Description of LIS Communication Protocol for Dymind Hematology Analyzers

1 Communication Protocol Description

1.1 Applicable Model

Instrument model: all 5-part and 3-part hematology analyzers of DYMIND. The MSH-4 field will be different for different instrument models during laboratory information system (LIS) transmission.

Transmission program (vendor name specified by MSH-3): Dymind

Transmission device (instrument model specified by MSH-4): DH56, DH51 and DH53

1.2 Messages Supported by the Interface Protocol

The LIS function provided by the system software is defined in accordance with the High Level Seven (HL7) v2.3.1 standard. The test results obtained on the instrument can be uploaded to the LIS and patient information can be queried in the LIS.

1.3 Underlying Transport-Layer Protocol

The system software transmits messages through Transmission Control Protocol (TCP) persistent connections. The communication process can be divided into three stages: connection, data transmission, and disconnection.

- Connection

  After being started, the system software will actively connect to the LIS server based on the software settings. If the system software fails to connect to the LIS server, it will keep trying. After it connects to the LIS server successfully, the connection will be held to ensure that data can be transmitted at any time. If the connection fails during operation, the system software will attempt to reconnect to the LIS server.

- Data transmission

  Users can send data records in batches on the report, review, and quality control (QC) interfaces. In addition, if the automatic communication function is enabled for counting results, the system software will send communication messages when new sample counting results are generated.

  If ACK synchronization is enabled, messages are sent and received synchronously regardless of batch communication or automatic communication. Specifically, after a message is sent, the next message will not be sent until an acknowledgement message is received within the specified time. If no acknowledgement

message is received within the specified time, the message fails to be sent and will be ignored. Then the next message will be sent.

QC data recording communication is similar to counting result communication. Users can send messages on the QC or QC history review interface. After a QC data message is sent, if an acknowledgement message is received within the specified time, the communication is successful. Otherwise, the communication fails. The next message will be sent after an acknowledgement message is received or the specified time elapses.

The communication of bi-directional LIS query is different. When the system software enables bi-directional LIS communication or saves work orders, or before counting, a query message carrying the sample ID will be sent. The LIS queries sample information according to the sample ID and responds with an HL7 message. The system software fills in the work order information or starts counting according to the response message. After a bi-directional LIS query message is sent, the query fails if no response message is received within 10s.

- Disconnection

  The communication connection will be terminated when the system software is closed. When the software communication settings are modified, the current connection will be terminated and another connection will be set up according to the new settings.

1.4 HL7 Message-Layer Protocol

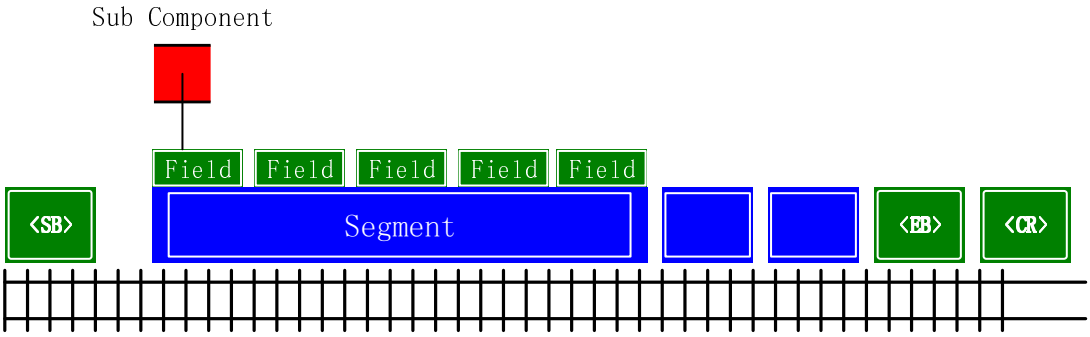
1.4.1 HL7 Upper-Layer Message Protocol

Data including sample results is encoded in Unicode transformation format (8-bit form) (UTF-8) during communication.

According to the HL7 standard, a message contains multiple segments, a segment contains multiple fields, a field contains multiple components, and a component contains multiple sub-components. Segments, fields, components, and sub-components are separated using separators.

Figure 1 shows the structure of an HL7 upper-layer message.

Figure 1 Structure of an HL7 upper-layer message



The following are examples of HL7 messages:

MSH|^~\&|DH56|Dymind|||20140927104252||ORU^R01|d51b54aca4064d20be8084f00850585f|P|2.3.1|||||UNICODEPID|1||05012006^^^^MR||^Zhang San||19991001000000|Male PV1|1|Inpatient|Internal medicine^1^2|||||||||||||||Self-paid OBR|1||5|00001^Automated Count^99MRC||20140918091000|20140918105930|||Dr. Wang||||20140918103000|||||||||HM|||||||developOBX|1|IS|02001^Loading Mode^99MRC||O|||||FOBX|2|IS|02002^Blood Mode^99MRC||W|||||FOBX|3|IS|02003^Test Mode^99MRC||CBC+DIFF|||||FOBX|4|NM|30525-0^Age^LN|||yr|||||FOBX|5|IS|09001^Remark^99MRC|||||||FOBX|6|IS|03001^Ref Group^99MRC||General|||||FOBX|7|NM|6690-2^WBC^LN||5.51|10*9/L|4.00-10.00||||FOBX|8|NM|770-8^NEU%^LN||66.1|%|50.0-70.0||||FOBX|9|NM|736-9^LYM%^LN||28.1|%|20.0-40.0||||FOBX|10|NM|5905-5^MON%^LN||4.4|%|3.0-12.0||||FOBX|11|NM|713-8^EOS%^LN||1.2|%|0.5-5.0||||FOBX|12|NM|706-2^BAS%^LN||0.2|%|0.0-1.0||||F

…

1.4.2 HL7 Lower-Layer Message Protocol

Transmission Control Protocol/Internet Protocol (TCP/IP) is a byte stream protocol that does not provide message boundaries. As an upper-layer protocol, HL7 is based on messages and does not provide a message termination mechanism. The Minimal Lower Layer Protocol (MLLP), which is introduced in *HL7 Interface Standards v2.3.1*, is used to determine message boundaries.

At the communication layer, messages are transmitted in the following format:

<SB>*ddddd*<EB><CR>

Where,

<SB> = Start Block character (1 byte) is a character string. HL7 interface messages are encoded in UTF-8 format.

<SB> indicates ASCII <VT>, that is, <0x0B>. Do not confuse it with ASCII character SOH or STX.

ddddd = Data (variable number of bytes)

ddddd is valid data of an HL7 message and represented as a character string. HL7 interface messages are encoded in UTF-8 format.

<EB> = End Block character (1 byte)

<EB> indicates ASCII <FS>, that is, <0x1C>. Do not confuse it with ASCII character ETX or EOT.

<CR> = Carriage Return (1 byte)

<CR> indicates ASCII carriage return, that is, <0x0D>.

2 Introduction to HL7

2.1 Syntax

2.1.1 Message Composition

An HL7 message consists of segments and each segment ends with <CR>.

A segment consists of a 3-character segment name and a variable number of fields. A field consists of components and sub-components. Separators of fields, components, and sub-components are defined at the message header (MSH) of each message.

For example:

MSH|^~\&|DH56|Dymind|||20140927104252||ORU^R01|d51b54aca4064d20be8084f00850585f|P|2.3.1|||||UNICODE

The five characters following the MSH are used to define the separators for distinguishing fields, components, and sub-components. These characters can be any non-text characters. The characters listed in the following table are recommended in the HL7 standard.

