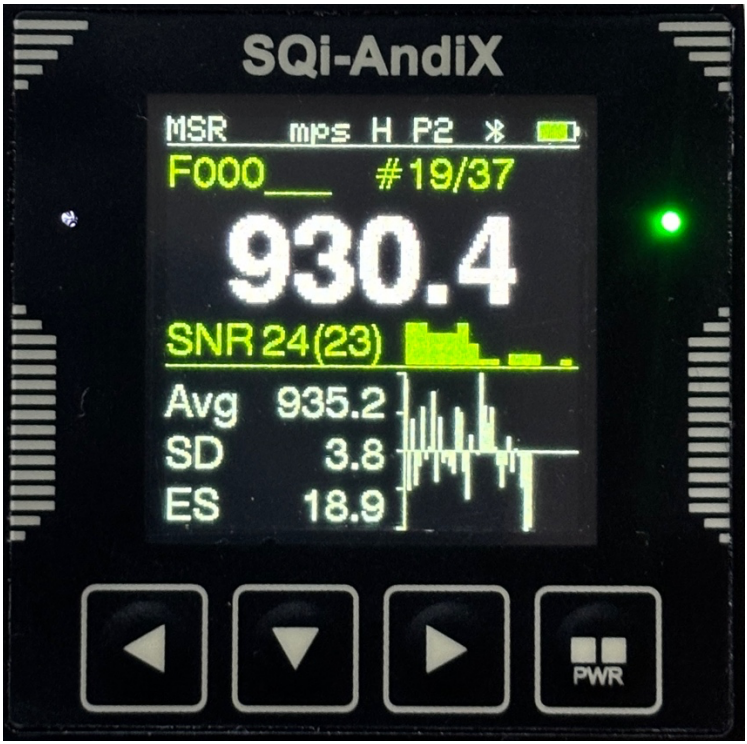
AndiScan

Model A3

User Guide



SQi-AndiX

Disclaimer

The manufacturer is not responsible for any damage or injuries caused by using this device and by utilization of the values measured by the device. It is an ultimate responsibility of the device operator to use the device safely and to correctly interpret the measured values.

User Guide version A3.1.0 (1.7.2024)

User Guide describes AndiScan Model A3
with FW version US_A3.1.0/TXR_A3.1.0

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1 Welcome

AndiScan A3 is a third generation of an advanced ballistic velocity Doppler radar for measuring muzzle velocity of projectiles. It operates in 24GHz frequency band. It is a highly integrated and extremely small form-factor device that may be used on a tripod, directly mounted on the rifle, or as an embedded module in more complex measurement instruments. A direct rifle mounting frees the user from a complicated setup alignment and it also allows to perform measurements under dynamic conditions.

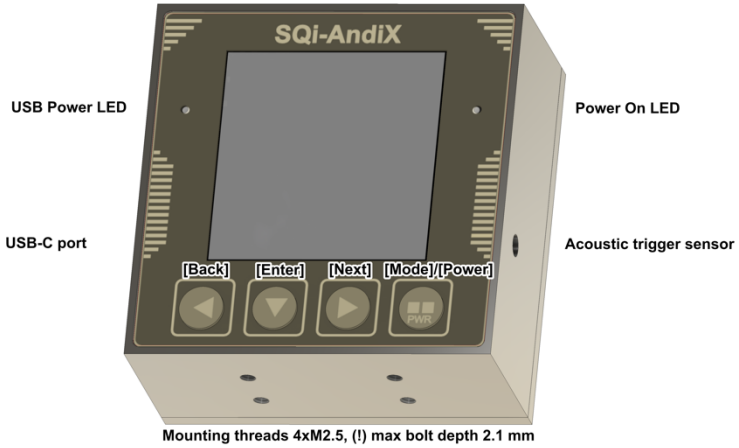
The device is a high precision measurement instrument. It uses highly advanced signal processing optimized for velocity measurement precision and for small device form-factor. The device provides the user with a full velocity measurement statistic including a graphical representation of data.

