Refrigerant Gas Detectors

for Machinery Rooms, Cold Rooms & Freezer

LKD 500 / 600

Refrigerant Leak Detection

P/N: 0024-9551 | November 2019 Revision F

User Manual

NOTICES

Product improvements and enhancements are on-going, therefore the specifications and information contained in this document may change without notice.

Manufacturer shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

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1. Introduction

1.1 About this Manual

Thank you for investing in a LKD Gas Detector. To ensure operator safety and the proper use of the gas detector, please read the contents of this manual for important information on the operation and maintenance of the instrument.

IMPORTANT: Before installing this product, carefully read and strictly follow the instructions in the manual.

1.2 Iconography

Alert	Icon	Description
DANGER		Imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING		Potentially hazardous situation which, if not avoided, could result in death or serious injury.
WARNING		Potential electrical shock hazard which, if not avoided, could result in death or serious injury.
CAUTION		Potentially hazardous situation which, if not avoided, could result in physical injury or damage to the product or environment. It may also be used to alert against unsafe practices.
IMPORTANT		Additional information on how to use the product.

1.3 General Safety Statements

IMPORTANT: Before using this product, carefully read and strictly follow the instructions in the manual. Ensure that all product documentation is retained and available to anyone operating the instrument.

DANGER: This instrument is neither certified nor approved for operation in oxygen-enriched atmospheres. Failure to comply may result in personal injury or death.

WARNING: Use this product only for the purposes specified in this document and under the conditions listed.

WARNING: This instrument has not been designed to be intrinsically safe for use in areas classified as being hazardous locations. For your safety, DO NOT use it in hazardous (classified) locations.

WARNING: In the event of an alarm or over-range condition, the sensor must be recalibrated to ensure continued accuracy.

WARNING: This product must be recalibrated if installed in a non-room condition environment (i.e. temperature or humidity extremes).

WARNING: The gas diffusion path can become occluded (moisture, dust, debris, frozen condensation) over time resulting in reduced or complete lack of gas detection and alarming function. Routine visual inspection of the gas detector and bump testing are suggested to ensure proper gas detection and alarm function.

CAUTION: Except for maintenance detailed in this manual, these products should only be opened and / or serviced by authorized Bacharach personnel. Failure to comply may void the warrant.

CAUTION: Operator assumes responsibility for complying with all laws, rules and regulations governing the use of this product.

CAUTION: Use only genuine Bacharach parts and accessories. Failure to comply may impair the operation of the product and / or void the warranty.

CAUTION: Only operate the product within the framework of a risk-based alarm signaling concept.

1.4 Product Overview

WARNING: Before connecting this instrument to electrical devices not mentioned in this manual, consult the manufacturer or a qualified professional. Failure to comply may result in injury and / or damage to the product.

2. Product Description

2.1 Intended Uses / Applications

LKD Gas Detection Series instruments continuously monitor ambient air (indoor or outdoor) for the following gas types:

- Refrigerants
- Toxic and combustible gases

The instruments may be purchased in the following configurations:

- LKD 500 - IP66
- LKD 500 - IP41
- LKD 600 - IP66 with Remote IP66 Sensor

LKD gas detectors may be connected to a third-party device capable of accepting digital and/or analog outputs from the gas detectors, such as a Building Management System (BMS), Programmable Logic Controller (PLC) and/or Modbus RTU. With the integrated audio-visual alarm indication, an instrument can be operated as a stand-alone unit (with additional local alarm signaling as required).

WARNING: This instrument is neither certified nor approved for operation in oxygen-enriched atmospheres. Failure to comply may result in EXPLOSION.

WARNING: This instrument has not been designed to be intrinsically safe for use in areas classified as being hazardous locations. For your safety, DO NOT use it in hazardous (classified) locations.

2.2 LKD 500

2.2.1 LKD 500 Product Overview

The LKD continuously monitors indoor or outdoor ambient air for the following gases:

- Refrigerants
- Toxic and combustible gases

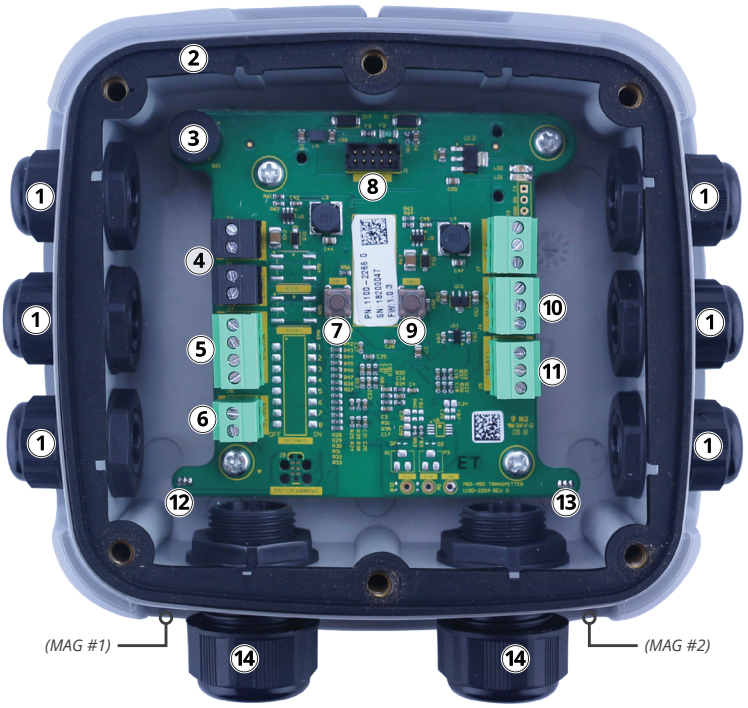
The instruments may be purchased in one of two configurations with or without relays output:

- LKD 500 - IP66
- LKD 500 - IP41

With the integrated Modbus communication, analog output and relays, the instrument can be operated as a stand-alone unit or a third-party device capable of accepting digital and/or analog outputs from the gas detectors, such as a Building Management System (BMS) , a Programmable Logic Controller (PLC) and/or Modbus RTU. The instrument is designed to be installed in non-classified, non-hazardous, permanent locations.

2.2.2 LKD 500 Components

This product uses semiconductors which can be damaged by electrostatic discharge (ESD). When handling the PCB, care must be taken so that the electronics are not damaged.



#	COMPONENT DESCRIPTION	#	COMPONENT DESCRIPTION
1	M16 Cable Glands *(×6)*	**8**	Ribbon Cable Connection *(To Sensor)*
2	Rubber Gasket *(IP66 Version Only)*	**9**	Tactile Switch #2
3	Internal Alarm Buzzer	**10**	Relay 2 Connection *(HIGH)*
4	Power Connections *(×2)*	**11**	Relay 1 Connection *(LOW)*
5	Digital Connection *(Modbus)*	**12**	Magnetic Switch #1
6	Analog Connection	**13**	Magnetic Switch #2
7	Tactile Switch #1	**14**	M20 Cable Glands *(×2)*

2.3 LKD 600

2.3.1 LKD 600 Product Overview

The LKD 600 continuously monitors indoor or outdoor ambient air for the following gases:

- Refrigerants
- Toxic and combustible gases

The instruments may be purchased in one of two configurations with or without relays output:

- IP66 with Remote IP66 Sensor, connected via RJ45 cable (up to 20 meters ?? in length)

With the integrated Modbus communication, analog output and relays, the instrument can be operated as a stand-alone unit or a third-party device capable of accepting digital and/or analog outputs from the gas detectors, such as a Building Management System (BMS), a Programmable Logic Controller (PLC) and/or Modbus RTU. The instrument is designed to be installed in non-classified, non-hazardous, permanent locations.

