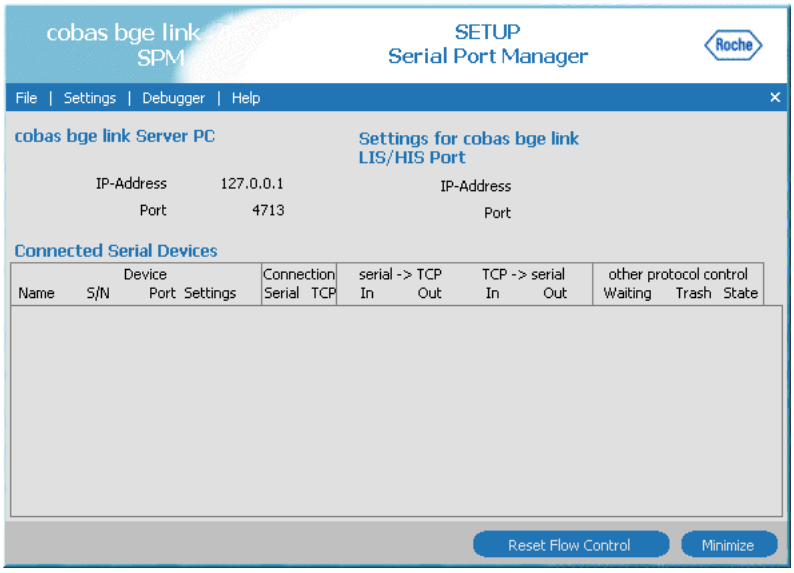

Figure D-9 Serial Port Manager Window

From the menu bar, selecting Settings - Add serial LIS/HIS will open a configuration wizard which guides step by step through the serial settings.

Figure D-10 Wizard - Add serial LIS/HIS

One of the available COM ports has to be selected.

The <Refresh> button checks Windows' COM port settings and updates the display (only unused COM ports are displayed).

Then click the <Next> button.

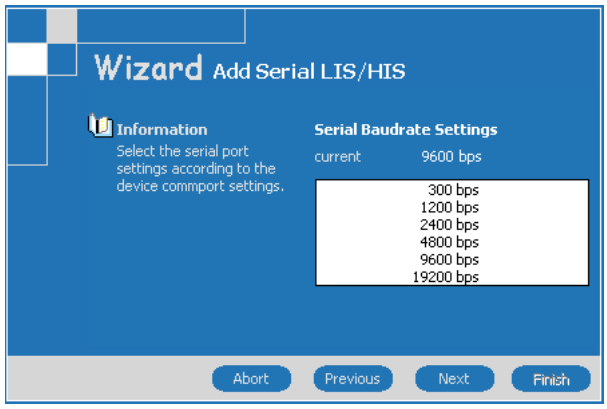

Figure D-11 Wizard - Add serial LIS/HIS

Select a baud rate matching the LIS or HIS host computer COM port baud rate. Then click the <Next> button.

Figure D-12 Wizard - Add serial LIS/HIS

Select parity settings matching the LIS or HIS host computer COM port's. Then click the <Next> button.

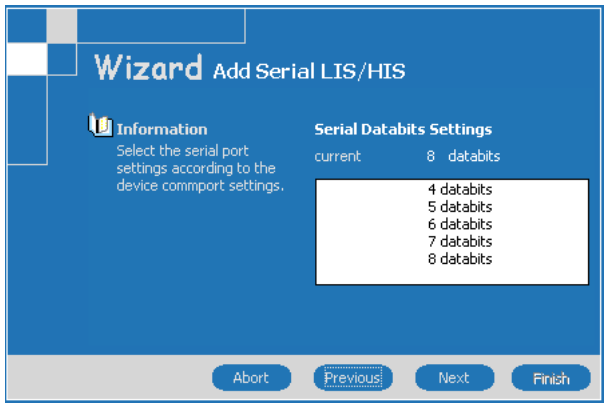

Figure D-13 Wizard - Add serial LIS/HIS

Select a number of data bits matching the LIS or HIS host computer COM port settings. Then click the <Next> button.

