FURUNO

GNSS General Catalog 2016

Positioning & Timing Solution

www.furuno.com

New Products

Multi-GNSS Receiver Chip

- World's best-in-class for number of acquired satellites
- Concurrent reception of GPS and GLONASS
- Ultra-fast TTFF
- Active noise rejection capability

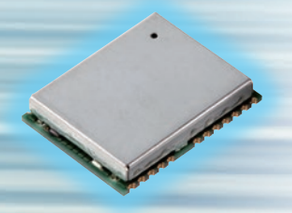
*eRide*OPUS 7

For details P9

DR/Multi-GNSS Receiver Module Based on *eRide*OPUS 7

GV-87

For details P19



Multi-GNSS Disciplined Oscillator Based on *eRide*OPUS 7

GF-8702

For details P31

Supports GLONASS Multi-GNSS Antenna

AU-18

For details P39

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Tatsuyuki Okamoto

Director Furuno

FURUNO commercialized our own marine GPS navigation product in 1986. Since then we have been offering a variety of product solutions for the automotive and communication infrastructure industries based on the technology we cultivated in the maritime industry and well accepted in the market.

With the increasing demand of current and emerging applications using GPS/GNSS receivers, we continue to innovate our technology to meet these growing requirements. In addition to GPS, other satellite systems including QZSS from Japan, GLONASS from Russia and Galileo from EU, are advancing and fully supported by our *eRide*OPUS 6 and *eRide*OPUS 7 product lines. Sensitivity also has been dramatically improved for the most demanding urban canyon and difficult applications.

Through the continued business and great supports by our valued customers in the automotive and the communication infrastructure industries, we introduced the Multi-GNSS receiver chip *eRide*OPUS 7, the compact GNSS receiver modules GN-87/GV-87 and the compact GNSS timing module GT-87. Our new GF-87 series, from the world's smallest to the most stable GNSS Disciplined Oscillator products, provide a wide range of solutions for all types of communication infrastructures.

We only pursue the highest quality and reliability products through the business with our valued customers and continue improving the performance and the functions including dead reckoning to contribute to a success of our customer's business.

In order to provide our product information to our customers, we issue our general catalog annually. Our catalog is one of the core tools to communicate with our customers. It provides information on our GPS/GNSS products including an overview, detailed specifications, information on the embedded advanced technologies and contacts for our sales network and distribution channels. Our valued customers and their continued support are one of our greatest assets. We will continue developing innovative products to meet all the needs of your automotive and communication infrastructure project requirements.

January 2016

Product lineup

Multi-GNSS Receiver Chips

*eRide*OPUS 7
P/N: ePV7010B

*eRide*OPUS 7SD
P/N: ePV7000B

*eRide*OPUS 6
P/N: ePV6010B

For details P7 ~P12

GPS / Multi-GNSS Receiver Modules

*eRide*OPUS 7 equipped
P/N: GN-87 / GV-87 / GT-87

*eRide*OPUS 6 equipped
P/N: GN-86 / GV-86 / GT-86

Support M12 Protocol
P/N: GT-8736

For details P13 ~P28

GPS / Multi-GNSS Disciplined Oscillator

TCXO/OCXO equipped
P/N: GF-8701 / GF-8702 / GF-8703

OCXO equipped
P/N: GF-8704 / GF-8705

OCXO equipped
P/N: GF-8557

Rubidium equipped
P/N: GF-8048

OCXO equipped
P/N: GF-8052

For details P29 ~P38

GNSS Antennas

For Vehicle Installation
P/N: AU-18

P/N: AU-15

For Base Station
P/N: AU-117

P/N: GPA-017

P/N: GPA-014

For details P39 ~P41

Market


Navigation System
Automatic Driving System
Tracking System
Marine
eCall / ERA-GLONASS
Seismic System
Digital Terrestrial Broadcasting Base Station
PND
Construction Equipment
Radar Detector
Wireless Broadband Base Station
V2X
Digital Camera

Multi-GNSS Receiver Chip

*eRide*OPUS 7

P/N: ePV7010B

Multi-GNSS Receiver Chip (pin-compatible with ePV5800B)

*eRide*OPUS 7SD

P/N: ePV7000B

Multi-GNSS Receiver Chip

*eRide*OPUS 6

P/N: ePV6010B

All FURUNO products supporting GLONASS can receive GPS concurrently.

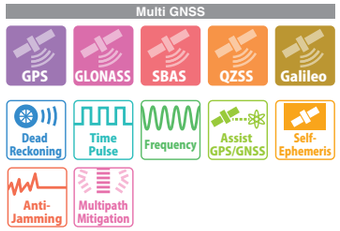
No need to select one of the satellite constellations, “GPS” or “GLONASS”.
Please find the pages of relevant products to know the details of concurrent positioning and navigation.

Part Number	Supported Satellite Constellations						Functions							Supply Voltage		Package	
	GPS	SBAS	QZSS	GLONASS	Galileo	QZSS L1S	Dead Reckoning (DR)	Time Pulse (1PPS)	Clock Output	AGPS/AGNSS (Network Assist)	Self-Ephemeris™	Anti-Jamming	Advanced Multipath Mitigation	3.3V	1.8V	Type & Pin Count	Size
ePV7010B	●	●	●	●	○	R	●	●	●	●	●	●	●	●	●	BGA-64	7.0mm×7.0mm
ePV7000B	●	●	●	●	○	R	●	●	●	●	●	●	●	●	●	BGA-141	9.0mm×9.0mm
ePV6010B	●	●	●		○	R	●	●	●	●	●	●	●	●	●	BGA-64	7.0mm×7.0mm

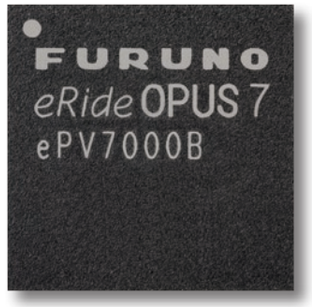
●: Supported
○: Galileo E1-B and E1-C signals receivable (ref. "Galileo OS SIS ICD Issue 1 Revision 1 September 2010)
R: Ready

Multi-GNSS Receiver Chip

*eRide*OPUS 7



P/N: ePV7010B



P/N: ePV7000B

*eRide*OPUS 7 is the world's best-in-class high sensitivity Multi-GNSS Receiver Chip for number of acquired satellites.

*eRide*OPUS 7 provides the best position accuracy and smoothest ground track using concurrent reception of GPS and GLONASS.

Characteristics

Concurrent reception of GPS and GLONASS

- Best positioning accuracy and smoothest ground tracking
- Improved robustness thanks to concurrent reception of GPS and GLONASS satellites signals
- Supports concurrent GPS, GLONASS, SBAS and QZSS. Receivable Galileo E1B/E1C

Improved positioning rate with the world's best-in-class number of acquired satellites

- Twice the number of satellites in view than with GPS-only positioning thanks to Multi-GNSS
- Improved success rate for positioning by receiving more satellites, even in urban canyons
- Improved positioning accuracy in harsh environments where position jumps and misalignments occur with GPS-only positioning

Suitable for Automotive and Industrial applications (ePV7010B)

- Passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification
- Suitable for applications requiring high reliability
- 64 pins BGA with 0.8mm ball pitch

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS/AGNSS (Network Assist*) with predicted ephemeris data for up to 7 days
- Self-Ephemeris™ (On-chip ephemeris predictions for the next 3 days)

*Assisted GLONASS ready

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Dead Reckoning

Provides position where GNSS signals cannot be received (in tunnels, underground parking lots, etc.)

- 3-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
- 1-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
- 1-Aixs Gyro Sensor + Speed Pulse

Time Pulse Output

Suitable for system synchronization with low jitter clock in addition to high accuracy time pulse

- PPS output synchronized to UTC time
- Clock output coherent with time pulse (e.g. 10MHz)

Ready for New Positioning System

QZSS L1S

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)
FURUNO Binary
M12 Binary (for timing solution)

Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

- Supports serial Flash (ePV7010B)
- Supports in-field software updates

Small Package (ePV7010B)

Easily mounted on 2 to 4 layer PCB incl. peripheral components

- 7x7mm 64pins BGA
- Ball pitch 0.8mm

Pin-to-pin Compatible *eRide*OPUS 7 (ePV7000B) with *eRide*OPUS 5 (ePV5800B)

GPS only receiver chip *eRide*OPUS 5 (ePV5800B) can be replaced with ePV7000B

- 9x9mm 141pins BGA

*Provide software suitable for your application.

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A Galileo E1B/E1C (Refer to P8 for details) (Ready): QZSS L1S
GNSS Concurrent Reception	32 channels (GPS, GLONASS, Galileo, QZSS, SBAS)
Update Rate (Configurable)	GNSS: 1 / 2 / 5 / 10 Hz Dead Reckoning: 1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm GLONASS Tracking: -157 dBm Hot Start: -157 dBm Warm Start: -143 dBm Cold Start: -143 dBm Reacquisition: -157 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP) GPS + SBAS + GLONASS: 2.0m (CEP)
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	1.8VDC / 3.3VDC
Power Consumption	Acquisition Mode: 61 mA (@ DC 3.3V)
Backup Supply	1.4 to 3.6 VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Package	ePV7010B: Size: TFBGA 7.0mm x 7.0mm, Pins: 64balls, Ball Pitch: 0.8mm ePV7000B: Size: TFBGA 9.0mm x 9.0mm, Pins:141balls, Ball Pitch: 0.65mm
Protocol	eSIP (NMEA 0183 Standard Ver. 4.10) FURUNO Binary (*3) M12 Binary
Interfaces	UART, I2C, Forward/Reverse signal, Speed Pulse, Time Pulse, Clock
Anti-Jamming	Available
Multipath Mitigation	Available

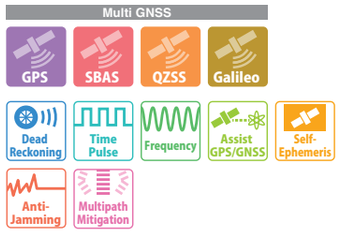
(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1 Hz
(*3) Not output raw data. Regarding the output of raw data, please ask FURUNO business contact described on the back cover.

Evaluation Kit

See page 42 for VN-87 series

Multi-GNSS Receiver Chip

*eRide*OPUS 6



P/N: ePV6010B

*eRide*OPUS 6 is a small and high sensitivity Multi-GNSS receiver chip with high position accuracy.
Supports SBAS and QZSS, Active Anti-Jamming and Advanced Multipath Mitigation functions.

Characteristics

Multi-GNSS Receiver Chip

- Supports GPS, QZSS and SBAS
- In addition to high position accuracy, ePV6010B achieves superior performance to regular Multi-GNSS Receiver Chips, such as fast TTFF, highly improved noise tolerance
- Receivable Galileo E1B/E1C, QZSS L1S Ready

Suitable for Automotive and Industrial Applications

- Passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification
- Suitable for applications requiring high reliability
- 64pins BGA with 0.8mm ball pitch

Easy upgrade to *eRide*OPUS 7 (ePV7010B)

- Pin-to-pin compatible and upper compatible data output format.
- Reduces time-to-market for product redesign

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS (Network Assist) with predicted ephemeris data for up to 7 days
- Self-Ephemeris™ (On-chip ephemeris predictions for the next 3 days)

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Dead Reckoning

Provides position where GNSS signals cannot be received (in tunnels, underground parking lots, etc.)

- 3-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
- 1-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
- 1-Aixs Gyro Sensor + Speed Pulse

Time Pulse Output

Suitable for System synchronization with low jitter clock in addition to high accuracy time pulse

- PPS output synchronized to UTC time
- Clock output coherent with time pulse (e.g. 10MHz)

Ready for New Positioning System

QZSS L1S

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)
FURUNO Binary

Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

- Supports serial Flash
- Supports in-field software updates

Small Package

Easily mounted on 2 to 4 layer PCB incl. peripheral components

- 7x7mm 64pins BGA
- Ball pitch 0.8mm

*Provide software suitable for your application.

