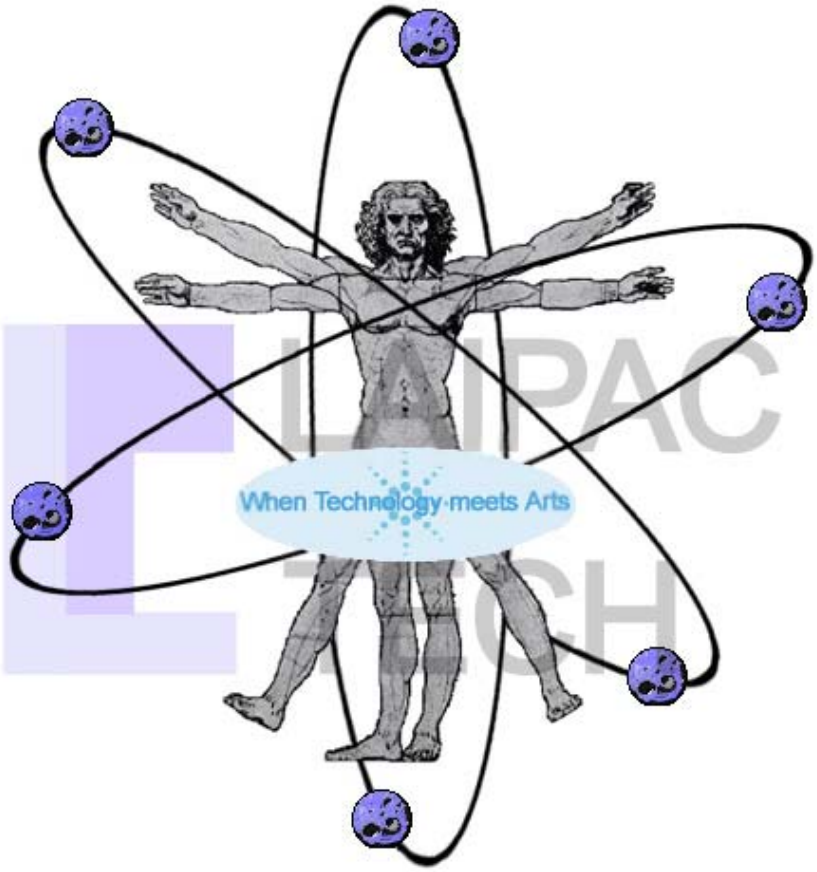
UV40 Ultra Small GPS Receiver-16Ch

April / 2002



UV40 Ultra Small GPS Receiver

Features:

- 16-Channel GPS Receiver.
- All-In-View Navigation.
- Differential Corrections supported
  - RTCM SC104 R2.1.
  - DARC BTA R-003.
- 3.3 VDC Operation.
- Very low power.
- Passive or Active antenna.
- Very small size.
- Wide operating temperature range.
- Using the Valence VS7001 Pure CMOS Front End and the Sony CXD2931R Baseband chip.
- TF-Star II Development board

Module Specification

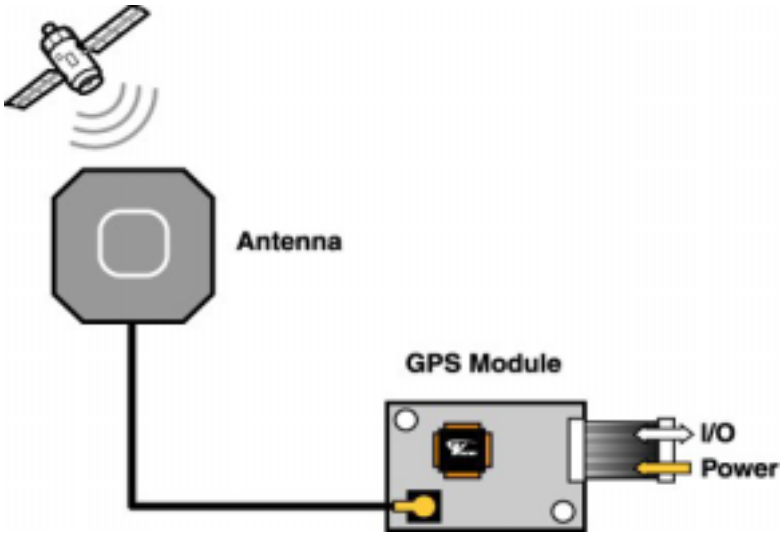
UV40 GPS Receiver Module Specification

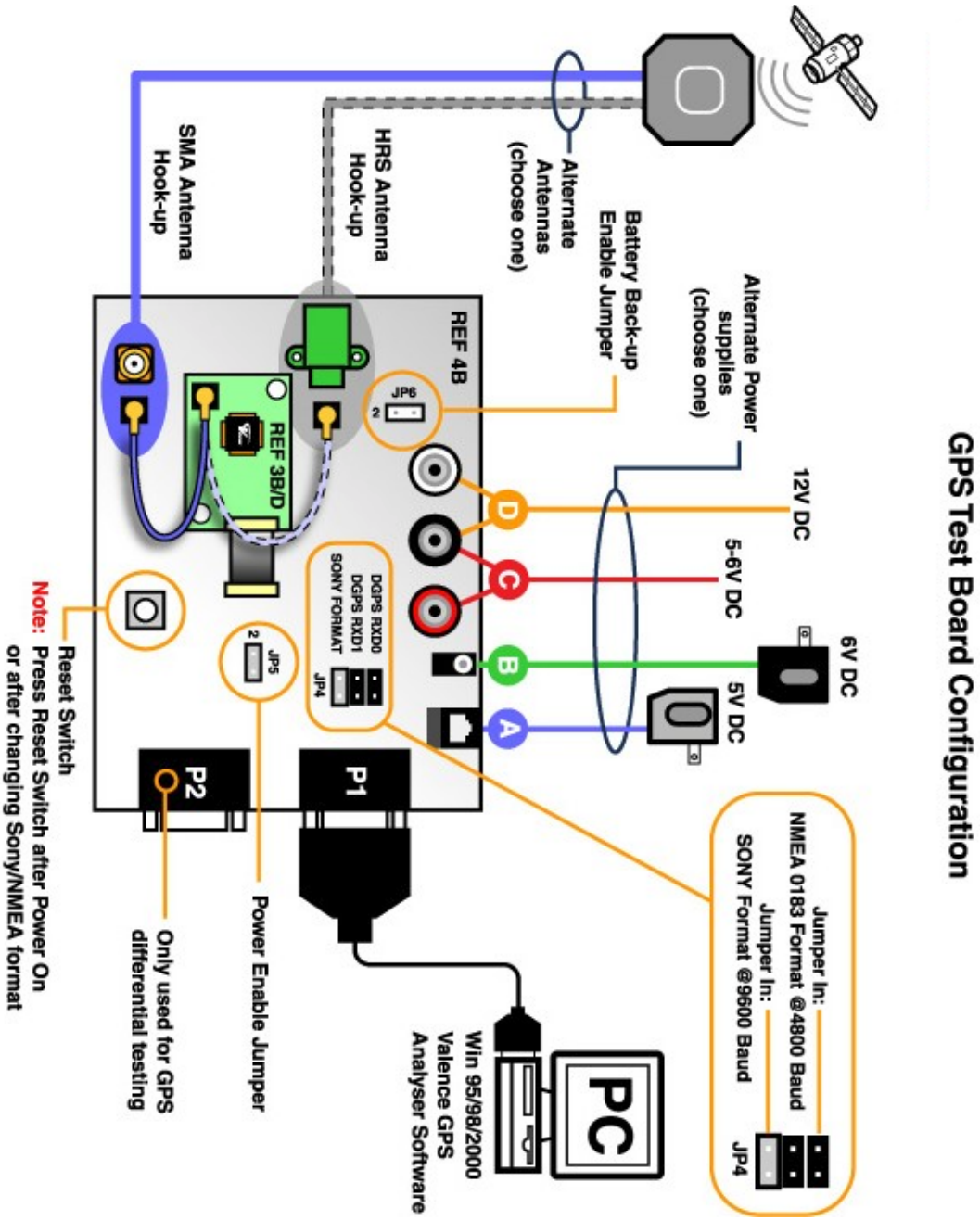
High Performance 16-channel GPS Receiver.

The Laipac UV40 is a complete high performance 16-channel GPS receiver module. The compact size and low power make this module ideally suited for a variety of applications. These include navigation systems for handheld applications, marine, aeronautical, and automotive. Additionally, this module is well suited for embedded systems that have requirements for location or timing information. Included is the capability to directly support either passive or active antennas

The Laipac UV40 module also supports all the standard navigation software features including differential corrections, all-in-view navigation, and two-satellite measurement. This module also operates on only 3.3 VDC, and can be operated from –40 °C to +85 °C.

16 Channel GPS Receiver




GPS Test Board Configuration
SMA Antenna Hook-up
HRS Antenna Hook-up
Alternate Antennas (choose one)
Battery Back-up Enable Jumper
Alternate Power supplies (choose one)
REF 4B
REF 3B/D
JP6
D
C
B
A
12V DC
5-6V DC
6V DC
5V DC
DGPS RXD0
DGPS RXD1
SONY FORMAT
JP4
JP5
P1
P2
Jumper In:
NMEA 0183 Format @4800 Baud
Jumper In:
SONY Format @9600 Baud
JP4
PC
Win 95/98/2000
Valence GPS
Analyser Software
Power Enable Jumper
Only used for GPS differential testing
Reset Switch
Note: Press Reset Switch after Power On
or after changing Sony/NMEA format

Absolute Maximum Ratings

Note: This module is not intended to operate under the conditions listed in Absolute Maximum Ratings. Continuous operation under these conditions or exceeding the maximum ratings may result in permanent damage to this device.

