

Appendix B Network communication interface protocol V1.1

A.1 Network communication interface protocol V1.1

The protocol is applicable to information transmission between Automatic Hematology Analyzer (model: BF-6900) and the upper computer (LIS). It is in compliance with HL7 standard, and the HL7 version is 2.3.1.

A.2 Definitions

Message header (MSH): the first portion of each message is used to define the purpose and usage of messages, and each message consists of several sections. The first segment of a message is the message head segment which shows the program name, message type and the only message ID number for sending and reception, and the composition of the following segments is determined by the message type. For example, a sample message is transmitted by the section format OBR, and a test result message is transmitted by several OBX sections.

Segment: a message section consists of several data fields and each segment is provided with a name to define its contents and function. For example, MSH, PID, and PV1.

Data field: a message section consists of several data fields. The fields are separated by separators.

A.3 Grammatical format

<SB>dddd <EB><CR>

<SB>: message start character (1 byte). ASCII character <VT>, i.e. 0x0B.

dddd: data (composed of different length of bytes). This is HL7 data contents of the block. The data can contain any values of single byte greater than the hexadecimal value 0x1F and carriage return of ASCII code, <CR>.

<EB>: message end character (1 byte). ASCII character <FS>, i.e. 0x1C.

<CR>: carriage return (1 byte). ASCII character <CR>, i.e. 0x0D.

For example:

<SB> MSH|^~\&|BCC3900|X1706900BF0001|||20090419104618||ORU^R01|1|P|2.3.1||||CHN|UTF-8 <CR>
<EB><CR>

Where:

The five characters after MSH are separators among data fields, assemblies and sub-assemblies. Although those characters are any non-text characters, the characters in the table below are recommended in HL7 standard:

Delimiter	value
Data field separator	
Component separator	^
Sub-component separator	&
Repeating delimiter	~
Quoting character	\

A.4 Message section of the protocol

(1)MSH— Message header

(2)PID— Patient information

(3)PV1— Case

(4)OBR— Testing report information

(5)OBX— Testing report detection information

(6)MSA- Response

(7)ORC- Application

A.5 HL7 attribute list

The message sections of the agreement are classified as required, optional and repeatable.

A.5.1 MSH definition list

MSH – message header: this section is required, including the basic information of HL7 message like the value of

message separator, message type and encoding system, and it is the first section of each HL7 message.

Message example:

MSH|^~\&|BF-6900|0000011||20180607102543||ORU^R01|1|P^S|2.4|||CHS|UTF-8

No.	Field name	Length	HL7 recommended length	Description	Examples
1	Field separator	1	1	The first field separator after the name of the message section which defines the values of section separators of the other parts.	
2	Coded character	4	4	Component separator, repetition separator, escaping separator, and sub-component separator.	^~\&
3	Sender program	7	180	Sender application program, value: XXX	XXX
4	Instrument code	10	180	Sender equipment, value: instrument code	1234567890
5	Receiving end program	3	180	Application program of receiving end.	LIS
7	Sending time	14	26	Time of current message. To call the time information of the system. Send time message to create time (in the form of YYYY[MM[DD[HH[MM[SS]]]]], and take the system time value. For instance, 20110310144704	20090419104618
9	Message type	7	7	Message type, like ORU^R01. The format is "Message type^Event type^Message structure name". Value: ORU^R01 (sample)	ORU^R01
10	Message control ID	20	20	The message control ID is used to uniquely identify a message. Value: PID	361
11	Processing ID number	3	3	Process ID and always take P (indicating the query information of samples and work lists); Q (QC count results)	P
12	HL7 version No.	3	60	The protocol uses HL7 version No. Value: 2.3.1	2.3.1
18	Character set	10	10	The worldwide character standard in ISO/IEC 10646-1-1993, value: UTF-8	UTF-8

A.5.2 PID definition list

PID – patient information: optional, used for transmission of patient sample, including case No., name, age and sex

Message example:

PID|1||7393670||Liu Jia||F|||||||||||||||||25^Y<cr>

No.	Field name	Length	HL7 recommended length	Description	Examples
1	No.	4	10	Determine the message segment of different patients.	1
3	Case No.	16	16	Patient ID, the case No. here	1234567890
5	Name	30	30	Patient name	Wang Sanqiang
8	Sex	1	1	Sex Male, sent as M; sex Female, sent as F; and others sent as O.	F
31	Age	5	5	Age and age unit. The age and age unit are separated by ^. The age is a integer with length of 3. The age unit is a character string with length of 1. Y stands for year, M for month, D for day, and H for hour.	25^Y

A.5.3 PV1 definition list

PV1 - Patient admission information: This message segment is optional and is used for transmission of patient

samples, including departments, charges, etc.

