# LARK-1S&LARK-1Q Modbus PROTOCOL

The LARK-1S&LARK-1Q sensor can communicate with a host device via an RS485 interface. This application note shows how to operate LARK-1S/Q with Modbus protocol, including sensor information inquiring, data logging, ZERO and SPAN calibration.

- **RS485 Serial Communication Interface of LARK-1S/Q**

RS485 interface is located in the black connector **H4** on the bottom of LARK-1S/Q main board, and involved pins and signal name are shown in figure 1 and figure 2. A+ / B- for RS485 should be connected to the external communication bus. The hardware circuit of the RS485 communication interface is shown in figure 4.

H4 Pin Definition
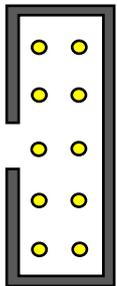
1. NC	2. Vout
3. RXD (TTL)	4. TXD (TTL)
5. A+ (RS485)	**6. B- (RS485)**
7. NC	8. GND
9. PWR_DC	10. GND

(Warning: 1. TTL communication CANNOT be connected in parallel; 2. TTL and RS485 communication CANNOT be used simultaneously)
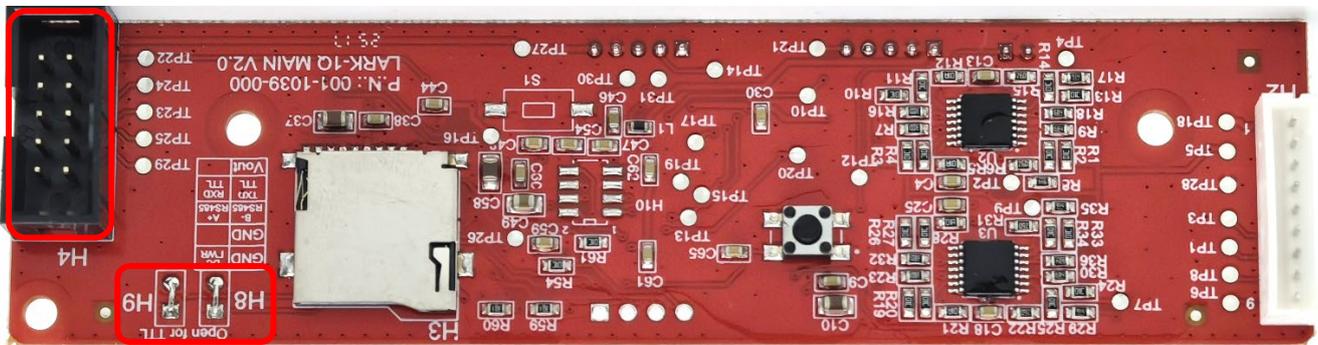

Figure 1. Bottom of LARK-1Q main board

(Warning: TTL communication can be used by cutting the jumper wire in the figure below. The factory default is RS485 communication)
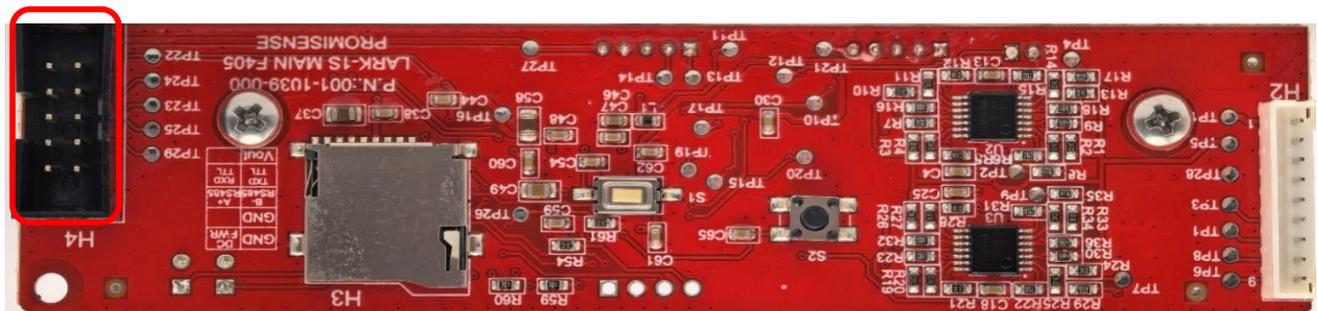

