SYNERGY SYSTEMS, LLC

Time proven products and support

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VP Oncore Command Reference

This document contains command and reply messages for the 6 channel PVT-6 and Basic Oncore and the 6 and 8 channel VP Oncore as supported by Synergy Systems, LLC beginning in 1992. It has been independently compiled and audited by Synergy Systems, LLC and checked against Motorola's Technical Reference Manual TRM0001 version 7.0 dated May 1996 for the VP Oncore series of OEM GPS receivers. For completeness, portions of this document include original text from TRM0001, reproduced here with Motorola's permission, and annotated with notes and clarifications by Synergy Systems, LLC. This document is made available in hyperlinked PDF to provide easy access to command and output message details by electronic means.

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VP ONCORE COMMAND REFERENCE

WHAT EXACTLY IS A VP?

I fully admit to being rather cavalier in my definition of a "VP". This command reference is usable for early packaged Oncore receivers such as the "PVT-6", 6 and 8 channel "Basic" Oncores, and finally the 6 and 8 channel board level product "VPs". The common thread is that they all respond to the commands shown here (or some subset, depending on age and firmware revision.)

IDENTIFICATION BY MODEL NUMBER

Most of the Oncore receivers have some sort of bar-code tag that identifies the receiver by model number and serial number. If there is no tag, the only way to positively identify the receiver is by querying the Receiver electronic ID using the binary @@Cj command. While by no means complete, the following list should allow you to identify 90% of the receivers out there. We know for a fact that a lot of "house numbered" receivers with total jibberish for model numbers have worked their way into the surplus market, but under the skin they are probably pretty standard parts. "*If it walks like a VP, talks like a VP, and acts like a VP, it's probably some variation of a VP....."*

Model Number	Receiver Details
PVT6xxxxxxxxx	Early 6 channel Oncore
A121xxxxxxxxx	"Basic Oncore", could be either 6 or 8 channel
B1xxxxxxxx	Early 6 Channel VP Oncore
B2xxxxxxxx	B1 with enhanced RF filtering
B3xxxxxxxx	First 8 channel VP Oncore
B4xxxxxxxx	B3 with enhanced RF filtering, interim configuration between B3 and B8
B8xxxxxxxx	Final version of 8 channel VP receiver

Naturally, the operating firmware was undergoing improvements and expansion during the progression through the various models of hardware. This means that your old 1994 vintage PVT-6 will probably NOT respond to all of the commands included in this document, while your B3, B4, and B8 receivers should work just fine. The good news is that most of these older receivers can have their firmware inexpensively re-flashed to give them increased functionality (add 1PPS functions, TRAIM, Carrier Phase), fix old bugs, etc. If this is of interest, simply email us at: *tech@synergy-gps.com*.

That's about all I have. If any of you VP gurus out there find any glaring errors or omissions in this doc, please let me know so that I can clean up after myself.....

Best Regards,

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COMMAND INDEX

Function	Description	Binary Command	Controller Command
Time	Time of Day	@@Aa	time
Ephemeris	Ephemeris Hold Option	@@AA	ephhold
Time	GMT Correction	@@Ab	gmt
Setup	Application Type Select	@@AB	aptype
Time	Date	@@Ac	date
DOP	2D to 0D HDOP Threshold	@@AC	dopmask
Position	Latitude	@@Ad	lat
Thresholds	Correction Thresholds	@@AD	corthr
Position	Longitude	@@Ae	lon
Receiver	Output Align	@@AE	
Position	Height	@@Af	hgt
Satellite	Satellite Mask Angle	@@Ag	mask
Satellite	Satellite Select Options	@@Ah	sm
Satellite	Manual Satellite Select	@@Ai	ss
DOP	xDOP Type	@@Aj	doptype
Differential	Differential Time-Out Select	@@AJ	dto
DOP	xDOP Hysteresis	@@Ak	dophys
DOP	3D to 2D xDOP Threshold	@@Al	dopthr
Satellite	Satellite Ignore List	@@Am	ignore
Almanac	Almanac Update	@@An	almhold
Setup	Datum Select	@@Ao	datum
Setup	Set User Defined Datum	@@Ap	udatum
Setup	Ionospheric Correction Mode	@@Aq	ion
Setup	Position Fix Algorithm Type	@@Ar	fix
Setup	Position-Hold Position	@@As	php
Setup	Position-Hold Select	@@At	ph
Setup	Altitude-Hold Height	@@Au	ahp
Setup	Altitude-Hold Select	@@Av	ah
Time	UTC/GPS Time Select	@@Aw	utc
Time	Measurement Epoch Offset	@@Ax	
1PPS	1PPS Time Offset	@@Ay	ppsoff
1PPS	1PPS Cable Delay	@@Az	ppsdelay
Position	6 Channel Position/Status/Data	@@Ba	pos
Satellite	Satellite Visibility Message	@@Bb	vis
DOP	6 Channel xDOP Table Status	@@Bc	dop
Almanac	Almanac Status Message	@@Bd	alm
Almanac	Almanac Data Output	@@Be	almout
Ephemeris	Ephemeris Input Message	@@Bf	ephin
Range Data	6 Channel Satellite Range Data	@@Bg	rng

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DGPS	Pseudorange Correction Output	@@Bh	corout
Ephemeris	Ephemeris Data Output Message	@@Bi	ephout
Setup	Leap Second Pending Status	@@Bj	leapsec
Position	6 Channel Position/Status/Data Extension	@@Bk	ext
Broadcast	Satellite Broadcast Data Message	@@Bl	
TRAIM	6 Channel TRAIM Setup/Status	@@Bn	trstat
Receiver	6 Channel Self Test	@@Ca	selftest
Almanac	Almanac Data Input	@@Cb	almin
Satellite	6 Channel Alert Planning Message	@@Cd	alert
DGPS	Pseudorange Correction Input	@@Ce	corin
Receiver	Set-to-Defaults	@@Cf	default
Receiver	Position Fix/Idle Mode Select	@@Cg	mode
Format	Switch I/O Format	@@Ci	ioformat
Receiver	Receiver ID String	@@Cj	id
Position	8 Channel Position/Status/Data	@@Ea	ps8
DOP	8 Channel xDOP Table Status	@@Ec	dp8
Range Data	8 Channel Satellite Range Data	@@Eg	rg8
Position	8 Channel Position/Status/Data Extension	@@Ek	et8
TRAIM	8 Channel TRAIM Setup/Status	@@En	trstat8
Receiver	8 Channel Self Test	@@Fa	selftest8
Satellite	8 Channel Alert Planning Message	@@Fd	alert8

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TIME OF DAY (@@Aa)

This input command changes the current time in the VP's Real Time Clock (RTC) to the time specified in the command. The GMT correction (@@Ab command) and the UTC/GPS Time Mode selection (@@Aw command) should be specified before the Time of Day is set.

The time in the GPS receiver will be correct if the internal RTC has been powered. It is not necessary for the user to enter the current time of day if the RTC power is removed; however the TTFF will be reduced if the time is initialized. The GPS receiver corrects the time data in the RTC with time information decoded from the satellite broadcast data as soon as one satellite is tracked.

The GPS receiver uses the satellite data to set the RTC; hence the Time of Day command is ignored if the GPS receiver is tracking at least one satellite. If the RTC has not been backup powered, then it is initialized at 12:00:00 at power up.

Time is stored as local time or GMT depending on the setting of the GMT Offset parameter. The GPS receiver automatically compensates for leap-second corrections, thus the seconds field in the message will indicate 60 when a leap second is inserted. Leap seconds are inserted approximately once per year. See Leap Second Pending Status Message (@@Bj command)

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Range: 00:00:00 to 23:59:59

Default value: Time from RTC if no satellites tracked (12:00:00 GPS Time if RTC and backup power not present.)
Time from satellite if at least one satellite tracked

VP ONCORE COMMAND REFERENCE

TIME OF DAY (@@Aa)

Motorola Binary Format

Input Command

- *Request Current Time of Day:*

@@AaxxxC<CR><LF>

xxx - 3 out of range bytes $ffffff
C - checksum
Message length: 10 bytes

- *Change Current Time of Day:*

@@AahmsC<CR><LF>

h - hours 0 .. 23
m - minutes 0 .. 59
s - seconds 0 .. 59
C - checksum
Message length: 10 bytes

Response Message

- *To either command:*

@@AahmsC<CR><LF>

h - hours 0 .. 23
m - minutes 0 .. 59
s - seconds 0 .. 59
C - checksum
Message length: 10 bytes

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EPHEMERIS HOLD OPTION (@@AA)

In normal operation the GPS receiver automatically acquires and uses the latest satellite ephemerides from the GPS satellites. When the GPS receiver detects a new ephemeris data set, it collects the new data and immediately begins using the new data.

If the user enables the Ephemeris Hold Option the GPS receiver holds the current ephemerides in memory and will not collect new ephemerides from the GPS satellites. With ephemeris hold enabled, the GPS receiver will only accept and use new ephemeris data input via the RS-232 port.

Ephemeris Hold Option is always disabled at power-on.

Default value: Disabled

EPHEMERIS HOLD OPTION (@@AA)

Motorola Binary Format

Input Command

- *Request Current Ephemeris Hold Mode:*

@@AAxC<CR><LF>

x - $ff (one byte, hex if)
C - checksum
Message Length: 8 bytes

- *Change Current Ephemeris Hold Mode:*

@@AAmC<CR><LF>

m - mode 0 - Disabled
1 - Enabled
C - checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@AAmC<CR><LF>

m - mode 0 - Disabled
1 - Enabled
C - checksum
Message Length: 8 bytes

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GMT CORRECTION (@@Ab)

This command changes the offset between GMT and local time. The VP receiver computes local time from GMT and the offset using the following equation:

Local Time = GMT + GMT Offset.

The minutes offset is provided for those locations in the world that do not use an even offset of hours between GMT and local time. If it is desired to operate on GMT, the offset is set to 0 hours, 0 minutes and the time set in the Time of Day parameter (@@Aa command) must be entered in GMT.

Range: Hours: -23 .. +23
Minutes: 00 .. 59

Default value: 00:00 (no GMT offset)

GMT CORRECTION (@@Ab)

Motorola Binary Format

Input Command

Query Current GMT Offset:

@@AbxxxC<CR><LF>

xxx - $ffffff (three bytes, all hex $ff)
C – checksum
Message length: 10 bytes

Change current GMT Offset:

@@AbshmC<CR><LF>

s - sign	00 = positive
	ff = negative
h - hours	0 .. 23
m - minutes	0 .. 59
C - checksum	

Message length: 10 bytes

Response Message *(To either command):*

@@AbshmC<CR><LF>

s - sign	00 = positive
	ff = negative
h - hours	0 .. 23
m - minutes	0 .. 59
C - checksum	

Message length: 10 bytes

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APPLICATION TYPE SELECT (@@AB)

This option is used to manually change the receiver application type. Setting this parameter allows the user to select optimized search and reacquisition strategies for different receiver applications.

Note the initial satellite search time is the time the receiver spends searching for the assumed visible satellites (based on the almanac and initial receiver position). Further note, for all application types, that if the set of assumed visible satellites have not been found by the end of the initial search time, the receiver begins a systematic search for all satellites in the GPS constellation.

Default value: Land

Application Type	Maximum Expected Velocity	Velocity Averaging	Approximate Initial Satellite Search Time
Air	> 100 m/s	1 sec	15 minutes
Handheld	< 100 m/s	5 sec	2 minutes
Land	< 100 m/s	1 sec	30 minutes
Marine	< 100 m/s	5 sec	2 minutes
Static	< 100 m/s	1 sec	2 minutes

VP ONCORE COMMAND REFERENCE

APPLICATION TYPE SELECT (@@AB)

Motorola Binary Format

Input Command

- *Request Current Application Type:*

@@ABxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Current Application Type:*

@@ABtC<CR><LF>

t - application type
- 0 - Air
- 1 - Handheld
- 2 - Land
- *3* - Marine
- 4 - Static

C - checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@ABtC<CR><LF>

t - application type
- 0 - Air
- 1 - Handheld
- 2 - Land
- 3 - Marine
- 4 - Static

C - checksum
Message Length: 8 bytes

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DATE COMMAND (@@Ac)

This input command changes the current date in the GPS receiver real-time clock (RTC) to the date specified in the command. The GMT Correction should be set using the @@Ab Command before the Date is set.

The date in the GPS receiver will normally be correct if the internal RTC has been powered. It is not necessary for the user to enter the current date if the RTC power is removed, however the TTFF will be reduced if the date is initialized. The GPS receiver corrects the date data in the RTC with date information decoded from the satellite broadcast data as soon as one satellite is tracked.

The GPS receiver uses the satellite data to set the RTC, hence the Date command is ignored if the GPS receiver is tracking at least one satellite. If the RTC has not been backup powered, then it is initialized at the default date at power up. This default date varies depending upon the firmware present in the receiver. Note that the Oncore receiver will automatically handle the rollover in GPS time that will happen in August 1999 as well as the year 2000 rollover.

Range:	Month:	1 .. 12
	Day:	1 .. 31
	Year:	1980 .. 2077

Default value: Date from RTC if no satellite tracked
Date from satellite if at least one satellite tracked

DATE (@@Ac)

Motorola Binary Format

Input Command

- *Request Current Date:*

@@AcxxxxC<CR><LF>

xxxx - 4 out of range bytes $ffffffff
C - checksum
Message length: 11 bytes

- *Change current Date:*

@@AcmdyyC<CR><LF>

m - month	1 .. 12
d - day	1 .. 31
yy - year	1980 .. 2077
C - checksum	

Message length: 11 bytes

Response Message

- *To either command:*

@@AcmdyyC<CR><LF>

m – month	1 .. 12
d - day	1 .. 31
yy - year	1980 .. 2077
C - checksum	

Message length: 11 bytes

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2-D TO O-D HDOP THRESHOLD (@@AC)

There are periods in the satellite pass where the two-dimensional (2-D) dilution of precision (HDOP) grows very large, and the position is too inaccurate for use. This command allows the user to set the DOP threshold above which the GPS receiver will quit 2-D positioning.

Range:	1.0 to 99.9
Default Value:	12.0
Resolution:	0.1

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2-D TO O-D HDOP THRESHOLD (@@AC)

Motorola Binary Format

Input Command

- *Request current 2-D to 0-D HDOP threshold:*

@@ACttC<CR><LF>

xx - $ffff (two bytes, all hex ff)
C – checksum
Message Length: 9 bytes

- *Change Current 2-D to 0-D HDOP threshold:*

@@ACttC<CR><LF>

tt - 2-D to 0-D threshold 10 .. 999 (0.1 resolution)
(1.0 .. 99.9)

C - checksum
Message Length: 9 bytes

Response Message

- *(to either command):*

@@ACttC<CR><LF>

tt - 2-D to 0-D threshold 10 .. 999 (0.1 resolution)
(1.0 .. 99.9)

C - checksum
Message Length: 9 bytes

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LATITUDE (@@Ad)

Three parameters (latitude, longitude, and height) are used to establish the initial position of the VP receiver. The initial position estimate provides the VP with a starting point to begin the satellite acquisition process. It is not necessary for the user to initialize the coordinates with a position estimate, however the TTFF will be minimized by providing an estimate that is close (within one degree is sufficient) to the user's position.

Latitude is measured in degrees north (+) or degrees south (-) of the earth's equator. The default datum for the latitude is WGS-84, however this may be changed by the user with the Datum Select (@@Ao command). This input command sets the initial latitude coordinate only if the VP is not yet computing a position fix, or is used to replace the current latitude with a new latitude while in Position Fix mode.

Range:	-90º (South Pole) .. +90º (North Pole)
Default value:	0º (Equator)
Units:	milliarcseconds (mas) (1º = 3,600,000 mas)

LATITUDE (@@Ad)

Motorola Binary Format

Input Command

- *Request Current Latitude:*

@@AdxxxxC<CR><LF>

xxxx - 4 out of range hex bytes $99999999
C – checksum
Message length: 11 bytes

- *Change current Latitude:*

@@AdddddC<CR><LF>

dddd - latitude in mas -324,000,000 .. 324,000,000 (-90º to 90º)

C - checksum
Message length: 11 bytes

Response Message

- *(to either command)*

@@AdddddC<CR><LF>

dddd - latitude in mas -324,000,000 .. 324,000,000 (-90º to 90º)

C - checksum
Message length: 11 bytes

NOTE: 1 degree of latitude equals 3,600 arcseconds or 3,600,000 milliarcseconds (mas).

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CORRECTION THRESHOLDS (@@AD)

This command allows the control of two timer thresholds that affect the following:

- the "smoothness" of the position fix (FIX_THR), and
- the "smoothness" of the differential correction output (OUT_THR).

The Motorola VP Oncore GPS receiver filters the noisy raw code phase measurements with the very smooth carrier phase measurements. This filtering process begins as soon as the signal is acquired and continues as long as the signal is tracked. The filter bandwidth is narrowed gradually and reaches its final state after 128 seconds. The VP Oncore keeps a filter timer for each channel to control the timing of the bandwidth changes. The filter bandwidth is reset to its initial wide setting and the timer is set to zero whenever the signal is lost.

The user-controllable threshold OUT_THR can be used to gate a channel's output of differential corrections until it has had some user-defined adequate time to filter the raw code phase. Earlier versions of the Oncore software used 32 as an internal threshold for this parameter.

