



Your easy way to space.

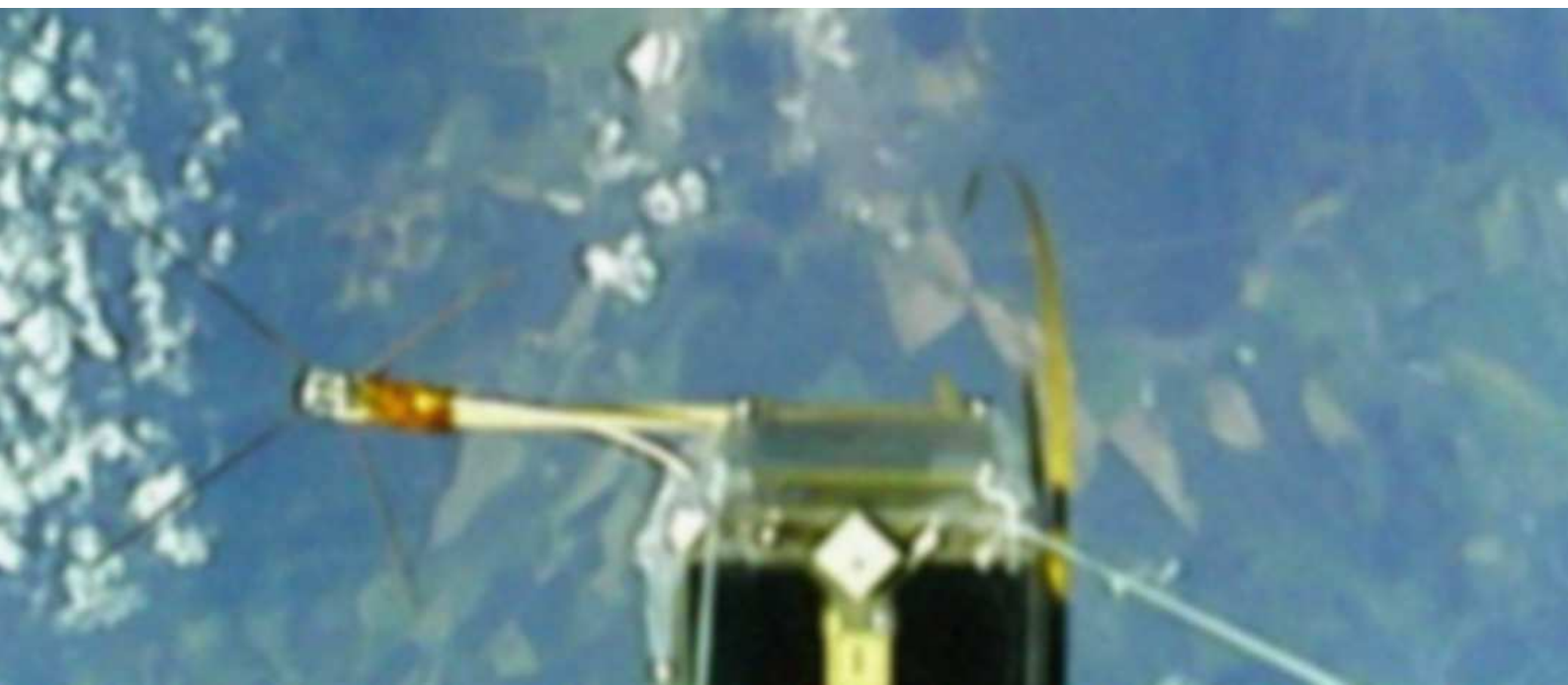


Space-Friendly™
PocketQube ADS-B Receiver
pqADSB-NG

Product Datasheet

Rev. A/2026

Intended to **track Aircrafts from Space.**



PRODUCT DATA SHEET

pqADSB-NG

FEATURES

- Realtime Aircraft Surveillance for Space Stations
- PocketQube ADS-B Receiver with No Deployables
- Fully functional Passive Radar for Aircraft tracking
- Automatic Dependent Surveillance – Broadcast (ADS-B) Receiver, Mode-S 1090ES
- Complete Receiver with Embedded Antenna
- 1090 MHz L-band Zero-IF receiver
- 112bit + 56bit Extended Squitters
- Downlink Format 11, 17 (DF11, DF17) output
- Highly Sensitive, Ultra Low Power, World's Lowest PocketQube Profile
- Up to 1600 km slant range (maximum)
- Squitter Counter for sanity check
- Embedded RHCP Patch Antenna system
- Intended to LEO up to h = 500+ km
- Squitter Filters, CRC calculation
- PocketQube standard Compatible
- Mega-Constellation Ready! product
- Easy-to-Implement Data Interface
UART 230400-8-N-1, 3V3-CMOS levels
- 2.7 to 3.6V Power supply
- Power consumption
260 mW (typical), 3.3 V @ 25°C
- Velocity
0 up to 9 km/s (Flight Model)
- Startup time less than 3 seconds (typical)
- Protocols
ASCII output (standard)
HEX or Binary (on request)
- Ultra Low Profile and Dimensions
Very compact 50×50×12.5 mm
- Wide temperature range
-40°C to +85°C
- Connectors
PicoBlade™ 6P connector
doubled (+, GND and TXD signal)
- Low mass 55 grams

APPLICATIONS

- Nonstop Aircraft tracking on Small Satellites
- Aircraft Search & Rescue (SAR) Node
