GREYSTONE
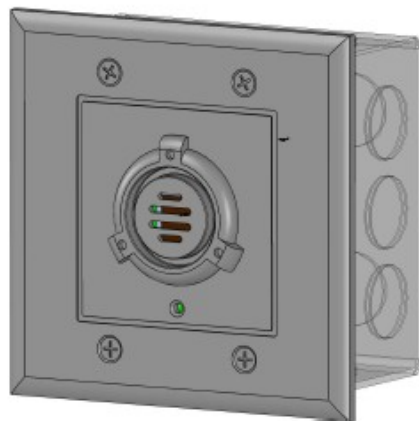ENERGY SYSTEMS INC

QVRF

REFRIGERANT GAS TRANSMITTER

INSTALLATION OPERATION AND MAINTENANCE MANUAL

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READ BEFORE OPERATING

All individuals who have or will have the responsibility of using, maintaining, or servicing this product must carefully read this manual. The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

1. General Information

1.1 What is a VRF System?

VRF stands for **Variable Refrigerant Flow** in the world of HVAC. It is an advanced HVAC technology designed for precise climate control in commercial and residential buildings. It operates by adjusting the refrigerant flow to match the heating and cooling needs of various zones or rooms, enhancing both efficiency and comfort. VRF is either a heat pump system or a heat recovery system.

1.2 How Does VRF Work?

Picture this: The refrigerant flows through condenser units to indoor units (those sleek wall-mounted thingies again). Since there's minimal need for ductwork, VRF systems are more flexible. They can even sneak into older buildings without causing a fuss.

Fun fact: Traditional ducts can leak cool air like a sieve, wasting energy. VRF eliminates that drama. No more cool air escaping through the cracks!

1.3 Monitor Refrigerant in VRF Systems

ASHRAE Standard 15: This one's all about safety. It sets limits on refrigerant charges to prevent disasters. It now nods to VRF systems, emphasizing the need for refrigerant detection. So, if the VRF system got a leak, the sensor should detect the leak at early detection and prevention.

IEC 60335-2-40 standard deals with the safety of electric heat pumps, sanitary hot water heat pumps and air conditioners, incorporating motor-compressors as well as hydronic fan coils units, dehumidifiers (with or without motor-compressors), thermoelectric heat pumps and partial units. Annex LL specifically defines requirements for refrigerant detection systems for use in such appliances, as well as testing methods to ensure the requirements are met.

1.4 QVRF Key Features

- \> 12 years life expectance in normal commercial environments
- Non-dispersive infrared (NDIR), immunity to poisoning.
- Maintenance free
- 2 SPDT Relay outputs
- RS-485 protocol: OptoMux or Modbus RTU
- Multicolor LED Status Indicator
- Easy installation to a two-gang electrical box
- IP Rate: IP54 with splashing guard
- Compliance:
    - IEC 60079-29-1
    - ARHRAE Standard 15
    - IEC/UL 60335-2-40

1.5 Specifications

Power Supply	Voltage: 24VDC nominal, range 18 to 30VDC 24VAC nominal, range 15 to 24VAC 50/60HZ **Note:** **QVRF has a half-wave rectifier circuit on board. You will damage devices if you mix half wave and full wave rectifiers on the same AC source. Use extreme caution when sharing a common AC source. Sharing a common DC source is less problematic.** Current: max. 0.4 A (normal working mode)
Fuse	F1 on the Main Board: Polyswitch 750mA Polyswitch device resets after the fault is cleared and power to the circuit is removed.
Enclosure	IP54 ratings with splashing guard
Environmental conditions	Location: Indoor use only Altitude: Up to 2 000 m Temperature: -40 °C to 70 °C Relative Humidity: 0 to 95% RH (non-condensing)
Measure Range	0 – 50%LFL R32, R454A, R454B, R454C
LED Indicator	Green blinking: Normal status with communication Yellow flash: Sensor Fault Red flash: Alarm and purge