There is an inherent interdependence in the use of these two thresholds. For instance, if FIX_THR is set to 16 and OUT_THR is set to 8, then the receiver will filter the raw code phase for 16 seconds before using that channel for fix and then will immediately output differential corrections for that channel (if the message has been requested). The 8-second OUT_THR threshold is effectively overridden by the 16 second FIX_THR threshold in this example.

Default values: FIX_THR = 0
OUT_THR = 32

CORRECTION THRESHOLDS (@@AD)

Motorola Binary Format

Input Command

- *Request Correction Thresholds:*

@@ADxxC<CR><LF>

xx - $ffff (two bytes, all hex ff)
C - checksum
Message Length: 9 bytes

- *Change Correction Thresholds:*

@@ADfdC<CR><LF>

f - FIX_THR	0 .. 127 seconds
d -OUT_THR	0 .. 127 seconds
C – checksum	

Message Length: 9 bytes

Message Response

- *(to either command):*

@@ADfdC<CR><LF>

f - FIX_THR	0 ..127 seconds
d - OUT_THR	0 ..127 seconds
C - checksum	

Message Length: 9 bytes

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LONGITUDE (@@Ae)

Longitude is measured in degrees east (+) or degrees west (-) of the Greenwich Meridian. The default datum for the longitude is WGS-84, however this may be changed by the user with the Datum Select (@@Ao command.) This input command sets the initial longitude coordinate only if the GPS receiver is not yet computing a position fix, or is used to replace the current longitude with a new input longitude while in the Position Fix mode.

Range:	-180º .. 180º
Default value:	0º (Greenwich Meridian)
Units:	milliarcseconds (mas) (1º = 3,600,000 mas)

LONGITUDE (@@Ae)

Motorola Binary Format

Input Command

- *Request Current Longitude:*

@@AexxxxC<CR><LF>

xxxx - 4 out of range hex bytes $99999999
C - checksum
Message length: 11 bytes

- *Change current Longitude:*

@@AeddddC<CR><LF>

dddd - longitude in mas -648,000,000 .. 648,000,000 (-180º to 180º)
C - checksum
Message length: 11 bytes

Response Message

- *(to either command)*

@@AeddddC<CR><LF>

dddd - longitude in mas -648,000,000 .. -648,000,000 (-180º to 180º)
C - checksum
Message length: 11 bytes

NOTE: 1 degree of latitude equals 3,600 arcseconds or 3,600,000 milliarcseconds (mas)

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OUTPUT ALIGN (@@AE)

This command, when enabled, will align all receiver periodic outputs with the top of the minute. The periodic output rates which can be aligned are 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60 seconds.

For example, with the Output Align command active, if the receiver time is 13:43:52 and the user requests the Satellite Range Data Output message every 10 seconds, then the receiver will echo one Satellite Range Data Output message on the next second (13:43:53) to show the command was received correctly. After this point, the receiver will align the output message to occur at the top of the minute, ten seconds after the top of the minute, twenty seconds after, etc.

If Output Align is disabled, then the Satellite Range Data Output message start at a random time and then occur every 10 seconds after the echo. Thus, the user might receive the next Satellite Range Data Output message at 13:43:53, the next at 13:44:03, the next at 13:44:13, etc.

Default value: Disabled

OUTPUT ALIGN (@@AE)

Motorola Binary Format

Input Command

- *Request current Output Alignment Mode:*

@@AExC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Output Alignment*

@@AEmC<CR><LF>

m – mode — 0 - Disabled, 1 - Enabled

C **-** checksum
Message Length: 8 bytes

Response Message

•*(to either command)*

@@AEmC<CR><LF>

m - mode — 0 - Disabled, 1 - Enabled

C - checksum
Message Length: 8 bytes

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HEIGHT (@@Af)

This input command sets the initial height coordinate only if the VP receiver is not yet computing a position fix, or is used to replace the current height with a new input height while in the Position Fix mode. The user can enter the height referred to either of the two following references:

- GPS (WGS-84) Ellipsoid Height
- Mean Sea Level (MSL)

Range:	- 1,000,00 .. 18,000.00 m
Default value:	0.00 meters
Resolution:	0.01 m

HEIGHT (@@Af)

Motorola Binary Format

Input Command

- *Request Current Height:*

@@AfxxxxxC<CR><LF>

xxxx - 5 out of range hex bytes $9999999999
C - checksum
Message length: 12 bytes

- *Change current Height:*

@@AfhhhhtC<CR><LF>

hhhh - height in cm	-100,000 .. 1,800,000 (-1,000.00 .. 18,000.00 m)
t - height type	0 = GPS ellipsoid height 1 = MSL height
C - checksum	

Message length: 12 bytes

Response Message

- (to either command)

@@AfhhhhmmmmC<CR><LF>

hhhh - height in cm (GPS height)	-100,000 .. 1,800,000 (-1,000.00 to 18,000.00 m)
mmmm – height in cm (MSL height)	-100,000 .. 1,800,000 (-1,000.00 to 18,000.00 m)
C - checksum	

Message length: 15 bytes

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SATELLITE MASK ANGLE (@@Ag)

The VP will attempt to track satellites for which the elevation angle is greater than the satellite mask angle. This parameter allows the user to control the elevation angle that was used for this decision.

Range: 0 to 89 degrees
Default value: 10 degrees

SATELLITE MASK ANGLE (@@Ag)

Motorola Binary Format

Input Command

- *Request current Mask Angle:*

@@AgxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message length: 8 bytes

- *Change current Mask Angle:*

@@AgdC<CR><LF>

d - degrees 0 .. 89
C - checksum
Message length: 8 bytes

Response Message

- *(to either command)*

@@AgdC<CR><LF>

d - degrees 0 .. 89
C - checksum
Message length: 8 bytes

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SATELLITE SELECT OPTIONS (@@Ah)

This command sets the Satellite Select option to either automatic, manual, or highest-in-the-sky satellite selection. With the "automatic" option enabled, the Motorola VP GPS receiver automatically selects the set of satellites to track with the best geometry (selection criteria optimized for the selected xDOP type using the @@Aj command), the xDOP hysteresis parameter (@@Ak command), and position fix type (@@Ar command). With the automatic satellite select option enabled, the GPS receiver will change satellites to maintain the set with the best geometry based on each new computation of satellite geometry. Selection of the manual satellite select option requires the user to select the satellites to be tracked.

With the "automatic highest-in-sky" mode, the receiver simply tracks the six (or eight, if the receiver is an eight channel unit) satellites currently highest above the horizon. Use of this option will result in more position fixes in urban canyon environments when more than six (or eight) satellites are visible at the expense of accuracy since geometry is not considered as a satellite selection criterion when this option is selected

The GPS receiver will power-up to either automatic or highest-in-the-sky, depending on which option was last selected by the user. The receiver will never power-up in manual mode. When manual mode is selected the receiver will continue to track those satellites set by either the automatic or highest-in-the-sky selection processes when the Satellite Select option is set to manual satellite select. The user can then change any satellite on any channel using the Manual Satellite Select command.

The VP always remembers the automatic satellite mode option last used when the GPS receiver is powered up. The GPS receiver continues to track those satellites set by automatic satellite selection processes when the Satellite Select option is set to manual satellite select. The user can then change any satellite on any channel using the Manual Satellite Select command.

Default value: Automatic

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SATELLITE SELECT OPTIONS (@@Ah)

Motorola Binary Format

Input Command

- *Query current Satellite Select Mode:*

@@AhxC<CR><LF>

x = $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Satellite Select Mode:*

@@AhoC<CR><LF>

o – option
- 0 – Automatic Best Geometry
- 1 – Manual
- 2 - Automatic Highest-In-Sky

C - checksum
Message Length: 8 bytes

Response Message

- *(to either command)*

@@AhoC<CR><LF>

o - option
- 0 – Automatic Best Geometry
- 1 - Manual
- 2 - Automatic Highest-In-Sky

C - checksum
Message Length:8 bytes

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MANUAL SATELLITE SELECT (@@Ai)

This option is used to manually change the satellites tracked by the Motorola VP GPS receiver. This input command is used only when the Manual Satellite Select option (Mode 1) has been enabled by the user with the Satellite Select Option (@@Ah command.)

The input command has no effect if either the Automatic or Highest-in-the-Sky Satellite Select options have been enabled.

Default value: none

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SATELLITE SELECT (@@Ai)

Motorola Binary Format

Input Command

- *Query Current Satellite Assignment on Channel:*

@@AicxC<CR><LF>

c - channel number	1 .. 8
x - $ff (one byte, hex ff)	
C - checksum	

Message Length: 9 bytes

- *Change Satellite Assignment on Channel:*

@@AicsC<CR><LF>

c - channel number	1 .. 8
s - sat ID per channel	0 .. 37 0 = Disable Channel 1 .. 37 = sat ID including pseudolite IDs
C - checksum	

Message Length: 9 bytes

Response Message

- *(to* either *command):*

@@AicsC<CR><LF>

c - channel number	1.. 8
s - sat ID per channel	0.. 37 0 = confirms channel is disabled 1 .. 37 = sat ID including pseudolite IDs
C – checksum	

Message Length: 9 bytes

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xDOP TYPE (@@Aj)

The xDOP Type parameter specifies which DOP type to use for satellite selection criteria. The user has the choice of allowing the Motorola VP GPS receiver to optimize its satellite selection based on minimum value of the chosen DOP type as defined by the following table:

PARAM	DEFINITION	GEOMETRY CONSIDERED
GDOP	Geometric Dilution of Precision	X, Y, Z, T or Φ, λ, H, T
PDOP	Position Dilution of Precision	X, Y, Z or Φ, λ, H
HDOP	Horizontal Dilution of Precision	Φ, λ
VDOP	Vertical Dilution of Precision	H
TDOP	Time Dilution of Precision	T

Default value: PDOP

VP ONCORE COMMAND REFERENCE

xDOP TYPE (@@Aj)

Motorola Binary Format

Input Command

- *Query Current xDOP Type:*

@@AjxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change xDOP Type:*

@@AjdC<CR><LF>

d - DOP Type	0 - GDOP
	1 - PDOP
	2 - HDOP
	3 - VDOP
	4 - TDOP

C - checksum
Message Length: 8 bytes

Response Message

- *(to either command)*

@@AjdC<CR><LF>

d - DOP Type	0 - GDOP
	1 - PDOP
	2 - HDOP
	3 - VDOP
	4- TDOP

C - checksum
Message Length: 8 bytes

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DIFFERENTIAL TIME-OUT SELECT (@@AJ)

The differential time-out select message allows the user to determine how long the receiver will stay in differential mode in the absence of valid updated corrections. The GPS receiver will stay in differential mode as long as it has a current and valid differential correction message.

The user should note that excessive differential correction latencies could lead to significant error growth. As a rough guideline, an acceleration error of 1cm/sec^2 due to Selective Availability can be assumed producing the following (one-sigma) error component values in the differentially corrected solution:

Correction Latency (s)	Induced Position Error (m)
30	4.5
60	18.0
90	40.5
120	72.0
150	112.5
180	162.0

Range: 5 to 180 seconds
Default: 90 seconds
Resolution: 1 second

NOTES: Since Selective Availability (S/A) was discontinued by the U.S. Government in May of 2000, autonomous position errors have dropped markedly. Likewise, the time induced position errors of differential systems are currently much lower than the values shown in the table above.

Later receivers such as the GT+ and M12 do not support the @@AJ command and utilize a fixed differential time-out of 90 seconds.

DIFFERENTIAL TIME-OUT SELECT (@@AJ)

Motorola Binary Format

Input Command

- *Request current Differential Time-Out:*

@@AJxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change differential time-out:*

@@AJsC<CR><LF>

s - seconds 5 .. 180
C - checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@AJsC<CR><LF>

s - seconds 5 .. 180
C - checksum
Message Length: 8 bytes

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xDOP HYSTERESIS (@@Ak)

Setting this parameter allows the user to change the criteria by which the Motorola VP GPS receiver selects satellites. The VP evaluates the geometry for all satellites in view every few seconds. In doing so, it evaluates every combination of the visible satellites (based on the Position Fix Algorithm Type selection), computes an xDOP parameter for each combination (xDOP type as selected with the @@Aj command) and sorts them into ascending order. If only three or four satellites are visible, the receiver tracks the visible satellites and computes position without regard to geometry (xDOP) since these satellites represent the only choice at that time. However, if five satellites are visible, then five combinations of four satellites are possible for navigation (with the Position Fix Algorithm Type set for "Best-4"). The VP computes an xDOP for each combination and determines position from the set of four satellites corresponding to the best xDOP, leaving any remaining satellites that are tracked in reserve for use if one or more of the primary four satellites are lost momentarily. With the Position Fix Algorithm Type set for "N-in-View" (@@Ar command) the GPS receiver compares the closeness of xDOP for all combinations of visible satellites greater than the number of receiver channels.

There are periods where the relative difference in xDOP among the many satellite combinations is small, and the GPS receiver would switch satellites needlessly if it were not for this parameter. To combat this, the xDOP hysteresis command can be used. When set to a non-zero number, a threshold on the change in xDOP is added to the satellite selection criteria. If the parameter is set to zero, then the GPS receiver will select the best satellites after every satellite alert computation without regard to the "closeness" of xDOP. If the parameter is set relatively high, then the receiver will switch satellites only if the geometry on the tracked satellites becomes very poor, or if one of the tracked satellites goes below the satellite elevation mask angle.

Range: 0.0 to 99.9 Default value: 1.0
Resolution:0.1

xDOP HYSTERESIS (@@Ak)

Motorola Binary Format

Input Command

- *Query Current xDOP Hysteresis:*

@@AkxxC<CR><LF>

xx - $ffff (two bytes, all hex ff)
C - checksum
Message Length: 9 bytes

- *Change xDOP Hysteresis:*

@@AkxxC<CR><LF>

xx - xDOP Hysteresis	0 .. 999
0.1 resolution	(0.0 .. 99.9)

C - checksum
Message Length: 9 bytes

Response Message

- *(to either command):*

@@AkxxC<CR><LF>

xx - xDOP hysteresis	0 .. 999
0.1 resolution	(0.0.. 99.9)

C - checksum
Message Length: 9 bytes

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3-D TO 2-D xDOP THRESHOLD (@@AI)

There may be periods during the day where the 3-dimensional (3-D) dilution of precision (PDOP and GDOP) grows very large, but the 2-D HDOP stays relatively small. This command allows the user to set the DOP threshold above which the GPS receiver will switch from 3-D positioning to altitude-hold at the current height. This allows the GPS receiver to maintain a relatively accurate position fix, and avoids the condition of a 3-D fix algorithm singularity

Range: 1.0 to 99.9
Default value: 6.0
Resolution: 0.1

Note: On later Oncore receivers such as the GT+, UT+, and M12, the xDOP Threshold is fixed at 6.0

VP ONCORE COMMAND REFERENCE

3-D TO 2-D xDOP THRESHOLD (@@AI)

Motorola Binary Format

Input Command

- *Query Current 3-D to 2-D DOP threshold:*

@@AIxxC<CR><LF>

(Note: The second character is a lowercase "L" not the number "1")

xx - $ffff (two bytes, both hex ff)
C - checksum
Message Length: 9 bytes

- *Change Current 3-D to 2-D DOP threshold:*

@@AIxxC<CR><LF>

xx - threshold	10 .. 999
(0.1 resolution)	(1.0 .. 99.9)

C - checksum
Message Length: 9 bytes

Response Message

- *(to either command):*

@@AIxxC<CR><LF>

xx - threshold	10 .. 999
(0.1 resolution)	(1.0 .. 99.9)

C - checksum
Message Length: 9 bytes

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SATELLITE IGNORE LIST (@@Am)

It is useful to have the flexibility to delete particular satellite identifications (IDs) from the selection process. The Motorola VP receiver includes, in its list of satellites to track, all satellites that are healthy and in the almanac. The user can elect to ignore particular satellites in the almanac by issuing an Ignore Satellite Command. In addition, the user can restore any previously ignored satellite IDs by issuing an Include Satellite Command. This command also affects the satellite Alert-Planning settings. Satellites that have been removed by this command are not included in the produced Alert-Planning outputs. The user may notice a delay between issuing this command and the actual removal or inclusion of particular satellites.

Default value: All satellite IDs included.

VP ONCORE COMMAND REFERENCE

SATELLITE IGNORE LIST (@@Am)

Motorola Binary Format

Input Command

- *Send Current Satellite Ignore List:*

@@AmxxxxxC<CR><LF>

xxxxx - $ff00000000 (five bytes, hex ff00000000)
C - checksum
Message Length: 12 bytes

- *Change Satellite ignore List:*

@@AmkssssC<CR><LF>

k - 00 fixed binary constant
ssss - 32 bit binary field
Each bit represents one SVID
(MSB = SVID 32, LSB = SVID 1)
1 - Ignore
0 - Include

C - checksum
Message Length: 12 bytes

Response Message *•(to either command)*

@@AmksssC<CR><LF>

k - 00 fixed binary constant
ssss - 32 bit binary field
Each bit represents one SVID
(MSB = SVID 32, LSB = SVID 1)
1 - Ignore
0 - Include

C - checksum

Message Length: 12 bytes

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ALMANAC UPDATE OPTION (@@An)

The user has the flexibility of allowing or disallowing the GPS receiver to automatically update its internal almanac when a new one is downloaded from the GPS satellites. With the automatic almanac update enabled, the GPS receiver will continuously gather the satellite-transmitted almanac from any of the active channels and compare the new almanac to the old one stored in its nonvolatile memory. When a new almanac is received, the GPS receiver will store the new almanac to nonvolatile memory and begin the process again. With the No-Update almanac option enabled, the GPS receiver will not obtain a new almanac from the received satellite signal.

