CELL-DYN EMERALD SYSTEM
LABORATORY INFORMATION SYSTEM
INTERFACE SPECIFICATION

LIST NO. 09H40-04
REVISION C

ABBOTT DIAGNOSTICS DIVISION
Abbott Laboratories
Abbott Park, IL 60064

TABLE OF CONTENTS

1. OBJECTIVE

This document describes the data transmission format protocol between CELL-DYN Emerald and a host Laboratory Information System (LIS).

The functionality must match the software specifications of the Emerald.

2. APPROVAL AND HISTORY

Version	Date	Author	Reason and Type of Change
A	14/10/08	O. Genet/M. Hepp	Document creation
B	13/02/09	O. Genet/M. Hosseini	Updated to align with CD-Emerald Operator's Manual changes.
C	11/06/10	E. Ayala	Updated to align with Software Version 2.1.0.

3. SCOPE

This document applies to the CELL-DYN Emerald instrument. It specifies the messages and behaviors of the initial version of the CELL-DYN Emerald Host Computer Interface.

4. TERMINOLOGY AND ABBREVIATIONS

Handshake: bi-directional communication using acknowledgement

LIS: Laboratory Information System, i.e. a HOST system

Host: external computer or data collection system

CRC: Cyclic Redundancy Code

5. SYSTEM OVERVIEW

This document describes the interface characteristics of the CELL-DYN EMERALD automated hematology analyzer when attached to a Host.

6. GENERAL SPECIFICATIONS

The Host Interface for the CELL-DYN EMERALD System is a specific format designed to transfer data to an external system. The system does not use the ASTM or CLSI (LIS-x) standards for communications with a host system.

The format is text-oriented and is compatible with the CSV format used by various Microsoft Office applications.

The Supervisor level password (default password is 123) is necessary to access the COMMUNICATION menu. When LIS customization is completed, it is imperative that the user returns the instrument to general user login (no password).

NOTES

1.1 Physical Interface

1.1.1 RS232 connector

The CELL-DYN EMERALD provides a standard DB-9 female connector, labelled RS232C, mounted on the rear of the instrument.

RS232 Label

Pins on the DB-9 connector: (standard RS-232 9-pin assignments)

Pin 1: Data Carrier Detect (DCD input)

Pin 2: (output) CELL-DYN Emerald Data to Host (LIS, results)

Pin 3: (input) Host Data to CELL-DYN EMERALD

Pin 4: (output) Data Terminal Ready (DTR)

Pin 5: Signal Ground

Pin 6: Data Set Ready (DSR)

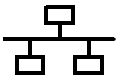
Pin 7: (input) Clear to Send (CTS input) (not enabled by CELL-DYN Emerald Software)

Pin 8: (output) Request to Send (RTS output) (not enabled by CELL-DYN Emerald Software)

Pin 9: (not connected)

1.1.2 Ethernet connector

The CELL-DYN EMERALD provides an RJ 45 connector 10/100Base, labelled with the symbol below, mounted on the rear of the instrument.



RJ 45 label

1.2 Data Interface

The system can be configured to use either TCP/IP or UDP/IP over Ethernet or RS232 in the COMMUNICATION menu by selecting HOST SERIAL (for RS 232) or HOST NET (for TCP/IP or UDP). The default setting is no host.

1.2.1 Host serial configuration

The system can be configured for data transmission on the RS232 channel by using the COMMUNICATION/SERIAL PARAM. Menu. The configurable transmission parameters include data bits, stop bits, parity and baud rate.

- The asynchronous method of data transmission (serial by bit) is used.
- All information transmitted is in character form and is represented by 8-bit or ASCII.
- Transmitted characters consist of one (1) start bit, eight (8) data bits (least significant first), odd, even or no parity bit, and one (1) or two (2) stop bits.
- Parity may be selected as none, odd, or even. Default parity is None.
- The transmission speed may be selected from 1200, 9600, 19200, 57600 or 115200 bits per second (bps).
- The Default setting is 115200 bits per second.
- The number of bits per character is eight bits.

1.2.2 Host net configuration

- The system can be configured for data transmission via TCP/IP or UDP/IP over Ethernet by using the COMMUNICATION/NET. PARAM. Menu.
- The configurable transmission parameters include protocol, host IP address, host port, Emerald IP address, Emerald mask address, and Gateway address.
- The protocol may be set to TCP/IP in this menu. The default setting is “UDP/IP”.
- The host default IP address is 192.168.0.103. Its port is default set to 1200. Its mask is 255.255.255.0.
- The Emerald default IP address is 192.168.0.200. The gateway default address is 192.168.0.1.
- The Emerald port is set to 3000.

1.3 Communication Protocol

The following is available with RS232 only.

- Transmission control is provided in one way: XOFF/XON protocol in which the Host transmits an XOFF character (hex 13) to stop transmission from the System and an XON character (hex 11) to re-start transmission.
- This is optional and not default-enabled. The option is available in COMMUNICATION/SERIAL PARAM. Menu with the FLOW setting.
- The CTS/RTS pinouts are not used.

1.3.1 Invoking Host Transmission

The following assumes that the HOST mode is selected in the COMMUNICATION menu.

1.3.1.1 RUN SAMPLE Menu Automatic Transmit Mode

The user is able to manually send the current results displayed in the RUN SAMPLE menu by selecting the SEND button available in the TOOLS menu.

1.3.1.2 QC RUN AND RESULTS Menu Automatic Transmit Mode

The user is able to manually send all selected QC runs by selecting the SEND button available in the TOOLS menu.

1.3.1.3 CALIBRATION Menu Automatic Transmit Mode

The user is able to manually send all selected calibration runs by selecting the SEND button available in the TOOLS menu.

1.3.1.4 DATALOG Menu Transmit Mode

The user is able to manually send a range of selected results viewable in the DATALOG menu or the DATE menu by selecting the SEND button available in the TOOLS menu.

1.3.2 Transmission Control

1.3.2.1 Response from Host

The following assumes that the HOST mode with handshake mode is selected in the COMMUNICATION menu.

There is no automatic re-transmission following a transmission error.

1.3.2.2 No response from the host

The instrument displays an error message “HOST: TIME OUT”.

1.3.2.3 Non valid Acknowledgement

If the acknowledgement message from the host is not the one expected, the instrument displays an error message “HOST: SYNCHRO ERROR”

1.3.2.4 Acknowledgement with error

The host acknowledges the message with an error.

The instrument displays an error message “HOST: ACK ERROR”.

1.3.3 Frame Format

Each frame sent by the instrument consists of the following elements:

FRAME HEADER FRAME ID DATA SEGMENT

Each frame sent by the host consists of the following elements:

FRAME ID DATA SEGMENT

DATA SEGMENT is optional according to the type of frame described in section 7.5.

The following subsections describe these constructs in detail.

1.3.3.1 Frame header

The Emerald always begins its frame with the following header, named frame header:

INSTRUMENT TYPE; INSTRUMENT NUMBER; INSTRUMENT SERIAL NUMBER; USER LOGIN[CR]

The semicolon ‘;’ is the field separator. [CR] is the carriage-return.

1.3.3.1.1 Field 1—Instrument Type

The Instrument Type is an alphanumeric field of seven (7) characters: enclosed in double quotation marks. The string for the CELL-DYN EMERALD is sent as “”EMERALD””.

1.3.3.1.2 Field 2—Instrument Number

The Instrument Number is a numeric field of up to two (2) characters ranging from 0 to 99.

This number is set in the COMMUNICATION menu. The default value is 1.

1.3.3.1.3 Field 3—Instrument Serial Number

The Instrument Serial Number is an alphanumeric field of thirteen (13) characters including the dash (-) character.

1.3.3.1.4 Field 4—User Login

The User Login is a field of up to ten (10) characters UTF8 encoded.

1.3.3.2 Frame ID

The frame ID allows to distinguish the type of information transmitted.

FRAME ID	SENDER		INFORMATION
	INSTRUMENT	HOST (with handshake enabled)	
CONNECT	X	X	Connection test request
ACK_CONNECT		X	Connection acknowledged
NAK_CONNECT		X	Connection acknowledged with failed status
RESULT_READY	X		Instrument ready to send result data
RESULT	X		Result data being sent
ACK_RESULT_READY		X	Host acknowledge: ready for result data
ACK_RESULT		X	Host acknowledge: end of result data receipt
CALIBRATION	X		Calibration report being sent
ACK_CALI		X	Host acknowledge: end of calibration report receipt

1.3.3.3 Frame length

The length is variable.

