FURUNO ELECTRIC CO., LTD.
SYSTEM PRODUCTS DIVISION

SPECIFICATION/PROTOCOL MANUAL

GPS Receiver

Model GH-80

Revision 1

Publication No.

RECORD OF REVISIONS

REV	DATE	DESCRIPTIONS
0	Aug 26/2002	Initial issue
1	Dec 25/2002	Updated Chapters 1 and 2 as a whole.

FURUNO ELECTRIC CO., LTD.
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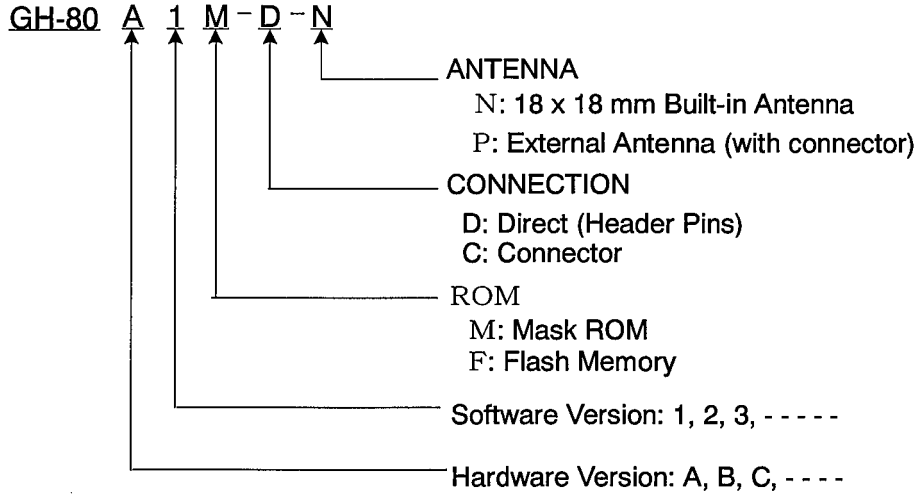
Chapter 1. OUTLINE

1. GENERAL

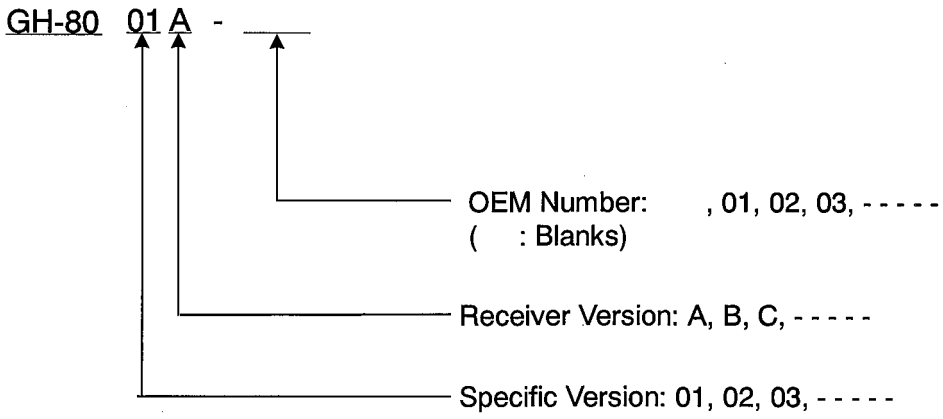
GH-80 is a GPS receiver module intended for mobile use. GH-80 has the following variants.

A. Standard Version



NOTE: The modules with non-standard specifications (Baud rate, first-stage band-pass filter) are classified as OEM versions.