- Air Traffic Control (ATC) Management
- Limited Power Budget Space Projects
- Stratospheric, Meteorological, Scientific Balloons
- PocketQube Missions, Tech Demo

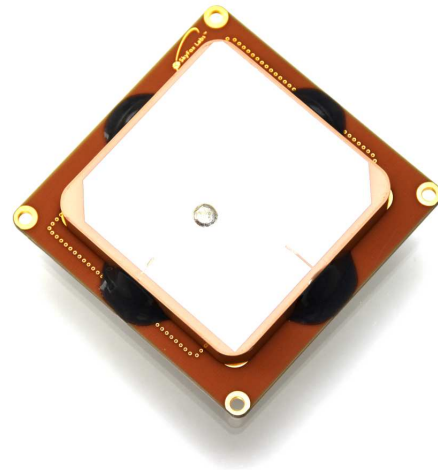


Fig. 1 Ultra Low Profile PocketQube ADS-B Receiver with embedded antenna, Flight Model.

GENERAL DESCRIPTION

The pqADSB-NG/Flight Model is the Next Generation of the World's First Space-Friendly™ Automatic Dependent Surveillance–Broadcast or ADS-B Extended Squitter, Mode-S Passive Radar Receiver System with No Deployables, Ultra Low Profile and Power requirements intended for PocketQubes. With integrated RHCP patch antenna the product is intended to track Aircrafts from satellites in Low Earth Orbit (LEO), High Altitude Balloons (HAB) or Unmanned Aerial Vehicles (UAVs) with limited power and mass budgets.

It requires only 10 % of power in comparison with conventional SDR-based space-grade ADS-B receivers allowing permanent data output.

Easy-to-use UART serial data interface output providing standardized ASCII sentences together with embedded ADS-B antenna provides a smart standalone solution for all kind of Space-grade or terrestrial projects where the precise Aircraft position, type, velocity, direction or ICAO/airliner information is required.

The unit is interfaced with power supply and data output using single six pin PicoBlade™ connector with double-redundant pins.

Very low mass and dimensions fits perfectly with all kind of space-demanding projects. The pqADSB-NG Evaluation Kit is available.

