



XP Series
ASTM Communication Specifications
(ASTM E1394-97, E1381-02/95)

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1. Scope

These specifications apply to modes that comply with the ASTM standard (see note) for communications between the XP series and a host computer. For the XP series, the IPU supports the following two modes for data output conforming to the ASTM 1394-97 format:

1. ASTM E1381-02 compliant mode

The physical layer supports serial (RS-232C) and LAN (Ethernet) connections.

The presentation layer complies with ASTM E1394-97 and other layers comply with ASTM E1381-02.

2. ASTM E1381 non-compliant mode

A LAN (Ethernet) connection that is not compliant with ASTM E1381-02.

Only the presentation layer is compliant with ASTM E1394-97, the other layers are compliant with IEEE802.3.

- * In LAN (Ethernet) connections, this instrument runs in the ASTM E1381 non-compliant mode if “1381-95” is selected for [ASTM Rev.] in the Host computer settings.

Note: ASTM is the abbreviation of the American Society for Testing and Materials.

ASTM is one of the world’s largest volunteer non-profit organizations, founded in 1898 to create standard regulations for materials, products and system services.

This mode conforms to the following 2 standards:

- ASTM E1381-02: Specifications for low level protocols to transfer data between clinical laboratory instruments and computer systems
- ASTM E1394-97: Standard specifications for transferring data between clinical instruments and computer systems

2. Communication Specifications

Communication specifications are based on a layer protocol.

(1) Physical layer

Specifies the sending and receiving of signals between the instrument and the host computer through mechanical and electrical connections.

Refer to “2.1 Physical layer (hardware).”

(2) Data link layer

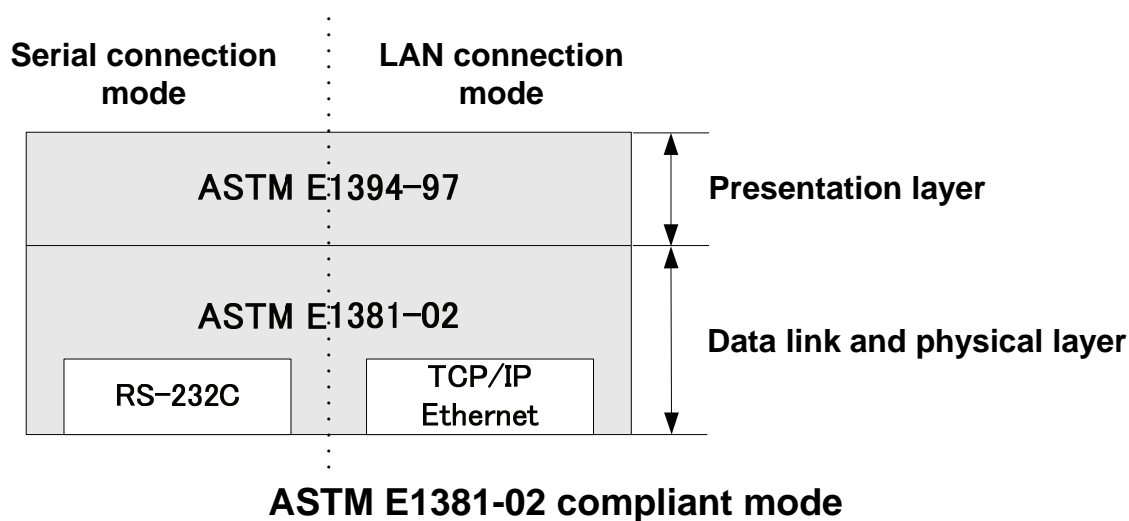
Specifies the sending and receiving of data by link connections and for each frame between the instrument and the host computer.

Refer to “2.2 Data link layer (transmission protocol).”

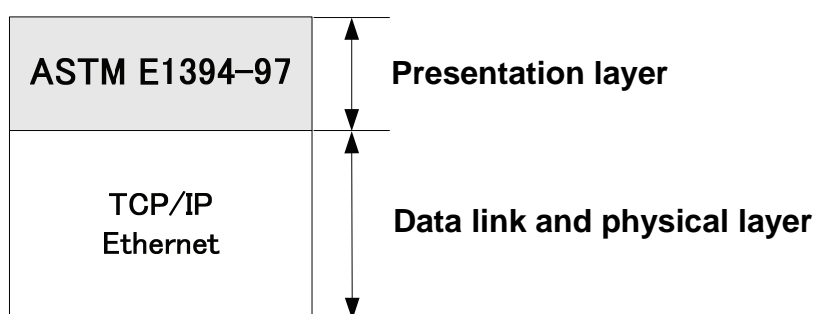
(3) Presentation Layer

Specifies the messages that are sent and received between the instrument and the host computer.