1.3.3.4 Control sum

A CRC 16 is provided according to the type of frame and may be optionally processed by the host to verify correct transmission.

Details of this algorithm are available in section 7.6.1.

1.3.3.5 Data representation

Numeric data are transmitted in fields of variable length. A data segment is made of several data fields.

1.3.3.5.1 Data field

Each data sent by the instrument consists of the following elements:

FIELD ID FIELD SEPARATOR DATA VALUE [CR]

According to the type of field, several data values, semicolon separated, may follow a field ID:

- The decimal separator is the dot '.'.
- The fields separator is the semicolon ';'.
- The lines separator and the end of frame indicator are the carriage return [CR].
- All field IDs must be transmitted. If no data value is available, the data value field is empty.
- There are two exceptions mentioned in the analysis result concerning the PDW and PCT values.

All Identifier key words (frame, parameter) are in upper case.

The following fields are UTF8 encoded: SID, PID, ID, blood type (specimen), operator, lot numbers.

1.4 FRAMES

1.4.1 Connection (HOST)

The Connection frame is used to determine if the connection between the CELL-DYN Emerald and the host computer is operational.

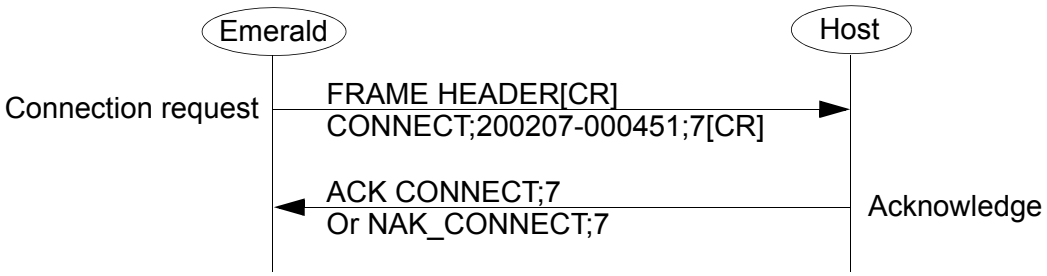
This frame is not mandatory to establish an operational connection with the host.

This transaction may be initiated either by the instrument or the host.

1.4.1.1 Connection request

1.4.1.1.1 Initiated by the Emerald

The Emerald sends this request when a user logs in.



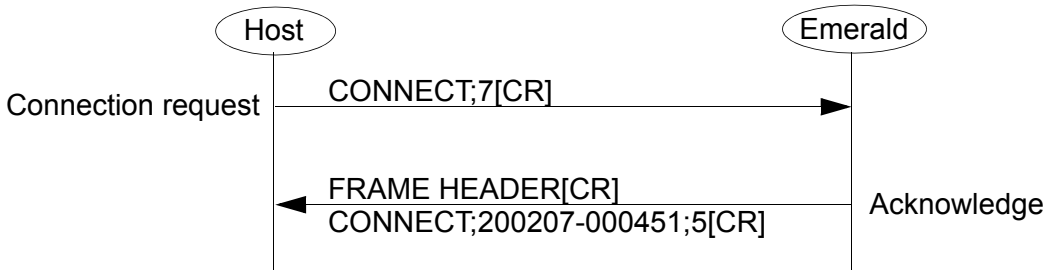
FRAME HEADER[CR]

CONNECT; instrument serial number; format version[CR]

Please refer to section 1.3.3.1 for details.

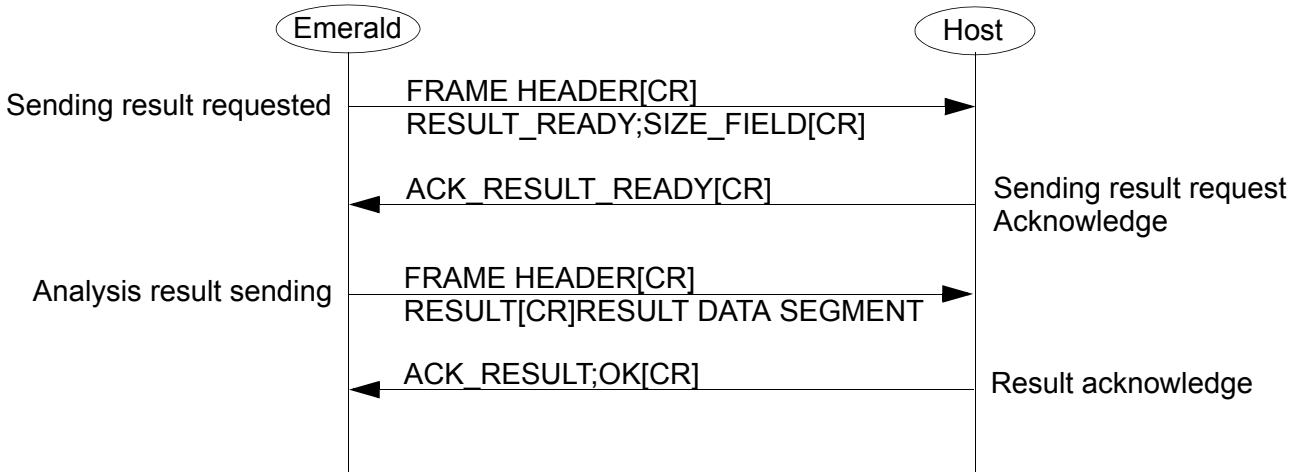
The current format version is number 7.

1.4.1.1.2 Initiated by the Host



1.4.2 SENDING RESULTS

The Emerald sends results after the Host acknowledgement occurs, in order to avoid sending a data stream when there is no host connected.



1.4.2.1 Sending result request

FRAME HEADER[CR]

RESULT_READY;Size_field[CR]

1.4.2.1.1 Field 1—Size

The size is a numeric field that is the size of the data segment to be sent by the instrument with a value ranging from 0 to 4294967295(2^32-1).

1.4.2.2 Sending result request acknowledgement

ACK_RESULT_READY[CR]

1.4.2.3 Sending analysis result

FRAME HEADER[CR]

RESULT[CR]

1.4.2.3.1 Result data segment

The following fields are described based upon their rank order in the data segment.

1.4.2.3.1.1 Field 1 - Date

The Specimen Date, giving the date on which the specimen was run, is an alphanumeric field of ten (10) characters. The date format is DD/MM/YYYY.

Field ID	Field ID length	Data Format	Length
DATE	4	DD/MM/YYYY	10

1.4.2.3.1.2 Field 2 - Time

The Specimen Time is an alphanumeric field of eight (8) characters. It gives the time at which the specimen was run in standard 24-hour format.

Field ID	Field ID length	Data Format	Length
TIME	4	HH:MM:SS	8

1.4.2.3.1.3 Field 3 - Mode

The mode field is an alphanumeric field of up to thirteen (13) characters. It gives the analysis mode: standard analysis run, QC run, precision run, calibration run, linearity run or startup run.

Field ID	Field ID length	Data format	Length
MODE	4	NORMAL	Variable

1.4.2.3.1.4 Field 4 - Unit

The unit code is a numeric field of one (1) character with a value ranging from 1 to 3.

The parameters reported by the instrument may be represented in any of three different sets of measurement units as follows:

Unit code value	Unit system
1	USA = standard
2	S.I.
3	S.I. MOD

Field ID	Field ID length	Data format	Length
UNIT	4	Unit code value	1

Following are the unit labels according to the selected unit set:

	UNITS		
Parameters	**USA(standard)**	**SI**	**SI MOD**
WBC	XXX.X 10^3/µL	XXX.X 10^9/L	XXX.X 10^9/L
RBC	XX.XX 10^6/µL	XX.XX 10^{12}/L	XX.XX 10^{12}/L
HGB	XX.X g/dL	XXX g/L	XX.XX mmol/L
HCT	XX.X %	X.XXX L/L	X.XXX L/L
MCV	XXX.X fL	XXX.X fL	XXX.X fL
MCH	XX.X pg	XX.X pg	X.XX fmol
MCHC	XX.X g/dL	XXX g/L	XX.XX mmol/L
RDW	XX.X %	XX.X %CV	XX.X %CV
PLT	XXXX 10^3/µL	XXXX 10^9/L	XXXX 10^9/L
MPV	XX.X fL	XX.X fL	XX.X fL
PCT*	X.XXX %	X.XXX mL/L	X.XXX mL/L
PDW*	XX.X %	XX.X %	XX.X %

1.4.2.3.1.5 Field 5 - Seq

The sequence number is a numeric field of four (4) characters with values ranging from 1 to 9999.

