AndiScan micro

Model A1

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.

A1.0.0 (29.5.2021)
This User Guide describes AndiScan Model A1 with SW version A1.0.

SQi-AndiX
Prague, Czechia

www.SQi-AndiX.com

1 Welcome

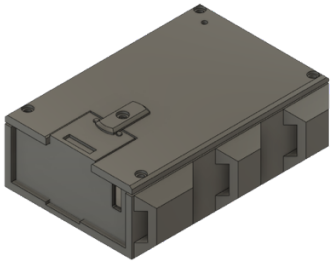
AndiScan micro is an advanced ballistic velocity Doppler radar for measuring muzzle velocity of projectiles. It operates in 24GHz frequency band. It is a highly integrated and extremely small form-factor device that is intended to be directly mounted on the rifle. This frees the user from a complicated setup alignment and it also allows to perform measurements under dynamic conditions. It is a first device of this form-factor on the public market.

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 graphical histogram data. Besides that, it also analyses the received signal properties. Based on that, the device can explicitly estimate its own measurement precision. It is defined as a stochastic confidence interval for measurements.

2 Description of the device

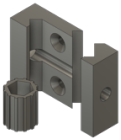
2.1 Package contents

(A) radar device

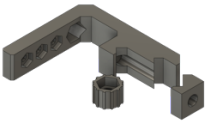


(B) rechargeable battery 16340
(C) charging USB cable
(D) micro SD memory card (inserted in the device)
(D1) SD card adapter
(H) hard case
(K) device mount bracket

(M1) picatinny mount adapter

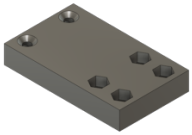


(M2) picatinny bracket narrow



(N1) bracket vertical

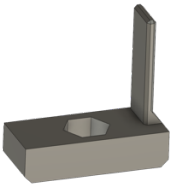
(N2) bracket horizontal extension



(R1) adapter UIT

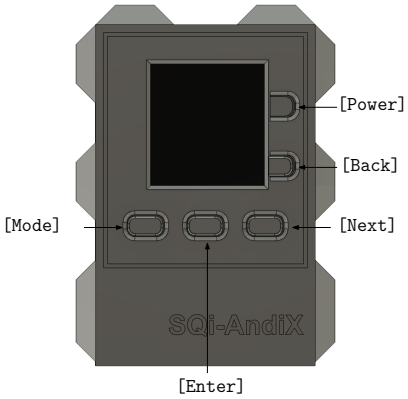
(R2) adapter Spuhr

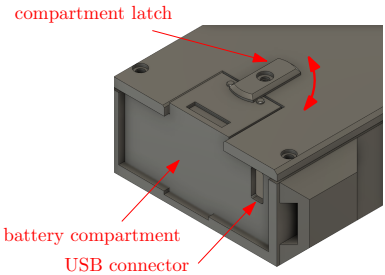
(T) tripod adapter



(S1) additional mounting screes M3x20 for bracket extension, M4 for Spuhr adapter

2.2 Device





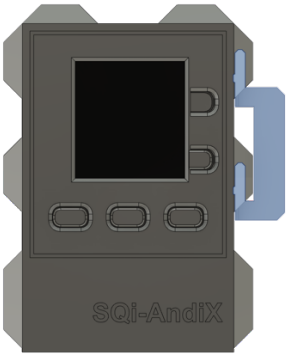
- There are no user-serviceable parts inside the device except those accessible by opening the battery compartment. The battery compartment allows the access to the battery and the SD card.

3 Installation and preparation for operation

The antenna of the device is placed under its back cover. The back of the device should be pointed into the direction of fire. The antenna radiation axis is perpendicular to the back cover. The display should face towards the back of the firearm. The device can be mounted directly on the rifle or on a nearby standing tripod.

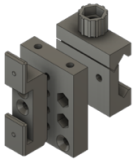
3.1 Rifle mounting

A direct mount on the rifle frees the user from keeping an eye on the device and the rifle alignment, since this is guaranteed by the device mount itself. It also makes the measurement triggering easier due to a direct mechanical contact of the device with the rifle. It causes a better shot shock-wave guidance from the chamber to the device. Several mounting options are provided. Some of the mounting brackets/extension have holes positioned on multiple places that allow the user to find the best position on the rifle.
The device (A) side slots fit into a device mount bracket (K). The device bracket is then attached to the mount according to the user choice.



