Binary Message Protocol

User's Guide

Version 1.5

May 30, 2005

REVISION HISTORY

Revision	Update Summary	Date
1.0	**Initial release**	2004-8-6
1.1	**Added Trace log command set**	2004-10-15
1.2	**Corrected message User PVT I**	2004-10-26
1.3	- **Added Message Extended Trace Status** - **WAAS Control**	2005-4-14
1.4	- **Changed Update rate (LS-4100 products only)**	2005-5-16
1.5	- **Added command 17h / 18h** - **Added messages 8Bh / 8Ch** - **Added command 12h (1PPS)**	2005-5-30

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BINARY MESSAGE STRUCTURE

The binary message comprises of binary string with length of up to 255 characters. It has the following format:

Format
%%<Message Start>Message Body><Message End><CR><LF>

Description		Value	
Leading Byte 1		%	25h
Leading Byte 2		%	25h
Message Start	Message Type		
	Message ID		
Message Body			Up to 250 bytes
Message End	Checksum Byte	<CS>	xxh
Ending Byte 1		<CR>	0Dh
Ending Byte 2		<LF>	0Ah

Message Start: <Frame Type> <Frame ID>

Message Type: ACK (06h), NAK (15h), Input (F1h), Output (F2h)
Message ID: Number between 0x01, 0xEF

Message Body: Contains input parameter or output information related to the particular message.

Message End: Checksum byte. The checksum is calculated by performing exclusive-or, XOR, of all bytes from <Message Type> till the last byte prior to <Checksum Byte>:

CS = CS ^ <Data Byte>, where initially CS = 0

Sample C-Code for Calculating Checksum

```
char BIN_ComputeChecksum( char* buf, int len )
{   int     i;
    char chksum;

    chksum = 0;

    for (i=0; i<len; i++ ) chksum ^= buf[i];

    return sum;
}
```

Sample Binary Message: The following binary message sets baud-rate to 19200.

```
25 25 f1 02 00 02 fd 7f 00 00 00 00 73 0d 0a
```

BINARY INPUT MESSAGE TYPE <F1h>

This group of binary messages are used to configure the GPS receiver, or to request information from the GPS receiver. If the receiver carries out the command successfully, ACK binary message is returned; otherwise NAK binary message is returned.

Data Types Used

UINT08: 8bit unsigned integer	SINT16: 16bit signed integer
UINT16: 16bit unsigned integer	SINT32: 32bit signed integer
UINT32: 32bit unsigned integer	SPFP: 32bit single precision floating point number
SINT08: 8bit signed integer	DPFP: 64bit double precision floating point number

Byte Ordering

All data is in little-endian format, with low-order byte (LSB) at lower address.

ACK/NAK

An output ACK message indicates GPS accepts the message while NAK indicates GPS cannot execute the command at the moment. **However, an error input command will not get any acknowledge message from GPS.**

Command ***Restart (01h)*** ***(All GPS modules)***

String *%%<F1h><01h>< Parameter Bytes><CS><CR><LF>*

Length *2 + 16 = 18*

Response ***ACK*** *%%<06h><01h><CS><CR><LF>*

NAK *%%<15h><01h><CS><CR><LF>*

Description *Force system to restart*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Restart Type		*0: Hardware Reset (all parameters below are unused)* *1: Initialized Restart*	*UNT08*	*-*	*1*
Start Mode		*When Restart type is Initialized Restart* *1: Hot start* *2: Warm start* *3: Cold start*	*UINT08*	*-*	*2*
(UTC) Date & Time	*Year*	*>= 1980*	*UINT16*	*-*	*3 – 4*
	Month	*1 ~ 12*	*UINT08*	*-*	*5*
	Day	*1 ~ 31*	*UINT08*	*-*	*6*
	Hour	*0 ~ 23*	*UINT08*	*-*	*7*
	Minute	*0 ~ 59*	*UINT08*	*-*	*8*
	Second	*0 ~ 59*	*UINT08*	*-*	*9*
Reserved		*-*	*UINT08*	*-*	*10*
(WGS-84) Initial Position	*Latitude*	*Between – 9000 and 9000* *> 0: North Hemisphere* *< 0: South Hemisphere*	*SINT16*	*1/100 degree*	*11 – 12*
	Longitude	*Between – 18000 and 18000* *> 0: East Hemisphere* *< 0: West Hemisphere*	*SINT16*	*1/100 degree*	*13 – 14*
	Altitude	*Between –1000 and 18300*	*SINT16*	*Meter*	*15 – 16*

Command		***Baud-Rate Configuration (02h)***	***(All GPS modules)***
String		*%%<F1h><02h>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 8 = 10*	
Response	***ACK***	*%%<06h><02h><CS><CR><LF>*	
	NAK	*%%<15h><02h><CS><CR><LF>*	

Description *Configure serial port baud-rate (UART2 is supported for LS-40EB only)*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
UART Selection	*0: UART1* *1: UART2*	*UNT08*	*-*	*1*
Baud Rate	*0: 4800* *1: 9600* *2: 19200*	*UNT08*	*-*	*2*
All non-used byte should be set to 0				*3 - 8*

Command ***Set Datum (03h)*** ***(All GPS modules)***

String *%%<F1h><03h>< Parameter bytes><CS><CR><LF>*

Length *2 + 8 = 10*

Response ***ACK*** *%%<06h><03h ><CS><CR><LF>*

NAK *%%<15h><03h ><CS><CR><LF>*

Description *Used to setup datum parameters for position transformation if non-WGS84 datum is required. Refer to Appendix A and B for the parameters to use.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Ellipsoid index	*See appendix A*	*UINT16*	*-*	*1 – 2*
Delta X	*See appendix B*	*SINT16*	*Meter*	*3 – 4*
Delta Y	*See appendix B*	*SINT16*	*Meter*	*5 – 6*
Delta Z	*See appendix B*	*SINT16*	*Meter*	*7 – 8*

Command ***Set NMEA Configuration (04h)*** ***(All GPS modules)***

String *%%<F1h><04h>< Parameter bytes><CS><CR><LF>*

Length *2 + 8 = 10*

Response ***ACK*** *%%<06h><04h ><CS><CR><LF>*

NAK *%%<15h><04h ><CS><CR><LF>*

Description *Define the output interval between two consecutive NMEA sentences of the same type. When all values are set to 0, no NMEA message is output.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Checksum flag	*0: Disable, 1:Enable*	*UINT08*	*-*	*1*
RMC Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*2*
VTG Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*3*
GGA Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*4*
GSA Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*5*
GSV Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*6*
GLL Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*7*
ZDA Interval	*0 ~ 255, 0: Disable*	*UINT08*	*Second*	*8*

Command		***Query Firmware Version (05h)***	***(All GPS modules)***
String		*%%<F1h><05h>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 2 = 4*	
Response	***ACK***	*%%<06h><05h><CS><CR><LF>*	
	NAK	*%%<15h><05h><CS><CR><LF>*	
	80h	*See message 80h for firmware version information*	

Description *Retrieve version information of the firmware.*
When CRC is enabled, it may take up to one second to calculate the CRC value.