Default value: Automatic Update

VP ONCORE COMMAND REFERENCE

ALMANAC UPDATE OPTION (@@An)

Motorola Binary Format

Input Command

- *Query Current Almanac Update Mode:*

@@AnxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Almanac Update Mode:*

@@AnmC<CR><LF>

m – mode 1 – Update
0 – No Update
C - checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@AnmC<CR><LF>

m - mode 1 - Update
0- No Update
C - checksum
Message Length: 8 bytes

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DATUM SELECT (@@Ao)

The VP receiver has 49 predefined datums in its internal memory and two user definable datums. All datums are referenced by an ID number. The predefined datums are numbered 1 through 49 and the user-defined datums are numbered 50 and 51.

The user instructs the GPS receiver which datum to use by sending the Datum Select command. The command contains the ID number of the desired datum and the GPS receiver returns a response message, which gives the user the ability to validate that the input command was accepted. The user can instruct the GPS receiver to use one of the two user defined datums by sending the Datum Select command with the datum ID set to 50 or 51.

Datum IDs 50 and 51 are set at the factory to default to WGS-84 parameters, but may be changed by the user with the User Defined Datum (@@Ap) command.

Default Datum: WGS-84 (ID code 49)

VP ONCORE COMMAND REFERENCE

DATUM SELECT (@@Ao)

Motorola Binary Format

Input Command

- *Query Current Datum ID Number:*

@@AoxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Datum ID Number:*

@@AodC<CR><LF>

d - Datum ID 1 .. 51
C – checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@AodsssffiiffffxxyyzzC<CR><LF>

d - datum ID	1 .. 51
sssff - semi-major axis	
sss - integer part	6,000,000 … 7,000,000 (6,000,000.0 ... 7,000,000.0)
ff - fractional part	0 .. 999 (0.0 ... 0.999)
iiffff - inverse flattening	
ii - integer part	285 .. 305 (285.0 .. 305.0)
ffff - fractional part	0 .. 999,999,999 (0.0 .. 0.999999999)
xx - delta X	-32768 .. 32767 (3276.8 .. 3276.7)
0.1 meter resolution	
yy - delta Y	-32768 .. 32767 (-3276.8 .. 3276.7)
0.1 meter resolution	
zz - delta Z	-32768 .. 32767 (-3276.8 .. 3276.7)
0.1 meter resolution	
C - checksum	

Message Length: 25 bytes

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SET USER DEFINED DATUM (@@Ap)

The Motorola VP GPS receiver may have two user-defined datums stored in Datum ID numbers 50 and 51. The following commands allow the user to define the constants used for custom datums by supplying values for the semi-major axis; an inverse flattening constant; and delta-X, delta-Y, and delta-Z parameters.

Default : Datums 50 and 51are factory set to WGS-84 parameters.

SET USER DEFINED DATUM (@@Ap)

Motorola Binary Format

Input Command

- *Request Current User Defined Datum Parameters:*

@@ApdxxxxxxxxxxxxxxxxxC<CR><LF>

d - Desired User Datum 50 or 51
xxxxxxxxxxxxxxxxx (17 bytes, all hex 00)
C - checksum

Message Length: 25 bytes

- *Define User Defined Datum Parameters:*

@@ApdsssffiiffffxxyyZzC<CR><LF>

d - Datum ID	50 .. 51
sssff - semi-major axis	
sss - integer part	6,000,000 .. 7,000,000
(meters)	(6,000,000.0.. 7,000,000.0)
ff - fractional part	0 .. 999 (0.0 .. 0.999)
(meters)	
iiffff - inverse flattening	
ii - integer part	285 .. 305 (285.0.. 305.0)
ffff - fractional part	0 .. 999,999,999 (0.0 .. 0.999999999)
xx – delta-X	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)
yy – delta-Y	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)
zz –delta-Z	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)

C - checksum

Message Length: 25 bytes

Response Message on Following Page

VP ONCORE COMMAND REFERENCE

SET USER DEFINED DATUM (@@Ap)

Motorola Binary Format

Response Message

- *(to either command):*

@@ApdsssffliffffxxyyzzC<CR><LF>

d - Datum ID	50 .. 51
sssff - semi-major axis	
sss - integer part	6,000,000 .. 7,000,000
(meters)	(6,000,000.0.. 7,000,000.0)
ff - fractional part	0 .. 999 (0.0 .. 0.999)
(meters)	
iiffff - inverse flattening	
ii - integer part	285 .. 305 (285.0.. 305.0)
ffff - fractional part	0 .. 999,999,999
	(0.0 .. 0.999999999)
xx – delta-X	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)
yy – delta-Y	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)
zz –delta-Z	-32768 .. 32767
(0.1 meter resolution)	(-3276.8 .. 3276.7)

C - checksum

Message Length: 25 bytes

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IONOSPHERIC CORRECTION MODE (@@Aq)

The user has the flexibility of turning the GPS ionospheric correction models on or off. The models do a reasonable job of taking out the range error induced by the earth's ionosphere by using algorithms and parameters transmitted to the users by the satellites. For some applications, such as differential systems, the atmospheric models should be disabled since the differential corrections include the atmospheric errors.

Default mode: Enabled

IONOSPHERIC CORRECTION MODE (@@Aq)

Motorola Binary Format

Input Command

- *Request current Ionospheric Correction Mode:*

@@AqxC<CR><LF>

x - 1 out of range hex byte $ff
C - checksum
Message length: 8 bytes

- *Change current Ionospheric Correction Mode:*

@@AqsC<CR><LF>

s - selection 0 = disabled
1 = enabled
C - checksum
Message length: 8 bytes

Response Message

- *(to either command)*

@@AqsC<CR><LF>

s - selection 0 = disabled
1 = enabled
C - checksum
Message length: 8 bytes

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POSITION FIX ALGORITHM TYPE (@@Ar)

The VP receiver uses a least-squares position computation algorithm, and operates in one of two Position Fix modes as set by the user: Best-4 or N-in-View.

Best-4: When enabled, the GPS receiver uses the best four satellites out of N satellites that the GPS receiver can track for the computation of position, where N is the number of satellites that the receiver is currently tracking. The GPS receiver uses the best four satellites as defined by the xDOP selection. The GPS receiver can have other satellites on the remaining channels that the receiver will use in the case that one or more of the primary selected satellites is lost due to signal blockage.

N-in-View: When enabled, the GPS receiver will use all satellites that it is tracking for the position fix. The assignment of satellites to channels is optimized for the N-in-View condition.

Default value: N-in-View

VP ONCORE COMMAND REFERENCE

POSITION FIX ALGORITHM TYPE (@@Ar)

Motorola Binary Format

Input Command

- *Request Current Position Fix Algorithm Type:*

@@ArxC<CR><LF>

x - $ff (one byte, hex ff)
C - checksum
Message Length: 8 bytes

- *Change Position Fix Algorithm Type:*

@@ArsC<CR><LF>

s – selection — 0 - Best-4, 1 - N-in-View
C - checksum
Message Length: 8 bytes

Response Message

- *(to either command):*

@@ArsC<CR><LF>

s - selection — 0 - Best-4, 1 - N-in-View
C - checksum
Message Length: 8 bytes

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POSITION-HOLD POSITION (@@As)

Note: The input/output messages detailed here are available only if VP receiver Options ‘A’, ‘B’, or ‘I’ are installed.

The user can specify receiver coordinates for Position-Hold applications such as timing to increase the timing accuracy, and real-time differential master station applications. This command is used to enter the position to be held. Note that this command will only be executed if the Position Hold Option is currently in the disabled mode. The position to be held is specified in the same units as the initial position coordinates of latitude, longitude, and height (to the same resolution). The height parameter can be either referenced to the GPS reference ellipsoid or Mean Sea Level (MSL.)

The datum specifying the coordinate system for the fixed position coordinates must be the same as the coordinate system specified by the datum currently in use. Note that all three parameters must be specified. The valid ranges of each parameter are the same as those specified in the Latitude, Longitude, and Height commands.

Default values:	Latitude =	0º (Equator)
	Longitude =	0º (Greenwich Meridian)
	Height =	0 m (GPS)

POSITION-HOLD POSITION (@@As)

Motorola Binary

Input Command

- *Request current Position-Hold Position*

@@AsxxxxxxxxxxxxxC<CR><LF>

xxxxxxxxxxxxx - 13 out of range bytes $7fffffff7fffffff7fffffff
C - checksum
Message length: 20 bytes

- *Change current Position-Hold Position:*

@@AsllllooooohhhhtC<CR><LF>

llll - latitude in mas	-324,000,000 .. 324,000,000 (-90º.. 90º)
oooo - longitude in mas	-648,000,000 .. 648,000,000 (-180º .. 180º)
hhhh - height in cm	-100000 .. 1,800,000 (-1,000.00 18,000.00)
t - height type	0 = GPS ellipsoid height reference 1 = MSL reference

C – checksum
Message length: 20 bytes

Response Message

- *To either command:*

@@AsllllooooohhhhtC<CR><LF>

llll - latitude in mas	-324,000,000 .. 324,000,000 (-90º .. 90º)
oooo - longitude in mas	-648,000,000 .. 648,000,000 (-180º .. 180º)
hhhh - height in cm	-100000 .. 1,800,000 (-1,000.00 .. 18,000.00 a)
t - height type	0 = GPS ellipsoid height reference 1 = MSL reference

C - checksum
Message length: 20 bytes

NOTE: 1 degree equals 3,600 arcseconds or 3,600,000 milliarcseconds (mas)

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POSITION-HOLD MODE SELECT (@@At)

NOTE: The input/output messages described here available only if VP receiver options ‘A’, ‘B’, or ‘I’ are installed.

The Position-Hold Mode Select command enables/disables the position-hold function for timing and real time differential applications. The coordinates for the position-hold **must** be specified using the before the Position-Hold Mode is enabled using the @@As Position-Hold-Position command; the receiver will not use the current position fix coordinates.

NOTE: The receiver must be in position-hold mode for the Time RAIM algorithm (only available if Option ‘I’ is installed) to isolate and remove bad satellite measurements.

Default value: Disabled

POSITION-HOLD MODE SELECT (@@At)

Motorola Binary Format

Input Command

- *Request current Position-Hold mode:*

@@AtxC<CR><LF>

x - 1 out of range byte $ff
C - checksum
Message length: 8 bytes

- *Change current Position-Hold Mode:*

@@AtmC<CR><LF>

m - mode	0 = disabled 1 = enabled

C - checksum
Message length: 8 bytes

Response Message

- *(to either command)*

@@AtmC<CR><LF>

m - mode	0 = disabled 1 = enabled

C - checksum
Message length: 8 bytes

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ALTITUDE-HOLD HEIGHT (@@Au)

The user can specify the receiver height for manual altitude-hold applications. Use the Altitude-Hold Mode command to enable or disable the altitude-hold feature. The Altitude-Hold Height is specified in units of meters to a resolution of 0.01 meters. The user can reference the height parameter to the GPS reference ellipsoid or to Mean Sea Level. The datum specifying the coordinate system for the Altitude-Hold height must be the same as the coordinate system specified by the Datum ID currently in use by the receiver.

Default value: 0 meters

VP ONCORE COMMAND REFERENCE

ALTITUDE-HOLD HEIGHT (@@Au)

Motorola Binary Format

Input Command

- *Request current Altitude-Hold Height:*

@@AuxxxxxC<CR><LF>

xxxxx - 5 out of range bytes $ffffffffff
C - checksum
Message length: 12 bytes

- *Change current Altitude-Hold Height:*

@@AuhhhhtC<CR><LF>

hhhh - height in cm	-100,000 .. 1,800,800 (-1000.00 to +18,000.00 m)
t - height type	0 = GPS reference ellipsoid 1 = MSL height

C - checksum
Message Length: 12 bytes

Response Message

- *(to either command)*

@@AuhhhhtC<CR><LF>

hhhh - height in cm	-100,000 .. 1,800,800 (-1000.00 to +18,000.00 m)
t - height type	0 = GPS reference ellipsoid 1 = MSL height

C - checksum
Message Length: 12 bytes

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ALTITUDE-HOLD SELECT (@@Av)

The user can specify a height coordinate for altitude-hold applications. This command allows the user to manually enable or disable the altitude-hold feature. Remember, the GPS receiver automatically holds the altitude to the last known height when the xDOP is greater than the value entered with the 3D to 2D xDOP Threshold command (@@Al), or when the GPS receiver is tracking only three satellites.

Default value: Disabled

ALTITUDE-HOLD SELECT (@@Av)

Motorola Binary Format

Input Command

- *Request current Altitude-Hold Mode:*

@@AvxC<CR><LF>

x - 1 out of range byte $ff
C – checksum
Message length: 8 bytes

- *Change current Altitude-Hold Mode:*

@@AvmC<CR><LF>

m - mode	0 = disabled 1 = enabled

C - checksum
Message length: 8 bytes

Response Message

- *(to either command)*

@@AvmC<CR><LF>

m - mode	0 = disabled 1 = enabled

C - checksum
Message length: 8 bytes

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UTC/GPS TIME MODE SELECT (@@Aw)

This command selects the type of time (either GPS or UTC) to be output in the Position/Status/Data Message and to be used as the synchronization point for the 1PPS timing pulse for timing receivers. See Time RAIM Setup and Status Messages (@@Bn or @@En.)

Note that if the receiver does not have the UTC parameters portion of the almanac, then UTC will be output as being equal to GPS time. The receiver will have the UTC parameters once an almanac has been downloaded from the satellites.

Default Value: UTC

UTC/GPS TIME MODE SELECT (@@Aw)

Motorola Binary Format

Input Command

- *Request current Time Mode:*

@@AwxC<CR><LF>

x - 1 out of range hex byte ($ff)
C - checksum
Message length: 8 bytes

- *Change current Time Mode:*

@@AwmC<CR><LF>

m – mode 0 = GPS
1 = UTC
C - checksum
Message length: 8 bytes

Response Message

- *(to either command)*

@@AwmC<CR><LF>

m – mode 0 = GPS
1 = UTC
C - checksum
Message length: 8 bytes

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MEASUREMENT EPOCH OFFSET OPTION (@@Ax)

NOTE: The input/output messages described here are available only if VP receiver Option ‘A’ or ‘I’ is installed.

The VP receiver computes a position relative to a measurement epoch that occurs once per second. The receiver can place the measurement epoch on any of 1000 one-millisecond measurement sample points. This one-millisecond time reference clock is synchronous to the receiver's internal oscillator and is asynchronous to GPS/UTC system time. The user can move the measurement epoch with this command.

At power-up, the receiver selects a measurement epoch by simply choosing one of the 1000 clock cycles. This epoch is asynchronous to GPS/UTC time mark. When the GPS receiver acquires satellites, it will compute the local time of the asynchronous measurement epoch (one of the 1000 1 kHz clock cycles), and then skew receiver timing so as to place the measurement epoch within 0.001 seconds of the desired measurement epoch offset. The skew action inserts between 0.000 and 0.999 seconds between measurement epoch so as to move the epoch to the desired sample point. In addition, the GPS receiver automatically will insert or delete one millisecond when necessary to keep the measurement epoch on the selected time because of the receiver local oscillator drift.

As an example, consider the case where the user specifies 0.333 for the Measurement Epoch Offset. For this case, the receiver skews the receiver times so that the fractional part of local receiver time is 0.333 for the Measurement Epoch Offset. For this case, the receive skews the receiver timing so that the fractional part of the local receiver time is 0.333xxxx... The receiver position output will be relative to this new measurement epoch until this parameter is changed again.

The corrected time reference is relative to either GPS or UTC time, as specified and set by the user via the @@Aw command.

Range: 0.000 to 0.999 seconds
Default value: 0.000 seconds
Resolution: 0.001 second

MEASUREMENT EPOCH OFFSET OPTION (@@Ax)

Motorola Binary Format

Input Command

- *Send Current Measurement Epoch Offset:*

@@AxxxC<CR><LF>

xx - $ffff (two bytes, all hex ff)
C - checksum
Message Length: 9 bytes

- *Change Current Measurement Epoch Offset:*

@@AxttC<CR><LF>

tt - Time offset in milliseconds 0.. 999 (0.000 to 0.999 sec)
C - checksum
Message Length: 9 bytes

Response Message

- *(to either command):*

@@AxttC<CR><LF>

tt - Time offset in milliseconds 0.. 999 (0.000 to 0.999 sec)
C - checksum
Message Length: 9 bytes

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1PPS TIME OFFSET COMMAND (@@Ay)

NOTE: The input/output messages described here are available only if VP Options ‘A’ or ‘I’ are installed.

The VP computes position relative to a measurement epoch that occurs once per second. In addition, the receiver outputs a one pulse-per-second (1PPS) signal, the rising edge of which is placed on top of the GPS/UTC one-second tic mark epoch. The 1PPS Time offset command allows the user to offset the one pulse-per-second time mark in one nanosecond increments. The offset is relative to the Measurement Epoch offset. The corrected time reference is relative to either GPS or UTC time, as specified and set by the user with the @@Aw command.