3.1.1 Picatinny side-mounted

Use parts (K)(M1)(N1)



3.1.2 Picatinny top-mounted

Use parts (K)(M1)(N1)(N2)

3.1.3 Picatinny bottom-mounted

Use parts (K)(M1)(N1)(N2) and reverse upside-down the orientation of (K) bracket.

3.1.4 UIT adapter

The UIT slot adapter (R1) allows the user to use arbitrary Picatinny mounting assembly on UIT slot.

3.1.5 Spuhr adapter

The Spuhr adapter (R2) allows the user to use arbitrary Picatinny mounting assembly. It is recommended to attach the adapter on a bottom left-side row of M4 threads and keep an eye on the depth of screw protrusion.

3.2 Tripod mounting

When the rifle does not allow to use rifle mounted adapters, the user can use a traditional tripod mount adapter (T) which attaches to standard 1/4" tripod interface. The support plate of (T) should be below the device (A). Its length is designed to allow unobstructed use of the device USB port.

3.3 General tips for positioning of the device

- The device should be pointed with its back side into the shot direction with horizontal +/- 20 deg and vertical +/- 10 deg tolerance at maximum.

- 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 (8-10 cm is optimal, 15-20 cm is acceptable). The forward position should be roughly at the chamber level, or slightly forward towards the muzzle.
- Do not position the device in front of the muzzle or in the hot gas path of the muzzle break.
- If some special measurement scenario requires that, the device does not need to be positioned with the vertical orientation having display on top and the battery compartment at the bottom. Any orientation is possible. However, keep an eye on keeping the radiation antenna axis in line with the direction of fire.

4 Device operation

4.1 Powering the device

- The device is ***switched on*** by a ***short press of the [Power] key***. The device is ***switched off*** by a ***long 2 seconds press of the [Power] key***. A shut down operation takes about 8 seconds, and can be cancelled by pressing any other key. A ***hard switch off*** is (e.g. if the device is not responsive) is done by a ***long 10 seconds press***. The power button is recessed to prevent its inadvertent press.
- The device can be powered by its internal battery and/or external USB power (e.g. a USB powerbank). If powered by an external USB power, the internal battery is charged. Internal battery does not need to be inserted when using the external USB power.
- When charging the internal battery from the external USB power, the device will always be powered on and cannot be switched off using [Power] button.
- Internal battery power
    - Internal battery is a replaceable ***Li-ion rechargeable 16340 size cell***. It is strongly recommended to use only supplied type and to use the one with internal overcharge and discharge security circuit. Also, different brands of batteries have different sizes and this can cause some issues on the reliability of the battery contact connection. They are designed with tight tolerances to avoid disconnection when the device receives high acceleration during the rifle recoil and other manipulations.
    - A mechanical construction of the battery compartment is optimized to provide a tight reliable contact. It is *not* intended for a frequent battery change. The battery is intended to be removed only when it reaches its end-of-life. Under normal situation, the battery should be charged inside the device from an external battery power.
    - The device is ***not compatible*** with CR123 standard ***non-rechargeable lithium battery***.
    - Battery operation time depend on the device mode used. The following are estimated values based on a typical 800mAh battery cell and typical operation and environment characteristics.
        - Device in Armed State (WiFi off) .. approx. 1h20m
        - Device in Ready State (WiFi off) .. approx. 3h05m

        - Device in Armed State (WiFi on) .. approx.1h05m
        - A full battery recharge cycle (using USB external power) is approx. 1h
    - Battery critical warning is activated on approximately last 5 minutes of power supply.
- External USB power
    - Any external 5V USB power source (e.g. a powerbank) capable of providing 1.4 A at 5V can be used. Please, take care to use a high quality and short cables to prevent voltage loss over the resistance of the cable.
- Switching between power sources.
    - While operating on the internal battery, you can plug-in the external USB any time and the device continues to work uninterrupted.
    - While operating on external USB power, even with fully charged internal battery, unplugging the USB power causes the device to restart. Please save your data to SD card before doing that.