2.3.2 LKD 600 Design Features

Transmitter options:

2× IP66 rated ABS enclosure connected via RJ45 cable (up to 5 meters in length)

Power options:

24 VAC

19.5 to 28.5 VDC

Diagnostic/status LED (3 color: green, orange and red)

Configurable output signal options:

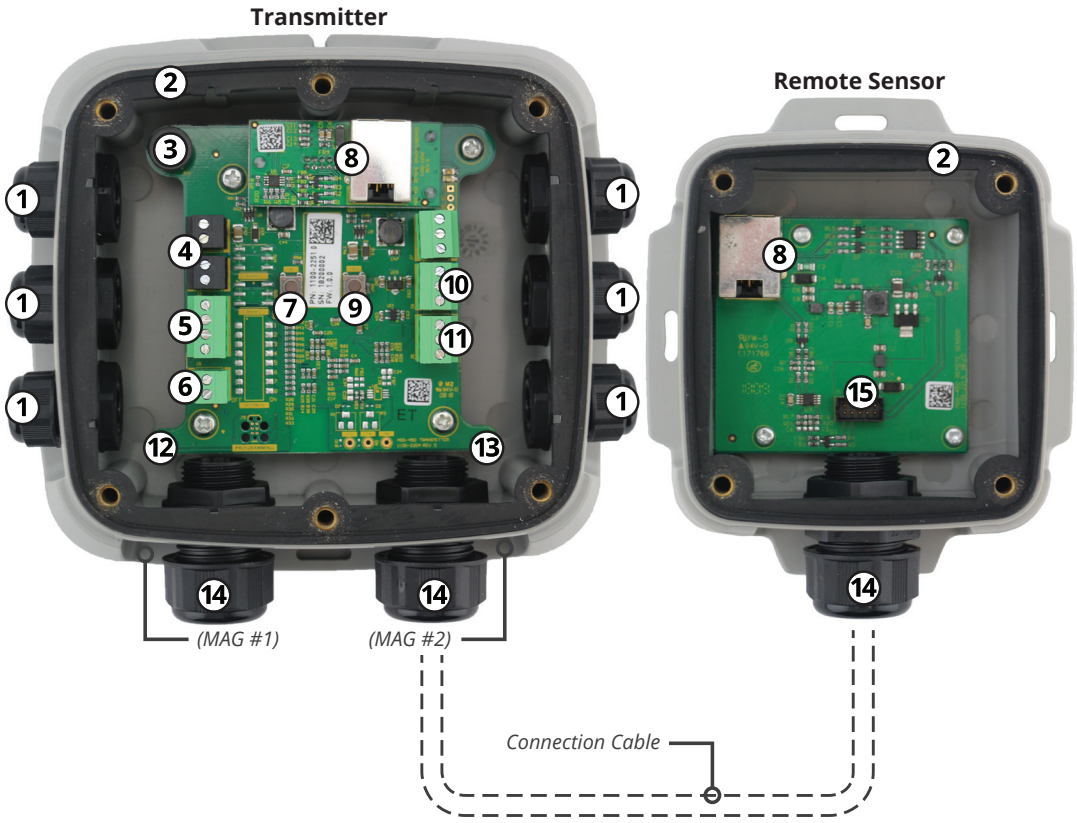
2 x relays as option (high alarm / low alarm / fault)

1× Analog Output (4 to 20 mA, 0 to 5 V, 0 to 10 V, 1 to 5 V, 2 to 10 V)

Digital output Modbus RTU signal

Pre-calibrated sensor exchange modules can be used for maintenance of the instrument instead of performing gas calibration on site.

Non-intrusive magnetic wand can be used to initiate calibration of the device.



#	COMPONENT DESCRIPTION	#	COMPONENT DESCRIPTION
1	M16 Cable Glands *(×6)*	**9**	Tactile Switch #2
2	Rubber Gaskets *(×2)*	**10**	Relay 2 Connection *(HIGH)*
3	Internal Alarm Buzzer	**11**	Relay 1 Connection *(LOW)*
4	Power Connections *(×2)*	**12**	Magnetic Switch #1
5	Digital Connection *(Modbus)*	**13**	Magnetic Switch #2
6	Analog Connection	**14**	M20 Cable Glands *(×2)*
7	Tactile Switch #1	**15**	Ribbon Cable Connection *(To Sensor)*
8	Remote Sensor Connections *(×2)*		

3. Installation

IMPORTANT: The manufacturer of this product requires that a bump test or calibration be performed following installation to verify instrument functionality.

3.1 General Information

Every detail of installation site selection is critical to ensure overall system performance and effectiveness. Strict compliance and considerable thought must be given to every detail of the installation process, including, but not limited to the following:

- **Regulations as well as local, state, and national codes that govern the installation of gas monitoring equipment**
- **Electrical codes that govern the routing and connection of electrical power and signal cables to gas monitoring equipment**
- **The full range of environmental conditions to which the instruments will be exposed**
- **The physical characteristics of the gas or vapor to be detected**
- **The specifics of the application (e.g., possible leaks, air movement/draft, etc.)**
- **The degree of accessibility required for maintenance purposes**
- **The types of optional equipment and accessories that will be used with the system**
- **Any limiting factors or regulations that would affect system performance or installations**
- **Wiring details, including:**
  - The LKD 500 enclosure provides the following cable gland openings:
    2×, M20, supports 10-14mm cable outer diameter
    6×, M16, supports 4-8mm cable outer diameter
  - The LKD 600 enclosure provides the following cable gland openings:
    1×, M20, supports 10-14mm cable outer diameter
    6×, M16, supports 4-8mm cable outer diameter

- Secondary circuit must be supplied from an isolating source
- The wiring for the relays must be selected and fused according to the rated voltages, currents, and environmental conditions
- If stranded conductors are used, a ferrule should be used
- To comply with RFI immunity regulations, it is necessary to ground the shield of the communications cable at the PLC, GDA controller, front-end controller, or Building Management System (e.g., the chassis, the ground bus-bar, etc.).

3.2 Restrictions

The installation location must have appropriate supply power available for the instrument (i.e., 19.5 to 28.5 VDC or 24 VAC). This ultimately determines the distance the instrument can be mounted from the controller or power supply.

3.3 Mechanical Installation

The installation location must have appropriate supply power available for the instrument (i.e., 19.5 to 28.5 VDC or 24 VAC). This ultimately determines the distance the instrument can be mounted from the controller or power supply.

WARNING: DO NOT allow the lid / sensor to hang from the ribbon cable. Failure to comply may result in damage to the product.

Using the provided hardware, securely mount the LKD Gas Detector according to the product dimensions, maximum wiring lengths and following considerations:

- **Environment:** the full range of environmental conditions when selecting a location.
- **Application:** the specifics of the application (possible leaks,air movement / draft, etc.) when selecting a location.
- **Accessibility:** the degree of accessibility required for maintenance purposes when selecting a location.
- **Target Gas:** the specific gravity of the target gas when selecting the height of the instrument.

1. **Using a 5/32"** *(4 mm)* **hex key / allen wrench** *(not included)* **remove the lid and disconnect the ribbon cable from the base.**
2. **Set the lid and rubber gasket** *(IP66 version only)* **aside to be reinstalled later.**

3.4 Electrical Installation

3.4.1 Preparations

WARNING: Ensure wiring for relays and connections for sensor(s) are made before applying power.

CAUTION: This product uses semiconductors which can be damaged by electrostatic discharge (ESD). When handling the printed circuit boards (PCBs), observe proper ESD precautions so that the electronics are not damaged.

3.4.2 Power & Signal Wiring

The product comes with cable glands and plugs pre-installed. The power entry cable gland is without a gland plug. Use the appropriate cable glands to insert and connect the wires for power and signal to the appropriate terminals as indicated in the figure and wiring table that follow. The PCB terminal blocks are pluggable type and may be removed to aid termination.

Polarity must not be reversed.