Specifications

GNSS Reception Capability	GPS L1 C/A, SBAS L1 C/A, QZSS L1 C/A Galileo E1B/E1C (Refer to P8 for details) (Ready): QZSS L1S
GNSS Concurrent Reception	24 channels (GPS, Galileo, QZSS, SBAS)
Update Rate (Configurable)	GNSS: 1 / 2 / 5 / 10 Hz Dead Reckoning: 1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP)
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	1.8VDC / 3.3VDC
Power Consumption	Acquisition Mode: 56.5 mA (@ DC 3.3V)
Backup Supply	1.4 to 3.6 VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Package	Size: TFBGA 7.0mm x 7.0mm, Pins: 64balls, Ball Pitch: 0.8mm
Protocol	eSIP (NMEA 0183 Standard Ver. 4.10) FURUNO Binary (*3)
Interfaces	UART, I2C, Forward/Reverse signal, Speed Pulse, Time Pulse, Clock
Anti-Jamming	Available
Multipath Mitigation	Available

(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1 Hz
(*3) Not output raw data. Regarding the output of raw data, please ask FURUNO business contact described on the back cover.

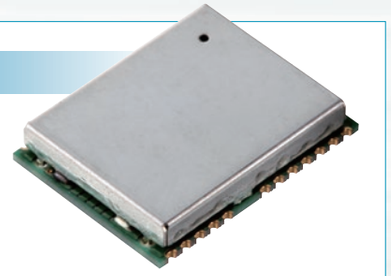
Evaluation Kit

See page 42 for VN-86 series

Multi-GNSS Receiver Module based on *eRide*OPUS 7

87 series

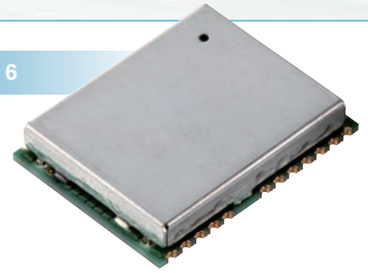
P/N: GN-87
GV-87 (support Dead Reckoning)
GT-87 (high accuracy timing, 1PPS/clock output)



GPS/Multi-GNSS Receiver Module based on *eRide*OPUS 6

86 series

P/N: GN-86
GV-86 (support Dead Reckoning)
GT-86 (high accuracy timing, 1PPS/clock output)



High accuracy timing, Support M12 potocol

Timing Multi-GNSS Receiver Module

P/N: GT-8736

All FURUNO products supporting GLONASS can receive GPS concurrently.

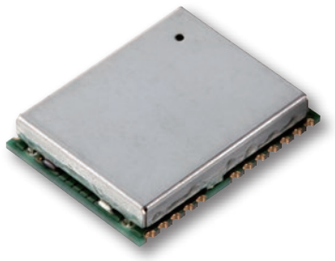
No need to select one of the satellite constellations, “GPS” or “GLONASS”.
Please find the pages of relevant products to know the details of concurrent positioning and navigation.

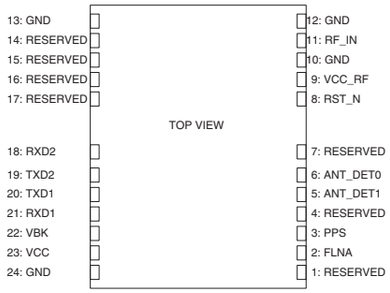
Product Name	Supported Satellite Constellations						Functions							Supply Voltage	Size
	GPS	SBAS	QZSS	GLONASS	Galileo	QZSS L1S	Dead Reckoning (DR)	Time Pluse (1PPS)	Clock Output	AGPS/AGNSS (Network Assist)	Self-Ephemeris™	Anti-Jamming	Advanced Multipath Mitigation		
GN-87	●	●	●	●	○	R		●		●	●	●	●	3.3V	12.2mm×16.0mm×2.8mm
GN-86	●	●	●		○	R		●		●	●	●	●	3.3V	12.2mm×16.0mm×2.8mm
GV-87	●	●	●	●	R	R	●	●		●		●	●	3.3V	12.2mm×16.0mm×2.8mm
GV-86	●	●	●		R	R	●	●		●		●	●	3.3V	12.2mm×16.0mm×2.8mm
GT-87	●	●	●	●	R	R		●	●	●		●	●	3.3V	12.2mm×16.0mm×2.8mm
GT-86	●	●	●		R	R		●	●	●		●	●	3.3V	12.2mm×16.0mm×2.8mm
GT-8736	●	●	●	●	R	R		●				●	●	3.3V	40.0mm×60.0mm×8.6mm

●: Supported
○: Galileo E1-B and E1-C signals receivable (ref. *Galileo OS SIS ICD Issue 1 Revision 1 September 2010)
R: Ready

Multi-GNSS Receiver Module

P/N: **GN-87**





GN-87 is the world's best-in-class high sensitivity concurrent Multi-GNSS Receiver Module for number of acquired satellites.

GN-87 provides the best position accuracy and smoothest ground track using concurrent reception of GPS and GLONASS.

Characteristics

Multi-GNSS, Concurrent reception of GPS and GLONASS

- The best positioning accuracy and smoothest ground tracking
- Improved robustness thanks to concurrent reception of GPS and GLONASS satellites signals
- Supports concurrent GPS, GLONASS, SBAS and QZSS. Receivable Galileo E1B/E1C

Improved positioning rate with the world's best-in-class number of acquired satellites

- Twice the number of satellites in view than with GPS-only positioning thanks to Multi-GNSS
- Improved success rate of positioning by receiving much more satellites even in urban canyons
- Improved positioning accuracy in harsh environments where position jumps and misalignments occur with GPS-only positioning

Suitable for Automotive and Industrial applications

- GNSS receiver chip *eRide*OPUS 7 passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification
- Suitable for applications requiring high reliability
- Adopts market's standard size allowing for easy upgrade from GPS Receiver Module of other manufacturers

SMT Module

Contains all components required for reception of GNSS

- TCXO, SAW Filter, Flash ROM, 32KHz Crystal

Antenna Detection Function

Outputs detection results thru UART (external circuit required)

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS/AGNSS (Network Assist*) with predicted ephemeris data for up to 7 days
- Self-Ephemeris™ (On-chip ephemeris prediction for the next 3 days)

*Assisted GLONASS ready

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Supports either Active or Passive Antenna

Time Pulse Output

Usable for simple timing application *

* GT series is recommended for high-accuracy time synchronization

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)
FURUNO Binary

Ready for New Positioning System

QZSS L1S

Embedded Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

Suitable for Automotive Applications

Market's standard size, superior design for assembly

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm
- Visible soldering condition with end-face electrodes

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A Galileo E1B/E1C (Refer to P14 for details) (Ready): QZSS L1S
GNSS Concurrent Reception	32 channels (GPS, GLONASS, Galileo, QZSS, SBAS)
Update Rate (Configurable)	1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm GLONASS Tracking: -157 dBm Hot Start: -157 dBm Warm Start: -143 dBm Cold Start: -143 dBm Reacquisition: -157 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP) GPS + SBAS + GLONASS: 2.0m (CEP)
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 72 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24 Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver 4.10) FURUNO Binary (*3)
Interfaces	UART, Time Pulse
Anti-Jamming	Available
Multipath Mitigation	Available

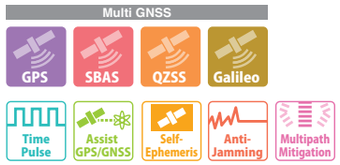
(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1 Hz
(*3) Not output raw data. Regarding the output of raw data, please ask FURUNO business contact described on the back cover.

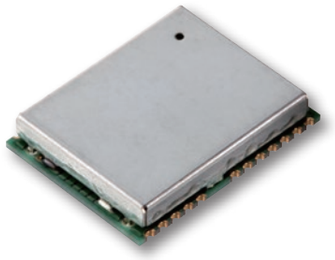
Evaluation Kit

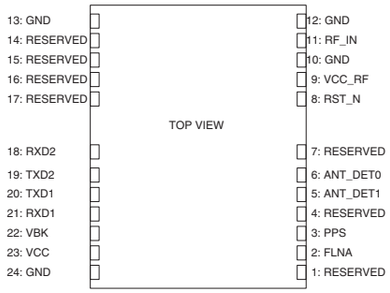
See page 42 for VN-870

Multi-GNSS Receiver Module

P/N: **GN-86**







GN-86 is a small and high sensitivity Multi-GNSS Receiver module with high positioning accuracy.
Supports SBAS and QZSS, Active Anti-Jamming and Advanced Multipath Mitigation functions.

Characteristics

Multi-GNSS Receiver Module

- Supports GPS, QZSS and SBAS
- In addition to high position accuracy, GN-86 achieves superior performance to regular Multi-GNSS Receiver Modules, such as fast TTFF, highly improved Noise Tolerance
- Receivable Galileo E1B/E1C, QZSS L1S Ready

Suitable for Automotive and Industrial Applications

- GPS Receiver Chip *eRide*OPUS 6 passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification
- Suitable for applications requiring high reliability
- Adopts market's standard size allowing for easy upgrade from GPS Receiver Module of other manufacturers

Easy to replace with GN-87 which supports GLONASS

- Pin-to-pin compatible and upper compatible data output format.
- Reduces time–to-market for product redesign

SMT Module

Contains all components required for reception of GNSS

- TCXO, SAW Filter, Flash ROM, 32KHz Crystal

Antenna Detection Function

Outputs detection results thru UART (external circuit required)

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS (Network Assist) with predicted ephemeris data for up to 7 days
- Self-Ephemeris™ (On-chip ephemeris prediction for the next 3 days)

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Supports either Active or Passive Antenna

Time Pulse Output

Usable for simple timing application *

* GT series is recommended for high-accuracy time synchronization

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)
FURUNO Binary

Ready for New Positioning System

QZSS L1S

Embedded Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

Suitable for Automotive Applications

Market's standard size, superior design for assembly

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm
- Visible soldering condition with end-face electrodes

Specifications

GNSS Reception Capability	GPS L1 C/A, SBAS L1 C/A, QZSS L1 C/A Galileo E1B/E1C (Refer to P14 for details) (Ready): QZSS L1S
GNSS Concurrent Reception	24 channels (GPS, Galileo, QZSS, SBAS)
Update Rate (Configurable)	1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP)
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 68 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver. 4.10) FURUNO Binary (*3)
Interfaces	UART, Time Pulse
Anti-Jamming	Available
Multipath Mitigation	Available

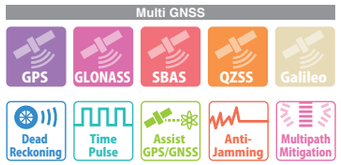
(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1 Hz
(*3) Not output raw data. Regarding the output of raw data, please ask FURUNO business contact described on the back cover.

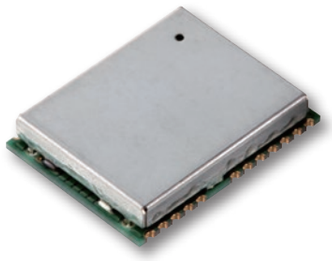
Evaluation Kit

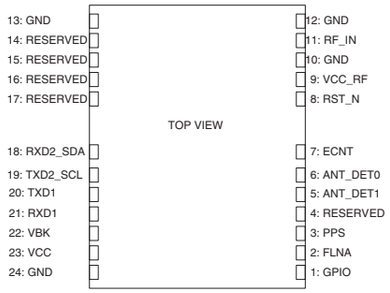
See page 42 for VN-860

DR/Multi-GNSS Receiver Module

P/N: **GV-87**







GV-87 is a concurrent Multi-GNSS Receiver Module supporting Dead Reckoning (DR) function, enabling high accuracy positioning with Multi-GNSS and also positioning in environments where no satellite signals are received.