Symbol	Parameter	Min	Typ	Max	Units
Vdd	Module Supply Voltage	- 0.3	3.3	3.6	V
V_I	Input Voltage	- 0.3		V_{dd}+0.3	V
V_O	Output Voltage	- 0.3		V_{dd}+0.3	V
T_A	Ambient Temp. (Power applied)	- 40		95	°C
T_{STG}	Storage Temp.	- 40		105	°C

Normal Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
Vdd	3.3V Module Supply Voltage	3.0	3.3	3.6	V
Vddn	Supply Voltage Noise			50	mV_{P-P}
Pw	Module Power Dissipation		200		mW
Vbk	Module Backup Supply Voltage	1.8		3.0	V
Ivbk	Module Backup Supply current		30	70	μA
Vpre	Preamplifier Supply Voltage	2.7		3.6	V
Ipre	Preamplifier Supply Current		10	30	mA
Top	Operational Temp. (Power applied)	-40	25	+85	°C

Module Specification

Satellite Tracking		16 Parallel channels
RF input code	Center frequency	1575.42MHz L1 band, C/A
	Characteristics impedance	50 ohm
	Signal sensitivity	-133 dBm or less
Positioning system	Default	WGS-84 for rev 3D, Tokyo for rev 3B.
	Software Selectable	All major coordinate systems
Positioning accuracy	Position	20m 2DRMS (PDOP = 2.5, HDOP = 1.5)
	Velocity	0.3m/s (PDOP = 2.5, HDOP = 1.5)
Positioning condition		A) DOP limit: 3D: PDOP < 12

		2D: HDOP < 6 B) Elevation mask: 5°
Follow-up performance	Velocity Acceleration	500km/h or less 2G or less
Navigation Update Rate		1second
D-GPS function		DARC BTA R-003 standard RTCM SC104 version 2.1 (6 of 8 format) Type 1 data for correction calculation
Navigation method		All-In-View solution 2-Satelite solution

Time To First Fix (TTFF)

Assumes previously listed navigation conditions and 8 satellites in view

Hot Start (time, position, valid ephemeris, and valid almanac)	7 to 20 seconds
Warm Start (time, position, no ephemeris, and valid almanac)	33 to 50 seconds
Cold Start (time, position, no ephemeris, and valid almanac)	35 to 60 seconds
Reacquisition Time (tracking loss recovery time)	
Loss < 5 minutes	2 to 6 seconds
Loss > 5 minutes	6 to 10 seconds

Module Interface

RF input connector	JST: CN connector
I/O connector (Power supply, serial data)	JST: SM10B-SRSS

Communication Specification

Communication method	Start-stop synchronization
Transfer rate input/output	4800bps NMEA 9600bps Sony New
Logic levels	TTL compatible
I/O code	ASCII
Communication format	NMEA or Sony New format

I/O Connector Pins

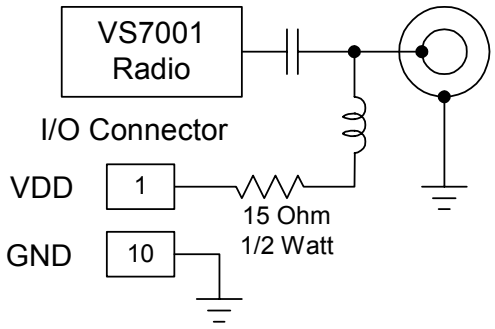
Pin Configuration

Pin No.	Symbol	I/O	Description
1	Vdd	-	Main power input.
2	TXA		Serial output
3	RXA		Serial input
7	Bat.Back		Back-up-battery
9	Reset		Reset-Low
11	GND		Ground
20	GND		Ground

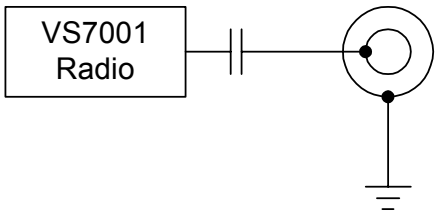
Electrical Characteristics

Item	Symbol	Parameter	Min	Typ	Max	Units
Vdd		3.3V Module Supply Voltage	3.0	3.3	3.6	V
Input Voltage	VIH	Input signal high level	.7Vdd			V
	VIL	Input signal low level			.2Vdd	V
Output Voltage	VOH	Output signal high level IOH = 4 mA	Vdd - 0.8			V
	VOL	Output signal low level IOL = 4 mA			.4	V

Active Antenna Pre-amplifier Power Supply Circuit



Passive Antenna Circuit



Recommend Antenna Specification

Antenna

Center frequency	1575.42MHz
Polarization	Right-handed circular polarization
Gain	-5dBi or more (5° ≤ Angle of elevation)
Axis ratio	3dB typical (Angle of elevation = 90°)

Pre-amplifier

Gain	22dB or more (without cable loss)
Noise figure (NF)	2.5dB or less

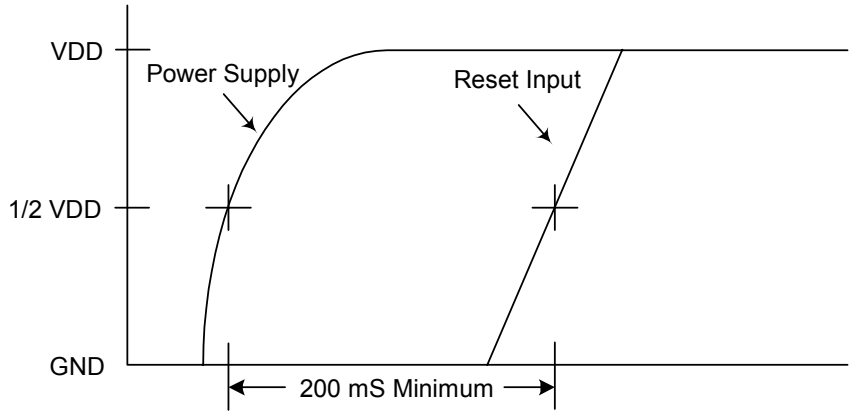
Overall Specification

Gain	17dBi or more (Angle of elevation = 90°)
Output impedance	50 ohms
Output VSWR	2.0 or less
Supply voltage	2.8 to 3.2V
Maximum Current consumption	30mA

GPS Receiver Initialization and Operation

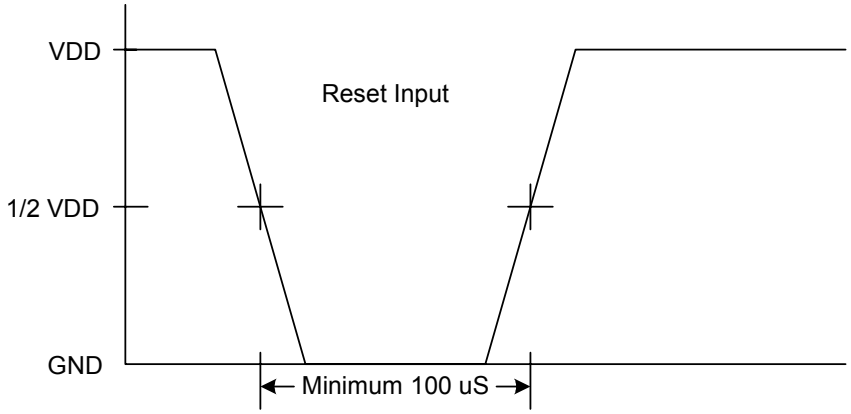
The UV40 GPS Receiver Module is initialized by setting the reset input signal RESET (Pin 2) for the to a logic high level. The timing should satisfy the conditions noted below.

During Power-on (power-on reset)
V_{DD} = 3.3 to 3.6V, , temperature = -40 to +85°C



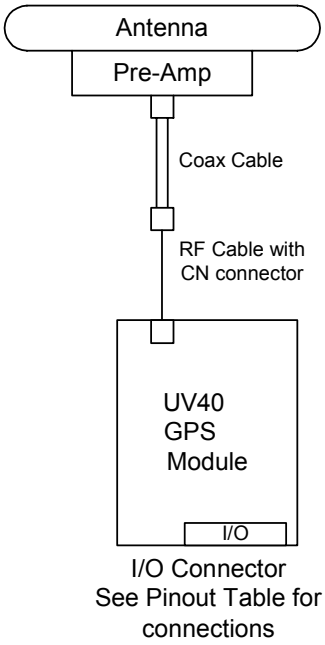
Initialization During Operation

V_{DD} = 3.3 to 3.6V, , temperature = -40 to +85°C



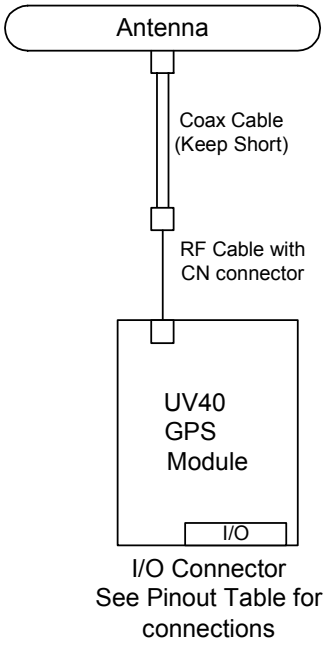
UV40 GPS Receiver Module Configuration

Configuration with Active Antenna



I/O Connector
See Pinout Table for
connections

Configuration with Passive Antenna



I/O Connector
See Pinout Table for
connections

GPS Receiver Data Input/Output Specifications

Contents

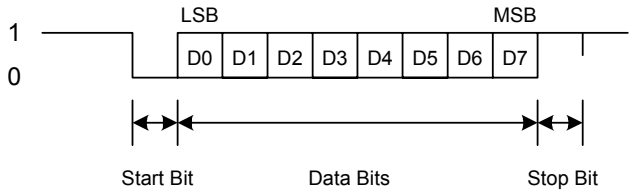
1.0 Sony I/O Data Input/Output Specifications

1.1 Communication

1.1.1 Serial input/output communication method

Interface:	Asynchronous serial interface (UART)
Baud rate:	9600 bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Hardware Control:	None
Output period:	Approximately 1s