|	
Accuracy	+/- 2.5%LFL at 0 – 25%LFL standard measurement range +/- 5.0%LFL at 25 – 50%LFL extended measurement range
Storage Temperature	-45 to 85C
Relay Output	2 Relays SPDT, Dry contacts, Relay1 & 2 • 1.0A maximum at 30 VDC (resistive load) • 0.3A maximum at 125VAC (resistive load) Relay1 is switched on when concentration > 20%LFL Relay1 is switched off when concentration < 15%LFL Relay2 is switched on when any fault happens
Buzzer	When relay1 is ON, the buzzer is on • 50 db at 10 cm, 2700 Hz
Digital Output	RS-485 OptoMux protocol • Connect to Controller: M-Controller, Q-Controller, or Q4 Controller RS-485 with Modbus RTU protocol **Default: Address 3, OptoMux, Baud rate: 4800bps**
Size	150mm x 150mm x 50mm
Weight	Less than 0.5lbs
Mounting Box	2 Gang electrical box **(Not included)**

2. Installation

2.1 Sensor Location

Several factors should be considered when selecting locations to install sensors. The following general suggestions should be considered to assure the detection of the target gas. Select the most suitable location for each sensor.

1. Air Currents: If there are fans, winds, or others sources of air movement, gases may tend to rise or collect in certain areas of a facility. The local air currents should be assessed to aid in selecting the sensor location. In outdoor situations considerations such as prevailing winds should be accounted for. Air convection can often be more important in determining gas concentrated areas than factors of Vapor Density.

2. Vapor Density: R32, R454A/B/C are heavier than air. Detecting location should be 9 - 18 inch (0.23m to 0.46m) above the floor.

3. Gas Emission Sources: As a rule, at least one sensor should be located in close proximity to each point where a leak is likely to occur. This is particularly important when a liquid having a low volatility is monitored.

4. Environmental Factors: Install sensors where they will be protected from wind, dust, snow, water, vibration and shock.

2.2 Physical Dimensions
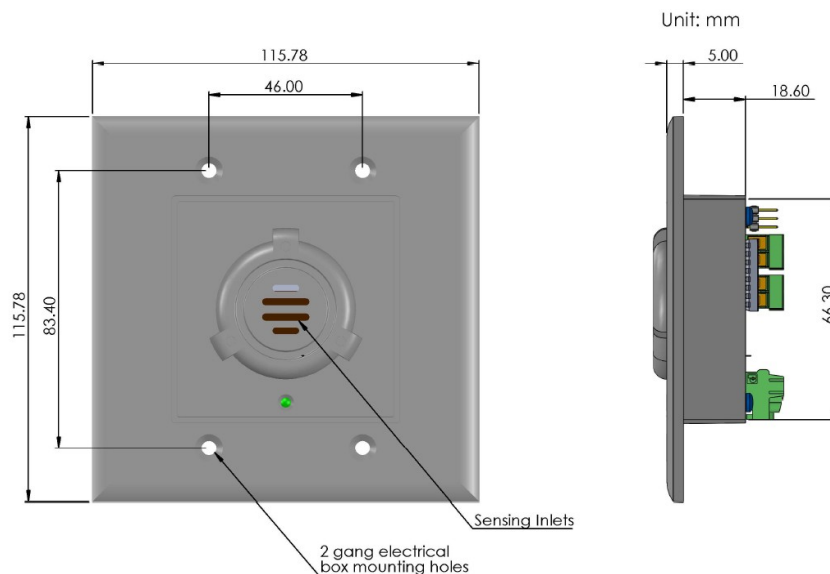
2.3 Mounting and System Wiring

Note: The 2-gang electrical box is not included in the shipping package.

QVRF can be used stand alone or can communicate to M-Controller or Q-Controller via RS-485 port, or to a Building Management System (BMS) vis RS-485 port with Modbus RTU protocol.

The QVRF is designed to mount on a 2-gang electrical box supplied by the contractor. It's secured to the electrical box ensuring protection from dust and construction debris

Installation must comply with all national and local codes regarding the installation and wiring.

