



# AIR Traffic

## Pilot's Manual

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Please read this manual carefully before using the device.

Observe limitations and safety instructions.

This manual is an essential portion of the device and must be kept in a safe place.

## Articles Covered

This manual covers the following articles:

- AT-1 "AIR Traffic".

## Revision History

<i>Rev.</i>	<i>Date</i>	<i>Status</i>	<i>Author</i>	<i>Changes</i>	<i>Approved</i>
1.0	2018/08/29	Release	M. Förderer	Initial release	H. Hoeth
2.0	2018/10/25	Release	M. Förderer	Second release, various functions added	–
2.1	2018/12/21	Release	M. Förderer	Added details regarding ARINC429 behavior while not moving	–
3.0	2019/05/20	Release	M. Förderer	Added information regarding the latest software version 5	–
4.0	2020/01/09	Release	M. Förderer	Added information regarding the latest software versions 7 and 8	–
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4.5	2022/12/05	Release	M. Förderer	Added information regarding the latest software versions 17/23.	–
4.6	2023/03/16	Release	M. Förderer	Added Error Code Information	–
5.0	2023/03/16	Release	M. Förderer	Added Information regarding software updates	–

## Product Support

If you have questions, our product support team will be happy to help you. Contact us via [support@air-avionics.com](mailto:support@air-avionics.com) or by phone. Please find details about our hotlines and availability online at <https://www.air-avionics.com>

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## 1.1 Introduction

The AIR Traffic (AT-1) by AIR Avionics is a traffic/electronic conspicuity system based on 1090 MHz receiving and FLARM transceiving technology.

AT-1 uses 1090 MHz Mode-S transponder replies<sup>1</sup>, 1090 MHz ADS-B broadcasts, and FLARM broadcasts to determine positions, flight vectors, and threat levels of other air traffic. AT-1 broadcasts the own ship's GPS position via FLARM to other FLARM equipped aircraft or ground stations.

Additionally AT-1 covers other functions such as obstacle warnings, alert zone warnings, and flight trajectory logging.

AT-1 is installed remotely. It interfaces to many avionics systems via a wide range of standardized wire-connected and wireless interfaces. These avionics systems (e.g. cockpit displays of traffic information, electronic flight information systems, or handheld navigators) display the information AT-1 provides.

As to date, there are no minimum performance specifications or technical standard orders for such traffic systems, AT-1 is not certified against an ETSO or TSO standard. Nevertheless, it is developed in accordance with aviation standards and meets aviation performance specifications. It can be installed into many aircraft using Supplementary Type Certificates (STC), Minor Change Approvals (MCA), or Standard Change Approvals under CS-STAN.

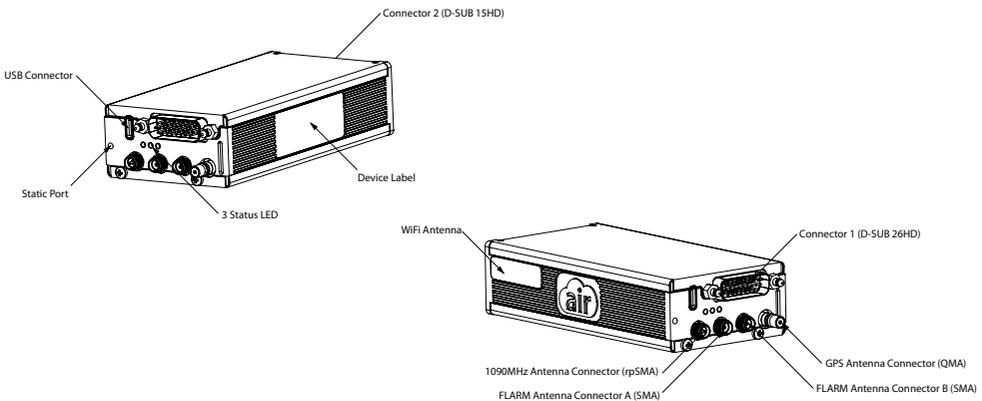


Figure 1.1.: AT-1 hardware overview

<sup>1</sup>AT-1 does not actively interrogate transponders

## 1.2 Safety Instructions and Limitations

### 1.2.1 Safety

AT-1 shall never distract from general practices of safe airmanship. Using AT-1 may impose significant workload on the flight crew if not adequately familiar with AT-1 and trained on its use. In order to use AT-1 effectively, familiarization with the unit's capabilities, limitations, and mode of operation is essential.

We recommend a thorough study of this manual and extensive familiarization on the ground.

Do not fly with AT-1 if you are unfamiliar with its use and limitations

Installations in which AT-1 devices are used may be complex. Familiarization of specific installation conditions in an aircraft, for example the number, type, and configuration of connected systems is essential before using AT-1.

AT-1 installations require several forms such as checkout forms and configuration logs to be filled out by installation personnel. These documents are stored in the aircraft's documentation and are a viable resource for pilots who wish to study installation specifics of an AT-1 in an aircraft.

### 1.2.2 Regulatory Requirements

It is the responsibility of those installing and using this article to determine that the installation and working conditions are within required standards.

### 1.2.3 Screen Shots

All screen shots used in this document are current at the time of publication.

Screen shots are intended to provide visual reference only. All information depicted in screen shots, including software file names, versions, and part numbers, is subject to change and may not be up to date.

### 1.2.4 Function Licensing and Software Expiry

Some software features such as FLARM functionality or obstacle databases have expiration dates and may become unavailable as they expire. Validity is checked regularly. After the FLARM software has expired, major functions become unusable until the software is updated.

Ensure that the installed software version is always valid and up to date. Failure to update the unit regularly will result in reduced functionality and system failures!