Message example:

PV1|1||Internal Medicine||||||||||Self-paying<cr>

No.	Field name	Length	HL7 recommended length	Description	Examples
1	No.	4	4	It is used to mark the different PV1 sections of message.	1
3	Department	80	80	Patient location information, indicated in the form of "Department"	Outpatient
20	Expense type	50	50	Charge type, character string	Self paying

A.5.4 OBR definition list

OBR - Inspection report information: This message section is optional and mainly contains inspection report information, including sample numbers, inspection time, and so on.

Message example:

OBR||23|31C3F010230DFB03|1001^CountResults||20071207080000|20071207160000|||||
|20071207083000|||||2311|322<cr>

No.	Field name	Length	HL7 recommended length	Description	Examples
1	No.	4	10	Determine different OBR fields.	1
2	Bar code	22	22	Number of the doctor's advice for the requester, used as the sample bar code No. Bar code ID for detection Lot number in L-J/Xbar/Xbar-R QC	1A2165C24B
3	Sample No.	12	12	Number of doctor's advice of the executor, used as the sample No. Sample ID for detection File No. in L-J/Xbar/Xbar-R QC	20090807011
4	Date servicing type	200	200	Service mark, for identifying different counting results. Specific values and parameter are shown in the appendix: OBR-4 message code definition.	1001^CountResults
6	Sampling time	14	26	Request time/date. Sampling time in sample detection Validity in LJ/Xbar/Xbar-R QC	20090807140600
7	Counting time	14	26	Counting time in sample information Counting time in LJ/Xbar/Xbar-R QC Counting time in X-B QC	20090807150616
10	Submitter	8	8	Submitter	Dr
14	Date of submitting	14	26	Date of submitting	20090807150000
20	Inspecting doctor	30	30	Attending doctor, for inspecting doctor	Dr
28	Auditor	150	150	Copy of results for reviewers	Dr

A.5.5 OBX definition list

OBX -Test result: repeatable, mainly including the test result parameters, analysis modes, reference groups, etc.

Message example:

OBX|6|NM|2007^V_WBC||4.63|10*9/L|11.00-12.00| ||F| <cr>

No.	Field name	Length	HL7 recommended length	Description	Examples
1	Serial No. ID	10	10	It is used to mark the different OBX sections of message.	1

No.	Field name	Length	HL7 recommended length	Description	Examples
2	Data type	3	3	Date type of test result, including “ST”, “NM”, “ED” and “IS”	ED
3	Identifier	250	250	Test item mark. The form is “ID^Name”, ID is the test item mark, and the Name is description of test item. The coding value of testing items is shown in appendix: definition of identifier code. Note: ID is the only way to confirm the test parameter, but the Name is used for description instead of marking.	
5	Test result, graphic data, remarks, QC level...	65536	65536	Test result data can be numbers or words. Strings, enumeration values, binary data, and so on [Histograms and scatterplots and the like converted using Base64 encoding] Remarks: Xbar-R QC data format is mean^limit.	4.63 Xbar-r 5.5^1.1
6	Unit	12	250	Unit, used for the test result value. ISO standard unit is adopted.	10*9/L
7	Reference value of test results	30	60	Test result range, format: "lower limit-upper limit of reference value"	12.463-33.569
11	Test result status	20	20	Test result status. The value is “F” - (Final Result) which means the final result.	F

A.5.6 ORC definition table

ORC-Message segment mainly contains Order-related information.

Message example:

ORC|RF||SampleID||IP <cr>

No.	Field name	Length	HL7 recommended length	Description	Examples
1	Order control word	2	2	Value: RF in ORM indicates request; AF in ORR message indicates confirmation.	RF
2	Originator number of Order	22	22	Originator number of Order ORM message is empty, while ORR message is bar code number.	
3	Receiver number of Order	22	22	Receiver number of Order There is a bar code number in the ORM message and empty value in the ORR message.	SampleID
5	Order status	2	2	Through worklist query, the value in ORM message is IP, indicating Order is in processing and no results have been got yet. No value in ORR.	IP

A.5.7 MSA definition table

The MSH segment of the interface includes the following domains:

