

Falcon SF

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- Lifetime StarFire license
- StarFire five (5) centimeter standalone accuracy worldwide
- "All-in-view" parallel tracking with 255 channels
- L1C/A, L2P, L2C, L5, G1C/A, G2P, G2 C/A, B1, B2, E1, E5A, E5B)
- Multi-constellation support (GPS / Galileo / BeiDou / GLONASS) code and full wavelength carrier phase tracking
- Ultra RTK (up to 40km baseline)
- SureNav
- RTK Extend™ –Coast through base station outages
- Operates as a base or rover
- Patented multipath rejection
- Fast acquisition/re-acquisition
- High sensitivity/low signal level tracking
- Superior interference suppression (both in-band& out-of-band)

WHO NEEDS A BASE STATION WHEN YOU HAVE STARFIRE?

Developed and
produced in Switzerland





Falcon SF

Falcon is a full featured GNSS, with 255 channels tracking satellites from all major positioning systems, Falcon will always produce accurate results, which can then be used by a whole host of applications. When used with a Base Station, or VRS network, Falcon SF will produce precise (1 cm + 0.5ppm) positions, and using the Starfire for Life option 5 cm accuracy can be achieved anywhere on the planet with no base station or correction signal. This is a very unique combination and makes Falcon SF perfect for remote and difficult areas.

The Falcon SF GPS is not only accurate but its smart. The heart of Falcon is its precise GNSS Onyx™ core that gives superior results, but Falcon also has a brain, which is a built in Arm Processor running Windows 10 or Linux. This gives Falcon the ability to think for itself, to log data, run user programs, talk to the cloud, and more.

Communications

UHF, GSM, Wifi, and Bluetooth communication links with support for multiple RTK formats allows the Falcon SF rover to work with a variety of base stations and VRS RTK networks.

Starfire for Life

StarFire is a global satellite-based augmentation system (GSBAS) which provides five centimeter positioning accuracy on a worldwide basis. Falcon SF includes a free lifetime license for StarFire. Aside from giving excellent accuracy StarFire also makes Falcon extremely easy to use because

there is no need for base stations, sim cards, or any other communications, its just press the on button and go.

UltraRTK™ and RTK Extend™

Falcon SF with UltraRTK can give excellent coverage with baselines up to 40km, and protection against communication outages of up to 15 minutes is easily handled with RTK Extend™

Universal GNSS interface

Falcon has a unique configuration that allows it to be set-up and configured to mimic other GPS units and therefore run other software.

Falcon Cloud

Everything collected by Falcon can instantly be backed up to the cloud where work can be monitored and processing can be started before the GNSS has even left the field. This connection also allows workers to share work as they are surveying and monitor work that has already been completed.

Built in Logging

Although Falcon can work with most industry standard data loggers and software, Falcon also has built in logging. You can log data right on the instrument without the need for a datalogger.

Falcon API

With Falcon you can write your own applications for the GNSS.

Direct Sensor Interface

Now external sensors like echo sounders and cable detectors can be interfaced directly to the GNSS.

Tough and Field Ready

The rugged, waterproof and shock proof design coupled with hot swappable batteries ensures continuous operation in the harshest of environments. Designed for all day use in surveying environments it includes several I/O options, a 2 Watt internal UHF radio, removable SD card.

Falcon Band

The Falcon band is worn on the wrist and gives you complete control of the Falcon remotely. Logging can be triggered, data displayed, and all in a rugged sunlight readable form factor.



Falcon SF Technical Specification

SYSTEM INCLUDES

- 2-Batteries
- Battery charger
- 4GB removeable SD memory card
- UHF Radio transceiver (up to 2 watt)
- Serial and USB cables
- AC/DC power cable
- Rugged Transport case

OPTIONAL ACCESSORIES

- Unterminated power cable
- Automotive power adapter
- Additional serial cable

Warranty

- Three year warranty

StarFire

- Lifetime StarFire license
- StarFire five (5) centimeter standalone accuracy worldwide (1 sigma)
- StarFire Quick Start
- Builtin 3-channel StarFire™ receiver/ demodulator
- StarFire Over IP delivery
- StarFire Rapid Recovery

Physical and Power

- Lightweight, rugged land survey receiver
- Dual hot swappable batteries for continuous operation



The Falcon SF Onyx engine includes a digital ASIC to handle high-speed signal processing and is provided with three built-in StarFire receiver/de-modulators.

