FURUNO

FURUNO Multi-GNSS Disciplined Oscillator

Models GF-8701, GF-8702, GF-8703

Hardware Specifications

(Document No. SE16-410-003-01)

FURUNO ELECTRIC CO., LTD.

www.furuno.com

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- GPS(USA)
- GLONASS (Russia)
- QZSS(Japan)
- SBAS(USA: WAAS, Europe: EGNOS, Japan: MSAS)

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Revision History

Version	Changed contents	Date
0	Initial release	2016.04.11
1	All revised	2017.02.27

Table of Contents

1 Outline

GF-8701, GF-8702 and GF-8703 (GF-8701/02/03) are FURUNO Multi-GNSS Disciplined Oscillators (GNSSDO). Main features are as follows:

- Supports GPS, GLONASS, SBAS and QZSS[1)]
- Provides highly accurate PPS signal synchronized with UTC
- Provides the clock (10 MHz: VCLK) synchronized with PPS
- Software upgrade capability by Flash ROM
- Active Anti-jamming capability to suppress effects of CW jammers
- Multi path mitigation effects
- GPS high sensitivity (-161 dBm (Hot acquisition))
- It is not necessary for user to use the power of high accuracy, high stability and low noise because the LDO is built in.
- The connector can be selected between the coaxial connector (RF_COAX) or IF connector (RF_ PIN) for signal input.
- These GNSSDO are pin compatible.[2)]

Notes:
1) These satellite systems are called as GNSS collectively.
2) The specifications of the power consumption, PPS and 10 MHz are different.

2 Block Diagram

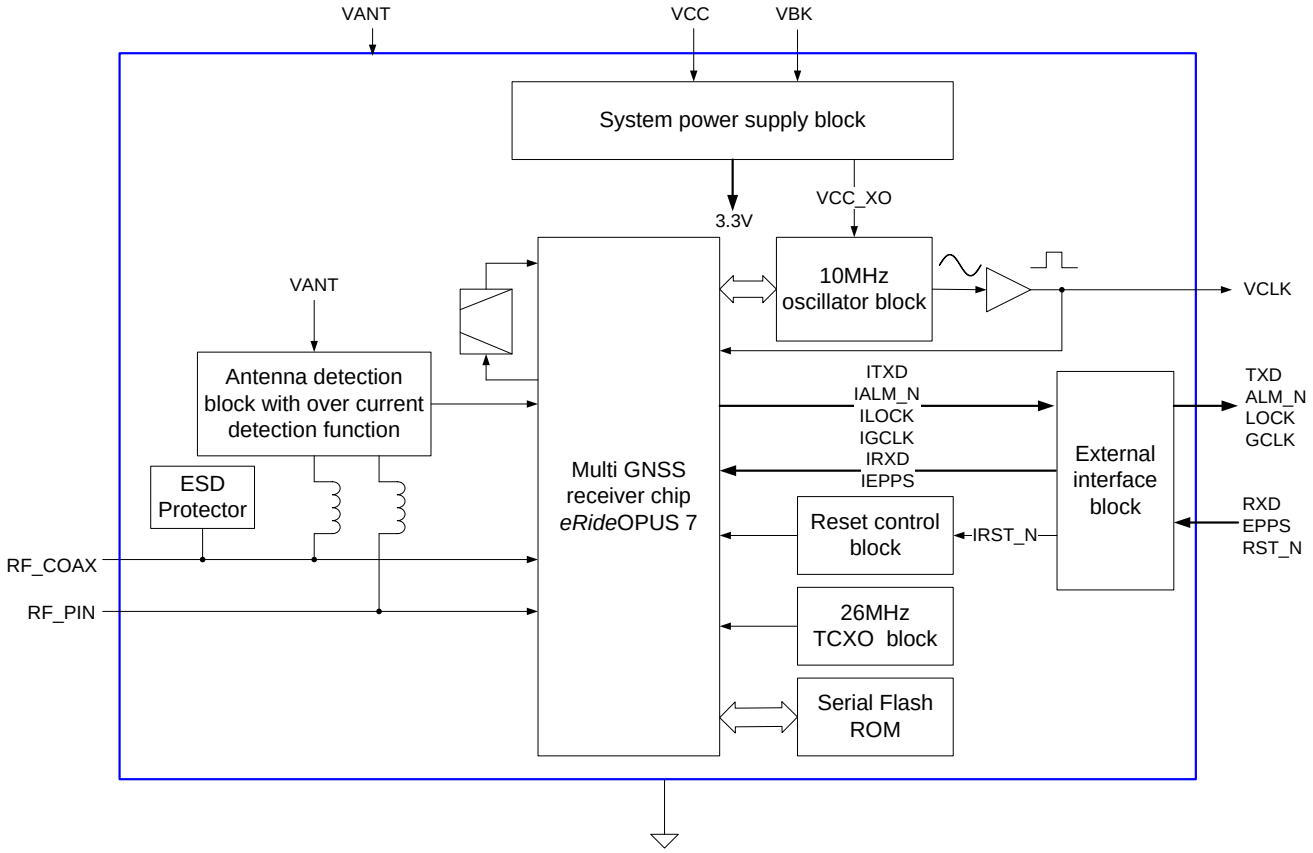


Figure 2.1 GF-8701/02/03 Block Level Diagram

3 GNSS General Specifications

Table 3.1 General Specifications

Items	Description		Notes
GNSS reception capability	GPS L1C/A	12	
	GLONASS L1OF	10	
	QZSS L1C/A	2	
	SBAS L1C/A	2	WAAS, MSAS, EGNOS, GAGAN
GNSS concurrent reception	GPS, GLONASS, QZSS, SBAS	26	
Environment robustness performance	Active Anti-jamming	8CW	
	Multipath Mitigation	●	
Serial data format	NMEA	●	Ver. 4.10, 38400 bps[3)]
Antenna	Active antenna	●	
Operational limits	Altitude	18,000m	Compliant with the Wassenaar Arrangement Specifications
	Velocity	515 m/s	

Notes:
3) See Protocol Specifications for details.