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Firmware type	*0: Boot code* *1: System code*	*UINT08*	*-*	*1*
CRC	*0: No CRC* *1: CRC information is requested*	*UINT08*	*-*	*2*

Command		***Restore Factory Default (08h)***	***(All GPS modules)***
String		*%%<F1h><08h>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 4 = 6*	
Response	***ACK***	*%%<06h><08h><CS><CR><LF>*	
	NAK	*%%<15h><08h><CS><CR><LF>*	

Description *Restore all configurable settings to factory default value.*
All user settings will be erased.

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Restoration Key	*0x53434C50*	*UINT32*	*-*	*1 - 4*

Command		***Set ID (0Dh)***	***(All GPS modules)***
String		*%%<F1h><0Dh>< Parameter byte><CS><CR><LF>*	
Length		*2 + 9 = 11*	
Response	***ACK***	*%%<06h><0Dh><CS><CR><LF>*	
	NAK	*%%<15h><0Dh><CS><CR><LF>*	

Description *Setup User ID for the module.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Type	*1: User ID type*	*UINT08*	*-*	*1*
ID	*1~2^32*	*UINT32*	*-*	*2 - 5*
Reserved	*-*	*UINT32*	*-*	*6 - 9*

Command		***Query Module ID (0Eh)***	***(All GPS modules)***
String		*%%<F1h><0Eh>< Parameter byte><CS><CR><LF>*	
Length		*2 + 1 = 3*	
Response	***ACK***	*%%<06h><0Eh><CS><CR><LF>*	
	NAK	*%%<15h><0Eh><CS><CR><LF>*	
	85h	*See message 85h for detail*	

Description *Retrieve User ID of the module.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Type	*1: User ID retrieval*	*UINT08*	*-*	*1*

Command ***Set DOP Mask (0Fh)*** ***(All GPS modules)***

String *%%<F1h><0Fh>< Parameter byte><CS><CR><LF>*

Length *2 + 4 = 6*

Response ***ACK*** *%%<06h><0Fh><CS><CR><LF>*

NAK *%%<15h><0Fh><CS><CR><LF>*

Description *To set the DOP mask value and which type of DOP mask to use. When the calculated DOP value is higher than this mask value, no valid position data will be available.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
DOP Mask Reference	*0: Disable DOP masking* *1: Use GDOP* *2: Use PDOP* (default)* *3: Use HDOP*	*UINT08*	*-*	*1*
GDOP Mask value	*0 ~ 255*	*UINT08*	*-*	*2*
PDOP mask value	*0 ~ 255*	*UINT08*	*-*	*3*
HDOP Mask value	*0 ~ 255*	*UINT08*	*-*	*4*

Command		***Set Elevation Mask (10h)***	***(All GPS modules)***
String		*%%<F1h><10h>< Parameter byte><CS><CR><LF>*	
Length		*2 + 1 = 3*	
Response	***ACK***	*%%<06h><10h><CS><CR><LF>*	
	NAK	*%%<15h><10h><CS><CR><LF>*	

Description *Set satellite elevation mask value. Satellite with elevation angle below this mask value is not used for position fix*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
Mask value	*0 ~ 89*	*UINT08*	*Degree*	*1*

Command ***DGPS control (11h)*** ***(All GPS modules)***

String *%%<F1h><11h>< Parameter byte><CS><CR><LF>*

Length *2 + 2 = 4*

Response ***ACK*** *%%<06h><11h><CS><CR><LF>*

NAK *%%<15h><11h><CS><CR><LF>*

Description *Enable / disable DGPS*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
Item	*0: Disable* *1: Waas / Egnos*	*UINT08*	*-*	*1*
Reserved	*-*	*UINT08*	*-*	*2*

Command ***1PPS control (12h)*** ***(All GPS modules)***

String *%%<F1h><11h>< Parameter byte><CS><CR><LF>*

Length *2 + 3 = 5*

Response ***ACK*** *%%<06h><12h><CS><CR><LF>*

NAK *%%<15h><12h><CS><CR><LF>*

Description *Enable / disable 1PPS and setup pulse width.*

- 1PPS signal is output when GPS satisfies the following condition at least 3 minutes
- *stationary state.*
- *3D position fix.*

- Any interrupt on one of the conditions results in restarting the counter (3 minutes).
- Pulse width = type x Multiplier

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
Item	*0: Disable* *1: 1PPS without Pulse* *2: 1PPS with Pulse*	*UINT08*	*-*	*1*
Pulse Type	*0: 20 ms* *1: 1 ms* *2: 20 us* *3: 1 us*	*UINT08*	*-*	*2*
Multiplier	*1 ~ 16*	*UINT08*	*-*	*3*

Command		***Set Output Format (13h)***	***(All GPS modules)***
String		*%%<F1h><13h>< Parameter byte><CS><CR><LF>*	
Length		*2 + 1 = 3*	
Response	***ACK***	*%%<06h><13h><CS><CR><LF>*	
	NAK	*%%<15h><13h><CS><CR><LF>*	

Description *Change to different message output format*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Type	*0: No output (Permanent change*)* *1: NMEA (Permanent change*)* *2: Binary (Temporary change, back to original after recycle power)* *3. Binary (Permanent change*)* **'Permanent change' means setting will be saved into flash for LS-40xx.*	*UINT08*	*-*	*1*

Command		***Query Navigation Parameters (17h)***	***(All GPS modules)***
String		*%%<F1h><17h>< Parameter byte><CS><CR><LF>*	
Length		*2 + 1 = 3*	
Response	***ACK***	*%%<06h><17h><CS><CR><LF>*	
	NAK	*%%<15h><17h><CS><CR><LF>*	
	86h	*See message 86h for detail*	

Description *Query current navigation parameters:*

Position update rate
DOP mask
Elevation mask
1PPS parameter
DGPS

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
type	*0: all*	*UINT08*	*-*	*1*

Command		***Query System Settings (18h)***	***(All GPS modules)***
String		*%%<F1h><18h>< Parameter byte><CS><CR><LF>*	
Length		*2 + 1 = 3*	
Response	***ACK***	*%%<06h><18h><CS><CR><LF>*	
	NAK	*%%<15h><18h><CS><CR><LF>*	
	87h	*See message 87h for detail*	

Description

Query current system settings:

NMEA configuration
Firmware revision
IO settings
Output format
Locale
Datum

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
type	*0: all*	*UINT08*	*-*	*1*

Command ***Set Local Time (19h)*** ***(All GPS modules)***

String *%%<F1h><19h>CS><CR><LF>*

Length *2 + 5 = 7*

Response ***ACK*** *%%<06h><19h><CS><CR><LF>*

NAK *%%<15h><19h><CS><CR><LF>*

Description *Set up user local time information. This command is useful to instruct module to output time information based on used zone.*
When flag is set to 0, system time is equal to UTC time.
When flag is set to 1, system time is adjusted to local time