Characteristics

Multi-GNSS, Concurrent reception of GPS and GLONASS

- The best positioning accuracy and smoothest ground tracking
- Improved of robustness thanks to concurrent reception of GPS and GLONASS signals
- Supports concurrent GPS, GLONASS, SBAS and QZSS. Galileo Ready

Position available even in the tunnels, underground parking lots. Effective in urban canyons

- Reduces degradation of position accuracy in harsh environments thanks to a combination of concurrent Multi-GNSS and Dead Reckoning
- Provides instant position at startup in underground parking lot type environments (Garage Start function)
- Dead Reckoning positioning accuracy can be improved with feedback from the navigation application (Map Matching Feedback function)

Emphasis on usability of Dead Reckoning, no need for sensor processing on host CPU

- Selectable from 3 different sensor configurations depending on customer's product concept
  1) 3-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse 2) 1-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
  3) 1-Aixs Gyro Sensor + Speed Pulse
- Autonomous, self-calibrating, tightly coupled Dead Reckoning.
- Dead Reckoning calculation is performed on the module and the results outputted in NMEA data

Auto Orientation Function

Flexible installation with original axial correction

- Sensors can be mounted sideways, on inclined surfaces, upside-down
- Adapted for installation on inclined surface of the dashboards

Designed for real-life usage

Evaluates driving patterns under actual environment

- Adapted for various cases causing large position errors such as "turn table", "low-speed U-turn" etc.

3D Gyro Sensor Function

Detects navigation on slopes

- Supports improvement of map matching accuracy at the entrance/exit of elevated highways

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS/AGNSS (Network Assist*) with predicted ephemeris data for up to 7 days

*Assisted GLONASS ready

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Time Pulse Output

Usable for time synchronization of moving vehicle *

* GT series is recommended for high-accuracy time synchronization

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)

Embedded Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

Suitable for Automotive Applications

Market's standard size, superior design for assembly

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm
- Visible soldering condition with end-face electrodes

High Reliability for Automotive Applications

GNSS Receiver Chip *eRide*OPUS 7 passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
GNSS Concurrent Reception	26 channels (GPS, GLONASS, QZSS, SBAS)
Update Rate (Configurable)	GNSS: 1 / 2 / 5 / 10 Hz Dead Reckoning: 1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm GLONASS Tracking: -157 dBm Hot Start: -157 dBm Warm Start: -143 dBm Cold Start: -143 dBm Reacquisition: -157 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP) GPS + SBAS + GLONASS: 2.0m (CEP)
Dead Reckoning Performance (*3)	Ground Tracking Distance * 1% Position Accuracy (urban canion): 2.5m (1σ)
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 72 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver. 4.10)
Interfaces	UART, I2C, Forward/Reverse signal, Speed Pulse, Time Pulse
Anti-Jamming	Available
Multipath Mitigation	Available

(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1 Hz
(*3) Measurement platform with recommended sensor

Evaluation Kit

See page 42 for VN-871

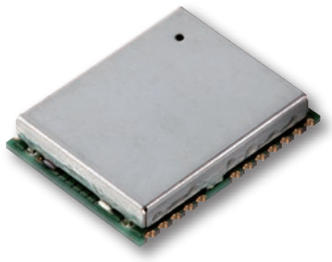
DR/GPS Receiver module

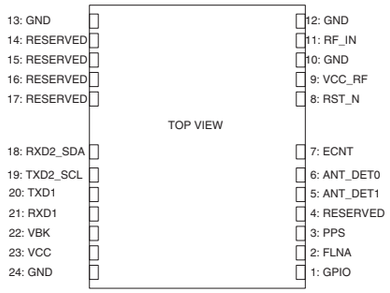
P/N: **GV-86**

GPS

GPS | SBAS | QZSS | Galileo

Dead Reckoning | Time Pulse | Assist GPS/GNSS | Anti-Jamming | Multipath Mitigation





GV-86 is a high sensitivity GPS Receiver Module supporting Dead Reckoning (DR) function enabling positioning in environments where no satellite signals are received

Characteristics

Advanced DR Performance

- Achieved DR performance in car navigation systems with a stand-alone GPS module
- Offsets misalignments and position jumps of GPS, complements position during GPS signal outages
- Dead Reckoning positioning accuracy can be improved with feedback from the navigation application (Map Matching Feedback function)

Emphasis on usability of Dead Reckoning, no need for sensor processing on host CPU

- Selectable from 3 different sensor configurations depending on customer's product concept
  1) 3-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse 2) 1-Aixs Gyro Sensor + 3-Aixs Accelerometer + Speed Pulse
  3) 1-Aixs Gyro Sensor + Speed Pulse
- Autonomous, self-calibrating, tightly coupled Dead Reckoning
- Dead Reckoning calculation is performed on the module and the results outputted in NMEA data

Auto Orientation Function

- Flexible installation with FURUNO's original axial correction which estimates mounting angle of sensors
- Sensors can be mounted sideways, on inclined surface, upside-down
- Adapted for installation on inclined surface of the dashboards

Designed for real-life usage

Evaluates driving patterns under actual environment

- Adapted for various cases causing large position errors such as "turn table", "low-speed U-turn" etc.

3D Gyro Sensor Function

Detects navigation on slopes

- Supports improvement of map matching accuracy at the entrance/exit of elevated highways

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <1 sec.
- AGPS (Network Assist) with predicted ephemeris data for up to 7 days

High Positioning Rate

Increased positioning rate for smooth ground tracking

- Configurable position output update rate up to 10Hz (10 times per sec.)

Time Pulse Output

Usable for simple timing application *

* GT series is recommended for high-accuracy time synchronization

Supports either Active or Passive Antenna

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Data Output Format

eSIP (NMEA 0183 Ver.4.10)

Embedded Flash ROM

Suitable for long-term use backed by FURUNO's continuous support and function enhancement

Suitable for Automotive Applications

Market's standard size, superior design for assembly

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm
- Visible soldering condition with end-face electrodes

High Reliability for Automotive Applications

GPS Receiver Chip *eRide*OPUS 6 passed rigorous reliability tests (AEC-Q100 Level3) for automotive qualification

Specifications

GPS Reception Capability	GPS L1 C/A, SBAS L1 C/A, QZSS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
GPS Reception	16 channels (GPS, QZSS, SBAS)
Update Rate (Configurable)	GNSS: 1 / 2 / 5 / 10 Hz Dead Reckoning: 1 / 2 / 5 / 10 Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm
Position Accuracy (Horizontal) (*1), (*2)	GPS: 2.5m (CEP) GPS + SBAS: 2.0m (CEP)
Dead Reckoning Performance	Ground Tracking Distance * 1%
TTFF (*1) (Typical)	Hot Start: <1 sec (@-130 dBm) Warm Start: 30 sec (@-130 dBm) Cold Start: 33 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 68 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver. 4.10)
Interfaces	UART, I2C, Forward/Reverse signal, Speed Pulse, Time Pulse
Anti-Jamming	Available
Multipath Mitigation	Available

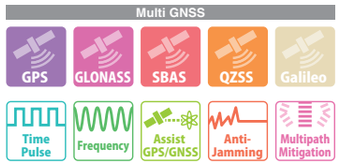
(*1) Measurement platform with recommended active antenna
(*2) Update rate: 1Hz

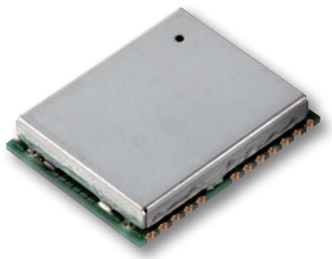
Evaluation Kit

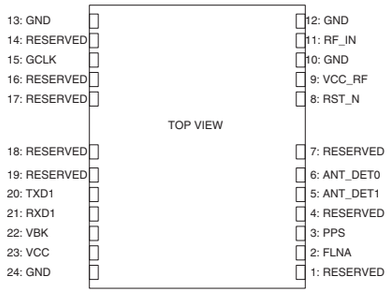
See page 42 for VN-861

Timing Multi-GNSS Receiver Module

P/N: **GT-87**







GT-87 is a high-sensitivity, high-accuracy Timing Multi-GNSS receiver.

GT-87 supports TRAIM and various position modes, allowing it to output accurate and robust 1PPS synchronized to UTC time.

GT-87 supports GPS, GLONASS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

Characteristics

Concurrent reception of GPS and GLONASS

- Improves robustness of the timing data thanks to concurrent reception of GPS and GLONASS
- Supports GPS, GLONASS, SBAS and QZSS. Galileo Ready

Suitable for LTE-Advanced small cellular base stations

- Twice the number of satellites in view than with GPS-only positioning only thanks to Multi-GNSS
- Enables to output accurate and robust UTC time and 1PPS from receiving much more satellites even in deep urban canyons
- Suitable for LTE-Advanced small cellular base stations

Supports both time pulse output and clock output

- Simultaneous output of time pulse (1PPS) and low jitter clock (configurable from 4KHz to 40MHz) synchronized with the 1PPS
- Supports highly stable synchronization system appropriate for infrastructure development

Time Pulse Output

Enable to output accurate and robust UTC time and 1PPS synchronized with UTC time

- 1PPS accuracy: < 15 nsec (1σ) (@ -130 dBm)

Clock Output

Suitable for system synchronization with low jitter clock in addition to high accuracy time pulse

- Configurable (from 4KHz to 40MHz) clock output, coherent with time pulse (1PPS)

One satellite tracking is enough to output precise 1PPS

TRAIM Function

Detect low-integrity satellite and satellite not to use for positioning

- Suitable for infrastructure development which needs high integrity.

Position Mode

Selectable Position Mode based on use case

- Position Hold Mode
- Position Survey Mode

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <5 sec (Typ.)
- Cold start: 40 sec (Typ.)
- AGPS/AGNSS (Network Assist*)

*Assisted GLONASS ready

Data Output Format

eSIP (NMEA 0183 Ver.4.10)
M12 Binary

Support either Active Antenna or Passive Antenna

Antenna Detection Function

Outputs detection result thru UART (External circuitry required)

Embedded Flash ROM

Suitable for long-term use backed by Furuno's continuous support and function enhancement

Small Package

Easy to check soldering condition thanks to castellated pads

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
GNSS Concurrent Reception	26 channels (GPS, GLONASS, QZSS, SBAS)
Update Rate	1Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm GLONASS Tracking: -157 dBm Hot Start: -157 dBm Warm Start: -143 dBm Cold Start: -143 dBm Reacquisition: -157 dBm
Position Accuracy (Horizontal) (*1)	GPS:2.5m (CEP) GPS+SBAS:2.0m (CEP) GPS+SBAS+GLONASS:2.0m (CEP)
1PPS Timing Accuracy	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm)
Clock Configurable Range	4 KHz to 40 MHz
TTFF (*1) (Typical)	Hot Start: <5 sec (@-130 dBm) Warm Start: 35 sec (@-130 dBm) Cold Start: 40 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 72 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver 4.10) M12 Binary
Interfaces	UART, I2C, Time Pulse (1PPS), Clock
Anti-Jamming	Available
Multipath Mitigation	Available

(*1) Measurement platform with recommended active antenna

Evaluation Kit

See page 42 for VN-872

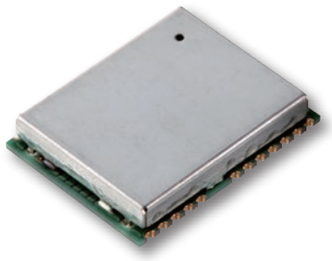
Timing GPS Receiver Module

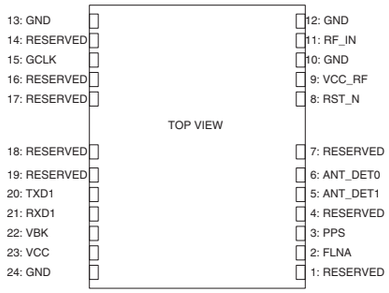
P/N: **GT-86**

GPS

GPS SBAS QZSS Galileo

Time Pulse | Frequency | Assist GPS/GNSS | Anti-Jamming | Multipath Mitigation





GT-86 is a high-sensitivity, high-accuracy Timing GPS receiver.

