Lassen™ SQ GPS Receiver

Trimble ASCII Interface Protocol (TAIP)

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Trimble ASCII Interface Protocol (TAIP)

Trimble ASCII Interface Protocol (TAIP) is a Trimble-specified digital communication interface based on printable ASCII characters over a serial data link. TAIP was designed specifically for vehicle tracking applications but has become common in a number of other applications because of its ease of use. TAIP supports both scheduled and polled responses.

TAIP messages may be scheduled for output at a user specified rate starting on a given epoch from top of the hour. For communication robustness, the protocol optionally supports checksums on all messages. It also provides the user with the option of tagging all messages with the unit's user specified identification number (ID). This greatly enhances the functional capability of the unit in a network environment. Additionally, given the printable ASCII format of all communication, TAIP is ideal for use with mobile data terminals, modems, and portable computers. Although, receivers incorporating this protocol are shipped from the factory with a specific serial port setting, the port characteristics are fully programmable through TAIP messages.

The Lassen SQ GPS receiver supports the following TAIP messages:

Table.1 Lassen SQ GPS Supported Messages

Message	Description
AL	Altitude/Up Velocity
*AP	Auxiliary Port Characteristics
CP	Compact Position Solution
ID	Identification Number
IP	Initial Position
LN	Long Navigation Message
PR	Protocol
PT	Port Characteristic
PV	Position/Velocity Solution
RM	Reporting Mode
RT	Reset Mode
ST	Status
TM	Time/Date
VR	Version Number

***** *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Message Format

All TAIP communication uses printable, uppercase ASCII characters. The interface provides the means to configure the output of various sentences in response to queries or on a scheduled basis. Each sentence has the following general format:

ABB{C}[;ID=DDDD][;*FF]<

where:.

Table.2 Message Formats

Message	Description
>	Start of new message
A	Message qualifier
BB	Two character message identifier
C	Data string
DDDD	Optional 4 character vehicle ID
FF	Optional 2 character checksum
<	Delimiting character
{x}	Signifies that x can occur any number of times
[x]	Signifies that x may optionally occur once

Start of a New Message

The > character (ASCII code 62 decimal) is used to specify the start of a new sentence.

Message Qualifier

A one character message qualifier is used to describe the action to be taken on the message. The following table lists the valid qualifiers.

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Table.3 Message Format Qualifiers

Qualifier	Action
Q	Query for a single sentence (sent to GPS receiver)
R	Response to a query or a scheduled report (from the receiver)
F	Schedule reporting frequency interval in seconds
S	Enables equipment to be initialized, and sets various message types
D	Specify a minimum distance traveled and a minimum and maximum time interval for the next report

Note – *All TAIP message characters must be in uppercase.*

Message Identifier

A unique two character message identifier consisting of alphabetical characters is used to identify type messages. For example: PR for Protocol or VR for Version Number.

Data String

The format and length of a data string is dictated by the message qualifier and the message identifier. The data string may contain any printable ASCII character with the exception of the >, <, and ; characters. Detailed descriptions of each message format are provided in the specific message sections of this Appendix. Most messages are length sensitive and unless otherwise specified, field separators, including spaces are not used.

Vehicle ID

A vehicle identification (ID) may optionally be used in all the communications with the receiver. Each receiver in the fleet may be assigned a four character alpha-numeric ID and be forced to output that ID in all messages. The default is: ID set to 0000 and the ID Flag set to F (false). The receiver will check all incoming messages for ID. If no ID is specified, the receiver will accept the message. If the ID is included in messages but does not compare with the ID previously set, the message will be ignored. This applies even when the ID Flag is turned off.

Checksum

The checksum field provides for an optional two digit hex checksum value, which is computed as XOR of *all characters* from the beginning of the sentence up to and including the * character. If provided, the checksum is always the last element of the sentence before the message delimiter. The default mode of operation is to include checksum in sentences. The use of checksums can help in instances where the communication channel is noisy.

Example

The following message used to set the vehicle ID flag includes checksum.

>SRM;ID_FLAG=T;*6F<

In this example, the checksum (6F) was generated by XOR'ing the ASCII codes for > and S then XOR'ing that result with the ASCII code for R and so forth, up to and including the * character.

Message Delimiter

The < character signifies end of a sentence and is used as the message delimiter.

Sample PV Message

The Position/Velocity Solution (PV) message is one of the more commonly used TAIP messages and most receivers using TAIP are set by default to output the PV message once every 5 seconds.

The following analysis of a typical PV message is provided to further explain the TAIP message protocol.

>RPV15714+3739438-1220384601512612;ID=1234;*7F<.

Table.4 Sample PV Message Fields

ID	Meaning
>	Start of message delimiter
R	Response qualifier
PV	PV message identifier
15714	GPS time of day
+3739438	Latitude
-12203846	Longitude
015	Speed
126	Heading
1	Source of data
2	Age of data
;ID=1234	Vehicle ID
;*7F	Checksum
<	End of message delimiter

Note – *See PV Position/Velocity Solution, page 22, for more detail on the interpretation of this message.*

Time and Distance Reporting

The ’D’ message qualifier allows you to specify a minimum distance traveled as well as a minimum and maximum time interval for the next report. Units that are stationed at a fixed location can be programmed to report only when the unit moves “off station” or after a certain elapsed time since last report, but no more often than the specified minimum time interval.

