HORIBA Medical

OUTPUT FORMATS

SAT

RAA052AEN

1. Table of Contents

2. Introduction

This document provides the necessary information to interface the SAT system with a host system, using the ASTM protocol.
This document is based on the following ASTM standard protocols:

- ASTM E1381-95 and NCCLS LIS01-A2 (low level protocol)·
- ASTM E1394-97 and NCCLS LIS02-A2 (high level protocol).

Below is a list of terms used in this document and their definition

Term	Definition
<ACK>	Acknowledgment (ASCII Decimal 6).
[C1]	The most significant character of Checksum.
[C2]	The least significant character of Checksum.
[DATA]	The data contents of the frames. In reference to the low level protocol, the [DATA] could either reference single records or the concatenation of all records of the messages. If the data is longer than 240 (or 64000) characters, then it must be split into two (or more) parts and sent in two (or more) communication packets. The intermediate packet uses the <ETB> character, and the ending packet uses the <ETX> character.
<ENQ>	Inquire (ASCII Decimal 5).
<ETB>	End of Transmission Block (ASCII Decimal 23). For use only when a single record is too large to fit into one frame.
<ETX>	End of Text (ASCII Decimal 3). Required at the end of each record.
[frame number]	Single digit frame number “0” to “7”, starts with “1”.
<LF>	Line Feed (ASCII Decimal 10).
<NAK>	Negative Acknowledgment (ASCII Decimal 21).
<STX>	Start of Frame (ASCII Decimal 2).
Communications packet	All framing required for transmission of data. This framing includes: <STX>[frame number][DATA] [<ETB> or <ETX>][C1][C2] <LF>. Data part can not be greater than 240 characters.

Term	Definition
Component Field	One of several related pieces of information within a field.
Download	The transmission of data from the host to the SAT5000V2.
Field	A specific location within a record for a piece of information, indicated by a field delimiter and position.
Frame	A complete communication packet.
LIS	Laboratory Information System.
Message	A collection of related information; a group of records that begins with a “Header” record and ends with a “Terminator” record. A single record could theoretically constitute a message, but within this context, a message always contains multiple records. Please refer to the Message Layer section and the descriptions of each type of records further down in this document.
RECEIVER	The device responding to the sender. The receiver in this document is either the host or SAT5000V2.
<EOT>	End of Transmission (ASCII decimal 4).
<CR>	Carriage Return (ASCII decimal 13).
RECORD	In reference to the message layer, a record can be one of the following codes: H (header), P (patient), O (order), R (result), L (terminator), C (comment). Please refer to the Message Layer section further down in this document.
REPEAT FIELD	An additional field of the same type as the previous and separated by a repeat delimiter.
SENDER	The device which is to send a message and which initiates the transmission process, here between the host and SAT5000V2. The sender in this document is either the host or SAT5000V2.
SESSION	An activity starting with the Setup phase and ending with the Termination phase. Please refer to the Frame Layer Protocol lsection further down in this document.
TEST	A single analysis or a combination of analysis or observations from which a variable or gradable result are derived.
UPLOAD	The transmission of data from the SAT5000V2 to the host.

3. Frame Layer Protocol

The transmission mode between SAT5000V2 and the host is bidirectional. The recommended Low Level Protocol to use to transfer messages is based on an ACK/ WAIT protocol. **The low level protocol transfers messages as specified by the ASTM E1381-95 standard.**

3.1.Setup Phase

During the protocol setup phase, the communication link between SAT5000V2 system and the host is set up.

Receiver state	Sender		Receiver
Receiver Ready	<ENQ>	-->	
		<--	<ACK>
Receiver not Ready	<ENQ>	-->	
		<--	<NAK>

After an <ENQ> is sent, the state of the sender must change in order to receive data. If both the SAT5000V2 system and the host send an <ENQ> simultaneously, the SAT5000V2 system takes priority.

3.2.Transfer Phase

During the protocol transfer phase, data is sent back and forth between the SAT5000V2 system and the host. The SAT5000V2 system uses data transfer conventions outlined in the ASTM E1381-95 standard for the data layer protocol. Any conventions that are not supported are noted and addressed. Please refer to the Message Layer section further down in this document.

3.3. Termination Phase

During the protocol termination phase, a sequence of characters or conditions causes communication between the SAT5000V2 system and the host to cease, either normally or abnormally.