### 1.2.5 Liability

IN NO EVENT WILL AIR AVIONICS BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER RESULTING FROM THE USE, MISUSE OR INABILITY TO USE THE PRODUCT OR FROM DEFECTS IN THE PRODUCT.

### 1.2.6 Limitations

AT-1 is subject to various limitations.

AT-1 does not protect the aircraft from collisions with other air traffic or obstacles. It only serves as an aid to the flight crew and intends to help recognizing threats and thus increasing situational awareness.

AT-1 is not capable of detecting the entire air traffic and all obstacles that may obstruct the aircraft's flight path. Only a fraction of the air traffic and a fraction of obstacles in some areas of the world can be detected.

AT-1 does not work all the time. Certain requirements need to be met for AT-1 to work properly. Examples are up-to-date software or the correct installation of AT-1, its antennas, and connected systems.

Errors and failures in the device may occur. It is possible that AT-1 fails during operation. It is possible that AT-1 shows misleading and/or wrong information to connected cockpit systems and/or to other aircraft. Never absolutely rely on data given by AT-1.

Do not make safety critical decisions based on data from AT-1 alone.

## 1.3 Switching On and Off

### 1.3.1 Power On

Depending on its installation, AT-1 either switches on automatically if sufficient supply power is present, or is switched on by a connected system, such as a compatible cockpit display of traffic information.

AT-1 requires at least 9V DC to switch on. Booting AT-1 normally takes less than one minute. Please note that depending on the unit's installation and connected systems it may take longer than one minute until full functionality is available.

### 1.3.2 Power Off

AT-1 is either powered off by a connected system, or by taking away supply power. AT-1 can always be safely switched off by taking away supply power.

# 2

## General Theory of Operation

### 2.1 ADS-B In

The AT-1 ADS-B In capability allows it to receive traffic data through a built in 1090 MHz Extended Squitter (1090 ES) receiver.

Automatic Dependent Surveillance - Broadcast (ADS-B) is the automatic broadcast of position reports by aircraft, surface vehicles, and transmitters on fixed objects. These broadcasts contain much more data than just a simple position report, they include: identity (Flight ID/Tail Number, ICAO registration number, etc), ground track, ground speed, pressure altitude, indications of equipment capabilities, and emergency status.

AT-1 processes all received ADS-B messages, also those from equipment with no source integrity or design assurance levels (SIL=0, SDA=0). Therefore, it is also processing information from ADS-B transmitters with non-certified GPS data sources.

### 2.2 Replies by 1090 MHz Mode-S Transponders

AT-1 receives and processes replies sent by Mode-S transponders on the 1090 MHz transponder frequency band.

As AT-1 does not actively interrogate transponders, it is unable to trigger transponder replies itself. Transponders have to be interrogated by radar stations or active traffic systems in order to transmit such replies that the AT-1 can receive. Additionally, the received replies must contain altitude reports in order to be processed by AT-1. Transponder replies without encoded altitude levels are not processed.

Mode-S transponder replies do not contain position reports. Therefore, AT-1 is not capable of determining the exact position of the replying target. It estimates the target's distance using the field strength of the received signal. These estimations have very limited precision. Moreover AT-1 determines the target's precise level and vertical rate by using the altitude encoded into the transponder reply. Vertical separation is determined using barometric data from the integrated barometric sensor in the AT-1.

Targets detected using this method are commonly referred to as "bearingless targets", as their relative bearing is unknown.

The relative bearing (direction) of targets solely detected via Mode-S transponder replies is unknown and can not be shown to the flight crew.

Mode-A and Mode-C transponder replies are not processed.

While AT-1 can process multiple bearingless targets, most cockpit displays only show the single most relevant bearingless target to the flight crew in order to minimize confusion

and user interface clutter. Some cockpit displays only show information about the most relevant bearingless target if a collision threat is detected and a warning is given to the flight crew. Some display systems only display bearingless targets as a numerical value, for example: *5 miles / +500ft*.

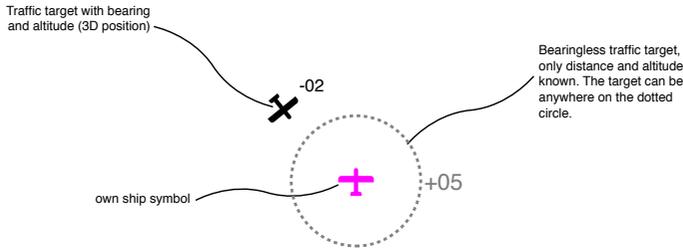


Figure 2.1.: Illustration of a traffic target shown in a 3D position and a bearingless traffic target.

## 2.3 FLARM

Based on GPS and a pressure sensor, FLARM predicts the short-term future flight path and continuously broadcasts this to nearby aircraft by means of a digital radio message. FLARM systems in nearby aircraft receive the radio message and return a similar message with the same set of data.

FLARM data is sent by aircraft, surface vehicles, or fixed obstacles. FLARM broadcasts contain GPS data, identity, altitude, and several status flags.

Practical experience shows that ADS-B does not provide sufficiently precise data to warn about aircraft conducting aerial work or glider traffic with its frequent altitude changes and steep turns. To ensure high alert quality, AT-1 does not use ADS-B data to compute alerts for targets which also broadcast FLARM data. Instead, it will exclusively rely on the target's more precise FLARM data.

## 2.4 GPS

AT-1 detects the own ship's 3D position using GPS. The GPS receiver used in AT-1 is an industry standard COTS GPS receiver. While the GPS receiver delivers high accuracy, low power consumption, and quick start times, the position integrity is unknown to AT-1. Please be aware that misleading information failure modes are possible. This means that the GPS position used may be wrong or of low accuracy without notice to the flight crew.