The message format used with the ’D’ qualifier is shown below:

>DAABBBBCCCCEEEEFFFF[;ID=GGGG][;*HH]<

The distance ‘D’ in the message refers to the radial distance. A message would be issued if the receiver has moved farther than a radius of ‘D’ away from where it was previously reported. If the accumulated distance traveled is longer than ‘D’ but the final location is still within the radius of ‘D’ (e.g. circling many times around a closed perimeter of radius smaller than ‘D’), then no message would be issued.

Table.5 Time and Distance Reporting Message Format Qualifiers

ID	Meaning
>	Start of message delimiter
D	Distance message qualifier
AA	Message to report (i.e. PV means Position Velocity message)
BBBB	Minimum time (seconds) interval between reports (^{T}interval)
CCCC	Report epoch (number of seconds from top of the hour)
EEEE	Delta distance (meters) from last reported distance
FFFF	Maximum time (seconds) interval between reports (^{T}max)
GGGG	Optional vehicle identification number (user selected)
HH	Optional checksum
<	End of message delimiter

Note – *If BBBB = 0, then the message output is disabled. If FFFF = 0, maximum time feature is disabled (the unit will only report if current position is greater than or equal to the delta distance specified in EEEE).*

Example

When the message: >DPV0030000505000900;ID=0105< is sent to the GPS receiver, it specifies that vehicle number 105 (*GGGG* = 0105) is to report the Position Velocity message (*AA* = PV) whenever its current position differs from the previously reported position by at least 500 meters (*EEEE* = 0500), but no more often than every 30 seconds (*BBBB* = 0030) or less often than every 15 minutes (*FFFF* = 0900 seconds). The minimum and maximum time-out reports are to be issued with a 5 second offset (*CCCC* = 0005) from the top of the hour. The optional checksum was not used in this example. The square brackets, [...], shown in the format description above are used to indicate optional data. The brackets themselves are never included in the actual TAIP message string.

Latitude and Longitude Conversion

The TAIP protocol reports latitude as positive north decimal degrees and longitude as positive east decimal degrees, using the WGS-84 datum. For your application, you may wish to convert to degrees, minutes and seconds. The following example illustrates the conversion of decimal degrees to degrees, minutes and seconds.

Example

Given latitude and longitude in decimal degrees,

Latitude: $+37.39438^{o}$

Longitude: -122.03846^{o}

Convert latitude by multiplying the decimal fraction of degrees by 60 to convert to minutes,

0.39438 x 60 = 23.6628 minutes

Retain the integer (23) portion as the minutes then multiply the decimal fraction by 60 to convert to seconds,

0.6628 x 60 = 39.768 seconds

Since the sign of the latitude in this example is positive the result is,

Latitude: N 37^{o} 23' 39.77"

The longitude is converted in the same fashion,

Longitude: W 122^{o} 02' 18.46"

Note – *At the earth's equator, one degree of latitude and longitude represents 68.7 miles; therefore, 0.00001 degrees represents approximately 3.6 feet or 1.1 meters. Each second represents approximately 100.76 ft. (30.7 m).*

Message Data Strings

The following table lists all the TAIP messages currently defined and comments regarding their application. The data string format of each message is described in the following pages.

Table.6 Message Data String Descriptions

Identifier	Message Format	Frequency and Distance	Query	Response/ Report	Set
AL	Altitude/Vertical Velocity	X	X	X	X
*AP	Auxiliary Port Characteristic		X	X	X
CP	Compact Position Solution	X	X	X	X
ID	Vehicle ID	X	X	X	X
IP	Initial Position	X	X	X	X
LN	Long Navigation Message	X	X	X	
PR	Protocol		X	X	X
PT	Port Characteristic	X	X	X	X
PV	Position/Velocity Solution	X	X	X	X
RM	Reporting Mode	X	X	X	X
RT	Reset				X
ST	Status	X	X	X	
TM	Time/Date	X	X	X	
VR	Version Number	X	X	X	X

***** *The 8-channel Lassen SQ GPS does not support this TAIP message.*

Note – *All TAIP message characters must be in uppercase.*

AL Altitude/Up Velocity

Note – *The first character of altitude or vertical velocity (S) is "+" or "–".*

Data String Format:

AAAA(S)BBBBB(S)CCCDE

.

Table.7 Altitude/Up Velocity Data String Descriptions

Item	# of Char	Units	Format	Value
GPS Time of Day	5	Sec	AAAAA	
Altitude	6	Meter	(S)BBBBB	
Vertical Velocity	4	MPH	(S)CCC	
Fix Mode	1	n/a	D	0=2D GPS 1=3D GPS 2=2D DGPS 3=3D DGPS 6=reserved 8=reserved 9=no fix avail.
Age of Data Indicator	1	n/a	E	2=Fresh,<10 sec. 1=Old,>10 sec. 0=Not available
Total # of Characters is 17				

Altitude is above mean sea level in WGS-84. The GPS time of day is the time of fix rounded to the nearest second. This message contains data obtained from the last 3 dimensional fix and may not be current.

