LARK-1 4-20mA MODBUS PROTOCOL

The LARK-1 sensor can communicate with a host device via an RS232 interface. We developed RS232-RS485 MODBUS Converter with 4-20mA analog output for LARK-1 in order to speed up users' development speed. RS232 of the converter is terminated with LARK-1. The Modbus terminal and 4-20mA analog output is connected to host device. This application note shows how to operate LARK-1 via Modbus protocol using this converter and obtain gas concentration via 4-20mA analog output.

The RS232-MODBUS Converter communicates in the RTU mode of Modbus protocol and serves as the slave device. The device communication address can be seen on the reverse side of the conversion board, as shown in Figure 1.

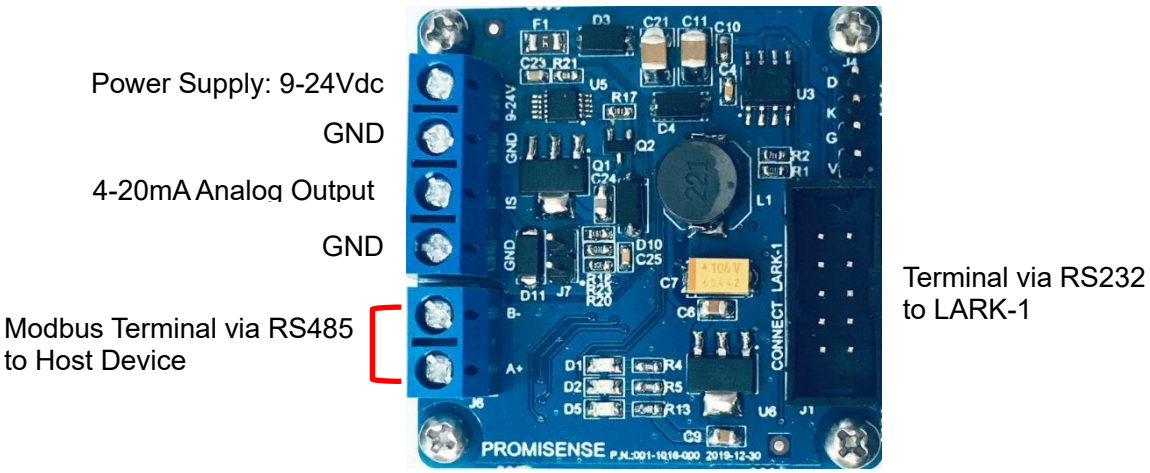

Figure 1. Photo of 4-20mA MODBUS Converter

1. **Modbus Description**

➢ **Modbus Interface Description**

Table 1. Description of Modbus Interface

Rec	Specification	Description
1	Physical Interface	RS485 Half Duplex
2	Baud Rate	9600 bps
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 Parity
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.

This converter 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 Register	0x2000 ~ 0x22FF
0x06	Write A Single Register	0x1000 ~ 0x100D
0x10	Write Multiple Registers	0x1000 ~ 0x100D

Please refer to AN-003 for detailed description of the function code, including the command format of request and response and description of illegal function code.

2. Register Description

Please refer to AN-003 for registers in table 4~table 7, including Register Address, Length(Byte), Name, Description, R/W and Type.

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

Table 5. Data Registers of LARK-1 (Read Only)

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

Table 7. Writable Registers of LARK-1 (Write Only)

3. Operate LARK-1 via Modbus Protocol

Please refer to AN-003 about how to operate LARK-1 via Modbus Protocol. There are Operating Instructions and Specific Instructions of the following three commonly used functions: 1. LARK-1 Sensor Information Inquiring, 2. LARK-1 Data Logging, 3. LARK-1 Calibration (ZERO and SPAN Calibration).

4. Obtain Gas Concentration via 4-20mA Analog Output

- **Direction of 4-20mA Current**

Host device can obtain the 4-20mA analog current via IS terminal in the 4-20mA Modbus Converter.

- **Calculating Gas Concentration**

The Output Current is determined by two parameters: Compensated Reading (0x200A) and Range 1 (0x211B). It's

calculated as follows:

$$\mathrm{IS(m}A) = \frac{\text{Compensated Reading}}{\text{Range 1}} \times 16 + 4$$

According to the above formula, Users can calculate the gas concentration using collected IS current by host device.

The calculation formula is as follows:

$$\text{Gas Concentration} = \frac{\mathrm{Is(m}A) - 4}{16} \times \text{Range 1}$$

Please refer to AN-003 for Compensated Reading (0x200A in Table 5) and Range 1 (0x211B in Table 4).

5. **Appendix**

Please refer to AN-003 for the following appendix 1~5 & appendix 7 may be involved.

Appendix 1. Sensor Type ID Definition

Appendix 2. Sensor sub ID Definition

Appendix 3. Reading unit ID

Appendix 4. Common Request (Take Slave Device Address 0x01 as An Example)

Appendix 5. CRC16 Calculation Method with C Language

Appendix 7. Status of LEDs