Document Type	Technical Document	Security Classification	Secret
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Communication Protocol

Reference Document(s)

Document No.	Description

Document dispatch department：(according to the following explanation) 1.Tooling、Fixture、all-purpose & Reagent doc must be filled in. 2. Confidential & Top secret doc. must be filled in,but only for needing to release.	

Table of Contents

1 Network Port Communication Process

The analyzer is configured with universal network port; it can be connected to PC or LAN with TCP communication protocol. After starting up, the analyzer monitors the message sent by LIS. After connection is built, the analyzer sends heartbeat control code 0x02 once in 3 seconds. Network communication supports HL7 protocol.

1.1 Process of HL7 communication

1.1.1 The main unit directly sends the test results

The analyzer actively sends the test results to the LIS. Test results and QC data are all send this way. The communication process is shown in Figure 1.

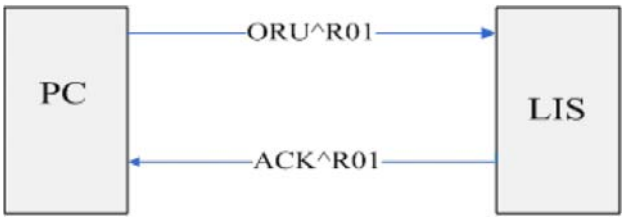

Figure 1 Test results communication process

1.1.2 Query worklist information

Worklist belongs to the Order message. Thus, the corresponding HL7 messages: ORM(General Order Message) and ORR(General Order Response Message) can be used. The communication process is shown in Figure 2.

Figure 2 Worklist searching communication process

2 Serial Port Communication Process

The analyzer support HL7 and 8ID/10ID protocol. For 8ID/10ID protocol, communication can work while handshake is activated or deactivated, Handshake must be activated for HL7 communication protocol.

2.1 Handshake control code

2.1.1 8ID/10ID Handshake Control Codes

Table 0-1 8ID/10ID Control Codes

[ENQ]	0x05
[STX]	0x02
[EOT]	0x04
[EOF]	0x1A
[ETX]	0x03
[ACK]	0x06
[NACK]	0x15
“A”	0x41
“B”	0x42
“C”	0x43
“#”	0x30-0x39
“*”	0x2A

2.1.2 HL7 Handshake Control Codes

Table 0-2 HL7 Control Codes

[ENQ]	0x10
[ETX]	0x0F
[ACK]	0x06
[NACK]	0x15

2.2 8ID/10ID Serial Port Communication Process

2.2.1 Handshake off

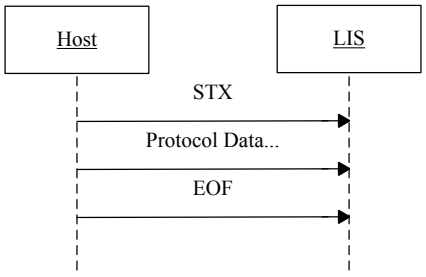

Figure 3 Data Transmission Process of 8ID/10ID (Handshake Off)

2.2.2 Handshake on

When handshake is set to “on”, the data transmission process includes the following 3 steps:

1. Building connection:

The analyzer sends ENQ, LIS returns ACK in 4 seconds, then the connection is built up successfully; if ACK is not returned in 4 seconds, the analyzer sends ENQ again; and if no ACK data is returned in 4 seconds, the transmission will be terminated, and communication error will be reported.

2. Sending protocol data block, which ends with EOT.

3. Terminating connection:

The analyzer sends ETX, LIS returns ACK in 4 seconds, data block transmission succeeds; if no data is returned in 4 seconds, it sends ETX again; if there is still no ACK data returned, the analyzer terminates the transmission and reports communication error, if NACK is returned, the analyzer repeats step 2; and if the message is sent twice without getting the correct response, the analyzer will report error.

