COMMUNICATION SPECIFICATIONS
OF
GPS RECEIVER
Part Number : D8120-2041

Revision:1.00

31.July.1998

July.31.1998 Revision:1.00

AISIN SEIKI CO.,LTD.

2-1, ASAHI-MACHI, KARIYA,
AICHI, 448-8650 JAPAN

Revision record

revision	contents	mark	date	name
1.00	newly-established	-	7/31/98	H.Yogo

1.Communication Method

(a)Type :full duplex serial interface

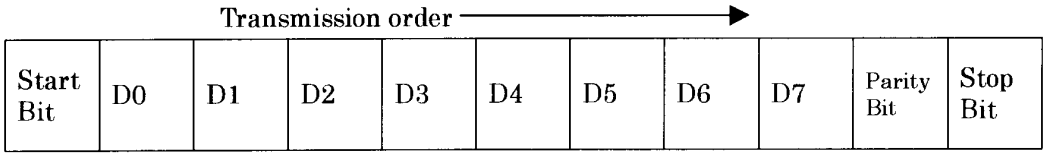
(b)Baud rate :9600bps

(c)Parity :even

(e)Data bits :8

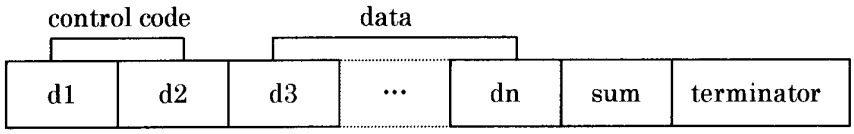
(f)Stop bits :1

(g)Data format1



(h)Data format2

(i)Check sum and Terminator



sum = the complement of (d1+d2+d3+···+dn)

terminator = 0DH(fixed)

Control Code							
Input Command (I/O → GPS)			Output Command(GPS → I/O)				
Item	Control code	Data Length (byte)	Item	Control Code	Data Length (byte)	Response Time (ms)	Update Time (ms)
Set Current Position	B0B0	9	Finish Set Current Position	B0B0	0	500(*1)	500(*2)
Set Height	B1B1	4	Finish Set Height	B1B1	0	↑	↑
Set Time	B2B2	6	Finish Set Time	B2B2	0	↑	↑
Set Timestamp	B3B3	1	Finish Set Timestamp	B3B3	0	↑	↑
Set Receiver Mode	B5B5	5	Finish Set Receiver Mode	B5B5	0	↑	↑
Set System Reset	B6B6	0	Finish Set System Reset	B6B6	0	↑	1000(*2)
Set Auto Transmit	B7B7	0	Finish Set Auto Transmit	B7B7	0	↑	↑
Set Stop Transmit	B8B8	0	Finish Set Stop Transmit	B8B8	0	↑	↑
Set Start Cold Start Fix	B9B9	0	Finish Set Start Cold Start Fix	B9B9	0	↑	↑
Request Receiver Mode	C3C3	0	Receiver Mode	C3C3	7	↑	1000(*3)
Request Diagnosis	C4C4	0	Diagnosis	C4C4	7	↑	↑ (*3,4)
Request Time Stamp	C5C5	1	Time Stamp	C5C5	42	↑	↑ (*3)
Request GPS Condition	C6C6	0	GPS Condition	C6C6	42	↑	↑
Request Position Data	CACA	0	Position Data	CACA	40	↑	↑
Request Receive SAT	CBCB	0	Receive SAT	CBCB	46	↑	↑ (*3,5)
Memo	*1:maximum time(from receive the command to response) *4:ROM,RAM,RTC are updated at the power on *2:maximum time(from response to valid the setting) *5:elevation and azimuth are updated every *3:maximum cycle time(update response data) 180seconds						

Command function I/O → GPS

Command	Set Current Position	Control Code	B0B0

	Number of byte
control code	2
d1	4
d2	4
d3	1
check sum	1
terminator	1
total	13 bytes

	number of byte	contents	units
d1	4	latitude	1/256″
d2	4	longitude	1/256″
d3	1	status code	–

Parameter

Send Latitude and Longitude by WGS-84

d1:Latitude
The north latitude 0° ～ 90° (00000000H～04F1A000H)
The south latitude 0° ～ -90° (00000000H～FB0E6000H)

d2:Longitude
The east longitude 0° ～ 180° (00000000H～09E34000H)
The west longitude 0° ～ -180° (00000000H～F61CC000H)

d3:When bit0 and bit1 = 0, this latitude and longitude are used to set GPS receiver position.