Field ID	Field ID length	Data format	Length
SEQ	4	Integer	1 up to 4

1.4.2.3.1.6 Field 6 - SID

The Sample ID is an alphanumeric field of up to sixteen (16) characters, UTF8 encoded. A SID is mandatory to run an analysis run.

Field ID	Field ID length	Data format	Length
SID	3	Alphanumeric, UTF8 encoded	1 up to 16

1.4.2.3.1.7 Field 7 - PID

The Patient ID is an alphanumeric field of up to sixteen (16) characters, UTF8 encoded.

Field ID	Field ID length	Data format	Length
PID	3	Alphanumeric, UTF8 encoded	0 up to 16

* Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.2.3.1.8 Field 8 - ID

The ID is an alphanumeric field of up to twenty (20) characters, UTF8 encoded. It is the patient name.

In Linearity mode, this field is forced to Linearity.

Field ID	Field ID length	Data format	Length
ID	2	Alphanumeric, UTF8 encoded	0 up to 20

1.4.2.3.1.9 Field 9 - Type

The Type is an alphanumeric field of up to ten (10) characters, UTF8 encoded. It is the specimen name.

Field ID	Field ID length	Data format	Length
TYPE	3	Alphanumeric, UTF8 encoded	1 up to 10

There are 20 specimen types that can be defined in the instrument software. The first (default) one, named STANDARD, cannot be modified.

1.4.2.3.1.10 Field 10 - Test

Test is an alphanumeric field of three (3) characters. It is set to LMG for the type of tests runs on this instrument.

Field ID	Field ID length	Data format	Length
TEST	4	LMG	3

1.4.2.3.1.11 Field 11 - Operator

The Operator is an alphanumeric field of up to ten (10) characters.

If no Operator ID is specified, the field is empty.

Field ID	Field ID length	Data format	Length
OPERATOR	8	Alphanumeric, UTF8 encoded	0 up to 10

1.4.2.3.1.12 Field 12 - WBC

NOTE:

- To better understand flagging fields, refer to Section 3-9 in the CELL-DYN Emerald System Operator's Manual.
- The count values are transmitted to the host in the selected unit.
- For Rank 3: '*' is used for L1 and/or L5 WBC flags and 's' is used for L2 and/or L3 WBC flags. If both flags are generated simultaneously, '*' will supercede 's'.

Rank	Data values	Data format	Length
1	Field ID	WBC	3
2	Count value	Numeric +++++ -----	Variable (refer to the units table). Maximum 5 5 5
3	Suspect flag	Empty, ‘s’ or ‘*’	Up to 1 character
4	Flag: over-range or panic flags	Empty or ‘D’ or ‘L’ or ‘l’ or ‘h’ or ‘H’	Up to 1 character
5	Low Panic value	Numeric	Variable (refer to the units table)
6	Low value	Numeric	Variable (refer to the units table)
7	High value	Numeric	Variable (refer to the units table)
8	High panic value	Numeric	Variable (refer to the units table)

For the data values at rank 2, 5, 6, 7 and 8, please refer to the following table to determine the maximum length:

	UNITS		
Parameters	**USA(standard)**	**SI**	**SI MOD**
WBC	XXX.X	XXX.X	XXX.X
RBC	XX.XX	XX.XX	XX.XX
HGB	XX.X	XXX	XX.XX
HCT	XX.X	X.XXX	X.XXX
MCV	XXX.X	XXX.X	XXX.X
MCH	XX.X	XX.X	X.XX
MCHC	XX.X	XXX	XX.XX
RDW	XX.X	XX.X	XX.X
PLT	XXXX	XXXX	XXXX
MPV	XX.X	XX.X	XX.X
PCT*	X.XXX	X.XXX	X.XXX
PDW*	XX.X	XX.X	XX.X

* Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.2.3.1.13 Field 13 - RBC

Please refer to the WBC field description for details. The field ID is RBC.

1.4.2.3.1.14 Field 14 - HGB

Please refer to the WBC field description for details. The field ID is HGB.

1.4.2.3.1.15 Field 15 - HCT

Please refer to the WBC field description for details. The field ID is HCT.

1.4.2.3.1.16 Field 16 - MCV

Please refer to the WBC field description for details. The field ID is MCV.

1.4.2.3.1.17 Field 17 - MCH

Please refer to the WBC field description for details. The field ID is MCH.

1.4.2.3.1.18 Field 18 - MCHC

Please refer to the WBC field description for details. The field ID is MCHC.

1.4.2.3.1.19 Field 19 - RDW

Please refer to the WBC field description for details. The field ID is RDW.

1.4.2.3.1.20 Field 20 - PLT

Please refer to the WBC field description for details. The field ID is PLT.

1.4.2.3.1.21 Field 21 - MPV

Please refer to the WBC field description for details. The field ID is MPV.

1.4.2.3.1.22 Field 22 - PCT*

Please refer to the WBC field description for details. The field ID is PCT.

1.4.2.3.1.23 Field 23 - PDW*

Please refer to the WBC field description for details. The field is PDW.

1.4.2.3.1.24 Field 24 - LYM%

Please refer to the WBC field description for details. The field is LYM%.

*Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.2.3.1.25 Field 25 - MID%

Please refer to the WBC field description for details. The field is MID%.

1.4.2.3.1.26 Field 26 - GRA%

Please refer to the WBC field description for details. The field is GRA%.

1.4.2.3.1.27 Field 27 - LYM

Please refer to the WBC field description for details. The field is LYM.

1.4.2.3.1.28 Field 28 - MID

Please refer to the WBC field description for details. The field is MID.

1.4.2.3.1.29 Field 29 - GRA

Please refer to the WBC field description for details. The field is GRA.

1.4.2.3.1.30 Field 30 - WBC channel data

Following the field ID, there are 128 values. Each value is followed by a ';' separator and with a value ranging from 0 to 255.

Field ID	Field ID length	Data format	Length
WBC CURVE	9	Numeric integer	Variable

1.4.2.3.1.31 Field 31 - WBC thresholds

This field gives the two WBC thresholds M1 and M2 set on the system. Each is a value ranging from 0 to 255.

Rank	Data values	Data format	Length
1	Field ID	WBC THRESHOLDS	14
2	Threshold M1	Numeric	Variable. Integer ranging from 0 to 255
3	Threshold M2	Numeric	Variable. Integer ranging from 0 to 255
4	Not used	0	1 character

1.4.2.3.1.32 Field 32 - RBC channel data

Following the field ID, there are 128 values. Each value is followed by a ';' separator and with a value ranging from 0 to 255.

Field ID	Field ID length	Data Format	Length
RBC CURVE	9	Numeric integer	Variable

1.4.2.3.1.33 Field 33 - RBC thresholds

This field gives both RBC thresholds that are unused on the Emerald. So, these values have no meaning on the system.

Rank	Data values	Data Format	Length
1	Field ID	RBC THRESHOLDS	14
2	Threshold M1	32	2
3	Threshold M2	55	2

1.4.2.3.1.34 Field 34 - PLT channel data

Following the field ID, there are 128 values. Each value is followed by a ';' separator and with a value ranging from 0 to 255.

1.4.2.3.1.35 Field 35 - PLT thresholds

This field gives the PLT thresholds set on the system. It is a value ranging from 0 to 255.

Rank	Data values	Data Format	Length
1	Field ID	PLT THRESHOLDS	14
2	Threshold P	Numeric	Variable

1.4.2.3.1.36 Field 36 - Alarms

This field lists the instrument alarms, operational alerts and measurand data flags applied on a result.

NOTE: To better understand Flagging fields, refer to Section 3-9 in the CELL-DYN Emerald System Operator's Manual.

Each flag is present in the list only if the flag is set. It means that the according data values are available if the according alarm flag is set. So, the number of data values depends on the number of flags set.