For 24 VAC installations in a daisy-chain configuration, the neutral polarity must be maintained for all instruments.

Fasten terminal screws.

Connection	Description	Label	Wiring Termination
Power	24 VDC/VAC IN	24V IN: -	24 VDC/VAC neutral / ground
		24V IN: +	24 VAC neutral
	24 VDC/VAC OUT *(power daisy chain terminal)*	24V OUT: -	24 VDC/VAC neutral / ground
		24V OUT: +	24 VAC neutral
Digital Output	Modbus Network Communications	MODBUS: B	RS-485 "B" *(inverted)*
		MODBUS: A	RS-485 "A" *(non-inverted)*
		MODBUS: GND	RS-485 GND
		MODBUS: SH	RS-485 Shield
Analog Output	Voltage or Current	ANALOG: -	Analog output ground
	Output	ANALOG: +	Analog output signal (+)

3.4.3 Relay Wiring

WARNING: Relays are rated for 0 to 24 VAC/DC. DO NOT apply mains power onto these relays.

Using appropriate cable glands, connect the wires for relay 1 and relay 2 to the terminals as indicated in the following wiring table.

Relay	Function
1	Low Alarm
2	High Alarm

When configured according to the factory default settings, the relays are de-energized during normal operation (not fail-safe). Fail-safe mode can be configured. When configured for fail-safe operation, relays are energized during normal operation. Fail-safe operation ensures relays are triggered in cases of power failure at the instrument. In failsafe operation normally open and normally closed terminals are reversed as indicated by the following table

Terminal	Normal Operation	Failsafe Operation
NC	Normally Closed	Normally Closed
COM	Common	Common
NO	Normally Open	Normally Closed

3.4.4 Installation of Remote Sensing Head (LKD 600)

Standard RJ45 “Cat 5E STP” Ethernet cables up to 5 meters long may be used with the remote sensor. The cable provided from the factory is 5 meters long.

IMPORTANT: Before using this product, carefully read and strictly follow the instructions in the manual. Ensure that all product documentation is retained and available to anyone operating the instrument.

Remove the bottom right M20 cable gland plug and gland cap, and carefully remove the gland rubber insert. The rubber insert is split to allow it to be installed around the provided RJ45 cable.

Slip the cable gland nut over one end of the terminated RJ45 cable. Apply the split rubber insert onto the cable so that it is between the gland nut and the end of the cable.

Feed the RJ45 connector through a cable gland and into the enclosure, taking care to not damage the PCB.

Reassemble the cable gland by sliding the rubber insert into the gland body and then tightening the gland nut. Confirm that the RJ45 cable is not binding or stressing the PCB terminal blocks (leave no excess cable inside the enclosure).

Plug the RJ45 connector into the provided RJ45 socket.

IMPORTANT: Before using this product, carefully read and strictly follow the instructions in the manual. Ensure that all product documentation is retained and available to anyone operating the instrument.

3.4.5 Modbus RTU RS-485 Interface

For the Modbus RS-485 network use a 16 to 24 AWG (0.5 to 1 mm2) 3-core, 2 twisted pair + ground, shielded cable with 120 Ω characteristic impedance.

Recommended: Belden 3106A (or equivalent)

The Modbus address, baud rate, stop bit, parity and slave termination is configured through the setup menu. No jumpers or hardware switch settings are required.

Ensure that the communication parameters within the network, including the Building Management System, are configured identically.

To ensure optimal performance of the Modbus network ensure the following guidelines are implemented:

- **Ensure instruments are configured in a single bus topology, connecting multiple buses in parallel or branching multiple units from the main bus, may introduce impedance mismatches, reflections and/or signal distortions**
- **Avoid long stubs when connecting instruments to the bus, stubs should be less than 1 meter in length**
- **Ensure instruments at end of bus have 120Ω terminating resistor enabled. Terminating resistors may be enabled (refer to Section 4.2.3.6 for more information).**
- **Ensure A/B signal polarity is maintained throughout RS-485 network**
- **Connect cable shield drain to physical earth or ground at the controller only.**
- **Connect cable shield drain to (SH) terminal at instrument**
- **Ensure cable shield integrity is maintained throughout RS-485 network.**
- **Do not use shield connection for signal ground. Use cable that provides dedicated ground conductor for signal ground. Connect signal ground to (GND) terminal of instrument.**

3.4.6 Conclusion

After all wiring is completed, power the transmitter and confirm operation, and then prepare to seal the enclosure. Note that the IP 41 configurations do not include a sealing gasket.

Ensure gasket is aligned correctly (IP66 versions only) and tighten the lid using the supplied hardware in an “X” pattern. To achieve proper seal, the lid screws should be torqued to 15 to 20 lbf in (1.5 to 2.0 Nm).

4. Operation

4.1 Overview of Normal Operation

WARNING: Before leaving the instrument for normal operation, check the configuration for proper settings and check calibration.

4.1.1 Applying Power & the Start-up Sequence

After applying power, the instrument will go through a start-up sequence (initialization, audible/visual test and self-test sequence). After start-up sequence completes, the instrument will enter a warm-up period to allow the sensor element to stabilize before reporting a valid output.

Step	Description
1.	Switch power on.
2.	Observe start-up sequence and warm-up phase. · Green LED will blink at 0.5 Hz for about 5 minutes · Modbus flag for warm-up is set · Buzzer is off · Relay state is “no alarm” · Gas reading invalid
3.	Observe normal operation. · Green LED is steady on · Modbus flag for warm-up is cleared · Buzzer is off · Relay state is “no alarm” · Gas reading valid

4.1.2 Verifying Analog Signals

The LKD 500/600 gas detector features a single configurable analog output. During normal operation the analog output of the instrument is proportional to the detected gas concentration and can be selected from the following.

1 to 5 V
0 to 5 V
2 to 10 V
0 to 10V
4 to 20 mA (Default)

The LKD Gas Detector uses different voltage/current values to indicate various modes of operation. In normal operation the relative gas concentration output is indicated by the analogue output level. Output level is proportional to the gas level as shown below:

Gas Concentration	1-5V	0-5V	2-10V	0-10V	4-20mA
0%	1V	0V	2V	0V	4 mA
50%	3V	2.5V	6V	5V	12 mA
100%	5V	5V	10V	10V	20 mA

The instrument may also enter several special states, these are indicated by the specific analogue output levels indicated below:

Mode of operation	1-5V	0-5V	2-10V	0-10V	4-20mA
Instrument Fault	≤ 0.3V	N/A	≤ 0.6V	N/A	≤ 1.2 mA
Offline Mode/ Maintenance	0.75V	N/A	1.5V	N/A	3 mA
Drift below zero	0.95V	N/A	1.9V	N/A	3.8 mA
Normal operation	1-5V	0-5V	2-10V	0-10V	4-20 mA
Measuring range exceeded	5.12V	5.12V	10.25V	10.25V	20.5 mA
Fault on analog interface	> 5.25V	> 5.25V	> 10.5V	> 10.5V	> 21mA

4.1.3 Verifying the Modbus Signal

The LKD Gas Detector provides a Modbus RTU digital interface.

4.1.4 Status Indication

The LKD gas detections provide external indication of its current operational state via audible and visual feedback. Visual indication of the instrument status is provided by a single tri-color LED (Green/Red/Orange).

LKD gas detection instruments, where provided, also provide relays outputs.

Instrument states and corresponding outputs are shown below:

State	LED	Buzzer	Relay 1 (LOW)	Relay 2 (HIGH)
Warm-up			OFF	OFF
Normal			OFF	OFF
Low Alarm			ON	OFF
High Alarm			ON	ON
Offline			OFF	OFF
Fault			OFF	OFF
Negative Gas Fault			OFF	OFF
Zero Cal. Fault			OFF	OFF
Span Cal. Fault			OFF	OFF

4.1.5 Switch Functions

User interaction with the LKD gas detector is accomplished through the use of two magnetic switches located on the bottom of each unit. To actuate a magnetic switch, apply the supplied magnetic wand to the relevant switch location as indicated below :

Switch locations above are referred to in this document as MAG#1 and MAG#2.