Command function GPS → I/O

Command	Finish Set Current Position	Control Code	B0B0

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set Current Position command(B0B0)

Command function I/O → GPS

Command	Set Height	Control Code	B1B1

Number of byte

control code	2
d1	2
d2	2
check sum	1
terminator	1

total 8 bytes

	number of byte	contents	units
d1	2	height	0.5m
d2	2	height accuracy	0.5m

Parameter

d1:Height by WGS-84
-100m～6000m(FF38H～2EE0H)
note:8000H indicates no height data.
Other value does not have the meaning.

d2:Height accuracy
0m～500m(0H～3E8H)

Command function GPS → I/O

Command	Finish Set Height	Control Code	B1B1
	Number of byte control code 2 check sum 1 terminator 1 total 4 bytes		
Condition of this command. 1.Response of the Set Height command(B1B1)			

Command function I/O → GPS

Command	Set Time	Control Code	B2B2

Number of byte

control code	2
d1	6
check sum	1
terminator	1

total 10 bytes

	number of byte	contents	units
d1	6	time	1s

Parameter

Send time by UTC

Year :98
Month : 7
Day :15
Hour :18
Minute :32
Second : 4

98H 07H 15H 18H 32H 04H

Command function GPS → I/O

Command	Finish Set Time	Control Code	B2B2
	Number of byte control code 2 check sum 1 terminator 1 total 4 bytes		
Condition of this command. 1.Response of the Set Time command(B2B2)			

Command function I/O → GPS

Command	Set Timestamp	Control Code	B3B3

	Number of byte
control code	2
d1	1
check sum	1
terminator	1
total	5 bytes

	number of byte	contents	units
d1	1	clear timestamp	-

Parameter

d1:bit0～7=0

Request to clear timestamp.

Command function GPS → I/O

Command	Finish Set Timestamp	Control Code	B3B3

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set Timestamp command(B3B3)

Command function I/O → GPS

Command	Set Receiver Mode	Control Code	B5B5

Number of byte

control code	2
d1	1
d2	1
d3	1
d4	1
d5	1
check sum	1
terminator	1

total 9 bytes

	number of byte	contents	units
d1	1	receiver mode	-
d2	1	elevation mask	1°
d3	1	signal level mask	0.2
d4	1	PDOP switch	-
d5	1	smooth level	-

Parameter

d1:position fix mode
00H 2D only
01H 3D only
02H auto(default)
If it can fix the position by 3D, it fixes the position by 3D. But if PDOP of 3D position fix exceed the value of PDOP switch, it fixes the position by 2D.
note:It takes maxim 180 seconds to be effective this command.

d2:the minimum elevation of satellites that it use to fix the position(unit 1°)
default=10

d3:the minimum signal level of satellites that it use to fix the position(unit 0.2)
default=0

d4:PDOP limit to employ the fixed position
00H:PDOP ≤ 5
01H:PDOP ≤ 10(default)
02H:PDOP ≤ 20

d5:smoothing level
00H: 2 seconds(default)
01H: 5 seconds
02H: smoothing is not used

Command function GPS → I/O

Command	Finish Set Receiver Mode	Control Code	B5B5

	Number of byte
control code	2
check sum	1
terminator	1
total	4 bytes

Condition of this command.
1.Response of the Set Receiver Mode command(B5B5)

Command function I/O → GPS

Command	Set System Reset	Control Code	B6B6

	Number of byte
control code	2
check sum	1
terminator	1
total	4 bytes

Contents

1.Request to clear backed up RAM.
2.By this command GPS receiver clear the contents of RAM. Then GPS receiver send out "Finish System Reset" command and begin to calculate the position by using almanac data stored in its ROM.

Command function GPS → I/O

Command	Finish Set System Reset	Control Code	B6B6

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set System Reset command(B6B6)

Command function I/O → GPS

Command	Set Auto Transmit	Control Code	B7B7

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Contents

1.After receive this command, GPS receiver send out these data described below every second.
"CACA"+"CBCB"+"C3C3"+"C4C4"

Note: Satellite's elevation and azimuth data in "CBCB" are updated every 180seconds.
Satellite's Health information in "CBCB" is updated every 6seconds.

