ART
Advanced Realtime Tracking

ART Hardware Installation Guide

ARTTRACK, AT7-50, AT7-80, & DTRACK

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The following changes have been done:

- NRTL certificate added for ***AT7-50***

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The following products have been added:

- ***DTRACK4***
- ***AT7-50***

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Terms and definitions

term	definition
3DOF	three degrees of freedom (i.e. only position)
6DOF	six degrees of freedom (i.e. position and orientation)
5DOF	five degrees of freedom (i.e. one degree less in orientation)
base	imaginary connecting line between two cameras
ARTTRACK6/M	infrared camera dedicated for compact environments or multi-sided projections
AT7-80	infrared camera dedicated for long range environments
AT7-50	infrared camera dedicated for standard range environments
body calibration	teach the system the geometry of a rigid body
body, rigid body	rigid arrangement of multiple markers intended for 6DOF tracking (see also "target")
calibration angle	belongs to the room calibration set and defines origin and orientation of the room coordinate system
ceiling suspension	equipment to mount an infrared camera to the ceiling
DTRACK4	
backend software	software service running on a customer's computer or dedicated PC doing all necessary calculations
frontend software	graphical user interface running on customer's computer to control the backend software
Field of View (FoV)	is the area of interest captured on the camera's image
finger thimble	a fixture for the finger tip to hold the active marker(s)
Fingertracking2	tracks the orientation of the hand and the position of the fingers
Fingertracking2 Tactile	tracks the orientation of the hand and the position of the fingers and provides Tactile Feedback
Flystick2/2+	wireless interaction device for virtual reality (VR) applications
Flystick feedback	vibrational or acoustic signal that can be triggered in a capable ***Flystick***
hand geometry	describes the dimensions of your hand and fingers
hybrid tracking	sensor fusion of optical and inertial data into one consolidated output
inertial sensor	an inertial measurement unit simultaneously measures 9 physical properties, i.e. angular rates, linear accelerations (unused) and magnetic field components (unused) along all 3 axes. This is achieved using solid state gyroscopes for measurement of roll, pitch and yaw and optical tracking for drift correction.
infrared optical tracking	position measurement of bodies (subjects or objects) based upon infrared light and optical measurement procedures
license code (license key)	software key to unlock certain capabilities of the tracking system
marker	object either made of retro reflective material or LED for position tracking (3DOF)
Measurement Tool	a pointing device which allows to measure the position of the tool's tip with high accuracy
measurement volume	defines the volume where optical tracking is possible
modulated flash	infrared signal which is used for wireless synchronization
motion capture	track movements of a human body
mutual blinding	at least one camera sees disturbing reflections caused by the infrared flashes of another camera
prediction	predicts output for the specified time in the future to compensate tracking and rendering latency
Radio Transceiver	exchange data with ***Flystick2/2+***

term	definition
RadioTransceiver2/3	uses USB port to exchange data with ***Flystick2/2+*** or ***Fingertracking2 Tactile***
room calibration	teach the system the position of each camera and define origin and orientation of the room coordinate system
room calibration set	consists of angle tool and wand
syncgroup	cameras being in one syncgroup receive the sync signal at the same time. Syncgroups are distinguished by a short time delay between their sync signals in order to avoid mutual blinding.
Tactile Feedback	system for finger-based interactions in immersive virtual reality applications (wires touch the inside of the finger tips and provide an impression when they are shortened)
target	rigid arrangement of multiple markers intended for 6DOF tracking (see also "rigid body")
tracking	position measurement of bodies that move in a defined space
virtual point cloud	used for calculating the relative position of cameras that cover the measurement volume
wand	precalibrated stick carrying two markers. The wand belongs to the room calibration set and is used to generate a virtual point cloud and to scale the measurement volume

1 Safety

1.1 Symbols and their meaning

You can find the following symbols and signs on the equipment or in the manual:

	Useful and important notes.
	Important notes, which may lead to system malfunction or to the loss of warranty by non-observance.
	Important safety warning to assure user's and operational safety. These warnings have to be observed, otherwise there is a potential risk for health and safety and damaging of the equipment resulting in loss of warranty and liability.
	Safety warning for infrared radiation. These warnings have to be observed, otherwise the user's eyes and sight are exposed to a potential hazard.

Table 1.1: Symbols and their meaning

1.2 Warnings



All warnings in this manual have to be observed for safe operation of the equipment.



Tous les avertissements dans ce manuel doivent être respectés pour garantir un fonctionnement sécurisé de l'équipement.



***ART* explicitly denies any warranty and liability if the product is not operated according to this manual or any other authorised documentation (e.g. quick-guides) or not according to the specifications of the equipment.**

1.2.1 Installation



The housings may NOT be damaged.



Do not install or use any equipment when it shows signs of damage (e.g. smoke, sparks, fire, smells, etc) or if parts of it show damaging.



Do not install or use any equipment when the power cord is damaged.



Insert batteries in the indicated polarity !



Insérer les piles dans le sens de polarité indiqué !



Some equipment employs connectors of proprietary design. Do not try to connect these to any other computer ports (e.g. COM port or LAN) !!!



Verify that voltage and frequency of your electrical grid comply with the appliance ratings of the equipment. The rating plates are found on the equipment's housing (typically on the rear side) or on the external power supplies.



Vérifiez que la tension et la fréquence de votre réseau électrique correspondent aux spécifications de l'appareil. Les plaques signalétiques se trouvent sur le boîtier de l'équipement (l'arrière du boîtier) ou sur l'alimentation externe.



The equipment may only be powered from power sockets connected to earth/ground. If the grounding wire is defective the requirement of the safety and the electromagnetic compatibility (EMC) cannot be guaranteed. To check the function of the grounding wire ask your local electrician.



L'équipement ne peut être alimenté que par des prises de courant reliées à la terre/au sol. Si le fil de mise à la terre est défectueux, les exigences de sécurité et de compatibilité électromagnétique (CEM) ne peuvent être garanties. Pour vérifier le fonctionnement du fil de mise à la terre, demandez à un électricien local.



The power switch on the equipment does not separate the device from mains. The equipment must be disconnected from mains.

1.2.2 Mounting



Do not touch the front pane of the cameras. The acrylic pane and the lens have highly sensitive surfaces. Be careful to avoid permanent damages (e.g. scratches).



Shock and severe vibrations can permanently damage the internal calibration of the cameras. De-calibrated cameras have to be sent in for maintenance.



The power cord and plug should be accessible freely. The power socket should be close to the equipment.



Install the cables that the line of sight of the cameras or *SMART-TRACK3+3/M* is not obstructed.



Grab the cameras only on the housing. Risk of Electrostatic Discharge (ESD) !



Tenez les caméras uniquement par le boîtier. Risque de décharge électrostatique (ESD) !



Do not drop the equipment.



Be sure that the cameras are firmly mounted using strong wall plugs / anchors and screws when mounting to walls or ceilings. Loosely mounted cameras may pose a serious hazard to health and safety.



Never unfasten screws that are not designed for mounting. All liability and warranty is void.



Use only accessories for mounting (screws, ceiling suspension) supplied by *ART* .



Ventilation holes on the equipment must not be covered. Ensure unblocked airflow at all times. The minimum distance between equipment and surrounding objects has to be larger than 3 cm.



Install a strain relief to all cables to avoid damage to the equipment.



Install the cables trip-proof (e.g. cable ducts or fixings). Inappropriate cabling may pose a serious hazard to health and safety.



Installez les câbles de manière à les protéger contre les risques (par exemple, en utilisant des canalisations ou des fixations pour câbles). Un câblage inapproprié peut représenter un grave danger pour la santé et la sécurité.

1.2.3 Operation



Unplug the equipment from mains immediately in any case of damage ! Please contact *ART* service



Removable batteries must be removed before shipping equipment.



Batteries should be removed when equipment is not used for a longer period of time - Risk of damage !



Do not use non-rechargable batteries in rechargable equipment (e.g. *Flystick2*) - Risk of explosion !



Ne pas utiliser de piles non rechargeables dans des équipements rechargeables (par exemple, *Flystick2*) - Risque d'explosion !



Do not crush or puncture batteries and avoid impact that might result in damage, leakage or short-circuiting.



Use only original components and accessories from *ART* or authorized by *ART* . Using unauthorized components or accessories may damage the equipment, may cause malfunctioning and may compromise operational safety.



Utilisez uniquement des composants et accessoires d'origine de *ART* ou autorisés par *ART* . L'utilisation de composants ou accessoires non autorisés peut endommager l'équipement, provoquer des dysfonctionnements et compromettre la sécurité opérationnelle.



In case connectivity is provided using third party equipment please ensure compliance to all applicable standards regarding connectivity and power supply (see chapter A on page 67). Non-compliance may result in loss of conformity ! All warranty and liability is void.



Only peripheral devices which meet the safety requirements of UL 60950-1 (U.S. only) and EN / UL / IEC 62368-1 (EU, U.S., etc.) for SELV may be attached on Ethernet-, BNC- and the DC-circuit of the equipment.



Do not change or modify the equipment in any way (e.g. mechanically, electrically). Non-compliance may result in loss of conformity ! All warranty and liability is void.



Do not spill fluids over the equipment!



Do not insert objects into the equipment (e.g. ventilation openings) !



Do not expose the equipment to high levels of humidity or condensing environments.



Ne pas exposer l'équipement à des niveaux élevés d'humidité ou à des environnements où la condensation est possible.



The equipment must not be operated in environments with intensive formation of dust.



L'équipement ne doit pas être utilisé dans des environnements avec une formation intense de poussière.



The equipment must not be operated in environments with elevated temperatures above 40° C (100° F).



L'équipement ne doit pas être utilisé dans des environnements avec des températures élevées supérieures à 40° C (100° F).



Do not use the equipment outdoors (i.e. outside of buildings or potentially moist / wet locations) !



Ne pas utiliser l'équipement à l'extérieur (c'est-à-dire en dehors des bâtiments ou dans des endroits potentiellement humides / mouillés) !



The cameras emit infrared light. Keep a distance of min. 20 cm when operating near cameras. All cameras are assigned to the Exempt Group according to IEC62471-1 and therefore pose no risk or hazard to the human eye or skin at this distance.



Les caméras émettent de la lumière infrarouge. Gardez une distance minimale de 20 cm lorsque vous travaillez à proximité des caméras. Toutes les caméras sont classés dans le Groupe Exempt selon la norme IEC62471-1 et ne présentent donc aucun risque ou danger pour les yeux ou la peau humaine à cette distance.

1.2.4 Maintenance



Only the housing of the cameras may be cleaned, do not touch lenses or other optical components. Before cleaning shut down the system and disconnect the power cords.



Do not use any solvents, water or chemicals to clean the cameras!



Do not try to repair anything by yourself!



All warranty and liability is void when the equipment is opened.



Danger High Voltage inside the equipment ! Do not open the equipment ! Risk of electric shock - even if the equipment is disconnected. Please contact *ART* service.



Danger Haute Tension à l'intérieur de l'équipement ! Ne pas ouvrir l'équipement ! Risque de choc électrique - même si l'équipement est déconnecté. Veuillez contacter service *ART* .



In order to replace mains fuses always unplug the power cord first. Risk of electric shock !



Pour remplacer les fusibles secteur, débrancher toujours d'abord le cordon d'alimentation. Risque de choc électrique !



Risk of explosion if removable batteries are replaced by an incorrect type!



Risque d'explosion si les batteries amovibles sont remplacées par un type incorrect!

1.2.5 Disposal & Recycling



Waste Electronic and Electrical Equipment (WEEE) should never be disposed of along with household waste.



Batteries should never be disposed of along with household waste.



Batteries or rechargeable batteries that are not permanently installed must be removed beforehand and disposed of separately.



To prevent fires due to short-circuits, tape battery terminals and/or place lithium-ion batteries in separate plastic bags.



Do not crush or puncture used batteries and avoid impact that might result in damage, leakage or short-circuiting.

2 General Information

2.1 Cleaning of the equipment



Use a dry, lint-free and antistatic cloth or tissue (e.g. lens-cleaning tissue for optical equipment).



Only the housing of the cameras may be cleaned, do not touch lenses or other optical components. Before cleaning shut down the system and disconnect the power cords.



Do not use any solvents, water or chemicals to clean the cameras!

2.2 Maintenance and service

Routine maintenance of the equipment is recommended every three years. If you experience any problems please do not hesitate to contact our support.



Do not try to repair anything by yourself!



Danger High Voltage inside the equipment (e.g. *ART Controller*) ! Do not open the equipment ! Risk of electric shock - even if the equipment is disconnected. Please contact *ART* service.



Danger Haute Tension à l'intérieur de l'équipement ! Ne pas ouvrir l'équipement ! Risque de choc électrique - même si l'équipement est déconnecté. Veuillez contacter service *ART* .



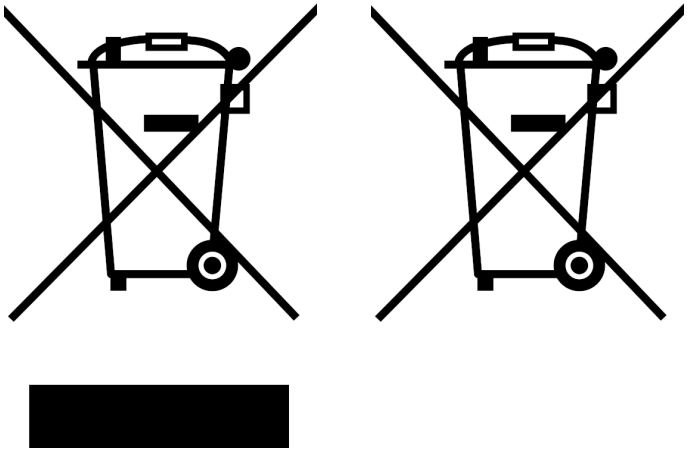
All warranty and liability is void when the equipment is opened.

2.3 Disposal and recycling of equipment

Waste Electronic and Electrical Equipment (WEEE) may contain a complex mixture of materials and hazardous substances. If not managed properly and thus exposed, these can cause serious damage to the environment, wildlife, and human health. In addition, modern electronics contain rare and expensive resources, which can be recycled and re-used to contribute to the circular economy. By ensuring that you dispose of WEEE properly, you are helping to improve sustainable production and consumption, to increase

resource efficiency and to preserve our natural resources and protect human health.

The symbol (crossed-out wheelie bin symbol according to Waste Electronic and Electrical Equipment (WEEE) Directive 2012/19/EU, see figure 2.1 (a) or (b) on page 15) indicates that the product should not be discarded as unsorted municipal waste but must be sent to separate collection facilities for recovery and recycling.



(a) equipment placed on the market prior to 2005

(b) equipment placed on the market after 2005

Figure 2.1: WEEE label

When your delivery address is outside of Germany, dispose of WEEE at your local waste facilities or recycling centers available by public waste management authorities only. Please consider that local regulations on the disposal of and recycling of electronic and electrical equipment may apply. Contact your local authority directly for more information.

For deliveries inside Germany only:

- End-users of WEEE are obliged to return the equipment or have it collected within the framework set up by ***ART*** .
- You are responsible for deleting personal or confidential data from the equipment to be disposed of. You can do this by resetting the device to its factory settings. Please refer to ***DTRACK4 User's Guide*** → *Connecting to the controller* → *Configuring your controller's network address without network access* for more details. ***ART*** is not liable for any data on your device. Before resetting your device, you should always back up any sensitive data.
- For further details regarding the WEEE directive, including how ***ART*** ensures the safe disposal of your electrical and electronic equipment, please refer to our website at `https://ar-tracking.de/de/art-geraete-ruecknahmekonzept`



Waste Electronic and Electrical Equipment (WEEE) should never be disposed of along with household waste.

2.4 Disposal and recycling of batteries

Batteries are made from important resources, including lead, cadmium, zinc, lithium and mercury. Many of the components of these batteries and rechargeable batteries could be recycled, avoiding the exposure of hazardous substances to the environment. In addition, by recycling your used batteries using the collection and recycling schemes available you are contributing to protecting Earth's natural resources by providing valuable materials to products and production processes.

The symbol (crossed-out wheeled bin symbol according to Battery Directive 2006/66/EC, see figure 2.1 (b) on page 15) indicates that you are legally obliged to dispose of batteries or rechargeable batteries separately from unsorted municipal waste, i.e. that they must be disposed of separately from household waste. If batteries or rechargeable batteries contain Mercury (Hg), Cadmium (Cd) or Lead (Pb), they are marked with the chemical symbols of the metals (Hg, Cd, Pb) for which the limit value is exceeded.

- Pb = battery contains more than 0.004 mass percent Lead
- Cd = battery contains more than 0.002 mass percent Cadmium
- Hg = battery contains more than 0.0005 mass percent Mercury

When your delivery address is outside of Germany, dispose of used batteries at dedicated battery collection points or recycling centers available by public waste management authorities only. Please consider that local regulations on the disposal of and recycling of batteries may apply. Contact your local authority directly for more information.

For deliveries inside Germany only:

- End-users of batteries are obliged to recycle used batteries via dedicated battery collection points or recycling centers set up by public waste management authorities or via retailers directly. Addresses of suitable collection points and recycling facilities in your area can be obtained from your city or by contacting your local authorities.
- For further details regarding the Battery Directive, please refer to our website at `https://ar-tracking.de/de/art-geraete-ruecknahmekonzept`



Batteries should never be disposed of along with household waste.



Batteries or rechargeable batteries that are not permanently installed must be removed beforehand and disposed of separately.



To prevent fires due to short-circuits, tape battery terminals and/or place lithium-ion batteries in separate plastic bags.



Do not crush or puncture used batteries and avoid impact that might result in damage, leakage or short-circuiting.