2.3.1 Terminals
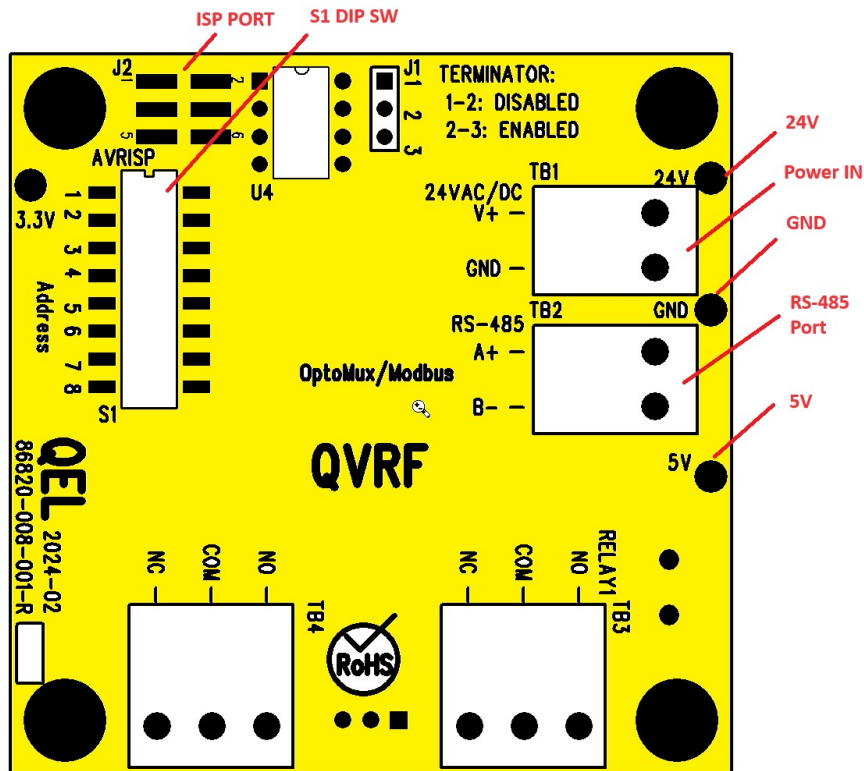
Installation Note on Terminal Block

- Remove the terminal block from the pin headers before wiring the terminal blocks. Torquing the terminal screws while attached to the pin header can damage the contact and can also cause loose connections.
- Don't over-torque the terminal block screws. If available, use a torque screwdriver to tighten the screw to 0.4NM.

2.3.2 Wiring and Connection

The terminal block plug TB1 to TB4 accept 12 AWG to 24 AWG wire, Use 16 AWG or 18 AWG wire for Power Supply in long wiring runs, which can be up to 1km (1,000 meters) long.
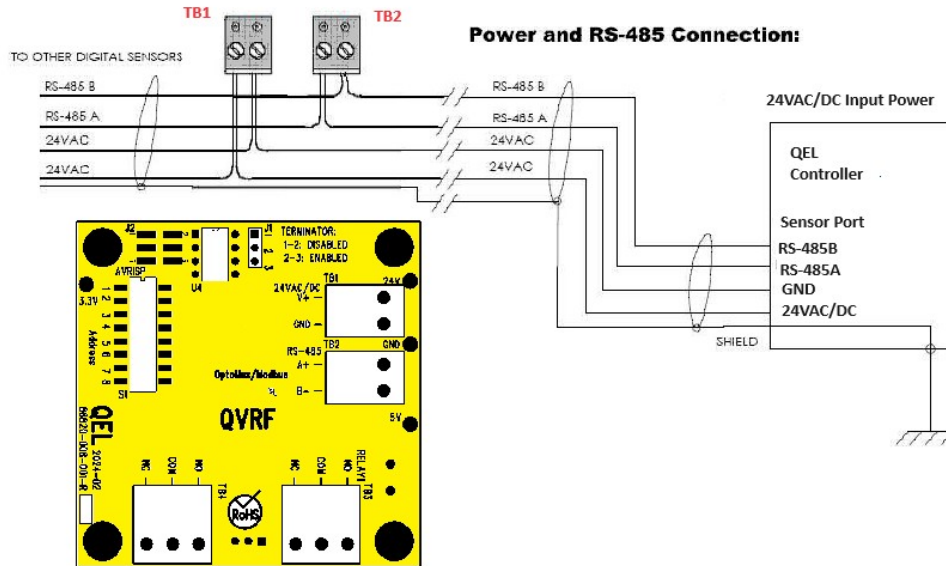
We recommend using BELDEN 9841 for communications. This wire has 120 ohm input impendence, which will eliminate RS-485 communication problems.