2.GPS receiver's default condition is set "Auto Transmit".

Command function GPS → I/O

Command	Finish Set Auto Transmit	Control Code	B7B7

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set Auto Transmit command(B7B7)

Command function I/O → GPS

Command	Set Stop Transmit	Control Code	B8B8

	Number of byte
control code	2
check sum	1
terminator	1
total	4 bytes

Contents

GPS receiver stops "Auto Transmit".

Command function GPS → I/O

Command	Finish Set Stop Transmit	Control Code	B8B8

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set Stop Transmit command(B8B8)

Command function I/O → GPS

Command	Set Start Cold Start Fix	Control Code	B9B9

	Number of byte
control code	2
check sum	1
terminator	1
total	4 bytes

Contents

GPS receiver begins "Cold Start".

Command function GPS → I/O

Command	Finish Set Start Cold Start Fix	Control Code	B9B9

Number of byte

control code	2
check sum	1
terminator	1

total 4 bytes

Condition of this command.
1.Response of the Set Start Cold Fix command(B9B9)

Command function I/O → GPS

Command	Request Receiver Mode	Control Code	C3C3
	Number of byte control code 2 check sum 1 terminator 1 total 4 bytes		

Command function GPS → I/O

Command	Receiver Mode	Control Code	C3C3

	Number of byte
control code	2
d1	1
d2	1
d3	1
d4	1
d5	1
d6	2
check sum	1
terminator	1

total 11 bytes

	number of byte	contents	units
d1	1	receiver mode	-
d2	1	elevation mask	1°
d3	1	signal level mask	0.2
d4	1	PDOP switch	-
d5	1	smooth level	-
d6	2	set height	0.5m

Parameter

d1:position fix mode(value set by B5B5)
- 00H 2D only
- 01H 3D only
- 02H auto

d2:the minimum elevation of satellites that it use to fix the position(unit 1°)

d3:the minimum signal level of satellites that it use to fix the position(unit 0.2)

d4:PDOP limit to employ the fixed position
- 00H:PDOP ≤ 5
- 01H:PDOP ≤ 10
- 02H:PDOP ≤ 20

d5:smoothing level and status of search mode

bit 7, 6, 5, 4, 3, 2, 1, 0

- 00 2 seconds
- 01 5 seconds
- 0,0,0,0 10 smoothing is not used
- 0 finish search mode, 1 not finish search mode
- 0 search mode, 1 not search mode

d6:set height by WGS-84 (unit:0.5m)
-100m～6000m(FF38H～2EE0H)

Condition of this command.
1.Response of the Request Receiver Mode command(C3C3)
2.While set "Auto Transmit" GPS receiver sends out every second.

Command function I/O → GPS

Command	Request Diagnosis	Control Code	C4C4

	Number of byte
control code	2
check sum	1
terminator	1

total 4 bytes

Command function GPS → I/O

Command	Diagnosis	Control Code	C4C4

Number of byte

control code	2
d1	3
d2	4
check sum	1
terminator	1

total 11 bytes

	number of byte	contents	units
d1	3	version code	-
d2	4	diagnosis	-

Parameter

d1:program version

	upper 4bits	lower 4bits	ex.85.87K
1st byte	d11	d12	d11:8H d12:5H
2nd byte	d13	d14	d13:8H d14:7H
3rd byte	d15	d16	d15:BH d16:0

d15:"A"=0H,"B"=1H,…

d2:GPS receiver's diagnosis information

1st byte not used (unsettled value)

2nd ～ 4th byte error code

priority	error	error code
1	RTC error	13H
2	ROM error	11H
3	RAM error	12H
4	TCXO error	41H
5	antenna short	51H
6	antenna open	53H

If the number of error exceeds 3, according their priority 3 error codes are set.

Condition of this command.

1.Response of the Request Diagnosis command(C4C4)

2.While set "Auto Transmit" GPS receiver sends out every second.