4 GNSS General Performance

Table 4.1 General Performance

T_A=25°C

Items	Description		Notes
TTFF	Hot Outdoor	<5 s	These are specified with the measurement platform shown in Figure 4.1. Simulator output level is set to -130 dBm.
	Warm Outdoor	35 s	
	Cold Outdoor	35 s	
GPS sensitivity	Tracking	-161 dBm	These are specified with the measurement platform shown in Figure 4.1.
	Hot Acquisition	-161 dBm	
	Cold Acquisition	-147 dBm	
	Reacquisition	-161 dBm	
GLONASS sensitivity	Tracking	-157 dBm	
	Hot Acquisition	-157 dBm	
	Cold Acquisition	-143 dBm	
	Reacquisition	-157 dBm	
Position accuracy	Horizontal Outdoor	2.5m CEP	Open sky[4] 24 hours continuous static test with GPS only by using recommended antenna
		2.0m CEP	Open sky[4] 24 hours continuous static test with GPS, GLONASS and SBAS by using recommended antenna

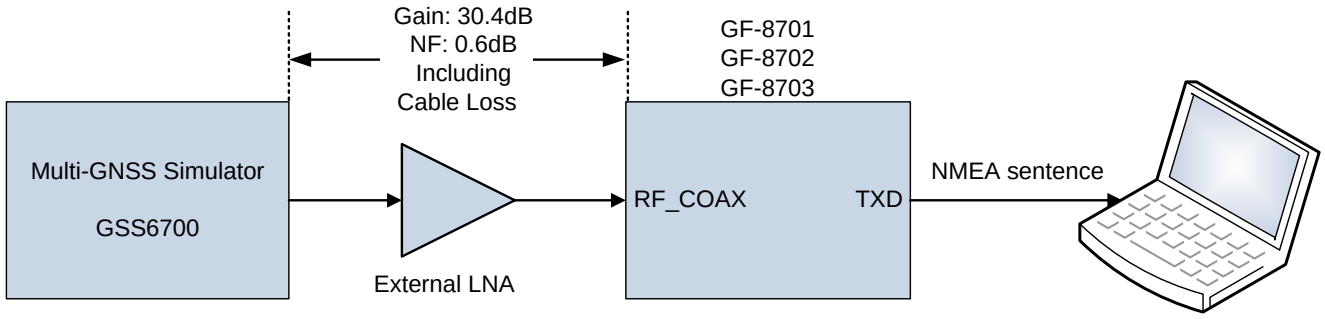


Figure 4.1 Measurement Platform

Notes:

4) Open sky is a environment that is more than 50% of the number of satellites in use with signal level of over 40 dB-Hz.

5 I/O Signal Description

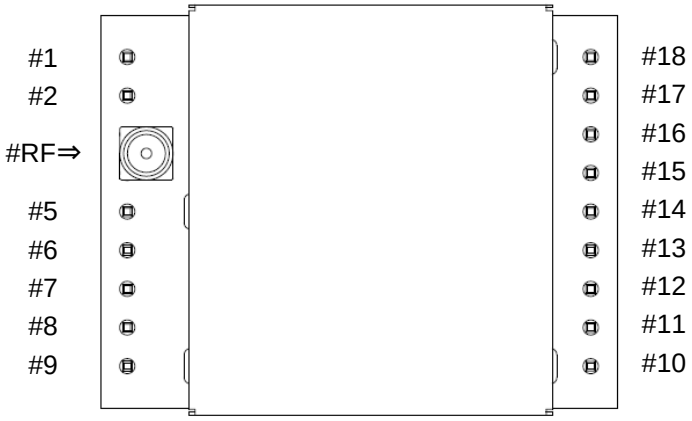


Figure 5.1 Top of View

Table 5.1 I/O Signal Description

#	Pin Name	Type	PU/PD[5)]	Description
1	RST_N	Digital input	Pull-up	External reset signal input pin Logic L : Reset Logic H or Open : Normal operation
2	VANT	Power input	-	Power supply output pin for active antenna
5	GND	-	-	Ground
6	RF_PIN	-	-	RF signal input VANT voltage is superimposed and output. In case of not using, do not connect anything.
7	GND	-	-	Ground
8	VBK	Power input	-	Backup power supply input pin[6)] Do not connect if battery backup function is not used
9	VCC	Power input	-	Main power supply input pin
10	GND	-	-	Ground
11	VCLK	Digital output	-	VCO clock output pin (10MHz) Square pulse
12	RXD	Digital input	Pull-up	Serial communication input pin
13	TXD	Digital output	-	Serial communication output pin
14	ALM_N	Digital output	-	Alarm signal output pin[7)] Logic L : Abnormal Logic H : Normal
15	LOCK	Digital output	-	Lock signal output pin[8)] Logic L : Unlock Logic H : Lock
16	GCLK	Digital output	-	Clock output pin (from 4kHz to 40MHz)
17	PPS	Digital output	-	Pulse per second output pin
18	EPPS	Digital input	Pull-down	External synchronized PPS input pin
RF	RF_COAX	Analog input	-	RF signal input connector Power for antenna pre-amplifier is superimposed (biased) from this connector (default). MMCX connector receptacle /50Ω

Notes:
5) Pull-up and pull-down resistor values are shown in Table 6.3.
6) The backup power is shown in Section 8.4.
7) The alarm output conditions are shown in Section 8.1.
8) The lock output conditions are shown in Section 8.2.

6 Electrical Characteristics

6.1 Absolute Maximum Rating

The lists of absolute maximum ratings are specified over operating case temperature shown in Table 10.1. Stresses beyond those listed under those range may cause permanent damage to module.

Table 6.1 Absolute Maximum Rating

Items	Symbol	Min.	Max.	Unit	Notes
VCC supply voltage	V_{CC}	-0.3	6.0	V	
VBK supply voltage	V_{BK}	-0.3	4.0	V	
VANT supply voltage	V_{ANT}	-0.3	6.0	V	VANT, RF_PIN, RF_COAX
Other pins DC voltage	V_{IN}	-0.5	6.5	V	Input voltage at power ON/OFF
	V_{OUT}	-0.5	3.8	V	Output voltage at power ON/OFF
Other pins DC current	-	-	±50	mA	
RF_COAX input power	P_{RF_COAX}	-	8	dBm	at 1575.42MHz & 1602MHz
		-	6	dBm	at 900MHz
		-	8	dBm	at 1800MHz
RF_IN input power	P_{RF_IN}	-	-5	dBm	at 1575.42MHz & 1602MHz
		-	0	dBm	at 900MHz
		-	-1	dBm	at 1800MHz