B. OEM Version



2. BLOCK DIAGRAM

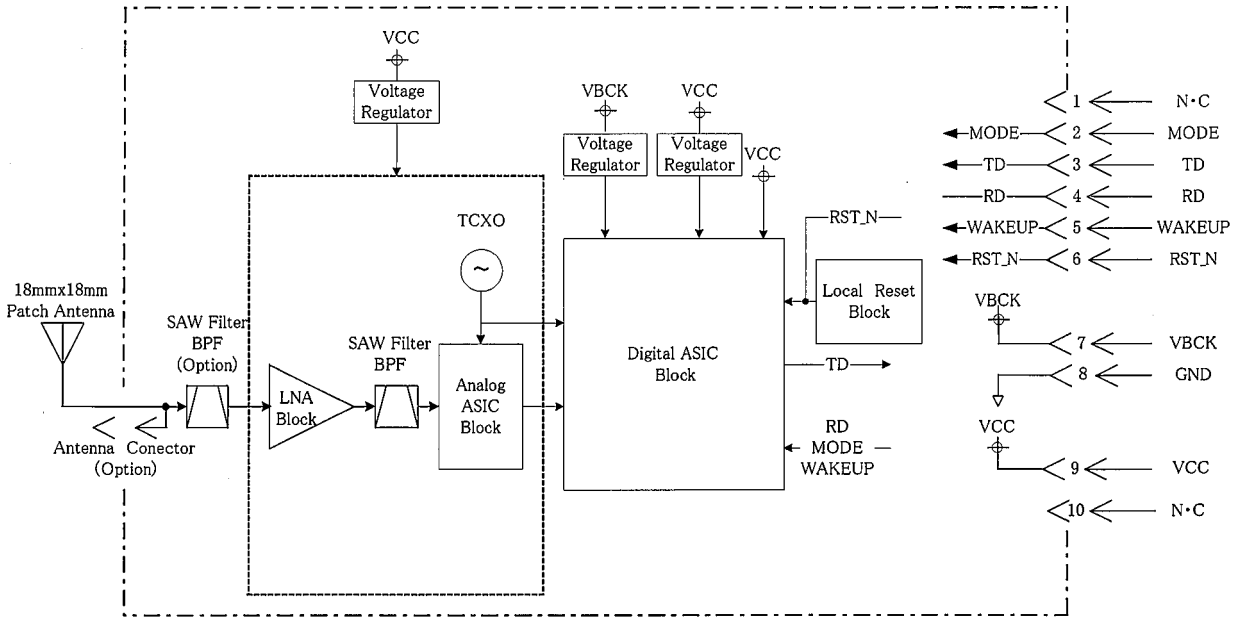


Fig. 1-01

3. FEATURES

- Fast TTFF by high-speed search engine
- High sensitivity by new tracking algorithm
- Power consumption drastically slashed by power-down control of digital ASIC, analog ASIC and LNA in the part-time mode operation
- Prevention of sensitivity reduction by new part-time mode operational algorithm
- Versatile external connection: connector or direct connection by header pins

Chapter 2. SPECIFICATIONS

1. GENERAL SPECIFICATIONS

ITEM	CONDITIONS	SPECIFICATION	NOTE
Receiving Signal	-	L1 (1575.42 MHz), C/A Code	
Positioning	-	SPS Sole Positioning	
	-	DGPS Positioning	RTCM SC-104 Protocol
Max. Number of Satellites Tracked	-	12 satellites	
Reference Oscillator Frequency	-	16.3678 MHz	
GPS-fix Data Renewal Rate	Full-time Mode	1 sec	
	Part-time Mode	1 to 60 sec	
External Serial Communication Speed	Standard	9600 bps	
	OEM	4800/19200/38400 bps	Factory-set before shipment
Output Data Format	-	FURUNO's proprietary format (binary)	Refer to Chapter 3.
Reset Circuit	-	Wired-OR with external reset	
Antenna Mounting	Select:	18 mm square patch antenna	
		Connection by connector	
1.5 GHz Band-pass Filter	Standard	-	
	OEM	Installed in front of LNA stage	
Module Mounting	Select:	Direct connection by 1-mm pin-pitched header pins	
		Cable (connector)	

2. POSITIONING SPECIFICATIONS

CONDITIONS: Full-time Mode, Ambient Temperature 25°C

ITEM		DESCRIPTIONS	SPECIFICATION
Initial Acquisition Time	Hot Start	(1) Turn on the power supply and measure the time until position-fixing begins. (2) Repeat the measurement (1) over 24 hours under open-sky condition. The periods listed left are averages of the above-obtained measurements.	9 sec (max)
	Warm Start		37 sec (max)
	Cold Start		52 sec (max)
Re-acquisition Time after Interruption	10-sec Interruption	(1) Remove antenna shield, and measure the time until position-fixing begins. (2) Repeat the measurement (1) over 24 hours under open-sky condition. The periods listed left are averages of the above-obtained measurements.	2 sec (max)
	1-min Interruption		5 sec (max)
	10-ms Interruption		10 sec (max)
Horizontal Accuracy (2 drms)		(1) Obtain horizontal/vertical positioning accuracy. (2) Continue the measurement (1) over 24 hours under open-sky condition while receiving the satellites s of which PDOP average is less than 2.5. The accuracy listed left are averages of the above-obtained measurements.	15 m (max)
Vertical Accuracy (2σ)			23 m (max)
Tracking Speed (Maximum)		Max-trackable speed when moving straightly on the ground at constant speed. (Without interruption under open sky condition.)	514 m/sec (min)
Trackable Acceleration (Maximum)		Max-trackable acceleration in constant-speed circular movement (with jerk 0.7G/S) on the ground Without interruption under open sky condition.	1.2 G (min)
Tracking Sensitivity		Measured by using GPS simulator	-132 dBm (min) -138 dBm (typ)