.

Rank	Data values	Data Format	Length
1	Field ID	ALARMS	6
2	L1	L1	2
3	L2	L2	2
4	L3	L3	2
5	L5	L5	2
6	P1	P1	2
7	P2	P2	2
8	P3	P3	2
9	Startup not done	S-UP NOT DONE	13
10	Startup failed	S-UP FAIL	9
11	QC not done	QC NOT DONE	11
12	QC failed	QC FAIL	7
13	Temperature alert	INS-T	5
14	Pressure alert	INS-P	5
15	HGB channel saturation	INS-H	5
16	WBC clog	W_CL	4
17	RBC clog	R_CL	4

1.4.2.3.1.37 Field 37 - WBC interpretive result

This field lists the WBC interpretive result.

NOTE: To better understand WBC interpretive results, refer to Section 3-19 in the CELL-DYN Emerald System Operator's Manual.

Each WBC interpretive result is present in the list only if it is set. This means that the according data values are available if the according interpretive flag is set. So, the number of data values depends on the number of interpretive flags set.

rank	Data values	Data Format	Length
1	Field ID	INTERPRETIV_WBC	16
2	Leukocytosis	LEU>	4
3	Leukopenia	LEU<	4
4	Lymphocytosis	LYM>	4
5	Lymphopenia	LYM<	4
6	Granulocytosis	GRA>	4
7	Granulocytopenia	GRA<	4
8	Unable to interpret	NO_INTERPRETATION	17

1.4.2.3.1.38 Field 38 - RBC interpretive result

This field lists RBC interpretive results.

NOTE: To better understand RBC interpretive results, refer to Section 3-19 in the CELL-DYN Emerald System Operator's Manual.

Each RBC interpretive result is present in the list only if it is set. This means that the according data values are available if the according interpretive flag is set. So, the number of data values depends on the number of interpretive flags set.

Rank	Data values	Data Format	Length
1	Field ID	INTERPRETIV_RBC	16
2	Anemia	ANE	3
3	Erythrocytosis	ERY>	4
4	Macrocytosis	MACRO	5
5	Microcytosis	MICRO	5
6	Unable to interpret	NO_INTERPRETATION	17

1.4.2.3.1.39 Field 39 - PLT interpretive result

This field lists PLT interpretive results.

NOTE: To better understand PLT interpretive results, refer to Section 3-19 in the CELL-DYN Emerald System Operator's Manual.

Each PLT interpretive result is present in the list only if it is set. This means that the according data values are available if the according interpretive flag is set. So, the number of data values depends on the number of interpretive flags set.

Rank	Data values	Data Format	Length
1	Field ID	INTERPRETIV_PLT	16
2	Thrombocytosis	ANE	3
3	Thrombocytopenia	ERY>	4
4	Giant platelets	MACRO	5
5	Cell debris	CELLD	5
6	Cold agglutinin	PLTAGGR	7
7	Unable to interpret	NO_INTERPRETATION	17

1.4.2.3.1.40 Field 40 - COMMENT

This field is filled with text if IUO** mode and US** mode are enabled. Both options are default disabled.

Field ID	Field ID length	Data Format	Length
COMMENT	7	PCT* and PDW* are for Info Only	29

1.4.2.3.1.41 Field 41 - END RESULT

This field is populated with the CRC value computed on the transmitted buffer and is the end marker of the result transmission.

The Algorithm is described in section 1.5.

Field ID	Field ID length	Data Format	Length
END RESULT	10	Integer	Variable

* Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S.

** These Options may only be selected outside of the U.S.

1.4.2.3.2 Result data segment example

```
DATE;06/06/2008[CR]
TIME;13:41:29[CR]
MODE;NORMAL[CR]
UNIT;1[CR]
SEQ;31;0[CR]SID;No ID Entered[CR]
PID;[CR]
ID;[CR]
TYPE;STANDARD[CR]
TEST;LMG[CR]
OPERATOR;OG[CR]
WBC;12.0 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
RBC;5.20 ;;H;0.00 ;0.00 ;0.00 ;0.00 [CR]
HGB;11.9;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
HCT;40.9;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
MCV;78.7 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MCH;22.9 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MCHC;29.1 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
RDW;17.7 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
PLT;220  ;;H;0    ;0    ;0    ;0    [CR]
MPV;7.6  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
LYM%;22.5;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
MID%;23.7;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
GRA%;53.8;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
LYM;2.7  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MID;2.8  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
GRA;6.5  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
WBC
CURVE;0;0;0;0;0;0;0;0;1;5;13;25;40;56;73;91;109;128;
146;165;184;202;220;235;244;245;240;229;215;199;182;
164;145;127;108;89;71;54;40;31;25;21;18;17;17;17;17;
17;17;18;20;23;25;27;29;32;35;37;39;41;44;47;49;51;
53;56;59;61;63;65;68;71;73;75;77;79;82;84;86;88;91;
94;96;98;98;98;97;95;94;92;89;87;85;83;81;78;75;73;
71;69;66;63;61;59;57;54;51;49;47;45;42;39;37;35;33;
30;27;23;17;11;6;2;0;0;0;0;0;0;[CR]
WBC THRESHOLDS;25;37;0;[CR]
RBC
CURVE;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
0;0;0;0;0;1;3;6;12;20;30;42;56;70;86;102;119;136;
153;170;186;201;213;221;225;225;221;214;204;192;178;
163;147;130;113;96;80;64;50;37;27;19;13;8;5;3;1;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
0;0;0;0;[CR]
```

```
RBC THRESHOLDS;32;55
[CR]PLT
CURVE;0;0;0;0;0;0;1;2;4;7;10;14;19;23;29;34;40;46;
52;58;64;70;77;83;89;95;100;104;108;110;112;113;114;
113;113;112;111;109;107;105;103;101;98;96;94;91;89;
86;83;81;78;75;73;70;68;65;63;60;57;55;52;49;47;44;
41;39;36;33;31;28;25;23;20;17;15;12;10;8;6;5;4;3;2;
1;1;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;[CR]
PLT THRESHOLDS;100[CR]
ALARMS;QC FAIL;INS-T;[CR]
INTERPRETIVE_WBC;LEU>;LYM>;GRA>;[CR]
INTERPRETIVE_RBC;ERY>;MACRO;[CR]
INTERPRETIVE_PLT;THR>;GIANTP;[CR]
COMMENT;;[CR]
END_RESULT;7774[CR]
```

1.4.2.4 Result acknowledgement

ACK_RESULT;A;B[CR]

Where A : OK or error code, B : Nothing.

Regardless of the error code transmitted by the host, the CELL-DYN Emerald does not interpret the error code, so if A is different from OK, the instrument generates an error such as described in section.1.3.2.4.

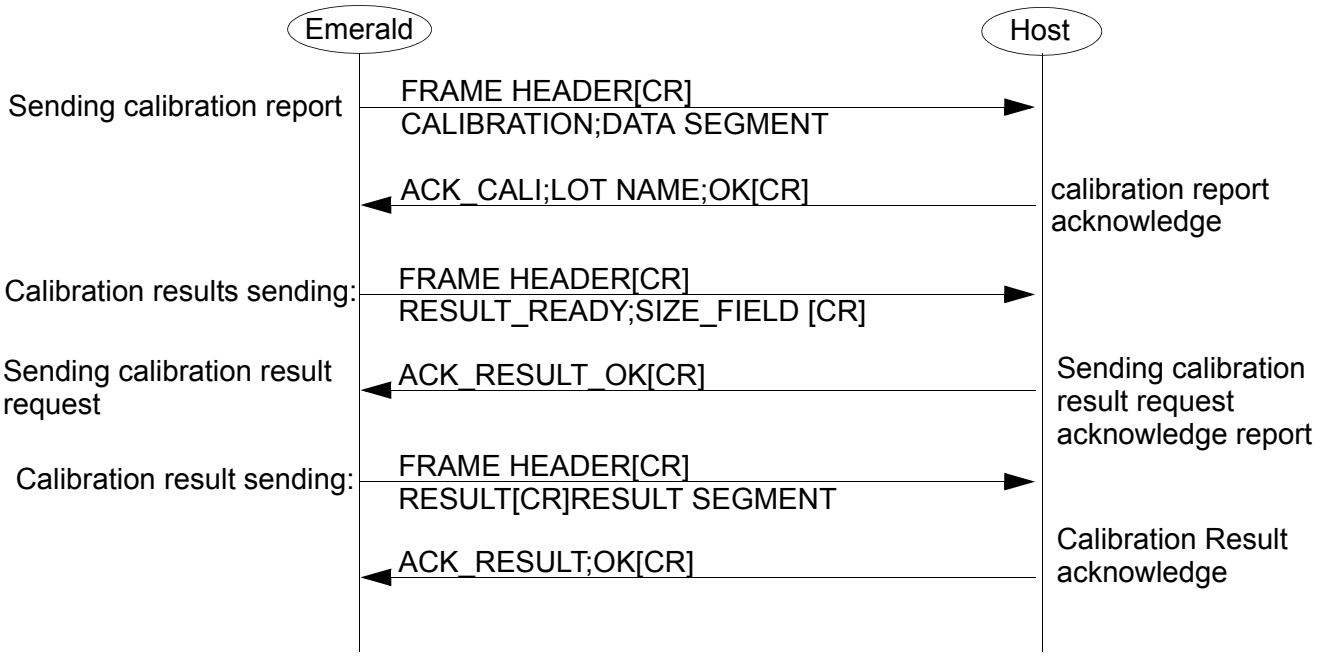
1.4.2.5 Error handling in handshake mode