4.2 Modes of operation

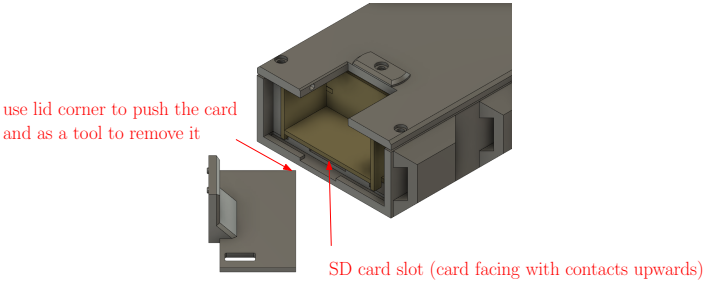
- Every press of the [Mode] key cyclically switches the device into the next mode. There are the following modes:
    - [TRG] Triggered Measurement
    - [MAN] Manual Measurement (* enabled only in Expert Mode)
    - [DAT] Data View Mode
    - [CFG] Configuration Mode
- The current mode is indicated in the status line of the display.

4.3 Measurement data storage and organization

- Measured data are organized in a hierarchy of (1) Folder, (2) Series, (3) Shot number.
- Maximum counts are the following.
    - 1000 folders, named F000 - F999
    - 100 series in one folder, named S00 - S99
    - 100 shots in one series, counted from 1 - 100
- The data are stored on the storage memory card each time you start a new series. Until this point, the data are stored in a volatile memory only. Remember to start a new series to keep all your data

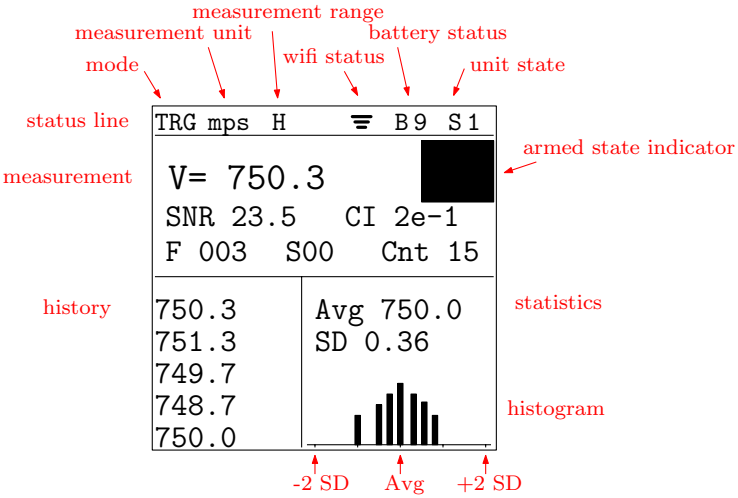
safely stored on SD card. This behavior is intentional and allows to speed up processing time between the shots.

- Each time you turn on the unit, the device checks for already used folders and a new folder is created. A similar procedure happens when the count of series rotates from 99 to 00. Under a normal situation, the device configuration file stores the last used folder name, and a new folder is created with the next sequential number.
- The device will never overwrite any existing folder. This ensures that all your data are completely under your control. If next sequential folder name is already used, the device will search for an unused folder name. If there is no unused folder name, the device stops and prompts you to insert a new fresh storage card or to manually erase the existing one. In order to do that, remove the SD card from the device and erase it on your personal computer.
- You can safely temporarily remove (and reinsert) the SD card, even if the device is powered on, provided that you make sure that the device is not trying to access it. The device accesses the SD card in the following situations: (1) during device start up, (2) when storing current series, after the new series is started, (3) when exiting from the configuration mode. When doing this temporary removal, please reinsert the same unmodified card, otherwise the device might be confused by a different folder structure.
- Inserting and removing the SD card. The device has a very small form factor, and the placement and access to the SD card had to be adjusted to that. The SD card has a spring-loaded push-push slot. Use the battery lid as a tool to push the card and to remove the card in the provided case opening by holding it between your nail and battery lid corner.



