GFC319 Steam Flow Computer

FEATURES

- **CALCULATES VOLUME, MASS, ENTHALPY, FLOW RATE, HEAT RATE, NET HEAT, DELTA HEAT (SATURATED ONLY), FLOW TOTAL AND HEAT TOTAL OF SATURATED OR SUPERHEATED STEAM**
- **FLOW INPUT – UNIVERSAL PULSE WITH 24VDC / 20 mA POWER FOR THE SENSOR, OR 4-20 mA LOOP POWER, 0.01% FS**
- **30 POINTS LINEARIZATION FOR THE PULSE INPUT**
- **TEMPERATURE INPUT CONNECTS DIRECTLY TO Pt100 RTD (0 TO 420 °C), 3 WIRE CONNECTION**
- **PRESSURE INPUT, LOOP POWER 4-20 mA, 0.01% FS**
- **SECOND TEMPERATURE INPUT (FOR DELTA HEAT) CONNECTS DIRECTLY TO Pt100 RTD, 3 WIRE**
- **ISOLATED ANALOG OUTPUT 0.05% FS, ACTIVE OR PASSIVE 0-20 mA, 4-20 mA, 0-5V, 0-10V, 1-5V, 2-10V, FIELD CONFIGURABLE**
- **ISOLATED PULSE OUTPUT UP TO 10 kHz OPEN DRAIN OR 5V SQUARE WAVE, FIELD CONFIGURABLE**
- **TWO ALARMS, 250VAC / 5 A ALARM RELAY WITH PROGRAMMABLE HYSTERESIS**
- **SEVEN DIGIT RATE, EIGHT DIGIT TOTAL**
- **SEPARATE UNITS FOR RATE AND TOTAL**
- **PROGRAMMABLE DECIMAL PLACES**
- **85-250 VAC, OR 12VDC OR 24 VDC, ALL WITH HIGH ISOLATION, SURGE, REVERSE POLARITY, UNDER-VOLTAGE, OVER-CURRENT AND SHORT CIRCUIT PROTECTION**
- **BRIGHT TRANSMISSIVE COLOR GRAPHIC DISPLAY WITH A WHITE LED BACKLIGHT**
- **FULLY COMPLIANT, PROGRAMMABLE RS485, 1/8 LOAD, MODBUS RTU FOR BAUD RATES UP TO 115 200**
- **SCROLL DROP LIST MENUS, SIMPLE TO USE**
- **MULTILEVEL MENUS, THE FIRST CAN BE LOCKED**
- **DIN 96x96mm PANEL MOUNT ENCLOSURE**
- **Weight 308 g (10.9 oz)**
- **ALL SOFTWARE OPTIONS CAN BE ENABLED ON THE FIELD WITH PASSWORDS**
- **VERY EASY TO PROGRAM AND USE**

APPLICATIONS

- **FLOW RATE, FLOW TOTAL, HEAT RATE, NET HEAT, DELTA HEAT AND HEAT TOTAL OF STEAM MEASUREMENT AND CONTROL**
- **SCADA**

1. DESCRIPTION

GFC319 is a steam flow computer that can be field upgraded later with passwords to the full functionality.

It can measure volume, mass, flow rate, flow total, enthalpy, heat rate, net heat, delta heat and heat total of steam.

The flow signal can be pulse open drain / collector, npn, pnp, reed switch, waves, dry contact, logical signals and coils without an external preamplifier. The flow signal can also be analog linear to the flow rate or a differential pressure signal that needs a square root extraction.

When measuring delta heat of saturated steam a second temperature input is available automatically.

The temperature and pressure can be set manually if no sensors are being used.

The steam density is very accurately calculated in a large temperature and pressure range. Enthalpy, heat rate, net heat, delta heat and heat total are calculated and displayed along with other useful parameters.

Separate volume or mass units can be chosen for rate and total.

Using the fast RS485 MODBUS communication all parameters can be read remotely many times a second.

A variety of isolated high accuracy programmable outputs can connect GFC319 to any device. Each output can represent many calculated parameters.

Drop list color menus that you scroll are very intuitive and easy to use.

Icons for disconnected analog input for flow, broken wire or shorted RTD, alarms, pulse output or communication are displayed along with a horizontal bar representing the analog output.

There is a special test menu where very easily all inputs and outputs can be checked and precisely tested.