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
Flag	*0:only local time is affected (e.g. ZDA sentence)* *1:both local and system time are affected (e.g. GGA sentence)*	*UINT08*	*-*	*1*
Time Zone Hour (GMT+-)	*-12 ~ +12*	*SINT08*	*Hour*	*2*
Time Zone Minute (GMT+-)	*-59 ~ +59* *'sign' should be the same as used for Hour*	*SINT08*	*Minute*	*3*
Time Zone Second (GMT+-)	*-59 ~ +59* *'sign' should be the same as used for Hour*	*SINT08*	*Second*	*4*
Adjust	*Normal: 0* *For Daylight Saving Time or Summer Time*	*SINT08*	*Hour*	*5*

Command ***~~Set Binary Configuration (1Ah)~~*** ***(Removed*)***

String *%%<F1h><1Ah>CS><CR><LF>*

Length *2 + 4 = 6*

Response ***ACK*** *%%<06h><1Ah><CS><CR><LF>*

NAK *%%<15h><1Ah><CS><CR><LF>*

Description *Configure Binary output format*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Binary	*0: disable, 1: enable* *Bit 0: reserved* *Bit 1: User PVT II information* *Bit 2: User Satellite information* *Bit 3: User Measurement Information* *Default: 000Eh when switched to binary output*	*UINT16*	*-*	*1 - 2*
Reserved	*-*	*-*	*-*	*3 - 4*

* No longer supported

Command ***Set Extended Datum (1Bh)*** ***(All GPS modules)***

String *%%<F1h><1Bh>< Parameter bytes><CS><CR><LF>*

Length *2 + 22 = 24*

Response ***ACK*** *%%<06h><1Bh ><CS><CR><LF>*

NAK *%%<15h><1Bh ><CS><CR><LF>*

Description *Set up datum parameters used for position transformation*
This command is used to input datum parameter other than build-in supported ones.
All information provided is based on WGS84 at initial position information.

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	*Byte #*
Ellipsoid Parameters	*A*	*Semi-major axis*	*DPFP*	*-*	*1 – 8*
	1/f	*Inversed Flattening*	*DPFP*	*-*	*9 – 16*
Delta X		*+- 2^15*	*SINT16*	*Meter*	*17 – 18*
Delta Y		*+- 2^15*	*SINT16*	*Meter*	*19 – 20*
Delta Z		*+- 2^15*	*SINT16*	*Meter*	*21 - 22*

Command		***Record Trace (1Dh)***	***(Product dependent*)***
String		*%%<F1h><1Dh>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 8 = 10*	
Response	***ACK***	*%%<06h><1Dh ><CS><CR><LF>*	
	NAK	*%%<15h><1Dh ><CS><CR><LF>*	

Description

Start/stop recording the user trace.
Parameter Distance is the distance between two contiguous recorded points. Time Period is the time between two contiguous recorded points. When one of two parameters reaches the criteria, this trace is recorded. If one of the parameter is 0, it is ignored. If both parameters are 0, the trace is recorded in every single second. When Recording time is 65535(0xFFFF), the trace is recorded continuously. When recording reaches the storage limitation, system will erase the earliest records to make space for newest records. Technically, it is a FIFO ring buffer.

Note: This ring buffer is consisted of 128 blocks in LS-40MM/CM/SM/EB. Each block contains 512 bytes. When ring buffer is full, system erases the oldest whole block to make room for incoming records. Users should see a 100% used percentage of ring buffer when ring buffer is full, however, the number of logged records may be reduced because the erased block contains more than one records while only one new coming record is added at that moment.

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Action	*0: stop, 1: start*	*UINT08*	*-*	*1*
Format	*0: Packed data*	*-*	*-*	*2*
Distance	*0 ~ 65535*	*UINT16*	*Meter*	*3 – 4*
Time period	*0 ~ 65535*	*UINT16*	*Second*	*5 – 6*
Recording time	*0 ~ 65535* *65535 (0xFFFF): no limitation (limitation in buffer size)*	*UINT16*	*Second*	*7 – 8*

* This function is supported on LS-40MM/SM/CM/EB.

Command		***Read Trace Log (1Eh)***	***(Product dependent*)***
String		*%%<F1h><1Eh>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 7 = 9*	
Response	***ACK***	*%%<06h><1Eh ><CS><CR><LF>*	
	NAK	*%%<15h><1Eh ><CS><CR><LF>*	
	88h	*Packed Trace data (See output message 88h)*	

Description

Start/stop reading the trace log.
A NAK message is returned when system is in recording. When logged records are outputting, the normal position messages (NMEA/Binary) are temporarily disabled until reading stops.

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Action	*0: stop, 1: start*	*UINT08*	*-*	*1*
(Reserved)	*-*	*UINT08*	*-*	*2*
Start #	*0 ~ 65535 (zero-based)*	*UINT16*	*-*	*3 – 4*
(Reserved)	*-*	*UINT08*	*-*	*5*
Baud rate	*0: 4800* *1: 9600* *2: 19200*	*UINT08*	*-*	*6*
Port	*0 = RS232 COM 1*	*UINT08*	*-*	*7*

* This function is supported on LS-40MM/SM/CM/EB.

Command		***Maintain Trace (1Fh)***	***(Product dependent*)***
String		*%%<F1h><1F>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 2 = 4*	
Response	***ACK***	*%%<06h><1Fh ><CS><CR><LF>*	
	NAK	*%%<15h><1Fh><CS><CR><LF>*	
	89h/8Ah	*When Action is 0 (see output message 89h/8Ah)*	

Description *Parameter Power-on is used to configure the GPS to start/stop recording when GPS is powered on. When status only is requested, field Power on should be set to 0 to prevent GPS from starting recording on next power-on.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Action	*0: Read status, 1: Clear all trace records*	*UINT08*	*-*	*1*
Power on	*0: begin with stop trace, 1: begin with start trace*	*UINT08*	*-*	*2*

* This function is supported on LS-40MM/SM/CM/EB.

Command		***Set Update Rate (20h)***	***(LS-4100 chipset only)***
String		*%%<F1h><20>< Parameter bytes><CS><CR><LF>*	
Length		*2 + 1 = 4*	
Response	***ACK***	*%%<06h><20h ><CS><CR><LF>*	
	NAK	*%%<15h><20h><CS><CR><LF>*	

Description *Change position update rate. When higher update rate is used, command 0x2 and 0x4 may be used to adjust the buadrate and NMEA period for secure the integrity of the output.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
rate	*1~5*	*UINT08*	*Hz*	*1*

BINARY OUTPUT MESSAGE TYPE <F2h>

This group of binary messages is output in response to commands that requests additional receiver information.