Command function I/O → GPS

Command	Request Time Stamp	Control Code	C5C5

Number of byte

control code	2
d1	1
check sum	1
terminator	1

total 5 bytes

	number of byte	contents	units
d1	1	search mode set	–

Contents

Request to send out Time Stamp information.

d1: set search mode / reset search mode
01H set search mode
else reset search mode

Command function GPS → I/O

Command	Time Stamp	Control Code	C5C5

Number of byte

control code	2
d1	2
d2	2
•	
d21	2
check sum	1
terminator	1

total 46 bytes

	number of byte	contents	units
d1	2	item1 timestamp	10 minutes
d2	2	item2 timestamp	10 minutes
•	•	•	•
d2	2	item21 timestamp	10 minutes

Parameter

d1:Time stamp information for item1
d2:Time stamp information for item2
•
•
•
d21:Time stamp information for item21

note : Time stamp indicates the time when error happen from January 1st 0:00.
(unit 10 minutes)
0H～CDDFH(～366days) ex. January 2nd 03:10 = A3H(163)
note : Time stamps are cleared by B3B3 command.

item 1	antenna open	item 12	reserved(0)
item 2	reserved(0)	item 13	reserved(0)
item 3	antenna short	item 14	RAM check NG1
item 4	reserved(0)	item 15	RTC error1
item 5	TCXO over	item 16	reserved(0)
item 6	TCXO under	item 17	reserved(0)
item 7	ROM check NG	item 18	reserved(0)
item 8	RAM check NG2	item 19	reserved(0)
item 9	RTC error2	item 20	reserved(0)
item 10	reserved(0)	item 21	reserved(0)
item 11	reserved(0)		

Condition of this command.
1.Response of the Request Time Stamp command(C5C5)

Command function I/O → GPS

Command	Request GPS Condition	Control Code	C6C6
	Number of byte control code 2 check sum 1 terminator 1 total 4 bytes		

Command function GPS → I/O

Command	GPS Condition	Control Code	C6C6

	Number of byte
control code	2
d1	1
d2	1
d3	1
d4	3
d5	4
d6	2
d7	4
d8	2
d9	6
d10	14
d11	2
d12	2
check sum	1
terminator	1
total	46 bytes

	number of byte	contents	units
d1	1	receiver condition	–
d2	1	number of health satellite	–
d3	1	number of visible satellite	–
d4	3	height	–
d5	4	longitude	–
d6	2	reserved(AAH)	–
d7	4	latitude	–
d8	2	reserved(AAH)	–
d9	6	date and time	–
d10	14	visible satellite ID and level	–
d11	2	reserved(AAH)	–
d12	2	diagnosis	–

Parameter

All data is BCD code.
0H～9H "0"～"9"
AH " "(space)
BH "-"
CH～FH " "(space)

	d1	d2	d3	d41	d42	d43
AH	receiver condition	number of health	number of visible	height		
	d51	d52	d53	d54	d61	d62
	longitude(degree)		(minute)	(second)	AAH	AAH
	d71	d72	d73	d74	d81	d82
	latitude(degree)		(minute)	(second)	AAH	AAH
	d91	d92	d93	d94	d95	d96
	year	month	day	hour	minute	second
	d101	d102	d103	d104	d105	d106
	SV1ID	SV1level	SV2ID	SV2level	SV3ID	SV3level
	d107	d108	d109	d110	d111	d112
	SV4ID	SV4level	SV5ID	SV5level	SV6ID	SV6level
	d113	d114	d121	d122	d131	d132
	SV7ID	SV7level	AAH	AAH	diagnosis1	diagnosis2

Condition of this command.
1.Response of the Request GPS Condition command(C6C6)

d1:receiver condition
lower 4bits
0H no satellite usable
1H 1 satellite usable
2H 2 satellites usable
Include the condition described below.
The number of decoded satellites is 3 or more, but the value of DOP is so bad then GPS receiver does not employ the fixed position.
3H 2D position fix
4H 3D position fix
5H impossible to employ the fixed position
acceleration exceed the limit (0.5G)
9H receiver error
else not used

d2:number of health satellite 0~32

d3:number of visible satellite 0~32

d41~d43:height

d41	upper 4bits	AH	
	lower 4bits	AH	positive value
		BH	negative value
d42,d43	d41=AAH	0~600m	
	d41=ABH	0~100m	

d51~d54:longitude

d51	upper 4bits	AH	East
		BH	West
	lower 4bits	the hundred's place of degree	
d52		degree(except the hundred's place)	
d53		minute	
d54		second	