2.5 Warranty

General Please refer to the terms & conditions on our website at https://ar-tracking.com/en/terms-agb

Hardware ***ART*** warrants the hardware to be free from defects in material and workmanship, design and manufacturing for the warranty period set forth in our terms & conditions (see website) after the time of delivery. The time of delivery is defined as the day when the end-user takes possession of the equipment. If ***ART*** or any third party authorized by ***ART*** installs the system, the time of delivery is the time of the first installation.
If a defect arises during this warranty period, provided the instructions for returning the hardware are followed, ***ART*** will, to the extent permitted by law, initially either (i) repair or (ii) replace the hardware or any defective parts. All replaced parts and hardware shall become property of ***ART*** . This limited warranty applies only to hardware components that have been under ordinary and intended use and service being in their original, unmodified state and thus have not been subject to damage from external causes, alteration or unauthorized repair.

Software Software supplied is delivered on a tested "As Is" basis. ***ART*** explicitly does not warrant that the software is error (bug) free. If the user detects bugs and notifies ***ART*** , ***ART*** will provide a workaround or bug fix as soon as possible after successfully reproducing the error.

Warranty restrictions All warranty and liability is void, if the equipment

- is not operated according to this manual or any other authorized documentation (e.g. quick-guides),
- has not been used according to the specifications of the equipment,
- shows damages or signs of improper use,
- has been opened by the user or other non-authorized personnel (non-members of ***ART*** and third parties not authorized by ***ART***),
- has been modified or tampered with by the user or other non-authorized personnel (non-members of ***ART*** and third parties not authorized by ***ART***).

2.6 Liability

General Please refer to the terms & conditions on our website at https://ar-tracking.com/en/terms-agb

In no event shall ***ART*** be liable for any incidental, indirect or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business

interruption, loss of business information, or any other pecuniary loss) arising out of the use of or inability to use the software or hardware.

Measurement results *ART* products are not authorized for use under any circumstance where human life might be at risk due to malfunction, measurement errors or interrupted operation of the system without written approval of a managing director of *ART* .
It is the user's sole responsibility to check the results of the measurement data and to protect any downstream system against malfunction, measurement errors or interrupted operation of the system. Under no circumstances shall *ART* be held liable for any incidental, indirect or consequential damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information, or any other pecuniary loss) arising out of malfunction, measurement errors or interrupted operation of the system.



***ART* explicitly denies any warranty and liability if the product is not operated according to this manual or any other authorized documentation (e.g. quick-guides) or not according to the specifications of the equipment.**



Do not change or modify the equipment in any way (e.g. mechanically, electrically). Non-compliance may result in loss of conformity ! All warranty and liability is void.

3 Introduction to tracking

The ***ART*** tracking systems are infrared (IR) optical tracking systems. In this user manual we are going to perceive "tracking" as measurement of positional and rotational information (i.e. orientation) of objects or individuals that move in a defined space.

Concept of optical tracking The cameras send out synchronized IR flashes which are reflected back into the lens by retro-reflective material covering the markers of the target. The reflected IR light is detected by the tracking cameras which create a greyscale image based on the received IR radiation.
In the next step these images are preprocessed by the cameras to calculate the marker positions (2DOF) on the camera sensor with high accuracy using pattern recognition algorithms. Then this 2DOF data is sent to a control unit to calculate 3DOF or 6DOF information. The simultaneous measurement of spatial position (X, Y, Z) and orientation (three independent angles) is called 'six degrees of freedom' (6DOF) tracking. If just the spatial position (X, Y, Z) is to be measured it is called 'three degrees of freedom' (3DOF) tracking.

The base for these calculations is that the cameras' field of views are overlapping. In a two-step teaching process, the position and orientation of the cameras is made known to the system (the 'room calibration'), after which the system is taught to identify the arrangements of markers as targets (the 'body calibration'). Then the paths of the optical rays from the cameras to the markers are calculated to deliver the ray intersections in three-dimensional coordinates. These intersections are the positions of the markers.

For 6DOF tracking, a target consists of a rigid arrangement of markers. The system uses the relative positions of these markers to identify the target geometry and determine the position and orientation of the body. Multiple targets with identical marker geometry can be tracked as separate instances of the same body. Figure 3.1 on page 20 shows the concept of infrared optical tracking with a two-camera system and a standard target. Single markers are sufficient if only 3DOF coordinates are needed, but single markers cannot be distinguished in principle. An ID is assigned to a tracked 3DOF marker as long as it can be followed, but after loosing the tracking (e.g. due to occlusions) one would not be able to re-identify the marker and thus a new ID will be assigned.

Based upon this, one is able to finally know position and orientation of the target and therefore the object or individual to be tracked.

Note: In pure stereo-based optical tracking systems tracking is only possible as long as

- objects or individuals to be tracked are equipped with single markers or targets

- the target is not occluded by any other objects in the cameras' line of sight, which could even be the object itself
- the target is positioned inside the tracking range of the cameras
- at least four markers of a target are visible to at least two cameras (this step enables tracking).

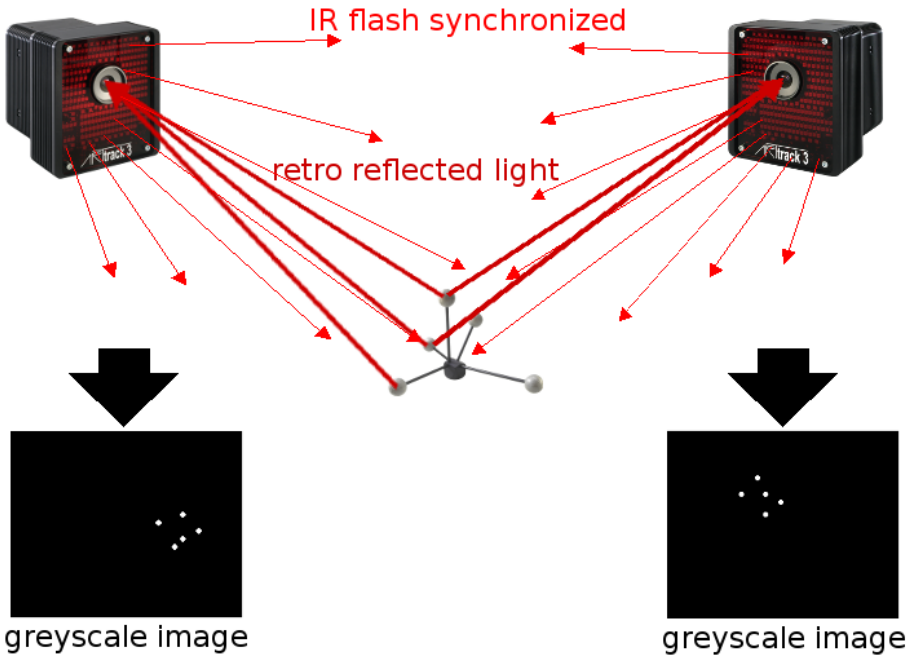


Figure 3.1: Concept of optical tracking (stereo vision)

One Camera Continuation Tracking An occlusion can leave a body visible to only one camera. If the body is already being tracked and the remaining camera still sees enough of its markers, tracking can continue and provide both position and orientation (6DOF). Initial detection of the body still requires observations from at least two cameras.

Marker types Passive markers are covered with retro reflective material - they act as light reflectors. Active light emitters (i.e. based on infrared LEDs) are called active markers (see chapter 7 on page 57).

Hybrid tracking (via 3rd party software) In addition to tracking by a pure optical system it is possible to utilize data from inertial measurement units (IMU). These devices usually consist of several components such as gyroscopes, accelerometers and magnetometers. The underlying principle is the combination of solid-state microelectromechanical systems with integrated circuits and analog or digital outputs to achieve 6DOF rotational information.

Some of the most important advantages of hybrid tracking are:

- tracking data from IMUs offers low noise-levels while running at very high frequencies in combination with low latencies
- IMUs deliver tracking data (i.e. rotational information) even when the optical target is not inside the tracking volume or if the target cannot be tracked due to viewing limitations or occlusions
- drifting of IMUs (i.e. mostly from the 3-axis gyroscope) is compensated by fusing the inertial data with position measurements calculated from the optical tracking system

A hybrid target is basically an optical target additionally equipped with an IMU.
There the tracking data from both worlds (i.e. hybrid) is combined, which also leads to the term 'sensor fusion'. By nature the IMU contains an independent coordinate system which needs to be aligned to the optical tracking system axes. This additional teaching process is called hand-eye calibration.

Tracking with *DTRACK4* All ***DTRACK4*** systems are based on a software service rather than a controller which operates cameras, interaction devices (optional) and targets respectively. The cameras (refer to chapter 4.1 on page 22) and the interaction devices (refer to chapter 6 on page 44) have to be connected to the respective PC running the service when using ***DTRACK4*** .
The backend software runs as a service on a PC - all necessary calculations (3DOF, 6DOF data, etc.) are performed there. The data and control commands are interchanged between the service and the ***DTRACK4*** frontend software either locally or via ethernet (TCP/IP connection) with a remote PC. ***DTRACK4*** frontend offers a GUI for easy handling that enables the user to control the tracking system at a distance. The benefit is that the system becomes more flexible, i.e. different users can control the tracking system at any one time (but not simultaneously!) from different working places.
Data output to the application or graphics workstation is also done via ethernet (UDP/IP connection).

DTRACK4 also provides the possibility to control the functions in the backend via ethernet (i.e. without the ***DTRACK4*** frontend software). This is also done by establishing a TCP/IP connection with the service and exchanging short command strings (refer to the ***DTRACK4 Programmer's Guide***).

4 Hardware Components

4.1 Cameras

4.1.1 *AT7-80*



Keep a distance of min. 20 cm when operating the camera ! The camera is assigned to the Exempt Group according to IEC62471-1 and therefore poses no risk or hazard to the human eye or skin at this distance.

Description The ***AT7-80*** infrared camera is intended for working environments with distances between camera and markers of up to 18 metres (see figure 4.1 on page 22). By default the ***AT7-80*** is equipped with a 4.8 mm lens. Depending on the application and the setup the ***AT7-80*** can be equipped with other lenses (i.e. with different focal lengths). Refer to A.1 on page 67 for a list of available focal lengths and the respective Field of View.

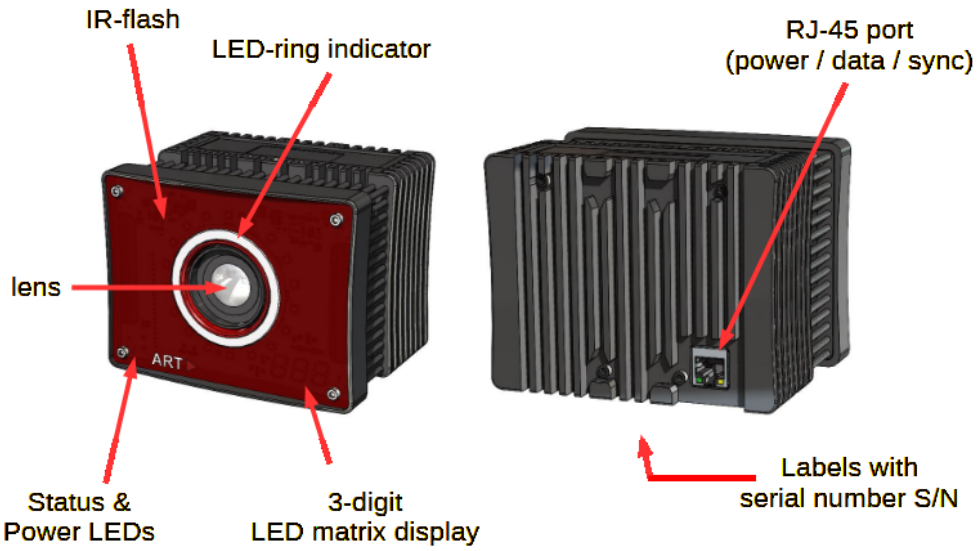


Figure 4.1: Camera ***AT7-80*** - Description of LEDs and interface connectors

4.1.2 *AT7-50*



Keep a distance of min. 20 cm when operating the camera ! The camera is assigned to the Exempt Group according to IEC62471-1 and therefore poses no risk or hazard to the human eye or skin at this distance.

Description The ***AT7-50*** infrared camera is intended for working environments with distances between camera and markers of up to 15 metres (see figure 4.2 on page 23). By default the ***AT7-50*** is equipped with a 3.5 mm lens. Depending on the application and the setup the ***AT7-50*** can be equipped with other lenses (i.e. with different focal lengths). Refer to A.1 on page 67 for a list of available focal lengths and the respective Field of View.

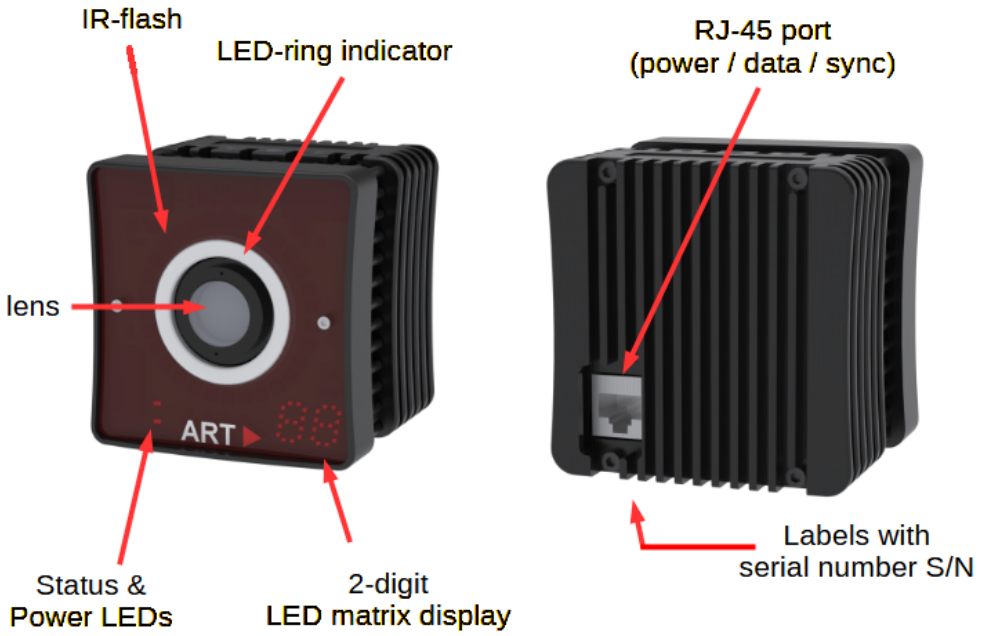


Figure 4.2: Camera ***AT7-80*** - Description of LEDs and interface connectors

4.1.3 *ARTTRACK6/M*



Keep a distance of min. 20 cm when operating the camera ! The camera is assigned to the Exempt Group according to IEC62471-1 and therefore poses no risk or hazard to the human eye or skin at this distance.

Description The ***ARTTRACK6/M*** infrared camera is intended for working environments with distances between camera and markers of up to 3.5 metres (see figure 4.3 on page 24). By default the ***ARTTRACK6/M*** is equipped with a 2.9 mm lens. Depending on the application and the setup the ***ARTTRACK6/M*** can be equipped with other lenses (i.e. with

different focal lengths). Refer to A.1 on page 67 for a list of available focal lengths and the respective Field of View.

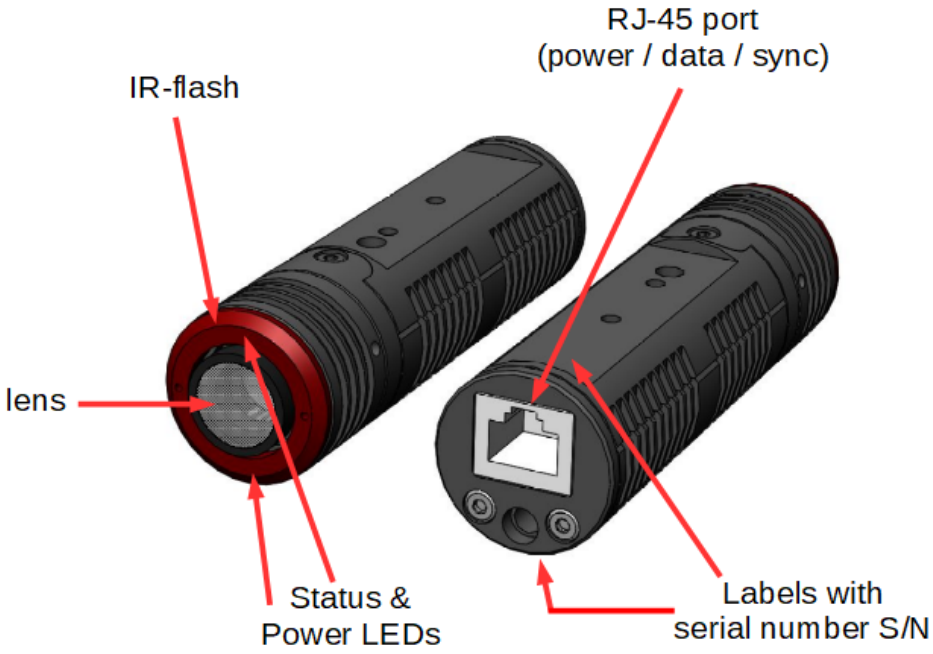


Figure 4.3: Camera ***ARTTRACK6/M*** - Description of LEDs and interface connectors

4.2 *DTRACK4*

Description All ***DTRACK4*** based multi-camera systems are controlled by a Microsoft Windows-based service (***DTRACK Backend Service***) which operates cameras, interaction devices (optional) and targets respectively and where all necessary calculations (3DOF, 6DOF data, etc.) are performed.