6.2 Power Supply

Table 6.2 Power Supply Characteristics

T_A=25°C, unless otherwise stated

Items		Symbol	Min.	Typ.	Max.	Unit	Notes
Supply voltage to VCC		V_{CC}	3.5	3.7	3.9	V	
Supply voltage to VANT		V_{ANT}	2.7	-	5.5	V	
Backup supply to VBK		V_{BK}	1.4	-	3.6	V	at using VBK
Rising slew rate of VCC		V_{CC_SR}	-	-	$3.9x10^4$	V/s	See Figure 6.1
Rising slew rate of VBK		V_{BK_SR}	3.6	-	$3.6x10^4$	V/s	See Figure 6.1
VCC current consumption (at start up)	GF-8701	I_{CC_WU01}	-	-	150	mA	
	GF-8702	I_{CC_WU02}	-	-	800	mA	
	GF-8703	I_{CC_WU03}	-	-	1400	mA	
VCC current consumption (at stable state)	GF-8701	I_{CC_ST01}	-	-	150	mA	
	GF-8702	I_{CC_ST02}	-	450	-	mA	
	GF-8703	I_{CC_ST03}	-	600	-	mA	
VBK current consumption at back up		I_{BKN}	-	9	20	μA	V_{CC}=0V
VBK current consumption at normal operation		I_{BKB}	-	0.4	2	μA	V_{CC}=3.3V

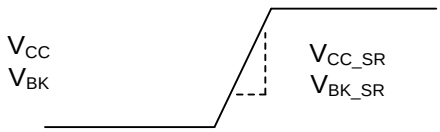


Figure 6.1 Rising Slew Rate

6.3 Interface Signal

Table 6.3 Interface Signal

T_A=25°C, unless otherwise stated

Items	Symbol	Min.	Typ.	Max.	Unit	Notes
Low-Level input voltage	V_{IL}	-	-	0.8	V	
High-Level input voltage	V_{IH}	2.0	3.3	5.5	V	
Low-Level output voltage	V_{OL}	-	-	0.4	V	I_{OL} = 16mA
High-Level output voltage	V_{OH}	2.4	3.3	3.6	V	I_{OH} = -18mA
Digital input pull-up resistor	R_{PU}	9.5	10	10.5	kΩ	Internal resistor
Digital input pull-down resistor	R_{PD}	9.5	10	10.5	kΩ	
Digital input pull-up voltage	V_{PU}	-	3.3	-	V	

6.4 Reset

6.4.1 Internal Power-on Reset

GNSSDO contains an internal power-on reset circuit which detects VCC voltage and creates POR_N (power-on reset) signal for initializing module. Table 6.4 shows the threshold voltages to detect and create POR_N signal.

Table 6.4 Power-on Reset Voltage

T_A=25°C, unless otherwise stated

Items	Symbol	Min.	Typ.	Max.	Unit	Notes
Power On Reset threshold voltage (rising)	V_{RTH_POR}	-	-	3.3	V	
Power On Reset threshold voltage (falling)	V_{FTH_POR}	2.7	-	-	V	

6.4.2 External Reset

GNSSDO is controlled by external reset signal (RST_N) with the following sequence.

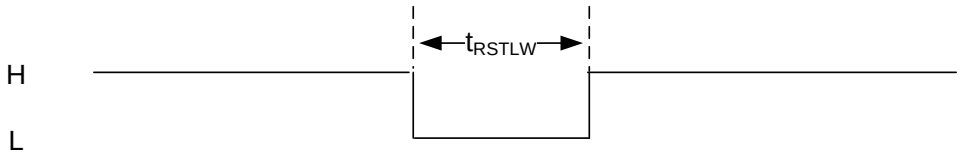


Figure 6.2 Reset Sequence

Table 6.5 Reset Sequence

Items	Symbol	Min.	Max.	Unit	Notes
Reset pulse width	T_{RSTLW}	300	-	ms	

6.5 UART Wake-up Timing after Reset

6.5.1 Internal Reset Control

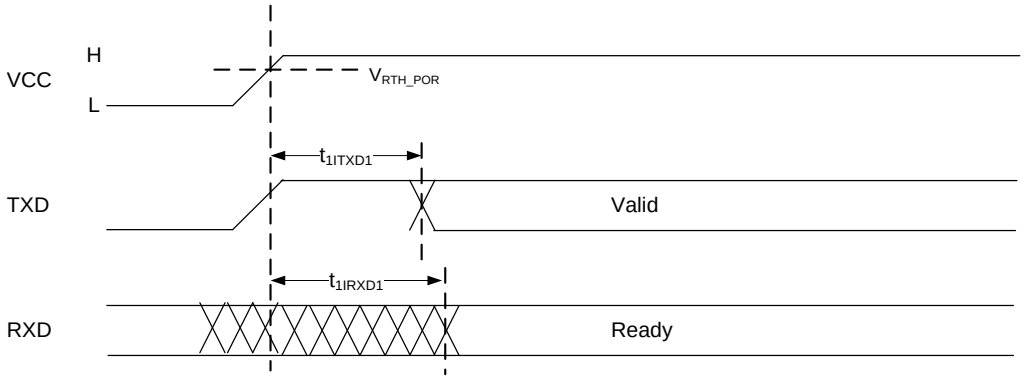


Figure 6.3 UART Wake-up Timing

Table 6.6 UART Wake-up Timing

Items	Symbol	Min.	Max.	Unit	Notes
Time delay from VCC reaches V_{RTH_POR} to TXD valid	t_{1ITXD1}	-	6	s	
Time delay from VCC reaches V_{RTH_POR} to RXD ready	t_{1IRXD1}	-	6	s	

6.5.2 External Reset Control

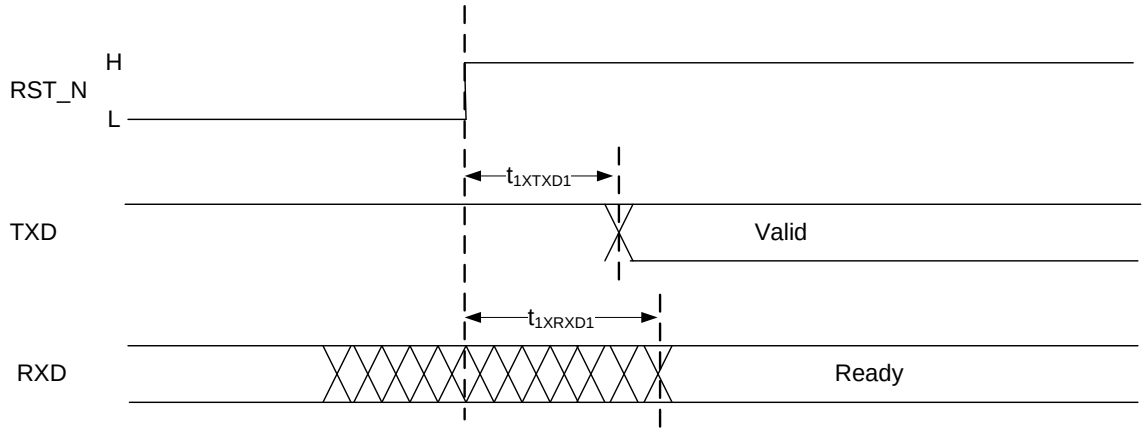


Figure 6.4 UART Wake-up Timing after RST_N

Table 6.7 UART Wake-up Timing after RST_N

Items	Symbol	Min.	Max.	Unit	Notes
Time delay from RST_N set to H to TXD valid	t_{1XTXD1}	-	6	s	
Time delay from RST_N set to H to RXD ready	t_{1XRXD1}	-	6	s	

