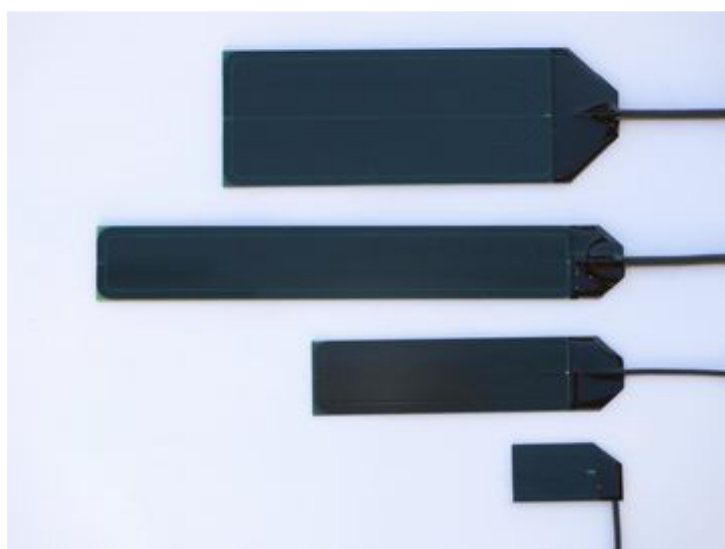


Air Gap Sensor

AGS

Installation and user manual

Valid for serial numbers up to: **172305**

Contents

Safety Recommendations	3
Important User Information.....	3
Warranty.....	3
Performance Data	4
1. Overview	5
2. Application.....	5
2.1. AGS selection table	5
2.2. AGS resolution and output signal samples	7
3. Technical specifications	8
4. Installation instructions	16
4.1. AGSC Signal Conditioner unit installation guide	16
4.2. Appropriate location for AGSC Signal Conditioner unit.....	18
4.3. Thermal considerations and thermal zones	18
4.4. Grounding of AGSC Signal Conditioner unit.....	18
4.5. Power supply connection.....	18
4.6. Calibration	18
4.7. AGSP Sensor probe installation guide.....	19
4.8. Placing the sensor	19
4.9. Preparing the stator surface	20
4.10. Mounting the sensor	20
4.11. True Air-Gap and offset	23
4.12. Cable installation	24
4.13. Connection to AGSC conditioner unit	25
5. Troubleshooting.....	26
6. Ordering information	27
7. Manufacturers Test and Calibration Report	28

THIS INSTRUCTION MANUAL SHOULD BE READ CAREFULLY AND THE SAFETY INSTRUCTIONS OBSERVED BEFORE INSTALLING, CALIBRATING OR USING THE EQUIPMENT DESCRIBED HEREIN.

Safety Recommendations

ALL WORK SHOULD BE DONE BY QUALIFIED PERSONNEL FAMILIAR WITH THE CONSTRUCTION, OPERATION, AND HAZARDS INVOLVED WITH THE EQUIPMENT.

Mikrotrend products are not authorized for use in safety-critical applications where a failure of the product would reasonably be expected to cause severe personal injury or death. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Mikrotrend products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Mikrotrend.

Mikrotrend products are neither designed nor intended for use in military/aerospace applications or environments.

Buyers acknowledge and agree that any such use of Mikrotrend products which Mikrotrend has not designed as military-grade is solely at the Buyers risk, and they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

Important User Information

This guide has been developed as a quick reference tool to Mikrotrend industrial automation controls and factory assemblies. Because of the variety of uses for the products described in this publication, those responsible for the application and use of these products must satisfy themselves that all necessary steps have been taken to assure that each application and use meets all performance and safety requirements, including any applicable laws, regulations, codes, and standards. Factory provided user manuals and technical documentation should not be solely relied on for those purposes.

Mikrotrend reserves the right to change the features or characteristics of its products at any time. Therefore, the information contained in this publication is subject to change at any time without notice.

The illustrations, charts, diagrams, and layout examples shown in technical documentation are intended solely as examples. Since there are many variables and requirements associated with any particular installation, Mikrotrend can not assume responsibility or liability (including intellectual property infringement liability) for actual use based upon the examples shown in this publication.

Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

All products are sold subject to Mikrotrend's General terms and conditions of sale, supplied at the time of order acknowledgment.

Mikrotrend warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with Mikrotrend's standard warranty. Testing and other quality control techniques are used to the extent Mikrotrend deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

Mikrotrend assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using Mikrotrend components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

Mikrotrend does not warrant or represent that any license, either express or implied, is granted under any Mikrotrend patent right, copyright, mask work right, or other Mikrotrend intellectual property right relating to any combination, machine, or process in which Mikrotrend products or services are used.

Information published by Mikrotrend regarding third-party products or services does not constitute a license from Mikrotrend to use such products or services or a warranty or endorsement thereof.

Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from Mikrotrend under the patents or other intellectual property of Mikrotrend.

Reproduction of information in Mikrotrend data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. Mikrotrend is not responsible or liable for such altered documentation. Resale of Mikrotrend products or services with statements different from or beyond the parameters stated by Mikrotrend for that product or service voids all express and any implied warranties for the associated Mikrotrend product or service and is an unfair and deceptive business practice. Mikrotrend is not responsible or liable for any such statements.

Warranty

(a) Hardware:

Seller warrants that **new hardware Products** furnished hereunder will be free from defects in material, workmanship and design for a period of **five (5) year from the date of invoice** from Seller or its appointed distributor, as the case may be. **Repaired or replacement Products** provided as a result of this warranty subparagraph are similarly warranted for a period of **one (1) year** from the date of invoice from Seller or the remainder of the original warranty term for that particular Product, whichever is longer.

(b) Software and Firmware: Unless otherwise provided in a Seller or third party license, Seller warrants that software or firmware Products furnished hereunder, when used with Seller-specified hardware, will perform in accordance with published specifications prepared, approved, and issued by Seller for a period of **five (5) year from the date of invoice** from Seller or its appointed distributor, as the case may be. Seller makes no representation or warranty, express or implied, that the operation of the software or firmware Products will be uninterrupted or error free, or that the functions contained therein will meet or satisfy Buyer's intended use or requirements.

(c) Non-Warranty Factory Remanufacture, Repair and Field Exchange:

Seller warrants that non-warranty factory remanufactured or field exchanged hardware Products or repaired hardware Product components will be free from defects in material and workmanship for a period of **one (1) year** from the date of invoice from Seller or its appointed distributor, as the case may be. Repaired or replacement Products provided as a result of this warranty subparagraph are warranted for a period of thirty (30) days from the date of shipment to Buyer or the remainder of the original warranty term, whichever is longer.

(d) Warranty for Services:

Seller warrants that Products comprised solely of services (e.g., training, on-site repair, engineering and custom application programming services) will be performed by appropriately skilled personnel employed or retained by Seller, in accordance with generally accepted professional standards. The Services, which do not so conform shall be corrected by Seller upon notification in writing by the Buyer within one (1) year after completion of the Services.

Buyer will, at its cost, provide Seller with unobstructed access to the defective Services, as well as adequate free working space in the immediate vicinity of the defective Services and such facilities and systems, including, without limitation, docks, cranes and utility disconnects and connects, as may be necessary in order that Seller may perform its warranty obligations.

The conducting of any tests shall be mutually agreed upon and Seller shall be notified of, and may be present at, all tests that may be made.

Buyer requested on-site warranty service (consisting of time, travel and expenses related to such services) will be at Buyer's expense. The foregoing will be the exclusive remedies for any breach of warranty or breach of contract arising therefrom.

(e) "Open Box" Products:

Seller warrants that hardware Products sold as "Open Box" (e.g., customer and distributor returns, factory refurbished or reconditioned, etc.) will be free from defects in material and workmanship for a period of ninety (90) days from the date of invoice from Seller or its appointed distributor, as the case may be. "Open Box" Products, while serviceable, may not reflect the latest series or revision. Repaired or replacement Products provided as a result of this warranty subparagraph are similarly warranted for a period of thirty (30) days from the date of shipment to Buyer or the remainder of the original ninety-day warranty term for that particular Product, whichever is longer.

(f) Buyer Specifications /Compatibility:

Unless otherwise agreed to in writing by Seller, Seller assumes no responsibility with respect to the suitability of the Buyer's equipment or with respect to any latent defects in the same. This warranty does not cover damage to Buyer's equipment, components or parts resulting in whole or in part from improper maintenance or operation or from their deteriorated condition. Seller does not warrant and will not be liable for any design, materials, construction criteria or goods furnished or specified by Buyer (including that sourced from other manufacturers or vendors specified by Buyer). Any warranty applicable to such Buyer-specified items will be limited solely to the warranty, if any, extended by the original manufacturer or vendor directly or indirectly to Buyer. Seller does not warrant the compatibility of its Products with the goods of other manufacturers or Buyer's application except to the extent expressly represented in Seller's published specifications or written quotation.

(g) Recyclable Materials:

In keeping with environmental policies and practices, Seller reserves the right to utilize in its product manufacturing, repair and remanufacturing processes certain recyclable materials (e.g., fasteners, plastics and the like) or remanufactured parts equivalent to new in performance or parts which may have been subject to incidental use. However, such utilization will not affect any provided Product warranty or published reliability statistics.

(h) Remedies:

In the event any Product fails to comply with the foregoing warranty Seller will, at its option, either (a) replace, repair, re-performance or modify the defective Product, or defective part or component thereof, Ex-Works with freight prepaid and allowed to the port or airport of Seller's choice, or (b) credit Buyer for the purchase price of the Product, provided that the Buyer promptly sends to Seller written notice of such defect and satisfactory proof thereof, establishes that the Product has been properly stored, installed, maintained and operated within limits of rated capacity and normal usage, assumes the obligations of all expenses of returning the defective Product or part to the Seller, if requested, and the return from the Seller of the repaired or replaced Product or part. Replacement Products may be new, remanufactured, refurbished or reconditioned at Seller's discretion. Buyer requested on-site warranty service (consisting of time, travel and expenses related to such services) will be at Buyer's expense. The foregoing will be the exclusive remedies for any breach of warranty or breach of contract arising therefrom.

(i) General:

Warranty satisfaction is available only if (a) Seller is provided prompt written notice of the warranty claim and (b) Seller's examination discloses that any alleged defect has not been caused by misuse; neglect; improper installation, operation, maintenance, repair, alteration or modification by other than Seller; accident; or unusual deterioration or degradation of the Products or parts thereof due to physical environment or electrical or electromagnetic noise environment. Rights under the above warranties (subject to noted limitations) extend to Buyer's customers if Buyer is a Seller-appointed distributor for the Products.

This warranty does not cover failure or damage due to storage, installation, operation or maintenance not in conformance with Seller's recommendations and industry standard practice or due to accident, misuse, abuse or negligence. This warranty does not cover reimbursement for labor, transportation, gaining access to, removal, installation, temporary power, or any other expenses which may be incurred in connection with repair or replacement. This warranty does not apply to equipment not manufactured by Seller. Seller limits itself to extending the same warranty it receives from the supplier.

(j) THE ABOVE WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES AND CONDITIONS, WHETHER EXPRESSED, IMPLIED OR STATUTORY, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE, OR PERFORMANCE OR APPLICATION WARRANTIES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW.

Performance Data

Performance data given in technical documentation is provided only as a guide for the user in determining suitability and do not constitute a performance warranty of any kind. Such data may represent the results of accelerated testing at elevated stress levels, and the user is responsible for correlating the data to actual application requirements. **ALL WARRANTIES AS TO ACTUAL PERFORMANCE, WHETHER EXPRESS OR IMPLIED, ARE EXPRESSLY DISCLAIMED.**

- Installation and maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the equipment.
- Installation and maintenance must be performed with the control out of operation and disconnected from all sources of power
- Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
- Ventilation passages should be kept open.
- The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity.
- Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.
- Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.

1. Overview

- Air Gap Sensor (AGS) is a high accuracy, non contact, capacitive type distance measuring sensor for measuring air-gap in air-cooled generators and electric motors.
- A low profile sensor probe with triaxial cable, preamplifier and Conditioner electronics.
- Unique Edge Mount type for wind generators and electric motors with very small air gap.
- High stability FR4 carbon particles sensor probe made for deep-inside or edge instalation, stator or rotor installation possible.
- Insulated DC/DC power supply and optocoupler output 0...20mA or 4...20mA.
- Stable operation over a wide temperature range of -20...140°C (sensor probe).
- Splash-proof electronics case (IP66) well suited for field applications.
- Immune to magnetic fields, dust and oil vapours, EMI, RFI....

