NerdSense Mk.1 Instruction Manual

IMPORTANT – READ CAREFULLY BEFORE USE
KEEP FOR FUTURE REFERENCE

EN

Contents

List of Abbreviations

ADC	Analog-Digital-Converter
ESD	Electrostatic Discharge
FPV	First Person View
OSD	On-Screen Display
PWM	Pulse Width Modulation
SELV	Safety Extra Low Voltage
RSSI	Received Signal Strength Indication

Scope of Delivery

The scope of delivery comprises the following items:

- 1 x NerdSense Mk.1 sensor,
- 1 x wire harness,
- 1 x instruction manual.

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Change Log

Datum	Version	Comments
2015-02-08	1.0	Initial Version

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The Product is not designed or intended for use in the development of on-line control equipment in hazardous environments requiring fail-safe controls, such as in the operation of nuclear facilities, aircraft navigation or communications systems, air traffic control, life support, or weapons systems (“High-Risk Applications”). The Manufacturer specifically disclaims any express or implied warranties of fitness for such High-Risk Applications. You represent that use of the Product in such High-Risk Applications is fully at your risk.

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1. Safety Instructions

Important! Please read carefully the following safety instructions before operating the NerdSense Mk.1 sensor!

1.1. Designated Use

The designated use of the NerdSense Mk.1 sensor is the operation as an extension board for the NerdCam3D FPV-camera (the “3D-camera”). All other uses of the sensor are considered improper and exclude all warranties and any liability of the manufacturer for personal injury, pecuniary damages or property damages.

1.2. Reasonably Foreseeable Misuse

The use of the NerdSense Mk.1 sensor as a toy, or as medical life-support or life-sustaining equipment, or as a safety device for monitoring/surveillance of persons or objects, or as a fail-safe sensor for operation of nuclear facilities, aircraft navigation or communication systems, or as part of a means for air traffic control, or as part of weapons systems is improper and excludes any liability of the manufacturer for personal injury, property damage or pecuniary damages.

1.3. General Safety Instructions

Please note the following general safety information before and during use of the sensor.

⚠ DANGER	Risk of electric shock! Risk of fire!
	Exposed electrical components!
	Danger of life through electric shock or fire outbreak!
	Operate sensor only with Separated/Safety Extra-Low Voltage (SELV) power sources!

NOTICE	Risk of electrostatic discharge (ESD)!
	Exposed electrical components!
	Permanent damage to parts of the sensor or the whole sensor with improper handling!
	Take appropriate measures to protect the sensor against electrostatic discharge!

1.4. Regulatory Notes

1.4.1. EUROPEAN UNION

Please find all additional information in relation to the fulfillment of regulatory requirements in the accompanying EU Declaration of Conformity on page 14 of this manual.

1.4.2. UNITED STATES OF AMERICA

Note: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

1.4.3. CANADA

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

2. Description

The NerdSense Mk.1 sensor is an expansion board for the NerdCam3D 3D-camera. The sensor allows for the digital measurement of relevant operating parameters of the utilized RC-vehicle like voltage or current consumption, for subsequent processing by the camera’s stereoscopic OSD. (Figure 1).

