BC-6000 Series
Communication Protocol

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Revision History

Ver.	ECR	Position	Revision Description	Revised by
1.0	/	/	Initial release	Qiong Wu

Chapter 1 LIS Communication Protocol

1.1 Connection Control

1.1.1 Analyzer as TCP Server

The TCP server starts monitoring after the analyzer is started up or the communication setup is modified. It can accept one LIS connection which sustains until message transmission fails, the communication setup is modified or the analyzer is closed.

1.1.2 Communication Control Between Network Interfaces

As for one-way LIS communication messages like the analysis results of blood or control samples, you can select synchronous response in HL7 protocol, which means after the analyzer sends a message, it will send the next message after receiving the response from LIS or after response time-out.

While saving worklist, or run a count without worklist, the analyzer initiates a LIS search request, and LIS responds to the request in 10s. If the response is received successfully, the analyzer will save the information or run the count in the mode acquired from LIS.

1.2 HL7 Communication Protocol

1.2.1 Overview

The analyzer provides communication between the analyzer and the PC in laboratory through Ethernet, including sending analysis results to and receiving worklists from lab PC.

This communication protocol is defined based on the HL7 Standards. HL7 is a series of electronic data exchange standards for healthcare industry, which is originally defined by the US and is now adopted worldwide. This protocol is defined based on HL7 v2.3.1. For details of HL7 standards, see *HL7 Interface Standards Version 2.3*.1.

1.2.2 Low-Level Transmission Protocol

The analyzer uses the TCP for communication. See Connection Control for details.

1.2.3 HL7 Message Level Protocol

1.2.3.1 HL7 Protocol Overview

1.2.3.1.1 HL7 Grammar

Message Constructing Principles

Every HL7 message consists of several segments, each of which ends up with the <CR> (0x0D) character.

Each segment consists of the segment name of three characters and a number of fields, and

each field consists of some components and subcomponents. For each message, the delimiters of the fields, components and subcomponents are defined in the MSH segment.

E.g.

MSH|^~\&|Mindray||||20060427194802||ORU^R01|1|P|2.3.1|||||UNICODE

Among which:

The five characters following MSH define the delimiters used between fields, components and subcomponents. Although they can be any non-text characters, HL7 standard recommends you use the characters in the table below:

Table 1 HL7 Delimiters

Character	Meaning
|	Field delimiter
^	Component delimiter
&	Subcomponent delimiter
~	Repetition delimiter
\	ESC

The first two fields of MSH contain all the delimiters. Some fields behind are null because they are optional and not used by Mindray HL7 interface. Details about field definition and selection will be stated in the following sections.

For message of any type, the segments behind MSH appear in a fixed order. The order will be described in the following sections and the following grammar is used to organize the segments in proper order.

[] encloses optional segments.

{ } encloses segments which can repeat once or more.

Principles of Escape Character Conversion

For the field data of ST, TX, FT, and CF, etc. delimiters may be used in strings like remarks, clinical diagnosis and customized gender etc. When coding, the delimiters in the original strings shall be converted to escape sequence; which is restored in decoding. The principles for escape character conversion for HL7 interface are as follows:

ESC Sequence	Original Character
\F	**Field delimiter**
\S	**Component delimiter**
\T	**Subcomponent delimiter**
\R	**Repetition delimiter**
\E	**Escape delimiter**
\.br	**<CR>, segment end character.**

Note: the "\" in the escapq sequence represents the ESC delimiter, whose value is defined in the MSH segment.

1.2.3.2 HL7 Low-Level Message Protocol

HL7 of high-level protocol is based on messages. The function of terminating the message is not provided. In order to determine the message boundary, the MLLP low-level protocol is used (see HL7 Interface Standards Version 2.3.1).

Communication Level

Messages are transmitted in the following format:

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

among which:

<SB> = Start Block character (1 byte)

ASCII <VT>, i.e. <0x0B>. Do not confuse with the SOH or STX character in ASCII.

***ddddd* = Data (variable number of bytes)**

ddddd is the effective data of HL7 message and expressed in the form of string. For the strings used in the HL7 interface messages of the analyzer, the UTF-8 code is used.

<EB> = End Block character (1 byte)

ASCII <FS>, i.e. <0x1C>. Do not confuse with the ETX or EOT character in ASCII.

<CR> = Carriage Return (1 byte)

ASCII carriage return character, i.e. <0x0D>.

1.2.4 Duplex Communication

1. The analyzer directly sends the analysis results (or QC data) to LIS, as shown in Figure 1.

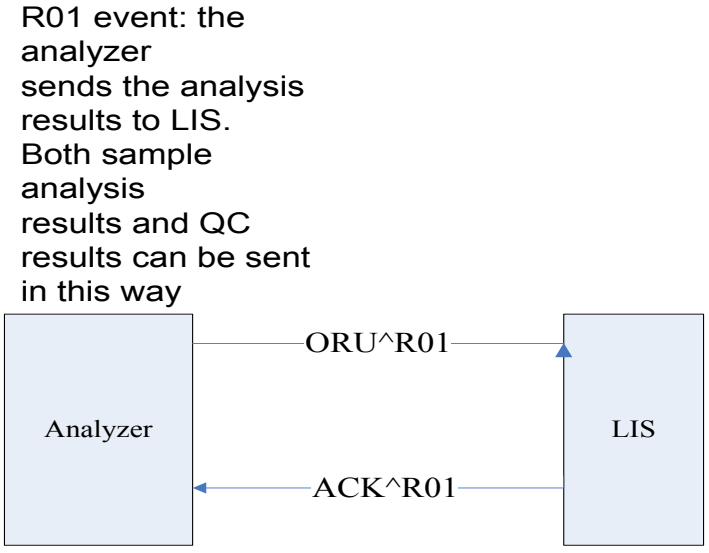

Figure 1 Analysis results (or QC data) communication process

2. Worklist information searching

Worklist belongs to the Order message. Thus, the corresponding HL7 messages: ORM

(General Order Message), ORR (General Order Response Message) can be used. The communication process is shown in Figure 2.

Figure 2 Worklist searching communication process

1.2.4.1 Mostly used messages:

ORU^R01 message: it is mostly used for the transmission of the analysis results and QC data.

ORU	Observational Results (Unsolicited)	Description

MSH Message Header, mandatory, including the communication information like message No., sending time, message delimiter and coding method, etc.

{

PID Patient demographic information, including patient name, gender, patient ID, date of birth, etc.

[PV1] Patient visit information, including patient type, department, bed No. and payer*, etc.

{

OBR sample information, including sample No., operator and time of analysis, etc.

{[OBX]} analysis data, including analysis results and mode of analysis, etc.

}

}

ACK^R01 message: it confirms the receival of ORU^R01 message.

ACK	Acknowledgment	Description

MSH Message header

MSA message acknowledgment, describing whether it has received the transmitted message

ORM^O01 message: Common order message, all the actions related to order basically use the message of this type. For example, create a new order or cancel an order. Here, the MRFlow requests LIS/HIS to re-fill the order message.

ORM	General Order Message	Description

MSH Message header

{ORC} Common message of Order, including the ID information of the sample searched

ORR^O02 Message: acknowledgement of the ORM^O01 message. Here, returning the completed information of order (i.e. worklist).

ORR^O02 General Order Response Message Description

MSH Message header
MSA Message acknowledgment
[PID patient information
[PV1]] patient visit information
{
ORC Common message of Order, including the sample ID
[
OBR Sample information
{[OBX]} Data of other sample information, including analysis mode, etc.
]
}

1.2.5 HL7 Segment Definitions

The tables in this section provide detailed definitions of the fields in all the message segments. Each row provides the information of one field, and the content of each column is described as follows:

1. No.: the HL7 message begins with the segment name of 3 characters followed by the fields which are separated by delimiters. "No." refers to the order of the field in the HL7 message segment.

E.g.

```
PID      | 1      |      |7393670^^^^MR||^Liu||19950804000000|F
 ↑       ↑              ↑
Segment name   Field 1        Field 3
```

Message example 1-1 Example of HL7 segment No.