2. ABSOLUTE MAXIMUM RATINGS *

Operating temperature	-20 °C to +70 °C
Power:	
AC version	264 VAC, 47-400 Hz
12 VDC version	18 VDC
24 VDC version	36 VDC
Alarm relay current	5 A / 250 VAC , 5A / 30 VDC
Pulse output current, open drain	100 mA DC
Pulse output voltage, open drain	100 V
Voltage for the an. output, 4-20 mA loop power, passive	42 VDC
Current for the pulse input sensor	20 mA DC

*** NOTICE: Stresses above those ratings may cause permanent damage to the device.**

3. CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Power Supply	**High isolation, surge, over-voltage/current protected**				
AC voltage option	47 – 400 Hz	85		250	VAC
Isolated 12 VDC option	Reverse polarity protected	9	12	18	VDC
Isolated 24 VDC option	Reverse polarity protected	18	24	36	VDC
Power Consumption	**Efficiency over 77%**				
85-250 VAC version	115 VAC, 60 Hz			5	VA
Pulse Input					
Voltage for the sensor	Regulated, filtered and protected, max 20 mA		24		V DC
Input threshold, high	Rectangular wave 3.3 V, 50 % duty cycle		1.86		V
Input threshold, low	Rectangular wave 3.3 V, 50 % duty cycle		1.44		V
Coil voltage	Symmetrical signal from the coil (sine, triangle, saw etc)	20			mVpp
Input frequency range	Rectangular wave 3.3 V, 50 % duty cycle	0 - 10			kHz
Pressure input					
Voltage for the loop	Regulated, filtered and protected		24		VDC
Input resistance	25 °C		157		ohm
Full scale error	25 °C, 4 – 20 mA		0.01	0.03	% FS
Temperature coefficient	-20 °C to +70 °C			25	ppm/°C
Temperature input					
Wiring	3 (or 2) wire connection				
RTD	Pt100, alpha = 0.00385				
Range	0 to 420 ºC				
Temperature 2 input					
Wiring	3 (or 2) wire connection				
RTD	Pt100, alpha = 0.00385				
Range	0 to 200 ºC				
Output, 4-20 mA	Loop power, passive, 2 wire				
Maximum load, passive	36V external power to the loop, Note 1	1575			ohm
Maximum load, active	no external power to the loop, Note 1	925			ohm
Power supply, passive	-20 °C to +70 °C, Note 1	4.5		36	V DC
Resolution	-20 °C to +70 °C, 4.5 – 36 V		1		uA
Error	250 ohm load, 24 V, 25 °C		0.05		% FS

Power supply error	4.5 - 36V, 4.000 mA, 25 °C		0.02		uA/V
Temperature coefficient	-20 °C to +70 °C, 24 V		35		ppm/°C
Output, 0–5/10 V	No external power required, 2 wire				
Resolution			0.3/0.6		mV
Minimum load for 0-5V		500			kohm
Minimum load for 0-10V		1			Mohm
Pulse Output, open drain	**High isolation, reverse polarity to 100 mA protected, 2 wire**				
Output ON resistance	-20 °C to +70 °C, 100 mA			1.5	ohm
Output OFF leakage	-20 °C to +70 °C, 100 V DC			1	uA
Maximum frequency	The durations of the pulse and the pause are equal	10	11.1		kHz
Pulse Output, wave	**High isolation, 5 V square wave, 2 wire**				
Protection resistor	Built-in resistor in series, to protect the output		510		ohm
Relay contact	**Normal open**				
Current	30 VDC or 250 VAC, resistive load			5	A
RS485	**2 wire**				
Load	1/8 of the standard RS485 driver load		1/8		
Enclosure	**DIN 96x96 panel mount**				

Note 1: The minimum voltage for the 4-20 mA passive output to operate is V = 4.5 + R load [ohm] * 0.020 [V DC]
For a GFC319 with a load of 250 ohm, the minimum voltage would be 9.5 V DC.
When active the output can work with a load up to 925 ohm

3.1. BUTTONS

There are four buttons: **SET** , **UP**, **LEFT** and **DOWN** arrows**.**

- **SET** is used to enter and exit menus and confirm options chosen
- **UP** is used to scroll up or increment
- **DOWN** is used to scroll down or decrement
- **LEFT** is used to move the cursor (blinking digit or icon) to the left or return to a previous menu

There are two types of buttons accepted by the GFC319 flow computer:

- Short is when the button is pressed and released in less than 0.5 second
- Long is when it is kept pressed for more than 5 seconds
- All other durations are ignored

NOTE: The UP and DOWN buttons will not change the digit at the cursor if the settings are locked.

3.2. INPUTS

GFC319 is shipped with its full hardware. Parts of the software that you did not order are disabled. You pay only for the parts that you ordered, but you can upgrade later very quickly.

Example: You need a flow computer now without outputs. You pay for that only. Later you decide to connect the device to a PLC, SCADA or other devices or systems. Just by calling or e-mailing G Instruments you receive special passwords. You enter these passwords in a special menu and the functions (outputs) are enabled in a couple of minutes. No interruption whatsoever to your application.