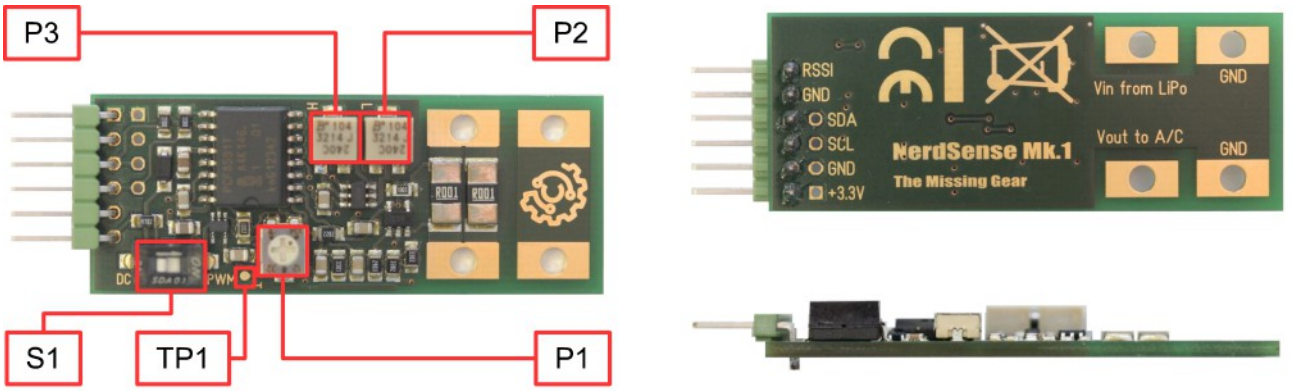

Figure 1: Sensor outline and controls

The sensor features a pin-header terminal for connection with the 3D-camera and the RC-receiver, as well as solder/screw terminals towards the power supply of the RC-vehicle. The controls P1, P2, P3 and S1 as well as the test point TP1 are only necessary for calibration of the RSSI display (see Chapter 5).

The sensor is designed without a specific protective enclosure. This decision gives the end-user the utmost level of freedom for final integration onto the RC-vehicle. However, it is in the end-users own responsibility to take care for a safe and rigid fixation and a suitable protection of the sensor against adverse mechanical, or electrostatic, or environmental conditions. For these reasons the utilization of a suitable protective enclosure, at minimum a protection with heat-shrink tubing, is highly recommended.

3. Technical Data

3.1. General Features

Property	Value	Comment
Product name	NerdSense	
Model designation	Mk.1	
Size	62 mm x 21 mm x 6 mm	
Mass	5 g	Without additional plugs/jacks.

3.2. Electrical Properties

Property	Value	Comment
Ingress Protection Marking	IP00	Installation of sensor into a suitable protective case or protection by heat-shrink tubing recommended

Property	Value	Comment
Appliance class	III	Use only with Separated/Safety Extra-Low Voltage (SELV) power sources
Power supply	+3.3V DC	Power supply via the expansion port of the NerdCam3D
Voltage range at sensor	0V to 25.5V DC	
Current range at sensor	0A to 100A DC	
Voltage range at RSSI input	DC-mode: 0V to 3.3V PWM-mode: 0V to 5V	Higher electric strength for PWM-RSSI-signals by dedicated Zener-diode.