By incorporating the use of GPS (L1, L2, L2C, L5), GLONASS (G1, G2), StarFire L- band, and SBAS (WAAS, EGNOS, MSAS, GAGAN) signals, the Falcon SF Onyx GNSS engine provides proven unparalleled performance even in adverse signal-tracking conditions. Onyx also tracks Beidou (B1, B2) and Galileo (E1, E5A, E5B), though these signals are not yet used in the navigation solution. The receiver is also equipped with 2 RF ASICs to accommodate future features such as a separate StarFire antenna and single-board heading.

Superior interference suppression (both in-band & out-band), multipath mitigation, and measurement accuracy are only a few of the technological advances incorporated into the small Falcon SF receiver. Because Falcon SF is a multi-frequency receiver, it is virtually immune to ionospheric effects. With 255 channels, Falcon SF provides All-In-View tracking for all signals.



Receiver FEATURES

- "All-in-view" parallel tracking with 255 channels
- L1C/A, L2P, L2C, L5, G1C/A, G2P, G2 C/A, B1, B2, E1, E5A, E5B)
- Multi-constellation support (GPS / Galileo / BeiDou / GLONASS) code and full wavelength carrier phase tracking
- Ultra RTK (up to 40km baseline)
- SureNav
- RTKExtend™-Coast through base station outages
- Operates as a base or rover
- Patented multipath rejection
- Fast acquisition/re-acquisition
- High sensitivity/low signal level tracking
- Superior interference suppression(both in-band& out-of-band)
- SBAS(WAAS/EGNOS/MSAS/GAGAN) tracking with two dedicated channels
- Single-base network with support for multiple Message formats

Communications

- Bluetooth® cable free, all-on-the pole design
- Bluetooth 4.1
- Bluetooth Low Energy (BLE)
- GSM quad frequency
- GSM 3G/4G VRS Network RTK support
- UHF radio
- WiFi 802.11n Wireless LAN

Tilt

- Tilt sensor
- Automatic height calculation

Sound

- Microphone and Speakers

Processor Specification

- A 1.2GHz 64-bit quad-core ARMv8 CPU
- VideoCore IV 3D graphics core
- 1GB RAM
- 4 USB ports
- Full size HDMI
- Ethernet port



WHO NEEDS A BASE STATION WHEN YOU HAVE STARFIRE?

StarFire 5 cm accuracy, available anywhere on the Earth's surface, land or sea.

SPECIFICATIONS

PERFORMANCE(1)

- Tracking (Carrier & Phase):

| | |
|---------|---|
| GPS | L1, L2, L2C & L5 carrier, CA, L1P, L2P & L2C code |
| GLONASS | G1 & G2 carrier, CA & P code |
| GALILEO | E1, E5A, E5B |
| BEIDOU | B1, B2 |
| SBAS | WAAS, EGNOS, MSAS & GAGAN |

- RTK Correction

RTCM types 18-22, and 1001-1013, 1019, 1020, 1033 NCT types 0x5B, 0x5C, 0x5E1, and 0x62(hex)

- Ports

2 x RS232
 USB 2.0 (Device) Bluetooth™

- Position & Raw data rates 1Hz, 5Hz, 10Hz

- Memory Removable Micro SD card

- User-Programmable Output Rates 1 Hz, 5 Hz, 10 Hz, 25Hz

PHYSICAL/ENVIRONMENTAL

- Size (D x H): 136mm x 136mm (5.35in x 5.35in)

- Weight (incl. batteries): 0.95kg (1.8lbs)

- Power Input: AC/DC Adapter 110/220VAC, 12VDC
 Nominal 0.5A (9.0V to 32VDC)

- Temperature (ambient):

Operating: -20° to +45° C (-4° to +113° F)
 Storage: -40° to +85° C (-40° to +185° F)

- Enclosure Rated IP67 (water resistant/dustproof)

- Certifications FCC / CE

- Connectors:

Power, Com1/USB LEMO, 8-Pin
 UHF Ant TNC (non visible)

- Accuracy (RMS)