All outputs are isolated each other, from the inputs and from the power. The inputs are not isolated each other.

- Pulse input from flow sensors in volume units. This input can power the sensor with 24 VDC and accepts open drain/collector npn/pnp sensors, reed switches, dry contacts, different types of waves, logical signals and coils. There is no need for external amplifiers for the coils or linearizers. This input can be linearized with a curve (calibration table) of up to 30 points.

  The flow signal must be proportional to the volume (in volume units).

- Using the DIP switches bellow the lower row of terminals the same input can be switched to accept analog 4-20 mA signal that can be linear to the volume flow rate or a differential pressure signal that needs square root extraction to calculate the volume flow rate.

  The "flow input type" menu must be properly set for the input chosen above.

- GFC319 has a temperature input that accepts directly Pt100 RTD, 2 or 3 wire connection.

- It also has a 4-20 mA input for pressure.

- When measuring delta heat of saturated steam a second Pt100 RTD input is available to measure the temperature of the condensate after the heat exchanger. This input is available at the terminals for pressure, just by configuring 2 jumpers.

3.3. OUTPUTS

GFC319 has one isolated universal analog, one isolated pulse and two relay outputs.

3.3.1. Isolated Analog output

It can be passive or active 0-20 mA, 4-20 mA or 0 – 5 V, 0 – 10 V, 1-5V, 2-10V. The voltage options do not need external power and use two wires. It can be programmed to represent the flow rate, temperature, pressure and others. **SET4** is the rate (temperature, pressure, heat rate ...) at 4 mA (0V for voltage output). **SET20** is the rate at 20 mA (5V or 10V). Configuring the type of the output is done using 2 jumpers only next to the terminals for the analog output.

Example: You program **SET4** = 1000 GPM and **SET20** = 320 GPM. Then the analog output will be inverse and change from 20 mA down to 4 mA when the flow rate changes from 320 to 1000 GPM.

3.3.2. Isolated Pulse output

The pulse output can be open drain 100V / 100 mA, sinking (npn) with reverse polarity for up to 100 mA protection. It can also be 5V square wave output. Switching between both is done using 2 jumpers only next to the terminals for the pulse output.

SETP parameter means how many gallons (other volume, mass or heat units) have to pass through the meter in order GFC319 output to produce one pulse.

Example: If **SETP** = 10.0, the output will produce one pulse at every 10 gallons (lbs, CF, tons etc) **SETP** has to be set in a way ensuring the frequency of the pulses will not exceed 10 kHz. Otherwise the frequency will be limited by GFC319 and some pulses may be lost.

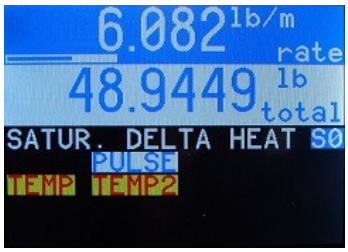
3.3.3. Alarm Relay outputs

GFC319 has 2 alarm relays. The alarms can be triggered by flow rate, heat rate, temperature, pressure or others. The **ALARM (1 or 2)** settings need to be set. The alarms can be set to be **HIGH** or **LOW** with a **HYSTERESIS (1 or 2)** in percents.

Example: **ALARM 1** = 100 GPM, alarm type is **HIGH**, the **HYSTERESIS 1** = 20%. The relay contact will close when the flow rate reaches 110 GPM and will open when it falls bellow 90 GPM. Hysteresis of 20 % means 10 % above and 10 % below the **ALARM 1** setting.

3.4. DISPLAY

It is a bright color graphic transmissive display with a white LED back light. There are 2 screens – S0 and S1.



The first screen S0 shows rate and total, the equation chosen and icons for the analog inputs and all outputs. It also shows a horizontal bar graph for the analog output. Rate is 7 digits, the total is 8 digits.

On the second screen S1 the display shows the flow input, temperature, pressure, uncorrected flow rate, density, enthalpy, heat rate, net heat, delta heat, total heat and others, depending on the equation chosen. If the flow input is analog the display will show mA or differential pressure. If the flow input is pulse the display will show frequency in Hz.
All values on both screens are updated twice a second.
Switching between the screens is by pressing **UP** or **DOWN** arrow.

3.4.1. Menus

There are a few levels of menus. The first level is designed to be used by the end user or not skilled personnel. All more important settings are hidden in the upper level menus. The first level menu can be locked. Then the user can only see but not change the settings in that menu.

3.4.1.1. First Level Menu

Entering the first level menu is by pressing and holding for 5 seconds the **SET** button. The first menu will appear.