Depending on the duration the switch is held, a short “TAP” or long “HOLD” will be detected.

To carry out a tap function, tap the relevant switch location for 1s, until a single “chirp” is heard, remove wand to confirm a “TAP”

To carry out a hold function, do not remove the magnetic wand after the first chirp but continue to hold for >5s, until a double “chirp” is heard, remove wand to confirm a “HOLD”

If either switch is held for >30s, a stuck switch fault will be indicated.

To interact with the instrument without use of the magnetic wand, two internal push button tactile switches may be used. Remove lid without removing ribbon cable to access. Internal switches TACT#1 and TACT#2 mirror the functions of MAG#1 and MAG#2.

The function of each switch depends on the current state of the instrument. Refer to the table on the following page for switch functions in each instrument state.

State	Switch 1 Hold	Switch 2 Hold
Warm-up	-	-
Normal	Start Zero Calibration	Start Span Calibration
Low Alarm	Mute Buzzer	Ack. Latched Alarm
High Alarm	Mute Buzzer	Ack. Latched Alarm
Offline	-	-
Fault	Mute Buzzer	Ack. Latched Alarm
Negative Gas Fault	Mute Buzzer	Start Zero Calibration
Zero Cal. Fault	Acknowledge Fault	-
Span Cal. Fault	-	Acknowledge Fault

4.1.6 Reset System to Factory Default Settings

To reset system to factory defaults, remove lid and hold TACT#1 and TACT#2 simultaneously for 30s. Instrument will restart to confirm factory reset.

5. Care & Maintenance

5.1 Overview of Normal Operation

Interval	Function
During Commissioning	Check calibration.
	Check LEDs for proper operation.
	Check for proper buzzer and relay operation.*
	Check signal transmission to the BMS/BAS (central controller) if connected.*
Every 6-12 Months**	Inspection by trained service personnel.
	Check LEDs for proper operation.*
	Check for proper buzzer and relay operation.*
	Check signal transmission to the BMS/BAS (central controller) if connected.*
	Calibrate the sensor change the sensor with A factory- calibrated sensor one
As Required	Replace sensor module(s)

* These can be activated via Modbus commands.
** Typical maintenance frequency can vary by sensor type.

WARNING: Electrochemical and semiconductor sensors should be checked after exposure to significant concentrations of gas, which can shorten the sensor lifetime and/or reduce its sensitivity.

Sensor Type	Recommended Maintenance Interval	Typical Sensor Lifetime
Electrochemical	12 months	2-3 years
Catalytic Bead	Zero calibration -1-3 months Span calibration - 6 months	5-7 years
Semiconductor	6 months after commissioning 12 months thereafter	4-6 years
Infrared	12 months	5-7 years

5.2 Adjustments

5.2.1 Introduction

Adjustment of the detector must be performed at regular intervals as required by national standards or regulations (e.g., EN 378, ASHRAE 15, BREEAM, etc.).

Breathing Hazard: Calibration gas MUST NOT be inhaled! See appropriate Safety Data Sheets. Calibration gas should be vented into a fume hood or to the outside of the building.

Zero First, Then Span: For proper operation, never adjust the span before completing a zero adjustment. Performing these operations out of order will cause faulty calibration.

IMPORTANT: Manufacturer recommends calibrating detectors within the application-specific condition and with target gas. This method of zeroing the detector in the application environment and performing a target gas calibration is more accurate. A surrogate gas calibration may only be performed as an alternative if a target gas calibration is not possible.

IMPORTANT: The sensor should be fully stabilized (at least 2 hours, preferably 24 hours).

IMPORTANT: When entering the functions for zero or span adjustment, the detector will automatically enter OFFLINE mode, and will remain OFFLINE until either the OFFLINE mode is canceled by tapping the respective magnetic switch, or the OFFLINE mode times out within 6 minutes (typical) after the adjustment has ended.

5.2.2 General Calibration Procedure

WARNING: The LKD Gas Detector MAY NOT be in an alarm or fault condition during calibration. Acknowledge any alarms or faults BEFORE attempting to begin the calibration process.

WARNING: Except for CO_2 sensors, calibration gas must be in a balance of air, not nitrogen (N_2).

IMPORTANT: Calibration and / or bump testing requires the LKD calibration adapter kit (P/N: LKD00ADAPTER0).

IMPORTANT: At elevations higher than 6,560’ (2,000 m), calibration will result in a lower reading. Above 6,560’, the instrument should be calibrated in the environment of operation.

1. Fit calibration adapter to the gas detector lid.
2. If using a variable flow regulator, adjust the gas flow to approximately 0.3 L/min.

5.2.3 Zero Adjustment

Ambient air can be used to zero the sensor instead of synthetic air only if the area is known to be free of the target gas or any gas to which the sensor may be cross-sensitive. In this case, no cylinder or calibration adapter is needed for the zero adjustment.

WARNING: The LKD MAY NOT be in an alarm or fault condition during calibration. Acknowledge any alarms or faults BEFORE attempting to begin the calibration process.

WARNING: Except for CO_2 sensors, ambient air may be used instead of zero gas if the area is know to be free of the target gas or any gases to which the sensor may be cross-sensitive.

IMPORTANT: Calibration and / or bump testing requires the calibration adapter kit (P/N:LKD00ADAPTER0).

1. **Begin zero adjustment:**
   Hold MAG#1 for >5-seconds. The LED will blink green-green-red when the instrument is ready.

2. **Apply zero gas (or ambient air per warning above).**

3. **Confirm the start of calibration:**
   Tap MAG#1 within 30-seconds or the instrument will time-out and return to normal operation.

4. **Complete zero adjustment:**
   The LED will blink green-red, green-red-red, green-red-red-red, etc. until calibration is complete. To abort, hold MAG#1 for >5-seconds, turn off gas flow and remove the calibration adapter. If calibration is successful (green LED), proceed to Step 5. If calibration is unsuccessful (LED blinks orange @ 2 Hz), tap MAG#1 to discard the calibration attempt.

5. **Turn off gas flow from zero gas.**

6. **Replace zero gas with calibration gas in preparation for span adjustment.**

5.2.4 Span Adjustment

WARNING: Except for CO_2 sensors, calibration gas must be in a balance of air, not nitrogen (N_2).

IMPORTANT: At elevations higher than 6,560' (2,000 m), calibration will result in a lower reading. Above 6,560', the instrument should be calibrated in the environment of operation.

1. **Begin span adjustment:**

   Hold MAG#2 for >5-seconds. The LED will blink green-green-orange when the instrument is ready.

2. **Apply calibration gas at the concentration listed on the calibration gas concentration label (located on top of the instrument).**

   Part Number

   Serial Number

   Sensor Type

   Maximum Range

3. **Confirm the start of calibration:**

   Tap MAG#2 within 30-seconds or the instrument will time-out and return to normal operation.

4. **Complete zero adjustment:**

The LED will blink green-orange, green-orange-orange, green-orange-orange-orange, etc. until calibration is complete. To abort, hold MAG#2 for >5-seconds, turn off gas flow and remove the calibration adapter. If calibration is successful (LED blinks green-orange-red), proceed to Step 5. If calibration is unsuccessful (LED blinks orange @ 2 Hz), tap MAG#2 to discard the calibration attempt.

5. **Turn off gas flow from calibration gas and remove the calibration adapter.**

6. **Allow sensor to recover / stabilize before the instrument returns to normal operation (green LED).**

5.2.5 System Bump Test

A bump test is a live test of the system to verify that the detector responds to gas and all connected alarm devices, BMS, etc. are operating accordingly. It is recommended that all involved persons are informed about the test and certain alarms might have to be inhibited *(e.g., shutdown valves, notification of authorities, etc.)*.

