TRX-2000

ADS-B Trafficmonitor

User Manual
Installation Manual

GARRECHT
Avionik GmbH

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Record of Revisions

Always keep this page in front of this document.

Date	Revision	Pages	Description of Change	Inserted by
30 MAR 2011	1.0	All	released	JG
19 DEC 2011	1.0b	All	English Translation revised (courtesy to Steve Hunt) Added: several information about updates procedures, Audio interface, configuration, max. Receiving range	JG

Table of contents

Preface

Many thanks for purchasing the TRX-2000 traffic monitor.

The TRX-2000 is a panel mounted system combining a high performance ADS-B receiver and a color LCD for displaying the traffic situation. It has been designed either to be connected to an external FLARM(R) or comes with an integral FLARM(R) module. The system provides interfaces for connecting two external Displays (CDTI) and a GPS interface to be connected to a Mode-S transponder (i.e. Garrecht Avionik VT-01, VT-02, VT-2000) with ADS-B out capability.

To avoid malfunction, reading and understanding of all chapters of this manual is required.

Limitations of the system are described in the chapter „System Limitations"

A detailed data port specification is described in the "TRX Data Port Specifications" manual, which is available on request from the manufacturer.

New releases of manuals or firmware udpates are published on the manufacturers website

www.garrecht.com

Your feedback or suggestions for improving the system are welcome. Please contact us via email:

info@garrecht.com

This manual provides all information, that is required for proper installation and safe operation.

For more information and addtional support, please contact your TRX-2000 dealer. ´

To avoid damage, please do not open the system housing.

The following symbols and terms are used in this manual:

	Warning *Warning statements identify conditions or practices that could result in injury or loss of life*
	Caution *Caution statements identify conditions or practices that could result in damage of this product or other property.*
	Important note: *Indicates important or usefull information. It is strongly recommended to read, understand and follow the statement.*

Unpacking the unit

The TRX-2000 system is supplied with the following:

- System unir TRX-2000
- 1:1 Patch cable (shielded) with RJ-45 connectors, lenght: 0,5m for connecting an external FLARM(R)
- open end patch cable for supplying power (EIA/TIA 568B)
- USB interface cable
- 1090 MHz antenna + antenna cable
- FLARM®- antenna + antenna cable (units with integral FLARM® module only)
- Antenna ground plane
- GPS antenna (units with integral FLARM® module only)
- This manual

If one or more parts are missing, please contact your supplier of the TRX-2000.

Required parts for proper operation

- Units without integral FLARM®: Original FLARM® or 3rd party licenced FLARM®

Options (not delivered with the TRX-2000)

- Antenna line extension
- Interconnection cable to GARMIN GPS series 39x/49x or 69x
- External display devices (CDTI), i.e. Butterfly, FlymapL, Garmin GPS 39x/49x/69x, PDA with appropriate software (WinPilot, PocketStrePla, SeeYou mobile)

These options will be supplied by your TRX-2000 supplier.

Important Information about integral FLARM® module

The TRX-2000 can be equipped with a FLARM® module optionally. FLARM is a very popular collision avoidance system for general aviation and gliders, which is installed in over 17.000 aircraft worldwide.

FLARM® features at a glance:

- Situational awareness display. Collision warning (audible and visible) if other aircraft is also FLARM® equipped.
- Obstacle warnings
- Intelligent trajectory prediction, also under unconventional conditions (i.e. thermaling gliders) to reduce pseudo warnings
- Typicial range: 4-8 km
- Operating in free ISM Band

Detailed information about the FLARM® system can be obtained under

www.flarm.com

> To keep all FLARM® up to date and to improve the system, mandatory updates are required from time to time (every 3 to 5 years). If your TRX-2000 is FLARM® equipped, these updates are mandatory in order to keep your FLARM® alive.
> After the expiration date, FLARM(R) stops working.

Mandatory updates are required to improve the whole FLARM® network without respecting downward compatibility. The aviation typical periodic maintenance has been extended to electronic systems.

The expiry date of the current firmware is Feb. 28 2015

Detailed information about the udpate process can be downloaded from

www.garrecht.com

All required files are provided via this website.

Please do not send the device to the manufacturer for firmware updates!!

1. Principles

1.1. General

Automatic Dependent Surveillance – **Broadcast** is a modern ATC system for broadcast aircraft position data. Transponders which are connected to a GPS system transmit her own position and other flight data, like call sign, Mode-S address, speed and altitude as well as track and vertical speed. The transponder transmits these data periodically – typically once per second – like a radio station (Broadcast).

TRX-2000 contains a sensitive 1090 MHz receivers with complex signal processing unit. Transponder signals broadcasted by other aircraft are received, processed and decoded.

Data from a connected or integral FLARM® will be extended by the data received from the TRX-2000 ADS-B receiver and indicated on the system LCD display.
To enhance display capability, traffic data will be provided via two interfaces for connecting external display devices. GPS data are provided on a dedicated port.

The presence of transponder equipped aircraft not broadcasting ADS-B output will be detected and indicated on the system display as a non directed target.

It is not essential to connect the TRX-1090 to a transponder. The system comes with its own 1090 Mhz receiver. To operate a TRX-1090, no transponder installation is required.

The TRX-1090 provides GPS data received from the FLARM via a dedicated port to supply an ADS-B out capable Mode-S transponder. (e.g. Garrecht Avionic VT-01, VT-02). This device broadcasts the current position message every secound - the message can be received by ADS-B receivers installed in other aircraft, as well as with receivers installed on ground.

The schematic below shows the basics of a TRX-1090 installation
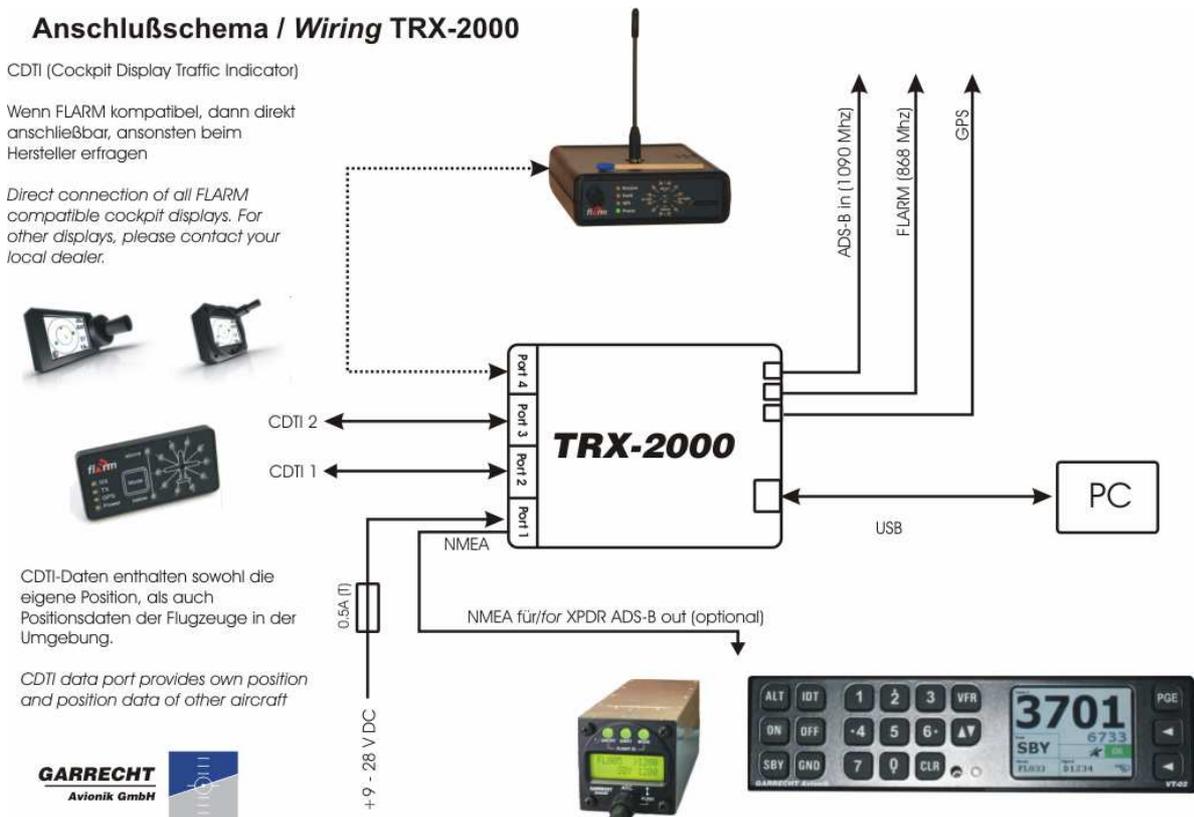
System setup and configuration needs to performed using a PC and the TRX-Tool. The unit needs to be connected to the USB port of your PC. Power will be supplied via the USB port.