Using **UP** and **DOWN** buttons choose the setting you want to see or change and press **SET**. The current value of that setting will appear and the decimal point will be blinking. You can increase or decrease the decimal places by pressing **UP** or **DOWN** while the decimal point is blinking. Pressing **LEFT** will move the cursor to the left. When finished press **SET**.

NOTE: The software will not accept zero for KFACTOR or SETP.

If **ABOUT** is chosen a new screen will appear and show the version, the serial number of GFC319 and all software options enabled. Press any button to go back to the first menu.

Test menu can not be entered at all if the first level menu is locked. If it is not locked the test menu will appear and all inputs and outputs can be tested. To enter the test menu you need to press **SET** and hold it for 5 seconds.

TEST
ALARM 1 ON
ALARM 1 OFF
ALARM 2 ON
ALARM 2 OFF
1000 PULSES
AN. OUTPUT
SHOW INPUTS

Choosing 1000 pulses item will produce exactly 1000 pulses on the pulse output with a frequency of 100 Hz.
Choosing **SHOW INPUTS** will show the flow input (current or frequency), the temperature input and the the pressure (temp. 2) input.
To test the analog output choose **AN. OUTPUT**. A new menu will appear.

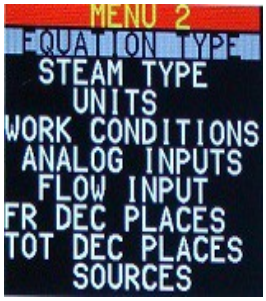
AN. OUTPUT
0 %
25 %
50 %
75 %
100 %

When finished press **LEFT** to return to the first menu and press **LEFT** one more time to exit this first level menu and return to the normal mode. GFC319 will store all settings automatically.

NOTE: There is a time out which will reset the flow computer and all changes will be lost. They will be stored only when you exit all the menus (by pressing LEFT) and return to the normal mode.

3.4.1.2. Hidden Menus

Enter the first level menu as described in **3.4.1.1.** Scroll down to **SETP**. Press and hold for 5 seconds the **LEFT** button. Then there will be a time slot of 3 seconds to release **LEFT**, press shortly **SET** and **LEFT** again. The first hidden menu (**second menu**) will appear:



- In the Equation Type menu volume, mass, net heat or delta heat can be chosen. Delta heat is available only for saturated steam.
  STEAM VOLUME will calculate the volume only of the steam without any corrections.

  Saturated steam mass:
  MASS and **NET HEAT of saturated steam** equations need temperature and quality of the steam. **DELTA HEAT** needs a second temperature – the temperature of the condensed steam (water) after the heat exchanger. The pressure input will be used as input for this second temperature. GFC319 will very accurately calculate the density, the mass of the steam, its enthalpy, net heat (delta heat) rate and will accumulate it in the heat total.

  Superheated steam mass:
  MASS and **NET HEAT** equations need both **temperature and pressure** of the steam. GFC319 will not allow you to choose superheated steam if **DELTA HEAT** equation has been chosen. It will very accurately calculate the density, the mass of the steam, its enthalpy, net heat rate and will accumulate it in the heat total.

- In the steam type menu choose between saturated and superheated steam. If you chose delta heat above GFC319 will not allow you to choose superheated steam.

- A variety of volume, mass, time, temperature, pressure, differential pressure and density units can be chosen in the **UNITS** menu.

- In **WORK CONDITIONS** menu manual temperature, manual pressure, atmospheric pressure, failsafe values for temperature, pressure, flow rate can be entered. The quality (dryness) of saturated steam can also be entered.

  TIP: ***All analog inputs have a failsafe value. It will be used automatically if the sensor gets disconnected or shorted. Always program those failsafe values.***

  Manual temperature and / or pressure can be used if you do not want to use a sensor for them.
  Atmospheric pressure is needed for measuring superheated steam if the pressure sensor is for gauge pressure.
  Steam quality (dryness) is used for measuring mass of saturated (wet) steam. Dry steam has 1.0 for quality, liquid phase only has 0.0 quality. A typical value in practice can be around 0.95 .

- **ANALOG INPUTS** menu is the place where you need to enter the pressure, flow rate and the differential pressure at 4 mA and at 20 mA. A cut-off in percents for the analog flow input can also be entered in this menu.

- The choices in the **FLOW INPUT** menu are:
  - pulse with a **KFACTOR**. A valid **KFACTOR** must be entered in the first menu.
  - pulse with a calibration curve (table) of up to 30 points. The software will allow this choice only if the option **C** is enabled. In this case a valid calibration curve must be entered prior to using the flow computer.
  - analog 4-20 mA linear to flow rate, in flow rate units. Neither KFACTOR nor curve data is needed.
  - analog 4-20 mA coming from a differential pressure sensor (in delta P units) that needs a square root extraction in order to get the flow rate.
    The KFACTOR will be used to calculate the flow rate according to the equation

    Flow Rate = KFACTOR * square_root(differential pressure)

- In r**ate and total decimal places** menus you can choose from none to 4 decimal places or AUTO.