Note: for MSH segment, the field delimiter subsequential to the segment name is considered to be the first field, used to define the field delimiter values of the whole message.

2. Field name: the logic sense of the field.
3. Data type: the data type based on HL7 standards. See Table 2 for details;
4. Recommended Max Length: The recommended max length based on HL7 standards. But during the communication process, the data length may be longer than recommended, in which case the fields shall be identified by delimiters while analyzing the message segment.
5. Description: description to the value of the field.

6. Example: example of the fields.

1.2.5.1 MSH

MSH (Message Header) segment contains basic information of HL7 messages, including delimiter value, message type and coding method etc. It is the first field of every HL7 message.

Message example:

MSH|^~\&|Mindray||||20101012092538||ORU^R01|1|P|2.3.1||||||UNICODE

See Table 2 for definition of each field in MSH segment.

Table 2 MSH Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Field Separator	ST	1	Includes the delimiter of the first field after the segment name; used to determine the delimiter values of the rest part of the message.	|
2	Encoding Characters	ST	4	Includes component delimiters, repetition delimiters, escape delimiters and subcomponent delimiters.	^~\&
3	Sending application	EI	180	Application of sending terminal. If it is the analyzer sends the message, the value is "*.	
4	Sending Facility	EI	180	Device of sending terminal. Value: Mindray (in Chinese and English version)	Mindray
7	Date/Time Of Message	TS	26	Time of creating the message (in the format of YYYY[MM[DD[HH[MM[SS]]]]]), using the system time	20101012092538
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 as the unique identifier of a message.	1
11	Processing ID	PT	3	Message processing ID. Value: "P": sample and worklist request message; "Q": QC analysis result message; In Ack messages, it is consistent with the previously received message.	P
12	Version ID	VID	60	HL7 version number. Value: "2.3.1".	2.3.1
18	Character	ID	10	Character set.	UNICODE

	Set			Value: "UNICODE", which means the message in communication is expressed in UTF-8 strings.	

1.2.5.2 MSA

The MSA (Message Acknowledgement) segment contains message acknowledge information.

Message example:

MSA|AA|1

See Table 3 for field definitions in use.

Table 3 MSA Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Acknowledgment Code	ID	2	Acknowledgement code:"AA"-received; "AE" – error; "AR"- rejected.	AA
2	Message Control ID	ST	20	Message control ID, consistent with the MSH-10 of the received message	1
6	Error Condition	CE	100	Error condition (status code), can be selected to transmit, and contains error condition descriptions; see Table 3* for the values.	

Table 4 Error Codes of MSA-6 Field

Status Code (MSA-6)	Status Text (MSA-3)	Description/Remark
Succeeded:		AA
0	Message accepted	Succeeded
Error status code:		AE
100	Segment sequence error	Segment sequence in the message is wrong, required segment missing
101	Required field missing	Required field in a segment missing
102	Data type error	Segment data type error, e.g. data type is character instead of numeric
103	Table value not found	Table value not found; not used temporarily
Rejected status code:		AR
200	Unsupported message type	Message type not supported
201	Unsupported event code	Event code not supported
202	Unsupported processing id	Processing ID not supported
203	Unsupported version	Version ID not supported

	id	
204	Unknown key identifier	Unknown key identifier, e.g. transmitting a nonexistent patient information
205	Duplicate key identifier	Repeated key words existed
206	Application record locked	Issues can not be executed in the application saving level, e.g. database is locked
207	Application internal error	Other unknown error of the application

1.2.5.3 PID

The PID (Patient Identification) segment contains the patient demographic information.

Message example:

PID|1||C1^^^^MR||^Liu||20101005084346|Male

See Table 5 f r field definitions in use.

Table 5 PID Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Set ID - PID	SI	4	Serial No., used to identify different PID segments in a message	1
3	Patient Identifier List	CX	20	Used as patient ID in the sample analysis result messages, in the form of "MR Number^^^^MR". Used as batch No. of control in QC messages.	C1^^^^MR
5	Patient Name	XPN	48	Patient name (consists of FirstName and LastName), in the form of "LastName^FirstName"	^Liu
7	Date/Time of Birth	TS	26	Used as time of birth in sample information messages. In the form of YYYY[MM[DD[HH[MM[SS]]]]]. Used as expiration date of the control in QC messages.	20101005084346
8	Sex	IS	1	Gender, string. Same with the strings displayed on the screen.	Male.

1.2.5.4 PV1

The PV1 (Patient Visit) segment contains the patient visit information.

Message example:

PV1|1|Outpatient|Medicine^^BN1||||||||||||||||MedicalInsurance

See Table 6 for field definitions in use.

Table 6 PV1 Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Set ID - PV1	SI	4	Serial No., used to identify different PV1 segments in a message.	1
2	Patient Class	IS	1	Patient type, string, content not defined. Same with the strings displayed on the screen.	Outpatient
3	Assigned Patient Location	PL	80	Patient location information, in the form of "Department^ ^ Bed No."	Medicine^^BN1
20	Financial Class	FC	50	Payer, string, content not defined.	MedicalInsurance

1.2.5.5 OBR

The OBR (Observation Request) segment contains the test report information.

Message example:

OBR|1||TestSampleID1|00001^Automated Count^99MRC||20101006084439|20101009091515|||Li|||Cold|20101007084458|||||||||HM|||||||admin

See Table 7 for field definitions in use.

Table 7 OBR Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Set ID - OBR	SI	4	Serial No., used to identify different OBR segments in a message	1
2	Placer Order Number	EI	22	Used as sample ID in the worklist searching response messages (i.e. ORR^O02 messages).	
3	Filler Order Number +	EI	22	Used as sample ID in sample analysis result messages. Used as QC file No. in QC messages.	TestSampleID1

4	Universal Service ID	CE	200	Universal service ID, used to identify different types of analysis results. See Appendix B for its value definitions.	00001^Automated Count^99MRC
6	Requested Date/time	TS	26	Draw time. Used as the time when the blood sample is drawn.	20101006084439
7	Observation Date/Time #	TS	26	Time of analysis.	20101009091515
10	Collector Identifier *	XCN	60	Analysis orderer Here indicates the person who order the analysis.	Li
13	Relevant Clinical Info.	ST	300	Relevant clinical information. Can be used as the clinical diagnostic information of patient information.	Cold
14	Specimen Received Date/Time *	TS	26	Time when the sample is received. Used as the time when the analysis is ordered.	20101007084458
15	Specimen Source *	CM	300	Source of the sample. Segment preserved for the analyzer.	
22	Results Rpt/Status Chng - Date/Time +	TS	26	Result report/Status change - Tie. Used as the time of validation.	
24	Diagnostic Serv Sect ID	ID	10	Diagnosis maker ID; value: "HM" (means Hematology)	HM
28	Result Copies To	XCN	150	Copy the result to. Used as the person who validate the sample results.	
32	Principal Result Interpreter +	CM	200	Principal result interpreter. Used as the operator of the sample analysis in sample messages. Used as the operator of the QC count in QC messages.	admin

1.2.5.6 OBX

The OBX (Observation/Result) segment contains the parameter information of each test result.

Message example:

OBX|8|NM|6690-2^WBC^LN||2.20|10*9/L|4.00-10.00|L~A|||F

See Table 8 for field definitions in use.