IMPORTANT: The manufacturer of this product requires that a bump test or calibration be performed following installation to verify instrument functionality.

1. **Connect adapter and gas cylinder according to the instructions in the General Calibration Procedure.**

2. **If desired, disable / silence external annunciators (e.g., shutdown valves, notification of authorities, etc.):**

   Inform building personnel of test so that external devices can be disabled / silenced.

3. **Apply a sufficiently high concentration of the target gas to trigger alarms, but NOT pure refrigerant or hydrocarbons (e.g., do not use a butane lighter).**

4. **Once thresholds have been exceeded, relays should activate, digital outputs should transmit the gas concentration and:**

   LED status should display "LOW ALARM" or "HIGH ALARM."

5. **Turn off gas flow and remove the calibration adapter.**

6. **Allow sensor to recover / stabilize before the instrument returns to normal operation (green LED).**

5.3 Troubleshooting

5.3.1 Hexadecimal Format

All fault codes can be retrieved through the Modbus interface and are shown in hexadecimal (hex) format. A hex digit can represent multiple codes as shown below.

Hex Code	Equivalent Error Code(s)	Hex Code	Equivalent Error Code(s)	Hex Code	Equivalent Error Code(s)	Hex Code	Equivalent Error Code(s)
0	0	4	4	8	8	C	4 + 8
1	1	5	1 + 4	9	1 + 8	D	1 + 4 + 8
2	2	6	1 + 2 + 3	A	2 + 8	E	2 + 4 + 8
3	1 + 2	7	1 + 2 + 4	B	1 + 2 + 8	F	1 + 2 + 4 + 8

5.3.2 Fault Codes

IMPORTANT: If a sensor fault occurs during a gas alarm condition, then the fault overrides the alarm condition.

Sensor faults may be decoded using the following table. Note that several faults may be reported at the same time For example, fault code “00000003” is a combination of fault codes 00000001 (No sensor signal) and 00000002 (Voltage out of specification 1V).

IMPORTANT: If a “last fault” attribute indicates that a fault has occurred at some point in time, but the corresponding “current fault” attribute shows no fault, then the problem has self-healed and no service action is required.

Fault Bit	System Fault	Possible Causes	Required Action(s)
0x00000001	Software fault	Firmware error (e.g. unexpected state)	Power-cycle. If it re-occurs then call service
0x00000002	Voltage out of specification 1V	Voltage rail out of range	Call service
0x00000004	Voltage out of specification 3.3V	Voltage rail out of range	Call service
0x00000008	Voltage out of specification 5V	Voltage rail out of range	Call service
0x00000010	Voltage out of specification 5.4V	Voltage rail out of range	Call service
0x00000020	Voltage out of specification 12V	Voltage rail out of range	Call service
0x00000040	Voltage out of specification VIN	Voltage rail out of range	Call service
0x00000080	System Flash Memory Read Fault	Error reading from internal Flash	Power-cycle. If it re-occurs then call service
0x00000100	System Flash Memory Write Fault	Error writing to internal Flash	Power-cycle. If it re-occurs then call service
0x00000200	System Flash Memory CRC fault	Error in internal Flash CRC	Power-cycle. If it re-occurs then call service
0x00000400	System Invalid Configuration	Error in system configuration	Power-cycle. If it re-occurs then call service
0x00000800	GPIO fault	Error detected on GPIO pin	Call service
0x00001000	Modbus Fault	Error detected in Modbus Communications	Power-cycle. If it re-occurs then call service
0x00002000	Analog Output Fault (LKD 500 Only)	Error updating DAC value	Power-cycle. If it re-occurs then call service
0x00008000	Stuck switch	Magnetic and/or Tactile switch activated for > 1 minute	Call service
0x00010000	Sensor Element Out	Cannot detect sensor element	Check sensor connection
0x00020000	Sensor Element Fault	Fault detected in sensor element	Replace Sensor Module
0x00040000	Sensor ADC Sensor Read	Cannot read from sensor ADC	Check sensor connection/ Replace Check sensor
0x00080000	Sensor ADC Current Read Fault	Cannot read from current ADC	Check sensor connection/ Replace Sensor Module

0x00100000	Sensor AFE Read Fault (EC only)	Cannot read from EC sensor AFE	Check sensor connection/ Replace Sensor Module
0x00200000	Sensor AFE Read Fault (EC only)	Cannot read from EC sensor AFE	Check sensor connection/ Replace Sensor Module
0x00400000	Sensor AFE Read Fault (EC only)	Cannot read from EC sensor AFE	Check sensor connection/ Replace Sensor Module
0x00800000	Sensor EEPROM Read Fault	Error in reading from sensor EEPROM	Power-cycle/Check sensor connection/Replace Sensor Module
0x01000000	Sensor EEPROM Write Fault	Error in writing to sensor EEPROM	Call service
0x02000000	Sensor EEPROM CRC Fault	Error in CRC from sensor EEPROM	Power-cycle/Replace Sensor Module
0x04000000	Sensor EEPROM Configuration Fault	Error in sensor EEPROM data	Replace Sensor Module
0x08000000	Sensor UART Read Fault	Cannot read from sensor	Check sensor connection/Replace Sensor Module
0x10000000	Sensor Temperature Fault	Temperature cannot be read or is out of specification	Ensure Sensor is operating within specified temperature range/Check
0x20000000	Negative Gas Concentration Fault	Sensor output has drifted too negative	Initiate Zero calibration (Via App/Hold MAG#2)
0x40000000	Zero Calibration failure	Zero calibration failed	Acknowledge failed calibration (Via App/Hold MAG#1)
0x80000000	Span Calibration failure	Span calibration failed	Acknowledge failed calibration (Via App/Hold MAG#2)

5.4 Sensor Maintenance

5.4.1 Replacing the Sensor Module

CAUTION: This product uses semiconductors which can be damaged by electrostatic discharge (ESD). When handling the PCB, care must be taken so that the electronics is not damaged.

To replace the gas detector's sensor module:

1. Power-down the gas detector.
2. Using a 5/32" (4mm) hex key / allen wrench (not included), remove the lid and disconnect the ribbon cable from the sensor module.
3. Remove installed sensor module from lid by holding onto the housing and turning counter-clockwise 90°. Take care not to apply excessive force to the sensor module's circuit board. When the square tab of the sensor housing is aligned with the lock icon, firmly pull the module to remove it from the housing.
4. Install the new sensor module by aligning the square tab with the lock icon before firmly pressing it into the enclosure. Taking care not to apply excessive force to the sensor module's circuit board, rotate the sensor module clockwise 90° (or until the triangle icon aligns with the lock icon on the lid).
5. Connect the ribbon cable (to the sensor module and transmitter) and close the lid.
6. Ensure gasket is aligned correctly (IP66 versions only) and tighten the lid using the supplied hardware in an "X" pattern. To achieve proper seal, the lid screws should be torqued to 15 to 20 lbf in (1.5 to 2.0 Nm).
7. Power-up the gas detector.
8. After start-up sequence has finished, check sensor response (bump test).

5.5 Cleaning the Instrument

Clean the detector with a soft cloth using water and a mild detergent. Rinse with water. Do not use any alcohols, cleaning agents, sprays, polishes, detergents, etc.

6. Additional Information

6.1 Sensor Principle

6.1.1 Electrochemical Sensors

Electrochemical sensors measure the partial pressure of gases under atmospheric conditions. The monitored ambient air diffuses through a membrane into the liquid electrolyte in the sensor. The electrolyte contains a measuring electrode, a counter-electrode and a reference electrode. An electronic "potentiostat" circuit ensures a constant electrical voltage between measuring electrode and reference electrode. Voltage, electrolyte, and electrode material are selected to suit the gas being monitored so that it is transformed electrochemically on the measuring electrode and a current flows through the sensor. This current is proportional to the gas concentration. At the same time, oxygen from the ambient air reacts at the counter electrode electrochemically. The current flowing through the sensor is amplified electronically, digitized and corrected for several parameters (e.g., the ambient temperature).