Data Types Used

(See Binary Input Message Type <F1h>)

Byte Ordering

(See Binary Input Message Type <F1h>)

Message ***Firmware Revision (80h)*** ***(All GPS modules)***

String *%%<F2h><80h>< Information bytes><CS><CR><LF>*

Length *2 + 22 = 24*

Description
- *Output the revision information of firmware.*
- *This message is provided by request***.**

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Revision code	*Xxxxxxxxxxxx*	*UINT08*	*-*	*1-12*
Date	*Example: 0xYYMMDD* *031101: 2003/11/01* *This value is represented as 0x031101*	*UINT32*	*-*	*13-16*
Time	*Example: 0xHHMMSS* *120801: 12:08:01* *This 4-byte value has value 0x120801*	*UINT32*	*-*	*17-20*
CRC	*CRC of the firmware code*	*UINT16*	*-*	*21-22*

Message ***Module ID (85h)*** ***(All GPS modules)***

String *%%<F2h><85h>< Information bytes><CS><CR><LF>*

Length *2 + 5 = 7*

Description *Provides module Identifier*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Type	*1: User ID*	*UINT08*	*-*	*1*
ID	*0 ~ 2^32*	*UINT32*	*-*	*2 - 5*

Message ***Navigation Parameters (86h)*** ***(All GPS modules)***

String *%%<F2h><86h>< Information bytes><CS><CR><LF>*

Length *2 + 18 = 20*

Description *Used to show current navigation parameters*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Update rate		*0 ~ 5*	*UINT08*	*Hz*	*1*
DOP	*Mask*	*0: Disable, 1: GDOP 2: PDOP 3: HDOP:*	*UINT08*	*-*	*2*
	GDOP	0 ~ 255	*UINT08*	*Degree*	*3*
	PDOP	0 ~ 255	*UINT08*	*Degree*	*4*
	HDOP	0 ~ 255	*UINT08*	*Degree*	*5*
Elevation mask		*0 ~ 89*	*UINT08*	*Degree*	*6*
DGPS		*0: disable 1: WAAS*	*UINT08*	*-*	*7*
1PPS	*Signal*	*0: off, 1: on*	*UINT08*	*-*	*8*
	Width	*0: 2ms, 1: 1ms, 2: 20us, 3:1us*	*UINT08*	*-*	*9*
	Multiplier	*1 ~ 16*	*UINT08*	*-*	*10*
Reserved 1		*0*	*UINT32*	*-*	*11 ~ 14*
Reserved 2		*0*	*UINT32*	*-*	*15 ~ 18*

Message ***Systems Settings (87h)*** ***(All GPS modules)***

String *%%<F2h><87h>< Information bytes><CS><CR><LF>*

Length *2 + 48 = 50*

Description *Used to show current system settings*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
COM 1		*0: 4800 1: 9600 2: 19200*	*UINT08*	*-*	*1*
COM 2		*0: 4800 1: 9600 2: 19200*	*UINT08*	*-*	*2*
NMEA	*Check sum*	*0: Disable, 1: Enable*	*UINT08*	*-*	*3*
	RMC	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*4*
	VTG	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*5*
	GGA	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*6*
	GSA	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*7*
	GSV	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*8*
	GLL	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*9*
	ZDA	*0 ~ 255, 0: Disable*	*UINT08*	*Degree*	*10*
Output Format		*0: No output 1: NMEA 2: Binary (Temporary) 3: Binary (Permanent)*	*UINT08*	*Degree*	*11*
Locale	*Flag*	*0:only local time is affected (e.g. ZDA sentence) 1:both local and system time are affected (e.g. GGA sentence)*	*UINT08*	*-*	*12*
	Hour	*-12 ~ +12*	*SINT08*	*Hour*	*13*
	Minutes	*-59 ~ +59 'sign' is the same as used for Hour*	*SINT08*	*Minute*	*14*
	Second	*-59 ~ +59 'sign' is the same as used for Hour*	*SINT08*	*Second*	*15*
	Adjusted Hour	*Normal: 0 For Daylight Saving Time or Summer Time*	*SINT08*	*Hour*	*16*
Datum	*Ellipsoid Index*	*0 ~ 23: system defined, 65535 : User defined*	*UINT16*	*-*	*17 - 18*
	A	*Semi-major axis*	*DPFP*	*-*	*19 – 26*
	1/f	*Inversed Flattening*	*DPFP*	*-*	*27 – 34*
	Delta X	*+- 2^15*	*SINT16*	*Meter*	*35 – 36*
	Delta Y	*+- 2^15*	*SINT16*	*Meter*	*37 – 38*
	Delta Z	*+- 2^15*	*SINT16*	*Meter*	*39 – 40*
Reserved 1		*0*	*UINT32*	*-*	*41 – 44*
Reserved 2		*0*	*UINT32*	*-*	*45 – 48*

Message ***Packed Trace Data (88h)*** ***(Product dependent*)***

String *%%<F2h><88h>< Information bytes><CS><CR><LF>*

Length *2 + 18 = 20*

Description *Used to output logged trace records*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
GPS Time	Week No	*Bit [31: 20]*	*UINT32*	*-*	*1 – 4*
	TOW	*Bit [19: 0]*			
Position (ECEF)	*X*	+/- 2^31	*SINT32*	*Meter*	*5 – 8*
	Y	+/- 2^31	*SINT32*	*Meter*	*9 – 12*
	Z	+/- 2^31	*SINT32*	*Meter*	*13 – 16*
Information	*Latest Flag*	*Bit [15]: 1- the last record*	*UINT16*	*-*	*17 - 18*
	Mode	*Bit [13]: 0 - 2D fix, 1 - 3D fix*			
	DGPS	*Bit [12]: 0-No, 1-Yes*			
	Velocity	*bit [9:0]*		*Meter/s*	

Message ***Trace Buffer Status (89h)*** ***(LS-40xx series)***

String *%%<F2h><89h>< Information bytes><CS><CR><LF>*

Length *2 + 7 = 9*

Description *Used to show status of the trace buffer*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
State	*0: stop, 1: recording, 2: Reading*	*UINT08*	*-*	*1*
Size - 1	*0 ~ 255*	*UINT08*	*K byte*	*2*
Used Percentage	*0 ~ 100*	*UINT08*	*%*	*3*
# of records logged	*0 ~ 65535*	*UINT16*	*-*	*4 – 5*
Reading Position	*0 ~ 65535 (zero-based)*	*UINT16*	*-*	*6 - 7*

Message ***Extended Trace Buffer Status (8Ah)*** ***(LS-4100 chipset only)***

String *%%<F2h><8Ah>< Information bytes><CS><CR><LF>*

Length *2 + 11 = 13*

Description *Used to show status of extended trace buffer*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
State	*0: stop, 1: recording, 2: Reading*	*UINT08*	*-*	*1*
Size - 1	*0 ~ 255*	*UINT08*	*64K byte*	*2*
Used Percentage	*0 ~ 100*	*UINT08*	*%*	*3*
# of records logged	*0 ~ 2^32-1*	*UINT32*	*-*	*4 – 7*
Reading Position	*0 ~ 2^32-1 (zero-based)*	*UINT32*	*-*	*8 – 11*