Note – *The data in this message is to be considered invalid and should not be used, if the Age of Data Indicator is equal to 0 (signifying data not available).*

AP Auxiliary Port Characteristics

Note – *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Data String Format:

AAAA,B,C,D,E,F

Table.8 Auxiliary Port Characteristics Data String Descriptions

Item	# of Char	Units	Format	Value
Baud Rate	4	n/a	AAAA	9600, 4800, 2400, 1200, or 0300
# of data bits	1	n/a	B	7 or 8
# of stop bits	1	n/a	C	1 or 2
Parity	1	n/a	D	N = None O = Odd E = Even
Auxiliary Port Number	1	n/a	E	1
Reserved	1	n/a	F	0
Total number of characters is 9 (excluding commas)				

This message defines the characteristics for the auxiliary port. The auxiliary port must be the RTCM input port on differential ready receivers.The default settings of the auxiliary port are 4800 baud, 8 data bits, parity none, and 1 stop bit.

Example:

The following command will set the auxiliary port characteristics to 2400 baud, 8 data bits, 1 stop bit, and no parity. >SAP2400,8,1,N,1,0<

Note 1. – *See the inclusion of 0 in the reserved field.*

Note 2. – *The AP command applies to receivers with dual serial ports.*

Note 3. – *The AP command requires commas between data fields.*

CP Compact Position Solution

Note – *The first character of latitude or longitude "(S)" is "+" or "-".*

Data String Format:

AAAAA(S)BBCCCC(S)DDDEEEEFG.

Table.9 Compact Position Solution Data String Descriptions

Item	# of Char	Units	Format	Value
GPS Time of Day	5	Sec	AAAAA	
Latitude	7	Deg	(S)BBCCCC	
Longitude	8	Deg	(S)DDDEEEE	
Fix Mode	1	n/a	F	0=2D GPS 1=3D GPS 2=2D DGPS 3=3D DGPS 6=reserved 8=reserved 9=no fix avail.
Age of Data Indicator	1	n/a	G	2=Fresh,<10 sec. 1=Old,>10 sec. 0=Not available
Total number of characters is 22				

Position is in latitude (positive north) and longitude (positive east) WGS-84. The GPS time of day is the time of fix rounded to the nearest second.

Note – *The data in this message is to be considered invalid and should not be used, if the Age of Data Indicator is equal to 0 (signifying that data is not available).*

ID Identification Number

Data String Format:

AAAA

Table.10 Identification Number Data String Descriptions

Item	# of Char	Units	Format
Vehicle ID	4	n/a	AAAA
Total number of characters is 4			

This message is used to report or set the vehicle's (or receiver's) unique, four character, alpha-numeric, user assigned ID. The default at cold start is 0000.

Example

The following message will set the vehicle ID to 101.

>SID0101<

The following is simply a response to a query for vehicle ID.

>RID0101<

Note – *The receiver will always check incoming messages for ID and compare with the vehicle ID set in the receiver's memory. If no ID is included in the message, the receiver will assume a match and accept the message. If the message sent to the receiver does contain a vehicle ID but that ID does not match the ID previously set in the receiver, the message will be ignored. This process is followed even when the ID_Flag is turned off (refer to the message RM).*

IP Initial Position

Data String Format:

(S)AA(S)BBB(S)CCCC

Table.11 Initial Position Data String Descriptions

Item	# of Char	Units	Format
Initial Latitude	3	Deg	(S)AA
Initial Longitude	4	Deg	(S)BBB
Initial Altitude	5	10 meters	(S)CCCC
Total number of characters is 12			

This is a very coarse initial position that can be used to aid the receiver in obtaining its first fix. This is particularly useful with a receiver that does not have battery backup enabled. In such cases, every time the unit is powered up, it goes through a complete cold-start and it has absolutely no knowledge of where it is. Providing this message improves performance by decreasing the time to first fix and enhances the accuracy of the initial two dimensional navigation solutions by providing a reference altitude. In case of units with battery backed memory, sending this message is only helpful if the unit has moved more than 1,000 miles since its previous fix. In either case, the receiver can initialize itself appropriately without any data from the user; it merely requires more time.

Note – *For all the above values, the first character (S) specifies the sign "+" or "-".*

Example:

The following message will set the initial position to 37^{o} North, 122^{o} West, altitude 10 meters.

>SIP+37-122+0001<

LN Long Navigation Message

Note – *The first character of latitude, longitude, altitude or vertical speed (S) is“+” or “-”.*

Data String Format:

AAAAA.BBB(S)CCDDDDDDD(S)EEEFFFFFFF(S)GGGGGGHHII
IJ(S)KKKLMMMNOOPPQQPPQQ...PPQQRRRRRRRRRRXT

Table.12 Long Navigation Message Data String Descriptions

Item	# of Char	Units	Format	Value
GPS Time of Day	8	Sec	AAAAA.BBB	
Latitude	10	Deg	(S)CC.DDDDDDD	
Longitude	11	Deg	(S)EEE.FFFFFFF	
Altitude above MSL	9	Ft	(S)GGGGGG.HH	
Horizontal speed	4	MPH	lll.J	
Vertical speed	5	MPH	(S)KKK.L	
Heading	4	Deg	MMM.N	
Number of SVs used	2	n/a	OO	
SV ID (see note)	2	n/a	PP	
IODE (see note)	2	n/a	QQ	
Reserved	10	n/a	RRRRRRRRRR	
Fix Mode	1	n/a	X	0=2D GPS 1=3D GPS 2=2D DGPS 3=3D DGPS 6=DR 8=Degraded DR 9=No fix avail.
Age of Data indicator	1	n/a	T	2=Fresh,<10 sec. 1=Old,>10 sec. 0=Not available
Total number of characters is 65 + 4x (number of SVs used)				

Note – *At least 2 satellites are required to get the LN Message.*

Position is in degrees, minutes, and decimal minutes. Latitude is (positive north); longitude is (positive east) WGS-84. Heading is in degrees from True North increasing eastwardly. The GPS time of day is the time of fix rounded to the nearest second.