Figure 2. Bottom of LARK-1S main board

(Warning: TTL communication can be used by cutting the jumper wire in the figure below. The factory default is RS485 communication)
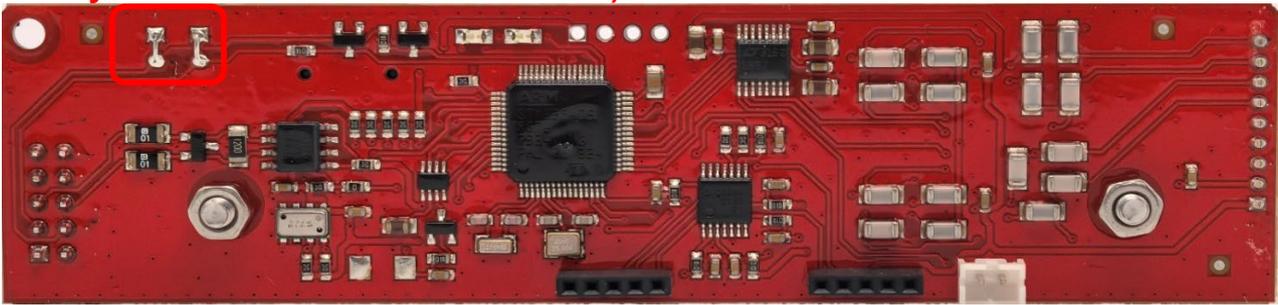

Figure 3. Top of LARK-1S main board
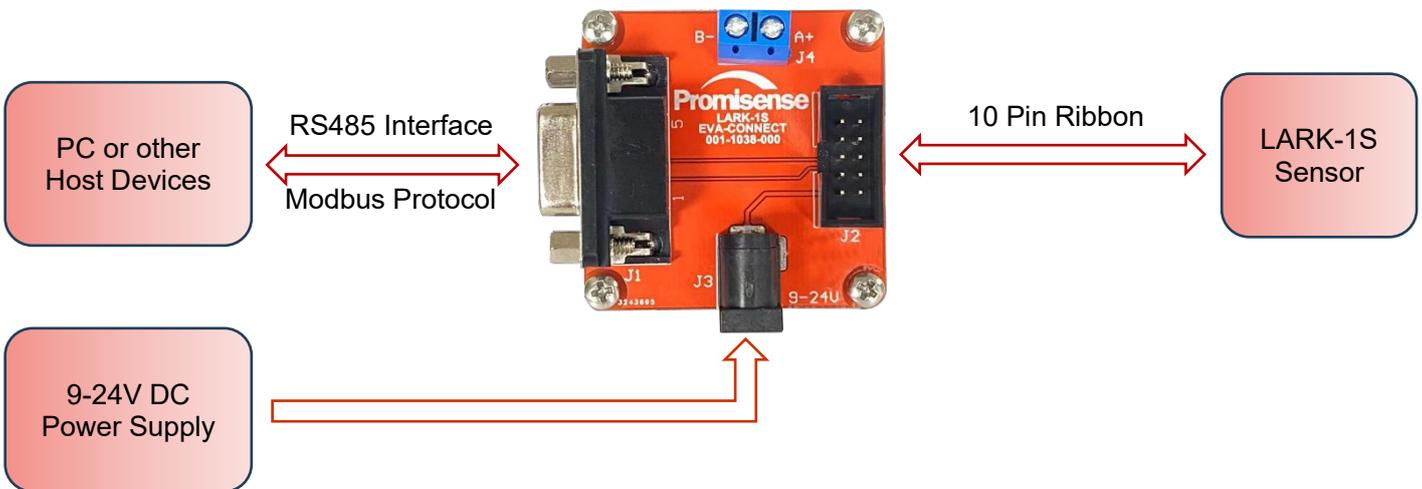
Figure 4. Connect LARK-1S/Q Sensor via EVA-CONNECT Board

- **Modbus Description**

  ➢ **Modbus Interface Description**

Table1. Description of Modbus Interface

Rec	Specification	Description
1	Physical Interface	RS485 Half Duple
2	Baud Rate	9600-115200 bps (Can be Modified)
3	Transfer Mode	RTU (Remote Terminal Unit)
4	Data Format	As Follows
5	Data Number	< 255
6	Check Method	CRC-16 / Modbus (Polynomial: x16+x15+x2+1)
7	Byte Format	1 Start Bit + 8 Data Bits + 1 Stop Bit, No Pa
8	Broadcast Address	0
9	Interface Pin	A(+), B(-)

➢ **Instruction Description of Modbus RTU Mode**

The Modbus RTU instruction consists of start mask, device address (1 Byte), function code (1 Byte), data field, CRC code (2 Bytes) and end mask, as shown in table 2.

Table 2. Modbus RTU Instruction Format

Start Mask	Device Address	Function Code	Data Field	CRC Code	End Mask
T1-T2-T3-T4	1 Byte (8-Bit)	1 Byte (8-Bit)	N Bytes (8*N-Bit)	2 Bytes (16-Bit)	T1-T2-T3-T4

T1-T2-T3-T4 in start mask and end mask indicates a pause interval of 4 bits. In RTU mode, the message transmission starts and ends with a pause interval of at least 3.5 bits.

The device address could be 1~247, and the Modbus protocol supports 247 slaves per master. However, RS485 interface can only drive up to 32 slaves without a repeater.

LARK-1S/Q sensor supports three function codes: 0x04, 0x06, 0x10. When user's host device operates with other function codes, it will return an exception code response, which means host device requesting illegal.