Message ***~~User Position, Velocity & Time I (D0h)~~*** ***(Removed*)***

String *%%<F2h><D0h>< Information bytes><CS><CR><LF>*

Length *2 + 41 = 43*

Description *Provide user PVT solution in ECEF format.*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Week No	*1 ~ 65535*	*UINT16*	*-*	*1 – 2*
Time of Week	*0 ~ 2^32*	*UINT32*	*-*	*3 – 6*
Date	*Example: 0xYYMMDD 031101 - 2003/11/01 This value is represented as 0x031101*	*UINT32*	*-*	*7 – 10*
Time	*Example: 0xHHMMSS 120801 - 12:08:01 This value is represented as 0x120801*	*UINT32*	*-*	*11 – 14*
X	*+- 2^31*	*SINT32*	*Meter*	*15 – 18*
Y	*+- 2^31*	*SINT32*	*Meter*	*19 – 22*
Z	*+- 2^31*	*SINT32*	*Meter*	*23 – 26*
DX	*+- 2^15*	*SINT16*	*Meter*	*27 – 28*
DY	*+- 2^15*	*SINT16*	*Meter*	*29 – 30*
DZ	*+- 2^15*	*SINT16*	*Meter*	*31 – 32*
Fix Indicator	*0: Autonomous mode 1: Differential mode 5: Data not valid*	*UINT08*	*-*	*33*
Quality of fix	*0: no fix, 1: 2D, 2; 3D, 3: 3D+DGPS*	*UINT08*	*-*	*34*
Number of SV (Line of sight)	*0 ~ 12*	*UINT08*	*-*	*35*
Number of SV in fix	*0 ~ 12*	*UINT08*		*36*
GDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*37*
PDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*38*
HDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*39*
VDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*40*
TDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*41*

*** No longer supported**

Message ***User Position, Velocity & Time II (D1h)*** ***(All GPS modules)***

String *%%<F2h><D1h>< Information bytes><CS><CR><LF>*

Length *2 + 37 = 39*

Description *Provide user PVT solution in Geodetic coordinates*

Parameters	***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Week No	*1 ~ 65535*	*UINT16*	*-*	*1 – 2*
Time of Week	*0 ~ 2^32*	*UINT32*	*-*	*3 – 6*
Date	*Example: 0xYYMMDD* *031101 - 2003/11/01* *This value is represented as 0x031101*	*UINT32*	*-*	*7 – 10*
Time	*Example: 0xHHMMSS* *120801 - 12:08:01* *This value is represented as 0x120801*	*UINT32*	*-*	*11 – 14*
Latitude	*- 90 ~ +90*	*SPFP*	*-*	*15 – 18*
Longitude	*-180 ~ +180*	*SPFP*	*-*	*19 – 22*
Altitude	*-1000 ~ +18000*	*SINT16*	*Meter*	*23 – 24*
Heading	*0 ~ 359*	*UINT16*	*Degree*	*25 – 26*
Speed	*0 ~ 500*	*UINT16*	*m/s*	*27 – 28*
Fix Indicator	*0: Autonomous mode* *1: Differential mode* *5: Data not valid*	*UINT08*	*-*	*29*
Quality of fix	*0: no fix, 1: 2D, 2; 3D, 3: 3D+DGPS*	*UINT08*	*-*	*30*
Number of SV (line of sight)	*0 – 12*	*UINT08*	*-*	*31*
Number of SV in fix	*0 – 12*	*UINT08*		*32*
GDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*33*
PDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*34*
HDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*35*
VDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*36*
TDOP	*1 ~ 255, 255 indicates > 25.5*	*UINT08*	*1/10*	*37*

Message ***User Satellite Information (D2h)*** ***(All GPS modules)***

String *%%<F2h><D2h>< Information bytes><CS><CR><LF>*

Length *2 + 102 = 104*

Description *Provides satellite view information.*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Week No		*1 ~ 65535*	*UINT16*	*-*	*1 - 2*
Time of week		*0 ~ 2^32*	*UINT32*	*-*	*3 - 6*
SV 1	*PRN*	*0: invalid data set* *1 ~ 32: GPS* *33,35,42,44,47,50: WAAS/EGNOS*	*UINT08*	*-*	*7*
	Health	*0: OK, > 0: error code*	*UINT08*		*8*
	Azimuth	*0 ~ 359*	*UINT16*	*Degree*	*9 – 10*
	Elevation	*0 ~ 90*	*UINT08*	*Degree*	*11*
	C/No	*0 ~ 255*	*UINT08*	*--*	*12*
	Status	*BIT0 = 1: Acquired* *BIT4 = 1: Frame Sync* *BIT5 = 1: Get Ephemeris* *Bit 8 = 1: Position Fix*	*UINT16*	*-*	*13 - 14*
SV 2	*See SV1*				*15 – 22*
SV 3	*See SV1*				*23 - 30*
SV 4	*See SV1*				*31 – 38*
SV 5	*See SV1*				*39 - 46*
SV 6	*See SV1*				*47 – 54*
SV 7	*See SV1*				*55 – 62*
SV 8	*See SV1*				*63 – 70*
SV 9	*See SV1*				*71 - 78*
SV 10	*See SV1*				*79 - 86*
SV 11	*See SV1*				*87 – 94*
SV 12	*See SV1*				*95 - 102*

Message ***User Measurement Information (D3h)*** ***(All GPS modules)***

String *%%<F2h><D3h>< Information bytes><CS><CR><LF>*

Length *2 + 152 = 154*

Description *Provide channel measurement information.*

Parameters		***Data (Range)***	***Type (Little-endian)***	***Unit***	***Byte #***
Week No		*1 ~ 65535*	*UINT16*	*-*	*1 – 2*
Time of week		*0 ~ 2^32*	*UINT32*	*-*	*3 – 6*
Clock Offset		*0 ~ 65535*	*UINT16*	*-*	*7 – 8*
SV 1	*PRN*	*1 ~ 32*	*UINT08*	*-*	*9*
	Reserved	*-*	*UINT08*	*-*	*10*
	Pseudo-range	+/- 2^31	*SINT32*	*Meter*	*11– 14*
	Delta Range	+/- 2^31	*SINT32*	*Meter*	*15 – 18*
	Doppler	0 ~ 65535	*UINT16*	*-*	*19 – 20*
SV 2		*See SV1*			*21 – 32*
SV 3		*See SV1*			*33 – 44*
SV 4		*See SV1*			*45 – 56*
SV 5		*See SV1*			*57 – 68*
SV 6		*See SV1*			*69 – 80*
SV 7		*See SV1*			*81 – 92*
SV 8		*See SV1*			*93 – 104*
SV 9		*See SV1*			*105 – 116*
SV 10		*See SV1*			*117 – 128*
SV 11		*See SV1*			*129 – 140*
SV 12		*See SV1*			*141 – 152*