Character	Description
|	Separator of fields
^	Separator of components
&	Separator of sub-components
~	Separator of duplicate items
\	Escape character

The first field of the MSH contains the separators. Some fields behind the MSH are blank because they are optional and are not used in Dymind HL7 interfaces. The fields are described in the following sections.

For any type of message, the segments behind the MSH are arranged in a certain sequence. The subsequent sections describe the sequences based on the following syntax structure:

- Segments in [] are optional.
- Segments in {} can be duplicated for one or more times.

2.1.2 Escape Character

An escape character may be used in field data of the ST, TX, FT or CF type, such as remarks, diagnosis information, and user-defined gender. During encoding, transfer the separator in the original character string into an escape character sequence and recover it during decoding.

The following table lists the rules for transferring character strings used in HL7 interfaces.

Escape Character Sequence	Original Character
\F\	Separator of fields
\S\	Separator of components
\T\	Separator of sub-components
\R\	Separator of duplicate items
\E\	Escape separator

Escape Character Sequence	Original Character
\.br\	<CR>, end of segment

Note: In an escape character sequence, the slash (\) indicates an escape separator and its value is defined in the MSH.

2.2 HL7 Data Types

All data is represented in different types of HL7 fields. Currently, only a part of field types defined in the HL7 standard are used. For details, see appendix I.

3 Duplex Communication

3.1 Supported HL7 Messages

3.1.1 Duplex Communication Process

1. The host sends the test results or QC data to the LIS. See Figure 2.

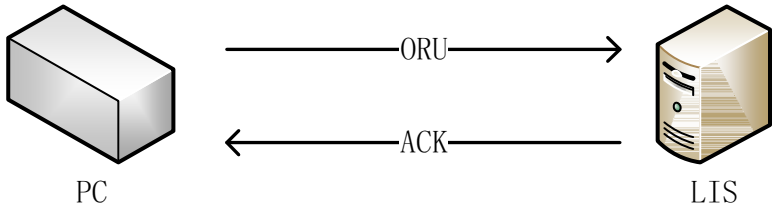


Figure 2 Communication process of sending test results or QC data

In the preceding figure, the ORU event indicates that the PC connecting to the host actively sends the test results to the LIS. Both the test results and QC data can be queried by sending work order information in this way.

2. Work order information can be queried by sending the following HL7 messages: General Order Message (ORM) and General Order Response Message (ORR). Figure 3 shows the communication process.

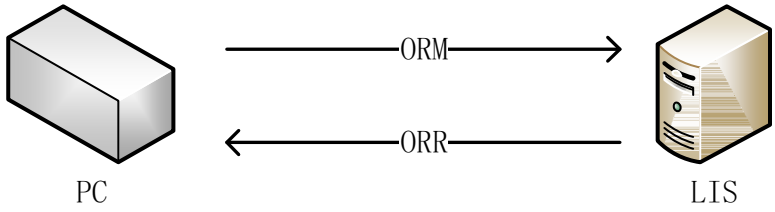


Figure 3 Communication process of querying work order information

3.1.2 Major Messages

- ORU^R01 message

  This message is used to transmit test results and QC data.

  ORU Observational Results (Unsolicited) Description

  MSH: message header, which is mandatory and carries the message ID, sending time, message separator, and encoding format

  {

  PID: basic patient information, including the patient name, gender, medical record number, and date of birth

  [PV1]: medical information, including the patient class, department, bed number, and payment type

  {

  OBR: sample information, including the sample ID, tester, and test time

  {[OBX]}: test data items, including the test parameter results and work mode

  }

  }

- ACK^R01 message

  This message is used to acknowledge the received ORU^R01 message.

  ACK Acknowledgment Description

  MSH: message header

  MSA: message acknowledgement, indicating whether a communication message is received successfully

- ORM^ O01 message

  Generally, for an order message, all actions related to the order will use the same message type, such as creating an order or canceling an order. In this example, the host requests the LIS to refill the order message.

  ORM General Order Message Description

  MSH: message header

  {ORC}: general order information, including the ID of the queried sample

- ORR^O02 message

  This message is the acknowledgement message of ORR^O01 and carries complete information about the work order.

  ORR^O02 General Order Response Message Description

  MSH: message header

  MSA: message acknowledgement

  [PID patient information

  [PV1]] medical information

  {

  ORC: general order information, including the sample ID

  [

  OBR: sample information

  {[OBX]}: other sample information items, including the work mode

]

}

3.2 Definitions of Involved HL7 Message Segments

The fields contained in segments are described below. A row in any of the following table matches a field in a segment. The contents in the tables are described as follows:

- SN

  The HL7 message segment begins with a 3-character segment name. Each field separator is followed with the content of a field. The SN indicates the sequential position of a field in the HL7 message segment.

  For example:

  PID | 1 | |05012006^^^^MR||^Zhang San||19991001000000|Male

  The fields are described as follows:

  PID: segment name

  1: field 1

  05012006^^^^MR: field 3

  Note: MSH message segments may be a little different. In an MSH message segment, the field separator following the segment name is the first field, which describes the value of the field separator used in the message.

- Field Name

  Specifies the logical meaning of a field.

- Data Type

  Specifies the HL7 data type of the field. The structure is described in appendix I.

- Recommended Maximum Length

  Specifies the length recommended in the HL7 standard. In actual message transmission, the length will exceed this value. Therefore, message fields should be read based on separators during message resolution.

- Description

  Specifies the description of the actual field value.

- Example

  Specifies an example field value.

3.2.1 MSH

The MSH segment contains basic information about an HL7 message, including the value of the message separator, message type, and encoding format. The MSH is the first field of every HL7 message.

Example:

MSH|^~\&|DH56|Dymind|||20140927104252||ORU^R01|d51b54aca4064d20be8084f00850585f|P|2.3.1|||||UNICODE

Table 1 defines the fields used in the MSH segment.

Table 1 MSH fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Field Separator	ST	1	The first field separator after the segment name, used to define the values of other field separators.	|
2	Encoding Characters	ST	4	Including the component separator, duplicate item separator, escape separator, and sub-component separator.	^~\&
3	Sending application	EI	180	Sending application. If the host sends messages, the value is **DH56**.	DH56
4	Sending Facility	EI	180	Sending device. The value is **Dymind**.	Dymind
7	Date/Time Of Message	TS	26	Message creation time, in the format of YYYY[MM[DD[HH[MM[SS]]]]]. Its value is the system time.	20140927104252
9	Message Type	CM	7	Message type, in the format of Message type^Event type.	ORU^R01
10	Message Control ID	ST	20	Message control ID, used to uniquely identify a message.	1
11	Processing ID	PT	3	Message processing ID. The value options are as follows: **P**: indicates sample and work order information. **Q**: indicates the QC counting result. In an ACK message, the processing ID is consistent with the received message.	P
12	Version ID	VID	60	HL7 version. Its value is **2.3.1**.	2.3.1

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
18	Character Set	ID	10	Character set. Its value is UNICODE, indicating that communication messages are encoded in UTF-8 format.	UNICODE

3.2.2 MSA

The message acknowledgement (MSA) segment contains message acknowledgement information.

Example:

MSA|AA|0

Table 2 defines the fields used in the MSA segment.