> **Before the first time connection of the TRX-1090 to your PC , the TRX-Tool needs to be installed properly!**
>
> **In some cases, the output power of the PC USB port might be insufficient for powering the TRX-2000 and the system must be powered via an external power supply.**

1.2. Output of position data and warnings

The TRX-2000 provides collision warnings and warnings to prevent dangerous situations

**nur Positionsanzeige bei Aufenthalt innerhalb
der eingestellten Reichweite
nur Warnung, wenn Kollisionsgefahr besteht**

unbed. Warnbereich horizontal

unbed. Warnbereich vertikal

X

**Warnung, da in den
unbedingten Warnbereich
eingedrungen**

**Warnung 18 sek. vor
Kollision**
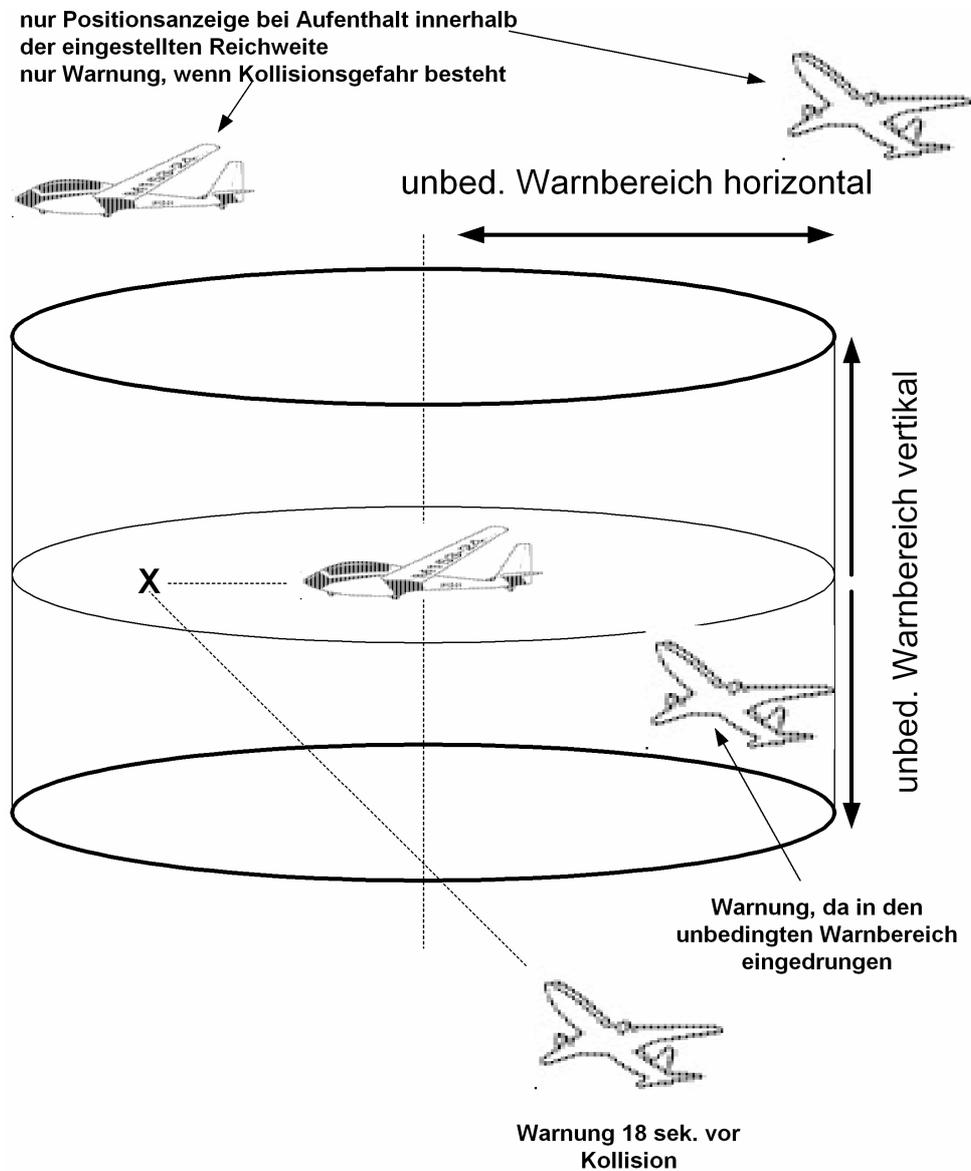
1.2.1. Position data:

The TRX-2000 determines position data of other aircraft and provides position data to the system LCD or connected displays, if the position is within the configured horizontal and vertical range.

1.2.2. Warnings:

The TRX-2000 warnings focus on different situations:

1. Entering the protection volume (ADS-B targets)
The protection volume is defined as a cylindric volume around the own position. Radius and height of the Cylinder can be configured using the TRX-Tool. The TRX-2000 generates a warning, if an aircraft violates the defined protection volume (if falling below the vertical AND horizontal limits)

2. Prediction of crossing the flight tracks (ADS-B and FLARM® targets)
Derived from the own position and trajectory data (position, speed, flight direction, vertical speed) and data from other aircraft, the TRX-2000 calculates the risk of a collision. If detecting a dangerous situation, a warning will be generated 18 sec. before collision.

> **WARNING: Due to sudden changes of the own or other aircraft's flight direction (track), this warning can be generated later / only few secounds before a calculated collision.**

nur Positionsanzeige bei Aufenthalt innerhalb
der eingestellten Reichweite
nur Warnung, wenn Kollisionsgefahr besteht

unbed. Warnbereich horizontal

unbed. Warnbereich vertikal

X

Warnung, da in den
unbedingten Warnbereich
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Warnung 18 sek. vor
Kollision
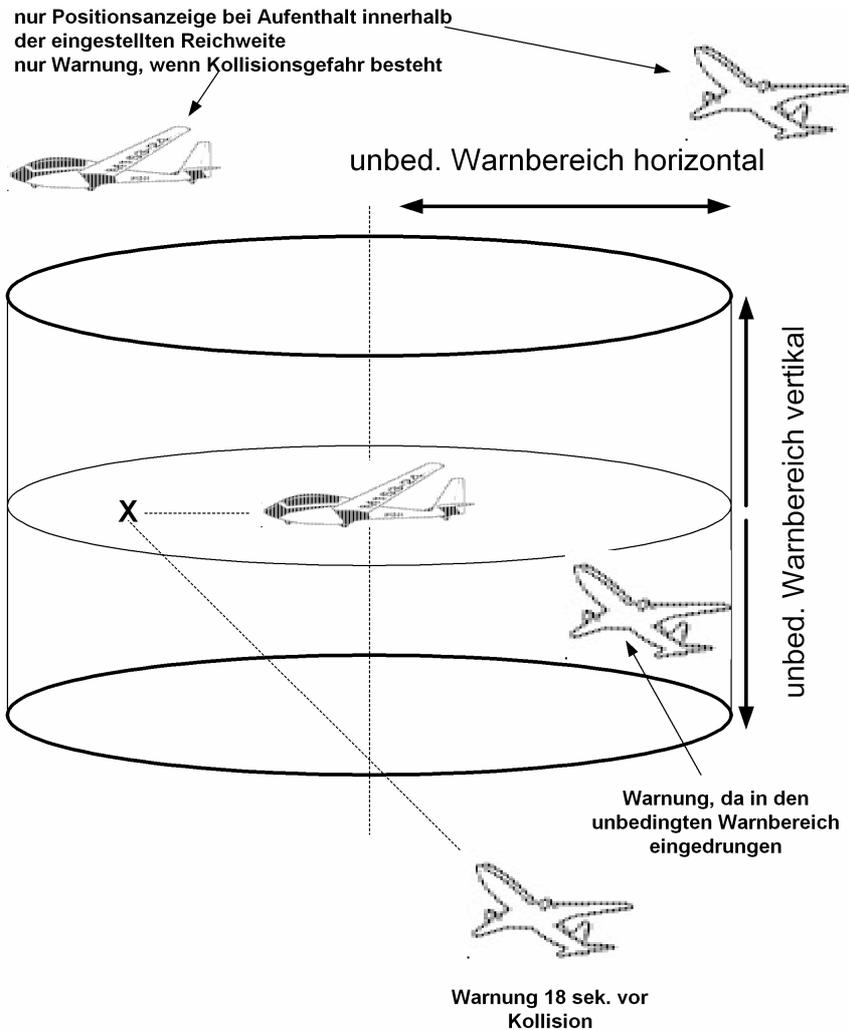
1.3. Transponder signals, FLARM® signals and system behaviour

Different transponder signals (ADS-B, Mode-S Replies, Mode-S Squitters) result in different system reaction. The table below shows the different signals and the related reactions.

1.3.1. Mode-S Extended Squitter with ADS-B out

Broadcasted by	Mode-S Transponder equipped aircraft **WITH connected GPS**
Broadcast interval	1 /sek.
System reactions TRX-2000	Output of aircraft's position and altitude data via system interfaces according to interface configuration. Output of warnings (violating the protection volume, collision warning) A warning is always focussing the most dangerous aircraft. FLARM® Warnings **always have** higher priority. If an aircraft is equipped with FLARM® and ADS-B out, only FLARM® warnings will be processed

1.3.2. Mode-S Squitter

Broadcasted by	Mode-S Transponder equipped aircraft **WITHOUT connected GPS**
Broadcast interval	1 /sek.
System reactions TRX-2000	Detecting of horizontal approximation (analyzing the signal strength). Alitude information will not be processed.

1.3.3. Mode-S Replies

Broadcasted by	Mode-S Transponder equipped aircraft, which are interrogated by radar ground station or TCAS
Broadcast interval	Depending on external interrogation, every 4-6 sek.
System reactions TRX-2000	Detecting of horizontal approximation (analyzing the signal strength) Detecting of vertical approximation (processing the coded altitude signals)

1.3.4. FLARM®

Broadcasted by	FLARM® equipped aircraft
Broadcast interval	1 /sek.
System reactions TRX-2000	Output of aircraft's position and altitude data via system interfaces according to interface configuration Output of warnings (collision or proximity warning). Output of distance, direction, vertical distance. A warning always indicates the most dangerous target. FLARM® Warnings **always have** higher priority. If an aircraft is equipped with FLARM® and ADS-B out, only FLARM® warnings will be processed

1.4. Limits of the Systems

1.4.1. General

> **The system has been developed as a support for VFR pilots. It is not certified as a TCAS system. The data port does not provide valid data for certified hazard displays.**

Observing the airspace is always the responsibility of the pilot in command. The TRX-2000 acts as a support device, which may operate wrong and generate wrong warnings or no warnings in dangerous situations.

Using the TRX-2000 and interpreting the warning generated by the device is under the sole responsibility of the pilot in command.

Displaying traffic information and providing collision avoidance information on connected 3rd party displays is under the sole responsibilty of the display manufacturer. It can not be influenced by Garrecht Avionik GmbH.

Garrecht avionics GmbH assumes no liability for any direct or indirect damage to human and material arising from the use of the TRX-2000, unless grossly negligent or intentional acts of Garrecht avionics GmbH is demonstrated.

A GPS receiver is included if an internal FLARM® module is present. If traffic information or collision avoidance should be provided by the TRX-2000 the system must know it's position and pressure altitude information. Thus, an internal FLARM® module or an external operating FLARM® must be present.