APPENDIX

A. Ellipsoid List

Ellipsoid Index	Ellipsoid	Semi-major axis (a)	Inversed Flattening (1/f)
1	Airy 1830	6377563.396	299.3249646
2	Modified Airy	6377340.189	299.3249646
3	Australian National	6378160	298.25
4	Bessel 1841 (Namibia)	6377483.865	299.1528128
5	Bessel 1841	6377397.155	299.1528128
6	Clarke 1866	6378206.4	294.9786982
7	Clarke 1880	6378249.145	293.465
8	Everest (India 1830)	6377276.345	300.8017
9	Everest (Sabah Sarawak)	6377298.556	300.8017
10	Everest (India 1956)	6377301.243	300.8017
11	Everest (Malaysia 1969)	6377295.664	300.8017
12	Everest (Malay. & Sing)	6377304.063	300.8017
13	Everest (Pakistan)	6377309.613	300.8017
14	Modified Fischer 1960	6378155	298.3
15	Helmert 1906	6378200	298.3
16	Hough 1960	6378270	297
17	Indonesian 1974	6378160	298.247
18	International 1924	6378388	297
19	Krassovsky 1940	6378245	298.3
20	GRS 80	6378137	298.257222101
21	South American 1969	6378160	298.25
22	WGS 72	6378135	298.26
23	WGS 84	6378137	298.257223563

B. Datum Reference List

Datum Name	Delta X	Delta Y	Delta Z	Ellipsoid	Ellipsoid Index	Region of Use
WGS-84	0	0	0	WGS 84	23	Global
WGS-84	0	0	0	WGS84	23	Global
Adindan	-118	-14	218	Clarke 1880	7	Burkina Faso
Adindan	-134	-2	210	Clarke 1880	7	Cameroon
Adindan	-165	-11	206	Clarke 1880	7	Ethiopia
Adindan	-123	-20	220	Clarke 1880	7	Mali
Adindan	-166	-15	204	Clarke 1880	7	MEAN FOR Ethiopia; Sudan
Adindan	-128	-18	224	Clarke 1880	7	Senegal
Adindan	-161	-14	205	Clarke 1880	7	Sudan
Afgooye	-43	-163	45	Krassovsky 1940	19	Somalia
Ain el Abd 1970	-150	-250	-1	International 1924	18	Bahrain
Ain el Abd 1970	-143	-236	7	International 1924	18	Saudi Arabia
American Samoa 1962	-115	118	426	Clarke 1866	6	American Samoa Islands
Anna 1 Astro 1965	-491	-22	435	Australian National	3	Cocos Islands
Antigua Island Astro 1943	-270	13	62	Clarke 1880	7	Antigua (Leeward Islands)
Arc 1950	-138	-105	-289	Clarke 1880	7	Botswana
Arc 1950	-153	-5	-292	Clarke 1880	7	Burundi
Arc 1950	-125	-108	-295	Clarke 1880	7	Lesotho
Arc 1950	-161	-73	-317	Clarke 1880	7	Malawi
Arc 1950	-143	-90	-294	Clarke 1880	7	Mean for Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, and Zimbabwe
Arc 1950	-134	-105	-295	Clarke 1880	7	Swaziland
Arc 1950	-169	-19	-278	Clarke 1880	7	Zaire
Arc 1950	-147	-74	-283	Clarke 1880	7	Zambia
Arc 1950	-142	-96	-293	Clarke 1880	7	Zimbabwe
Arc 1960	-160	-6	-302	Clarke 1880	7	Mean for Kenya and Tanzania
Arc 1960	-157	-2	-299	Clarke 1880	7	Kenya
Arc 1960	-175	-23	-303	Clarke 1880	7	Taanzania
Ascension Island 1958	-205	107	53	International 1924	18	Ascension Island
Astro Beacon E 1945	145	75	-272	International 1924	18	Iwo Jima
Astro DOS 71/4	-320	550	-494	International 1924	18	St Helena Island
Astro Tern Island (FRIG) 1961	114	-116	-333	International 1924	18	Tern Island
Astronomical Station 1952	124	-234	-25	International 1924	18	Marcus Island
Australian Geodetic 1966	-133	-48	148	Australian National	3	Australia; Tasmania
Australian Geodetic 1984	-134	-48	149	Australian National	3	Australia; Tasmania
Ayabelle Lighthouse	-79	-129	145	Clarke 1880	7	Djibouti
Bellevue (IGN)	-127	-769	472	International 1924	18	Efate & Erromango Islands
Bermuda 1957	-73	213	296	Clarke 1866	6	Bermuda
Bissau	-173	253	27	International 1924	18	Guinea-Bissau
Bogota Observatory	307	304	-318	International 1924	18	Colombia
Bukit Rimpah	-384	664	-48	Bessel 1841	5	Indonesia(Bangka & Belitung Ids)
Camp Area Astro	-104	-129	239	International 1924	18	Antarctica(McMurdo Camp Area)
Campo Inchauspe	-148	136	90	International 1924	18	Argentina
Canton Astro 1966	298	-304	-375	International 1924	18	Phoenix Islands
Cape	-136	-108	-292	Clarke 1880	7	South Africa
Cape Canaveral	-2	151	181	Clarke 1866	6	Bahamas; Florida
Carthage	-263	6	431	Clarke 1880	7	Tunisia
Chatham Island Astro 1971	175	-38	113	International 1924	18	New Zealand (Chatham Island)
Chua Astro	-134	229	-29	International 1924	18	Paraguay
Corrego Alegre	-206	172	-6	International 1924	18	Brazil
Dabola	-83	37	124	Clarke 1880	7	Guinea
Deception Island	260	12	-147	Clarke 1880	7	Deception Island; Antarctia
Djakarta (Batavia)	-377	681	-50	Bessel 1841	5	Indonesia (Sumatra)
DOS 1968	230	-199	-752	International 1924	18	New Georgia Islands (Gizo Island)