## 2.5 Collision Warnings

### 2.5.1 Normal Collision Warnings

AT-1 is able to calculate conflicting flight patterns and to issue collision warnings. AT-1 warns about obstacles on the ground (cables, masts, etc.) if a current obstacle database is installed.

Collision warnings are issued depending on the time remaining to a potential collision (time to impact), not the geometric distance between aircraft. Warnings are selective, that means they are only issued if the calculation detects a high probability of a collision.

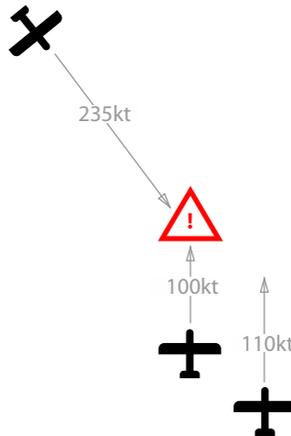


Figure 2.2.: Example of a conflicting traffic situation. Two closely flying aircraft do not cause a collision warning from each other, as their trajectories are not estimated to produce a conflict. The trajectory of a third aircraft, that is farther away, however, will be conflicting, therefore a collision warning is issued.

Warnings are issued with different threat levels depending on their severity. In traffic displays and the audio output, different threat levels are reproduced differently in order to inform the flight crew about the threat level and urgency of the warning.

1. The first warning is typically issued between 19 and 25 seconds before the calculated potential collision with an aircraft or an obstacle (time to impact).
2. The second warning is issued 14 to 18 seconds in advance.
3. The third warning 6 to 8 seconds in advance.

Warnings are sustained as long as the threat remains. Depending on changes in the prediction, the threat level is downgraded or the warning is ceased entirely.

## 2.5.2 Protection Volumes

In addition to calculated threat levels, several “protection volumes” can be defined in the system configuration of the AT-1. Up to four different volumes can be configured, each of which has different priorities.

If a target enters a protection volume, a predefined threat level is assigned to this target, independent from its calculated threat level and, therefore, also independent from the estimated time to impact. Protection volume horizontal and vertical sizes as well as their threat levels can be selected freely by the installer.

In the default setup, only one protection volume is configured in a rather small size. We strongly recommend this setting as the calculated traffic warnings based on flight patterns are way better for almost any standard application. Multiple protection volumes are only used in very special applications like towing banners/drones/probes or in helicopters who regularly perform winching operations.

Depending on the protection volume setup, AT-1 may stop working entirely, stop to provide collision warnings, or issue nuisance alarms. Do never change the respective configuration parameters unless you know exactly what you are doing and why.

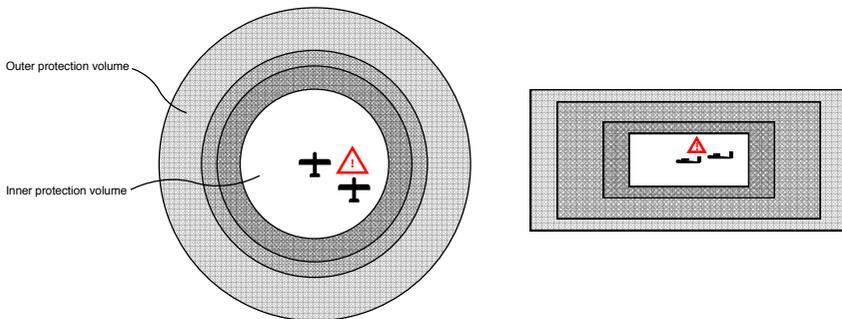


Figure 2.3.: Example of a setup with four protection volumes. A threat level is assigned to the target inside of protection volume 1 (white background) although it would not receive a threat level based on its flight pattern (no collision course).

# 3

## Displaying Traffic Information

At least one cockpit system displaying traffic is required. AT-1 allows to connect multiple traffic displays simultaneously.

Traffic displays typically show a two-dimensional (top-down) view of traffic that is detected by the AT-1 system. Target position, bearing, distance, relative altitude, and vertical trend can be depicted on the traffic display, depending on type of display and target data availability.

### 3.1 Dedicated Cockpit Displays of Traffic Information

AT-1 is compatible to a broad range of dedicated cockpit displays of traffic information (CDTI).

Depending on the type and capabilities of the used CDTI, not all functions of AT-1 may be supported. Please refer to the CDTI's documentation for details.

While many navigation systems or electronic flight information systems display traffic information and warnings, it is recommended to use at least one dedicated CDTI. Experience and human factors research have shown that using a dedicated CDTI improves the traffic situational awareness of the flight crew compared to integrated multi-function systems alone.

AT-1 has been designed to work with the AIR Avionics AIR Traffic Display line of products (ATD-XX). AIR Traffic Displays offer comprehensive functionality and amongst others are capable of configuring the system configuration parameters of the AT-1.



Figure 3.1.: The AIR Traffic Display product family as an example for cockpit displays of traffic information (CDTI).

The data interfaces from the AT-1 to the CDTI are configured during the installation process. For detailed information on available interfaces, compatible CDTI systems, and their configuration, please consult the AT-1 Installation Manual [1].

## 3.2 Navigation and Electronic Flight Information Systems

AT-1 is compatible to most navigation systems (portable and panel mount) and electronic flight information systems (EFIS).

Depending on the type and capabilities of the used EFIS, not all functions of AT-1 may be supported. Please refer to the EFIS documentation for details. Some EFIS systems do not support AT-1 status display. If only using an EFIS system to display traffic, please ensure AT-1 operates correctly, for example by monitoring the unit's status LED.