➢ **Function Code Description**

Table 3. Supported Function Code Description

Function Code	Function	Register Address
0x04	Read Registers	0x0000~0x06FF
0x06	Write A Single Register	0x1000~0x104F
0x10	Write Multiple Registers	0x1000~0x104F

Function Code 0x04: Read one single register or contiguous registers, the address range is: 0x0000~0x06FF

Request

Device Address	Function Code	Starting Register Address		No. of Registers		CRC Code	
		Hi	Lo	Hi	Lo	Lo	Hi
0x01	0x04	0x05	0x20	0x00	0x02	0x70	0xCD

Response

Device Address	Function Code	Byte Count	Register Value				CRC Code	
							Lo	Hi
0x01	0x04	0x04	0x00	0x00	0X02	0x73	0xBB	0x01

Function Code 0x06: Write a single register, the address range：0x1000~0x104F

Request & Response

Device Address	Function Code	Starting Register Address		Register Value		CRC Code	
		Hi	Lo	Hi	Lo	Lo	Hi
0x01	0x06	0x10	0x20	0xFF	0xFE	0x4C	0xBF

Function Code 0x10: Write multiple registers, the address range is：0x1000~0x104F

Request

Device Address	Function Code	Starting Register Address		No. of Registers		Byte Count	Register Value				CRC Code	
		Hi	Lo	Hi	Lo						Lo	Hi
0x01	0x10	0x10	0x014	0x00	0x02	0x04	0x00	0x00	0xC3	0x50	0x6E	0x5C

Response

Device Address	Function Code	Starting Register Address		No. of Registers		CRC Code	
		Hi	Lo	Hi	Lo	Lo	Hi
0x01	0x10	0x10	0x14	0x00	0x02	0x05	0x0C

Exception Code: Response to the illegal request

Response

Device Address	Function Code	Error Code	CRC Code	
			Lo	Hi
0x01	Function Code of Illegal Request + 0x80: 0x84 / 0x86 / 0x90	0x01: Function Code Error 0x02: Register Address Error 0x03: Register No. Error 0x04: Register Value Error	0xXX	0xXX

● **Register Description**

Registers involved in the LARK-1S/Q Modbus protocol are divided into two parts which are read-only registers and writable registers. Information Registers (Address Range: 0x0000 ~ 0x04FF), Data Registers (Address Range: 0x0500 ~ 0x05FF), and Status Registers (Address Range: 0x0600 ~ 0x06FF), are all read-only registers and cannot be written. And the address range of writable registers is 0x1000 to 0x104F.

The basic information of LARK-1S/Q sensor can be obtained from the Information Registers as shown in table 4, such as gas type, serial number, produce date, user calibration information. Operating data of sensor's working process can be obtained from data registers as shown in table 5, including detector temperature, lamp temperature, air pressure, reading value, signal and reference value of detector , etc. The status of operation performed by external device can be obtained from status registers as shown in table 6. Status should be read to confirm whether the operation is successful or not, after external device performs commands such as calibration, heating on, etc. The writable registers as shown in table 7 are used for external devices to operate the sensor and perform commands, such as calibration, heating on and resetting calibration data, etc.

Table 4. Information Registers of LARK-1S/Q (Read Only)

Register Address	Length (Byte)	Name	Description	R/W	Type
0x0000	4	Bit Map Version	A, B, C, … '20 20 20 41' for the 'A'	R	ASCII
0x0002	2	Sensor Type ID	See Sensor Type of Appendix 1 '00 00 00 01' is 'NDIR'	R	HEX INT
0x0004	16	Sensor S.N.	1st: Hardware Version 2nd & 3rd: Firmware Version 4th~7th: Light path number 8th~12th: Serial Number 13th~16th: Year & Month YYMM '31 30 31 30 30 30 32 30 30 31 30 30 31 31 37 31 30' for '1 01 0004 00101 1710'	R	ASCII
0x001E	4	Gas 1 – Gas 4 Available Bitmap	Bit0: 0-Gas 1 Enable Bit1: 0-Gas 2 Enable, 1-Gas 2 Disable Bit2: 0-Gas 3 Enable, 1-Gas 3 Disable Bit3: 0-Gas 4 Enable, 1-Gas 4 Disable 'FF FF FF F0' means GAS1-GAS4 are all Enable	R	HEX INT