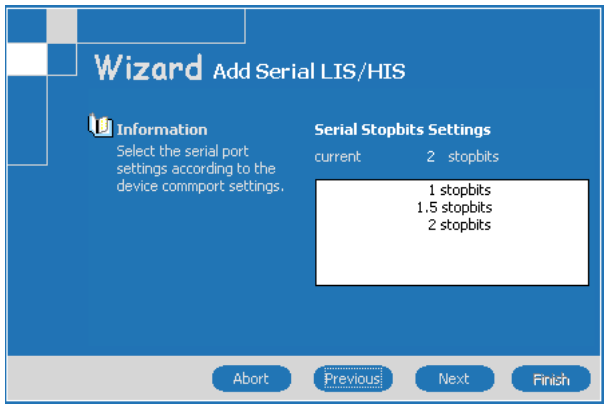

Figure D-14 Wizard - Add serial LIS/HIS

Select a number of stop bits equal to the LIS or HIS host computer COM port settings. Then click the <Next> button.

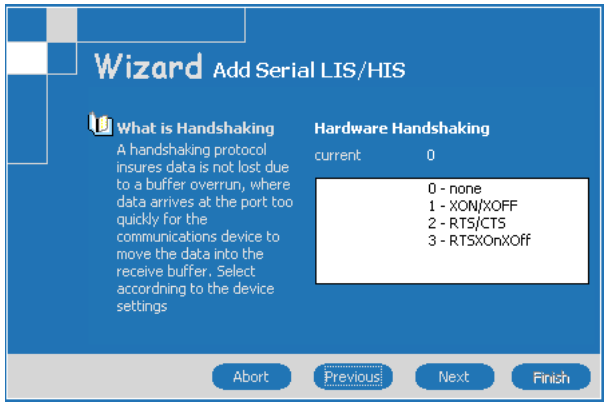

Figure D-15 Wizard - Add serial LIS/HIS

Select a handshake type matching the LIS or HIS host computer COM port handshaking. Then click the <Next> button.

Figure D-16 Wizard - Add serial LIS/HIS

Ensure that the settings displayed match the host computer port settings. Apply the settings by clicking the <Finish> button.

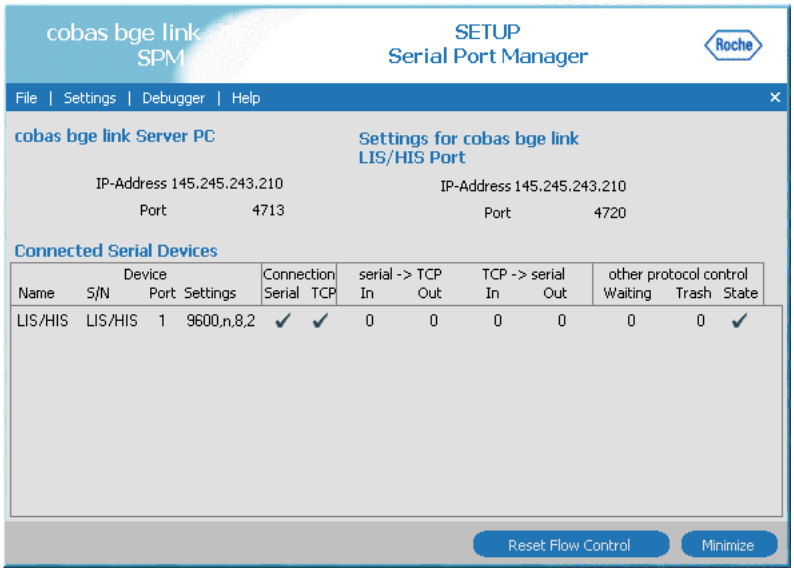

Figure D-17 Serial Port Manager Window

The setup window displays connection statistics and indicators.

In case all settings are correct, you will see only checkmark indicators.

If the IP address and port were entered correctly, the LIS/HIS connection indicator in the Status Overview window will show a checkmark:

Figure D-18 LIS/HIS connection indicator

Otherwise the indicator (see below) will indicate problems in this element of the transmission chain.

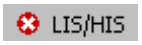

Figure D-19 LIS/HIS connection indicator

The serial connection wizard and the TCP/IP settings have to be run again to fix the settings

Record Termination Settings

To change the record termination character(s), open the file **olChaLIS.ini** in ...\Roche\Diagnostics\OMNILINK\Data\Ini directory (default installation path for English language Windows) on the Connection Server PC.
In the [**action**] section, change the value of the **RecordTerminator** entry from CR (<CR> only) to CRLF (<CR><LF>) and save the changes. The new settings will be applied after the Connection Server module has been restarted.