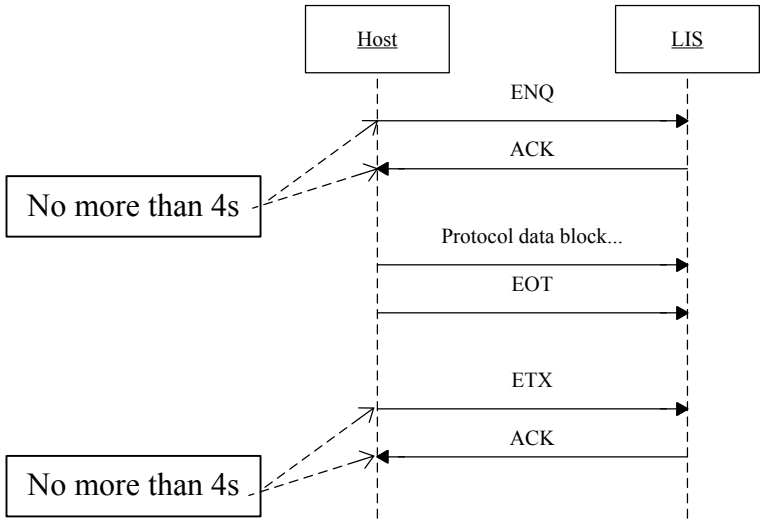

Figure 4 Normal Transmission Process of 8ID/10ID

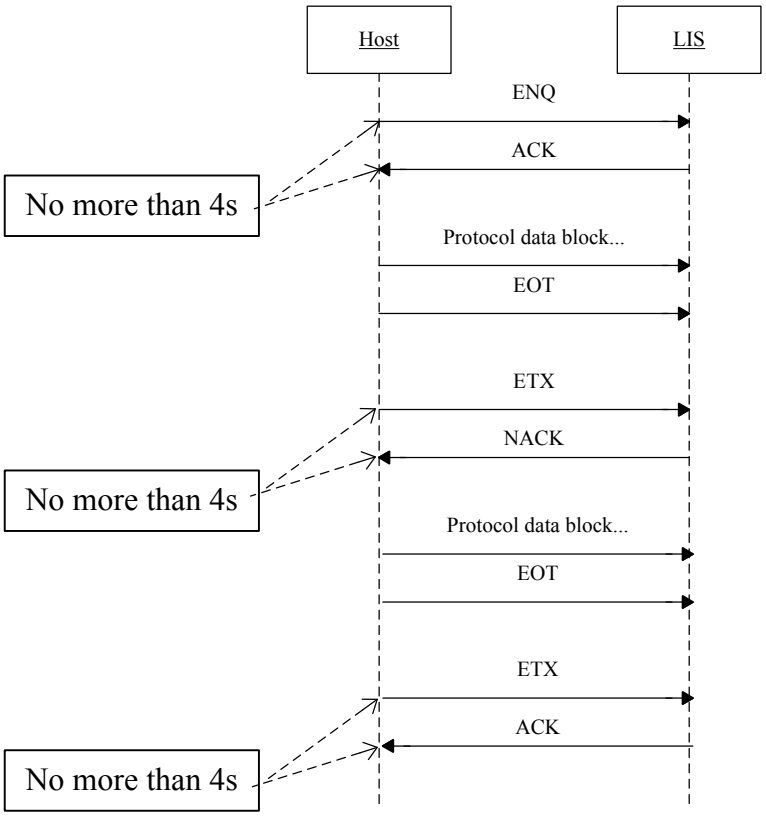

Figure 5 8ID/10ID Handshake Message Resending Process

2.3 HL7 Serial Port Communication Process

HL7 Serial Port Communication Process includes the following 3 steps:

1. Building connection:

The analyzer sends ENQ, LIS returns ACK in 4 seconds, then the connection is built up successfully. If no response is received after 4s, the analyzer resends ENQ. If no response again, it will report error.

2. The analyzer sends protocol data block.

3. Terminating connection:

The analyzer sends EXT, LIS sends ACK back in 4s. If no ACK received in 4s, the analyzer resends EXT. If no ACK received again, it will report error. If NACK is sent back by the LIS in 4s after the analyzer sends EXT, the analyzer will repeat step 2, and if the message is sent twice without getting the correct response, the analyzer will report error.