Table 8 OBX Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Set ID - OBX	SI	10	Serial No., used to identify different OBX segments in a message.	8
2	Value Type	ID	3	Data type of the analysis result. Values can be: "ST", "NM", "ED", "IS", etc. See Appendix A for details.	NM
3	Observation Identifier	CE	590	Analysis item identifier. In the form of "ID^Name^EncodeSys", where ID is the identifier of the analysis item; Name is the description of the item; EncodeSys is the coding system of the item. See the configuration files and Appendix B for the values of the codes for different items. Note: ID and EncodeSys are used to identify different analysis parameters, while Name is for description purpose rather than identification.	6690-2^WBC^LN
5	Observation Value	*	65535	Analysis result data, which can be numeric, string, enumeration value, binary data, etc. See Appendix B for detailed value definitions (Binary data like histogram or scattergram are converted to codes using the Base 64 coding method. See **Appendix** C for the coding method).	2.20
6	Units	CE	60	Unit of analysis items. Use the standard units defined in HL7. See Appendix B for units used in communication.	10*9/L
7	References Range	ST	60	Reference range of analysis results, in the form of "lower limit-higher limit", "<upper limit" or ">lower limit".	4.00-10.00

8	Abnormal Flags	ID	5	Analysis result flags. Value definitions: "N": normal "A": abnormal "H": higher than upper limit "L": lower than lower limit Note: The flag for normal or abnormal and that for high or low result may appear in this field at the same time. In this case, the two types of flags are connected by a "~", e.g. "H~A".	L~A
11	Observ Result Status	ID	1	Status of the analysis result. "F": final result.	F
13	User Defined Access Checks	ST	20	User-defined. For flags of reagent expiration or modification, etc. In the form of "Flag1~Flag2". There are 5 types of flags in all: O – reagent expired E – result edited e – result calculated from result edited C – result corrected V – result out of linearity range	

1.2.5.7 ORC

The ORC (Common Order) segment contains the common information of order.

Message example:

ORC|RF||SampleID||IP

See Table 8 for field definitions.

Table 1ORC Field Definitions

No.	Field/Delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Order Control	ID	2	Order control. In ORM message, the value is "RF", which means "re-fill order request" In ORR message, the value is "AF", which means "acknowledge order re-filling"	RF
2	Placer Order Number	EI	22	Code for order placer. In ORM message, the value is null. In ORR message, the value is the sample ID.	
3	Filler OrderNum	EI	22	Code for order receiver. In ORM message, the value is the sample ID. In ORR message, the value is null.	SampleID
5	Order Status	ID	2	Order status. In ORM message of worklist information searching communication, the value is "IP", which means "the order is being processed, but has no result yet"; in ORR message, the value is null.	IP

1.2.6 Complete Message Examples

The two message examples below shows the communication process of sample data

1.2.6.1 Sample Message

MSH|^~\&||Mindray|||20111124091140||ORU^R01|1|P|2.3.1||||||UNICODE
PID|1||^^^^MR
PV1|1
OBR|1||ste5|00001^Automated Count^99MRC|||20111101170410||||||||||||||||HM
OBX|1|IS|08001^Take Mode^99MRC||O||||||F
OBX|2|IS|08002^Blood Mode^99MRC||W||||||F
OBX|3|IS|08003^Test Mode^99MRC||CBC+DIFF||||||F
OBX|4|IS|01002^Ref Group^99MRC||General||||||F
OBX|5|NM|6690-2^WBC^LN||6.58|10*9/L|4.00-10.00|N|||F

OBX|6|NM|704-7^BAS#^LN||0.02|10*9/L|0.00-0.10|N|||F
OBX|7|NM|706-2^BAS%^LN||0.4|%|0.0-1.0|N|||F
OBX|8|NM|751-8^NEU#^LN||4.81|10*9/L|2.00-7.00|N|||F
OBX|9|NM|770-8^NEU%^LN||73.2|%|50.0-70.0|H~N|||F
OBX|10|NM|711-2^EOS#^LN||0.21|10*9/L|0.02-0.50|N|||F
OBX|11|NM|713-8^EOS%^LN||3.2|%|0.5-5.0|N|||F
OBX|12|NM|731-0^LYM#^LN||1.38|10*9/L|0.80-4.00|N|||F
OBX|13|NM|736-9^LYM%^LN||21.0|%|20.0-40.0|N|||F
OBX|14|NM|742-7^MON#^LN||0.15|10*9/L|0.12-1.20|N|||F
OBX|15|NM|5905-5^MON%^LN||0.2|%|3.0-12.0|L~N|||F
OBX|16|NM|789-8^RBC^LN||3.77|10*12/L|3.50-5.50|A|||F
OBX|17|NM|718-7^HGB^LN||105|g/L|110-160|L~N|||F
OBX|18|NM|787-2^MCV^LN||84.4|fL|80.0-100.0|A|||F
OBX|19|NM|785-6^MCH^LN||27.9|pg|27.0-34.0|A|||F
OBX|20|NM|786-4^MCHC^LN||330|g/L|320-360|A|||F
OBX|21|NM|788-0^RDW-CV^LN||14.9|%|11.0-16.0|A|||F
OBX|22|NM|21000-5^RDW-SD^LN||51.7|fL|35.0-56.0|A|||F
OBX|23|NM|4544-3^HCT^LN||31.8|%|37.0-54.0|L~A|||F
OBX|24|NM|777-3^PLT^LN||228|10*9/L|100-300|N|||F
OBX|25|NM|32623-1^MPV^LN||7.3|fL|7.0-11.0|N|||F
OBX|26|NM|32207-3^PDW^LN||15.4||9.0-17.0|N|||F
OBX|27|NM|10002^PCT^99MRC||0.166|%|0.108-0.282|N|||F
OBX|28|NM|10014^PLCR^99MRC||*****|%|11.0-45.0|N|||F
OBX|29|NM|10013^PLCC^99MRC||*****|10*9/L|30-90|N|||F
OBX|35|NM|15051^RBC Histogram. Left Line^99MRC||25||||||F
OBX|36|NM|15052^RBC Histogram. Right Line^99MRC||149||||||F
OBX|37|NM|15053^RBC Histogram. Binary Meta Length^99MRC||1||||||F
OBX|38|NM|15057^RBC Histogram. Total^99MRC||52978||||||F
OBX|39|NM|15111^PLT Histogram. Left Line^99MRC||3||||||F
OBX|40|NM|15112^PLT Histogram. Right Line^99MRC||41||||||F
OBX|41|NM|15113^PLT Histogram. Binary Meta Length^99MRC||1||||||F
OBX|42|NM|15117^PLT Histogram. Total^99MRC||3010||||||F
OBX|43|NM|15203^WBC DIFF Scattergram. Meta len^99MRC||4||||||F
OBX|44|NM|15205^WBC DIFF Scattergram. Fsc dimension^99MRC||0||||||F
OBX|45|NM|15206^WBC DIFF Scattergram. Ssc dimension^99MRC||0||||||F
OBX|46|NM|15207^WBC DIFF Scattergram. FL dimension^99MRC||0||||||F
OBX|47|NM|15208^WBC DIFF Scattergram. FSC-LOG dimension^99MRC||0||||||F

1.2.6.2 Sample Response Message

During synchronous communication, the analyzer needs to answer each analysis result message with a response message. which contains two segments: MSH and MSA. To send a correct response message, take into consideration that: the MSH-9 field should be ACK^R01 which indicates that it is a sample response message; If the value in the MSA-2 field is the same with the MSH-10 value of the received analysis result, it indicates that this response message is corresponding to the sent analysis result. The MSA-2 value in the following

example is 1
MSH|^~\&|LIS||||20111124091140||ACK^R01|1|P|2.3.1||||||UNICODE
MSA|AA|1

1.2.6.3 QC Message

The content of the QC message differs from the sample analysis result message: the MSH-11 value of the QC message is Q which indicates that it is a QC message; each QC message corresponds to one QC point in the DMU software which may contain several analysis results. For example, there is one analysis result in an L-J QC message, while there are two analysis results and one mean calculation result in an X mean-R QC message.

A QC message consists of an MSH message header and several analysis results, each of which begins with the PID and OBR segments which contain sample information, and followed by several OBX segments to carry parameter results and other information. The OBR-4 field of each analysis result indicates the type of the result See Appendix B for details.