4.2.1 *DTRACK Backend Service* and *DTRACK4 Frontend*

For installation of both ***DTRACK Backend Service*** and ***DTRACK4 Frontend*** please refer to ***DTRACK4 User's Guide*** → *Installing the DTRACK4 software* for details.

Please insert the CmStick USB copy-protection dongle (WIBU-SYSTEMS) in one of the USB slots and restart the PC after the installation of *DTRACK Backend Service* has been finished.

Please do not insert more than 1 CmStick USB copy-protection dongle (WIBU-SYSTEMS) in the *DTRACK Backend Service* PC.

After changing the CmStick USB copy-protection dongle (WIBU-SYSTEMS) the *DTRACK Backend Service* has to be restarted manually (e.g. using the *DTRACK4 Frontend*)

4.2.2 Compatibility

	DTRACK4
ARTTRACK6/M	×
AT7-80	×
AT7-50	×
Flystick2	×
Flystick2+	×
Fingertracking2 [1]	×
Fingertracking2 Tactile [1]	×
Measurement Tool	×

[1] for ***Fingertracking*** it is recommended to use six cameras for ideal operation

Table 4.1: Compatibility of ***DTRACK4*** with ***ARTTRACK*** cameras, interaction devices and controllers

4.3 Other equipment

4.3.1 PoE+ switch for larger systems

Description In all ***DTRACK4*** systems (i.e. ***AT7-80*** , ***AT7-50*** , ***ARTTRACK6/M***), please use compatible switches authorized by ***ART*** (refer to figure 4.4 on page 26 and table 4.2 on page 25).

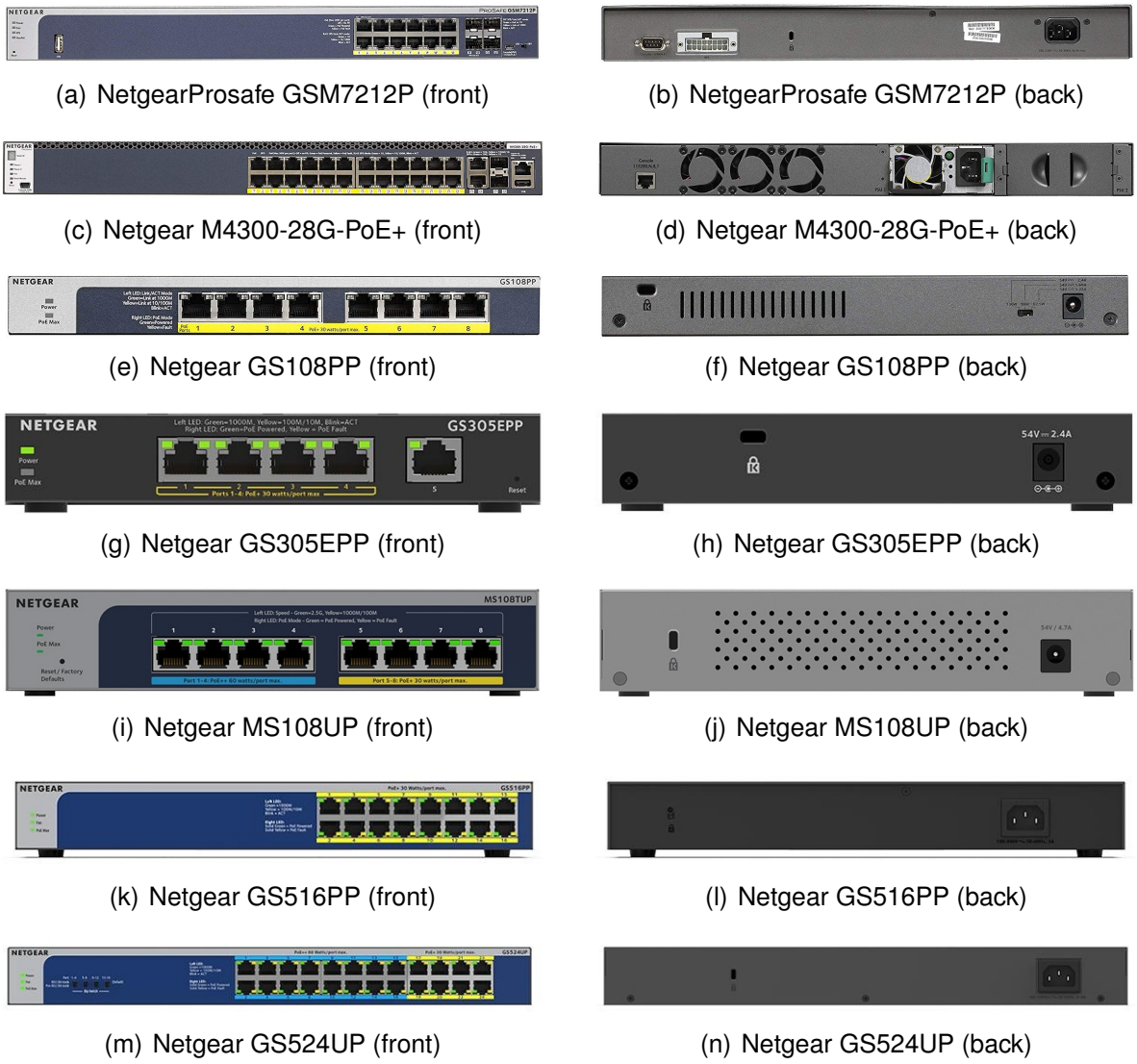
Type	*ports*	*Description*
Netgear Prosafe GSM7212P PoE+	12	See note [1,2,3]
Netgear M4300-28G-PoE+	24	See note [1,2,4]
Netgear GS108PP	8	See note [2,7]
Netgear GS305EPP	4	See note [2,3]
Netgear MS108UP	8	See note [2,5]
Netgear GS516PP	16	See note [2,6]
Netgear GS524UP	24	See note [2,4]

[1] Please use the accessible ports without protective caps only.
[2] To turn on the PoE+ switch, please connect it to mains or external power supply respectively.
[3] max. 4 ***AT7-80*** supported
[4] max. 18 ***AT7-80*** supported
[5] max. 8 ***AT7-80*** supported
[6] max. 9 ***AT7-80*** supported
[7] not authorized with ***AT7-80***

Table 4.2: Compatible PoE+ switches authorized by ***ART***

☞ **Please allow min. 3 minutes for booting prior to starting *DTRACK4* !**

☞ **Due to non-default settings do not tamper with the configuration of all managed switches authorized by *ART* . Ask your *ART* representative for details when necessary.**



(a) NetgearProsafe GSM7212P (front)

(b) NetgearProsafe GSM7212P (back)

(c) Netgear M4300-28G-PoE+ (front)

(d) Netgear M4300-28G-PoE+ (back)

(e) Netgear GS108PP (front)

(f) Netgear GS108PP (back)

(g) Netgear GS305EPP (front)

(h) Netgear GS305EPP (back)

(i) Netgear MS108UP (front)

(j) Netgear MS108UP (back)

(k) Netgear GS516PP (front)

(l) Netgear GS516PP (back)

(m) Netgear GS524UP (front)

(n) Netgear GS524UP (back)

Figure 4.4: View of PoE+ switches authorized by *ART*

Only PoE(+) switches and PoE(+) injectors that meet the applicable regional safety requirements may be used to power the cameras (e.g. EN 62368-1 within the EU, UL 62368-1 in the U.S., etc.).

Use only original components and accessories from *ART* or authorized by *ART* . Using unauthorized components or accessories may damage the equipment, may cause malfunctioning and may compromise operational safety.

In case connectivity is provided using third party equipment please ensure compliance to all applicable standards regarding connectivity and power supply (see chapter A on page 67). Non-compliance may result in loss of conformity ! All warranty and liability is void.

4.3.2 *RadioTransceiver2/3*

Description The ***RadioTransceiver2/3*** are used for radio communication with interaction devices such as ***Flystick2/2+*** or ***Fingertracking2 Tactile*** . Plug-in the ***RadioTransceiver2/3*** to any free USB port of the controller, then press *F2* in order to search for new hardware. Configuration is done automatically.
In case you need to change settings manually please refer to the ***DTRACK4 User's Guide*** .



Figure 4.5: USB Radio Transceiver3 - Description of LEDs

When ***DTRACK4*** is started, LED (1) (see figure 4.5 on page 27, square frame) turns on and indicates that the radio transceiver was correctly initialized; LED (2) extinguishes.

During measurements, LED (1) is flashing whenever data is received from or transmitted to the ***Flystick2/2+*** . In case of unsuccessful data transmission to the ***Flystick2/2+*** , LED (2) starts flashing.

During boot-up of the controller, LED (2) (see figure 4.5 on page 27, circular frame) is running continuously.

5 System setup

5.1 Camera orientation

While mounting the cameras it is vital to adjust the orientation of each camera respectively such that the measurement volume is covered completely by the field of view (FoV) of all cameras.
On the one hand camera mounting has to ensure that tracking is possible over the entire measurement volume. On the other hand attention has to be paid to the fact that the calibration angle (for room calibration) can be seen completely by at least two cameras. When using multi-camera setups, the FoV of all cameras has to overlap sufficiently to enable the calculation of the photogrammetric orientation of all cameras in a common coordinate system, especially if the calibration angle can not be seen by each camera.

Furthermore it is important to remove disturbing reflections (refer to 5.6.1 on page 36) from the FoV of the cameras. Additionally this step is important to minimize mutual blinding of the cameras, i.e. the IR flash of one camera is inside the FoV of another(refer to 5.6.2 on page 37).

Therefore, as part of its GUI ***DTRACK4*** provides the *Monitor 2DOF display* which is a 2-dimensional graphical display or monitor for each camera equivalent to its field of view. At this point, you will probably find it most useful to become acquainted with the graphical user interface and the main window of ***DTRACK4*** . Please refer to the ***DTRACK4 User's Guide*** for detailed information.

5.2 Mounting the cameras

5.2.1 General requirements

The cameras are optimized for a predefined range of measurement volumes. System operation in significantly smaller or larger measurement volumes can lead to reduced accuracy. The measurement volume can be adjusted within certain limits simply by changing the flash intensity of the ***ART*** infrared cameras (see ***DTRACK4 User's Guide*** → *Hardware* → *Cameras*).

Major changes of the measurement volume may require different lenses and thus a new determination of camera parameters. Please contact your ***ART*** representative.

The flash intensities should not be too high. In general, a flash intensity of 30-60 might be sufficient.

To further avoid problems no light sources or highly reflecting areas should be visible to the camera. Especially strong point light sources like e.g. halogen lamps and direct or reflected sunlight may imply problems for the measurement (fluorescent lamps are ok).

Make sure to install the system in a way that you can easily access the cameras and its cables.

Do not touch the front pane of the cameras. The acrylic pane and the lens have highly sensitive surfaces. Be careful to avoid permanent damages (e.g. scratches). Grab the cameras only on the housing.

Shock and severe vibrations can permanently damage the internal calibration of the cameras. De-calibrated cameras have to be sent in for maintenance.

The power cord and plug should be accessible freely. The power socket should be close to the equipment.

Do not drop the equipment.

Never unfasten screws that are not designed for mounting. All liability and warranty is void.

Use only accessories for mounting (screws, ceiling suspension) supplied by *ART* . Do not forget the toothed washer !

The ventilation holes of the equipment must not be covered. Ensure unblocked airflow at all times. The minimum distance between equipment and surrounding objects has to be larger than 3 cm.

5.2.2 Tripod mounting

Most *ART* cameras are equipped with UNC 1/4" threads on both sides and thus can be mounted to tripod heads directly. For *ARTTRACK6/M* just mount the T-piece (UNC 1/4" thread integrated) on the bottom of the camera (see figure 5.3 on page 32.

Mounting on tripods may be sufficient for presentations and preliminary installations, but is not suitable as a permanent solution!

5.2.3 Wall mounting

Be aware that a tracking system is very sensitive to camera movements. Therefore the cameras have to be mounted in a way that camera movements (especially vibrations) are reduced as much as possible.

Feel free to contact *ART* in case you want to realise a complex installation. We will assist you in your planning.

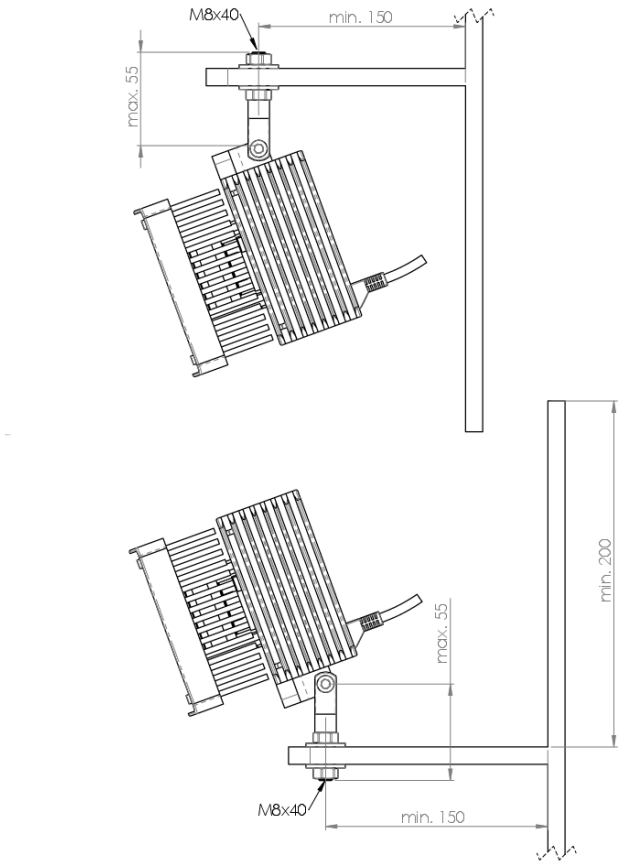


Figure 5.1: Mounting a camera to a wall or a ceiling (e.g. ***AT7-80*** camera)

Figure 5.1 on page 30 shows the correct mounting for a camera to a wall with a ceiling suspension using the example of an ***AT7-80*** camera. Make sure to keep a distance to the wall so enough room is left for the cables and to allow re-adjustment of the camera angles and in case for maintenance purpose. For easy adjustment it is highly recommended to attach the ceiling suspension in a way that the threaded bolt is vertical. This way heading and elevation of the camera view can be adjusted individually.

If in doubt, ask a skilled craftsman for assistance. Use massive and long enough angle irons to provide the required stiffness and stability.

Be sure that the cameras are firmly mounted using strong wall plugs / anchors and screws when mounting to walls or ceilings. Loosely mounted cameras may pose a serious hazard to health and safety.

5.2.4 Mounting the *AT7-80* and *AT7-50*

The ceiling suspension can be attached on both bottom and top side of the camera. Attach the carrier with the T-piece to the camera as shown in figure 5.2 on page 31. For more flexibility, the T-piece can be mounted pointing forward or backward. Note, the

threaded bolt is already connected to the carrier in figure 5.2.



Figure 5.2: Attaching the ceiling suspension to the *AT7-80* and *AT7-50* cameras

5.2.5 Mounting the *ARTTRACK6/M*

The ceiling suspension can be attached on two sides of the camera. Attach the carrier with the T-piece to the camera as shown in figure 5.3 on page 32. For more flexibility, the T-piece can be mounted pointing forward or backward. Note, the threaded bolt is already connected to the carrier in figure 5.3.

5.3 Installation of the tracking camera network

5.3.1 Installation of cables

Mount the cameras at the desired position before connecting the cables.

Please install the cables

- trip-proof so no one can trip over the cords,
- so the cords cannot be damaged,

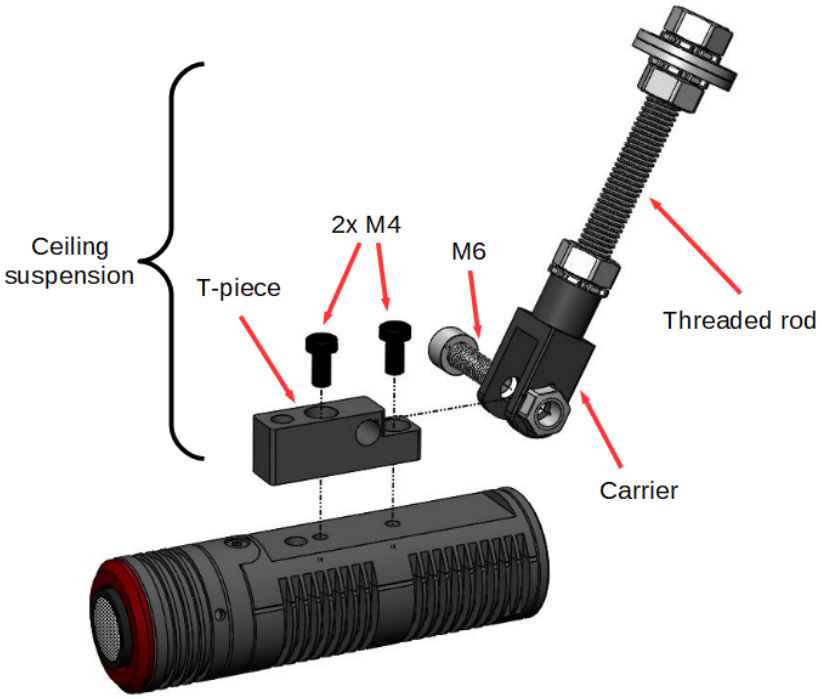


Figure 5.3: Attaching the ceiling suspension to the *ARTTRACK6/M* camera

- so the cords cannot damage the equipment due to mechanical strain,
- so the line of sight of the cameras is not obstructed.

The power cord and plug should be accessible freely. The power socket should be close to the equipment.