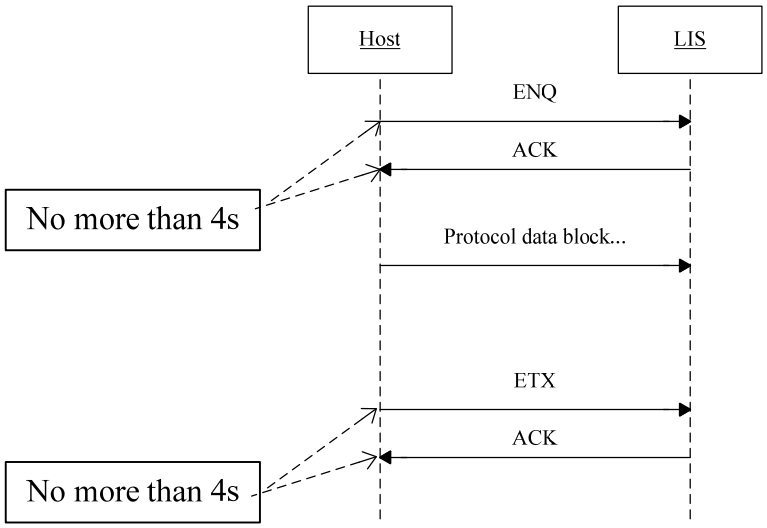

Figure 6 Normal Transmission Process of HL7

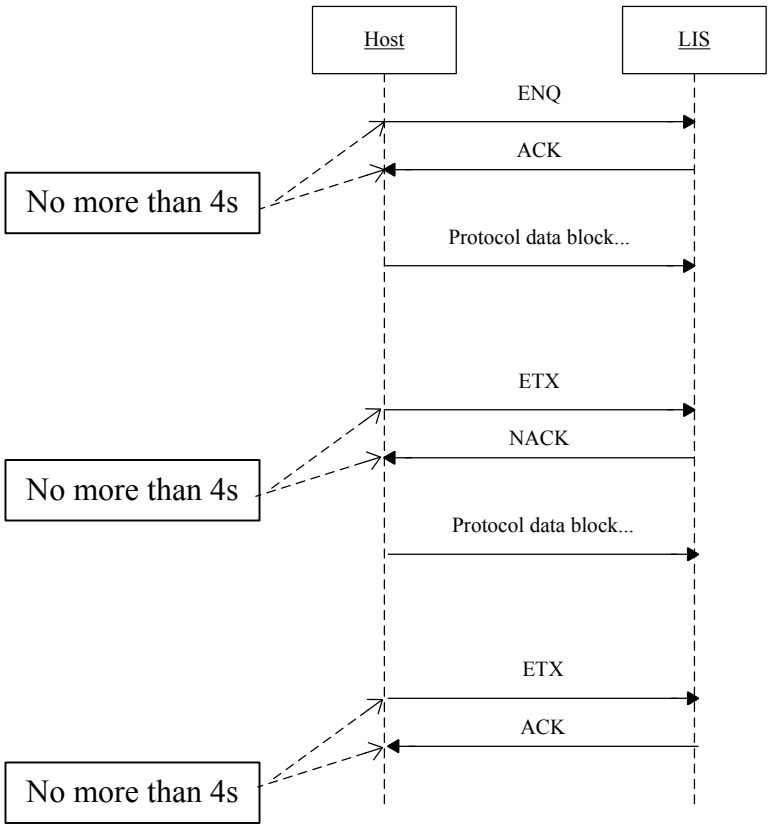

Figure 7 Message Resending Process of HL7

3 8ID/10ID Serial Port Communication Protocol

If the software supports sample IDs up to 8 or 10 digits, select the 8ID/10ID communication protocol; if the software supports sample IDs up to 20 digits, select the HL7 communication protocol.

3.1 Sample Data Format

Table 0-3 Sample Data Format

If handshake is activated	[ENQ]
If handshake is deactivated	[STX]
Body of the text start	
Text Identifier	“A”
Version (for 10ID only)	##
ID length (for 10ID only)	###
The number of parameters (for 10ID only)	###
Number of the parameters having format descriptions (for 10ID only)	##
ID (8ID/10ID supports 8/10 digits)	########/##########
Sample Mode	#
Month	##
Day	##
Year	####
Hour	##
Minutes	##
WBC[109/L]	###.#
Lymph#[109/L]	###.#
Mid#[109/L]	###.#
Gran#[109/L]	###.#
Lymph%[%]	#.###
Mid%[%]	#.###
Gran%[%]	#.###
RBC[1012/L]	#.##
HGB[g/L]	###
MCHC[g/L]	####
MCV[fL]	###.#
MCH[pg]	###.#
RDW-CV[%]	#.###
HCT[%]	#.###
PLT[109/L]	####
MPV[fL]	##.#
PDW	##.#

PCT[%]	#.##
RDW—SD[fL]	###.#
Reserved	##########
Rm	#
R1	#
R2	#
R3	#
R4	#
Pm	#
Pl	#
Ps	#
L1 Region	###
L2 Region	###
L3 Region	###
L4 Region	###
L5 Region	###
L6 Region	###
L7 Region	###
L8 Region	###
Reserved	################
WBC Histo(256 channels)	###
RBC Histo(256 channels)	###
PLT Histo(256 channels)	###
Body of the text end	
If handshake is activated	[EOT]
If handshake is deactivated	[EOF]
If handshake is activated	[ETX]

For all the data formats, if the data are marked "*", then "*" (2A Hex) will be transmitted to the host.

3.2 Standard L-J QC Data Format

Table 0-4 Standard L-J QC Data Format

If handshake is activated	[ENQ]
If handshake is deactivated	[STX]
Body of the text start	
Text Identifier	"B"
File No.	#
Lot No.	######
Month	##
Day	##

Year	####
WBC[109/L]	###.#
RBC[1012/L]	#.##
HGB[g/L]	###
PLT[109/L]	####
Lymph#[109/L]	###.#
Lymph%[%]	#.###
Gran#[109/L]	###.#
Gran%[%]	#.###
HCT[%]	#.###
MCV[fL]	###.#
MCH[pg]	###.#
MCHC[g/L]	####
WBC Limit[109/L]	###.#
RBC Limit[1012/L]	#.##
HGB Limit[g/L]	###
PLT Limit[109/L]	####
Lymph# Limit[109/L]	###.#
Lymph% Limit[%]	#.###
Gran# Limit[109/L]	###.#
Gran% Limit[%]	#.###
HCT Limit[%]	#.###
MCV Limit[fL]	###.#
MCH Limit[pg]	###.#
MCHC Limit[g/L]	####
Body of the text end	
If handshake is activated	[EOT]
If handshake is deactivated	[EOF]
If handshake is activated	[ETX]

In the standard L-J QC data format, if any of the lot number, month, day or year fields in the L-J QC Edit screen is left blank, it will be transmitted as "*" (2A Hex).