TABLE OF CONTENTS

APPLICATIONS.....	2	PROTOCOLS	6
GENERAL DESCRIPTION.....	2	OUTPUT DATA DESCRIPTION	6
TABLE OF CONTENTS	3	EVALUATION KIT	7
ABSOLUTE MAXIMUM RATINGS	3	ANTENNA	9
PARAMETRIC SPECIFICATION.....	3	APPLICATION NOTES & RECOMMENDATIONS.....	9
CONNECTORS DESCRIPTION	4	QUALITY ASSURANCE	10
FUNCTIONAL BLOCK DIAGRAM	4	EXPORT CONTROL.....	11
THEORY OF OPERATION.....	5	DISCLAIMER	12

ABSOLUTE MAXIMUM RATINGS

V_{DD} to GND.....	-0.3 V to +4.2 V	Other Pins to GND:.....	-0.3 V to +(V _{DD} +0.3) V
DC Input Voltage: V _I	-0.3 V to V _{DD} + 0.3 V (≤ 4.2 V max.)	Maximum RF Input Power:.....	+15 dBm
DC Output Voltage: V _O	-0.3 V to V _{DD} + 0.3 V (≤ 4.2 V max.)	Operating Temperature Range:.....	-40°C to +85°C
DC Input Current: I _I at V _I < 0 V or V _I > V _{DD}	±20 mA	Storage Temperature Range:.....	-45°C to +105°C
DC Output Current: I _O at V _O < 0 V or V _O > V _{DD}	±20 mA		

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.

PARAMETRIC SPECIFICATION

T_A = -40°C to +85°C, V_{DD} = 3.3 V, Integrated RHCP patch antenna used, unless otherwise noted.

Parameter	Symbol	Min	Typ	Max	Units	Notes/Conditions
Operating Supply Voltage	V _{DD}	2.7	3.3	3.6	V	
Operating Supply Current	I _D		78		mA	Continuous DC current consumption during nominal operations.
Operating Power Consumption	P _{Operation}		260		mW	
Operating Frequency	f _{RFIN}		1090		MHz	1090ES, L-band
RF Bandwidth	BW		15		MHz	-3dB
Operating Velocity	V	0		9	km/s	
Time-to-First-Frame	t _{TTF}			3	s	The pqADSB-NG Start-up time.
RF Sensitivity	P _{IN}	-104	-105	-106	dB	BER 10 ⁻⁴
Dynamic range	DR		20	30	dB	-76 to -86 dBm maximum input power
Slant Range	d		800	1600	km	Depending on the ADS-B Out transponder output power/aircraft antenna radiation pattern.
Output Data Framerate	FR	1		~75000	fpm	Frame rate given by DF11, DF17 frames filtering and provided at 1.25 Mbps output bitrate per minute. Frame rate is limited by amount of Downlink Format frames selected and output bitrates and was measured with periodical frame transmission generator, at 1.25 Mbps output data rate. Minimum frame rate is 1 fpm telemetry frame, if no aircraft transponder is received.
Output Data Bitrate	BR		230400	1250000	bps	Bitrate settings are uploaded and fixed during manufacturing process. No post-manufacturing settings possible.
Output Frame Data Quality	DQ		99.999	100	%	As a standard, only CRC-checked Downlink Format 11 and 17 frames are provided. Most civil airliners uses ADS-B 1090ES frames to broadcast the most useful and detailed data in this frame type. 100% of all output data frames are valid, based on internal software-defined Cyclic redundancy check.

CONNECTORS DESCRIPTION

The pqADSB-NG/FM receiver is connected to the target system via standardized MOLEX 6 pin connector. Each pin, its function and direction or manner of use is indicated in the Tab.: 1 below. The connector location within the Flight Model is displayed in Fig. 2.

Tab.: 1 **The pqADSB-NG/Flight Model Pin Description**, NOTE: Minimum required interface pins are highlighted.

Pin	Name	Input, Output, Power	Description
1	VDD	Power	Positive system power input. Positive power supply input, connect to +3.3 V with respect to GND system ground pins.
2			
3	TXD	Output	ADS-B Receiver serial data output. ASCII sentences are present on this pin. Data is provided by standard UART serial transfer at a rate of 230400 bps (up to 1.25 Mbit), no parity, 8 data bits, 1 stop bit. LVCMOS compatible signaling.
4			
5	GND	Power	System ground. Must be connected to ground potential. This pin may be internally connected to standoff pads. Solder GND-1, GND-2, GND-3 or GND-4 to connect ground potential to chassis pads.
6			