1.1.2 Asynchronous serial interface



1.2 Output Data

1.2.1 Standard Output

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	1101 0000	Header	-	D0
2	0xxx xxxx	Software Version	01	01
3	0xxx xxxx	Latitude	North latitude	0F
4	0xxx xxxx	Resolution: 0.01”	87° 29’ 10.24”	02
5	0xxx xxxx	South Latitude is 2’s complement notation	(=314950.24)	26
6	0xxx xxxx	Value range: 32400000 to -32400000		70
7	0xxx xxxx	Longitude	West longitude	61
8	0xxx xxxx	Resolution: 0.01"	175° 42' 30.11"	6B
9	0xxx xxxx	West longitude is two's complement notation.	(= -632550.11")	1C
10	0xxx xxxx	Value range: 64800000 to -64800000		1D
11	0xxx xxxx	Altitude	3775m	00
12	0xxx xxxx	Resolution: 1m		1D
		Negative altitude is two's complement notation. Value range: 8191 to -8191		3F
13	0xxx xxxx	Speed	Speed	04
14	0xxx xxxx	Resolution: 0.1km/h Value range: 0 to 5150	Resolution: 0.1km/h Value range: 0 to 5150	5D
15	0xxx xxxx	Direction	310.7°	18
16	0xxx xxxx	Resolution: 0.1° Value range: 0 to 3599		23
17	0xxx xxxx	PDOP value Resolution: 0.1 Value range: 0	51.2	04
18	0xxx xxxx	to 999		00
19	0xxx xxxx	Current time mode 0: UTC time	1	01
		1: JST time		
		Current time		
20	0xxx xxxx	Year	1999	0F
21	0xxx xxxx	Year		4F
22	0xxx xxxx	Month	02	02
23	0xxx xxxx	Date	22	16
24	0xxx xxxx	Hour	12	0C
25	0xxx xxxx	Minute	54	36
26	0xxx xxxx	Second	46	2E
27	0xxx xxxx	Day	01	01
		Measurement calculation time		
28	0xxx xxxx	Year	1999	0F
29	0xxx xxxx	Year		4F
30	0xxx xxxx	Month	02	02
31	0xxx xxxx	Date	22	16
32	0xxx xxxx	Hour	12	0C
33	0xxx xxxx	Minute	55	37
34	0xxx xxxx	Second	30	1E

1.2.1 Standard Output (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
35	1101 0000	Number of visible satellites Value range: 0 to 32	8	08
36 37 38 39 40 41 42 43	0xxx xxxx 0xxx xxxx 0xxx xxxx 0xxx xxxx 0xxx xxxx 0xxx xxxx 0xxx xxxx 0xxx xxxx	Satellite Nos. used for measurement 8 satellite Nos. Value range: 0 to 32 Satellite No.: 0 is invalid.	4 10 18 9 20 25 7 31	04 0A 12 09 14 19 07 1F
44	0xxx xxxx	Measurement calculation mode 0: Invalid 1: 2-satellite measurement 2: 3-satellite measurement 3: 4-(or more) satellite measurement	1	01
45	0xxx xxxx	Geodesic system Value range: 0 to 25	18	12
46	0xxx xxxx	Measurement delay time Resolution: 0.1s Value range: 0 to 9	0.4s	04
		Information for the first satellite		
47	0xxx xxxx	Satellite No. Value range: 0 to 32	16	10
48 49	0xxx xxxx 0xxx xxxx	Azimuth Resolution: 1° Value range: 0 to 359°	218°	01 5A
50	0xxx xxxx	Angle of elevation Resolution: 1° Value range: 0 to 90°	56°	38
51	0xxx xxxx	Reception status 0: Searching 1: Acquired 2: Usable for calculation 3: Radio waves cut off; interpolating 4: Satellite Unhealthy 5: Currently being used for position calculation	3	03
52	0xxx xxxx	Signal level Resolution: 1dBHz Value range: 0 to 100	100	64
53 to		Information for the 2nd satellite		
59 to		Information for the 3rd satellite		
65 to		Information for the 4th satellite		
71 to		Information for the 5th satellite		

1.2.1 Standard Output (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
77 to		Information for the 6th satellite		
83 to		Information for the 7th satellite		
89 to		Information for the 8th satellite		
95 to		Information for the 9th satellite		
101 to		Information for the 10th satellite		
107 to		Information for the 11th satellite		
113 to		Information for the 12th satellite		
119 to		Information for the 13th satellite		
125 to		Information for the 14th satellite		
131 to		Information for the 15th satellite		
137 to		Information for the 16th satellite		
143	0xxxxxxx	Preamplifier Check 0: Normal 1: Disconnected 2: Short circuit	2	02
144 to		Reserved		
150	110 10110	Terminator. “Z” + 80H	-	DA

1.2.2 Expanded Output

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
150	0xxx xxxx	Latitude 0.01 to 0.0001" value Value range: 0 to 99	0.0025"	19
151	0xxx xxxx	Longitude 0.01 to 0.0001" value Value range: 0 to 99	0.0091"	5B
152	0xxx xxxx	Speed 0.01 km/h value Value range: 0 to 9	0.03km/h	03
153	0xxx xxxx	Number of healthy satellites Value range: 0 to 32	15	0F
154 155 156	0xxx xxxx 0xxx xxxx 0xxx xxxx	Not related to user	-	-
157	0xxx xxxx	Not related to user	-	-
158	0xxx xxxx 0xxx xxxx	Not related to user	-	-
159	0xxx xxxx	SVACC Value range: 0 to 15	13	0D
160 161	0xxx xxxx 0xxx xxxx	Error major axis radius (1s estimated error) Resolution: 1m Value range: 0 to 510	130	01 02
162 163	0xxx xxxx 0xxx xxxx	Error minor axis radius (1s estimated error) Resolution: 1m Value range: 0 to 510	41	00 29
164 165	0xxx xxxx 0xxx xxxx	Error major axis inclination Resolution: 1° Value range: 0 to 179 Angle clockwise from north	165	01 25
166 167	0xxx xxxx 0xxx xxxx	HDOP value Resolution: 0.1 Value range: 0 to 999	51.2	04 00
168 169	0xxx xxxx 0xxx xxxx	VDOP value Resolution: 0.1 Value range: 0 to 999	51.2	04 00
170	0xxx xxxx	D-GPS measurement flag 0: Invalid 1: GPS measurement 2: D-GPS measurement	1	01
171 172	0xxx xxxx 0xxx xxxx	D-GPS station No. Value range: 0 to 1023	1023	07 7F
173	0xxx xxxx	D-GPS data elapsed time Resolution: 1s	1	01

1.2.2 Expanded Output (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
174	0xxx xxxx	DARC/RTCM mode 0: DARC 1: RTCM	1	01
175	0xxx xxxx	PDOP limit value when D-GPS is on	1	01
176	0xxx xxxx	HDOP limit value when D-GPS is on	1	01
177	0xxx xxxx	PDOP limit value when D-GPS is off	1	01
178	0xxx xxxx	HDOP limit value when D-GPS is off	1	01
179	0xxx xxxx	Angle of elevation limit value	1	01
180 181	0xxx xxxx 0xxx xxxx	Speed Limit Value	1	00 01
182 to		Reserved		
190	11011010	Terminator. “Z” + 80H	-	DA

1.2.3 Almanac Data Output

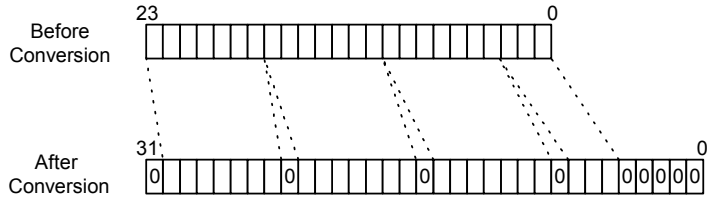
No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100100	Header		A4
2 44	0xxx xxxx 0xxx xxxx			01
45	11011010	Terminator. “Z” + 80H	-	DA

After the receiver receives an almanac output request, it transmits a response and then outputs the almanac data. The above format is for 1 frame of the almanac data, and 64 frames of this data are sent in succession. This data is sent by dividing the original almanac into 7-bit sections.

The almanac data stored in the GPS receiver memory has the configuration shown below. Normally each word of the almanac data has 6-bit parity, but this is eliminated when the data is stored in the memory. In addition, the 16-bit checksum is added to facilitate communication.

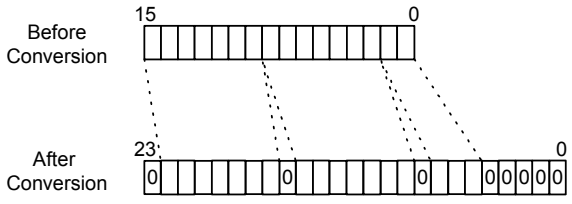
Word 1	24 bits
Word 2	24 bits
Word 3	24 bits
Word 4	24 bits
Word 5	24 bits
Word 6	24 bits
Word 7	24 bits
Word 8	24 bits
Word 9	24 bits
Word 10	24 bits
Checksum	16 bits

(1) Relationship between word data and conversion data



(2) Relationship between checksum and communication data

The relationship between the above Data and the communication data Is shown to the right.



1.3 Input Data

1.3.1 TM Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100000	Header	-	A0
2	0xxx xxxx	Year	1999	0F
3				4F
4	0xxx xxxx	Month	10	0A
5	0xxx xxxx	Date	29	1D
6	0xxx xxxx	Hour	8	08
7	0xxx xxxx	Minute	46	2E
8	0xxx xxxx	Second	59	3B
9	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.2 PT Command (receiver latitude and longitude initial value settings)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	A1
2	0xxx xxxx	Latitude	North latitude	0F
3	0xxx xxxx	Resolution: 0.01"	87° 29' 10.24"	02
4	0xxx xxxx	South latitude is two's complement	(= 314950.24")	26
5	0xxx xxxx	notation. Value range: 32400000 to –32400000		70
6	0xxx xxxx	Longitude	West longitude	61
7	0xxx xxxx	Resolution: 0.01"	175° 42' 30.11"	6B
8	0xxx xxxx	West longitude is two's complement	(= -632550.11")	1C
9	0xxx xxxx	notation. Value range: 64800000 to –64800000		1D
10	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.3 SK Command (receiver geodesic system parameter setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100010	Header	-	A2
2	0xxx xxxx	Geodesic system Value range: 0 to 25	18	12
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.4 AMI Command (receiver almanac data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100011	Header	-	A3
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response. The NAVI (PC) side receives this command and then sends the almanac data to the GPS side.