Refer to “2.3 Presentation layer.”



LAN connection mode



2.1 Physical layer (hardware)

2.1.1 Physical layer of the serial interface

This section describes the physical layer of the communication mode of a serial (RS-232C) interface compliant with ASTM E1381-02.

2.1.1.1 Connectors

Although the ASTM standard specifies a D-SUB 25-pin male connector as standard, a D-SUB 9-pin-male I/O connector located on the back of the XP series is used for communications.

Table: Connector pin assignment

Pin No.	Signal name		Signal direction
1	NC		
2	Receive data	RxD	IN
3	Transmit data	TxD	OUT
4	Data terminal ready	DTR	OUT
5	Signal ground	SG	–
6	Data set ready	DSR	IN
7	Request to send	RTS	OUT
8	Clear to send	CTS	IN
9	NC		

The control signals are not used with ASTM specifications. For this reason, do not make connections to pins not in use.

2.1.1.2 Signal identification level

Table: Signal identification level

Level	Data signal	Control signals
+3V or higher	Logic “0”, start bit	ON
-3V or lower	Logic “1”, stop bit	OFF

2.1.1.3 Connection cable

Use a connector cable to connect the analyzer’s D-SUB 9-pin female connector as shown in the connection chart below.

Analyzer DB-9		Host computer DB-9 DB-25		
TxD	3	3	2	TxD
RxD	2	2	3	RxD
SG	5	5	7	SG
RTS	7	7	4	RTS
CTS	8	8	5	CTS
DTR	4	4	20	DTR
DSR	6	6	6	DSR
NC	1			
NC	9			

2.1.1.4 Interface parameters

Table: Interface parameter settings

Parameter	Selection of settings
Baud rate	1200, 2400, 4800, <u>9600</u> , 19200
Data length	7 bits, <u>8 bits</u>
Stop bit	<u>1 bit</u> , 2 bits
Parity	<u>None</u> , Even, Odd

The underlined values conform to the ASTM standard.

Note: However, 7-bit data lengths, even or odd parity, and 2 stop bits are allowed by the ASTM standard for use with special applications.

2.1.1.5 Standard specifications (ASTM E1381-02)

The physical layer of the serial interface conforms to ASTM E1381-02 “5. Physical Layer,” except for the connector type.

The analyzer uses a D-SUB 9-pin male connector. (ASTM standard specifies a 25-pin male connector.)

2.1.2 Physical layer of a LAN connection

This section describes the physical layer of the communication mode during LAN connection.

2.1.2.1 Connector and cable

Connect the LAN connector (RJ-45F) on the back of the XP series to the host computer using a commercially available LAN (CAT5) cable.

Connect the XP series either directly to the host computer using a cross cable or connect it using an intermediate hub.

2.1.2.2 Transmission speed

Conforming to IEEE 802.3, a transmission speed of 10 MBps is supported.

2.1.2.3 Establishing a TCP connection

LAN communications require that a TCP connection be established prior to communication. To establish the TCP connection, the host computer acts as a server and the XP acts as a client. The XP establishes a connection by requesting a connection to the IP address and the port number that are provided by the host computer.

2.1.2.4 Standard specifications

If “1381-02” is selected for [ASTM Rev.] in the Host computer settings, the physical layer conforms to ASTM E1381-02 “7. Physical layer of TCP/IP communications.”

Otherwise, the physical layer conforms to IEEE 802.3.

2.2 Data link layer (transmission protocol)

In an ASTM E1381-02 compliant mode, the data link layer transfers data between systems using a character-based protocol in accordance with ASTM E 1381-02 “6. Data Link Layer.”

This section briefly describes communication control procedures. For details, refer to ASTM E1381-02.

2.2.1 Communication states

The data link layer has the following 2 communication states:

- (1) Neutral status
- (2) Linked status

Transition to each status is accomplished through the following 3 phases.