Some EFIS systems are not capable of displaying bearingless targets at all, some are not capable of displaying other targets while a bearingless target is displayed.

The data interfaces from the AT-1 to the EFIS system are configured during the installation process. For detailed information on available interfaces, compatible EFIS, and their configuration, please consult the AT-1 Installation Manual [1].

### 3.2.1 Special behavior of EFIS systems requiring an aircraft heading to show traffic targets

Some EFIS systems and some data interfaces require a current heading to be transmitted by the AT-1 to display traffic targets. This especially applies to all EFIS systems that use the ARINC429 data interface like, for example, GARMIN GTN or GNS.

Without a movement of the own aircraft, the AT-1 is unable to determine the own aircraft's current heading.

Therefore, while sitting on the ground or while hovering with groundspeed zero, only the closest traffic target is shown. This target is shown as a bearingless target (distance and vertical separation only, no bearing).

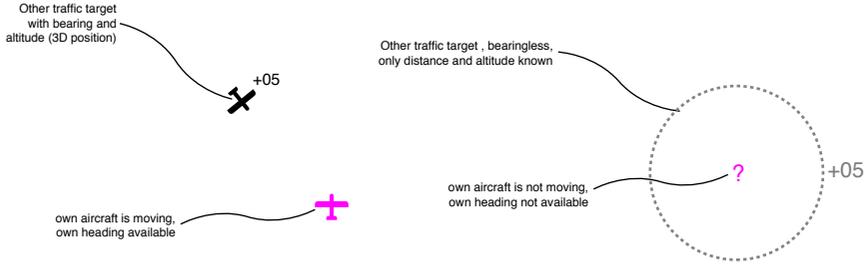


Figure 3.2.: Left: A traffic target is shown as a 3D position when aircraft movement is present and, therefore, the own aircraft heading is known. Right: Aircraft does not move, the own aircraft heading is unknown, therefore, a traffic target is shown as a bearingless target (distance and altitude only). Some EFIS systems only display bearingless targets as a numerical value, for example: *5 miles / +500ft*.

Depending on the AT-1 system configuration, the output of traffic target data can be suppressed without movement. In this case, if no traffic data is transmitted over the ARINC429 interface the traffic interface status "STANDBY" is shown on the EFIS system.

### 3.3 Wireless Connectivity to Tablets and Smartphones

AT-1 has an integrated WiFi Interface. This interface allows the direct connection of devices with WiFi capabilities such as personal computers, smartphones or tablets (in this manual, these are referred to as "personal devices").

The AT-1 can be configured over the AT-1 configuration webpage via WiFi. For details, please consult the AT-1 Installation Manual [1].

AT-1 offers an in-flight WiFi data connection that is compatible with a wide range of aviation apps and allows these apps to display traffic data from the AT-1. In addition to traffic information and warnings, AT-1 also shares the current GPS position and the accurate barometric altitude with connected apps.

#### 3.3.1 List of Tested Apps

The following Apps have been tested and are considered compatible with AT-1. Other Apps may be compatible as well. If you are using an app not covered in the list below, please consult the app manufacturer for details on compatibility.

<i>App</i>	<i>Make</i>	<i>Remarks</i>
iGlide/iPilot	AIR Avionics	–
SkyDemon	SkyDemon	–
AirNav Pro	XAMPLE	–
Runways HD	AIRBOX	–
SkyMap	SkyMap	–
FlyMap	Stauff	–
EasyVFR	PocketFMS	–
Foreflight	FOREFLIGHT	Please select the GDL90 data protocol
Enroute Flight Navigation	Akaflieg Freiburg	–

### 3.3.2 Establishing a Connection

In order to establish a wireless network connection with the AT-1, please follow these steps:

1. Open the WiFi configuration page in your personal device. Normally you can find this page in the settings/system preferences app of your personal device.
2. Select the AIR Traffic WiFi network and establish a connection. The network name/SSID will be “AIR-Traffic-” followed by the last two digits of the serial number of the AT-1.
3. Enter the network password. The password is the full serial number as printed below the bar code on the sticker on the device, for example *AT1-00003*.

If establishing a connection is not possible, please ensure the WiFi interface in AT-1 has been activated during installation. Depending on its setup, the WiFi interface might only work for 15 minutes after power-on. In this case, please open the AT-1 configuration webpage directly after switching the device on and change the setup for the WiFi interface to be permanently active. For details, please consult the AT-1 installation manual [1].

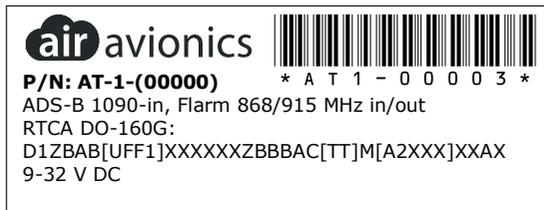


Figure 3.3.: AT-1 serial number sticker

### 3.3.3 Using Data in an App

In order to use data from the AT-1 in an app, in most cases the connection has to be activated in the app. For details, please consult the app’s documentation.

Please ensure that the AT-1 WiFi interface has been configured to the correct data protocol. The factory setting (FLARM protocol) works for all apps besides FOREFLIGHT. If using FOREFLIGHT, please in the AT-1 configuration webpage, set the protocol for the WiFi Interface to “GDL90”.

# 4

## Audio Output and Discrete Switches

### 4.1 Audio Output

AT-1 features an audio output that can be interfaced to the aircraft's audio system. The audio output can be set up to generate beep tones or voice messages.

Before using AT-1 in combination with a connected audio interface, please familiarize yourself with the installation conditions. For detailed information on the interface, wiring, and compatibility, please consult the AT-1 Installation Manual [1].