Table 2 MSA fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Acknowledgement Code	ID	2	Acknowledgement code. The value options are as follows: **AA**: message received **AE**: error **AR**: message refused	AA
2	Message Control ID	ST	20	Message control ID, which is the same as that specified by MSH-10 in the received message.	0
6	Error Condition	CE	100	Error condition (status code). The message can be transmitted, or the error condition description can be carried. For details about the error codes, see Table 3.	

Table 3 Error codes of the MSA-6 field

Status Code (MSA-6)	Status Text (MSA-3)	Description
Success status code: AA		
0	Message accepted	Success
Error status code: AE		
100	Segment sequence error	The sequence of segments in the message is wrong, or the

Status Code (MSA-6)	Status Text (MSA-3)	Description
		mandatory segment is missing.
101	Required field missing	The mandatory field of a segment is missing.
102	Data type error	The data type of the field is wrong. For example, the data type is set to character for digits.
103	Table value not found	The table value is not found.
Rejection status code: AR		
200	Unsupported message type	The message type is not supported.
201	Unsupported event code	The event code is not supported.
202	Unsupported processing id	The processing ID is not supported.
203	Unsupported version id	The version ID is not supported.
204	Unknown key identifier	An unknown key identifier is found. For example, an unknown key identifier is used to transmit the information about a patient that does not exist.
205	Duplicate key identifier	The key identifier is duplicate with an existing one.
206	Application record locked	A transaction cannot be executed. For example, the database is locked.
207	Application internal error	An unknown internal application error occurs.

3.2.3 PID

The patient identification (PID) segment contains basic patient information.

Example:

PID|1||05012006^^^^MR||^Zhang San||19991001000000|Male

Table 4 defines the fields used in the MSH segment.

Table 4 PID fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Set ID -PID	SI	4	Set ID, used to identify a PID segment in a message.	1
3	Patient Identifier List	CX	20	It is used as the medical record number in the sample test result message. The format is Medical record number^^^^MR. It is used to represent the QC batch number in a QC message.	05012006^^^^MR
5	Patient	XP N	48	Patient name (including the first name and	Zhang San

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
	Name			last name), in the format of Last name^First name.	
7	Date/Time of Birth	TS	26	It is used to represent the date of birth in a sample result message. The format is YYYY[MM[DD[HH[MM[SS]]]]]. It is used to represent the QC validity period in QC information.	19991001000000
8	Sex	IS	1	Gender of the patient. Its value is a character string.	Male

3.2.4 PV1

The patient visit (PV1) segment contains medical information about a patient.

Example:

PV1|1|Inpatient|Surgical^1^2||||||||||||||||Self-paid

Table 5 describes the fields used in the PV1 segment.

Table 5 PV1 fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Set ID -PV1	SI	4	Set ID, used to identify a PV1 segment in a message.	1
2	Patient Class	IS	1	Patient class. Its value is a character string and the content is not limited.	Inpatient
3	Assigned Patient Location	PL	80	Patient location, represented in the format of Department^Room^Bed number.	Internal medicine
20	Financial Class	FC	50	Financial class. Its value is a character string and the content is not limited.	Self-paid

3.2.5 OBR

The observation request (OBR) segment contains the test report.

Example:

OBR|1||5|00001^Automated Count^99MRC||20140918091000|20140918105930|||Dr. Wang||||20140918103000|||||||||HM|||||||develop

Table 6 describes the fields used in the OBR segment.

Table 6 OBR fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Set ID - OBR	SI	10	Set ID, used to identify an OBR segment in a message.	1
2	Placer Order Number	EI	22	Used as the sample ID, that is, ORC^O02, in the response to a work order query message.	
3	Filler Order Number +	EI	22	Used as the sample ID in a sample test result message, or used as the file ID in a QC message.	20140918091000
4	Universal Service ID	CE	200	Universal service ID, used to identify the counting result type. For details about the values, see appendix II.	00001^Automate d Count^99MRC
6	Requested Date/time	TS	26	Request time. It is used to represent the sampling time.	20140918091000
7	Observation Date/Time #	TS	26	Test time.	20140918105930
10	Collector Identifier *	XC N	60	Sample collector. In this example, it is used to represent the person that takes the sample for testing.	Dr. Wang
13	Relevant Clinical Info.	ST	300	Clinical information. It can be used to represent clinical diagnosis information in the patient information.	
14	Specimen Received Date/Time *	TS	26	Sample receiving time. It is used to represent the time when the sample is submitted for testing.	20140918103000
15	Specimen Source *	CM	300	Sample source. In an HL7 message, its value is BLDV, which indicates venous blood, or BLDC, which indicates peripheral blood.	
22	Results Rpt/Status Chng -Date/Time +	TS	26	Result report or status change time. It is used to represent the approval time.	
24	Diagnostic Serv Sect ID	ID	10	Diagnostic section ID. The value is HM, which indicates hematology.	HM

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
28	Result Copies To	XC N	60	Recipient of result copies. It represents the sample approver.	
32	Principal Result Interpreter +	CM	200	Principal result interpreter. It is used to represent the tester in a sample message, or the operator in a QC counting message.	develop

3.2.6 OBX

The observation/result (OBX) segment contains the test result parameters.

Example:

OBX|7|NM|6690-2^WBC^LN||5.51|10*9/L|4.00-10.00||||F

Table 7 defines the fields used in the OBX segment.

Table 7 OBX fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	Set ID -OBX	SI	10	Set ID, used to identify an OBX segment in a message.	7
2	Value Type	ID	3	Data type of the test results. The value options include **ST**, **NM**, **ED** and **IS**.	NM
3	Observation Identifier	CE	590	Test item identifier. The format is ID^Name^EncodeSys, where ID indicates the test item identifier, Name indicates the description of the test item, and EncodeSys indicates the encoding system. For details about the values of test item codes, see the configuration file and appendix II. Note: ID and EncodeSys uniquely identify a test parameter, and Name specifies the description information and	6690-2^WBC^LN

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
				therefore cannot be used for identification.	
5	Observation Value	*	6553 5	Test result data. It can be digits, character strings, enumerated values, or binary data. For details, see appendix II. Binary data including histograms and scattergrams is encoded in Base64 format. For details about the Base64 encoding format, see appendix III.	5.51
6	Units	CE	90	Test unit. The International Organization for Standardization (ISO) unit is used. For details about the units used in communication, see appendix II.	10*9/L
7	References Range	ST	90	Test result range. Three formats are available: Upper reference limit-lower reference limit < Upper reference limit > Lower reference limit	4.00-10.00
8	Abnormal Flags	ID	5	Test result flag. The value options are as follows: **N**: indicates that the test result is normal. **A**: indicates that the test result is abnormal. **H**: indicates that the test result exceeds the upper reference limit. **L**: indicates that the test result is lower than the lower reference limit. Note: The abnormal flag and high or low alarm flag may exist concurrently. Multiple flags are separated with ~, for example, H~A.	

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
11	Observ Result Status	ID	1	Test result status. The value F indicates the final result.	F

3.2.7 ORC

The common order (ORC) segment contains general order information.

Example:

ORC|RF||SampleID||IP

Table 7 describes the fields used in the ORC segment.

Table 7 ORC fields

SN	Field Name	Data Type	Recommended Maximum Length	Description	Example
1	OrderControl	ID	2	Order control field. Its value is RF in an ORM message, indicating refilling the order request, and is AF in an ORR message, indicating order refilling confirmation.	RF
2	Placer Order Number	EI	22	Number of the party that places the order. Its value is blank in an ORM message, and is the sample ID in an ORR message.	
3	Filler OrderNum	EI	22	Number of the order receiver. Its value is the sample ID in an ORM message, and is blank in an ORR message.	SampleID
5	Order Status	ID	2	Order status. Its value is always IP in an ORM message, indicating that the order is being processed and no result is obtained, and is blank in an ORR message.	IP

3.3 Message Examples

The following messages set an example of the sample data communication process.