The resolution of this parameter is one nanosecond. This does not imply that the accuracy of the 1PPS output signal is to this level. The absolute accuracy of the signal is a function of GPS time accuracy, and is subject to degradation due to U.S. Department of Defense policy.

Range:	0.000000000 to 0.999999999 seconds
Default Value:	0.000 seconds
Resolution:	1 nanosecond

1PPS TIME OFFSET COMMAND (@@Ay)

Motorola Binary Format

Input Command

- *Query Current 1PPS offset*

@@AyxxxxC<CR><LF>

xxxx - $ffffffff (four bytes, all hex ff)
C - checksum
Message Length: 11 bytes

- *Change Current 1PPS offset:*

@@AyttttC<CR><LF>

tttt -Time offset	0 .. 999999999
resolution = 1 nsec	(0.0 .. 0.999999999 sec)

C - checksum
Message Length: 11 bytes

Response Message

- *(to either command):*

@@AyttttC<CR><LF>

tttt - Time offset	0 .. 999999999
resolution = 1 nsec	(0.0 .. 0.999999999 sec)

C - checksum
Message Length: 11 bytes

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1PPS CABLE DELAY OPTION (@@Az)

NOTE: The input/output messages described here are available only if VP Options ‘A’ or ‘I’ are installed.

The GPS receiver outputs a 1PPS signal, the rising edge of which is placed on top of the GPS/ UTC one-second tic mark epoch. The 1PPS Cable Delay offset allows the user to offset the one-pulse-per-second time mark in one nanosecond increments relative to the Measurement Epoch. The Cable Delay allows the user to select between zero and one additional millisecond to compensate for the length of the antenna cable.

This parameter instructs the GPS receiver to output the 1PPS output pulse earlier in time to compensate for antenna cable delay. Up to one millisecond of equivalent cable delay can be removed. Zero cable delay is set for a zero-length antenna cable. The user should consult a cable data book for the delay per foot for the particular antenna cable used in order to compute the total cable delay needed for a particular installation.

The corrected time reference is relative to either GPS or UTC time, as specified and set by the user using the @@Aw command.

Range:	0.000 to 0.000999999 seconds
Default Value:	0.000 seconds
Resolution:	1 nanosecond

1PPS CABLE DELAY OPTION (@@Az)

Motorola Binary Format

Input Command

- *Query Current 1PPS offset*

@@AzxxxxC<CR><LF>

xxxx - $ffffffff (four bytes, all hex ff)
C - checksum
Message Length: 11 bytes

- *Change Current 1PPS offset:*

@@AzttttC<CR><LF>

tttt -Time offset	0 .. 999999
resolution = 1 nsec	(0.0 .. 0.000999999 sec)

C - checksum
Message Length: 11 bytes

Response Message

- *(to either command):*

@@AzttttC<CR><LF>

tttt - Time offset	0 .. 999999
resolution = 1 nsec	(0.0 .. 0.000999999 sec)

C - checksum
Message Length: 11 bytes

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6 CHANNEL POSITION/STATUS/DATA OUTPUT MESSAGE (@@Ba)

The input command sets the rate at which the 6-Channel Position/Status/Data Message is output by the VP receiver. The mode parameter (m) in the input message instructs the GPS receiver to either output this message one time (polled), or to output this message at the indicated update rate (continuously). Once the GPS receiver is set to continuous output, the continuous message flow can be stopped by sending a one-time output (poll) request. The GPS receiver will output the message one more time, then terminate any further message outputs. If the VP receiver has been placed in Idle Mode with the @@Cg command, it outputs the last known valid Position/Status/Data message once when polled.

The state of the mode bit is stored in nonvolatile memory. If the VP was continuously outputting the 6 Channel Position/Status/Data message when turned off, it will begin to output this message continuously (at the selected update rate) again when power is reapplied.

The 6 Channel Position/Status/Data output is explained in the response message section. Refer to the Date, Time of Day, Latitude, Longitude, and Height commands for more details on the formats of these parameters.

The number of satellites visible is computed using the current date, time, position, almanac, and a default mask angle of ten degrees. If no almanac is available, this number will be zero. This condition will not prevent satellites from being tracked.

In order for a satellite to be used for positioning, the satellite mode must reach eight, indicating that the ephemeris for that satellite has been acquired. Once the ephemeris is available, the satellite can be used for positioning in modes five through eight. Refer to the Response Message section for definition of channel tracking modes. The signal strength value is meaningless when the channel tracking mode is zero.

The VP Oncore GPS receiver has a “Position Propagate” mode that is used to extend coverage when satellite dropouts occur. When a 2D fix can no longer be computed, the last known velocity vector is used to propagate the position solution ahead for up to five seconds. This condition is indicated in the receiver status message byte.

NOTE: *United States export laws prohibit commercial GPS receivers from outputting valid data if the altitude is greater than 18,000 meters and the velocity is greater than 514 meters per second. If the GPS receiver is used above both these limits, the height and velocity outputs are clamped to the maximum values. In addition, the latitude and longitude data will be incorrect.*

VP ONCORE COMMAND REFERENCE

6 CHANNEL POSITION/STATUS/DATA OUTPUT MESSAGE (@@Ba)

Motorola Binary Format

Input Command

- *Set response message rate:*

@@BamC<CR><LF>

m – mode
- 0 - output response message once
- 1.. 255 - response message output at indicated rate (continuous)
  - 1 - once per second
  - 2 - once every two seconds
  - 255 - once every 255 seconds

C - checksum

Message Length: 8 bytes

Response Message

- *(to command)*

@@Bamdyyhmsffffaaaaooooohhhhmmmm
vvhhddtntimsdimsdimsdimsdimsdimsds
C<CR><LF>

Date

m – month	1 .. 12
d – day	1 .. 31
yy – year	1980 .. 2079

Time

h – hours	0 .. 23
m – minutes	0 .. 59
s – seconds	0 .. 60
ffff - fractional seconds	0 .. 999, 999,999 (0.0 to 0.999999999)

Position

aaaa - latitude in mas	-324,000,000 .. 324,000,000 (-90^o to 90^o)
oooo - longitude in mas	-648,000,000 .. +648,000,000 (-180^o to 180^o)
hhhh - height in cm (GPS ref ellipsoid)	-100,000 .. 1,800,000 (-1000.00 to 18000.00 m)
mmmm - height in cm MSL ref	-100,000 .. 1,800,000 (-1,000.00 to +18,000.00 m)

6 CHANNEL POSITION/STATUS/DATA OUTPUT MESSAGE (@@Ba) *continued*

Velocity	
vv - velocity in cm/s	0 .. 51400 (0 to 514.00 m/s)
hh – heading (true north - res 0.1°)	0 .. 3599 (0.0 to 359.9°)
Geometry	
dd - current DOP (0.1 res)	0 .. 999 (0.0 to 99.9 DOP) (0 - not computable, or Position-Hold, or Position Propagate)
t - DOP type	0 - PDOP (in 3D mode) 1 - HDOP (in 2D mode)

Satellite visibility and tracking status

n - num of visible sat	0 .. 12
t - num of sat tracked	0 .. 6

For each of six receiver channels

i – sat ID	0 .. 37
m - channel tracking mode	
0 - Code Search	5 - Message Sync Detect
1 - Code Acquire	6 - Satellite Time Available
2 - AGC Set	7 - Ephemeris Acquire
3 - Freq Acquire	8 - Avail for Position
4 - Bit Sync Detect	
s - Signal Strength	0 .. 255 (number proportional to SNR)

6 CHANNEL POSITION/STATUS/DATA OUTPUT MESSAGE (@@Ba) *continued*

d - Channel Status Flag

Each bit represents one of the following:

(msb)	Bit 7: Using for Position Fix
	Bit 6: Satellite Momentum Alert Flag Set
	Bit 5: Satellite Anti-Spoof Flag Set
	Bit 4: Satellite Reported Unhealthy
	Bit 3: Satellite Reported Inaccurate (>16 m)
	Bit 2: Spare
	Bit 1: Spare
(lsb)	Bit 0: Parity Error

(End of Channel Dependent Data)

s **-** Receiver Status Message

(msb)	Bit 7: Position Propagate mode
	Bit 6: Poor Geometry (DOP > 20)
	Bit 5: 3D fix
	Bit 4: Altitude Hold (2D fix)
	Bit 3: Acquiring Satellites/Position Hold
	Bit 2: Differential
	Bit 1: Insufficient visible satellites (< 3)
(lsb)	Bit 0: Bad Almanac

C - checksum

Message Length: 68 bytes

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SATELLITE VISIBILITY STATUS MESSAGE (@@Bb)

This command requests the results of the most current satellite alert computation. The response message gives a summary of the satellite visibility status showing the number of visible satellites, the Doppler frequency and the location (azimuth and elevation) of the currently visible satellites. The reference position for the most recent satellite alert is the current position coordinates. Note that these coordinates may not compare to the GPS receiver's actual position when initially turned on, since the GPS receiver may have moved a great distance since it was last used.

Default mode: Polled

NOTE: If more than 6 satellites are visible, this message is simply output several times by the receiver, with any unneeded fields filled with zeroes.

This same message is also used by newer 8 and 12 channel Motorola receivers such as the UT+, GT+, and M12. Again, if more than 6 satellites are visible, the message is simply output several times in order to convey the additional information.

VP ONCORE COMMAND REFERENCE

VISIBLE SATELLITE STATUS MESSAGE (@@Bb)

Motorola Binary Format

Input Command

- *Request current Satellite Visibility Status:*

@@BbmC<CR><LF>

m – mode — 0 = output response message once (polled)
1 = output response message when visibility data changes

C - checksum

Length: 8 bytes

Response Message

- *(to above command)*

@@Bbniddeaasiddeaasiddeaasiddeaas
iddeaasiddeaasiddeaasiddeaasiddeaas
iddeaasiddeaasiddeaasC<CR><LF>

n - number of visible sats	0 - 12
For each visible satellite, up to n fields contain the following valid data	
i - satellite ID	1 .. 32
dd - Doppler in Hz	-5000 .. 5000
e - elevation in degrees	0 .. 90
aa - azimuth in degrees	0 .. 359
s - satellite health	0 = healthy & not removed 1 = healthy & removed 2 = unhealthy & not removed 3 = unhealthy & removed

C - checksum

Message length: 92 bytes

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6 CHANNEL xDOP TABLE STATUS MESSAGE (@@Bc)

This command requests the xDOP parameters corresponding to combinations of currently visible satellites based on the latest satellite visibility calculation. The VP receiver will send up to nine combinations of satellites with the corresponding xDOP parameter. The DOP type is selected by the user using the xDOP Type Parameter message (@@Aj.)

The receiver will either compute xDOP of all combinations of satellites taken N-at-a-time, or for all satellites taken four at a time depending on which mode has been chosen by the user with the Position Fix Algorithm Type (@@Ar) command.

6 CHANNEL xDOP TABLE STATUS MESSAGE (@@Bc)

Motorola Binary Format

Input Command

- *Request xDOP Table Status:*

@@BcmC<CR><LF>

m – mode — 0 - output response message once (polled)
1 - output response message when data changes (continuous)

C - checksum

Message Length: 8 bytes

Response Message

- *(to command)*

@@Bctnmddssssssddssssssddssssss
ddssssssddssssssddssssssddssssss
ddssssssddssssssC<CR><LF>

t - xDOP Type	0 - GDOP 1 - PDOP 2 - HDOP 3 - VDOP 4 – TDOP
n - number of valid combinations	0 .. 9
m - Best-4 or N-in-View	4 or 6 or 8

For n valid combinations of satellites:

dd - xDOP	10 .. 999
resolution 0.1	(1.0 ..99.9)
ssssss - Sat Combo ID's	0 .. 32
C - checksum	

Message Length: 82 bytes

Note: The number of valid "s" fields is given by m.

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ALMANAC STATUS MESSAGE (@@Bd)

This command requests the almanac status information corresponding to the currently used satellite almanac data (in RAM), as well as the almanac data currently stored in receiver nonvolatile memory (EEPROM). The GPS receiver captures a new almanac to internal RAM first and uses this data immediately to compute satellite visibility information. The receiver also copies the RAM data to nonvolatile EEPROM using a slow background process. Consequently there is a delay between the receipt of a new almanac and copying the new one to EEPROM. The user is given status information on both almanac data sets.

VP ONCORE COMMAND REFERENCE

ALMANAC STATUS MESSAGE (@@Bd)

Motorola Binary Format

Input Command

- *Request Almanac Status:*

@@BdnC<CR><LF>

m - mode	0 - Output status once (polled) 1 - Output status when RAM almanac data changes (continuous)
C - checksum	

Message Length: 8 bytes

Response Message

- *(to command):*

@@BdvwtasssvwtasssC<CR><LF>

RAM Almanac Status –

v - Almanac valid flag	0 - no almanac in receiver 1 - valid almanac in receiver
w - almanac week number (raw)	0 .. 255 (ref ICD-GPS-200)
t - time of almanac (raw)	0 .. 147 (ref ICD-GPS-200)
a - number of avail sats	0 .. 32
ssss - sat IDs in almanac 32 bit binary field, each bit represents one SVID (msb = SVID 32; lsb = SVID 1)	0 - SV not available 1 - SV included

EEPROM Almanac Status -

v - Almanac valid flag	0 - no almanac in receiver 1 - valid almanac in receiver
w - almanac week number (raw)	0 .. 255 (ref ICD-GPS-200)
t - time of almanac (raw)	0 .. 147 (ref ICD-GPS-200)
a - number of avail sats	0 .. 32
ssss - sat IDs in almanac 32 bit binary field, each bit represents one SVID (msb = SVID 32; lsb = SVID 1)	0 - SV not available 1 - SV included
C – checksum	

Message Length: 23 bytes

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ALMANAC DATA OUTPUT MESSAGE (@@Be)

This parameter determines the rate the almanac data is output. The user has the option of requesting the almanac data output one time (polled), or each time the almanac data changes (continuously). The almanac data output parameter set is stored in nonvolatile memory

Almanac data for the GPS satellites is transmitted in words 3 through 10 of sub-frame 5 (pages 1 through 25), and words 3 through 10 of subframe 4 (pages 2 through 5, 7 through 10, and 25) of the satellite broadcast data message. The user is directed to the ICD-GPS-200 for specifics on the format of the almanac data.

The GPS receiver outputs the almanac data through a series of output messages, each of which is identified by the particular subframe and page. The data fields of each individual message correspond to words 3 through 10 of the broadcast data. Each word contains 24 data bits.

The entire almanac data output consists of 34 output response messages corresponding to the 25 pages of sub frame 5 and the 9 pages in subframe 4 that contain almanac data (pages 2 through 5, 7 through 10, and 25). The total message output for one output request is 1122 bytes including the @@Be prefix and the checksum I carriage return I Tine feed for each output. The output message begins with sub-frame 5 page 1.

The GPS receiver will output about 750 bytes of message data for each one second output opportunity If selected, the almanac response message is output until the total number of bytes sent on a 1-second epoch exceeds 750. The remainder of the almanac message is sent on the next 1-second epoch (up to the 750 byte limit per second) until all of the almanac data is output.

If the user issues this command and the GPS receiver does not contain an almanac, then the GPS receiver returns one response message with the subframe and page bytes equal to zero.

VP ONCORE COMMAND REFERENCE

ALMANAC DATA OUTPUT MESSAGE (@@Be)

Motorola Binary Format

Input Command

- *Set Almanac Data Output Rate:*

@@BemC<CR><LF>

m – mode	0 - output response message once (polled) 1 - output response message when almanac data changes (continuous)
C - checksum	

Message Length: 8 bytes

Response Message

- *(to command)*

@@Cbspxxxxx ... xxxxc<CR><LF>

sp – subframe/page Number	sf 5 / pgs 1 - 25 or sf 4 / pgs2-5, 7 - 10, 25
xxx... xxx	Words 3 - 10, each word is 3 bytes long (format per ICD-GPS-200)
C - checksum	

Message Length: 33 bytes

Note: If no almanac is present in GPS receiver, then the receiver returns one output response message with the "sp" field set to 0, and all other bytes in the field set to 0.

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INPUT EPHEMERIS DATA (@@Bf)

This command will cause the receiver to accept satellite ephemeris data input via the serial port. The receiver keeps the ephemerides decoded from all satellites in memory as long as backup voltage is applied to the receiver, and the ephemerides are still valid (t-toe < 4 hours). However, the ephemeris data that the user inputs via the serial port is only remembered until the next time the receiver power is cycled, or until it is replaced as a normal part of decoding new ephemeris data from a satellite. This is true even though backup power may have been applied during the receiver off period. The @@AA command can be used to prevent the receiver from replacing the user input ephemeris with new data decoded from the satellites.

The input format is identical to the format output by the receiver for the output ephemeris command to allow the same ephemeris output file to be used by the receiver for an ephemeris input file. The receiver echoes the input ephemeris data format message so the user can validate the ephemeris data with the new user supplied ephemeris upon completion of the receipt of a valid ephemeris.