4. Wiring Diagram

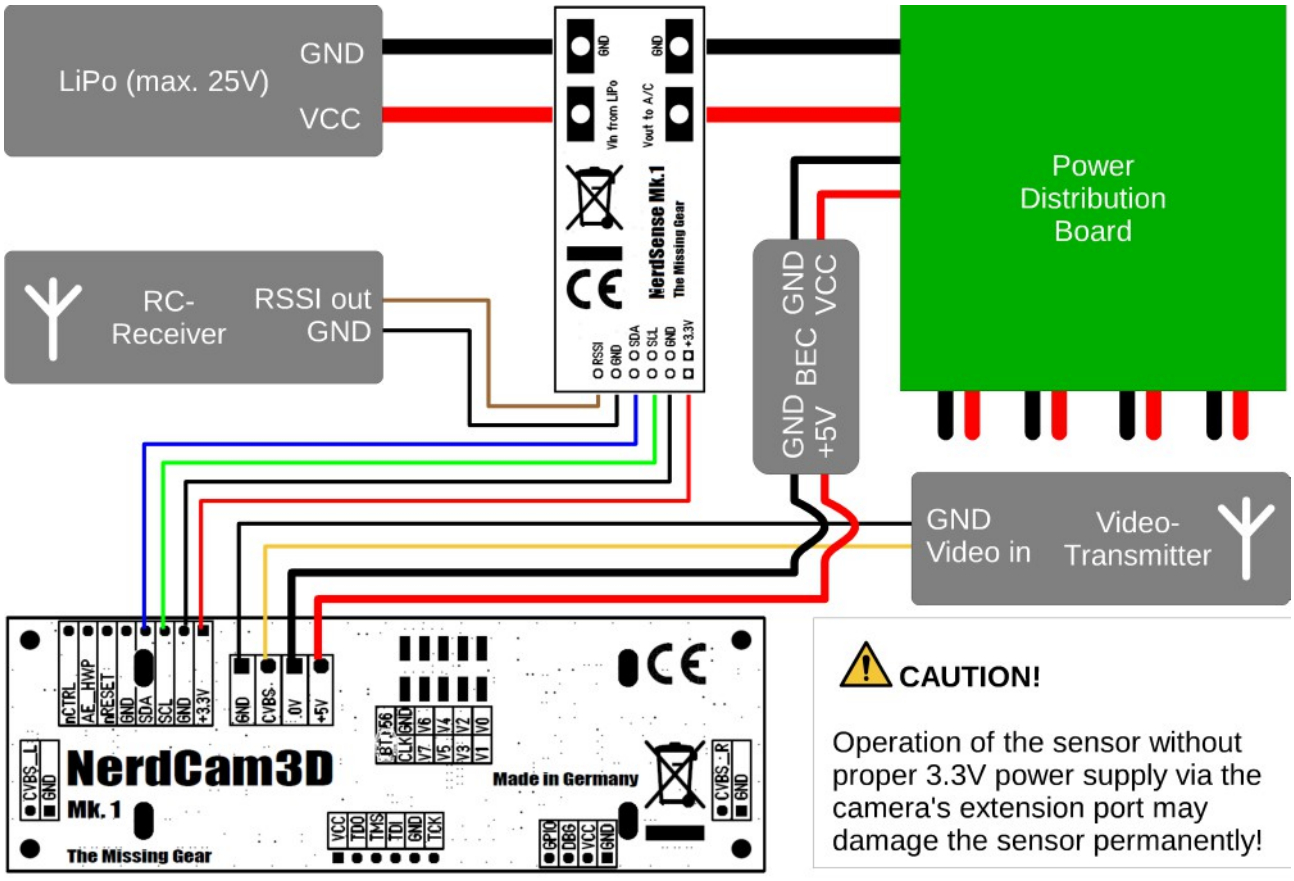

Figure 2: Wiring of the sensor with the 3D-camera and other components

The sensor does not require any specific setup steps, except the calibration of the RSSI sensing circuitry (see Chapter 5). It will work with any firmware version of the NerdCam3D, however the number of displayed parameters is dependent on the actual firmware version. The following table summarizes those firmware versions currently in use and explains which OSD parameters are supported respectively.

Type and Serial Number	FW Version	OSD Parameters
NerdCam3D Mk.1 up to S/N 1096	2.1	Voltage, Current consumption, Time
NerdCam3D Mk.1 starting with S/N 1097	2.3	Voltage, Current consumption, Time, mAh Counter and RSSI

The next figure highlights the difference in OSD functionality between both mentioned firmware versions, here depicted for the case of a Side-by-Side 3D video signal.

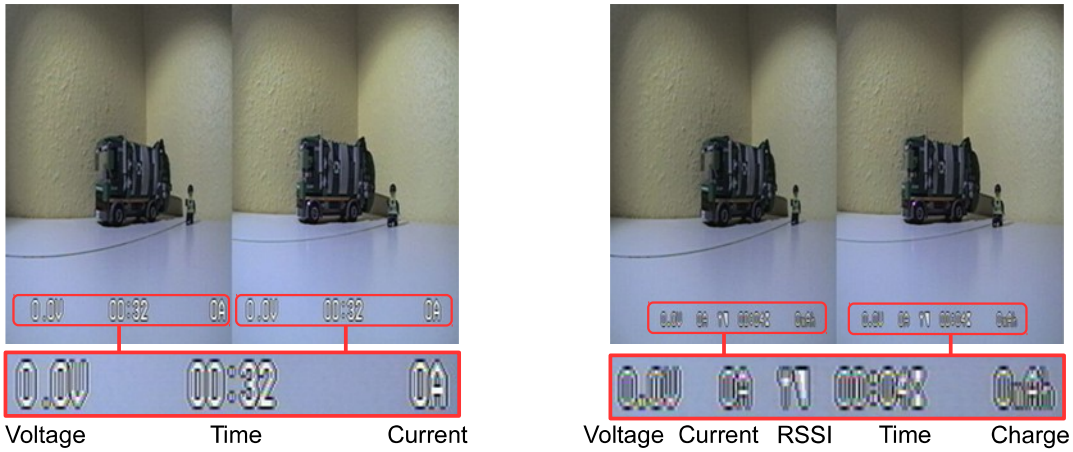

Figure 3: OSD of firmware version 2.1 (left) and 2.3 (right)

Any NerdCam3D 3D-camera with firmware version 2.1 can be updated with a newer firmware. For this, the 3D-camera must be sent to the manufacturer. If interested please contact us (see Chapter 11) to arrange a firmware update. Updating the camera via the reseller network is unfortunately not possible at the moment.

5. Calibration of the RSSI Display

The sensor is able process RSSI signals, which are characterized as a variable DC voltage or a pulse width modulated servo signal (PWM). PWM signals are smoothed by an internal RC filter. In order to display the RSSI information in the OSD, a NerdCam3D 3D-camera with at least firmware version 2.3 is required. The sensor's input circuitry including the variable gain amplifier stage is shown in the following figure.