RTK (<40km) (H)+ 1.5 cm +1ppm / (+ 1 cm +0.5ppm 1-sigma)⁽¹⁾
 (V)+ 3.0cm +2ppm (+ 2 cm +1ppm 1-sigma)

RTK Extend (<15min) (H)+ 4.5cm +1ppm (+ 3 cm +1ppm 1-sigma)
 (V)+ 10cm +1ppm (+ 6 cm +2ppm 1-sigma)

RTK Float (H) + 30cm +3ppm
 (V) + 60cm +3ppm

Rapid Recovery (StarFire GNSS) (H) + 7cm / (V) + 14cm

RR Outage Duration: < 55sec

Recovery Period: Up to 4min

- StarFire GNSS (multi-frequency)

(H)+ 7cm (+ 5 cm 1-sigma)
 (V) + 14cm (+ 10 cm 1-sigma)

- StarFire GPS (multi-frequency)

(H)+ 14cm (+ 10 cm 1-sigma)
 (V) + 21cm (+ 15 cm 1-sigma)

- Heading - Multi-Frequency 0.1 degrees

*Antenna baseline length/ 0.6 Requires 10Hz update rate

- Enhanced SBAS (WAAS/EGNOS/ (H) +60cm MSAS/GAGAN)
 (V) + 120cm

- Position Accuracy (RMS)

Velocity 0.01m/s
 Post Processing 5mm + 0.5ppm/10mm + 0.5ppm

- Time-to-First-Fix

Cold Start: 65 seconds
 Warm Start: 55 seconds
 Hot Start: 20 seconds

Signal Reacquisition

Multiple Frequency

>60 second outage: 2 seconds

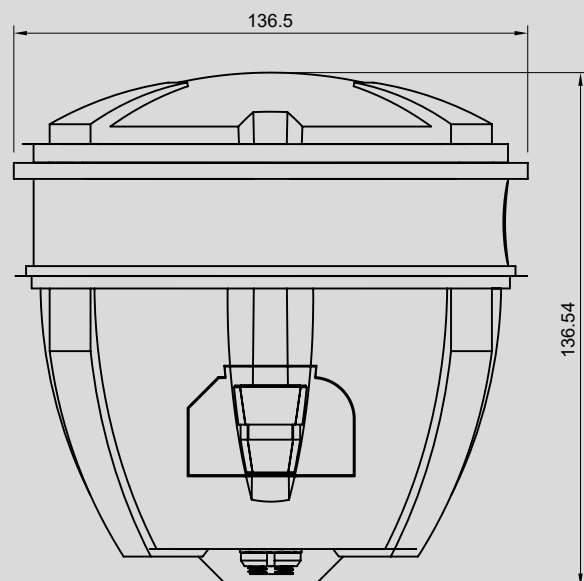
COMMUNICATIONS

- UHF radio 2 watt, 403-473MHz

- Data message formats

NMEA-0183 ALM, GBS, GGA, GLL, GRS, GSA, GST, GSV, MLA, RMC, RRE, VTG, ZDA DTM GFA, GNS, HDT, MLA, ROT, TTM

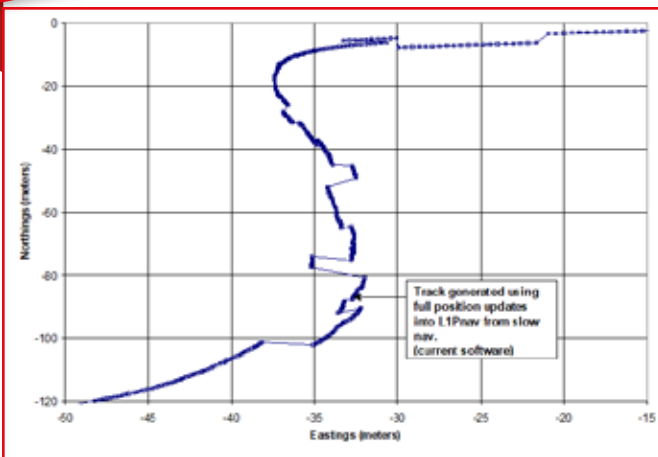
- Differential Correction RTCM 2.3 and 3.0, RTCM types 1, 2, 3, 9, 31, and 34, SBAS (WAAS/EGNOS/ MSAS/ GAGAN), and StarFire