3. ENVIRONMENTAL SPECIFICATIONS

ITEM	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Operating Temperature	TA	-	-30	-	80	°C
Storage Temperature	TSTG	-	-40	-	85	°C
Operating Humidity		Ambient temperature of 60°C without condensing.	-	-	90	%RH
		Ambient temperature of 55°C without condensing.	-	-	95	%RH

4. EXTERNAL I/O SIGNAL SPECIFICATIONS

A. Functions of I/O Signals

PIN #	SIGNAL	I/O	CONDITIONS	FUNCTION	NOTE
1	N.C.	-	-	No connection	Do NOT connect to this pin.
2	MODE	I	For mask-ROM version only	RAM all clear L: Normal H: RAM all clear	Refer to "D. AC Characteristics".
			For flash-memory version only	Flash memory write L: Normal H: RAM all clear and flash-memory write	
3	TD	O	-	Asynchronous serial transmission data	
4	RD	I	-	Asynchronous serial reception data	
5	WAKEUP	I	Valid in part-time mode operation only	Make this level HIGH to invoke full-time mode from within part-time mode.	Refer to Chapter 3.
6	RST_N	I	-	Module reset signal L: Reset H: Normal	
7	VBCK	I	-	Backup power supply for SRAM's backup area	
8	GND	-		Ground	
9	Vcc	I	-	Module power supply (3.3 V)	
10	N.C.	-	-	No connection	Do NOT connect to this pin.

Connector Type
GH-80-C: SM09B-SSR-H-TB

B. Absolute Maximum Ratings

SIGNAL	DESCRIPTIONS	MIN	MAX	UNIT
RD	DC input voltage	-0.3	Vcc + 0.3	V
RST_N				
MODE				
WAKEUP				
TD	DC output current	-8	8	mA
Vcc	Module power supply (3.3 Vdc)	-0.3	4.5	V
V_{BCK}	Backup power for SRAM's backup area	-0.3	4.5	V

C. DC Characteristics and Power Supply Requirements

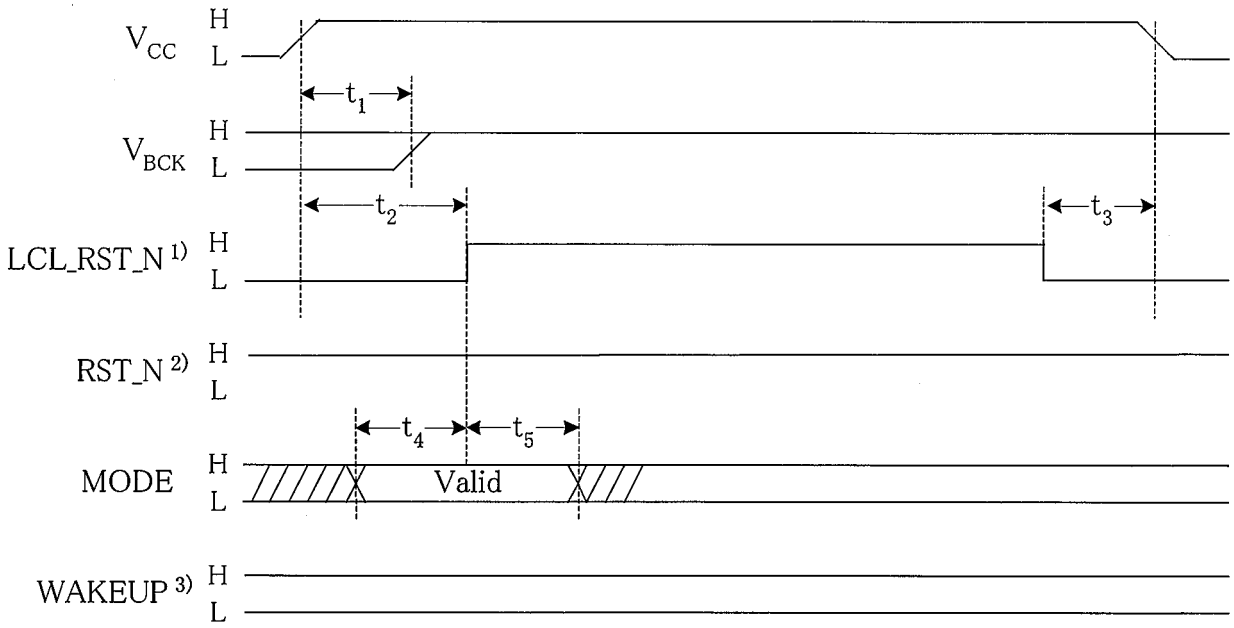
(Ambient Temperature: 25°C)