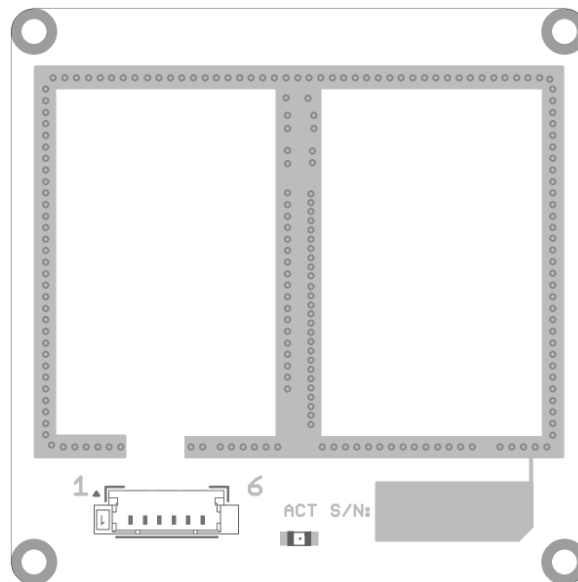


Fig. 2 **The pqADSB-NG/FM Connector pinout and LED location**. NOTE: The pqADSB-NG/FM is displayed from the BOTTOM side. The SMD mount connector type is MOLEX 53398-0671 with 1.25mm pitch. Detailed dimensions drawing is available online as STEP model.

FUNCTIONAL BLOCK DIAGRAM

The key functional blocks of the pqADSB-NG/FM are described in Fig. 3. The system consists of the high gain Patch antenna, Low Noise Amplifier (LNA), SAW Filter, Down Converter to Zero-IF and High speed baseband data processing core. The design of the front-end guarantees excellent noise figure and ensure high suppression of the out of band signals. The frame decoder, downlink format filter, CRC calculation and serialization is performed in high speed digital core. Output ASCII sentences are provided via UART interface. The pqADSB-NG/FM receiver is realized on 6-layers PCB including two power planes to maximally suppress the noise of analogue and digital circuits and protect the receiver circuits against interference from the other electronics (EMC susceptibility). Frame transmission indication LED is used for quick check of the receiver's activity. DC discharge attenuation and ESD protection is applied on the RF connector input.

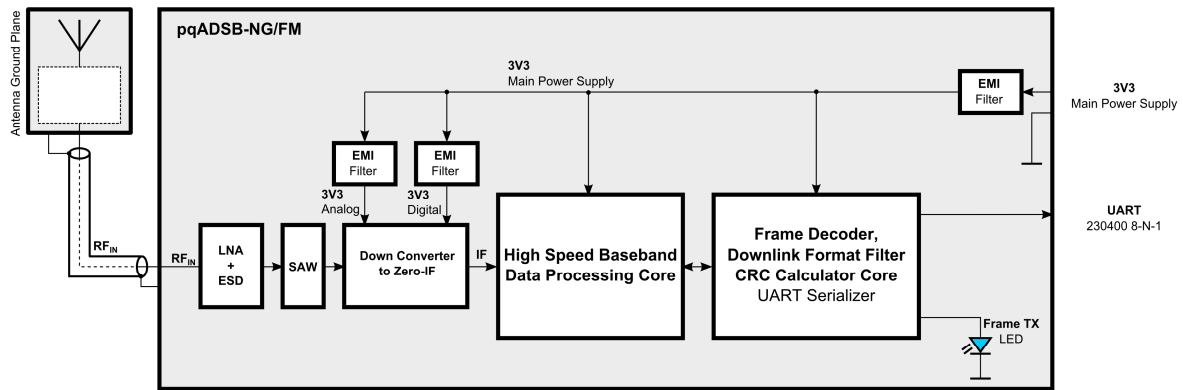


Fig. 3 The pqADSB-NG Receiver Block Diagram.