3.3 Run L-J QC Data Format

Table 0-5 Run L-J QC Data Format

If handshake is activated	[ENQ]
If handshake is deactivated	[STX]
Body of the text start	
Text Identifier	“C”
Month	##

Day	##
Year	####
Hour	##
Minutes	##
WBC[109/L]	###.#
RBC[1012/L]	#.##
HGB[g/L]	###
PLT[109/L]	####
Lymph#[109/L]	###.#
Lymph%[%]	#.###
Gran#[109/L]	###.#
Gran%[%]	#.###
HCT[%]	#.###
MCV[fL]	###.#
MCH[pg]	###.#
MCHC[g/L]	####
Body of the text end	
If handshake is activated	[EOT]
If handshake is deactivated	[EOF]
If handshake is activated	[ETX]

4 HL7 Communication Protocol

4.1 Low-Level Protocol

TCP interface communication/port communication is based on byte stream, there is no message boundary. 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). Messages are transmitted in the following format:

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

among which:

<SB> = Start Block character (1 byte)

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

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

ddddd is valid data of the HL7 information, and is displayed as UTF-8 code string.

<EB> = End Block character (1 byte)

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

<CR> = Carriage Return (1 byte)

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

4.2 HL7 Message Constructing Principles

Every HL7 message consists of several segments and ends up with the <CR>.

Each segment consists of the segment name of three characters and a number of fields, and each field consists of some components and subcomponents. The first segment of each segment is MSH segment, which includes the field, unit and unit of delimiter.

MSH|^~\&| | |||1231235941||ORU^R01|2|P|2.3.1||||||UNICODE

The five characters following MSH segment 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 4-1 HL7 standard recommends characters

Character	It means...
|	Field delimiter
^	Component delimiter
&	Subcomponent delimiter
~	Repetition delimiter
\	ESC

The first field of MSH contains 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 below.

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.

4.3 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:

Table 4-2 Principles for escape character conversion for HL7 interface

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 escape sequence represents the ESC delimiter, whose value is defined in the MSH segment.

4.4 Message Information

During the communication process, the message construction involves ORU^R01 message and ACK^R01 message. ORU^R01 message and ACK^R01 message appeared twinning, and is used for the communication of the analysis result and QC data.

4.4.1 ORU^R01 message

ORU^R01 message: is mainly 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.

}

}

4.4.2 ACK^R01 message

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

ACK Acknowledgment Description

MSH Message head

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

4.4.3 ORM^O01 message

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

ORM General Order Message	Description
MSH	Message header
{ORC}	Common message of Order, including the No. information of the sample searched

4.4.4 ORM^O02 message

ORR^O02 message: affirming 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 affirm
[	
PID	Patient basic information
[PV1]	Patient visit information
]	
{	
ORC	Common message of Order, including the sample No.
[	
OBR	sample information
{	
[OBX]	Data of other sample information, including work mode, etc.
}	
]	
}	

4.5 Message Description

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 Jia ||19950804000000|Female

↑ ↑ ↑

Segment name Field 1 Field 3

Note: for MSH segment, the field delimiter following 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 HL7 Data Type Definition 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 mark while analyzing the message segment.
5. Description: description to the value of the field.
6. Example: example of the fields.

4.5.1 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|^~\&| | |||20361231235941||ORU^R01|2|P|2.3.1|||||UNICODE

For the value of each filed of the MSH message.

Table 4-3 Meaning table of the MSH message

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.	
4	Sending Facility	EI	180	Device of sending terminal.	
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	20361231235925
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.	2
11	Processing ID	PT	3	Message processing ID. Value:	P

				"P": sample and worklist searching message; "Q": QC analysis result message; In Ack messages, it is consistent with the previously received message.	
12	Version ID	VID	60	HL7 version number. Value: "2.3.1".	2.3.1
18	Character Set	ID	10	Character set. Value: "UNICODE", which means the message is expressed in UTF-8 strings.	UNICODE

4.5.2 MSA

MSA(Message Acknowledgment)message includes the confirmation information, which appears in the Bi-Directional Response Message.

Message example:

MSA|AA|1

See Table 4-4 for field definitions in use.

Table 4-4 MSA Field Definitions

No.	Field/delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Acknowledgment Code	ID	2	Acknowledgment 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); it also contains error condition specification information; see **错误!未找到引用源。** for the value.	

Table 4-5 Error code of MSA-6 field

Status code (MSA-6)	Status text (MSA-3)	Description/Remark
Successful:		AA
0 Message	accepted	Successful
Error status code:		AE
100	Segment sequence error	Segment order in the message is wrong, or necessary segment lost
101	Required field missing	Necessary field lost in a segment
102	Data type error	Segment data type error, e.g. numbers are replaced by characters

103	Table value not found	Table value is not found; not used temporarily
Rejection status code:		AR
200	Unsupported message type	Message type is not supported
201	Unsupported event code	Event code is not supported
202	Unsupported processing id	Processing ID is not supported
203	Unsupported version id	Version ID is not supported
204	Unknown key identifier	Unknown key identifier, e.g. transmitting the patient information that is not exited
205	Duplicate key identifier	Repeated key words existed
206	Application record locked	Issues can not be executed at application program saving level, e.g. database is locked
207	Application internal error	Other interior errors of application program

4.5.3 PID

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

Message example:

PID|1||7393670^^^^MR||Jerry^Tom||19900804000000|Male

See Table 4-6 for field definitions in use.