An example of the L-J QC message is shown as follows:

MSH|^~\&||Mindray|||20111124091422||ORU^R01|1|Q|2.3.1||||||UNICODE
PID|1||1||||20111103000000
OBR|1||1|00003^LJ QCR^99MRC|||20111103150042|||||||||||||||HM|||||||| R&D engineer
OBX|1|IS|05001^Qc Level^99MRC||M||||||F
OBX|2|IS|08001^Take Mode^99MRC||O||||||F
OBX|3|IS|08002^Blood Mode^99MRC||W||||||F
OBX|4|IS|08003^Test Mode^99MRC||CBC+DIFF||||||F
OBX|5|NM|6690-2^WBC^LN||3.91|10*9/L|0.10-0.50|H~N|||F
OBX|6|NM|704-7^BAS#^LN||0.02|10*9/L||N|||F
OBX|7|NM|706-2^BAS%^LN||0.5|%||N|||F
OBX|8|NM|751-8^NEU#^LN||2.13|10*9/L||N|||F
OBX|9|NM|770-8^NEU%^LN||54.3|%||N|||F
OBX|10|NM|711-2^EOS#^LN||0.06|10*9/L||N|||F
OBX|11|NM|713-8^EOS%^LN||1.6|%||N|||F
OBX|12|NM|731-0^LYM#^LN||1.54|10*9/L||N|||F
OBX|13|NM|736-9^LYM%^LN||39.4|%||N|||F
OBX|14|NM|742-7^MON#^LN||0.16|10*9/L||N|||F
OBX|15|NM|5905-5^MON%^LN||4.2|%||N|||F
OBX|16|NM|789-8^RBC^LN||4.16|10*12/L||N|||F
OBX|17|NM|718-7^HGB^LN||132|g/L|2-8|H~N|||F
OBX|18|NM|787-2^MCV^LN||85.2|fL||N|||F
OBX|19|NM|785-6^MCH^LN||31.7|pg||N|||F
OBX|20|NM|786-4^MCHC^LN||373|g/L||N|||F
OBX|21|NM|788-0^RDW-CV^LN||11.4|%||N|||F
OBX|22|NM|21000-5^RDW-SD^LN||41.7|fL||N|||F
OBX|23|NM|4544-3^HCT^LN||35.4|%||N|||F
OBX|24|NM|777-3^PLT^LN||176|10*9/L|1-3|H~N|||F
OBX|25|NM|32623-1^MPV^LN||8.6|fL||N|||F

OBX|26|NM|32207-3^PDW^LN||16.3|||N|||F
OBX|27|NM|10002^PCT^99MRC||0.151|%||N|||F
OBX|28|NM|10014^PLCR^99MRC||0.0|%||N|||F
OBX|29|NM|10013^PLCC^99MRC||0|10*9/L||N|||F

1.2.6.4 QC Response Message

The only difference between the QC response message and the sample analysis result response message is that the MSH-11 value of the QC response message is Q.

An example of the ACK X-R QC message is shown as follows:

MSH|^~\&|LIS||||20111124091422||ACK^R01|1|Q|2.3.1||||||UNICODE
MSA|AA|1

1.2.6.5 2-Way LIS/HIS Request Message

A 2-way LIS/HIS request message contains a sample ID. After the LIS/HIS received the request message, it will search for the corresponding patient and sample information to provide a response.

A request response message contains two segments: MSH and ORC. The MSH segment is almost the same with that of the analysis result message, except that the MSH-9 value is ORM^O01. The ORC-3 field should be filled with the receiver code (in this case, the sample ID; where in the following sample, it is SampleID1). Note that in the autoloading analysis, if there is a barcode scanning error while sending a request message, the sample ID will be "Invalid".

An example of the request message is shown as follows:

MSH|^~\&||Mindray|||20081120174836||ORM^O01|4|P|2.3.1||||||UNICODE
ORC|RF||SampleID1||IP

1.2.6.6 2-Way LIS/HIS Request Response Message

When the LIS received an request message, it needs to send back an request response message. The first two message segments of the request response message are MSH and MSA. The MSH-9 message type field (indicating the type of the segment) is filled with ORR^O02, while the MSA segment should be filled up as shown in the following example of the request response message. If the LIS/HIS gets searching results for the request, there will be PID, PV1, ORC, OBR and OBX message segments after the two heading segments to provide the patient and sample information, in the same way as the sample data message does. The ORC segment is indispensable for an request response message with searching results, in which the ORC-1 value is AF, and ORC-2 is the key searching field(the sample ID). Note that the OBR-2 field indicates the sample ID, which should be the same as in the ORC-2 field; otherwise, the message will be regarded as incorrect.

An example of the request response message with searching results is shown as follows:

MSH|^~\&|LIS||||20081120174836||ORR^O02|1|P|2.3.1||||||UNICODE
MSA|AA|4
PID|1||ChartNo^^^^MR||^FName||19810506|NT
PV1|1|E| Internal Medicine ^^Bn4|||||||||||||||NewCharge

ORC|AF|SampleID1|||
OBR|1|SampleID1||||20060506||||tester|||Diagnose content....|20060504|||||||20080821||HM ||||Validated by||||Operated by
OBX|1|IS|08001^Take Mode^99MRC||A|||||F
OBX|2|IS|08002^Blood Mode^99MRC||W|||||F
OBX|3|IS|08003^Test Mode^99MRC||CBC|||||F
OBX|4|IS|01002^Ref Group^99MRC||XXXX|||||F
OBX|5|NM|30525-0^Age^LN||1|hr|||||F
OBX|6|ST|01001^Remark^99MRC||remark content....|||||F

An example of the request response message with no search result is shown as follows, in which the MSA-2 field indicates the result of the response. In this example, the MSA-2 value is "AR", indicating the request was rejected; if it is “AE", then there is an error in the request process.

MSH|^~\&|LIS||||20081120175238||ORR^O02|1|P|2.3.1|||||UNICODE
MSA|AR|9

Appendix A HL7 Data Type Definition

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

Format defined by the 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 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)>

Appendix B Message Coding Definition

1. In HL communication messages, the OBR-4 (Universal Serview ID) field, in the form of "ID^Name^EncodeSys", is used to identify the type of the analysis result (e.g. sample analysis result, microscopic examination result, QC result, etc.). Table 9 lists all the coding values of this field.

Table 9 OBR-4 Coding

Data	Code (ID)	Name	EncodeSys
Sample Analysis Result	00001	Automated Count	99MRC
Microscopic result	00002	Manual Count	99MRC
LQ QC count result	00003	LJ QCR	99MRC
X mean QC count result	00004	X QCR	99MRC
X-B QC count result	00005	XB QCR	99MRC
X mean R QC count result	00006	XR QCR	99MRC
Mean value f X mean QC results	00007	X QCR Mean	99MRC
Mean value f X mean R QC results	00008	XR QCR Mean	99MRC
X-M QC count result	00009	XM QCR	99MRC

2. Each OBX segment contains information of one analysis parameter or non-parameter data item. It consists of the following fields: OBX-2, indicating the type of the HL7 data contained; OBX-3 (Observation Identifier), the identifier of the data in the form of "ID^Name^EncodeSys"; OBX-5, containing the value of the data; OBX-6, containing the unit for the parameter, (in the standard unit recommended by HL7).

Table 10 lists the HL7 type and code identifier of each communication data item. Table 11 lists all the units for parameters in the communication.