2. Application

Air Gap sensor is a **capacitive type distance measuring device** designed but not limited for air-cooled generators and electrical motors.

Suited for measuring of air-gap, rotor vibrations, rotor and stator symmetry, winding short circuits detection, etc...

With it's inherent high sensitivity, high resolution, temperature stability and low noise make it possible to reliably measure distance with resolution up to 20 micrometers (with oversampling).

CAUTION: AGS is not certified for and shall not be installed in hydrogen-cooled alternators.

2.1. AGS selection table

To ensure ample **measurement headroom** please select Air Gap Sensor measuring range according to **the true air gap range** per Table 1. Given dimensions are absolute maximum values.

Air-gap sensor measuring range shall be selected as close to the middle of true air gap range as possible. If in doubt please contact Mikrotrend for help.

Sensor type	AGS-4S	AGS-7,5N	AGS-13N	AGS-15N	AGS-25N	AGS-50N	AGS-51N	AGS-65N
Linear measuring distance (mm)	0,8...4	1,5... 7,5	2,6...13	3...15	5...25	10...50	5...50	6,5...65
Recommended for true air gap range (mm)	1,7...4,9	2,7...8,7	4,8...15,2	5,2...17,2	8,3...28,3	13,3...53,3	8,3...53,3	9,8...68

Table 1. Sensor measuring reange vs. true air gap distance
(other ranges available per request)

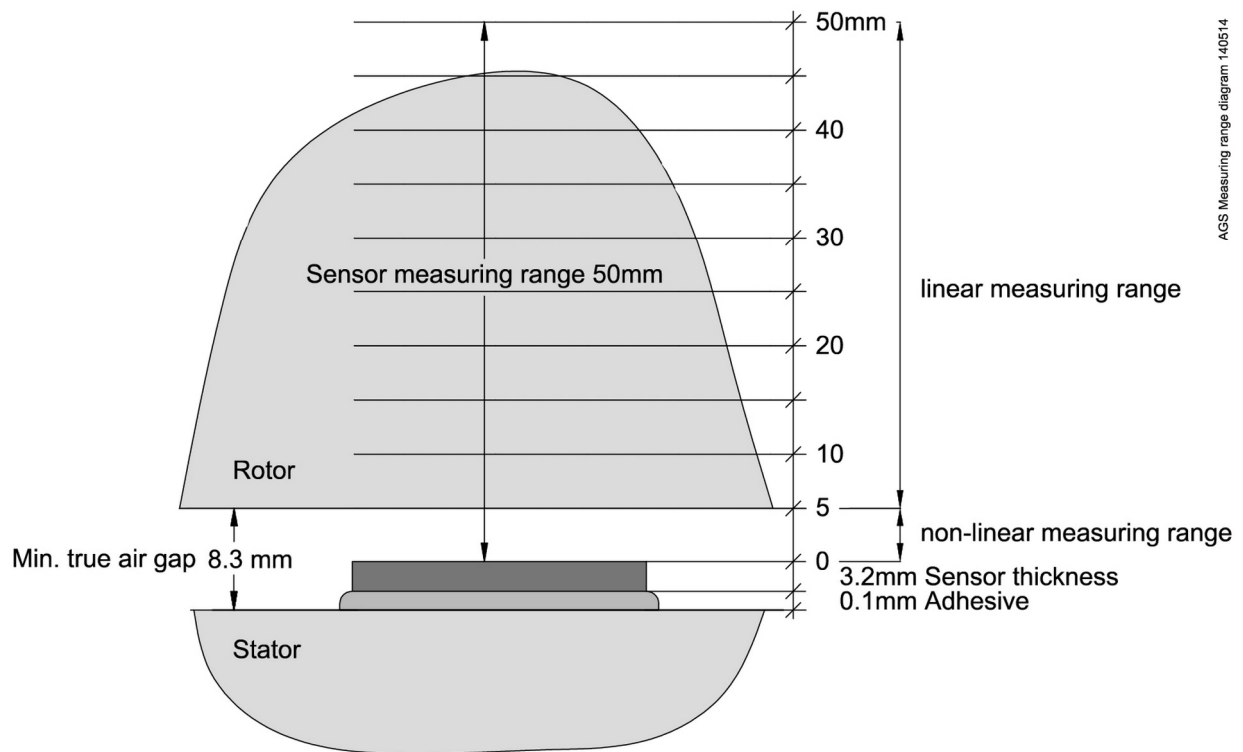


Figure 1. Minimum true air gap vs. measuring range for AGS-51

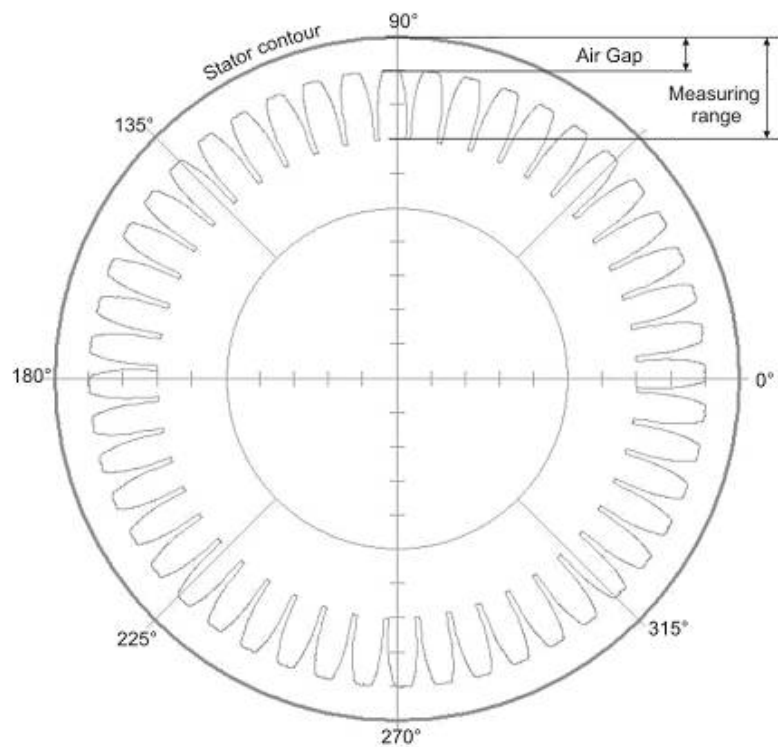


Figure 2: Image of AGS output signal, polar data

2.2. AGS resolution and output signal samples

Capacitive distance measuring principle is based on the following formula:

$$C = k \times S/d$$

C = capacity, k = dielectric constant, S = target surface area facing sensor, d = distance.

Since area covered by sensor's measuring surface is small, relative to the rotor pole surface area, a high resolution is possible. Below are samples of recorded waveforms with arrows pointing toward what at first seems electrical disturbance but in fact is threaded hole for pole lifting hoist attachments, (Figure 3, 4, 5).

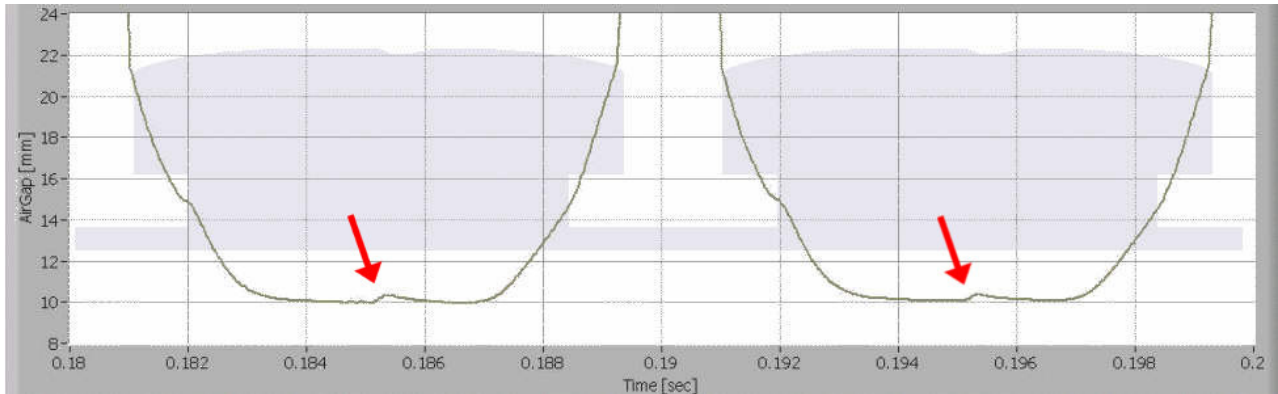


Figure 3: Image of AGS pole profile output signal, (two poles view), arrow showing hoist attachment holles

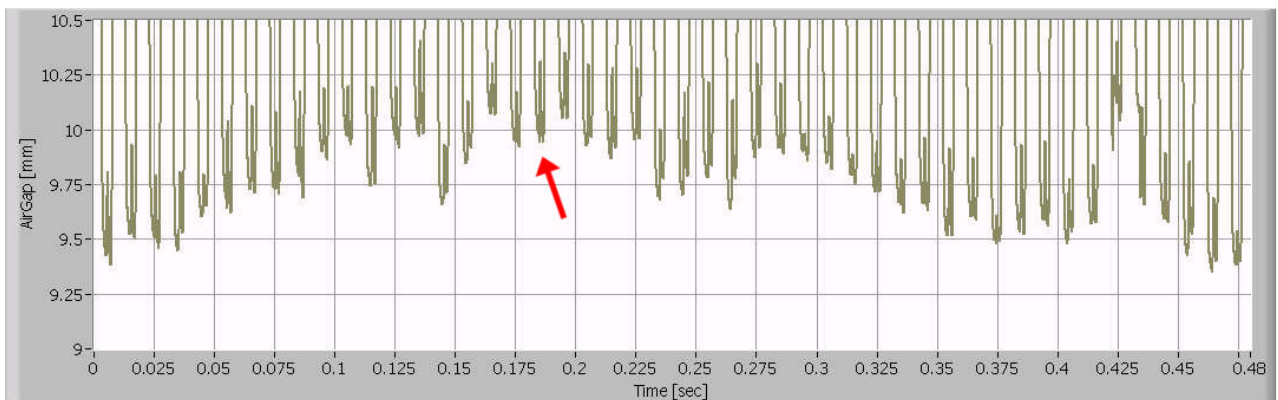


Figure 4: AGS Pole profile output signal (one rotation) arrow showing hoist attachment holles



Figure 5: Rotor pole, arrow showing positions of pole lifting hoist attachments

3. Technical specifications

	AGS-4-S	AGS-7,5-N	AGS-13-N	AGS-15-N	AGS-25-N	AGS-50-N	AGS-51-N	AGS-65-N
Measuring range (mm) (from sensor surface)	0...4	0...7,5	0...13	0...15	0...25	0...50		0...65
Linear measuring range (mm) (from sensor surface)	0,8...4	1,5...7,5	2,6...13	3...15	5...25	10...50	5...50	6,5...65
True air gap range (min...max), (mm)	1,7...4,9	3,2...8,7	4,8...15,2	5,2...17,2	8,3...28,3	13,3...53,3	8,3...53,3	9,8...68
Linearity FSD (25°C)	+/-1,5%					+/-3%		
Linearity FS (-20...80/125°C) (1)	+/-3%					+/-5%		
Linearity FS (-20...80/140°C) (2)	+/-3%					+/-5%		
Output noise (% of reading)	0,3%							
Repeatability	0,3%							
Output pole profile	0...20mA, (0mA=0mm), or 4...20mA (4mA=0mm) with 500 Ohm termination resistor: 0...10V (0V=0mm) or 2...10V, (2V=0mm) opto-insulated							
Sensitivity 0...20mA output (mA/mm)	5	2,667	1,539	1,33	0,8	0,4	n.a.	
Sensitivity 0...10V output (V/mm)	2,5	1,334	0,769	0,667	0,4	0,2	n.a.	
Sensitivity 4...20mA output (mA/mm)	4	2,134	1,231	1,067	0,64	0,32		0,2462
Sensitivity 2...10V output (V/mm)	2	1,067	0,615	0,533	0,32	0,16		0,1231
Typical frequency response	0...1000Hz, (-3dB), other bandwidth optional							
Magnetic flux density withstand	+/-2 Tesla							
Operating temp. (probe only)	-20...125°C, option: -20...140°C							
Operating/store temp. (AGSC+preamplifier)	-20...80°C							
Power input	+24Vdc, ±10%, 0,15A max.							
Warm-up time	approx. 20 min.							
Relative humidity	95% non condensing							
Vibration	IEC 68 2.27, 5 g peak, 10 Hz to 150 Hz							
Shock	IEC 68 2.27, 15 g peak, 11ms							
EMC	Sensor probe not affected by magnetic fields +/- 2 Tesla, 50/60 Hz							
Probe immunity	magnetic fields, dust and oil vapours, without degradation of material							
AGSP probe dimension (mm)		81x32x1,1	125x32x2,2(3)	135x32x2,2(3)	232x32x3,3	175x60x3,3		265x60x3,3
AGSP cable length (m)	0,8m + 10m, optional: 0,8m + 20m				1,8m + 10m, optional: 1,8m + 20m			
AGSC dimension (mm)	220 × 120 × 80 w/o cable inlets type CAB, 220 x 125 x 55 type CON							
AGSC protection class	IP66 (type CAB) IP60 (type CON)							
Weight AGSP (probe + cable)	6g + 230g	10g + 230g	15g + 230g	20g + 230g	50g + 250g	100g + 250g		150g + 250g
Weight AGSC unit	1500g (type CAB) 720g (type CON)							

Table 2. Technical specifications

NOTES:

- (1) AGSC (signal conditioner) at 80°C, AGSP (preamp.) at 80°C, AGSP (probe) at 125°C
- (2) AGSC (signal conditioner) at 80°C, AGSP (preamp.) at 80°C, AGSP (probe) at 140°C
- (3) AGS-13 and AGS-15 sensor probe tickness from S/N: 153601 onward has been changed from 1.2mm to current 2.2mm.