GT-86 supports TRAIM and Various position modes, allowing it to outputs accurate and robust 1PPS synchronized with UTC time.

GT-86 supports GPS, QZSS, SBAS, Active Anti-Jamming and Advanced Multipath Mitigation Functions.

Characteristics

Perfect form of Timing GPS Receiver Module

- Supports GPS, QZSS and SBAS. Galileo Ready

Supports both time pulse output and clock output

- Concurrent output of time pulse (1PPS) and low jitter clock (configurable from 4KHz to 40MHz) synchronized with the 1PPS
- Supports highly stable synchronization system appropriate for infrastructure development

Improved Noise Tolerance

- Active Anti-Jamming technology capable of removing up to 8 CW jammers simultaneously
- Advanced Multipath Mitigation technology allowing to maintain high accuracy even in deep urban canyons

Time Pulse Output

Enable to output accurate and robust UTC time and 1PPS synchronized with UTC time

- 1PPS accuracy: < 15 nsec (1σ) (@ -130 dBm)

Clock Output

Suitable for system synchronization with low jitter clock in addition to high accuracy time pulse

- Configurable (from 4KHz to 40MHz) clock output, coherent with time pulse (1PPS)

One satellite tracking is enough to output precise 1PPS

TRAIM Function

Detect low-integrity satellite and satellite not to use for positioning

- Suitable for infrastructure development which needs high integrity.

Position Mode

Selectable Position Mode based on use case

- Position Hold Mode
- Position Survey Mode

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <5 sec (Typ.)
- Cold start: 40 sec (Typ.)
- AGPS (Network Assist)

Data Output Format

eSIP (NMEA 0183 Ver.4.10)

Selectable either Active or Passive Antenna

Antenna Detection Function

Outputs detection result thru UART (External circuitry required)

Embedded Flash ROM

Suitable for long-term use backed by Furuno's continuous support and function enhancement

Small Package

Easy to check soldering condition thanks to castellated pads

- 24Pin LCC (Leadless Chip Carrier)
- 12.2mm x 16.0mm x 2.8mm

Specifications

GPS Reception Capability	GPS L1 C/A, SBAS L1 C/A, QZSS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
GPS Reception	16 channels (GPS, QZSS, SBAS)
Update Rate	1Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm
Position Accuracy (Horizontal) (*1)	GPS: 2.5m (CEP) GPS+SBAS: 2.0m (CEP)
1PPS Timing Accuracy	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm)
Clock Configurable Range	4 KHz to 40 MHz
TTFF (*1) (Typical)	Hot Start: <5 sec (@-130 dBm) Warm Start: 35 sec (@-130 dBm) Cold Start: 40 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 68 mA
Backup Power	1.4 to 3.6VDC / 10 µA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	24Pin LCC (Leadless Chip Carrier) 12.2mm x 16.0mm x 2.8mm
Protocol	eSIP (NMEA 0183 Standard Ver 4.10)
Interfaces	UART, I2C, Time Pulse (1PPS), Clock
Anti-Jamming	Available
Multipath Mitigation	Available

(*1) Measurement platform with recommended active antenna

Evaluation Kit

See page 42 for VN-862

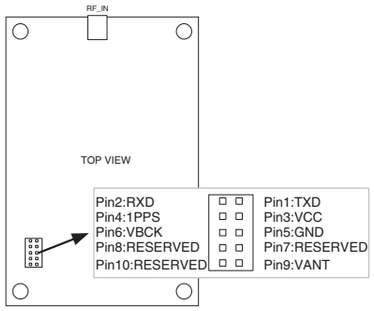
Timing Multi-GNSS Receiver Module

P/N: GT-8736

Multi GNSS

GPS GLONASS SBAS QZSS Galileo

Time Pulse | Anti-Jamming | Multipath Mitigation



GT-8736 is a high-sensitivity, high-accuracy Timing Multi-GNSS receiver.

GT-8736 supports TRAIM and various position modes, allowing it to output accurate and robust 1PPS synchronized to UTC time.

GT-8736 features an identical footprint to the Motorola M12M device.

Characteristics

Concurrent reception of GPS and GLONASS

- Improves robustness of the timing data thanks to concurrent reception of GPS and GLONASS
- Supports GPS, GLONASS, SBAS and QZSS. Galileo Ready

Suitable for LTE-Advanced small cellular base stations

- Twice the number of satellites in view than with GPS-only positioning only thanks to Multi-GNSS
- Enables to output accurate and robust UTC time and 1PPS from receiving much more satellites even in deep urban canyons
- Suitable for LTE-Advanced small cellular base stations

Easy to replace with Motorola M12M device

- Supports M12 binary protocol as well as identical footprint to the Motorola M12M device

Time Pulse Output

Enable to output accurate and robust UTC time and 1PPS synchronized with UTC time

- 1PPS accuracy: < 15 nsec (1σ) (@ -130 dBm)

One satellite tracking is enough to output precise 1PPS

TRAIM Function

Detect low-integrity satellite and satellite not to use for positioning

- Suitable for infrastructure development which needs high integrity.

Position Mode

Selectable Position Mode based on use case

- Position Hold Mode
- Position Survey Mode

Improved Noise Tolerance

Reduces effects of internal and external noise

- Active Anti-Jamming
- Advanced Multipath Mitigation

Fast TTFF

Selectable appropriate method for fast TTFF

- Hot start: <5 sec (Typ.)
- Cold start: 35 sec (Typ.)

Data Output Format

M12 Binary

Ready for New Positioning Systems

Galileo E1B/E1C
QZSS L1S

Embedded Flash ROM

Suitable for long-term use backed by Furuno's continuous support and function enhancement

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A (Ready): Galileo E1B/E1C, QZSS L1S
GNSS Concurrent Reception	26 channels (GPS, GLONASS, QZSS, SBAS)
Update Rate	1Hz
Sensitivity (*1)	GPS Tracking: -161 dBm Hot Start: -161 dBm Warm Start: -147 dBm Cold Start: -147 dBm Reacquisition: -161 dBm GLONASS Tracking: -157 dBm Hot Start: -157 dBm Warm Start: -143 dBm Cold Start: -143 dBm Reacquisition: -157 dBm
Position Accuracy (Horizontal) (*1)	GPS:2.5m (CEP) GPS+SBAS:2.0m (CEP) GPS+SBAS+GLONASS:2.0m (CEP)
1PPS Timing Accuracy	15ns(1σ) (@-130 dBm) 50ns(1σ) (@-150 dBm)
TTFF (*1) (Typical)	Hot Start: <5 sec (@-130 dBm) Warm Start: 35 sec (@-130 dBm) Cold Start: 35 sec (@-130 dBm)
Supply Voltage	3.3VDC
Power Consumption	Acquisition Mode: 60 mA (Typ)
Backup Power	2.2 to 3.6VDC / 10 μA (Typ)
Operating Temperature	-40°C to +85°C
Storage Temperature	-40°C to +85°C
Package	40.0mm x 60.0mm x 8.6mm (from bottom side to data header)
Protocol	M12 Binary
Anti-Jamming	Available
Multipath Mitigation	Available

(*1) Measurement platform with recommended active antenna

Muiti-GNSS Disciplined Oscillator

P/N: GF-8701 / GF-8702 / GF-8703

Muiti-GNSS Disciplined Oscillator

P/N: GF-8704 / GF-8705

GPS Disciplined Oscillator

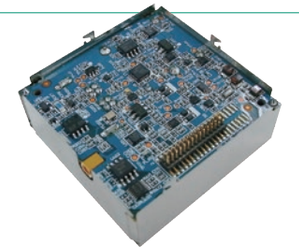
P/N: GF-8557

GPS Disciplined Oscillator

P/N: GF-8048

GPS Disciplined Oscillator

P/N: GF-8052



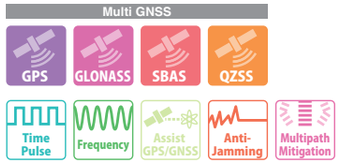
Product Name	Supported Satellite Constellations				Timing Specifications (1PPS)		Frequency Specifications (10MHz)	Size (mm)
	GPS	SBAS	QZSS	GLONASS	Normal Status	Holdover	Nomal Status (24h avg.)	
GF-8701	●	●	●	●	<±100ns	<±1μs/100s	<±1×10^{-11}	34×27×11
GF-8702	●	●	●	●	<±100ns	<±50μs/24h	<±1×10^{-12}	34×27×15.5
GF-8703	●	●	●	●	<±100ns	<±10μs/24h	<±1×10^{-12}	34×27×20
GF-8704	●	●	●	●	<±50ns	<±5μs/24h	<±1×10^{-12}	100×52×20
GF-8705	●	●	●	●	<±50ns	<±1.5μs/24h	<±1×10^{-12}	100×52×20
GF-8557	●	●			<±150ns	<±8μs/24h	<±1×10^{-12}	100×100×19.9
GF-8048	●				<±100ns	<±0.4μs/1h	<±1×10^{-11}	207×327×98.5
GF-8052	●	●			<±100ns	<±15μs/24h	<±1×10^{-12}	51×51×19

What is a Multi-GNSS Disciplined Oscillator (GNSSDO)?

GNSSDO receives GNSS signals and outputs a highly accurate and stable 1PPS (pulse per second) and reference frequency from a precise clock. A periodic calibration is not required because the GNSSDO always corrects 1PPS and the reference frequency by using the receiving GNSS signals. Even if GNSS signal reception is interrupted, the FURUNO GNSSDO can continue to output highly accurate and stable 1PPS and reference frequency thanks to our advanced intelligent holdover function. FURUNO provides many different GNSSDO products to meet customer's requirements for holdover function, phase noise reduction function, size and cost. Also FURUNO will address the customer requests with many kinds of extended function and robustness of timing data in harsh environments.

Multi-GNSS Disciplined Oscillator

P/N: GF-8701 / GF-8702 / GF-8703



* Assist GPS/GNSS : Software update required

P/N: GF-8702

GF-8701, GF-8702 and GF-8703 are high sensitivity GNSSDO units which achieves the world's best-in-class small size and low price.

GF-8701, GF-8702 and GF-8703 are suitable for various applications thanks to small packaging. For example radio communications, network communications and master clock applications for multimedia broadcast.