3.3.1 Sample Message Example

- Sample message

MSH|^~\&|BC-6800|Mindray|||20140927131905||ORU^R01|2849dc32654641d2b5c8ae229cf4f061|P|2.3.1|||||UNICODE
PID|1||05012006^^^^MR||^Zhang San||19991001000000|Male
PV1|1|Inpatient|Internal medicine^1^2|||||||||||||||Self-paid
OBR|1||5|00001^Automated Count^99MRC||20140918091000|20140918105930|||Dr. Wang||||20140918103000|||||||||HM|||||||develop
OBX|1|IS|02001^Loading Mode^99MRC||O|||||F
OBX|2|IS|02002^Blood Mode^99MRC||W|||||F
OBX|3|IS|02003^Test Mode^99MRC||CBC+DIFF|||||F
OBX|4|NM|30525-0^Age^LN||15|yr|||||F
OBX|5|IS|09001^Remark^99MRC|||||||F
OBX|6|IS|03001^Ref Group^99MRC||Adult male|||||F
OBX|7|NM|6690-2^WBC^LN||5.51|10*9/L|4.00-10.00||||F
OBX|8|NM|770-8^NEU%^LN||66.1|%|50.0-70.0||||F
OBX|9|NM|736-9^LYM%^LN||28.1|%|20.0-40.0||||F
OBX|10|NM|5905-5^MON%^LN||4.4|%|3.0-12.0||||F
OBX|11|NM|713-8^EOS%^LN||1.2|%|0.5-5.0||||F
OBX|12|NM|706-2^BAS%^LN||0.2|%|0.0-1.0||||F
OBX|13|NM|751-8^NEU#^LN||3.65|10*9/L|2.00-7.00||||F
OBX|14|NM|731-0^LYM#^LN||1.55|10*9/L|0.80-4.00||||F
OBX|15|NM|742-7^MON#^LN||0.24|10*9/L|0.12-1.20||||F
OBX|16|NM|711-2^EOS#^LN||0.06|10*9/L|0.02-0.50||||F
OBX|17|NM|704-7^BAS#^LN||0.01|10*9/L|0.00-0.10||||F
OBX|18|NM|26477-0^*ALY#^LN||0.02|10*9/L|0.00-0.20||||F
OBX|19|NM|13046-8^*ALY%^LN||0.3|%|0.0-2.0||||F
OBX|20|NM|10000^*LIC#^99MRC||0.00|10*9/L|0.00-0.20||||F
OBX|21|NM|10001^*LIC%^99MRC||0.0|%|0.0-2.5||||F
OBX|22|NM|789-8^RBC^LN||4.57|10*12/L|4.00-5.50||||F
OBX|23|NM|718-7^HGB^LN||156|g/L|120-160||||F
OBX|24|NM|4544-3^HCT^LN||47.8|%|40.0-54.0||||F
OBX|25|NM|787-2^MCV^LN||104.5|fL|80.0-100.0||||F
OBX|26|NM|785-6^MCH^LN||34.2|pg|27.0-34.0||||F
OBX|27|NM|786-4^MCHC^LN||327|g/L|320-360||||F
OBX|28|NM|788-0^RDW-CV^LN||12.9|%|11.0-16.0||||F
OBX|29|NM|21000-5^RDW-SD^LN||58.0|fL|35.0-56.0||||F
OBX|30|NM|777-3^PLT^LN||181|10*9/L|100-300||||F
OBX|31|NM|32623-1^MPV^LN||10.1|fL|6.5-12.0||||F
OBX|32|NM|32207-3^PDW^LN||15.7||15.0-17.0||||F
OBX|33|NM|10002^PCT^99MRC||0.183|%|0.108-0.282||||F
OBX|34|IS|17790-7^WBC Left Shift?^LN||T|||||F
OBX|35|NM|15001^WBC Histogram. Left Line^99MRC||16|||||F
OBX|36|NM|15003^WBC Histogram. Middle Line^99MRC||77|||||F
OBX|37|ED|15008^WBC Histogram. BMP^99MRC||^Image^BMP^Base64^……WBC histogram bitmap data…|||||F
OBX|38|NM|15051^RBC Histogram. Left Line^99MRC||28|||||F
OBX|39|NM|15052^RBC Histogram. Right Line^99MRC||245|||||F
OBX|40|ED|15056^RBC Histogram. BMP^99MRC||^Image^BMP^Base64^……RBC histogram bitmap data…|||||F

OBX|41|NM|15111^PLT Histogram. Left Line^99MRC||5|||||F

OBX|42|NM|15112^PLT Histogram. Right Line^99MRC||56|||||F

OBX|43|ED|15116^PLT Histogram. BMP^99MRC||^Image^BMP^Base64^……PLT histogram bitmap data…|||||F

OBX|44|ED|15200^WBC DIFF Scattergram. LS-MS BMP^99MRC||^Image^BMP^Base64^……Diff scattergram bitmap LS-MS data…|||||F

OBX|45|ED|15201^WBC DIFF Scattergram. LS-HS BMP^99MRC||^Image^BMP^Base64^……Diff scattergram bitmap LS-HS data…|||||F

OBX|46|ED|15202^WBC DIFF Scattergram. HS-MS BMP^99MRC||^Image^BMP^Base64^……Diff scattergram bitmap HS-MS data…|||||F

OBR|2||5|00002^Manual Count^99MRC

- Sample response message

A sample response message must be returned each time a sample result is received. A sample response message contains two segments: MSH and MSA. In a correct response message, the MSH-9 field is set to ACK^R01, indicating that the type of this message is sample response message. The value of the MSA-2 field is the same as that of the MSH-10 field in the received counting result, indicating the counting result that the response message matches. In this example, the value of MSA-2 is 1.

MSH|^~\&|DH56|Dymind|||20140927104252||ACK^R01|d51b54aca4064d20be8084f00850585f |P|2.3.1|||||UNICODE

MSA|AA|1

3.3.2 QC Message Example

- QC request message

The content and format of a QC message are different from those of a sample counting result message. In a QC message, the value of MSH-11 is Q, indicating that the message type is QC data. A QC message matches a QC point in the system software. A QC message may contain multiple counting results. For example, an L-J QC message contains a single counting result whereas an X-R QC message may contain two counting results and the average counting result.

A QC message consists of an MSH and multiple counting results. Each counting result begins with the PID and OBR segments that contain the sample information, followed by multiple OBX segments, which carry the result parameters and other information.

In each counting result, the OBR-4 field indicates the type of the counting result, which may be an X-R counting result, the average value of the X-R counting results, or an L-J counting result. For details, see appendix II.

- QC response message

A QC response message differs from a counting result response message only in the value of MSH-11, which is Q.

The following is an ACK message of an X-R QC message:

MSH|^~\&|DH56|Dymind|||20140927104252||ACK^R01|d51b54aca4064d20be8084f00850585f |Q|2.3.1|||||UNICODE

MSA|AA|1

3.3.3 Example of Bi-directional LIS Query Request

- Bi-directional LIS query request

  A bi-directional LIS query request contains the sample ID. After receiving the request, the LIS queries the patient and sample information based on the sample ID, and returns the query results.