Table 10 Data Type and Coding System

Data	HL7 Type (OBX-2)	Code (ID)	Name	EncodeSys	Example of OBX-3 field
Non-parameter Data Items					
Presentation mode	IS	08001	Take Mode	99MRC	08001^Take Mode^99MRC
Sample mode	IS	08002	Blood Mode	99MRC	08002^Blood Mode^99MRC
Test Panel	IS	08003	Test Mode	99MRC	08003^Test Mode^99MRC
Age	NM	30525-0	Age	LN	30525-0^Age^LN
Remark	ST	01001	Remark	99MRC	01001^Remark^99MRC
Reference group	IS	01002	Ref Group	99MRC	01002^Ref Group^99MRC
Reexam flag	IS	01006	Recheck flag	99MRC	01006^Recheck flag^99MRC
Sample type	IS	01007	Sample Type	99MRC	01007^Sample Type^99MRC
Inpatient zone	IS	01008	Patient Area	99MRC	01008^Patient Area^99MRC
Custom patient information 1	ST	01009	Custom patient info 1	99MRC	01009^Custom patient info 1^99MRC
Custom patient information 2	ST	01010	Custom patient info 2	99MRC	01010^Custom patient info 2^99MRC
Custom patient information 3	ST	01011	Custom patient info 3	99MRC	01011^Custom patient info 3^99MRC
Tube rack No.	ST	01012	Shelf No	99MRC	01012^Shelf No^99MRC
Tube No.	ST	01013	Tube No	99MRC	01013^Tube No^99MRC
Report time	ST	01014	Report Time	99MRC	01014^Report Time^99MRC
Payer	ST	01015	Charger type	99MRC	01015^Charger type^99MRC
Patient	ST	01016	Patient type	99MRC	01016^Patient

type					type^99MRC
Level of control	IS	05001	Qc Level	99MRC	05001^Qc Level^99MRC
QC date edited flag	IS	05002	QC test date modify flag	99MRC	05002^QC test date modify flag^99MRC
QC time edited flag	IS	05003	QC test time modify flag	99MRC	05003^QC test time modify flag^99MRC
Expiration date of control	ST	05004	Qc valid date	99MRC	05004^Qc valid date ^99MRC
QC file No.	ST	05005	Qc file No	99MRC	05005^Qc file No ^99MRC
Lot No. of control	ST	05006	Qc lot No	99MRC	05006^Qc lot No ^99MRC
Test Panel	ST	05007	Project Type	99MRC	05007^Project Type^99MRC
Name	ST	09001	Analyzer	99MRC	09001^Analyzer^99MRC
Sample ID	ST	08005	SerialNumber	99MRC	08005^SerialNumber^99MRC
Parameter Result Items					
WBC	NM	6690-2	WBC	LN	6690-2^WBC^LN
WBC_CORRECT	NM	12227-5	WBC	LN	12227-5^WBC^LN
BAS	NM	704-7	BAS#	LN	704-7^BAS#^LN
BAS_PER	NM	706-2	BAS%	LN	706-2^BAS%^LN
NEU	NM	751-8	NEU#	LN	751-8^NEU#^LN
NEU_PER	NM	770-8	NEU%	LN	770-8^NEU%^LN
EOS	NM	711-2	EOS#	LN	711-2^EOS#^LN
EOS_PER	NM	713-8	EOS%	LN	713-8^EOS%^LN
LYM	NM	731-0	LYM#	LN	731-0^LYM#^LN
LYM_PER	NM	736-9	LYM%	LN	736-9^LYM%^LN
MON	NM	742-7	MON#	LN	742-7^MON#^LN
MON_PER	NM	5905-5	MON%	LN	5905-5^MON%^LN
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 (Plateletcrit)	NM	10002	PCT	99MRC	10002^PCT^99MRC
RET	NM	14196-0	RET#	LN	14196-0^RET#^LN
RET_PER	NM	4679-7	RET%	LN	4679-7^RET%^LN
IRF	NM	33516-6	IRF	LN	33516-6^IRF^LN
LFR	NM	10015	LFR	99MRC	10015^LFR^99MRC
MFR	NM	10016	MFR	99MRC	10016^MFR^99MRC
HFR	NM	10017	HFR	99MRC	10017^HFR^99MRC
NRBC	NM	30392-5	NRBC#	LN	30392-5^NRBC#^LN
NRBC_PER	NM	26461-4	NRBC%	LN	26461-4^NRBC%^LN
P_LCR	NM	10014	PLCR	99MRC	10014^PLCR^99MRC
P_LCC	NM	10013	PLCC	99MRC	10013^PLCC^99MRC
RBC-O	NM	10018	RBC-O	99MRC	10018^RBC-O^99MRC
PLT-O	NM	10019	PLT-O	99MRC	10019^PLT-O^99MRC
HFC	NM	10020	HFC#	99MRC	10020^HFC#^99MRC
HFC_PER	NM	10021	HFC%	99MRC	10021^HFC%^99MRC
PLT-I	NM	10022	PLT-I	99MRC	10022^PLT-I^99MRC
WBC-R	NM	10023	WBC-R	99MRC	10023^WBC-R^99MRC
WBC-D	NM	10024	WBC-D	99MRC	10024^WBC-D^99MRC
WBC-B	NM	10025	WBC-B	99MRC	10025^WBC-B^99MRC
WBC-N	NM	10026	WBC-N	99MRC	10026^WBC-N^99MRC
PDW_SD	NM	10031	PDW_SD	99MRC	10031^PDW-SD^99MRC
InR	NM	10032	InR#	99MRC	10032^InR#^99MRC
InR_PER	NM	10033	InR‰	99MRC	10033^InR‰^99MRC

WBC_BF	NM	57845-0	WBC-BF	LN	57845-0^WBC-BF^LN
RBC_BF	NM	23860-0	RBC-BF	LN	23860-0^RBC-BF^LN
MN_BF	NM	26490-3	MN#	LN	26490-3^MN#^LN
MN_BF_PER	NM	26493-7	MN%	LN	26493-7^MN%^LN
EOS_BF	NM	35063-7	Eos-BF#	LN	35063-7^Eos-BF#^LN
EOS_BF_PER	NM	26452-3	Eos-BF%	LN	26452-3^Eos-BF%^LN
PMN_BF	NM	10034	PMN#	99MRC	10034^PMN#^99MRC
PMN_BF_PER	NM	10035	PMN%	99MRC	10035^PMN%^99MRC
TNC_BF_BF	NM	10036	TC-BF#	99MRC	10036^TC-BF#^99MRC
HF-BF#	NM	10037	HF-BF#	99MRC	10037^ HF-BF#^99MRC
HF-BF%	NM	10038	HF-BF%	99MRC	10038^ HF-BF%^99MRC
RBC-BF-R	NM	10039	RBC-BF-R	99MRC	10039^ RBC-BF-R ^99MRC
IMG#	NM	51584-1	IMG#	LN	51584-1^ IMG# ^LN
IMG%	NM	38518-7	IMG%	LN	38518-7^ IMG% ^LN
IPF	NM	10041	IPF	99MRC	10041 ^ IPF ^99MRC
Micro#	NM	15199-3	Micro#	LN	15199-3 ^ Micro# ^ LN
Micro%	NM	10042	Micro%	99MRC	10042 ^ Micro% ^99MRC
Macro#	NM	15198-5	Macro#	LN	15198-5 ^ Macro# ^ LN
Macro#	NM	10040	Macro#	99MRC	10040 ^ Macro% ^99MRC
MRV	NM	48706-6	MRV	LN	48706-6 ^ MRV ^ LN
RHE	NM	10043	RHE	99MRC	10043 ^ RHE ^99MRC
Neu-BF#	NM	10044	Neu-BF#	99MRC	10044 ^ Neu-BF# ^99MRC
Neu-BF%	NM	10045	Neu-BF%	99MRC	10045 ^ Neu-BF% ^99MRC
Neuts Band%. Manual	NM	764-1	Neuts Band%. Manual	LN	764-1 ^ Neuts Band%. Manual ^LN
Neuts Seg%. Manual	NM	769-0	Neuts Seg%. Manual	LN	769-0 ^ Neuts Seg%. Manual ^ LN
Abnormal Lymphs%	NM	29261-5	Abnormal Lymphs%.	LN	29261-5 ^ Abnormal Lymphs%. Manual ^LN