Characteristics

Outputs highly accurate Time Pulse and highly stable Frequency coherent to 1PPS

- Continuously outputs highly accurate and stable 1PPS (pulse per second) synchronized with UTC time as well as highly stable frequency coherent to 1PPS

Built-in high-sensitivity timing Multi-GNSS receiver with improved noise tolerance for harsh environments

- Receives concurrent GPS, GLONASS, QZSS (Quasi-Zenith Satellite System) and SBAS signals
- Flexible antenna installation locations thanks to high sensitivity and twice the number of satellites in view as opposed to GPS-only positioning
- Reduces effects of internal and external noise thanks to Active Anti-Jamming and Advanced Multipath Mitigation

Supports Holdover function with the world's smallest size

- Even if GNSS falls into unlock, the FURUNO GNSSDO will predict oscillator behavior and automatically make corrections thanks to FURUNO's Advanced Oscillator Control Function
- Continuously outputs highly accurate and stable 1PPS and frequency
- Expands GNSSDO applications for many devices which in the past could not use GNSSDO thanks to miniaturized size and reasonable price

Support compatible design depending on customer's requirement

Supports the same output format as well as pin-compatible design

- GNSSDO can be customized to meet unique customer requirements

Time Synchronization

Selectable sources for time synchronization from UTC time or GPS time

Selectable Position Mode

- Time Only (Position-hold) Mode will output stable time pulse (1PPS) and frequency even if only one GNSS satellite signal is received
- Navigation Mode to be used in the moving vehicle applications

Antenna Connection Status Check Function

Checks the antenna connection status (Open or Short)

- Assesses antenna connection failure or malfunction easily

Antenna Power Supply Function

Provides power from GNSSDO directly to antenna

- Enabling a simplified antenna connection

Backup Power Supply

Significantly reduces recovery time to GNSS lock after rebooting or interruption

Synchronization with external pulse

Enables synchronizing to time pulse from an external source

- Usable to synchronize to time information such as IEEE1588 or SyncE obtained through the network
- Improves robustness of the system

Arbitrary frequency output

Enables arbitrary frequency output separately from reference frequency

Wide operation temperature range

- -40°C to +85°C

Suitable for various communication and broadcasting applications

Society's infrastructure requiring product reliability

- Small cell applications including LTE (TDD/ MBSFN/ CoMP/ eICIC)
- Multimedia broadcast base stations or wireless base stations
- Smart grids

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A
GNSS Concurrent Reception	26 channels (GPS, GLONASS, QZSS, SBAS)
Sensitivity (*1)	GPS Tracking: -161 dBm Acquisition: -147 dBm GLONASS Tracking: -157 dBm Acquisition: -143 dBm
Adjusting Time	5 min
Supply Voltage	3.7VDC
Power Consumption	GF-8701: <0.15A (3.7V, Normal Status) GF-8702: <0.45A (3.7V, Normal Status) GF-8703: <0.6A (3.7V, Normal Status)
Backup Power	1.4 to 3.6VDC / 0.4 μA (Normal Operation)
Antenna Detection	Short and Open Detection
Operating Temperature	-40°C to +85°C
Outer Size	GF-8701: 34mm x 27mm x 11mm GF-8702: 34mm x 27mm x 15.5mm GF-8703: 34mm x 27mm x 20mm
Protocol	eSIP (NMEA 0183 Standard Ver 4.10)
Function	External Referense Synchronisation, Output Status Signal
Anti-Jamming	Available
Multipath Mitigation	Available
10MHz Output (Normal Status)	Frequency Accuracy (24h avg.) GF-8701: <±1×10^{-11} GF-8702: <±1×10^{-12} GF-8703: <±1×10^{-12} Short Term Stability GF-8701: <1×10^{-9} GF-8702: <2×10^{-10} GF-8703: <2×10^{-10}
1PPS Output (Normal Status)	1PPS Accuracy: <±100ns 1PPS Stability: <15ns (1σ)
10MHz Output (Holdover)	Frequency Accuracy (24h) GF-8701: <±2.5×10^{-6} GF-8702: <±3×10^{-9} GF-8703: <±1×10^{-9} Short Term Stability GF-8701: <1×10^{-9} GF-8702: <2×10^{-10} GF-8703: <2×10^{-10}
1PPS Output (Holdover)	1PPS Accuracy GF-8701: <±1μs/100s GF-8702: <±50μs/24h GF-8703: <±10μs/24h

(*1) Measurement platform with recommended active antenna

Multi-GNSS Disciplined Oscillator

P/N: GF-8704 / GF-8705

Multi GNSS

GPS GLONASS SBAS QZSS

Time Pulse | Frequency | Assist GPS/GNSS | Anti-Jamming | Multipath Mitigation

* Assist GPS/GNSS : Software update required

GF-8704 and GF-8705 are high sensitivity GNSSDOs which have expanded capabilities, more accurate holdover function and low phase noise.

GF-8704 and GF-8705 are suitable not only for wireless communication, network communication and master clock for multimedia broadcast, but also as a atomic oscillator replacement.

Characteristics

Outputs accurate 1PPS, low phase noise, highly stable frequency coherent to 1PPS

- Continuously outputs highly accurate and stable 1PPS (pulse per second) synchronized with UTC time as well as highly stable frequency coherent to 1PPS
- Reduces errors in digital communication by providing highly accurate and stable frequency

Built-in high-sensitivity timing Multi-GNSS receiver with improved noise tolerance for harsh environments

- Receives concurrent GPS, GLONASS, QZSS (Quasi-Zenith Satellite System) and SBAS signals
- Flexible antenna installation locations thanks to high sensitivity and twice the number of satellites in view as opposed to GPS-only positioning
- Reduces effects of internal and external noise thanks to Active Anti-Jamming and Advanced Multipath Mitigation

Supports world's best-in-class holdover function

- Even if GNSS falls into unlock, the FURUNO GNSSDO will predict oscillator behavior and automatically make corrections thanks to FURUNO's Advanced Oscillator Control Function
- Continuously outputs highly accurate and stable 1PPS and frequency
- Achieved superior cost/performance as a atomic oscillator replacement

Support compatible design depending on customer's requirement

Supports the same output format as well as pin-compatible design

- GNSSDO can be customized to meet unique customer requirements

Time Synchronization

Selectable sources for time synchronization from UTC time or GPS time

Selectable Position Mode

- Time Only (Position-hold) Mode will output stable time pulse (1PPS) and frequency even if only one GNSS satellite signal is received
- Navigation Mode to be used in the moving vehicle applications

Antenna Connection Status Check Function

Checks the antenna connection status (Open or Short)

- Assesses antenna connection failure or malfunction easily

Antenna Power Supply Function

Provides power from GNSSDO directly to antenna

- Enabling a simplified antenna connection

Backup Power Supply

Significantly reduces recovery time to GNSS lock after rebooting or interruption

Synchronization with external pulse

Enables synchronizing to time pulse from an external source

- Usable to synchronize to time information such as IEEE1588 or SyncE obtained through the network
- Improves robustness of the system

Arbitrary frequency output

Enables arbitrary frequency output separately from reference frequency

Wide operation temperature range

- -40°C to +85°C

Suitable for various communication and broadcasting applications

Society's infrastructure requiring product reliability

- Small cell applications including LTE (TDD/ MBSFN/ CoMP/ eICIC)
- Multimedia broadcast base stations or wireless base stations
- Smart grids

Specifications

GNSS Reception Capability	GPS L1 C/A, GLONASS L1OF, SBAS L1 C/A, QZSS L1 C/A
GNSS Concurrent Reception	26 channels (GPS, GLONASS, QZSS, SBAS)
Sensitivity (*1)	GPS Tracking: -161 dBm Acquisition: -147 dBm GLONASS Tracking: -157 dBm Acquisition: -143 dBm
Adjusting Time	5 min
Supply Voltage	5.5VDC
Power Consumption	GF-8704: <0.5A (5.5V, Normal Status) GF-8705: <0.5A (5.5V, Normal Status)
Backup Power	1.4 to 3.6VDC / 0.4 µA (Normal Operation)
Antenna Detection	Short and Open Detection
Operating Temperature	-40°C to +85°C
Outer Size	100mm x 52mm x 20mm
Protocol	eSIP (NMEA 0183 Standard Ver 4.10)
Function	External Reference Synchronisation, Output Status Signal
Anti-Jamming	Available
Multipath Mitigation	Available
10MHz Output (Normal Status)	Frequency Accuracy (24h avg.) GF-8704: <±1×10^{-12} GF-8705: <±1×10^{-12} Short Term Stability GF-8704: <1×10^{-10} GF-8705: <1×10^{-10}
1PPS Output (Normal Status)	1PPS Accuracy: <±50ns 1PPS Stability: <15ns (1σ)
10MHz Output (Holdover)	Frequency Accuracy (24h) GF-8704: <±1×10^{-9} GF-8705: <±1×10^{-9} Short Term Stability GF-8704: <1×10^{-10} GF-8705: <1×10^{-10}
1PPS Output (Holdover)	1PPS Accuracy GF-8704: <±5µs/24h GF-8705: <±1.5µs/24h

(*1) Measurement platform with recommended active antenna

GPS Disciplined Oscillator

P/N: **GF-8557**

GF-8557 incorporates a high sensitivity GPS receiver and an OCXO as a frequency source.

GF-8557 is designed especially for wireless broadband base stations for WiMAX, and LTE networks and for multimedia broadcast base stations.

Characteristics

Outputs highly accurate Time Pulse and highly stable Frequency coherent to 1PPS

- Continuously outputs highly accurate and stable 1PPS (pulse per second) synchronized with UTC time as well as highly stable frequency coherent to 1PPS

Continuously outputs highly accurate and stable 1PPS and 10MHz clock even when the GPS signal is lost in holdover

- Even if GPS falls into unlock, the FURUNO GPSDO will predict oscillator behavior and automatically make corrections thanks to FURUNO's Advanced Oscillator Control Function
- Continuously outputs highly accurate and stable 1PPS and frequency

One Satellite Operation

- Continuously outputs highly-accurate and highly-stable 1PPS and 10MHz clock even when only one GPS satellite signal is received

High Sensitivity

Built in high sensitivity GPS receiver chip *eRide*OPUS 5.

Provides highly-stable frequency (10MHz) and highly accurate 1PPS

- Frequency Accuracy (24h avg.) :< $\pm 1\times10^{-12}$
- 1PPS Accuracy: < ±150ns

Maintenace-free

Maintenance-free with the OCXO controlled by GPS.

Antenna Connection Status Check Function

Checks the antenna connection status (Open or Short)

- Outputs detection result thru UART
- Assesses antenna connection failure or malfunction easily

Antenna Power Supply Function

Provides power from GPSDO directly to antenna

- Enabling a simplified antenna connection

Supports SBAS

Sychronized with SBAS satellites

- WAAS / MSAS / EGNOS

Data Output Format

- NMEA 0183
- TOD

Alarm Output Function

Provides various alarm outputs except antenna detection

Wide operation temperature range

- -20°C to +80°C

Specifications

GPS Reception Capability	GPS L1 C/A, SBAS L1 C/A
GPS Reception	14 channels (GPS, SBAS)
Sensitivity (*1)	-140dBm to -110dBm
Supply Voltage	5.5VDC
Power Consumption	Normal Status: <10W, Startup: <14W
Antenna Detection	Short and Open Detection
Operating Temperature	-20°C to +80°C
Outer Size	100mm x 100mm x 19.9mm (Excluding interface connectors)
Protocol	NMEA 0183 TOD
Alarm Output	Available
10MHz Output (Normal Status)	Frequency Accuracy (24h avg.): $<\pm1\times10^{-12}$ Short Term Stability: $<2\times10^{-10}$
1PPS Output (Normal Status)	1PPS Accuracy: <±150ns 1PPS Stability: <30ns(1σ)
10MHz Output (Normal Status)	Frequency Accuracy: $<\pm1\times10^{-9}$/24h
1PPS Output (Normal Status)	1PPS Accuracy: <±8μs/24h

GPS Disciplined Oscillator

P/N: GF-8048

GPS

Time Pulse | Frequency

GF-8048 incorporates rubidium oscillator as a base oscillator.

GF-8048 is suitable for use in digital terrestrial broadcasting main stations and satellite control stations.

Characteristics

- Receives GPS signals and generates 1PPS (pulse per second) synchronized with UTC time as well as a 10MHz sine-wave coherent to 1PPS.
- Provides 8 output ports, each capable to output 1PPS and 10MHz clock.
- Continuously outputs highly accurate and stable 1PPS and 10MHz clock even if the GPS signal is lost in holdover mode.
- Uses GPS for “Automatic calibration function”.
- With real time GPS control, GF-8048 provides maintenance-free GPS-steered Frequency.
- Provides various alarm outputs and a serial communication interface for maintenance (RS-232C).
- Optional battery back-up.

Specifications

GPS Reception Capability	GPS L1 C/A
GPS Reception	12 channels (GPS)
Sensitivity	-133dBm to -110dBm
Supply Voltage	48VDC
Antenna Detection	Short and Open Detection
Operating Temperature	-10°C to +45°C (Performance Assurance Temperature) -20°C to +60°C (Operating Temperature)
Outer Size	207mm x 327mm x 98.5mm
Protocol	NMEA 0183
Alarm Output	Open Collector Output, LED Display
10MHz Output	GPS mode (Normal Status): Frequency Accuracy (24h avg.): $<\pm1\times10^{-11}$ No GPS mode (Free running Rubidium): Frequency Accuracy: $<\pm5\times10^{-10}$/year
1PPS Output	1PPS Accuracy: <±100ns (95%)

GPS Disciplined Oscillator

P/N: GF-8052

GPS

GPS | SBAS

Time Pulse | Frequency

GF-8052 incorporates an OCXO as a base oscillator.