  A query request contains two segments: MSH and ORC. The MSH in a query request is basically the same as that in a sample counting result message. The only difference is that the value of MSH-9 is ORM^O01. ORC-3 specifies the recipient number. Its value is the sample ID in this example, that is, **SampleID1**. The value of the sample ID is **Invalid** if an error occurs in scanning the internal barcode when querying the automatic loading counting result.

  The following is an example of the query result:

  MSH|^~\&|DH56|Dymind|||20140910083000||ORM^O01|4|P|2.3.1|||||UNICODE

  ORC|RF||SampleID1||IP

- Bi-directional LIS query response
- After receiving a query request, the LIS must return a query result response message. The first two segments of a query response message are MSH and MSA. The value of MSH-9 is ORR^O02. For details about setting fields of the MSA segment, see the description of the sample response message. If the query is successful, the response message will contain the PID, PV1, ORC, OBR and OBX segments, which describe the patient and sample information. The information description method is the same as that in sample data communication messages. In a query success message, the ORC segment is mandatory. The value of ORC-1 is **AF**, and the value of ORC-2 is the sample ID. OBR-2 specifies the sample ID and its value must be consistent with that of ORC-2. Otherwise, a message error will be reported.
- MSA-2 specifies the response result. In this example, its value is **AR**, indicating that the query request is rejected. Its value can also be **AE**, indicating that an error occurs in processing the query request.

4 Appendix I HL7 Data Types

- CE - Code Element

  <identifier (ST)> ^ <text (ST)> ^ <name of coding system (ST)> ^ <alternate identifier (ST)> ^ <alternate text (ST)> ^ <name of alternate coding system (ST)>

- CM - Composite

  The format is defined by a specific field.

  CX - Extended composite ID with check digit

<ID (ST)> ^ <check digit (ST)> ^ <code identifying the check digit scheme employed (ID)> ^ < assigning authority (HD)> ^ <identifier type code (IS)> ^ < assigning facility (HD)>

- ED – Encapsulate Data

  <source application(HD)> ^ <type of data(ID)> ^ <data sub type(ID)> ^ <encoding(ID)> ^ <data(ST)>

- EI - Entity Identifier

  <entity identifier (ST)> ^ <namespace ID (IS)> ^ <universal ID (ST)> ^ <universal ID type(ID)>

- FC – Financial Class

  <financial class(IS)> ^ <effective date(TS)>

- HD - Hierarchic designator

  <namespace ID (IS)> ^ <universal ID (ST)> ^ <universal ID type (ID)>

  Used only as a part of EI and other data types

- FT - Formatted text

  This data type is derived from the string data type by allowing the addition of embedded formatting instructions. These instructions are limited to those that are intrinsic and independent of the circumstances under which the field is being used.

- IS - Coded value for user-defined tables

  The value of such a field follows the formatting rules for an ST field except that it is drawn from a site-defined (or user-defined) table of legal values. There shall be an HL7 table number associated with IS data types.

- ID - Coded values for HL7 tables

  The value of such a field follows the formatting rules for an ST field except that it is drawn from a table of legal values. There shall be an HL7 table number associated with ID data types.

- NM - Numeric

  A number represented as a series of ASCII numeric characters consisting of an optional leading sign (+ or -), the digits and an optional decimal point.

- PL - Person location

  <point of care (IS)> ^ <room (IS)> ^ <bed (IS)> ^ <facility (HD)> ^ < location status (IS)> ^ <person location type (IS)> ^ <building (IS)> ^ <floor (IS)> ^ <location description (ST)>

- PT - Processing type

  <processing ID (ID)> ^ <processing mode (ID)>

- SI - Sequence ID

  A non-negative integer in the form of an NM field. The uses of this data type are defined in the chapters defining the segments and messages in which it appears.

- ST – String

  TS - Time stamp

  YYYY[MM[DD[HHMM[SS[.S[S[S[S]]]]]]]][+/-ZZZZ] ^ <degree of precision>

- XCN - Extended composite ID number and name

  In Version 2.3, use instead of the CN data type. <ID number (ST)> ^ <family name (ST)>&<last_name_prefix (ST) ^ <given name (ST)> ^ <middle initial or name (ST)> ^ <suffix (e.g., JR or III) (ST)> ^ <prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (ST)> ^ <source table (IS)> ^ <assigning authority (HD)> ^ <name type code (ID)> ^ <identifier check digit (ST)> ^ <code identifying the check digit scheme employed (ID)> ^ <identifier type code (IS)> ^ <assigning facility (HD)> ^ <name representation code (ID)>

- XPN - Extended person name

  In Version 2.3, replaces the PN data type. <family name (ST)> ^ <given name (ST)>&<last_name_prefix (ST)> ^ <middle initial or name (ST)> ^ <suffix (e.g., JR or III) (ST)> ^ <prefix (e.g., DR) (ST)> ^ <degree (e.g., MD) (IS)> ^ <name type code (ID) > ^ <name representation code (ID)>

- VID - Version identifier

  <version ID (ID)> ^ <internationalization code (CE)> ^ <international version ID (CE)>

5 Appendix II Message Codes

In HL7 communication messages, the universal service ID (OBR-4) field is used to identify the type of the test result, which may be sample test result, microscopic test result, or QC counting result, in the format of ID^Name^EncodeSys. Table 8 lists all codes of the OBR-4 field.

Table 8 OBR-4 codes

Data Item	Code (ID)	Name	Encoding System
Counting result	01001	Automated Count	99MRC
Microscopic test result	01002	Manual Count	99MRC
L-J QC counting result	01003	LJ QCR	99MRC
X-B QC counting result	01004	XB QCR	99MRC

Each OBX segment contains the information about a test parameter or other data items. The information consists of the following fields:

- OBX2: specifies the HL7 data type of the carried data item.
- OBX-3 (observation identifier): specifies the identifier of the data item, in the format of ID^Name^EncodeSys.
- OBX-5: specifies the value of the data item.
- OBX-6: specifies the unit of the test parameter, which is an ISO unit.

Table 9 lists the HL7 data types and codes of all communicate data items. Table 10 lists all used communication parameter units.

Table 9 Data item types and encoding systems

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
Other Data Items					
Take mode	IS	02001	Take mode	99MRC	02001^Loading Mode^99MRC
Blood mode	IS	02002	Blood Mode	99MRC	02002^Blood Mod e^99MRC
Test mode	IS	02003	Test Mode	99MRC	02003^Test Mode ^99MRC
Age	NM	30525-0	Age	LN	30525-0^Age^LN
Reference group	IS	03001	Ref Group	99MRC	03001^Ref Group ^99MRC
Remarks	IS	09001	Remark	99MRC	09001^Remark^99 MRC
QC level	IS	31001	Qc Level	99MRC	31001^Qc Level^99MRC
Test Result Data Items					
WBC	NM	6690-2	WBC	LN	6690-2^WBC^LN
BAS#	NM	704-7	BAS#	LN	704-7^BAS#^LN
BAS%	NM	706-2	BAS%	LN	706-2^BAS%^LN
NEU#	NM	751-8	NEU#	LN	751-8^NEU#^LN
NEU%	NM	770-8	NEU%	LN	770-8^NEU%^LN
EOS#	NM	711-2	EOS#	LN	711-2^EOS#^LN
EOS%	NM	713-8	EOS%	LN	713-8^EOS%^LN
LYM#	NM	731-0	LYM#	LN	731-0^LYM#^LN
LYM%	NM	736-9	LYM%	LN	736-9^LYM%^LN
MON#	NM	742-7	MON#	LN	742-7^MON#^LN
MON%	NM	5905-5	MON%	LN	5905-5^MON%^LN
ALY#	NM	26477-	*ALY#	LN	26477-0^*ALY#^L N