Install the cables that the line of sight of the cameras is not obstructed.

Install a strain relief to all cables to avoid damage to the equipment.

Install the cables trip-proof (e.g. cable ducts or fixings). Inappropriate cabling may pose a serious hazard to health and safety.

5.3.2 Connection of *AT7-80* , *AT7-50* and *ARTTRACK6/M* cameras

All *ART* cameras are designed as a single cable solution for data, power and synchronisation.

Systems with *DTRACK4* In all *DTRACK4* systems the use of a PoE+ switch is necessary. All *AT7-80* , *AT7-50* and *ARTTRACK6/M* cameras have to be connected via twisted pair cables (min. Cat 5, max. length 100 m) to a PoE+ switch. You can also build mixed

systems connecting different camera models to the same PoE+ switch. The PoE+ switch is then to be connected to any free ethernet port on the PC where the ***DTRACK Backend Service*** is installed.

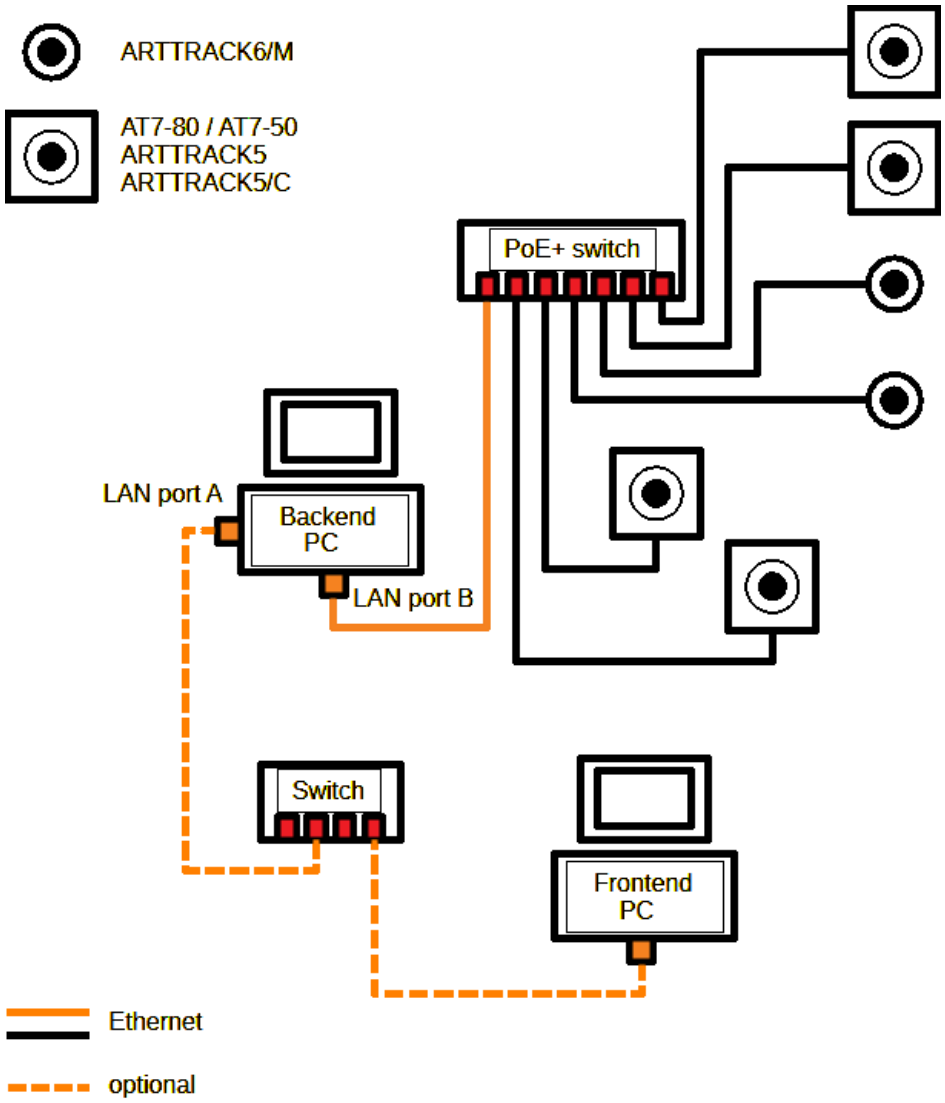


Figure 5.4: Connecting cameras to ***DTRACK4***

In order to configure your secondary network adapter for connection to the tracking camera network please refer to the ***DTRACK4 User's Guide*** → *Configuration of the network adapter*.

Please refer to the *DTRACK4 User's Guide* → *Configuration of the network adapter*

Your *DTRACK Backend Service* PC should offer at least 2 physical network adapters.

The camera IP addresses are predefined - changes by the user are not possible:

- **IP address: 172.28.X.X**
- **subnet mask: 255.255.0.0**

Please enable Jumbo Frames (min. size 9014 bytes) on your network adapter connecting to the tracking camera network!

Do not connect any discontinued cameras (i.e. *ARTTRACK2* , *ARTTRACK3* or *TRACKPACK/E*) via external PoE+ switches !

***DTRACK4* does not offer synchronization output for discontinued *ARTTRACK1* – *ARTTRACK3* or *TRACKPACK* cameras**

All PoE+ switches are designed to operate with *AT7-80* , *AT7-50* , *ARTTRACK6/M* , *ARTTRACK5* or *ARTTRACK5/C* cameras up to the designated power budget. Please check the combined power consumption of all connected cameras!

Use only original components and accessories from *ART* or authorized by *ART* . Using unauthorized components or accessories may damage the equipment, may cause malfunctioning and may compromise operational safety.

In case connectivity is provided using third party equipment please ensure compliance to all applicable standards regarding connectivity and power supply (see chapter A on page 67). Non-compliance may result in loss of conformity ! All warranty and liability is void.

5.3.3 Dynamically adding / removing of cameras

You can (dis-)connect additional cameras to the PoE+ switch without the need of restarting neither the switch nor the backend service. Please refer to ***DTRACK4 User's Guide*** → *Hardware* → *Search Hardware*) for details.

***DTRACK4* is able to operate when cameras have been added or removed; for best performance it is highly recommended to perform a room (re-)calibration**

5.4 Installation of peripheral devices

Please plug in all USB based peripheral devices in your designated PC running the ***DTRACK Backend Service*** .

- ***RadioTransceiver2/3*** for communication with ***Flystick2/2+*** (refer to chapter 4.3.2 on page 27).
- CmStick USB copy-protection dongle (WIBU-SYSTEMS)
- any other copy-protection dongles (e.g. for ART-Human)

5.5 Connection to local network LAN

The ***DTRACK Backend Service*** PC uses ethernet for data output to any PC within the local network. Figure 5.5 on page 35 shows two possibilities of system architecture using ***DTRACK4*** . You can either separate ***DTRACK Backend Service*** and ***DTRACK4 Frontend*** and install them on two different computers (left side of the figure) or you may install both instances on one PC (right side of the figure). In either case the ***DTRACK Backend Service*** PC will work as a client within your network, i.e. the tracking data is transmitted directly via your local network. A remote PC for running ***DTRACK4 Frontend*** will access the ***DTRACK Backend Service*** over the same LAN.

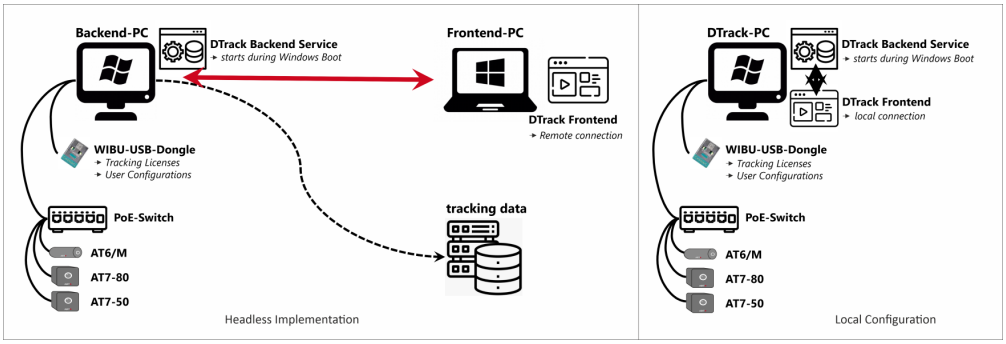


Figure 5.5: Connecting a ***DTRACK Backend Service*** PC to a local network

In case of security restrictions (e.g. company guidelines, that do not allow to connect the ***DTRACK Backend Service*** PC to your local network), you may also separate the data traffic (i.e. 6DoF tracking data and ***DTRACK4 Frontend*** connection data) from the rest of your local network by using dedicated switches that connect only to your application PC and your remote PC running the ***DTRACK4 Frontend*** respectively. As an alternative you may use the ***DTRACK4 Frontend*** on a remote PC as router for the tracking data. In this case install two network cards in your remote PC - one is connected to the ***DTRACK Backend Service*** PC and the other one is connected to your local network.



Using *DTRACK4 Frontend* as router to forward the tracking data to your application PC, will add an additional latency of approx. 1 ms.

5.5.1 Connection to LAN using DHCP

By default your ***DTRACK Backend Service*** PC like any other Windows PC is set up to support DHCP. Therefore, it will acquire an IP address that is automatically provided by a DHCP server.
If in doubt ask your system administrator for configuration of your primary network adapter. In order to configure your secondary network adapter for connection to the tracking camera network please refer to the ***DTRACK4 User's Guide*** → *Installing the DTRACK4 software*.

☞ **In case of LANs protected by firewalls all necessary ports for *DTRACK4* network communication have to be unblocked. Please refer to section A.4 on page 72.**

5.5.2 Connection to LAN using a static IP address

You may alternatively configure a static IP address on your primary network adapter to connect directly to a remote PC or other clients. Again please ask your system administrator for proper configuration.

☞ **Please note that changing the primary network adapter settings is not part of your personal configuration or Windows user account. Changes of the IP address will affect all users of your *DTRACK Backend Service* PC! Your *DTRACK Backend Service* PC may become unreachable with wrong IP settings!**

5.6 Camera setup recommendations

5.6.1 Localizing and removing of disturbing reflections

Possible sources of disturbing reflections may be diverse. Still all of them may be detected when starting the *Monitor 2DOF display* in ***DTRACK4*** . They are illustrated the same way as markers, i.e. with small coloured crosses or circles, depending on the distance to the camera (see figure 5.6 on page 36).

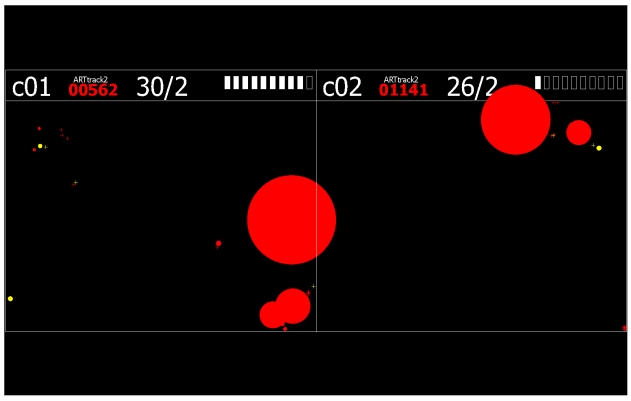


Figure 5.6: Typical situation arising from reflections through sunlight

Typically the reflections arise from one (or more) of the following points:

- active or passive targets that are inside the FoV / tracking range of the cameras,
- strong IR sources (e.g. sunlight or sunrays, halogen lamps, ...),
- mutual blinding of opposing or adjacent cameras
- any kind of reflective material on clothes or shoes (e.g. reflective tape on safety vests),

- blank metal surfaces that act as mirrors, especially curved surfaces and polished surfaces with 90° angles,
- some types of packaging foils.

For localising and removing disturbing reflections follow this simple approach:

- active targets or IR sources: reduce the flash intensity of all cameras to '0'
  Try to localize and remove the remaining markers / reflections which originate from infrared radiation sources (e.g. sunlight, halogen lamps, ...).
- mutual blinding: reduce the flash intensity of all cameras to '0', then set each camera's flash intensity to full one after the other
  Corresponding / opposing cameras can be easily identified. Re-mount the relevant cameras until *Monitor 2DOF display* does not show markers and the LED bar does not indicate levels of intensity. You may also assign different syncgroups at this stage. Please refer to chapter ***DTRACK4 User's Guide*** → *Hardware Configuration* → *Cameras* for further information.
- other non-specific reflections:set the flash intensity of all cameras to '50'
  Try to localize the reflection by moving a target or reflective marker towards the origin of the reflection (use the *Monitor 2DOF display*) and remove it.

5.6.2 Mutual blinding

Another possible source of disturbing reflections is mutual blinding of adjacent or opposing cameras that are inside the FoV of each other. This can be well observed in the *Monitor 2DOF display* as the cameras falsely identify the IR flashes as numerous flickering markers (i.e. clusters of crosses or circles). Tracking will be severely affected in the involved areas of the measurement volume / FoV. The intensity of the simulated LED bar next to the number of markers seen / used for tracking may serve as another indicator.
In order to distinguish from targets or other reflections please remove all reflective markers from the measurement volume in the first step. Then check whether the *Monitor 2DOF display* still shows the presence of markers and whether the LED bar shows high levels of intensity. Try to re-arrange or re-adjust the cameras (i.e. position and orientation).

Rarely there may also be mutual blinding that is not fully illustrated in the *Monitor 2DOF display*. Then only the simulated LED bar will indicate high levels of intensity whereas the presence of markers is missing (see figure 5.7 on page 38).

5.6.2.1 Assigning syncgroups

If reorienting the cameras seems not feasible, the cameras can also be assigned to different syncgroups, i.e. setting individual time delays for each camera in order to shift the IR flash / measurement of one camera in time from the measurement recording of another camera. In other words, a short time delay (typically < 1ms) is introduced between the measurements of two cameras which are assigned to different syncgroups. Thus the IR flash of one camera cannot be detected by the other and vice versa.

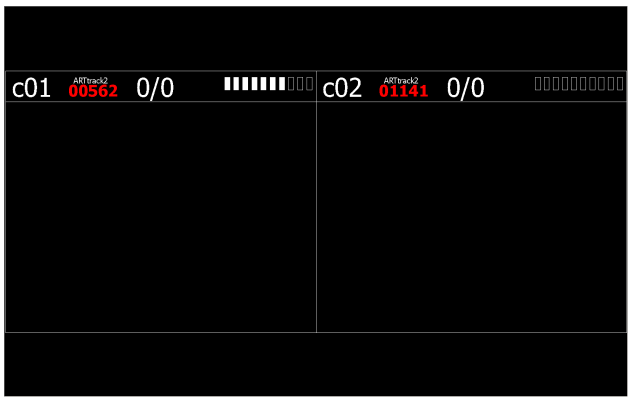


Figure 5.7: Mutual blinding without reflex illustration

Recommendation Assign opposing or adjacent cameras within the FoV of each other to different syncgroups (e.g. '*Channel 1*' and '*Channel 2*'). Cameras, that are outside of the FoV of each other (e.g. mounted on the same wall) should be assigned to the same syncgroup. For ***AT7-80*** , ***AT7-50*** and ***ARTTRACK6/M*** systems it is possible to configure the syncgroups via software. Please refer to the ***DTRACK4 User's Guide*** → *Hardware* → *Cameras* for further information.

5.6.3 Static reflex suppression

If, by any means, reflections cannot be eliminated completely you may use the static reflex suppression of ***DTRACK4*** ,i.e. blocking individual areas of the FoV / measurement volume to eliminate mutual blinding. ***DTRACK4*** , all ***ART*** cameras are able to suppress all reflections in defined areas of the image sensor. Scanning for static reflections allows searching the measurement FoV for unwanted reflections. Areas are defined on top of the visible reflections, where all data on the image sensor is neglected during measurements. This is especially important for setups in multisided projections or in the corner of a room where the cameras may suffer from unwanted reflections from the nearby walls. For good tracking results these reflections should be suppressed. Be aware that the FoV / effective measurement volume will be decreased, which is why reflex suppression should always be the last option to be considered. If possible, try re-orienting the cameras in order to minimize reflections.
Please refer to the ***DTRACK4 User's Guide*** for further details.

☞ **Be aware that reflex suppression leads to decreased FoV / effective measurement volume by blocking the area in which the reflection originated.**

5.7 Room Calibration - Overview

5.7.1 Room calibration - multi-camera setups

Before you can start tracking, a so called room calibration has to be carried out. During this calibration, the system identifies the position of the cameras inside the measurement volume and determines the three-dimensional coordinate system. Carrying out a room calibration is always the first step. Without it, body calibration and tracking will not be possible.



Example: If a camera with 3.5mm lenses (standard for *AT7-50*) is rotated by one tenth of a degree it will cause aberrations of the optical rays that are as high as 5 millimetres in 3 metres distance from the camera. This will result in unacceptable errors in the measurement results, hence, *DTRACK4* will exclude data from such a camera and it will not contribute to tracking.

In summary room calibration has to be carried out

- after the first system setup,
- when the default orientation and position of the coordinate system is not adequate for your application
- after any changes of IR camera positions (→ Room re-calibration),
- after any changes to the number of cameras,
- before a body calibration (when system has been setup initially),
- whenever any uncertainty regarding the mechanical stability or the environmental conditions of the setup occurs.

5.7.1.1 Room calibration hardware

For angle-based room calibration, use the '*calibration angle*' and the '*wand*' from the room calibration set (see figure 5.8 on page 40). The position and orientation of the '*calibration angle*' define the origin and axes of the room coordinate system. The '*first camera*' option sets the origin at camera '*c01*' and requires no calibration angle.