Note – *The data in this message is to be considered invalid and should not be used, if the Age of Data Indicator is equal to 0 (signifying data not available).*

PR Protocol

The protocol message (PR) is the method used to control which I/O protocols are active on the Lassen SQ GPS port. Each protocol can be set to:

- Off
- Input only
- Output only
- Both input and output

The PR data string format is:

[;TAIP=xy] [;TSIP=xy] [;NMEA=xy] [;RTCM=xy]

Table.13 PR Data String Descriptions

Item	# of Char	Units	Format	Value
Port 1 protocol	1	n/a	X	T = Both in and out I = Input only O = Output only F = Off N = Not available
Port 2 protocol	1	n/a	y	T = Both in and out I = Input only O = Output only F = Off N = Not available

Sending the following message will set the receiver to TAIP in and out on PORT 1. The PORT 2 settings are not applicable in the 8-channel version of the Lassen SQ GPS.

>SPR;TAIP=TF;TSIP=FF;NMEA=FO;RTCM=FI<

Note 1. – *There are two restrictions to setting protocols: RTCM is input only, and TAIP cannot be running on both ports at the same time.(This is not applicable to the 8-channel Lassen SQ GPS.)*

Note 2. – *If a protocol is not implemented within the application, x and/or y will have the value N, and any set message for that protocol is ignored.*

It is possible to turn off all input processing on a port. If this is done, neither TAIP nor TSIP can be used to change the active protocols.

If you do not use battery back-up, all port characteristics will reset to the default after power is removed.

PT Port Characteristic

This message defines the characteristics for the primary TAIP port.

Data String Format:

AAAA,B,C,D

Table.14 Port Characteristic Data String Descriptions

Item	# of Char	Units	Format	Value
Baud Rate	4	n/a	AAAA	2400, 4800, 9600, 19200, 38400
# of data bits	1	n/a	B	(7 or 8)
# of stop bits	1	n/a	C	(1 or 2)
Parity	1	n/a	D	(“N” = None) (“O” = Odd) (“E” = Even)
Total number of characters is 10 (includes commas)				

Most TAIP using receivers use the following default port characteristics

- 4800 baud
- 8 data bits
- 1 stop bit
- No parity

Note 1. – *The characteristics set by this message will be stored in the receiver’s battery backed ram. The Lassen SQ GPS family of receivers do not include an internal battery but provide a battery back-up input line that may be used to retain memory when main power is removed.*

Note 2.– *If you do not use battery back-up, all port characteristics will reset to either the default settings after power is removed, or to the settings previously stored in Flash.*

Note 3. – *The PT command uses commas between data fields.*

PV Position/Velocity Solution

Note – *The first character of latitude or longitude "(S)" is "+" or "-".*

Data String Format:

AAAAA(S)BBCCCCC(S)DDDEEEEEFFFGGGHI

.

Table.15 Position/Velocity Solution Data String Descriptions

Item	# of Char	Units	Format	Value
GPS Time of Day	5	Sec	AAAAA	
Latitude	8	Deg	(S)BBCCCCC	BB=degrees CCCC=decimal degrees
Longitude	8	Deg	(S)DDDEEEEE	DDD=degrees EEEE=decimal degrees
Speed	3	MPH	FFF	
Heading	3	Deg.	GGG	
Fix Mode	1	n/a	H	0=2D GPS 1=3D GPS 2=2D DGPS 3=3D DGPS 6=Reserved 8=Reserved 9=No fix avail.
Age of Data Indicator	1	n/a	I	2=Fresh,<10 sec. 1=Old,>10 sec. 0=Not available
Total number of characters is 30				

Position is in latitude (positive north) and longitude (positive east) WGS-84. Heading is in degrees from True North increasing eastwardly. The GPS time of day is the time of fix rounded to the nearest second.

Note – *The data in this message is to be considered invalid and should not be used, if the Age of Data Indicator is equal to 0 (signifying data not available).*

RM Reporting Mode

Data String Format:

[;ID_FLAG= A][;CS_FLAG= B][;EC_FLAG= C] [;FR_FLAG= D]

[;CR_FLAG=E]

Table.16 Reporting Mode Data String Descriptions

Item	# of Char	Units	Format	Value
ID Flag	1	n/a	A	T = True F = False
CS Flag	1	n/a	B	T = True F = False
EC Flag	1	n/a	C	T = True F = False
FR Flag	1	n/a	D	T = True F = False
CR Flag	1	n/a	E	T = True F = False

ID Flag determines whether the unit is to include the vehicles ID with each report.

CS Flag determines whether the unit is to include a checksum as part of each message.

EC Flag, when set, will cause the unit to echo back all complete and properly formatted set commands with a *response qualifier*. This provides an easy way to verify that the unit did in fact receive the intended data.

FR Flag indicates whether the unit is to report messages automatically per their individually scheduled frequency. When set to false, the unit will only respond when queried for a specific message.