SIGNAL	SYMBOL	DESCRIPTIONS	CONDITIONS	MIN	TYP	MAX	UNIT	NOTE
RST_N	V_{IH}	High-level LVTTL	Vcc=3.1 to 3.6V	2	-	Vcc	V	Pulled down internally.
	V_{IL}	Low-level LVTTL	Vcc=3.1 to 3.6V	0	-	0.8	V	Positive (negative) current indicates current flow into (out of) the module.
	I_H	Leak current from H input	V_I=Vcc	-	-	+380	μA	
	I_L	Leak current from L input	V_I=0 V	-	-	-20	μA	
MODE	V_{IH}	High-level LVTTL	Vcc=3.1 to 3.6V	2	-	Vcc	V	Pulled down internally.
	V_{IL}	Low-level LVTTL	Vcc=3.1 to 3.6V	0	-	0.8	V	Positive (negative) current indicates current flow into (out of) the module.
	I_H	Leak current from H input	V_I=Vcc	-	-	+200	μA	
	I_L	Leak current from L input	V_I=0 V	-	-	-20	μA	
WAKE-UP	V_{IH}	High-level LVTTL	Vcc=3.1 to 3.6V	2	-	Vcc	V	Pulled down.
	V_{IL}	Low-level LVTTL	Vcc=3.1 to 3.6V	0	-	0.8	V	Positive (negative) current indicates current flow into the module.
	I_H	Leak current from H input	VI=Vcc	-	-	+200	μA	
	I_L	Leak current from L input	VI=0 V	-	-	-20	μA	
RD	V_{IH}	High-level LVTTL	Vcc=3.1 to 3.6V	2	-	Vcc	V	Pulled down internally.
	V_{IL}	Low-level LVTTL	Vcc=3.1 to 3.6V	0	-	0.8	V	Positive (negative) current indicates current flow into (out of) the module.
	I_H	Leak current from H input	VI=Vcc	-	-	+20	μA	
	I_L	Leak current from L input	VI=0 V	-	-	-80	μA	
TD	V_{OH}	HIGH-level output	I_{OH}=-2mA, Vcc=3.1V	2.4	-	-	V	
	V_{OL}	LOW-level output	I_{OL}=2mA	-	-	0.4	V	

(Continued)

SIGNAL	SYMBOL	DESCRIPTIONS	CONDITIONS	MIN	TYP	MAX	UNIT	NOTE
Vcc	Vcc	3.3V module supply voltage	-	3.1	3.3	3.6	V	
	Icc	3.3V module supply draw current	Vcc=3.6V	-	78	88	mA	
VBCK	VBCK	Backup voltage	Normal	2.1	3.3	3.6	V	For relation with Vcc, refer to " H. Recommended External Power Supply Circuit ".
			Backup	2.1	3.3	3.6	V	
	IBCK	Backup draw current	Normal Vcc=3.6V	-	174	250	μA	
			Backup Vcc=0V	-	6	10	μA	