- (1) Establishment phase

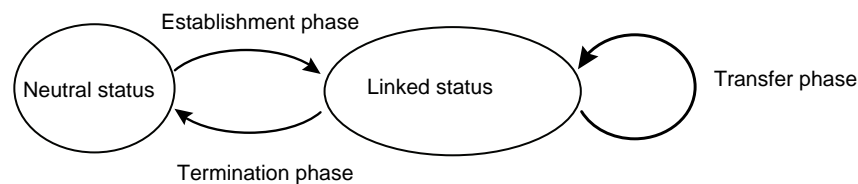
A communication line is established, and determines the direction of data transfer. In this way, the sender and the receiver are identified, and a change is made from neutral status to linked status.

- (2) Transfer phase

The sender transmits messages to the receiver until all messages are transferred.

- (3) Termination phase

The communication line is released. Both the sender and the receiver are changed from linked status to neutral status.

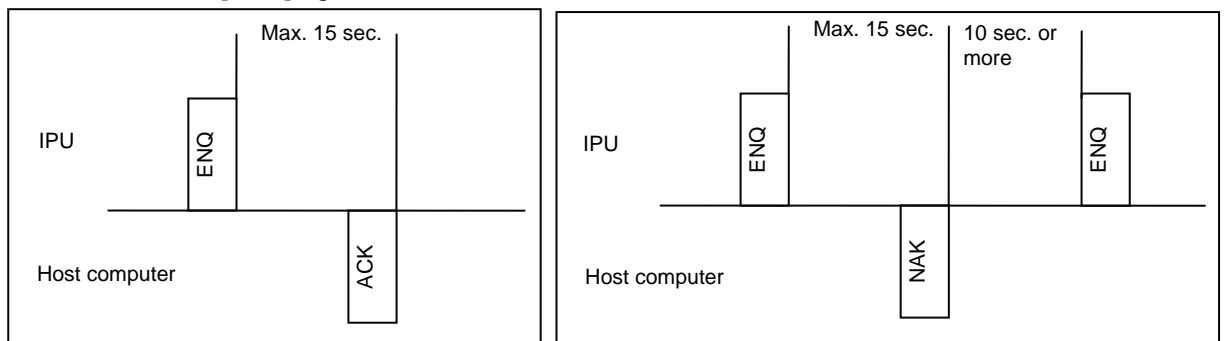


2.2.2 Establishment phase

- (1) The sender sends an [ENQ] signal to the receiver. To respond to the sender, the receiver performs the following action:

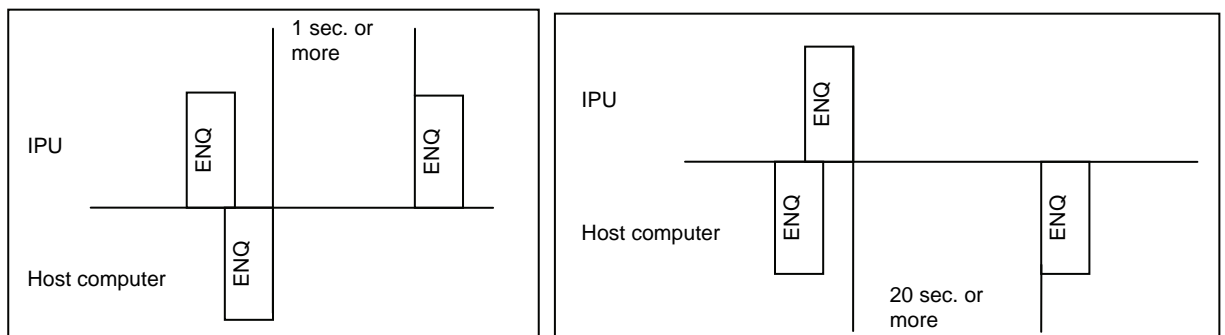
- When communication is enabled, returns an [ACK] signal.
- When the communication is disabled, returns a [NAK] signal.

If the receiver responds with a [NAK] signal, the sender waits for at least 10 seconds before attempting to send another [ENQ] signal.



- (2) When both the sender and receiver send [ENQ] signals, the host computer must yield control authority to the IPU.

- The IPU sends an [ENQ] signal again after 1 second.
- The host computer must wait for 20 seconds before sending an [ENQ] signal again.



2.2.3 Transfer phase

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

- (1) Messages are sent in multiple frames. Each frame contains a maximum of 247 characters (including frame overhead). If the message is longer than 240 characters, it is divided into 2 or more frames.
- (2) Multiple messages cannot be included in a single frame.
- (3) If the message contains 240 characters or less, a frame with the following structure will be transferred.