THEORY OF OPERATION

The pqADSB-NG/FM unit is the standalone single channel zero-IF receiver processing freely available frame transmissions of the Aircrafts' Mode-S Automatic Dependent Surveillance–Broadcast or ADS-B Extended Squitter, Mode-S Passive Radar working on 1090 MHz frequency band. Signals are broadcasted by flying or fly-ready aircraft transponders upon terrestrial Air Traffic Control (ATC) interrogations broadcasted at 1030 MHz. Concurrent in-flight transponders interrogations occurs also by line-of-sight airplanes in the air.

Data processing core and RF signal chain supports 1090ES transport protocol only. Interrogation reception on 1030 MHz or 978 MHz Universal Access Transceiver (UAT) transport protocol are not implemented.

Aircraft Flight Management System (FMS) produces data which are then stored in Binary Data Store or so-called BDS registers. This aircraft's digital memory space is updated according to actual in-flight values as a database source for Mode-S interrogation replies. Moreover a total of 56 and 112 bits long Mode-S Extended Squitter frames transmitted at a rate of 1 Mbps contains cyclic redundant check (CRC) bytes to help control the correctness of transmitted data on receiver side.

High frequency L-band RF signal from the passive antenna is fed through the Low Noise Amplifier with ultra low Noise Figure and ESD protection blocking the DC bias and possible antenna plasma charging in space. Signal is then filtered out to clean out-of-band signals using SAW filter with as low as 2 dB passband attenuation. Downconversion to zero-IF band is then performed to feed the high speed data processing core. The frame header pattern is continuously searched in digitized input signal. In case the frame initial header is correctly found in the signal, the record of following 56 and 112 bits long datagram is extracted using SkyFox Labs' developed demodulator and decoder. Zero-IF conversion together with software-defined decoder allows the receiver to perform the whole reception task using ultra low power requirement only.

On top of signal recordings the Downlink Format or data type filtering is performed and in case of Downlink Format 11 and 17, the CRC is calculated. If the calculated CRC matches the received CRC data, the serialized data output is provided on output TX pin. During the processed datagram transmission the associated SMD LED is On to indicate the receiver performance. Ultra low power LED requirement and short duty cycle allows user to remain the LED soldered even for flight conditions with negligible impact on power requirements.

The pqADSB-NG receiver software-defined demodulator and data processing core allows to perform also other Downlink Format reception processing and output. However, in most cases Downlink Format 11 and 17 frames provided by civil aircrafts' broadcasts contains the most useful and most detailed data such as position, ICAO callsign, velocity, heading, etc. From this point of view, the DF11 and DF17 filter has been implemented as fixed providing CRC-checked datagrams.

The same frequency band (1090 MHz) is also shared with the Traffic Collision Avoidance System (TCAS), by different frequency channel spacing also due to the Distance Measuring Equipment (DME) system interrogations. Furthermore, more aircraft transponders may share the same band at a time by nature of timing-uncoordinated media access transmissions. Several transponders in the range are also broadcasting different types of frames. Certain amount of packet loss rate is thus always expected. Including the CRC filtering, the frame rate of DF11 and DF17 pqADSB-NG/FM output data is therefore in order of 4000 sentences per minute in a typical open space (yet terrestrial) environment.

PROTOCOLS

The physical communication is realized via the standard UART data interface. The baud rate is set to 230400 (up to 1.25M) bps, no parity, 8 data bits, 1 stop bit. Logical levels are equal to LVCMOS (3.3V) levels as defined in JEDEC JESD8C.01 standard.

Baudrate is defined during the manufacturing process and cannot be changed later on. The recommended 230400 bps bitrate is a well tested compromise between the receiver lock-out time needed to process the data transfer and slow enough to not overload upper level system with too much interrupt requests caused by UART data reception.

OUTPUT DATA DESCRIPTION

Data is provided in ASCII representation of HEX characters. Thus for example one received byte from air radio traffic represented by binary set (0b00111100), which means 60d (Decadic) and 0x3C in Hexadecimal representation is provided as two bytes - ASCII letter "3" followed by ASCII letter "C". This is to make the data reception easily readable using standard serial terminal in PC. Fully binary data output would cause non-printable characters to be shown on serial terminal (like Hyperterminal, etc.) However, fully binary data output is two times shorter than ASCII representation.