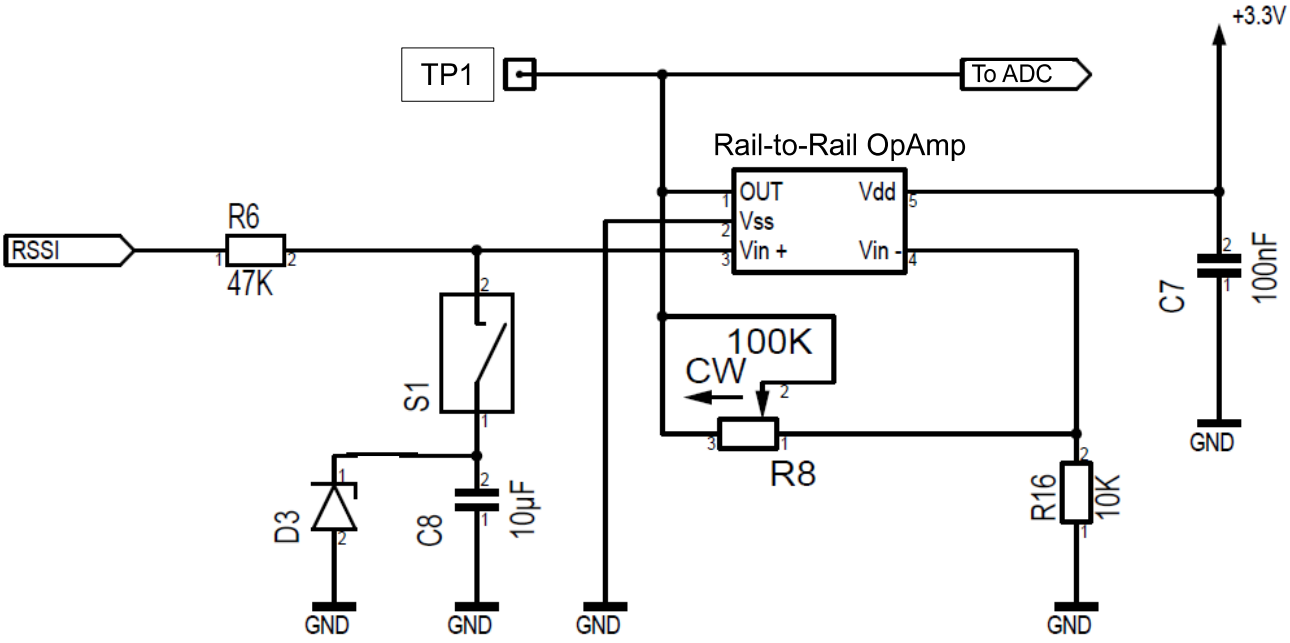

Figure 4: Circuitry details of the RSSI input

The calibration of the RSSI display is made via manual adjustments using the trimmers P1, P2 and P3 (see Figure 1).

Trimmer	Type	Function
P1	Single-turn	User-defined amplification (by factor 1 to factor 11) of the unprocessed RSSI input signal.
P2	5-turn	User-defined lower boundary of the RSSI signal level. Corresponds to 0% RSSI.
P3	5-turn	User-defined upper boundary of the RSSI signal level. Corresponds to 100% RSSI.

All three mentioned trimmers follow the same rule with respect to the sense of rotation:

- Turning clockwise (CW) = increase set value,
- Turning counterclockwise (CCW) = decrease set value.

Both trimmers P2 and P3 do not have mechanical end stop. Further turning over the end of scale neither changes the last set value nor has a negative impact on the mechanics of the trimmer. The characteristic of the RSSI signal (DC-RSSI or PWM-RSSI) is configured via **DIP switch S1**. This switch either connects or separates the filtering capacitor of the RC-filter at the OpAmp's input cir-

cuitry. The amplified RSSI signal can be measured at **test point TP1**. This signal will be fed directly into the ADC for further processing.

5.1. Calibration Procedure for Direct Current RSSI Signals

CAUTION! The RC-receiver's output voltage for 0% RSSI must be lower than the voltage corresponding to 100% RSSI. Please note the permitted voltage range of 0V to 3.3V DC at the RSSI input of the sensor.