4.4 Triggered Measurement

- The triggered measurement triggers the device by acoustic and mechanical vibration input occurring when the shot is fired.
- The screen in Triggered Measurement Mode



  - Status line
    - TRG .. indicates the Triggered Measurement
    - measurement unit .. {mps, fps, kph, mph}
    - measurement range .. H (High), M (Mid), L (Low)
    - WiFi status .. (no icon) WiFi off, (icon) WiFi on, (highlighted icon) WiFi client connected
    - battery status .. B9 means fully charged battery, B0 means battery seconds before being cut-off.
    - unit activity states
      - S0 "ready state" .. transmitter and receiver are in idle low-power consumption mode
      - S1 "armed state" .. device is waiting for the shot and it is ready to immediately activate the transmitter and receiver upon the triggering
      - S2 "active state" .. device is actively transmitting and receiving the signal

- Measurement field
  - V= .. shows the velocity measurement. The "***" indicator at the place of the measured value indicates, that the unit has been triggered but the measured signal signal-to-noise ratio (SNR) is below the detection threshold.
  - armed status indicator shows large rectangle when the unit is in armed state.
  - animated long rectangle over the measurement field indicates the undergoing active state.
  - SNR .. shows the signal-to-noise ratio [dB] of the current measurement. The higher the value the stronger signal was received and the measurement has a better precision.
  - CI .. confidence interval. Based on the SNR value, the device predicts the statistic interval for its own velocity measurement error. The true velocity is expected to be within +/- CI tolerance with 99% probability.
  - F .. indicates current folder for storing data
  - S .. indicates current series for storing data
  - Cnt .. indicates total number of measurements in a given series
- History field
  - last 5 measurements are shown
- Statistics
  - Avg .. shows average velocity of the whole series
  - SD .. shows Standard Deviation of the whole series
- Histogram
  - the horizontal axis has a center point corresponding to the average measured value, the horizontal range is +/- 2 SD
  - the line height is proportional to the number of measurements in the vicinity of a given distance from the average value

- Operations in TRG mode
    - Key [Enter] toggles between ready and armed state. In order to measure the shot, the unit must be in armed state.
    - Key [Next] stores the current series into a SD card and starts the new series.
    - Key [Back] deletes the last shot data (1 last shot only).

4.5 Manual Measurement

- It is enabled only in Expert Mode.
- The screen in Manual Measurement Mode
    - The screen has identical fields as in the Triggered Measurement mode. The only difference is MAN mode indicator in the status line.
- There are only two device states in this mode: S0 (ready) and S2 (active).
- Operations in MAN mode
    - Key [Enter] starts manually one measurement
    - Key [Next] stores the current series into a SD card and starts the new series.
    - Key [Back] deletes the last shot data (1 last shot only).

4.6 Data View Mode

- Data View Mode allows the user to see the stored measured data on the SD card.
- When entering the mode, the current or the last stored folder/series is prefilled by default for a quick access to the last stored series. However, any SD card stored data are accessible.
- Operations in DAT mode
    - Key [Enter] .. shows the data of the selected folder/series. If the series needs multiple screens to show the data, pressing [Enter] shows the next screen. The screen counter (D0, D1, D2,..) is shown on right side of the status line.
    - Key [Next] .. increases the series counter
    - Key [Back] .. decreases the series counter. If the current series is S00, it decreases the folder counter and shows the series S00 in that folder. This allows to quickly move across the folders.

4.7 Configuration Mode

- Configuration Mode allows to set various system settings. These are organized each at a separate screen. The configuration screen number is indicated in the display status line.
- Operations in CFG mode
    - Key [Enter] .. cycles through the values of configured parameter
    - Key [Next] .. moves to the next configuration screen.
    - Key [Back] .. moves to the previous configuration screen.
    - Key [Mode] .. leaves the configuration mode. All configured values are actuated only when user leaves the CFG mode and they are also stored at that moment to the SD card.
- C0 screen .. System Information (no changes allowed - only showing the information)
    - Model .. device model ID
    - Version .. version of the SW
    - Serial# .. serial number of the device
    - Tx [C] .. temperature of the unit processor
    - Tb [C] .. temperature of the unit transceiver
- C1 screen .. Velocity Unit
    - VelUnit .. unit for the measurement {mps, fps, kph, mph}
- C2 screen .. Trigger Gain
    - TrigGain .. values {0,1,..,10} set the acoustic/vibration triggering sensor sensitivity. The higher the value the higher sensitivity. Values close to 0 are recommended for a rifle mounted device and reduce the chance of false triggering by neighbor shooters. Values close to 10 are recommended for tripod mounted scenarios and rifles with suppressor. These values however make the device more prone to false triggering.
- C3 screen .. Velocity Range
    - VelRange .. {Low, Mid, High}
        - settings Low and Mid are enabled only in the Expert mode
    - Min/Max .. the minimum and maximum value of the measurement range
    - dv .. device measurement resolution for a given range. Notice however that this is just a numerical resolution

limit. The true indicator of the measurement precision is given by CI and SNR factors.