2 Device

2.1 Package Contents

- radar device
- universal mount (Arca, 1/4" tripod thread, 20 mm custom rail)
- hard storage box

2.2 Device



- The device is operated by keys [Back], [Enter], [Next], [Mode].
    - Keys distinguish a short and a long press. The long press is denoted as [Enter-Long] in this user guide.
    - The long press on keys [Back], [Enter], [Next] has duration longer then approximately 1 second.
    - The long press on [Mode] key has a special dedicated meaning - it switches the device on and off.
- ***Warning:*** *Absolutely do not exceed the maximum bolt depth in mounting threads. Violating this would cause a permanent damage of the device electronics and its dust/water seal.*

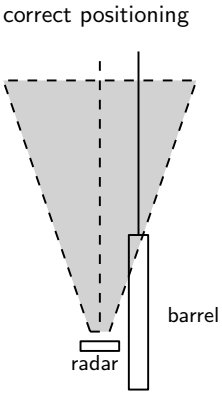
3 Measurement Setup

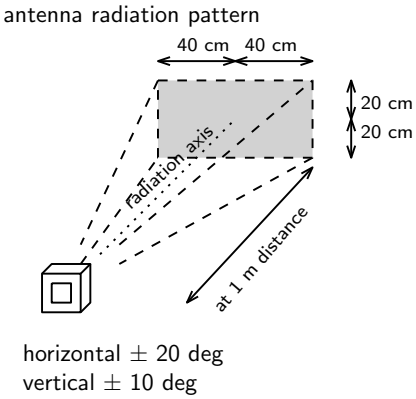
3.1 Device Mounting

The device can be used mounted on a tripod or directly on the gun. Some caution is however required for heavily recoiling guns. The provided mount adapter allows Arca or standard 1/4" thread mounting. It also contains a custom 20 mm rail with small footprint for custom mount solutions.
The device has form factor suitable as a building block built into complex custom measurements setups. In this situation, the adapter can be detached, and the device can be fixed directly by its 4xM2.5 threads. Do *not* exceed the maximum depth 2.1 mm.

3.2 General Tips for Positioning the Device

- The device measures a true V0 velocity with the measurement window roughly from 0 to 2 meters downrange from the muzzle. It is important to make sure that the antenna radiation pattern intercepts the bullet trajectory immediately when it leaves the barrel.
- The device should be pointed with its back side in the shot direction with horizontal +/- 20 deg and vertical +/- 10 deg tolerance at maximum. A slight tilt of the device radiation axes towards the bullet path could improve the bullet path coverage by the radiation pattern.





- Ideally, the device is positioned with its vertical center at the barrel level and with its side position as close as possible to the barrel (5-10 cm is optimal, 15-20 cm is acceptable). The forward position should be roughly at the chamber level, or slightly forward towards the muzzle (roughly 30-70 cm back from muzzle). Do not position the device in front of the muzzle or in the hot gas path of the muzzle brake.
- A special attention is needed when measuring the gun with a muzzle brake. The hot gasses and plasma from the muzzle brake are strong blocks for radio waves. Some muzzle brakes are quite aggressive in creating a "wall" for the signal. Avoiding this is a necessity. The solution is to allow the signal to go "around" by putting the device e.g. a bit higher - some experimentation is needed.
- If some special measurement scenario requires that, the device can be rotated upside-down, or in a (counter) clock-wise direction. The display setting allows to properly rotate the display.
- Radio waves are strongly affected by metallic parts (bipod, large forearm). The device should be in such a position that its radiation pattern is not shaded by these obstacles in the direction of the measurement. For the first experiments, it is best to use the tripod mount and once the correct position is found, a rifle mounting can be used. The correct position is defined by having sufficiently strong received signal, which is indicated by Signal-to-Noise Ratio (SNR) and power profile. SNR values larger that 20 dB means a good quality of the signal.

4 Device Operation

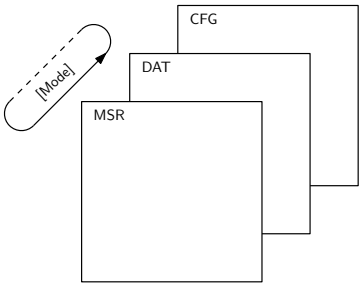
4.1 Powering the Device

- The device is powered by the internal LiPo battery or by the external USB power source. The internal battery is charged when the device is on external USB power. The device can be used normally during charging.
- The internal battery is not replaceable by the user. If it is needed, it must be replaced by the manufacturer.
- When the device is on *battery only* power source:
    - Power on: press and hold [Power] key for 2 seconds.
    - Power off: press and hold [Power] key for 3 seconds until Powering Off screen appears.
    - Hard power off: if the device stops responding, press and hold [Power] key for 10 seconds and the release it.
- When the device is on *external USB power* source:
    - Device automatically powers on when the external USB power is applied.
    - The device cannot be switched off when the external USB power is applied.

