SONY

GXB1000

16-Channel GPS Receiver Module

Description

The GXB1000 is a 16-channel GPS receiver module. The GXB1000 is a small and light device, and it includes all the functions required for GPS except for the antenna.

The GXB1000 can support the various kinds of the portable applications as well as the car navigation system.

Features

- 16-channel GPS receiver capable of simultaneously receiving 16 satellites
- All-in-view measurement
- 2-satellite measurement
- D-GPS (Differential GPS)
  - RTCM SC104 version 2.1
  - DARC BTA R-003 standard
- Low current consumption (275mW, typ.)
- Small and light package type
- The countermeasure of EMI (electromagnetic wave impediment)

Recommended Operating Conditions

• Supply voltage	(3V spec.)	V_{DD}	3.0 to 3.6	V
	(5V spec.)	V_{CC}	4.5 to 5.5	V
• Operating temperature		Topr	–40 to +85	°C

GPS (Global Positioning System) is the position measurrment system that the U.S. control and operate. It have some posibility of the position measurement deterioration that depends on the working GPS.
It dose not gurantee the standard,etc in this material including the case above.

E99657-PS

Specification

Specification of reception unit

Reception method		Parallel 16 channels
RF input	Reception frequency	1575.42MHz L1 band, C/A code
	Characteristics impedance	50Ω
	Reception sensitivity	–130dBm or less (Sony's recommended anntena input level)
Positioning system		WGS-84
Positioning accuracy	Position	100m 2DRMS (SA ON, PDOP = 2.5, HDOP = 1.5)
	Velocity	0.9m/s (SA ON, PDOP = 2.5, HDOP = 1.5)
Positioning condition		A) DOP limit 3D: PDOP ≤ 12 2D: HDOP ≤ 6 B) Elevation mask: 5° or more
Follow-up performance	Velocity	500km/h or less
	Acceleration	2G or less
Measured data update time		Every 1s
D-GPS function		DARC BTA R-003 standard RTCM SC104 version 2.1 (6 of 8 format) Using type 1 data for correct caluculation
Measurement method		All-in-view measurement 2-satellite measurement

TTFF (No signal break) *1

Hot Start (time, position, with ephemeris and almanac)
7 to 20s

Warm Start (time, position, without ephemeris, with almanac)
33 to 50s

Cold Start (time, position, without ephemeris and almanac)
35 to 60s

Reacquisition Time (interrupt recovery time)

The case of the interrupt less than 5 minutes	2 to 6s
The case of the interrupt more than 5 minutes	6 to 10s

*1 Condition: The case of meeting positioning condition and receiving 8 satellites continuously and normally.

Conditons of Cold Start	Abnormal RAM data and abnormal RTC data for the command input
RF input connector	JST: CN connector
I/O connector (Power supply, data mode)	JST: SM10B-SRSS

Communication Specification

Communication method	Start-stop synchronization
Transfer rate input/output	9600bps
Electric level	TTL level
I/O code	ASCII code
Communication format	Sony/NMEA0183 switching possible

Electrical Specification

Supply voltage (3V spec.)	3.1 to 3.6V Ripple 50mVp-p or less
(5V spec.)	4.5 to 5.5V Ripple 50mVp-p or less
Current consumption	83mA typ. (Vcc = 3.3V, 25°C)
Backup supply voltage	1.8 to 3.0V
current	30µA typ. (+B = 3.0V, 25°C)
	70µA max. (+B = 3.0V, 85°C)
Pre-amplifier power supply	2.7 to 3.6V, 10 to 30mA
Operating temperature	–40 to +85°C

I/O Connector Pin

Pin Configuration

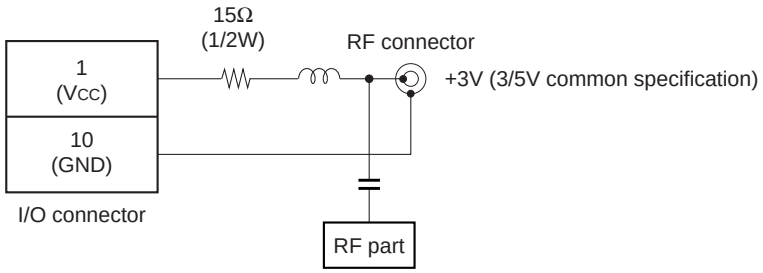
Pin No.	Symbol	I/O	Description
1	V_{CC}	—	Main power supply.
2	RESET	I	Reset input for initializing the reception unit.
3	TXD0	O	Measured data output.
4	RXD0	I	Command input.
5	RXD1	I	D-GPS data input.
6	MODE	I	Communication format switching pin. (L = Sony, H = NMEA0183)
7	NC	—	Fixed H level.
8	+BU	—	Power supply for backup.
9	NC	—	No connection.
10	GND	—	GND

Electrical Characteristics

(Topr = –40 to +85°C)

Item		Symbol	Conditions	Min.	Typ.	Max.	Unit	Applicable pins
Supply voltage	3V spec.	V_{DD}		3.0	3.3	3.6	V	1
	5V spec.	Vcc		4.5	5.0	5.5		
Input voltage	H level	V_{IH}		0.7V_{DD}		5.5	V	2, 4, 5
	L level	V_{IL}				0.2V_{DD}		
Output voltage	H level	V_{OH}	I_{OH} = –4mA	V_{DD} – 0.8			V	3
	L level	V_{OL}	I_{OL} = 4mA			0.4		
Backup supply voltage				1.8		3.0	V	8
Current consumption at backup			+BU = 3V	5	30	70	µA	8

Antenna Pre-amplifier Power Supply Circuit



Sony Recommend Antenna Specification

Antenna part

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

Pre-amplifier part

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

All-round specification (antenna + pre-anplifire + cable loss)

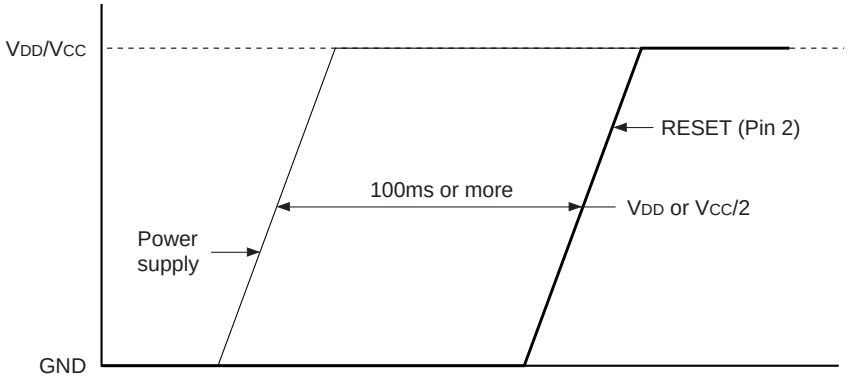
Gain	17dBi or more (Angle of elevation = 90°)
Output impedance	50Ω
Output VSWR	2.0 or less
Supply voltage	2.8 to 3.2V
Current consumption	30mA or less

Reception Unit Initialization and Operation

The GXB1000 operation is started by setting the reset input signal RESET (Pin 2) for the reception unit initialization to high level. The timing should satisfy the conditions noted below.

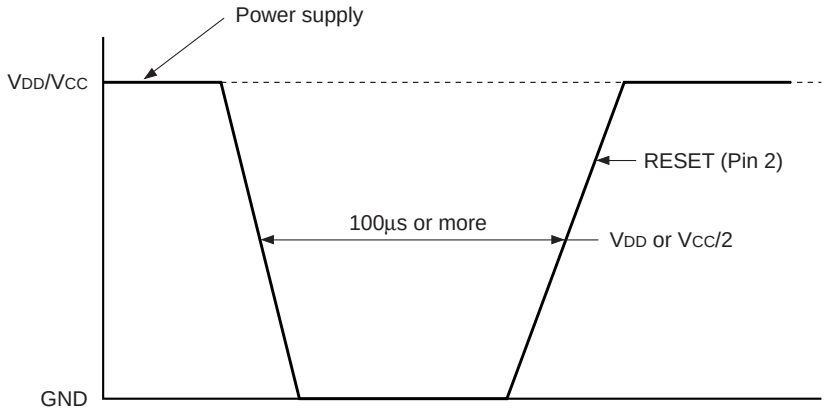
During Power-on (power-on reset)