2.3.3 RS-485 Terminator

The terminator on each end of the RS485 loop is designed to match the electrical impedance characteristic of the twisted pair loop, and will prevent signal echoes from corrupting the data on the line. The terminator should be enabled on BOTH ends of the RS485 loop. Short and medium length Modbus/RS-485 loops can operate without the terminating resistor. Longer runs may require the terminating resistors. But adding terminator dramatically increases power consumption.

Factory default setting is disabled terminator.

The QVRF supplies this resistor onboard, and it is chosen using a jumper at J1.
- J1 1-2: Terminator Disabled / OFF (default)
- J1 2-3: Terminator Enabled / ON

2.3.4 RS-485 Driver Replacement

RS-485 lines in heavy industrial environments are sometimes subjected to magnetic disturbances causing sufficient inducted power surges to damage the driver integrated circuit (IC). This IC U4 has a socket on the circuit card for ease of replacement in the field.

2.3.5 Relays Output

QVRF is equipped with two Single-Pole Double-Throw (SPDT) Relays on board, which can make it work alone to control other equipment, such as fans, lights, horns, or visual alarm indicators in different applications.

Switching capability of each relay TB3/TB4 is:

- 1.0 A maximum resistive load at 30 VDC

- 0.3A maximum resistive load at 125VAC
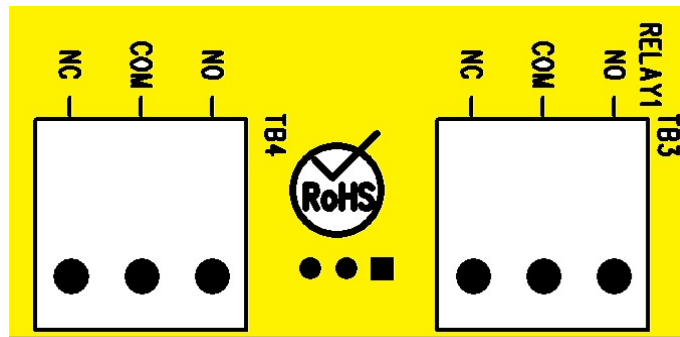
Both relay terminals have normally open, common, and normally closed (NO, COM and NC) connections and can accommodate a wire size 12 to 24 AWG.

3. Function and Configuration

3.1 System Initialization

When the QVRF is turned on, it initializes hardware and software. As the QVRF is through an internal self-test procedure, the LED indicator will flash green. When the QVRF is ready for detection, the LED indicator will turn to solid green.

3.2 Alarm Settings

- Alarm set point is factory set and sealed with no field adjustment as required by IEC 60335-2-40
- Alarm is ON when gas concentrations > 20%LFL
- Alarm is OFF when gas concentrations < 15%LFL

3.3 Status LED indicator

LED Status	Description
Flash Green	Warm up and internal self-test procedure or in purge cycle
Solid Green	Normal operation and no alarm and fault
Blink Green	When the QVRF is connected to a Controller System through RS-485, it indicates the data stream received and replied between the QVRF and the Controller.
Flash Yellow	Sensor Fault (Sensor Offline, End of life, Overflow, Signal Error)
Flash Red	Alarm is ON

3.4 Relays and Beeper Performance

- Relay1 is activated when Alarm is on or sensor fault
- **Relay1 will remain ON for 5 minutes after the alarm has reset to maintain the purge cycle which is required by the IEC/UL 60335-2-40, so the Relay1 can be used to switch on circulation fans to meet the requirements in Annex GG and LL of IEC/UL 60335-2-40**
- Relay2 is activated only when found sensor fault
- Beeper constant beeping when Alarm is on
- Beeper chirp once every 3 seconds when in purge cycle
- Beeper chirp twice every 10 seconds when found sensor fault