NOTE: Firmware modification to provide only BINARY data is possible to perform on request during manufacturing process. To make the use of the unit as much simple as possible, no settings is needed and also is not possible (no RXD pin on the Main Interface Connector). Customer shall decide which format requires in advance.

A) ASCII Output - STANDARD:

As a standard, the pqADSB-NG unit is delivered with firmware providing 56 bit and 112 bit long 1090ES sentences of Downlink Format 11 and 17, which means the datagram contains 14 and 28 bytes of ASCII data with 1 byte prefix and 3 bytes suffix. Total of 1+14+3 = **18 bytes** or 1+28+3 = **32 bytes**, respectively are provided, with fixed length.

B) BINARY Output - ON REQUEST ONLY:

*In case the Binary output is selected during the order process, the prefix and suffix characters remains the same, to keep good orientation in data stream. However, internal datagram is shorter, only 7 or 14 bytes. Total of 1+7+3 = **11 bytes** or 1 + 14 + 3 = **18 bytes**, respectively are provided, with fixed length.*

Each datagram is initiated with the character "*" (star) prefix and ended with semicolon ";" and **CR + LF** (0x13h + 0x10h) suffix string.

There are four different types of datagrams provided by the pqADSB-NG in the output serial data stream:

1) The Initial Sentence available after power up or automatic reset (via watchdog within the radiation environment) is still the same and distinguishing between the Engineering and Flight Model firmware as highlighted below (0xAF for PocketQube Flight Model):

pqADSB-NG INITIAL SENTENCE (Flight Model)

```
*AF00112233445566778899AABBCC;
```

2) During nominal operations, the 56 bit squitter sentence is provided in following form,

pqADSB-NG 56bit Squitter OUTPUT SENTENCE Example

```
*5DA2A3D2010CDA;
```

3) and the 112 bit squitter sentence in following form:

pqADSB-NG 112bit Squitter OUTPUT SENTENCE Example

```
*8D3C54659909C8173004A132B0C5;
```

There are several freely available online resources describing how to parse the output data into dedicated BDS register's information. It is out of scope of this document to provide detailed squitter content and parsing procedures.

However, for **Search and Rescue (SAR) applications**, the most valuable content is stored on byte positions shown in underlined **bold** below. Each received sentence provided by the pqADSB-NG represents published unique Mode - S Aircraft ICAO Registration Code. From the example above is thus the ICAO code as following:

*8D**3C5465**9909C8173004A132B0C5;

☞ Identified Aircraft ICAO Code is: **3C5465**

There is much more information provided about the aircraft flight parameters such as Aircraft Velocity, Altitude, Heading, GPS position, etc. in pqADSB-NG data output, DF11 and DF17. Above is listed only one example showing how to easily interpret the data.

4) For a backward compatibility with the piADSB-NG unit intended for CubeSats, allowing larger electronics to accurately measure input bus voltage and input current, the pqADSB-NG does not measure these values, but keep them filled as fixed (3.30V, 78 mA, +21°C). However, the Received Squitter counter is fully supported and shown actual. If the counter reaches 9999999 frames, the value is reset down to 00000000.

piADSB-NG Telemetry OUTPUT SENTENCE Example (Packet Counter Valid Only!)

#3.30V,078mA,+21°C,00004187;

EVALUATION KIT

To connect the pqADSB-NG with a conventional PC during satellite development, the Evaluation Kit is provided to serve as a power supply from the USB bus via voltage regulator (3.3V), ESD protection and EMI filters. The PCB contains signal test pins for oscilloscope probe hooks, current sensing/power cycling jumper (3.3V Main Power) and a set of indicating LEDs. A **Starboard Side (Right wing) green LED** indicates the available power. It is lit up once the input power is available (regardless the ADS-B 3.3V Main Power jumper status). **Port Side (Left wing) red LED** is active during the data transmission FROM the pqADSB-NG towards the PC/satellite/terminal, the idle status is indicated as OFF (no light).