CR Flag, when set to True, will cause the receiver to append a carriage return and line feed [CR] [LF] to the end of each message output. This is useful when viewing the unencoded receiver responses on a terminal or a PC.

The default value at start-up for ID flag and the CR flag is false; the default for CS, EC and FR flags is true.

Example

The following command will turn checksums off and carriage return on:

>SRM;CS_FLAG=F;CR_FLAG=T<

Note – *Notice the use of semicolon before the flag name.*

RT Reset Mode

Data String Format:

Any one of the following data strings can be set. Upper case characters are required.

[ ]

[COLD]

[FACTORY]

[SAVE_CONFIG]

Table.17 Reset Mode Data String Descriptions

Message	Description
>SRT<	Warm Set
>SRTCOLD<	Cold Start
>SRTFACTORY<	Factory Reset
>SRTSAVE_CONFIG<	Save settings to Flash memory

The following procedure is used to change the Lassen SQ GPS protocol from TSIP to TAIP:

1. Use the TSIP 0x7E command to setup the TAIP output configuration (see page 36).
2. Change the protocol to TAIP using TSIP command 0xBC.
3. Save the TAIP settings to Flash memory using the TAIP command >SRTSAVE_CONFIG<.

ST Status

Data String Format:

AABCDDEFGG

Note – *This message provides information about the satellite tracking status and the operational health of the receiver. This information is contained in five status bytes which are output as five 2 digit hexadecimal values. The data format and the meanings of the hex characters are given in the following tables.*

Table.18 Data String HEX Characters

Item	# of Char	Units	Format	Definition
Tracking Status Code	2	n/a	AA	(see table below)
Status Codes - Nibble 1	1	n/a	B	(see table below)
Status Codes - Nibble 2	1	n/a	C	(see table below)
Machine ID	2	n/a	DD	
Status Code - Nibble 3	1	n/a	E	(not currently used)
Status Code - Nibble 4	1	n/a	F	(see table below)
Reserved	2	n/a	GG	(see table below)

Table.19 Tracking Status Code

Value	AA Meaning
00	Doing position fixes
01	Don’t have GPS time yet
02	Not used
03	PDOP is too high
08	No usable satellites
09	Only 1 usable satellite
OA	Only 2 usable satellites
OB	Only 3 usable satellites
OC	Chosen satellite is unusable

Table.20 Error Codes: Nibble 1

Value	B Meaning
0	No problems reported
1	Antenna feedline fault

Table.21 Error Codes: Nibble 2

Value	C Meaning
0	No problems reported
1	Battery-back-up failed; RAM not available at power-up (see Note below).

Table.22 Machine ID Code

Value	DD Meaning
DD	Displays the machine ID

Table.23 Error Codes: Nibble 3

Value	E Meaning
Not used	Not used

Table.24 Error Codes: Nibble 4

Value	F Meaning
0	No problems reported
2	RTC not available at power-up (see Note below)
8	Stored almanac not complete and current
A	RTC not available; stored almanac not complete and current

Table.25 Error Codes: Reserved

Value	GG Meaning
Not used	Reserved

Note – *After the status is detected, this bit remains set until the receiver is reset.*

TM Time/Date

Data String Format:

AABBCCDDDEEFFGGGGHHIJJKLLLLL

.

Table.26 TM Time/Data String Descriptions

Item	# of Char	Units	Format	Value
Hours	2	Hour	AA	
Minutes	2	Min	BB	
Seconds	5	Sec	CC.DDD	
Date; Day	2	Day	EE	
Date; Month	2	Month	FF	
Date; Year	4	Year	GGGG	
GPS UTC Time Offset	2	Sec	HH	
Fix Mode	1	n/a	f	0=2D GPS 1=3D GPS 2=2D DGPS 3=3D DGPS 6=Reserved 8=Reserved 9=No fix avail.
Number of usable satellites	2	n/a	JJ	
GPS UTC Offset flag	1	n/a	K	(1 = Valid) (0 = Invalid)
Reserved	5	n/a	LLLLL	
Total number of characters is 28				

This message outputs the time and date as computed by the GPS receiver. The time is most accurate when the unit is doing fixes. It is less accurate but still usable when the unit is not doing fixes but the Number of Usable SVs is one or more. If the GPS UTC offset is available, the time will be in UTC. If not, the time will be in GPS.

Note 1. – *GPS UTC Time Offset is the difference between GPS and UTC time standards in seconds. The UTC time of Day is only valid if the GPS UTC Offset Valid Flag is indicating valid.*

Note 2.– *The TM message is not supported under the Set qualifier.*

VR Version Number

Data String Format:

XXXXXXX;VERSION A.AA(BB/BB/BB); CORE VERSION C.CC (DD/DD/DD); E

.

Table.27 Version Number Data String Descriptions

Item	# of Char	Units	Format
Product Name	n/a	n/a	n/a
Major version number	4	n/a	A.AA
Major release date	8	n/a	BB/BB/BB

X1 Extended Status

The Lassen SQ GPS does not support this message.

Communication Scheme for TAIP

Communication with the unit takes place in four different ways. Message qualifiers are used to differentiate between these.

Query for Single Sentence

The query (Q) message qualifier is used to query the GPS receiver to respond immediately with a specific message. The format is:

>QAA[;ID=BBBB][;*CC]<

where AA is the requested message identifier. Messages supported by this qualifier are

AL, AP, CP, ID, IP, LN, PT, PV, RM, ST, TM, and VR.