[STX] [F#] [Text] [ETX] [CHK1] [CHK2] [CR] [LF]

Any text longer than 240 characters is divided into 2 or more frames. The end-of-text code of the intermediate frame is changed to [ETB], and the end-of-text code of the final frame to [ETX], as shown below.

[STX] [F#] [Text] [ETB] [CHK1] [CHK2] [CR] [LF]

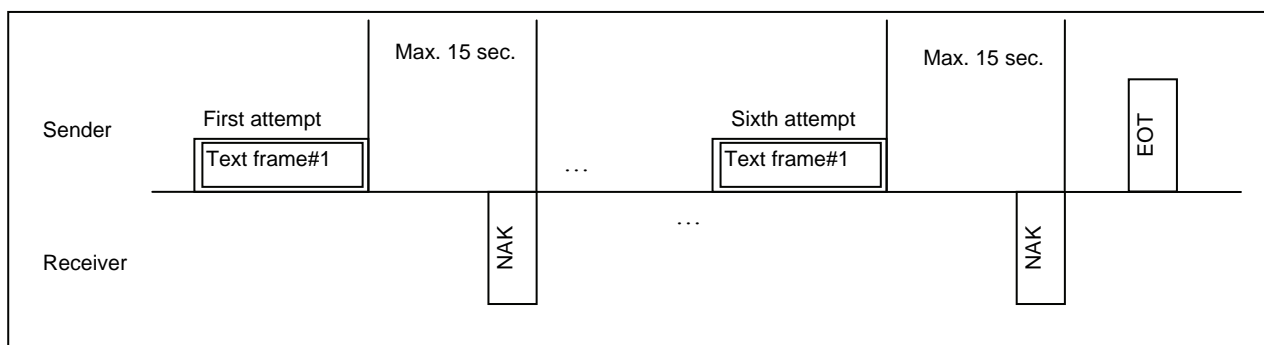
[STX] [F#] [Text] [ETB] [CHK1] [CHK2] [CR] [LF]

.....

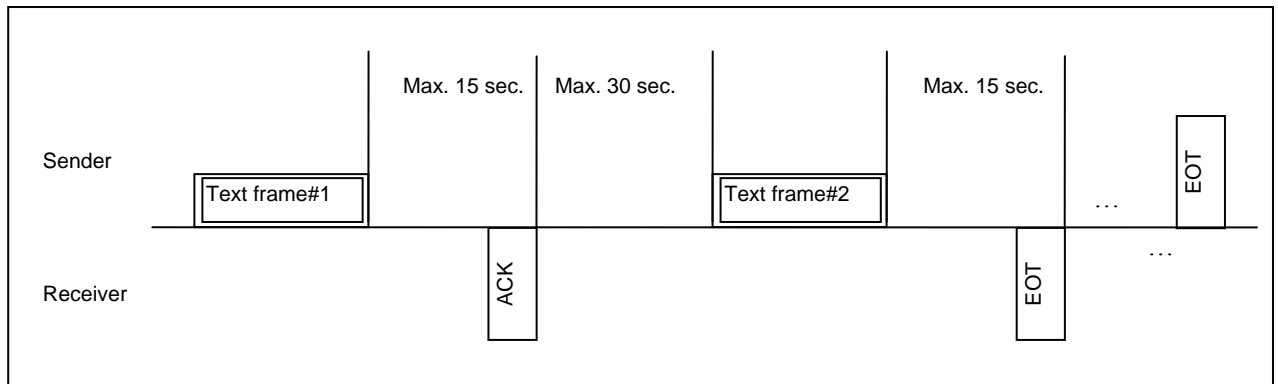
[STX] [F#] [Text] [ETX] [CHK1] [CHK2] [CR] [LF]

Symbol	Description
[STX]	Start of a frame
[F#]	Frame number One of the numbers 0 to 7 is used, beginning with 1 and repeating 2, 3, 4, 5, 6, 7, and 0. In case of retransmission, the same frame number is sent.
[Text]	ASTM E1394-97 records are used. (See 2.3.) For this reason, the codes below will not be used. 0x00-0x06, 0x08, 0x0A, 0x0E-0x1F, 0x7F, 0xFF
[ETB]	Control code indicating end of text (for intermediate frames)
[ETX]	Control code indicating end of text (for the final frame)
[CHK1] [CHK2]	Expressed by characters "0" - "9" and "A" - "F." Characters beginning from the character following [STX] and until [ETB] or [ETX] (including [ETB] or [ETX]) are added in binary. The 2-digit numbers, which represent the least significant 8 bits in hexadecimal code, are converted to ASCII characters "0" - "9" and "A" - "F." The most significant digit is stored in CHK1 and the least significant digit in CHK2.
[CR] [LF]	Control code indicating end of frame