V_{DD} = 3.0 to 3.6V, V_{CC} = 4.5 to 5.5V, temperature = –40 to +85°C

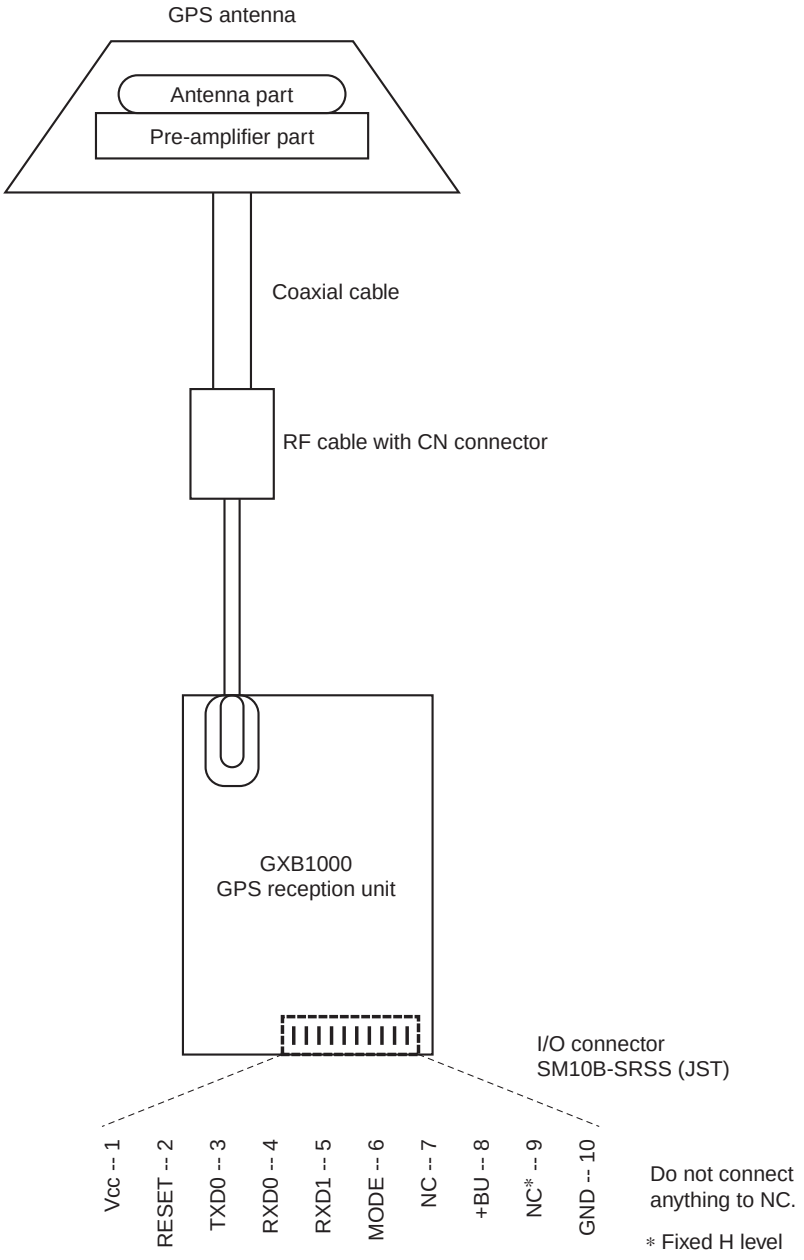


Initialization During Operation

V_{DD} = 3.0 to 3.6V, V_{CC} = 4.5 to 5.5V, temperature = –40 to +85°C



GXB1000 GPS Reception Unit Composition



GXB1000 GPS Reception Unit External Figure (Connector type)

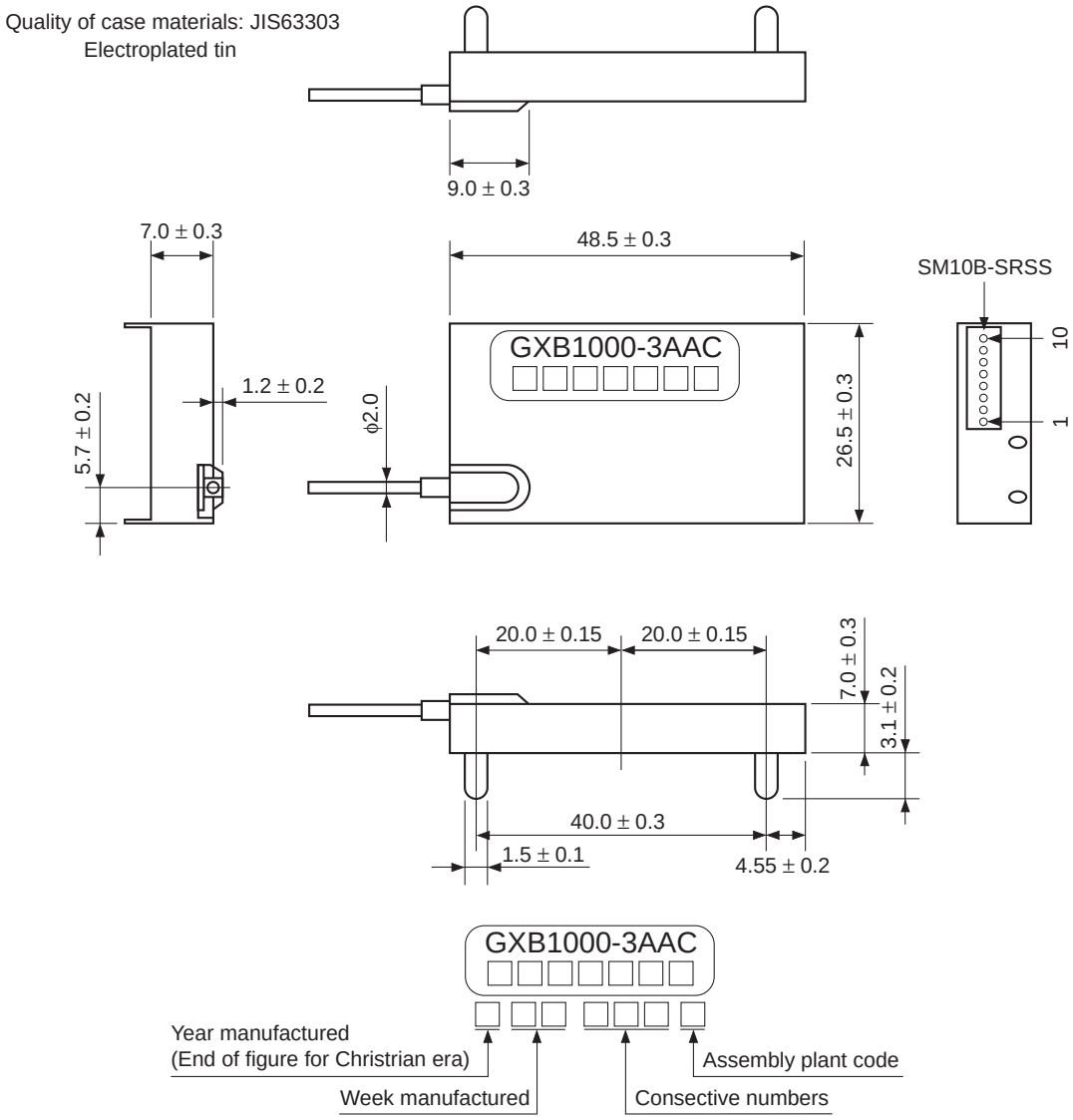
Specification of form name

GXB10○○-□□□C

- Advance of software: An English letter (A to Z)
- Advance of hardware: An English letter (A to Z)
- Supply voltage: 3V spec. = 3, 5V spec. = 5
- Customer code: Figure (0 to 99)