3.4.Transport Layer Sequence

The following tables illustrate a transport layer sequence:

Session Description	Sender		Receiver
Normal Session:	<ENQ>	-->	
		<--	<ACK>
	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	-->	
		<--	<ACK>
	<EOT>	-->	
			No Response Expected

Session Description	Sender		Receiver
Failure Session (NAK):	<ENQ>	->	
		<-	<NAK>
(Delay 10 seconds)			
(Repeat up to 6 times)	<ENQ>	->	
(Before 6 <NAK>s)		<-	<ACK>
(Before 6 <NAK>s)	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
		<-	<ACK>
	<EOT>	->	
			No Response Expected

Session Description	Sender		Receiver
Failure Session (Max <NAK>s):	<ENQ>	->	
		<-	<NAK>
Delay 10 seconds)	<ENQ>	->	
(Repeat up to 6 times)		<-	<NAK>
	<EOT>	->	
(After 6 <NAK>s)			No Response Expected

Session Description	Sender		Receiver
Failure Session (No Response):	<ENQ>	->	
			No Response
(Time-out after 15 seconds)	<EOT>	->	
			No Response Expected

Session Description	Sender		Receiver
Failure Session (Multiple <NAK>s):	<ENQ>	->	
		<-	<ACK>
	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
		<-	<NAK>
(Delay 10 seconds)			
(Repeat up to 6 times)	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
		<-	<NAK>
(Before 6 <NAK>s)	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
		<-	<ACK>
	<EOT>	->	
			No Response Expected

Session Description	Sender		Receiver
Failure Session (Max <NAK>s):	<ENQ>	->	
		<-	<ACK>
	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
			<NAK>
(Delay 10 seconds)			
(Repeat up to 6 times)	<STX> [F1] [DATA] <ETX> [C1] [C2] <CR> <LF>	->	
		<-	<NAK>
(After 6 <NAK>s)	<EOT>	->	
			No Response Expected

3.5.Sending multiple frames

If a Message is greater than 240 characters, it will be splited into several frames where each frame will be up to 240 characters. For example if the message (Msg) contains 489 characters, it will be splitted as follows: Msg: Data1+Data2+Data3 Where:

- Data1 are the characters 1 to 240 of Msg
- Data2 are the characters 241 to 480 of Msg
- Data3 are the characters 481 to 489 of Msg

The message will be sent as follow:

Session Description	Sender		Receiver
Normal session with Msg split	<ENQ>	->	
		<-	<ACK>
	<STX> [F1] [DATA1] <ETB> [C1] [C2] <CR> <LF>	->	
		<-	<ACK>
	<STX> [F2] [DATA2] <ETB> [C1] [C2] <CR> <LF>		
		<-	<ACK>
	<STX> [F3] [DATA3] <ETX> [C1] [C2] <CR> <LF>		
		<-	<ACK>
	<EOT>	->	
			No Response Expected

4. Physical Layer

4.1.Serial Interface

All communications are expected to use the RS232 communication protocol, based upon the Electronics Industries Association (EIA) standard RS232-C. As part of the conformance to this standard, the SAT5000V2 system is configured as Data Terminal Equipment (DTE).
The SAT5000V2 system is cabled to the host via a DB-9 connector on the back of the computer or a DB-25 connector on the octopus cable plugged into the back of the SAT5000V2 system. The DB-9 Connector provides RXD at pin 2, TXD at pin 3, and signal ground at pin 5.
The DB-25 Connector provides RXD at pin 2, TXD at pin 3, and ground signal at pin 7. No other connections are used for the ASTM E1381-95 protocol.
Following table shows the pin assignments for both SAT5000V2 system and host.

Pin (DB9)	Pin (DB25)	SAT5000V2 Host port configuration	Host cable must provide
2	3	RXD	TXD
3	2	TXD	RXD
5	7	Ground	Ground

The cable must be compliant with:
- IEC 228 / IEC 332-1
- VDE 0295
- NF C 32-013 / NF C 32-070 C2

And its length should not exceed 10m.
The operator defines the baud rate, choosing 1200, 2400, 4800, 9600, 19200 (recommended) or 38400 baud. The number of data bits per character, parity bit, and number of stop bits are as defined in ASTM standard E1381-95.
The flow of information from the SAT5000V2 system to the host can be controlled through a Xon Xoff protocol.