In handshake mode, each result is tagged as sent if no error is generated in the acknowledgement process. If an error is ever generated then the result is not tagged as sent.

At next login, the CELL-DYN Emerald prompts the user to automatically transmit the results not sent. The user then has the ability to accept, to postpone or ignore (in this case the results are flagged as sent).

In non handshake mode, the CELL-DYN Emerald assumes that all frames were correctly sent and so marks all samples as ‘transmitted’.

1.4.3 CALIBRATION



1.4.3.1 Sending a calibration report

FRAME HEADER[CR]
CALIBRATION;CALIBRATION DATA SEGMENT
The following fields are described based on their rank order in the calibration data segment.

1.4.3.1.1 Field 1 - Calibration field ID - data segment

Rank	Data values	Data Format	Length
1	Field ID	CALIBRATION	11
2	User login	Alphanumeric	Up to 10 characters. UTF8 encoded
3	Calibration Date	DD/MM/YYYY	10
4	Calibration Time	HH:MM:SS	8
5	Lot Name	Alphanumeric	Up to 10 characters. UTF8 encoded
6	Expiry Date	DD/MM/YYYY	10
7	Creation Date	DD/MM/YYYY	10
8	Creation Time	HH:MM:SS	8
10	WBC calibration factor	numeric	Float ranging from 0.5 to 2.0
11	RBC calibration factor	numeric	Float ranging from 0.5 to 2.0
12	HGB calibration factor	numeric	Float ranging from 0.5 to 2.0
13	MCV calibration factor	numeric	Float ranging from 0.5 to 2.0
14	PLT calibration factor	numeric	Float ranging from 0.5 to 2.0
15	Number of result	numeric	Integer ranging from 0 to 10

1.4.3.1.1.1 User Login

The User Login, which identifies the operator that performed the calibration, is an alphanumeric field of up to ten (10) characters. It is UTF8 encoded.

1.4.3.1.1.2 Calibration Date

The Calibration Date, the date on which the calibration was done, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY.

1.4.3.1.1.3 Calibration Time

The Calibration Time is an alphanumeric field of eight (8) characters. It gives the time at which the Calibration was done in standard 24-hour format.

1.4.3.1.1.4 Lot name

The Calibration Lot is an alphanumeric field of up to eight (8) characters.

1.4.3.1.1.5 Expiry Date

The Expiry Date, the expiration date of the calibrator lot, is an alphanumeric field of ten (10) characters.The default format of the date is DD/MM/YYYY.

1.4.3.1.1.6 Creation Date

The Creation Date, the date on which the calibration was done, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY.

1.4.3.1.1.7 Creation Time Field

The Creation Time is an alphanumeric field of eight (8) characters. It gives the time at which the Calibration was done in standard 24-hour format.

1.4.3.1.1.8 WBC calibration factor

The WBC calibration factor is a numeric field filled out with the computed calibration factor. It ranges from 0.5 to 2.0.

1.4.3.1.1.9 RBC calibration factor

The RBC calibration factor is a numeric field filled out with the computed calibration factor. It ranges from 0.5 to 2.0.

1.4.3.1.1.10 HGB calibration factor

The HGB calibration factor is a numeric field filled out with the computed calibration factor. It ranges from 0.5 to 2.0.

1.4.3.1.1.11 MCV calibration factor

The MCV calibration factor is a numeric field filled out with the computed calibration factor. It ranges from 0.5 to 2.0.

1.4.3.1.1.12 PLT calibration factor

The PLT calibration factor is a numeric field filled out with the computed calibration factor. It ranges from 0.5 to 2.0.

1.4.3.1.1.13 Number of result

When a manual calibration is performed, the number of results is set to 0.

1.4.3.1.2 Field 2 - WBC target assay / limit

This field lists the assay value and limits input from the calibrator's assay sheet for the WBC parameter.

Rank	Data values	Data Format	Length
1	Field ID	WBC	3
2	WBC assay value	Numeric	Float
	WBC limit	Numeric	Float

1.4.3.1.3 Field 3 - RBC target value /limits

This field lists the assay value and limits input from the calibrator's assay sheet for the RBC parameter.

Rank	Data values	Data Format	Length
1	Field ID	RBC	3
2	RBC assay value	Numeric	Float
3	RBC limit	Numeric	Float

1.4.3.1.4 Field 4 - HGB target value / limits

This field lists the assay value and limits input from the calibrator's assay sheet for the HGB parameter.

Rank	Data values	Data Format	Length
1	Field ID	HGB	3
2	HGB assay value	Numeric	Float
3	HGB limit	Numeric	Float

1.4.3.1.5 Field 5 - MCV target value / limits

This field lists the assay value and limits input from the calibrator's assay sheet for the MCV parameter.

Rank	Data values	Data Format	Length
1	Field ID	MCV	3
2	MCV assay value	Numeric	Float
3	MCV limit	Numeric	Float

1.4.3.1.6 Field 6 - PLT target value / limits

This field lists the assay value and limits input from the calibrator's assay sheet for the PLT parameter.

Rank	Data values	Data Format	Length
1	Field ID	PLT	3
2	PLT assay value	Numeric	Float
3	PLT limit	Numeric	Float

1.4.3.1.7 Field 7 - END CALI

This field is populated with the CRC value computed on the transmitted buffer and is the end marker of the calibration report transmission.

The Algorithm is described in section 1.5

Field ID	Field ID length	Data Format	Length
END CALI	8	Integer	Variable

1.4.3.1.8 Calibration data segment example

```
CALIBRATION;OG;20/06/2008;15:02:08;CALI;01/01/
2009;20/06/
2008;14:54:30;OG;0.556000;1.000000;1.000000;0.922000
;1.000000;2[CR]
WBC;  5.0;  2.0[CR]
RBC; 6.00; 2.00[CR]
HGB;25.0; 5.0[CR]
MCV; 80.0; 20.0[CR]
PLT;  150;   10[CR]
END_CALI;8333[CR] ...
```

1.4.3.2 Calibration report acknowledgement

Calibration acknowledgement by the host is done by the following frame:

ACK_CALI;Calibration Lot;A[CR]

Where A : OK or Error code.

1.4.3.3 Calibration results

The runs used for the calibration are sent after the calibration report. The number of calibration results is given in the calibration field.

The calibration result segment is a subset of the fields described in the analysis result segment with some specific details listed below.

1.4.3.3.1 Calibration result segment

1.4.3.3.1.1 Field 1 - Date

The Date, the date on which the calibration run was done, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY.

Field ID	Field ID length	Data Format	Length
DATE	4	DD/MM/YYYY	10

1.4.3.3.1.2 Field 2 - Time

The Time is an alphanumeric field of eight (8) characters. It gives the time at which the calibration run was done in standard 24-hour format.

Field ID	Field ID length	Data Format	Length
TIME	4	HH:MM:SS	8

1.4.3.3.1.3 Field 3 - Mode

The mode field is an alphanumeric field of up to thirteen (13) characters. It gives the analysis mode, which is here CALIBRATION.