Package Outline

Unit: mm



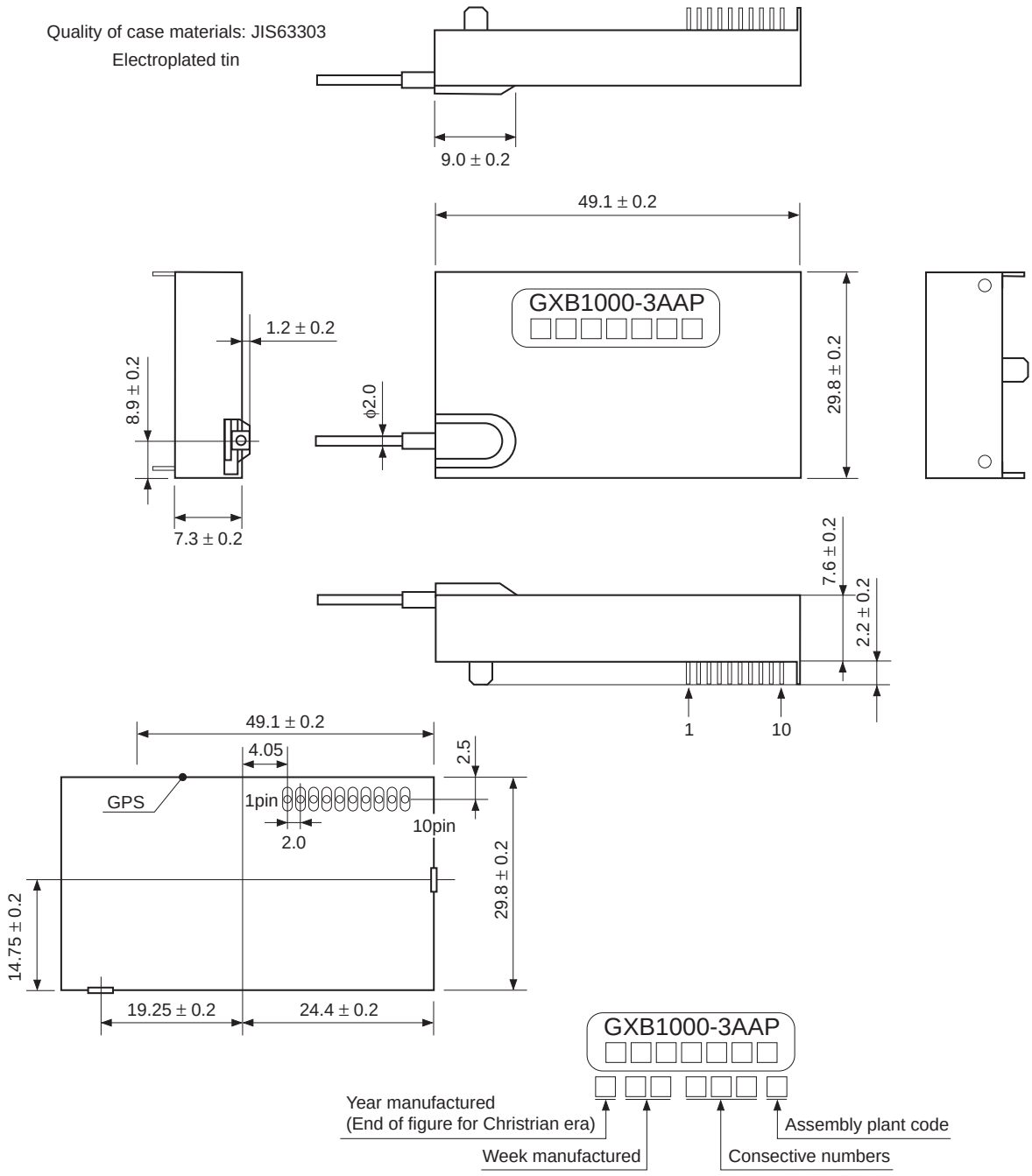
GXB1000 GPS Reception Unit External Figure (Pin type)

Specification of form name

GXB10○○-□□□P

- Advance of software: An English letter (A to Z)
- Advance of hardware: An English letter (A to Z)
- Supply voltage: 3V spec. = 3, 5V spec. = 5
- Customer code: Figure (0 to 99)

Package Outline Unit: mm



GPS Receiver
Data Input/Output Specifications

Contents

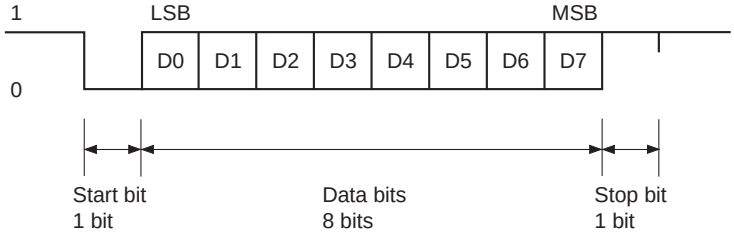
1. I/O Data Input/Output Specifications

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
Communication control signal:	None
Output period:	Approximately 1s

1-1-2. Asynchronous serial interface



1-2. Output Data

1-2-1. Standard output

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	11010000	Header	—	D0
2	0xxxxxxx	Software version information	01	01
3 4 5 6	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Latitude Resolution: 0.01" South latitude is two's complement notation. Value range: 32400000 to –32400000	North latitude 87° 29' 10.24" (= 314950.24")	0F 02 26 70
7 8 9 10	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Longitude Resolution: 0.01" West longitude is two's complement notation. Value range: 64800000 to –64800000	West longitude 175° 42' 30.11" (= –632550.11")	61 6B 1C 1D
11 12	0xxxxxxx 0xxxxxxx	Altitude Resolution: 1m Negative altitude is two's complement notation. Value range: 8191 to –8191	3775m	00 1D 3F
13 14	0xxxxxxx 0xxxxxxx	Speed Resolution: 0.1km/h Value range: 0 to 5150	60.5km/h	04 5D
15 16	0xxxxxxx 0xxxxxxx	Direction Resolution: 0.1° Value range: 0 to 3599	310.7°	18 23
17 18	0xxxxxxx 0xxxxxxx	PDOP value Resolution: 0.1 Value range: 0 to 999	51.2	04 00
19	0xxxxxxx	Current time mode 0: UTC time 1: JST time	1	01
		Current time		
20	0xxxxxxx	Year	1999	0F
21	0xxxxxxx	Year		4F
22	0xxxxxxx	Month	02	02
23	0xxxxxxx	Date	22	16
24	0xxxxxxx	Hour	12	0C
25	0xxxxxxx	Minute	54	36
26	0xxxxxxx	Second	46	2E
27	0xxxxxxx	Day	01	01
		Measurement calculation time		
28	0xxxxxxx	Year	1999	0F
29	0xxxxxxx	Year		4F
30	0xxxxxxx	Month	02	02
31	0xxxxxxx	Date	22	16
32	0xxxxxxx	Hour	12	0C
33	0xxxxxxx	Minute	55	37
34	0xxxxxxx	Second	30	1E

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
35	0xxxxxxx	Number of visible satellites Value range: 0 to 32	8	08
36 37 38 39 40 41 42 43	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	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	0xxxxxxx	Measurement calculation mode 0: Invalid 1: 2-satellite measurement 2: 3-satellite measurement 3: 4-(or more) satellite measurement	1	01
45	0xxxxxxx	Geodesic system Value range: 0 to 25	18	12
46	0xxxxxxx	Measurement delay time Resolution: 0.1s Value range: 0 to 9	0.4s	04
		Information for 1st satellite		
47	0xxxxxxx	Satellite No. Value range: 0 to 32	16	10
48 49	0xxxxxxx 0xxxxxxx	Azimuth Resolution: 1° Value range: 0 to 359°	218°	01 5A
50	0xxxxxxx	Angle of elevation Resolution: 1° Value range: 0 to 90°	56°	38
51	0xxxxxxx	Reception status 0: Searching 1: Acquired 2: Usable for calculation 3: Radio waves cut off; interpolating 4: Satellite Unhealth 5: Currently being used for position calculation	3	03
52	0xxxxxxx	Signal level Resolution: 1dBHz Value range: 0 to 100	100	64
53 to		Information for 2nd satellite		
59 to		Information for 3rd satellite		
65 to		Information for 4th satellite		
71 to		Information for 5th satellite		

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
77 to		Information for 6th satellite		
83 to		Information for 7th satellite		
89 to		Information for 8th satellite		
95 to		Information for 9th satellite		
101 to		Information for 10th satellite		
107 to		Information for 11th satellite		
113 to		Information for 12th satellite		
119 to		Information for 13th satellite		
125 to		Information for 14th satellite		
131 to		Information for 15th satellite		
137 to		Information for 16th satellite		
143 to	0xxxxxxx	Preamplifier check 0: Normal, 1: Disconnected, 2: Short circuit	2	02
144 to		Reserved		
150	1101101	Terminator. "Z" + 80H	—	DA

1-2-2. Expanded output

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
150	0xxxxxxx	Latitude 0.001 to 0.0001" value Value range: 0 to 99	0.0025"	19
151	0xxxxxxx	Longitude 0.001 to 0.0001" value Value range: 0 to 99	0.0091"	5B
152	0xxxxxxx	Speed 0.01 km/h value Value range: 0 to 9	0.03km/h	03
153	0xxxxxxx	Number of healthy satellites Value range: 0 to 32	15	0F
154 155 156	0xxxxxxx 0xxxxxxx 0xxxxxxx	Not related to user	—	—
157	0xxxxxxx	Not related to user	—	—
158	0xxxxxxx	Not related to user	—	—
159	0xxxxxxx	SVACC Value range: 0 to 15	13	0D
160 161	0xxxxxxx 0xxxxxxx	Error major axis radius (1σ estimated error) Resolution: 1m Value range: 0 to 510	130	01 02
162 163	0xxxxxxx 0xxxxxxx	Error minor axis radius (1σ estimated error) Resolution: 1m Value range: 0 to 510	41	00 29
164 165	0xxxxxxx 0xxxxxxx	Error major axis inclination Resolution: 1° Value range: 0 to 179 Angle clockwise from north	165	01 25
166 167	0xxxxxxx 0xxxxxxx	HDOP value Resolution: 0.1 Value range: 0 to 999	51.2	04 00
168 169	0xxxxxxx 0xxxxxxx	VDOP value Resolution: 0.1 Value range: 0 to 999	51.2	04 00
170	0xxxxxxx	D-GPS measurement flag 0: Invalid 1: GPS measurement 2: D-GPS measurement	1	01
171 172	0xxxxxxx 0xxxxxxx	D-GPS station No. Value range: 0 to 1023	1023	07 7F
173	0xxxxxxx	D-GPS data elapsed time Resolution: 1s	1	01