3.5 QVRF DIP Switch S1 Settings

SW-1	SW-2	SW-3	SW-4	SW-5	Address
OFF	OFF	OFF	OFF	OFF	0
ON	OFF	OFF	OFF	OFF	1
OFF	ON	OFF	OFF	OFF	2
ON	ON	OFF	OFF	OFF	3
OFF	OFF	ON	OFF	OFF	4
ON	OFF	ON	OFF	OFF	5
OFF	ON	ON	OFF	OFF	6
ON	ON	ON	OFF	OFF	7
OFF	OFF	OFF	ON	OFF	8
ON	OFF	OFF	ON	OFF	9
OFF	ON	OFF	ON	OFF	10
ON	ON	OFF	ON	OFF	11
OFF	OFF	ON	ON	OFF	12
ON	OFF	ON	ON	OFF	13
OFF	ON	ON	ON	OFF	14
ON	ON	ON	ON	OFF	15
OFF	OFF	OFF	OFF	ON	16
ON	OFF	OFF	OFF	ON	17
OFF	ON	OFF	OFF	ON	18
ON	ON	OFF	OFF	ON	19
OFF	OFF	ON	OFF	ON	20
ON	OFF	ON	OFF	ON	21
OFF	ON	ON	OFF	ON	22
ON	ON	ON	OFF	ON	23
OFF	OFF	OFF	ON	ON	24
ON	OFF	OFF	ON	ON	25
OFF	ON	OFF	ON	ON	26
ON	ON	OFF	ON	ON	27
OFF	OFF	ON	ON	ON	28
ON	OFF	ON	ON	ON	29
OFF	ON	ON	ON	ON	30
ON	ON	ON	ON	ON	31

SW-6	Protocol
OFF	OptoMux protocol
ON	Modbus protocol

SW-7	SW-8	Baud Rate
OFF	OFF	4800 bps
ON	OFF	9600 bps
OFF	ON	19200 bps
ON	ON	38400 bps

S1
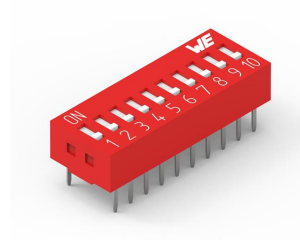
Default: Address 3, OptoMux, Baud rate: 4800bps

4. Zero and Span Calibration

- **Each QVRF is factory calibrated for the specific gas to meet the specifications.**
- **Ensure sensing inlets are not clogged and are free of debris.**
- **The QVRF is maintenance free and has a built-in self-correcting ABC algorithm. But in accordance with local code requirements, it's recommended to test or calibrate at least annually or a proper calibration strategy required by local code requirements.**
- **Before Zeroing and Span Calibration, the QVRF should be powered up at least 60 min for stabilization.**
- **Zeroing Calibration and Span Calibration can only be done through the PC software QVRF-Mate.**

4.1 Equipment Required

- A cylinder of Zero Gas: it can be clean room air or Zero Air (20.9% Oxygen in Nitrogen or pure Nitrogen)
- A cylinder of Cal Gas (50%LFL R32 balanced with **NITROGEN**)
- Flow Limiting Regulator(s) **0.4 to 0.6 lpm**
- Tubing