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
		0			
ALY%	NM	13046-8	*ALY%	LN	13046-8^*ALY%^L N
LIC# (large immature cell)	NM	11001	*LIC#	99MRC	11001^*LIC#^99M RC
Percentage of large immature cells	NM	11002	*LIC%	99MRC	11002^*LIC%^99M RC
RBC	NM	789-8	RBC	LN	789-8^RBC^LN
HGB	NM	718-7	HGB	LN	718-7^HGB^LN
MCV	NM	787-2	MCV	LN	787-2^MCV^LN
MCH	NM	785-6	MCH	LN	785-6^MCH^LN
MCHC	NM	786-4	MCHC	LN	786-4^MCHC^LN
RDW-CV	NM	788-0	RDW-CV	LN	788-0^RDW-CV^LN
RDW-SD	NM	21000-5	RDW-SD	LN	21000-5^RDW-SD^ LN
HCT	NM	4544-3	HCT	LN	4544-3^HCT^LN
PLT	NM	777-3	PLT	LN	777-3^PLT^LN
MPV	NM	32623-1	MPV	LN	32623-1^MPV^LN
PDW	NM	32207-3	PDW	LN	32207-3^PDW^LN
PCT	NM	11003	PCT	99MRC	11003^PCT^99MRC
PLCR	NM	48386-7	P-LCR	LN	48386-7^P-LCR^LN
PLCC	NM	34167-7	P-LCC	LN	34167-7^P-LCC^LN
GRAN-X	NM	11004	GRAN-X	99MRC	11004^GRAN-X^99MRC
GRAN-Y	NM	11005	GRAN-Y	99MRC	11005^GRAN-Y^99MRC
GRAN-Z	NM	11006	GRAN-Z	99MRC	11006^GRAN-Z^99MRC
W-MCV	NM	11007	W-MCV	99MRC	11007^W-MCV^99MRC
CRP	NM	71426-1	CRP	LN	71426-1^CRP^LN
GRAN#	NM	19023-1	GRAN#	LN	19023-1^GRAN#^LN
GRAN %	NM	20482-	GRAN %	LN	20482-6^GRAN%^LN

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
		6			
MID#	NM	32154-7	MID#	LN	32154-7^MID#^LN
MID%	NM	32155-4	MID%	LN	32155-4^MID%^LN
Microscopic Test Results and Relevant Data					
Blood type	ST	882-1	Blood Type	LN	882-1^Blood Typ e^LN
Erythrocyte sedimentation rate (ESR)	NM	30341-2	ESR	LN	30341-2^ESR^LN
White blood cell (WBC) morphology	ST	11156-7	WBC Morphology	LN	11156-7^WBC Morphology^LN
Red blood cell (RBC) morphology	ST	6742-1	RBC Morphology	LN	6742-1^RBC Morphology^LN
Platelet morphology	ST	11125-2	PLT Morphology	LN	11125-2^PLT Morphology^LN
Neutrophilic segmented granulocyte	NM	769-0	Neuts Seg%. Manual	LN	769-0^Neuts Seg%. Manual^LN
Neutrophilic segmented granulocyte	NM	764-1	Neuts Band%. Manual	LN	764-1^Neuts Band%. Manual^LN
Lymphocytes	NM	737-7	Lymphocytes %. Manual	LN	737-7^Lymphocyt es%. Manual^LN
Monocyte	NM	744-3	Monocytes%. Manual	LN	744-3^Monocytes%. Manual^LN
Eosinophils	NM	714-6	Eosinophils %. Manual	LN	714-6^Eosinophi ls%. Manual^LN
Basophils	NM	707-0	Basophils%. Manual	LN	707-0^Basophils %. Manual^LN
Atypical lymphocyte	NM	29261-5	Abnormal Lymphs%. Manual	LN	29261-5^Abnorma l Lymphs%. Manual^LN
Myeloblast	NM	747-6	Myeloblasts %. Manual	LN	747-6^Myeloblas ts%. Manual^LN
Promyelocyte	NM	783-1	Promyelocyt es%. Manual	LN	783-1^Promyeloc ytes%. Manual^LN

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
Myelocyte	NM	749-2	Myelocytes% . Manual	LN	749-2^Myelocyte s%. Manual^LN
MetaMyelocyte	NM	740-1	Metamyelocy te%. Manual	LN	740-1^Metamyelo cyte%. Manual^LN
Prolymphocytes	NM	6746-2	Prolymphocy tes%. Manual	LN	6746-2^Prolymph ocytes%. Manual^LN
Promonocytes	NM	13599-6	Promonocyte s%. Manual	LN	13599-6^Promono cytes%. Manual^LN
Reticulocyte	NM	31112-6	Reticulocyt es%. Manual	LN	31112-6^Reticul ocytes%. Manual^LN
NRBCS	NM	18309-5	NRBCs%. Manual	LN	18309-5^NRBCs%. Manual^LN
Undefined cells	NM	21001	Undefined Cells%. Manual	99MRC	21001^Undefined Cells%. Manual^99MRC
Other abnormal cells	NM	21002	Other Abnormal Cells%. Manual	99MRC	21002^Other Abnormal Cells%. Manual^99MRC
Plasmacyte	NM	21003	Plasmacyte%. Manual	99MRC	21003^Plasmacyte%. Manual ^99MRC
Eosinophilic myelocyte	NM	21004	Eosinophilic myelocyte%. Manual	99MRC	21004^Eosinophilic myelocyte%. Manual ^99MRC
Basophilic myelocyte	NM	21005	Basophilic myelocyte%. Manual	99MRC	21005^Basophilic myelocyte%. Manual ^99MRC
Eosinophilic metamyelocyte	NM	21006	Eosinophilic metamyelocyte%. Manual	99MRC	21006^Eosinophilic metamyelocyte%. Manual ^99MRC
Basophilic metamyelocyte	NM	21007	Basophilic metamyelocyte%. Manual	99MRC	21007^Basophilic metamyelocyte%. Manual ^99MRC
Intermediate Data of Test Results (WBC, RBC and PLT Histogram and Scattergram Data)					
Left line of WBC histogram	NM	12001	WBC Histogram. Left Line	99MRC	12001^WBC Histogram. Left Line^99MRC
Right line of WBC histogram	NM	12002	WBC Histogram. Right Line	99MRC	12002^WBC Histogram. Right Line^99MRC
WBC histogram bitmap data	ED	12003	WBC Histogram. BMP	99MRC	12003^WBC Histogram. BMP^99MRC
Left line of RBC	NM	12051	RBC Histogram.	99MRC	12051^RBC Histogram. Left