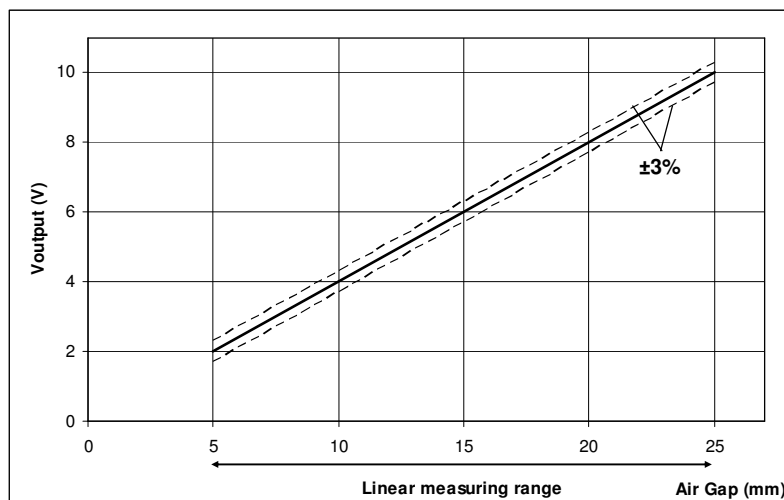


Figure 6. AGS-25 Linearity definition for +/-3% of reading

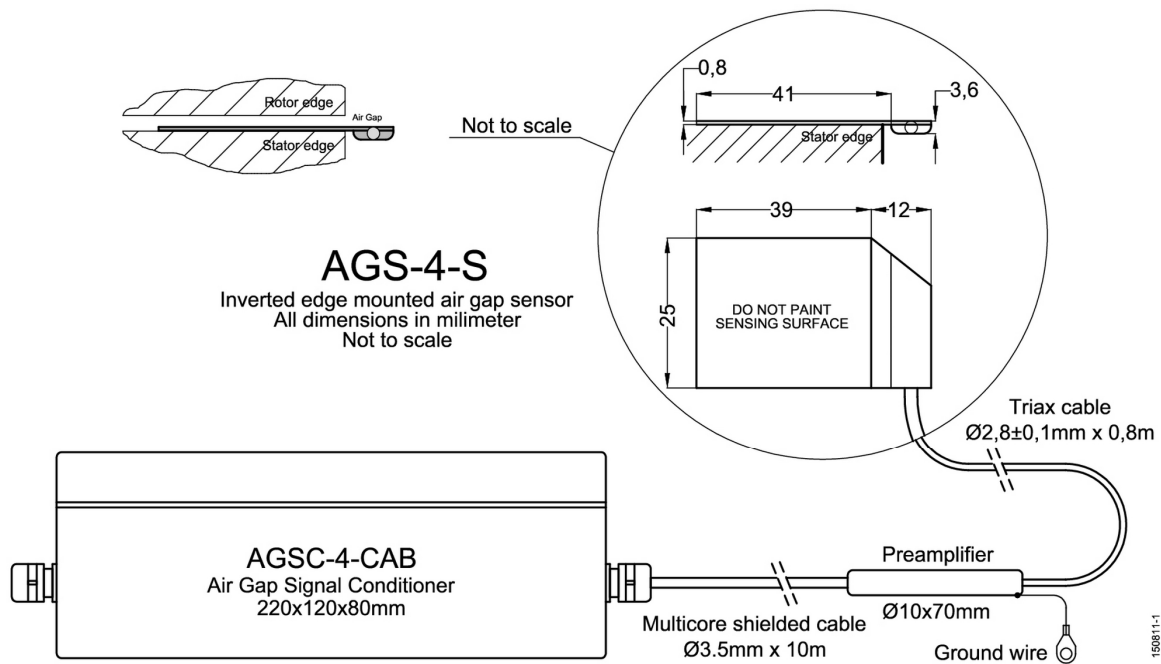


Figure 7. AGS-4S (cable attachment inverted type) outline drawing

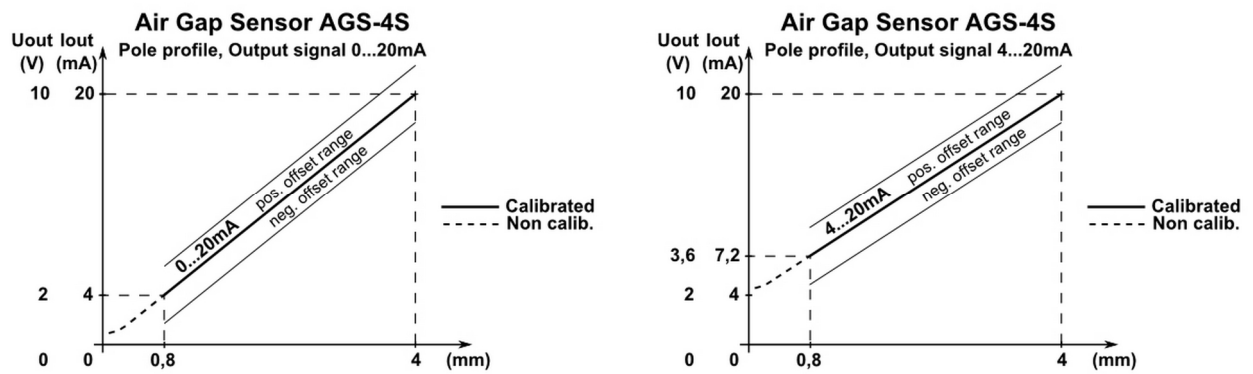


Figure 8. AGS-4S output signal diagrams

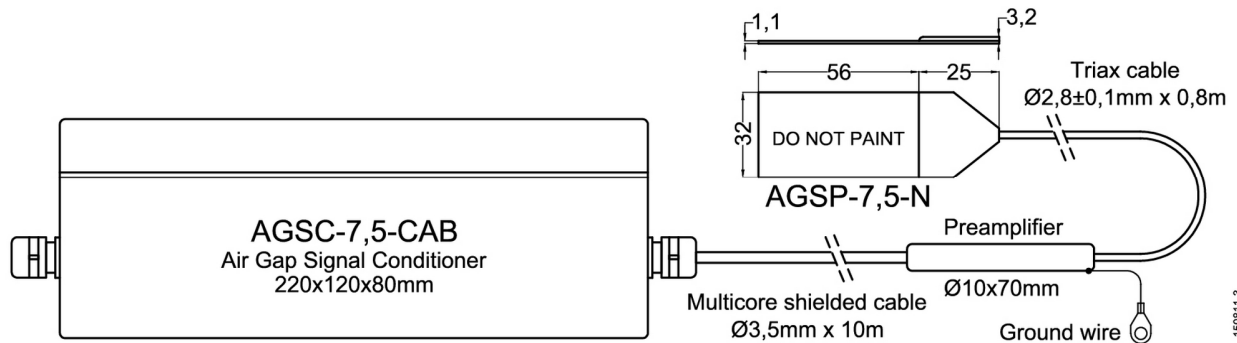


Figure 9. AGS-7,5-N outline drawing

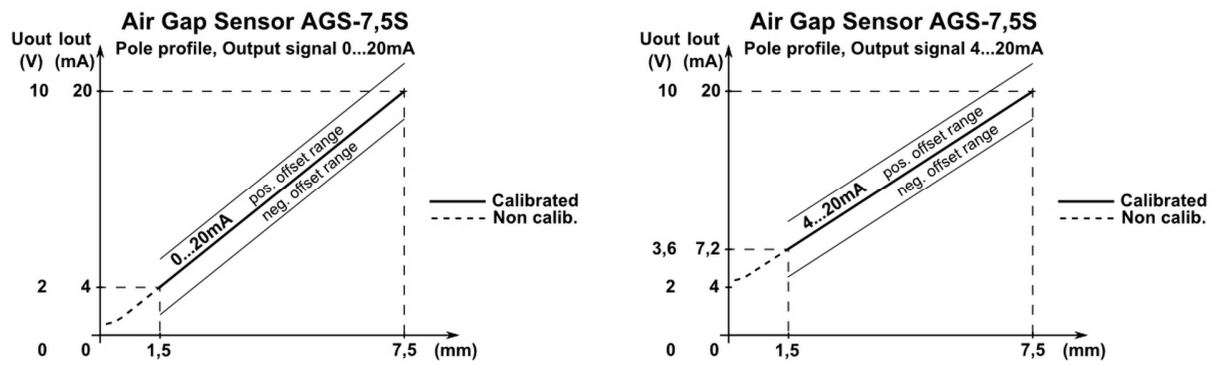


Figure 10. AGS-7,5 output signal diagrams

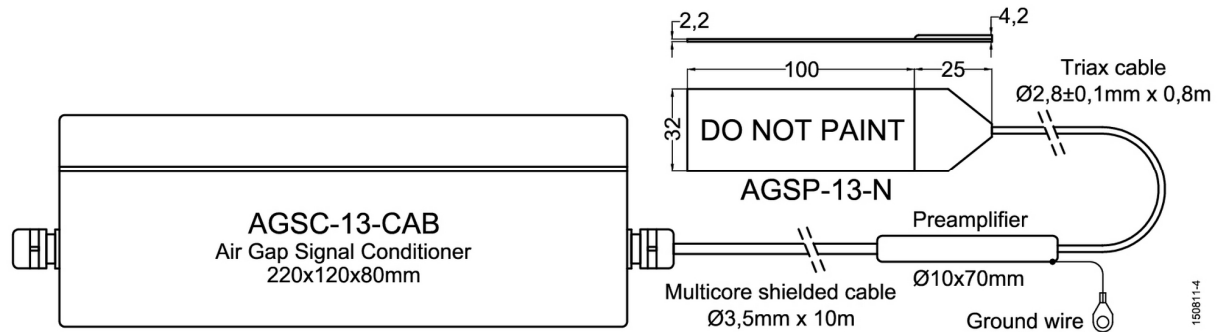


Figure 11. AGS-13-N outline drawing

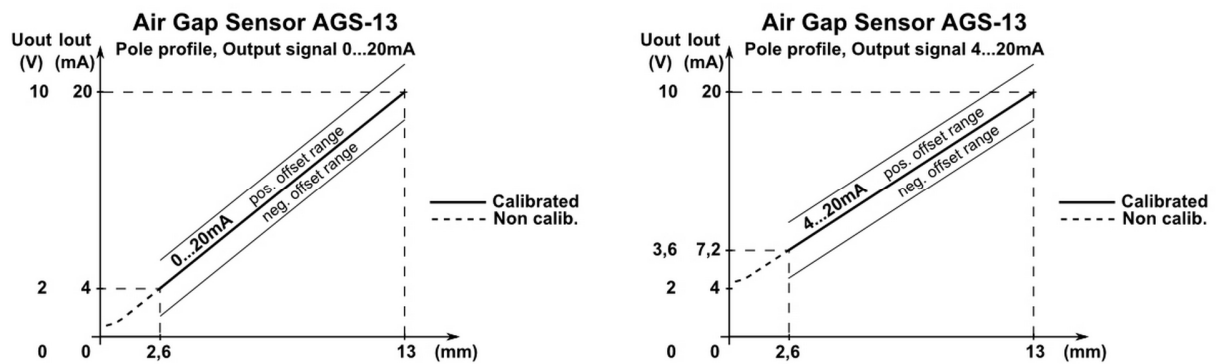


Figure 12. AGS-13 output signal diagrams

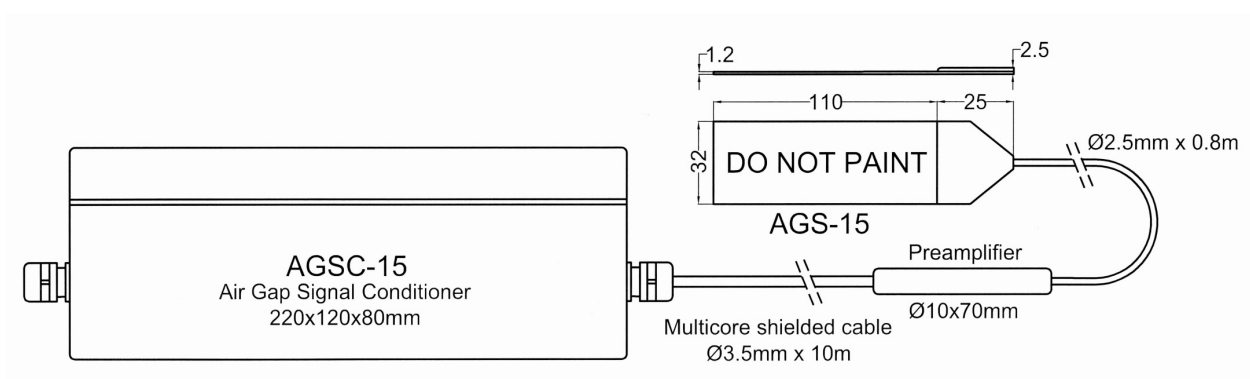


Figure 13. AGS-15-N outline drawing before S/N: 153601

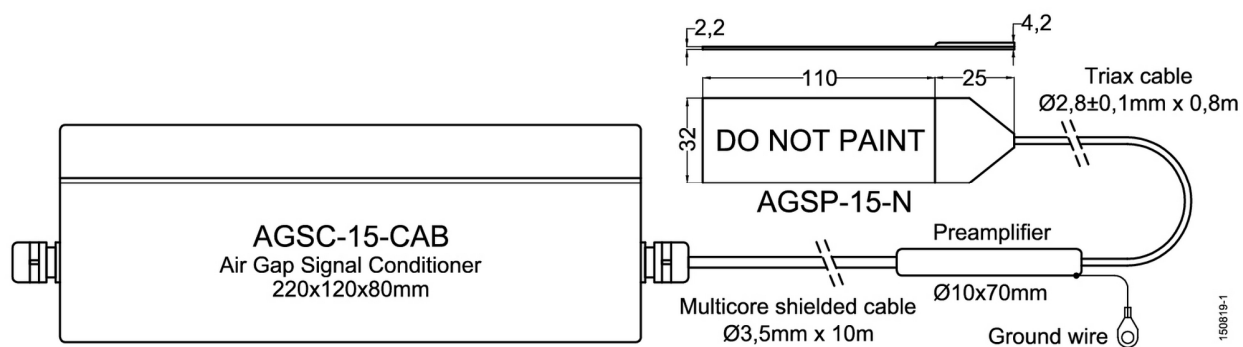


Figure 14. AGS-15-N outline drawing after S/N:153601, (changed sensor probe thickness)