- (4) After sending a frame, the sender waits until the receiver responds. Thus the next frame is not sent until a response is received.
- (5) If the receiver has successfully received the frame and is prepared to receive the next frame, the receiver responds with an [ACK] signal. After the sender receives the [ACK] signal, the sender advances the frame number and either sends a new frame or transitions to the termination frame.
- (6) If the receiver fails to receive the frame and is prepared to receive the same frame again, the receiver responds with a [NAK] signal. After receiving [NAK], the sender sends the most recent frame again, using the same frame number. If the sender fails to send the same frame 6 times consecutively, the sender has to transition to the termination phase to stop sending the message.



- (7) The analyzer processes the response of [EOT] from the host computer as [ACK].
- (8) During the transfer phase, the 15-second timer is set when the sender sends the final character of a frame. A timeout occurs if no response is received within 15 seconds. After the timeout, the sender transitions to the termination phase. The receiver sets a 30-second timer when entering the transfer phase initially or when responding (either with a [ACK] signal or [NAK] signal) to a frame. A timeout occurs if the receiver receives no frame or no [EOT] signal from the sender within 30 seconds. After the timeout, the receiver discards the current incomplete message and transitions to the termination phase.



2.2.4 Termination phase

During the termination phase, the status returns to neutral.

The sender sends an [EOT] signal to inform the receiver that the message transmission has been completed.

The sender transitions to neutral status by sending an [EOT] signal, and the receiver transitions to neutral status by receiving an [EOT] signal.

2.2.5 Timeout

The timer is used to detect a failure to coordinate between the sender and the receiver. The timer is used as a means of recovery from failure in a communication line or in a communication destination device.

- (1) During the establishment phase, the timer is set when the sender sends an [ENQ] signal. A timeout occurs if an [ACK], [NAK] or [ENQ] signal response is not received within 15 seconds. After the timeout, the sender transitions to the termination phase.
- (2) During the transfer phase, the timer is set when the sender transfers the final character of a frame. A time-out occurs when a response is not received within 15 seconds. After the time-out, the sender transitions to the termination phase and stops sending messages.

2.3.2 Messages, records, and fields

2.3.2.1 Messages

A message is an aggregate of records starting from a message header record (H) and ending with a message termination record (L).

2.3.2.2 Records

A record is a series of text, beginning with an ASCII alphabetic character called a record identifier and ending with [CR].

Record type	Record identifier	Level	Description
Header Record	H	0	Contains the sender and the receiver information
Patient Information Record	P	1	Contains the patient information
Inquiry Record	Q	1	Not used
Order Record	O	2	Contains the analysis order information
Result Record	R	3	Contains analysis results
Comment Record	C	1-4	Not used
Manufacturer Information Record	M	1-4	Not used
Scientific Information Record	S	N/A	Not used
Message Termination Record	L	0	Indicates the end of the message

- A smaller level number indicates a higher level.
- A higher-level record has information that is commonly contained in all lower-level records.
- Any level other than 0 must be located after higher levels. However, the manufacturer information record (not used) and the comment record can be inserted at any level. These records are considered to be one level lower than the preceding record.

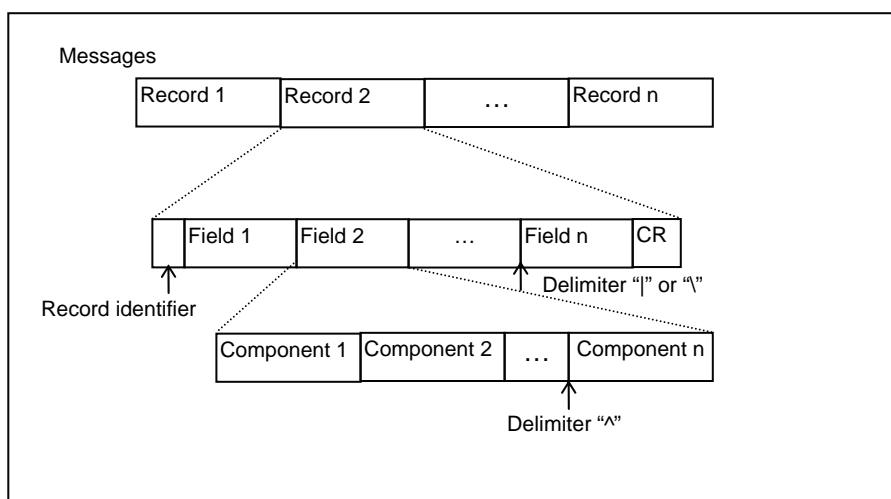
2.3.2.3 Fields

A record is further divided into multiple fields by field delimiters.