1.3.5 AMO command (transmit almanac data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.6 CD Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.7 SR command (wait 400ms and hot start)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100110	Header	-	A6
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.8 EL command (angle of elevation limit value setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100111	Header	-	A7
2	0xxx xxxx	Angle of elevation Resolution: 1° Value range: 0 to 90°	56°	38
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.9 BC command (clear DARC receive data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101000	Header	-	A8
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.10 DG command (D-GPS on/off setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	0xxx xxxx	D-GPS on/off setting 0: Off 1: On	1	1
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.11 TM Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101010	Header	-	AA
2	0xxx xxxx	PDOP threshold value when D-GPS is on	64	40
4	0xxx xxxx	HDOP threshold value when D-GPS is on	50	32
5	0xxx xxxx	PDOP threshold value when D-GPS is off	64	40
2	11011010	HDOP threshold value when D-GPS is off	50	32
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.12 DMD command (DARC data input mode)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101011	Header	-	AB
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.13 DMR command (RTCM data input mode)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101100	Header	-	AC
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.14 EX command (expanded output mode on/off)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101101	Header	-	AD
2	0xxx xxxx	Expanded output on/off setting 0: Off 1: On	1	1
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.15 SW command (eliminate ephemeris and warm start)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101110	Header	-	AE
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.16 TC command (current time mode setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101111	Header	-	AF
2	0xxx xxxx	Current time mode setting 0: UTC 1: JST	1	01
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.17 CH command (satellite No. setting during manual setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11000000	Header	-	C0
2	0xxx xxxx	Satellite Nos. for 16 channels	9	09
3	0xxx xxxx	Value range: 1 to 64	5	05
4	0xxx xxxx	0 is invalid	18	12
5	0xxx xxxx		1	01
6	0xxx xxxx		20	14
7	0xxx xxxx		2	02
8	0xxx xxxx		6	06
9	0xxx xxxx		12	0C
10	0xxx xxxx		-	-
11	0xxx xxxx		-	-
12	0xxx xxxx		-	-
13	0xxx xxxx		-	-
14	0xxx xxxx		-	-
15	0xxx xxxx		-	-
16	0xxx xxxx		-	-
17	0xxx xxxx		-	-
18	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.18 LF command (D-GPS valid time setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11000111	Header	-	C7
2	0xxx xxxx 0xxx xxxx	D-GPS valid time Resolution: s		
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

1.3.19 EP1 command (receive ephemeris data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11001101	Header	-	CD
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response. The NAVI (PC) side receives this command and then sends the ephemeris data to the GPS side.

1.3.20 EP0 command (transmit ephemeris data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11001101	Header	-	CD
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response, followed by the ephemeris data

1.3.21 VF command (heading filter value setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10110001	Header	-	B2
2	0xxx xxxx 0xxx xxxx	Heading filter value Resolution: 0.1km/h	999 (99.9km/h)	07 67
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

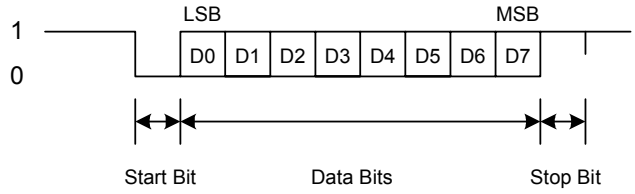
2.0 D-GPS Data Input Specification

2.1 Communication

2.1.1 Serial Input Communication Method

Interface:	Asynchronous serial interface (UART)
Baud rate:	9600 bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Communication control signal:	None
Input period:	1s or more

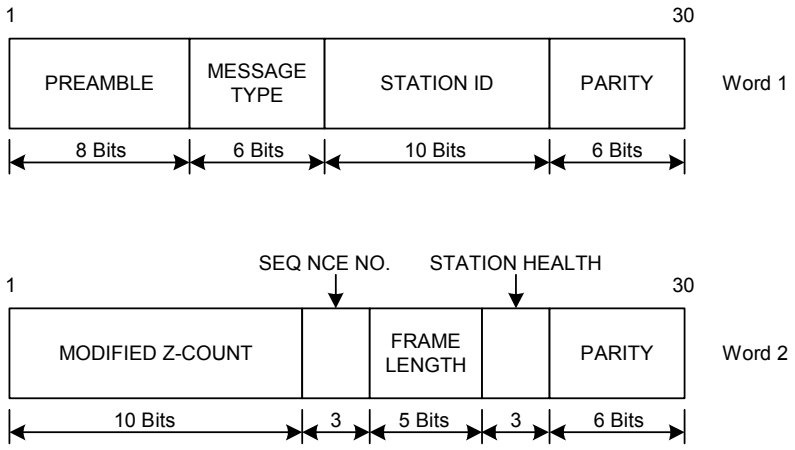
2.1.2 Asynchronous Serial Interface



2.2 RTCM Data Input

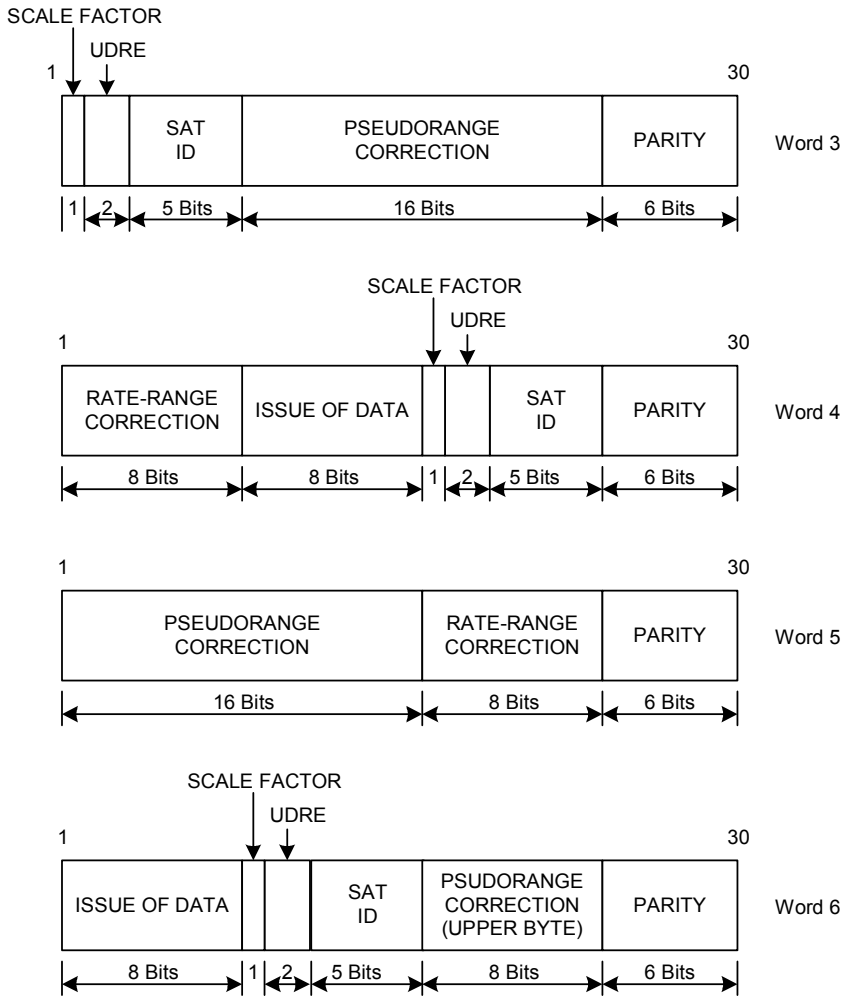
RTCM data input conforms to the RTCM SC-104 format and supports message type 1.
The message type shared header and message type 1 format are shown below. These data are sent in the "6 of 8" format. In this format, each word is divided into 6-bit units, the bits are reordered so that the LSB comes first and the MSB comes last, and then "01" is added to the head of the bits.

2.2.1 Message Type Shared Header

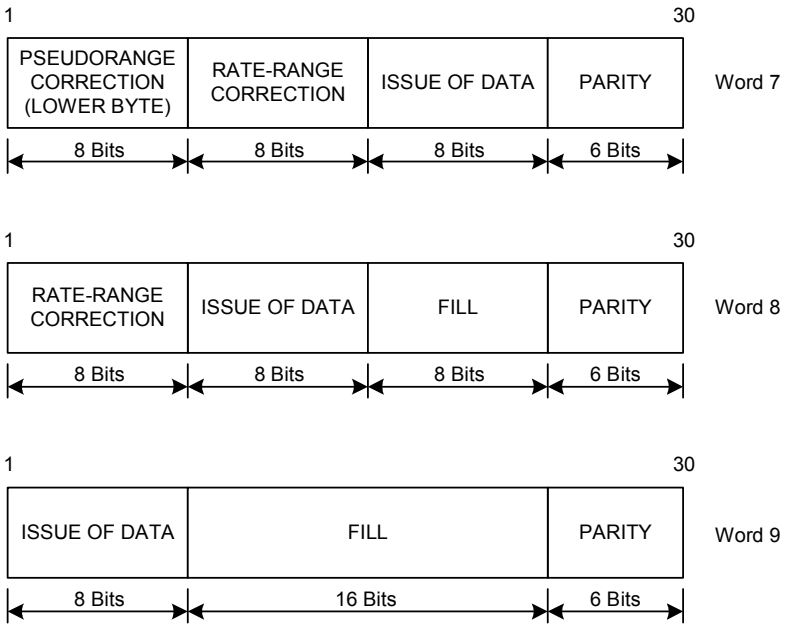


PREAMBLE:	Preamble
MESSAGE TYPE:	Message type
STATION ID:	Reference station ID No.
PARITY:	Error correction code
MODIFIED Z-COUNT:	Modified Z-count
SEQ NCE NO.:	Frame sequence No.
FRAME LENGTH:	Frame length
STATION HEALTH:	Reference station health

2.2.2 Message Type 1 (Differential GPS Correction Value)



SCALE FACTOR: Pseudorange correction value scale factor
UDRE: User differential range error index
SAT ID: Satellite ID No.
PSEUDORANGE CORRECTION: Pseudorange correction value
RANGE-RATE CORRECTION Pseudorange rate-of-change correction value
ISSUE OF DATA Data issue No.



FILL: Dummy Bits

2.3 DARC Data Input

DARC data is output in the communication format noted below. The D-GPS basic data is located in the D-GPS segments. The D-GPS basic data is comprised of 288 bits (36 bytes).

Data Packet 1 22 Bytes		Data Packet 2 22 Bytes			Checksum 1 Byte	Terminator 1 Byte
Prefix 4 Bytes	D-GPS Segment 18 Bytes	Prefix 2 Bytes	D-GPS Segment 18 Bytes	CRC 2 Bytes	xxh	0Dh

The D-GPS basic data configuration is as follows.