Note – *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Scheduled Reporting Frequency Interval

The scheduled reporting frequency interval (F) message qualifier is used to tell the unit how often and when to report a specific message. The format is:

>FAABBBBCCCC[;ID=DDDD][;*FF]<

where sending this sentence tells the unit to report message specified by the two digit identifier AA at the time interval of BBBB seconds with time epoch at CCCC seconds from top of the hour. Specifying time interval of 0000 stops scheduled reporting of the message. The default is 0000 time interval for all messages except PV. The output frequency for PV at cold-start is set at once every five seconds, zero seconds from top of the hour. Messages supported by this qualifier are AL, AP, CP, ID, IP, LN, PT, PV, RM, ST, TM, and VR.

Note 1. – *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Note 2. – ***Note –*** *The data specified by this qualifier is the timing of the message output and may be different from the time tag of the data in the message.*

The Response to Query or Scheduled Report

The response (R) qualifier carry various types of data between the unit and the user equipment. The format is:

>RAA[{B}][;ID=CCCC][;*DD]<

where AA is the two character message identifier and {B} specifies the data string within the message. For the format of {B}, please refer to the message definitions in the previous section. Messages supported by the response qualifier are AL, AP, CP, ID, IP, LN, PT, PV, RM, ST, TM, and VR.

Note – *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

The Set Qualifier

The set (S) qualifier enables the user equipment to initialize/set-up various types of data in the GPS unit. The format is:

>SAA[{B}][;ID=CCCC][;*DD]<

where AA is the two character message identifier and {B} specifies the data string within the message. For the format of {B}, please refer to the message definitions in the previous section. Note that all the messages have very specific formats and are length dependent.

Messages normally supported by the set qualifier are AL, AP, CP, DC, DD, ID, IP, LN, PT, PV, and RM.

The set qualifier may be used with the AL, CP, LN, or PV message to set more precise initial position data into the GPS receiver than can be set with the IP message.

Note – *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Sample Communication Session

The following is a sample communication session to illustrate how message qualifiers are used. Query the receiver for version number for the TAIP firmware:

>QVR<

The receiver responds with a message in the following form:

>RVR OEM SQ OEM STTP APP; VERSION 1.04 (05/23/02);*38<

Note – *The receiver identified its product name, firmware version number, core signal processing version number, and release dates, then included the checksum for the message (the default for the CS Flag is TRUE). Also notice that the receiver did respond to our query even though we did not send a checksum.*

Query the receiver for its ID number:

>QID<

The receiver will respond (assuming factory default settings):

>RID0000;*70<

Set the ID to match the number for a vehicle in your fleet and then tell the receiver to include the Vehicle ID in its responses:

>SID1234<

>SRM;ID_FLAG=T<

The Lassen SQ GPS receiver is set by default to report the PV message once every 5 seconds. To schedule the PV message from vehicle 1234 to respond once every 10 seconds, starting at 5 seconds after the top of the hour, use the following command:

>FPV00100005;ID=1234<

The receiver will check the ID included in the message for a match with its own and then reschedule the PV message. At the next scheduled time, the receiver will respond with:

>RPV15714+3739438-1220384601512612;ID=1234;*7F<

Note 1.– *The 8-channel Lassen SQ GPS does not support the AP TAIP message.*

Note 2. – *The time given in the message is the time of the last GPS fix (04:21:54 GPS), not necessarily the time of the message response. If the time of last fix is 10 or more seconds old, the age flag will be set to 1.*

TAIP Message Output (Packet 0x7E)

TSIP packet 0x7E is a new command added to Lassen SQ GPS for setting up the output configuration for TAIP messages. This packet expands the features similar to what have been provided by packet 0x8E-40, which can be found in some older generation Trimble receiver products.(The Lassen SQ does not support the 0x8E-40 command). The settings provided by the packet can be divided into 4 groups:

1. Reporting Flags – byte 1. For information on the RM command, see Appendix A in the *Lassen SQ GPS Receiver System Designer Reference Manual.*
2. The Top-of-Hour Offset – byte 2,3. This setting applies to all eight messages included in this packet. (If different values have to be applied to each message individually, use the Time-Distance feature from TAIP protocol.)
3. Automatic Output Intervals for the 8 commonly used messages – bytes 4 - 19
4. Device ID – bytes 20-23.

This packet provides the capability to set the output frequencies for the eight commonly used messages individually. This is the same as the F<message type><output interval> command in TAIP. In contrast to packet 0x8E-40, the settings in this packet are not just for the so-called Heartbeat messages, meaning the output frequency settings are not only applied when the receiver is not generating a position fix. In practice, this packet provides a comprehensive but straightforward means to set up the TAIP output configuration. It can also be used to reset the output configuration. For example, if any of these eight messages was set up as Time-Distance mode from the TAIP protocol, this packet would reset any such message back to plain periodic output mode or no automatic output mode (frequency=0).

For customization, the settings in this packet can be stored into the Flash by either TSIP packet 0x8E-26 or TAIP command SRTSAVE_CONFIG. The flash storage commands store the latest output configuration which may be set up by either this packet or any other commands from the TAIP protocol. For example, if this packet was executed first from the TSIP protocol and then the SQ was switched to TAIP protocol and the output settings were changed (e.g. changed to Time-Distance mode), or vise-versa, then the latest settings would be stored into the Flash (when the flash storage command is used).