GF-8052 is designed especially for wireless broadband base stations for CDMA, WiMAX, and LTE networks and for multimedia broadcast base stations.

Characteristics

- Small package:51mm×51mm×19mm.
- Provides highly-stable frequency and highly accurate UTC time anywhere around the world.
- Outputs 1PPS (pulse per second) synchronized with UTC time as well as 10MHz sine-wave and square-wave coherent to 1PPS.
- Continuously outputs highly accurate and stable 1PPS and 10MHz clock even if the GPS signal is lost in holdover.
- Continuously outputs highly accurate and stable 1PPS and 10MHz clock even if only one GPS satellite signal is received.
- Pin-to-pin compatible with GF-180TC(TCXO).

Specifications

GPS Reception Capability	GPS L1 C/A, SBAS L1 C/A
GPS Reception	14 channels (GPS, SBAS)
Sensitivity	-133dBm to -110dBm
Supply Voltage	5.0VDC
Power Consumption	0.6A and lower (5.0V, Normal Status) 1.2A and lower (5.0V, Startup)
Antenna Detection	Short and Open Detection
Operating Temperature	-20°C to +85°C
Outer Size	51mm x 51mm x 19mm
Protocol	NMEA 0183, TOD
Alarm Output	Available
10MHz Output (Normal Status)	Frequency Accuracy (24h avg.): $<\pm1\times10^{-12}$ Short Term Stability: $<5\times10^{-10}$
1PPS Output (Normal Status)	1PPS Accuracy: <±100ns (95%) 1PPS Stability: <30ns (1σ)
10MHz Output (Holdover)	Frequency Stability: $<\pm3\times10^{-9}$/24h
1PPS Output (Holdover)	1PPS Accuracy: <±260μs/24h <±15μs/24h (Typ)

Muiti-GNSS antenna for Automotive and Industrial Applications

P/N: AU-18

Characteristics

- Antenna for GPS signal (L1 band) and GLONASS (G1 band) reception.
- Suitable for use with GN-87, GV-87, and GT-87 receiver modules.
- The antenna assembly consists of a patch antenna for receiving GNSS signals and a preamplifier for signal amplification.
- Power supply to the antenna preamplifier must be provided by the application on the same RF signal trace as the GNSS RF signal is carried to the application.
- Available with a choice of antenna connector type. The choice is SMA, BNC, GT-5 or SMB.
- The antenna has an internal magnet so that it can be fixed on a metallic surface.
- Easy to use antenna. Does not require RF or antenna knowledge.

Specifications

Input Frequency	1575MHz to 1610MHz
Polarization	R. H. C. P. (Right Hand Circular Polarization)
Antenna Gain	>=-0.5dBi (at 90° elev. angle) >=-10dBi (at 10° elev. angle)
Output Impedance	50Ω
Total Gain	26±3dBi (1575.42MHz) 27±3dBi (1602MHz)
Pre. Amp Noise Figure	1.5dB (Typ) (3.0VDC, 1575.42MHz) 1.5dB (Typ) (3.0VDC, 1602MHz)
VSWR	<=2.0
Supply Voltage	1.8 to 5.5VDC
Power Consumption	10mA (Typ) (3.0VDC)
Environmental Specifications	Operating Temperature: -40°C to +85°C Storage Temperature: -40°C to +85°C Operating relative humidity: 40% to 95%RH
Series Lineup (Connector , Cable)	AU-18-5A (SMA(M), RG174 x 5m) AU-18-5B (BNC(M), RG174 x 5m) AU-18-5G (GT-5(F), RG174 x 5m) AU-18-5S (SMB(F), RG174 x 5m)

GPS antenna for Automotive and Industrial Applications

P/N: AU-15

Characteristics

- Antenna for GPS signal reception (L1 band) .
- Suitable for use with GN series and GV series GPS receiver modules.
- The antenna assembly consists of a patch antenna for receiving GPS signals and a preamplifier for signal amplification.
- Power supply to the antenna preamplifier must be provided by the application on the same RF signal trace as the GPS RF signal is carried to the application.
- Available with a choice of antenna connector type. The choice is BNC, GT-5 or SMB.
- The antenna has an internal magnet so that it can be fixed on a metallic surface.
- Easy to use antenna. Does not require RF or antenna knowledge.

Specifications

Input Frequency	1575.42MHz±1.023MHz
Polarization	R. H. C. P. (Right Hand Circular Polarization)
Antenna Gain	>=2.0dBi (at 90° elev. angle) >=-6.0dBi (at 10° elev. angle)
Output Impedance	50Ω
Total Gain	20±6dBi (AU-15-5B, AU-15-5G, AU-15-5S) 24±6dBi (AU-15-1.0B)
Pre. Amp Noise Figure	<=2.3dB
VSWR	<=2.0
Supply Voltage	5.0 ±0.5VDC
Power Consumption	<=30mA
Environmental Specifications	Operating Temperature: -30°C to +85°C Storage Temperature: -40°C to +100°C Operating relative humidity: <95%RH
Series Lineup (Connector , Cable)	AU-15-5B (BNC, 1.5DS x 5m) AU-15-1.0B (BNC, 1.5DS x 1m) AU-15-5G (GT-5, 1.5DS x 5m) AU-15-5S (SMB, 1.5DS x 5m)

GPS Antenna

P/N: **AU-117**

P/N: **GPA-017**

P/N: **GPA-014**

Characteristics

- Antenna for GPS signal reception (L1 band).
- Suitable for use with GT series Timing GPS receiver modules and GF series GPS Disciplined Oscillator.
- The antenna assembly consists of a patch antenna for receiving GPS signals and a preamplifier for signal amplification.
- Power supply to the antenna preamplifier must be provided by the application on the same RF signal trace as the GPS RF signal is carried to the application.
- Easy installation with optional use of Furuno's antenna fixing bracket.

Specifications

P/N	AU-117	GPA-017	GPA-014
Input Frequency	1575.42MH±1.023MHz	1575.42MH±1.023MHz	1575.42MH±1.023MHz
Polarization	R. H. C. P. (Right Hand Circular Polarization)	R. H. C. P. (Right Hand Circular Polarization)	R. H. C. P. (Right Hand Circular Polarization)
Antenna Gain	<=2.0dBi (at 90° elev. angle) <=-4.0dBi (at 10° elev. angle)	<=2.0dBi (at 90° elev. angle) <=-4.0dBi (at 10° elev. angle)	<=0dBi (at 90° elev. angle) <=-10dBi (at 5° elev. angle)
Output Impedance	50Ω	50Ω	50Ω
Pre. Amp Gain	30±5dB	27.5±5.5dB	32±3dB
Pre. Amp Noise Figure	<=3.5dB	<=1.6dB	<=2.1dB
VSWR	<=2.0	<=2.0	<=2.0
Supply Voltage	4 to 5.5VDC	4 to 5.5VDC	4 to 13VDC
Power Consumption	<=28mA	<=25mA	25mA (Typ) to 30mA (MAX)
Environmental Specifications	Operating Temperature: -25°C to +70°C Storage Temperature: -35°C to +75°C Operating relative humidity: <=95%RH	Operating Temperature: -25°C to +70°C Storage Temperature: -35°C to +75°C Operating relative humidity: <=95%RH	Operating Temperature: -30°C to +80°C Storage Temperature: -40°C to +85°C Weather Resistant Equivalent to JIS A 1415 WS Water Resistant Equivalent to JIS C 0920 IP-X6 Salt-Water Resistant Equivalent to JIS Z 2371
Connector Type	TNC-J	TNC-J	BNC-J
Note	Ideal for use in locations with intense electric field	Standard type	Ideal for use in location with frequent/heavy snowfalls

*eRide*OPUS 6 / *eRide*OPUS 7 Evaluation Kits & Monitoring Software

Evaluation Kits: VN-87x and VN-86x series

The VN-87x and VN-86x series are evaluation kits for *eRide*OPUS 6 and *eRide*OPUS 7 chips and modules.
The performance of these GNSS receivers can easily be checked using a PC, a USB cable and a monitoring software.

(W)110mm x (D)112mm x (H)30mm

Lineup

GNSS
VN-870: For *eRide*OPUS 7 and GN-87 (with GLONASS)
VN-860: For *eRide*OPUS 6 and GN-86

GNSS + Dead Reckoning
VN-871: For *eRide*OPUS 7 and GV-87 (with GLONASS)
VN-861: For *eRide*OPUS 6 and GV-86

GNSS + Timing
VN-872: For *eRide*OPUS 7 and GT-87(with GLONASS)
VN-862: For *eRide*OPUS 6 and GT-86

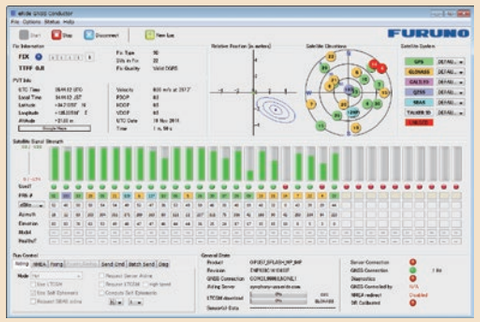
Contents

1. Antenna *1
2. USB cable
3. CD (GNSS Conductor monitoring software)
4. CAR I/F cable*2

*1 VN-87x: GNSS antenna, VN-86x: GPS antenna
*2 VN-871/VN-861 only

Monitoring Software: GNSS Conductor

The GNSS Conductor is the monitoring and communication software for the GNSS receiver chip & module evaluation kits.
It allows easy evaluation of the *eRide*OPUS GPS and GNSS receiver advanced features such as AGPS / AGNSS, Self-Ephemeris™, Dead Reckoning.



Features

- Displays status of GNSS satellite reception.
- Displays status of *eRide*OPUS GNSS/GPS receiver advanced features (AGPS/AGNSS, Self-Ephemeris™, Dead Reckoning).
- Provides a simple and easy to use interface to input commands to *eRide*OPUS GNSS/GPS receivers and to store *eRide*OPUS GNSS/GPS receiver operation log files.
- Supports both eSIP (NMEA) and FURUNO Binary.
- OS version : Windows XP / 7 (32 bit, 64bit) / 8.1 (64bit)

Multi-GNSS

A Multi-GNSS (Global Navigation Satellite System) receiver is the system able to calculate position, velocity and time by receiving the satellite signals broadcasted from multiple navigation satellite systems.

Previously, GPS, operated by the United States, was the representative positioning system, but other satellite navigation systems such as GLONASS of Russia, Galileo of Europe, BeiDou (Compass) of China are now in operation or are about to start operation. Moreover, SBAS (Satellite Based Augmentation System) a network of the geostationary satellite systems (WAAS of United States, EGNOS of Europe, MSAS of Japan) is in operation and Japan has started the operation of QZSS (Quasi-Zenith Satellite System).

FURUNO has been engaged in research and development of GPS receivers for over 20 years and consistently engages in research activities in reception and positioning technology using signals from new navigation satellite systems.

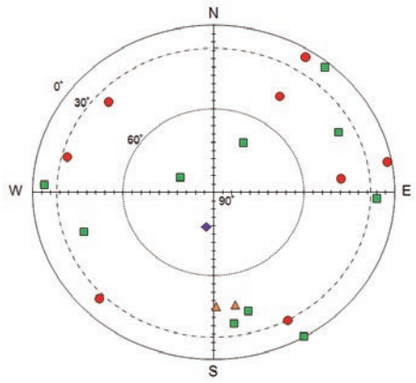
Today FURUNO's research is focusing on modernization of GPS, Galileo and BeiDou. FURUNO also has developed and produced QZSS receivers, dual-frequency SBAS receivers and other satellite navigation based receivers.

JAXA (Japan Aerospace Exploration Agency) is using FURUNO's QZSS receivers for its terrestrial monitor stations for the Quasi-Zenith Satellites System, A testimony given by JAXA to the high reliability of FURUNO's technology in the GNSS field.