6.5.3 Baud Rate Setting

The baud rate clock is created from 71.5 MHz system clock, hence it has some deviation errors against ideal baud rate clock as shown in Table 6.8.

Table 6.8 Baud Rate vs. Deviation Error (TXD)

Baud rate [bps]	Deviation error [%]
4800	+0.00
9600	+0.11
19200	-0.11
38400	+0.32
57600	-0.54
115200	-0.54
230400	+2.08
460800	-3.02

The baud rate of serial communication input RXD and the lower and upper limit of tolerance error is shown as Table 6.9.

Table 6.9 Baud Rate and Tolerance Error (RXD)

Baud rate [bps]	Tolerance error [%] Lower limit	Tolerance error [%] Upper limit
4800	-4.64	5.26
9600	-4.53	5.38
19200	-4.74	5.15
38400	-4.33	5.60
57600	-5.15	4.70
115200	-5.15	4.70
230400	-2.65	7.45
460800	-7.52	2.08

6.6 Antenna

6.6.1 Recommended Antenna

Table 6.10 Recommended Antenna

Items	Min.	Typ.	Max.	Unit	Notes
GPS center frequency	-	1575.42	-	MHz	2.046 MHz bandwidth
GLONASS center frequency	-	1602	-	MHz	9 MHz bandwidth
Antenna element gain	0	-	-	dBi	
Pre-amplifier gain	15	-	35	dB	Including cable loss
Pre-amplifier NF	-	-	3.5	dB	
Impedance	-	50	-	Ω	
VSWR	-	-	2	-	

6.6.2 Antenna Amplifier Power

The power input from the pin #2 (VANT) is superimposed with the antenna connector (RF_COAX) or the interface connector (RF_PIN) and output. The power supply is ON by default and it is able to be stopped the power supply with the command.

GNSSDO incorporates an antenna current error sensing function. In case of detecting an antenna current error, the alarm (ALM_N) is output. If the error is an antenna short (an over current), the antenna pre-amplifier power supply is stopped.

Table 6.11 Antenna Pre-amplifier Power Supply

Items	Symbol	Min.	Typ.	Max.	Unit	Notes
Antenna pre-amplifier output voltage	V_{APO}	V_{ANT}-0.5	-	-	V	@ I_{APO}=75mA
Antenna pre-amplifier output current	I_{APO}	-	-	75	mA	
Threshold current of antenna open	I_{AOD}	-	5	10	mA	
Threshold current of antenna short	I_{ASD}	80	85	-	mA	
Antenna current upper limitation	I_{AOL}	-	-	200	mA	Antenna shortage

Multiple GNSSDO can be connected for one antenna since the antenna pre-amplifier power output incorporates a preventive function of current backflow. It is not necessary for user to use a DC cut for redundancy.

6.6.3 RF_COAX and RF_PIN

RF_COAX and RF_PIN are GNSS signal input pins. User can reduce the time for design and evaluation because of omitting the high frequency circuit design by using the RF_COAX. User will also be able to reduce the cost since it is not necessary to use a special cable to connect the RF_COAX when the RF_PIN is used.

Users will be able to use either one of RF_COAX and RF_PIN. Use the RF_COAX when the antenna coaxial cable will be connected directly to the MMCX connector of this product. Use the RF_PIN when GNSS signals are input via the microstrip line from the user board. Refer to the "FURUNO GPS/GNSS Receiver 86/87 Module Design Guide SE13-900-000" for microstrip line.

RF_COAX and RF_PIN cannot be used at the same time, and it is needed to switch by the command. The default is set to RF_COAX. When the RF_COAX is set, it is not used even the GNSS signals will be input into the RF_PIN.

7 VCLK/GCLK/PPS Signal Specification

7.1 GNSS Locked State

Table 7.1 shows the specifications of GNSS locked state.

Table 7.1 GNSS Locked State Specifications

VCC=3.7V

Symbol	Items		Specification	Unit	Notes
PPS	Frequency		1	Hz	Temperature gradient: ±20°C/H Open Sky
	Programmable duty ratio by PPS command		50(typ)	%	
	Timing accuracy[9)10)]		<±100	ns	
	Timing precision (1 sigma) [9)]		<±15	ns	
VCLK	Frequency		10	MHz	
	Frequency accuracy (24 hour average)	GF-8701	<±1E-11	-	
		GF-8702	<±1E-12	-	
		GF-8703	<±1E-12	-	
	Short term stability (Root Allan variance (τ=1s))	GF-8701	<1E-9	-	
		GF-8702	<2E-10	-	
		GF-8703	<2E-10	-	
GCLK	Programmable frequency range by GCLK command		0.004 to 40	MHz	T_A=25°C Open Sky
	Frequency accuracy (24hour average)		<±5E-11	-	
	Frequency precision (3 sigma)		<±3E-9	-	
	Total jitter		<±8	ns	

Notes:
9) Valid position mode is the Hold position survey and the Position-hold mode.
10) Synchronization source is selectable by TIMEALIGN command. In order to achieve the performance, the user should compensate the cable delay with PPS command correctly.

7.2 Holdover

Table 7.2 shows the specification of Holdover when GNSSDO is not able to get the GNSS time data at static operation, which means that the PPS specification of Holdover is not guaranteed with the following condition:

- Mobile and vehicle application with NAV mode in SURVEY command.
- EPPS as external PPS signal source is available.
- GNSSDO has the influence of mechanical vibration.