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
174	0xxxxxxx	DARC/RTCM mode 0: DARC 1: RTCM	1	01
175	0xxxxxxx	PDOP limit value when D-GPS is on	1	01
176	0xxxxxxx	HDOP limit value when D-GPS is on	1	01
177	0xxxxxxx	PDOP limit value when D-GPS is off	1	01
178	0xxxxxxx	HDOP limit value when D-GPS is off	1	01
179	0xxxxxxx	Angle of elevation limit value	1	01
180 181	0xxxxxxx 0xxxxxxx	Speed limit value	1	00 01
182 to		Reserved		
190	1101101	Terminator. "Z" + 80H	—	DA

1-2-3. Almanac data output

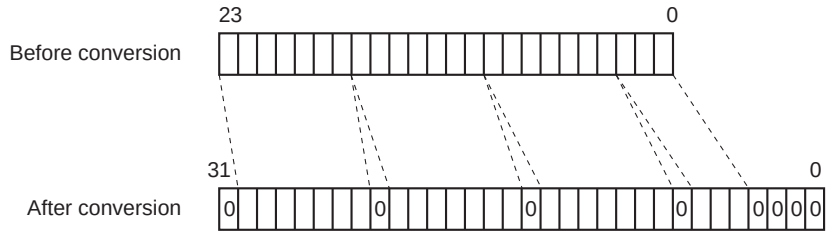
No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	10100100	Header		A4
2 44	0xxxxxxx 0xxxxxxx			
45	11011010	Terminator. "Z" + 80H	—	DA

After the receiver receives an almanac output request, it transmits a response and then outputs the almanac data. The above format is for 1 subframe of the almanac data, and 64 frames of this data are sent in succession. Almanac communication data is sent by dividing the original data 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, a 16-bit checksum is added in consideration of communication.

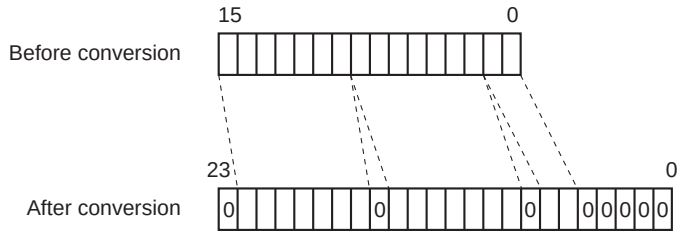
WORD1	24 bits
WORD2	24 bits
WORD3	24 bits
WORD4	24 bits
WORD5	24 bits
WORD6	24 bits
WORD7	24 bits
WORD8	24 bits
WORD9	24 bits
WORD10	24 bits
Checksum	16 bits

(1) Relationship between word data and communication 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	Contents	Example	
			Setting value	Input data (HEX)
1	10100000	Header	—	A0
2 3	0xxxxxxx 0xxxxxxx	Year	1999	0F 4F
4	0xxxxxxx	Month	10	0A
5	0xxxxxxx	Date	29	1D
6	0xxxxxxx	Hour	8	08
7	0xxxxxxx	Minute	46	2E
8	0xxxxxxx	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100001	Header	—	A1
2 3 4 5	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Latitude Resolution: 0.01" South latitude is two's complement notation. Value range: 32400000 to –32400000	North latitude 87° 29' 10.24" (= 314950.24")	0F 02 26 70
6 7 8 9	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Longitude Resolution: 0.01" West longitude is two's complement notation. Value range: 64800000 to –64800000	West longitude 175° 42' 30.11" (= –632550.11")	61 6B 1C 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	Contents	Example	
			Setting value	Input data (HEX)
1	10100010	Header	—	A2
2	0xxxxxxx	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 (receive almanac data)

No.	BIT 76543210	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	10100100	Header	—	A4
2	11011010	Terminator. "Z" + 80H	—	DA

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

1-3-6. CD command (initialize almanac data area and cold start)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10100101	Header	—	A5
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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	10100111	Header	—	A7
2	0xxxxxxx	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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	10101001	Header	—	A9
2	0xxxxxxx	D-GPS on/off setting 0: Off 1: On	1	01
3	11011010	Terminator. "Z" + 80H	—	DA

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

1-3-11. GS command (4 DOP threshold value settings)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10101010	Header	—	AA
2	0xxxxxxx	PDOP threshold value when D-GPS is on	64	40
3	0xxxxxxx	HDOP threshold value when D-GPS is on	50	32
4	0xxxxxxx	PDOP threshold value when D-GPS is off	64	40
5	0xxxxxxx	HDOP threshold value when D-GPS is off	50	32
6	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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	10101101	Header	—	AD
2	0xxxxxxx	Expanded output on/off setting 0: Off 1: On	1	01
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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	10101111	Header	—	AF
2	0xxxxxxx	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	Contents	Example	
			Setting value	Input data (HEX)
1	11000000	Header	—	C0
2	0xxxxxxx	Satellite Nos. for 16 channels	9	09
3	0xxxxxxx	Value range: 1 to 64	5	05
4	0xxxxxxx	0 is invalid.	18	12
5	0xxxxxxx		1	01
6	0xxxxxxx		20	14
7	0xxxxxxx		2	02
8	0xxxxxxx		6	06
9	0xxxxxxx		12	0C
10	0xxxxxxx		—	—
11	0xxxxxxx		—	—
12	0xxxxxxx		—	—
13	0xxxxxxx		—	—
14	0xxxxxxx		—	—
15	0xxxxxxx		—	—
16	0xxxxxxx		—	—
17	0xxxxxxx		—	—
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	Contents	Example	
			Setting value	Input data (HEX)
1	11000111	Header	—	C7
2	0xxxxxxx	D-GPS valid time		
3	0xxxxxxx	Resolution: s		
4	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	Contents	Example	
			Setting value	Input 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	Contents	Example	
			Setting value	Input data (HEX)
1	11001110	Header	—	CE
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	Contents	Example	
			Setting value	Input data (HEX)
1	10110001	Header	—	B2
2 3	0xxxxxxx 0xxxxxxx	Heading filter value Resolution: 0.1km/h	999 (99.9km/h)	07 67
4	11011010	Terminator. "Z" + 80H	—	DA