- C4 screen .. Detection Threshold
  - DetThr [dB] .. detection threshold in dB, values {13, 17, 20, 23}. The shot is detected as a valid measurement if the current measurement SNR exceeds this value. The higher the value the stronger the received signal must be for a device to evaluate it as a valid measurement. The optimal value depends on many factors (the bullet caliber, the triggering delay, the position of the device). Some experimentation is needed. The lower values are recommended for small calibers, the larger values for large calibers. The recommended all-purpose default value is 17 dB. The smaller values should be used only when the device frequently does not capture strong enough signal. As a guidance, use the SNR value shown on the measurement screen for a current shot.
- C5 screen .. WiFi
  - Although it is not enforced, a restart of the device is recommended after switching it on.
  - WiFi .. {on, off} switches WiFi on/off
  - Network .. the name of the WiFi Access Point (AP)
  - Password .. the password for accessing the WiFi AP
  - IP .. the IP address to which the web client on a computer or a smartphone should be pointed to.
- C6 screen .. Carrier Frequency
  - CarrierFreq .. the carrier frequency of the device, values {24150, 24160,..,24250} MHz. Make sure that no other radar device in 24GHz band uses the same frequency in the vicinity of this device.

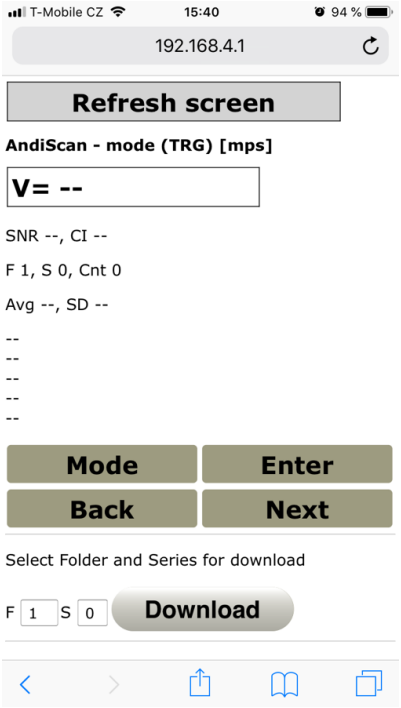
4.8 Data on SD memory card

- The data on SD card are stored with the following hierarchy:
  - CONFIG.CSV .. This is system configuration file. Do not modify it, unless you perfectly know what you are doing. It the file is missing, e.g. on a newly formatted SD card, the system uses the factory default settings and the file is then stored for the next use.

    - F000 - F999 .. These are named folders storing your series data.
    - Fxxx/DATA00.CSV - Fxxx/DATA99.CSV .. These are files each storing one series data.
- All files on the card use CSV (Comma Separated Values) format and can be easily imported to your personal computer.
- The device supports FAT16 and FAT32 file systems on standard SD and SDHC cards. You can name your card arbitrarily.

4.9 WiFi access

- The WiFi access is implemented as web mini-server over WiFi Access Point (AP) provided by the device. The purpose of this functionality is twofold.
    1. ***Remote control:*** It allows the client device (smartphone) on the shooting range to perform as a remote control and remote view of the measurements.
    2. ***Wireless access to SD card:*** It allows to access the data (CSV files) without the need of removing the SD card from the device. This is typically used when transferring the measured data to the personal computer for further evaluation and archiving.
- In order to use the WiFi access, connect your smartphone or computer to the WiFi AP with the name and password shown on C5 WiFi configuration screen. Observe the WiFi status icon in the status line on the screen and wait till your client is connected. Then point your web browser to the IP address shown in the C5 WiFi configuration screen.
- The web page you will see on your device is shown below. Please notice (!) that the web page does *not* update itself after finished measurement. You need to update it manually using the button on the page top.



- Activated WiFi access decreases the battery life. It is recommended to activate it only when it is necessary. Due to a nature of WiFi/AP and web communication protocol, the activity of the web client and/or WiFi/AP protocol might interfere with some critical timings of the internal radar signal processing. This may cause some technical issues. Also, some operations may take longer time, since WiFi/AP and web server need to perform their own operations.