No.	Field name	Length	HL7 recommended length	Description	Examples
1	Confirmation code	2	2	Confirmation code, AA indicating acceptance, AE error, and AR rejection	AA
2	Message control ID	20	20	The message control ID is same to the MSH-10 of the sender.	1

No.	Field name	Length	HL7 recommended length	Description	Examples
6	Error condition	100	100	Error condition (status code).See the figure below for details	

The value of MSA-6 field is shown in the table below:

Status code (MSA-6)	Status text (MSA-3)	Description/Remark
Success		AA
0	Message accepted	Succeeded
Error status code		AE
100	Segment sequence error	Sequence of middle message segment is incorrect or necessary fields are missing.
101	Required field missing	Required fields in a segment are missing.
102	Data type error	Field data type error, like the figure is written in character.
103	Table value not found	Tabular value not found, not used temporarily.
Status code rejected		AR
200	Unsupported message type	Message type not supported.
201	Unsupported event code	Event code not supported.
202	Unsupported processing id	Handling ID not supported.
203	Unsupported version id	Version ID not supported.
204	Unknown key identifier	Unclear key identifier, like transmitting the information of a nonexistent patient.
205	Duplicate key identifier	Existing repeated key identifier.
206	Application record locked	Affair cannot be executed in application program storage level, like database being locked.
207	Application internal error	Other unknown internal error of application.

The protocol applies the custom coding mode.

A.6 OBR-4 coding definition

Code	Name	Description	OBR-4 field
1001	Count Results	Sample count results	1001^CountResults
1002	LJ QC	L-J QC count results	1002^LJQC
1003	Xbar QC	Xbar QC count results	1003^XbarQC
1004	XB QC	X-B QC count results	1004^XBQC
1005	CRP QC	CRP QC count results	1005^CRPQC
1006	XbarR QC	Xbar-R QC count results	1006^XbarRQC

A.7 OBX-3 identifier code definition

Code	Name	Description	Value type	OBX-3 field
2001	MODE	Analysis mode	IS	2001^MODE
2002	MODE_EX	Measurement mode	IS	2002^MODE_EX
2003	Ref	Reference group	IS	2003^Ref
2004	Note	Remarks	ST	2004^Note
2005	Level	L-J/Xbar/Xbar-R/CRP QC level	IS	2005^Level
2006	V_WBC	Total number of white blood cell	NM	2006^V_WBC
2007	V_NEU_p	Percentage of neutrophil	NM	2007^V_NEU_p
2008	V_LYM_p	Percentage of lymphocyte	NM	2008^V_LYM_p

Code	Name	Description	Value type	OBX-3 field
2009	V_MON_p	Percentage of monocyte	NM	2009^V_MON_p
2010	V_EOS_p	Percentage of eosinophil	NM	2010^V_EOS_p
2011	V_BAS_p	Percentage of basophil	NM	2011^V_BAS_p
2012	V_NEU_c	Number of neutrophil	NM	2012^V_NEU_c
2013	V_LYM_c	Number of lymphocyte	NM	2013^V_LYM_c
2014	V_MON_c	Number of monocyte	NM	2014^V_MON_c
2015	V_EOS_c	Number of eosinophil	NM	2015^V_EOS_c
2016	V_BAS_c	Number of basophil	NM	2016^V_BAS_c
2017	V_RBC	Number of red blood cell	NM	2017^V_RBC
2018	V_HGB	Hemoglobin	NM	2018^V_HGB
2019	V_MCV	Mean red blood cell volume	NM	2019^V_MCV
2020	V_HCT	RBC hematocrit	NM	2020^V_HCT
2021	V_MCH	Mean red blood cell hemoglobin content	NM	2021^V_MCH
2022	V_MCHC	Mean red blood cell hemoglobin concentration	NM	2022^V_MCHC
2023	V_RDW_SD	Standard deviation of red blood cell distribution width	NM	2023^V_RDW_SD
2024	V_RDW_CV	Red blood cell distribution width variation coefficient	NM	2024^V_RDW_CV
2025	V_PLT	Number of platelet	NM	2025^V_PLT
2026	V_MPV	Average platelet volume	NM	2026^V_MPV
2027	V_PCT	Platelet hematocrit	NM	2027^V_PCT
2028	V_PDW	Platelet distribution width	NM	2028^V_PDW
2029	V_P_LCR	Platelet - ratio of macrophage	NM	2029^V_P_LCR
2030	V_P_LCC	Platelet ratio	NM	2030^V_P_LCC
2031	V_CRP	C reactive protein	NM	2031^V_CRP
2032	V_HS_CRP	Hypersensitive C-reactive protein	ST	2032^V_HS_CRP
2101	RBCHistogram.PNG	RBC histogram PNG data	ED	2101^RBCScattergram.PNG
2102	PLTHistogram.PNG	PLT histogram PNG data	ED	2102^PLTScattergram.PNG
2033	BASOScattergram.PNG	BASO scattergram PNG data	ED	2033^BASOScattergram.PNG
2034	DIFFScattergram.PNG	DIFF scattergram PNG data	ED	2034^DIFFScattergram.PNG