4.2 Install and Run QVRF-Mate

- Run software QVRF-Mate on your PC or laptop
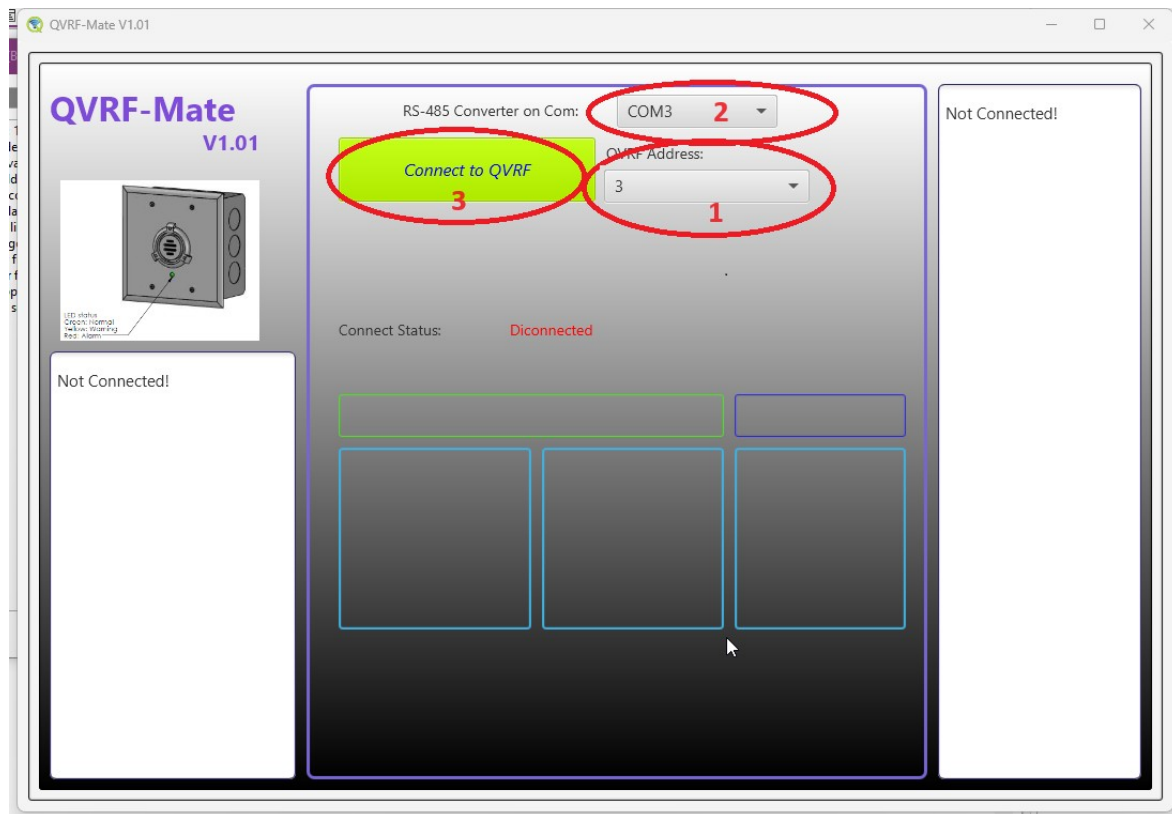
- Plug a USB to RS-485 Converter to the PC

- Connect the "USB to RS-485 Converter" to QVRF TB2

- Set the "QVRF Address" to 3 shown as above screenshot, or the address that the QVRF DIP-SW 1-5 address settings