4.2 Modes of Operation

Every press of the [Mode] key cyclically switches the device into the next mode. There are three modes:

- [MSR] Measurement Mode
- [DAT] Data Mode
- [CFG] Configuration Mode



4.3 Data Storage

- In a live measurement session, each measurement is immediately stored into the non-volatile memory. The device can be switched off during the live measurement session and after subsequent switching on, it shows all measurements as they were recorded before the switch off.
- At the end of the session, the session data can be stored into a file. Files are named F000..F999. The device storage handles 1000 files each containing 100 shots in the session.
- Each file contains the session statistics summary, data/time of file storage and data of individual shots.
- Arbitrary file can be reopen for additional shots or for deleting individual shots. Even an empty file can be reopen. It allows the user to select a particular file number for a given shooting session.

4.4 Device External Communication

The device has USB and BLE (Bluetooth Low Energy) external communication ports. The USB power supply and charging role works independently.

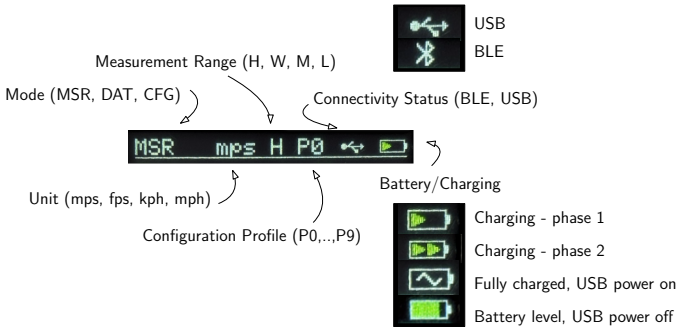
- BLE
    - The BLE is on by default.
    - The BLE serves for a remote control of the device, live data display, and measurement files downloads.
- USB
    - A communication protocol on USB must be explicitly enabled during the device boot - press and hold [Back] key and then switch on the device. Release the [Back] once the Welcome screen appears.
    - USB and BLE communication protocols cannot be activated simultaneously. Activating USB disables BLE.
    - The USB communication protocol is used for device FW (FirmWare) updates and remote control of the device, live data display, and measurement files downloads. The protocol is suited for embedding the device as a measurement module into more complex measurement setups.

- The USB port also allows, in a special analog communication protocol, to trigger the device from the external trigger sensor. External USB trigger cable is available separatelly.

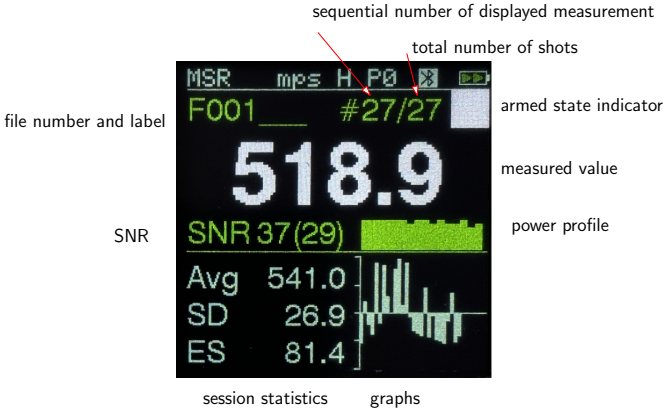
5 Measurement Mode (MSR)

5.1 Display

- Status Line



- Measurement Screen



  - file number and label
  - sequential number of displayed shot and total number of shots in the session
  - measured velocity value
  - SNR (Signal-to-Noise Ratio) - signal quality
    - SNR xx (yy) - unit [dB]
    - xx SNR for the measurement
    - yy SNR for the signal acquisition (signal trigger)

        - SNR values
            - < 20 dB low signal quality
            - > 20 dB good signal quality
            - > 30 dB excellent signal quality
    - Power profile - signal level profile in the measurement window
        - The power profile can help identify problems with radio signal blockage, antenna alignment or triggering sensitivity setting.
    - session statistics
        - Avg - average value
        - SD - standard deviation
        - ES - extreme spread
    - graphs
        - plot of velocity vs. shot number
            - center line corresponds to the average value
            - one division on vertical axis corresponds to SD
        - histogram of velocities
            - center line corresponds to the average value
            - one division on horizontal axis corresponds to SD
        - history of recent values and their difference from the average value