#### 4.1.1 Beep Tones

The audio output generates beep tones with a base frequency of 3300Hz. The intensity of the beeps is increased if a traffic or obstacle warning becomes more urgent. The following table describes which tones are generated:

<i>Situation</i>	<i>Beep Pattern</i>
Shortly after device power-on	Short single test beep (1s)
Info Alert (Aircraft is received for the first time)	Short single beep (0,15s)
Warning (target lower than own aircraft)	Double beep (normal beep followed by lower frequency beep)
Warning (target higher than own aircraft)	Double beep (normal beep followed by higher frequency beep)

#### 4.1.2 Voice Messages

The voice output generates spoken messages with a natural male voice. The following table describes which messages are generated:

<i>Situation</i>	<i>Message</i>	<i>Example</i>
Device power-on	AIR Traffic + SOFTWAREVERSION	"AIR TRAFFIC SIX"
Warning	TONE + DIRECTION + AZIMUTH + TARGET	BEEP "10 O'CLOCK ABOVE GLIDER"
Urgent Warning	TONE + DIRECTION + AZIMUTH	WOOTWOOT "10 O'CLOCK ABOVE"
System message	COMPONENT + STATUS	"GPS FAULT"

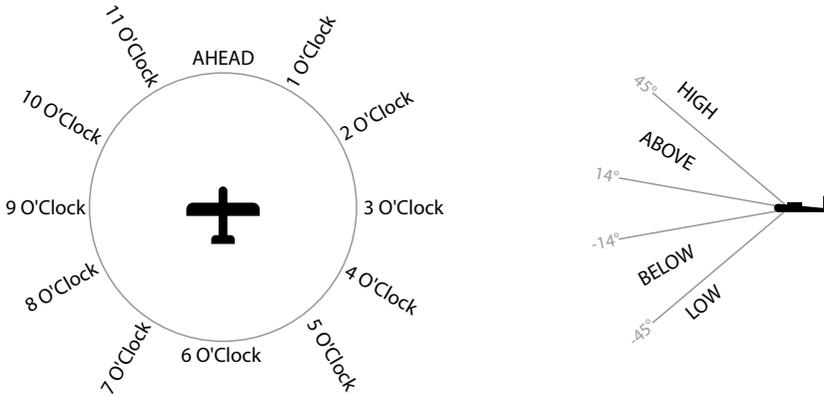


Figure 4.1.: Direction and azimuth indications in voice warning messages.

Voice messages can be acknowledged by pushing an optional VOICE ACK button, or by pushing the inner knob pushbutton on a connected AIR Traffic Display (ATD).

When acknowledging a traffic or obstacle warning message, all voice warning messages, generated by the specific target, are suppressed for five minutes.

Up to 10 system voice messages can be acknowledged once and will then be suppressed until the AT-1 is restarted.

### 4.1.3 Volume Control

The volume of the AT-1 audio output is typically controlled in the aircraft's audio panel. In this case the output volume is pre-adjusted once in the AT-1 system configuration during installation and is then controlled in-flight via the aircraft audio panel's controls.

The output volume can also be controlled by means of an external volume control rotary knob that is directly connected to the AT-1. When adjusting the volume by using this knob, an info beep indicating the current volume is played while turning the knob.

Please consult the aircraft's documentation for details on the specific installation.

Audio messages can be very distracting to the flight crew and significantly increase crew workload. Always familiarize yourself with the specific installation conditions and ensure the volume level is appropriate before each flight.

## 4.2 Discrete Switches

AT-1 features discrete inputs that can optionally be used together with switches/buttons in the airframe or panel. Depending on the specific installation, the following functions can be triggered using switches:

- MUTE – The AT-1 audio output can be muted.
- NO ALARMS – Traffic warnings issued over the AT-1 data interfaces can be suppressed.
- ON GND – In this case, the switch sets the aircraft's flight state as on-the-ground.
- APPROACH MODE – In approach mode, the warning sensitivity is reduced. This mode can be used during IFR approaches or during formation flying.
- VOICE ACK – Acknowledges a voice message for 5 minutes, e.g. a traffic warning from a specific traffic target.

## 5.1 Flight Recording

AIR Traffic features an integrated flight recorder. It records the trajectories of the own aircraft and received traffic targets. It stores this information on a per-flight basis, one data file per flight.

A minimum of 10 hours and up to 40 hours of flight-time can be recorded, depending on the number of received traffic targets. Older flightlog files are automatically overwritten by newer files.

## 5.2 Flight Data Readout

To download flight files from the AT-1, please carry out the following steps:

1. Insert a USB thumb drive into the AT-1 or the USB jack of the installed USB extension cable while the AT-1 is powered off.
2. Power the AT-1 on. The files are downloaded onto the thumb drive automatically.

## 5.3 Post Flight Analysis

Flight files can be exported in two formats, KML (default) and IGC. The export format can be changed at any time in the AT-1 system configuration. For details, please consult the AT-1 installation manual [1].

The following table gives an overview:

<i>File Format</i>	<i>Content</i>	<i>Software required to view data</i>
KML	Own aircraft track, resolution 1Hz, based on GPS position and pressure altitude. Other traffic targets within a range of 5km / 500m, including target threat levels.	Google Earth
IGC	Own aircraft track, resolution 1Hz, based on GPS position and pressure altitude.	IGC Software, e.g. SeeYou

# 6

## Software and Database Updates

### 6.1 Version Identification

The software version can be reviewed in the AT-1 configuration webpage via WiFi and in the logfiles written onot USB thumb drives. Additionally, AT-1 transmits a software version identification over its data interfaces and over the voice audio output. These information can be displayed in compatible displays like, for example, the AIR Avionics AIR Traffic Displays.