0x0100	4	Gas 1 Sub ID	See Appendix 2 '00 00 00 01' for the 'CH4'	R	HEX INT
0x0102	12	Gas 1 Gas Name	'20 20 20 20 20 20 20 20 20 20 4E 4F' means ' NO'	R	ASCII
0x0108	4	Gas 1 Reading Unit Code	See Appendix 3 '00 00 00 04' for the 'PPM'	R	HEX INT
0x010A	8	Gas 1 Reading Unit Name	Character string，such as 'PPM', '%vol' '20 20 20 20 20 50 50 4D' means ' PPM'	R	ASCII
0x010E	4	Gas 1 Range 1	Gas 1 High precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0110	4	Gas 1 Range 2	Gas 1 Low precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0112	4	Gas 1 Alarm Limit 1	Gas 1 Alarm lower threshold '00 00 00 FA' for the '250'	R	HEX INT
0x0114	4	Gas 1 Alarm Limit 2	Gas 1 Alarm high threshold '00 00 AF C8' for the '45000'	R	HEX INT
0x011C	4	Gas 1 Drift Limit	Zero Calibration is not allowed, if zero drift exceeds this value '00 00 27 10' for the '10000'	R	HEX INT
0x0126	4	Gas 1 Minimum Calibration Value	Minimum SPAN concentration of Gas 1 '00 00 30 D4' for the '12500'	R	HEX INT
0x012A	4	Gas 1 Calibration available bitmap	Bit0 - ZERO CALI Available Bit1 - SPAN CALI Available 0 - Enable, 1 - Disable 'FF FF FF FC' means ZERO and SPAN calibration are both enable	R	HEX INT
0x012C	4	Gas 1 Zero Cali Data 1	Gas 1 ZERO Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x012E	4	Gas 1 Zero Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x0130	4	Gas 1 Zero Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0132	4	Gas 1 Zero Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0138	4	Gas 1 Span Concentration	Gas 1 SPAN Calibration Concentration	R	HEX INT
0x013A	4	Gas 1 Span Cali Data 1	Gas 1 SPAN Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x013C	4	Gas 1 Span Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x013E	4	Gas 1 Span Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0140	4	Gas 1 Span Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0200	4	Gas 2 Sub ID	See Appendix 2 '00 00 00 01' for the 'CH4'	R	HEX INT
0x0202	12	Gas 2 Gas Name	'20 20 20 20 20 20 20 20 20 20 4E 4F' means ' NO'	R	ASCII

0x0208	4	Gas 2 Reading Unit Code	See Appendix 3 '00 00 00 04' for the 'PPM'	R	HEX INT
0x020A	8	Gas 2 Reading Unit Name	Character string，such as 'PPM', '%vol' '20 20 20 20 20 50 50 4D' means ' PPM'	R	ASCII
0x020E	4	Gas 2 Range 1	Gas 2 High precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0210	4	Gas 2 Range 2	Gas 2 Low precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0212	4	Gas 2 Alarm Limit 1	Gas 2 Alarm lower threshold '00 00 00 FA' for the '250'	R	HEX INT
0x0214	4	Gas 2 Alarm Limit 2	Gas 2 Alarm high threshold '00 00 AF C8' for the '45000'	R	HEX INT
0x021C	4	Gas 2 Drift Limit	Zero Calibration is not allowed, if zero drift exceeds this value '00 00 27 10' for the '10000'	R	HEX INT
0x0226	4	Gas 2 Minimum Calibration Value	Minimum SPAN concentration of Gas 2 '00 00 30 D4' for the '12500'	R	HEX INT
0x022A	4	Gas 2 Calibration available bitmap	Bit0 - ZERO CALI Available Bit1 - SPAN CALI Available 0 - Enable, 1 - Disable 'FF FF FF FC' means ZERO and SPAN calibration are both enable	R	HEX INT
0x022C	4	Gas 2 Zero Cali Data 1	Gas 2 ZERO Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x022E	4	Gas 2 Zero Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x0230	4	Gas 2 Zero Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0232	4	Gas 2 Zero Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0238	4	Gas 2 Span Concentration	Gas 2 SPAN Calibration Concentration	R	HEX INT
0x023A	4	Gas 2 Span Cali Data 1	Gas 2 SPAN Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x023C	4	Gas 2 Span Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x023E	4	Gas 2 Span Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0240	4	Gas 2 Span Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0300	4	Gas 3 Sub ID	See Appendix 2 '00 00 00 01' for the 'CH4'	R	HEX INT
0x0302	12	Gas 3 Gas Name	'20 20 20 20 20 20 20 20 20 20 4E 4F' means ' NO'	R	ASCII
0x0308	4	Gas 3 Reading Unit Code	See Appendix 3 '00 00 00 04' for the 'PPM'	R	HEX INT
0x030A	8	Gas 3 Reading Unit Name	Character string，such as 'PPM', '%vol' '20 20 20 20 20 50 50 4D' means ' PPM'	R	ASCII