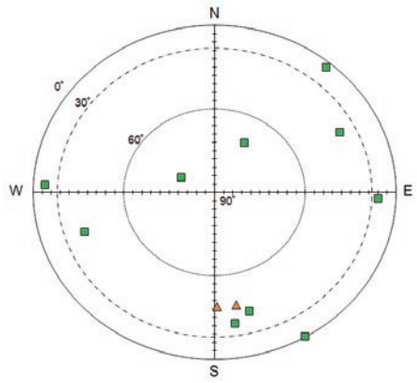
FURUNO Multi-GNSS Receiver Chip *eRide*OPUS 7 and Multi-GNSS Receiver Module 87 series enable to receive concurrently the signals of most navigation satellite systems (GPS, SBAS, QZSSS, GLONASS, Galileo). With these GNSS receivers, the number of satellites to be used for positioning has doubled, by receiving simultaneously Multi-GNSS signals, compared to GPS-only positioning receivers.

In addition, *eRide*OPUS 7 and the 87 series modules can also receive new GNSS signals scheduled to start operation in the future.

Comparison of the number of acquired satellites (Left: Multi-GNSS receiver, Right: GPS receiver)



GPS+SBAS+QZSS+GLONASS
Number of satellites in view:21
GPS:10 SBAS:2 QZSS:1 GLONASS:8



GPS+SBAS
Number of satellites in view:12
GPS:10 SBAS:2

Advantages of Multi-GNSS

1. Achieves high position accuracy with increased number of satellites compared to GPS-only positioning.
2. Improves success rate of positioning by receiving much more satellite signals even in harsh environments (urban canyon etc.) where the GPS-only positioning is difficult.
3. Improves robustness against interferences by using different frequency bands such as GPS L1 C/A and GLONASS L1OF.

Suitable application with Multi-GNSS

- Automotive navigation and telematics systems (navigation/ infotainment systems, eCall, ERA-GLONASS, etc)
- Intelligent Transport Systems (vehicle monitoring, etc.)
- Geographical Information Systems (computerized construction works, etc.), Location Based Services (Augmented Reality applications, etc.)
- Applications with precision timing (Time transfer, etc.)
- Disaster prevention management systems (monitoring for seismic surges and landslides, dam monitoring, etc.)

Multi-GNSS is available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GN-87, GV-87, GT-87, GT-8736
*eRide*OPUS 6 (ePV6010B), GN-86
GF-8701, GF-8702, GF-8703, GF-8704, GF-8705

Active Anti-Jamming / Advanced Multipath Mitigation

Active Anti-Jamming

The power level of the GNSS satellite signals when received at the antenna is below the noise floor. Signal processing techniques inside the GNSS receiver allow extracting these signals. However, to achieve the highest sensitivity it is critical to keep all sources of noises as low as possible; especially the ones that add in-band noise. These various types of noises are such as the radio waves or harmonics of the clock generated from other electronic devices.

The use of the Active Anti-Jamming function allows FURUNO's GNSS receiver chips and modules to detect GNSS in-band jamming signals and to remove them. This function is even more effective at detecting and cancelling the narrowband noise and jamming signals, which have a strong impact on GNSS receivers. This function is protecting both the GPS and the GLONASS signal bands.

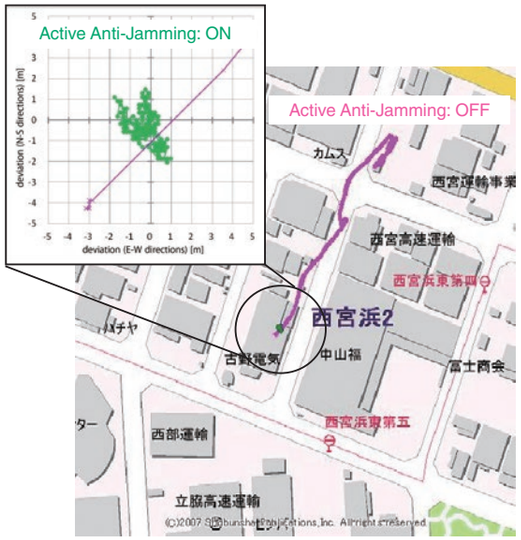
FURUNO's GNSS receiver chips and modules demonstrate optimum performance thanks to the Active Anti-Jamming function even when used in environments with high electrical noise.

Advanced Multipath Mitigation

The GNSS receiver measures the transit time of signals sent by the GNSS satellites and calculates its position from the distances between the receiver and the satellites. When the GNSS receiver antenna is not receiving directly the satellite signals but reflections of these signals, a position error may occur since the computation of the distances between the receiver and the satellites may be biased. The use of the Advanced Multipath Mitigation function allows FURUNO's GNSS receiver chips and modules to mitigate position errors caused by the reception of the reflected signals.

The Advanced Multipath Mitigation function allows the receiver to distinguish directly received signals from reflected signals and processes them all to compute accurate positions and provide precise ground tracking.

●Active Anti-Jamming



The graph above shows the actual positioning data, in green with Active Anti-Jamming enabled and in purple with Active Anti-Jamming disable of *eRide*OPUS 7 when a strong jammer is injected in the GNSS signal at the receiver antenna.

●Advanced Multipath Mitigation

● Advanced Multipath Mitigation ON
● Advanced Multipath Mitigation OFF

Actual positioning data of *eRide*OPUS 7 with Advanced Multipath Mitigation enabled & disabled in the deep urban canyon of Tokyo, Japan

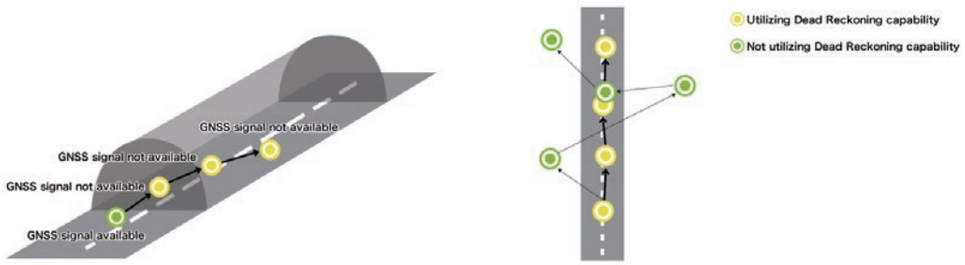
Active Anti-Jamming / Advanced Multipath Mitigation are available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GN-87, GV-87, GT-87, GT-8736
*eRide*OPUS 6 (ePV6010B), GN-86, GV-86, GT-86
GF-8701, GF-8702, GF-8703, GF-8704, GF-8705

Dead Reckoning

Precise GPS/GNSS positioning can be achieved only by receiving signals from three to four GPS/GNSS satellites at the same time. When relying on GPS/GNSS only positioning, there may be cases where the position accuracy is degraded or lost. For example when the vehicle moves in areas where the GPS/GNSS signals cannot be received (tunnels or underground passages) or where very strong multipath propagation occurs (areas surrounded by tall glass covered buildings).

To overcome such limitations of GPS/GNSS positioning, a Dead Reckoning solution is useful. It enables to keep high accuracy positioning by using information from various sensors (gyro sensor, accelerometer, speed pulse, etc.) to calculate the current position, even when GPS/GNSS only positioning is difficult or impossible. Dead Reckoning solution is widely utilized in automotive navigation systems.

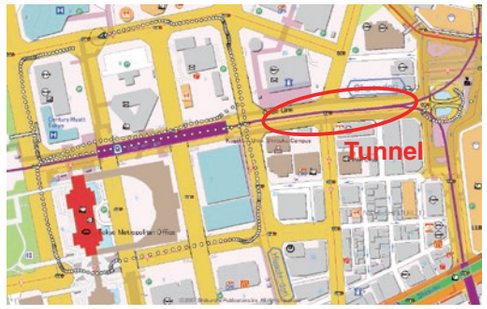


Ground tracking in tunnels where the GPS/GNSS signals are shielded and unavailable

FURUNO's Dead Reckoning Receivers use data from Gyro sensor, Accelerometer, Speed pulse, Wheel speed data of two non-turning wheels in various combinations. A Dead Reckoning solution can easily be implemented by connecting the recommended gyro sensor and accelerometer to FURUNO GPS (GNSS) Dead Reckoning Receiver I2C terminal. Likewise, a speed pulse can be directly input to speed pulse terminal of the receiver. The sensors and speed pulse will be automatically calibrated by the receiver.

FURUNO's GPS (GNSS)/Dead Reckoning Receiver will continuously output position in tunnels using our Dead Reckoning function, but also performs hybrid positioning with GPS/GNSS + Dead Reckoning when GPS/GNSS signals are received. This function helps to achieve very high accuracy positioning even in urban canyons where typical GPS/GNSS stand alone receivers cannot perform positioning in high accuracy.

Dead Reckoning positioning
(Continuous positioning even in tunnel)



GNSS-only positioning
(Positioning interrupted in tunnel)

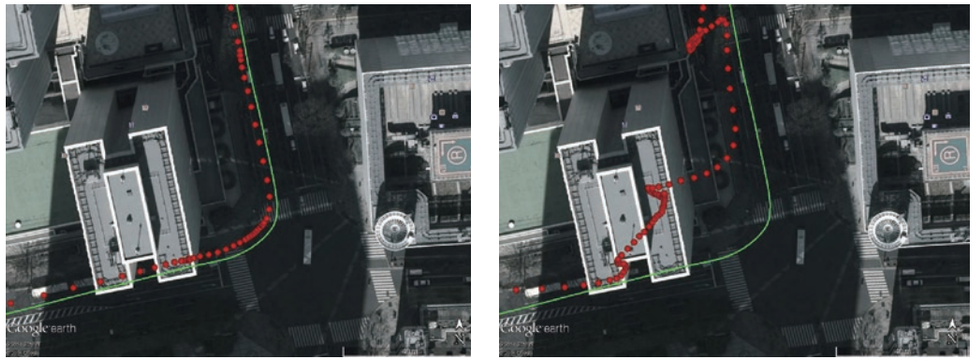
Multi-GNSS + Dead Reckoning: Position accuracy of 2.5m (1σ) has been achieved in urban canyon (Shinjuku, Tokyo, Japan)

To improve the Dead Reckoning performance, FURUNO's R & D team set our own test course around the Tokyo Metropolitan Government Towers in Shinjuku, Tokyo. It is a very harsh environment of skyscrapers that reflect satellite signals and with tunnels where no satellite signal is received.

FURUNO's GNSS (GPS)/Dead Reckoning Receiver GV-87 has achieved position accuracy of 2.5m (1σ) without position shift from the road. This same environment causes loss of satellite tracking, fluctuation of ground track, position shift and position errors when observed with previous GPS stand-alone receivers.

The new GV series which detects the vehicle position in high accuracy have been developed by integrating FURUNO's conventional signal tracking and positioning calculation technologies for GPS/GNSS receivers. The GV-87 provides superior performance for the most demanding automotive applications. It has concurrent Multi-GNSS reception of GPS, GLONASS, Galileo (when operational), and highly accurate Dead Reckoning function.

The position accuracy is equivalent to or higher than that of in-car navigation system even without map matching. The GV-87 provides an excellent source of position for car navigation systems and for other automotive devices such as fleet management system, tracking devices for commercial vehicles, drive recorders, bus location systems, navigation systems for emergency vehicles where current position accuracy has not been sufficient. The FURUNO products will also help prevent accidents and contribute to safety of driving functions and vehicle-to-vehicle communication and the Advanced Driver Assistance Systems (ADAS) in the future.