The Holdover specification is guaranteed under the temperature condition in Table 7.2. In case the GNSSDO has a big temperature gap between Fine Lock and Holdover state, which means that the temperature of Fine Lock state is constant and the temperature of Holdover state is rapidly changed as example, the Holdover specification is not guaranteed.

Table 7.2 Holdover Specifications

VCC=3.7V

Symbol	Items		Specification	Unit	Notes
PPS	Frequency		1	Hz	The temperature range[11]: -40°C to 85°C Ambient temperature change: 20 °C Temperature gradient: +/- 5 °C/h Integrated value of temperature variation[12]: 240 H * °C Before moving to Holdover mode, time to “Fine Lock” should be more than 72 hours and the time of power on should be more than 7 days.
	Duty ratio		50(typ)	%	
	Timing accuracy[13)14)] (after 24 hour)	GF-8701	N/A	-	
		GF-8702	<±50	us	
		GF-8703	<±10	us	
	Timing precision (1 sigma)		N/A	-	
VCLK	Frequency		10	MHz	
	Frequency accuracy	GF-8701	N/A	-	
		GF-8702	<±3E-9	-	
		GF-8703	<±1E-9	-	
	Short term stability (Root Allan variance (τ=1s))	GF-8701	<1E-9	-	
		GF-8702	<2E-10	-	
		GF-8703	<2E-10	-	
GCLK	Frequency variable range		0.004 to 40	MHz	
	Frequency accuracy (24hour average)		N/A	-	
	Total jitter		<±8	ns	

Notes:

11) Terminal temperature of the product.
12) The time integrated value [H*°C] of temperature variation. The integrated value per 24 hours based on the temperature of the beginning of Holdover.
13) These are measured at the environment shown in Figure 7.1.
14) Valid position mode is the Hold position survey and the Position-hold mode.

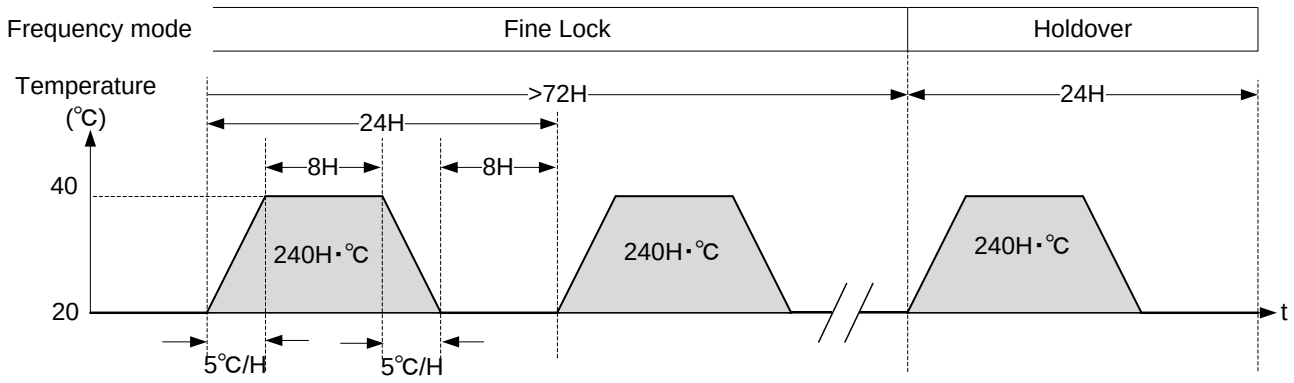


Figure 7.1 Holdover Measurement Environment

7.3 Time to Fine Lock

Table 7.3 shows the time to Fine Lock from power-on to GNSS lock.

Table 7.3 Fine Lock Specifications

T_A=25°C, unless otherwise stated
Open sky

VCC OFF time	VBK state	State before VCC OFF	Adjusting time
5 seconds and more	-	-	・vs GPS…<5 min ・vs UTC…<15 min
less than 5 seconds	N/A		
	Available	Other than the below state	
		・UTC(USNO) or UTC(SU) alignment[15)] ・pps status: UTC(USNO) or UTC(SU)[16)]	・vs GPS…<5 min ・vs UTC…<5 min

Notes:
15) This is selectable by TIMEALIGN command. The default is UTC(USNO) alignment.
16) See field 7 in CRW(TPS1) sentence about the pps status.

7.4 Phase Relation between PPS and VCLK

Figure 7.2 shows the phase relation between PPS and VCLK. This relation is coherent.

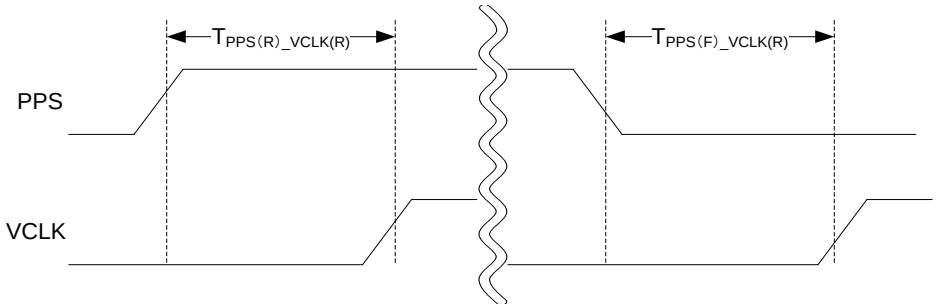


Figure 7.2 Phase Relation between PPS and VCLK

Table 7.4 VCLK Delay Time

Symbol	Description	Condition	Min.	Max.	Unit
$T_{PPS(R)\_VCLK(R)}$	VCLK rising delay time after voltage of PPS is valid	Valid frequency mode: Pull-In, Coarse Lock, Fine Lock	35	55	ns
$T_{PPS(F)\_VCLK(R)}$	VCLK rising delay time after voltage of PPS is invalid		35	55	ns

8 Interface Signal Specification

8.1 Alarm Signal (ALM_N)

It is able to confirm the alarm signal (ALM_N) status by "alarm" field in CRZ (TP4) sentence. Table 8.1 shows the protocol specifications of alarm signal.

Table 8.1 Alarm Signal Specifications

CRZ(TPS4) “alarm” field	ALM_N pin	Description
00	Logic H	Normal
Other than 00	Logic L	Abnormal

8.2 Lock Signal (LOCK)

It is able to confirm the lock signal (Lock) status by "frequency mode" field in CRZ (TP4) sentence and to set the lock pin output condition by "Lock post set" field in MODESET command. Table 8.2 shows the protocol specifications of lock signal.