4.10 Firmware configuration

- Power on the device and when the Welcome screen appears press within 1 second the [Mode] Key and keep it pressed until the Firmware configuration screen appears.
- Key [Enter] changes the configuration value.
- Key [Next] moves to the next configuration screen. When the last configuration screen is left, the device starts into the standard operation.

- Firmware Configuration #1 - Expert Mode
    - Expert mode enables Manual measurement mode and Mid/Low measurement ranges.
    - It is intended only for an advanced user or when the user needs to test the device operation on slowly moving objects (other than the firearm projectiles).
    - The Mid range is suitable for measuring airsoft guns.
    - The Low range is suitable for measuring velocity of the objects of the ordinary environment. For example, when you want to test the device at home, you can measure the velocity of you hand movement, etc.
    - (!) Important notes:
        - A high care is needed when setting the device configuration (namely TrigGain, DetThr) to suit the intended use. Also, the user should carefully evaluate the validity of the obtained result. By a principle of the device operation, the Mid and Low ranges are particularly vulnerable to self-interference in the device signal processing. Some measured values might be false measurements.
        - The device is designed to measure only objects *departing* from the device. It will not correctly measure the object that are approaching.

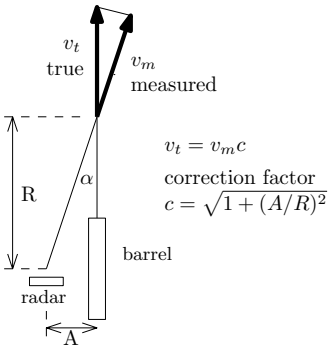
5 Data statistics and measurement processing details

5.1 Measurement accuracy and precision

Accuracy is a measure of systematic bias of the measurement. Mathematically it is given by a mean bias, i.e. a difference between the true value and the mean measurement value, if the same experiment was repeated many times. Precision is a measure of the measurement error dispersion from the mean value. Mathematically it is given by variance of the measurement. For unbiased measurement, the variance equals to the Mean Square Error (MSE) of the measurement, which is an ultimate fidelity indicator.

5.2 Impact of radar position offset

The closer the device is side-wise positioned to the barrel, the better. The distance between the barrel and the device antenna causes a reduction of the perceived bullet velocity as it is measured by the device. This is dictated by a simple geometry (see Figure below). While the distance *A* is well under user control, the distance *R* depends on many factors with many interactions (device triggering delay, bullet actual speed, accuracy of device antenna aiming, etc.). The table below must be taken only as a rough guidance for a typical value of *R*. It differs from case to case. Under normal conditions, the distance of the measurement R (in High velocity range) is 1-2 meters typically, 3-5 m at maximum. The device itself does not perform any post-processing correction of this error.



A [m]	R [m]	c
0.1	1.0	1.005
0.2	1.0	1.020
0.1	2.0	1.001
0.2	2.0	1.005

5.3 Impact of triggering delay

For a Doppler based radar device, it is practically impossible to directly measure the true V0 velocity (i.e. at zero distance from the muzzle). All radar devices measure VR, where R is a given distance in meters from the muzzle. AndiScan performs a highly precise velocity measurement at a very short (but nonzero) range. A very short triggering delay is critically needed for this. A direct device mount on the rifle and utilization of the shock wave mechanical transmission, together with optimized internal signal processing, allows to keep the delay minimal. Practically, under normal conditions and under a typical triggering delay, the value R is 1-2 meters (3-5m at maximum).

The delay of triggering operation has some impact on the measurement accuracy and precision. A delayed triggering means that the projectile velocity is not measured close to the muzzle but further down range where the bullet is already slowing down. If the delay was constant this would affect only the accuracy. In fact, it will be somewhat balanced with the measurement geometry explained above. The higher the distance R is, the lower the measurement geometry induced bias is, but on the other hand, the higher the effect of slowing projectile is. However, if the delay differs from shot to shot it also affects the precision. It depends on many factors - the position of the device, the mounting option (rifle mounted vs. tripod mounted), presence of suppressor, and many others. Some experimentation with the device configuration may be needed.

Numerical value of the actual velocity decrease, if the measurement is done at R distance instead of 0 distance, depends on the bullet ballistic coefficient and the true V0 velocity. For small distances R, the velocity drop is approximately linear with distance. Table below shows velocity decrease in m/s per 1 m of the distance R as a function of the G7 ballistic coefficient and the true V0. The device itself does not perform any post-processing correction of this error.