Bit Position	Description	Number of Bits
1 to 3	D-GPS data ID	3 bits
4	Correction time	1 bit
5 to 38	1st GPS satellite correction data	34 bits
39 to 72	2nd GPS satellite correction data	34 bits
73 to 106	3rd GPS satellite correction data	34 bits
107 to 140	4th GPS satellite correction data	34 bits
141 to 174	5th GPS satellite correction data	34 bits
175 to 208	6th GPS satellite correction data	34 bits
209 to 242	7th GPS satellite correction data	34 bits
243 to 276	8th GPS satellite correction data	34 bits
277 to 288	Communication data	12 bits

The GPS satellite correction data configuration is as follows.

Bit Position	Description	Number of Bits
1	Scale factor	1 bit
2 to 3	UDRE (User differential range error index)	2 bits
4 to 8	GPS satellite ID	5 bits
9 to 19	PRC (Pseudorange correction value)	11 bits
20 to 26	RRC (Pseudorange rate-of-change correction value)	7 bits
27 to 34	IODE (Ephemeris data issue No.)	8 bits

Geodetic System and Corresponding Country

Setting Value	Geodetic System	Reference Ellipsoid	Corresponding Country
0	WGS-84	WGS-84	
1	TOKYO	Bessel 1841	Japan, Korea
2	ADINDAN	Clarke 1880	Ethiopia, Mali, Senegal, Sudan
3	ARC 1950	Clarke 1880	Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe
	CAPE	Clarke 1880	South Africa
4	MERCHICH	Clarke 1880	Morocco
5	HONG KONG 1963	International	Hong Kong
6	SOUTH ASIA	Modified Fisher 1960	Singapore
7	LUZEN	Clarke 1866	Philippines
8	INDIAN	Everest	Thailand, Vietnam
9	INDIAN	Everest	Bangladesh, India, Nepal
10	KERTAU 1948	Modified Everest	West Malaysia, Singapore
11	NORTH AMERICAN 1927	Clarke 1866	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Mexico
12	EUROPEAN 1950 EUROPEAN 1950	International	Austria, Belgium, Cyprus, Channel Islands, Denmark, England, Finland, France, Germany, Gibraltar, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Scotland, Shetland Island, Spain, Sweden, Switzerland
13	IRELAND 1965	Modified Airy	Ireland
14	ORDNANCE SURVEY OF GREAT BRITAIN 1936	Airy	England, Isle of Man, Scotland, Shetland Island, Wales
15	NAHRWAN	Clarke 1880	Masirash Island, Oman, United Arab Emirates
16	NAHRWAN	Clarke 1880	Saudi Arabia
17	OLD EGYPTIAN	Helmert 1906	Egypt
18	NORTH AMERICAN 1927	Clarke 1866	Canada, Newfoundland Island
19	NORTH AMERICAN 1983	GRS 80	Alaska, Canada, Mexico, Central America, United States of America
20	AUSTRALIAN GEODETIC 1984	Australian National	Australia, Tasmania Island
21	GEODETIC DATUM 1949	International	New Zealand
22	PROVISIONAL SOUTH AMERICAN 1956	International	Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela
23	South American 1969	South American 1969	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Trinidad and Tobago, Venezuela
24	CAMPO INCHAUSPE	International	Argentina
25	CORREGO ALEGE	International	Brazil

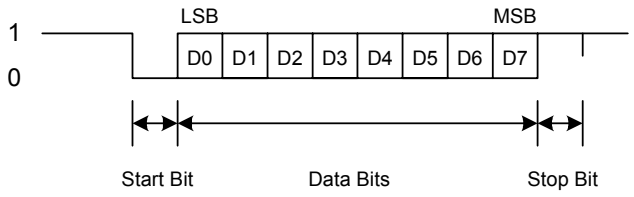
3.0 NMEA I/O Data Input/Output Specifications

3.1 Communication

3.1.1 Serial input/output communication method

Interface:	Asynchronous serial interface (UART)
Baud rate:	9600 bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Hardware Control:	None
Output period:	Approximately 1s

3.1.2 Asynchronous serial interface



3.2 Almanac Data Output

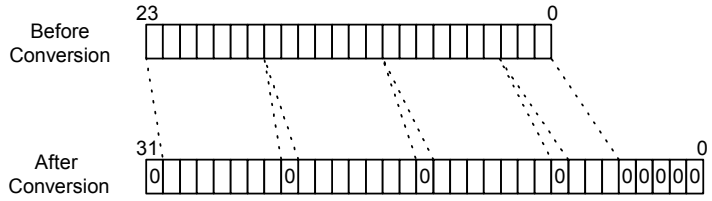
No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100100	Header		A4
2 44	0xxx xxxx 0xxx xxxx			01
45	11011010	Terminator. “Z” + 80H	-	DA

After the receiver receives an almanac output request, it transmits a response and then outputs the almanac data. The above format is for 1 frame of the almanac data, and 64 frames of this data are sent in succession. This data is sent by dividing the original almanac into 7-bit sections.

The almanac data stored in the GPS receiver memory has the configuration shown below. Normally each word of the almanac data has 6-bit parity, but this is eliminated when the data is stored in the memory. In addition, the 16-bit checksum is added to facilitate communication.

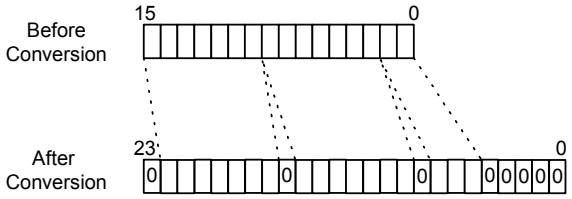
Word 1	24 bits
Word 2	24 bits
Word 3	24 bits
Word 4	24 bits
Word 5	24 bits
Word 6	24 bits
Word 7	24 bits
Word 8	24 bits
Word 9	24 bits
Word 10	24 bits
Checksum	16 bits

(1) Relationship between word data and conversion data



(3) Relationship between checksum and communication data

The relationship between the above Data and the communication data Is shown to the right.



3.3 Input Commands

3.3.1 TM Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100000	Header	-	A0
2	0xxx xxxx	Year	1999	0F
3				4F
4	0xxx xxxx	Month	10	0A
5	0xxx xxxx	Date	29	1D
6	0xxx xxxx	Hour	8	08
7	0xxx xxxx	Minute	46	2E
8	0xxx xxxx	Second	59	3B
9	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.2 PT Command (receiver latitude and longitude initial value settings)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	A1
2	0xxx xxxx	Latitude	North latitude	0F
3	0xxx xxxx	Resolution: 0.01"	87° 29' 10.24"	02
4	0xxx xxxx	South latitude is two's complement	(= 314950.24")	26
5	0xxx xxxx	notation. Value range: 32400000 to –32400000		70
6	0xxx xxxx	Longitude	West longitude	61
7	0xxx xxxx	Resolution: 0.01"	175° 42' 30.11"	6B
8	0xxx xxxx	West longitude is two's complement	(= -632550.11")	1C
9	0xxx xxxx	notation. Value range: 64800000 to –64800000		1D
10	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.3 SK Command (receiver geodesic system parameter setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100010	Header	-	A2
2	0xxx xxxx	Geodesic system Value range: 0 to 25	18	12
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.4 AMI Command (receiver almanac data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100011	Header	-	A3
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response. The NAVI (PC) side receives this command and then sends the almanac data to the GPS side.

3.3.5 AMO command (transmit almanac data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.6 CD Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.7 SR command (wait 400ms and hot start)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100110	Header	-	A6
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.8 EL command (angle of elevation limit value setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100111	Header	-	A7
2	0xxx xxxx	Angle of elevation Resolution: 1° Value range: 0 to 90°	56°	38
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.9 BC command (clear DARC receive data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101000	Header	-	A8
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.10 DG command (D-GPS on/off setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10100001	Header	-	
2	0xxx xxxx	D-GPS on/off setting 0: Off 1: On	1	1
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.11 TM Command (receiver clock setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101010	Header	-	AA
2	0xxx xxxx	PDOP threshold value when D-GPS is on	64	40
4	0xxx xxxx	HDOP threshold value when D-GPS is on	50	32
5	0xxx xxxx	PDOP threshold value when D-GPS is off	64	40
2	11011010	HDOP threshold value when D-GPS is off	50	32
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.12 DMD command (DARC data input mode)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101011	Header	-	AB
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.13 DMR command (RTCM data input mode)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101100	Header	-	AC
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.14 EX command (expanded output mode on/off)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101101	Header	-	AD
2	0xxx xxxx	Expanded output on/off setting 0: Off 1: On	1	1
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.15 SW command (eliminate ephemeris and warm start)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101110	Header	-	AE
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.16 TC command (current time mode setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10101111	Header	-	AF
2	0xxx xxxx	Current time mode setting 0: UTC 1: JST	1	01
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.17 CH command (satellite No. setting during manual setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11000000	Header	-	C0
2	0xxx xxxx	Satellite Nos. for 16 channels	9	09
3	0xxx xxxx	Value range: 1 to 64	5	05
4	0xxx xxxx	0 is invalid	18	12
5	0xxx xxxx		1	01
6	0xxx xxxx		20	14
7	0xxx xxxx		2	02
8	0xxx xxxx		6	06
9	0xxx xxxx		12	0C
10	0xxx xxxx		-	-
11	0xxx xxxx		-	-
12	0xxx xxxx		-	-
13	0xxx xxxx		-	-
14	0xxx xxxx		-	-
15	0xxx xxxx		-	-
16	0xxx xxxx		-	-
17	0xxx xxxx		-	-
18	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.18 LF command (D-GPS valid time setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11000111	Header	-	C7
2	0xxx xxxx 0xxx xxxx	D-GPS valid time Resolution: s		
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

3.3.19 EP1 command (receive ephemeris data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11001101	Header	-	CD
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response. The NAVI (PC) side receives this command and then sends the ephemeris data to the GPS side.

3.3.20 EP0 command (transmit ephemeris data)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	11001101	Header	-	CD
2	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response, followed by the ephemeris data

3.3.21 VF command (heading filter value setting)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data(HEX)
1	10110001	Header	-	B2
2	0xxx xxxx 0xxx xxxx	Heading filter value Resolution: 0.1km/h	999 (99.9km/h)	07 67
3	11011010	Terminator. “Z” + 80H	-	DA

After receiving the above command, the GPS side sends this command as a response.