A.8 Enumeration type list

Data item	Value
Analysis mode	0 - Whole blood 1 -Trace whole blood 2 -Pre-dilution
Measurement mode	0 -CBC 1-CBC+DIFF 2-CBC+DIFF+CRP 3- CRP
Reference group	0 - Normal 1 - Male 2 - Female 3 - Child 4 - Newborn 5 -Self-defined 16- Self-defined 27 -Self-defined 38 -Self-defined 4 9 -Self-defined 5
QC level	0-high 1-middle 2-low

Example of a complete message section:

(1) Patient sample

```
<SB>MSH|^~&|BF-6900|20180613001|LIS||20110613153322||ORU^R01|3|P|2.3.1|||||UTF-8<cr>
PID|1|||||U|||||||||||||||||1^Y<cr>
```

PV1|1|||||||||||||<cr>
 OBR|1||5|1001^CountResults||20180601091634|20180601091637|||||20180601091634|||||---|||||<cr>
 OBX|1|IS|2001^MODE||0||||F||<cr>
 OBX|2|IS|2002^MODE_EX||1||||F||<cr>
 OBX|3|IS|2003^Ref||0||||F||<cr>
 OBX|4|IS|2004^Note|||||F||<cr>
 OBX|5|NM|2006^V_WBC||0|10^9/L|4-10||||F||<cr>
 OBX|6|NM|2007^V_NEU_p||0|%|50-70||||F||<cr>
 OBX|7|NM|2008^V_LYM_p||0|%|20-40||||F||<cr>
 OBX|8|NM|2009^V_MON_p||0|%|3-8||||F||<cr>
 OBX|9|NM|2010^V_EOS_p||0|%|0.5-5||||F||<cr>
 OBX|10|NM|2011^V_BAS_p||0|%|0-1||||F||<cr>
 OBX|11|NM|2012^V_NEU_c||0|10^9/L|2-7||||F||<cr>
 OBX|12|NM|2013^V_LYM_c||0|10^9/L|0.8-4||||F||<cr>
 OBX|13|NM|2014^V_MON_c||0|10^9/L|0.12-0.8||||F||<cr>
 OBX|14|NM|2015^V_EOS_c||0|10^9/L|0.02-0.5||||F||<cr>
 OBX|15|NM|2016^V_BAS_c||0|10^9/L|0-0.1||||F||<cr>
 OBX|16|NM|2017^V_RBC||0|10^12/L|3.5-5.5||||F||<cr>
 OBX|17|NM|2018^V_HGB||1|g/L|110-160||||F||<cr>
 OBX|18|NM|2019^V_MCV||0|fL|80-100||||F||<cr>
 OBX|19|NM|2020^V_HCT||0|L/L|0.35-0.5||||F||<cr>
 OBX|20|NM|2021^V_MCH||0|pg|27-34||||F||<cr>
 OBX|21|NM|2022^V_MCHC||0|g/L|320-360||||F||<cr>
 OBX|22|NM|2023^V_RDW_SD||0|fL|35-56||||F||<cr>
 OBX|23|NM|2024^V_RDW_CV||0|%|11-16||||F||<cr>
 OBX|24|NM|2025^V_PLT||0|10^9/L|100-300||||F||<cr>
 OBX|25|NM|2026^V_MPV||0|fL|7-13||||F||<cr>
 OBX|26|NM|2027^V_PCT||0|%|0.1-0.28||||F||<cr>
 OBX|27|NM|2028^V_PDW||0|fL|15-18||||F||<cr>
 OBX|28|NM|2029^V_P_LCR||0|%|13-43||||F||<cr>
 OBX|29|NM|2030^V_P_LCC||0|10^9/L|13-129||||F||<cr>
 OBX|30|NM|2031^V_CRP||0|mg/L|0-6||||F||<cr>
 OBX|31|ST|2032^V_HS_CRP||0.00|mg/L|0-6||||F||<cr>
 OBX|32|ED|2101^V_RBCScattergram.PNG||.....PNG binary data converted into BASE64 coding.....|||||F||<cr>
 OBX|33|ED|2102^V_PLTScattergram.PNG||.....PNG binary data converted into BASE64 coding.....|||||F||<cr>
 OBX|34|ED|2033^V_BASOScattergram.PNG||.....PNG binary data converted into BASE64 coding.....|||||F||<cr>
 OBX|35|ED|2034^V_DIFFScattergram.PNG||.....PNG binary data converted into BASE64 coding.....|||||F||<cr>
 <EB><CR>
 (2) L-J QC
 <SB>MSH|^~&|BF-6900|20180613001|LIS||20110613153445||ORU^R01|5|Q|2.3.1|||||UTF-8<cr>
 PID|1|||||||||||||<cr>
 PV1|1|||||||||||||<cr>
 OBR|1||1|1002^LJQC|20180420||20180420113307|||||||||<cr>
 OBX|1|IS|2005^Level||1||||F||<cr>