Field ID	Field ID length	Data Format	Length
MODE	4	CALIBRATION	11

1.4.3.3.1.4 Field 4 - Unit

Please refer to Section 1.4.2.3.1.4

1.4.3.3.1.5 Field 5 - Seq

Please refer to Section 1.4.2.3.1.5

1.4.3.3.1.6 Field 6 - Test

Please refer to Section 1.4.2.3.1.10

1.4.3.3.1.7 Field 7 - Operator

Please refer to Section 1.4.2.3.1.11

1.4.3.3.1.8 Field 8 - WBC

NOTE: To better understand Flagging fields, refer to Section 3-9 in the CELL-DYN Emerald System Operator's Manual.

- The count values transmitted to the host are sent in the selected units.
- For Rank 3: '*' is used for L1 and/or L5 WBC flags and 's' is used for L2 and/or L3 WBC flags. If both flags are generated simultaneously, '*' will supercede 's'.

Rank	Data values	Data Format	Length
1	Field ID	WBC	3
2	Count value	Numeric +++++ -----	Variable (look at the units table). Maximum 5 5 5
3	Suspect flag	Empty, 's' or '*'	Up to 1 character
4	Flag: over range or panic flags	Empty or 'D' or 'L' or 'l' or 'h' or 'H'	Up to 1 character
5	Low Panic value	Empty	0
6	Low value	Empty	0
7	High value	Empty	0
8	High panic value	Empty	0

1.4.3.3.1.9 Field 9 - RBC

Please refer to the WBC field description for details. The field ID is “RBC”.

1.4.3.3.1.10 Field 10 - HGB

Please refer to the WBC field description for details. The field ID is “HGB”.

1.4.3.3.1.11 Field 11 - MCV

Please refer to the WBC field description for details. The field ID is “MCV”.

1.4.3.3.1.12 Field 12 - PLT

Please refer to the WBC field description for details. The field ID is “PLT”.

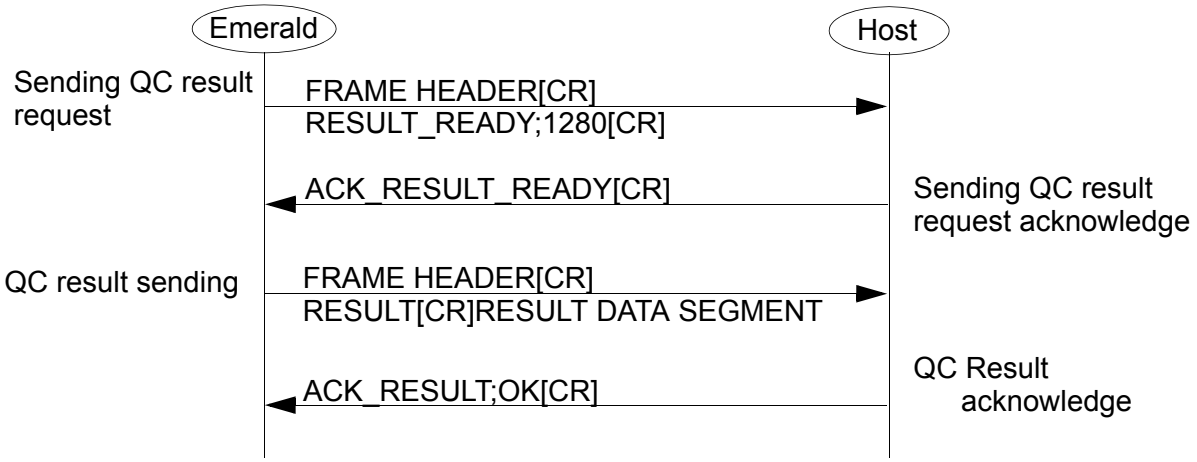
1.4.3.3.1.13 Field 13 - END RESULT

Please refer to Section 1.4.2.3.1.41

1.4.3.3.2 Calibration result segment example

```
RESULT[CR]
DATE;20/06/2008[CR]
TIME;15:00:24[CR]
MODE;CALIBRATION[CR]
UNIT;1[CR]
SEQ;1;0[CR]
TEST;LMG[CR]
OPERATOR;OG[CR]
WBC;7.0  ;;;;;;[CR]
RBC;4.70 ;;;;;;[CR]
HGB;11.4;;L;;;;[CR]
MCV;86.0 ;;;;;;[CR]
PLT;120  ;;L;;;;[CR]
END_RESULT;11687[CR] ..
```

1.4.4 QC



1.4.4.1 QC Result

The QC result segment is a subset of the fields described in the analysis result segment with some specific details listed below.

1.4.4.1.1 QC Result segment

1.4.4.1.1.1 Field 1 - Date

The Date, the date on which the QC run was done, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY.

Field ID	Field ID length	Data Format	Length
DATE	4	DD/MM/YYYY	10

1.4.4.1.1.2 Field 2 - Time

The Time is an alphanumeric field of eight (8) characters. It gives the time at which the QC run was done in standard 24-hour format.

Field ID	Field ID length	Data Format	Length
TIME	4	HH:MM:SS	8

1.4.4.1.1.3 Field 3 - Mode

The mode field is an alphanumeric field of up to thirteen (13) characters. It gives the analysis mode: here QC.

Field ID	Field ID length	Data Format	Length
MODE	4	QC	2

1.4.4.1.1.4 Field 4 - Unit

Please refer to Section 1.4.2.3.1.4

1.4.4.1.1.5 Field 5 - Seq

Please refer to Section 1.4.2.3.1.5

Note that in this case the SEQ field is filled out with the sequence number initialized by the CELL-DYN Emerald when the QC run is requested.

If the QC results are sent later, then the sequence number becomes a rank number from 0 to n.

1.4.4.1.1.6 Field 6 - Lot Name

The Lot Name giving the name of the QC lot is an alphanumeric field of up to eight (8) characters, UTF8 encoded.

Field ID	Field ID length	Data Format	Length
LOT	3	Alphanumeric	From 1 up to 8

1.4.4.1.1.7 Field 7 - Level

The Lot Level, giving the level of the QC, is an alphanumeric field of one (1) character.

Field ID	Field ID length	Data Format	Length
LEVEL	5	H or L or N	1

H for High Level

L for Low Level

N for Normal Level

1.4.4.1.1.8 Field 8 - Lot Date

The Lot Date, giving the date and time on which the QC lot was created.

rank	Fields	Data Format	Length
1	Field ID	LOT DATE	8
2	Creation date	DD/MM/YYYY	10
3	Creation time	HH:MM:SS	8

1.4.4.1.1.9 Field 9 - Expiry DateType

The Expiry Date, the expiration date of the QC lot, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY

Field ID	Field ID length	Data Format	Length
EXPIRY DATE	11	DD/MM/YYYY	10

1.4.4.1.1.10 Field 10 - User

The User, the operator who created the QC lot, is an alphanumeric field of up to ten (10) characters. It is UTF8 encoded.

Field ID	Field ID length	Data Format	Length
USER	4	Alphanumeric	Up to 10. UTF8 encoded.

1.4.4.1.1.11 Field 11 - Test

Please refer to Section 1.4.2.3.1.10

1.4.4.1.1.12 Field 12 - Operator

Please refer to Section 1.4.2.3.1.11

1.4.4.1.1.13 Field 13 - WBC

NOTE: To better understand Flagging fields, refer to Section 3-9 in the CELL-DYN Emerald System Operator's Manual.

- The count values transmitted to the host are sent in the selected unit.
- For Rank 3: '*' is used for L1 and/or L5 WBC flags and 's' is used for L2 and/or L3 WBC flags. If both flags are generated simultaneously, '*' will supercede 's'.

rank	Data values	Data Format	Length
1	Field ID	WBC	3
2	Count value	Numeric +++++ -----	Variable (refer to the units table). Maximum 5 5 5
3	Suspect flag	Empty, 's' or '*'	Up to 1 character
4	Flag: over range or panic flags	Empty or 'D' or 'L' or 'l' or 'h' or 'H'	Up to 1 character
5	Low Panic value	Numeric	Variable (refer to the units table) In QC, the value here is the low limit assay value.
6	Low value	Empty	0
7	High value	Empty	0
8	High panic value	Numeric	Variable (refer to the units table) In QC, the value here is the high limit assay value.