. Manual			Manual		
Pla-Aly%	NM	33835-0	Pla-Aly%	99MRC	33835-0 ^ Pla-Aly% ^99MRC
Mon-Aly %	NM	4662-3	Mon-Aly%	99MRC	4662-3 ^ Mon-Aly% ^99MRC
Imm-Aly %	NM	10046	Imm-Aly%	99MRC	10046 ^ Imm-Aly% ^99MRC
Other-Aly %	NM	10047	Other-Aly%	99MRC	10047 ^ Other-Aly% ^99MRC
Metamyelocyte%. Manual	NM	740-1	Metamyelocyte%. Manual	LN	740-1 ^ Metamyelocyte%. Manual ^LN
Myelocytes%. Manual	NM	749-2	Myelocytes %. Manual	LN	749-2 ^ Myelocytes%. Manual ^LN
Promyelocytes%. Manual	NM	783-1	Promyelocytes%. Manual	LN	783-1 ^ Promyelocytes%. Manual ^ LN
Imm-Eos %	NM	33803-8	Imm-Eos%	99MRC	33803-8 ^ Imm-Eos% ^99MRC
Imm-Bas %	NM	33786-8	Imm-Bas%	99MRC	33786-8 ^ Imm-Bas% ^99MRC
Blast%	NM	10049	Blast%	99MRC	10049 ^ Blast% ^99MRC
Myeloblasts%. Manual	NM	747-6	Myeloblasts %. Manual	LN	747-6 ^ Myeloblasts%. Manual ^LN
Monoblasts%. Manual	NM	33840-0	Monoblasts %. Manual	LN	33840-0 ^ Monoblasts%. Manual ^ LN
Lymphoblasts%. Manual	NM	33831-9	Lymphoblasts%. Manual	LN	33831-9 ^Lymphoblasts%. Manual ^LN
IMG/Blast %	NM	10048	IMG/Blast%	99MRC	10048 ^ IMG/Blast% ^99MRC
Prolymphocytes%. Manual	NM	6746-2	Prolymphocytes%. Manual	LN	6746-2 ^ Prolymphocytes%. Manual ^LN
Promonocytes%. Manual	NM	13599-6	Promonocytes%. Manual	LN	13599-6 ^ Promonocytes%. Manual ^ LN
Plsm-cell %	NM	40492-1	Plsm-cell%	99MRC	40492-1 ^ Plsm-cell% ^99MRC
WBC_O	NM	10051	WBC-O	99MRC	10051^ WBC-O

					^99MRC
TNC_D	NM	10052	TNC-D	99MRC	10052^ TNC-D ^99MRC
IME	NM	10053	IME#	99MRC	10053^ IME# ^99MRC
IME_PER	NM	10054	IME%	99MRC	10054^ IME% ^99MRC
H_NR_PER	NM	10055	H-NR%	99MRC	10055^ H-NR% ^99MRC
L_NR_PER	NM	10056	L-NR%	99MRC	10056^ L-NR%^99MRC
NLR	NM	10057	NLR	99MRC	10057^ NLR ^99MRC
PLR	NM	10058	PLR	99MRC	10058^ PLR ^99MRC
TNC_N	NM	10059	TNC-N	99MRC	10059^ TNC-N ^99MRC
RPI	NM	10060	RPI	99MRC	10060^ RPI ^99MRC
H_IPF	NM	10061	H-IPF	99MRC	10061^ H-IPF ^99MRC
IPF_R	NM	10062	IPF#	99MRC	10062^ IPF# ^99MRC
LY_BF	NM	10063	LY-BF#	99MRC	10063^ LY-BF# ^99MRC
LY_BF_PER	NM	10064	LY-BF#	99MRC	10064^ LY-BF% ^99MRC
MO_BF	NM	10065	MO-BF#	99MRC	10065^ MO-BF# ^99MRC
MO_BF_PER	NM	10066	MO-BF%	99MRC	10066^ MO-BF%^99MRC
Intermediate Data of Analysis Results (histogram and scattergram data of WBC, RBC, and PLT, etc.)					
RBC histogram binary data	ED	15050	RBC Histogram. Binary	99MRC	15050^RBC Histogram. Binary^99MRC
Left discriminator of the RBC histogram	NM	15051	RBC Histogram. Left Line	99MRC	15051^RBC Histogram. Left Line^99MRC
Right discriminator of the RBC histogram	NM	15052	RBC Histogram. Right Line	99MRC	15052^RBC Histogram. Right Line^99MRC
RBC historgram metadata	NM	15053	RBC Histogram. Binary Meta Length	99MRC	15053^RBC Histogram. Binary Meta Length^99MRC

length					
RBC histogram left discriminator adjusted flag	IS	15054	RBC Histogram. Left Line Adjusted	99MRC	15054^RBC Histogram. Left Line Adjusted^99MRC
RBC histogram right discriminator adjusted flag	IS	15055	RBC Histogram. Right Line Adjusted	99MRC	15055^RBC Histogram. Right Line Adjusted^99MRC
RBC histogram bitmap data	ED	15056	RBC Histogram. BMP	99MRC	15056^RBC Histogram. BMP^99MRC
Total number of RBC histograms	NM	15057	RBC Histogram. Total	99MRC	15057^RBC Histogram. Total^99MRC
PLT histogram binary data	ED	15100	PLT Histogram. Binary	99MRC	15100^PLT Histogram. Binary^99MRC
Left discriminator of the PLT histogram	NM	15111	PLT Histogram. Left Line	99MRC	15111^PLT Histogram. Left Line^99MRC
Right discriminator of the PLT histogram	NM	15112	PLT Histogram. Right Line	99MRC	15112^PLT Histogram. Right Line^99MRC
PLT historgram metadata length	NM	15113	PLT Histogram. Binary Meta Length	99MRC	15113^PLT Histogram. Binary Meta Length^99MRC
PLT	IS	15114	PLT	99MRC	15114^PLT Histogram.

histogram left discriminator adjusted flag			Histogram. Left Line Adjusted		Left Line Adjusted^99MRC
PLT histogram right discriminator adjusted flag	IS	15115	PLT Histogram. Right Line Adjusted	99MRC	15115^PLT Histogram. Right Line Adjusted^99MRC
PLT histogram bitmap data	ED	15116	PLT Histogram. BMP	99MRC	15116^PLT Histogram. BMP^99MRC
Total number of PLT histograms	NM	15117	PLT Histogram. Total	99MRC	15117^PLT Histogram. Total^99MRC
Version information of scattergram	NM	15014	Scattergram ParaVer	99MRC	15014^ScattergramParaVer^99MRC
Type array of the particles that need to be grayed out in sacttergram.	ED	15015	Scattergram GraphicFlags	99MRC	15015^ScattergramGraphicFlags^99MRC
DIFF 2D scattergram bitmap data	ED	15200	WBC DIFF Scattergram. BMP	99MRC	15200^WBC DIFF Scattergram. BMP^99MRC
Diff scattergr	NM	15203	WBC DIFF Scattergram	99MRC	15203^WBC DIFF Scattergram. Meta

am metadata length			. Meta len		len^99MRC
Fsc dimension of DIFF scattergram	NM	15205	WBC DIFF Scattergram. Fsc dimension	99MRC	15205^WBC DIFF Scattergram. Fsc dimension^99MRC
Ssc dimension of DIFF scattergram	NM	15206	WBC DIFF Scattergram. Ssc dimension	99MRC	15206^WBC DIFF Scattergram. Ssc dimension^99MRC
FL dimension of DIFF scattergram	NM	15207	WBC DIFF Scattergram. FL dimension	99MRC	15207^WBC DIFF Scattergram. FL dimension^99MRC
FSC－LOG dimension of DIFF scattergram	NM	15208	WBC DIFF Scattergram. FSC-LOG dimension	99MRC	15208^WBC DIFF Scattergram. FSC-LOG dimension^99MRC
DIFF scattergram binary data	ED	15201	WBC DIFF Scattergram. BIN	99MRC	15201^WBC DIFF Scattergram. BIN^99MRC
BASO 2D scattergram bitmap data	ED	15250	Baso Scattergram. BMP	99MRC	15250^Baso Scattergram. BMP^99MRC
BASO scattergram binary data	ED	15251	Baso Scattergram. BIN	99MRC	15251^Baso Scattergram. BIN^99MRC
BASO scattergram metadata length	NM	15253	Baso Scattergram. Meta Len	99MRC	15253^Baso Scattergram. Meta Len^99MRC
Fsc dimensio	NM	15255	Baso Scattergram	99MRC	15255^Baso Scattergram. Fsc