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

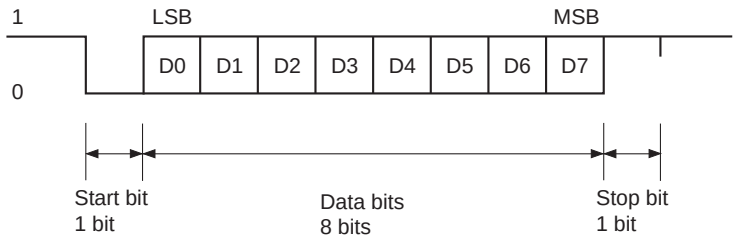
2. D-GPS Data Input Specifications

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

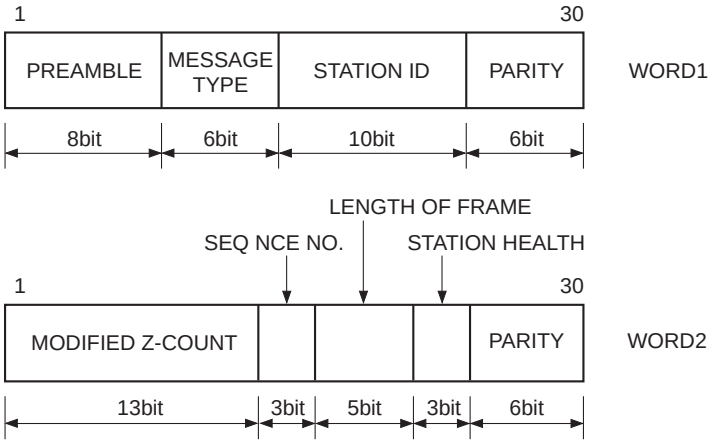
2-1-2. Asynchronous serial interface



2-2. RTCM Data Input

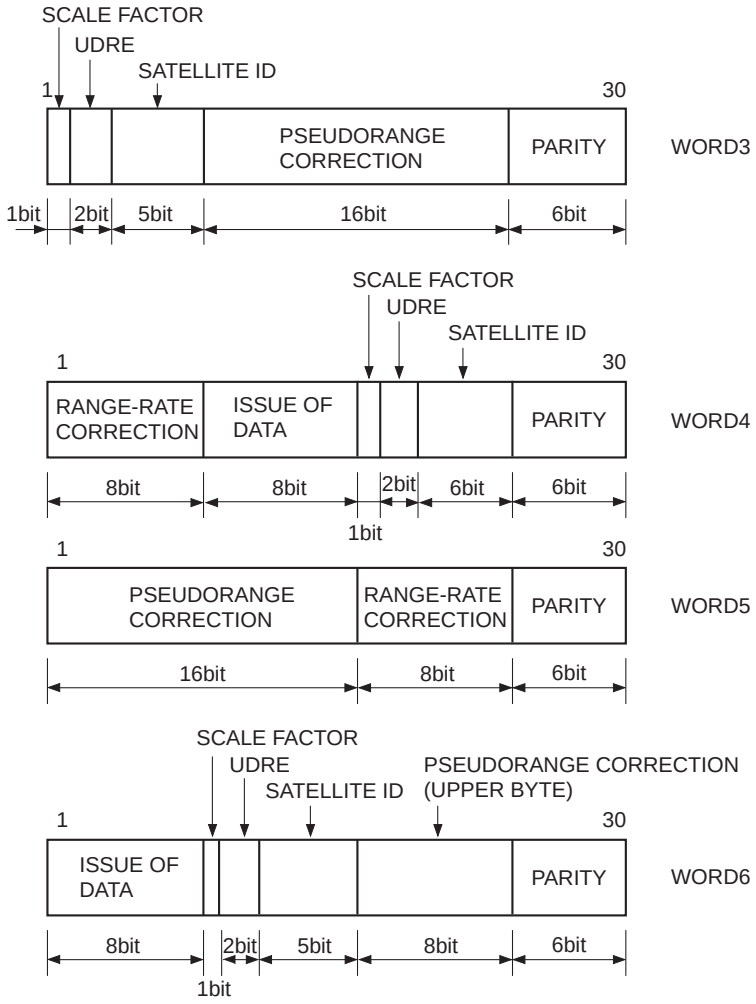
RTCM data input conforms to the RTCM SC-104 format and supports message type 1.
The message type shared header and message type 1 format are shown below. These data are sent in the "6 of 8" format. In this format, each word is divided into 6-bit units, the bits are reordered so that the LSB comes first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

2-2-1. Message type shared header

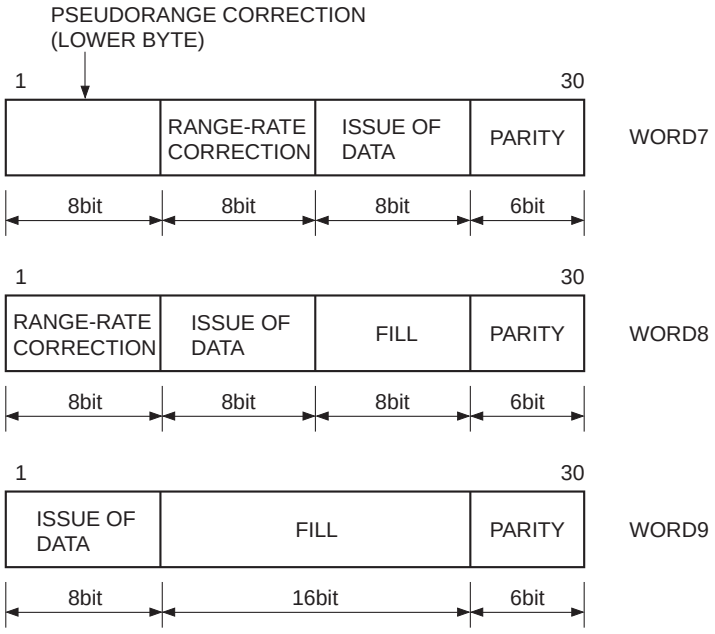


PREAMBLE:	Preamble
MESSAGE TYPE:	Message type
STATION ID:	Reference station ID No.
PARITY:	Error correction code
MODIFIED Z-COUNT:	Modified Z-count
SEQ NCE NO.:	Frame sequence No.
LENGTH OF FRAME:	Frame length
STATION HEALTH:	Reference station health

2-2-2. Message type 1 (differential GPS correction value)



SCALE FACTOR:	Pseudorange correction value scale factor
UDRE:	User differential range error index
SATELLITE 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 bit

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 byte	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	
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

GPS Receiver
NMEA-0183 Input/Output Specifications

Contents

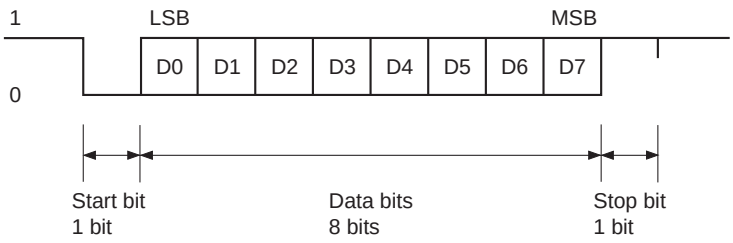
1. I/O Data Input/Output Specifications

1-1. Communication

1-1-1. Serial input/output communication method

Interface:	Asynchronous serial interface (UART)
I/O channel:	CH0
Baud rate:	4800bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Communication control signal:	None
Output period:	Approximately 1s

1-1-2. Asynchronous serial interface



1-2. Almanac Data Output

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	10100100	Header		A4
2 44	0xxxxxxx 0xxxxxxx			
45	11011010	Terminator. "Z" + 80HEX	—	DA

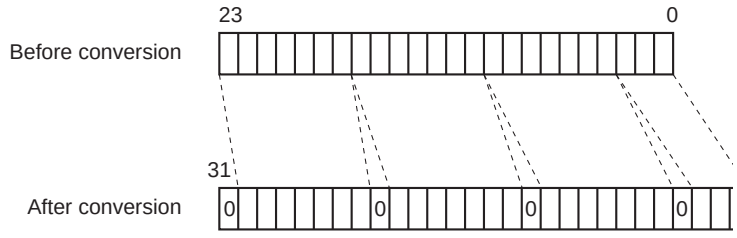
After the receiver receives an almanac output request, it transmits a response and then outputs the almanac data. The above format is for 1 subframe of the almanac data, and 64 frames of this data are sent in succession. Almanac communication data is sent by dividing the original data into 7-bit sections.

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, a 16-bit checksum is added in consideration of communication.

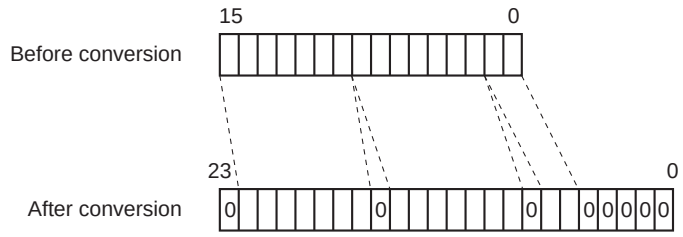
WORD1	24 bits
WORD2	24 bits
WORD3	24 bits
WORD4	24 bits
WORD5	24 bits
WORD6	24 bits
WORD7	24 bits
WORD8	24 bits
WORD9	24 bits
WORD10	24 bits
Checksum	16 bits

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

(1) Relationship between word data and communication data



(2) Relationship between checksum and communication data



1-3. Input Commands

1-3-1. TM command (receiver clock setting)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10100000	Header	—	A0
2 3	0xxxxxxx 0xxxxxxx	Year	1999	0F 4F
4	0xxxxxxx	Month	10	0A
5	0xxxxxxx	Date	29	1D
6	0xxxxxxx	Hour	8	08
7	0xxxxxxx	Minute	46	2E
8	0xxxxxxx	Second	59	3B
9	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100001	Header	—	A1
2 3 4 5	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Latitude Resolution: 0.01" South latitude is two's complement notation. Value range: 32400000 to –32400000	North latitude 87° 29' 10.24" (= –314950.24")	0F 02 26 70
6 7 8 9	0xxxxxxx 0xxxxxxx 0xxxxxxx 0xxxxxxx	Longitude Resolution: 0.01" West longitude is two's complement notation. Value range: 64800000 to –64800000	West longitude 175° 42' 30.11" (= –632550.11")	61 6B 1C 1D
10	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100010	Header	—	A2
2	0xxxxxxx	Geodesic system Value range: 0 to 25	18	12
3	11011010	Terminator. "Z" + 80HEX	—	DA

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

1-3-4. AMI command (receive almanac data)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10100011	Header	—	A3
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100100	Header	—	A4
2	11011010	Terminator. "Z" + 80HEX	—	DA

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

1-3-6. CD command (initialize almanac data area and cold start)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10100101	Header	—	A5
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100110	Header	—	A6
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10100111	Header	—	A7
2	0xxxxxxx	Angle of elevation Resolution: 1° Value range: 0 to 90°	56°	38
3	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101000	Header	—	A8
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101001	Header	—	A9
2	0xxxxxxx	D-GPS on/off setting 0: Off 1: On	1	01
3	11011010	Terminator. "Z" + 80HEX	—	DA

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

1-3-11. GS command (4 DOP threshold value settings (up to 99 (63HEX) max.))