A field is identified by its position within a record and has a variable length.

The following are used as delimiters.

Delimiter type	Code	Description
Field Delimiter		Separates adjacent fields within a record
Repeat Delimiter	\	Used when there are plural components of the same type in one field, to repeat the same field
Component Delimiter	^	Further divides 1 field into a number of sub-fields.
Escape Delimiter	&	Used to embed special characters into the data. (''→&F&, \"'→&R&, '^'→&S&, '&'→&E&, hexadecimal→&Xxxxx&)



2.3.3 Record details

2.3.3.1 Header record

Example of transmission

* XP → host computer *

H|\^&||XP-100^00-00^Sysmex XP-100 01^12345678|||||E1394-97<CR>

* Host computer → XP *

H|\^&|||||E1394-97<CR>

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
7.1.1	Record Type	H	H	
7.1.2	Delimiter Definition	\^&	\^&	
7.1.3	Message Control ID	Not used	Not used	
7.1.4	Access Password	Not used	Not used	
7.1.5	Sender Name Or ID	Analyzer name^ Software version^^^^ User device number^ PS code	Not used	
7.1.6	Sender Address	Not used	Not used	
7.1.7	Reserved	Not used	Not used	
7.1.8	Sender Phone Number	Not used	Not used	
7.1.9	Sender Characteristics	Not used	Not used	
7.1.10	Receiver ID	Not used	Not used	
7.1.11	Comment	Not used	Not used	
7.1.12	Processing ID	Not used	Not used	
7.1.13	ASTM Version Number	E1394-97	E1394-97	Fixed
7.1.14	Date And Time Of Message	Not used	Not used	

“7.1.5 Sender name or ID”: Analyzer name is fixed to “XP-100” or “XP-300.” Instrument ID is fixed to “00-00” for each software version. Each time the software version is upgraded, the instrument ID is updated to “00-01,” “00-02,” etc. The user device number is the serial number set in “Settings” - “Product id.” The PS code is the PS code set in Service - Settings - Change - Parameters.

2.3.3.2 Patient Information Record

Example of transmission

* XP → host computer *

P|1<CR>

* Host computer → XP *

Not used

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
8.1.1	Record Type	P	P	
8.1.2	Sequence Number	Sequence No.	Not used	The sequence number starts with 1 and indicates the sequence position in which the record appeared in the message. This number is reset to 1 when a higher-level record appears in the message.
8.1.3	Practice-Assigned Patient ID	Not used	Not used	
8.1.4	Laboratory-Assigned Patient ID	Not used	Not used	
8.1.5	Patient ID	Not used	Not used	
8.1.6	Patient Name	Not used	Not used	
8.1.7	Mother's Maiden Name	Not used	Not used	
8.1.8	Birth Date	Not used	Not used	
8.1.9	Patient Sex	Not used	Not used	
8.1.10	Patient Race	Not used	Not used	
8.1.11	Patient Address	Not used	Not used	
8.1.12	Reserved Field	Not used	Not used	
8.1.13	Patient Telephone Number	Not used	Not used	
8.1.14	Attending Physician ID	Not used	Not used	
8.1.15	Special Field 1	Not used	Not used	
8.1.16	Special Field 2	Not used	Not used	
8.1.17	Patient Height	Not used	Not used	
8.1.18	Patient Weight	Not used	Not used	
8.1.19	Patient's Known or Suspected Diagnosis	Not used	Not used	
8.1.20	Patient Active Medications	Not used	Not used	
8.1.21	Patient's Diet	Not used	Not used	
8.1.22	Practice Field 1	Not used	Not used	
8.1.23	Practice Field 2	Not used	Not used	
8.1.24	Admission and Discharge Dates	Not used	Not used	
8.1.25	Admission Status	Not used	Not used	
8.1.26	Location	Not used	Not used	
8.1.27	DRG or AVG	Not used	Not used	
8.1.28	DRG or AVG2	Not used	Not used	
8.1.29	Patient Religion	Not used	Not used	
8.1.30	Marital Status	Not used	Not used	
8.1.31	Isolation Status	Not used	Not used	
8.1.32	Language	Not used	Not used	
8.1.33	Hospital Service	Not used	Not used	
8.1.34	Hospital Institution	Not used	Not used	
8.1.35	Dosage Category	Not used	Not used	