1.4.2. The TRX-2000 system provides

- Position determination and visualisation of ADS-B 1090 ES out and / or FLARM® equipped aircraft.

- Generation of directed warnings of ADS-B 1090 ES out Funktion and / or FLARM® equipped aircraft, if the configured distances (protection volume) is violated or risk of collision occurs.

- Generation of undirected warnings of Mode-S equipped aircraft without ADS-B 1090 ES out capability. Approximation of such aircraft is determined by analysing the field strength.

- Providing of FLARM® and ADS-B 1090 ES out warnings and aircraft position on two external ports for connection of appropriate 3rd party display systems.

- Visualisation of aircraft specific information (TRK, Altitude difference refered to own altitude, vertical speed, FlarmNET data.

- Obstacle warnings (data provided by FLARM® obstacle database)

1.4.3. The TRX-2000 system does <u>NOT</u> provide

- Mode-S SSR transponder capability. **The TRX-2000 is NO transponder!!!**

- Active interrogation of other SSR transponders (TRX-2000 is NO TCAS)

- Resolution advisory similar to TCAS

- Position determination or directed warnings of Mode-A/C and Mode-S (no ADS-B out) equipped aircraft

- Generation of traffic information or collision avoidance warning, if no internal FLARM® is present and no external FLARM® is connected.

2. Aircraft installation

2.1. General

Installation of the TRX-2000 in an aircraft needs to be performed in accordance with the applicable engineering standards by qualified personnel only.
If the required skills and tools are not available, please contact your avionic shop or maintenance organsiation.

The Installation of the TRX-2000 may not influence other aircraft equipment.

The TRX-2000 has been developed for integration with the FLARM(R) system. An installed and operating original FLARM(R) or licenced 3rd party device (i.e. LX Red Box) or an TRX-2000 integral FLARM(R) module is mandatory for operation.

Visualization of received data and audible warnings are provided by the system human machine interface, or a connected 3rd party device (Butterfly, FlyMapL, V2/V3 or any Flarm(R) compatible display as well as any device with GARMIN(R) TIS compatible interface.

According to EASA decision 2006/13/R and 2006/14/R, the TRX-2000 may be considered as standard part, which can be installed in CS-22 aircraft (gliders and powered gliders).

- ## For operating a TRX-2000, no transponder needs to be installed in the aircraft.
- ## Connecting a TRX-2000 and a transponder to a common antenna (transponder antenna) is not possible.

The TRX-2000 provides all data interfaces via four RJ-45 connectors on the backside of the device. To prevent noise in the radio, the use of shielded lines is strongly recommended.

2.2. Panel installation

The unit has been designed for panel mount installation (58mm panel cut out). It has to be fixed using 4 screws (M3x8mm).

For proper operation and readability choose an appropriate position in the panel of your aircraft. To avoid reduced airspace observation when using the system , do not fit the device in the lower area of your panel.

The system housing is not waterproof. Take this fact into consideration when choosing a place for installation.

A system exposed to water or severe humidity must not be supplied with external power or switched on. Consult your local avionics shop or maintenance organisation for further steps.

2.3. Antenna installation

2.3.1. General

Choosing an appropriate position
For best transmitting and receiving performance, ADS-B and FLARM(R) antenna must be installed in vertical position. The GPS antenna has to be installed in horizontal position.

All antenna must not be covered by conductive material (aluminium, carbon fibre). If no appropriate position can be determined, antennas need to be installed outside at appropriate position. Antennae for utside installation and antenna line extensions are not delivered with the device and must be purchased seperatly.

Each antenne must be installed in a manner to have free line of sight in all directions. Metal parts (i.e. engine, prop, gear) close to the antenne may reduce the device receiving and transmitting performance.

Minimum distance to NAV/COM antennas is 1m (3ft), to transponder and / or DME antenna is 2m (6ft).

Antenna ground plane
Stub antennas (λ/4 beamer) always require the use of a conductive antenna ground plane. In wooden or fibre glas made airframes, a conductive ground plane (metal film, sheet metal, size: as large as practical) has to be installed. Antennas need to be in the center of this ground plane. To small ground plane may reduce the antenna performance. A proper conductive connection between antenna foot and groundplane is essential. Insulating covers (painted or oxidzed) need to be sanded in the place of contact with the antenna foot to provide an conductive connection.

The TRX-2000 comes with a aluminum sheet ground plane for installation of Flarm- and ADS-B antenna. Do not reduce the size of this ground plane.

Important

⚠	If using antennae installed in the instrument panel cover which are part of the removable canopy (i,e, gliders), always use pull to release connectors types to avoid proper canopy release in case of emergency exit.

2.3.2. Antenne cable and connectors

Handle the antenna lines carefull and avoid sharp bends or damaging the antenna line during installation to avoid reducing system performance. Depending on the cable type, keep a minimum radius of 1-5 cm (smaller radius for smaller cables).

Line extensions has to be performed in accordance with good workmanship using appropriate connectors and cable types (Impedance: 50 Ohms). For adopting to other connector types, always use industrial made connectors to reduce attenuation.

Do not reduce the length of supplied cables. Tie unused cable in 8-shape loops.

Nuts of used SMA connectors (ADS-B antenna connector of TRX-2000) may be screwed down tight carefully only to avoid damaging the antenna connector.

2.3.3. ADS-B Antenna

Whenever possible, use the supplied λ/4 - 1090 MHz stub antenne (shorter antenna) for installation on the instrument panel cover.
An appropriate groundplane is supplied with the TRX-2000 as well as nuts for antenna installation and antenna line for connecting the antenna to the TRX-2000

> The SMB type connector acts as a pull to release connector for disconnecting the antenna in case of canopy release for emergency exit. For proper disconnection in case of pulling, a loose installation of at least 0,3m (1ft) of the antenna line after the antenna connector is recommended. The remaining part of the antenna line should be tied to a fixed part.

For external ADS-B antenna installation, the use of an of-the-shelf SSR-transponder antenna (stub or fin type) is recommended.

> **Do not use a transponder antenna, which is used by an installed transponder already!!!**

If a Mode-S transponder is installed in your aircraft, be sure to have entered the 24 Bit aircraft address into the external Flarm (if present) to avoid ghost targets.

2.3.4. FLARM TX/RX Antenna (devices with integral FLARM® module only)

A λ/4 - 868 MHz stub antenna (longer antenna) is supplied with the TRX-2000. All instructions for ADS-B 1090 MHz antennas shown above are mandatory for this antenna as well.

The FLARM® antenna is connected to the TRX-2000 FLARM(R) antenna socket via a MCX type connector (self locking).

For outdoor installation, appropriate 868 MHz antenna are supplied by the several companies. These antennas are designed to comply with the requirements for installation in aircraft or cars (withstanding drag, moisture etc.). For installation of this antenna type, please follow the instructions for installing external antennas (free line of sight, groundplane etc.) to avoid reducing system performance as the FLARM(R) system is sensitive against poor antenna installation.

2.3.5. GPS Antenna (devices with integral FLARM® module only)

For operating the TRX-2000. an active GPS antenna with MCX connector is required and supplied with the device.

All general consideration for antenna installation shown above are suitable for GPS antennas. For proper function, a GPS antenna requires free line of sight in horizontal and vertical direction.

To avoid interference with other GPS antennae installed in your aircraft, make sure to keep a minimum distance of 0,6m (2ft) to other GPS antennae.

A GPS antenna must not be installed on the bottom side of the airframe nor under conductive or shielding material.

As the antenna supplied with the TRX-2000 does not provide cut off capability, it may not installed on top or bottom of an instrument panel cover, which is part of a removable canopy.

2.4. Wiring (power supply and data)

The TRX-2000 provides a mini-USB , four RJ-45 jacks and an SMA jack for electrical, data and RF connectivity. If the unit is equipped with an internal FLARM® module, two additional RF connectors (type MCX) are provided for FLARM®- and GPS antenna.
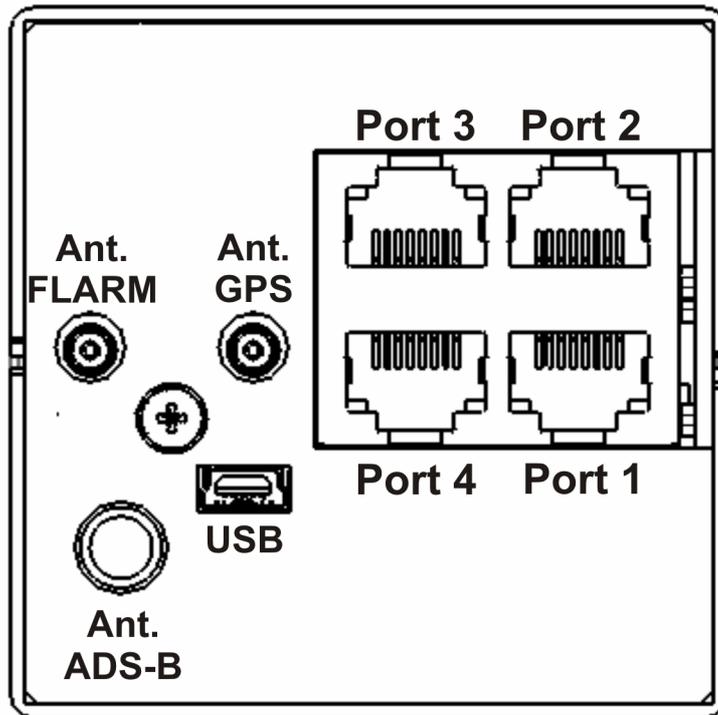
TRX-2000 -Rear view

2.4.1. USB interface

The unit's USB interface is intended to be used for system configuration via PC and TRX-Tool software.