6.1.2 Catalytic Bead Sensors

A catalytic bead sensor measures the partial pressure of combustible gases and vapors in ambient air. It uses the heat-of-combustion principle.

The monitored air diffuses through the sintered metal disc into the sensor. The mixture of combustible gases, vapors, and air are catalytically combusted at a heated detector element (called a pellistor). The oxygen content in the air must be greater than 12 Vol%. Due to the resulting heat-of-combustion, the temperature of the detector element rises. This increase in temperature causes a change of resistance in the detector element, which is proportional to the concentration of the mixture of combustible gases and vapors in the monitored air. In addition to the catalytically active detector element, there is a compensator element. Both elements are parts of a Wheatstone bridge. Thus environmental effects like changes in ambient temperature or humidity are almost entirely compensated.

IMPORTANT: Certain substances in the atmosphere to be monitored may impair the sensitivity of the sensors. Such substances include, but are not limited to:

1. Polymerizing substances such as acrylonitrile, butadiene and styrene,

2. Corrosive compounds such as halogenated hydrocarbons (releasing halogens such as bromine, chlorine or fluorine when oxidized) and halogen hydride acids as well as acidic gaseous compounds such as sulfur dioxide and nitrogen oxides, Catalyst poisons such as sulfurous and phosphorous compounds, silicon compounds (especially silicones), and metal-organic vapors.

It may be necessary to check the calibration if the sensor has been exposed for a long time to a high concentration of flammable gases, vapors, or the above-mentioned contaminating substances.

The nature of catalytic bead sensor technology means that sensor drift may typically be up to ±5% LEL per month. Instruments using these sensors should be zeroed regularly following the instructions in section 5 of this manual.

6.1.3 Semiconductor Sensors

Semiconductor or metallic oxide sensors (MOSs) are among the most versatile of all broad-range sensors. They can be used to detect a variety of gases and vapors in low ppm or even combustible ranges. The sensor is made up of a mixture of metallic oxides. They are heated to a temperature between 150º and 300º C depending on the gas(es) to be detected. The temperature of operation

as well as the "recipe" of mixed oxides determines the sensor selectivity to various toxic gases, vapors, and refrigerants. Electrical conductivity greatly increases as soon as a diffusion process allows the gas or vapor molecules to come in contact with the sensor surface. Water vapor, high ambient humidity, temperature fluctuations, and low oxygen levels can result in higher readings.

IMPORTANT: Certain substances in the environment to be monitored may impair the sensitivity of the sensors:

1. Materials containing silicone or silicone rubber/putty

2. Corrosive gases such as hydrogen sulfide, sulfur oxide, chlorine, hydrogen chloride, etc.

3. Alkaline metals, salt water spray.

6.1.4 Infrared Sensors

The infrared (IR) gas sensor is designed to measure the concentration of combustible gases and vapors in the ambient air. The sensor principle is based on the concentration-dependent absorption of infrared radiation in measured gases.

The monitored ambient air diffuses through a sintered metal material into the enclosure of an optical "bench". The broadband light emitted by an IR source passes through the gas in the optical bench and is reflected by the walls from where it is directed towards a dual-element detector. One channel of the detector measures the gas-dependent light transmission, while the other channel is used as a reference. The ratio between measurement and reference signal is used to determine the gas concentration. Internal electronics and software calculate the concentration and produce an output signal.

6.2 Disposing of the Instrument

6.2.1 Disposing of the Electrical & Electronic Equipment

EU-wide regulations governing the disposal of electrical and electronic appliances which have been defined in the EU Directive 2012/19/EU and in national laws have been effective since August 2012 and apply to this device.

Common household appliances can be disposed of using special collecting and recycling facilities. However, this device has not been registered for household usage. Therefore it must not be disposed of through these channels. The device can be returned to your national Bacharach Sales Organization for disposal. Please do not hesitate to contact Bacharach if you have any further questions on this issue.

6.2.2 Disposing of Sensors

Dispose of sensors in accordance with local laws.

DANGER: Do not dispose of sensors in fire due to the risk of explosion and resulting chemical burns.

WARNING: Do not force open electrochemical sensors

WARNING: Observe the applicable local waste disposal regulations. For information, consult your local environmental agency, local government offices or appropriate waste disposal companies.

6.3 Technical Specifications

6.3.1 General Specifications

Category	Specifications	
Signals to Central Controller	Analog Current	Normal operation: 4 to 20 mA Drift below zero: 3.8 mA Measuring range exceeded: 20.5 mA Instrument fault: ≤ 1.2 mA Fault on analog interface: > 21 mA Offline mode/Maintenance signal: 3 mA steady signal
	Analog Voltage	0 to 5 V; 1 to 5 V; 0 to 10 V; 2 to 10 V (selectable) During fault condition, 1 to 5 V and 2 to 10 V outputs are 0 V
	Modbus RTU over RS-485	Baud rate: 9,600 or 19,200 (selectable) Start bits: 1 Data bits: 8 Parity: Even (default), Odd or None Stop bits: 1 or 2 (selectable) Retry time: 500 ms, min time between retries End of message: Silent 3.5 characters
Power Supply and Relays	Operating voltage	19.5 to 28.5 VDC; 24 VAC ± 20%, 50/60 Hz
	Inrush current	1.5 A
	Operating current, max.	4W, 170mA @ 24VDC
	Relay rating	2 SPDT 1 A at 24 VAC/VDC, resistive load
	Audible alarm	Internal Buzzer ≥72 dB at 4” (10 cm)
	Alarm delay	0 to 15 minutes (selectable)

Wiring	Power and analog signal	2-core shielded cable, 16 to 20 AWG (0.5 to 1.5 mm^2)
	Modbus network	3-core, 2 twisted pair + ground, shielded cable with 120 Ω characteristic impedance, 16 to 24 AWG (0.5 to 1.5 mm^2).
	Cable gland	M20, 10-14mm cable outer diameter M16, 4-8mm cable outer diameter
Physical Specifications	Enclosure protection	IP41 / IP66
	Enclosure Size (W×H×D) (Approx.)	LKD 500 IP41: 6.5× 6.5×3.0” (165×165×77 mm) LKD 500 IP66: 6.5×6.5×3.4” (165×165×87 mm) LKD 600: 6.5×6.5×3.4” (165×165×87 mm) LKD 600 Remote: 4.5× 5.4×2.7” (115×136×68 mm)
	Weight (Approx.)	LKD 500: 1lb, 1oz (480 g) LKD 600: 1lb, 11.7oz (758 g)
Environmental	Temperature	- 40 to 120 ºF (-40 to 50 ºC)
	Storage temperature	- 5 to 100 ºF (-20 to 40 ºC)
	Humidity	5 to 90 %RH, non-condensing (15 to 90 %RH, non-condensing, EC sensors
	Pressure	23.6 to 32.5 inch Hg / 800 to 1,100 mbar
	Elevation	0 to 10,000 ft. (3,050 m) altitude
	Sensors	See Section 6.3.2 for sensor specifications.
	Influences	For influences on the measurement performance and restrictions of a particular sensor see sensor data sheet.
Agency Approvals	CE, EN 50270:2015	
Company Certifications		

6.3.2 Sensor Specifications

Sensor Information	Electro-Chemical (EC)	Semi-Conductor (SC)	Catalytic Bead (CAT)	Infrared (IR)
Sensor Life (Typical)	2 to 3 years	5 to 8 years	5 years	5 years
Temperature Range	NH3 100 / 1,000 ppm: -40 to 40° C NH3 5,000 ppm: -20 to 40° C CO 500 ppm: -40 to 50° C	-40º to 50º C	-40º to 50º C	-40º to 50º C
	NH3 100 / 1,000 ppm: -40 to 104° F NH3 5,000 ppm: -4 to 104° F CO 500 ppm: -40 to 122° F	-40º to 122º F	-40º to 122º F	-40º to 122º F

EC Sensors	Formula	Measuring Range(s)
Ammonia	NH_3	0 to 100, 0 to 1,000, 0 to 5,000 ppm
Carbon Monoxide	CO	0 to 1,000 ppm
Nitrogen Dioxide	NO_2	0 to 20 ppm

6.4 Modbus Registers

IMPORTANT: If items span two registers (e.g., 1005 and 1006), then the registers are "long" or "float" data types. Otherwise, the registers are integer data types or ASCII.