0x030E	4	Gas 3 Range 1	Gas 3 High precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0310	4	Gas 3 Range 2	Gas 3 low precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0312	4	Gas 3 Alarm Limit 1	Gas 3 Alarm lower threshold '00 00 00 FA' for the '250'	R	HEX INT
0x0314	4	Gas 3 Alarm Limit 2	Gas 3 Alarm high threshold '00 00 AF C8' for the '45000'	R	HEX INT
0x031C	4	Gas 3 Drift Limit	Zero Calibration is not allowed, if zero drift exceeds this value '00 00 27 10' for the '10000'	R	HEX INT
0x0326	4	Gas 3 Minimum Calibration Value	Minimum SPAN concentration of Gas 3 '00 00 30 D4' for the '12500'	R	HEX INT
0x032A	4	Gas 3 Calibration available bitmap	Bit0 - ZERO CALI Available Bit1 - SPAN CALI Available 0 - Enable, 1 - Disable 'FF FF FF FC' means ZERO and SPAN calibration are both enable	R	HEX INT
0x032C	4	Gas 3 Zero Cali Data 1	Gas 3 ZERO Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x032E	4	Gas 3 Zero Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x0330	4	Gas 3 Zero Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0332	4	Gas 3 Zero Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0338	4	Gas 3 Span Concentration	Gas 3 SPAN Calibration Concentration	R	HEX INT
0x033A	4	Gas 3 Span Cali Data 1	Gas 3 SPAN Calibration Data: Data 1 - Sig CTS	R	HEX INT
0x033C	4	Gas 3 Span Cali Data 2	Data 2 - Ref CTS Data 3 - DET Temperature	R	HEX INT
0x033E	4	Gas 3 Span Cali Data 3	Data 4 - IR Source Temperature	R	HEX INT
0x0340	4	Gas 3 Span Cali Data 4	'00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x0400	4	Gas 4 Sub ID	See Appendix 2 '00 00 00 01' for the 'CH4'	R	HEX INT
0x0402	12	Gas 4 Gas Name	'20 20 20 20 20 20 20 20 20 20 4E 4F' means ' NO'	R	ASCII
0x0408	4	Gas 4 Reading Unit Code	See Appendix 3 '00 00 00 04' for the 'PPM'	R	HEX INT
0x040A	8	Gas 4 Reading Unit Name	Character string, such as 'PPM', '%vol' '20 20 20 20 20 50 50 4D' means ' PPM'	R	ASCII
0x040E	4	Gas 4 Range 1	Gas 4 High precision reading range '00 00 C3 50' for the '50000'	R	HEX INT
0x0410	4	Gas 4 Range 2	Gas 4 low precision reading range '00 00 C3 50' for the '50000'	R	HEX INT

0x0412	4	Gas 4 Alarm Limit 1	Gas 4 Alarm lower threshold '00 00 00 FA' for the '250'	R	HEX INT
0x0414	4	Gas 4 Alarm Limit 2	Gas 4 Alarm high threshold '00 00 AF C8' for the '45000'	R	HEX INT
0x041C	4	Gas 4 Drift Limit	Zero Calibration is not allowed, if zero drift exceeds this value '00 00 27 10' for the '10000'	R	HEX INT
0x0426	4	Gas 4 Minimum Calibration Value	Minimum SPAN concentration of Gas 4 '00 00 30 D4' for the '12500'	R	HEX INT
0x042A	4	Gas 4 Calibration available bitmap	Bit0 - ZERO CALI Available Bit1 - SPAN CALI Available 0 - Enable, 1 - Disable 'FF FF FF FC' means ZERO and SPAN calibration are both enable	R	HEX INT
0x042C	4	Gas 4 Zero Cali Data 1	Gas 4 ZERO Calibration Data: Data 1 - Sig CTS Data 2 - Ref CTS Data 3 - DET Temperature Data 4 - IR Source Temperature '00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x042E	4	Gas 4 Zero Cali Data 2		R	HEX INT
0x0430	4	Gas 4 Zero Cali Data 3		R	HEX INT
0x0432	4	Gas 4 Zero Cali Data 4		R	HEX INT
0x0438	4	Gas 4 Span Concentration	Gas 4 SPAN Calibration Concentration	R	HEX INT
0x043A	4	Gas 4 Span Cali Data 1	Gas 4 SPAN Calibration Data: Data 1 - Sig CTS Data 2 - Ref CTS Data 3 - DET Temperature Data 4 - IR Source Temperature '00 00 11 94' for '4500' (DEC) '00 00 03 E8' for '1000' (DEC)	R	HEX INT
0x043C	4	Gas 4 Span Cali Data 2		R	HEX INT
0x043E	4	Gas 4 Span Cali Data 3		R	HEX INT
0x0440	4	Gas 4 Span Cali Data 4		R	HEX INT

Table 5. Data Registers of LARK-1S/Q (Read only)

Register Address	Length (Byte)	Name	Description	R/W	Type
0x0500	4	Sensor Det_Temp	Detector Temperature (0.01K) '72 74' for the '29300', 293K	R	HEX INT
0x0502	4	Sensor IR_Temp	IR Source Temperature (0.01K) '72 74' for the '29300', 293K	R	HEX INT
0x0504	4	Air Pressure	Air Pressure (0.01kPa) '00 00 27 94' for '10132', 101.32kPa	R	HEX INT
0x050C	4	IR Source_Vol	Voltage of IR Source (mV) '00 00 09 60' for the '2400', 2400mV	R	HEX INT
0x050E	4	IR Source_Cur	Current of IR Source (0.01mA) '00 01 5F 90' for the '90000', 900mA	R	HEX INT
0x0510	4	Gas 1 Reading	Gas 1 Concentration '00 00 C3 50' for the '50000'	R	HEX INT