5.2 Operations in MSR Mode

- Arming and Disarming
    - Press [Enter] to arm or disarm the device.
    - In the armed state, the device actively transmits the signal and has much larger current consumption from the battery. Also, when keeping the device in Armed state for long time, the device electronic can heat up considerably. *Activate the armed state only if you intend to take the measurements and after that disarm the device.*

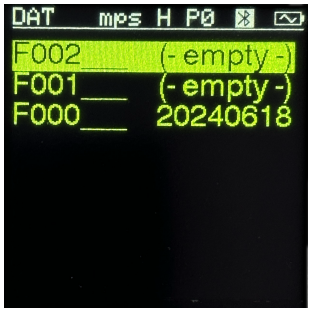
- View detailed data for individual shots in the session
    - Press [Back]/[Next] to go backward/forward through the shots in the sessions.
- Delete shot
    - Display the shot intended to be deleted.
    - Press [Back-Long] to delete the shot.
- Save the active session into the file
    - Press [Next-Long] to save the file.
    - A new session will be automatically started.

6 Data Mode (DAT)

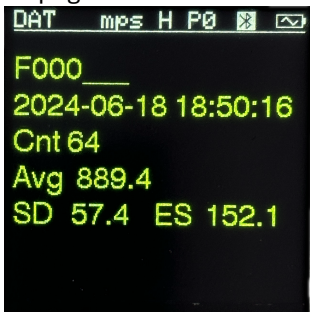
6.1 List of Files and File Data

In DAT mode, the first screen shows the list of the files. The list shows the file name Fxxx with the optional editable label. Non-empty files display the date of saving the file.

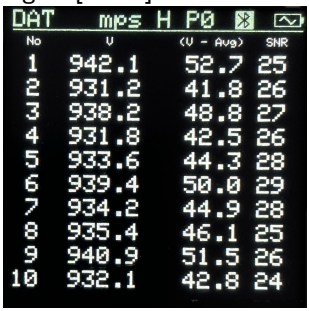
- List of files



- Moving backward/forward in the list of files
  - Press [Back] or [Next].
- View file contents
  - Press [Enter] to view file data contents.
  - The first page shows the session statistics.



- Press again [Enter] to see data for individual shots.



- Press again [Enter] to see subsequent data pages. After the last page, the screen returns back to the file list.
- Pressing [Back]/[Next] during file view shows previous/next file without the need to go back to the file list. This is useful when quickly checking the summary pages for several files.
- Pressing [Back-Long]/Next-Long] moves fast through the files.

6.2 File Operations

- File operations menu
  - In the file list screen, press [Enter-Long] to enter the menu.

  - Press [Enter] to activate the next field.
  - In Reopen and Erase fields, press [Next] to confirm the operation.
  - In Label field, press [Back]/[Next] to select characters for the 3 letters of the label.

- Reopening of the file loads the file data as a current measurement session. Then, the measurements can be viewed, added, deleted, and at end, the file can be saved again with modified contents.
- Any file, even an empty one, can be reopen. Reopening the empty file allows to use a particular file number for a given session.
- ***Caution:*** Reopening a file overwrites and current live session data. In order not to lose them, the current session should be saved before reopening the another file.

7 Configuration Mode (CFG)

- Configuration Mode has several numbered screens CFGn. Each screen allows editing some group of parameters.
- When entering CFG mode, the last used CFG screen is shown (or the default CFG0 after powering on).
- All settings are stored in the non-volatile memory and the device will use the last used ones in subsequent boots.

7.1 Setting Configuration Values

- Move to the previous/next CFG screen
  - Press [Back]/[Next]
- Activate the value field
  - Press [Enter] to activate the field. Activated field will be highlighted.
  - If the screen contains more than 1 field, pressing [Enter] again activates the next field.
- Changing the value
  - In the activated field, press [Back]/[Next] to change the value.
  - Some fields support fast change by pressing [Back-Long]/[Next-Long].

7.2 Configuration Screens

7.2.1 CFG0 Configuration Profile

- There are 10 (P0..P9) configuration profiles. Each profile contains a separate and a complete set of device settings.

- Profiles are pre-initialized by factory-default settings for various measurement scenarios, but each profile can be freely user-edited.
- Any parameter change in other CFG screens is always applied to the currently selected profile only.