Not all registers are immediately accessible and required "Supervisor Mode". Supervisor mode is activated through the diagnostics commands.

6.4.1 Integration - Dynamic Sensor Data

1094	Signed Raw Gas Concentration (PPM/PPB/VOL/LEL)	Signed Raw Gas Concentration PPM or % VOL or % LEL - no thresholding; used for zero-calibration to see negative values	32-bit signed Integer
1095			
1096	Signed Raw Gas Concentration (PPM)	Signed Raw Gas Concentration PPM or % VOL or % LEL - no thresholding; used for zero-calibration to see negative values	32-bit float
1097			
1098	Sensor Uptime	Hours since last restart	16-bit unsigned Integer
1099	Offline Mode Status	Offline mode status	
1100	Concentration % FS (0-100)	Gas concentration in % full-scale	
1101	Concentration (PPM/PPB/VOL/LEL)	Concentration in display units	

1102	Concentration PPM	Signed Raw Gas Concentration PPM or % VOL or % LEL - no thresholding; used for zero-calibration to see negative values	32-bit signed Integer
1103			
1104	Sensor Burning Hours	Hours since last calibration	16-bit unsigned Integer
1105	PPM Hours	Accumulated PPM Hours since sensor manufacture (100ppm for 2 hours = 200ppm hours)	32-bit unsigned Integer
1106			
1107	Temperature (°C)	Current sensor temperature sensor reading (°C)	16-bit signed Integer
1108	Fault Code	Bit packed sensor fault flags currently active (see faults sheet for details of flags)	32-bit unsigned Integer
1109			
1110	Last Sensor Fault Code	Sticky faults as above but fault bits remain set after clearing to catch transient faults	16-bit unsigned Integer
1111	Last System Fault Code	Sticky faults as above but fault bits remain set after clearing to catch transient faults	
1112	Calibration Expired Flag	Calibration expired flag, when set sensor needs recalibration	Boolean
1113	Sensor Startup Flag	Set if sensor is still in warm-up stabilization period	
1114	Low Alarm Flag	Set if low alarm is active	
1115	High Alarm Flag	Set if high alarm is active	
1116	Fault Flag	Set if any fault flag is active	
1117	Sensor Saturation Flag	Set if gas concentration exceeds full-scale range	
1118	Sensor Underflow Flag	Set if gas concentration falls below zero	

1119	Auto Cal Zero Time Remaining	Seconds remaining in auto zero calibration procedure	Unsigned Integer
1120	Auto Cal Span Time Remaining	Seconds remaining in auto span calibration procedure	
1121	Auto Cal Recovery Time Remaining	Seconds remaining in span recovery	
1122	Maximum Temperature Reported (°C)	Maximum Temperature reported by sensor Temperature sensor	Signed Integer
1123	Maximum Gas Concentration Reported (%FS)	Maximum Gas Concentration reported by sensor	Unsigned Integer

6.4.2 Integration - Static Sensor Data

1124	Sensor Type Code	Type code of connected sensor module	16-bit Unsigned Integer
1125	Display units sensor (PPM / PPB / VOL / LEL)	Indication of connected sensor gas concentration unit (ppm=1 , ppb =2, vol=3, lel=4) VOL/LEL scale x10 i.e. 123 = 12.3%	
1126	Full-scale (PPM / PPB / VOL / LEL)	Full-scale in display units	
1127	Local Low Alarm Set point (PPM / PPB / VOL / LEL)	Low Alarm in display units (alias of 2106)	
1128	Local High Alarm Set point (PPM / PPB / VOL / LEL)	High Alarm in display units (alias of 2107)	
1129	Calibration Gas Concentration (PPM / PPB / VOL / LEL)	Sensor Calibration gas concentration in display units	
1130	Sensor Squelch, Unit dependent	Value below which gas concentration reads zero to suppress low level noise	
1131	Low Alarm Behavior	Low Alarm Behavior Flag, Sensor. 0 => alarm triggered when gas above alarm level; 1 => alarm triggered when gas below alarm level	Boolean

1132	Sensor cal gas lower limit	Sensor calibration gas lower limit in display units	16-bit Unsigned Integer
1133	Sensor cal gas upper limit	Sensor calibration gas upper limit in display units	
1134	Sensor Low Alarm Limit	Sensor Low Alarm Limit in display units. (The minimum which the level low alarm set point may be set.)	
1135	% LEL to PPM Conversion Factor	%LEL to PPM conversion scaled x 10 (e.g. 44 for gas with 4.4% LEL)	
1136	Gas Type Text Char 1,2	Gas Type Characters 1 & 2 (10 character gas string = "XXXXXXXXXX")	
1137	Gas Type Text Char 3,4	Gas Type Characters 3 & 4 (10 character gas string = "XXXXXXXXXX")	
1138	Gas Type Text Char 5,6	Gas Type Characters 5 & 6 (10 character gas string = "XXXXXXXXXX")	
1139	Gas Type Text Char 7,8	Gas Type Characters 7 & 8 (10 character gas string = "XXXXXXXXXX")	
1140	Gas Type Text Char 9,10	Gas Type Characters 9 & 10 (10 character gas string = "XXXXXXXXXX")	
1141	Sensor Module SID Char 1,2	SID Characters 1 & 2 (8 character UID string = "XXXXXXXX")	
1142	Sensor Module SID Char 3,4	SID Characters 3 & 4 (8 character UID string = "XXXXXXXX")	
1143	Sensor Module SID Char 5,6	SID Characters 5 & 6 (8 character UID string = "XXXXXXXX")	
1144	Sensor Module SID Char 7,8	SID Characters 7 & 8 (8 character UID string = "XXXXXXXX")	

1145	Sensor Controller UID Char 1,2	UID Characters 1 & 2 (8 character UID string = "XXXXXXXX")	16-bit Unsigned Integer
1146	Sensor Controller UID Char 3,4	UID Characters 3 & 4 (8 character UID string = "XXXXXXXX")	
1147	Sensor Controller UID Char 5,6	UID Characters 5 & 6 (8 character UID string = "XXXXXXXX")	
1148	Sensor Controller UID Char 7,8	UID Characters 7 & 8 (8 character UID string = "XXXXXXXX")	
1149	Alias Text Char 1,2	Alias Characters (16 character alias string = "XXXXXXXXXXXXXXXX")	
1150	Alias Text Char 3,4		
1151	Alias Text Char 5,6		
1152	Alias Text Char 7,8		
1153	Alias Text Char 9,10		
1154	Alias Text Char 11,12		
1155	Alias Text Char 13,14		
1156	Alias Text Char 15,16		
1157	Software Version Sensor Major	Major software version level (XX in firmware XX.YY.ZZ format)	
1158	Software Version Sensor Minor	Minor software version level (YY in firmware XX.YY.ZZ format)	
1159	Software Version Sensor Bug fix	Bug fix software version level (ZZ in firmware XX.YY.ZZ format)	
1160	Temperature Lower Limit (°C)	Set Temperature Fault flag when Temp < Temperature Lower Limit	16-bit Signed Integer
1161	Temperature Upper Limit (°C)	Set Temperature Fault flag when Temp > Temperature Upper Limit	