- Select the PC COM Port that the PC assigned to the USB to RS-485 Converter

- Click the Button <Connect to QVRF>
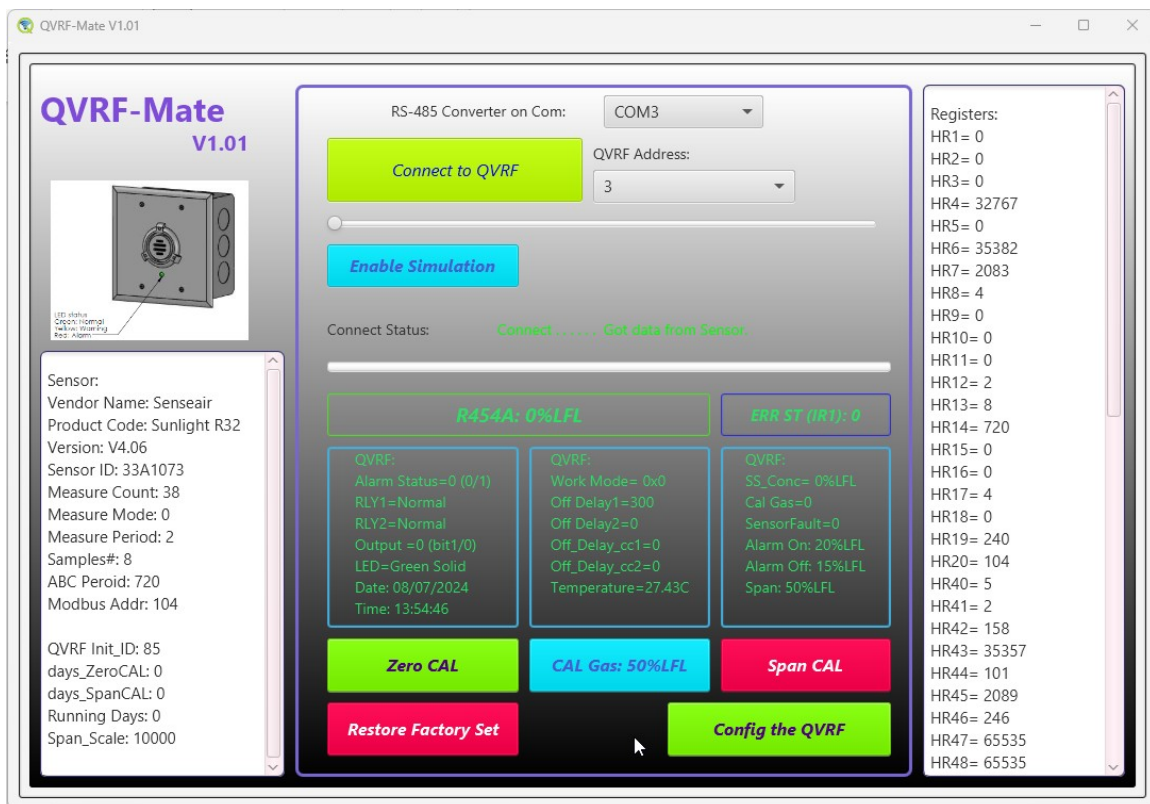
4.3 Zeroing Calibration

Note: Zeroing Calibration must be performed before Span Calibration.

- Apply Zero Gas

- Wait for about 1- 3 minutes or till the reading is stable

- Click Button <Zero CAL> and confirm you want to do Zero CAL

- QVRF is zeroing, it will take 10 to 30 seconds to finish

- Make sure there is no Cal Error displayed

- Remove gas.

4.4 Span Calibration:

- Click Button <CAL Gas> first to set the CAL Gas: 50%LFL

- Apply CAL GAS: 50%LFL R32

- Wait for about 1- 3 minutes or till the reading is stable

- Click Button <Span CAL> and confirm you want to do Span CAL

- When the span calibration is finished, it will display the gas reading

- Make sure there is no Cal Error displayed

- Remove gas

5. MODBUS Protocol Supported By QVRF

5.1 Serial Transmission Mode

- Modbus RTU Slave Mode
- Baud rate: 4800, 9600, 19200 and 38400 (bps)
- Byte parity: None parity
- Data format: One start bit, 8 data bit, (one parity bit), one stop bit, LSB first.
- Frame Check: CRC check.

5.2 Function Code

- **#03   Read Holding Registers**

Function: Read inputs and outputs statuses and readings, such as

- Sensor readings and statuses
- Relay / Buzzer Statuses

Attribute: Read Only.
Broadcast is not supported.

Query:

Slave Address:	xx (0 – 30)
Function code:	03
Starting addr. Hi:	000
Starting addr. Lo:	xxx (00 to 15)
No. of points Hi:	000
No. of points Lo:	xxx (01 to 16)
CRC check:	xxxxH

Example: to read all holding registers (Address: 0x01)
    Query: [001] [003] [000] [000] [000] [004] [068] [009] in unsigned decimal.