Table 4-6 Definition table of the PID field

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 "patient ID^^^^MR". Used as batch No. of control in QC messages.	7393670^^^^MR
5	Patient Name	XPN	48	Patient name (consists of Animal Name and Owner Name), in the form of "AnimalName^OwnerName"	Jerry^Tom
7	Date/Time of Birth	TS	26	Used as time of birth in sample information messages. In the form of	19900804000000

				YYY[MM[DD[HH[MM[SS]]]]]. Used as expiration date of the control in QC messages.	
8	Sex	IS	1	Gender, string.	Male

4.5.4 PV1

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

Message example:

PV1|1||ICU^^BedNO1

See Table4-7 for field definitions in use.

Table 4-7 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, consistent with the interface	
3	Assigned Patient Location	PL	80	Patient location information; in the form of “Department^ ^Bed No.”	

4.5.5 OBR

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

Message example:

OBR|1||ABCDEF-0YT-4|00001^Automated

Count^99MRC||20000706050000|20090626103851|||DELIVERY||||20000706070000|||||||||HM|||||||Li

See Table 4-8 for field definitions in use.

Table 4-8 OBR Field Definitions

No.	Field/delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Set ID - OBR	SI	10	Serial No., used to identify different OBR segments in a message	1
3	Filler Order Number +	EI	22	Used as sample ID in sample analysis result messages. Used as QC file No. in QC messages.	ABCDEF-0YT-4
4	Universal	CE	200	Universal service ID, used to	00001^Autom

	Service ID			identify different types of analysis results. See the enumeration constant sampling section for details.	ated Count^99MRC
6	Requested Date/time	TS	26	Draw time. Used as the time when the blood sample is drawn.	20000706050000
7	Observation Date/Time #	TS	26	Time of analysis.	20090626103851
10	Veterinarian	XCN	60	Veterinarian	DELIVERY
13	Relevant Clinical Info.	ST	300	Relevant clinical information. Can be used as the clinical diagnostic information of patient information.	
14	Specimen Received Date/Time *	TS	26	Time when the sample is received. Used as the time when the analysis is ordered.	20000706070000
24	Diagnostic Serv Sect ID	ID	10	Diagnosis maker ID; value: "HM" (means Hematology)	HM
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.	Li

4.5.6 OBX

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

Message example:

OBX|7|NM|6690-2^WBC^LN||9.55|10*9/L|4.00-10.00||||F

See Table 4-9 for field definitions in use.

Table 4-9 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.	7
2	Value Type	ID	3	Data type of the analysis result. Value: "ST", "NM", "ED", "IS", etc.	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 enumeration constant sampling section for details. 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. (Binary data like histogram or scattergram are converted to codes using the Base64 coding method. See the following sections for the coding method).	9.55
6	Units	CE	90	Unit of analysis items. It adopts the ISO standard unit. See the enumeration constant sampling section for details.	10*9/L
7	References Range	ST	90	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”	
11	Observ Result Status	ID	1	Status of the analysis result. "F" -（Final Result）, which refers to 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 3 types of flags in all: O – reagent expiration E – result edited flag e – result changed due to the manual editing of another parameter result based on which it is calculated	

4.5.7 ORC

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

Message example:

ORC|RF||SampleID||IP

See Table 4-10 for definition of the fields used.

Table 4-10 ORC Field Definitions

No.	Field/delimiter Name	Data Type	Recommended Max Length	Description	Example
1	Order Control	ID	2	Order control word In the ORM message the value is “RF” which means “re-fill the order request”. In the ORR message the value is “AF” which means “affirm the re-filled order”.	RF
2	Placer Order Number	EI	22	Placer order number In the ORM message the value is empty; in the ORR message the value is the sample ID.	
3	Filler Order Num	EI	22	Filler Order Number In the ORM message the value is the sample ID; in the ORR message the value is empty.	SampleID
5	Order Status	ID	2	Order status In the ORM message	IP

				the value is “IP” which means “order is being processed, but results are not obtained”; in the ORR message the value is empty.	