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	10101010	Header	—	AA
2 3	0xxxxxxx 0xxxxxxx	PDOP threshold value when D-GPS is on	64	00 40
4 5	0xxxxxxx 0xxxxxxx	HDOP threshold value when D-GPS is on	50	00 32
6 7	0xxxxxxx 0xxxxxxx	PDOP threshold value when D-GPS is off	135	01 07
8 9	0xxxxxxx 0xxxxxxx	HDOP threshold value when D-GPS is off	114	00 72
10	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101011	Header	—	AB
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101100	Header	—	AC
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101101	Header	—	AD
2	0xxxxxxx	Expanded output on/off setting 0: Off 1: On	1	01
3	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101110	Header	—	AE
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10101111	Header	—	AF
2	0xxxxxxx	Current time mode setting 0: UTC 1: JST	1	01
3	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	11000000	Header	—	C0
2	0xxxxxxx	Satellite Nos. for 16 channels	9	09
3	0xxxxxxx	Value range: 1 to 64	5	05
4	0xxxxxxx	0 is invalid.	18	12
5	0xxxxxxx		1	01
6	0xxxxxxx		20	14
7	0xxxxxxx		2	02
8	0xxxxxxx		6	06
9	0xxxxxxx		12	0C
10	0xxxxxxx		—	—
11	0xxxxxxx		—	—
12	0xxxxxxx		—	—
13	0xxxxxxx		—	—
14	0xxxxxxx		—	—
15	0xxxxxxx		—	—
16	0xxxxxxx		—	—
17	0xxxxxxx		—	—
18	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	11000111	Header	—	C7
2 3	0xxxxxxx 0xxxxxxx	D-GPS valid time Resolution: s		
4	11011010	Terminator. "Z" + 80HEX	—	DA

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

1-3-19. EPI command (receive ephemeris data)

No.	BIT 76543210	Contents	Example	
			Setting value	Input data (HEX)
1	11001101	Header	—	CD
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	11001110	Header	—	CE
2	11011010	Terminator. "Z" + 80HEX	—	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	Contents	Example	
			Setting value	Input data (HEX)
1	10110001	Header	—	B2
2 3	0xxxxxxx 0xxxxxxx	Heading filter value Resolution: 0.1km/h	999 (99.9km/h)	07 67
4	11011010	Terminator. "Z" + 80HEX	—	DA

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

2. NMEA Output Specifications

2-1. Output Messages

2-1-1. GPGGA message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
		Address field	Fixed	
2	01000111	"G"		47
3	01010000	"P"		50
4	01000111	"G"		47
5	01000111	"G"		47
6	01000001	"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	xxxxxxxx	Degree (10's digit)		33
16	xxxxxxxx	Degree (1's digit)		36
17	xxxxxxxx	Minute (10's digit)		30
18	xxxxxxxx	Minute (1's digit)		33
19	00101110	" . "		2E
20	xxxxxxxx	Minute (0.1's digit)		39
21	xxxxxxxx	Minute (0.01's digit)		37
22	xxxxxxxx	Minute (0.001's digit)		39
23	01001100	" , "	Fixed	2C
		Latitude direction	North latitude	
24	xxxxxxxx	"N" or "S"		4E
25	01001100	" , "	Fixed	2C
		Longitude	140° 10.296'	
26	xxxxxxxx	Degree (100's digit)		31
27	xxxxxxxx	Degree (10's digit)		34
28	xxxxxxxx	Degree (1's digit)		30
29	xxxxxxxx	Minute (10's digit)		31
30	xxxxxxxx	Minute (1's digit)		30
31	00101110	" . "		2E
32	xxxxxxxx	Minute (0.1's digit)		32
33	xxxxxxxx	Minute (0.01's digit)		39
34	xxxxxxxx	Minute (0.001's digit)		36

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
35	01001100	" , "	Fixed	2C
36	xxxxxxxx	Longitude direction "E" or "W"	West longitude	57
37	01001100	" , "	Fixed	2C
38	xxxxxxxx	GPS Quality Indicator "0": Invalid "1": GPS measurement "2": D-GPS measurement	D-GPS measurement	32
39	01001100	" , "	Fixed	2C
40 41	xxxxxxxx xxxxxxxx	Number of satellites used for measurement calculation "00" to "12"	7-satellite measurement	30 37
42	01001100	" , "	Fixed	2C
43 44 45 46	xxxxxxxx xxxxxxxx 00101110 xxxxxxxx	HDOP 10's digit 1's digit " . " 0.1's digit	1.2	30 31 2E 32
47	01001100	" , "	Fixed	2C
48 49 50 51	xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx	Altitude (m) 1,000's digit 100's digit 10's digit 1's digit	23m	30 30 32 33
52	01001100	" , "	Fixed	2C
53	01001101	Altitude units "M"	Fixed	4D
54	01001100	" , "	Fixed	2C
55	01001100	" , "	Fixed	2C
56	01001101	"M"	Fixed	4D
57	01001100	" , "	Fixed	2C
58 59 60	xxxxxxxx xxxxxxxx xxxxxxxx	D-GPS data elapsed time (s) 100's digit 10's digit 1's digit	5s	30 30 35
61	01001100	" , "	Fixed	2C
62 63 64 65	xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx	D-GPS reference station ID 1,000's digit 100's digit 10's digit 1's digit	0	30 30 30 30
66	00101010	" * "	Fixed	2A

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
		Checksum	4A	
67	xxxxxxxx	Hexadecimal upper digits		34
68	xxxxxxxx	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).

2-1-2. GPGLL message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
		Address field	Fixed	
2	01000111	"G"		47
3	01010000	"P"		50
4	01000111	"G"		47
5	01001100	"L"		4C
6	01001100	"L"		4C
7	01001100	" , "	Fixed	2C
		Latitude	36° 03.979'	
8	xxxxxxxx	Degree (10's digit)		33
9	xxxxxxxx	Degree (1's digit)		36
10	xxxxxxxx	Minute (10's digit)		30
11	xxxxxxxx	Minute (1's digit)		33
12	00101110	" . "		2E
13	xxxxxxxx	Minute (0.1's digit)		39
14	xxxxxxxx	Minute (0.01's digit)		37
15	xxxxxxxx	Minute (0.001's digit)		39
16	01001100	" , "	Fixed	2C
		Latitude direction	North latitude	
17	xxxxxxxx	"N" or "S"		4E
18	01001100	" , "	Fixed	2C
		Longitude	140° 10.296'	
19	xxxxxxxx	Degree (100's digit)		31
20	xxxxxxxx	Degree (10's digit)		34
21	xxxxxxxx	Degree (1's digit)		30
22	xxxxxxxx	Minute (10's digit)		31
23	xxxxxxxx	Minute (1's digit)		30
24	00101110	" . "		2E
25	xxxxxxxx	Minute (0.1's digit)		32
26	xxxxxxxx	Minute (0.01's digit)		39
27	xxxxxxxx	Minute (0.001's digit)		36
28	01001100	" , "	Fixed	2C
		Longitude direction	West longitude	
29	xxxxxxxx	"E" or "W"		57
30	01001100	" , "	Fixed	2C
		UTC time	06:22:43	
31	xxxxxxxx	Hour (10's digit)		00
32	xxxxxxxx	Hour (1's digit)		36
33	xxxxxxxx	Minute (10's digit)		32
34	xxxxxxxx	Minute (1's digit)		32
35	xxxxxxxx	Second (10's digit)		34
36	xxxxxxxx	Second (1's digit)		33
37	01001100	" , "	Fixed	2C

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
38	xxxxxxxx	Status "A": Data valid "V": Data invalid	Valid	41
39	00101010	" ∗ "	Fixed	2A
40 41	xxxxxxxx xxxxxxxx	Checksum Hexadecimal upper digits Hexadecimal lower digits	4A	34 41
42 43	00001101 00001010	Terminator <CR> <LF>	Fixed	0D 0A

2-1-3. GPGSA message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	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	01001100	" , "	Fixed	2C
8	xxxxxxxx	GPS measurement switching mode "M": Manual "A": Auto	Fixed to "A"	41
9	01001100	" , "	Fixed	2C
10	xxxxxxxx	GPS measurement mode "1": Invalid "2": 2D measurement "3": 3D measurement	3D measurement	33
11	01001100	" , "	Fixed	2C
12 13 14	xxxxxxxx xxxxxxxx 01001100	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	xxxxxxxx xxxxxxxx 00101110 xxxxxxxx	PDOP 10's digit 1's digit " . " 0.1's digit	2.4	 30 32 2E 34
52	01001100	" , "	Fixed	2C

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
		HDOP	1.2	
53	xxxxxxxx	10's digit		30
54	xxxxxxxx	1's digit		31
55	00101110	" . "		2E
56	xxxxxxxx	0.1's digit		32
57	01001100	" , "	Fixed	2C
		VDOP	2.0	
58	xxxxxxxx	10's digit		30
59	xxxxxxxx	1's digit		32
60	00101110	" . "		2E
61	xxxxxxxx	0.1's digit		30
62	00101010	" * "	Fixed	2A
		Checksum	4A	
63	xxxxxxxx	Hexadecimal upper digits		34
64	xxxxxxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
65	00001101	<CR>		0D
66	00001010	<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.