1. Move DIP switch S1 to position **DC**.
2. Turn trimmer P1 counterclockwise until mechanical end stop (sets the OpAmp's amplification factor to unity).
3. Turn both trimmers P2 and P3 counterclockwise to minimum set value (at least 5 turns respectively). RSSI display (antenna and bar symbols) will be deactivated temporarily.
4. Connect the sensor to the camera and the RC-receiver as shown in Figure 2.
5. Activate RC-vehicle and ground station to observe the transmitted FPV video signal. The RSSI-symbols (see Figure 3) in the OSD should be invisible.
6. Activate the remote control of the RC-vehicle and position it close to the vehicle to maximize the RC-receiver's RSSI output voltage.
7. Measure the voltage at test point TP1. If this voltage is significantly less than 3.2V, the unprocessed RSSI signal from the RC-receiver can be amplified by turning trimmer P1 clockwise, in order to improve the dynamic range of the RSSI measurement. However the amplified RSSI signal cannot be larger than approximately 3.2V. Therefore P1 should be turned just to that position, at which the measured voltage at TP1 reaches its maximum value. DC-RSSI signals typically need only a slight level of signal amplification or even no amplification at all.
8. Slightly turn trimmer P3 clockwise. The RSSI display becomes active and immediately shows the maximum RSSI signal level. Continue clockwise turning of P3 until that position is reached, at which the RSSI display can just maintain all bars.
9. Deactivate the remote control of the RC-vehicle to minimize the RC-receiver's RSSI output voltage.
10. Slightly turn trimmer P2 clockwise until that position is reached, at which the first bar of the RSSI bar symbol in the OSD becomes visible. Ideally, this first bar should just not be visible, when the remote control of the RC-vehicle is switched off.

5.2. Calibration Procedure for Pulse Width Modulated RSSI Signals

CAUTION: The pulse width of the RC-receiver's RSSI signal for 0% RSSI must be lower than the corresponding pulse width for 100% RSSI[1]. Please note the maximum PWM signal magnitude of 5V DC at the RSSI input of the sensor.

1. Move DIP switch S1 to position **PWM**.
2. Turn trimmer P1 counterclockwise until mechanical end stop (sets the OpAmp's amplification factor to unity).
3. Turn both trimmers P2 and P3 counterclockwise to minimum set value (at least 5 turns respectively). RSSI display (antenna and bar symbols) will be deactivated temporarily.
4. Connect the sensor to the camera and the RC-receiver as shown in Figure 2.
5. Activate RC-vehicle and ground station to observe the transmitted FPV video signal. The RSSI-symbols (see Figure 3) in the OSD should be invisible.
6. Activate the remote control of the RC-vehicle and position it close to the vehicle, such that the RC-receiver outputs the waveform for maximum RSSI.
7. Measure the voltage at test point TP1. Typically this voltage will be significantly less than 3.2V and should be amplified by turning trimmer P1 clockwise. This signal amplification increases the dynamic range of the RSSI measurement. PWM-RSSI signals typically need a high level or even maximum level of signal amplification.
8. Slightly turn trimmer P3 clockwise. The RSSI display becomes active and immediately shows the maximum RSSI signal level. Continue clockwise turning of P3 until that position is reached, at which the RSSI display can just maintain all bars.
9. Deactivate the remote control of the RC-vehicle, such that the RC-receiver outputs the waveform for minimum RSSI.
10. Slightly turn trimmer P2 clockwise until that position is reached, at which the first bar of the RSSI bar symbol in the OSD becomes visible. Ideally, this first bar should just not be visible, when the remote control of the RC-vehicle is switched off.

5.3. Deactivating RSSI Symbols in OSD

The RSSI symbols within the OSD (antenna symbol and bar symbols) can be deactivated by turning both trimmers P2 and P3 counterclockwise to their minimum set value (at least 5 turns respectively). Please note that both trimmers do not have a mechanical end stop.

6. Error Indication and Troubleshooting

The sensor does not have any dedicated operation indicators. The communication with the 3D-camera is based on an standard I²C interface, which is **not hot-pluggable**. With properly attached sensor the 3D-camera must show the OSD directly after power-up, even if the sensor is not con-

1 EzUHF receivers provide both RSSI and Link Quality (LQ) signals. Unfortunately only the LQ signal is compliant with this requirement.

nected at terminals X4 and X5 (see Figure 5). In case the sensor is disconnected from the camera while being in operation, the OSD may freeze. In such a case the camera has to be reset by disconnecting it from power supply, in order to remove this blockage.