n of BASO scattergram			. Fsc dimension		dimension^99MRC
Ssc dimension of BASO scattergram	NM	15256	Baso Scattergram. Ssc dimension	99MRC	15256^Baso Scattergram. Ssc dimension^99MRC
FL dimension of BASO scattergram	NM	15257	Baso Scattergram. FL dimension	99MRC	15257^Baso Scattergram. FL dimension^99MRC
FSC-LOG dimension of BASO scattergram	NM	15258	Baso Scattergram. FSC-LOG dimension	99MRC	15258^Baso Scattergram. FSC-LOG dimension^99MRC
RET 2D scattergram bitmap data	ED	15300	RET Scattergram. BMP	99MRC	15300^RET Scattergram. BMP^99MRC
PLT-O 2D scattergram bitmap data	ED	15301	PLT-O Scattergram. BMP	99MRC	15301^PLT-O Scattergram. BMP^99MRC
RET-EXT 2D scattergram bitmap data	ED	15302	RET-EXT Scattergram. BMP	99MRC	15302^RET-EXT Scattergram. BMP^99MRC
RET dimension of RET scattergram	NM	15303	RET Scattergram. Fsc dimension	99MRC	15303^RET Scattergram. Fsc dimension^99MRC

SSC dimension of RET scattergram	NM	15304	RET Scattergram. Ssc dimension	99MRC	15304^RET Scattergram. Ssc dimension^99MRC
FL dimension of RET scattergram	NM	15305	RET Scattergram. FL dimension	99MRC	15305^RET Scattergram. FL dimension^99MRC
RET scattergram binary data	ED	15306	RET Scattergram. BIN	99MRC	15306^RET Scattergram. BIN^99MRC
RET scattergram metadata length	NM	15307	RET Scattergram. Meta Len	99MRC	15307^RET Scattergram. Meta Len^99MRC
FSC-LOG dimension of RET scattergram	NM	15308	RET Scattergram FSC-LOG dimension	99MRC	15308^RET Scattergram FSC-LOG dimension^99MRC
NRBC 2D scattergram bitmap data	ED	15350	NRBC Scattergram. BMP	99MRC	15350^NRBC Scattergram. BMP^99MRC
FSC dimension of NRBC scattergram	NM	15351	NRBC Scattergram. Fsc dimension		15351^NRBC Scattergram. Fsc dimension^99MRC
SSC dimension of NRBC scattergram	NM	15352	NRBC Scattergram. Ssc dimension	99MRC	15352^NRBC Scattergram. Ssc dimension^99MRC
FL dimensio	NM	15353	NRBC Scattergram	99MRC	15353^NRBC Scattergram. FL

n of NRBC scattergram			. FL dimension		dimension^99MRC
NRBC scattergram binary data	ED	15354	NRBC Scattergram. BIN	99MRC	15354^NRBC Scattergram. BIN^99MRC
NRBC scattergram metadata length	NM	15355	NRBC Scattergram. Meta Len	99MRC	15355^NRBC Scattergram. Meta Len^99MRC
FSC-LOG dimension of NRBC scattergram	NM	15356	NRBC Scattergram FSC-LOG dimension	99MRC	15356^NRBC Scattergram FSC-LOG dimension^99MRC
WNB 2D scattergram bitmap data	ED	15600	WNB Scattergram. BMP	99MRC	15350^WNB Scattergram. BMP^99MRC
Fsc dimension of WNB scattergram	NM	15601	WNB Scattergram. Fsc dimension	99MRC	15351^WNB Scattergram. Fsc dimension^99MRC
Ssc dimension of WNB scattergram	NM	15602	WNB Scattergram. Ssc dimension	99MRC	15352^WNB Scattergram. Ssc dimension^99MRC
FL dimension of WNB scattergram	NM	15603	WNB Scattergram. FL dimension	99MRC	15353^WNB Scattergram. FL dimension^99MRC
WNB scattergram binary data	ED	15604	WNB Scattergram. BIN	99MRC	15354^WNB Scattergram. BIN^99MRC

WNB scattergram metadata length	NM	15605	WNB Scattergram. Meta Len	99MRC	15355^WNB Scattergram. Meta Len^99MRC
FSC-LOG dimension of WNB scattergram	NM	15606	WNB Scattergram FSC-LOG dimension	99MRC	15356^WNB Scattergram FSC-LOG dimension^99MRC
Flags of Abnormal Blood Cell Differential or Morphology					
WBC Scattergram Abn.	IS	12000	WBC Abnormal scattergram	99MRC	12000^WBC Abnormal scattergram^99MRC
WBC Histogram Abn.	IS	12001	WBC Abnormal histogram	99MRC	12001^WBC Abnormal histogram^99MRC
Leucocytosis	IS	12002	Leucocytosis	99MRC	12002^Leucocytosis^99MRC
Leucopenia	IS	12003	Leucopenia	99MRC	12003^Leucopenia^99MRC
Neutrophilia	IS	12004	Neutrophilia	99MRC	12004^Neutrophilia^99MRC
Neutropenia	IS	12005	Neutropenia	99MRC	12005^Neutropenia^99MRC
Lymphocytosis	IS	12006	Lymphocytosis	99MRC	12006^Lymphocytosis^99MRC
Lymphopenia	IS	12007	Lymphopenia	99MRC	12007^Lymphopenia^99MRC
Monocytosis	IS	12008	Monocytosis	99MRC	12008^Monocytosis^99MRC
Eosinophilia	IS	12009	Eosinophilia	99MRC	12009^Eosinophilia^99MRC
Basophilia	IS	12010	Basophilia	99MRC	12010^Basophilia^99MRC
WBC Abn.	IS	12011	WBC Abnormal	99MRC	12011^WBC Abnormal^99MRC
Left Shift?	IS	17790-7	WBC Left Shift?	LN	17790-7^WBC Left Shift?^LN
Immature Granulocyte?	IS	34165-1	Imm Granulocytes?	LN	34165-1^Imm Granulocytes?^LN
Abn./Atyp	IS	15192-8	Atypical	LN	15192-8^Atypical

ical Lymph?			Lymphs?		Lymphs?^LN
RBC Lyse Resist?	IS	34525-6	rstRBC	LN	34525-6^rstRBC^LN
Erythrocytosis	IS	12012	Erythrocytosis	99MRC	12012^Erythrocytosis^99MRC
RBC Distribution Abn.	IS	12013	RBC Abnormal distribution	99MRC	12013^RBC Abnormal distribution^99MRC
Anisocytosis	IS	15150-6	Anisocytosis	LN	15150-6^Anisocytosis^LN
Macrocytosis	IS	12075	Macrocytes	99MRC	12075^Macrocytes^LN
Microcytosis	IS	12076	Microcytes	99MRC	12076^Microcytes^LN
Dimorphologic	IS	10379-6	RBC Dual Pop	LN	10379-6^RBC Dual Pop^LN
Anemia	IS	12014	Anemia	99MRC	12014^Anemia^99MRC
Hypochromia	IS	15180-3	Hypochromia	LN	15180-3^Hypochromia^LN
HGB Abn./Interfere?	IS	12015	HGB Interfere	99MRC	12015^HGB Interfere^99MRC
Platelet Distribution Abn.	IS	12016	PLT Abnormal Distribution	99MRC	12016^PLT Abnormal Distribution^99MRC
Thrombocytosis	IS	12017	Thrombocytosis	99MRC	12017^Thrombocytosis^99MRC
Thrombopenia	IS	12018	Thrombopenia	99MRC	12018^Thrombopenia^99MRC
Platelet Clump?	IS	7796-6	Platelet Clump?	LN	7796-6^Platelet Clump?^LN
Right Shift	IS	12020	Right Shift	99MRC	12020^Right Shift^99MRC
Asp. Abn./Sample Abn.	IS	12021	Sample Abnormal	99MRC	12021^Sample Abnormal^99MRC
RBC Agglutination?	IS	12022	RBC Clump	99MRC	12022^RBC Clump^99MRC
Small Platelet	IS	32208-1	Platelets.small	LN	32208-1^Platelets.small^LN