- In the **SOURCES** menu:
  - In the **TEMPERATURE and TEMPERATURE 2 SOURCE** menus you choose between manual entered temperature or a temperature from a Pt100 RTD connected to the terminals.

  - The **PRESSURE SOURCE** can be a manually entered pressure or a signal from a pressure sensor. It must be 4-20 mA loop power and linear to pressure. Pressures at 4 and at 20 mA have to be entered in the **ANALOG INPUTS** menu.

  - In the **ALARM 1 (2)** and **AN. OUT source** menu you can choose between flow rate, temperature, pressure or heat rate.

  - In the **PULSE OUT source** menu choose between flow total and heat total.

  - To **CLEAR A TOTAL** press **SET** button and hold it for 5 seconds while on that line of the menu.

  - The **ALARM TYPE** can be high or low. **High** means the relay contact will close when the variable is above the alarm setting plus half of the hysteresis. The contact will open when the variable is lower than the alarm set point minus half of the hysteresis. For **low alarm** the action is reversed.

  - In the **CURVE POINTS** menu a calibration table for the flow meter can be entered. This way the flow meter linearity, accuracy and turn down ratio can be greatly improved. Each point consists of a frequency in [Hz] and a KFACTOR for the flow meter at that frequency. If all 30 points are entered the software will automatically return to the previous menu. If the points are less than 30, enter zero for both the frequency and the KFACTOR to indicate that no more points will be entered. The software will sort the points and validate them.

    NOTE: The software will not accept zero for a KFACTOR unless the frequency entered before it is also also zero.

  - In the **FILTER/RESPONSE** menu a digital filter (damping) can be programmed. The least damping corresponds to the fastest response and the highest filtering – to the slowest response. There is also an **AUTO** setting that will provide both high filtering and fast response.

  - RS485 communication protocol is MODBUS RTU. The **MODBUS address**, the **baud rate** and the **parity** can be easily programmed.

  - In the **LOCK/UNLOCK** menu the first menu can be locked so all settings there can only be

viewed but not changed.

- In the **AN. OUT CFG** choose 4-20 mA if you want the output to be 4-20 mA, or 1-5V, or 2-10V Choose 0-20 mA for 0-20 mA, or 0-5V, or 0-10V.

  DO NOT FORGET to c change the jumpers on the back, next to the analog output terminals accordingly. Different type of output also requires different wiring.

- The options that you purchased later can be enabled using the menu **OPTIONS EN**. The software will not allow you to enter a password for an option that you already have. For the newly purchased options you have to enter the passwords that you received from G Instruments. There is a separate password for for each option.

  The options that can be enabled at the time of order at the factory or by passwords later in the field are:

  O = ANALOG OUTPUT
  P = PULSE OUTPUT
  A = ALARM 1
  R = ALARM 2
  B = MODBUS COMM.
  C = PULSE CURVE

  GFC319 will have full hardware for all of the above options but the software for them will be enabled or disabled. If ordered at the time of the purchase of GFC319, they will be enabled by the factory. If you want to purchase some option(s) later, contact G Instruments to receive a special password for each option which will allow you to upgrade in a couple of minutes without interrupting the work of your equipment and without the need to disconnect, uninstall and ship your GFC319 to the factory.

NOTE: There is a time out which will reset the flow computer and all changes will be lost. They will be stored only when you exit all the menus (by pressing LEFT) and return to the normal mode.

NOTE: All totals are stored in the non-volatile memory every 50 seconds.
Before powering down the flow computer make sure that there was no flow for the last minute. All important settings are stored in a non-volatile memory and will not be lost.

3.5. COMMUNICATION

GFC319 has a RS485 two wire communication port with high surge and transients protection.
The communication protocol is MODBUS RTU. The MODBUS address, the baud rate and the parity are programmable. Stop bits are programmable only if the parity is none.

MODBUS standard requires two stop bits with no parity and one stop bit with even or odd parity.

Shorting the termination jumper next to the terminals connects a 120 ohm 0.5W resistor between A (D+) and B (D-). This is needed only if GFC319 is at the very end of the buss and/or far from the MODBUS master. For better quality of communication and achieving higher baud rates a shielded twisted pair (STP) should be used.

The RS485 port is not isolated from the inputs of GFC319, but it is isolated from the power and all outputs.