4.6 Example

4.6.1 Sample Message

MSH|^~\&|||||20150120161704||ORU^R01|1|P|2.3.1||||||UNICODE

PID|1||binglihao^^^^MR||^zhangsan||19820123000000|Male

PV1|1|Zhuyuan|ICU^^chuanghao

OBR|1||dz-1-19|00001^Automated

Count^99MRC||20141013101300|20141013125435|||lisi||||20141013121200|||||||||HM

OBX|1|IS|08001^Take Mode^99MRC||O||||||F

OBX|2|IS|08002^Blood Mode^99MRC||W||||||F

OBX|3|IS|01002^Ref Group^99MRC||Adult Male||||||F

OBX|4|NM|30525-0^Age^LN||32|yr|||||F

OBX|5|ST|01001^Remark^99MRC||beizhu||||||F

OBX|6|NM|6690-2^WBC^LN||5.2|10*9/L|4.0-10.0|N|||F

OBX|7|NM|731-0^LYM#^LN||2.2|10*9/L|0.8-4.0|N|||F

OBX|8|NM|736-9^LYM%^LN||42.4|%|20.0-40.0|H~N|||F

OBX|9|NM|789-8^RBC^LN||3.03|10*12/L|4.00-5.50|L~N|||F

OBX|10|NM|718-7^HGB^LN||96|g/L|120-160|L~N|||F

OBX|11|NM|787-2^MCV^LN||96.1|fL|80.0-100.0|N|||F

OBX|12|NM|785-6^MCH^LN||31.7|pg|27.0-34.0|N|||F

OBX|13|NM|786-4^MCHC^LN||330|g/L|320-360|N|||F

OBX|14|NM|788-0^RDW-CV^LN||17.8|%|11.0-16.0|H~N|||F

OBX|15|NM|21000-5^RDW-SD^LN||63.7|fL|35.0-56.0|H~N|||F

OBX|16|NM|4544-3^HCT^LN||29.1|%|40.0-54.0|L~N|||F

OBX|17|NM|777-3^PLT^LN||235|10*9/L|100-300|N|||F

OBX|18|NM|32623-1^MPV^LN||11.0|fL|6.5-12.0|N|||F

OBX|19|NM|32207-3^PDW^LN||16.5||15.0-17.0|N|||F

OBX|20|NM|10002^PCT^99MRC||0.258|%|0.108-0.282|N|||F

OBX|21|NM|10027^MID#^99MRC||0.7|10*9/L|0.1-1.5|N|||F

OBX|22|NM|10029^MID%^99MRC||12.5|%|3.0-15.0|N|||F

OBX|23|NM|10028^GRAN#^99MRC||2.4|10*9/L|2.0-7.0|N|||F

OBX|24|NM|10030^GRAN%^99MRC||45.1|%|50.0-70.0|L~N|||F

OBX|25|NM|10013^PLCC^99MRC||83|10*9/L|30-90|N|||F

OBX|26|NM|10014^PLCR^99MRC||35.2|%|11.0-45.0|N|||F

OBX|27|NM|15004^WBC Histogram. Meta Length^99MRC||1||||||F

OBX|28|NM|15009^WBC Histogram. Total^99MRC||128||||||F

OBX|29|NM|15010^WBC Lym left line.^99MRC||8||||||F

OBX|30|NM|15011^WBC Lym Mid line.^99MRC||26||||||F

OBX|31|NM|15012^WBC Mid Gran line.^99MRC||44||||||F

OBX|32|NM|15013^WBC Gran right line^99MRC||105||||||F

OBX|33|ED|15000^WBC Histogram.

Binary^99MRC||^Application^Octer-stream^Base64^AAAAAAABAwkVKUZjdn59d21gUUQ6MSsmIh8dH

BsbGhgXFhYWFhcWFRQTExQUExIREhMUFRYYGhsbHB0dHR0fISMkJSYnKCoqKiooJyUiIB0bGhkYF

xYUEhEPDw0MCggHBgYFBAQDAwMCAgICAgEBAQEBAQEBAQEAAAAAAAAAAAA=||||||F

OBX|34|NM|15051^RBC Histogram. Left Line^99MRC||17||||||F

OBX|35|NM|15052^RBC Histogram. Right Line^99MRC||79||||||F

OBX|36|NM|15053^RBC Histogram. Binary Meta Length^99MRC||1||||||F

OBX|37|NM|15057^RBC Histogram. Total^99MRC||128||||||F

OBX|38|ED|15050^RBC Histogram.

Binary^99MRC||^Application^Octer-stream^Base64^AAAAAAAAAAAAAAAAAAAAAAECAgMEBQUH

CQsPFBoiLDdFUl9sd3Z7fnx2bWhhWk9GPzk0LCYgGhURDgwLCQgHBwYFBAQDAwICAgIBAQICAgE

BAQEBAQEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

AA=||||||F

OBX|39|NM|15111^PLT Histogram. Left Line^99MRC||3||||||F

OBX|40|NM|15112^PLT Histogram. Right Line^99MRC||96||||||F

OBX|41|NM|15113^PLT Histogram. Binary Meta Length^99MRC||1||||||F

OBX|42|NM|15117^PLT Histogram. Total^99MRC||128||||||F

OBX|43|ED|15100^PLT Histogram.

Binary^99MRC||^Application^Octer-stream^Base64^AAUJDhQaISgxOkNNVl9lanB0eHt9fX59fHt5dnNvbG

hlYV5aVlNPTElGQ0E+PDk3NDIwLSspJyUjIR8dGxkXFhQTEhEREA8PDg0NDQ0NDQwMDAwMDAwM

DA0NDQ0ODg4PDw8PDw8PDw8PDw8PEBARERITExQVFRYWFhYWFxgYGBg=||||||F

4.6.2 Sample Response Message

A sample response message needs to be responded after receiving a sample result each time. 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 2.

MSH|^~\&|LIS||||20361231235956||ACK^R01|1|P|2.3.1||||||UNICODE MSA|AA|2

4.6.3 QC Message

The content form of QC Message is different from that of the sample count result message, the MSH-11 of the QC message is valued as Q, the represented message type is QC data.