4.2.Network Interface (optionnal)

In the host system, the implementation of network-based communication is based on the Windows socket standard. Refer to **NCCLS LIS01-A2**.
The socket client establishes a permanent session to the socket server. If, for any reason, the connection aborts, the SAT5000V2 system would attempt to re-establish the connection.
The data transmitted between the client and the server takes the form of ASTM high level packets. The control characters are the same as those used for the Serial Interface (please see the Frame Layer protocol chapter).

5. High-level : Message Layer

This document references the ASTM standard E1394-97 (or NCCLS LIS02-A2), and the recommended support of the ASTM protocol. This section intends to provide a complete understanding of the particular records and fields as supported by the host system. The low level protocol communications are separate from the message level. It is recommended that the ACK / WAIT specified in the Frame Layer Protocol section are used with this ASTM standard.

Message Content

Below is a list of the limitations and general considerations regarding message content.

Allowed Characters	ASCII 7 (BEL), 9 (HT), 11 (VT), 12 (FF), 13 (CR), 32-126, 128-254 are allowed. However, the message data (shown as [DATA]) sent to the host system must be restricted to ASCII 32-126 for proper operation of the host software. Specific fields may further restrict allowed characters.
Maximum Field Length	No maximum field length is imposed within the message-receiving mechanism. However, the message parsing performed by the host / SAT5000V2 interface software enforces certain restrictions. Please refer to the record tables further down in this document for specific field restrictions. Default maximum field length is 128 bytes.
Delimiters	Any of the allowable characters, as specified in ASTM E1394-97, may be used as delimiters. Unless otherwise documented, the following characters should be used: Field Delimiter = vertical bar (|) Repeat delimiter = backslash (\) Component delimiter = caret (^) Escape delimiter = ampersand (&)
Record Codes	The following codes are required in relation to the ASTM standard: Header Record H Patient Record P Test Order Record O Result Record R Comment Record C Manufacturer Record M Request Information Record Q Final Record L
Fields with Null Values	Nulls are sent when data do not need to be updated. A null value does not conflict with existing data in most cases. Erroneous data is the responsibility of the sender.

6. High-level : Communication format

6.1.Message types

The communication between the SAT5000V2 and the host system is managed with 3 messages types:

1- [SAT => ML] Query message.
2- [ML => SAT] Program message. Could be an answer to the SAT query, or also a direct programming.
3- [SAT => ML] Tube tracking info.

6.2.ASTM records

The following of this chapter will describe the different message types. Every message is composed of some ASTM records, in respect of ASTM standard E1394-97. The unreferenced fields of the records shall be considered as non-interpreted in the context of this SAT5000V2 -host procol implementation.
Following each record is a list of the requirements and general considerations regarding the contents of one or more fields of the record.
The following types of fields are allowed:

- A Alpha Characters (A to Z, a to z)
- N Numeric (from 0 to 9)
- N. Numeric plus the '.' which is the decimal delimiter
- AN Any allowed character
- D Date with format YYYYMMDD
- T Time with format HHMMSS
- DT Date + Time with format YYYYMMDDHHMMSS

A field description may contain the format and number of character size limitation following this nomenclature: [Type/max size].

The following codes are used to define the fields requirements (for [SAT => ML] : "In" or [ML => SAT] : "Out")
- R Required
- O Optional
- C Configurable
- - Not supported

6.3.Common Records

In respect of the ASTM standard E1394-97, every message will be excanged within a "Header record" and a "Terminator record":

6.3.1. Header Record (« H »)

N°	Field	Description	In	Out	Example
1	Record Identifier	H	R	R	
2	Delimiter setting	Set delimiter characters for Field, Repeat, Component, Escape. Always "|\^&"	R	R	|$^&
5	Sender name	1) Sender name: Set characters [A] 2) Sender No. (S/N) [A] 3) Sender version: Characters / digits [A]	O	O	1) PentraML 2) 9380BDED579C 3) V10.0.1
12	Processing ID	Always "P"	O	O	P
13	Version Number	Always "E1394-97"	O	O	E1394-97
14	Date and Time of Message	Communication date / time [DT]	R	R	20120504095215
	End of record	End of record	R	R	<CR> (0x0D)

Ex:
H|\^&|||PentraML^9380BDED579C^V10.0.1|||||||P|E1394-97|20120504095215<CR>

6.3.2. Terminator Record

N°	Field	Description	In	Out	Example
1	Record Identifier	L	R	R	
2	Sequence Number	Set digit [N] – Always “1”	R	R	
3	Termination Code	Always “N”	R	R	
	End of record	End of record	R	R	<CR> (0x0D)

Ex:
L|1|N<CR>

6.4.[SAT => ML] Query message

The SAT5000 instrument queries host for pending analysis.