- **Before the first time connection of the TRX-1090 to your PC , the TRX-Tool needs to be installed properly!**

- **As the output power of the PC USB port might be insufficient for powering the TRX-2000. the system must be powered via an external power supply during communication with the PC. Use one of the RJ-45 connectors for supplying external power.**

- **The TRX-2000 must be switched on for communication with PC**

2.4.2. Data interfaces (Port-1 to Port-4)

The rear side of the TRX-2000 provides four data interfaces (Port-1 to Port-4). Each port can be configured using the TRX-TOOL PC software

> **If using standard patchkabel, be sure to use 1:1 cable.**
>
> **DO NOT US crossover cable to prevent injury of FLARM, TRX-2000 or connected display units.**
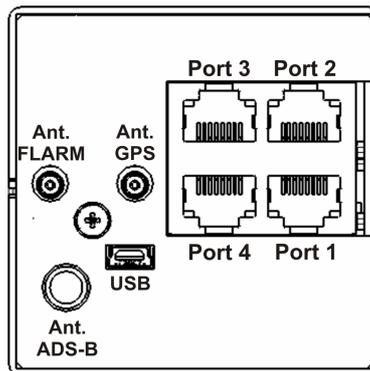
rear view system unit

2.4.2.1. Use of interface ports

Port -#	Funktion
1	Power supply, NMEA output for supplying Mode-S transponders
2	CDTI 1, Interface 1 for vockpitdisplay (kompatibel zu FLARM extended Displays)
3	CDTI 2, Schnittstelle 2 zu Cockpitdisplay (compatibel zu FLARM basic Display oder GARMIN GPS series 39x, 49x, 69x), configuration via TRX-Tool
4	FLARM® I/O, Interface to external FLARM®. **Warning: Do not connect an external FLARM®, if an internal FLARM® module is present!**

- External power can be supplied using each of the 4 ports. Using a fuse is mandatory to prevent damages. Missing fuse or wrong fuse dimension will cause damages, which are not covered by manufacturers warranty.

- Do not feed electrical power through the 3.3V pins of the CDTI interfaces (port 2 and port 3) to avoid damaging internal circuits of the TRX-1090.

- Max. outout current of the internal 3.3V converter: 0,5 A

- The use of 6 pin connectors (RJ-12) is possible in an 8 pin RJ-45 connector, but connector lifetime will be reduced. So using of 8 pin RJ-45 connectors is strongly recommended.

- If connecting a GARMIN GPS series 39x, 49x, 69x, the TIS interface needs to be activated (consult the user manual of the GARMIN GPS).

2.4.2.2. Pinout of the RJ-45 connectors

| The pinout complies with the standards of the International Gliding Commission (IGC) for flight recoders. The pin numbering is reversed to the industrial standard. |

Remember, that the TX/RX lines of port 2 and port 3 (CDTI interfaces) are reversed to the IGC standard. Pin 3 provides a 3.3V DC power supply for powering external FLARM displays. This makes the interface compatible to existing external FLARM compatible displays.

Power can be supplied via each port. Be sure to power only FLARM and TRX-2000 via these lines to prevent exceeding the maximum current.
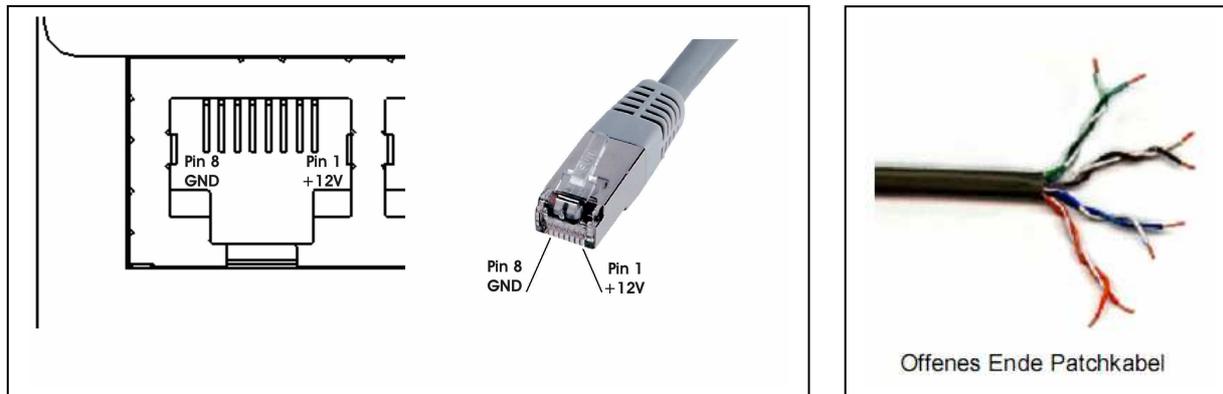
Pinbelegung RJ-45 Buchse

Offenes Ende Patchkabel

Pinout Port 1		
Pin #	Function	**Wire color of supplied connection cable (acc. to EIA/TIA 568B)**
1	+ 9 - +28 V DC	Brown
2	+ 9 - +28 V DC	Brown-White
3	n.c. (not connected)	Green
4	n.c. (not connected)	Blue-White
5	RX 1 (Data input 1)	Blue
6	TX 1 (Data output 1)	Green-White
7	GND	Orange
8	GND	Orange-white

It is recommended to power the TRX-2000 via port 1. Use the NMEA data provided on port 1 to feed your Mode-S transponder for ADS-B out purposes. The baudrate can be set up using the TRX-Tool.

| To prevent injury on the TRX-2000 and/or connected devices, always check the pinout of the used connection cable.

Damages caused by reverse polarity or wrong connection are not covered by the manufacturer's warranty. |

Pinout Port 4	
Pin #	Function
1	+ 9 - +28 V DC
2	+ 9 - +28 V DC
3	n.c. (not connected)
4	n.c. (not connected)
5	RX 4
6	TX 4
7	GND
8	GND

If the TRX-2000 comes without integral FLARM® module, an external FLARM® has to be connected for proper operation. Connect your external FLARM® to port 4 to establish connection for power supply and interfaces. Use a 1:1 RJ-45 patchcable (delivered with the TRX-2000)

Pin out port 2 and port 3 (CDTI 1, CDTI 2)

Pin out Port 2 and Port 3	
Pin #	Function
1	+ 9 - +28 V DC
2	+ 9 - +28 V DC
3	3,3V Supply for external displays
4	GND
5	TX 2 / TX 3
6	RX 2 / RX 3
7	GND
8	GND

Connect existing CDTI to port 2 or port 3. 3.3V DC power will be supplied by the TRX-2000

Default settings port 2 and port 3:

Port 2:   preconfigured for connecting external FLARM extended displays (Butterfly, FlymapL, PDA with appropriate software

Port 3:   preconfigured for connecting FLARM® Basic Displays (V2, V3, V4)

Default settings might be changed using the TRX-Tool.

Future firmware upgrades will make the TRX-1090 compatible to other display systems.

The TRX-Tool software checks periodically for new updates. Sending the unit to your dealer for firmware upgrades is not required.

New information about firmware will be published on the manufacturers website.

www.garrecht.com

2.4.3. Audio interface

The TRX-2000 comes with an audio interface to provide audible warnings additionally.

Electrical specifications:

Impedance: 8 Ohms
Voltage Level: appr. 3 V (VSS)

A small speaker can be connected directly to this interface. If the cockpit noise level is to high and if using a headset, connecting the audio signal of the TRX-2000 to a audio panel or Line-in interface of a radio or intercom is requried.

Refer to the radio's or intercom's installations manual for detailed information, how to hook up external audio sources properly.

> Always consult the manuals before connecting the TRX-2000 to avoid damages to the units caused by exceeding the maximum specified input level
>
> Consult your avionics workshop for addtional information.

In some cases, connection of the TRX-2000 to your audio panel or Line-in interface of your radio requires impedance matching.

Connecting a TRX-2000 to a Line-in interface:

- Use a voltage divider
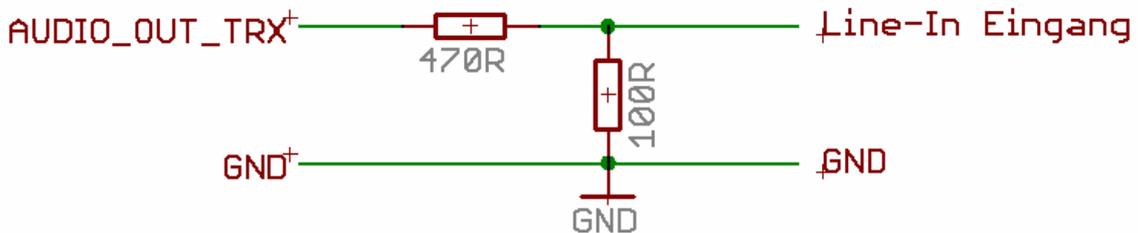
Connecting a TRX-2000 to a avionic audio panel (Input Impedance: 500 Ohms)

Units with automatic impedance matching:	direct connection (conceivably)
Unist without automatic impedance matching:	Connection via impedance matching transformer (i.e. Conrad Electronic P/N 515 952
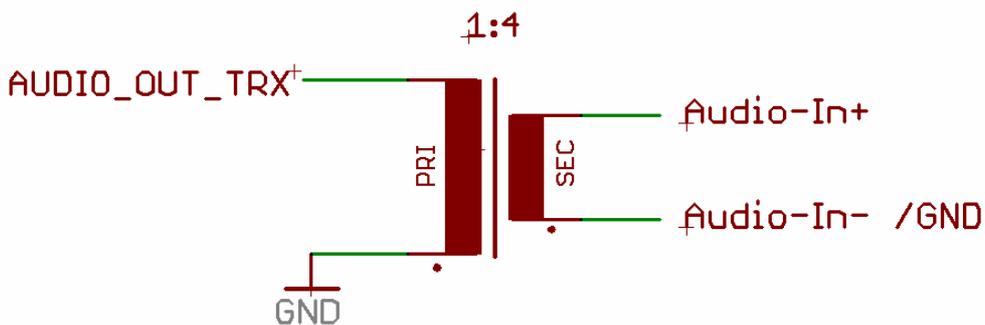
3. Operation

3.1. Human machine interface

µ-SD Card Slot

Double shaft rotary encoder with inner and out knob
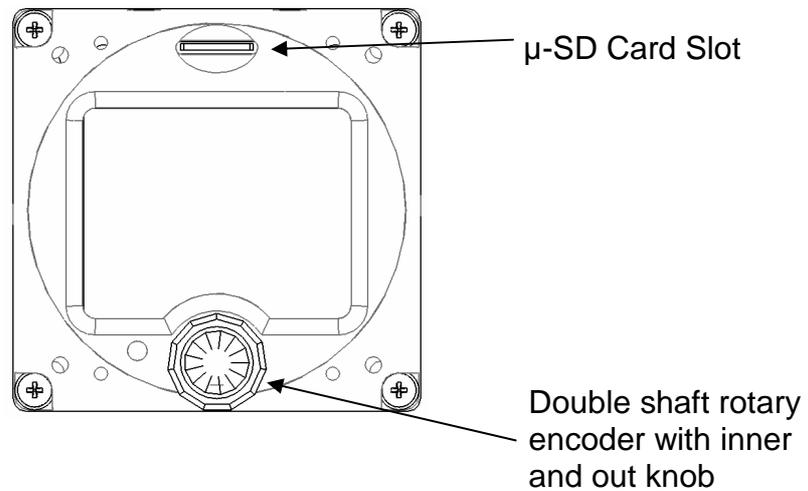
3.1.1. microSD Card Slot

The TRX-2000 provides a microSD card slot for updating TRX-2000 firmware, FLARM® firmware and FLARMNEt database.