D. AC Characteristics



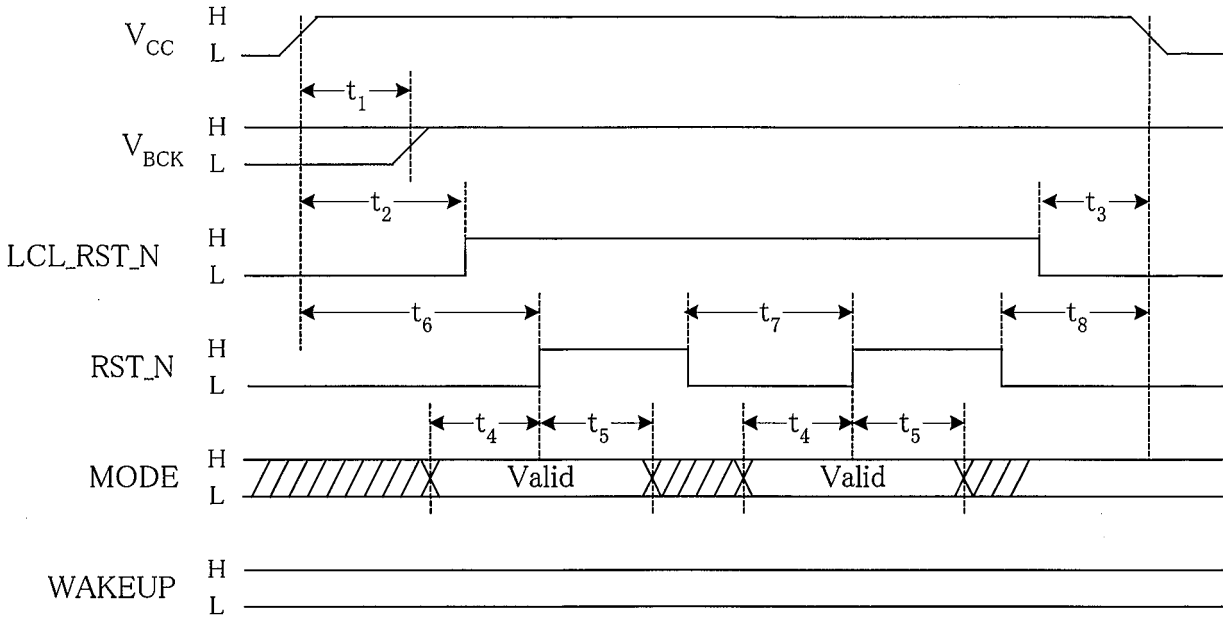
NOTE

1) Internal reset signal of the module

2) Make the level HIGH when turning on the power supply.
(Leave the pin open if not used).

3) WAKEUP signal is asynchronous with the power-on and reset timings.

MODE SIGNAL CONTROL BY INTERNAL RESET
Fig. 2-01



MODE SIGNAL CONTROL BY EXTERNAL RESET
Fig. 2-02

SYMBOL	DESCRIPTIONS	MIN	TYP	MAX	UNIT
t1	When Vcc (specified voltage) fails, VBCK (specified voltage) must be applied within t1 (sec). NOTE: If application of VBCK delays exceeding t1 (sec), module reset may be removed. In this case, the system function can not be assured. Unless VBCK can not be applied within t1 (sec), restarting by reset is required.	-	-	5	sec
t2	When Vcc (specified voltage) is applied, internal reset signal (LCL_RST_N) removes ASIC reset within t2 (ms).	40	-	300	ms
t3	When Vcc drops below the specified level, LCL_RST_N goes L (0V) in t3 (ms).	0	-	-	ms
t4	When the internal reset (LCL_RST_N) or external reset (RST_N) goes H (Vcc), MODE level must be set t4 (ms) in advance.	0	-	-	ms
t5	After the internal reset (LCL_RST_N) or external reset (RST_N) goes H (Vcc), MODE level must be held for t5 (ms).	-	-	1	ms
t6	After Vcc (voltage specified) is applied, RST_N must be kept LOW for t6 (ms) to allow ASIC reset. NOTE: t6 equals to maximum limit of t2.	300	-	-	ms
t7	Except for the power-on reset, LOW-duration of RST_N must be longer than t7 (ms) to allow ASIC reset.	1	-	-	μs
t8	When Vcc goes below the rated level, make the RST_N level LOW t8 (ms) in advance.	0	-	-	Ms

E. Logic Levels of TD/RD Signals

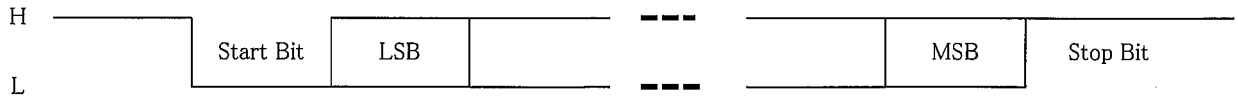
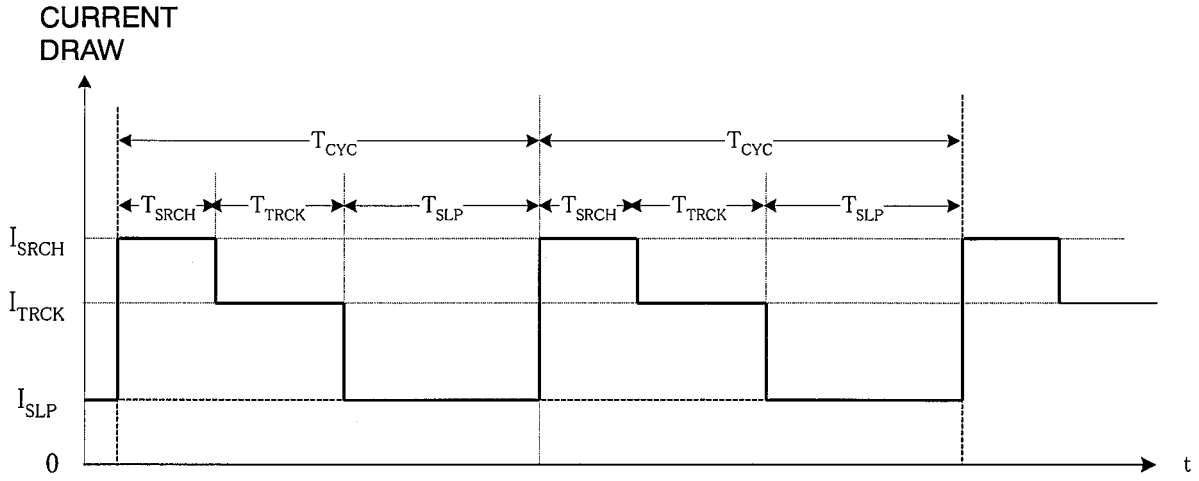