6.4.1. Message structure

H: Header Record
Q: Request information Record
L: Terminator Record

6.4.2. Request information Record

N°	Field	Description	In	Example
1	Record Identifier	Q	R	
2	Sequence Number	Set digit [N]	R	1
3	Starting Range ID Number (a)			
3.1	Patient ID number	not used	-	<Empty>
3.2	Sample ID number[AN/16]	Sample ID	R	SID00123
13	Request Info. Status Codes	Always “O”	R	
	End of record	End of record	R	<CR> (0x0D)

Ex:
Q|1|^SID00123|||||||||O <CR>

6.4.3. Query message example

H|\^&|||Sat5000^1234567^V2.0||||||P|E 1394-97|20130314095215
Q|1|^SID00123|||||||||O<CR>
L|1|N<CR>

6.5. [ML => SAT] Program message.

host programs to the The SAT5000 instrument.
Could be:
- A direct programming.
- An answer to a previous Query of the SAT5000

6.5.1. Content

- Patient demography Information.
- Pending Tests.

6.5.2. Message structure

H: Header Record
P: Patient information Record

O: Test order Record
L: Terminator Record

6.5.3. Patient information Record

N°	Field	Description	In	Out	Example
1	Record Identifier	P	R	R	
2	Sequence Number	Set digit [N]	R	R	1
4	Laboratory Assigned Patient ID	Patient ID [AN/25]	O	O	PID123456
6	Patient Name		-	O	Smith
6.1	Last Name [AN/20]		-	O	John
6.2	First Name [AN/20]				
8	Patient Birthdate				
8.1	Birthdate [D/8]		-	O	19631124
8.2	Age [N/3]		-	O	48
8.3	Age unit [A/1]		-	O	Y
9	Patient Sex	Sex code [A/1]	-	O	M
14	Attending Physician ID [AN/20]	Doctor Info	-	O	Dr Queen
26	Location [AN/20]	Service Info	-	O	Emergency
	End of record	End of record	R	R	<CR> (0x0D)

Ex:
P|1||PID123456||Smith^John||19631124^48^Y|M||||Dr Queen||||||||||Emergency<CR>

a) Field “Age Unit” supported codes:
- Y: Years
- M: Months
- D: Days
- W: Weeks
- H: Hours

b) Patient Sex Field supported codes:
- M: Male
- F: Female
- U: Unknown
- All other values will be treated as “Unknown”

6.5.4. Test Order Record

N°	Field	Description	Out	Example
1	Record Identifier	O	R	
2	Sequence Number	Set digit [N]	R	1
3	Specimen ID			
3.1	Sample ID number [AN/16]	Sample ID or AUTO-SID	R	SID54321
5	Universal Test ID			
5.1	Identifier	not used	-	
5.2	Name	not used	-	
5.3	Type	not used	-	
5.4	Local code	Pending analysis code	R	ERB
6	Priority	Priority code [A/1] Always “R”(routine) or“S”(stat)	R	
8	Collection Date and Time	Specimen collection date/time [DT]	O	20120504095215
12	Action Code	Action code [A/1] N (New), P (Pending) or A (Add)	R	N
26	Report Type	See c)	R	O
	End of record	End of record	R	<CR> (0x0D)

Ex:
O|1|SID00123||^^^ERB\^^^Groupe\^^^Coag\^^^ESR\^^^HbA1c|R||20120504095215||
||N||||||||||||O|<CR>

c) Fields “Action code” and “Report type” details
The following codes are supported

Action code	Report Type	Description
N	O	Initial download
P	Q	Response to query
P	Y	Response to query: nothing pending
P	Z	Response to query: Unknown tube