2-1-4. GPGSV message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
		Address field	Fixed	
2	01000111	"G"		47
3	01010000	"P"		50
4	01000111	"G"		47
5	01010011	"S"		53
6	01010110	"V"		56
7	01001100	" , "	Fixed	2C
		Total number of GPGSV messages	2	
8	xxxxxxxx	"1" to "3"		32
9	01001100	" , "	Fixed	2C
		GPGSV message number	1	
10	xxxxxxxx	"1" to "3"		31
11	01001100	" , "	Fixed	2C
		Number of satellites within field of vision	08	
12	xxxxxxxx	10's digit		30
13	xxxxxxxx	1's digit		38
14	01001100	" , "	Fixed	2C
		Information on satellites within field of vision for four satellites Satellite No.		
15	xxxxxxxx	10's digit		
16	xxxxxxxx	1's digit		
17	01001100	" , "		
		Angle of elevation (°)		
18	xxxxxxxx	10's digit		
19	xxxxxxxx	1's digit		
20	01001100	" , "		
		Azimuth (°)		
21	xxxxxxxx	100's digit		
22	xxxxxxxx	10's digit		
23	xxxxxxxx	1's digit		
24	01001100	" , "		
		C/N (dB)		
25	xxxxxxxx	10's digit		
26	xxxxxxxx	1's digit		
27	01001100	" , "		
28 to 40		Information for 2nd satellite		
41 to 53		Information for 3rd satellite		
54 to 56		Information for 4th satellite		
67	00101010	" * "	Fixed	2A
		Checksum	4A	
68	xxxxxxxx	Hexadecimal upper digits		34
69	xxxxxxxx	Hexadecimal lower digits		41

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
70	00001101	Terminator <CR>	Fixed	0D
71	00001010	<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.

2-1-5. GPRMC message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
2	01000111	Address field "G"	Fixed	47
3	01010000	"P"		50
4	01010010	"R"		52
5	01001101	"M"		4D
6	01000011	"C"		43
7	01001100	" , "	Fixed	2C
8	xxxxxxxx	UTC time Hour (10's digit)	06:22:43	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
15	xxxxxxxx	Status "A": Data valid "V": Data invalid	Valid	41
16	01001100	" , "	Fixed	2C
17	xxxxxxxx	Latitude Degree (10's digit)	36° 03.979'	33
18	xxxxxxxx	Degree (1's digit)		36
19	xxxxxxxx	Minute (10's digit)		30
20	xxxxxxxx	Minute (1's digit)		33
21	00101110	" . "		2E
22	xxxxxxxx	Minute (0.1's digit)		39
23	xxxxxxxx	Minute (0.01's digit)		37
24	xxxxxxxx	Minute (0.001's digit)		39
25	01001100	" , "	Fixed	2C
26	xxxxxxxx	Latitude direction "N" or "S"	North latitude	4E
27	01001100	" , "	Fixed	2C
28	xxxxxxxx	Longitude Degree (100's digit)	140° 10.296'	31
29	xxxxxxxx	Degree (10's digit)		34
30	xxxxxxxx	Degree (1's digit)		30
31	xxxxxxxx	Minute (10's digit)		31
32	xxxxxxxx	Minute (1's digit)		30
33	00101110	" . "		2E
34	xxxxxxxx	Minute (0.1's digit)		32
35	xxxxxxxx	Minute (0.01's digit)		39
36	xxxxxxxx	Minute (0.001's digit)		36

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
37	01001100	" , "	Fixed	2C
38	xxxxxxxx	Longitude direction "E" or "W"	West longitude	57
39	01001100	" , "	Fixed	2C
40	xxxxxxxx	Speed (knots) 100's digit	20knot/h	30
41	xxxxxxxx	10's digit		32
42	xxxxxxxx	1's digit		30
43	00101110	" . "		2E
44	xxxxxxxx	0.1's digit		30
45	01001100	" , "	Fixed	2C
46	xxxxxxxx	Heading (°) 100's digit	48.5°	30
47	xxxxxxxx	10's digit		34
48	xxxxxxxx	1's digit		38
49	00101110	" . "		2E
50	xxxxxxxx	0.1's digit		35
51	01001100	" , "	Fixed	2C
52	xxxxxxxx	Date 10's digit	July 13, 1999	31
53	xxxxxxxx	1's digit		33
54	xxxxxxxx	Month 10's digit		30
55	xxxxxxxx	1's digit		37
56	xxxxxxxx	Year 10's digit		39
57	xxxxxxxx	1's digit		39
58	01001100	" , "	Fixed	2C
59	01001100	" , "	Fixed	2C
60	00101010	" * "	Fixed	2A
61	xxxxxxxx	Checksum Hexadecimal upper digits	4A	34
62	xxxxxxxx	Hexadecimal lower digits		41
63	00001101	Terminator <CR>	Fixed	0D
64	00001010	<LF>		0A

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

2-1-6. GPVTG message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
2 3 4 5 6	01000111 01010000 01010110 01010100 01000111	Address field "G" "P" "V" "T" "G"	Fixed	 47 50 56 54 47
7	01001100	" , "	Fixed	2C
8 9 10 11 12	xxxxxxxx xxxxxxxx xxxxxxxx 00101110 xxxxxxxx	Heading (°) 100's digit 10's digit 1's digit " . " 0.1's digit	48.5°	 30 34 38 2E 35
13	01001100	" , "	Fixed	2C
14	01010100	"T"	Fixed	54
15	01001100	" , "	Fixed	2C
16	01001100	" , "	Fixed	2C
17	01001101	"M"	Fixed	4D
18	01001100	" , "	Fixed	2C
19 20 21 22 23	xxxxxxxx xxxxxxxx xxxxxxxx 00101110 xxxxxxxx	Speed (knots) 100's digit 10's digit 1's digit " . " 0.1's digit	20knot/h	 30 32 30 2E 30
24	01001100	" , "	Fixed	2C
25	01001110	"N"	Fixed	4E
26	01001100	" , "	Fixed	2C
27 28 29 30 31	xxxxxxxx xxxxxxxx xxxxxxxx 00101110 xxxxxxxx	Speed (km/h) 100's digit 10's digit 1's digit " . " 0.1's digit	20km/h	 30 32 30 2E 30
32	01001100	" , "	Fixed	2C
33	01001011	"K"	Fixed	4B
34	00101010	" * "	Fixed	2A
35 36	xxxxxxxx xxxxxxxx	Checksum Hexadecimal upper digits Hexadecimal lower digits	4A	 34 41

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
		Terminator	Fixed	
37	00001101	<CR>		0D
38	00001010	<LF>		0A

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

2-1-7. GPZDA message

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
2 3 4 5 6	01000111 01010000 01011010 01000100 01000001	Address field "G" "P" "Z" "D" "A"	Fixed	 47 50 5A 44 41
7	01001100	" , "	Fixed	2C
8 9 10 11 12 13	xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx xxxxxxxx	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	01001100	" , "	Fixed	2C
15 16	xxxxxxxx xxxxxxxx	Date 10's digit 1's digit	13th	 31 33
17	01001100	" , "	Fixed	2C
18 19	xxxxxxxx xxxxxxxx	Month 10's digit 1's digit	July	 30 37
20	01001100	" , "	Fixed	2C
21 22	xxxxxxxx xxxxxxxx	Year 10's digit 1's digit	1999	 39 39
23	01001100	" , "	Fixed	2C
24	01001100	" , "	Fixed	2C
25	00101010	" * "	Fixed	2A
26 27	xxxxxxxx xxxxxxxx	Checksum Hexadecimal upper digits Hexadecimal lower digits	4A	 34 41
28 29	00001101 00001010	Terminator <CR> <LF>	Fixed	 0D 0A

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

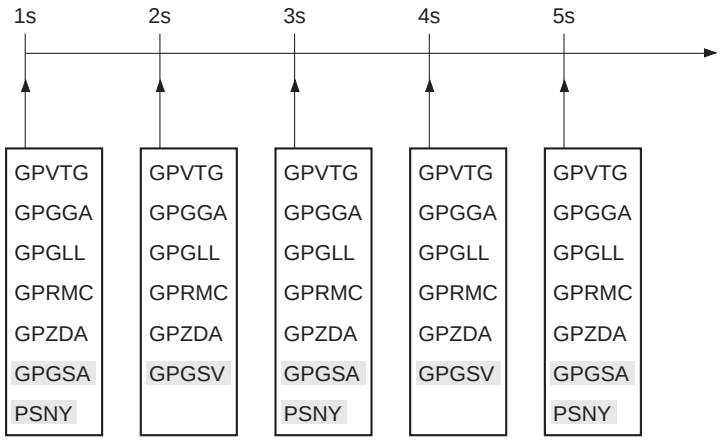
2-1-8. PSNY message (manufacturer expanded output)