INPUT EPHEMERIS DATA (@@Bf)

Motorola Binary Format

Input Command

- *Input satellite ephemeris data:*

@@Bfixxx...xxxC<CR><LF>

i - sat ID	1 .. 37
xxx... xxx ephemeris	sf 1 - 3/words 3 - 10 (72 bytes per sat; format per ICD-GPS-200)
C - checksum	

Message Length: 80 bytes

Response Message

- *(to command)*

@@Ccixxx...xxxC<CR><LF>

i - Sat ID	1 .. 37
xxx... xxx ephemeris	sf 1 - 3/words 3 - 10 (72 bytes per sat; format per ICD-GPS-200)
C - checksum	

Message Length: 80 bytes

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6 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Bg)

NOTE: The input/output messages described here are available only if GPS receiver Option C is installed.

This parameter determines the rate that basic satellite range and range-rate information for each of the satellites that the VP receiver is tracking is output. The user has the option of requesting the satellite range data status one time, (polled) or continuously at a user specified update rate. The selected rate is stored in the VP receiver's non-volatile memory. If the receiver was continuously outputting the satellite range data output when turned off, it will begin to output this message continuously (at the selected update rate) again when power is reapplied.

If the VP receiver is in Idle mode (see @@Cg command), the output rate parameter selection does not exist, and the GPS receiver outputs the last known valid Range Data Output information once when polled.

Two bits in each of the channel tracking mode words of the response message are used to denote whether or not the channel has lost phase lock or frequency lock since the last output of this message. This information is helpful for users who perform post-processing and it eliminates the need to output this message at a one-second rate.

The channel tracking mode in this response message is not necessarily the same as the channel tracking mode in the Position/Status/Data Output Messages (@@Ba and/or @@Ea). When the receiver is not using the channel as part of the position fix solution, the GPS satellite time (Integrated Carrier Phase Filtered) will be zero, and the channel tracking mode will report mode 4 or lower. When the receiver is using the channel as part of the position fix solution (modes 5 through 8, after reaching mode 8 once), the GPS satellite time (Integrated Carrier Phase Filtered) will be valid, and the channel tracking mode will be the same as the channel tracking mode in the Position/Status/Data Output Messages.

6 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Bg)

Motorola Binary Format

Input Command

- *Set response message rate:*

@@BgmC<CR><LF>

m – mode
- 0 - output response message once (polled)
- 1.. 255 - response message output at indicated rate (continuous)
  - 1 - once per second
  - 2 - once every two seconds
  - 255 - once every 255 seconds

C - checksum

Message Length: 8 bytes

Response Message

- *(to command)*

@@Bgtttffffimsssffffccffrrrdd
imsssffffccffrrddimsssffffccffrrrdd
imsssffffccffrrrddimsssffffccffrrrdd
imsssffffccffrrrddC<CR><LF>

ttt - GPS local time in seconds	0 .. 604799
ffff - GPS local fractional time in ns	0 .. 0.999999999
resolution - 1 ns	(0 .. 0.999999999)

6 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Bg) *continued*

For each of six channels:

i - satellite ID	0.. 32 0 = channel not used 1 = 32 satellite ID

m - channel tracking mode where bits 0 - 3 are decoded as
- 0 - code search
- 1 - code acquire
- 2 - AGC set
- 3 - frequency acquire
- 4 - bit sync detect
- 5 - message sync detect
- 6 - sat time available
- 7 - ephemeris acquire
- 8 - avail for position

where bit 6 is decoded as:
- 0 - frequency locked since last range message
- 1 - not frequency locked since last range message

and where bit 7 (MSB) is decoded as
- 0 - phase locked since last range message
- 1 - not phase locked since last range message

sssfiff - GPS satellite time (Integrated Carrier Phase Filtered)

sss - integer part (resolution - 1 sec)	0 .. 604799
ffff - fractional part (resolution - 1 nsec)	0 .. 999,999,999 (0 .. 0.999999999)

ccff - integrated carrier phase

cc - integer part 16 MS bits of carrier phase (above decimal point)	0 .. 65535 (cycles)
ff - fractional part 16 bits of carrier NCO below decimal point at measurement epoch	0 .. 65535 (0 .. 359.9945 degrees)
rrr - raw code phase (carrier cycles)	0 .. 1575420
dd - code discriminator output at measurement epoch LSB = (2^{-12}) * SOL * 0.001/28644 meters	-32,768 .. 32767
C - checksum	

Message Length: 122 bytes

6 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Bg) *continued*

In the discussions that follow, the subscript ($_k$) refers to the current measurement data, and the subscript ($_{k-1}$) refers to the previous (1 second old) data. The user can convert the above message into pseudorange and pseudorange rate for each satellite by using the following formulas:

Conversion Formulas

Pseudorange (in meters) = (GPS local time - GPS satellite time) * SOL
Note: Not corrected for possible End-Of-Week Rollovers.

Pseudorange Rate (in meters per second) = K2 * (ICP_k – ICP_{k-1})

ICP is the integer and fractional part of ICP treated as a 32 bit unsigned quantity Use 32 bit unsigned integer subtraction to avoid rollovers.

Absolute Carrier Phase at measurement epoch in degrees = K4 * ICP_f

The GPS satellite time used in the first equations for the computation of pseudorange is the same value that the Oncore uses internally. This satellite time value combines code and carrier information and has been pre-smoothed using carrier aided filtering with a very narrow-band (0.005 Hz) low-pass filter algorithm. The user has access to the unfiltered raw code phase via the following:

Raw Code Phase (in meters) = K1 * RCP - K2 * ICP_f + K3 * K5 * CD
where:
RCP is the raw code phase from the message
ICP_f is the fractional part of the integrated carrier phase
CD is the code discriminator output from the message
K5 is a variable code discriminator calibration constant

Code discriminator calibration constant: When tracking satellites, the receiver causes the raw code phase to move back and forth once per second in discrete steps of 1 code phase quantum. One code phase quantum is equal to 55 carrier cycles, or about 10.4662 meters. This intentional dither allows the receiver to calibrate the output of the code discriminator.

6 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Bg) *continued*

The user can accurately calibrate the code discriminator output by using the fact that the long term average difference between subsequent code discriminator measurements will be equal to 1 quantum. K5, the calibration constant, varies slowly over time as a function of received signal to noise ratio and multipath. Typical values of K5 are between 0.5 and 1.5. A simple low-pass filter can be used to generate K5 as follows:

diff = K3 * abs (CD_k – CD_{k-1})
CD_{k-1} = CD_k
LPF = LPF + beta * (diff - LPF) (initialize LPF = 10.4662 meters)
K5 = 10.4662 / LPF

The constant "beta" establishes the filter time constant. Typical values of beta are 0.001 (maximum filtering) to 0.5 (minimum filtering). The Oncore uses a constant of 0.05 internally.

OTHER FIXED CONSTANTS:

L1FO = 1,575,420,000.0 Hz (L1 carrier frequency)
SOL = 299,792,458.0 m/s (GPS value for the speed of light)
K1 = SOL / L1FO
K2 = K1 / 65536
K3 - (2^{-11}) * SOL * 0.001 / 28644
K4 = 360 / 65536

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PSEUDORANGE CORRECTION OUTPUT MESSAGE (@@Bh)

This parameter sets the rate at which pseudorange corrections are output from the Motorola VP GPS receiver using the binary @@Ce message format.

The pseudorange correction response message allows the VP to be used as a master site receiver in a real-time differential system. The message is structured to return pseudorange and pseudorange rate corrections for up to six receiver channels, and identifies the satellite ID that corresponds to each channel. To use this output properly, the receiver must have the **Position-Hold** option enabled *(see @@At command)* with the current GPS receiver position coordinates entered using the **Position-Hold-Position** command *(see @@As command.)* The assignment of satellites to channels is accomplished during normal receiver operation (or may done manually.)

Helpful Note: although the @@Ce message is only formatted to generate corrections for up to six tracked satellites, the same message structure is also generated by 8 Channel VP receivers. If an 8 channel receiver is tracking and developing corrections for more than 6 satellites, the @@Ce message is simply issued twice in succession, with any unneeded data fields filled with zeroes.

PSEUDORANGE CORRECTION OUTPUT MESSAGE (@@Bh)

Motorola Binary Format

Input Command

- *Set response rate:*

@@BhmC<CR><LF>

m – mode	0 - output response message once (polled) 1 .. 255 - response message output at indicated rate (continuous) 1 - once per second 2 - once every two seconds 255 - once every 255 seconds
C - checksum	

Message Length: 8 bytes

Response Message

- *(to command):*

@@Cetttippprrdippprrdippprrdippprrdippprrd ippprrdC<CR><LF>

ttt - GPS time ref	0 .. 6047999 (0.0 .. 604799.9)

For each of six channels:

i - Satellite ID	0 .. 32 0 = not used 1 - 32 = Sat ID
ppp - pseudorange correction	-1,048,576 ..+1,048,576
0.01 meter resolution	(-10,485.76 .. +10,485.76)
rr - pseudorange rate correction	-4096 .. +4096
0.001 m/s resolution	(-4.096 .. +4.096)
d - issue of data ephemeris	
C - checksum	

Message length: 52 bytes

Note: This is one of the few Motorola binary commands in which the Input Command header (@@Bh) is different from the Response Message header (@@Ce.)

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EPHEMERIS DATA OUTPUT MESSAGE (@@Bi)

This parameter determines the rate that satellite ephemeris data is output. The user has the option of requesting the ephemeris data output one time (polled), or each time the satellite ephemeris data changes (continuously). The commanded satellite ephemeris data output rate is stored in RAM and is retained between power cycles if backup battery power is applied.

Ephemeris data for each of the GPS satellites is contained in subframes 1, 2, and 3, words 3 through 10. Each satellite transmits the ephemeris data for itself only. The user is directed to the ICD-GPS-200 for specifics on the format of the ephemeris data.

When polled, the VP outputs a complete Ephemeris Data Output Message for each of the satellites that the receiver is currently using for position fix. When continuous output is requested, the VP outputs the current ephemerides once for all satellites currently tracked, then outputs individual channel ephemerides again any time the ephemerides on that channel change.

The GPS receiver outputs the ephemeris data through a series of output messages, each of which corresponds to a particular satellite. The data fields of each message correspond to words 3 through 10 of subframes 1 through 3 as defined in ICD-GPS-200. Each word contains 24 data bits.

The GPS receiver will output about 750 bytes of message data for each one-second output opportunity. If selected, the ephemeris response message is output for each satellite that is currently tracked until the total number of bytes sent during a one-second epoch exceeds 750. The remainder of the ephemeris message is sent during the next one-second epoch (up to the 750 byte limit per second) until all of the ephemeris data for all satellites is output.

VP ONCORE COMMAND REFERENCE

EPHEMERIS DATA OUTPUT MESSAGE (@@Bi)

Motorola Binary Format

Input Command

- *Set Response Message Rate:*

@@BimC<CR><LF>

m – mode	0 - output response message once (polled) 1 - output response message when ephemeris data changes (continuous)
C - checksum	

Message Length: 8 bytes

Response Message

- *(to command):*

@@Bfixxxxx ... xxxxC<CR><LF>

i - Sat ID	1.. 37
xxx ... xxx - Ephemeris	sf 1 -3/words 3 - 10 (72 bytes per sat; format per ICD-GPS-200)
C - checksum	

Message Length: 80 bytes

Note: The GPS receiver returns one output response message for each of the currently tracked satellites. For example, if the GPS receiver is currently tracking five satellites, five output response messages will be sent by the receiver, one for each satellite.

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LEAP SECOND PENDING STATUS (@@Bj)

This command causes the receiver to send a message to the user indicating the status of any pending leap second corrections to UTC. If a leap second is pending, its direction is also indicated. This is a polled-only output message.

Leap seconds are occasionally inserted in UTC and generally occur on midnight UTC June 30 or midnight UTC December 3 1. The GPS Control Segment notifies GPS users of pending leap second insertions before the event via a special broadcast message in the satellite downlink message. The receiver decodes this data and then inserts the time correction in the appropriate one second time bin.

When a leap second is inserted, the Time of Day will show a value of 60 in the seconds field. When a leap second is removed, the date will roll over at 58 seconds. See Time of Day @@Aa command.

NOTE: Although the GPS Control Segment historically has issued Leap Second Pending messages within a month of the time of the actual Leap Second event, the message can (and has) been issued as much as six months ahead of the actual insertion.

LEAP SECOND PENDING STATUS (@@Bj)

Motorola Binary Format

Input Command

- *Request current Leap Second Status:*

@@BjmC<CR><LF>

m - mode 0 = output response message once (polled)
C - checksum
Message length: 8 bytes

Response Message

- *To above command:*

@@BjmC<CR><LF>

m - status 0 = no leap second pending
1 = addition of one second pending
2 = subtraction of one second pending
C - checksum
Message length: 8 bytes

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6 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Bk)

This message contains information that can be considered an extension of the data output in the @@Ba 6 Channel Position/Status/Data message. Some users may have applications requiring use of this data at the same rate as the 6 Channel Position/Status/Data message while other users may only need portions of this data at a much slower rate (e.g., magnetic variation).

Magnetic variation can be used to correct the true north heading (see Position/Status/Data Message) to magnetic north. The correction is computed using an algorithm developed by the U.S. Naval Oceanographic Office. It is based on the WMM-95 (World Magnetic Model 1995) magnetic field model which was generated from actual field measurements and was valid until January 1, 2000. Another table will be available from the U.S. Defense Mapping Agency (DMA) at that time. The algorithm primarily characterizes that portion of the Earth's magnetic field which is generated by the Earth's conducting fluid outer core. Portions of the geomagnetic field generated by the Earth's crust, mantle, ionosphere, and magnetosphere are for the most part not represented in these models. Consequently, a magnetic sensor such as a compass or magnetometer may observe spatial and temporal magnetic anomalies when referenced to the appropriate World Magnetic Model. In particular, certain local, regional, and temporal magnetic declination anomalies can exceed 10 degrees. Anomalies of this magnitude are not common, but they do exist. Declination anomalies on the order of 2 or 3 degrees are not uncommon, but are of small spatial extent and relatively isolated. From a global perspective, the root-mean-square (RMS) error at sea level of the World Magnetic Model are estimated to be less than 1.0 degrees over the entire 5-year life of the model.

VP ONCORE COMMAND REFERENCE

6 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Bk)

Motorola Binary Format

Input Command

- *Request extension message:*

@@BkmC<CR><LF>

m - mode
- 0 - output response message once (polled)
- 1 .. 255 - output response message at indicated rate (continuous)
- 1 - once per second
- 2 - once every two seconds
- 255 - once every 255 seconds

C - checksum

Message Length: 8 bytes

Response Message

- *(to command):*

@@Bkggpphhvvttmmnneeuuaaxxxxyyyyzzzz
rrrrrriiiiiiiiiiiiiiiiiiccooC<CR><LF>

Note: DOP values are NOT valid if in Position Hold mode.

Current GDOP

gg - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current PDOP

pp - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current HDOP

hh - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 2D or 3D Fix mode)

Current VDOP

vv - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current TDOP

tt – 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if tracking at least one satellite

6 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Bk) *continued*

Magnetic Variation

mm -	-1800 to +1800 (-180.0^{o} to +180.0^{o}) resolution = 0.1 positive angles are east negative angles are west

Velocity in north, east, up coordinate system

nn -	north - 32767 to 32767 (m/s) resolution = 0.1
ee -	east - 32767 to 32767 (m/s) resolution = 0.1
uu -	up - 32767 to 32767 (m/s) resolution = 0.1

Response Message Continued on Following Page

6 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Bk)

Age of differential correction data (for slave receiver)
- aa - 0 to 65535 (resolution 0.1s)

Receiver position in ECEF coordinate system (X, Y, Z)
- xxxx - resolution = 0.01 meters
- yyyy - resolution = 0.01 meters
- zzzz - resolution = 0.01 meters

URA for each of six receiver channels (6 elements)
- r- as decoded from the GPS satellite message (0-15 is valid URA, 63 if not decoded yet) see NAVSTAR GPS-ICD-200, Section 20.3.3.3.1.3

Least Squares A-1 Symmetrical Matrix element (10 elements)
- ii - A-1 Matrix element where:
  - element #1 is A-1[0][0]
  - element #2 is A-1[0][1]
  - element #3 is A-1[0][2]
  - element #4 is A-1[0][3]
  - element #5 is A-1[1][1]
  - element #6 is A-1[1][2]
  - element #7 is A-1[1][3]
  - element #8 is A-1[2][2]
  - element #9 is A-1[2][3]
  - element #10 is A-1[3][3]
  - resolution = 0.1 (unitless)

Receiver clock bias
- cc - 32767 to +32767 (in meters)
  resolution = 0.1

Receiver oscillator offset
- oo - 0 to 65535 (in m/s)
  resolution = 0.1

C – checksum

Message Length: 69 bytes

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SATELLITE BROADCAST DATA MESSAGE (@@BI)

The Global Positioning System satellites each broadcast a 50 bits per second (BPS) data message called the Navigation data. The structure of each satellite data message consists of 1500 bits (transmission time is 30 seconds) distributed across 5 sub-frames (6 seconds each). Each subframe is further subdivided into ten 30 bit words, where each word consists of 24 bits of data and 6 bits of parity. Subframes 4 and 5 are commutated over 25 pages spread over 12.5 minutes.

The data transmitted by the satellites consists of satellite Keplerian orbital elements (ephemerides), almanac data, telemetry word, hand-over word, ionospheric correction data, satellite health data, UTC time correction data, special message fields, etc. More information on the content of the message is provided in the Navstar GPS Space Segment/Navigation User Interface Control Document ICD-GPS-200.