> Pay attention for correct insertion of the microSD card. Card labeling must show upwards. Wrong orientation may cause damages to the microSD card socket.

Additional information about handling Updatefiles (Firmware and Obstacle database) for the internal FLARM® module via microSD card can be obtained from

www.flarm.com

Additional information about handling Updatefiles (Firmware and FLARMNet database) via microSD-Card for the TRX-2000 can be obtained from

www.garrecht.com

3.1.1.1. System behavior with inserted memory card (microSD-Card)

1) General:

After switching on, the TRX-2000 checks, if

- an SDHC (>= 4GB) or SDSC (<= 2GB) memory card type is inserted
- the card is formatted with FAT16 or FAT32 file system
- a subdirectory (folder) GAV exists in the root directory of the memory card

If all conditions are valid, the system checks for existing firmware update in the GAV folder. If a newer firmware oder FLARMNet file is detected, the updates start automatically.

During the update process, the LCD backlight blinks in 0.5 sec. intervals. No information will be shown on the screen during the update process of the TRX-2000 firmware

	Refer to chap. 5 of this manual for a step by step instruction for Flarm- and TRX-Firmware updates.

	Do not remove the memory card during the update process to prevent damages to the TRX-2000

2) TRX-2000 devices with integral FLARM® module only

If the inserted memory card is an SDHC type or it is formatted with a FAT32 filesystem, the TRX-2000 does not start, as the FLARM® does not accept memory cards > 2GB (this information is applicable to all FLARM® devices with firmware < 5.x).

If the inserted memory card is an SDSC type and it is FAT16 formatted or SDHC and internal FLARM firmware 5.x or later, the unit starts normal and FLARM® module detects the memory card. All FLARM® startup procedures with inserted memory card will be processed now: Checking for update files (Firmware, obstacle database, flight declaration, cofiguration), performing updates, copying IGC files stored in the FLARM® flash memory, which are not present on the memory card already.

Information about the update process or IGC file transfer are displayed on the TRX-2000 system LCD.

	Do not remove the memory card until all read / write operations are finished. This is indicated by the system if the normal system screen (Time, GPS status) appears.

3.1.2. Double shaft rotary encoder

µ-SD Card Slot

Double shaft rotary
encoder with inner
and out knob
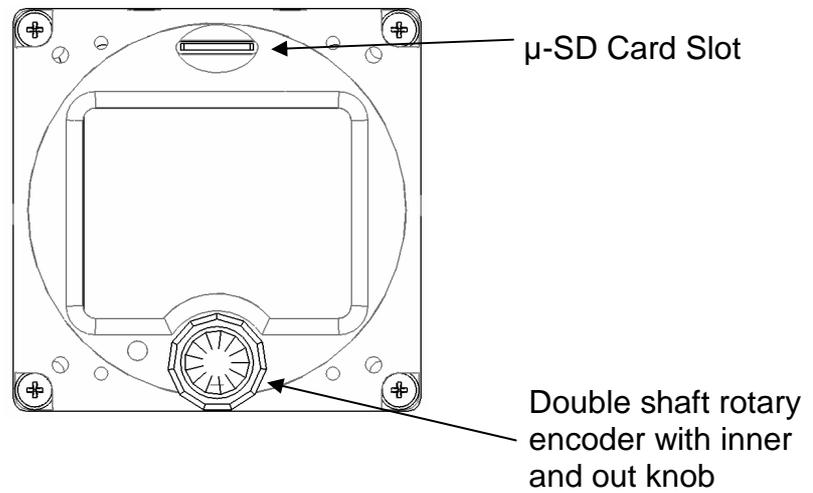
Additional to the LCD screen, the TRX-2000 provides a double shaft rotary encoder for user input. The inner (smaller) knobs provides push button capability. The double shaft rotary encoder is the main user input device. The following chapters decribe the system functions step by step.

3.2. Switching on and off

Pressing the inner knob of the rotary encoders shortly switches on the TRX-2000. The LCD backlight flashes after powering up the device. Then the following screen appears.

TRX-2000 **GARRECHT** **Avionik**	**Startup screen TRX-2000**
Software : TRX_v0.18 Flarmnet : v. 000949 built-in Flarm	**Status report TRX-2000:** **Software**: Firmwareversion TRX 2000 **Flarmnet** Version of internal FLARMNet-DB **Status report FLARM®:** **built-in Flarm** internal FLARM detected **external Flarm** external FLARM detected **selftest** FLARM self test running **detected µSD-Card** FLARM detected SD card **updates Obst-DB** Updating FLARM obstacle DB **updates Firmware*** Updating FLARM firmware **saves IGC files*** FLARM writes IGC Files to SD card **hangs on SDC*** FLARM hangs **in unknown state*** FLARM in onknown state .
12:21:01 UTC GPS TX	The ready state device shows the screen shown beside The squares indicate the status of GPS and FLARM® transmitting device (green = operational, rot = not operational) When receiving traffic data (FLARM® or ADS-B/Mode-S the screen switches to the traffic page automatically.
⏻ **Switching Off...**	For switching off, press and hold the inner knob of the rotary encoder until the system switches off. The shutdown process is indicated as shown beside.
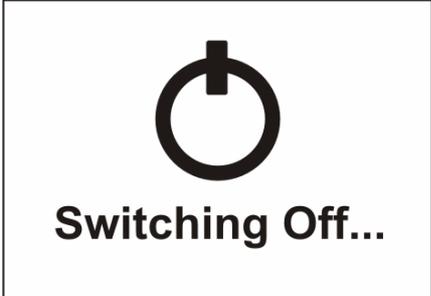
3.3. System configuration

Configuring the TRX-2000 via the human machine interface requires external power. Some settings (i.e. port configuration can be performed using the TRX-TOOL PC software only.

A portable PC / Notebook with installed TRX-TOOL is required

General notes for navigation through the menu and setting up parameters:

1. Pressing the inner rotary knob for appr. 2 sec. invokes the setup menu.

2. Rotating the inner knob of the rotary encoder selects the different menu items

3. Pressing the inner knob of the rotary encoder enters the selected sub menu.

4. Rotating the inner knob of the rotary encoder changes parameters in the selected and entered menu.

5. Pressing the inner knob of the rotary encoder or rotating the outer knob exits the configration menu.

The menue item shown in the table below are available for setting up the device.

Display screen shot	Description of the submenu
Configuration Main Menu	**Warning Volume** Setup of buzzer volume (only one volume level at the moment) **Privacy Settings** Setup for suppressing specific data (vertical speed, position) broadcasted by FLARM®. Warnings are not affected by this setting. **ADS-B Settings** Invoke the ADS-B Setting sub menu
ADS-B Configuration Menu	**Own Aircraft ID** Enter your own 24 Bit aircaft address for suppressing warnings from your own Mode-S transponder. **Horizontal Range** Defines the maximum horizontal ADS-B receiving range [1…25km, ALL] , ALL = unlimited **vertical Range** Defines the maximum vertical ADS-B receiving range [+-100…1500m, ALL], ALL = unlimited Range Settings no not affect the maximum FLARM® receiving range
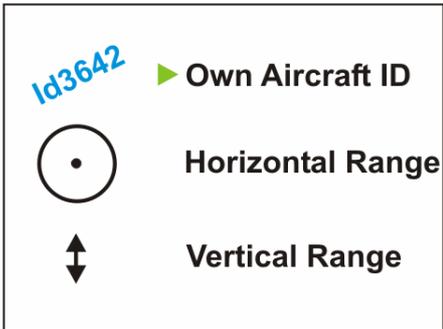
4. Traffic indication

Depending on the traffic situation, the system screen shows the different screens shown below:

Status display w/o traffic

No traffic in defined receiving range. FLARM® status and UTC time is indicated.
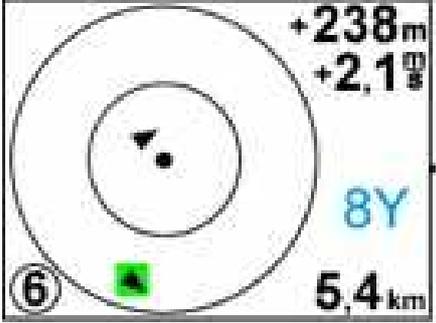
Radar view 6km Radius (outer circle)

Radar view 1km Radius (outer circle)

Radar view 0,5km Radius (outer circle)

ADS-B Traffic within the defined receiving range or received FLARM® traffic invokes the radar view of the TRX-2000

The system screen provides three zoom levels, which can be changed by rotating the outer knob of the rotary encoder.

Aircaft outside the maximum scale are displayed beyound the outer circle.