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
histogram			Left Line		Line^99MRC
Right line of RBC histogram	NM	12052	RBC Histogram. Right Line	99MRC	12052^RBC Histogram. Right Line^99MRC
RBC histogram bitmap data	ED	12053	RBC Histogram. BMP	99MRC	12053^RBC Histogram. BMP^99MRC
Left line of PLT histogram	NM	12101	PLT Histogram. Left Line	99MRC	12101^PLT Histogram. Left Line^99MRC
Right line of PLT histogram	NM	12102	PLT Histogram. Right Line	99MRC	12102^PLT Histogram. Right Line^99MRC
PLT histogram bitmap data	ED	12103	PLT Histogram. BMP	99MRC	12103^PLT Histogram. BMP^99MRC
DIFF scattergram bitmap data LS-MS	ED	12151	WBC DIFF Scattergram. LS-MS BMP	99MRC	12151^WBC DIFF Scattergram. LS-MS BMP ^99MRC
DIFF scattergram bitmap data LS-HS	ED	12152	WBC DIFF Scattergram. LS-HS BMP	99MRC	12152^ WBC DIFF Scattergram. LS-HS BMP ^99MRC
DIFF scattergram bitmap data HS-MS	ED	12153	WBC DIFF Scattergram. HS-MS BMP	99MRC	12153^ WBC DIFF Scattergram. HS-MS BMP ^99MRC
BASO scattergram bitmap data LS-MS	ED	12154	BASO DIFF Scattergram. LS-MS BMP	99MRC	12154^ BASODIFF Scattergram. LS-MS BMP ^99MRC
BASO scattergram bitmap data LS-HS	ED	12155	BASO DIFF Scattergram. LS-HS BMP	99MRC	12155^ BASODIFF Scattergram. LS-HS BMP ^99MRC
BASO scattergram bitmap data HS-MS	ED	12156	BASO DIFF Scattergram. HS-MS BMP	99MRC	12156^ BASODIFF Scattergram. HS-MS BMP ^99MRC
Alarm Information					
Leucocytosis	IS	13101	Leucocytosis	99MRC	13101^Leucocytosis^99MRC
Leucopenia	IS	13102	Leucopenia	99MRC	13102^Leucopeni a^99MRC
Neutrophilia	IS	13103	Neutrophilia	99MRC	13103^Neutrophilia^99MRC
Neutropenia	IS	13104	Neutropenia	99MRC	13104^Neutropenia^99MRC
Lymphocytosis	IS	13105	Lymphocytosis	99MRC	13105^Lymphocytosis^99MRC

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
Lymphopenia	IS	13106	Lymphopenia	99MRC	13106^Lymphopenia^99MRC
Monocytosis	IS	13107	Monocytosis	99MRC	13107^Monocytosis^99MRC
Eosinophilia	IS	13108	Eosinophilia	99MRC	13108^Eosinophilia^99MRC
Basophilia	IS	13109	Basophilia	99MRC	13109^Basophili a^99MRC
Neutrophilia	IS	13110	Neutrophilia	99MRC	13110^Neutrophilia^99MRC
Neutropenia	IS	13111	Neutropenia	99MRC	13111^Neutropen ia^99MRC
Increased mid cells	IS	13112	Increased Mid Cells	99MRC	13112^Decreased Mid Cells^99MRC
Decreased mid cells	IS	13113	Decreased Mid Cells	99MRC	13113^Increased Mid Cells^99MRC
rstRBC?	IS	34525-6	rstRBC	LN	34525-6^rstRBC^ LN
WBC left shift?	IS	17790-7	WBC Left Shift?	LN	17790-7^WBC Left Shift?^LN
Immature granulocytes?	IS	34165-1	Imm Granulocytes?	LN	34165-1^Imm Granulocytes?^L N
Atypical lymphs?	IS	15192-8	Atypical Lymphs?	LN	15192-8^Atypica l Lymphs?^LN
Background/aspiration abnormal	IS	13001	Background/Aspiration Abn.	99MRC	13001^Background/Aspiration Abn.^99MRC
WBC abnormal	IS	13002	WBC Abnormal	99MRC	13002^WBC Abnormal^99MRC
Abnormal WBC scattergram	IS	13003	Abn. WBC scattergram	99MRC	13003^Abn. WBC scattergram ^99MRC
Abnormal WBC historgram	IS	13004	Abn. WBC histogram	99MRC	13004^Abn. WBC histogram ^99MRC
Abnormal WBC channel	IS	13005	Abnormal WBC Channel	99MRC	13005^Abnormal WBC Channel^99MRC
Abnormal DIFF channel	IS	13006	Abnormal DIFF Channel	99MRC	13006^Abnormal DIFF Channel^99MRC
Anisocytosis	IS	15150-6	Anisocytosis	LN	15150-6^Anisocy tosis^LN
Macrocytes	IS	15198-5	Macrocytes	LN	15198-5^Macrocy tes^LN

Data Item	HL7 Data Type (OBX-2)	Code (ID)	Name	Encoding System	Example of OBX-3
Microcytes	IS	15199-3	Microcytes	LN	15199-3^Microcy tes^LN
Hypochromia	IS	15180-3	Hypochromia	LN	15180-3^Hypochr omia^LN
Erythrocytosis	IS	13301	Erythrocytosis	99MRC	13301^Erythrocy tosis^99MRC
Anemia	IS	13302	Anemia	99MRC	13302^Anemia^99 MRC
RBC dual pop	IS	10379-6	RBC Dual Pop	LN	10379-6^RBC Dual Pop^LN
RBC abnormal distribution	IS	13201	RBC Abnormal distribution	99MRC	13201^RBC Abnormal distribution^99 MRC
RBC clump?	IS	13202	RBC Clump?	99MRC	13202^RBC Clump?^99MRC
Iron deficiency?	IS	13203	Iron Deficiency?	99MRC	13203^Iron Deficiency?^99MRC
HGB Interfere	IS	13204	HGB Interfere	99MRC	13204^HGB Interfere^99MRC
Abnormal RBC channel	IS	13205	Abnormal RBC Channel	99MRC	13205^Abnormal RBC Channel^99MRC
Abnormal HGB channel	IS	13206	Abnormal HGB Channel	99MRC	13206^Abnormal HGB Channel^99MRC
Thrombocytosis	IS	13501	Thrombocytosis	99MRC	13501^Thrombocy tosis^99MRC
Thrombopenia	IS	13502	Thrombopenia	99MRC	13502^Thrombope nia^99MRC
PLT abnormal distribution	IS	13401	PLT Abnormal Distribution	99MRC	13401^PLT Abnormal Distribution^99 MRC
Platelet clump?	IS	7796-6	Platelet Clump?	LN	7796-6^Platelet Clump?^LN
CRP increased	IS	13701	CRP Increased	99MRC	13701^CRP Increased^99MRC
HS-CRP increased	IS	13702	HS-CRP Increased	99MRC	13702^HS-CRP Increased^99MRC
Abnormal CRP channel	IS	13601	Abnormal CRP Channel	99MRC	13601^Abnormal CRP Channel^99MRC

Table 10 Communication parameter units

Parameter Unit on Software Interface	Communication Parameter Unit (OBX-6)
10^12/L	10*12/L
10^9/L	10*9/L
10^6/uL	10*6/uL
10^4/uL	10*4/uL
10^3/uL	10*3/uL
10^2/uL	10*2/uL
mL/L	mL/L
/nL	/nL
/pL	/pL
g/L	g/L
g/dL	g/dL
L/L	L/L
mmol/L	mmol/L
%	%
fL	fL
um^3	um3
pg	pg
fmol	fmol
amol	amol
Year (unit of age)	yr
Month (unit of age)	mo
Week (unit of age)	w
Day (unit of age)	d
Hour (unit of age)	hr

A part of the OBX message data uses user-defined enumerated values. The following table describes the values of different data items.

