SkyFox Labs™

Your easy way to space.

Space-Friendly™

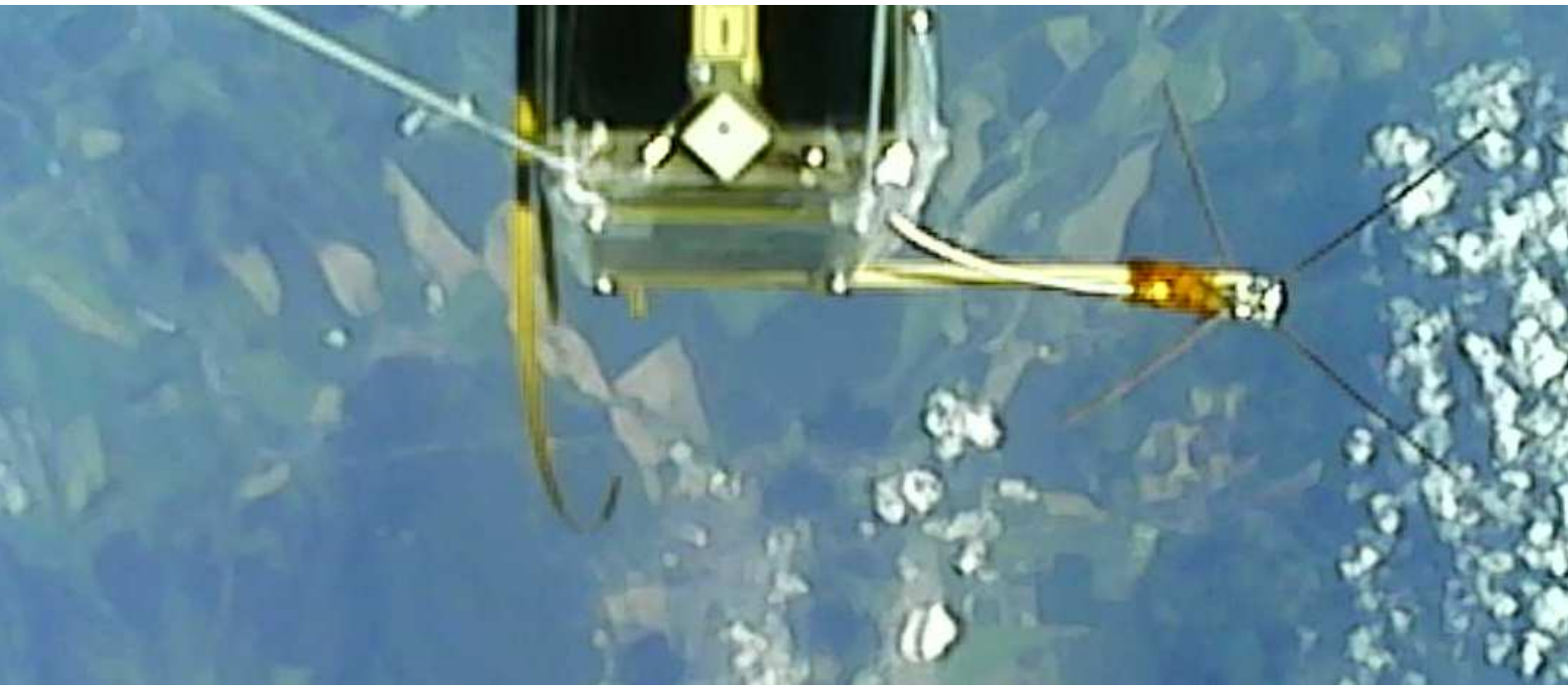
Active GNSS Patch Antenna Module

piPATCH-MAX

Product Datasheet

Rev. A/2025

Intended to cover all **Satellite GNSS** needs.



Made in Czech Republic, a country with space heritage since 1978.