Table.28 TAIP Packet 0 x 7E

Byte	Bit	Item	Type	Value	Definition	Default
0		Subcode	UNIT 8	0	Setting the packet	0
1	0	ID Flag	Bit	0/1	On/Off	0
	1	CS Flag	Bit	0/1	On/Off	1
	2	EC Flag	Bit	0/1	On/Off	1
	3	FR Flag	Bit	0/1	On/Off	1
	4	CR Flag	Bit	0/1	On/Off	0
	5-7	Reserved				
2,3		TOH	UNIT 16	0-3599	Top of hour offset	0
4,5		AL output period	UNIT 16	0-3599	Auto output period for AL (sec)	0 (see note)
6.7		CP output period	UNIT 16	0-3599	Auto output period for CP (sec)	0
8,9		ID output period	UNIT 16	0-3599	Auto output period for ID (sec)	0
10,11		LN output period	UNIT 16	0-3599	Auto output period for LN (sec)	0
12,13		PV output period	UNIT 16	0-3599	Auto output period for PV (sec)	0
14,15		ST output period	UNIT 16	0-3599	Auto output period for ST (sec)	0

Table.28 TAIP Packet 0 x 7E

Byte	Bit	Item	Type	Value	Definition	Default
16,17		TM output period	UNIT 16	0-3599	Auto output period for TM (sec)	0
18,19		VR output period	UNIT 16	0-3599	Auto output period for VR (sec)	0
20-23		Veh ID	String	See TAIP ID	Vehicle ID	“0000”

Note – *0 second period means the corresponding message is not to be output at all.*

Command Packet 0x35 - Set Request I/O Options

This packet requests the current I/O options and allows the I/O options to be set. To request the options settings without any changes, send the packet with no data bytes. To change the options settings, include four data bytes with the values. The I/O options, their default settings, and the byte values for all possible configurations are shown below.

The Set/Request I/O options are stored in battery-backed memory. To store them in non-volatile RAM (Flash), use the 0x8E-26 command. The GPS receiver returns Packet 0x55.

These abbreviations are used in the following table:

- ALT Altitude
- ECEF Earth-centered, Earth-fixed
- XYZ Cartesian Coordinates
- LLA Latitude, Longitude, Altitude
- HAW Height Above Ellipsoid
- WGS-84 Earth Model (ellipsoid)
- MSL Geoid Mean Sea Level
- UTC Coordinated Universal Time

Table.29 Command Packets 0x35 and 0x55 Data Descriptions

Byte	Bit	Item	Type	Value	Definition
Position					
0	0 (LSB)	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on
	1	LLA Output	Bit	0 1	LLA output off LLA output on
	2	LLS ALT Output	Bit	0 1	HAE (Note 1) MSL geoid
	3	ALT input	Bit	0 1	HAE (Note 1) MSL geoid
	4	Precision-of-position output	Bit	0 1	Send single-precision packet Send double-precision packet
	5	Super Packet Output	Bit	0 1	Output no Super Packets Output all enabled Super Packets
	6-7	Reserved			
Velocity					
1	0	XYZ ECEF	Bit	0 1	XYZ ECEF output off XYZ ECEF output on
	1	ENU Output	Bit	0 1	ENU output off ENU output on
Timing, PPS Mode and Silent TSIP					

Table.29 Command Packets 0x35 and 0x55 Data Descriptions

Byte	Bit	Item	Type	Value	Definition
2	0	Time Type	Bit	0 1	GPS Time UTC
	1-4	Reserved			
	5-6	PPS Mode	Bit	00 01 10 11	Auto output period for LN (sec)
	7	Reserved			
Auxiliary/Pseudo Range Measurements					
3	0	Raw Measuring	Bit	0 1	Raw measurements off Raw measurements on
	1	Raw/Filtered	Bit	0 1	Raw PR's in 5A Filtered PR's in 5A
	2	Reserved			
	3	Output dB Hz instead of AMU	Bit	0 1	Output dB Hz OUtput AMU's
	4-7	Reserved			

Note 1. – *In the current version of the Lassen SQ GPS, the input and output HAE altitude is in the WGS-84 datum.*

Note 2. – *Packet 8E must be used to specify which Super Packet is to be output.*

Note 3.– *The Lassen SQ GPS supports automatic output of 0x5A messages for backwards compatibility with older TSIP applications.*

PPS Output Mode

PPS output mode can be controlled by TSIP command packet 0 x 35. Once a specific mode is selected, it can be stored in non-volatile memory (flash) using TSIP command 0x8E-26. The following PPS modes are supported.

Always Off

When the *Always Off* mode is selected, the PPS output remains low at all times. Disabling the PPS output has no affect on normal receiver operations, and position fixes are calculated as usual. This mode can be selected at any time during receiver operation. The PPS output is immediately switched off (disabled) when the TSIP command for this mode is received.

Always On (default)

When the PPS output is configured for *Always On* (early PPS), it is driven by the Real Time Clock (RTC) until the receiver acquires GPS time is generating position fixes. In this mode, the PPS output continues even if the receiver loses GPS tracking. The maximum drift of the PPS pulse when not tracking satellites could be quite large, therefore the PPS output should not be used for precise synchronization when no position fix occurs. The PPS can be switched to *Always On* mode any time during normal operation. This mode is the factory default setting.