Table 8.2 Lock Signal Specifications

MODESET “Lock port set” field	CRZ(TPS4) “frequency mode” field	LOCK pin
0	2, 3, 4	Logic H
	other than above values	Logic L
1 (default)	2, 3	Logic H
	other than above values	Logic L
2	3	Logic H
	other than above value	Logic L
3	3,4	Logic H
	other than above values	Logic L

8.3 PPS Input Signal for External Synchronization (EPPS)

When 1PPS is input to the EPPS pin and the command is set up, the VCLK and the PPS will be synchronized with the pulse. The synchronous target is the rising edge of the pulse to be input to the EPPS. Refer to the "EXTSYNC" in the protocol specification to set the external synchronized function.

8.4 Backup Power Supply (VBK)

When using the backup power supply, the information obtained from the navigation message of each satellite, the positioning result and the input value of the command set by the user are saved into the backup RAM (BBRAM) in the GNSSDO at the main power-off. With this backup function, when the GNSSDO returns from the main power-off, the TTFF and the time to GNSS Lock State will be reduced. However, the almanac and ephemeris data should be received before the main power shut down. Refer to the protocol specifications for the data to be saved into BBRAM.

9 State Transition

It is able to confirm the state transition by "frequency mode" field in CRZ (TPS4) sentence. See the protocol specifications about this sentence.

10 Environmental Specifications

Table 10.1 Environmental Specifications

Items	Specification	Unit	Notes
Operating temperature	-40 to +85	°C	
Storage temperature	-40 to +85	°C	
Operation humidity	85 (MAX)	%R.H	T_A= 60°C, No condensation

11 RoHS

This product is RoHS compliant.

12 Flame Retardancy Rank

UL94V-1 compliance.

13 FIT

GF-8701 --- 2000FIT
GF-8702 --- 2500FIT
GF-8703 --- 3100FIT

Calculation requirements
- Telcordia 332 issue3
- Parts count method
- Environmental factor: GF
- Operating temperature: 50°C
- Quality level: level 0
- Using the failure rate from manufacturer: Yes

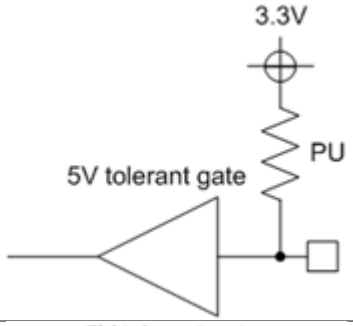
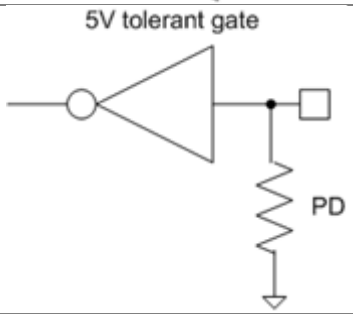
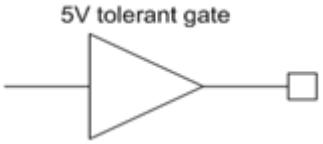
14 Reliability Test

#	Test Item	Conditions
1	High temperature high humidity bias life	1000 hours, T_A = 85°C, RH =85%
2	High temperature high humidity storage life	1000 hours, T_A = 85°C, RH =85%
3	Low temperature operating life	500 hours, T_A = -40°C
4	Low temperature storage life	500 hours, T_A = -40°C
5	Drop Test	With packing, 50cm natural drop
6	Vibration Test	The each three direction (x,y,z), 10 to 55Hz 4.7G (46m/s^2) 30 minutes (Not operating).
7	ESD Test	JIS C 61000-4-2 Contact

15 Equivalent Circuit

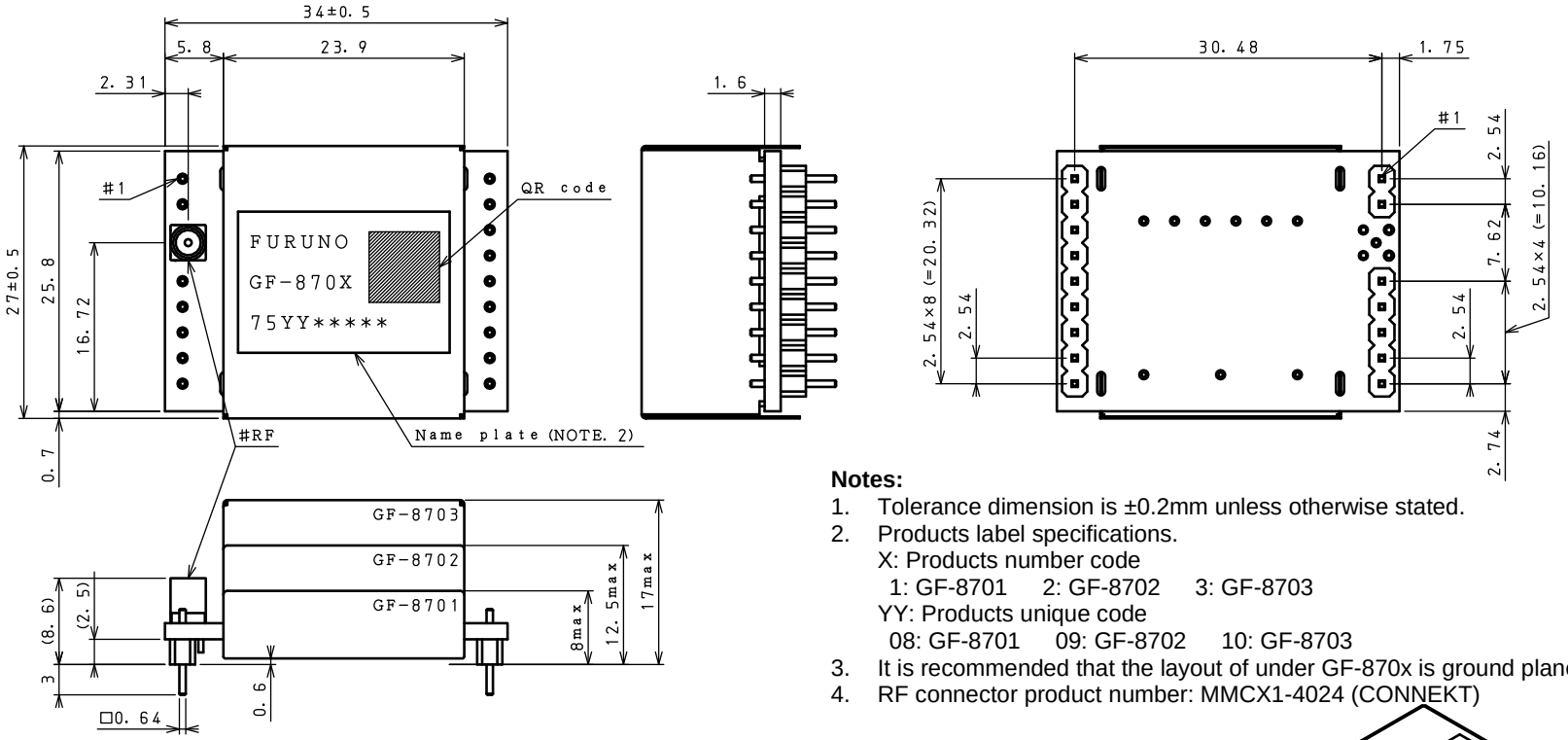
Table 15.1 shows the equivalent circuits of digital signal port.