4.0 NMEA Output Specifications

4.1 Output messages

4.1.1 GPGGA Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		Header	Fixed	24
1	0010 0100	“$”		
2		Address field	Fixed	
3	0100 0111	"G"		47
4	0101 0000	"P"		50
5	0100 0111	"G"		47
6	0100 0111	"G"		47
	0100 0001	"A"		41
7	01001100	“, "	Fixed	2C
		UTC time	06:22:43	
8	xxxxxxxx	Hour (10's digit)		00
9	xxxxxxxx	Hour (1's digit)		36
10	xxxxxxxx	Minute (10's digit)		32
11	xxxxxxxx	Minute (1's digit)		32
12	xxxxxxxx	Second (10's digit)		34
13	xxxxxxxx	Second (1's digit)		33
14	01001100	“, "	Fixed	2C
		Latitude	36° 03.979'	
15	xxxx xxxx	Degree (10's digit)		33
16	xxxx xxxx	Degree (1's digit)		36
17	xxxx xxxx	Minute (10's digit)		30
18	xxxx xxxx	Minute (1's digit)		33
19	0010 1110	“. "		2E
20	xxxx xxxx	Minute (0.1's digit)		39
21	xxxx xxxx	Minute (0.01's digit)		37
22	xxxx xxxx	Minute (0.001's digit)		39
23	0100 1100	“, "	Fixed	2C
24	xxxx xxxx	Latitude direction "N" or "S"	North latitude	4E
25	0100 1100	“, "	Fixed	2C
		Longitude	140° 10.296'	
26	xxxx xxxx	Degree (100's digit)		31
27	xxxx xxxx	Degree (10's digit)		34
28	xxxx xxxx	Degree (1's digit)		30
29	xxxx xxxx	Minute (10's digit)		31
30	xxxx xxxx	Minute (1's digit)		30
31	0010 1110	“. "		2E
32	xxxx xxxx	Minute (0.1's digit)		32
33	xxxx xxxx	Minute (0.01's digit)		39
34	xxxx xxxx	Minute (0.001's digit)		36

4.1.1 GPGGA Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
35	0100 1100	","	Fixed	2C
36	xxxx xxxx	Longitude direction "E" or "W"	West longitude	 57
37	0100 1100	","	Fixed	2C
38	xxxx xxxx	GPS Quality Indicator "0": Invalid "1": GPS measurement "2": D-GPS measurement	D-GPS measurement	32
39	0100 1100	","	Fixed	2C
40 41	xxxx xxxx xxxx xxxx	No. of satellites used for measurement calc. "00" to "12"	7-satellite measurement	30 37
42	0100 1100	","	Fixed	2C
43 44 45 46	xxxx xxxx xxxx xxxx 0010 1110 xxxx xxxx	HDOP 10's digit 1's digit "." 0.1's digit	1.2	 30 31 2E 32
47	0100 1100	","	Fixed	2C
48 49 50 51	xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx	Altitude (m) 1,000's digit 100's digit 10's digit 1's digit	23m	 30 30 32 33
52	0100 1100	","	Fixed	2C
53	0100 1101	Altitude units "M"	Fixed	 4D
54	0100 1100	","	Fixed	2C
55	0100 1100	","	Fixed	2C
56	0100 1101	"M"	Fixed	4D
57	0100 1100	","	Fixed	2C
58 59 60	xxxx xxxx xxxx xxxx xxxx xxxx	D-GPS data elapsed time (s) 100's digit 10's digit 1's digit	5s	 30 30 35
61	0100 1100	", "	Fixed	2C
62 63 64 65	xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx	D-GPS reference station ID 1,000's digit 100's digit 10's digit 1's digit	0	 30 30 30 30
66	0010 1010	" * "	Fixed	2A

4.1.1 GPGGA Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		Checksum	4A	
67	xxxx xxxx	Hexadecimal upper digits		34
68	xxxx xxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
69	00001101	<CR>		0D
70	00001010	<LF>		0A

The Geoidal Separation parameter is not output (between No. 54 and No. 55).

4.1.2 GPGLL Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
		Address field	Fixed	
2	0100 0111	"G"		47
3	0101 0000	"P"		50
4	0100 0111	"G"		47
5	0100 1100	"L"		4C
6	0100 1100	"L"		4C
7	0100 1100	“,"	Fixed	2C
		Latitude	36° 03.979'	
8	xxxx xxxx	Degree (10's digit)		33
9	xxxx xxxx	Degree (1's digit)		36
10	xxxx xxxx	Minute (10's digit)		30
11	xxxx xxxx	Minute (1's digit)		33
12	0010 1110	“."		2E
13	xxxx xxxx	Minute (0.1's digit)		39
14	xxxx xxxx	Minute (0.01's digit)		37
15	xxxx xxxx	Minute (0.001's digit		39
16	0100 1100	“,"	Fixed	2C
		Latitude direction	North latitude	
17	xxxx xxxx	"N" or "S"		4E
18	0100 1100	“,"	Fixed	2C
		Longitude	140° 10.296'	31 34 30
19	xxxx xxxx	Degree (100's digit)		31 30 2E
20	xxxx xxxx	Degree (10's digit)		32 39 36
21	xxxx xxxx	Degree (1's digit)		
22	xxxx xxxx	Minute (10's digit)		
23	xxxx xxxx	Minute (1's digit)		
24	0010 1110	“."		
25	xxxx xxxx	Minute (0.1's digit)		
26	xxxx xxxx	Minute (0.01's digit)		
27	xxxx xxxx	Minute (0.001's digit)		
28	0100 1100	“,"	Fixed	2C
		Longitude direction "E" or "W"	West longitude	
29	xxxx xxxx			57
30	0100 1100	“,"	Fixed	2C
		UTC time	06:22:43	
31	xxxx xxxx	Hour (10's digit) Hour (1's digit) Minute (10's		00
32	xxxx xxxx	digit) Minute (1's digit) Second (10's digit)		36
33	xxxx xxxx	Second (1's digit)		32
34	xxxx xxxx			32
35	xxxx xxxx			4
36	xxxx xxxx			33
37	0100 1100	“,"	Fixed	2C

4.1.2 GPGLL Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
38	xxxx xxxx	Status "A": Data valid "V": Data invalid	Valid	41
39	00101010	" * "	Fixed	2A
40 41	xxxx xxxx xxxx xxxx	Checksum Hexadecimal upper digits Hexadecimal lower digits	4A	34 41
42 43	0000 1101 0000 1010	Terminator <CR> <LF>	Fixed	 OD OA

4.1.3 GPGSA Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
2 3 4 5 6	01000111 01010000 01000111 01010011 01000001	Address field "G" "P" "G" "S" "A"	Fixed	 47 50 47 53 41
7	0100 1100	“,"	Fixed	2C
8	xxxx xxxx	GPS measurement switching mode "M": Manual "A": Auto	Fixed to "A"	41
9	0100 1100	“,"	Fixed	2C
10	xxxx xxxx	GPS measurement mode "1": Invalid "2": 2D measurement "3": 3D measurement	3D measurement	33
11	0100 1100	“,"	Fixed	2C
12 13 14	xxxx xxxx xxxx xxxx 0100 1100	Satellite Nos. used for measurement 1st satellite No. 10's digit 1's digit “, "		
15 to 17		2nd satellite No.		
18 to 20		3rd satellite No.		
21 to 23		4th satellite No.		
24 to 26		5th satellite No.		
27 to 29		6th satellite No.		
30 to 32		7th satellite No.		
33 to 35		8th satellite No.		
36 to 38		9th satellite No.		
39 to 41		10th satellite No.		
42 to 44		11th satellite No.		
45 to 47		12th satellite No.		
48 49 50 51	xxxx xxxx xxxx xxxx 0010 1110 xxxx xxxx	PDOP 10's digit 1's digit “." 0.1's digit	2.4	 30 32 2E 34
52	01001100	“, "	Fixed	2C

4.1.3 GPGSA Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		HDOP	1.2	
53	xxxx xxxx	10's digit		30
54	xxxx xxxx	1's digit		31
55	0010 1110	“.”		2E
56	xxxx xxxx	0.1's digit		32
57	0100 1100	“, ”	Fixed	2C
		VDOP	2.0	
58	xxxx xxxx	10's digit		30
59	xxxx xxxx	1's digit		32
60	0010 1110	“.”		2E
61	xxxx xxxx	0.1's digit		30
62	0010 1010	" * "	Fixed	2A
		Checksum	4A	
63	xxxx xxxx	Hexadecimal upper digits		34
64	xxxx xxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
65	0000 1101	<CR>		0D
66	0000 1010	<LF>		0A

The data length for "Satellite Nos. used for measurement" is variable in order to output the numbers of all the satellites used for position measurement.

4.1.4 GPGSV Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
2 3 4 5 6	01000111 01010000 01000111 01010011 01010110	Address field "G" "P" "G" "S" "V"	Fixed	47 50 47 53 56
7	01001100	“, "	Fixed	2C
8	xxxx xxxx	Total number of GPGSV messages "1" to "3"	2	32
9	01001100	“, "	Fixed	2C
10	xxxx xxxx	GPGSV message number "1" to "3"	1	31
11	01001100	“, "	Fixed	2C
12 13	xxxx xxxx xxxx xxxx	Number of satellites within field of vision 10's digit 1's digit	08	30 38
14	01001100	“, "	Fixed	2C
15 16 17 18 19 20 21 22 23 24 25 26 27	xxxx xxxx xxxx xxxx 0100 1100 xxxx xxxx xxxx xxxx 01001100 xxxx xxxx xxxx xxxx xxxx xxxx 01001100 xxxx xxxx xxxx xxxx 01001100	Information on satellites within field of vision for four satellites Satellite No. 10's digit 1's digit “, " Angle of elevation (°) 10's digit 1's digit “, " Azimuth (°) 100's digit 10's digit 1's digit “, " C/N (dB) 10's digit 1's digit “, "		
15 to 17		2nd satellite No.		
18 to 20		3rd satellite No.		
21 to 23		4th satellite No.		
67	00101010	" * "	Fixed	2A
68 69	xxxx xxxx xxxx xxxx	Checksum Hexadecimal upper digits Hexadecimal lower digits	4A	34 41

4.1.4 GPGSV Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		Terminator	Fixed	
70	0000 1101	<CR>		0D
71	0000 1010	<LF>		0A

The satellite information for up to four satellites can be sent with a single GPGSV message, so multiple GPGSV messages (up to three messages) are sent when there are four or more satellites within the field of vision. When there are fewer than four satellites, the information for that number of satellites is sent.