⁽¹⁾ Performance dependent on location, satellite geometry, atmospheric conditions and GNSS corrections. The specifications herein are based on the following: PDOP <4, 2-sigma (95%; unless otherwise noted), 24-hour averaged set of data. Technical specifications subject to change at Geozone's discretion

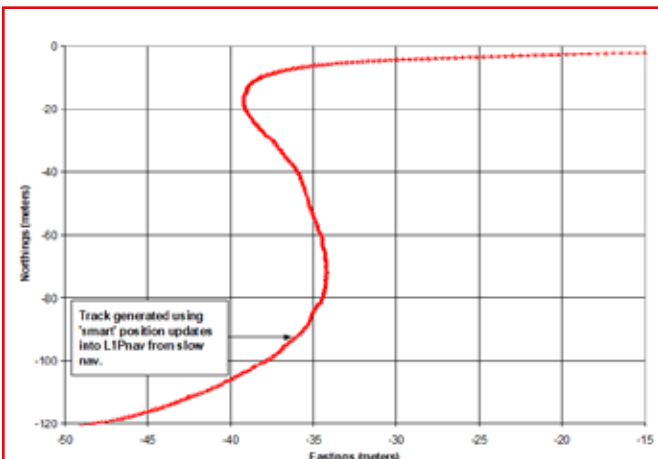
Navigation: SureNav

- Ensures the rover will transition from one navigation mode up or down to the next mode smoothly, without position jumps
- The receiver runs a second navigation engine in the background to crosscheck primary PVT solution
- The receiver can also listen to two correction sources at once and apply the dominant correction
- The receiver takes advantage of statistical data, filtering, and certain assumptions to discard outlying measurement data
- Shading and mode transitions will not be followed by position jumps



Trajectory WITHOUT SureNav in Shading Area A

Full Code Solution Updates



Trajectory WITH SureNav in Shading Area A

'Smart' Position Updates to L1 Phase Nav – 'SureNav'

StarFire: QuickStart

- Reduces convergence time and allows StarFire to pull-in instantly, provided the receiver is on a known point
- Saves users valuable time in the field, increasing productivity
- Convergence can be almost eliminated in many applications

StarFire Over IP

- An optional service to receive StarFire corrections over the Internet
- Provides access to StarFire corrections in environments where satellite delivery is unavailable, such as deep urban canyons or very high latitude locations.
- Available delivery modes:
 - Once every second (streaming)
 - Once every 15/30/60 seconds
- If you can get an internet connection, you can get StarFire Over IP corrections

StarFire: Rapid Recovery

- Improving productivity in the field by eliminating pull-in after GNSS outage
- Helps users ride through short GNSS signal outages of up to one minute
- Regains 3 cm StarFire accuracy within two minutes after entering StarFire mode.
- When used with Quick Start, users are up and running within 5 minutes achieving maximum possible uptime
- Adopts an MBRTK technique
- Requires that the pre-event state is converged
- Uses the last pre-event fix state to resolve post-event errors in conjunction with post-event corrections
- Re-convergence due to temporary navigation loss is nearly eliminated

Multipath Rejection

- Falcon SF perform a comparison of Narrow Early minus Late discriminator
- The receiver performs pulse and polarization detection and discriminates anomalies
- Phase error detection between composite signal and direct path signal
- Sub-carrier channel detection
- Receiver & software architecture are coupled with antenna design

Ultra RTK

- Allows RTK operation up to 40km separation between base and rover
- We have tested Ultra RTK to 75km – and it works
- Resolving ambiguities over 40km takes longer and may fail initially
- Once the rover is at 40km, the typical error is 3.5cm
- Customers needing longer baselines are better off using StarFire standalone
- Long baseline work can be done if the operational needs demand it

RTK Extend

- Allows rover to operate to RTK levels when RTK correction signal is lost due to range or shading.
- When a StarFire-enabled receiver with RTK Extend falls out of RTK mode, the system automatically transitions to RTK Extend mode.

- Base and rover listen to StarFire signal simultaneously.
- Base includes a StarFire offset component.
- Rover is compatible with 3rd party base connection.
- Requires twice the normal convergence period to maintain RTK levels since the offset is being received from the base.
- You don't have to move the base as soon as you lose the RTK signal.