Table 15.1 Equivalent Circuit

Pin Name	Equivalent Circuit
1. RST_N 12. RXD	
18. EPPS	
11. VCLK 14. ALM_N 15. LOCK 16. GCLK 17. PPS	

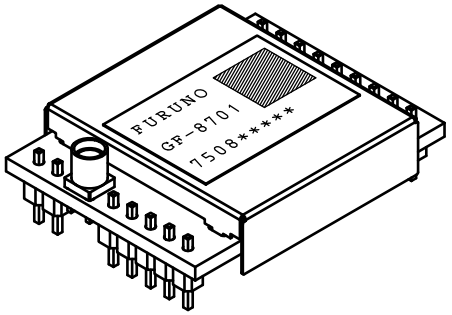
16 Mechanical Specifications

16.1 Outline Drawing

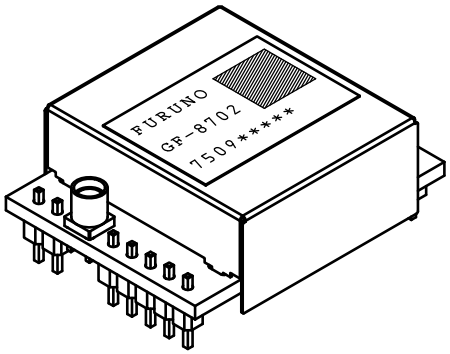


Notes:

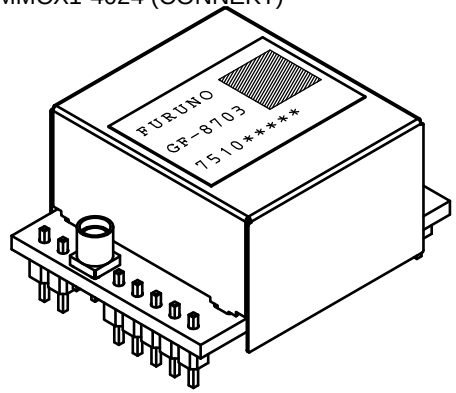
1. Tolerance dimension is ±0.2mm unless otherwise stated.
2. Products label specifications.
   X: Products number code
   1: GF-8701 2: GF-8702 3: GF-8703
   YY: Products unique code
   08: GF-8701 09: GF-8702 10: GF-8703
3. It is recommended that the layout of under GF-870x is ground plane.
4. RF connector product number: MMCX1-4024 (CONNEKT)