4.6.4 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.

4.6.5 Bidirectional LIS inquiry response message

When the LIS received an inquiry message, it needs to send back an inquiry response message. The first two message segments of the inquiry response message are MSH and MSA. The MSH-9 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 inquiry response message. If the LIS gets searching results for the inquiry, 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 inquiry response message with searching results, in which the ORC-1 value is AF, and ORC-2 is the filter (the sample ID). Note that the OBR-2 field indicates the sample ID, which should be the same value as in the ORC-2 field; Otherwise, the message will be regarded as incorrect.

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

MSH|^~\&||Mindray|||20141105151358||

ORR^O02||P|2.3.1||||||UNICODE

MSA|AA|60PID|1||test1^^^^MR||^Tom||20080525000000|

PV1|1||ICU^^BedNO1

ORC|AF|257

OBR|1|257||00001^Automated Count^99MRC||20090205100000||||S1||||20090203101020|||||||||HM|||||||A5

OBX|1|IS|08002^Blood Mode^99MRC||W||||||F

OBX|2|IS|08003^Test Mode^99MRC||CBC||||||F

OBX|3|NM|30525-0^Age^LN||14|yr|||||F

OBX|4|ST|01001^Remark^99MRC||R5||||||F

4.7 HL7 Coding and Constant Definition

4.7.1 OBR-4 Message Type Coding

OBR-4 field is used to mark the analysis type

Table 4-11 OBR-4 message type value table

Data	Code（ID）	Name	EncodeSys
Sample Analysis Result	00001	Automated Count	99MRC
LJ QC count result	00003	LJ QCR	99MRC

4.7.2 OBX-3 parameter type code

Each OBX message field contains an analysis item or information of other data. OBX-2 defines the HL7 data type of the carried data; OBX-3(Observation Identifier) is the mark of the data item, which displays as “ID^Name^EncodeSys”; OBX-5 contains the value of the data item; OBX-6 contains the parameter unit, which is displayed as the ISO standard unit.

Table 4-12 OBX-3 parameter type code

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
Blood Mode	IS	08002	Blood Mode	99MRC	08002^Blood Mode^99MRC
Measurement Mode	IS	08003	Test Mode	99MRC	08003^Test Mode^99MRC
Age	NM	30525-0	Age	LN	30525-0^Age^LN
Remarks	ST	01001	Remark	99MRC	01001^Remark^99MRC
Reference group	IS	01002	Ref Group	99MRC	01002^Ref Group^99MRC
Level of control	IS	05001	Qc Level	99MRC	05001^Qc Level^99MRC
Reexam flag	IS	01006	Recheck flag	99MRC	01006^ Recheck flag^99MRC
Parameter Result Items					
WBC	NM	6690-2	WBC	LN	6690-2^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
MID	NM	10027	MID #	99MRC	10027^ MID #^99MRC
MID_PER	NM	10029	MID %	99MRC	10029^ MID %^99MRC
GRAN	NM	10028	GRAN#	99MRC	10028^GRAN#^99MRC
GRAN_PER	NM	10030	GRAN%	99MRC	10030^GRAN%^99MRC
RUO parameter					
ALY	NM	26477-0	*ALY#	LN	26477-0^*ALY#^LN
ALY_PER	NM	13046-8	*ALY%	LN	13046-8^*ALY%^LN
LIC (Large Immature Cell)	NM	10000	*LIC#	99MRC	10000^*LIC#^99MRC
LIC_PER（Large	NM	10001	*LIC%	99MRC	10001^*LIC%^99MRC

Immature Cell Percentage）					
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
PLCC	NM	10013	PLCC	99MRC	10013^ PLCC^99MRC
PLCR	NM	10014	PLCR	99MRC	10014^ PLCR^99MRC
QC specific parameter					
GRAN-X	NM	10003	GRAN-X	99MRC	10003^GRAN-X^99MRC
GRAN-Y	NM	10004	GRAN-Y	99MRC	10004^GRAN-Y^99MRC
GRAN-Y(W)	NM	10005	GRAN-Y(W)	99MRC	10005^GRAN-Y(W)^99MRC
WBCMCV	NM	10006	WBC-MCV	99MRC	10006^WBC-MCV^99MRC
Intermediate Data of Analysis Results histogram and scattergram data of WBC, RBC, and PLT, etc.)					
WBChistogram binary data	ED	15000	WBC Histogram. Binary	99MRC	15000^WBC Histogram. Binary^99MRC
Left discriminator of the WBC histogram	NM	15001	WBC Histogram. Left Line	99MRC	15001^WBC Histogram. Left Line^99MRC
Right discriminator of the WBC histogram	NM	15002	WBC Histogram. Right Line	99MRC	15002^WBC Histogram. Right Line^99MRC
Middle discriminator of the WBC	NM	15003	WBC Histogram. Middle Line	99MRC	15003^WBC Histogram. Middle Line^99MRC