Fix Based

In this mode, the PPS output is turned on only while fixes are taking place. If the receiver is not tracking satellites, the PPS output is turned off until the signals are required and position fixes are valid again. If the receiver is switched from *Always On* to *Fix Mode*, and the receiver has not yet started generating position fixes, the PPS output will turn off until a new fix is obtained.

Programmable Characteristics - Signal Offset (Cable Delay Compensation)

The receiver firmware also enables the user to offset the delay of the PPS pulse with reference to the actual UTC second tick. This delay is the result of antenna cable length and propagation delay of the PPS output signal. The delay compensation parameter can be set (in nano seconds) using TSIP super packet 0x8E-4A. Note that the current firmware version only allows the update of the PPS offset parameter of the PPS definition packet (0x8E-4A). Other parameters are read only. The PPS offset selection can be stored in non-volatile memory by sending command packet 0x8E-26 to the receiver.

Command Packet 8E-4A - Set/Request Lassen SQ GPS Cable Delay

Using this packet, you can query and control the Lassen SQ GPS cable delay characteristics. The receiver responds to a query or control command with packet 8F-4A. The packet contains 16 bytes.

Table.30 Command Packet 8E-4A

Byte	Item	Type	Meaning
0	Sub-packet ID	BYTE	Always 0x4A
1	Reserved		
2	Time Base	BYTE	0: GPS 1: UTC (default)
3	Reserved		
4-11	PPS Offset of Cable Delay	DOUBLE	Seconds (default=0.0)
12-15 Reserved			

Command Packet 0xBB - Navigation Configuration

In query mode, Packet 0xBB is sent with a single data byte and returns Report Packet 0xBB.

Note – *This Command Packet replaces Packets 0x2C, 0x62, 0x75, and 0x77.*

Table.31 Command Packet 0xBB Query Mode Data Format

Byte	Item	Type	Value	Definition	Default
0	Subcode	UNIT 8	0x00	Query Mode	

TSIP Packet 0xBB is used to set GPS Processing options. The table below lists the individual fields within the 0xBB Packet.

Table.32 Command and Report Packet 0xBB Field Descriptions

Byte	Item	Type	Value	Definition	Default
0	Subcode	UNIT 8	0x00	Query Mode	0x03
1	Operating Dimension	UNIT 8	0 3 4	Automatic (2D/3D) Horizontal (2D) Full Position (3D)	Automatic
2	DGPS Mode	UNIT 8	0 1 2 or 3	DGPS Off DGPS Only DGPS Auto	DGPS Auto
3	Dynamic Code	UNIT 8	1 2 3 4	Land Sea Air Stationary	Land
4	Reserved				
5-8	Elevation Mask	Single	0.0 - 1.57 (radian)	Lowest satellite elevation for fixes	0.0873 (5^{o})

Table.32 Command and Report Packet 0xBB Field Descriptions

Byte	Item	Type	Value	Definition	Default
9-12	AMU Mask	Single	0-25 (AMU)	Minimum signal level for fixes	3.0
13-16	DOP Mask	Single	0.2-100	Maximum DOP for fixes	12.0
17-20	DOP Switch	Single	0.2-100	Selects 2D/3D mode	6.0
21	DGPS Age Limit	UNIT 8	2-90 (seconds)	Maximum time to use a DGPS corrections (seconds)	30
22-39	Reserved				

Command Packet 0xBC - Protocol Configuration

TSIP Packet 0xBC is used to query the port characteristics. In query mode, Packet 0xBC is sent with a single data byte and returns Report Packet 0xBC. (See Table A.4 for information on saving the settings to non-volatile memory.)

TSIP Packet 0xBC is used to set the communication parameters on Port 1. The table below lists the individual fields within the Packet 0xBC and provides query field descriptions.

The BC command settings are retained in battery-backed RAM.

Table.33 Command and Report Packet 0xBB Field Descriptions

Byte	Bit	Item	Type	Value	Definition
0		Port to Set	UNIT 8	0 1 0xFF	Port 1 Port 1 Current Port
1		Input Baud Rate	UNIT 8	2 3 4 5 6 7 8 9	Reserved Reserved Reserved 2400 baud 4800 baud 9600 baud 19200 baud 38400 baud
2		Output Baud Rate	UNIT 8	As above	As above
3		# Data Bits	UNIT 8	2 3	7 bits 8 bits
4		Parity	UNIT 8	0 1 2	None Odd Even

Table.33 Command and Report Packet 0xBB Field Descriptions

Byte	Bit	Item	Type	Value	Definition
5		# Stop Bits	UNIT 8	0 1	1 bit 2 bits
6		Flow Control	UNIT 8	0	0=none
7	0	TAIP	Bit	0 1	Off On
	1	TSIP input	Bit	0 1	Off On
	2	Reserved			
	3	Reserved			
	4-7	Reserved			
8	0	TAIP	Bit	0 1	Off On
	1	TSIP Output	Bit	0 1	Off On
	2	NMEA Output	Bit	0 1	Off On
	3-7	Reserved			
9		Reserved			

Note – *The Lassen SQ GPS requires that the input and output baud rates be identical.*

Warning – TSIP input or output must have 8 databits (byte 3).