GF-8701 External view

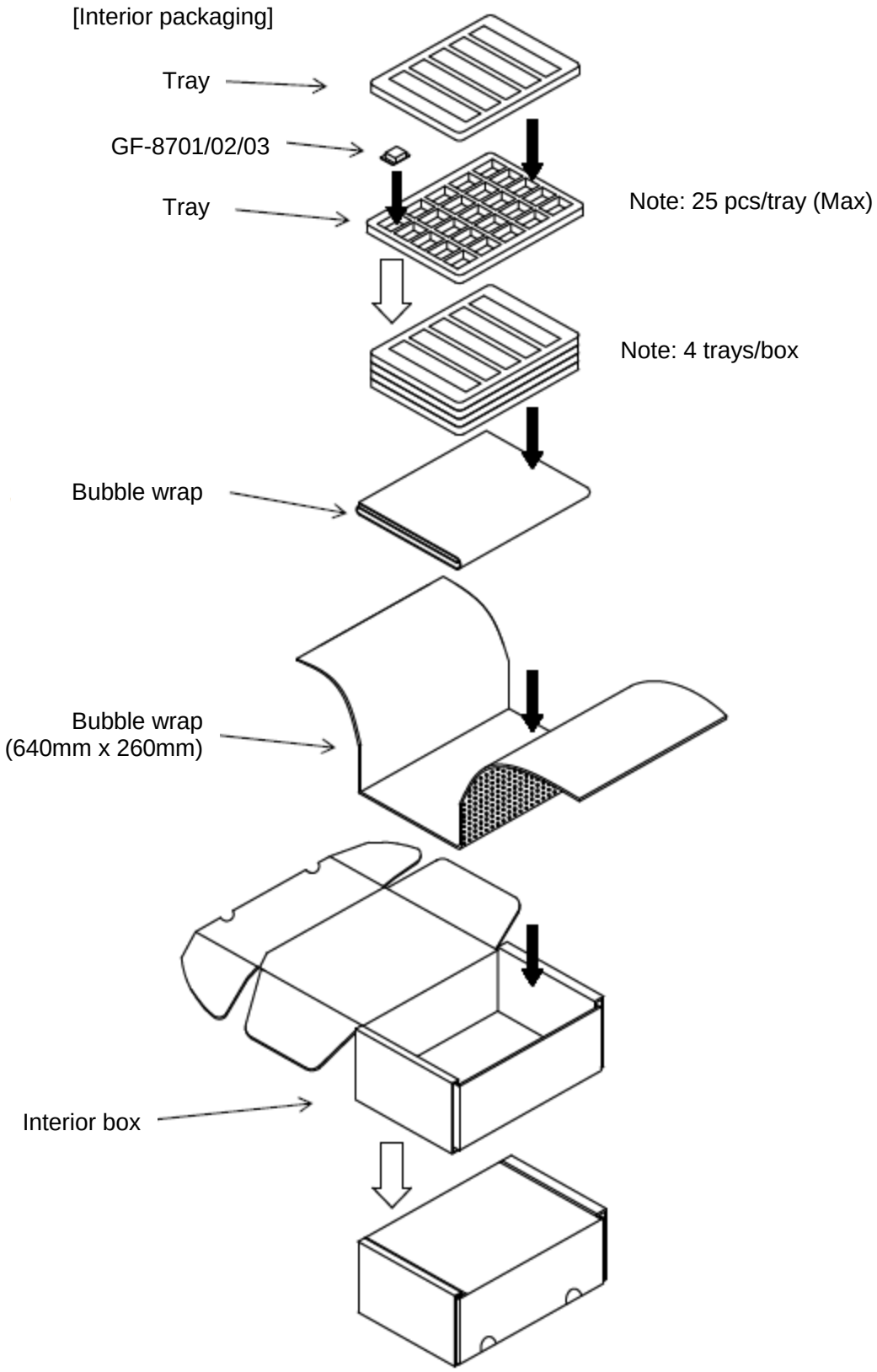


GF-8702 External view



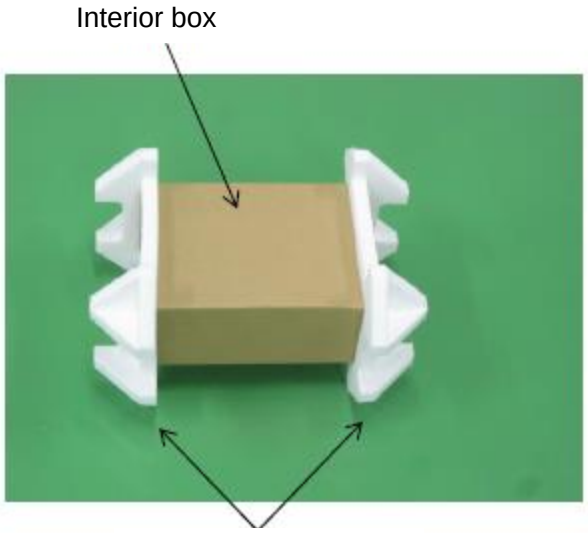
GF-8703 External view

17 Packaging



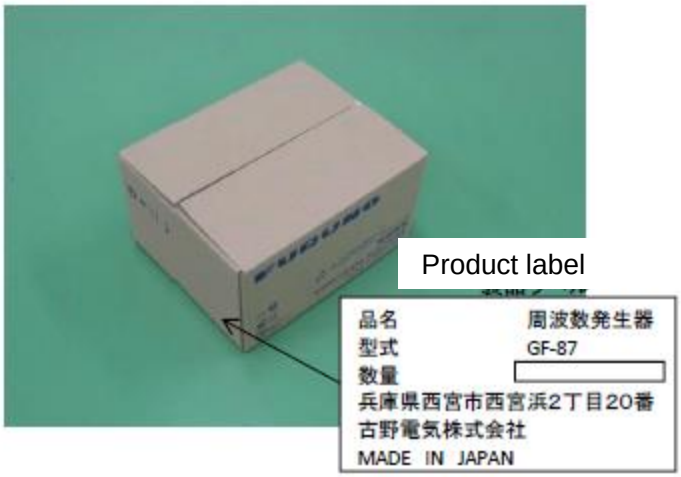
[Exterior packaging]

Attach the cushioning materials to the interior box.



Put the interior box in the exterior box.

Close the cover with sealing tape, and attach the product label.



18 Warranty

The warranty term of this product is one year after the delivery.

19 Special Attention

19.1 Precautions for Use

(1) A GNSS receiver receives very weak signals sent by the GNSS satellites. Using an antenna with band limitations or insufficient preamplifier could be disrupted by transmitted power from TV broadcast, mobile phone, MCA or similar transmitting devices causing unstable reception status. Therefore use an antenna equipped with a SAW filter on the preamplifier front stage to ensure stable GNSS reception.

(2) It is recommended to install the antenna vertically outdoors in a location where there are no obstacles within its elevation angle of 5°. GNSS signals may reflect from buildings, trees or ground surfaces and reach a GNSS antenna via the reflected (delayed) route. Therefore install a GNSS antenna in environment where there are no reflected waves. Therefore avoid mounting near buildings or other obstructions.

(3) Radio waves transmitted by handheld transmitters or transmitting antennas may adversely affect GNSS signal reception by superimposing interfering signal onto the GNSS antenna. When locating the GNSS antenna ensure is not located in the direction of offending transmitting antenna beam.

(4) RF noise may interfere via the GNSS antenna and adversely affect the GNSS signal reception. Avoid using GNSS devices near equipment emitting RF noise.

(5) Considering the information above check tracking status of the GNSS satellites and positioning information. Possibly for an extended period of time (8 to 24 hours) to ensure no multipath signal or other reception issues exist. Also check the overall environment where the GNSS antenna will be located.

(6) Ensure a stable power supply connection.

(7) Install in a stable temperature, wind free environment for the GNSS unit to eliminate errors caused by temperature deviations.

(8) Improper heat dissipation may increase the device temperature beyond the upper limit specifications resulting in performance degradation or failure. Install the device allowing sufficient space around the device for heat dissipation considerations.

(9) Lightning may strike the GNSS antenna. This product does not have a lightning protector so we recommend inserting an appropriate arrester between the GNSS antenna and this product.

19.2 Electronic Component

Components in the GNSSDO such as chip resistors, capacitors, memories and TCXO are planned to be purchased from multiple manufacturers/vendors according to FURUNO's procurement policy. So it is possible that multiple components from multiple manufacturers/vendors could be used even in the same production lot.

19.3 Precautions at Mounting

(1) This product contains semi-conductor inside. While handling this, be careful about the static electrical charge (less than 100V). To avoid it, use conductive mat, ground wristband, anti-static shoes, ionizer, etc. as may be necessary.

(2) Try to avoid mechanical shock and vibration. Try not to drop this product.

19.4 Precautions on Industrial Property Rights

(1) Since this document includes our copyrights and know-how, do not use it for any purpose other than the intended use of this product. Do not make any copies of this document and disclose it to any third parties without our prior consent.

(2) Except the use of this product itself, the sale and its disposal, the sale of this product to you does not grant explicitly or implicitly the right of use or implement any Intellectual Property rights or any other rights contained in this product to your company.

19.5 Export Control for Security

(1) Based on the catch-all controls, if an end-user or application is related or suspected to be related to development, manufacturer or usage of mass-destruction weapons, export is prohibited.

(2) If you intend to export this device, contact us beforehand.