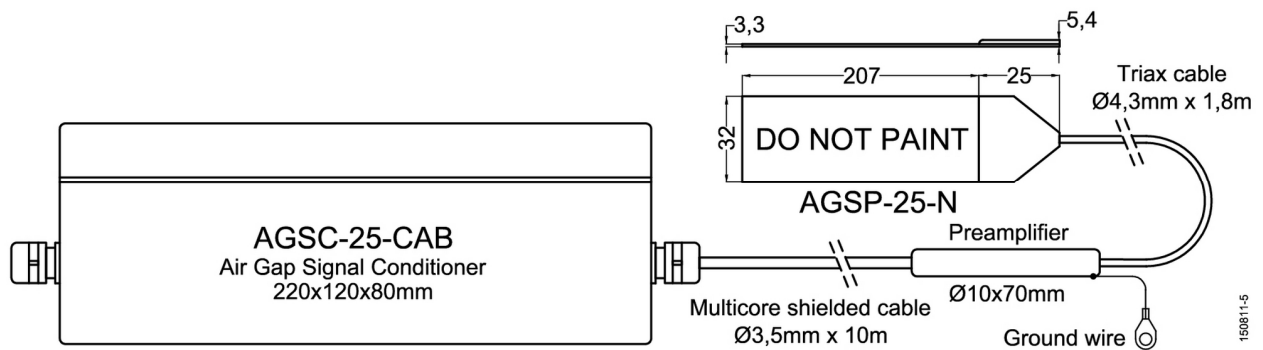


Figure 15. AGS-25-N outline drawing

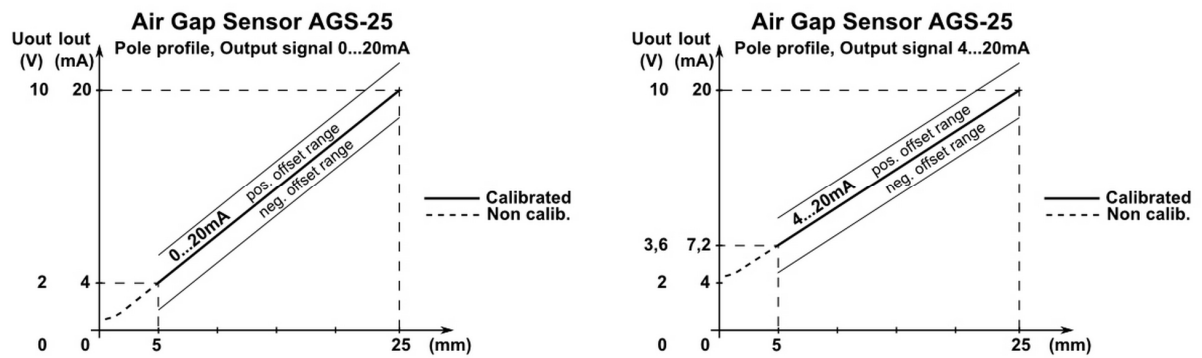


Figure 16. AGS-25 output signal diagrams

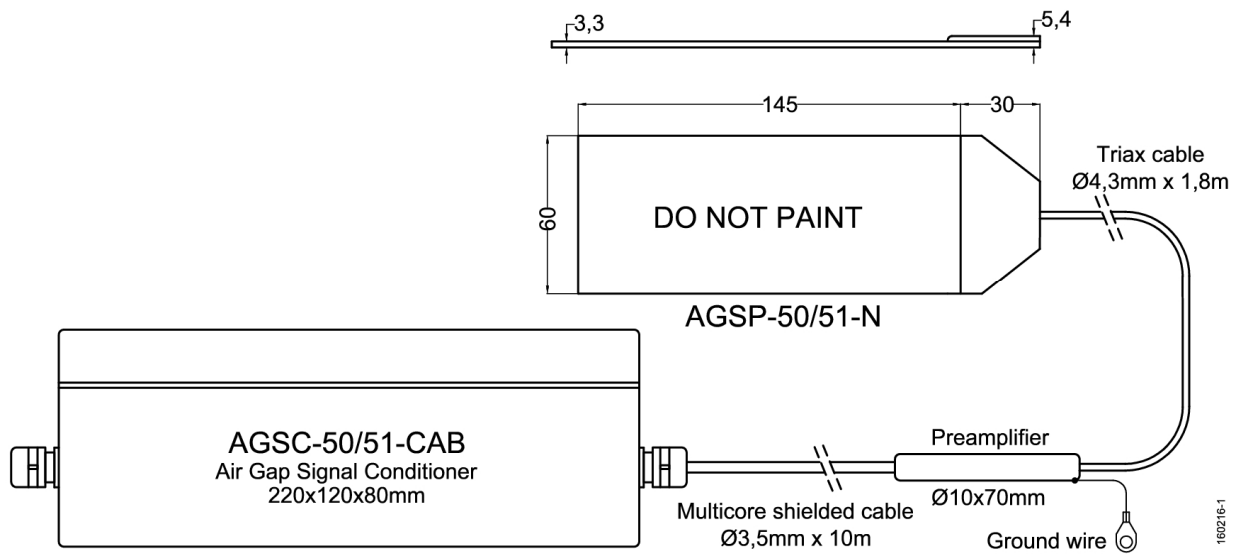


Figure 17. AGS-50 / AGS-51 outline drawing

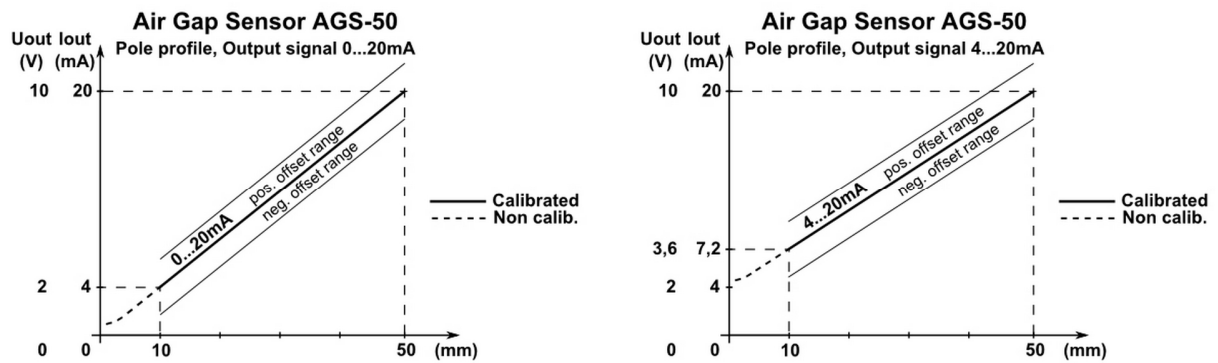


Figure 18. AGS-50 output signal diagrams

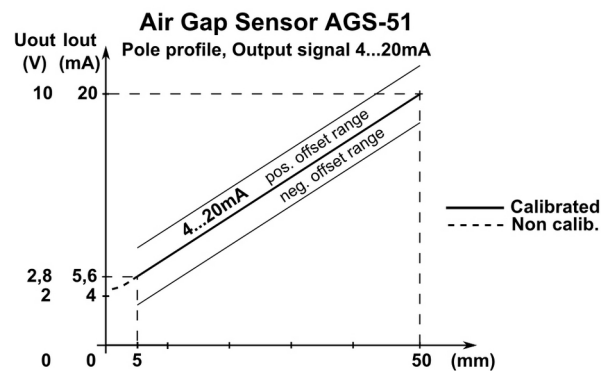


Figure 19. AGS-51 output signal diagrams

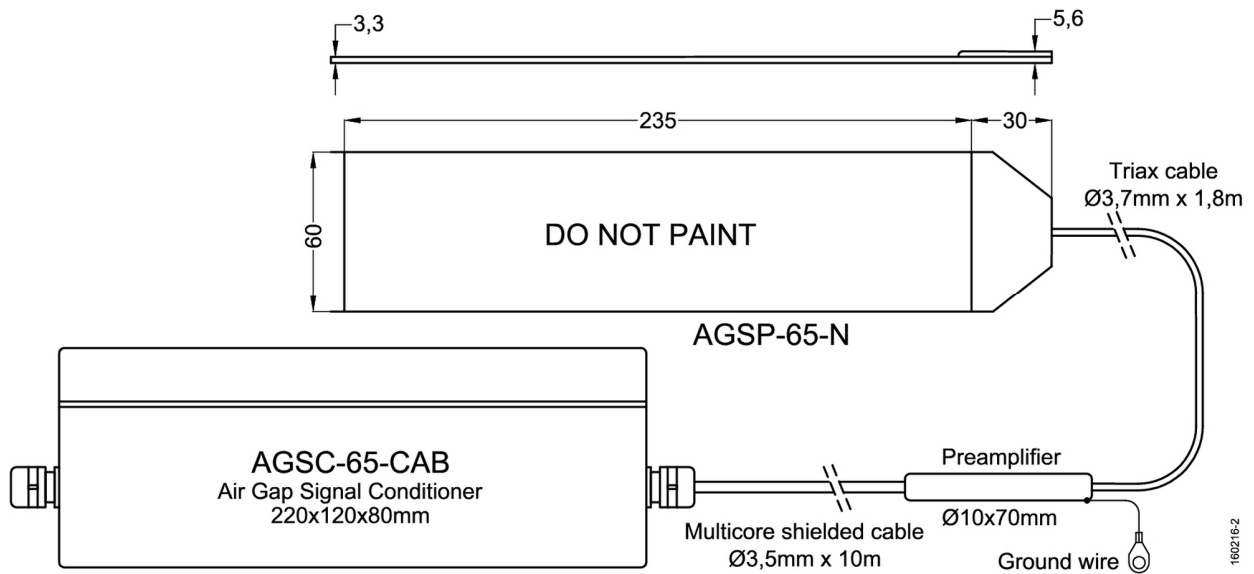


Figure 20. AGS-65 outline drawing

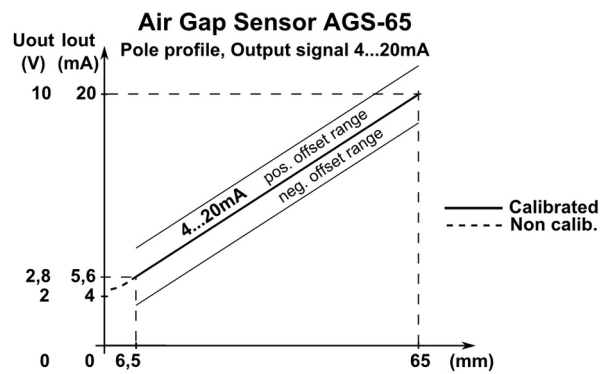


Figure 21. AGS-65 output signal diagrams

4. Installation instructions

4.1. AGSC Signal Conditioner unit installation guide

Please select AGSC signal conditioner enclosure type:

a) **Sealed enclosure with connectors**, preferred enclosure type, use for Stator installation. Water and oil proofed IP60 cable connectors allow for easy installation **without opening** enclosure cover. Offset adjustment possible from outside without opening. Practical and simple installation within door-and-hinge box for EMC protection of cable wires. No need to open and no replacement of desiccant needed.

NOTE: *Sealed enclosure must be placed inside auxiliary door-and-hinge enclosure for EMC protection of connection wires.*



Figure 22. AGSC Signal Conditioner unit enclosure with connectors (CON)

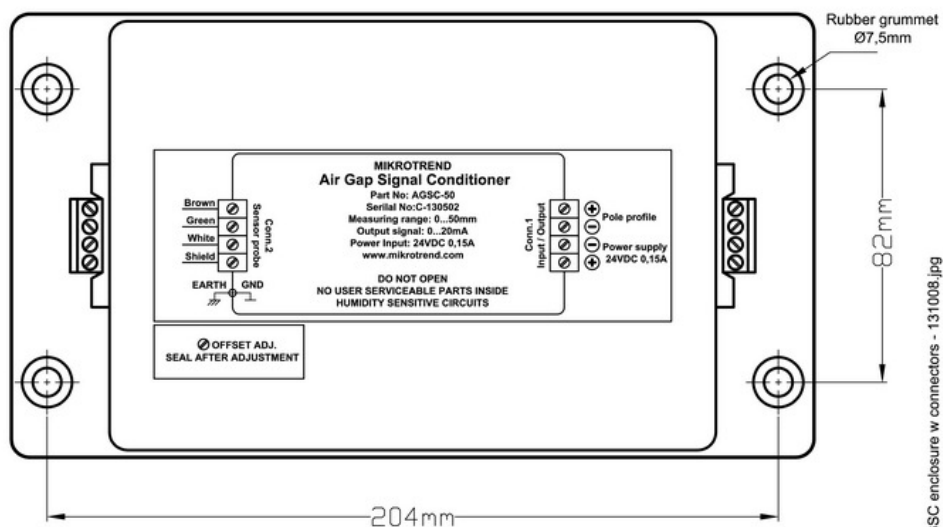


Figure 23. AGSC Signal Conditioner unit enclosure with connectors (CON), (mounting dimensions)

b) Enclosure with cable inlets, use for Rotor mounted and stand alone installation **where no door-and-hinge enclosure is available** for protection.
Cables can be installed with tight fitting, oil and water proofed up to IP64.

NOTE: *For AGSC-CAB units before S/N:144701:
AGSC enclosure contains humidity sensitive circuits and must be closed during operation, .
Replace desiccant after prolonged opening and allow at least 12h to dry-up before calibration
and /or measuring
Later S/N numbers are fully sealed and does not need desiccant (Figure 25).*



Figure 24. AGS Signal Conditioner unit enclosure with cable inlets (CAB) (before S/N 144701)



Figure 25. AGS Signal Conditioner unit enclosure with cable inlets (CAB) (after S/N 144701)

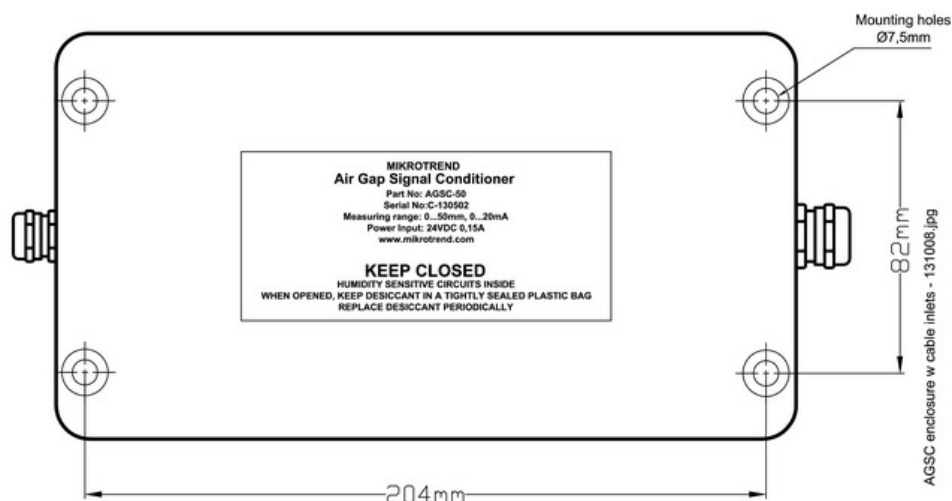


Figure 26. AGS Signal Conditioner unit enclosure with cable inlets (CAB), (mounting dimensions)

4.2. Appropriate location for AGSC Signal Conditioner unit

Distance up to 10 meters from the sensor probe (longer distance is possible, please enquire), up to 200 meters from acquisition unit with 0...20mA loop. If voltage output is used, interference free distance may vary, depending on type of wiring and nearby equipment which may generate electromagnetic disturbance.

- Prefer well ventilated, dry area free of vibrations and stray magnetic fields,
- Ensure adequate grounding for enclosure with minimum length of wire,
- Ensure access to 24 VDC / 0,15A power supply.

NOTE: *When using enclosure with connectors auxiliary enclosure with door and hinge is mandatory to shield AGSC signal conditioner wires from environmental influences, for EMC protection etc.*

4.3. Thermal considerations and thermal zones

Life time of electronic components and MTBF hours depend on thermal load and ambient temperature. AGS electronics is designed to provide more than 20 years of continuous service if installed properly. As a general rule for every 10°C increase of ambient temperature above maximum specified, components life time will be halved.