Only the 24 data bits of each word are output by the receiver. The 6 parity bits from each word are not output but are used to verify the contents of the data field internal to the receiver. The receiver collects each subframe (6 seconds of data) and then outputs the data on the serial port after successful receipt of all 10 words of a particular subframe for each satellite tracked.

No format conversion is applied to the data; it is output in its raw binary form for subsequent processing outside the receiver.

If the user selects the satellite broadcast data in the continuous output mode, the receiver outputs a single satellite broadcast data message record for all channels for the current subframe after word ten of that subframe has been collected. Consequently, in continuous mode, the receiver outputs one message per satellite approximately every six seconds (the subframe transmission rate). Data being output for any channel will output data for all channels (active or inactive).

If the user selects satellite broadcast data in the polled output mode, the receiver outputs a single satellite broadcast data record for all satellites tracked for the current subframe after word ten of that subframe has been collected. No other data is output after that time unless the user selects the data to be output again in the polled or continuous modes.

For either case, the GPS receiver outputs the broadcast data through a series of output messages, each of which is identified by the particular channel, satellite ID (PRN number), subframe, and when appropriate, the page number (subframes 4 and 5 only.

The entire broadcast data output message consists of N output response messages corresponding to the N receiver channels.

If the user requests the satellite broadcast data message and the receiver does not properly receive the next subframe of data, only the valid words will be output with the remaining fields set to zero.

SATELLITE BROADCAST DATA MESSAGE (@@BI)

Motorola Binary Format

Input Command

- *Request Broadcast message:*

@@BImC<CR><LF>

(Note: The second character is a lower case "L" not the number "1")

m – mode	0 - Output Next Subframe Data when collected (polled) 1 - Output Next and Subsequent data Messages (continuous)
C - checksum	

Message Length: 8 bytes

Response Message

- *(to command)*

@@BIcispxxxxx... xxxxxxC<CR><LF>

c - channel number	1 .. 8
i - Satellite ID	0 .. 32 0 = channel not used 1-32 = sat ID
s - Subframe number/ valid words	
where bits 0-2 (i.e. the LS nibble) are decoded as:	0 = no subframe 1-5 = subframe
where bits 4-7 (i.e. the MS nibble) are decoded as:	0-10 = number of contiguous, valid words starting at word 1
p - Page number	0 .. 25 0 = no page number 1-25 = page number
xxx....xxx -	Data Words 1 - 10, each word is 3 bytes long (Format per ICD-GPS-200)
C - checksum	

Message Length: 41 bytes

See Note on following page

SATELLITE BROADCAST DATA MESSAGE (@@BI)

Note: If a particular channel of the receiver is not assigned to a satellite, then the satellite PRN ID field (i) will be set to zero. If the receiver cannot decode any single word of a particular subframe, then the subframe number, page number, and data word fields will all be set to zero for that particular subframe. Since the data words represent the stream of contiguous data starting at word one, the VALID_WORDS field represents the number of valid words of data starting with one through the word number indicated by the VALID_WORDS parameter. The last (10 - VALID WORDS) three-byte-words will be zero.

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6 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@Bn)

NOTE: The input/output messages described here are available only if VP receiver option 'I' is installed.

The Motorola VP receiver uses the Time RAIM algorithm to exploit redundancy in the GPS time solution in order to detect and isolate faulty satellites. The Time RAIM Setup and Status Message allows the user to change the update rate, the configuration for the 1PPS output, and the Time RAIM alarm limit.

The rate parameter instructs the GPS receiver to either output this message one-time (polled), or to output this message at the indicated update rate (continuously). If the message rate is the same as the 1PPS rate, then the message and the 1PPS pulse are synchronized. Once the GPS receiver is set to continuous output, the continuous message flow can be stopped by sending a one-time output request. The GPS receiver will output the message one more time, then terminate any further message outputs. The state of the rate parameter is stored in nonvolatile memory If the GPS receiver was continuously outputting the message when turned off, it will begin to output this message continuously (at the selected rate) again when power is reapplied. If the VP has its Idle Mode option enabled, the rate parameter selection is unavailable, and the GPS receiver outputs the last valid message once when polled.

The state of the rate byte is stored in RAM. If the GPS receiver was continuously outputting the message when turned off and backup power is applied, then it will begin to output this message continuously (at the selected update rate) again when the main power is reapplied. If backup power is not applied during power down, then the GPS receiver will start up with a default rate of zero. The other Time RAIM control parameters are also stored in RAM, so they will be reset to their default values if backup power is not applied during power down.

The pulse generation can be controlled with the 1PPS control mode byte. The pulse can be on all the time, off all the time, on only when the receiver is tracking at least one satellite, or on only when the time solution is within the alarm threshold. The number of satellites appearing in the table below are the minimum which must be tracked to ensure the detection, isolation, and removal of faulty satellites. The probability of detection and isolation of a faulty satellite is greater.

6 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@Bn) *continued*

than 99.99%, which corresponds to less than one missed detection per every 10,000 failures. Given the infrequency of GPS satellite failures, this makes a missed detection virtually impossible. The probability of a false alarm is less than 2.e-4%, which corresponds to less than one false alarm every 5.7 days. Given that lock is maintained on eight satellites, the time alarm can be set as low as 300 ns without compromising performance.

Time Alarm (ns)	SVs needed to detect	SVs needed to isolate
T > 1000	2	3
1000 > T > 700	3	3
700 > T > 500	4	4
500 > T > 300	4	8
300 > T > 250	8*	8*

* The minimum time required false alarm rate of 2.e-4% cannot be achieved for this time alarm range.

The 6 Channel Time RAIM Setup and Status Message outputs the status of the Time RAIM solution when the algorithm is on. This message also outputs several values relating to the Time RAIM solution.

The receiver can make an estimate of the overall accuracy of the time solution. The one-sigma accuracy estimate is computed using the residuals of the least-squares time solution. This number is a measure of the spread of the observations, not an estimate of the absolute time accuracy.

The underlying noise due to the granularity of the clock generating the 1PPS signal is deterministic on every pulse. The receiver computes and outputs the negative sawtooth residual so that the user can compensate for the error and remove granularity.

Finally, the time solution of each individual satellite is output.

Default values:
Time RAIM algorithm: Off
Time RAIM alarm limit: 1000 ns
1PPS control mode: setting 1

6 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@Bn) *continued*

Motorola Binary Format

Input Command

- *Send current Time RAIM Setup and Status:*

@@BnxxxxxxxxxxxxxxxxC<CR><LF>

x - 15 out of range bytes $ff ff ff ff ...
C - checksum
Message length: 22 bytes

- *Change current Time RAIM Setup:*

@@BnotaapxxxxxxxC<CR><LF>

o - output message rate	0 .. 255 0 = output response message once (polled) 1 .. 255 = response message output at indicated rate (continuous) 1 = once per second 2 = once every two seconds 255 = once every 255 seconds
t - Time RAIM algorithm on/off	0 = off 1 = on
aa - Time RAIM alarm limit in 100s of nanoseconds	3 .. 65535
p - 1PPS control mode	0 = 1PPS pulse off all the time 1 = 1PPS on all the time 2 = pulse active only when tracking at least one satellite 3 = pulse active only when Time RAIM algorithm confirms time solution error is within the user defined alarm limit
nnn - not used	0
mdyylms - not used	0
C - checksum	

Message length: 22 bytes

VP ONCORE COMMAND REFERENCE

6 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@Bn) *continued*

Response Message

- *(to either command):*

@@Bnotaapnnnmdyyhmspysreensfffffffff
sfffffffffffffffC<CR><LF>

o - output message rate	0.. 255
t - Time RAIM algorithm on/off	0 = off 1 = on
aa - Time RAIM alarm limit in 100s of nanoseconds	3 .. 65535
p - 1PPS control mode	0 = 1PPS pulse is off all the time 1 = 1PPS on all the time 2 = pulse active only when tracking at least one satellite 3 = pulse active only when Time RAIM algorithm confirms time solution error is within the user defined alarm limit
nnn - 1PPS output rate	0 .. 86400
mdyyhms - time to next fire	
m - months	0 .. 12
d - days	0 .. 31
yy - years	1980.. 2079
h - hours	0 .. 23
m - minutes	0 .. 59
s - seconds	0 .. 60
p - pulse status	0 = off 1 = on
y - 1PPS pulse sync	0 = pulse referenced to UTC 1 = pulse referenced to GPS time
s - Time RAIM solution status	0 = OK: solution within alarm limits 1 = ALARM: user specified limit exceeded 2 = UNKNOWN: due to... a) alarm threshold set too low b) Time RAIM turned off c) insufficient satellites being tracked

6 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@Bn) *continued*

r - Time RAIM status	0 = detection and isolation possible 1 = detection only possible 2 = neither possible
ee - time solution one sigma accuracy estimate in nanoseconds	0 .. 65535
n - negative sawtooth time error of next 1PPS pulse in nanoseconds	-128 .. 127

For each of six receiver channels

s - satellite ID	0 .. 37
ffff - fractional GPS local time estimate of satellite in nanoseconds	0 .. 999999999
C - checksum	

Message length: 59 bytes

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6 CHANNEL SELF-TEST (@@Ca)

The VP GPS receiver user has the ability to perform an extensive self-test. The tests that are accomplished during the commanded self-test are as follows:

- ROM Checksum
- RAM
- EEPROM
- Correlator IC
- SPI port communications with DCXO
- SPI port communications with RTC and Time increment
- SCI communication is verified operational if the RS-232 port is active

The output of the self-test command is a 16-bit field, where each bit of the field represents the go/no-go condition of the particular item tested.

When the self-test is initiated the VP automatically goes into Idle mode. The self-test may take up to ten seconds to execute. Once the self-test is complete, the VP remains in Idle mode until commanded back into Fix mode by the user. The date, time, position, almanac, and ephemeris information is all retained.

Note: The 6 Channel Self Test was a late addition to the firmware package. Receivers with firmware earlier than v8.4 will not respond to the @@Ca command.

6 CHANNEL SELF-TEST (@@Ca)

Motorola Binary Format

Input Command

- *Initiate 6 Channel Self-Test:*

@@CaC<CR><LF>

C - checksum

Message length: 7 bytes

Response Message

- *(To command)*

@@CaxxC<CR><LF>

xx - self test result

Two bytes as detailed below. Each bit of the self-test field is either zero (pass) or one (fail) and represents the results of the following tests:

Bit 15: (msb)	Spare
Bit 14:	Spare
Bit 13:	RTC Comm & Time
Bit 12:	DCXO SPI Comm
Bit 11:	EEPROM
Bit 10:	RAM MSByte
Bit 9:	ROM LSByte
Bit 8:	RAM MSByte Checksum
Bit 7:	ROM MSByte Checksum
Bit 6:	1 KHz Presence
Bit 5:	channel 6 correlation test
Bit 4:	channel 5 correlation test
Bit 3:	channel 4 correlation test
Bit 2:	channel 3 correlation test
Bit 1:	channel 2 correlation test
Bit 0: (lsb)	channel 1 correlation test

C - checksum

Message length: 9 bytes

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ALMANAC DATA INPUT MESSAGE (@@Cb)

This input data command loads an almanac into the receiver's nonvolatile memory via the serial port. The entire almanac data message consists of 34 unique formatted messages that correspond to the subframe and page number of the almanac data (see GPS-ICD-200 for format description).

The VP echoes the input almanac data subframe and page numbers of messages received so the user can validate that each almanac slice has been accepted. The receiver will collect an entire almanac in local storage, then check the almanac for validity The receiver will update the internal almanac data with the new user-supplied almanac upon completion of the receipt of a valid almanac.

Upon completion of the receipt of a valid almanac, the VP outputs an almanac status message (see Almanac Status.) This output verifies that the almanac was accepted and is currently being used for satellite visibility and DOP computations. Upon completion of the storage of the new almanac to nonvolatile memory (EEPROM), the VP will output another almanac status message to verify successful storage of the almanac.

Any single input message that has an invalid subframe (i.e., not 4 or 5) will reset the almanac collection software so that the local collection of almanac data can begin fresh. Subframe 5 page 1 marks the beginning message and resets the collection process. The data for subframe 5 page 1 must appear first in the string of 34 commands that make up the total almanac input data. The order for the remaining data is not important.

At 9600 baud, the user can insert up to about 1K of data per second into the serial port. Consequently, the user should be aware that the 34 total messages (of 33 bytes each) that make up the almanac data will take longer than one second to input into the receiver. Also, the output response message to each input is limited to 750 maximum byte transfers per second. As a result, the VP will take several seconds to operate on all 34 input almanac data commands.

If the VP is currently storing an almanac when the user inputs another almanac, the VP will complete storage of the first almanac to nonvolatile memory before accepting the new user input almanac.

VP ONCORE COMMAND REFERENCE

ALMANAC DATA INPUT MESSAGE (@@Cb)

Motorola Binary Format

Input Command

- *Input one Almanac Data page:*

@@Cbspxxx ... xxxC<CR><LF>

sp - subframe/page number	subframe 5 / pages 1 - 25, or subframe 4 / pages 2 - 5, 7 - 10, 25
xxx….xxx - data words	words 3 - 10, each word is 30 bits long (format per ICD-GPS-200)
C - checksum	

Message length: 33 bytes

Response Message

- *To each of 34 pages:*

@@ChspC<CR><LF>

sp - subframe/page number	subframe 5 / pages 1 - 25, or subframe 4 / pages 2 - 5, 7 - 10, 25
C - checksum	

Message length: 9 bytes

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6-CHANNEL ALERT PLANNING (@@Cd)

This utility command allows the user to compute satellite visibility information for other locations than the GPS receiver's current location. This can be accomplished in either the Idle or the Position Fix modes. The input command allows the user to specify the date, time, location, satellite mask angle, and GMT offset correction to compute the satellite visibility information, and the output response message returns satellite elevation, azimuth, and Doppler information for up to 12 visible satellites as well as DOP vs. satellite selection combinations for up to 9 different combinations. The receiver uses the current datum ID, Satellite Ignore List, Position Fix Algorithm Type, and xDOP Computation Type parameters in order to compute the Alert Plan.

The time the GPS receiver requires to compute the output response message is a function of the current loading on the Oncore GPS receiver CPU. The response message will be output much faster if the GPS receiver is placed in the Idle mode before the input command string is entered. Otherwise, the output message is made available when there is sufficient time for the GPS receiver to process the input command and compute the output visibility data. The user can build a visibility vs. time table by inputting alert request commands, one at a time, that increase the time parameter at some constant rate (i.e. every 15 minutes).

VP ONCORE COMMAND REFERENCE

6-CHANNEL ALERT-PLANNING (@@Cd)

Motorola Binary Format

Input Command • *Initiate 6 Channel Alert Planning:*

@@CdmdyyhmsggaaaaooooohhinC<CR><LF>

Date
- m - month: 1 .. 12
- d - day: 1 .. 31
- yy - year: 1980 .. 2079

Time
- h – hours: 0 .. 23
- m – minutes: 0 .. 59

GMT Correction
- s - sign of GMT corr: 00 = positive, FF = negative
- gg - GMT Correction (hrs, mm)
  - hrs: 0 .. 12
  - min: 0 .. 59

Position
- aaaa - latitude (in mas): -324,000,000 .. 324,000,000 (-90 to +90)
- oooo - longitude (in mas): -648,000,000 .. 648,000,000 (-180 to +180)
- hh - height in meters: -1000 .. 18,000

Satellite Mask Angle
- m - Sat mask (angle in degrees): 0 .. 89

C - Checksum

Message length: 27 bytes

Note: The response message to an alert-planning command with at least one out-of-range input parameter is to return all fields of the above response message zero-filled. In addition, the response is zero filled when no almanac is present in the VP receiver.

6-CHANNEL ALERT-PLANNING (@@Cd)

continued

Response Message

- *(to command):*

@@Cdmdyyhmniddeaasiddeaasiddeaas
iddeaasiddeaasiddeaasiddeaasiddeaas
iddeaasiddeasiddeaasiddeaastddssssss
ddssssssddssssssddssssssddssssssddssssss
ddssssssddssssssddssssssC<CR><LF>

Date

m – month	1 .. 12
d – day	1 .. 31
yy - year	1980 .. 2079

Time

h-hours	0..23
m - minutes	0.. 59

Satellite Visibility Information

n - number of visible sats	0 .. 12 (for each visible sat, up to n fields contain valid data)
i – Satellite ID	1 .. 32
dd – Doppler in Hz	-5000 .. 5000
e – elevation (degrees)	0 .. 90
aa – Azimuth (degrees)	0 .. 359
s – satellite health	0 - healthy 1 - removed from sv sel 2 - unhealthy

xDOP vs. Satellite Selection Information (up to 9 combinations)

t-xDOPtype	0 - GDOP 1 - PDOP 2 - HDOP 3 - VDOP 4 - TDOP
dd – DOP (0.1 resolution)	0, 10 .. 999 dd = 0 if the combination is not valid
ssssss - SVID per channel	each s = 0 .. 32 for sat ID (0 indicates chan not used)

C - checksum

Message Length: 171 bytes

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PSEUDORANGE CORRECTION INPUT (@@Ce)

NOTE: The input/output messages described here are available only if VP Option ‘B’ is installed.