Rotatng the inner knob of the rotary encoder selects the indicated targets (green inverted). Additional information of the selected aircfraft are shown on the left hand side of the screen.

Pressing the inner knob of the rotary encoder invokes a detail page for indicating additional information of the selected aircraft (see chap. 4.3 - FlarmNet)

The Out of Range display indicates the selected target is out of receiving range.

For internal reasons, the maximum range is limited to 46,8 km.

4.1. Radar view

Additional information of the selected target (aircraft) are indicated as hown below:
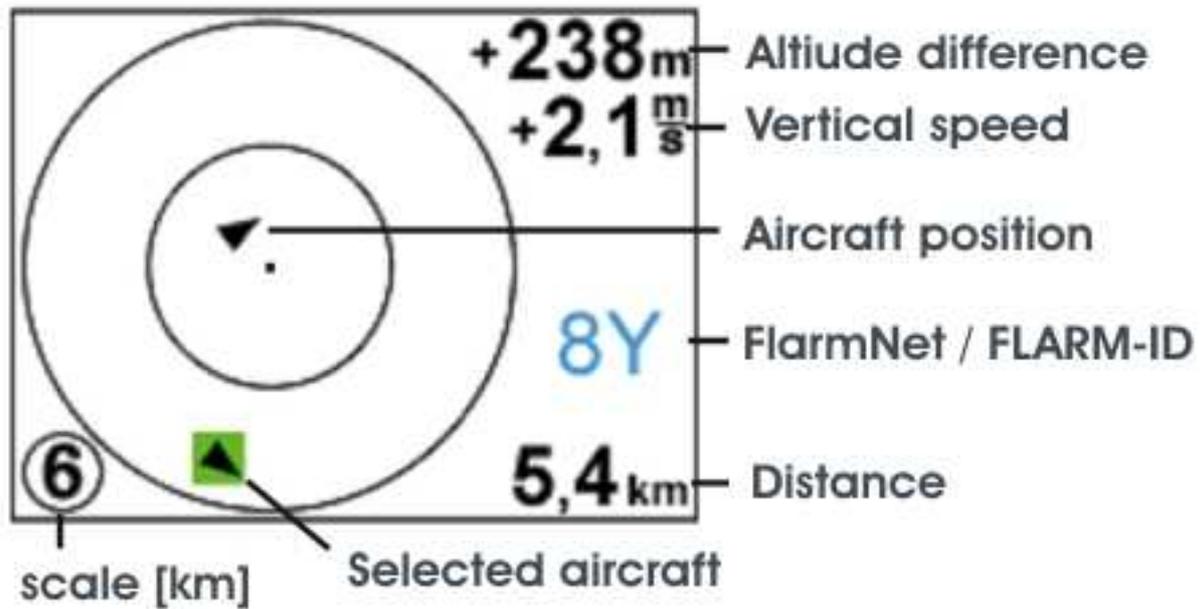
Screen symbols	Definition
	Thermaling aircraft within the receiving range
	Cruising aircraft are indicated as arrow shape symbol. The arrowhead indicated the flight direction.
	Aircraft with activated FLARM® stealth mode are indicated as black square without additional information.

4.2. List view

The TRX-2000 provides a list view of all aircraft within the receiving range, sorted by distance.

List view	Numeric information of • current altitude difference [m] • horizontal Distance [km] • vertical speed [m/s] • The arrow indicated aircraft position related to own position and TRK • Flarm- or Mode-S Adresse or FLARM®-CoID, if target data has been registered to FlarmNET and the FlarmNET file is installed on the TRX-2000

4.3. FlarmNET view

Detailed information about received aircraft is provided by the FlarmNet Page.

FlarmNET is a service provided by Butterfly Avionics Ltd.

Please check

www.flarmnet.org

for detailed information and registering for sharing your data with other users.
FlarmNet assigns aircraft and pilot data to a your specific Flarm-ID. IF you enter your Flarm-ID and information about your aircraft, other people can display these data in their devices if they also use FlarmNet.

FlarmNet screen	Pressing the inner knob of the double shaft rotary encoder invokes the FlarmNet page for displaying additional information: **FLARM - ID:** Shows FLARM-ID or 24 Bit Mode-S Adress **CoID:** Competition ID or Flight-ID **Name:** Pilot's name (from FlarmNET database) **Type:** aircraft type (from FlarmNET database) **Reg.:** aircraft registration (from FlarmNET database) **Airport:** Home airport (from FlarmNET database) **Freq.:** Frequency (from FlarmNET database) **Hinweis:** All information is provided only, if a valid FlarmNet file has been uploaded into the TRX-2000 memory. Not all pilot or aircraft owners share their data with FlarmNet. So the information might be incomplete. Please also check **www.flarmnet.org** for more information.

4.4. Traffic warning

4.4.1. FLARM®- and ADS-B out targets
The TRX-2000 detects dangerous situations, caused by FLARM® or ADS-B out equipped aircaft crossing the own predicted flightpath. Warnings are provided visual as shown below.

	Collision warning One FLARM® or ADS-B out equipped aircraft in 10 o' clock position, distance 0,6km, flying below the own altitude rises up to a dangerous situation
	Collision warning Two aircraft at 10 o' clock are causing a dangerous situation. Number of dangerous aircraft is shown in the red direction bubble.
	Collision warning and potential dangerous situation If avoiding of the collision (red bubble) would result in a new dangerous situation (i.e. close flying team partner) a grey bubble indicates the potential dangerous aircraft close to the own position.
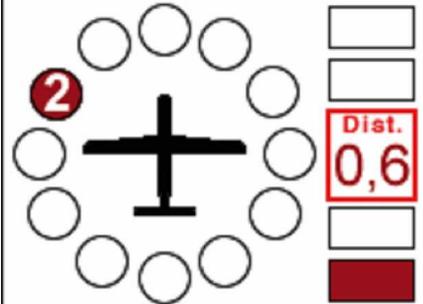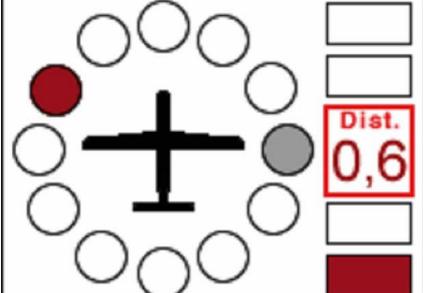
4.4.2. Mode-S targets without ADS-B out
Warnings generated from Mode-S (no ADS-B out) equipped aircraft are displayed as undirected warnings. The distance is estimated from the signal strength and might be inaccurate. Altitude informations are decoded from the transponder replies and indicated related to the own altitude. No direction information is provided in this case (= undirected warning)

	Undirected warning A potential dangerous target moves 343 m above the own altitude in an estimated distance of 0,64km.

4.5. Obstacle warnings

The FLARM® obstacle database allows warnings from obstacles installed on ground (such as power lines, cable cars in the European Alps area. More than 35.000 coordinates of 11.000 ground installed obstacles are stored in the database.

Updates of the obstacle database need to be performed via microSD card of the TRX-2000.

The obstacle database is under sole control of FLARM Technology GmbH. Garrecht Avionik GmbH does not take any responsibility for the data provided In this database.

	Osbtacle warning (updated every secound) Warnings are generated also, if flying underneath an object (i.e. powerline). No vertical position information is provided for obstacle warnings.
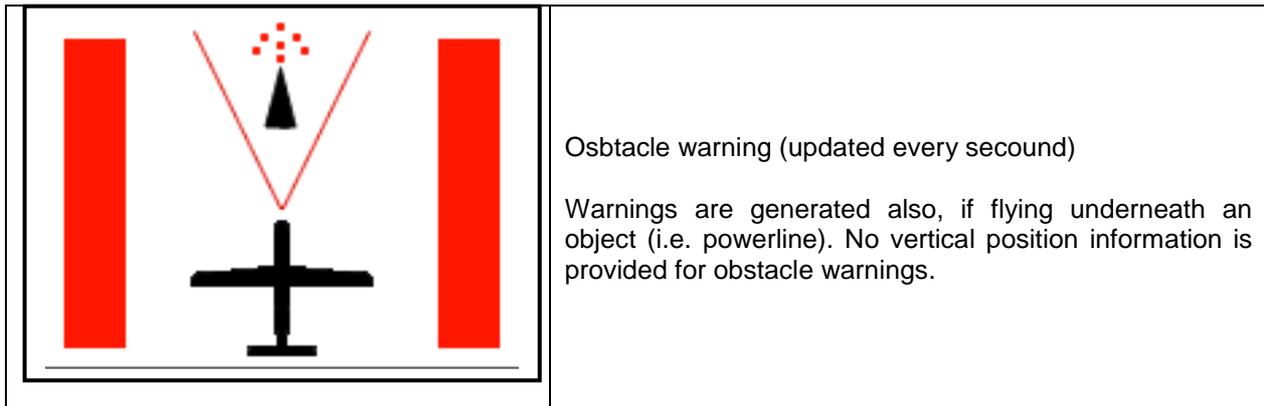
5. Firmware updates (FLARM + TRX-2000) via mircoSD-Card

The integral FLARM® module requires the same update procedures and interval as an original FLARM® system. In the same step, the TRX-2000 Firmware and the FLARM-Net file should be updatet to the newest release.

The FLARM® firmware update is mandatory. Please read the statement of the FLARM-Team for detailed information about the 2011 update:

FLARM Software Maintenance 2011

*Every few years, all FLARM devices have to undergo a scheduled maintenance through software update. The next such free, but mandatory update is due end February 2011 for version 4; this behaviour is explained in the operating manual. **Update now for free both software version 5 and obstacle data, in any case before the next flight!***

Release 5 contains a new, higher performance FLARM engine which will be able to process more aircraft, a major redesign of the software required for integration of FLARM-features into hang-gliders and powered aircraft (PowerFLARM), its software-data-fusion with transponder-data and related requirements from regulators like EASA and FCC. This requires a modification to the radio communication amongst the units where we introduce frequency hopping to increase the radio bandwidth and reliability as well as some back-and-forth radio bursts for checking radio communication quality. In addition, version 5 accepts all sizes of microSD cards. An updated obstacle database, which has grown to over 35'000 objects is available, too.