A front side yellow LED is indicating the transmission of data TO the pqADSB-NG from the PC/satellite/terminal. Not connected on pqADSB-NG, intended for future use.

The layout of the Evaluation Kit PCB is depicted in Fig. 4. The associated USB-to-Serial FTDI cable can connect and power the unit from the USB. A simple communication with PC App is realized via Virtual COM Port (VCP).

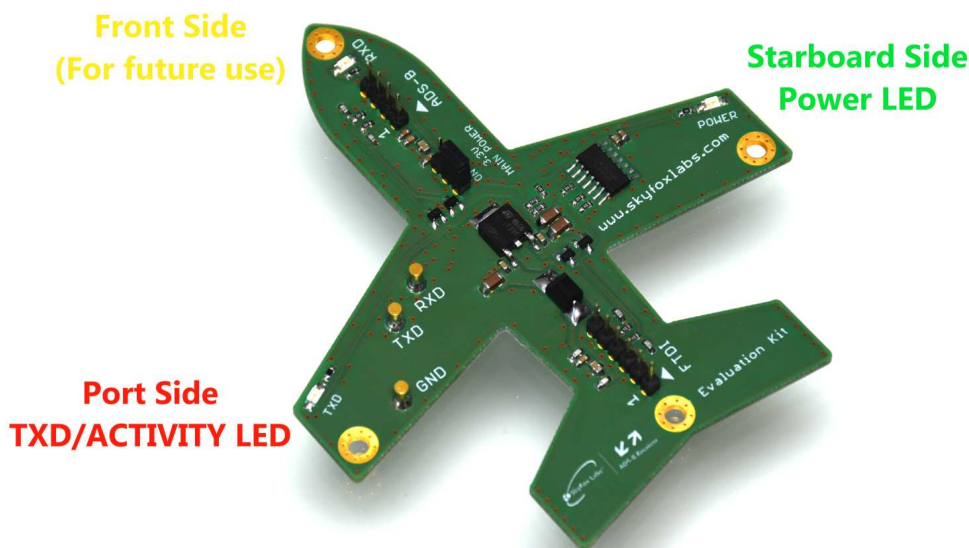


Fig. 4 The pqADSB-NG Evaluation Kit.

ANTENNA

The pqADSB-NG/FM receiver system is equipped with high gain RHCP ceramic patch antenna with benefit to neglect vertical/horizontal polarization losses in orbit operations. The pqADSB-NG embedded antenna uses the PocketQube Conductive structure as an extension of the basic 50×50 mm groundplane. A proper DC+AC coupling between the PocketQube structure and the pqADSB-NG ground potential and mounting holes must be provided to keep the antenna performance working nominally. An example of the antenna mount on the Z- part of the 3p PocketQube structure is depicted in Fig. 7. To achieve fully symmetrical radiation pattern the opposite-to-slider panel mount is recommended. Conductive elements, parts or other obstacles elevated above the pqADSB-NG ceramic antenna groundplane and in its close proximity might decrease the overall system performance.

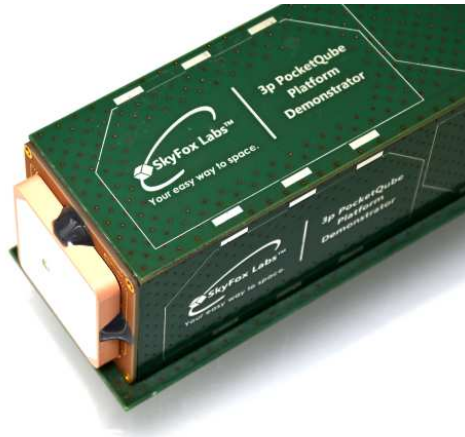


Fig. 7 Optimized pqADSB-NG/FM Antenna mount.

As aircrafts typically uses vertically polarized monopole antenna, their radiation pattern minimizes the power transmitted directly from Aircraft to Zenith. From this reason, it is recommended to keep the pqADSB-NG antenna facing slightly off the Nadir (downstream) with suitable ADCS (Attitude Determination and Control Subsystem) during orbital operations. In-flight aircraft's Angle-of-Attack (AoA) helps to increase the off-Zenith (upstream) transmitter radiation pattern angle and thus increases the datagram reception probability.