0x0512	4	Gas 1 Sig_CTS	Gas 1 SIG Value '00 03 22 BC' for the '205500'	R	HEX INT
0x0518	4	Gas 2 Reading	Gas 2 Concentration '00 00 C3 50' for the '50000'	R	HEX INT
0x051A	4	Gas 2 Sig_CTS	Gas 2 SIG value '00 03 22 BC' for the '205500'	R	HEX INT
0x0520	4	Gas 3 Reading	Gas 3 Concentration '00 00 C3 50' for the '50000'	R	HEX INT
0x0522	4	Gas 3 Sig_CTS	Gas 3 SIG value '00 03 22 BC' for the '205500'	R	HEX INT
0x0528	4	Gas 4 Reading	Gas 4 Concentration '00 00 C3 50' for the '50000'	R	HEX INT
0x052A	4	Gas 4 Sig_CTS	Gas 4 SIG value '00 03 22 BC' for the '205500'	R	HEX INT
0x0530	4	Gas 1 Compensated Reading	Gas 1 Concentration measured with Negative Drift Compensation '00 00 C3 50' for the '50000'	R	HEX INT
0x0532	4	Gas 2 Compensated Reading	Gas 2 Concentration measured with Negative Drift Compensation '00 00 C3 50' for the '50000'	R	HEX INT
0x0534	4	Gas 3 Compensated Reading	Gas 3 Concentration measured with Negative Drift Compensation '00 00 C3 50' for the '50000'	R	HEX INT
0x0536	4	Gas 4 Compensated Reading	Gas 4 Concentration measured with Negative Drift Compensation '00 00 C3 50' for the '50000'	R	HEX INT

Note：Gas 3 Reading is measured gas concentration for LARK-1S/Q UNI Series. Gas 3 Sig_CTS and Gas 1 Sig_CTS are raw CTS values of signal and reference respectively.

Table 6. Status Registers of LARK-1S/Q (Read Only)

Register Address	Length (Byte)	Name	Description	R/W	Type
0x0600	2	Gas 1 Zero Record Status	0x0000: ZERO Record Succeeded 0x0001: Error1 - Ref CTS is Zero 0x0002: Error2- Zero Drift Exceeds Drift Limit 0xFFFF：Write Data Error	R	HEX INT
0x0601	2	Gas 2 Zero Record Status		R	HEX INT
0x0602	2	Gas 3 Zero Record Status		R	HEX INT
0x0603	2	Gas 4 Zero Record Status		R	HEX INT
0x0604	2	Gas 1 Span Record Status	0x0000: SPAN Record Succeeded 0x0001: Error1 - Ref CTS is Zero 0x0002: Error2 - SPAN Gas Concentration is less than a quarter of the Range 1 or out of Range 1 0x0004: Error4 - SPAN Value Measured Error (Check SPAN Gas and Concentration) 0xFFFF: Data Frame Destroyed	R	HEX INT
0x0605	2	Gas 2 Span Record Status		R	HEX INT
0x0606	2	Gas 3 Span Record Status		R	HEX INT
0x0607	2	Gas 4 Span Record Status		R	HEX INT

Register Address	Length (Byte)	Name	Description	R/W	Type
0x0608	2	Activate Calibration Status	0x0000: Calibration Active Succeeded Bit0 = 1: GAS 1 Calibration Active Failed Bit1 = 1: GAS 2 Calibration Active Failed Bit2 = 1: GAS 3 Calibration Active Failed Bit3 = 1: GAS 4 Calibration Active Failed	R	HEX INT
0x0609	2	Restore Factory Calibration Status	0x0000: Restore Calibration Succeeded Bit0 = 1: GAS 1 Restore Failed Bit1 = 1: GAS 2 Restore Failed Bit2 = 1: GAS 3 Restore Failed Bit3 = 1: GAS 4 Restore Failed	R	HEX INT
0x060A	2	Heat On / Off Status	0x0000: Heat Off 0x0001: Heat On	R	HEX INT

Table 7. Writable Registers of LARK-1S/Q (Writable)

Register Address	Length (Byte)	Name	Description	R/W	Type
0x1001	2	Heat On/Off	Write 0x00FF: Heat On Write 0x0000: Heat Off	W	HEX INT
0x1010	2	Gas 1 Zero Calibration Record	Writing 0xFFFE: Record ZERO Calibration Data, which can take effect only after calibration activation	W	HEX INT
0x1011	2	Gas 2 Zero Calibration Record		W	HEX INT
0x1012	2	Gas 3 Zero Calibration Record		W	HEX INT
0x1013	2	Gas 4 Zero Calibration Record		W	HEX INT
0x1014	4	Gas 1 Span 1 Concentration	SPAN Calibration Concentration of Gas 1~Gas 4 (25%~100%FS) '00 00 30 D4' for the '12500'	W	HEX INT
0x101E	4	Gas 2 Span 1 Concentration		W	HEX INT
0x1028	4	Gas 3 Span 1 Concentration		W	HEX INT
0x1032	4	Gas 4 Span 1 Concentration		W	HEX INT
0x103C	2	Gas 1 Calibration Activate	Writing 0xFFFE: Activate ZERO Calibration Write 0xFFFC: Activate SPAN Calibration	W	HEX INT
0x103D	2	Gas 2 Calibration Activate		W	HEX INT
0x103E	2	Gas 3 Calibration Activate		W	HEX INT
0x103F	2	Gas 4 Calibration Activate		W	HEX INT
0x1040	2	Gas 1 Restore Factory Calibration	Writing 0x00FF: Restores Factory Calibration	W	HEX INT
0x1041	2	Gas 2 Restore Factory Calibration		W	HEX INT
0x1042	2	Gas 3 Restore Factory Calibration		W	HEX INT
0x1043	2	Gas 4 Restore Factory Calibration		W	HEX INT