V0 [m/s]	**500**	**600**	**700**	**800**	**900**	**1000**
G7= 0.1	0.95	1.03	1.12	1.20	1.29	1.37
G7= 0.2	0.48	0.52	0.56	0.60	0.63	0.69
G7= 0.3	0.32	0.34	0.37	0.40	0.43	0.46
G7= 0.4	0.24	0.26	0.28	0.30	0.32	0.34

5.4 Impact of internal signal processing

The internal signal processing in the device is designed in such a way that it produces negligible accuracy decay. Numerically it is better than 50 ppm. On the other hand, the precision is strongly affected by signal-to-noise ratio (SNR) of the received signal reflected from the projectile. The noise level is practically given by the receiver hardware and some level of external interference noise. The received signal level is however significantly influenced by the projectile effective reflection area, the start and end projectile distance on which it is intercepted by a finite signal frame of the measurement, the antenna alignment and many other factors. The device monitors the SNR and provides an estimate of the expected precision in terms of confidence interval (CI). CI is set as

$$CI = 3 \times SDr$$

where SDr is standard deviation of the radar own measurement. For unbiased measurement, the MSE equals to the measurement variance $(SDr)^2$. Please, do not confuse SDr, which describes the precision of the own radar measurement, with SD, which describes dispersion of projectile velocities across the series.

As the measurement error closely follows normal Gaussian distribution, we then easily evaluate that +/- CI interval represent 99% confidence value.

The confidence interval (CI) value is shown in a compact exponential notation to save space on the display and to allow its more straightforward interpretation. The exponential notation consists of mantissa (m) and exponent (x) used in a notation m e x. The CI value is then $CI = m \times 10^x$. For example, 2e-3 means $2 \times 10^{-3} = 0.002$.

5.5 Statistics of the sample set of measured velocity series

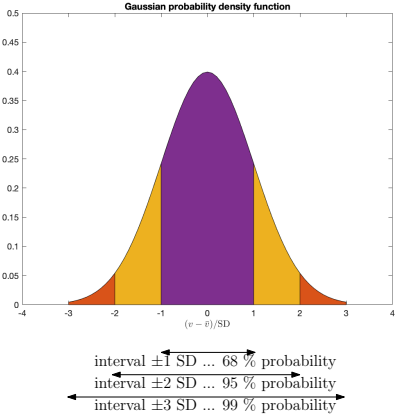
The device calculates (uncorrected) velocity sample standard deviation (SD) estimate as

$$SD = \sqrt{\frac{1}{N}\sum_{n=1}^{N}(v_n - \overline{v})^2}$$

where v_n is the n-th measured value, $\overline{v}$ is the mean velocity and N is the sample size. This SD estimate is consistent (approaches the true value for large N), however, for small N, it is slightly biased towards smaller SD.

Under normal conditions, when your shooting equipment does not change, you use the same ammo type (or the same reloading recipe),

and the sample set is sufficiently large, the statistic distribution of muzzle velocities nicely follow normal Gaussian distribution. It is fully described by two numerical values. Its mean value (Avg) and the variance. The variance is square value of the SD. These two values are uniquely bound together. However, from the practical point of view, the SD is easier to interpret, since it directly measures the width of the interval into which fall measured velocity values with given probability.



It is important to stress, that mean (Avg) and standard deviation (SD) are estimated by the algorithms programmed into the device and are based on sample measured data. They approach the true values when the sample size is very large (practically several tens, or hundreds). If the sample size is small (particularly for values less than 10), the estimation precision suffers. However, the two characteristics Avg, SD are the best robust statistics available. They are robust in the sense, that even for substantially small sample sizes, they still provide relevant statistics.

The histogram shown in the device measurement screen shows the statistic distribution of the measurements over the $+/-$ 2 SD width on the horizontal axis centered around the mean value. For large sample sizes, it will approach the theoretical normal Gaussian distribution.

Frequently used Extreme Spread (ES) characteristics is definitely *not* a robust estimation characteristic, especially for small sample sizes. In order to avoid its misleading interpretations, the device does not provide this value.