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
1	00100100	Header "$"	Fixed	24
2 3 4 5	01010000 01010011 01011110 01011001	Address field "P" "S" "N" "Y"	Fixed	 50 53 5E 49
6	01001100	" , "	Fixed	2C
7	xxxxxxxx	Preamplifier status "0": Normal "1": Open "2": Shorted	Open	 31
8	01001100	" , "	Fixed	2C
9 10	xxxxxxxx xxxxxxxx	Geodesic system "0" to "25"	WGS-84	 30 30
11	01001100	" , "	Fixed	2C
12 13	xxxxxxxx xxxxxxxx	Angle of elevation limit (°) 10's digit 1's digit	5°	 30 35
14	01001100	" , "	Fixed	2C
15 16 17	xxxxxxxx xxxxxxxx xxxxxxxx	Speed limit (km/h) 100's digit 10's digit 1's digit	500km/h	 35 30 30
18	01001100	" , "	Fixed	2C
19 20	xxxxxxxx xxxxxxxx	PDOP limit (D-GPS on) 10's digit 1's digit	4	 30 34
21	01001100	" , "	Fixed	2C
22 23	xxxxxxxx xxxxxxxx	HDOP limit (D-GPS on) 10's digit 1's digit	6	 30 36
24	01001100	" , "	Fixed	2C
25 26	xxxxxxxx xxxxxxxx	PDOP limit (D-GPS off) 10's digit 1's digit	4	 30 34
27	01001100	" , "	Fixed	2C
28 29	xxxxxxxx xxxxxxxx	HDOP limit (D-GPS off) 10's digit 1's digit	6	 30 36

No.	BIT 76543210	Contents	Example	
			Setting value	Output data (HEX)
30	00101010	" ∗ "	Fixed	2A
		Checksum	4A	
31	xxxxxxxx	Hexadecimal upper digits		34
32	xxxxxxxx	Hexadecimal lower digits		41
		Terminator	Fixed	
33	00001101	<CR>		0D
34	00001010	<LF>		0A

2-2. Output Timing

1s period: GPVTG, GPGGA, GPGLL, GPRMC, GPZDA
2s period: GPGSA, PSNY, GPGSV



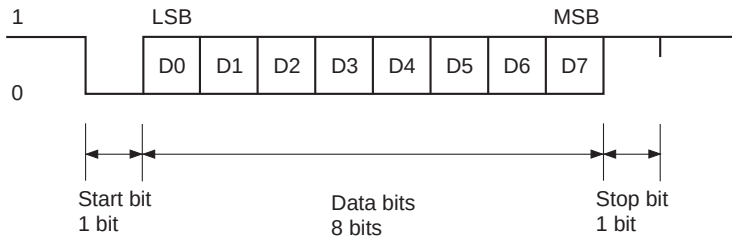
3. D-GPS Data Input Specifications

3-1. Communication

3-1-1. Serial input communication method

Interface:	Asynchronous serial interface (UART)
I/O channel:	CH1
Baud rate:	9600bps
Start bit:	1 bit
Data bits:	8 bits
Stop bit:	1 bit
Parity bit:	None
Communication control signal:	None
Input period:	1s or more

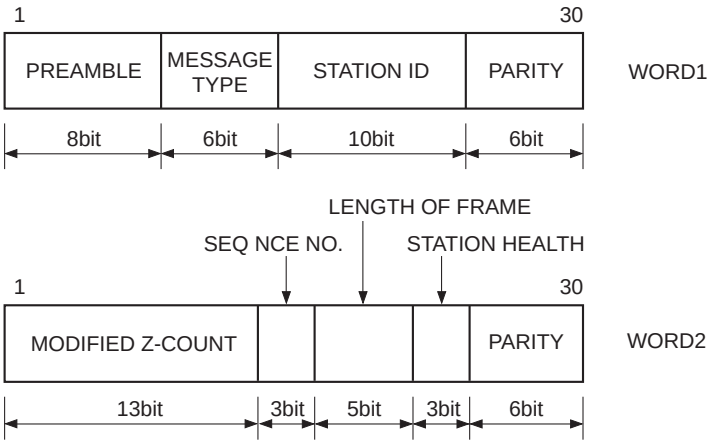
3-1-2. Asynchronous serial interface



3-2. RTCM Data Input

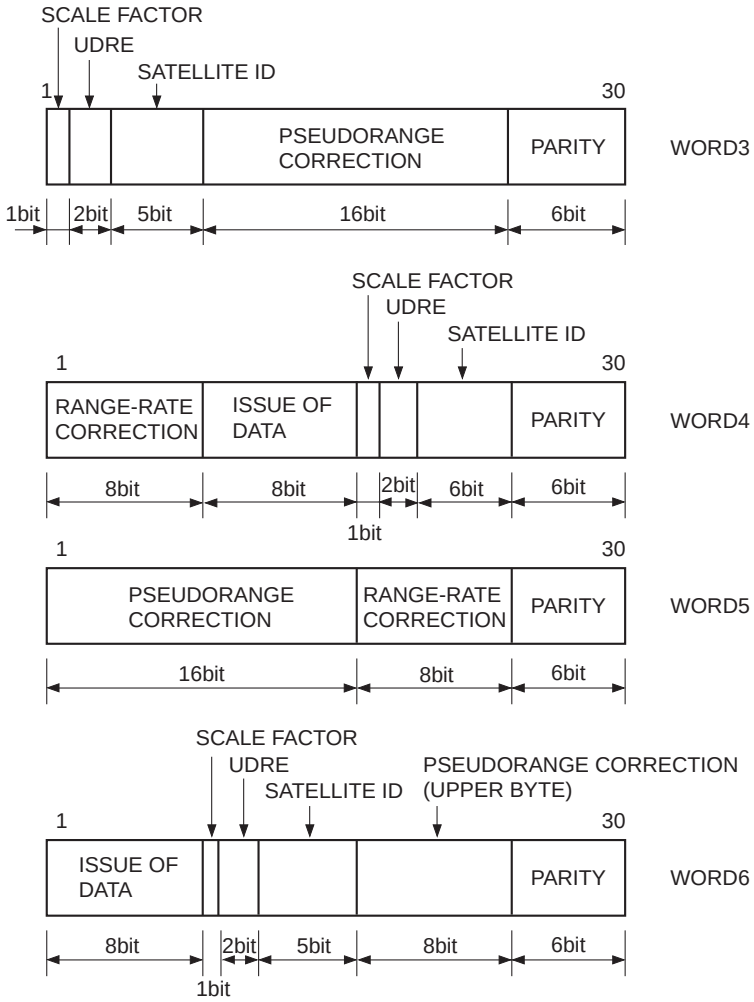
RTCM data input conforms to the RTCM SC-104 format and supports message type 1.
The message type shared header and message type 1 format are shown below. These data are sent in the "6 of 8" format. In this format, each word is divided into 6-bit units, the bits are reordered so that the LSB comes first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

3-2-1. Message type shared header

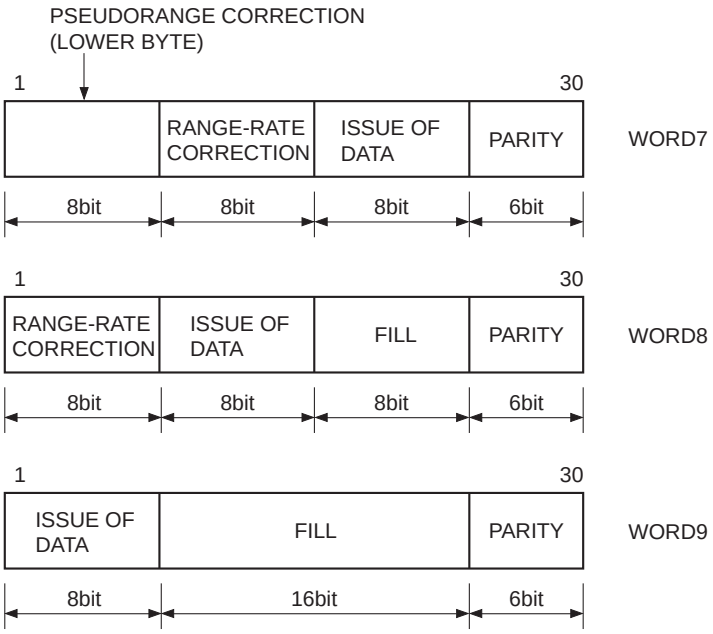


PREAMBLE:	Preamble
MESSAGE TYPE:	Message type
STATION ID:	Reference station ID No.
PARITY:	Error correction code
MODIFIED Z-COUNT:	Modified Z-count
SEQ NCE NO.:	Frame sequence No.
LENGTH OF FRAME:	Frame length
STATION HEALTH:	Reference station health

3-2-2. Message type 1 (differential GPS correction value)



SCALE FACTOR:	Pseudorange correction value scale factor
UDRE:	User differential range error index
SATELLITE 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 bit

3-3. 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