6.4.3 Integration - General System Setup

Holding Register (Function 03/06 Read / Write)

2100	Parameter Unlock	Writing the correct unlock code allows an external controller to change system parameters (0000-9999)	16-bit Unsigned Integer
2101	RS-485 Node Address	Modbus address 1-247 (if hardware override - write exception / read Modbus switch state)	
2102	Baud Rate	0 = 9600 Baud; 1 = 19200 Baud (if hardware override - write exception / read dip8)	Boolean
2103	Stop Bits	Stop bits = 1 or 2	16-bit Unsigned Integer
2104	Parity	0 = None, 1 = Odd, 2 = Even	
2105	Enable 120ohm Termination	0 = No termination, 1 = termination enabled	Boolean
2106	Sensor Low Alarm (PPM/PPB/ VOL/LEL)	Low gas alarm in display units (Local Alarm set points stored on controller, override sensor values)	16-bit Unsigned Integer
2107	Sensor High Alarm (PPM/PPB/ VOL/LEL)	High gas alarm in display units (Local Alarm set points stored on controller, override sensor values)	
2108	Analog output Range	Set voltage output (0=1-5V, 1=0-5V, 2=0-10V, 3=4-20mA, 4=2-10V) (if hardware override - write exception / read dip 2&3)	
2109	Analog output Zero Adjust	Sets Analog output zero offset to allow output calibration (in DAC codes)	
2110	Analog output Span Adjust	Sets Analog output scaling factor to allow output calibration (in % scaled by x10 ie 123 = 12.3%)	

2111	Buzzer disable	0 = Buzzer normal operation, 1 = Buzzer disabled (if hardware override - write exception / read dip 4)	Boolean
2112	Relay Contact Behavior / Failsafe	0 = NO relay, 1 = Failsafe relay (if hardware override - write exception / read dip 5)	
2113	Alarm Latching Behavior	0 = Alarms automatically reset, 1 = Alarms must be acknowledged (if hardware override - write exception / read dip 6)	
2114	Alarm ON Delay (0-900) seconds	Alarm on delay in seconds Range (0-900 secs), i.e. (0-15 mins). (if hardware override - write exception/ read dip 7)	16-bit Unsigned Integer
2115	Alias Text Char 1,2	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2116	Alias Text Char 3,4	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2117	Alias Text Char 5,6	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2118	Alias Text Char 7,8	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2119	Alias Text Char 9,10	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2120	Alias Text Char 11,12	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2121	Alias Text Char 13,14	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2122	Alias Text Char 15,16	Alias Characters (16 char alias string = "XXXXXXXXXXXXXXXX")	
2123	Unlock code	4-digit code used to unlock user settings (0000-9999), numeric, can only be read/written if system is already unlocked	16-bit Unsigned Integer

2124	Bluetooth Passkey	6-digit Bluetooth passkey (000000-999999), numeric, can only be read/written if system is unlocked, requires power cycle to take effect	32-bit Unsigned Integer
2125			

6.4.4 Integration – Calibration

Holding Register (Function 03/06 Read / Write)

2200	Sensor Calibration gas applied (PPM/PPB/VOL/LEL)	Concentration of calibration gas applied during calibration (must be set before calibration if using gas != sensor nominal) set to sensor nominal on reset	16-bit Unsigned Integer

6.4.5 Integration - User Debug Tools

Holding Register (Function 03/06 Read / Write)

2800	Offline Mode	Setting this flag places the unit into offline mode. When offline the unit will not respond to gas events or generate alarm conditions. The flag will remain asserted for the duration of offline mode. Offline mode will end after 30 minutes or by clearing this flag.	Boolean
2801	Manual override Enable	Override external outputs to test system functionality. Time out after 30 minutes	
2802	Relay 1 state (Low Alarm)	Set state of relay 1 (1 = energized)	
2803	Relay 2 state (High Alarm)	Set state of relay 1 (1 = energized)	
2804	Relay 3 state (Fault)	Set state of relay 1 (1 = energized)	
2805	Buzzer state	Set state of buzzer (1 = active)	
2806	Green LED State	Set state of Green LED (1 = on)	
2807	Red LED State	Set state of Red LED (1 = on)	

2808	Analog Output Value	Set value of analog output in % full-scale (0% to 100%)	16-bit Signed Integer
2809	Analog Output Value State	Set value control state of analog output (0=Manual, 1= Fault, 2 = Offline, 3 = Underflow, 4= Overflow , 5=PPM)	16-bit Unsigned Integer

6.4.6 LKD Compatibility - Status Flags

Read Input Status (Function 02 Read)

3000	Alarm flag (0 or 1 = alarm) for Any Alarm	Set if low or high alarm state	Boolean
3001	Relay state (0 or 1=energized) for any Relay	Set if any relay is active (follows relay logical state not physical if failsafe is active)	
3002	Sensor fault (0 or 1 = fault) for Any Sensor or System Fault	Set if any fault flag is active	
3003	Red LED state (0 or 1=Red LED On)	Set if Red LED is on	
3004	Green LED state (0 or 1=Green LED On)	Set if Green LED is on	
3005	Saturation (0 or 1= gas outside limits)	Set if gas concentration exceeds full-scale range	
3006	Start up (0=normal op 1=starting up)	Set if sensor is still in warm-up stabilization period	

6.4.7 Integration - Status Flags

Read Input Status (Function 02 Read)

3100	Sensor Startup (0 or 1 = startup)	Set if sensor is still in warm-up stabilization period	Boolean
3101	Low Alarm flag (0 or 1 = alarm)	Set if low alarm is active	
3102	High Alarm flag (0 or 1 = alarm)	Set if high alarm is active	

3103	Sensor Fault (0 or 1 = fault)	Set if any fault flag is active	Boolean
3104	Sensor Saturation (0 or 1 = gas outside limits)	Set if gas concentration exceeds full-scale range	
3105	Sensor Underflow (0 or 1 = gas less than zero)	Set if sensor is still in warm-up stabilization period	
3106	Calibration Due (0 or 1 = cal due)	Set if burning hours > calibration interval	

6.4.8 LKD Compatibility - Clear Special States

Read / Force Coil (Function 01/05 Read / Write)

4000	Mute Buzzer	Sounder Mute	Boolean
4001	Calibration due	Clear Calibration Due Flag	
4002	not implemented - return 0 on read/exception on write	Reconfigure MGS	

6.4.9 Integration - User Task

Read / Force Coil (Function 01/05 Read / Write)

4100	Restart	Force application restart	Boolean
4101	Factory Reset	Restore system settings to defaults	
4102	Clear last faults	Clear any fault flags held in the last fault registers. Any active faults will remain set in the last fault register	
4103	Acknowledge latched alarms/ faults	Acknowledge latched alarms/faults	
4104	Mute Buzzer	Mute Buzzer for 60 minutes	
4105	Immediate Zero Calibration	Calibrate zero now	
4106	Immediate Span Calibration	Calibrate span now	
4107	Auto Zero Calibration	Calibrate zero after auto calibration time	

4108	Auto Span Calibration	Calibrate span after auto calibration time	Boolean
4109	Clear calibration expired flag	Clear calibration due flag and rest burning hours to 0	
4110	Clear Maximum Temperature	Clear Maximum Temperature	
4111	Clear Maximum Gas Concentration	Clear Maximum Gas Concentration	
4112	Bluetooth Enable	0 = Disable, 1 = Enable	

Technical Customer Support
+39 0437 986 300

Sales
+39 0437 986 100 *(Italy)*
+39 0437 986 200 *(Other Countries)*

Manufactured by Bacharach, Inc.
621 Hunt Valley Circle
New Kensington, PA 15068, USA

MADE IN USA