It is important to consider installing AGS components in locations which will ensure minimum thermal stress and therefore longest life time.

Thermal zones are pictured in Figure 27. Technical specifications are given for these maximum continuous permissible temperatures. However, AGS components will endure higher temperatures for short periods with no apparent damage but life time will be affected accordingly.

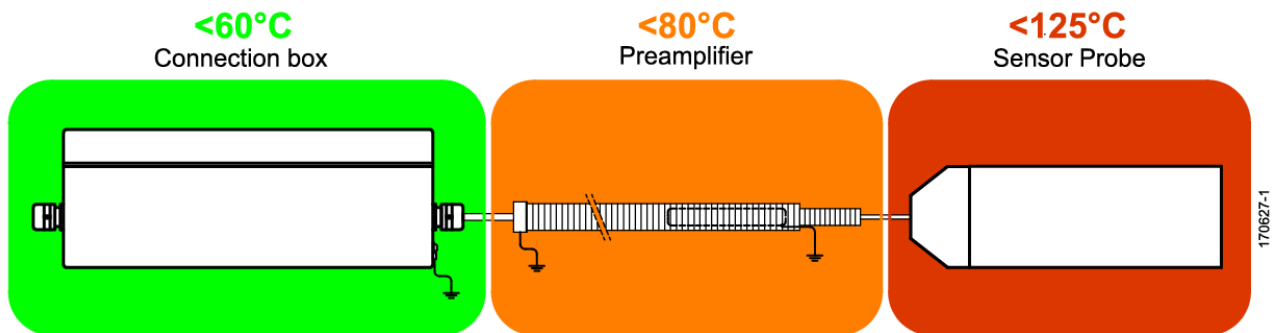


Figure 27, Thermal zones

4.4. Grounding of AGSC Signal Conditioner unit

CAUTION: *Grounding is essential for system operation integrity as well as for protection against hazardous voltages. For best grounding, provide the shortest path possible between the AGSC signal conditioner unit and the grounded structure. Use flexible steel conduit to protect all cables from electromagnetic fields except inside of stator winding where PVC conduit shall be used. Keep ample distance from nearby power lines (Figure 36).*

WARNING: *MULTICORE CABLE SHIELD SHALL BE GROUNDED AT ACQUISITION CARD INPUT ONLY. MULTIPLE GROUND POINTS WILL CAUSE NOISE PICK-UP AND CAN DAMAGE CONDITIONER UNIT ELECTRONICS.*

4.5. Power supply connection

Power to AGSC signal conditioner unit shall be 24VDC, $\pm 10\%$, 0,15A max.

Conditioner unit input has insulated DC-DC converter allowing any pole to be grounded or floating power supply as well as daisy chain of several Conditioner units.

4.6. Calibration

The AGSP sensor probe and AGSC signal conditioner units are factory matched and calibrated for best performance. However if needed, may be calibrated at site. For details please contact Mikrotrend.

4.7. AGSP Sensor probe installation guide

CAUTION: *AGSP sensor probe shall be handled with care.
Do not apply paint or silicone to the sensor surface.
Never pull or use excessive force on the sensor cable or preamplifier.*

The sensor surface is treated with high quality insulation varnish, it shall not be scratched as damage to semiconductive electrodes may occur.

4.8. Placing the sensor

Choose position for AGSP sensor probe considering number of sensors and machine poles.

True accurate rotor/stator geometry can be obtained with one (1) Rotor mounted Air Gap Sensor and four (4) Stator mounted Air Gap Sensors, upper side and four (4) at lower side.

<http://www.mikrotrend.com/wrm-wireless-hydrogenerator-rotor-monitor.htm>

If **Wireless Rotor AGS** is not used than good practical results are achieved with (**Figure 24.**)

- 4 sensors for upper and 4 for lower side, generator diameter of less than **7,5 meters**,
- 8 sensors for upper and 8 for lower side, generator with diameter **7,5...12 meters**,
- 12 to 16 sensors per side for larger diameters.

Economy solution for vertical machines would be to place the sensors on the upper side of the stator only as it will have higher excentricity than the lower side. For stator height of more than 1,8 meters Air Gap sensors should be placed on both sides (upper and lower side).

Sensor shall be glued against stator laminations as deep as practical in the air gap or at stator edge if EDGE type of sensor probe is to be used.

In general, this is beneath the second ventilation hole. The preamplifier (small cylinder shape integrated within the cable) **must** stay outside of the air gap and outside of the endwindings, if possible outside of the stator casing.