d61,62:space

d71~d74:latitude

d71	upper 4bits	AH	North
		BH	South
	lower 4bits	the hundred's place of degree	
d72		degree(except hundred's place)	
d73		minute	

d81,82:space

d91～d96:date and time
- d91 year
- d92 month
- d93 day
- d94 hour
- d95 minute
- d96 second

d101～d114:visible satellite ID and level
- d101 satellite 1 ID
- d102 satellite 1 signal level(0～51)
- d103 satellite 2 ID
- d104 satellite 2 signal level(0～51)
- d105 satellite 3 ID
- d106 satellite 3 signal level(0～51)
- d107 satellite 4 ID
- d108 satellite 4 signal level(0～51)
- d109 satellite 5 ID
- d110 satellite 5 signal level(0～51)
- d111 satellite 6 ID
- d112 satellite 6 signal level(0～51)
- d113 satellite 7 ID
- d114 satellite 7 signal level(0～51)
- note: the value of signal level is 1/5 of "C1C1 signal level"

d111,112:space

d121,122:diagnosis

d121	upper 4bits	1H cold start by RAM check NG1
		2H cold start by RAM check NG2
		AH normal
	lower 4bits	1H cold start by RTC error 1
		2H cold start by RTC error 2
		AH normal
d122	upper 4bits	AH (fixed)
	lower 4bits	1H almanac information is too old (elapsed time is more than 255days)
		AH normal

Command function I/O → GPS

Command	Request Position Data	Control Code	CACA
	Number of byte control code 2 check sum 1 terminator 1 total 4 bytes		

Contents

Request to send out Position Data

Command Function GPS → I/O

Command	Position Data	Control Code	CACA

	Number of byte
control code	2
d1	1
d2	4
d3	4
d4	2
d5	1
d6	1
d7	2
d8	1
d9	2
d10	1
d11	1
d12	1
d13	1
d14	6
d15	1
d16	1
d17	1
d18	8
d19	1
check sum	1
terminator	1
total	44 bytes

	number of byte	contents	units
d1	1	validity	-
d2	4	latitude	1/256″
d3	4	longitude	1/256″
d4	2	height	0.5m
d5	1	error ellipse 1	2m
d6	1	error ellipse 2	2m
d7	2	heading	360° /1024
d8	1	expected heading error	90° /256
d9	2	ground speed	1/4m/s
d10	1	exected ground speed error	1/4m/s
d11	1	not used	-
d12	1	not used	-
d13	1	not used	-
d14	6	current data & time	1s
d15	1	HDOP	0.2
d16	1	VDOP	0.2
d17	1	satellite count	-
d18	8	satellite used information	-
d19	1	not used	-

d1:indicate the number of satellites used to fix the current position
00H:the number of decoded satellites = 0
01H:the number of decoded satellites = 1
02H:the number of decoded satellites = 2
OR the number of decoded satellites is more than 3 but no position fix because of bad DOP. *DOP limit is determined by another command.
03H:fix the position(2D)
04H:fix the position(3D)
note:
bit4=1 (3 seconds from change the combination of the satellites to use fix the position or first tracking or recovery of interrupt)
13H:fix the position(2D)
14H:fix the position(3D)
0FH:calcurated acceleration exceeds the acceleration limit 1G and it is limited 1G.
FFH:exist the information of some diagnosis.

Condition of this command.
1.Response of the request position data command(CACA)
2.While auto transmit mode set, this command is sent out every second.

d2~d4:indicate the latitude, longitude and height with WGS-84

Latitude	North	0° ~ 90°	(00000000H~04F1A000H)
	South	0° ~-90°	(00000000H~FB0E6000H)
Longitude	East	0° ~180°	(00000000H~093E34000H)
	West	0° ~-180°	(00000000H~F61CC000H)
Height		-100~6000m	(FF38H~2EE0H)

d5~d6:indicate the 2σ of the long axis and short axis of the error ellipse
0~508m (00H~FEH)
more than 510m : FFH

d7:indicate the heading from North with clockwise
0° ~359.65° (0000H~03FFH)

d8:indicate the expected heading error from North with clockwise
0° ~89.30° (00H~FEH)
more than 89.65° (FFH)

d9:indicate the ground speed.
0~299.7km/h (0000H~014DH)
more than 300.0km/h (FFFFH)