Fig. 2-03

F. Current Draw in Part-time Mode Operation

(1) Short-termed Part-time Mode



CURRENT DRAW TIME CHART
(SHORT-TERMED PART-TIME MODE)
Fig. 2-04

SYMBOL	DESCRIPTIONS	MIN	TYP	MAX	UNIT
TCYC	Part-time mode operation interval	TCYC is user-definable. Refer to Chapter 3.			
TSLP	Sleeping period	TSLP is determined when TCYC is set. Refer to Chapter 3.			
TSRCH	Satellite-search period after start-up. NOTE: TSRCH becomes longest (TCYC -TSLP) if only satellite-search is performed at start-up.	0.02	-	TCYC -TSLP	sec
TTRCK	Satellite-tracking period after start-up NOTE: TSRCH (min)=Minimum satellite-search period TSRCH becomes shortest (0 sec) if only satellite-search is performed at start-up.	0	-	TCYC -TSLP - TSRCH (min)	sec

(Continued)

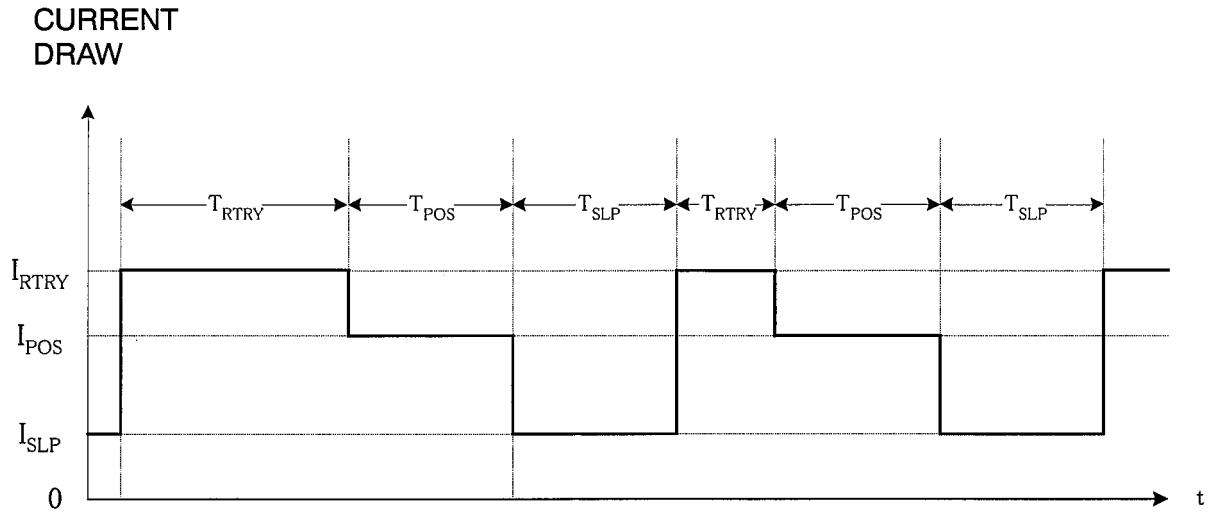
SYMBOL	DESCRIPTIONS	MIN	TYP	MAX	UNIT
ISRCH	Current draw in satellite-search operation (8 satellites) after start-up.		78	88	mA
ITRCK	Current draw in satellite-tracking operation (8 satellites) after start-up.		48	58	mA
ISLP	Current draw in sleeping condition (CPU and GPS circuits idle).	-	7	17	mA

TCYC is user-definable, but TSLP is determined by TCYC. For further details, refer to Chapter 3.

Mean current consumption in short-termed part-time mode is given by the following formula:

$$Icc=(I_{SRCH} \times T_{SRCH} + I_{TRCK} \times T_{TRCK} + I_{SLP} \times T_{SLP}) / T_{CYC}$$

(2) Long-termed Part-time Mode



CURRENT DRAW TIME CHART
(LONG-TERMED PART-TIME MODE)
Fig. 2-05

SYMBOL	DESCRIPTIONS	MIN	TYP	MAX	UNIT
TRTRY	Retrial period	TRTRY is user-definable. Refer to Chapter 3.			
TPOS	Continuous operating period after position-fixing	TPOS is user-definable. Refer to Chapter 3.			
TSLP	Sleeping period	TSLP is user-definable. Refer to Chapter 3.			
IRTRY	Current draw in retrial period (8-satellite searching)	-	78	88	mA
IPOS	Current draw in continuous operating period after position-fixing. (4-satellite search and 8-satellite tracking)	-	65	75	mA
	Current draw in continuous operating period after position-fixing. (8-satellite tracking)	-	48	58	mA
ISLP	Current draw in sleeping condition (CPU and GPS circuits idle).	-	5	10	mA

TRTRY, TPOS and TSLP may be set by users. For TRTRY, continuous operation is performed after position-fixing. Refer to Chapter 3.