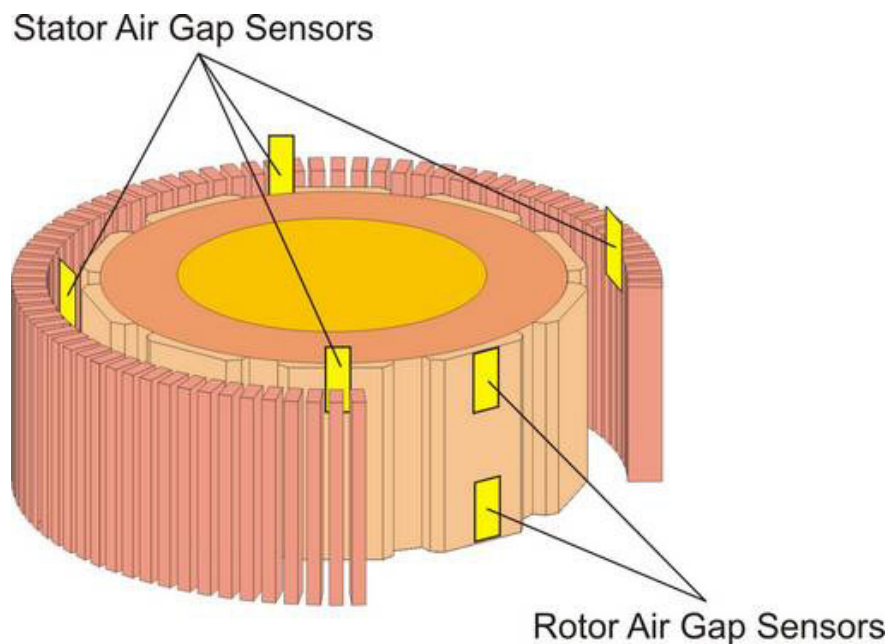


Figure 28. Air Gap Sensor probe positions (upper side)

4.9. Preparing the stator surface

Thoroughly clean the stator surface, use allowed cleaning liquid such as isopropanol alcohol, disposable cotton fabric and fine non-metallic sandpaper.

WARNING: *DO NOT USE ACETONE, MEDICAL ALCOHOL OR OTHER SOLVENTS.*
Medical alcohol contains oils and additives, other solvents may damage sensor surface!

Use a clean rag moistened with isopropanol over the stator surface to remove oil and carbon deposits. Epoxy coated or painted stator laminations inspect for **mechanical stability**. If necessary polish the surface and/or remove unstable particles with **non-metallic** sandpaper.

CAUTION: *Sensor's bottom surface shall be insulated from stator iron.
Sensor's bottom surface is coated with insulating varnish and a thin coat of adhesive will provide additional insulation.*

After sanding, once again clean stator surface with a rag moistened with isopropanol. The glue surface should be flat, without protruding laminations, Slight unevenness can be tolerated ($\pm 0.5\text{mm}$).

Let the isopropanol evaporate at room temperature for about 10 minutes before proceeding with glue application.

4.10. Mounting the sensor

The **AGSP** sensor probe shall be aligned with the plane area of the rotor pole. A small misalignment may be compensated with offset adjustment. The sensor measuring surface shall be entirely covered by the pole surface.

We recommend three methods for fastening the sensors, each with different curing times and operating temperatures:

CAUTION: *Commonly found Epoxy adhesive is not flexible enough. The sensor may come off due to uneven surface tensions during high load periods on generator.*

A. Double sided tape, (150°C):
Double Side adhesive 3M Scotch Acrylic Foam Tape VHB 4611.

With glue thickness of 1mm, a foam type tape will allow stator unevenness of up to 0,3 mm. Allowed temperatures of 149°C (for weeks) and short time up to 230°C (hours).

Clean the back surface of the sensor with a cotton rag moistened with isopropanol.

Place double sided adhesive tape on the back side of the sensor. Remove protective foil and carefully place sensor in position without touching adhesive surface. Using protective gloves or a rag press the sensor firmly against the stator surface. Adhesive is pressure sensitive and reacts on the first applied pressure. The sensor can be put in use immediately after gluing, full strength will be reached after 24 hours.

B. Silicone sealant-adhesive, non-acid (neutral), high temperature
TEMPFLEX Loctite 5145 (250°C)

Our preferred mounting technique with high flexibility and high holding force. This is only method recommended for **Wireless Rotor AGS** where high G-forces are present. Standard operation temperatures from -85...250°C, short time up to 300°C.

A must for locations where stator surface coating has low adhesion to stator laminate. Silicone adhesive/sealant effectively compensates uneven surface tensions during high load periods on generator thus ensuring stable mounting of the sensor.

With paper adhesive tape, mark border area about 5 mm larger on each side than sensor surface.

Apply Silicone sealant about 1mm thick, evenly spread over entire **back surface** of the sensor.

Carefully place sensor within paper covered opening and firmly press until sealant stops coming out.

Wipe of excess sealant with paper towel until clean and remove adhesive paper border.

Fix the sensor in position with adhesive tape (Power-Tape) for at least 6 hours. Full curing times up to 24 h. shorter with higher ambient moisture.

C: Two component glue (short curing time) LOCTITE MULTIBOND 330
continuous operation temperature not exceeding 80°C

If stator laminate coating is strong and stable, You can use two component adhesive type **LOCTITE MULTIBOND 330**. It is quick and simple application, but flexibility is not great and above mentioned precautions about surface stability and operating temperature shall be observed.

When generator is under heavy load and if surface is not stable enough, the sensor may come off due to stator core tensions which adhesive cannot compensate.

Clean the back surface of the sensor with a rag moistened with alcohol.

Follow manufacturers instructions. Curing times will vary with surface temperature, 50% of the final strength is reached after 10...30 minutes, full strength after approx. 5 hours.

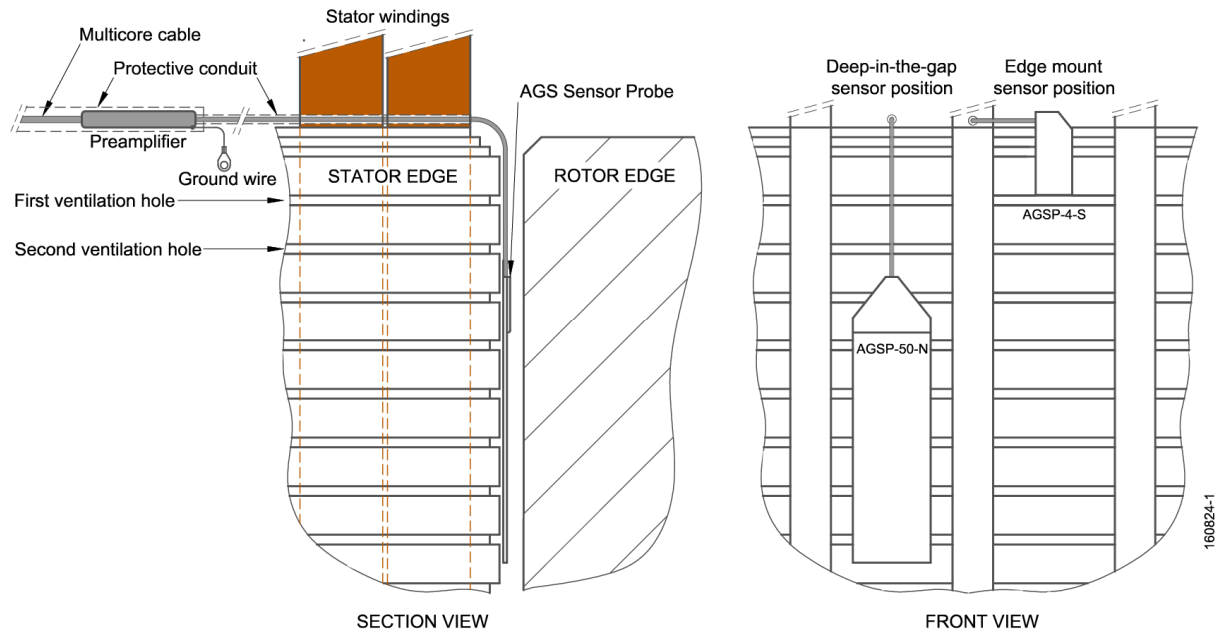


Figure 29. Air gap sensor probe mounting position diagram



Figure 30. AGS Sensor probe mounting position showing triax cable and protective conduit



Figure 31. AGSP sensor probe installed at stator surface
(AGS sensor pictured on the left, magnetic field sensor on the right side)



Figure 32. AGSP sensor probe installed at rotor pole
(AGSP sensor pictured next to Magnetic field sensor in the middle of rotor pole)

4.11. True Air-Gap and offset

The output of the signal conditioner provides the distance value between **the sensor surface and rotor pole**.

Offset is the distance between the stator surface and sensor surface, including the thickness of the glue:

Offset = glue thickness+sensor thickness, varies with sensor type and mounting metod.

True air-gap is sum of measured and offset value.

Offset compensation shall be made at the monitoring system and displayed value will be True air gap distance.

NOTE: *Before attempting new offset adjustment let AGSC Signal conditioner unit be powered for 20...30 minutes.*
Slowly turn trimmer potentiometer labeled **Offset adj.** untill reaching required output current or voltage.
Normally, very small rotation will provide large changes on output.

CAUTION: *DO NOT adjust other trimmer potentiometers (factory adjustment only).*

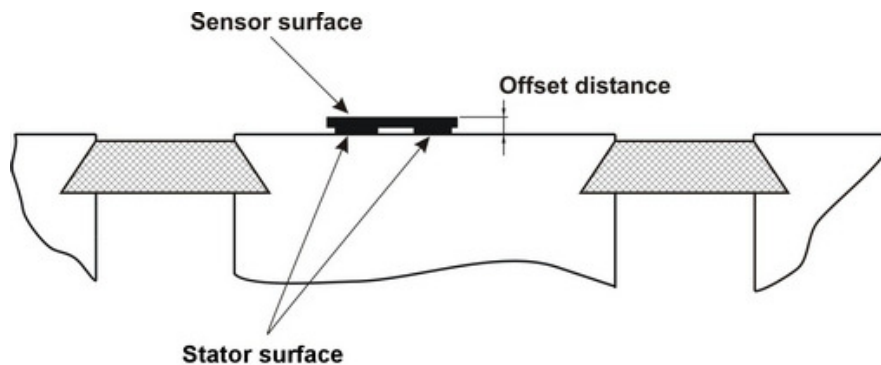


Figure 33. AGS - Offset distance

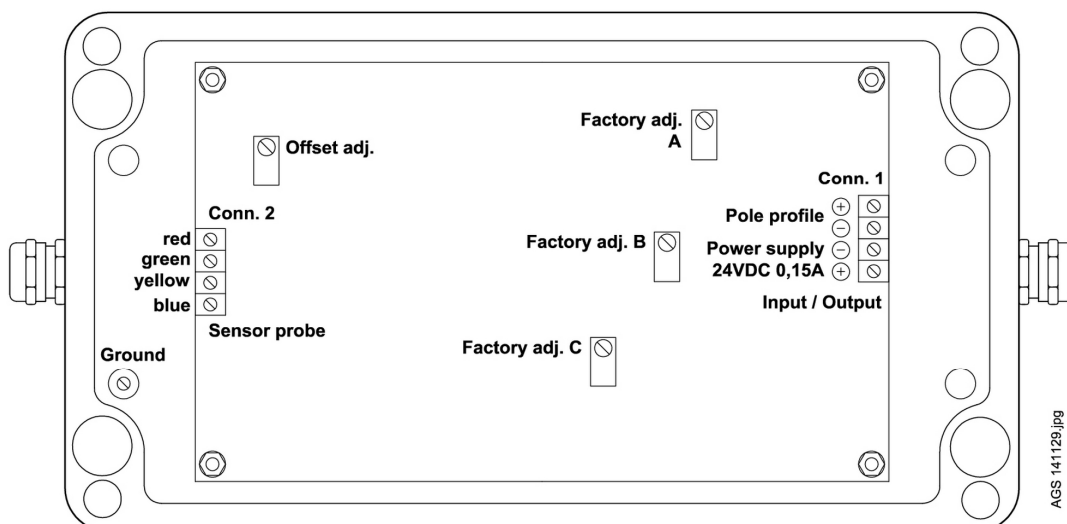


Figure 34. AGSC - signal conditioner, cable inlet enclosure, adjustments (before S/N 144701)