USER BASE

- Offshore
- Mil/gov
- Agriculture
- Survey
- Construction/Machine Control
- UAV
- And many more

Precise Point Positioning (PPP)

- The StarFire Network is the world's first Global Satellite Based Augmentation System (GSBAS)
- Performance is no longer a function of your distance from a reference station, so you have the freedom to use StarFire anywhere in the world.
- Real-time Five Centimeter Global Accuracy
- Worldwide Coverage
- No Base Station Necessary
- Fully Redundant, Global, Geo-Stationary Satellite Coverage

The StarFire™ Network is a global system for the distribution of SBAS corrections that gives users the ability to measure their position anywhere in the world with exceptional reliability and unprecedented accuracy of better than 5 cm (2 inches). Because the SBAS corrections are broadcast via INMARSAT geostationary satellites, users need no local reference stations or postprocessing to get this exceptional accuracy. Furthermore, the same accuracy is available virtually anywhere on the Earth's surface, on land or sea, with a look angle of 10° to the satellite, due to the worldwide coverage of these geo-stationary satellites.

APPLICATIONS

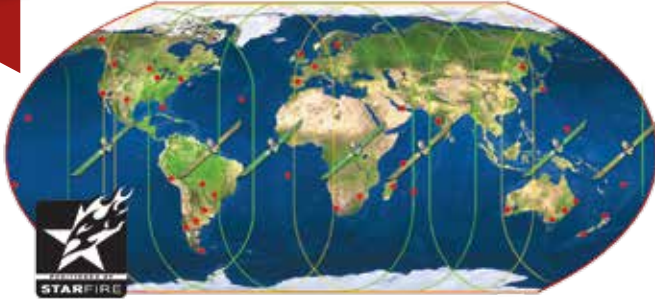
StarFire receivers are available as fully integrated units or modular systems. Applications that can benefit from StarFire performance, accuracy and availability include:

StarFire



- **Land Survey**
- **Offshore Positioning**
- **Precision Agriculture**
- **UAV Aerial Photogrammetry and LIDAR**
- **GIS and Asset Mapping**
- **Machine Control**
- **Unmanned Vehicles**
- **Government & Military**

StarFire network coverage area



METHODOLOGY

The StarFire Network is a major advance from earlier ground based augmentation systems because it considers each of the GNSS satellite signal error sources independently. GNSS satellite orbit and clock corrections are calculated from a global tracking network of dual frequency receivers. These corrections are transmitted via geo-stationary satellite links direct to StarFire receivers, resulting in minimal data latency and worldwide operation.

All StarFire receivers use a multi frequency GNSS receiver that measures the ionospheric delay for each satellite. Tropospheric zenith delays are calculated from a multi-state time and position model aided by redundant satellite observables.

SYSTEM INTEGRITY

A global network of multi frequency GNSS receivers provide raw data every second via reliable redundant data links to two network processing centers located in California, (S.W., USA) and Illinois, (N.E., USA). These receivers are tied to the latest realization of the International Terrestrial Reference Frame (ITRF) coordinate system. StarFire's primary time reference is coupled to the International Atomic Time standard.

The network is a fully automated continuously self-monitoring system overseen around the clock by StarFire Network operators. Orbit and clock corrections from both processing centers are distributed via dedicated circuits with multiple communication backups to three geostationary satellite uplink stations. An independent network of StarFire user equipment continuously monitors system accuracy to ensure maximum reliability.

RELIABILITY

- 99.999% availability
- Extensive monitoring through internal checks
- Real-time monitoring of global positioning results
- Redundancy throughout all segments of the system
Redundant data links, geographically separated processing hubs and dual satellite uplink equipment ensure continuous reliable positioning. The system is inherently robust with the ability to calculate a full set of corrections even if multiple reference stations were to become unavailable.

PERFORMANCE

Using Falcon SF StarFire GNSS receiver provides better than 5 cm horizontal and 10 cm vertical accuracy (1 sigma).

Unlike DGPS positions that are relative to the reference station location, StarFire produces absolute, ITRF positions anywhere, any time. StarFire accuracy is independent of the distance to the nearest reference station.