Data Item	Enumerated Value
Loading Mode	**O**: open **A**: automatic **C**: closed
Blood Mode	**W**: whole blood **P**: pre-diluted blood
Test Mode	CBC

Data Item	Enumerated Value
	CBC+DIFF
Blood Type	The format is AB blood type RH blood type. The values of AB blood type are A, B, AB, and O, and those of RH blood type are RH+ and RH-.
Qc Level	**L**: low **M**: medium **H**: high
Histogram line adjustment flag and alarm flag	The data type of OBX-2 is IS. Its value can be either of the following enumerated values: **T**: true **F**: false

Histogram data transmission falls into the following cases according to software settings:

- Histogram data is not transmitted.

  Histogram data is transmitted in the form of bitmap. In the OBX segment, the value of the data type field is **ED**. The value of the data field is in the format of ^Image^BMP^Base64^…bitmap of histogram data. Image indicates that an image is transmitted. BMP is a user-defined sub-data type, indicating that a bitmap of the BMP type is transmitted. Currently supported image formats include BMP and PNG.

- Base64 indicates the encoding format of bitmap data.

  The printed bitmap and displayed bitmap are differentiated.

  For scattergram data, the value of the data type field in the OBX segment of the bitmap data is **ED**. The value of the data field is in the format of ^Image^BMP^Base64^…bitmap of scattergram data. Image^BMP^Base64 indicates transmitting BMP bitmap data that is encoded in Base64 format.

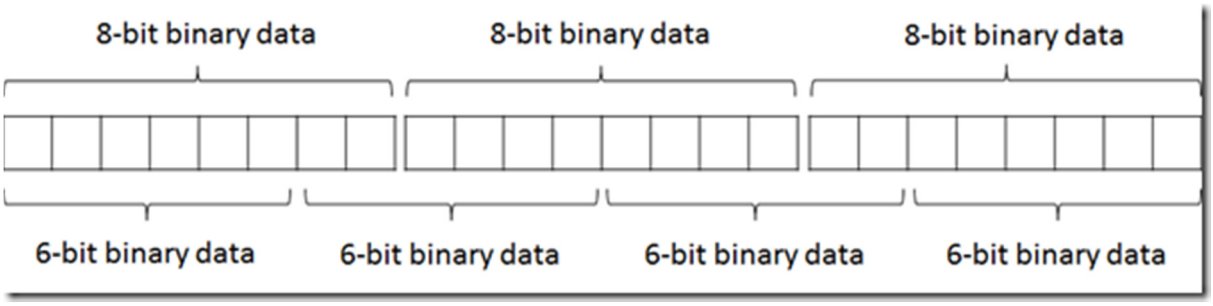
- The printed bitmap and displayed bitmap are differentiated.

  In the patient information, the age is transmitted in an OBX segment. The value is an integer with a unit. In the system software, the age may be displayed as < 1 day. In this case, the age is 0.

6 Appendix III Introduction to Base64

Base64 Encoding Process

Base64 encoding involves converting every three bytes into four characters. Each character occupies six bits.



The six bits can be combined in 64 ways. That is, Base64 requires at least 64 characters. A special character = will be introduced later. Base64 uses characters from A to Z, a to z, 0 to 9, +, and /.

Value	Char	Value	Char	Value	Char	Value	Char
0	A	16	Q	32	g	48	w
1	B	17	R	33	h	49	x
2	C	18	S	34	i	50	y
3	D	19	T	35	j	51	z
4	E	20	U	36	k	52	0
5	F	21	V	37	l	53	1
6	G	22	W	38	m	54	2
7	H	23	X	39	n	55	3
8	I	24	Y	40	o	56	4
9	J	25	Z	41	p	57	5
10	K	26	a	42	q	58	6
11	L	27	b	43	r	59	7
12	M	28	c	44	s	60	8
13	N	29	d	45	t	61	9
14	O	30	e	46	u	62	+
15	P	31	f	47	v	63	/

Assume that there is a 3-byte data record, which is as follows in binary format:

00000001 | 00000010 | 00000011

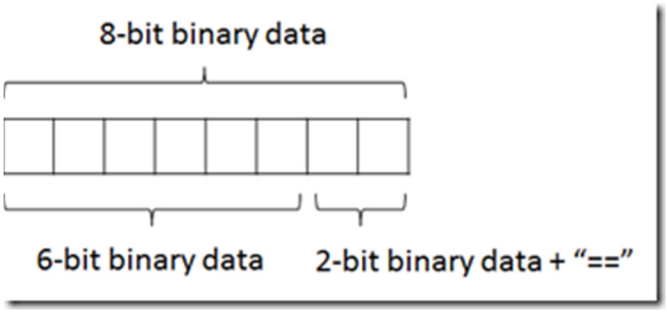
The data record is as follows after being encoded in Base64 format:

000000 | 010000 | 001000 | 000011

The data record is 0 | 16 | 8 | 3 in decimal format, and is AQID in text format after encoding.

Base64 encoding involves converting every three bytes into four characters. How does it work for an image with a number of bytes that cannot be exactly divided by 3?

In Base64 encoding, if there is one remaining byte after division, this byte will also be converted into four characters. The first six bits of this byte will be converted into a character, the other two bits will be converted into a character (zeros will be added on the right), and two equal signs (==) are added at the end.



Assume that there is a 4-byte data record, which is as follows in binary format:

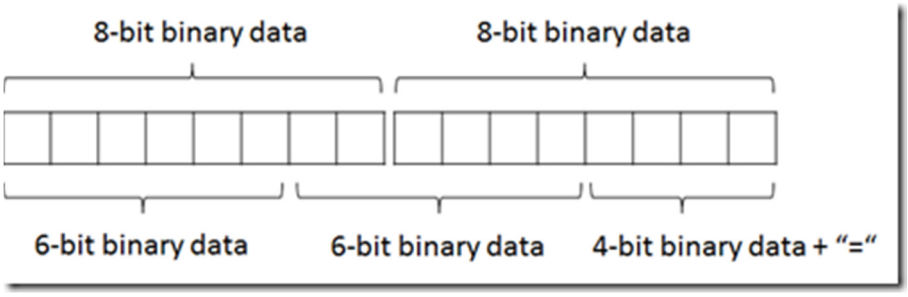
00000001 | 00000010 | 00000011 | 00000100

The data record is as follows after being encoded in Base64 format:

000000 | 010000 | 001000 | 000011 | 000001 | 000000

The data record is 0 | 16 | 8 | 3 | 1 | 0 in decimal format, and is AQIDBA== in text format after encoding.

After division by 3, two bytes are left. The encoding mode is similar to that for a single byte. Each byte will be converted into four characters, and an equal sign (=) will be added at the end.



Assume that there is a 5-byte data record, which is as follows in binary format:

00000001 | 00000010 | 00000011 | 00000100 | 00000101

The data record is as follows after being encoded in Base64 format:

000000 | 010000 | 001000 | 000011 | 000001 | 000000 | 010100

The data record is 0 | 16 | 8 | 3 | 1 | 0 | 20 in decimal format, and is AQIDBAU= in text format after encoding.

Application Example

When the application needs to save binary data in plaintext, it can convert unprintable binary data into printable character strings through Base64 encoding.

Mozilla Thunderbird and Evolution employ Base64 encoding to encrypt email passwords.

Base64 encoding is also used to simply encrypt some data. The actual encryption process is usually complex.

Spam spreaders will use Base64 encoding to prevent spam from being blocked by anti-spam tools because these tools will not translate information encoded in Base64 format.

In LDIF archives, Base64 is used to encode characters strings.