2.3.3.3 Order Record

Example of transmission

* XP → host computer *

```
O|1||^ 12345ABCDE^B|^^^WBC\^^^RBC\^^^HGB\
^^^HCT\^^^MCV\^^^MCH\^^^MCHC\^^^PLT\^^^W-SCR\
^^^W-MCR\^^^W-LCR\^^^W-SCC\^^^W-MCC\^^^W-LCC\
^^^RDW-SD\^^^RDW-CV\^^^PDW\^^^MPV\^^^P-LCR
|||||N|||||||F<CR>
```

* Host computer → XP *

Not used

The output of the sample ID number of Field 9.4.4 switches according to the ASTM QC Out setting in the service parameter setting.

- When File No is selected, a right aligned 15-digit file number will be output as a sample ID number.

Output example (QC file: No.3, lot ID: 0123456789):

```
O|1||^ QC03-2^A|^^^WBC\<Omitted>^^^W-LMV|||||Q|||||||F
```

- When LotID is selected, a “QC-” string and a left aligned space suppressed lot ID (up to 10 digits) are assigned as the sample number, which is output as a 15-digit right aligned number.

Output example (QC file: No. 3, lot ID 0123456789):

```
O|1||^ QC-0123456789^A|^^^WBC\<Omitted>^^^W-LMV|||||Q|||||||F
```

- Output when File+Lot is set is as follows. File number and lot ID are output aligned 15 digits to the right.

Output example (file no. 3, lot ID: 0123456789, X-bar (average) or L-J):

```
O|1||^ QC3-0123456789^A|^^^WBC\<Omitted>^^^W-LMV|||||Q|||||||F
```

Output example (file no. 3, lot ID: 0123456789, X-bar 1st time):

```
O|1||^ QC31-0123456789^A|^^^WBC\<Omitted>^^^W-LMV|||||Q|||||||F
```

Output example (file no. 3, lot ID: 0123456789, X-bar 2nd time):

```
O|1||^ QC32-0123456789^A|^^^WBC\<Omitted>^^^W-LMV|||||Q|||||||F
```

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
9.4.1	Record Type	O	Not used	
9.4.2	Sequence Number	Sequence No.	Not used	The sequence number starts with 1 and indicates the sequence position in which the record appeared in the message. This number is reset to 1 when a higher-level record appears in the message.
9.4.3	Specimen ID	Not used	Not used	
9.4.4	Instrument Specimen ID	^^ Sample ID No.^ Sample No. Attribute	Not used	Sample ID Number: Sample numbers that are not 15 digits long are space padded or zero padded to 15 digits as specified by the ID Pad. setting in Settings-Host output setting. Sample ID No. Attribute: “M”: Manual input “A”: Automatic assignment “B”: Read by ID reader

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
9.4.5	Analysis parameter ID	^^^^ Parameter name	Not used	Parameter name: WBC RBC HGB HCT MCV MCH MCHC PLT W-SCR W-MCR W-LCR W-SCC W-MCC W-LCC RDW-SD RDW-CV PDW MPV P-LCR PCT W-SMV W-LMV * Use a repeat delimiter to output repetitive items (for example: ^^^^Item no. 1\^^^^Item no. 2\^^^^Item no. 3). * As specified by setting Setting-System settings- Item name, W-SCR, W-MCR, W-LCR, W-SCC, W-MCC and W-LCC are output as LYM%, MXD%, NEUT%, LYN#, MXD# and NEUT# (as displayed on the screen). * <u>PDW, P-LCR and PCT are output only when the service setting PDW/P-LCR/PCT is set to Enable.</u>
9.4.6	Priority	Not used	Not used	
9.4.7	Requested/Ordered Date and Time	Not used	Not used	
9.4.8	Specimen Collection Date and Time	Not used	Not used	
9.4.9	Collection End Time	Not used	Not used	
9.4.10	Collection Volume	Not used	Not used	
9.4.11	Collector ID	Not used	Not used	
9.4.12	Action Code	N, Q	Not used	“N”: Normal sample data “Q”: QC data
9.4.13	Danger Code	Not used	Not used	
9.4.14	Relevant Clinical Information	Not used	Not used	
9.4.15	Date/Time Specimen Received	Not used	Not used	
9.4.16	Specimen Descriptor	Not used	Not used	