PRODUCT DATA SHEET piPATCH-MAX

FEATURES – Flight Model

- **Active GNSS antenna for Microsatellites**
- **Stable 50-52+ dBc-Hz SNR on ground for close-Zenith Satellites (GPS)**
- **Stable 46-48+ dBc-Hz SNR on ground for close-Zenith Satellites (Galileo)**
- **Stable 50+ dBc-Hz SNR on ground for close-Zenith Satellites (GLONASS)**
- **Stable 48+ dBc-Hz SNR on ground for close-Zenith Satellites (BeiDou)**
- **Civil GPS-L1 + GLONASS-G1 + GALILEO-E1 + BEIDOU-B1 bands**
- **Civil GPS-L1 + Galileo-E1 bands version available on request (+ 1-2dB in gain due to narrower band patch antenna element)**
- **Power consumption**
  20 mA (typical), 3.3 V @ 25°C
- **2.7 to 5.5V power supply**
- **Large groundplane insulated from Structure, AC-coupled to GND potential**
- **Double ESD Protection, Patch Antenna DC-Shorted to GND potential**
- **Mass 89 grams**
- **Dimensions 74×74×13 mm**
- **Wide temperature range**
  -40˚C to +85˚C
- **Connector**
  SMA-F, (both Signal + Power)
  Straight or Right-angle on request
- **FR-4, 4-layers PCB**
- **SAW Filter (wideband L1+G1+E1+B1 version or standard band L1+E1 version available)**
- **Patch Epoxy-fixed (3M Ultra Low Outgassing)**
- **Double-sided Kapton® fix below Patch**
- **60/40 Tin-Lead used (prevent tin whiskers)**

FEATURES – Engineering Model

- **Active GNSS antenna for Microsatellites**
- **RF and DC characteristics of the Flight Model**
- **Red Remove Before Flight hardened PVC cover**
- **Mechanical outline fitting the Flat Sat design and AIT/AIV activities requirements**
- **Not intended for spaceflight/vacuum environment**

APPLICATIONS

- **Microsatellites, Cargo Ship Satellites GNSS receivers**
- **Satellite Projects using multi-constellation navigation/PVT experiments**
- **High precision GNSS systems with multichannel GNSS receivers**
- **Combined GPS, Galileo, GLONASS, BeiDou supportive GNSS systems RF signal source antenna**

Fig. 1 piPATCH-MAX Patch Antenna Flight Model.

GENERAL DESCRIPTION

The piPATCH-MAX is the Space-Friendly™ Microsatellite GNSS Active Antenna module specially designed to provide strong signal for GPS-L1 + GALILEO-E1 + GLONASS-G1 + BEIDOU-B1 navigation satellite bands reception in space. An optimized version for GPS-L1 + Galileo-E1 is available on request benefiting with +1-2 dB more gain with respect to all band version. Integrated Low Noise Amplifier (LNA) as well as SAW filter are matched together with 35×35 mm Patch antenna and large ground plane DC-insulated from the mounting structure and AC-coupled to enhance the RF groundplane using the satellite wall.

Easy-to-use SMA signal and power interface provides compact solution for all kind of projects where strong GNSS signal reception with enough margins is required.

The module can be easily mounted to the satellite structure using four M4 screws.

High quality conformal coating, Kapton® based patch antenna fixture, Sn/Pb tin-lead soledring compound (non-RoHS) and Ketron® PEEK used for the Flight Model radome brings the best possible outgassing performance in vacuum environment of space.

The Engineering Model with red Remove Before Flight hardened PVC is available for satellite development, flatsat design and AIT/AIV activities.

The antenna is fully compatible with majority of 3.3 - $5V_{DC}$ GNSS receivers equipped with active bias over RF coaxial input.

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ABSOLUTE MAXIMUM RATINGS

RF V_{IN} to GND ……..-0.3 V to (≤ 7 V max)
Chassis to GND Potential ……..+/- 50 V max
DC Input Current: I_I at V_I < 0 V or V_I > V_{DD} .....30 mA

Operating Temperature Range:……..-40°C to +85°C
Storage Temperature Range:……...-55°C to +100°C

NOTE: Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under specification conditions is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability. Voltage values are with respect to system ground terminal. The manufacturer reserves all rights to decline the responsibility for any damage caused by improper using of the piPATCH-MAX product.