1.4.4.1.1.14 Field 14 - RBC

Please refer to the WBC field description for details. The field ID is RBC.

1.4.4.1.1.15 Field 15 - HGB

Please refer to the WBC field description for details. The field ID is HGB.

1.4.4.1.1.16 Field 16 - HCT

Please refer to the WBC field description for details. The field ID is HCT.

1.4.4.1.1.17 Field 17 - MCV

Please refer to the WBC field description for details. The field ID is MCV.

1.4.4.1.1.18 Field 18 - MCH

Please refer to the WBC field description for details. The field ID is MCH.

1.4.4.1.1.19 Field 19 - MCHC

Please refer to the WBC field description for details. The field ID is MCHC.

1.4.4.1.1.20 Field 20 - RDW

Please refer to the WBC field description for details. The field ID is RDW.

1.4.4.1.1.21 Field 21 - PLT

Please refer to the WBC field description for details. The field ID is PLT.

1.4.4.1.1.22 Field 22 - MPV

Please refer to the WBC field description for details. The field ID is MPV.

1.4.4.1.1.23 Field 23 - PCT*

Please refer to the WBC field description for details. The field ID is PCT.

1.4.4.1.1.24 Field 24 - PDW*

Please refer to the WBC field description for details. The field ID is PDW.

1.4.4.1.1.25 Field 25 - LYM%

Please refer to the WBC field description for details. The field ID is LYM%.

1.4.4.1.1.26 Field 26 - MID%

Please refer to the WBC field description for details. The field ID is MID%.

1.4.4.1.1.27 Field 27 - GRA%

Please refer to the WBC field description for details. The field ID is GRA%.

1.4.4.1.1.28 Field 28 - LYM

Please refer to the WBC field description for details. The field ID is LYM.

1.4.4.1.1.29 Field 29 - MID

Please refer to the WBC field description for details. The field ID is MID.

1.4.4.1.1.30 Field 30 - GRA

Please refer to the WBC field description for details. The field ID is GRA.

1.4.4.1.1.31 Field 31 - END RESULT

Please refer to Section 1.4.2.3.1.41

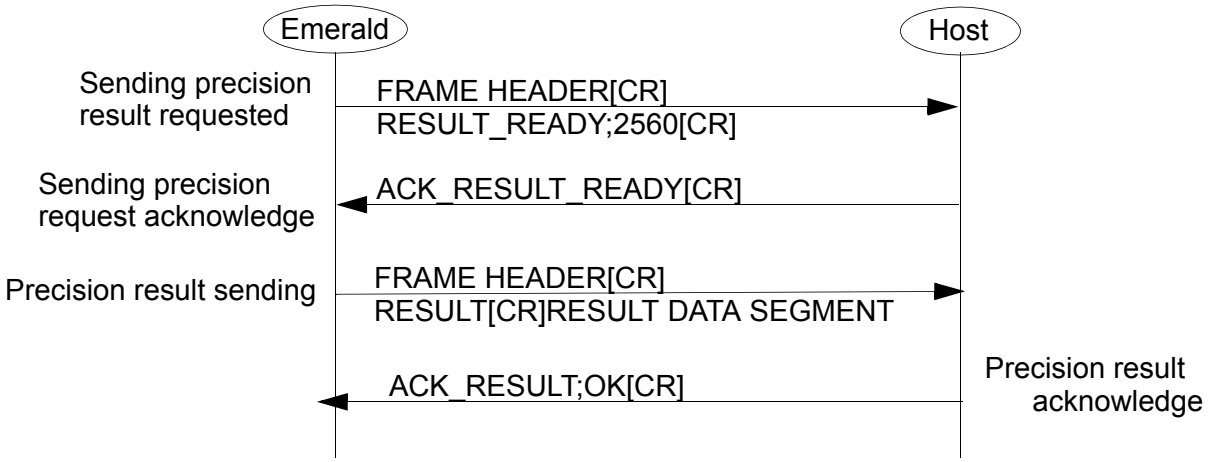
*Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.4.1.2 QC Result example

```
RESULT[CR]
DATE;21/06/2008[CR]
TIME;10:08:25[CR]
MODE;QC[CR]
UNIT;1[CR]
SEQ;1;0[CR]
LOT;16961CD[CR]
LEVEL;L[CR]
LOT DATE;21/06/2008;10:07:59[CR]
EXPIRY DATE;07/06/2009[CR]
USER;OG[CR]
TEST;LMG[CR]
OPERATOR;OG[CR]
WBC;8.0  ;;L;15.0 ;;;20.0 [CR]
RBC;4.80 ;;;4.68 ;;;5.28 [CR]
HGB;11.5;;L;14.4;;;15.8[CR]
HCT;40.5;;;37.8;;;44.8[CR]
MCV;84.4 ;;;79.0 ;;;87.0 [CR]
MCH;24.0 ;;L;27.8 ;;;32.8 [CR]
MCHC;28.4 ;;L;33.2 ;;;39.8 [CR]
RDW;16.6 ;;;0.0  ;;;99.8 [CR]
PLT;220  ;;L;407  ;;;527  [CR]
MPV;15.8 ;;;0.0  ;;;99.8 [CR]
*PCT;0.580;;H;0.000;;;0.000[CR]
*PDW;12.2 ;;H;0.0  ;;;0.0  [CR]
LYM%;28.1;;L;46.8;;;56.8[CR]
MID%;29.5;;H;6.2 ;;;12.2[CR]
GRA%;42.4;;;34.0;;;44.0[CR]
LYM;2.2  ;;L;6.8  ;;;11.4 [CR]
MID;2.4  ;;;0.8  ;;;2.4  [CR]
GRA;3.4  ;;L;4.8  ;;;8.8  [CR]
END_RESULT;29885[CR] ...
```

* Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.5 Precision



1.4.5.1 Precision Result

The Precision result segment is a subset of the fields described in the analysis result segment with some specific details listed below.

1.4.5.1.1 Precision result data segment

1.4.5.1.1.1 Field 1 - Date Field

The Date, the date on which the precision run was done, is an alphanumeric field of ten (10) characters. The default format of the date is DD/MM/YYYY.

Field ID	Field ID length	Data Format	Length
DATE	4	DD/MM/YYYY	10

1.4.5.1.1.2 Field 2 - Time Field

The Time is an alphanumeric field of eight (8) characters. It gives the time at which the precision run was done in standard 24-hour format.

Field ID	Field ID length	Data Format	Length
TIME	4	HH:MM:SS	8

1.4.5.1.1.3 Field 3 - Mode

The mode field is an alphanumeric field of up to thirteen (13) characters. It gives the analysis mode: here REPEATABILITY.

Field ID	Field ID length	Data Format	Length
MODE	4	REPEATABILITY	13

1.4.5.1.1.4 Field 4 - Unit

Please refer to Section 1.4.2.3.1.4

1.4.5.1.1.5 Field 5 - Seq

Please refer to Section 1.4.2.3.1.5

1.4.5.1.1.6 Field 6 - Test

Please refer to Section 1.4.2.3.1.10

1.4.5.1.1.7 Field 7 - Operator

Please refer to Section 1.4.2.3.1.11

1.4.5.1.1.8 Field 8 - WBC

NOTE: To better understand Flagging fields, refer to Section 3-9 in the CELL-DYN Emerald System Operator's Manual.

- The count values transmitted to the host are sent in the selected unit.
- For Rank 3: '*' is used for L1 and/or L5 WBC flags and 's' is used for L2 and/or L3 WBC flags. If both flags are generated simultaneously, '*' will supercede 's'.

rank	Data values	Data Format	Length
1	Field ID	WBC	3
2	Count value	Numeric +++++ -----	Variable (refer to the units table). Maximum 5 5 5
3	Suspicion flag	Empty, 's' or '*'	Up to 1 character
4	Flag: overange or panic flags	Empty or 'D' or 'L' or 'l' or 'h' or 'H'	Up to 1 character
5	Low Panic value	Empty	0
6	Low value	Empty	0
7	High value	Empty	0
8	High panic value	Empty	0

1.4.5.1.1.9 RBC- Field 9

Please refer to the WBC field description for details. The field ID is RBC.