RBC or HGB Abn.	IS	12023	RBC HGB Abnormal	99MRC	12023^ RBC HGB Abnormal^ 99MRC
Iron Deficiency	IS	12024	Iron Deficiency	99MRC	12024^Iron Deficiency^99MRC
RBC or HGB suspicious	IS	12025	RBC HGB doubt	99MRC	12025^ RBC HGB doubt^99MRC
DIFF Data Collection Error	IS	12026	DIFF Sampling Error	99MRC	12026^DIFF Sampling Error^99MRC
DIFF Data Analysis Error	IS	12027	DIFF-CH Error	99MRC	12027^DIFF-CH Error^99MRC
Blast cell	IS	44017-2	Blasts	LN	44017-2^Blasts^LN
NRBC /PLT Clump?	IS	12028	NRBC /PLTClumps	99MRC	12028^NRBC /PLTClumps^99MRC
RBC Data Collection Error	IS	12029	RBC Sampling Error	99MRC	12029^RBC Sampling Error^99MRC
RBC Data Analysis Error	IS	12030	RBC-CH Error	99MRC	12030^RBC-CH Error^99MRC
RBC Agglutination?	IS	50670-9	RBC Agglutination?	LN	50670-9^ RBC Agglutination?^LN
HGB Abn.	IS	12031	HGB Defect	99MRC	12031^HGB Defect^99MRC
PLT Data Collection Error	IS	12032	HGB Sampling Error	99MRC	12032^HGB Sampling Error^99MRC
PLT Data Analysis Error	IS	12033	PLT-CH Error	99MRC	12033^PLT-CH Error^99MRC
BASO Data Collection	IS	12034	BASO Sampling Error	99MRC	12034^BASO Sampling Error^99MRC

Error					
BASO Data Analysis Error	IS	12035	BASO-CH Error	99MRC	12035^BASO-CH Error^99MRC
Leucocytosis (BASO)	IS	12036	Leukocytosis(BASO)	99MRC	12036^Leukocytosis(BASO)^99MRC
Leucopenia (BASO)	IS	12037	Leukopenia(BASO)	99MRC	12037^Leukopenia(BASO)^99MRC
RET Data Collection Error	IS	12038	RET Sampling Error	99MRC	12038^RET Sampling Error^99MRC
RET Data Analysis Error	IS	12039	RET-CH Error	99MRC	12039^RET-CH Error^99MRC
RET Scattergram Abn.	IS	12040	RET Abn Scattergram	99MRC	12040^RET Abn Scattergram^99MRC
Reticulocytosis	IS	12041	Reticulocytosis	99MRC	12041^Reticulocytosis^99MRC
NRBC Data Collection Error	IS	12042	NRBC Sampling Error	99MRC	12042^NRBC Sampling Error^99MRC
NRBC Data Analysis Error	IS	12043	NRBC-CH Error	99MRC	12043^NRBC-CH Error^99MRC
NRBC Scattergram Abn.	IS	12044	NRBC Abn Scattergram	99MRC	12044^NRBC Abn Scattergram^99MRC
NRBC present	IS	34188-3	NRBC present	LN	34188-3^NRBC present^LN
Insufficient aspiration volume	IS	12101	Aspiration Abn	99MRC	12101^ Aspiration Abn ^99MRC
WNB Analysis Abnormal	IS	12102	WNB Analysis Abn	99MRC	12102^ WNB Analysis Abn ^99MRC
Abnormal WNB	IS	12103	Abnormal WNB	99MRC	12103^ WNB Abn Scattergram ^99MRC

Scattergram			Scattergram		
WBC Fragments?	IS	12104	WBC Fragments?	99MRC	12104^ WBC Fragments? ^99MRC
Sample aspiration is abnormal	IS	12105	Aspiration Abnormal	99MRC	12105^ Aspiration Abnormal ^99MRC

Table 11 Parameter Units in Communication

Parameter Units in Software	**Parameter Units in Communication (OBX-6)**
10^12/L	10*12/L
10^9/L	10*9/L
10^4/L	10*4/L
10^3/L	10*3/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 (age unit)	yr
month (age unit)	mo
day (age unit)	d
hour (age unit)	hr
week (age unit)	wk

3. Some OBX messages uses custom enumeration values. See Table 12 for the meaning of the values.

Table 12 Enumeration value definition in HL7

Data	Value Enumeration
Take Mode	Value enumeration: "O" - open-vial "A" - autoloading "C" – closed-tube
Blood Mode	Value enumeration: "W"- whole blood "P" - predilute "B" – body fluid "Q" – control "M" – micro-WB
Test Mode	Value enumeration: "CBC" "CBC+DIFF" "CBC+RET" "CBC+NRBC" "CBC+DIFF+RET" "CBC+DIFF+NRBC" "CBC+DIFF+RET+NRBC" "RET"
Qc Level	Value enumeration: "L" - low "M" - normal "H" - high
Histogram discriminator adjusted flag and other flags	The data type of OBX-2 is "IS". Value enumeration: "T" - true "F" - false
QC analysis date/time edited flag	"E" - edited. Not transmitted if the date/time is not edited.
Panel (Project Type)	"BL": blood "BF": body fluid

4. Histogram data: the histograms can be transmitted in the following ways based on the software configuraton:

1) do not transmit histogram data.

2) transmitted as bitmap. The data type field of OBX segment is "ED", and the data field is in the form of "^Image^BMP^Base64^……bitmap histogram data……", where "Image" indicates that the data in transmission is data of graphs, "BMP" is the custom subdata type, and

"Base64" is the way of coding the bitmap data.

3) transmitted as binary histogram data. The data type field of OBX segment is "ED", and the data field is in the form of "^Application^Octet-stream^Base64^……histogram data……", where "Application^Octer-stream" is the HL7 standard subdata type, indicating the binary data defined by the application, and "Base64" is the way of coding the bitmap data.

Note: the ID field in the OBX segment defines whether the histogram is transmitted in bitmap or binary data.

5. Scattergram data: the data type field of OBX segment is "ED", and the data field is in the form of "^Image^BMP^Base64^……scattergram bitmap data……", where "Image^BMP^Base64" indicates that the data in transmission is BMP data coded by Base 64.

6. Communication of patient age: the age of the patient is transmitted in an OBX segment which contains an integer and a unit. The age could be "<1" day (same as the analyzer UI).

Appendix C Base64 Encoding Process

1. Select the 3 adjacent bytes (i.e. 24 bit) from the data stream to be encoded; from left to right, divide them into 4 6-bit groups; and then, the ASCII string is obtained by mapping based on Table 13, as shown below:

Initial Data:	15H	A3H	4BH	
Binary data	00010101	10100011	01001011	
6-bit groups obtained after dividing	000101	011010	001101	001011
Corresponding codes	5H	1AH	0DH	0BH
Corresponding characters	F	a	N	L

Table 13 Base64 Mapping

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

2. Repeat step 1 continuously till the whole data stream is encoded.

When the data left is less than 3 bytes, 0 is added to the right to complement. If the 6-bit groups obtained is composed of the complement bit (0) only, then it is mapped to the "=" character. When there is the last one byte left, there will be two "=" characters in the obtained coding string; when two bytes are left, then the obtained coding string consists of one "=" character. See the two examples below:

① Raw data 0AH

00001010

Data obtained after complementing	00001010	00000000	00000000	
6-bit groups obtained after dividing	000010	100000	000000	000000
Corresponding codes	02H	20H	00H	00H
Corresponding characters	C	g	=	=

② Raw data 0AH 0BH

00001010 00001011

Data obtained after complementing		00001010	00001011		00000000
6-bit groups obtained after dividing		000010	100000	101100	000000
Corresponding codes	02H	20H	2CH	00H	
Corresponding characters		C	g	s	=

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