### 6.2 Software/Database Loading

Software updates and the obstacle database are loaded using a USB thumb drive (USB stick). A USB jack capable of hosting a thumb drive is shipped with AT-1 and normally installed into the aircraft.

Never remove the USB thumb drive while the device is booting. The device's software may stop working. In this case a system restart would be required.

Inserting the USB thumb drive in the wrong orientation may damage the slot.

AT-1 is compatible with all FAT or FAT32 formatted USB thumb drives normally in use with Windows PC or Apple Macintosh computers. It has been successfully tested with USB thumb drives with a storage capacity of 2 to 64 gigabytes.

AT-1 does not work with some USB Type C thumb drives. We recommend only using standard USB Type A drives with the supplied extension cable.

#### 6.2.1 Loading Software to the AT-1

To install a new software version, please carry out the following steps:

1. Download the latest AT-1 update files from <https://www.air-avionics.com>.
2. Load the update files onto a USB thumb drive into the root folder (main folder, no subfolder).
3. Insert the USB thumb drive into the AT-1 or the USB jack of the installed USB extension cable while AT-1 is powered off.
4. Power the AT-1 on. The update is automatically loaded. Please wait at least 15 minutes before removing the USB thumb drive.

## 6.2.2 Loading an Obstacle Database

To install an obstacle database, please carry out the following steps:

1. Purchase a valid obstacle database file from <https://www.flarm.com>.
2. Load the obstacle database file onto a USB thumb drive into the root folder (main folder, no subfolder). Please ensure that the file name is no longer than 8 characters. If too long, please shorten the file name.
3. Insert the USB thumb drive into the AT-1 or the jack of the installed USB extension cable while AT-1 is powered off.
4. Power the AT-1 on. The database is automatically loaded. Please wait at least 10 minutes before removing the USB thumb drive.

When the database license expires, the database can no longer be used and database functions are no longer available.

# 7

## System Status

AT-1 features a range of built-in self test features that continuously monitor system state and the state of connected systems to detect failures.

The detection of a failure is always transferred to connected cockpit systems and additionally displayed using the built-in status LEDs. Additionally, failures can be reviewed in the AT-1 configuration webpage.

For details on possible failure messages and for details on accessing and using the AT-1 configuration webpage, please consult the AT-1 installation manual [1].

Not all compatible cockpit systems are capable of displaying all types of failure messages. Some cockpit systems do not show any failure messages even if they display traffic data. If there is no system in your installation that is capable of displaying failure messages, please monitor the status LEDs.

Depending on the detected failure and its severity, the system may completely seize to function or functionality may be reduced.

### 7.1 Status LEDs

#### 7.1.1 LED Positions

The device status of the AT-1 is shown using three multi-color LEDs located in the back of the AT-1 unit.

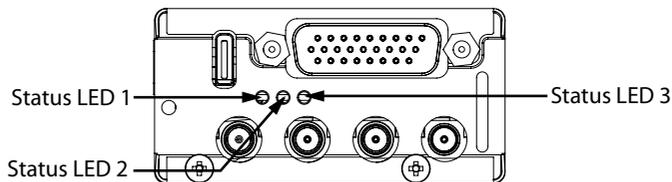


Figure 7.1.: Three status LEDs on the back of the AT-1 main unit

#### 7.1.2 Status LED Assignment

Each status LED is assigned to specific functional modules inside the AT-1:

1. Status LED 1 shows the status of the integrated 1090 MHz receiver module.

2. Status LED 2 shows the status of the integrated FLARM transceiver module.
3. Status LED 3 shows the status of the integrated GPS receiver module, the integrated WiFi module and the general system state.

### 7.1.3 Lighting Patterns

#### Normal Operation: Status LED 1

<i>Status</i>	<i>LED 1 Pattern</i>	<i>LED 1 Color</i>
Fatal error/failure, 1090 MHz receiver module unavailable.		red
Last dataset from 1090 MHz receiver module has been received over 30 seconds ago.		red
Last dataset from 1090 MHz receiver module has been received over 3 seconds ago.		red
Reduced function error of 1090 MHz module		yellow
Normal operation, ADS-B/Transponder traffic has been received or is currently received		green
Never received a traffic signal via 1090 MHz (ADS-B/Transponder)		green

## Normal Operation: Status LED 2

<i>Status</i>	<i>LED 2 Pattern</i>	<i>LED 2 Color</i>
Fatal error/failure, FLARM transceiver module unavailable.		red
FLARM software incompatible or expired.		red
Last dataset from FLARM transceiver module has been received over 30 seconds ago.		red
Last dataset from FLARM transceiver module has been received over 3 seconds ago.		red
Reduced function error of FLARM module		yellow
No GPS datasets received from FLARM module.		yellow
No FLARM data (about the own ship) sent out by FLARM transceiver module.		yellow
Power supply problem in the FLARM transceiver module.		yellow
Normal operation, FLARM traffic has been received and is sent.		green
Never received a traffic signal via FLARM		green

## Normal Operation: Status LED 3

<i>Status</i>	<i>LED 3 Pattern</i>	<i>LED 3 Color</i>
Fatal error/failure, AT-1 main system unavailable.		red
Fatal error of GPS or WiFi, for example, GPS antenna not connected		red
Last GPS position has been received over 30 seconds ago or never.		red
Last GPS position has been received over 3 seconds ago.		red
Reduced function error affecting traffic data processing and warnings. For example, no barometric pressure data is available.		yellow
Reduced function error not directly affecting traffic data processing/warnings. For example, the USB interface has detected a current consumption above maximum rating.		yellow
Warning: Bad GPS reception		yellow
Normal function, GPS 3D fix, no errors		green
GPS 2D fix		green
GPS has invalid fix quality, no error		green
GPS acquiring satellite data, no errors		green