Easter Island 1967	211	147	111	International 1924	18	Easter Island
Estonia; Coordinate System 1937	374	150	588	Bessel 1841	5	Estonia
European 1950	-104	-101	-140	International 1924	18	Cyprus
European 1950	-130	-117	-151	International 1924	18	Egypt
European 1950	-86	-96	-120	International 1924	18	England; Channel Islands; Scotland; Shetland Islands
European 1950	-86	-96	-120	International 1924	18	England; Ireland; Scotland; Shetland Islands
European 1950	-87	-95	-120	International 1924	18	Finland; Norway
European 1950	-84	-95	-130	International 1924	18	Greece
European 1950	-117	-132	-164	International 1924	18	Iran
European 1950	-97	-103	-120	International 1924	18	Italy (Sardinia)
European 1950	-97	-88	-135	International 1924	18	Italy (Sicily)
European 1950	-107	-88	-149	International 1924	18	Malta
European 1950	-87	-98	-121	International 1924	18	Mean for Austria; Belgium; Denmark; Finland; France; W Germany; Gibraltar; Greece; Italy; Luxembourg; Netherlands; Norway; Portugal; Spain; Sweden; Switzerland
European 1950	-87	-96	-120	International 1924	18	Mean for Austria; Denmark; France; W Germany; Netherlands; Switzerland
European 1950	-103	-106	-141	International 1924	18	Mean for Iraq; Israel; Jordan; Lebanon; Kuwait; Saudi Arabia; Syria
European 1950	-84	-107	-120	International 1924	18	Portugal; Spain
European 1950	-112	-77	-145	International 1924	18	Tunisia
European 1979	-86	-98	-119	International 1924	18	Mean for Austria; Finland; Netherlands; Norway; Spain; Sweden; Switzerland
Fort Thomas 1955	-7	215	225	Clarke 1880	7	Nevis; St. Kitts (Leeward Islands)
Gan 1970	-133	-321	50	International 1924	18	Republic of Maldives
Geodetic Datum 1949	84	-22	209	International 1924	18	New Zealand
Graciosa Base SW 1948	-104	167	-38	International 1924	18	Azores (Faial; Graciosa; Pico; Sao Jorge; Terceira)
Guam 1963	-100	-248	259	Clarke 1866	6	Guam
Gunung Segara	-403	684	41	Bessel 1841	5	Indonesia (Kalimantan)
GUX 1 Astro	252	-209	-751	International 1924	18	Guadalcanal Island
Herat North	-333	-222	114	International 1924	18	Afghanistan
Hermannskogel Datum	653	-212	449	Bessel 1841 (Namibia)	4	Croatia -Serbia, Bosnia-Herzegovina
Hjorsey 1955	-73	46	-86	International 1924	18	Iceland
Hong Kong 1963	-156	-271	-189	International 1924	18	Hong Kong
Hu-Tzu-Shan	-637	-549	-203	International 1924	18	Taiwan
Indian	282	726	254	Everest (India 1830)	8	Bangladesh
Indian	295	736	257	Everest (India 1956)	10	India; Nepal
Indian	283	682	231	Everest (Pakistan)	13	Pakistan
Indian 1954	217	823	299	Everest (India 1830)	8	Thailand
Indian 1960	182	915	344	Everest (India 1830)	8	Vietnam (Con Son Island)
Indian 1960	198	881	317	Everest (India 1830)	8	Vietnam (Near 16øN))
Indian 1975	210	814	289	Everest (India 1830)	8	Thailand
Indonesian 1974	-24	-15	5	Indonesian 1974	17	Indonesia
Ireland 1965	506	-122	611	Modified Airy	2	Ireland
ISTS 061 Astro 1968	-794	119	-298	International 1924	18	South Georgia Islands
ISTS 073 Astro 1969	208	-435	-229	International 1924	18	Diego Garcia
Johnston Island 1961	189	-79	-202	International 1924	18	Johnston Island
Kandawala	-97	787	86	Everest (India 1830)	8	Sri Lanka
Kerguelen Island 1949	145	-187	103	International 1924	18	Kerguelen Island
Kertau 1948	-11	851	5	Everest (Malay. & Sing)	12	West Malaysia & Singapore
Kusaie Astro 1951	647	1777	-1124	International 1924	18	Caroline Islands
Korean Geodetic System	0	0	0	GRS 80	20	South Korea
L. C. 5 Astro 1961	42	124	147	Clarke 1866	6	Cayman Brac Island

Leigon	-130	29	364	Clarke 1880	7	Ghana
Liberia 1964	-90	40	88	Clarke 1880	7	Liberia
Luzon	-133	-77	-51	Clarke 1866	6	Philippines (Excluding Mindanao)
Luzon	-133	-79	-72	Clarke 1866	6	Philippines (Mindanao)
M'Poraloko	-74	-130	42	Clarke 1880	7	Gabon
Mahe 1971	41	-220	-134	Clarke 1880	7	Mahe Island
Massawa	639	405	60	Bessel 1841	5	Ethiopia (Eritrea)
Merchich	31	146	47	Clarke 1880	7	Morocco
Midway Astro 1961	912	-58	1227	International 1924	18	Midway Islands
Minna	-81	-84	115	Clarke 1880	7	Cameroon
Minna	-92	-93	122	Clarke 1880	7	Nigeria
Montserrat Island Astro 1958	174	359	365	Clarke 1880	7	Montserrat (Leeward Islands)
Nahrwan	-247	-148	369	Clarke 1880	7	Oman (Masirah Island)
Nahrwan	-243	-192	477	Clarke 1880	7	Saudi Arabia
Nahrwan	-249	-156	381	Clarke 1880	7	United Arab Emirates
Naparima BWI	-10	375	165	International 1924	18	Trinidad & Tobago
North American 1927	-5	135	172	Clarke 1866	6	Alaska (Excluding Aleutian Ids)
North American 1927	-2	152	149	Clarke 1866	6	Alaska (Aleutian Ids East of 180øW)
North American 1927	2	204	105	Clarke 1866	6	Alaska (Aleutian Ids West of 180øW)
North American 1927	-4	154	178	Clarke 1866	6	Bahamas (Except San Salvador Id)
North American 1927	1	140	165	Clarke 1866	6	Bahamas (San Salvador Island)
North American 1927	-7	162	188	Clarke 1866	6	Canada (Alberta; British Columbia)
North American 1927	-9	157	184	Clarke 1866	6	Canada (Manitoba; Ontario)
North American 1927	-22	160	190	Clarke 1866	6	Canada (New Brunswick; Newfoundland; Nova Scotia; Quebec)
North American 1927	4	159	188	Clarke 1866	6	Canada (Northwest Territories; Saskatchewan)
North American 1927	-7	139	181	Clarke 1866	6	Canada (Yukon)
North American 1927	0	125	201	Clarke 1866	6	Canal Zone
North American 1927	-9	152	178	Clarke 1866	6	Cuba
North American 1927	11	114	195	Clarke 1866	6	Greenland (Hayes Peninsula)
North American 1927	-3	142	183	Clarke 1866	6	Mean for Antigua; Barbados; Barbuda; Caicos Islands; Cuba; Dominican Republic; Grand Cayman; Jamaica; Turks Islands
North American 1927	0	125	194	Clarke 1866	6	Mean for Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua
North American 1927	-10	158	187	Clarke 1866	6	Mean for Canada
North American 1927	-8	160	176	Clarke 1866	6	Mean for CONUS
North American 1927	-9	161	179	Clarke 1866	6	Mean for CONUS (East of Mississippi; River Including Louisiana; Missouri; Minnesota)
North American 1927	-8	159	175	Clarke 1866	6	Mean for CONUS (West of Mississippi; River Excluding Louisiana; Minnesota; Missouri)
North American 1927	-12	130	190	Clarke 1866	6	Mexico
North American 1983	0	0	0	GRS 80	20	Alaska (Excluding Aleutian Ids)
North American 1983	-2	0	4	GRS 80	20	Aleutian Ids
North American 1983	0	0	0	GRS 80	20	Canada
North American 1983	0	0	0	GRS 80	20	CONUS
North American 1983	1	1	-1	GRS 80	20	Hawaii
North American 1983	0	0	0	GRS 80	20	Mexico; Central America
North Sahara 1959	-186	-93	310	Clarke 1880	7	Algeria
Observatorio Meteorologico 1939	-425	-169	81	International 1924	18	Azores (Corvo & Flores Islands)
Old Egyptian 1907	-130	110	-13	Helmert 1906	15	Egypt
Old Hawaiian	89	-279	-183	Clarke 1866	6	Hawaii