The pre-calibrated rod carrying two markers is called the '*wand*'. Its function is to create a virtual "point cloud" in the measurement volume that is used for calculating the relative positions of the IR cameras with high accuracy. Furthermore the '*wand*' is used for scaling the system. Therefore damaging the wand (loose markers, bent rods, etc.) leads to miscalculations of the scale and the measurement volume.



Figure 5.8: A room calibration set consisting of angle and wand

5.7.1.2 Room calibration process

For angle-based room calibration, first place the '*calibration angle*' inside the tracking volume (i.e. into the FoV of the IR cameras), see figure 5.9 on page 41. At least two IR cameras must see all markers of the '*calibration angle*'. When using the '*first camera*' based room calibration no calibration angle is required.

For either method, the two markers of the '*wand*' should be visible to all IR cameras.
Now move the '*wand*' gently in all possible directions (up/down, left/right, back/forth) and additionally rotate it within the measurement volume in order to generate a virtual point cloud . If possible, try to walk around to maximize the point cloud in all dimensions (see figure 5.9 on page 41).

The point cloud is used for calculation of IR cameras positions, so moving the '*wand*' in only a very small part of volume will result in reduced accuracy of calibration. Also avoid quick and jerky movements.
Please refer to the ***DTRACK4 User's Guide*** → *Tracking* → *Room* for further details of the procedure.

If in a system setup no sufficient part of the measurement volume is seen by all IR cameras simultaneously, the point cloud created by the '*wand*' movement has to connect all cameras in a way that ensures the arrangement of all cameras in a common room coordinate system.

Example : A pair of cameras is connected via a shared point cloud as long as both cameras can detect the markers of the '*wand*' for a sufficient time. Additional cameras can be connected if they form a suitable pair with the original ones. This way the calibration is stepping forward from camera to camera.

☞ **The point cloud should fill at least two thirds of the measurement volume. Moving the wand in a restricted volume will result in reduced accuracy of calibration or failure.**

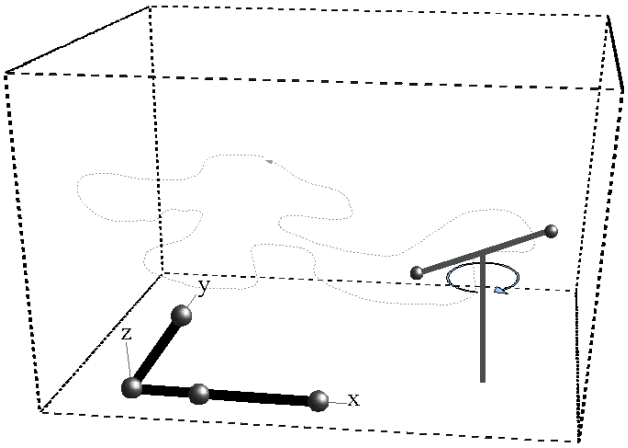


Figure 5.9: Room calibration process

5.8 Cascaded systems

Cascading means that two or more stand-alone tracking systems are combined to one large tracking system. Consequently the system is divided into one master ***DTRACK Backend Service*** and up to eight slave ***SMARTTRACK3+3/M*** . The task of the master is to gather all camera data from all slaves and to merge them into one single data output. The ***DTRACK4*** frontend connects to the master only and allows to configure (e.g. cameras, output, tracking, etc.) the entire tracking system.

The total number of cameras in a Cascaded System cannot exceed 80. Note: *SMARTTRACK3* & *SMARTTRACK3/M* count as two cameras each.

5.8.1 Connecting a cascade

General requirements When building a cascaded system, please proceed according to the following description:

1. mount the cameras at the designated positions
2. connect all cameras to the PoE+ switches
3. connect all PoE+ switches to the ***DTRACK Backend Service*** PC
4. connect all peripheral devices to the ***DTRACK Backend Service*** PC (e.g. ***RadioTransceiver2/3***)
5. establish a connection between the ***DTRACK Backend Service*** PC and all slave(s) for data and synchronisation of the cascade (see 5.8.1.1 on page 42)

The *ART RadioTransceiver2/3* for *Flystick2/2+* has to be connected to the *DTRACK Backend Service* PC.

5.8.1.1 Connecting slave *SMARTTRACK3+3/M*

Using the PoE+ switch Connect each data output '*LAN network port*' of the ***SMARTTRACK3*** & ***SMARTTRACK3/M*** to the PoE+ ports of the PoE+ switch. Synchronisation with the ***DTRACK Backend Service*** is provided through the PoE+ switch, a BNC coaxial connection is not necessary, see fig. 5.10 on page 43).

This connection option is only valid for:

- master: ***DTRACK Backend Service*** with all camera models ↔ slave(s): ***SMARTTRACK3*** & ***SMARTTRACK3/M***



The *DTRACK Backend Service* PC must be set to an additional specific static IP address 172.29.0.1 with subnet mask 255.255.0.0. Please refer to the *DTRACK4 User's Guide* → *Configuration of the network adapter*



Do not use the PoE injector nor the BNC synchronisation when connecting *SMARTTRACK3* & *SMARTTRACK3/M* slaves to a *DTRACK Backend Service* via a PoE+ switch.

5.8.1.2 Starting the cascades

Double-check that the cameras are connected properly to the PoE+ switch and connect the ***DTRACK Backend Service*** PC to your local network. Turn on the slave ***SMARTTRACK3*** first and wait for proper start-up (indicated by a beep). Then start the ***DTRACK4*** frontend software on the remote PC and establish a connection to the ***DTRACK Backend Service*** PC. Please refer to ***DTRACK4 User's Guide*** → *Connecting to the* ***DTRACK Backend Service*** for more details.



If any slave *SMARTTRACK3+3/M* is not connected via an ethernet cable during boot-up, it will use a fall-back IP address (IP 192.168.0.1, subnet mask 255.255.255.0) and you will not able to connect!



If the cascade is connected via a PoE+ switch (see 5.10 on page 43), all *SMARTTRACK3* & *SMARTTRACK3/M* slaves must be set to a specific static IP address in the subnet 172.29.xxx.xxx with subnet mask 255.255.0.0. Do not use IP addresses in the range from 172.29.0.1 to 172.29.0.20 ! Please refer to the DTRACK3 User's Guide.

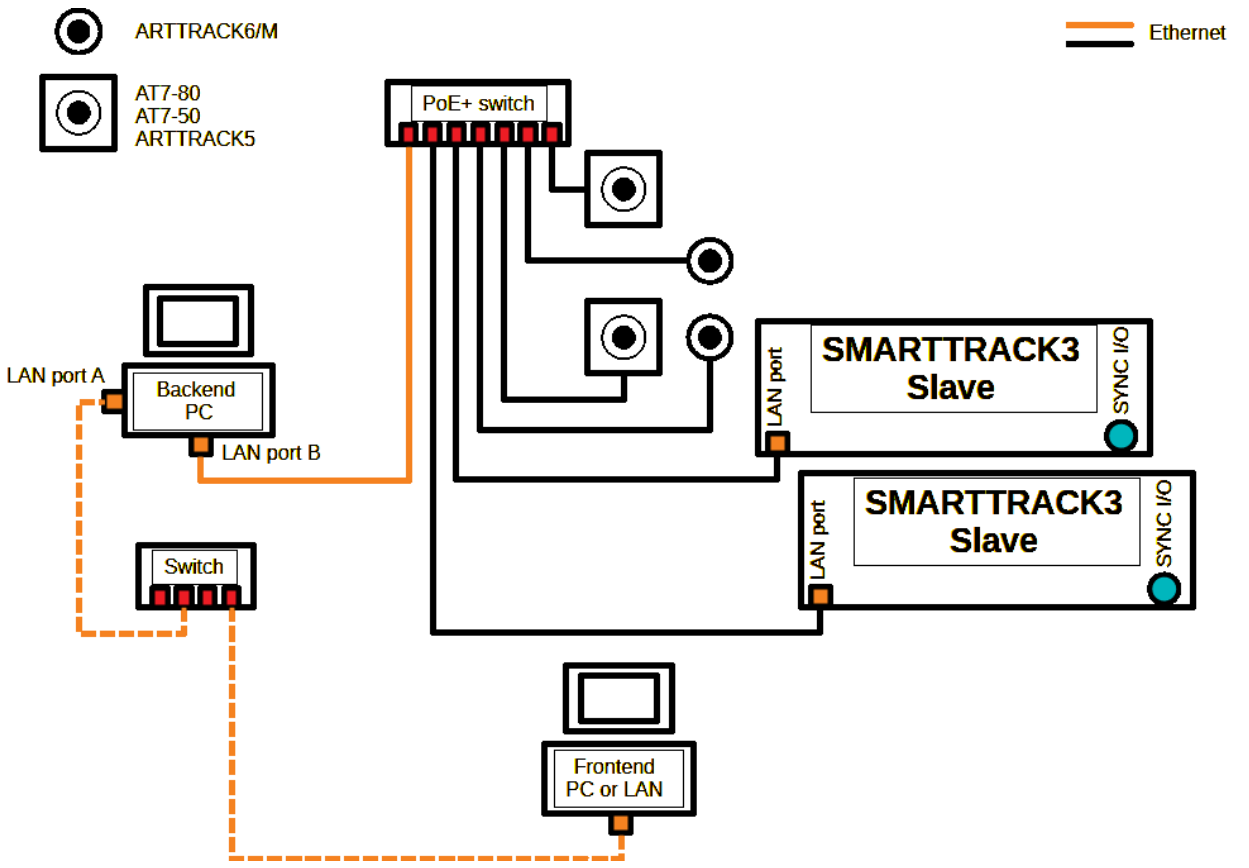


Figure 5.10: Principle of cascading master ***DTRACK Backend Service*** - slave ***SMARTTRACK3*** & ***SMARTTRACK3/M***

6 Interaction devices

6.1 Flystick2+



The batteries must be removed before shipping the Flystick2+, otherwise the radio transmitter could be started by shock or vibration.

Description The *Flystick2+* is a wireless input device for *ART* infrared optical tracking systems. The *Flystick2+* has an analogue trigger, six buttons and an analogue joystick with an additional button functionality (see figure 6.1 on page 45). For durability against impacts (e.g. dropping the device) the *Flystick2+* features two detachable marker compartments protected by cone-shaped enclosures. Both compartments are held magnetically and are secured by plastic safety wires. Additionally, the *Flystick2+* offers a vibration motor for inducing feedback patterns and a beep function.

Input transactions (buttons & joystick) are transmitted via low-rate wireless personal area network (IEEE 802.15.4) to the controller and added to the 6DOF tracking result of the *Flystick2/2+* bodies. Tracking and interaction data are then transmitted to the application via Ethernet.



The *Flystick2+* has no power switch. It is activated automatically within a few seconds after a button event (#1, #3 - #7) and is deactivated after 10 minutes without usage.



The *Flystick2+* is tracked via passive markers which are covered by an acrylic housing. This means that 6DOF tracking is still valid when the *Flystick2+* electronics is off.

6.1.1 Control elements

The numbering sequence of the buttons is as follows (see also figure 6.2 on page 45):

- # 1 trigger
- # 2 - # 5 colored buttons, right to left
- # 6 pressing the joystick
- # 7 - # 8 grey buttons, left to right

The *Flystick2+* device provides all functions (buttons, trigger and joystick) simultaneously. In neutral position the joystick transmits x=0, y=0.



Figure 6.1: ***Flystick2+***

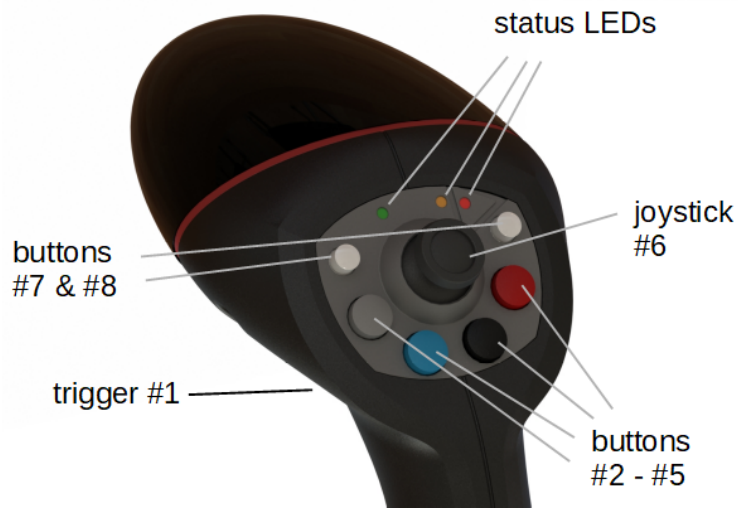


Figure 6.2: ***Flystick2+*** control elements

- Moving left creates negative x values, moving right positive x values.
- Moving down creates negative y values, moving up positive y values.
- Full extension into any direction creates values of 1.0 or -1.0.

Additionally, the ***Flystick2+*** offers:

- one vibration motor for vibrational feedback patterns
- beep function

Top View	*Event*	*Description*
green status LED	flashing	active radio transmission (e.g. button pressed or joystick position successfully transmitted)
yellow status LED	flashing	→ indicates assignment process to controller & radio communication
red status LED	flashing active continously	→ indicates low battery, recharge soon → battery charging
trigger, buttons & joystick	press	invoke an interaction which can be defined in the user application (e.g. drag objects while button trigger pressed, open a menu dialogue, . . .)

Table 6.1: Description of the ***Flystick2+*** Control Elements

6.1.2 Data output

The output data consists of:

- position and orientation of the Flystick,
- status of buttons and joystick,
- number of used ***Flystick*** .

Please refer to the ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet* for more information about the format of the output data.

6.1.3 Feedback control

Flystick2+ offers a list of control commands to address the feedback and beep function within your application. These consist of:

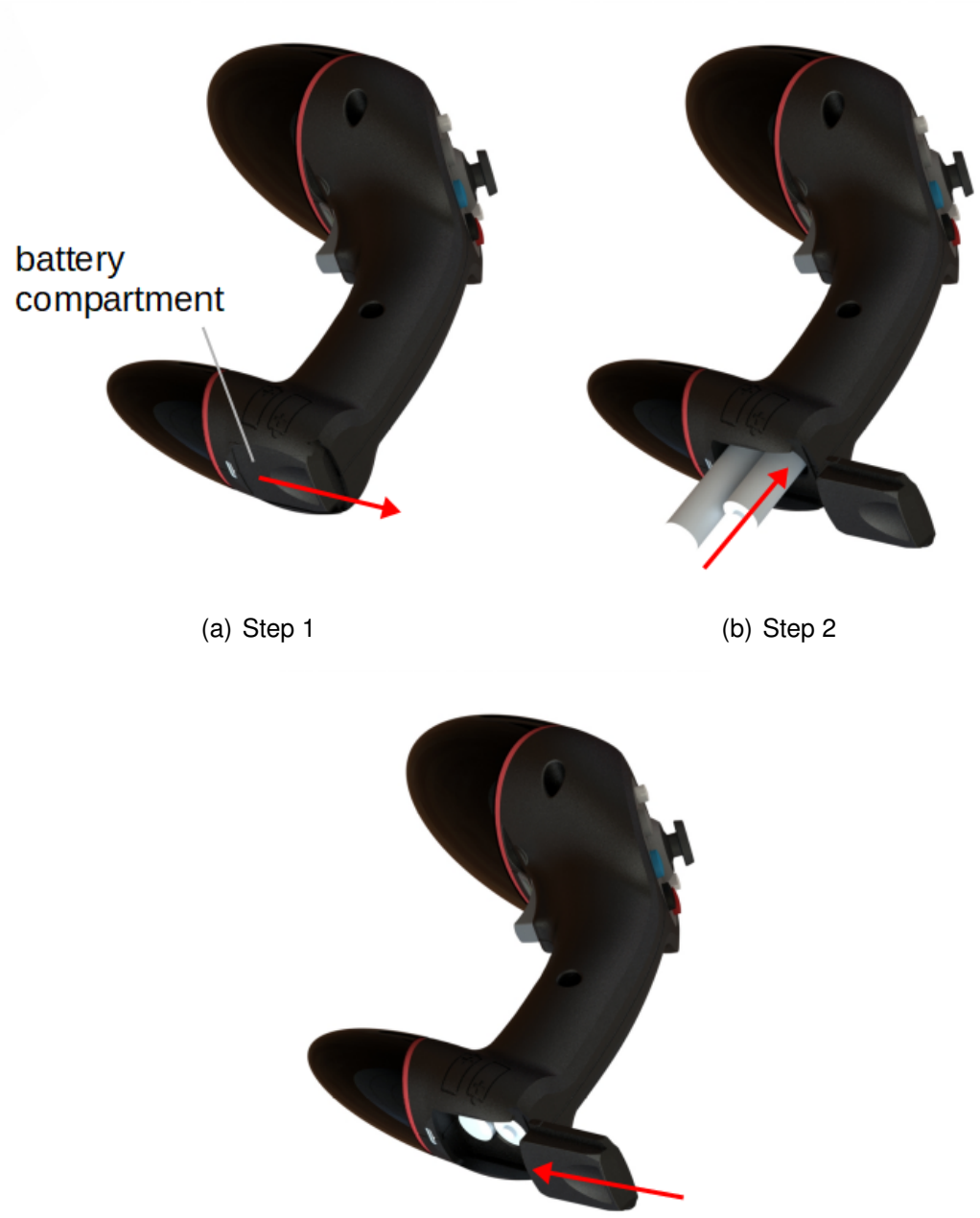
- the *beep duration* and *beep frequency*
- the *vibration pattern ID*

Please refer to ***DTRACK4 Programmer's Guide*** → *Input of Control Data via Ethernet* for details.