The MODBUS software of GFC319 supports functions 0x03 (read holding registers) and 0x04 (read input registers). Exceptions 1, 2, 3 and 6 are handled.

Register Address	***Register Type***	***Read/Write***	***Description***	***Format***
80	Input	R	Rate volume unit	NOTE 2
81	Input	R	Total volume unit	NOTE 2
82	Input	R	Time unit	NOTE 5
83	Input	R	Mass rate unit	NOTE 3
84	Input	R	Mass total unit	NOTE 4
85	Input	R	Temperature unit	NOTE 7
86	Input	R	Pressure unit	NOTE 8
87	Input	R	Density unit	NOTE 9
88	Input	R	Differential pressure unit	NOTE 10
89	Input	R	Heat Rate unit	NOTE 11
90	Input	R	Heat Total unit	NOTE 12
91	Input	R	Equation	NOTE 6
94	Input	R	Steam type	NOTE 13
120	Input	R	Uncorrected Flow Rate, High.	IEEE-754 floating point
121	Input	R	Uncorrected Flow Rate, Low.	NOTE 1
122	Input	R	Uncorrected Total, High.	IEEE-754 floating point
123	Input	R	Uncorrected Total, Low.	NOTE 1
124	Input	R	Temperature, High.	IEEE-754 floating point
125	Input	R	Temperature, Low.	NOTE 1
126	Input	R	Pressure / TEMP2, High.	IEEE-754 floating point
127	Input	R	Pressure / TEMP2, Low.	NOTE 1
128	Input	R	Corrected Flow Rate, High.	IEEE-754 floating point
129	Input	R	Corrected Flow Rate, Low.	NOTE 1
130	Input	R	Corrected Total, High.	IEEE-754 floating point
131	Input	R	Corrected Total, Low.	NOTE 1
132	Input	R	Density, High.	IEEE-754 floating point
133	Input	R	Density, Low.	NOTE 1
134	Input	R	Mass Flow Rate, High.	IEEE-754 floating point
135	Input	R	Mass Flow Rate, Low.	NOTE 1
136	Input	R	Mass Total, High.	IEEE-754 floating point
137	Input	R	Mass Total, Low.	NOTE 1
138	Input	R	Enthalpy, High.	IEEE-754 floating point
139	Input	R	Enthalpy, Low.	NOTE 1
140	Input	R	Heat Rate, High.	IEEE-754 floating point
141	Input	R	Heat Rate, Low.	NOTE 1
142	Input	R	Heat Total, High.	IEEE-754 floating point
143	Input	R	Heat Total, Low.	NOTE 1

Note 1: This is a IEEE-754 floating point number. High word contains the exponent and the most significant byte of the mantissa. The low

word contains the middle and the least significant byte of the mantissa. Both high and low must be read, merged and used like a IEEE-754 floating point number.

Note 2: 0 = gal, 1 = igal, 2 = ft^3, 3 = SCF, 4 = hL, 5 = m^3, 6 = MCF, 7 = AF, 8 = SCC, 9 = L, 10 = qts, 11 = bbl 31.0 gal, 12 = bbl 31.5 gal, 13 = bbl 36.0 gal, 14 = bbl 40.0 gal, 15 = bbl 42.0 gal, 16 = bbl 55.0 gal
Note 3: 0 = lb, 1 = kg, 2 = g, 3 = t, 4 = ts, 5 = tl (ton, ton short and ton long)
Note 4: 0 = lb, 1 = kg, 2 = g, 3 = t, 4 = ts, 5 = tl, 6 = hlb, 7 = klb, 8 = Mlb (hecto_lb, kilo_lb, mega_lb)
Note 5: 0 = per second, 1 = per minute, 2 = per hour, 3 = per day
Note 6: 0 = steam volume, 1 = steam mass, 2 = steam net heat, 3 = steam delta heat
Note 7: 0 = ^{O}C 1 = ^{O}F, 2 = ^{O}K, 3 = ^{O}R
Note 8: 0 = bara, 1 = kPaa, 2 = Mpaa, 3 = psia, 4 = atma, 5 = barg, 6 = kPag, 7 = MPag, 8 = psig, 9 = atmg
Note 9: 0 = kg/m^3, 1 = kg/dm^3, 2 = lb/gal, 3 = lb/ft^3
Note 10: 0 = inch, 1 = mbar
Note 11: 0 = kJ/h, 1 = MJ/h, 2 = GJ/h, 3 = kW, 4 = MW, 5 = Btu/h, 6 = kBtu/h, 7 = Mbtu/h, 8 = Gbtu/h, 9 = kCal/h, 10 = Mcal/h, 11 = Gcal/h
Note 12: 0 = kJ, 1 = MJ, 2 = GJ, 3 = kWh, 4 = MWh, 5 = Btu, 6 = kBtu, 7 = Mbtu, 8 = Gbtu, 9 = kCal, 10 = Mcal, 11 = Gcal
Note 13: 0 = saturated, 1 = superheated

4. APPLICATION

4.1. Steam volume

4.1.1. Pulse input with a KFACTOR

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a **KFACTOR** in pulses per total volume unit. You can connect a temperature sensor(s) and / or pressure sensor but they are not needed for the calculations.