Enabling this option allows the VP to accept pseudorange correction messages from a differential master site receiver. The input message is structured to accept pseudorange and pseudorange-rate corrections for up to six satellites. The slave receiver uses the corrections in the input message by associating the satellite ID with the corresponding satellite (channel) that the slave is tracking. The user can specify up to 12 satellite corrections through the use of two back-to-back input commands. Back-to-back commands must be input with no time delay in between.

PSEUDORANGE CORRECTION INPUT (@@Ce)

Motorola Binary Format

Input Command

- *Input Pseudorange Corrections (for up to six satellites):*

@@Cetttippprrdipppprrdipppprrdipppprrd ippprrdi ppprrdC<CR><LF>

ttt - GPS time ref	0 .. 6047999 (0.0 .. 604799.9)
i - sat ID	0 .. 37
	0 = not used
	1-37 = sat ID
ppp - pseudorange corr	-1,048,576 .. +1,048,576
0.01 meter resolution	(-10485.76 .. +10485.76 m)
rr - pseudorange-rate corr	-4096 .. 4096
0.001 m/s resolution	(-4.096 .. 4.096 m/s)
d - issue of data ephemeris	0 .. 255
C - checksum	

Message length: 52 bytes

Response Message

- *(to command)*

@@CkC<CR><LF>

C - checksum

Message length: 7 bytes

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SET-TO-DEFAULTS (@@Cf)

This command sets all of the GPS receiver parameters to their default values. Performance of this utility results in all continuous messages being reset to polled only output, and clears the almanac and ephemeris data. The time and date stored in the internal real-time clock are not changed by the execution of this utility.

SET-TO-DEFAULTS (@@Cf)

Motorola Binary Format

Input Command

- *Set receiver to Default values:*

@@CfC<CR><LF>

C - checksum

Message length: 7 bytes

Response Message

- *To above command:*

@@CfC<CR><LF>

C - checksum

Message length: 7 bytes

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POSITION FIX/IDLE MODE SELECT(@@Cg)

This utility allows the user to place the VP receiver into one of two possible operating modes: **Position Fix** or **Idle** mode. The Position Fix mode is the normal operating mode of the VP receiver in which it acquires and tracks satellites and computes position from the satellite measurements. The Idle mode is a reduced power mode in which the VP does not track satellites. The receiver's MPU is active only while it operates on input commands and creates output response messages. All other times the receiver is placed in a low-power wait state in which it waits for the next command string to be entered via the serial port.

Default value: Idle

NOTE: This command has probably caused more confusion and consternation amongst Oncore receiver users than the rest of the commands combined. This is especially true of users who first learned how to work with newer Oncores such as the GT/UT, and then were handed a VP to work with.

The VP was the ONLY Oncore ever supplied with a **Position Fix/Idle** command, so if you are not used to dealing with it, it can drive you nuts until you figure out what is going on. Basically, when in **Idle** mode, the RF section of the receiver shuts down, and all internal activity stops. This means no message traffic, etc. There are three ways to get into **Idle** mode:

1. Command the receiver into **Idle** mode using this command.
2. Default the receiver using the @@Cf command.
3. Perform a receiver Self-Test.

This is what trips up most users familiar with the GT/UT receivers. Whenever they default the receiver they simply issue an @@Ea command (or whatever...) and the receiver starts right back up again. Well, the VP won't. You must issue the **Position Fix Mode** command in order to restart the receiver.

The Self Test problem is similar. After performing a Self Test, a GT/UT will start right up where it left off. The VP will complete the Self-Test, go into **Idle Mode,** and simply sit there until the **Position Fix Mode** command is received.

VP ONCORE COMMAND REFERENCE

POSITION IDLE/FIX MODE SELECT (@@Cg)

Motorola Binary Format

Input Command

- *Select Operating Mode:*

@@CgmC<CR><LF>

m – mode
- 0 – Go to Idle mode
- 1 – Go to Position Fix mode
- 2 – Send current receiver mode

C - checksum

Message length: 7 bytes

Response Message

- *To above command:*

@@CgmC<CR><LF>

m – mode
- 0 – Idle mode
- 1 – Position Fix mode

C - checksum

Message length: 7 bytes

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SWITCH I/O FORMAT (@@Ci)

This command switches the serial data format on the primary port from Motorola binary to one of the other embedded formats (either NMEA 0183 or Loran Emulation.)

SWITCH I/O FORMAT (@@Ci)

Motorola Binary Format

Input Command

- *Set Output Format to Desired Mode:*

@@CimC<CR><LF>

m - format 1 = NMEA 0183 (4800 baud)
2 = Loran Emulation (1200 baud)

C - checksum

Message length: 8 bytes

Response Message

- *There is no binary response to this command*

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RECEIVER ID MESSAGE (@@Cj)

The GPS receiver outputs an ID message upon request. The information contained in the ID string is self-explanatory.

VP ONCORE COMMAND REFERENCE

RECEIVER ID MESSAGE (@@Cj)

Motorola Binary Format

Input Command

- *Request Receiver ID String:*

@@CjC<CR><LF>

C - checksum
Message length: 7 bytes

Response Message

- *Response to command:*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
@	@	C	j	(cr)	(lf)	C	O	P	Y	R	I	G	H	T		1	9	9	1	-	1	9	9	X	1
	M	O	T	O	R	O	L	A		I	N	C	.	(cr)	(lf)	S	F	T	W		P	/	N		2
#		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	(cr)	(lf)	S	O	F	T	W	A	3
R	E		V	E	R		#		X	X	X	X	X	X	X	X	X	X	X	(cr)	(lf)	S	O	F	4
T	W	A	R	E		R	E	V		#		X	X	X	X	X	X	X	X	X	X	X	(cr)	(lf)	5
S	O	F	T	W	A	R	E		D	A	T	E			X	X	X	X	X	X	X	X	X	X	6
X	(cr)	(lf)	M	O	D	E	L		#					X	X	X	X	X	X	X	X	X	X	X	7
X	X	X	X	(cr)	(lf)	H	D	W	R		P	/	N		#		X	X	X	X	X	X	X	X	8
X	X	X	X	X	X	X	(cr)	(lf)	S	E	R	I	A	L		#				X	X	X	X	X	9
X	X	X	X	X	X	X	X	X	X	(cr)	(lf)	M	A	N	U	F	A	C	T	U	R		D	A	10
T	E		X	X	X	X	X	X	X	X	X	X	(cr)	(lf)	O	P	T	I	O	N	S		L	I	11
S	T					X	X	X	X	X	X	X	X	X	X	C	(cr)	(lf)							12

Message length: 294 bytes

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8 CHANNEL POSITION/STATUS/DATA MESSAGE (@@Ea)

This input command sets the rate that the 8 Channel Position/Status/Data information in the response message is output. The mode parameter (m) in the input message instructs the GPS receiver to either output this message one time (polled), or to output this message at the indicated update rate (continuously). Once the GPS receiver is set to continuous output, the continuous message flow can be stopped by sending a onetime output request. The GPS receiver will output the message one more time, then terminate any further message outputs. If the VP has been commanded into Idle mode, it outputs the last known valid 8 Channel Position/Status/Data message once when polled.

The state of the rate byte is stored in non-volatile memory. If the GPS receiver was continuously outputting the position/status/data output when turned off it will begin to output this message continuously (at the selected update rate) again when the main power is reapplied.

The 8 Channel Position/Status/Data output is explained in the response message section. Refer to commands for more details on the formats of these parameters.

The number of satellites visible is computed using the current date, time, position, almanac, and a default mask angle of ten degrees. If a current almanac is unavailable, the number of reported visible satellites will be zero. This condition will not prevent satellites from being tracked.

In order for a satellite to be used for positioning, the satellite mode must reach eight, indicating that the ephemeris for that satellite has been acquired. Once the ephemeris is available, the satellite can be used for positioning in modes five through eight.

NOTE: *United States export laws prohibit GPS receivers from outputting valid data if the altitude is greater than 18,000 meters and the velocity is greater than 514 meters per second. If the GPS receiver is used above both these limits, the height and velocity outputs are clamped to the maximum values. In addition, the latitude and longitude data will be incorrect.*

Default mode: Polled

VP ONCORE COMMAND REFERENCE

8 CHANNEL POSITION/STATUS/DATA MESSAGE (@@Ea)

Motorola Binary Format

Input Command

- *Set Message Response Rate:*

@@EamC<CR><LF>

m - mode	0 = output response message once (polled) 1 .. 255 = response message output at indicated rate (continuous) 1 = once per second 2 = once every two seconds 255 = once every 255 seconds
C - checksum	

Message length: 8 bytes

Response Message

- *(to command):*

@@Eamdyyhmsffffaaaaooooohhhhmmmmvvh
hddtntimsdimsdimsdimsdimsdimsdimsdimsds
C<CR><LF>

Date	
m - month	1 .. 12
d - day	1 .. 31
yy - year	1980 .. 2079
Time	
h - hours	0 .. 23
m - minutes	0 .. 59
s - seconds	0 .. 60
ffff - fractional second	0 .. 999,999,999 (0.0 .. 0.999999999)
Position	
aaaa - latitude in mas	-324,000,000 .. 324,000,000 (-90º .. 90º)
oooo - longitude in mas	-648,000,000 .. 648,000,000 (-180º .. 180º)
hhhh - height in cm GPS ref	-100,000 .. 1,800,000 (-1000.00 .. 18,000.00 m)
mmmm – height in cm MSL Ref	-100,000 .. 1,800,000 (-1000.00 .. 18,000.00 m)

8 CHANNEL POSITION/STATUS/DATA MESSAGE (@@Ea) *continued*

Velocity

vv - velocity in cm/s	0 .. 51,400 (0 .. 514.00 m/s)
hh - heading (true north res 0.1º)	0 .. 3,599 (0.0 .. 359.9º)

Geometry

dd - current DOP (0.1 res)	0 .. 999 (0.0 to 99.9 DOP) (0 = not computable, position-hold, or position propagate)
t - DOP type	0 = PDOP (have 3D fix) 1 = HDOP (have 2D fix)

Satellite visibility and tracking status

n - num of visible sats	0 .. 12
t - num of satellites tracked	0 .. 8

For each of eight receiver channels

i - sat ID	0 .. 37
m - channel tracking mode	0 .. 8
0 = code search	5 = message sync detect
1 = code acquire	6 = satellite time available
2 = AGC set	7 = ephemeris acquire
3 = freq acquire	8 = avail for position
4 = bit sync detect	
s – Signal Strength	0 .. 255 (number proportional to SNR)

d - Channel Status Flag

Each bit represents one of the following:

(msb)	Bit 7: using for position fix
	Bit 6: satellite momentum alert flag
	Bit 5: satellite anti-spoof flag set
	Bit 4: satellite reported unhealthy
	Bit 3: satellite reported inaccurate (> 16 m)
	Bit 2: spare
	Bit 1: spare
(lsb)	Bit 0: parity error

(End of channel dependent data)

s - Receiver Status Byte

(msb)	Bit 7: position propagate mode
	Bit 6: poor geometry (DOP > 20)
	Bit 5: 3D fix
	Bit 4: 2D fix
	Bit 3: acquiring satellites/position hold
	Bit 2: differential fix
	Bit 1: insufficient visible satellites (< 3)
(lsb)	Bit 0: bad almanac

C - checksum

Message length: 76 bytes

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8 CHANNEL xDOP TABLE STATUS MESSAGE (@@Ec)

This command requests the xDOP parameters corresponding to combinations of currently visible satellites based on the latest satellite visibility calculation. The VP receiver will send up to nine combinations of satellites with the corresponding xDOP parameter. The DOP type is selected by the user using the xDOP Type Parameter message (@@Aj.)

The receiver will either compute xDOP of all combinations of satellites taken 8-at-a-time, or for all satellites taken four at a time depending on which mode has been chosen by the user with the Position Fix Algorithm Type (@@Ar) command.

8 CHANNEL xDOP TABLE STATUS MESSAGE (@@Ec)

Motorola Binary Format

Input Command

- *Request xDOP Table Status:*

@@EcmC<CR><LF>

m – mode — 0 - output response message once (polled)
1 - output response message when data changes (continuous)

C - checksum

Message Length: 8 bytes

Response Message

- *(to command)*

@@Ectnmddssssssddssssssddssssss
ddssssssddssssssddssssssddssssss
ddssssssddssssssC<CR><LF>

t - xDOP Type — 0 - GDOP
1 - PDOP
2 - HDOP
3 - VDOP
4 – TDOP

n - number of valid combinations — 0 .. 9

m - Best-4 or 8-in-View — 4 or 8

For n valid combinations of satellites:

dd - xDOP — 10 .. 999
resolution 0.1 — (1.0 ..99.9)

ssssss - Sat Combo ID's — 0 .. 32

C - checksum

Message Length: 82 bytes

Note: The number of valid "s" fields is given by m.

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8 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Eg)

NOTE: The input/output messages described here are available only if GPS receiver Option C is installed.

This parameter determines the rate that basic satellite range and range-rate information for each of the satellites that the VP receiver is tracking is output. The user has the option of requesting the satellite range data status one time, (polled) or continuously at a user specified update rate. The selected rate is stored in the VP receiver's non-volatile memory. If the receiver was continuously outputting the satellite range data output when turned off, it will begin to output this message continuously (at the selected update rate) again when power is reapplied.

If the VP receiver is in Idle mode (see @@Cg command), the output rate parameter selection does not exist, and the GPS receiver outputs the last known valid Range Data Output information once when polled.

Two bits in each of the channel tracking mode words of the response message are used to denote whether or not the channel has lost phase lock or frequency lock since the last output of this message. This information is helpful for users who perform post-processing and it eliminates the need to output this message at a one-second rate.

The channel tracking mode in this response message is not necessarily the same as the channel tracking mode in the Position/Status/Data Output Messages (@@Ba and/or @@Ea.) When the receiver is not using the channel as part of the position fix solution, the GPS satellite time (Integrated Carrier Phase Filtered) will be zero, and the channel tracking mode will report mode 4 or lower. When the receiver is using the channel as part of the position fix solution (modes 5 through 8, after reaching mode 8 once), the GPS satellite time (Integrated Carrier Phase Filtered) will be valid, and the channel tracking mode will be the same as the channel tracking mode in the Position/Status/Data Output Messages.

8 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Eg)

Motorola Binary Format

Input Command

- *Set response message rate:*

@@EgmC<CR><LF>

m – mode
- 0 - output response message once (polled)
- 1.. 255 - response message output at indicated rate (continuous)
  - 1 - once per second
  - 2 - once every two seconds
  - 255 - once every 255 seconds

C - checksum

Message Length: 8 bytes

Response Message

- *(to command)*

@@Egtttffffimsssffffccffrrrdd
imsssffffccffrrrddimsssffffccffrrrdd
imsssffffccffrrrddimsssffffccffrrrdd
imsssffffccffrrrddimsssffffccffrrrdd
imsssffffccffrrrddC<CR><LF>

ttt - GPS local time in seconds	0 .. 604799
ffff - GPS local fractional time in ns	0 .. 0.999999999
resolution - 1 ns	(0 .. 0.999999999)

Response Message Continued on Following Page

8 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Eg) *continued*

For each of eight channels:

i - satellite ID — 0.. 32
0 = channel not used
1 - 32 = satellite ID

m - channel tracking mode where bits 0 - 3 are decoded as
- 0 - code search
- 1 - code acquire
- 2 - AGC set
- 3 - frequency acquire
- 4 - bit sync detect
- 5 - message sync detect
- 6 - sat time available
- 7 - ephemeris acquire
- 8 - avail for position

where bit 6 is decoded as:
- 0 - frequency locked since last range message
- 1 - not frequency locked since last range message

and where bit 7 (MSB) is decoded as
- 0 - phase locked since last range message
- 1 - not phase locked since last range message

sssfiff - GPS satellite time (Integrated Carrier Phase Filtered)

sss - integer part (resolution - 1 sec)	0 .. 604799
ffff - fractional part (resolution - 1 nsec)	0 .. 999,999,999 (0 .. 0.999999999)

ccff - integrated carrier phase

cc - integer part 16 MS bits of carrier phase (above decimal point)	0 .. 65535 (cycles)
ff - fractional part 16 bits of carrier NCO below decimal point at measurement epoch	0 .. 65535 (0 .. 359.9945 degrees)
rrr - raw code phase (carrier cycles)	0 .. 1575420
dd - code discriminator output at measurement epoch	-32,768 .. 32767

LSB = (2^{-12}) * SOL * 0.001/28644 meters

C - checksum

Message Length: 158 bytes

8 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Eg) *continued*

In the discussions that follow, the subscript ($_k$) refers to the current measurement data, and the subscript ($_{k-1}$) refers to the previous (1 second old) data. The user can convert the above message into pseudorange and pseudorange rate for each satellite by using the following formulas:

Conversion Formulas

Pseudorange (in meters) = (GPS local time - GPS satellite time) * SOL
Note: Not corrected for possible End-Of-Week Rollovers.

Pseudorange Rate (in meters per second) = K2 * (ICP_k – ICP_{k-1})

ICP is the integer and fractional part of ICP treated as a 32 bit unsigned quantity Use 32 bit unsigned integer subtraction to avoid rollovers.