6.1.4 Batteries

The battery compartment is at the lower end of the handle. Remove the cover of the battery compartment (see figure 6.3 on page 47). Then insert the batteries taking care of the polarity - also note the imprinting '+ -' on the handle. Close the compartment after inserting the batteries.

2 standard AA rechargeable batteries are provided with the *Flystick2+* .



(a) Step 1

(b) Step 2

(c) Step 3

Figure 6.3: ***Flystick2+*** - inserting the batteries

Dispose of used batteries at dedicated battery collection points and recycling facilities only! Batteries should never be disposed of along with household waste.

Do not use non-rechargable batteries - Risk of explosion !

Insert the rechargable batteries into the battery compartment in the indicated polarity - Risk of explosion !

6.1.5 Charging jack

The charging jack is at the bottom of the handle and has to be connected with the supplied battery charger (see figure 6.4 on page 48).

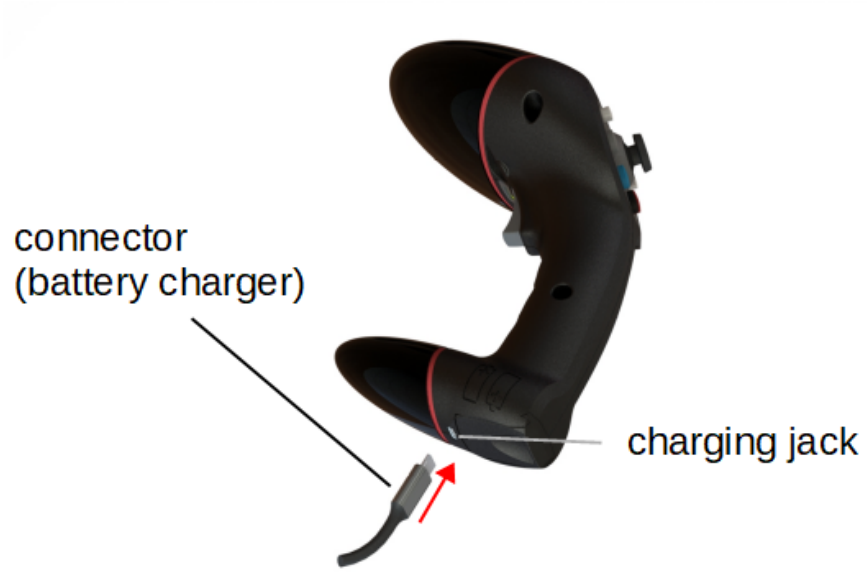


Figure 6.4: Charging the battery of the *Flystick2+*

After connecting the battery charger the *Flystick2+* may still be used during the charging process !

To ensure long battery life, do not let the batteries become discharged completely. Recharge whenever convenient.

Use the supplied charger authorized by *ART* only ! Do not charge for > 24 h.

6.1.6 Battery charger

A battery charger is supplied with the *Flystick2+* and must be used for charging the batteries.

Charging the batteries As soon as the charger is connected to *Flystick2+* the charging process is started (red status LED: continously active). Once the battery pack is fully charged (approx. 5 h) the batteries may be used again (red status LED: off).

The batteries may remain inside the *Flystick2+* for charging.

6.1.7 Radio module

The ***Flystick2+*** uses a low-rate wireless personal area network (IEEE 802.15.4) radio module in the 2.4GHz band. This band is standardized internationally and can be used without a license. Range with line of sight is more than 7m but can be reduced when the signal penetrates material, e.g. projection screens.

6.2 FINGERTRACKING2

Description The ***ART Fingertracking2*** system allows measuring the position of the hand and the finger bones. To achieve this, a 6DOF target is attached to the palm of the hand and thimbles with 2 markers are worn on the measured finger tips (see figure 6.5 on page 49. All other information is derived from the kinematics of the hand, which are measured by a short calibration process.

The active markers for the finger tips are sequentially addressed to allow the tracking system to discriminate between the single fingers. Therefore the update rate of the fingers is only a fraction of the tracking frequency for the hand target, i.e. one-third for 3 thimbles and one-fifth for 5 finger tracking.



Figure 6.5: ***Fingertracking2*** and ***Fingertracking2 Tactile*** device (shown with three active finger markers)

Fingertracking2* and *Fingertracking2 Tactile* are not available for *SMARTTRACK3+3/M

The tracking frequency for each finger is dependent on the number of finger thimbles, i.e. using 300 Hz tracking frequency this corresponds to 60 Hz for each finger (*Fingertracking2* 5 finger thimble set) or 100 Hz (*Fingertracking2 Tactile* 3 finger thimble set and/or tactile feedback)

General specifications There are two different *Fingertracking2* versions available, *Fingertracking2* and *Fingertracking2 Tactile* .
All *Fingertracking2* devices consist of:

- a hand target unit for fixing on the back of the hand with IR LEDs (active markers) for tracking (see figure 6.6 on page 51).
- three or five finger thimbles (a fixture for the finger tip), each featuring IR LEDs connected via flexible wires (see figure 6.9 on page 53)
- wireless synchronization using a receiver for a coded IR flash (modulated flash)
- rechargable batteries and a battery charger

Additionally, the *Fingertracking2 Tactile* has:

- one vibration motor for tactile feedback on each thimble
- radio module in the hand unit for addressing the vibration motors

6.2.1 *Fingertracking2* and *Fingertracking2 Tactile* Hand Targets

On/Off switch Move the switch to the *On* position to turn on the hand target unit. The vibration motors are started sequentially as a test run (*Fingertracking2 Tactile* only). After turning on the hand target unit, the status LEDs light up according to table 6.2 on page 51. In *Off* position the hand target is switched off completely. There is no need to remove the batteries when not using the devices for a longer period of time.

L/H switch Move the switch to *H* position to increase the brightness of the IR LEDs if necessary, e.g. at far distances (> 3 m) from the cameras. Extend the battery lifetime by switching to *L* position.

Set 1/2 switch To use two pairs of *Fingertracking2* or *Fingertracking2 Tactile* sets simultaneously, configure one to Set *1* and the other to Set *2*.

Select the Set *1* or *2* configuration of the *Fingertracking2* or *Fingertracking2 Tactile* handtargets during first-time installation only. Do not change the setting during routine operation or tracking will fail.

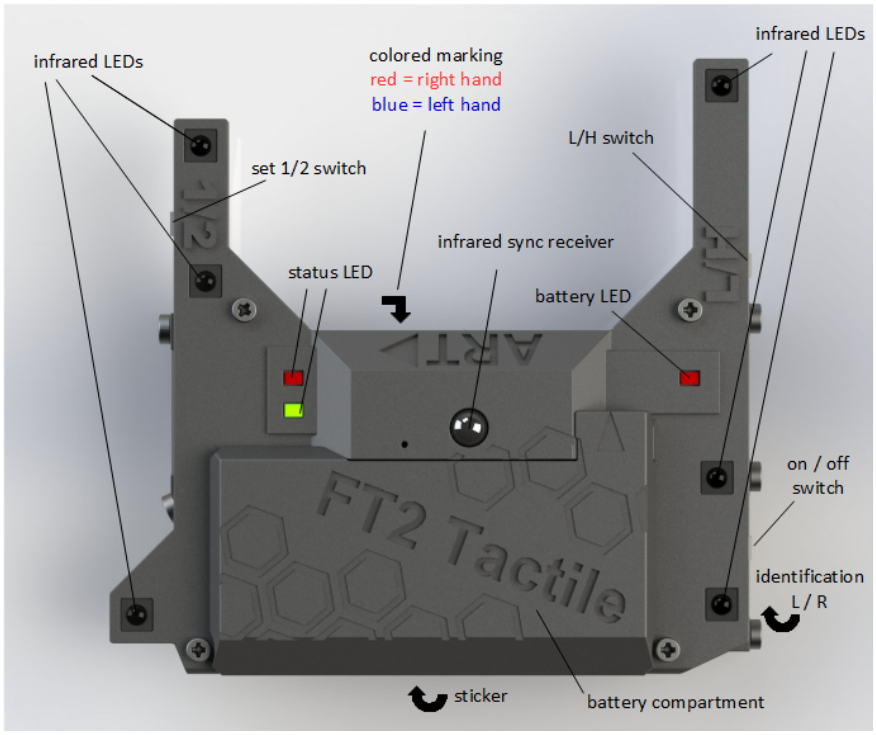


Figure 6.6: ***Fingertracking2*** and ***Fingertracking2 Tactile*** hand target

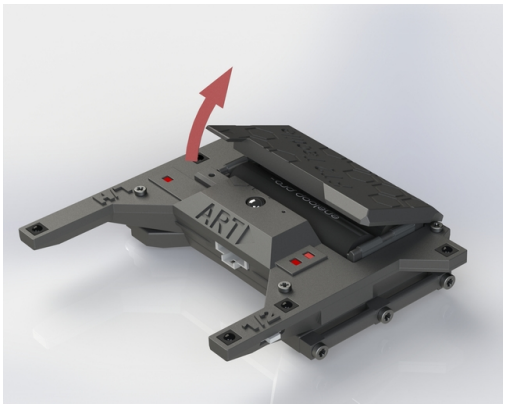
Top View	*Event*	*Description*
green status LED	continuously on flashing slowly	→ synchronization received and tracking → assigned to a controller, no active tracking (tactile only)
yellow status LED	flashing fast flashing slowly flashing slowly	→ indicates radio communication (tactile only) → not assigned to a controller (tactile only) → no active tracking (not tactile)
red battery LED	continously on	→ battery low or discharged
infrared LEDs		IR LEDs for tracking
On/Off switch		activates / deactivates the hand target
L/H switch		select the IR LED brightness (low / high)
set 1/2 switch		select the target geometry (i.e. 2=second pair)
colored marking front-side		indicates the correct thimble set (red=right hand or blue=left hand)
letters (L and R) embossed bottom-side		indicates whether the hand target is dedicated for the red=right hand or blue=left hand
sticker bottom-side		showing the type and serial number of the device
infrared sync receiver		receiver for the coded IR flash (i.e. synchronization signal)

Table 6.2: Description of ***Fingertracking2*** and ***Fingertracking2 Tactile*** hand target

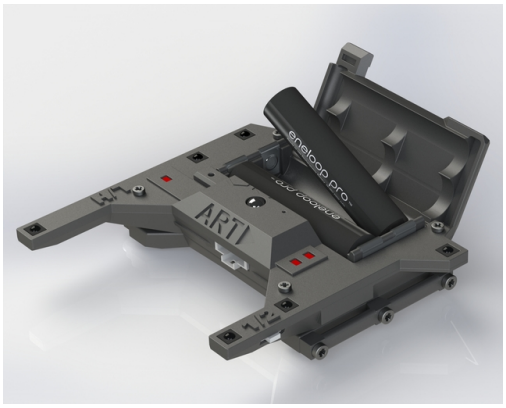
Inserting the battery The *Fingertracking2* and *Fingertracking2 Tactile* hardware uses standard micro-AAA batteries. A set of batteries and a charger are provided with each set. Open the battery compartment and insert the batteries (see figure 6.7 on page 52). Close the lid of the battery compartment afterwards.



Insert batteries in the indicated polarity



(a) Step1



(b) Step2

Figure 6.7: Inserting the battery (*Fingertracking2* and *Fingertracking2 Tactile*)

Connecting the finger thimble set to the hand target unit Just plug in the connector of the finger thimble sets into the hand target as shown in figure 6.8 on page 53. Please connect the correct thimble set to the corresponding hand target by verifying the colored markings. Then apply the finger thimbles to your thumb and fingers observing the order of the flexible wires shown in figure 6.5 on page 49.



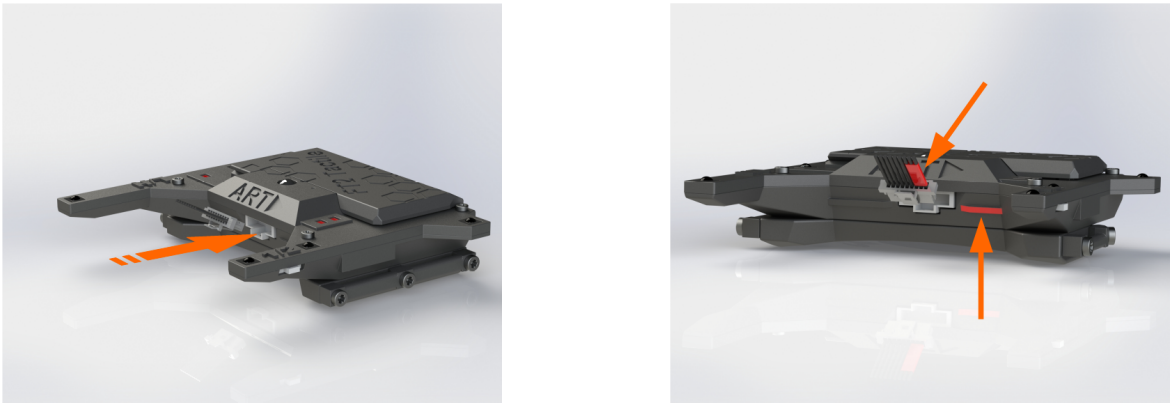
Watch out for the colored marking of the thimble set! red=right hand, blue=left hand

Radio module (*Fingertracking2 Tactile* only) *Fingertracking2 Tactile* uses a radio module in the 2.4GHz band. This band is standardized internationally and can be used without a license. Range with line of sight is more than 10m but can be reduced when passing material, e.g. projection screens.

6.2.2 Finger thimble sets *Fingertracking2*

Fingertracking2 can be ordered as a 3-finger AR or a 5-finger AR version, while *Fingertracking2 Tactile* can be ordered as a 3-finger AR version only. Tactile thimbles additionally feature a vibrational motor to induce feedback.

Fingertracking2 and *Fingertracking2 Tactile* are delivered with three pairs of thimble



(a) Plugging in the connector

(b) Colored marking of thimble set and handheld red=right hand, blue=left hand

Figure 6.8: Connecting the finger thimble connector with the hand target (***Fingertracking2*** and ***Fingertracking2 Tactile***)



AR thimble set for all fingers

AR thimble set for the thumb

Figure 6.9: Comparison of the finger thimble sets (AR) for ***Fingertracking2*** (vibrational motor on ***Fingertracking2 Tactile*** only)

sets with different sizes (see table 6.3 on page 53).

Finger size	**Scope of delivery**
Extra-Small-sized fingers (optional)	Diameters of 14mm (thumb) and 11-12mm (other fingers)
Small-sized fingers	Diameters of 16mm (thumb) and 13-14mm (other fingers)
Medium-sized fingers	Diameters of 18mm (thumb) and 15-16mm (other fingers)
Large-sized fingers	Diameters of 20mm (thumb) and 17-18mm (other fingers)

Table 6.3: Description of the finger thimbles ***Fingertracking2*** and ***Fingertracking2 Tactile***

6.2.3 Wireless synchronization

The black sphere on top of the ***Fingertracking2*** & ***Fingertracking2 Tactile*** hand targets is a receiver for the coded IR flash (i.e. modulated infrared signal) which is used for

synchronization (see figure 6.6 on page 51). This coded signal can be generated by all ***ARTTRACK*** cameras (***DTRACK4*** is required). In some cases (discontinued products) an additional external flash is necessary. Please contact your ***ART*** representative.

The modulated flash is adjustable in ***DTRACK4*** → *Hardware* → *Cameras*. Tick the checkbox '*modulated flash*' or select an individual camera which is in syncgroup # 1 from the list. Press *OK* to apply the changed settings. Please refer to the ***DTRACK4 User's Guide*** → *Camera Settings*.

Active targets need synchronization in order to make sure that the IR LEDs are flashing at the proper time. To ensure wireless synchronization the following points should be observed:



- **All cameras with activated modulated flash have to be assigned to syncgroup #1 (default) ! Please refer to paragraph Sync group in the *DTRACK4 User's Guide* → *Camera Settings*.**
- **Note that the synchronization will not work near plasma screens.**
- **If two or more tracking systems using wireless synchronization are in the same room, then external synchronization of the systems might be necessary (e.g. at tradeshows).**

6.2.4 Battery charger

A battery charger is supplied with all ***Fingertracking2*** and ***Fingertracking2 Tactile*** devices and must be used for charging the batteries.

Insert the batteries in the corresponding slots and plug the charger into a power socket. Charging will start automatically. When the batteries are fully charged all LEDs adjacent to the corresponding slot will light up. Please refer to the manual of the charger for further details.

6.2.5 Data output

The output data consists of:

- position and orientation of the hand,
- number of the tracked fingers and a value to distinguish between left and right hand
- position and orientation of the outermost phalanxes; the radius of the finger tip to identify its position and orientation
- angles between the single phalanxes and their respective lengths

Please refer to ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet* for more information about the format of the output data.

6.2.6 Tactile control

Additionally ***Fingertracking2 Tactile*** offers a list of control commands to address the tactile feedback within your application. These consist of:

- the *Hand ID* and *Finger ID* to address each finger of each hand individually
- a value denoting the strength of the feedback

Please refer to ***DTRACK4 Programmer's Guide*** → *Input of Control Data via Ethernet* for details.

6.3 Measurement Tool

Introduction The Measurement Tool is an add-on to ***ART*** tracking systems and is unlocked in ***DTRACK4*** by entering the corresponding license code. Please contact your ***ART*** representative. Please refer to the ***DTRACK4 User's Guide*** → *Basic Configuration* for details how to upgrade your system.

Description The ***ART*** Measurement Tool is a pointing device for measurement applications. In this specialized field it is very important to measure positions of points with high accuracy. Therefore the Measurement Tool is equipped with a measurement tip which can be measured with the optical tracking system.