● GV-87 (left) , GPS Receiver (right) ● Actual Ground Track

©Google

Test course in Shinjuku, Tokyo, Japan
[Left: GV-87] Position error: 2.5m (1σ) [Right: GPS Receiver] Position error: 10m (1σ)

Descriptions and features of Dead Reckoning

Available sensor combinations for Dead Reckoning are as follows;

Gyro Sensor	Accelerometer	Speed Pulse	Features
3-Aixs	3-Aixs	●	For best positioning performance
1-Aixs	3-Aixs	●	For better balance of performance and cost
1-Aixs	—	●	For low cost

Dead Reckoning is available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GV-87
*eRide*OPUS 6 (ePV6010B), GV-86

AGPS (Assisted GPS) / AGNSS (Assisted GNSS)*

The GPS/GNSS receiver must receive signals from GNSS satellites to acquire the exact position information of these satellites and calculate its own position accordingly.

The orbital and navigational data of the GPS satellite are contained within its signal. These data are broken into 30 second blocks, the first 18 seconds of which contain the data needed for accurate satellite positioning, known as ephemeris data.

A GPS/GNSS receiver reads the signals transmitted by the GNSS satellites and decodes the navigational information from the signal, and by accurately pinpointing the satellite's positions is then able to calculate its own position based on the ones of these satellites. To that end, a GPS/GNSS receiver with no navigational information cannot calculate its position until it has the proper ephemeris data.

The signal level to decode the navigational information in the received signal must be greater than the receivable signal level from the GPS satellite. The GPS signal level is generally -147 dBm and the GLONASS one is generally -143 dBm. A signal level that is higher than -147 dBm for GPS must be received continuously for at least 18 seconds* in order for the GPS receiver to obtain the ephemeris data.

This signal level is adequate for using the GPS/GNSS receiver in an open air environment, but in an obstructed environment, GPS signal level of only -147 dBm or less may be receivable. When inside a building, for example, only GPS signal below -147 dBm may be receivable, and even GPS signal over -147 dBm may not be continuously receivable in an urban environment with many tall buildings. In this case, even when the signal from the satellite can be received, the ephemeris cannot be decoded and the GPS/GNSS receiver position cannot be computed.

The most recently received ephemeris data from the current target GPS satellite has an expiration period of 4 hours**, after which the ephemeris data cannot be used and the satellite position will be lost. All ephemeris data received by the GPS/GNSS receiver will soon become unusable, so the ephemeris data must be updated in fixed periods of every 2-4 hours.

When using a GPS/GNSS receiver in a situation such as in a building, where only a weak signal can be received, it may be necessary to periodically receive the orbital information of the target satellites from a source other than the GPS satellites themselves. These data are called assisted GPS/GNSS data, and the GPS/GNSS receiver that uses the assisted GPS/GNSS data to aid in the calculation of its position is called an Assisted GPS/GNSS receiver. Assisted GPS/GNSS data can be provided to the GPS/GNSS receiver from any network- or internet-connected assist server.

* 8 seconds for GLONASS
** ephemeris data for GLONASS available for 30 min

A GPS/GNSS receiver can have the following advantages when using assisted GPS/GNSS data:

- Continuous position tracking with high sensitivity signal level (-161 dBm).
- Positioning within a few seconds of operation after receiving the assist data.
- Reduction of power consumption by reducing the time it takes to receive navigational data from the GNSS satellites and calculate the current position.

All FURUNO GPS/GNSS receiver chips and modules using *eRide*OPUS technology can use assisted GPS/GNSS data. These data are provided through FURUNO GPS/GNSS Assist Server.

Accordingly, the FURUNO Assist Server can also provide the data listed below, for faster and more accurate positioning.

Max. 7 day Satellite orbital data

Use predicted orbital positioning data for a longer expiration period than usual.

Accurate time log data

Positioning is possible even without using the real time clock of the GPS/GNSS receiver.

Ionosphere data

Use the Ionosphere data for more accurate positioning.

Approximates worldwide altitudes

Assisted GNSS enables faster TTFF and accurate & stable positioning for the FURUNO's GNSS receiver chips and modules.

AGPS/AGNSS* is available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GN-87, GV-87, GT-87
*eRide*OPUS 6 (ePV6010B), GN-86, GV-86, GT-86
GF-8701, GF-8702, GF-8703, GF-8704, GF-8705
* Assisted GLONASS ready

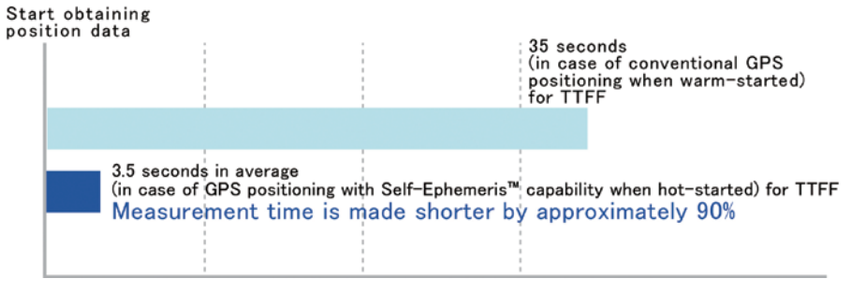
Self-Ephemeris™

The GPS/GNSS receiver uses the orbital information of the target satellite (ephemeris data) to calculate its own position. If the GPS/GNSS receiver already has a backup of valid ephemeris data stored, it will quickly (within a few seconds) calculate its position after powering on (known as a hot start). However, if there are no valid backup ephemeris data, or if the backup data have expired, it must receive the navigational information from the transmitting satellite, or access the assisted GPS/GNSS server via the internet (known as a warm start). It takes roughly 18 to 30 seconds to extract the ephemeris data from the satellite navigational information, and therefore roughly 35 seconds before a position is calculated. If the GPS/GNSS receiver is connected to a network and able to get the satellite orbital information from the assisted GPS/GNSS server, it can get the required information faster than it can from a satellite, but will still need time to transmit the data. Therefore, a warm start requires more time than a hot start.

The active ephemeris validity period is usually 4 hours, and, if exceed, the ephemeris data must be refreshed. Accordingly, the GPS/GNSS receiver can quickly calculate its position from the new ephemeris data (hot start) only for a maximum period of 4 hours. Devices with onboard GPS installed (for example a car navigation system), normally need to re-calculate their position if turned off for more than 4 hours, and require time to do so (warm start). Self-Ephemeris™ solves this problem by allowing for a startup that is equivalent to a hot start for up to 72 hours. This is performed independently by the GPS/GNSS receiver, and can function without a network connection or a connection to an assisted GPS/GNSS server.

Self-Ephemeris™ technology uses a specialized algorithm to predict and estimate the orbital information of a satellite based on previously received ephemeris data, and allows the GPS/GNSS receiver to have a TTFF in the same amount of time as a hot start, for up 72 hours.

With Self-Ephemeris™, every time the GPS/GNSS receives new ephemeris data, the internal receiver automatically recalculates the data as required, for operation that requires minimal user interference.



Self-Ephemeris™ is available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GN-87
*eRide*OPUS 6 (ePV6010B), GN-86

Positioning at 10 Hz update rate

Positioning at 10 Hz update rate (ten times per second) creates more detailed and higher resolution vehicle tracking capabilities. Trails of the vehicle can be recorded with ten times the resolution compared with the more traditional 1 Hz positioning update rate.

[Usage example]

Car navigation system / PND ("Portable Navigation Device" or "Personal Navigation Device")
By updating the positions ten times per second, the map can be scrolled more smoothly.

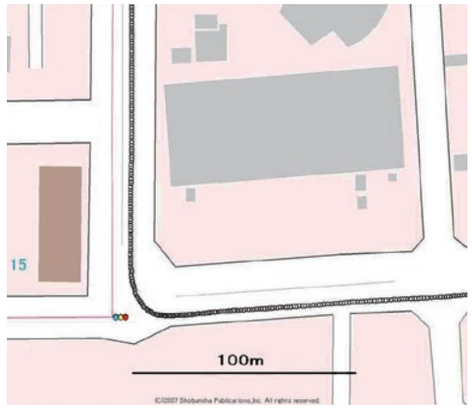
Data Logger
Even while driving on the express highway, the trails of the vehicle can be recorded in minute detail to ensure accurate and complete data analysis capabilities.

Drive Recorder (Event Data Recorder)
In the event of abrupt steering, braking or a collision while driving, the detailed position where such events take place can be accurately recorded.

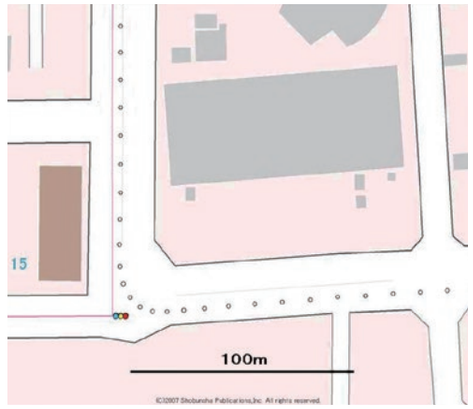
GPS Speed Meter
Speed of the vehicle can be output 10 times per second. This is a much more detailed speed output compared with the conventional update rate of once a second.

Vehicle-to-vehicle (V2V) communication/ vehicle-to-infrastructure (V2I) communication
10Hz helps automated systems accurately determine the positions of other vehicles nearby even in poor visibility conditions and difficult areas such as intersections or junctions.

Actual positioning data of 10 Hz on a town street in Nishinomiya (Japan)
Below is an example that shows the difference between 1 Hz and 10 Hz position update rate. The vehicle driving at 60km/hour travels 16.7m in a second. Since position update is ten times more frequent, the record of the vehicle's trail is shown much smoother at 10 Hz position update than at 1 Hz position update.



10Hz



1Hz

10 Hz update rate available in the following products

*eRide*OPUS 7 (ePV7010B / ePV7000B), GN-87, GV-87
*eRide*OPUS 6 (ePV6010B), GN-86, GV-86

GPS	GPS	Supports GPS
GLONASS	GLONASS	Supports GLONASS
SBAS	SBAS	Supports SBAS (WAAS, EGNOS, MSAS)
QZSS	QZSS	Supports QZSS
Galileo	Galileo	Supports Galileo (Refer to P8/P14 for details)
Dead Reckoning	Dead Reckoning	Dead Reckoning enables navigation to continue in tunnels or underground passages
Time Pulse	Time Pulse	Time Pulse provides synchronized signal with UTC time. Example: 1PPS
Frequency	Frequency	Provides a clock output coherent with UTC time. Example: 10MHz
Assist GPS/GNSS	Assist GPS/GNSS	Assist GPS/GNSS shortens TTFF (Time To First Fix) and reduces power consumption by getting assist data (satellite models) through internet.
Self-Ephemeris™	Self-Ephemeris	Self-Ephemeris™ shortens TTFF (Time To First Fix) by extending validity period of satellite's ephemeris to maximum 72 hours
Anti-Jamming	Anti-Jamming	Anti-Jamming protects *eRide*OPUS GPS/GNSS Receiver from external noise and jamming signals
Multipath Mitigation	Multipath Mitigation	Advanced Multipath Mitigation suppresses position misalignments caused by satellite signals reflected by buildings or other structures

For Products Information

Detailed products information is avaialble on FURUNO official website.

Please refer to
http://www.furuno.com/en/gnss/

www.furuno.com

Specification and appearance are subject to change without notice.
Color shade may differ somewhat between printed matter and products.
For more detail of this catalog, please contact to following address.

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FURUNO ELECTRIC CO., LTD.

System Products Division
2-20 Nishinomiya-hama, Nishinomiya, 662-0934, Japan
Phone: +81-798-33-9588 Fax: +81-798-33-7511
Contact: https://www.furuno.co.jp/cgi/cnt_gps_e01.cgi

FURUNO USA, Inc.
70 Engerman Avenue Denton, MD 21629, U.S.A.
Phone: +1(410)479-4420 Fax: +1(410)479-4429
Contact: http://www.furunogps.com/contact.html

FURUNO DEUTSCHLAND GmbH
Konrad Zuse Platz 8, Munich 81829, Germany
Phone: +49 89 207 042 340
Contact: support@eRide.com

No. H-021b
15121AD