When is the next scheduled service update due?
*Since its creation FLARM has maintained scheduled updates, initially in a one year cycle, in 2006 a two year cycle, and last time in 2008 a three year cycle. As the technology matures, we further extend this period to now four years, i.e. **version 5 expires on March 1, 2015**. This is more convenient for some users, but slows down the innovation cycle, possibly delaying the use in new applications.*

Why scheduled, mandatory updates?
The ability to update the whole network without being limited by constraints of the past is one of the key features of FLARM and has allowed it to adapt to rapidly expanding requirements. Many parts of aircraft require scheduled maintenance; this is not a concept which is new to aviation.

Best regards
The FLARM team

(from: www.flarm.com)

5.1. Step by step instruction

5.1.1. General information about required files

TRX-2000 related files:

TRXDB.B02:   FLARM®Net database snapshot (created 02/2011)
TRXFW20.B01:   TRX-2000 Firmware file, Rev. 20

Alle TRX-2000 related files are provided for download at section "Support.Downloads.TRX-2000"on www.garrecht.com.

FLARM® related files:

Flarm_50x.fw: FLARM® Firmware file, Rev. 5.0x (x may indicate a number)
alps20110124_.obs: FLARM® Obstacle database (created 24 JAN 2011)

All FLARM® related files are provided for download at section "Mandatory Update 5.0"on www.flarm.com.

5.1.2. Prepare your microSD memory card (SDSC, no SDHC type) for the update process

1. Remove all old .fw und .obs files from the memory card
2. Create the folder GAV in the root of the memory card
3. Copy the files TRXDB.B02 und TRXFW20.B01 into the subfolder GAV of the memory card
4. Copy the files flarm_50x.fw und alps20110124_.obs into the root of the memory card

5.1.3. Performe the update process

1. Switch of the TRX-2000 and disconnect the external power supply
2. Insert and lock the prepared microSD card into the microSD card slot of the TRX-2000
3. Re-establish external power supply and switch on the TRX-2000
4. The unit performs the firmware update of the TRX-2000 (not FLARM® firmware) first. The LCD backlight illumination starts blinking periodically and the TRX-2000 restarts few times.
5. After performing the TRX firmware update succecssflly, the device restarts and the integral FLARM® module will detect the memory card.
6. The integral FLARM® module starts the firmare update and the update of the obstacle database (NOTE: This process takes 2-3 min.)
   DO NOT BREAK THE POWER SUPPLY NOR SWITCH OFF THE DEVICE DURING THE UPDATE PROCESS!!
7. After completing the firmware and file updats, the screen of the TRX-2000 shows firmware revisions of TRX and FLARM® firmware as well as the revisions of the FLARM® Net file and the obstacle database.

6. PC Software *TRX-TOOL*

Configuring the system interfaces requires using the TRX-TOOL PC software. Die Konfiguration der Geräteschnittstellen erfolgt über das Programm *TRX-TOOL*. . A PC with Windows XP or newer is required to run the software. The TRX-1090 will be powered via USB during the configuration process.

In some cases, the output power of the PC USB port might be insufficient for powering the TRX-2000 and the system must be powered via an external power supply

The newest release of the TRX-Tool is available free of charge on the manufacturer's website.

www.garrecht.com

6.1. Step by Step instruction for successfull installation process

1. Do not connect the TRX-2000 to your PC
2. Download the TRX-2000 installer from the manufacturer's website and store it on your computer
3. Start the installation by double clicking the downloaded file.
4. Follow the instructions of the installer
5. Connect the TRX-2000 to the USB port of your PC to complete the USB / FTDI driver installation and follow the instructions shown in the dialogs
6. Start the software after successfull installation to check for updates (internet connection required)
7. Updates will be installed, if available
8. After the update process, the software needs to be restarted.
9. A connection will be established now. TRX-Tool show the status of the connection
10. If an older firmware will be detected, the TRX-Tool offers to update the TRX-1090 by a newer version.
11. TRX-Tool is ready for use now.
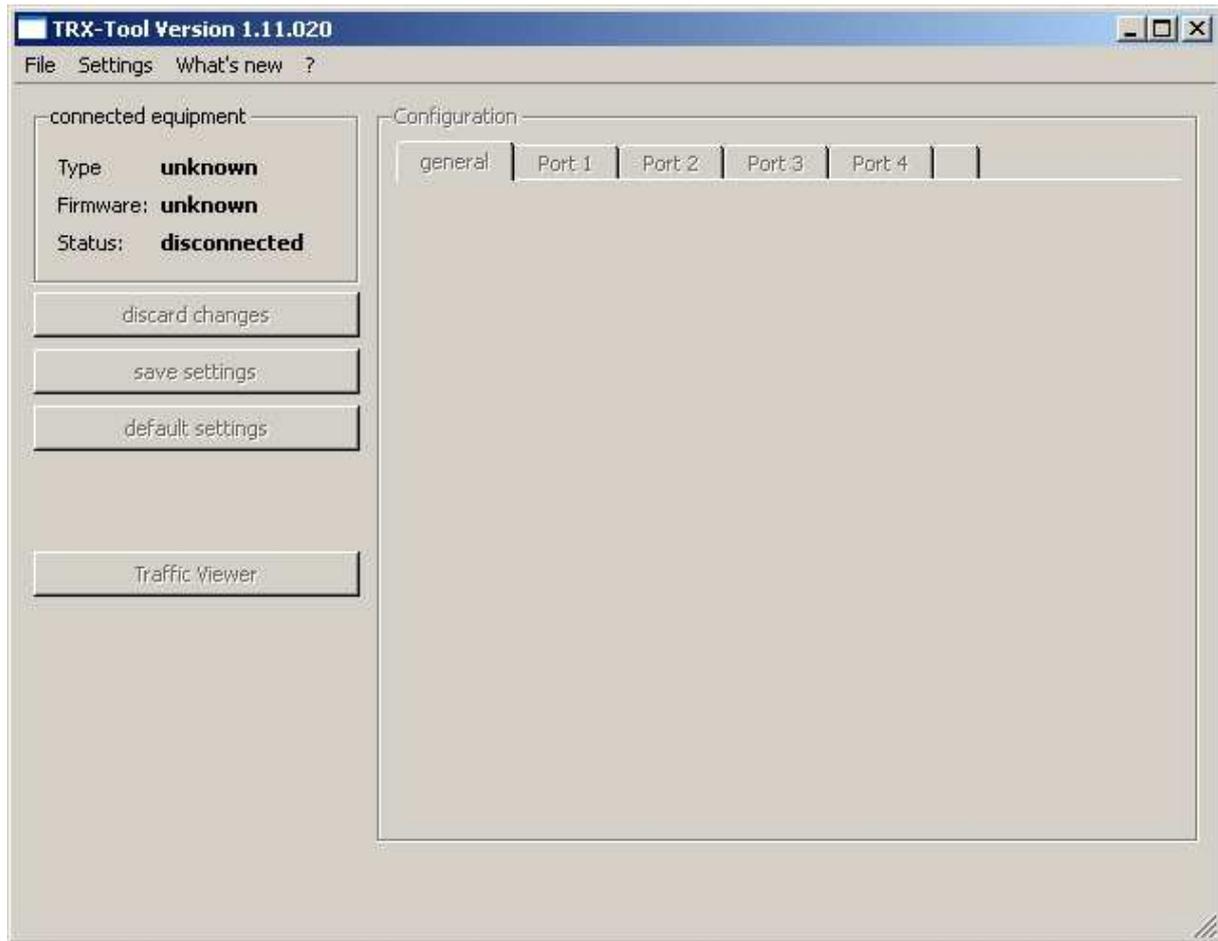
TRX-Tool main window (no TRX connected)

6.2. Software and firmware release

The title bar of the TRX-TOOL shows software release of the TRX-Tool (1.11) and integrated firmware release for the connected TRX device (020).

6.3. Program and firmware update via internet
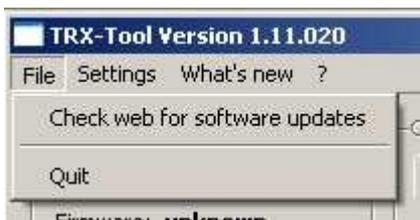
The TRX-TOOL checks the web automatically for newer release. This process can be invoked manually vie File.Check web for software updates.

6.4. Device configuration
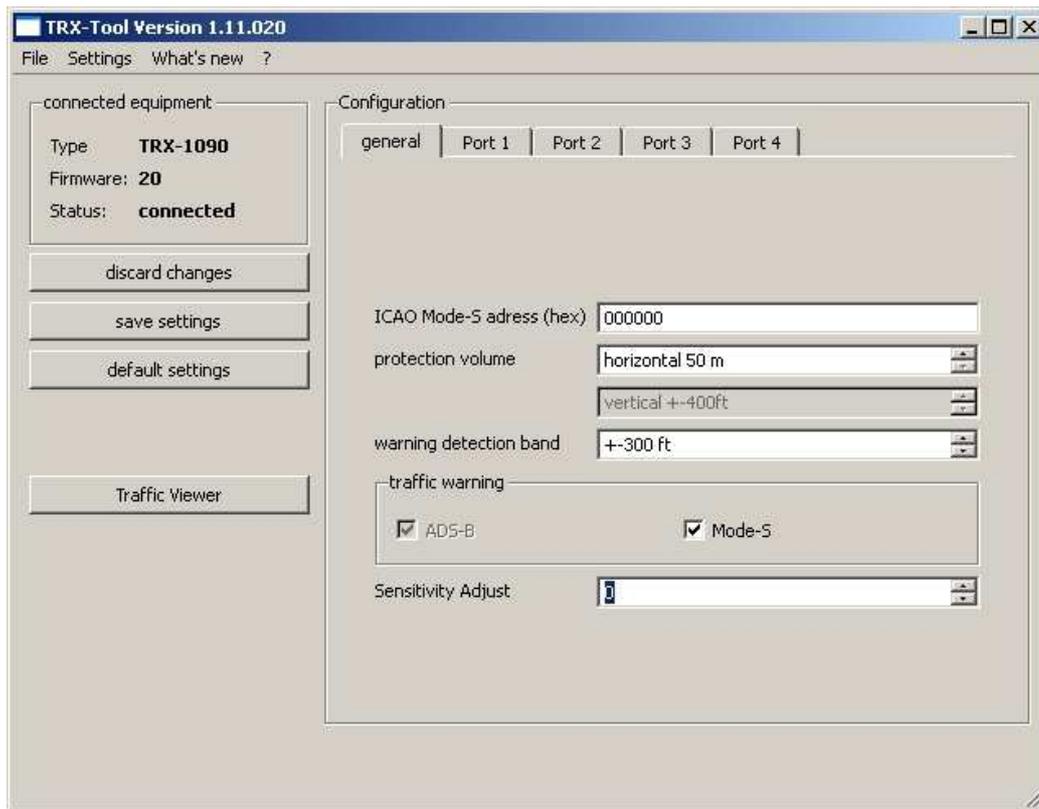
TRX-Tool main window (TRX device connected)

	Type: Detected TRX device **Firmware:** Reports firmware release of connected TRX device **Status:** Reports the connection status **If status is COMM ERROR, either the USB drivers are installed inproperly, no external power is supplied to the TRX device or the system is switched off.**