4.1.5 GPRMC Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
2 3 4 5 6	0100 0111 0101 0000 0101 0010 0100 1101 0100 0011	Address field "G" "P" "R" "M" "C"	Fixed	47 50 52 4D 43
7	0100 1100	“,"	Fixed	2C
8 9 10 11 12 13	xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx	UTC time Hour (10's digit) Hour (1's digit) Minute (10's digit) Minute (1's digit) Second (10's digit) Second (1's digit)	06:22:43	00 36 32 32 34 33
14	0100 1100	“,"	Fixed	2C
15	xxxxxxxx	Status "A": Data valid "V": Data invalid	Valid	41
16	0100 1100	“,"	Fixed	2C
17 18 19 20 21 22 23 24	xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx 0010 1110 xxxx xxxx xxxx xxxx xxxx xxxx	Latitude Degree (10's digit) Degree (1's digit) Minute (10's digit) Minute (1's digit) “. " Minute (0.1's digit) Minute (0.01's digit) Minute (0.001's digit)	36° 03.979'	33 36 30 33 2E 39 37 39
25	0100 1100	“,"	Fixed	2C
26	xxxx xxxx	Latitude direction "N" or "S"	North latitude	4E
27	0100 1100	“,"	Fixed	2C
28 29 30 31 32 33 34 35 36	xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx xxxx 0010 1110 xxxx xxxx xxxx xxxx xxxx xxxx	Longitude Degree (100's digit) Degree (10's digit) Degree (1's digit) Minute (10's digit) Minute (1's digit) “. " Minute (0.1's digit) Minute (0.01's digit) Minute (0.001's digit)	140° 10.296'	31 34 30 31 30 2E 32 39 36

4.1.2 GPRMC Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
37	0100 1100	“,"	Fixed	2C
38	xxxx xxxx	Longitude direction "E" or "W"	West longitude	57
39	0100 1100	“,"	Fixed	2C
		Speed (knots)	20knot/h	
40	xxxx xxxx	100's digit		30
41	xxxx xxxx	10's digit		32
42	xxxx xxxx	1's digit		30
43	0010 1110	“. "		2E
44	xxxx xxxx	0.1's digit		30
45	0100 1100	“,"	Fixed	2C
		Heading (°)	48.5°	
46	xxxx xxxx	100's digit		30
47	xxxx xxxx	10's digit		34
48	xxxx xxxx	1's digit		38
49	0010 1110	“. "		2E
50	xxxx xxxx	0.1's digit		35
51	0100 1100	“,"	Fixed	2C
		Date	July 13, 1999	
52	xxxx xxxx	10’s digit		31
53	xxxx xxxx	1's digit		33
		Month		
54	xxxx xxxx	10's digit		30
55	xxxx xxxx	1's digit		37
		Year		
56	xxxx xxxx	10’s digit		39
57	xxxx xxxx	1's digit		39
58	0100 1100	“,"	Fixed	2C
59	0100 1100	“,"	Fixed	2C
60	0010 1010	" * "	Fixed	2A
		Checksum	4A	
61	xxxx xxxx	Hexadecimal upper digits		34
62	xxxx xxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
63	0000 1101	<CR>		0D
64	0000 1010	<LF>		0A

The Magnetic Variation parameter is not output.
(Between No. 58 and No. 59, and between No. 59 and No. 60)

4.1.6 GPVTG Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
		Address field	Fixed	
2	0100 0111	"G"		47
3	0101 0000	"P"		50
4	0101 0110	"V"		56
5	0101 0100	"T"		54
6	0100 0111	"G"		47
7	0100 1100	“,"	Fixed	2C
		Heading (°)	48.5°	
8	xxxx xxxx	100's digit		30
9	xxxx xxxx	10's digit		34
10	xxxx xxxx	1’s digit		38
11	0010 1110	“. "		2E
12	xxxx xxxx	0.1's digit		35
13	0100 1100	“,"	Fixed	2C
14	0101 0100	"T"	Fixed	54
15	0100 1100	“,"	Fixed	2C
16	0100 1100	“,"	Fixed	2C
17	0100 1101	“M”	Fixed	4D
18	0100 1100	“,"	Fixed	2C
		Speed (knots)	20knot/h	
19	xxxx xxxx	100's digit		30
20	xxxx xxxx	10’s digit		32
21	xxxx xxxx	1's digit		30
22	0010 1110	“. "		2E
23	xxxx xxxx	0.1's digit		30
24	0100 1100	“,"	Fixed	2C
25	0100 1110	“N”	Fixed	4E
26	0100 1100	“,"	Fixed	2C
		Speed (km/h)	20knot/h	
27	xxxx xxxx	100's digit		30
28	xxxx xxxx	10’s digit		32
29	xxxx xxxx	1's digit		30
30	0010 1110	“. "		2E
31	xxxx xxxx	0.1's digit		30
32	0100 1100	“,"	Fixed	2C
33	0100 1011	“K”	Fixed	4B
34	0010 1010	" * "	Fixed	2A
		Checksum		
35	xxxx xxxx	Hexadecimal upper digits	4A	34
36	xxxx xxxx	Hexadecimal lower digits		41

4.1.6 GPVTG Message (Cont.)

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		Terminator	Fixed	
37	0000 1101	<CR>		0D
38	0000 1010	<LF>		0A

The Course Over Ground and Degree Magnetic parameters are not output. (Between No. 15 and No. 16)

4.1.7 GPZDA Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
		Header	Fixed	24
1	0010 0100	“$”		
		Address field	Fixed	
2	0100 0111	"G"		47
3	0101 0000	"P"		50
4	0101 1010	"Z"		5A
5	0100 0100	"D"		44
6	0100 0001	"A"		41
7	0100 1100	“,"	Fixed	2C
		UTC time	06:22:43	
8	xxxx xxxx	Hour (10's digit)		00
9	xxxx xxxx	Hour (1's digit)		36
10	xxxx xxxx	Minute (10's digit)		32
11	xxxx xxxx	Minute (1's digit)		32
12	xxxx xxxx	Second (10's digit)		34
13	xxxx xxxx	Second (1's digit)		33
14	0100 1100	“,"	Fixed	2C
		Date	13^{th}	
15	xxxx xxxx	10’s digit		31
16	xxxx xxxx	1's digit		33
17	0100 1100	“,"	Fixed	2C
		Month	July	
18	xxxx xxxx	10's digit		30
19	xxxx xxxx	1's digit		37
20	0100 1100	“,"	Fixed	2C
		Year 10’s digit 1's digit	1999	
21	xxxx xxxx			39
22	xxxx xxxx			39
23	0100 1100	“,"	Fixed	2C
24	0100 1100	“,"	Fixed	2C
25	0010 1010	" * "	Fixed	2A
		Checksum	4A	
26	xxxx xxxx	Hexadecimal upper digits		34
27	xxxx xxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
28	0000 1101	<CR>		0D
29	0000 1010	<LF>		0A

The Local Zone Description parameter is not output. (Between No. 23 and No. 24, and between No. 24 and No. 25)

4.1.8 PSNY Message

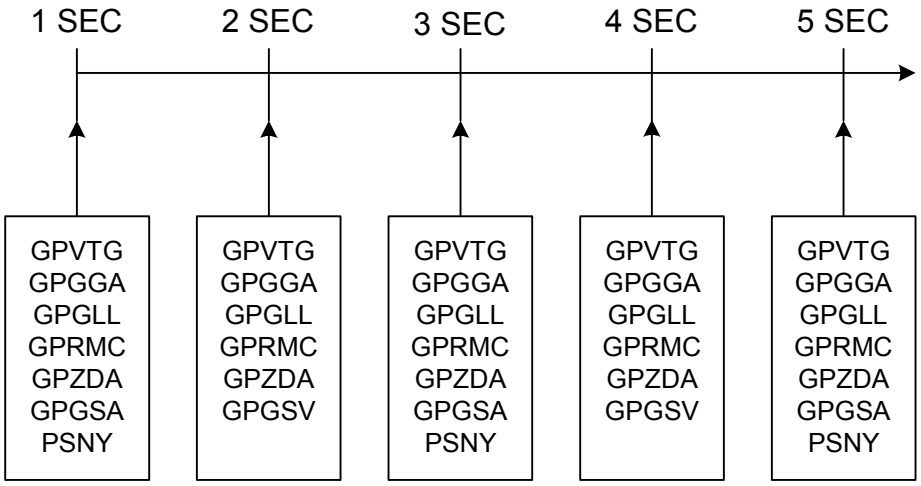
No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
1	0010 0100	Header “$”	Fixed	24
2 3 4 5	01010000 01010011 01011110 01011001	Address field "P" "S" "N" "Y"	Fixed	 50 53 5E 49
6	0100 1100	“,"	Fixed	2C
7	xxxx xxxx	Preamplifier status "0": Normal "1": Open "2": Shorted	Open	31
8	0100 1100	“,"	Fixed	2C
9 10	xxxx xxxx xxxx xxxx	Geodesic system "0" to "25"	WGS-84	 30 30
11	0100 1100	“,"	Fixed	2C
12 13	xxxx xxxx xxxx xxxx	Angle of elevation limit (°) 10's digit 1's digit	5°	 30 35
14	0100 1100	“,"	Fixed	2C
15 16 17	xxxx xxxx xxxx xxxx xxxx xxxx	Speed limit (km/h) 100's digit 10's digit 1's digit	500km/h	 35 30 30
18	0100 1100	“,"	Fixed	2C
19 20	xxxx xxxx xxxx xxxx	PDOP limit (D-GPS on) 10's digit 1's digit	4	 30 34
21	0100 1100	“,"	Fixed	2C
22 23	xxxx xxxx xxxx xxxx	HDOP limit (D-GPS on) 10's digit 1's digit	6	 30 36
24	0100 1100	“,"	Fixed	2C
25 26	xxxx xxxx xxxx xxxx	PDOP limit (D-GPS off) 10's digit 1's digit	4	 30 34
27	0100 1100	“,"	Fixed	2C
28 29	xxxx xxxx xxxx xxxx	HDOP limit (D-GPS off) 10's digit 1's digit	6	 30 36