Old Hawaiian	45	-290	-172	Clarke 1866	6	Kauai
Old Hawaiian	65	-290	-190	Clarke 1866	6	Maui
Old Hawaiian	61	-285	-181	Clarke 1866	6	Mean for Hawaii; Kauai; Maui; Oahu
Old Hawaiian	58	-283	-182	Clarke 1866	6	Oahu
Oman	-346	-1	224	Clarke 1880	7	Oman
Ordnance Survey Great Britain 1936	371	-112	434	Airy 1830	1	England
Ordnance Survey Great Britain 1936	371	-111	434	Airy 1830	1	England; Isle of Man; Wales
Ordnance Survey Great Britain 1936	375	-111	431	Airy 1830	1	Mean for England; Isle of Man; Scotland; Shetland Islands; Wales
Ordnance Survey Great Britain 1936	384	-111	425	Airy 1830	1	Scotland; Shetland Islands
Ordnance Survey Great Britain 1936	370	-108	434	Airy 1830	1	Wales
Pico de las Nieves	-307	-92	127	International 1924	18	Canary Islands
Pitcairn Astro 1967	185	165	42	International 1924	18	Pitcairn Island
Point 58	-106	-129	165	Clarke 1880	7	Mean for Burkina Faso & Niger
Pointe Noire 1948	-148	51	-291	Clarke 1880	7	Congo
Porto Santo 1936	-499	-249	314	International 1924	18	Porto Santo; Madeira Islands
Provisional South American 1956	-270	188	-388	International 1924	18	Bolivia
Provisional South American 1956	-270	183	-390	International 1924	18	Chile (Northern; Near 19 øS)
Provisional South American 1956	-305	243	-442	International 1924	18	Chile (Southern; Near 43 øS)
Provisional South American 1956	-282	169	-371	International 1924	18	Colombia
Provisional South American 1956	-278	171	-367	International 1924	18	Ecuador
Provisional South American 1956	-298	159	-369	International 1924	18	Guyana
Provisional South American 1956	-288	175	-376	International 1924	18	Mean for Bolivia; Chile; Colombia; Ecuador; Guyana; Peru; Venezuela
Provisional South American 1956	-279	175	-379	International 1924	18	Peru
Provisional South American 1956	-295	173	-371	International 1924	18	Venezuela
Provisional South Chilean 1963	16	196	93	International 1924	18	Chile (Near 53 øS) (Hito XVIII)
Puerto Rico	11	72	-101	Clarke 1866	6	Puerto Rico; Virgin Islands
Pulkovo 1942	28	-130	-95	Krassovsky 1940	19	Russia
Qatar National	-128	-283	22	International 1924	18	Qatar
Qornoq	164	138	-189	International 1924	18	Greenland (South)
Reunion	94	-948	-1262	International 1924	18	Mascarene Islands
Rome 1940	-225	-65	9	International 1924	18	Italy (Sardinia)
S-42 (Pulkovo 1942)	28	-121	-77	Krassovsky 1940	19	Hungary
S-42 (Pulkovo 1942)	23	-124	-82	Krassovsky 1940	19	Poland
S-42 (Pulkovo 1942)	26	-121	-78	Krassovsky 1940	19	Czechoslavakia
S-42 (Pulkovo 1942)	24	-124	-82	Krassovsky 1940	19	Latvia
S-42 (Pulkovo 1942)	15	-130	-84	Krassovsky 1940	19	Kazakhstan
S-42 (Pulkovo 1942)	24	-130	-92	Krassovsky 1940	19	Albania
S-42 (Pulkovo 1942)	28	-121	-77	Krassovsky 1940	19	Romania
S-JTSK	589	76	480	Bessel 1841	5	Czechoslavakia (Prior 1 JAN 1993)
Santo (DOS) 1965	170	42	84	International 1924	18	Espirito Santo Island
Sao Braz	-203	141	53	International 1924	18	Azores (Sao Miguel; Santa Maria Ids)
Sapper Hill 1943	-355	21	72	International 1924	18	East Falkland Island
Schwarzeck	616	97	-251	Bessel 1841 (Namibia)	4	Namibia
Selvagem Grande 1938	-289	-124	60	International 1924	18	Salvage Islands

Sierra Leone 1960	-88	4	101	Clarke 1880	7	Sierra Leone
South American 1969	-62	-1	-37	South American 1969	21	Argentina
South American 1969,	-61	2	-48	South American 1969	21	Bolivia
South American 1969,	-60	-2	-41	South American 1969	21	Brazil
South American 1969,	-75	-1	-44	South American 1969	21	Chile
South American 1969,	-44	6	-36	South American 1969	21	Colombia
South American 1969,	-48	3	-44	South American 1969	21	Ecuador
South American 1969,	-47	26	-42	South American 1969	21	Ecuador (Baltra; Galapagos)
South American 1969,	-53	3	-47	South American 1969	21	Guyana
South American 1969,	-57	1	-41	South American 1969	21	Mean for Argentina; Bolivia; Brazil; Chile; Colombia; Ecuador; Guyana; Paraguay; Peru; Trinidad & Tobago; Venezuela
South American 1969,	-61	2	-33	South American 1969	21	Paraguay
South American 1969,	-58	0	-44	South American 1969	21	Peru
South American 1969,	-45	12	-33	South American 1969	21	Trinidad & Tobago
South American 1969,	-45	8	-33	South American 1969	21	Venezuela
South Asia	7	-10	-26	Modified Fischer 1960	14	Singapore
Tananarive Observatory 1925	-189	-242	-91	International 1924	18	Madagascar
Timbalai 1948	-679	669	-48	Everest (Sabah Sarawak)	9	Brunei; E. Malaysia (Sabah Sarawak)
Tokyo	-148	507	685	Bessel 1841	5	Japan
Tokyo	-148	507	685	Bessel 1841	5	Mean for Japan; South Korea; Okinawa
Tokyo	-158	507	676	Bessel 1841	5	Okinawa
Tokyo	-147	506	687	Bessel 1841	5	South Korea
Tristan Astro 1968	-632	438	-609	International 1924	18	Tristan da Cunha
Viti Levu 1916	51	391	-36	Clarke 1880	7	Fiji (Viti Levu Island)
Voirol 1960	-123	-206	219	Clarke 1880	7	Algeria
Wake Island Astro 1952	276	-57	149	International 1924	18	Wake Atoll
Wake-Eniwetok 1960	102	52	-38	Hough 1960	16	Marshall Islands
WGS 1972	0	0	0	WGS 72	22	Global Definition
Yacare	-155	171	37	International 1924	18	Uruguay
Zanderij	-265	120	-358	International 1924	18	Suriname