The interval of the long-termed part-time mode operation varies depending on TRTRY.

Mean current consumption in long-termed part-time mode is given by the following formula:

$$Icc=(I_{RTRY} \times T_{RTRY} + I_{POS} \times T_{POS} + I_{SLP} \times T_{SLP}) / (T_{RTRY} + T_{POS} + T_{SLP})$$

G. I/O Port Equivalent Circuits

(1) RD

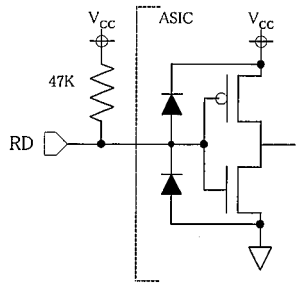


Fig. 2-06

(2) TD

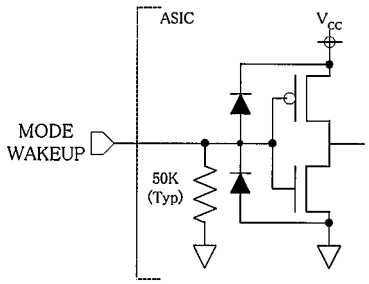


Fig. 2-07

(3) MODE and WAKEUP

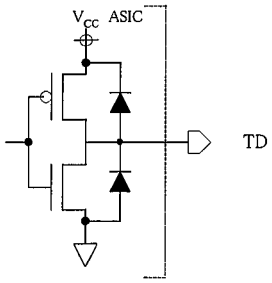


Fig. 2-08

(4) RST_N

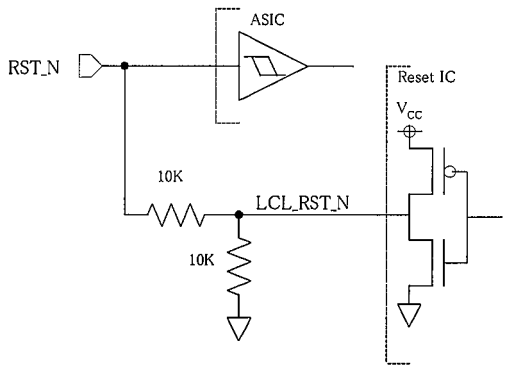


Fig. 2-09

H. Recommended External Power Supply Circuit

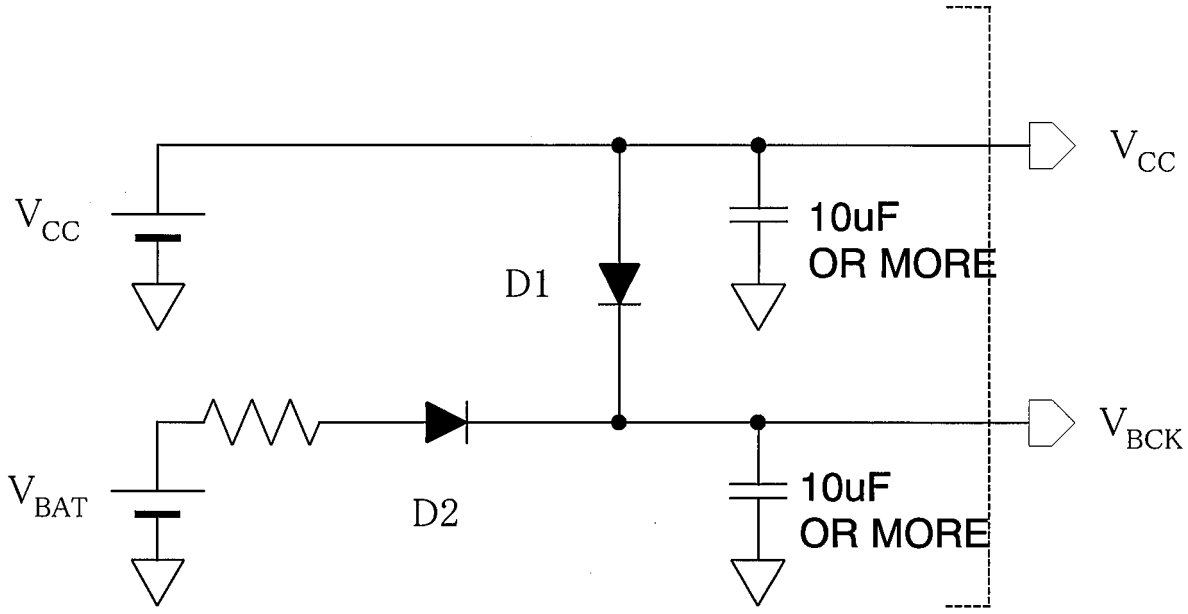


Fig. 2-10

The current drawn by the backed-up circuits is 195 μA (max) in normal operation. In order to minimize battery consumption (to prevent VBCK from lowering below the rated voltage), always supply battery power (VBAT) through D1 and satisfy the following condition.

$$V_{BCK}(min) + Vf2(max) < V_{BAT} < V_{CC}(min) - Vf1(max)$$

NOTE: Vf1 and Vf2 are forward voltage drops across D1 and D2, respectively.

For specifications of Vcc and VBAK, refer to " C. DC Characteristics and Power Supply Specifications".

5. ENVIRONMENTAL TEST STANDARD

A. Definitions of Terms

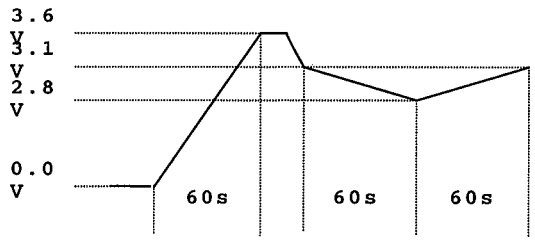
"STANDARD TEST CONDITION" used in this section means the following conditions:

ITEM	CONDITION
Temperature	20 ± 15°C
Humidity	65 ± 20% RH
Input signal (GPS signal input)	-126 dBm (by GPS simulator)
Power supply voltage (Vcc)	3.1 to 3.6 V
Backup power supply voltage (V_{BCK})	3.0 ± 0.3 V

"BASIC PERFORMANCE" used in this section means the following performance:

ITEM	PERFORMANCE
C/No	C/No ratio is higher than 34 dB-Hz when the GPS signal fed from the GPS simulator measures -126 dBm at the antenna terminal.
Current draw for continuous operation	Below 88 mA
Current draw for sleeping condition (CPU idle)	Below 10 mA
Backup current	Below 250 μA (Vcc=3.3 V) Below 10 μA (Vcc=0 V)
Reset operation	After internal or external reset is removed, serial data is output normally.
Self-test results	ROM/RAM check results are OK. Data is backed up safely.
Visual inspection	No sign of damaged parts or outer surface.

B. Environmental Test Standard

TEST ITEM	TEST	STANDARD