4.1.8 PSNY Message

No.	Bit 76543210	Description	Example	
			Setting Value	Output Data (HEX)
30	0010 1010	" * "	Fixed	2A
		Checksum	4A	
31	xxxx xxxx	Hexadecimal upper digits		34
32	xxxx xxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
33	0000 1101	<CR>		0D
34	0000 1010	<LF>		0A

4.2 Output Timing

1 Second Period: GPVTG, GPGGA, GPGLL, GPRMC, GPZDA
2 Second Period: GPGSA, PSNY, GPGSV



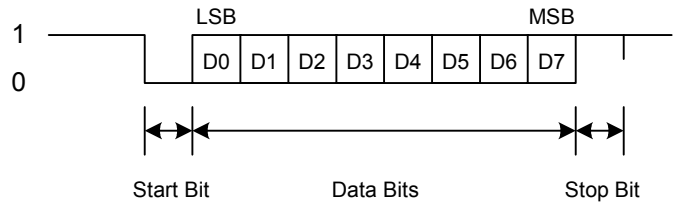
5.0 D-GPS Data Input Specification

5.1 Communication

5.1.1 Serial Input Communication Method

Interface:	Asynchronous serial interface (UART)
Baud rate:	9600 bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Communication control signal:	None
Input period:	1s or more

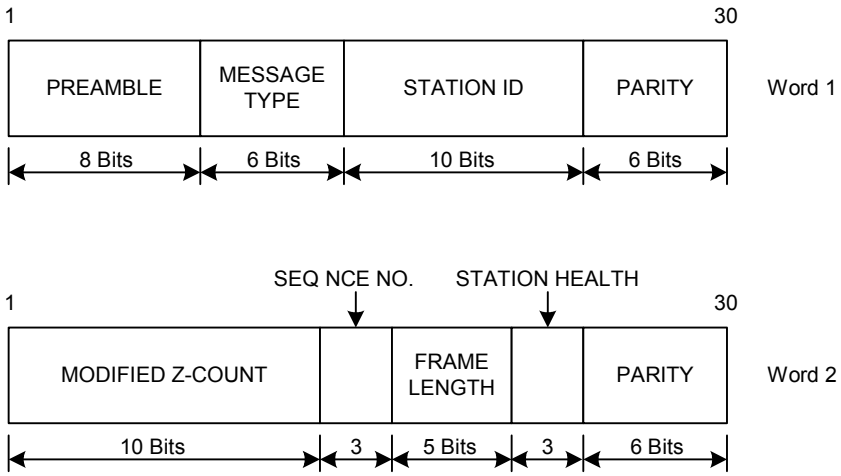
5.1.2 Asynchronous Serial Interface



5.2 RTCM Data Input

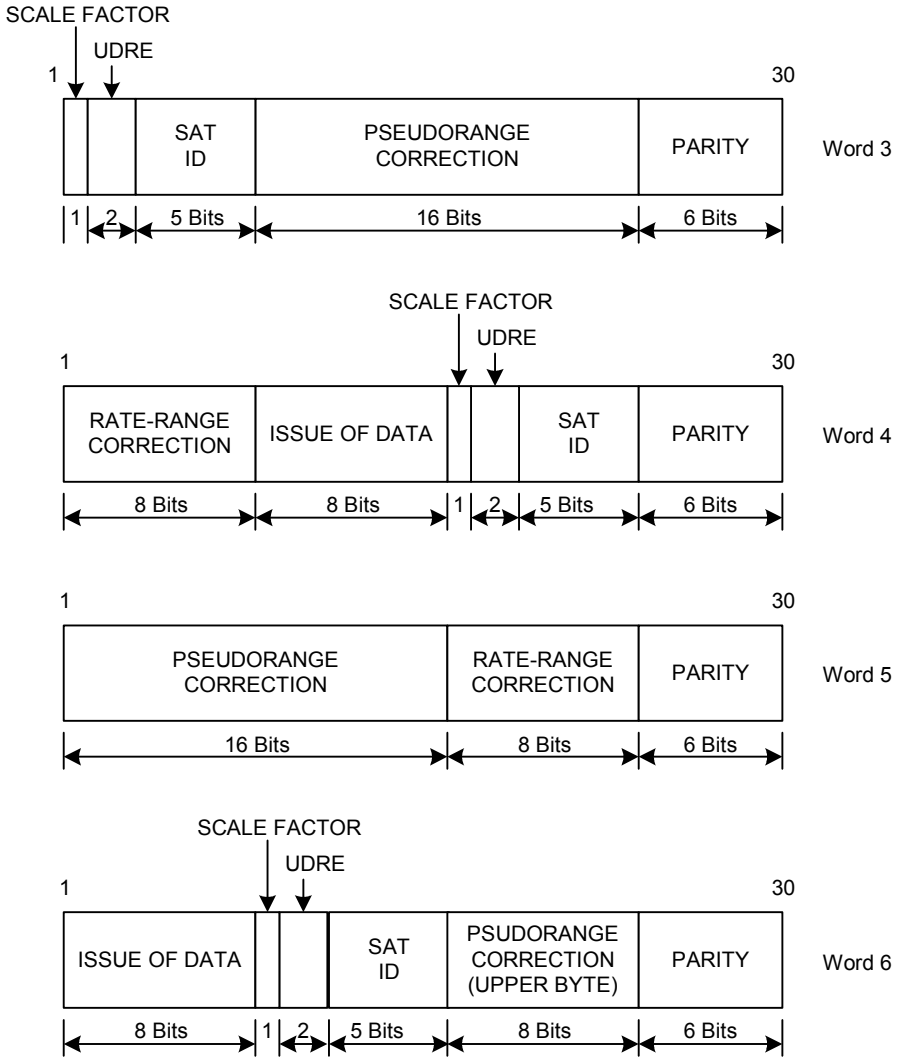
RTCM data input conforms to the RTCM SC-104 format and supports message type 1.
The message type shared header and message type 1 format are shown below. These data are sent in the "6 of 8" format. In this format, each word is divided into 6-bit units, the bits are reordered so that the LSB comes first and the MSB comes last, and then "01" is added to the head of the bits.

5.2.1 Message Type Shared Header

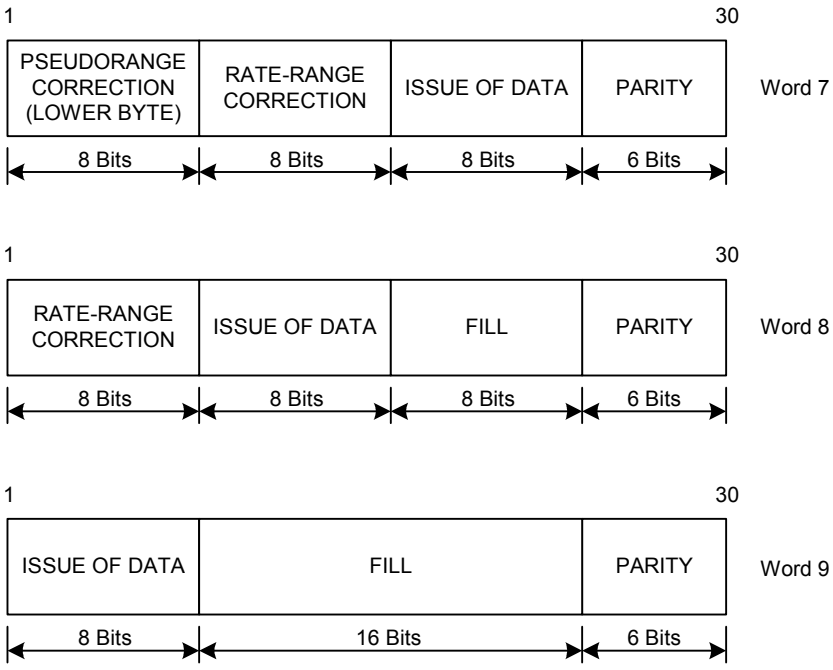


PREAMBLE:	Preamble
MESSAGE TYPE:	Message type
STATION ID:	Reference station ID No.
PARITY:	Error correction code
MODIFIED Z-COUNT:	Modified Z-count
SEQ NCE NO.:	Frame sequence No.
FRAME LENGTH:	Frame length
STATION HEALTH:	Reference station health

5.2.2 Message Type 1 (Differential GPS Correction Value)



SCALE FACTOR:	Pseudorange correction value scale factor
UDRE:	User differential range error index
SAT ID:	Satellite ID No.
PSEUDORANGE CORRECTION:	Pseudorange correction value
RANGE-RATE CORRECTION	Pseudorange rate-of-change correction value
ISSUE OF DATA	Data issue No.



FILL: Dummy Bits

5.3 DARC Data Input

DARC data is output in the communication format noted below. The D-GPS basic data is located in the D-GPS segments. The D-GPS basic data is comprised of 288 bits (36 bytes).

Data Packet 1 22 Bytes		Data Packet 2 22 Bytes			Checksum 1 Byte	Terminator 1 Byte
Prefix 4 Bytes	D-GPS Segment 18 Bytes	Prefix 2 Bytes	D-GPS Segment 18 Bytes	CRC 2 Bytes	xxh	0Dh

The D-GPS basic data configuration is as follows.

Bit Position	Description	Number of Bits
1 to 3	D-GPS data ID	3 bits
4	Correction time	1 bit
5 to 38	1st GPS satellite correction data	34 bits
39 to 72	2nd GPS satellite correction data	34 bits
73 to 106	3rd GPS satellite correction data	34 bits
107 to 140	4th GPS satellite correction data	34 bits
141 to 174	5th GPS satellite correction data	34 bits
175 to 208	6th GPS satellite correction data	34 bits
209 to 242	7th GPS satellite correction data	34 bits
243 to 276	8th GPS satellite correction data	34 bits
277 to 288	Communication data	12 bits

The GPS satellite correction data configuration is as follows.

Bit Position	Description	Number of Bits
1	Scale factor	1 bit
2 to 3	UDRE (User differential range error index)	2 bits
4 to 8	GPS satellite ID	5 bits
9 to 19	PRC (Pseudorange correction value)	11 bits
20 to 26	RRC (Pseudorange rate-of-change correction value)	7 bits
27 to 34	IODE (Ephemeris data issue No.)	8 bits