4.1.2. Pulse input with a calibration curve (table)

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a calibration table. All **KFACTOR**s must be in pulses per total volume unit. Option **C** must be enabled. You can connect a temperature sensor(s) and / or pressure sensor but they are not needed for the calculations.

4.1.3. Analog input linear to flow rate

Connect the analog signal to the flow input and set the DIP switch for analog input.
Enter flow rate for 4 and for 20 mA in the **ANALOG INPUTS** menu.
You can connect a temperature sensor and / or pressure sensor but they are not needed for the calculations.

4.1.4. Differential pressure sensor

Connect the analog signal to the flow input and set the DIP switch for analog input. Enter a **KFACTOR**.
Enter differential pressure for 4 and for 20 mA in the **ANALOG INPUTS** menu.
You can connect a temperature sensor and / or pressure sensor but they are not needed for the calculations.

4.2. Steam mass and steam net heat

4.2.1. Pulse input with a KFACTOR

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a **KFACTOR** in pulses per total volume unit.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Connect a pressure sensor or enter a manual pressure and accordingly set the pressure source

in the **SOURCES** menu. Make sure the jumpers next to the terminals are for pressure sensor (not for RTD). Enter pressure for 4 and 20 mA in the **ANALOG INPUTS** menu if analog input has been chosen for pressure source.

4.2.2. Pulse input with a calibration curve (table)

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a calibration table. All **KFACTOR**s must be in pulses per total volume unit.
Option **C** must be enabled.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Connect a pressure sensor or enter a manual pressure and accordingly set the pressure source in the **SOURCES** menu. Make sure the jumpers next to the terminals are for pressure sensor (not for RTD). Enter pressure for 4 and 20 mA in the **ANALOG INPUTS** menu if analog input has been chosen for pressure source.

4.2.3. Analog input linear to flow rate

Connect the analog signal to the flow input and set the DIP switch for analog input.
Enter flow rate for 4 and for 20 mA in the **ANALOG INPUTS** menu.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu. Connect a pressure sensor or enter a manual pressure and accordingly set the pressure source in the **SOURCES** menu. Make sure the jumpers next to the terminals are for pressure sensor (not for RTD). Enter pressure for 4 and 20 mA in the **ANALOG INPUTS** menu if analog input has been chosen for pressure source.

4.2.4. Differential pressure sensor

Connect the analog signal to the flow input and set the DIP switch for analog input.
Enter differential pressure for 4 and for 20 mA in the **ANALOG INPUTS** menu. Enter a **KFACTOR**.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu.
  Connect a pressure sensor or enter a manual pressure and accordingly set the pressure source in the **SOURCES** menu. Make sure the jumpers next to the terminals are for pressure sensor (not for RTD). Enter pressure for 4 and 20 mA in the **ANALOG INPUTS** menu if analog input has been chosen for pressure source.

4.3. Steam delta heat

4.3.1. Pulse input with a KFACTOR

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a **KFACTOR** in pulses per total volume unit.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu. This sensor must measure the

steam temperature. Connect a second Pt100 temperature sensor to the pressure / TEMP2 terminals. This second (TEMP2) temperature sensor must measure the condensed steam (water) temperature after the heat exchanger. Make sure the jumpers next to the terminals are for RTD (not for pressure).
Enter the steam quality in the **WORK CONDITIONS** menu.

- **Superheated steam:** delta heat is not available for superheated steam

4.3.2. Pulse input with a calibration curve (table)

Connect the pulse signal to the flow input and set the DIP switches according to the wiring diagrams in paragraph **4.4.1.** Enter a calibration table. All **KFACTOR**s must be in pulses per total volume unit.
Option **C** must be enabled.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu. This sensor must measure the steam temperature. Connect a second Pt100 temperature sensor to the pressure / TEMP2 terminals. This second (TEMP2) temperature sensor must measure the condensed steam (water) temperature after the heat exchanger. Make sure the jumpers next to the terminals are for RTD (not for pressure).
  Enter the steam quality in the **WORK CONDITIONS** menu.