## Status LED Patterns for Maintenance Operation

Status	LED 1	LED 2	LED 3
Searching for USB thumb drive after power-on	blue 	blue 	blue 
Reading configuration from USB thumb drive	blue 	blue 	off
Reading config. from USB successfully finished	blue 	blue 	green 
Reading config. from USB failed: no or invalid file	blue 	blue 	yellow 
Reading config. from USB failed: file syntax	blue 	blue 	red 
Writing log file to USB USB thumb drive	blue 	off	blue 
Writing log file to USB successfully finished	blue 	green 	blue 
Writing log file to USB failed	blue 	red 	blue 
Initiating maintenance of the 1090 MHz module	blue 	off	off
Initiating maintenance of the FLARM module	off	blue 	off
Updating the FLARM module	off	blue 	off
Loading FLARM license or obstacle file	off	blue 	off
Initiating maintenance of the WiFi module	off	off	blue 
Updating WiFi module	off	off	blue 
Updating WiFi module, 2nd attempt after update error	off	off	blue 

## Bootloader/Update Operation

<i>Situation</i>	<i>LED 1</i>	<i>LED 2</i>	<i>LED 3</i>
Initializing bootloader	magenta 	off	off
Bootloader initialized successfully	off	magenta 	off
Flash checked: no application installed	magenta 	off	magenta 
Flash checked: application installed ok	off	off	magenta 
Flash checked: incompatible application	magenta 	magenta 	magenta 
Bootloader processing a software container file	magenta 	magenta 	magenta 
Bootloader is installing application	magenta 	magenta 	magenta 
Bootloader has finished the installation ok	magenta 	magenta 	magenta 

# 8

## Troubleshooting

### 8.1 My AT-1 does not seem to power up.

IS the ENABLE pin pulled to GND correctly? In most configurations, the ENABLE pin on the front or rear connector has to be connected to a GND pin. Please consult the AT-1 installation manual [1] for details.

If using an AIR Traffic Display 57, software version 1.9 or higher, the ENABLE pin on the AT-1 does not need to be connected to GND.

### 8.2 I am unable to connect via WiFi, the network is not visible.

If establishing a connection is not possible even though no failures are indicated by the AT-1 status LEDs, please ensure the WiFi interface in AT-1 has been activated during installation.

Depending on its setup, the WiFi interface might only work for 15 minutes after power-on. In this case, please open the AT-1 configuration webpage directly after switching the device on and change the setup for the WiFi interface setup to be permanently active. For details, please consult the AT-1 installation manual [1].

[1] AIR Avionics, *AT-1: Installation Manual*, version 5.0, October 2023.

# B

## AT-1 Error Codes

### B.1 RGB LED Driver

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000001	RGBLED OTHER	
0x00000002	RGBLED NOT INITIALIZED	
0x00000003	RGBLED INVALID PARAMETER	
0x00000004	RGBLED INIT FAILED	
0x00000005	RGBLED DEINIT FAILED	

### B.2 Barosensor Driver

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x0000000C	BAROSENSOR OTHER	
0x0000000D	BAROSENSOR NOT INITIALIZED	
0x0000000E	BAROSENSOR INVALID PARAMETER	
0x0000000F	BAROSENSOR INIT FAILED	
0x00000010	BAROSENSOR DEINIT FAILED	
0x00000011	BAROSENSOR INVALID CRC	
0x00000012	BAROSENSOR INVALID CALIBRATION	
0x00000013	BAROSENSOR RANGE EXCEEDED	

### B.3 UART Driver

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000014	UART OTHER	
0x00000015	UART NOT INITIALIZED	
0x00000016	UART INVALID PARAMETER	
0x00000017	UART INIT FAILED	
0x00000018	UART DEINIT FAILED	
0x00000019	UART RX OVERFLOW	
0x0000001A	UART TX OVERFLOW	

## B.4 CAN Aerospace

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x0000001B	CANAS OTHER	
0x0000001C	CANAS NOT INITIALIZED	
0x0000001D	CANAS INVALID PARAMETER	
0x0000001E	CANAS INIT FAILED	
0x0000001F	CANAS DEINIT FAILED	
0x00000020	CANAS SEND FAILED	
0x00000021	CANAS INVALID FRAME	
0x00000022	CANAS INVALID DATASIZE	
0x00000023	CANAS INVALID DATATYPE	
0x00000024	CANAS INVALID IDENTIFIER	
0x00000025	CANAS INVALID MSGTYPE	
0x00000026	CANAS INVALID SERVICECODE	
0x00000027	CANAS INVALID SERVICECHANNEL	
0x00000028	CANAS REMOTEFRAME NOT SUPPORTED	
0x00000029	CANAS IRRELEVANT SERVICEFRAME	

## B.5 ARINC429 Interface

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000051	ARINC429 OTHER	
0x00000052	ARINC429 NOT INITIALIZED	
0x00000053	ARINC429 RX OVERFLOW	
0x00000054	ARINC429 TX OVERFLOW	

## B.6 Bootloader

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000059	BL OTHER	
0x0000005A	BL INVALID CMD	
0x0000007A	BL NO APP	No valid application could be found.
0x0000007B	BL INCOMPATIBLE DEVICE	The installed application is build for an incompatible device type.
0x0000007C	BL INCOMPATIBLE HW VER	The installed application is build for an incompatible hardware version.