● **Operate LARK-1S/Q via Modbus Protocol**

Appendix 5 provides common operation commands. Note that all the commands in appendix 5 take the device address 0x01 as an example.

➢ **Setting Device Address and Baud Rate**

Users could set up device address and baud rate of LARK-1S/Q sensor by modifying the text file in SD card on the main board. The SD card can be removed from LARK-1S/Q sensor. And via a card reader, the text file

"config.txt" could be edited in the computer. Enter "baud rate = 19200" to set the baud rate to be 19200 bps. Enter "addr = 83" to set the device address to be 83 (0x53). The valid device address ranges from 1 to 247.

> ➤ **LARK-1S/Q Sensor Information Inquiring**

Read registers in the address segment of 0x0000 to 0x04FF according to table 4 using function code 0x04.

For example, to obtain the S.N. of LARK-1S/Q with the device address of 0x01. The corresponding register address is found to be 0x0004 in table 4. The length is 16 bytes and the data format is ASCII.

Request

01 04 00 04 00 08 B0 0D

Response

01 04 10 31 30 31 30 30 32 33 30 30 30 30 36 31 38 31 32 34 23

S.N. if found to be 1 01 0023 00006 1812 in the above response command.

> ➤ **LARK-1S/Q Data Logging**

Read registers in the address segment of 0x0500 to 0x05FF according to table 5 using function code 0x04.

For example, to obtain the Gas 3 concentration to be measured by LARK-1S/Q with the device address of 0x01. The Gas 3 concentration to be measured is found to be Gas 3 Reading register in table 5, the address of which is 0x0520. The length is 4 bytes and the data format is HEX INT.

Request

01 04 05 20 00 02 70 CD

Response

01 04 04 00 00 02 73 BB 01

Gas 3 Reading is found to be 0x00000273 in the above response. So, measured Gas 3 concentration is 627 in decimal. The concentration unit could be obtained from the register in address of 0x0308 (Gas 3 Reading Unit Code) or 0x030A (Reading Display Unit Name).

> ➤ **LARK-1S/Q Calibration**

ZERO Calibration requires two steps: 1 - ZERO Calibration Record (Gas 1 / Gas 2 / Gas 3 / Gas 4 Zero Calibration Record), 2 - ZERO Calibration Activating after recording successfully (Gas 1 / Gas 2 / Gas 3 / Gas 4 Calibration Activate).

Taking Gas 3 ZERO calibration as an example.

Gas 3 Zero Calibration Record: After ZERO gas pumped in, write 0xFFFE to the register in address of 0x1012 according to table 7 using function code 0x06.

Request

01 06 10 12 FF FE ED 7F

Response

01 06 10 12 FF FE ED 7F

Receiving above response means that Zero Calibration record is successful. If the error code 0x04 is received, the Zero Calibration Record Status register in table 6 should be read to find Zero Record failure reason using function code 0x04.

Gas 3 Zero Calibration Activate: Write 0xFFFE to the register in address of 0x103E according to table 7 using

function code 0x06.

Request

01 06 10 3E FF FE 2C B6

Response

01 06 10 3E FF FE 2C B6

Receiving above response means that Zero Calibration activating is successful. If the error code 0x04 is received, the Activate Calibration Status register in table 6 should be read to find activation failure reason using function code 0x04.

SPAN Calibration (Gas 1 / Gas 2 / Gas 3 / Gas 4 Span 1 Calibration) requires two steps: 1 - Span Calibration Record (Gas 1 / Gas 2 / Gas 3 / Gas 4 Span 1 Calibration Record), 2 - Span Calibration Activating after recording successfully (Gas 1 / Gas 2 / Gas 3 / Gas 4 Span 1 Calibration Activate).

Taking Gas 3 Span 1 Calibration with 50,000 ppm concentration as an example.

Gas 3 SPAN Calibration Record: After SPAN gas pumped in, write SPAN gas Concentration to the register in address of 0x1028 (Gas 3 Span1 Calibration Concentration) according to table 7 using function code 0x10.

Request

01 10 10 28 00 02 04 00 00 C3 50 6D 1D

Response

01 10 10 28 00 02 C5 00

Gas 3 SPAN Calibration Activate: Write 0xFFFC to the register in address of 0x103E according to table 7 using function code 0x06.