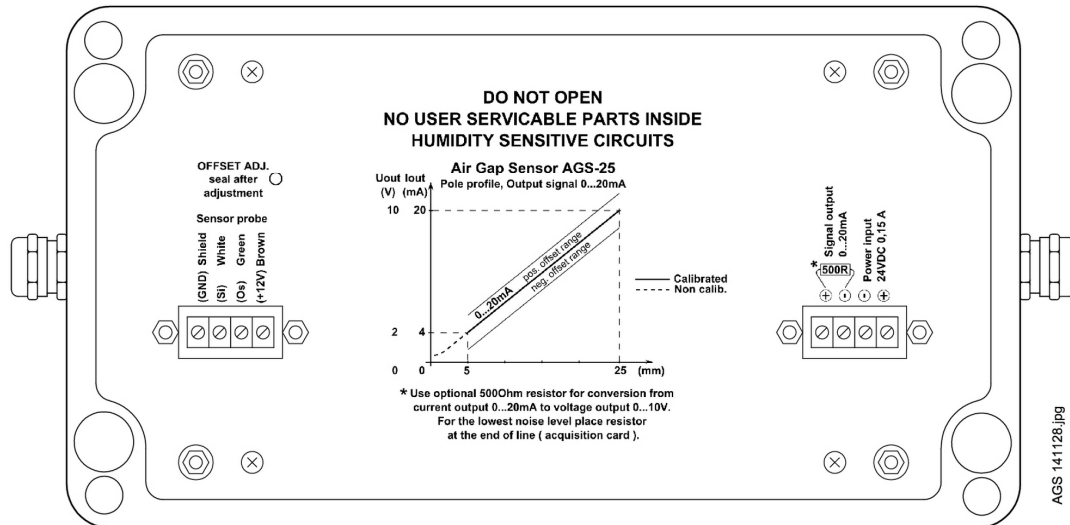


Figure 35. AGSC - signal conditioner, cable inlet enclosure, adjustments (after S/N 144701)

4.12. Cable installation

WARNING: **BEWARE OF HIGH VOLTAGES ON THE STATOR BARS (5...22 KV). DO NOT ATTACH TRIAXIAL CABLE DIRECTLY TO THE STATOR BARS. THE TRIAXIAL CABLE, PREAMPLIFIER AND MULTICORE SHIELDED CABLE MUST BE PROTECTED BY A FLEXIBLE OR SEMI-RIGID STEEL WITH POLYETHYLENE (PVC) CONDUIT, (SEE FIGURE 36).**

CAUTION: **The triaxial cable shall not be modified.**

Muticore shielded cable (between preamplifier and signal conditioner unit) **may be shortened** if neccessary. This will change output readings approx. 3% / met. Please adjust offset accordingly.

- Gently preshape the triaxial cable by hand to get the right form, avoid to bend it beyond a right angle with minimum bending radius of 30mm.

Immobilize the triaxial cable inside the air gap to prevent vibrations and/or mechanical displacement:

- Hold the triaxial cable temporary with Cyanoacrylate type adhesive, point-glued to the stator laminations (iron) surface.
- Apply Silicone sealant along the cable in the air gap up to the exit making a strong permanent bond (Figure 30).

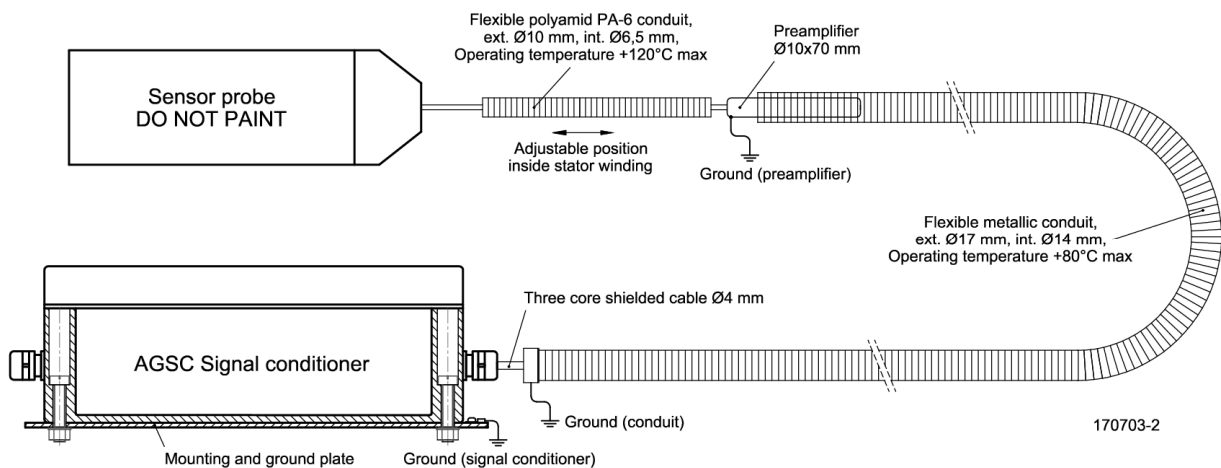


Figure 36. Air Gap Sensor AGS Shielding and grounding

4.13. Connection to AGSC conditioner unit

The Figure 37, 38, illustrates how to connect the multicore cable to the AGSC conditioner unit.

Pole profile output gives instantaneous air-gap value measured by the sensor (Fig.2, 3, 4). It is optocoupled and insulated from sensor ground and also from power supply negative. Output shall be grounded at acquisition card input. Output signal can be ordered as 0...20mA or 4...20mA.

NOTE: When 0...10V output is needed instead of 0...20mA, a current to voltage conversion resistor of 500 ohms should be placed at the end of line at the acquisition unit (for the lowest noise level).

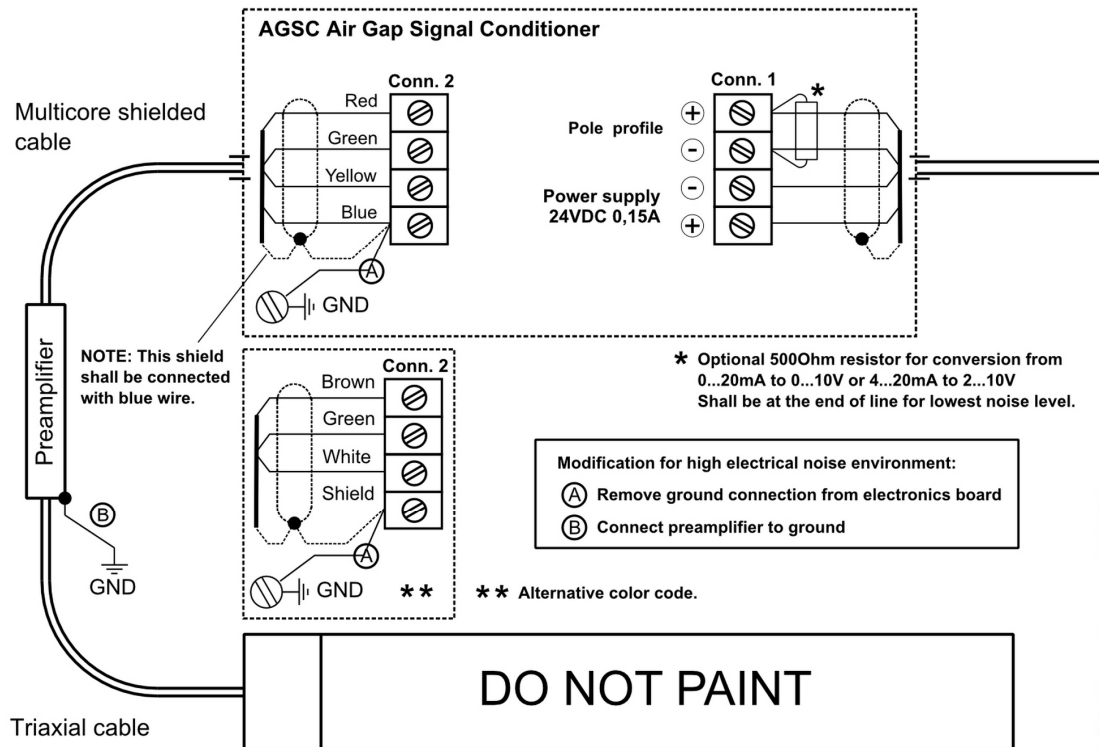


Figure 37. AGS Wiring diagram (before S/N 144701)

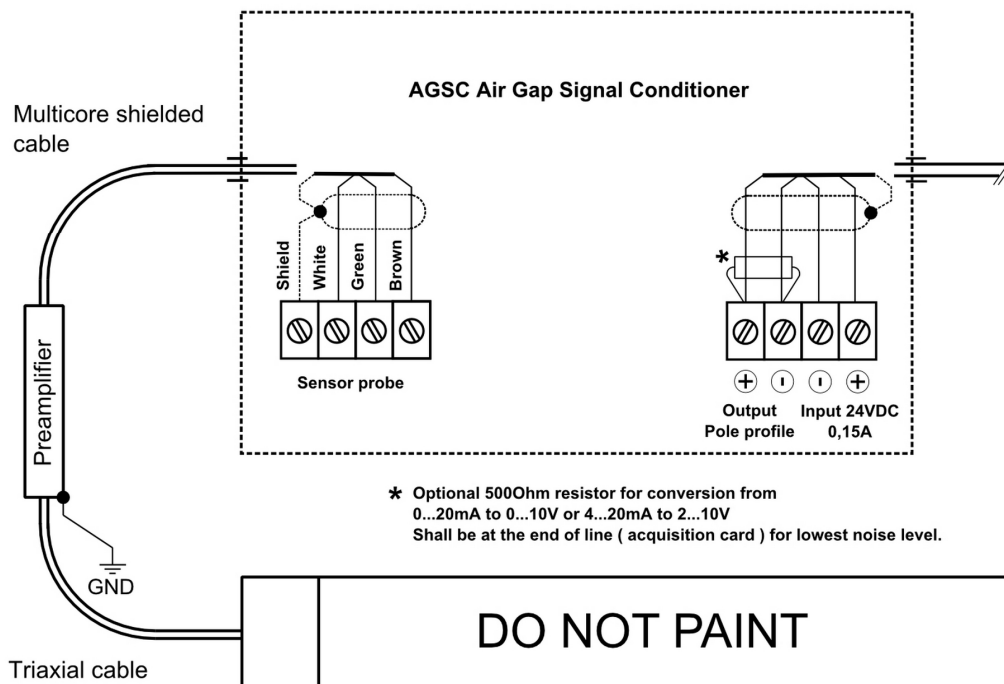


Figure 38. AGS Wiring diagram (after S/N 144701)

AGS - Wiring diagram - 141119.jpg

AGS - Wiring diagram - 141121.jpg

Distance (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	0	0
5	4	2
25	20	10

Table 3. AGS-25 0...20mA 0,8mA/mm, Output example

Distance (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	4	2
5	7,2	3,6
25	20	10

Table 4. AGS-25 4...20mA 0,64mA/mm, Output example

5. Troubleshooting

5.1. Q: Output signal drift with change of temperature/humidity:

A:

5.1.1. For units before S/N 144701:

Although Air Gap Sensor Probe (AGSP) is not temperature sensitive, Air Gap Signal Conditioner (AGSC) contains humidity sensitive components which can cause significant output signal drift if humidity enters AGSC enclosure. Each AGSC unit shall contain a fresh desiccant pack.

Please keep desiccant in tightly sealed zip-bag during installation or, better, replace desiccant every time AGSC enclosure is opened.

OFFSET adjustment shall be made **only** after fresh pack of dessicant has been installed for at least

12 hours, (time needed to dry AGSC electronics components).

Another option is to use **AGSC-x-x-CON** enclosure which has connectors for cable installation and OFFSET adjustment is possible without opening.

5.1.2. For units after S/N 144701:

New enclosure for electronics with protection from humidity.

No desiccant replacement needed.

OFFSET adjustment trimmer shall be sealed with adhesive tape after adjustment.

5.2. Q: Pole profile Output signal higher/lower than nominal:

A:

5.2.1. Check the distance to pole surface is within measuring range.

5.2.2. Check Sensor or Triax cable for damages.

5.2.3. If replacement sensor probe is connected to already installed "old" Signal Conditioner, slowly turn OFFSET adjustment trimmer potentiometer until reaching desired output. Please see also 5.1 (Output drift with change of temperature / humidity)

5.3. Q: 50/100Hz and/or higher frequency noise in pole profile signal:

A.