6 Troubleshooting and Usage Recommendations

- After a shot, the device did not react in any way.
    - Make sure that the acoustic or vibration excitation of the shot is properly accessible on the device, eg. by removing acoustic/vibration attenuation obstacles, repositioning of the device, or using different point for rifle mounted configuration.
    - Make sure that the device is in TRG mode and Armed (S1) state.
    - Check the configuration of the trigger sensitivity (TrigGain) and try to increase the level. Too high TrigGain value can however cause excessive false triggering by neighbor shooters.
- The device is correctly triggered after a shot, but no velocity measurement result is shown, only "***" appears on the display.
    - Try to reposition or realign (if the device is mounted on tripod) the device to increase the actual SNR measured value.
    - Monitor the value of SNR on the display and adjust the configuration of the detection threshold (DetThr). Lower its value to allow the real measured SNR exceed the threshold. Too low DetThr value can however cause the excessive false detections caused by noise and/or interference.
- The device stopped responding to the key presses.
    - Wait few seconds and make sure that the device is not performing some longer operation, e.g. a search for the free folder, saving to SD card, or some WiFi/web activity.
    - If this is not the case, restart the device by long 10 seconds press of [Power] key until it switches off and then power the device again.
- The device triggers and measures the velocity but the SNR values are low (well below 20dB).
    - Under normal conditions, most common calibers (.22 - .338) should have values of SNR above 20dB, the higher the better. Low values might mean also a delayed triggering causing the measurement to start late when the projectile is already at some distance from the muzzle.

- It is generally a good practice to keep the TrigGain as high as possible to allow the device to react during early shot stages. Decrease this value only when the device is frequently false triggered by other shooters in the vicinity.

7 Service and Maintenance

- Do not unscrew the back cover of the device. There are no user serviceable parts inside. There is a high danger of damaging sensitive electronics.
- The only user accessible parts (battery and SD card) are inside the battery compartment. Under normal conditions, this is supposed to be accessed only when changing the battery at the end of its life or when inserting a new SD card. A regular battery charging is done using the USB connector. Also, there is no need to take the SD card out on a regular basis. All stored data are accessible over WiFi connection.
- To save the battery power, keep the device in Ready (S0) state unless you are actually performing the measurement. The power consumption in Armed (S1) state is much higher and also the transceiver and microprocessor chip internal temperature rise substantially. The small form-factor of the device is vulnerable to overheating, particularly when the device is operated in hot environment.
- Avoid disposing the device to the water, heavy rain or direct long-lasting sunshine.
- Factory Defaults. The device is set into factory defaults settings by deleting (e.g. on personal computer) the configuration CONFIG.CSV file from the SD card. At the next start of the device, the new CONFIG.CSV is created. Folders F000..F999 may be let untouched and the device will respect their presence and preserves the stored data. By inserting a new or fresh formatted SD card, the device will set the factory defaults and starts creating folders from F000.
- Firmware update. Follow the detailed instructions on www.SQi-AndiX.com.
- In the case of the device malfunction and/or damage, please contact the manufacturer (see www.SQi-AndiX.com) for the technical assistance and the instruction regarding repairs and part replacements.

8 Technical Specification

dimensions	(H) 92 x (W) 66 x (D) 28 mm
weight (including internal battery)	141 g
operational environment temperature range	-20 deg C .. 50 deg C
operating frequency band	24.150-24.250 GHz channel spacing 10 MHz
transmitter output power	11 dBm
internal battery	Li-ion rechargeable 16340 size cell standard 800mAh capacity. ***Device is not compatible with lithium CR123 battery.***
external power	through USB micro connector
storage card	micro SD (or SDHC) card FAT16 and FAT32 file system
units of measurement	mps, fps, kph, mph
velocity measurement range	High 242.5 - 1309.3 mps (*) Mid 30.3 - 303.1 mps (*) Low 1.0 - 121.3 mps
processing resolution granularity	0.303 mps at High range 0.038 mps at Mid range 0.015 mps at Low range
measurement precision (**) (99% confidence)	0.50 mps High range, SNR= 20dB 0.06 mps Mid range, SNR= 20dB 0.03 mps Low range, SNR= 20dB 0.16 mps High range, SNR= 30dB 0.02 mps Mid range, SNR= 30dB 0.008 mps Low range, SNR= 30dB
measurement accuracy (***)	internal processing .. < 50ppm measurement geometry .. < 0.5%
minimum time between triggered measurements	approx. 1 s

(*) only in Expert Mode
(**) expected value based on theoretical analysis
(***) under typical conditions