6.5.5. Program Message examples:

a) Answer to a query, tube is unknown:

H|\^&|||PentraML^9380BDED579C^V10.0.1||||||P|E1394-97|20120504095215<CR>
P|1<CR>
O|1|SID00123||^^^|R||20120504095215||||P||||||||||||Z|<CR>
L|1|N<CR>

b) Answer to a query, no more analysis are pending

H|\^&|||PentraML^9380BDED579C^V10.0.1||||||P|E1394-97|20120504095215<CR>
P|1||PID123456||Smith^John||19631124^48^Y|M|||||Dr Queen|||||||||||Emergency <CR>
O|1|SID00123||^^^|R||20120504095215||||P||||||||||||Y|<CR>
L|1|N<CR>

c) Answer to a query, pending analysis

H|\^&|||PentraML^9380BDED579C^V10.0.1||||||P|E1394-97|20120504095215<CR>
P|1||PID123456||Smith^John||19631124^48^Y|M|||||Dr Queen|||||||||||Emergency <CR>
O|1|SID00123||^^^ERB\^^^Groupe\^^^Coag\^^^ESR\^^^HbA1c|R||20120504095215||
||P||||||||||||Q|<CR>
L|1|N<CR>

d) Initial download

H|\^&|||PentraML^9380BDED579C^V10.0.1||||||P|E1394-97|20120504095215<CR>
P|1||PID123456||Smith^John||19631124^48^Y|M|||||Dr Queen|||||||||||Emergency <CR>
O|1|SID00123||^^^ERB\^^^Groupe\^^^Coag\^^^ESR\^^^HbA1c|R||20120504095215||
||N||||||||||||O|<CR>
L|1|N<CR>

6.6.[SAT => ML] Tracking feedback message

The SAT5000 instrument informs the host of a tube tracking info.

6.6.1. Message structure

H: Header Record
P: Patient information Record
O: Test order Record
M: Manufacturer : Tracking info
L: Terminator Record

6.6.2. Patient information Record

Same description as in « Patient information Record, page 12 »

6.6.3. Test Order Record

N°	Field	Description	In	Example
1	Record Identifier	O	R	
2	Sequence Number	Set digit [N]	R	1
3	Specimen ID			
3.1	Sample ID number [AN/16]	Sample ID or AUTO-SID	R	SID54321
5	Universal Test ID			
5.1	Identifier	not used	-	
5.2	Name	not used	-	
5.3	Type	not used	-	
5.4	Local code	not used	-	
6	Priority	Priority code [A/1] Always “R”(routine) or“S”(stat)	O	
8	Collection Date and Time	Specimen collection date/time [DT]	O	20120504095215
12	Action Code	Action code [A/1] Always N (New)	O	N
	End of record	End of record	R	<CR> (0x0D)

Ex:
O|1|SID54321||^^^ERB\^^^Groupe\^^^Coag\^^^ESR\^^^HbA1c|R||20120504095215|||N<CR>

6.6.4. Manufacturer tracking Record

N°	Field	Description	In	Example
1	Record Identifier	M	R	
2	Sequence Number	Set digit [N]	R	1
3	Message Type	Always “TRACKING”	R	TRACKING
4	Tracking Information			
4.1	Location	Instrument type	R	SAT
4.2	Rack Type		O	ERB
4.3	Cabinet	In case of a rack type “ARC”, will contain the refrigerator cabinet number.	O	CAB1
4.4	Rack	Rack or draw number (draw in case of “ARC” rack type)	O	003
4.5	Position	Position. (In case of “ARC” rack type, Cartesian coordinates of the tube in the rack: [A-D][0-32])	O	B21
	End of record	End of record	R	<CR> (0x0D)

Examples :

M|1|TRACKING|SAT^ARC^CAB1^30^B21|<CR>
M|1|TRACKING|SAT^VS^^003^43|<CR>

Tracking message example

H|\^&|||PentraML^9380BDED579C^V10.0.1|||||||P|E1394-97|20120504095215<CR>
P|1||PID123456||Smith^John||19631124^48^Y|M|||||Dr Queen|||||||||||Emergency <CR>
O|1|SID00123|||R||20120504095215||||N<CR>
M|1|TRACKING|SAT^ARC^CAB1^30^B21|<CR>
L|1|N<CR>