Figure 6.10: Measurement Tool

The pointing device carries a target specifically developed for optimal tracking quality using two cameras. The best results are achieved when the pointing device is facing the cameras as shown in figure 6.10 on page 55 (i.e. all markers are oriented towards the

cameras). Typically, the position of the tool's tip is measured in the room coordinate system which was set up during room calibration.

Optionally, the ***ART*** Measurement Tool can calculate the position relative to a reference body. This way the Measurement Tool is measuring distances to the origin of the reference body coordinate system and not to the origin which was defined during room calibration.

6.3.1 Data output

The output data consists of:

- position and orientation of the tool's tip,
- number of the Measurement Tool ,
- rotation matrix of the target.

Please refer to ***DTRACK4 Programmer's Guide*** → *Output of Measurement Data via Ethernet* for more information about the format of the output data.

7 Markers and targets (rigid bodies)

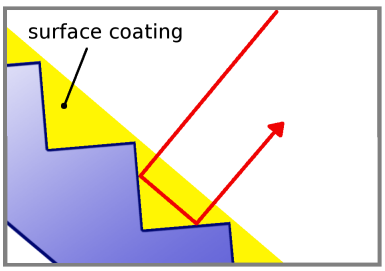
7.1 Passive markers

Basics Passive markers used in ***ART*** tracking systems are retro-reflective, which means they reflect a high fraction of the incoming light in a small cone around the incoming light's direction (cat's eye effect). More precisely the IR radiation is reflected into a narrow range of angles around the (opposite) direction of the incoming light. Passive markers used by ***ART*** are mostly spheres covered with retro-reflecting material. However, they also flat markers can be used (i.e. stickers made from retro-reflecting material).
The different types have distinctive advantages / disadvantages:

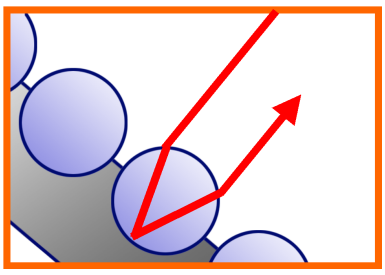
- **spherical markers**:
  - \+ excellent visibility from any perspective,
  - \- expensive fabrication,
  - \- sensitive surface,
  - \- target requires larger volume $\rightarrow$ danger of mechanical damage.
- **flat markers**:
  - \+ low price,
  - \+ flat targets possible,
  - \+ robust surface because cover may be applied,
  - \- the angular range of visibility is limited to approx. $\pm 45^{\circ}$.
- **ring markers**:
  - \+ low price,
  - \+ cylindrically shaped targets possible,
  - \+ robust surface,
  - \- the angular range of visibility is limited to approx. $\pm 45^{\circ}$.

Retro reflecting sheets or foils available on the market can be based on two different optical principles:

Triple mirrors, which are arranged such that their planes form angles of 90° by pairs, are reflecting light in the described way. Mostly foils with arrangements of many very small mirrors in a plane are used.



Glass spheres (with a proper refraction index) are focussing incoming light approximately to the opposite surface of the ball. A layer of microscopic glass spheres, carried by a reflecting material, acts as a retro reflector. These foils can be fabricated on a flexible carrier material, thus they are widely used for equipping spherical markers with retro reflecting surfaces.



***ART* spherical markers are covered with retro reflecting foils, based on the glass spheres principle.**

The quality of the markers decreases when they are in contact with dust, dirt, fat, liquids, glue or comparable contaminants. Please make sure that the markers are not touched or damaged.

7.2 Active markers

Basics Active markers are light (i.e. infrared light) emitting elements, usually LEDs.

In *ART* tracking systems four types of LED-based active markers may be used, depending on the application:

Single LEDs without diffusor sphere:

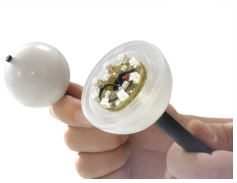
+ can be covered with acrylic protection film,
+ results in simple and robust markers providing visibility up to high distances (up to 10m),
- the angular range of visibility is limited to approx. ±60°.

Single LEDs with diffusor sphere:

+ for optimum angular range of visibility,
- distance between marker and tracking camera is limited to a short distance (up to 4.5m).



Big active spherical markers:



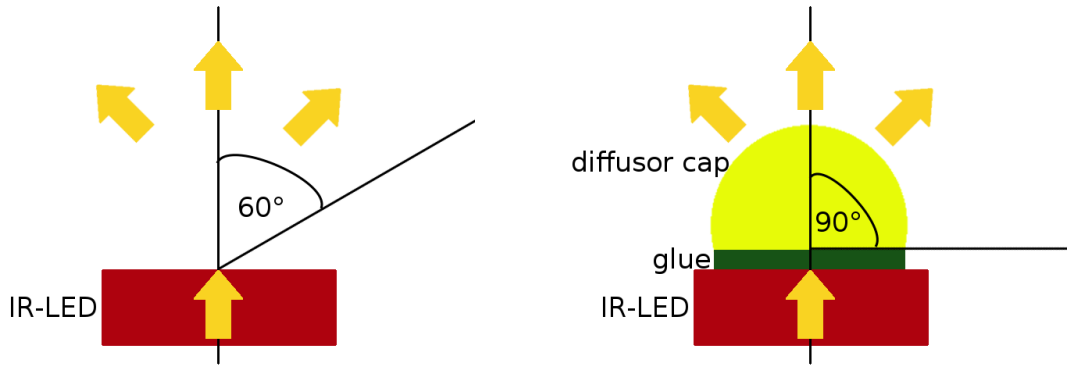
+ several single LEDs per marker, covered with light scattering spheres,
+ provide visibility from all sides and up to very high distances (approx. 20m),
+ suitable for outdoor tracking,
- diameter: 50mm,
- weight: 50g.

Big active flat markers:



+ several single LEDs per marker, covered with light scattering surface,
+ tracking up to very high distances (approx. 20m),
+ suitable for outdoor tracking,
+ magnetic base for easy positioning on metal surfaces,
- the angular range of visibility is limited to less than 180°,
- diameter: 30mm.

All active markers provided by ***ART*** are controlled by a special PC board and need power supply.



(a) Single LED (b) Single LED with diffusor sphere

Figure 7.1: Angular range of visibility

Synchronization of active markers The easiest way to create an active marker is to have it emit IR light continuously. However, this would be inefficient in respect to energy dissipation and would yield low signal-to-noise ratios. ***ART*** tracking cameras have very

short exposure times, i.e. narrow time slots of sensitivity. Most of the light emitted by the markers would hit the cameras sensors at times when it is inactive rendering the light useless for tracking. As a consequence, the range between cameras and marker would become significantly shorter. Additionally the active markers can be configured to emit high power intensities by flashing just like the camera flash. This also helps with energy dissipation due to an upper limit allowed for each single LED. Therefore, most active markers supplied by ***ART*** are synchronized with the cameras to emit radiation only during exposure times. This allows both more robust and longer ranging targets.

Synchronization can be done either by a wired connection between the tracking system and the pc-board controlling the active markers but also in a wireless way. For wireless synchronization a coded (i.e. modulated) IR flash is being sent out by a tracking camera. The active marker's PC board recognizes the coded flash and activates the LEDs.

7.3 Standard targets

Type	Description	Weight	approx. Dimension	Marker size
Hand target 	The hand target is designed for hand tracking in usability and assembly studies respectively. It is also frequently used as a small general-purpose target. Due to the small size this target is easily occluded by the hand carrying it. Therefore, proper arrangement of tracking cameras has to be used in order to avoid occlusions.	25g / 0.9oz	(110 × 80 × 28)mm	12mm
Large hand target 	This hand target is designed for hand tracking in a two camera tracking system. Its large size allows to move the hand in almost all directions, without losing tracking.	30g / 1.1oz	(170 × 120 × 35)mm	12mm
Claw target 	The claw target looks just the same as the hand target. But it comes in a bigger size and is equipped with bigger markers.	35g / 1.2oz	(160 × 110 × 30)mm	16mm

Type	Description	Weight	approx. Dimension	Marker size
Tree target 	Originally designed for tracking HMDs, the tree target is a general-purpose target for tracking from longer distances. It is equipped with 20mm markers.	75g / 2.65oz	(195 × 170 × 120)mm	20mm
Generic glasses target 	For head tracking mostly in passive stereo systems, tracking targets must be fixed to the stereo glasses. ***ART*** offers several light-weight standard targets for this purpose.	min: 14g / 0.5oz max: 22g / 0.7oz	(270 × 120 × 35)mm	12mm
INFITEC PREMIUM target 	Target tailored to the INFITEC PREMIUM passive stereo glasses.	26g / 0.9oz	(225 × 85 × 80)mm	12mm

Type	Description	Weight	approx. Dimension	Marker size
CrystalEyes® 2/3 target 	Target tailored to the shutter glasses of the StereoGraphics active stereo system. It fits to both CrystalEyes® 2 and 3.	28g / 1oz	(215 × 120 × 60)mm	12mm
CrystalEyes® 5 target 	Target tailored to the shutter glasses of the StereoGraphics active stereo system. It fits to the CrystalEyes® 5.	19g / 0.7oz	(195 × 105 × 40)mm	12mm
NuVision APG6000 and APG6100 target 	Target tailored to the NuVision APG6000 and APG6100 shutter glasses.	17g / 0.6 oz	(220 × 125 × 75)mm	12mm

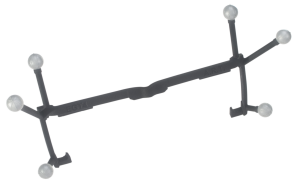
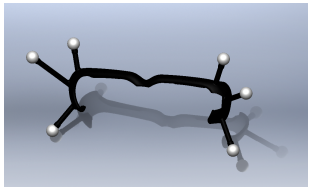
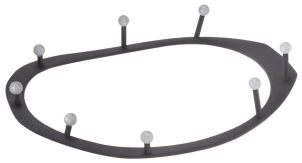
Type	Description	Weight	approx. Dimension	Marker size
Volfoni EDGE® target 	Target tailored to the Volfoni EDGE® shutter glasses.	23g / 0.7 oz	(230 × 95 × 60)mm	12mm
NVIDIA 3D Vision® Pro target 	Target tailored to the NVidia 3D Vision Pro shutter glasses.	25g / 0.9 oz	(225 × 100 × 60)mm	12mm
NVisor SX 60 target 	Target tailored to the NVisor SX 60 head mounted display.	55g / 1.94oz	(300 × 215 × 35)mm	12mm

Table 7.3: Standard targets overview

8 Frequently asked questions (FAQ)

Within this FAQ chapter we are offering solutions for easy-to-solve questions that our support encounters from time to time. The questions are grouped into specific topics to make it more convenient for you to find a solution.

In case you do not find a proper solution for your specific problem, please do not hesitate to contact us.
Our goal is to offer the best support possible. Therefore, we ask you to have the system running and that you have internet access when you call us. Additionally we will need details about your system. Please refer to the ***DTRACK4 User's Guide*** → *Menu Help* → *Service* → *Export System Information File* for details how to export a system information file. Please include it in your mail when you contact tech support.

8.1 Cameras

⇨ *DTRACK4* doesn't recognize the correct number of cameras connected. What can I do?

- First of all, please check whether cabling is correct.
- Please make sure that all cameras are powered up, indicated by their status LEDs.
- If you are using an external PoE+ switch, please make sure that no camera is connected to the uplink port and, if applicable, the switch is powered up. Use only compatible switches authorized by ***ART*** and do not tamper with the configuration of managed switches.
- Within ***DTRACK4*** press '*F2*' in order to perform a search for new hardware. The cameras should be detected now.
- Double-check that the secondary network adapter is configured to the correct subnet of the tracking camera network, please refer to 5.3 on 31.
- Please ensure that Jumbo Frames (min. 9014 bytes) are enabled on the secondary network adapter connecting to the tracking camera network.
- Finally, reboot the cameras, the external switch and the ***DTRACK Backend Service*** PC

⇨ What is the meaning of the red LEDs at the front of the camera?

They are indicating the status of the camera:

- ***AT7-80*** & ***AT7-50*** : The lower LED shows that the camera is powered up and booted. Whereas, the upper LED indicates that the measurement is active. In addition to the two status LEDs the 3-digit LED-matrix (2-digit for ***AT7-50***) on the right displays the assigned camera ID (default) and the number of markers in the camera's corresponding field of view (when activated under camera settings). Additonally the LED ring indicator shows the current status of the camera during calibration, boot up, etc. Please refer to figure 4.1 on page 22 for the visualization of the camera.
- ***ARTTRACK6/M*** : One LED shows that the camera is powered up and booted. Whereas, the second LED indicates that the measurement is active. Please refer to figure 4.3 on page 24 for the visualization of the camera.

⇨ One of my cameras recognizes a reflection which I can't eliminate. What can I do?

You may enable the suppression of static reflexes within ***DTRACK4*** . But carefully read the notes in chapter 5.6.1 on page 36.

⇨ I'd like to expand my system. Is it possible?

Tracking systems with ***ARTTRACK*** cameras are expandable up to a total number of 80 cameras. A tracking system can be expanded by simply adding additional ***ARTTRACK*** cameras. Please double-check if you need an additional PoE+ switch.

⇨ Which upgrade possibilities do I have?

Please refer to table 4.1 on page 25.

8.2 Synchronization and Power

⇨ Power issues in *AT7-80* , *AT7-50* & *ARTTRACK6/M* systems

If you have connected ***AT7-80*** , ***AT7-50*** & ***ARTTRACK6/M*** cameras via a PoE+ switch, please check the model of the switch. Some acquirable PoE+ switch models might not be suitable for usage with ***ART*** cameras. Use only authorized equipment by ***ART*** . Please refer to table 4.2 on page 25 for more information.

⇨ Synchronization in *DTRACK4*

Due to the Windows based service architecture, external trigger units, e.g. projectors or graphics cards are not supported.

A Technical specifications

☞ **The specifications are subject to change without notice.**

A.1 Cameras

A.1.1 *AT7-80*

IR Source

invisible IR	850 nm
flash intensity adjustable in 100 steps	

Performance

Sensor resolution	8.1 MPixels
Frame rate	up to 450 Hz

Field of view (FoV)

Lens		Camera mode		
		Full Frame	Speed	High Speed
		8.1 MPix 180 Hz	4.7 MPix 300 Hz	2.9 MPix 450 Hz
F = 4.8 mm	FoV (hor. x vert.)	86° × 86°	86° × 51°	86° × 32°
	Max. tracking range	11 m	tba	tba
F = 6.0 mm	FoV (hor. x vert.)	72° × 72°	72° × 41°	72° × 25°
	Max. tracking range	15 m	tba	tba
F = 8.0 mm	FoV (hor. x vert.)	56° × 56°	56° × 31°	56° × 20°
	Max. tracking range	18 m	tba	tba

tracking ranges based on targets with 12 mm spherical passive markers and default sensor gain

Connectivity & Power Supply

single cable solution via Gigabit Ethernet, RJ45, PoE+ (IEEE 802.3at Standard)	
max. cable length	100 m
Voltage	50 - 57 V (defined by the Standard)
max. power consumption	25 W
Protection category	III
Interface connectors	RJ45 (hosts data, synchronization and power)

Operating conditions

Temperature	0 .. 38°C
Relative humidity	5 .. 85% (non-condensing)
Cooling system	passive

Dimensions

Length	104 mm
Width	134 mm
Height	102 mm
Weight	1.3 kg

A.1.2 *AT7-50*

IR Source

invisible IR	850 nm

flash intensity adjustable in 100 steps

Performance

Sensor resolution	5.1 MPixels
Frame rate	up to 500 Hz

Field of view (FoV)

Lens		Camera mode			
		Full Frame	Medium	Speed	High Speed
		5.1 MPix 230 Hz	4.4 Mpix 270 Hz	3.2 MPix 360 Hz	2.2 MPix 500 Hz
F = 3.5 mm	FoV (hor. x vert.)	108° × 90°	108° × 77°	108° × 54°	108° × 37°
	Max. tracking range	7 m	7m	tba	tba
F = 4.5 mm	FoV (hor. x vert.)	82° × 69°	82° × 60°	82° × 43°	82° × 29°
	Max. tracking range	13 m	13m	tba	tba
F = 6.0 mm	FoV (hor. x vert.)	62° × 52°	62° × 45°	62° × 32°	62° × 22°
	Max. tracking range	15 m	15m	tba	tba

tracking ranges based on targets with 12 mm spherical passive markers and default sensor gain

Connectivity & Power Supply

single cable solution via Gigabit Ethernet, RJ45, PoE+ (IEEE 802.3at Standard)	
max. cable length	100 m
Voltage	50 - 57 V (defined by the Standard)
max. power consumption	16 W
Protection category	III
Interface connectors	RJ45 (hosts data, synchronization and power)

Operating conditions

Temperature	0 .. 35°C

Relative humidity	5 .. 85% (non-condensing)
Cooling system	passive

Dimensions

Length	80 mm
Width	80 mm
Height	80 mm
Weight	0.7 kg

A.1.3 *ARTTRACK6/M*

IR Source

invisible IR	850 nm

flash intensity adjustable in 100 steps

Performance

Sensor resolution	1.3 MPixels
Frame rate	up to 500 Hz

Field of view (FoV)

Lens		Camera mode			
		Full Frame	Medium	Speed	High Speed
		1.3 MPix 180 Hz	1.0 MPix 240 Hz	0.8 MPix 300 Hz	0.5 MPix 500 Hz
F = 2.9 mm	FoV (hor. x vert.)	135° × 102°	135° × 82°	135° × 61°	77° × 56°
	Max. tracking range	5.0 m	4.5 m	3.5 m	3.5 m
F = 3.5 mm	FoV (hor. x vert.)	83° × 70°	83° × 61°	83° × 48°	63° × 46°
	Max. tracking range	5.2 m	4.7 m	3.9 m	3.9 m
F = 6.0 mm	FoV (hor. x vert.)	59° × 46°	59° × 37°	59° × 28°	59° × 26°
	Max. tracking range	TBA	TBA	TBA	TBA

tracking ranges based on targets with 12 mm spherical passive markers

Connectivity & Power Supply

single cable solution via Gigabit Ethernet, RJ45, PoE (IEEE 802.3af Standard)

max. cable length	100 m
Voltage	44 - 57 V (defined by the Standard)
max. power consumption	6 W
Protection category	III
Interface connectors	RJ45 (hosts data, synchronization and power)

Operating conditions	
Temperature	0 .. 38°C
Relative humidity	5 .. 85% (non-condensing)
Cooling system	passive

Dimensions	
Diameter	30 mm
Length	100 mm
Weight	0.1 kg



Only PoE(+) switches and PoE(+) injectors that meet the applicable regional safety requirements may be used to power the cameras (e.g. EN 62368-1 within the EU, UL 62368-1 in the U.S., etc.).