	Discard changes Reloads stored configuration data from connected TRX device. Settings made in the TRX-TOOL will be overwritten without further notification. **Save settings** Transfers current configuration data made in the TRX-TOOL to the TRX device. **Default settings** Resets all user configuration in the TRX-TOOL to factory setting. Transfering the default data to the TRX device must be triggered by clicking **Save Settings.** **Traffic Viewer** Starts a basic traffic viewer to show live ADS-B and FLARM® traffic

ICAO Mode-S Adresse
Enter your own 24 Bit ICAO Mode-S adress to suppress warnings from own transponder

Protection volume
If falling below BOTH values, a warning will be generated to indicate dangerous situation in case of change the flight direction.

Warning detection band
Aircraft within this altitude band are considered in the collision avoidance algorithms.

Traffic warning

ADS-B
Activates warnings of ADS-B out equipped aircraft (this feature can not be disabled)

Mode-S
Activates warnings of Mode-S equipped aircraft
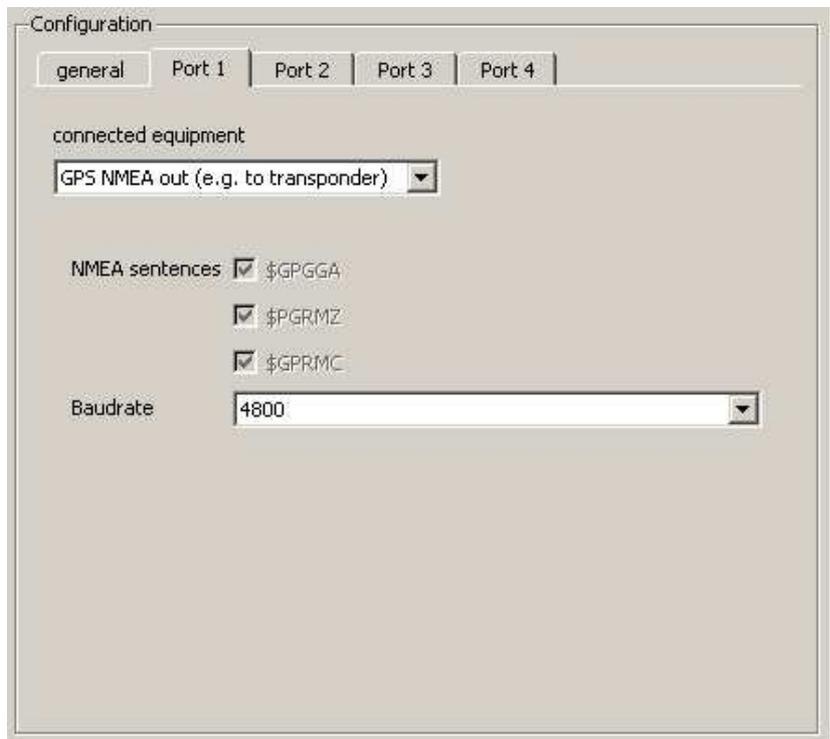
Configuration Port 1

This port is preconfigured as a NMEA output (i.e. for supplying Mode-S transponders with GPS data)

Baudrate

Sets up the baudrate for the NMEA data stream.

Consult the manual of the connected device for proper settings.

Configuration Port 2

This port can be configured for connecting FLARM basic (LED) displays or Flarm extended devices (such as Butterfly).

Connected equipment:

Preconfigures setttings depending on the choosen display type. Depending on the used display or your preferences, manuell modification of the settings might be required.

Hor. + vert. Range
Sets the maximum display range for indicating aircraft position

Baudrate
Sets up the baudrate for the data stream (consult the display manual for proper setting)

Display non-ADSB traffic

No
No warnings of aircraft without ADS-B out will be send from the TRX device.

As circling LED
Warnings of aircraft without ADS-B out will be indicated as rotating Bearing position / LED.

With empty bearing field
Warnings of aircraft without ADS-B out are interpreted from the connected display in an own manner. Please check the display manual for detailed information.

GPS data
Activates GPS data set in the data stream (requried for Flarm extended displays)

Configuration

| general | Port 1 | Port 2 | Port 3 | Port 4 |

connected equipment

Flarm-compatible custom display

horiz. Display range   ☐ unlimited   9900m

vert. Display range   ☑ unlimited

Baudrate   4800

display non-ADSB traffic   as circling LED

☐ GPS Data

Configuration Port 3
This port can be used for connecting Flarm basic or extended displays (see port-2) as well as for connecting display devices with GARMIN TIS compatible interface

Anschlußnutzung
Konfiguration des gewünschten Display-Typs

Anzeigebereich
Refer to port 2

For Garmin TIS protocoll:
Vertical range can be configured

Baudrate
Refer to port 2

Nicht-ADSB Verkehrswarnungen

Nein
Refer to port 2

Als umlaufende LED
Refer to port 2

Mit leerem Bearing Datenfeld
Refer to port 2

Displaytyp GARMIN

As circling balls
Rotating string of pearls around the own position

```
┌─ Configuration ──────────────────────────────────────────────┐
│  ┌─────────┬────────┬────────┬────────┬ Port 4 ┐              │
│  │ general │ Port 1 │ Port 2 │ Port 3 │        │              │
│                                                                │
│  connected equipment                                           │
│  ┌──────────────────────────────────┬───┐                     │
│  │ FLARM (original or compatible)   │ ▼ │                     │
│  └──────────────────────────────────┴───┘                     │
│                                                                │
│                                                                │
└────────────────────────────────────────────────────────────────┘
```

Configuration Port 4

This port is configured as FLARM I/O port. No change of settings are possible.

Note:
A TRX device configures a connected external FLARM® device to a 19.200 bps.

For restoring to factory settings. press the Button on the frontpanel of the external FLARM® device at least for 20 secs.

7. Check list installation and konfiguration

Check all items of the checklist shown below in order to verify your installation.

☐   TRX-2000 manual **<u>read and unterstood completely</u>**.

☐   TRX-2000 configured (i.e. protection volume, port configuration)

☐   24 Bit Mode-S aircraft adress entered in the TRX-2000 aircraft (only required, if the aircraft is Mode-S equipped)

☐   Device installed in suitable position.

☐   Connection to external displays established and tested

☐   All antennas installed in accordance with the instructions of the manual and connected to the device

☐   Shortbreaker installed

☐   All cables placed in right position. Cables overlengths tied in 8-shape loops, not in ring loops.

☐   Final test of complete system

☐   Emergency canopy release tested. and not impaired by installation

8. Specifications TRX-2000

Dimensions	61,5 x 61,5 x 131mm (WxHxD)
Mass	0.3 kg
Supply Voltage	9 - 16 V DC
Output voltage for external displays	3.3 V, max. 0.5A
Current consumption	Appr. 150mA @ 12V DC
Required circuit breaker	500 mA slow blow
Interfaces	4x RS-232 1x USB
Operating frequencies	ADS-B: 1090 MHz (RX) FLARM: 868 MHz (TX + RX)
Temperatures **Operating** **Storage**	-20℃ - +70℃ -30℃ - +80℃

9. Installation schematic diagram

TRX-2000 Wiring Diagram

Notes:
CDTI = Cockpit Display of Traffic Information

Note 1: Use 3.3V DC only for powering external CDTI

Note 2: reserved for future Audio out

TRX-2000

FLARM

ADS-B ANT / GND
FLARM ANT / GND
GPS ANT / GND

P2
1 Aircraft Power
2 Aircraft Power
3 (*1) 3.3 V DC
4 RS-232 GND
5 RS-232 TX 2
6 RS-232 RX 2
7 Aircraft GND
8 Aircraft GND

P1
1 Aircraft Power
2 Aircraft Power
3 n.c.
4 (*2) reserved
5 RS-232 RX 1
6 RS-232 TX 1
7 Aircraft GND
8 Aircraft GND

P3
1 Aircraft Power
2 Aircraft Power
3 3.3 V DC (*1)
4 RS-232 GND
5 RS-232 TX 3
6 RS-232 RX 3
7 Aircraft GND
8 Aircraft GND

P4
1 Aircraft Power
2 Aircraft Power
3 n.c.
4 n.c.
5 RS-232 RX 4
6 RS-232 TX 4
7 Aircraft GND
8 Aircraft GND

FLARM connector:
1 Aircraft Power
2 Aircraft Power
3 3.3 V DC
4 RS-232 GND
5 RS-232 TX
6 RS-232 RX
7 GND
8 GND

GPS Ant.
FLARM Ant.
ADS-B Ant.
Antenna Groundplane

RF1
RF2
RF3

CDTI

Avionik Bus
0,5A T

NMEA-out to ADS-B out capable Mode-S Transponder
GND

10. Dimensions