Thermo-voltage test	After leaving the module in -30, 5, 25, 65 and 80°C for 1±0.5 hours, respectively, operate it from 3.1, 3.3 and 3.6 V supply voltages.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Power interruption test	After leaving the module in -30, 5, 25, 65 and 80°C for 1±0.5 hours, respectively, interrupt power supply for 10 μs, 100μs, 1 ms and 50 ms.	For each interruption CPU shall keep on transmitting data with proper format without hanging up. If the module is reset by the power interruption, necessary data are backed up properly.
Supply voltage fluctuation test	Change the supply voltage as shown below:  Fig. 2-11	For each fluctuation CPU shall keep on transmitting data with proper format without hanging up. If the module is reset by the power interruption, necessary data are backed up properly.
Electro-static test	By using the test equipment (150 pF, 330 Ω) specified by the JASO D 001-94 standard, add ±1 kV (1-sec period or longer) to each connector pin and antenna power feeder pin.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Low-temperature storage test	Store the module in -40°C for 6±2 hours.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Low-temperature operation test	Operate the module in -30°C with 3.1 V supply voltage for 72 hours.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.

(Continued)

TEST ITEM	TEST	STANDARD
High-temperature storage test	Store the module in 85°C for 6±2 hours.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
High-temperature operation Test	Operate the module in 80°C with 3.6 V supply voltage for 72 hours.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Humidity operation test	Operate the module in 50°C and 95% RH environment for 2±0.5 hours.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Vibration test	Frequency: 10 to 120 Hz (changed linearly) Period: 20 minutes (one way) Acceleration: 19.6 m/s2 (2G) Vibration is added 2 times (40 min) in each X, Y and Z direction.	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.
Mechanical shock test	The module fixed onto the bottom of a hard box is dropped 3 times for 6 surfaces, respectively. Height: 1000±50 mm	After the test, the BASIC PERFORMANCE is obtainable in the STANDARD TEST CONDITION.