CAUTION: *The antenna mounting bracket is DC-insulated from the RF coaxial connector GND potential acting as a power source return wire in order to prevent the grounding loops between the antenna, receiver, onboard power supply and satellite mounting wall (if conductive). Internal active electronic circuits are capacitively AC-coupled to the antenna mounting bracket (chassis) to improve the antenna RF performance. Keep the chassis grounding in mind when designing the satellite power system to prevent the charge build-up in case the chassis is not grounded and the satellite mounting wall is not conductive or dissipatively-wise not matched to discharge the charge build-up in the plasma environment of space. Always connect the power before start to change the antenna electrical/mechanical setup. Overloading over the Absolute maximum ratings may affect device reliability, damage the power source device and void the product warranty.*

DIMENSIONS

Four layer PCB with outer dimensions of 70×70 mm is mounted on top of a Al-6061-T6 aerospace grade aluminum mounting bracket with Ketron® PEEK radome cover. The piPATCH-MAX antenna is equipped with the SMA-Female straight or right angle RF connector (on request).

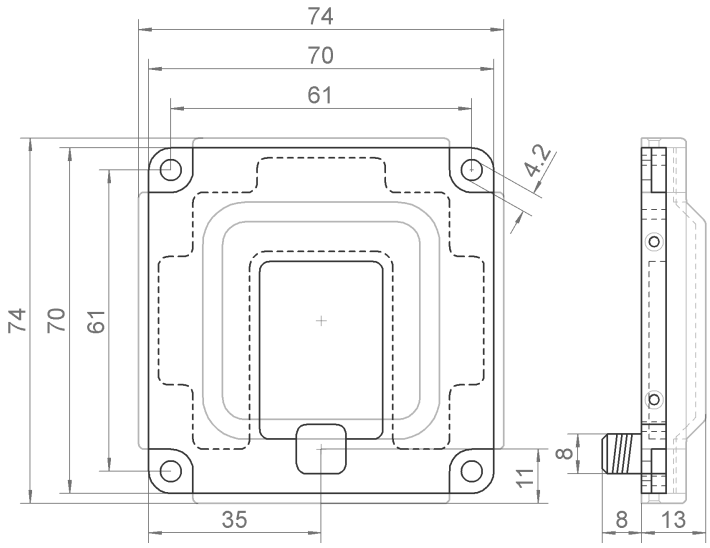

Fig. 2 piPATCH-MAX Dimensions drawing in millimeters. Detailed STEP file available for download.

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Tab.: 1 **The piPATCH-MAX SMA-F Connector Description.**

Pin	Name	I/O, Power or Do Not Connect	Description
Shield	GND	Power	**System ground.** Must be connected to receiver ground potential. This signal is internally connected to the inner ground plane and patch antenna tap.
Center	VDD	Power	**Positive system power input.** Positive power supply input and RF signal output.

ENGINEERING MODEL

To test the GNSS system aboard the satellite prototype or engineering / development / qualification model, the Engineering Model grade with identical electrical and RF properties is available. The red Remove Before Flight finish with respective label reminds the user to replace the unit with the Flight Model grade unit suitable for the environment of space. Photo of the piPATCH-MAX/EM unit is depicted in Fig. 3.

Fig. 3 Engineering Model of the piPATCH-MAX unit with red Remove Before Flight finish.

APPLICATION NOTES & RECOMMENDATIONS

EMC CONSIDERATIONS

As the size of the small satellites imply the high level of integration of different electronic devices (switch mode power supplies, high speed digital electronics, pulse-width modulated electromagnetic actuators, etc.) into a limited satellite structure volume containing potential sources of disturbing signals, the electromagnetic susceptibility and compatibility is critical for implementation of any subsystems sensitive to electromagnetic radiation.

Proper ground planes and PCB design rules minimizing the radiated and conducted emissions shall be applied within the whole small satellite structure, including custom payloads, conventional (Communication and Data Handling, Power Supply and Power Distribution, Onboard Computer, Attitude Determination and Control) and third party electronic subsystems. The small satellite electronics should be properly designed to not disturb the GNSS receiver input frequency band with harmonic frequencies falling to the GPS-L1 + Galileo-E1 + GLONASS-G1 + BeiDou-B1 or GPS-L1 + Galileo-E1 frequency bands respectively.