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
9.4.17	Ordering Physician	Not used	Not used	
9.4.18	Physician Telephone Number	Not used	Not used	
9.4.19	User Field No. 1	Not used	Not used	
9.4.20	User Field No. 2	Not used	Not used	
9.4.21	Laboratory Field No. 1	Not used	Not used	
9.4.22	Laboratory Field No. 2	Not used	Not used	
9.4.23	Date/time Results Reported or Last Modified	Not used	Not used	
9.4.24	Instrument Charge to Computer System	Not used	Not used	
9.4.25	Instrument Section ID	Not used	Not used	
9.4.26	Report Type	F	Not used	“F” (fixed)
9.4.27	Reserved	Not used	Not used	
9.4.28	Location or Ward of Specimen Collected	Not used	Not used	
9.4.29	Nosocomial Infection Flag	Not used	Not used	
9.4.30	Specimen Service	Not used	Not used	
9.4.31	Specimen Institution	Not used	Not used	

2.3.3.4 Result Record

Example of transmission

* XP → host computer *

R|1|^^^^WBC^26|78|10*2/uL||N|||123456789012345||20011221163530<CR>

R|2|^^^^RBC^26|350|10*4/uL||L|||123456789012345||20011221163530<CR>

R|3|^^^^HGB^26|***.*|g/dL||A|||123456789012345||20011221163530<CR>

.....

R|19|^^^^P-LCR^26|50.0|%||H|||123456789012345||20011221163530<CR>

* Host computer → XP *

Not used

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
10.1.1	Record Type	R	Not used	
10.1.2	Sequence Number	Sequence No.	Not used	The sequence number starts with 1 and indicates the sequence position in which the record appeared in the message. This number is reset to 1 when a higher-level record appears in the message.
10.1.3	Analysis parameter ID	^^^^ Parameter name^ Dilution ratio	Not used	Parameter name: Refer to the analysis parameter ID (ASTM field 9.4.5) of the Order Record. Dilution ratio: “1”: Whole blood mode “26”: Diluent mode
10.1.4	Data Value	Data value	Not used	Data value: The decimal point is added and output at the location of the set unit. If there is any masked data, mask symbols are output in the same priority as displayed on the screen (for example: “+++.”). <u>*Masked when output in diluent mode.</u>
10.1.5	Unit	Unit	Not used	Unit: Output in the format according to the set unit. Exponents are represented by “*.” (For example: 10 ² /uL → “10*2/uL.”)
10.1.6	Reference Range	Not used	Not used	
10.1.7	Result Abnormal Flags	L, H, >, N, A, W	Not used	“A”: Masked data “>”: “!” flagged data “W”: “*” flagged data “H”: “+” flagged data “L”: “-” flagged data “N”: Data other than that above (normal data) * Order of priority starting from the highest is indicated as: “A,” “>,” “W,” “H,” “L” and “N.”
10.1.8	Nature of Abnormality Testing	Not used	Not used	
10.1.9	Result Status	Not used	Not used	

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
10.1.10	Date of Change in Instrument Normative Values or Units	Not used	Not used	
10.1.11	Operator Identification	Operator Identification	Not used	Operator Identification (A 15-character ID that is left aligned and padded with spaces). Example: “ABCDEFGHI ” * Output only when the service parameter setting OPERATOR is set to Used.
10.1.12	Date/Time Test Started	Not used	Not used	
10.1.13	Date/Time Test Completed	YYYYMMDDhhmmss	Not used	A fixed “YYYYMMDDhhmmss” format that does not depend on date setting. YYYY: 4-digit year MM: 2-digit month DD: 2-digit day hh: 2-digit hour mm: 2-digit minute ss: 2-digit second * All are zero padded.
10.1.14	Instrument Section ID	Not used	Not used	

2.3.3.5 Message Termination Record

Example of transmission

* XP → host computer *

L|1|N<CR>

* Host computer → XP *

L|1|N<CR>

ASTM field	Field name	Analyzer → Host computer	Host computer → Analyzer	Remarks
13.1.1	Record Type	L	L	
13.1.2	Sequence Number	1	1	Always “1”
13.1.3	Termination Cord	N	N	N: Normal termination