histogram					
WBC histogram metadata length	NM	15004	WBC Histogram. Meta Length	99MRC	15004^WBC Histogram. Meta Length^99MRC
WBC histogram left discriminator adjusted flag	NM	15005	WBC Histogram. Left Line Adjusted	99MRC	15005^WBC Histogram. Left Line Adjusted^99MRC
WBC histogram right discriminator adjusted flag	NM	15006	WBC Histogram. Right Line Adjusted	99MRC	15006^WBC Histogram. Right Line Adjusted^99MRC
WBC histogram middle discriminator adjusted flag	NM	15007	WBC Histogram. Middle Line Adjusted	99MRC	15007^WBC Histogram. Middle Line Adjusted^99MRC
WBC histogram bitmap data	ED	15008	WBC Histogram. BMP	99MRC	15008^WBC Histogram. BMP^99MRC
Total number of WBC Histogram	NM	15009	WBC Histogram. Total	99MRC	15009^WBC Histogram. Total^99MRC
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	99MRC	15053^RBC Histogram. Binary Meta Length^99MRC

length			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
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 histogram left discriminator adjusted flag	IS	15114	PLT Histogram. Left Line Adjusted	99MRC	15114^PLT Histogram. 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
DIFF scattergram bitmap data	ED	15200	WBC DIFF Scattergram. BMP	99MRC	15200^WBC DIFF Scattergram. BMP^99MRC
DIFF scattergram binary data	ED	15201	WBC DIFF Scattergram. BIN	99MRC	15201^WBC DIFF Scattergram. BIN^99MRC

DIFF Scattergram Type data	ED	15202	WBC DIFF Scattergram. BIN	99MRC	15202^ WBC DIFF Scattergram. BIN type data^99MRC
DIFFscattergram metadata length	NM	15203	WBC DIFF Scattergram. Meta len	99MRC	15203^ WBC DIFF Scattergram. Meta len^99MRC
DIFF scattergram metadata length	NM	15204	WBC DIFF Scattergram. Meta count	99MRC	15204^ WBC DIFF Scattergram. Meta count^99MRC
Flags of Abnormal Blood Cell Differential or Morphology					
WBC Abn.	IS	12011	WBC Abnormal	99MRC	12011^WBC Abnormal^99MRC
Immature Granulocyte?	IS	34165-1	Imm Granulocytes ?	LN	34165-1^Imm Granulocytes?^LN
Abn./Atypical Lymph?	IS	15192-8	Atypical Lymphs?	LN	15192-8^Atypical Lymphs?^LN
RBC Distribution Abn.	IS	12013	RBC Abnormal distribution	99MRC	12013^RBC Abnormal distribution^99MRC
Anemia	IS	12014	Anemia	99MRC	12014^Anemia^99MRC
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
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^99M

					RC
Eosinophilia	IS	12009	Eosinophilia	99MRC	12009^Eosinophilia^99MRC
Macrocytes	IS	15198-5	Macrocytes	LN	15198-5^Macrocytes^LN
Microcytes	IS	15199-3	Microcytes	LN	15199-3^Microcytes^LN
Erythrocytosis	IS	12012	Erythrocytosis	99MRC	12012^Erythrocytosis^99MRC
Thrombocytosis	IS	12017	Thrombocytosis	99MRC	12017^Thrombocytosis^99MRC
Thrombopenia	IS	12018	Thrombopenia	99MRC	12018^Thrombopenia^99MRC

4.7.3 Analysis Parameter

The analysis parameter unit is displayed as standard unit.

Table 4-13 Parameter Units in Analysis

Units in Software	Parameter Units in Communication (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 (age unit)	yr
month (age unit)	mo
day (age unit)	d

hour (age unit)	hr
week (age unit)	wk

4.8 Enumeration Value of the Other HL7 Field

Table 4-14 Enumeration Value of the Other HL7 Field

Data	Value Enumeration
Take Mode	Value enumeration: “O” - open-vial “A” - autoloading
Blood Mode	Value enumeration: “W”- whole blood “P” - predilute “W_WBCHGB” － WBC/HGB whole blood “P_WBCHGB” －WBC/HGB predilute. specific 3-diff blood mode “W_RBCPLT” － RBC/PLT whole blood, specific 3-diff blood mode “P_RBCPLT""－ RBC/PLT predilute, specific 3-diff blood mode
Test Mode	Value enumeration: “CBC+DIFF”
Qc Level	Value enumeration: “L”- low “M”- normal “H”- high
Histogram discriminator adjusted mark and reexam flag and other flags	The data type of OBX-2 is "IS". Value enumeration: “T”- true “F”- false

4.9 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)>

4.10 Binary Data Communication

Histogram data is transmitted the binary. :The data type field of OBX segment is "ED", and the data field is in the form of ^Application^Octer-stream^Base64^……histogram data……", meanwhile the "Application" indicates that application program data is transmitted, "Octer-stream" indicates the data is of byte stream type, "Base64" indicates the coding mode of the bitmap data.

The scattergram binary data transmission is the similar as the histogram data.

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

4.11 Base64 Coding

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 4-15 below.

Raw 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 4-15 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 l	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 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 00001010 00001011 00000000

6-bit groups obtained after 000010 100000 101100 000000

Corresponding codes 02H 20H 2CH 00H

Corresponding characters C g s =