## B.7 AT-1 Modules

### B.7.1 WiFi Module

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x0000005B	AT-1: WIFI INIT ESP	
0x0000005C	AT-1: WIFI SET SSID FAILED	Setting of the SSID (the name of the WiFi network) has failed.
0x0000005D	AT-1: WIFI SET PASS FAILED	Setting of the WiFi passcode has failed.
0x0000005E	AT-1: WIFI SET MODE FAILED	Setting of the WiFi mode has failed.
0x0000005F	AT-1: WIFI WIFI START FAILED	Starting the integrated WiFi modules network has failed.
0x00000060	AT-1: WIFI NO IP	

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000061	AT-1: WIFI WRONG IP	
0x00000062	AT-1: WIFI TCP SEND	
0x00000063	AT-1: WIFI NO DATA	

## B.7.2 TAS Module

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x0000007D	AT-1: TAS OTHER	
0x0000007E	AT-1: TAS BATTERY	
0x0000007F	AT-1: TAS GPS	
0x00000080	AT-1: TAS HW	
0x00000081	AT-1: TAS DIV ZERO	
0x00000082	AT-1: TAS ILLEGAL INSTR	
0x00000083	AT-1: TAS ADDR ERROR	
0x00000084	AT-1: TAS MEMORY	
0x00000085	AT-1: TAS CW	
0x00000086	AT-1: TAS COUPLER	
0x00000087	AT-1: TAS SUPP SHORT	
0x00000088	AT-1: TAS SUPP CONT	
0x00000089	AT-1: TAS INTGR	

## B.7.3 AT-1 Main Application

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000064	AT-1: USB OVERCURRENT	The electrical current drawn from the USB port has exceeded its rated maximum. To avoid damage, the USB port power supply has been switched off.
0x00000065	AT-1: GPSANTENNA OPEN	The current consumption of the GPS antenna is too low. No GPS antenna is connected or the cable connection is interrupted.

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00000066	AT-1: GPSANTENNA SHORT-CIRCUIT	There seems to be a short circuit in the GPS antenna. To avoid damage, the GPS antenna power supply has been switched off.
0x00000067	AT-1: WIFI CONN LOST	The data connection to the integrated WiFi module has been lost.
0x00000068	AT-1: WIFI UPD IMG	A software update image intended for updating the integrated WiFi module software contains errors.
0x00000069	AT-1: WIFI BOOTLOADER	A software update of the integrated WiFi module is not working due to an error in the modules bootloader component.
0x0000006A	AT-1: WIFI UPD FLASH	A software update of the integrated WiFi module is not working due to an error in the modules flash component.
0x0000006B	AT-1: TRX CONN INTR	The data connection to the integrated 1090MHz (ADS-B/Transponder) receiver module has been interrupted.
0x0000006C	AT-1: TRX CONN LOST	The data connection to the integrated 1090MHz (ADS-B/Transponder) receiver module has been lost.
0x0000006D	AT-1: FLARM CONN INTR	The data connection to the integrated FLARM transceiver module has been interrupted.
0x0000006E	AT-1: FLARM CONN LOST	The Data connection to the integrated FLARM transceiver module has been lost.
0x0000006F	AT-1: FLARM CFGSYNC UNKN	An unknown configuration dataset has been sent by the integrated FLARM transceiver module.
0x00000070	AT-1: FLARM COULD NOT APPLY ACFT	AT-1 has been unable to change the aircraft category in the integrated FLARM transceiver module.
0x00000071	AT-1: FLARM COULD NOT APPLY NOTRACK	AT-1 has been unable to change the no-track setting in the integrated FLARM transceiver module.
0x00000072	AT-1: FLARM COULD NOT APPLY PRIV	AT-1 has been unable to change the stealth mode setting in the integrated FLARM transceiver module.
0x00000073	AT-1: FLARM COULD NOT APPLY RADIOID	AT-1 has been unable to change the FLARM Radio ID in the integrated FLARM transceiver module.
0x00000074	AT-1: FLARM COULD NOT INIT BIN MODE	A software update of the integrated FLARM transceiver module failed due to a timeout error while trying to initialize the binary data transfer mode.
0x00000075	AT-1: FLARM COULD NOT INSTALL LICENSE	The installation of at least one software license into the integrated FLARM transceiver module failed due to unknown reasons.
0x00000076	AT-1: FLARM COULD NOT INSTALL OBST DB	The installation of an obstacle database into the integrated FLARM transceiver module failed due to unknown reasons.
0x00000077	AT-1: GPS CONN INTR	The data connection to the integrated GPS receiver module has been interrupted.
0x00000078	AT-1: GPS CONN LOST	The data connection to the integrated GPS receiver module has been lost.
0x00000079	AT-1: NO MODE-S ALTITUDE DATA	Altitude data encoded into the own transponder replies is not available.
0x0000008A	AT-1: NO EXTERNAL ALTITUDE DATA	Altitude data from configured external source is not available.

## B.8 AT-1 Flarm Module

<i>Code</i>	<i>Title</i>	<i>Description</i>
0x00008011	FLARM FW EXP	The installed FLARM firmware has expired, please update the unit.
0x00008043	FLARM INV ID	The configured ICAO address is invalid, please enter a valid address.
0x00008051	FLARM COMM	Error in the communication in the FLARM module.
0x00008082	FLARM OBST DB EXP	The installed obstacle database is expired, please load a new database.
0x000080A1	FLARM CFG	The configuration of the FLARM module is wrong or corrupted.
0x000080B1	FLARM LIC OBST DB	The installed obstacle database is not licensed correctly.
0x000080B5	FLARM LIC RFB	The installed 2nd FLARM radio channel is not licensed correctly.
0x00008120	FLARM REGION	The unit is used in a region that is not supported due to regulatory restrictions. Transmissions are disabled.
0x000080F1	FLARM OTHER	Unknown internal FLARM error or warning.