A.2 *Flystick2* & *Flystick2+*

	Flystick2	Flystick2+
Power supply		
Rechargeable battery [1]	3 Micro-AAA batteries	2 AA batteries
Continuous operation[2]	at least 10 hours	at least 80 hours
Battery charging duration		typically 5 h
Operation possible with connected charger	no	yes
Radio module		
Type ID	IEEE 802.15.4	IEEE 802.15.4
Frequency	2.4 GHz	2.4 GHz
Transmission power	4 dBm (2.5 mW)	4 dBm (2.5 mW)
Radio range (depending on setup location, e.g. walls)	at least 7 m	at least 7 m
Operating conditions		
Operating temperature	0 .. 40°C	0 .. 40°C
Relative humidity	5 .. 85%, non-condensing	5 .. 85%, non-condensing
General features		
Target type	passive markers	passive markers
Tracking range (@ 3.5 mm focal length)	approx. 4 m	approx. 4 m
Weight	250 g	250 g
Size	220 mm x 180 mm x 100 mm	183 mm x 188 mm x 99 mm

[1] replacement after a period of 2 years is recommended
[2] valid for new batteries

A.3 Fingertracking

A.3.1 *Fingertracking2*

Features	
Synchronization	via modulated IR flash
Battery [1]	2 Micro-AAA batteries, 1.2 - 1.5 V, typ. 900 mAh
Continuous operation [2]	typ. 9 hours
Continuous operation [3]	typ. 12 hours
Performance	
Frame rate (hand target)	up to 300 Hz
Frame rate (thimbles, 3-finger version)	up to 100 Hz with handtarget @ 300 Hz
Frame rate (thimbles, 5-finger version)	up to 60 Hz with handtarget @ 300 Hz
Tracking range	typ. 4-5 m (depending on focal length of the cameras and selected LED brightness)
Operating conditions	
Operating temperature	5 .. 40°C
Relative humidity	5 .. 85%, non-condensing
Dimensions	
Hand target	72 x 77 x 21 mm
Thimble set	available in 4 different sizes (extra-small, small, medium, large)
Weight Handset	55 g (without batteries)
Weight Thimbles	10 g (3-finger version)
Battery charger	
Input	AC 100 - 240 V, 50/60 Hz, 0.25 A or DC 9 - 12 V, 1 A
Charging time [1]	approx. 2 hours
Weight (without batteries)	approx. 0.2 kg

[1] valid for new batteries
[2] 150 Hz tracking frequency, LED brightness high
[3] 150 Hz tracking frequency, LED brightness low

A.3.2 *Fingertracking2 Tactile*

Features	
Synchronization	via modulated IR flash
Battery [1]	2 Micro-AAA batteries, 1.2 - 1.5 V, typ. 900 mAh
Continuous operation with tactile feedback [2]	typ. 6 hours
Continuous operation no tactile feedback [3]	typ. 9 hours
Continuous operation no tactile feedback [4]	typ. 12 hours
Performance	
Frame rate (hand target)	up to 300 Hz
Frame rate (thimbles, 3-finger version)	up to 100 Hz with handtarget @ 300 Hz
Tracking range	typ. 4-5 m (depending on focal length of the cameras and selected LED brightness)
Radio module	
Type ID	IEEE 802.15.4
Frequency	2.4 GHz
Transmission power	3 dBm (2.0 mW)
Operating conditions	
Operating temperature	5 .. 40°C
Relative humidity	5 .. 85%, non-condensing
Dimensions	
Hand target	72 x 77 x 21 mm
Thimble set	available in 4 different sizes (extra-small, small, medium, large)
Weight Handset	55 g (without batteries)
Weight Thimbles	15 g
Battery charger	
Input	AC 100 - 240 V, 50/60 Hz, 0.25 A or DC 9 - 12 V, 1 A
Charging time [1]	approx. 2 hours
Weight (without batteries)	approx. 0.2 kg

[1] valid for new batteries
[2] 150 Hz tracking frequency, LED brightness high, 2 vibrations per 5 seconds (vibrations 1 second in duration)
[3] 150 Hz tracking frequency, LED brightness high
[3] 150 Hz tracking frequency, LED brightness low

A.4 Overall system

System parameters	
number of cameras	2 - 80
max. number of targets	70
max. number of hands	4
max. number of Flysticks	
- Flystick2	5
- Flystick2+	5

- Flystick3	2
Scalability	***ARTTRACK*** system: fully scalable (2 - 80 cameras)
Accuracy	
- of the timestamp	based on ***DTRACK4*** backend: $\Delta t_{err} \sim \pm 1ms$

Compatible shutter glasses

none for ***DTRACK4***

DTRACK Backend Service

System requirements	
- Free disk space	$\geq$ 200MB
- Processor	Intel: $\geq$ Core i3-13100T AMD: $\geq$ Ryzen 5600X
- RAM	$\geq$ 16GB
Operating systems	Windows 11 Pro 64 Bit Windows 10 Pro 64 Bit

DTRACK4 Frontend

System requirements	
- Free disk space	$\geq$ 200MB
- Processor	min. requirements for Windows 10 / 11 compatibility
- RAM	min. requirements for Windows 10 / 11 compatibility
Operating systems	Windows 11 64 Bit Windows 10 64 Bit

Used IP ports in *DTRACK4*

backend		frontend	purpose
TCP 50105	$\leftrightarrow$	TCP dynamic	general communication
UDP 50105	$\leftrightarrow$	UDP dynamic	general communication
UDP 50107	$\rightarrow$	UDP dynamic	measurement data (6DOF, timestamps, etc.)
backend		user's application (e.g. DTrackSDK)	purpose
TCP 50105	$\leftrightarrow$	TCP variable	remote commands (optional)
UDP 50107	$\rightarrow$	UDP user-defined (default: 5000)	measurement data (6DOF, timestamps, etc.)
UDP 50110	$\leftarrow$	UDP variable	control commands (optional; for ***Fingertracking2*** ***Tactile*** or ***Flystick*** feedback devices)

'dynamic' port	defined by the OS; can be among all local ports within the accessible range of the OS (i.e. from the pool of 'registered ports' in Microsoft WINDOWS)
'variable' port	arbitrary, by design of the user's application
'user-defined' port	defined from within the frontend (Menu *Tracking* $\rightarrow$ *Output*)

A.5 Declaration of conformity

ART
Advanced Realtime Tracking

CE

EUROPEAN DECLARATION OF CONFORMITY STATEMENT

Advanced Realtime Tracking GmbH & Co. KG

declares under its sole responsibility that the product

AT7-80

to which this declaration relates is in conformity to the following standard(s) or other normative document(s)

2014/30/EC (EMC Directive):	EN 55032:2015/A11:2020 EN 55035:2017/A11:2020
2011/65/EC (RoHS Directive):	EN 63000:2018

Weilheim i. OB, 20.12.2024

Robert Scheibe (Managing Director)

Advanced Realtime Tracking GmbH & Co. KG Am Öferl 6 82362 Weilheim i. OB Germany

Supplier's Declaration of Conformity

This Declaration of Conformity is hereby issued according to Chapter 1, Subpart A, Part 2 of Title 47 of the Code of Federal Regulations by:

Advanced Realtime Tracking GmbH & Co. KG
Am Oeferl 6
82362 Weilheim i. OB
Germany

EQUIPMENT "AT7-80" complies with the applicable requirements of FCC Rule Part 15

RESPONSIBLE PARTY located in the United States:

Violette Engineering Corporation
313 Park Avenue, Suite 300
Falls Church, VA 22046
info@violettecorp.com

The responsible party warrants that each unit of equipment marketed under this Declaration of Conformity will be identical to the unit tested and found acceptable with the standards and that the records maintained by the responsible party continue to reflect the equipment being produced under such Supplier's Declaration of Conformity continue to comply within the variation that can be expected due to quantity production and testing on a statistical basis.

Weilheim i. OB, 09/09/2024

Robert Scheibe (Managing Director)

ART
Advanced Realtime Tracking

CE

EUROPEAN DECLARATION OF CONFORMITY STATEMENT

Advanced Realtime Tracking GmbH & Co. KG

declares under its sole responsibility that the product

AT7-50

to which this declaration relates is in conformity to the following standard(s) or other normative document(s)

2014/30/EC (EMC Directive):	EN 55032:2015/A11:2020 EN 55035:2017/A11:2020
2011/65/EC (RoHS Directive):	EN 63000:2018

Weilheim i. OB, 03.11.2025

Robert Scheibe (Managing Director)

Advanced Realtime Tracking GmbH & Co. KG Am Öferl 6 82362 Weilheim i. OB Germany

Supplier's Declaration of Conformity

This Declaration of Conformity is hereby issued according to Chapter 1, Subpart A, Part 2 of Title 47 of the Code of Federal Regulations by:

Advanced Realtime Tracking GmbH & Co. KG
Am Oeferl 6
82362 Weilheim i. OB
Germany

EQUIPMENT "AT7-50" complies with the applicable requirements of FCC Rule Part 15

RESPONSIBLE PARTY located in the United States:

Violette Engineering Corporation
313 Park Avenue, Suite 300
Falls Church, VA 22046
info@violettecorp.com

The responsible party warrants that each unit of equipment marketed under this Declaration of Conformity will be identical to the unit tested and found acceptable with the standards and that the records maintained by the responsible party continue to reflect the equipment being produced under such Supplier's Declaration of Conformity continue to comply within the variation that can be expected due to quantity production and testing on a statistical basis.

Weilheim i. OB, 11/03/2025

Robert Scheibe (Managing Director)

ART
Advanced Realtime Tracking

CE

EUROPEAN DECLARATION OF CONFORMITY STATEMENT

Advanced Realtime Tracking GmbH

declares under its sole responsibility that the product

ARTTRACK6/M

to which this declaration relates is in conformity to the following standard(s) or other normative document(s)

2014/30/EC (EMC Directive):	EN 55032:2015 EN 55035:2017
2011/65/EC (RoHS Directive):	EN 63000:2018

Weilheim i. OB, 24.11.2020

Dr. A. Weiss (Managing Director)

Advanced Realtime Tracking GmbH Am Öferl 6 82362 Weilheim i. OB Germany

Supplier's Declaration of Conformity

This Declaration of Conformity is hereby issued according to Chapter 1, Subpart A, Part 2 of Title 47 of the Code of Federal Regulations by:

Advanced Realtime Tracking GmbH & Co. KG
Am Oeferl 6
82362 Weilheim i. OB
Germany

EQUIPMENT "ARTTRACK6/M" complies with the applicable requirements of FCC Rule Part 15

RESPONSIBLE PARTY located in the United States:

Violette Engineering Corporation
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Falls Church, VA 22046
info@violettecorp.com

The responsible party warrants that each unit of equipment marketed under this Declaration of Conformity will be identical to the unit tested and found acceptable with the standards and that the records maintained by the responsible party continue to reflect the equipment being produced under such Supplier's Declaration of Conformity continue to comply within the variation that can be expected due to quantity production and testing on a statistical basis.

Weilheim i. OB, 09/09/2024

Robert Scheibe (Managing Director)

ART
Advanced Realtime Tracking

CE

EUROPEAN DECLARATION OF CONFORMITY STATEMENT

Advanced Realtime Tracking GmbH & Co. KG

declares under its sole responsibility that the product

Flystick2+

to which this declaration relates is in conformity to the following standard(s) or other normative document(s)

2014/53/EC (RE Directive):	ETSI EN 300 328 V2.2.2
2014/30/EC (EMC Directive):	EN 55032:2015 EN 55035:2017
2011/65/EC (RoHS Directive):	EN 63000:2018

Weilheim i. OB, 29.10.2021

Dr. A. Weiss (Managing Director)

Advanced Realtime Tracking GmbH & Co. KG Am Öferl 6 82362 Weilheim i. OB Germany

Supplier's Declaration of Conformity

This Declaration of Conformity is hereby issued according to Chapter 1, Subpart A, Part 2 of Title 47 of the Code of Federal Regulations by:

Advanced Realtime Tracking GmbH & Co. KG
Am Oeferl 6
82362 Weilheim i. OB
Germany

EQUIPMENT "Flystick2+" complies with the applicable requirements of FCC Rule Part 15

RESPONSIBLE PARTY located in the United States:

Violette Engineering Corporation
313 Park Avenue, Suite 300
Falls Church, VA 22046
info@violettecorp.com

The responsible party warrants that each unit of equipment marketed under this Declaration of Conformity will be identical to the unit tested and found acceptable with the standards and that the records maintained by the responsible party continue to reflect the equipment being produced under such Supplier's Declaration of Conformity continue to comply within the variation that can be expected due to quantity production and testing on a statistical basis.

Weilheim i. OB, 09/09/2024

Robert Scheibe (Managing Director)

ZERTIFIKAT ◆ CERTIFICATE ◆ 認證證書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

America

CERTIFICATE

No. U8 052228 0029 Rev. 00

Holder of Certificate: **Advanced Realtime Tracking GmbH & Co. KG**
Am Öferl 6
82362 Weilheim i. OB
GERMANY

Certification Mark:

Product: **Information Technology Equipment (IR-Tracking Camera)**

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing, Certification, Validation and Verification Regulations (TCVVR)". TÜV SÜD America Inc. is an OSHA recognized NRTL for USA and a Standards Council of Canada ISO/IEC 17065 accredited Certification body for Canada.

Test report no.: 713340244

Date, 2024-12-12

(Ralph Fischer)

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SCC Accredited CB-P/S OCPS Accrédité CCN TM

OSHA NRTL

TÜV SÜD America

CERTIFICATE

No. U8 052228 0029 Rev. 00

Model(s):	**AT7-80**
Brand Name:	**ART**
Tested according to:	UL 62368-1:2019/R:2021-10 CSA C22.2 No. 62368-1:2019/U1:2021-10

Parameter:

Nominal Input voltage:	PoE powered
Environmental conditions:	0°C ... 38°C

Condition of Acceptability:

- Only external LPS/PS2 PoE power supply shall be used for this product.

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America

CERTIFICATE

No. U8 052228 0031 Rev. 00

Holder of Certificate: **Advanced Realtime Tracking GmbH & Co. KG**
Am Öferl 6
82362 Weilheim i. OB
GERMANY

Certification Mark:

Product: **Information Technology Equipment**
(IR-Tracking Camera)

Brand Name: **ART**

Model(s): **AT7-50**

Parameters: PoE+ powered

Condition of Acceptability:
Only certified external LPS/PS2 PoE power supply shall be used for this product.

Tested according to: UL 62368-1:2019/R:2021-10
CSA C22.2 No. 62368-1:2019/U1:2021-10

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing, Certification, Validation and Verification Regulations (TCVVR)". TÜV SÜD America Inc. is an OSHA recognized NRTL for USA and a Standards Council of Canada ISO/IEC 17065 accredited Certification body for Canada.

Test report no.: 713380383

Date, 2025-12-04

(Ralph Fischer)

Page 1 of 1

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America

CERTIFICATE

No. U8 052228 0024 Rev. 00

Holder of Certificate:	**Advanced Realtime Tracking GmbH** Am Öferl 6 82362 Weilheim GERMANY
Production Facility(ies):	052228
Certification Mark:	
Product:	**Information Technology Equipment** **(IR-Tracking Camera)**
Brand Name:	**ART**
Model(s):	AT6/M
Parameters:	PoE powered
Tested according to:	UL 62368-1:2014 CAN/CSA-C22.2 No. 62368-1:2014

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing and Certification Regulations". TÜV SÜD America Inc. is an OSHA recognized NRTL and a Standards Council of Canada accredited Certification body.

Test report no.: 713198040

Date, 2020-11-20

(Abdul Sabbagh)

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America

CERTIFICATE

No. U8 052228 0025 Rev. 00

Holder of Certificate: **Advanced Realtime Tracking GmbH & Co. KG**
Am Öferl 6
82362 Weilheim i. OB
GERMANY

Certification Mark:

Product: **Information Technology Equipment**

Brand Name: **ART**

Model(s): **Flystick2+**

Parameters: 2x 1.2 V NiMH AA batteries supplied.
USB-C: 5 Vdc, 500 mA.

Tested according to: UL 62368-1:2014
CAN/CSA-C22.2 No. 62368-1:2014

This product was voluntarily tested to the relevant safety requirements referenced on this certificate. It can be marked with the certification mark above. The mark must not be altered in any way. This product certification system operated by TÜV SÜD America Inc. most closely resembles system 3 as defined in ISO/IEC 17067. Certification is based on the TÜV SÜD "Testing and Certification Regulations". TÜV SÜD America Inc. is an OSHA recognized NRTL and a Standards Council of Canada accredited Certification body.

Test report no.: 713210723

Date, 2021-06-09

(Abdul Sabbagh)

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