Holding Register Address Table

Modbus	Name	Description
40001	Transmitter Status	Status Byte Definition: Value = 0: Normal • b0: reserved • b1=1: Sensor 3.3V is low • b2=1: Sensor Offline • b3=1: Sensor Signal Error • b4: reserved • b5=1: Calibration Error • b6=1: Overflow Error • b7: reserved • Others: N/A
40002	Gas Reading	The Gas Reading is 16 bits signed integer.
40003	Relay / Buzzer Status	Relay / Buzzer Status Byte Definition: bit = 1: ON, bit = 0: OFF • b0: Relay 1 and Buzzer Status. • b1: Relay 2 Status. • Others: N/A
40004	Alarm On	Relay1 and Buzzer Actuation On concentration
40005	Alarm Off	Relay1 and Buzzer Actuation Off concentration
40006	Detect Range	The QVRF detection range
40007	QVRF Version	• High version number is in high 8 bits. • Low version number is in low 8 bits.
40008	Sensor Version	• High version number is in high 8 bits. • Low version number is in low 8 bits.
40009 to 40011	Gas Name	Gas Name
40012 to 40013	Gas Unit	Gas Unit
40014	Running Days	The QVRF running days since first power-up
40015	Days since last Zero CAL	Days since last Zero Calibration
40016	Days since last Span CAL	Days since last Span Calibration

- **#05**   **Write Single Coil**

Function: is used to write a single output to either ON or OFF
- Relay1, Relay 2: Address 0, Address 1

Attribute: Write Only.
Broadcast is not supported.

The requested ON/OFF state is specified by a constant in the request data field. A value of FF 00 hex requests the output to be ON. A value of 00 00 requests it to be OFF. All other values are illegal and will not affect the output.

The Request PDU specifies the address of the coil to be forced. Coils are addressed starting at zero. Therefore coil numbered 1 is addressed as 0. The requested ON/OFF state is specified by a constant in the Coil Value field. A value of 0XFF00 requests the coil to be ON. A value of 0X0000 requests the coil to be off. All other values are illegal and will not affect the coil.

The normal response is an echo of the request, returned after the coil state has been written.

Note: The function will override the Transmitter Relay/Buzzer state. The forced state will remain valid until the manually reset of output is performed by pressing and hold Key [ESC] for 3 seconds.

Query:
    Slave Address: xx
                          (Check Address in [Menu]-->[System Setting]-->[Address])
    Function code: 05
    Output addr. Hi: 000
    Output addr. Lo: xxx (000 to 001)
    Output Value Hi: 255 or 000
    Output Value Lo: 000
    CRC check: xxxxH

Response:
    Slave Address: xx (Address)
    Function code: 05
    Output addr. Hi: 000
    Output addr. Lo: xxx (000 to 001)
    Output Value Hi: 255 or 000
    Output Value Lo: 000
    CRC check: xxxxH

6. WARRANTY STATEMENT

The information contained in this manual is based upon data considered accurate; however, no warranty is expressed or implied regarding the accuracy of this data. All GES equipment is warranted against defects in material and workmanship for a period of two years from date of shipment with the following exceptions:

Electrochemical Sensors (Toxic)   Six Months
Catalytic Sensors (Combustible)   One Year

During the warranty period we will repair or replace, at our discretion, any components or complete units that prove, in our opinion, to be defective. We are not liable for consequential or incidental damage to auxiliary interfaced equipment.

A returned material authorization number should be obtained from the factory prior to returning any goods. All return shipments must be shipped freight prepaid and a copy of the maintenance records should accompany the unit concerned.

Warranty should be considered F.O.B. the factory. Labour and travel time are chargeable for any field site visits required for warranty work.

LIMITED LIABILITY

All GES systems shall be installed by a qualified technician/electrician and maintained in strict accordance with data provided for individual systems in the form of installation/maintenance manuals. GES assumes no responsibility for improper installation, maintenance, etc., and stresses the importance of reading all manuals. GES shall not be responsible for any liability arising from auxiliary interfaced equipment nor any damage resulting from the installation or operation of this equipment.

GES's total liability is contained as above with no other liability expressed or implied, as the purchaser is entirely responsible for installation and maintenance of systems.

This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for GES any liability in connection with the sales of our products other than that set forth herein.

NOTE: Due to on-going product development, GES reserves the right to change specifications without notice and will assume no responsibility for any costs as a result of modifications.

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