7.2.2 CFG1 Triggering Mode/Gain

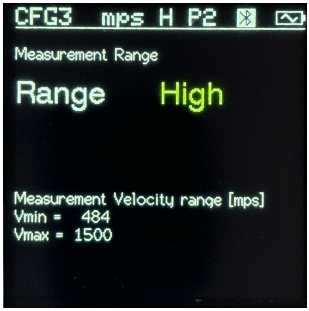
- TrigMode - Trigger Mode
    - SIG (Signal Detection) - It triggers the measurement by detecting a reflected signal from the moving bullet once it leaves the muzzle.
        - Signal detection quality is indicated in MSR screen by signal acquisition SNR (the second value in parenthesis).
        - For SIG triggering, it is important that the antenna radiation pattern properly intercepts the bullet path immediately from the muzzle with the radio signal not being blocked by metallic objects.
        - The direct signal detection is not affect by other nearby shooters.
    - ACST (Acoustic Detection) - It triggers the measurement by detecting acoustic pressure generated by the weapon.
        - Since the triggering and measurement are done by independent means, it allows more freedom in setting the sensitivity (and subsequently the mutual timing between the trigger and the measurement).

        - The acoustic trigger is affected by nearby other shooters, however the device uses fast response trigger mode which quickly analyses the false trigger by the other shooter and quicky resets the device for the next measurement. The device thus may false trigger but quicky recovers for the measurement of the intended shot.
    - EXT (External) - A special USB communication protocol allows to trigger the device from an external trigger sensor.
        - This setup is mainly intended for specialized laboratory setups and/or for using the device as an embedded measurement module.
- TrigGain - Trigger Gain
    - A numeric value 0 .. 10 sets the sensitivity of triggering. The higher the value, the higher the sensitivity.

7.2.3 CFG2 Detection Threshold

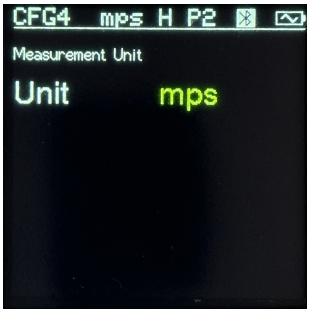
- DetThld - Detection Threshold
    - A minimum SNR (Signal-to-Noise Ratio) [dB] of signal quality required for detecting the measurement as a valid measurement. The true measured SNR is shown in MSR screen.

7.2.4 CFG3 Measurement Range



- Range - Measurement velocity range
    - H (High), W (Wide), M (Mid), L (Low) - a velocity measurement range.

7.2.5 CFG4 Measurement Unit

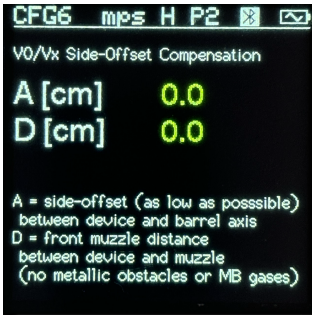


- Unit - Unit for the velocity measurement
    - mps, fps, kph, mph

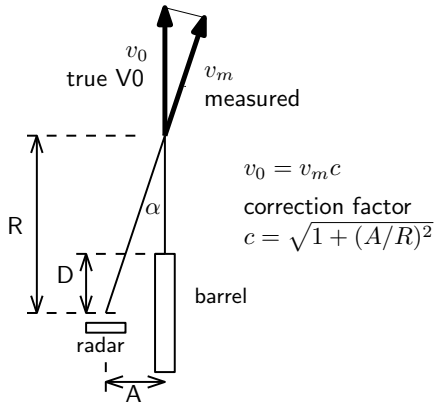
7.2.6 CFG5 Carrier Frequency Channel

- Freq - Carrier Frequency Channel
  - auto, manual (24150,...24220 MHz) - automatic or manual setting for carrier frequency channel.
  - auto - The device uses a fine grid of frequency channels and automatically senses for any possible interferences. If there is an interference, another channel is searched.
  - manual - The carrier frequency is set manually in coarse grid of channels. The device senses for an interference on a given channel, and if there is an interference it issues a warning.
- LastCF - Last used Carrier Frequency
  - The device shows what was the last used carrier frequency in the previous armed state. It can be used to track the channel use history.

7.2.7 CFG6 V0/Vx Side-Offset Compensation



- A - side-offset distance between the antenna radiation axis and the barrel axis. Entering A = 0 switches off any compensation.
- D - front muzzle distance between the device and the first point where the radio signal intercepts the bullet (ideally the muzzle)
- In order to minimize an impact of the side offset, the ratio A/D should be kept as small as possible and particularly the value A should be small (the device as close as possible to the barrel axis).
- The device calculates the compensation of the measured velocity to obtain true V0 velocity. The value R is calculated automatically based on the user-set values A and D and the true measured signal properties. The calculated correction value c is shown in downloaded full version of the measurement file.