Request

01 06 10 3E FF FC AD 77

Response

01 06 10 3E FF FC AD 77

Receiving above response means that Gas 3 SPAN Calibration activating is successful.

- **Appendix**

➢ **Appendix 1. Sensor Type ID Definition**

Please refer to AN-011 Appendix 1

➢ **Appendix 2. Sensor sub ID Definition (Some common gases)**

Please refer to AN-011 Appendix 2

➢ **Appendix 3. Reading unit ID**

Please refer to AN-011 Appendix 3

> ➤ **Appendix 4. CRC16 Calculation Method with C Language**

const uint8_t CRCTABL[] =   //CRCL Value Table

{

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,

    0x00, 0xC1, 0x81, 0x40

};

const uint8_t CRCTABH[] =   //CRCH Value Table

{

    0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7,

    0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E,

    0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9,

    0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,

    0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,

    0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32,

    0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D,

    0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,

    0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF,

    0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,

    0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1,

    0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,

    0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB,

    0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA,

    0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,

    0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,

    0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97,

    0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E,

    0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89,

    0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,

    0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83,

```
    0x41, 0x81, 0x80, 0x40
};
typedef struct _sCRC16Data
{
    uint8_t crch;
    uint8_t crcl;
}sCRC16Data;
sCRC16Data CRC16_8005Calc(uint8_t *p, int len)//x16+x15+x2+x1
{
    sCRC16Data crc = {0xFF, 0xFF};
    if (len > 0)
    {
        int i, index;
        for (i = 0; i<len; i++)
        {
            index = crc.crcl ^ (*(p + i));
            crc.crcl = crc.crch^CRCTABL[index];
            crc.crch = CRCTABH[index];
        }
    }
    return crc;
}
```

➤ **Appendix 5. Common Request (Take Slave Device Address 0x01 as An Example)**

Register	Item	Function	Request (HEX)
Information register	1	Inquire S.N. of LARK-1S/Q	01 04 00 04 00 08 B0 0D
	6	Inquire Gas Type of Gas 2	01 04 02 00 00 02 70 73
	7	Inquire Reading Unit of Gas 2	01 04 02 08 00 02 F1 B1
	8	Inquire Range of Gas 2	01 04 02 10 00 02 71 B6
	9	Inquire Minimum Calibration Value of Gas 2	01 04 02 26 00 02 91 B8
	10	Inquire Gas Type of Gas 3	01 04 03 00 00 02 71 8F
	11	Inquire Reading Unit of Gas 3	01 04 03 08 00 02 F0 4D
	12	Inquire Range of Gas 3	01 04 03 10 00 02 70 4A
	13	Inquire Minimum Calibration Value of Gas 3	01 04 03 26 00 02 90 44
	14	Inquire Gas Type of Gas 4	01 04 04 00 00 02 70 FB
	15	Inquire Reading Unit of Gas 4	01 04 04 08 00 02 F1 39
	16	Inquire Range of Gas 4	01 04 04 10 00 02 71 3E
	17	Inquire Minimum Calibration Value of Gas 4	01 04 04 26 00 02 91 30
Data Register	18	Obtain Gas Concentration of Gas 1	01 04 05 10 00 02 70 C2
	19	Obtain Gas concentration of Gas 2	01 04 05 18 00 02 F1 00
	20	Obtain Gas concentration of Gas 3	01 04 05 20 00 02 70 CD
	21	Obtain Gas concentration of Gas 4	01 04 05 28 00 02 F1 0F
	22	Acquire Temperature of Detector	01 04 05 00 00 04 F1 05
	23	Acquire Air Pressure	01 04 05 04 00 02 30 C6
Write Register	24	ZERO Calibration Record of Gas 2	01 06 10 11 FF FE 1D 7F
	25	SPAN Calibration Record with 50,000 ppm Concentration of Gas 2	01 10 10 1E 00 02 04 00 00 C3 50 EE 23
	26	ZERO Calibration Active of Gas 2	01 06 10 3D FF FE DC B6

	27	SPAN Calibration Active of Gas 2	01 06 10 3D FF FC 5D 77
	28	RESTORE Factory Calibration of Gas 2 (Clear User Calibration Data)	01 06 10 41 00 FF 9D 5E
	29	Heat On	01 06 10 01 00 FF 9C 8A
	30	Heat Off	01 06 10 01 00 00 DC CA
Status Register	31	Inquire Status of Gas 2 ZERO Calibration Record	01 04 06 01 00 01 60 82
	31	Inquire Status of Gas 2 SPAN 1 Calibration Record	01 04 06 05 00 01 21 43
	33	Inquire Status of Calibration Active	01 04 06 08 00 01 B0 80
	34	Inquire Status of Restore Factory Calibration	01 04 06 09 00 01 E1 40
	35	Inquire Status of Heat On or Off	01 04 06 0A 00 01 11 40

Note: Gas 1 of Lark-1S/Q series is reference channel by default, so there is no need to inquire Gas Type, Range, Minimum Calibration Value and other information. And ALL Calibration related request CANNOT be performed.