d10:indicate the expected ground speed error.
0~228.6km/h (00H~FEH)
more than 229.5km/h (FFH)

d11~d13:not used

d14:indicate the time sent from GPS satellites with UTC

d15:indicate the HDOP
0~50.8 (00H~FEH)
more than 51.0 (FFH)

d16:indicate the VDOP
0~50.8 (00H~FEH)
more than 51.0 (FFH)

d17:indicate the number of health satellites

d18:indicate the information of used satellites

	MSB							LSB
1st byte	d32	d31	d30	d29	d28	d27	d26	d25
2nd byte	d24	d23	d22	d21	d20	d19	d18	d17
3rd byte	d16	d15	d14	d13	d12	d11	d10	d09
4th byte	d08	d07	d06	d05	d04	d03	d02	d01
5th byte	s20	s21	g20	g21	s10	s11	g10	g11
6th byte	s40	s41	g40	g41	s30	s31	g30	g31
7th byte	s60	s61	g60	g61	s50	s51	g50	g51
8th byte	s80	s81	g80	g81	s70	s71	g70	g71

1st byte～4th byte:set 1 at the bit applied the entry satellite number

dn : entry = 1

not entry = 0 (n=satellite number 1～32)

5th byte～8th byte:indicate the receive condition and received signal level of entry satellites

s*0	s*1	condition
0	0	search
0	1	tracking
1	0	decoded(not use to fix the position)
1	1	decoded(use to fix the position)

g*0	g*1	receive level
0	0	0
0	1	level<10
1	0	level<20
1	1	more than 20

d19:not used

Command function I/O → GPS

Command	Request Receive SAT	Control Code	CBCB

	Number of byte
control code	2
check sum	1
terminator	1

total 4 bytes

Contents

Request to send out Receive SAT

Command Function GPS → I/O

Command	Receive SAT	Control Code	CBCB

Number of byte

control code	2
d1	1
d2	40
d3	5
check sum	1
terminator	1

total 50 bytes

	number of byte	contents	units
d1	1	time	1s
d2	40	satellite information	–
d3	5	almanac	–

Parameter

d1:link information with "CACA" data. The same second is sent.

d2:ID, receive status, signal level, azimuth and elevation of each satellite

	ID	condition	level	azimuth	elevation
SAT1	d201	d202	d203	d204	d205
SAT2	d206	d207	d208	d209	d210
SAT3	d211	d212	d213	d214	d215
SAT4	d216	d217	d218	d219	d220
SAT5	d221	d222	d223	d224	d225
SAT6	d226	d227	d228	d229	d230
SAT7	d231	d232	d233	d234	d235
SAT8	d236	d237	d238	d239	d240

ID: satellite ID(d201,d206,d211,d216,d221,d226,d231,d236)

0 : satellite is not registered

1～32(01H～20H) : PRN code of satellite

Condition: (d202,d207,d212,d217,d222,d227,d232,d237)

upper 4bits

value of SVACC	b7 b6 b5 b4 b3
0	0 0 0 0 0
1	0 0 0 0 1
2	0 0 0 1 0
:	:
15	1 1 1 1 1

lower 4 bits

b0 : search

b1 : track

b2 : finish decode but not used to fix position

b3 : finish decode and used to fix position

Signal level: (d202,d207,d212,d217,d222,d227,d232,d237)

received signal level of each satellites (unit 0.2)

0～50.8(00H～FEH) more than 51.0(FFH)

Azimuth: (d204,d209,d214,d219,d224,d229,d234,d239)
azimuth of each satellites(unit 360 degree/256)
0° ～359° (00H～FFH) updated every 180 seconds

Elevation: (d205,d210,d215,d220,d225,d230,d235,d240)
elevation of each satellites(unit 180 degree/256)
0° ～90° (00H～80H) updated every 180 seconds

d3:almanac information
health information of satellites and elapsed date of almanac

1st byte	b7	···	b0	elapsed date 0～254 days(00H～FEH):more than 255 days(FFH)
2nd byte	d8	···	d1	health dn = 1 : health
3rd byte	d16	···	d9	dn = 0 : unhealth
4th byte	d24	···	d17	(n = 1～32 : satellite ID)
5th byte	d32	···	d25	

Condition of this command.
1.Response of the request Receive SAT command(CBCB)
2.While auto transmit mode set, this command is sent out every second.