Absolute Carrier Phase at measurement epoch in degrees = K4 * ICP_f

The GPS satellite time used in the first equations for the computation of pseudorange is the same value that the Oncore uses internally. This satellite time value combines code and carrier information and has been pre-smoothed using carrier aided filtering with a very narrow-band (0.005 Hz) low-pass filter algorithm. The user has access to the unfiltered raw code phase via the following:

Raw Code Phase (in meters) = K1 * RCP - K2 * ICP_f + K3 * K5 * CD
where:
RCP is the raw code phase from the message
ICP_f is the fractional part of the integrated carrier phase
CD is the code discriminator output from the message
K5 is a variable code discriminator calibration constant

Code discriminator calibration constant: When tracking satellites, the receiver causes the raw code phase to move back and forth once per second in discrete steps of 1 code phase quantum. One code phase quantum is equal to 55 carrier cycles, or about 10.4662 meters. This intentional dither allows the receiver to calibrate the output of the code discriminator.

The user can accurately calibrate the code discriminator output by using the fact that the long term average difference between subsequent code discriminator measurements will be equal to 1 quantum. K5, the calibration constant, varies slowly over time as a function of received signal to noise ratio and multipath.

8 CHANNEL SATELLITE RANGE DATA OUTPUT MESSAGE (@@Eg) *continued*

Typical values of K5 are between 0.5 and 1.5. A simple low-pass filter can be used to generate K5 as follows:

diff = K3 * abs (CD_k – CD_{k-1})
CD_{k-1} = CD_k
LPF = LPF + beta * (diff - LPF) (initialize LPF = 10.4662 meters)
K5 = 10.4662 / LPF

The constant "beta" establishes the filter time constant. Typical values of beta are 0.001 (maximum filtering) to 0.5 (minimum filtering). The Oncore uses a constant of 0.05 internally.

OTHER FIXED CONSTANTS:

L1FO = 1,575,420,000.0 Hz (L1 carrier frequency)
SOL = 299,792,458.0 m/s (GPS value for the speed of light)
K1 = SOL / L1FO
K2 = K1 / 65536
K3 - (2^{-11}) * SOL * 0.001 / 28644
K4 = 360 / 65536

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8 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Ek)

This message contains information that can be considered an extension of the data output in the @@Ea 8 Channel Position/Status/Data message. Some users may have applications requiring use of this data at the same rate as the @@Ea message while other users may only need portions of this data at a much slower rate (e.g., magnetic variation).

Magnetic variation can be used to correct the true north heading (see Position/Status/Data Message) to magnetic north. The correction is computed using an algorithm developed by the U.S. Naval Oceanographic Office. It is based on the WMM-95 (World Magnetic Model 1995) magnetic field model which was generated from actual field measurements and was valid until January 1, 2000. Another table will be available from the U.S. Defense Mapping Agency (DMA) at that time. The algorithm primarily characterizes that portion of the Earth's magnetic field which is generated by the Earth's conducting fluid outer core. Portions of the geomagnetic field generated by the Earth's crust, mantle, ionosphere, and magnetosphere are for the most part not represented in these models. Consequently, a magnetic sensor such as a compass or magnetometer may observe spatial and temporal magnetic anomalies when referenced to the appropriate World Magnetic Model. In particular, certain local, regional, and temporal magnetic declination anomalies can exceed 10 degrees. Anomalies of this magnitude are not common, but they do exist. Declination anomalies on the order of 2 or 3 degrees are not uncommon, but are of small spatial extent and relatively isolated. From a global perspective, the root-mean-square (RMS) error at sea level of the World Magnetic Model are estimated to be less than 1.0 degrees over the entire 5-year life of the model.

VP ONCORE COMMAND REFERENCE

8 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Ek)

Motorola Binary Format

Input Command

- *Request extension message:*

@@EkmC<CR><LF>

m - mode
- 0 - output response message once (polled)
- 1 .. 255 - output response message at indicated rate (continuous)
- 1 - once per second
- 2 - once every two seconds
- 255 - once every 255 seconds

C - checksum

Message Length: 8 bytes

Response Message

- *(to command):*

@@Ekggpphhvvttmmnneeuuaaxxxxyyyyzzzz
rrrrrrrriiiiiiiiiiiiiiiiiiccooC<CR><LF>

Note: DOP values are NOT valid if in Position Hold mode.

Current GDOP

gg - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current PDOP

pp - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current HDOP

hh - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 2D or 3D Fix mode)

Current VDOP

vv - 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if in 3D Fix mode)

Current TDOP

tt – 0 to 32767 (0.0 to 3276.7 DOP) resolution 0.1 (only valid if tracking at least one satellite

8 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Ek) *continued*

Magnetic Variation

mm - -1800 to +1800 (-180.0° to +180.0°)
resolution = 0.1
positive angles are east
negative angles are west

Velocity in north, east, up coordinate system

nn - north - 32767 to 32767 (m/s)
resolution = 0.1

ee - east - 32767 to 32767 (m/s)
resolution = 0.1

uu - up - 32767 to 32767 (m/s)
resolution = 0.1

Response Message Continued on Following Page

8 CHANNEL POSITION/STATUS/DATA EXTENSION MESSAGE (@@Ek)

Age of differential correction data (for slave receiver)

aa -	0 to 65535 (resolution 0.1s)

Receiver position in ECEF coordinate system (X, Y, Z)

xxxx -	resolution = 0.01 meters
yyyy -	resolution = 0.01 meters
zzzz -	resolution = 0.01 meters

URA for each of eight receiver channels (8 elements)

r-	as decoded from the GPS satellite message (0-15 is valid URA, 63 if not decoded yet) see NAVSTAR GPS-ICD-200, Section 20.3.3.3.1.3

Least Squares A-1 Symmetrical Matrix element (10 elements)

ii -	A-1 Matrix element where: element #1 is A-1[0][0] element #2 is A-1[0][1] element #3 is A-1[0][2] element #4 is A-1[0][3] element #5 is A-1[1][1] element #6 is A-1[1][2] element #7 is A-1[1][3] element #8 is A-1[2][2] element #9 is A-1[2][3] element #10 is A-1[3][3] resolution = 0.1 (unitless)

Receiver clock bias

cc -	32767 to +32767 (in meters) resolution = 0.1

Receiver oscillator offset

oo -	0 to 65535 (in m/s) resolution = 0.1

C – checksum

Message Length: 71 bytes

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8 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@En)

NOTE: The input/output messages described here are available only if GPS receiver option 'I' is installed.

The Motorola VP receiver uses the Time RAIM algorithm to exploit redundancy in the GPS time solution in order to detect and isolate faulty satellites. The Time RAIM Setup and Status Message allows the user to change the update rate, the configuration for the 1PPS output, and the Time RAIM alarm limit.

The rate parameter instructs the GPS receiver to either output this message one-time (polled), or to output this message at the indicated update rate (continuously). If the message rate is the same as the 1PPS rate, then the message and the 1PPS pulse are synchronized. Once the GPS receiver is set to continuous output, the continuous message flow can be stopped by sending a one-time output request. The GPS receiver will output the message one more time, then terminate any further message outputs. The state of the rate parameter is stored in nonvolatile memory If the GPS receiver was continuously outputting the message when turned off, it will begin to output this message continuously (at the selected rate) again when power is reapplied. If the VP has its Idle Mode option enabled, the rate parameter selection is unavailable, and the GPS receiver outputs the last valid message once when polled.

The state of the rate byte is stored in RAM. If the GPS receiver was continuously outputting the message when turned off and backup power is applied, then it will begin to output this message continuously (at the selected update rate) again when the main power is reapplied. If backup power is not applied during power down, then the GPS receiver will start up with a default rate of zero. The other Time RAIM control parameters are also stored in RAM, so they will be reset to their default values if backup power is not applied during power down.

The pulse generation can be controlled with the 1PPS control mode byte. The pulse can be on all the time, off all the time, on only when the receiver is tracking at least one satellite, or on only when the time solution is within the alarm threshold.

The number of satellites appearing in the table below are the minimum which must be tracked to ensure the detection, isolation, and removal of faulty satellites. The probability of detection and isolation of a faulty satellite is greater

8 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@En) *continued*

than 99.99%, which corresponds to less than one missed detection per every 10,000 failures. Given the infrequency of GPS satellite failures, this makes a missed detection virtually impossible. The probability of a false alarm is less than 2.e-4%, which corresponds to less than one false alarm every 5.7 days. Given that lock is maintained on eight satellites, the time alarm can be set as low as 300 ns without compromising performance.

* The minimum time required false alarm rate of 2.e-4% cannot be achieved for this time alarm range.

The 8 Channel Time RAIM Setup and Status Message outputs the status of the Time RAIM solution when the algorithm is on. This message also outputs several values relating to the Time RAIM solution.

The receiver can make an estimate of the overall accuracy of the time solution. The one-sigma accuracy estimate is computed using the residuals of the least-squares time solution. This number is a measure of the spread of the observations, not an estimate of the absolute time accuracy.

The underlying noise due to the granularity of the clock generating the 1PPS signal is deterministic on every pulse. The receiver computes and outputs the negative sawtooth residual so that the user can compensate for the error and remove granularity.

Finally, the time solution of each individual satellite is output.

Default values:	Time RAIM algorithm:	Off
	Time RAIM alarm limit:	1000 ns
	1PPS control mode:	setting 1

8 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@En)

Motorola Binary Format

Input Command

- *Send current Time RAIM Setup and Status:*

@@EnxxxxxxxxxxxxxxxxC<CR><LF>

x - 15 out of range bytes $ff ff ff ff...
C - checksum
Message length: 22 bytes

- *Change current Time RAIM Setup:*

@@EnotaapxxxxxxxC<CR><LF>

o - output message rate	0 .. 255 0 = output response message once (polled) 1 .. 255 = response message output at indicated rate (continuous) 1 = once per second 2 = once every two seconds 255 = once every 255 seconds
t - Time RAIM algorithm on/off	0 = off 1 = on
aa - Time RAIM alarm limit in 100s of nanoseconds	3 .. 65535
p - 1PPS control mode	0 = 1PPS pulse off all the time 1 = 1PPS on all the time 2 = pulse active only when tracking at least one satellite 3 = pulse active only when Time RAIM algorithm confirms time solution error is within the user defined alarm limit
nnn - not used	0
mdyyhms - not used	0
C - checksum	

Message length: 22 bytes

8 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@En) *continued*

Response Message

- *(to either command):*

@@Enotaapnnnmdyyhmspysreensfffsffff sfffsfffsfffsfffsfffsfffsfffC<CR><LF>

o - output message rate	0.. 255
t - Time RAIM algorithm on/off	0 = off 1 = on
aa - Time RAIM alarm limit in 100s of nanoseconds	3 .. 65535
p - 1PPS control mode	0 = 1PPS pulse is off all the time 1 = 1PPS on all the time 2 = pulse active only when tracking at least one satellite 3 = pulse active only when Time RAIM algorithm confirms time solution error is within the user defined alarm limit
nnn - 1PPS output rate	0 .. 86400
mdyyhms - time to next fire	
m - months	0 .. 12
d - days	0 .. 31
yy - years	1980.. 2079
h - hours	0 .. 23
m - minutes	0 .. 59
s - seconds	0 .. 60
p - pulse status	0 = off 1 = on
y - 1PPS pulse sync	0 = pulse referenced to UTC 1 = pulse referenced to GPS
s - Time RAIM solution status	0 = OK: solution within alarm limits 1 = ALARM: user specified limit exceeded 2 = UNKNOWN: due to... a) alarm threshold set too low b) Time RAIM turned off c) insufficient satellites being tracked

8 CHANNEL TIME RAIM SETUP AND STATUS MESSAGE (@@En) *continued*

r - Time RAIM status	0 = detection and isolation possible 1 = detection only possible 2 = neither possible
ee - time solution one sigma accuracy estimate in nanoseconds	0 .. 65535
n - negative sawtooth time error of next 1PPS pulse in nanoseconds	-128 .. 127
For each of eight receiver channels	
s - satellite ID	0 .. 37
ffff - fractional GPS local time estimate of satellite in nanoseconds	0 .. 999999999
C - checksum	
Message length: 69 bytes	

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8 CHANNEL SELF-TEST (@@Fa)

The VP GPS receiver user has the ability to perform an extensive self-test. The tests that are accomplished during the commanded self-test are as follows:

- ROM Checksum
- RAM
- EEPROM
- Correlator IC
- SPI port communications with DCXO
- SPI port communications with RTC and Time increment
- SCI communication is verified operational if the RS-232 port is active

The output of the self-test command is a 16-bit field, where each bit of the field represents the go/no-go condition of the particular item tested.

When the self-test is initiated the VP automatically goes into Idle mode. The self-test may take up to ten seconds to execute. Once the self-test is complete, the VP remains in Idle mode until commanded back into Fix mode by the user. The date, time, position, almanac, and ephemeris information is all retained.

VP ONCORE COMMAND REFERENCE

8 CHANNEL SELF-TEST (@@Fa)

Motorola Binary Format

Input Command

- *Initiate 8 Channel Self-Test:*

@@FaC<CR><LF>

C - checksum

Message length: 7 bytes

Response Message

- *(To command)*

@@FaxxC<CR><LF>

xx - self test result

Two bytes as detailed below. Each bit of the self-test field is either zero (pass) or one (fail) and represents the results of the following tests:

Bit 15: (msb)	RTC Comm and Time
Bit 14:	DCXO SPI communications
Bit 13:	EEPROM
Bit 12:	RAM MSByte
Bit 11:	RAM LSByte
Bit 10:	ROM MSByte checksum
Bit 9:	ROM LSByte checksum
Bit 8:	1 KHz presence
Bit 7:	channel 8 correlation test
Bit 6:	channel 7 correlation test
Bit 5:	channel 6 correlation test
Bit 4:	channel 5 correlation test
Bit 3:	channel 4 correlation test
Bit 2:	channel 3 correlation test
Bit 1:	channel 2 correlation test
Bit 0: (1sb)	channel 1 correlation test

C - checksum

Message length: 9 bytes

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8-CHANNEL ALERT-PLANNING (@@Fd)

This utility command allows the user to compute satellite visibility information for other locations than the GPS receiver's current location. This can be accomplished in either the Idle or the Position Fix modes. The input command allows the user to specify the date, time, location, satellite mask angle, and GMT offset correction to compute the satellite visibility information, and the output response message returns satellite elevation, azimuth, and Doppler information for up to 12 visible satellites as well as DOP vs. satellite selection combinations for up to 9 different combinations. The receiver uses the current datum ID, Satellite Ignore List, Position Fix Algorithm Type, and xDOP Computation Type parameters in order to compute the Alert Plan.

The time the GPS receiver requires to compute the output response message is a function of the current loading on the Oncore GPS receiver CPU. The response message will be output much faster if the GPS receiver is placed in the Idle mode before the input command string is entered. Otherwise, the output message is made available when there is sufficient time for the GPS receiver to process the input command and compute the output visibility data. The user can build a visibility vs. time table by inputting alert request commands, one at a time, that increase the time parameter at some constant rate (i.e. every 15 minutes).

VP ONCORE COMMAND REFERENCE

8-CHANNEL ALERT-PLANNING (@@Fd)

Motorola Binary Format

Input Command

- *Initiate 8 Channel Alert Planning:*

@@FdmdyyhmsggaaaaooooohhinC<CR><LF>

Date
- m - month: 1 .. 12
- d - day: 1 .. 31
- yy - year: 1980 .. 2079

Time
- h – hours: 0 .. 23
- m – minutes: 0 .. 59

GMT Correction
- s - sign of GMT corr: 00 = positive; FF = negative
- gg - GMT Correction (hrs, mm)
  - hrs: 0 .. 12
  - min: 0 .. 59

Position
- aaaa - latitude (in mas): -324,000,000 .. 324,000,000 (-90 to +90)
- oooo - longitude (in mas): -648,000,000 .. 648,000,000 (-180 to +180)
- hh - height in meters: -1000 .. 18,000

Satellite Mask Angle
- m - Sat mask (angle in degrees): 0 .. 89

C - Checksum

Message length: 27 bytes

Note: The response message to an alert-planning command with at least one out-of-range input parameter is to return all fields of the above response message zero-filled. In addition, the response is zero filled when no almanac is present in the VP receiver.

8-CHANNEL ALERT-PLANNING (@@Fd)

continued

Response Message

- *(to command):*

```
@@Fdmdyyhmniddeaasiddeaasiddeaasiddeaas
  iddeaasiddeaasiddeaasiddeaasiddeaasiddeas
  iddeaasiddeaastddssssssssddssssssssddssss
  ssssddssssssssddssssssssddssssssssddsssss
  sssddssssssssddssssssssC<CR><LF>
```

Date	
m – month	1 .. 12
d – day	1 .. 31
yy - year	1980 .. 2079
Time	
h-hours	0..23
m - minutes	0.. 59
Satellite Visibility Information	
n - number of visible sats	0 .. 12 (for each visible sat, up to n fields contain valid data)
i – Satellite ID	1 .. 32
dd – Doppler in Hz	-5000 .. 5000
e – elevation (degrees)	0 .. 90
aa – Azimuth (degrees)	0 .. 359
s – satellite health	0 - healthy 1 - removed from sv sel 2 - unhealthy
xDOP vs. Satellite Selection Information (up to 9 combinations)	
t-xDOPtype	0 - GDOP 1 - PDOP 2 - HDOP 3 - VDOP 4 - TDOP
dd – DOP (0.1 resolution)	0, 10 .. 999 dd = 0 if the combination is not valid
ssssssss – SVID per channel	each s = 0 .. 32 for sat ID (0 indicates chan not used)
C - checksum	

Message Length: 189 bytes