7.2.8 CFG7 Display Settings

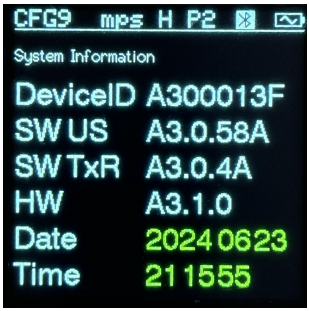
- Graph - Graph area of MSR screen
    - Plot
    - Histogram
    - None
    - List
- Scheme - Display color scheme
    - WhtGrn - White/Green
    - WhtWht - White
    - RedRed - Red
- Light - Display backlight intensity
- Rotate - Display rotation

7.2.9 CFG8 System Maintenance

- PSM erase - Erase PSM (Prime Storage Memory)
    - PSM contains system configuration files and current live session data.
    - After erasing PSM, the factory default configuration will be filled in all profiles.
- SSD erase - Erase SSD (Solid State Drive)
    - SSD contains measured stored data files and FW update files (loaded through USB RemoteShell).
    - After erasing SSD, all measurements files will be empty.
    - Erasing SSD takes about 60 seconds.
- SSD Wear Level
    - SSD memory has very high (roughly 100000) but limited number of write/erases cycles. Read cycles are not limited. Some portions of SSD memory are used more frequently. Wear Level indicates how far the SSD usage went.

- This value is important only for some specific (typically laboratory) setups with automated quicky repeated measurement of huge repetition quantities. For normal range use, it is highly unlikely that this would make any limitations for the user. It is however recommended not to use the same files for the measurement with massive repetitions. A good strategy is to use evenly all numbers in F000-F999 range and erase the SSD once per shooting season.

7.2.10 CFG9 System Information



- DeviceID - Device Identification Number
  - DeviceID is used to uniquely identify the device. It is used in RemoteShell App.
- SW US - SoftWare UserShell (user interface) FW version
- SW TxR - SoftWare TxR (Transceiver) FW version
- HW - Device HardWare version
- Date
- Time

8 Remote Shell Application

- AndiScan Remote Shell Application (RemShApp) enables to remotely control the device, remotely view the displayed and measured data and access the stored data and apply FirmWare updates. It uses web Bluetooth (BLE Bluetooth Low Energy) technology and USB to connect to the AndiScan device. The application operates inside the supported web browser on arbitrary remote device platform (iOS, Android, Mac, Windows, Linux). The application web page can be used either on-line or locally stored on the remote access device (if there is no on-line Internet access).
- The RemShApp is available at https://www.sqi-andix.com/RemShApp/A3RemSh.html
- Detailed instruction are at https://www.sqi-andix.com/a3-remshapp-guide/

9 Technical Specification

dimensions	50 x 50 x 25 mm (2.0 x 2.0 x 1.0 in)
weight (w/o mount adapters)	96 g (3.4 oz)
operational environment temperature range	-20 deg C .. 50 deg C
environment	dust and rain resistant
radar operating frequency range	24.150 - 24.220 GHz
radar transmitter output power	19 dBm EIRP
BLE output power at 2.4 GHz	18 dBm EIRP
internal LiPo battery operation time (battery is not user-replaceable)	6 hours 3 hours in Armed state (*)
external power	USB-C
internal storage capacity	1000 files, each file 100 shots
velocity measurement range	High (H) 484 - 1502 mps Wide (W) 242 - 1308 mps Mid (M) 30 - 303 mps Low (L) 1.0 - 121 mps
units of measurement	mps, fps, kph, mph
measurement precision (**) (99% confidence)	0.50 mps H/W range, SNR= 20dB 0.06 mps M range, SNR= 20dB 0.03 mps L range, SNR= 20dB 0.16 mps H/W range, SNR= 30dB 0.02 mps M range, SNR= 30dB 0.008 mps L range, SNR= 30dB
measurement accuracy	internal processing < 50ppm measurement side-offset(***)
minimum time between triggered measurements	approx. 1 s
external remote control, live view display, file management	BLE and USB - with universal Remote Shell Application (iOS, Android, Mac, Windows)

(*) BLE off, display backlight = min

(**) expected value based on theoretical analysis

(***) geometry impact can be compensated