OBX|2|NM|2006^V_WBC||465.11|10^9/L|490-510||||F||<cr>
 OBX|3|NM|2007^V_NEU_p||0|0%|0-0||||F||<cr>
 OBX|4|NM|2008^V_LYM_p||0|0%|0-0||||F||<cr>
 OBX|5|NM|2009^V_MON_p||0|0%|0-0||||F||<cr>
 OBX|6|NM|2010^V_EOS_p||0|0%|0-0||||F||<cr>
 OBX|7|NM|2011^V_BAS_p||0|0%|0-0||||F||<cr>
 OBX|8|NM|2012^V_NEU_c||0|10^9/L|0-0||||F||<cr>
 OBX|9|NM|2013^V_LYM_c||0|10^9/L|0-0||||F||<cr>
 OBX|10|NM|2014^V_MON_c||0|10^9/L|0-0||||F||<cr>
 OBX|11|NM|2015^V_EOS_c||0|10^9/L|0-0||||F||<cr>
 OBX|12|NM|2016^V_BAS_c||0|10^9/L|0-0||||F||<cr>
 OBX|13|NM|2017^V_RBC||3.94|10^12/L|0-0||||F||<cr>
 OBX|14|NM|2018^V_HGB||110|g/L|0-0||||F||<cr>
 OBX|15|NM|2019^V_MCV||87.6|fL|0-0||||F||<cr>
 OBX|16|NM|2020^V_HCT||0.345|L/L|0-0||||F||<cr>
 OBX|17|NM|2021^V_MCH||27.9|pg|0-0||||F||<cr>
 OBX|18|NM|2022^V_MCHC||319|g/L|0-0||||F||<cr>
 OBX|19|NM|2023^V_RDW_SD||51.2|fL|0-0||||F||<cr>
 OBX|20|NM|2024^V_RDW_CV||15|0%|0-0||||F||<cr>
 OBX|21|NM|2025^V_PLT||135|10^9/L|0-0||||F||<cr>
 OBX|22|NM|2026^V_MPV||12.2|fL|0-0||||F||<cr>
 OBX|23|NM|2027^V_PCT||0.165|0%|0-0||||F||<cr>
 OBX|24|NM|2028^V_PDW||19.2|fL|0-0||||F||<cr>
 OBX|25|NM|2029^V_P_LCR||42.5|0%|0-0||||F||<cr>
 <EB><CR>

(3) Worklist application

<SB>MSH|^~\&|BF-6900|20180613001|LIS||20110613153408||ORM^O01|4|P|2.3.1|||||UTF-8<cr>
 ORC|RF||218||IP<cr>
 <EB><CR>

(4) Worklist obtaining

<SB>MSH|^~\&|LIS|||20180613154025||ORR^O02|4|P^S|2.3.1|||||UTF8<cr>
 MSA|AA|1||||0<cr>
 PID|1||5||T5||M|||||||||||||3^Y<cr>
 PV1|1||orthopedics|||||||||medical insurance<cr>
 ORC|AF|218||<cr>
 OBR|1|218|5|1001^Count ||20180613153909|||Gu Yisheng|||20180613153919|||||||<cr>
 OBX|1|IS|2001^MODE||0||||||<cr>
 OBX|2|IS|2002^MODE_EX||0||||||<cr>
 OBX|3|IS|2003^Ref||0||||||<cr>
 OBX|4|ST|2004^Note||test||||||<cr>
 <EB><CR>