5.3.1. EMC protection with metallic cable conduits are mandatory for AGS installation.

Most important for generators with newer Switching power regulators in the Exciter circuit (a source of broadband electrical noise) (Figure 36).

5.3.2. Check grounding scheme. Ground loops shall be avoided (Figure 36).

Installations before S/N 144701 will have lower noise level with modification as per Fig.16. Main ground connection shall be removed from AGSC electronics PCB and placed at the Preamplifier body. Calibration is not affected with this modification.

Pole profile output signal is electrically floating, minus pole shall be grounded at acquisition card input (preffered) or AGSC enclosure **but not at both places**.

Please **do not allow multiple grounding** ie. at AGSC **and** at acquisition card unit **and** at monitoring PC-power supply, **and** at Ethernet adapter, etc. Use opto-isolated Ethernet adapters if needed.

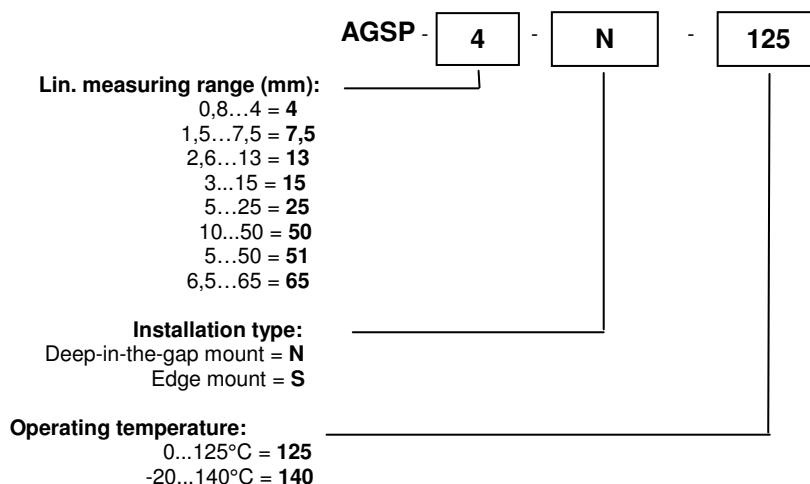
5.3.3. **Air Gap Signal Conditioner** unit will tolerate aprox 0,2 Tesla of stray magnetic fields. If stronger fields are present use additional protection-box made from ferromagnetic material or move to other location.

6. Ordering information

AGS Air Gap Sensor is delivered as factory calibrated sets containing:

- P/N: AGSP sensor probe with integrated preamplifier and connection cable,
- P/N: AGSC signal conditioner.

When ordering AGSP sensor probe please use the following format:



When ordering AGSC signal conditioner please use the following format:

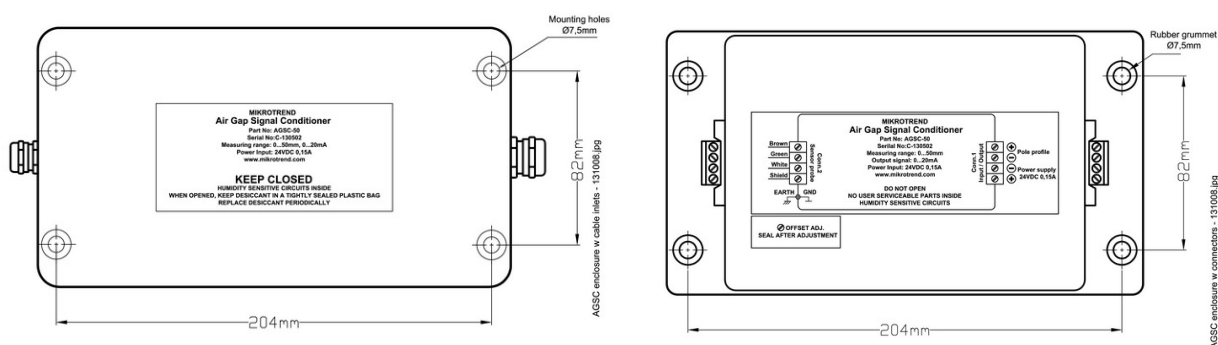
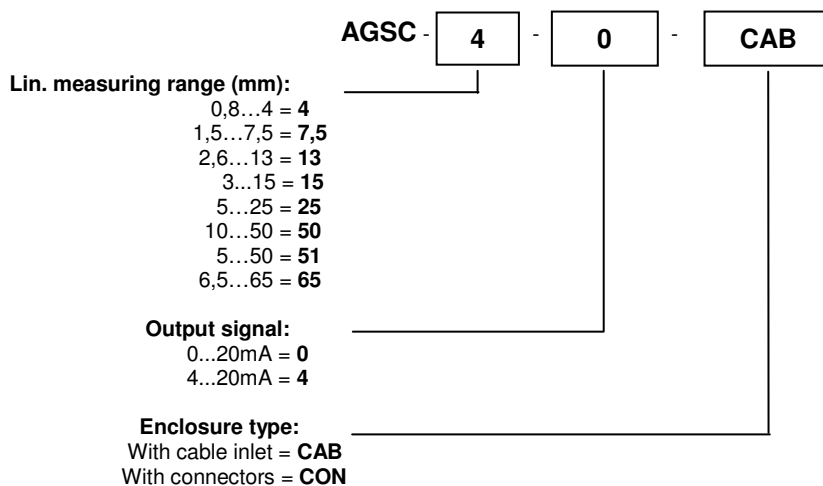


Figure 39. AGSC-CAB (left), AGSC-CON (right)

7. Manufacturers Test and Calibration Report

Air Gap Sensors are individually calibrated and Manufacturers Test and Calibration report (MTR) included with each unit as per sample below:

Manufacturer: **MIKROTREND d.o.o.** 4.Bizek 14, 10090 Zagreb, CROATIA
 e-mail: info(at)mikrotrend.com , www.mikrotrend.com
 Date: 02. June 2017
 Ambient: 22°C
 Test performed by: **K. Pavlovic**

Manufacturers Test and Calibration report No. (sample)

Scope of testing: sensor output at specified distance

Passed

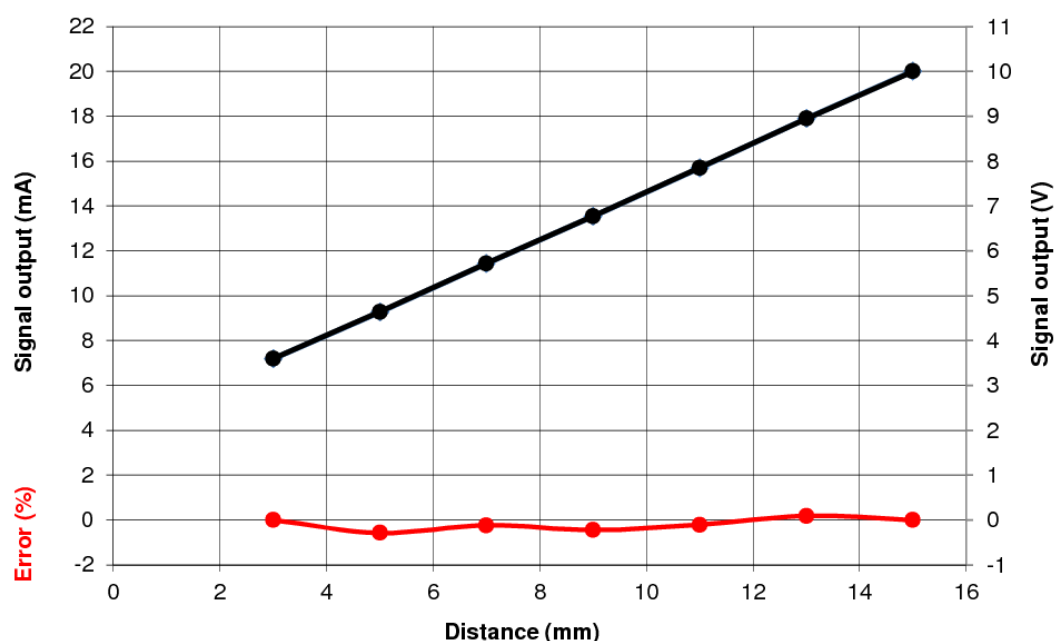
The product and the factory surveillance system meet all applicable requirements as laid down in the relevant datasheets and/or Installation and user manual

Product name:	Air Gap Sensor Probe	Part No:	AGSP-15-N-125	Ser. No:	(sample)
	Air Gap Signal Conditioner	Part No:	AGSC-15-4-CAB	Ser. No:	(sample)
Measuring range:	0...15mm	Linear measuring range:	3...15mm		
Output:	4...20mA or 2...10V				
Sensitivity:	1,06667mA or 0,53334V/mm				

Calibration Instrument used:

Z-axis:	Custom design with vacuum table
Laser Micrometer:	Keyence LC-2100, Ser. No. 004936
Micrometer:	Mitutoyo ID-H0560, Ser. No. 002450
Multimeter:	Agilent 34401A, Ser. No. US36115736

Distance	Signal output		Error	Signal output	
d(mm)	Ioutput(mA)	Imeasured(mA)	(%)	Voutput(V)	Vimeasured(V)
3,00	7,20	7,20	0,00	3,60	3,60
5,00	9,33	9,28	-0,57	4,67	4,64
7,00	11,47	11,44	-0,23	5,73	5,72
9,00	13,60	13,54	-0,44	6,80	6,77
11,00	15,73	15,70	-0,21	7,87	7,85
13,00	17,87	17,90	0,19	8,93	8,95
15,00	20,00	20,00	0,00	10,00	10,00



IMPORTANT NOTICE FOR MIKROTREND REFERENCE DESIGNS AND APPLICATION INFORMATIONS

Buyers are authorized to use Mikrotrend reference designs with the Mikrotrend component(s) identified in each particular reference design and to modify the reference design in the development of their end products. Applications that are described herein for any of these products are for illustrative purposes only. Mikrotrend make no representation or warranty that such applications will be suitable for the specified use without further testing or modification. Mikrotrend reference designs are solely intended to assist designers ("Buyers") who are developing systems that incorporate Mikrotrend products (also referred to herein as "components"). Buyer understands and agrees that Buyer remains responsible for their products and applications using Mikrotrend components, using its independent analysis, evaluation and judgment in designing Buyer's systems and products. Mikrotrend assumes no liability for applications assistance or the design of Buyers' products.

MIKROTREND REFERENCE DESIGNS ARE PROVIDED "AS IS". MIKROTREND MAKES NO WARRANTIES OR REPRESENTATIONS WITH REGARD TO THE REFERENCE DESIGNS OR USE OF THE REFERENCE DESIGNS, EXPRESS, IMPLIED OR STATUTORY, INCLUDING ACCURACY OR COMPLETENESS.

MIKROTREND DISCLAIMS ANY WARRANTY OF TITLE AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, QUIET ENJOYMENT, QUIET POSSESSION, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS WITH REGARD TO MIKROTREND REFERENCE DESIGNS OR USE THEREOF.

MIKROTREND SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY BUYERS AGAINST ANY THIRD PARTY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON A COMBINATION OF COMPONENTS PROVIDED IN A MIKROTREND REFERENCE DESIGN. IN NO EVENT SHALL MIKROTREND BE LIABLE FOR ANY ACTUAL, SPECIAL, INCIDENTAL, CONSEQUENTIAL OR INDIRECT DAMAGES, HOWEVER CAUSED, ON ANY THEORY OF LIABILITY AND WHETHER OR NOT MIKROTREND HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, ARISING IN ANY WAY OUT OF MIKROTREND REFERENCE DESIGNS OR BUYER'S USE OF MIKROTREND REFERENCE DESIGNS.

Right to make changes

Mikrotrend d.o.o. reserves the right to make changes, without notice, in the products, including circuits, and/or software, described or contained herein in order to improve design and/or performance.

Mikrotrend d.o.o. assumes no responsibility or liability for the use of any of these products, conveys no licence or title under any patent, or copyright to these products, and makes no representations or warranties that these products are free from patent or copyright infringement, unless otherwise specified.

MIKROTREND d.o.o.

4.Bizek 14, 10090 Zagreb, Croatia, e-mail: [info\(at\)mikrotrend.com](mailto:info(at)mikrotrend.com), web: www.mikrotrend.com

All rights reserved. The material contained herein may not be reproduced, adapted, merged, translated, stored, or used without the prior written consent of Mikrotrend d.o.o. (Ltd).