NOTE: The C/N_0 parameters (Signal-to-Noise Ratios) provided in GNSS receiver output NMEA sentences can be exploited as a diagnosis tool if the EMC issues affect the reception capability. **Always observe the C/N_0 levels and switch On/Off each electronic subsystem to identify the potential source of the disturbance if needed, using (best possible) open-sky signal quality.** Typical terrestrial SNR readings for close-Zenith (high elevation) satellites are as follows: **50-52+** dBc-Hz (GPS), **46-48+** dBc-Hz (Galileo), **50+** dBc-Hz (GLONASS), **48+** dBc-Hz (BeiDou) for wideband (all constellation) version. In case significantly lower SNR readings are detected during the RF test, it is recommended to review the whole RF/GNSS/satellite setup.

ANTENNA LOCATION

Special care should be taken to the interference with the small satellite communication or power subsystem, as an active electronic device radiating the high power electromagnetic waves. The manufacturer recommends installing the GNSS antenna as far from the (transmitting) communication antennas as possible. The RF coaxial cable (harness) between the antenna and the receiver may also pick up harmful interference along the path inside of the satellite body. **Be sure to test** the target small satellite subsystems against affecting the performance of the GNSS receiver under all satellite operation conditions.

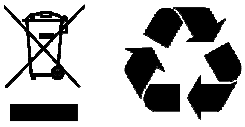
Keep in mind the receiver may be sensitive to harmonics of the downlink (transmitter) frequency (i.e. 1553-1620 MHz /9, /8, /7, /6, /5 /4, /3,/2, etc.) or uplink receiver spurious emissions, local MPPT EMC radiation, magnetorquer PWM EMC radiation, etc. **It is highly recommended to perform full functional test on the flight or flight-representative satellite model to ensure the EMC compatibility.**

In order to maintain and/or improve the antenna radiation pattern, gain, efficiency and performance, it is **recommended to mount** the antenna **in the center, on top of a flat and conductive surface** with thickness of **at least 0.2 mm or thicker** (L-band frequency RF penetration depth for typical metallic materials of satellite walls) in order to expand the basic antenna footprint size (70×70mm). The mounting plate size is not necessary to be larger than ~190 mm in diameter (approximate L-band GNSS wavelength). If smaller, the antenna radiation pattern shall be studied further and checked/verified to conform with mission/satellite pointing requirements.

RECYCLING

Below mentioned logo given on the goods, its packaging or inside this Quick Start Guide or other related documentation means that used electrical or electronic devices or products should not be disposed with household waste. To ensure proper disposal of the product hand it to designated collection points, where they will be accepted free of charge.

Eco disposal of SkyFox Labs s.r.o. products is maintained by collective system RETELA in Czech Republic. Please recycle product and its packaging in proper way according to valid laws in country of disposal.



The piPATCH-MAX / **Engineering Model** is RoHS compliant.

The **piPATCH-MAX / Flight Model** is **RoHS** compliant through exemptions, contains leaded solder.

PRODUCT SAFETY

According to use of the product in line with this Quick Start Guide, the product is safe under normal use The CE mark (Conformité Européenne) has been issued on this family of products. Related EC Declaration of Conformity is issued with each supply and is available online at manufacturer's website http://www.skyfoxlabs.com .

CE

EXPORT CONTROL

Since the country of origin of this product (the Czech Republic) is a valid participating member of the Wassennaar Agreement (http://www.wassenaar.org) and agrees with the Missile Technology Control Regime (http://www.mtcr.info) and the **piPATCH-MAX/FM (Space-grade Flight Model), piPATCH-MAX/EM (Engineering Model)** functional parameters are considered as a regulated (Dual Use) goods, the export is controlled and needs special Export License approved by the Ministry of Industry and Trade of the Czech Republic (the local control entity), if exported outside EU-member states territory. The request for the Export License has to be submitted by the manufacturer to the local control entity, based on the binding order, including all the information as: the characteristics of goods, target country (territory), detailed end-user and target application information, etc.

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DISCLAIMER

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Prague, Czech Republic