Recommended range of deviation angles-of-Nadir allowing the pqADSB-NG to track data is presented for two LEO altitude is in the range of ~20°-70°.

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 ADS-B receiver input with harmonic frequencies falling to the 1090 MHz L-band.

Observe the maximum distance logged over 1 hour of daylight operations and compare it with switched On/Off electronic subsystem to identify the potential source of the disturbance if needed, unless the ADS-B Signal Generator is used to validate the sensitivity once the complete spacecraft is up and running.

QUALITY ASSURANCE

GENERAL INFORMATION

Since the pqADSB-NG/FM receiver has been designed for the operation in harsh space environment as a specially featured electronic device based on Commercial Off-the-Shelf (COTS) components, the special care is taken to follow the standardized space-grade product assembly procedures, materials and components where possible (i.e. no Radiation Hardened integrated circuit are used).

MATERIALS

Components are soldered on the Space-grade 4-layers FR-4 PCB, using 60/40% (Tin/Lead) compound. Special flux is used for precise soldering of the integrated circuits for its excellent soft soldering quality properties, complying with the RoHS 2002/95/EC directive. No PCB conformal coating is used on products to minimize the outgassing. The NASA approved 3M Scotch Weld Epoxy is used for critical component fixings.

Vacuum-proof electronic components from ESA and NASA-preferred space-grade vendors are used (i.e. no electrolytic capacitors) in industrial or military temperature grade, where possible.

PACKAGING & SHIPPING

Once the pqADSB-NG/FM successfully passes the production screening test, it is finally cleaned, optically inspected and shipped encapsulated in ESD protective packaging.

EXPORT CONTROL

Since the country of origin of this product (the Czech Republic) is a valid participating member of the Wassenaar Agreement (<http://www.wassenaar.org>) and agrees with the Missile Technology Control Regime (<http://www.mtr.info>) and the **pqADSB-NG/FM (Space-grade Flight 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). 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.

DISCLAIMER

THIS DEVICE HAS BEEN DEVELOPED WITH IDEA TO SUPPORT THE SMALL SATELLITE COMMUNITY EFFORT IN SPACE RELATED RESEARCH, ENGINEERING AND PEACEFUL CONQUEST OF SPACE. THE MANUFACTURER RESERVES ALL RIGHTS TO DECLINE THE ORDER OF THIS PRODUCT OR PROVIDE ANY FURTHER INFORMATION TO END USERS ASSUMING TO VIOLATE ANY LOCAL OR GLOBAL NATIONAL LAWS BY THIS DEVICE OR INFORMATION MENTIONED IN THIS AND RELATED DOCUMENTS. MANUFACTURER DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF THIS PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS. MANUFACTURER RESERVES THE RIGHT TO MAKE CHANGES OF THIS PRODUCT DATASHEET WITHOUT FURTHER NOTICE. THE UNIT MUST NOT BE USED IN ANY SAFETY-CRITICAL APPLICATION, OR MILITARY-RELATED, OR BY ARMED FORCES, OR BY POLICE GUARDS, OR IN NUCLEAR FACILITIES, OR IN RELATION TO OIL AND GAS MINING, ON LAUNCHERS, MISSILES, TARGET DRONES, WEAPONS OF MASS DESTRUCTION, OR GOVERNMENTAL END USE OR END USER. SAFETY-CRITICAL SYSTEMS ARE THOSE SYSTEMS WHOSE FAILURE COULD RESULT IN LOSS OF LIFE, SIGNIFICANT PROPERTY DAMAGE OR DAMAGE TO THE ENVIRONMENT. THE LIST CONTAINS MOST IMPORTANT AREAS OF PROHIBITED USE AND IS NOT COMPLETE. FOR MORE DETAILS, PLEASE CONTACT FACTORY.



Prague, Czech Republic

© 2014-2026 SkyFox Labs, All rights reserved.