7. Modifications

The sensor board features provisions for electronic modifications. These modifications include the attachment of cables, wires or pin-headers to the appropriate terminals on the sensor board and the connection of the sensor with other electronic devices, preferably with the NerdCam3D 3D-camera.

CAUTION!
Consolidated knowledge and appropriate tools necessary!

Consolidated knowledge and special tools may be necessary in order to conduct the modification in a professional manner. For these reasons the warranty on the sensor becomes void in case of improperly conducted modifications.

NOTICE!
Electrostatic Discharge!

The sensor contains sensitive electronic components that can be destroyed by electrostatic discharge. Handle electronic components with care! Implement a suitable grounding for persons, workplace and packing! Do not touch any electrically conductive parts, when not absolutely necessary!

7.1. Electrical Interface Description

The sensor features a number of terminals at which cables, wires or pin-headers can be attached by soldering (Figure 5).

Figure 5: Overview of sensor interfaces

The following table summarizes the function of the respective sensor terminals together with technical comments.

X1: Power Supply and I²C-Interface		
+3.3V	+3.3V power supply input from 3D-camera	
GND	Electrical ground	
SCL	I²C clock line	3.3V bus level. No pull-up resistors on the sensor board.
SDA	I²C data line	3.3V bus level. No pull-up resistors on the sensor board.

X2: RSSI Interface		
GND	Electrical ground	
RSSI	Input for RSSI signals from RC-receiver	Refer to Chapter 3.2 for maximum input signal levels!

X3: Expansion Port for other I²C-Devices		
+3.3V	+3.3V power supply	
GND	Electrical ground	
SCL	I²C clock line	3.3V bus level. No pull-up resistors on the sensor board.
SDA	I²C data line	3.3V bus level. No pull-up resistors on the sensor board.

X4: V_in Interface		
GND	Electrical ground from battery	
Vin	Power supply from battery	Notice security advice in Figure 2!

X5: V_out Interface		
GND	Electrical ground to RC-vehicle	
Vout	Power supply to RC-vehicle	Notice security advice in Figure 2!

8. Warranty

For this product the German statutory warranty applies. The warranty is fulfilled at the seller's option by repair, replacement or withdrawal of the purchase contract.

The warranty becomes void when the error was caused by third party, or by improper installation, or commissioning or modification, by incorrect or negligent handling, or improper transport, or excessive stress, by unsuitable operating resources or by improper use or operation of the product.

9. Limitation of Liability

TMG - Ingenieurbüro UG (haftungsbeschränkt), THE MANUFACTURER, SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS, REVENUE OR DATA (WHETHER DIRECT OR INDIRECT) OR COMMERCIAL LOSS FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ON YOUR PRODUCT EVEN IF THE MANUFACTURER HAS

BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. Some jurisdictions do not allow the exclusion or limitation of special, indirect, incidental or consequential damages, so the above limitation or exclusion may not apply to You, but the remainder of this Limited Warranty shall remain in full force and effect.

10. Disposal and Environmental Protection

Electrical and Electronic Equipment (EEE) can be recycled when no longer needed and must not be disposed together with usual household waste. Therefore we kindly ask you to support us with your active contribution to the conservation of resources and the protection of the environment by disposing this device at the official EEE collection points.

11. Manufacturer Information and Technical Support

This sensor was developed for you by:

TMG - Ingenieurbüro UG (haftungsbeschränkt)	Sales tax ID: DE294861035
Römerstr. 14	WEEE ID: DE 55557702
89077 Ulm	Internet: www.themissinggear.eu
GERMANY	Kontakt: info@themissinggear.eu

Please feel free to contact us using the above mentioned e-mail address for technical assistance or other questions about the product.

EU-Declaration of Conformity

We,

TMG - Ingenieurbüro UG (haftungsbeschränkt)

Römerstr. 14

89077 Ulm

GERMANY

declare under our sole responsibility, that the product

Product name	NerdSense
Trade name	The Missing Gear
Model	Mk. 1

to which this declaration relates, is in conformity with the following directives and harmonized standards:

EMC Directive 2004/108/EG	EN 55022:2010
	EN 55024:2010
RoHS Directive 2011/65/EU	EN 50581:2012
WEEE Directive 2012/19/EU	EN 50419:2006

The technical documentation is kept at the above mentioned address open for inspection.

Ulm, February 8, 2015

Dr.-Ing. Michael Sabielny
Managing Director

Notes