1.4.5.1.1.10 HGB- Field 10

Please refer to the WBC field description for details. The field ID is HGB.

1.4.5.1.1.11 Field 11 - HCT

Please refer to the WBC field description for details. The field ID is HCT.

1.4.5.1.1.12 Field 12 - MCV

Please refer to the WBC field description for details. The field ID is MCV.

1.4.5.1.1.13 Field 13 - MCH

Please refer to the WBC field description for details. The field ID is MCH.

1.4.5.1.1.14 Field 14 - MCHC

Please refer to the WBC field description for details. The field ID is MCHC.

1.4.5.1.1.15 Field 15 - RDW

Please refer to the WBC field description for details. The field ID is RDW.

1.4.5.1.1.16 Field 16 - PLT

Please refer to the WBC field description for details. The field ID is PLT.

1.4.5.1.1.17 Field 17 - MPV

Please refer to the WBC field description for details. The field ID is MPV.

1.4.5.1.1.18 Field 18 - PCT*

Please refer to the WBC field description for details. The field ID is PCT.

1.4.5.1.1.19 Field 19 - PDW*

Please refer to the WBC field description for details. The field is PDW.

1.4.5.1.1.20 Field 20 - LYM%

Please refer to the WBC field description for details. The field is LYM%.

1.4.5.1.1.21 Field 21 - MID%

Please refer to the WBC field description for details. The field is MID%.

1.4.5.1.1.22 Field 22 - GRA%

Please refer to the WBC field description for details. The field is GRA%.

1.4.5.1.1.23 Field 23 - LYM

Please refer to the WBC field description for details. The field is LYM.

1.4.5.1.1.24 Field 24 - MID

Please refer to the WBC field description for details. The field is MID.

1.4.5.1.1.25 Field 25 - GRA

Please refer to the WBC field description for details. The field is GRA.

1.4.5.1.1.26 Field 26 - END RESULT

Please refer to section 1.4.2.3.1.41

*Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

1.4.5.1.2 Precision result example

```
RESULT[CR]
DATE;21/06/2008[CR]
TIME;10:23:09[CR]
MODE;REPEATABILITY[CR]
UNIT;1[CR]
SEQ;2;0[CR]
TEST;LMG[CR]
OPERATOR;OG[CR]
WBC;12.0 ;;;;;;[CR]
RBC;4.70 ;;;;;;[CR]
HGB;11.4;;;;;;[CR]
HCT;40.4;;;;;;[CR]
MCV;86.0 ;;;;;;[CR]
MCH;24.3 ;;;;;;[CR]
MCHC;28.2 ;;;;;;[CR]
RDW;16.2 ;;;;;;[CR]
PLT;220  ;;;;;;[CR]
MPV;10.4 ;;;;;;[CR]
*PCT;0.380;;;;;;[CR]
*PDW;12.0 ;;;;;;[CR]
LYM%;9.3 ;;;;;;[CR]
MID%;9.7 ;;;;;;[CR]
GRA%;81.0;;;;;;[CR]
LYM;1.1  ;;;;;;[CR]
MID;1.2  ;;;;;;[CR]
GRA;9.7  ;;;;;;[CR]
END_RESULT;59882[CR]
```

1.5 Control sum

The control sum is a CRC code: CRC-16.

1.5.1 Algorithm

The source code used is below(C code).
It allows generation of standard CRC-16.

This algorithm is mainly used in embedded systems (like a hard disk controller).

For best performance, computation is done from a seek table with 16 values.

Here is the CRC computation:

```
CRC = 0xFFFF
For each nibble:
        Work on high weight nibble:
        Index = byte EXCLUSIVE OR CRC
        Index = Index AND 000F
        CRC = Table (Index) EXCLUSIVE OR (CRC divided by 16)

        Index = byte divided by 16
        Index = Index EXCLUSIVE OR CRC
        Index = Index AND 000F
        CRC = Table (Index) EXCLUSIVE OR (CRC divided by 16)
```

* Clinical significance has not been established for these parameters; therefore they are not reportable in the U.S. These options may only be selected outside of the U.S.

C language source example implementation:

Seek table declaration:

```
static const unsigned short ausCrcTab1[] =
 {
 0x0000, 0xCC01,0xD801,0x1400,0xF001,0x3C00,0x2800,0xE401,
 0xA001,0x6C00,0x7800,0xB401,0x5000,0x9C01,0x8801,0x4400,
};
```

CRC computation:

```
unsigned short calc_crc(unsigned char *pucData, long lSize)
{
unsigned short usAcc1 = 0xFFFF;

 while ( lSize > 0 )
           {
           usAcc1 = ausCrcTab1[(*pucData ^ usAcc1) & 15] ^ (usAcc1 >> 4);
           usAcc1 = ausCrcTab1[((*pucData >> 4) ^ usAcc1) & 15] ^ (usAcc1 >>
4);

           pucData++;
           lSize--;
           }

return(usAcc1);
}
```

^: EXCLUSIVE OR

>>: LOGICAL RIGHT SHIFT.

&: LOGICAL AND.

This CRC is computed from the beginning of the sent data until the end of the line ([CR] included) preceding the checksum line (Identifier + value).

1.5.2 Example

The CRC is computed with all grey background data:

```
EMERALD;INSTRUMENT NUMBER;INSTRUMENT SERIAL NUMBER;USER LOGIN[CR]
RESULT[CR]
DATE;06/06/2008[CR]
TIME;13:41:29[CR]
MODE;NORMAL[CR]
UNIT;1[CR]
SEQ;31;0[CR]SID;No ID Entered[CR]
PID;[CR]
ID;[CR]
TYPE;STANDARD[CR]
TEST;LMG[CR]
OPERATOR;OG[CR]
WBC;12.0 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
RBC;5.20 ;;H;0.00 ;0.00 ;0.00 ;0.00 [CR]
HGB;11.9;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
HCT;40.9;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
MCV;78.7 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MCH;22.9 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MCHC;29.1 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
RDW;17.7 ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
PLT;220  ;;H;0    ;0    ;0    ;0    [CR]
MPV;7.6  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
LYM%;22.5;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
MID%;23.7;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
GRA%;53.8;;H;0.0 ;0.0 ;0.0 ;0.0 [CR]
LYM;2.7  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
MID;2.8  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
GRA;6.5  ;;H;0.0  ;0.0  ;0.0  ;0.0  [CR]
WBC
CURVE;0;0;0;0;0;0;0;0;1;5;13;25;40;56;73;91;109;128;146;165;184;202;
220;235;244;245;240;229;215;199;182;164;145;127;108;89;71;54;40;31;25;
21;18;17;17;17;17;17;17;18;20;23;25;27;29;32;35;37;39;41;44;47;49;51;
53;56;59;61;63;65;68;71;73;75;77;79;82;84;86;88;91;94;96;98;98;98;97;
95;94;92;89;87;85;83;81;78;75;73;71;69;66;63;61;59;57;54;51;49;47;45;
42;39;37;35;33;30;27;23;17;11;6;2;0;0;0;0;0;0;[CR]
WBC THRESHOLDS;25;37;0;[CR]
RBC
CURVE;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;1;3;6;
12;20;30;42;56;70;86;102;119;136;153;170;186;201;213;221;225;225;221;
214;204;192;178;163;147;130;113;96;80;64;50;37;27;19;13;8;5;3;1;0;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;[CR]
```

```
RBC THRESHOLDS;32;55
[CR]PLT
CURVE;0;0;0;0;0;0;1;2;4;7;10;14;19;23;29;34;40;46;52;58;64;70;77;83;
89;95;100;104;108;110;112;113;114;113;113;112;111;109;107;105;103;101;
98;96;94;91;89;86;83;81;78;75;73;70;68;65;63;60;57;55;52;49;47;44;41;
39;36;33;31;28;25;23;20;17;15;12;10;8;6;5;4;3;2;1;1;0;0;0;0;0;0;0;0;0;
0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;0;
[CR]
PLT THRESHOLDS;100[CR]
ALARMS;QC FAIL;INS-T;[CR]
INTERPRETIVE_WBC;LEU>;LYM>;GRA>;[CR]
INTERPRETIVE_RBC;ERY>;MACRO;[CR]
INTERPRETIVE_PLT;THR>;GIANTP;[CR]
COMMENT;;[CR]
```