- **Superheated steam:** delta heat is not available for superheated steam

4.3.3. Analog input linear to flow rate

Connect the analog signal to the flow input and set the DIP switch for analog input.
Enter flow rate for 4 and for 20 mA in the **ANALOG INPUTS** menu.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu. This sensor must measure the steam temperature. Connect a second Pt100 temperature sensor to the pressure / TEMP2 terminals. This second (TEMP2) temperature sensor must measure the condensed steam (water) temperature after the heat exchanger. Make sure the jumpers next to the terminals are for RTD (not for pressure).
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** delta heat is not available for superheated steam

4.3.4. Differential pressure sensor

Connect the analog signal to the flow input and set the DIP switch for analog input.
Enter differential pressure for 4 and for 20 mA in the **ANALOG INPUTS** menu. Enter a **KFACTOR**.

- **Saturated steam:** Connect a Pt100 temperature sensor or enter a manual temperature and accordingly set the temperature source in the **SOURCES** menu. This sensor must measure the steam temperature. Connect a second Pt100 temperature sensor to the pressure / TEMP2 terminals. This second (TEMP2) temperature sensor must measure the condensed steam (water) temperature after the heat exchanger. Make sure the jumpers next to the terminals are for RTD (not for pressure).
  Enter the steam quality in the **WORK CONDITIONS** menu

- **Superheated steam:** delta heat is not available for superheated steam

4.4. ELECTRICAL

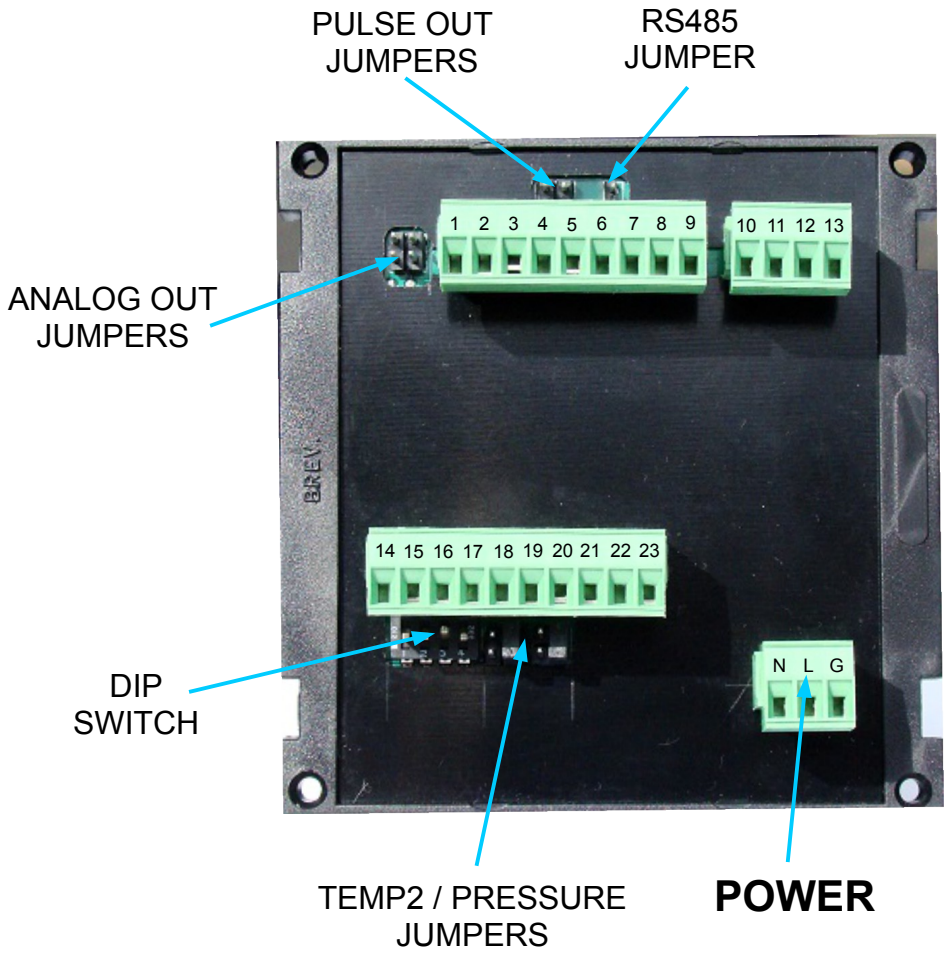
GFC319 has:

- one flow input for pulses or 4-20 mA
- one input for temperature to connect directly a Pt100 RTD

- one input that can be configured for a second temperature (temp2) accepting directly a Pt100 RTD, or for pressure accepting 4-20 mA signal
- one analog output that can be configured to be active or passive, 0-20 mA, 4-20 mA, 0-5V, 0-10V, 1-5V or 2-10V
- two normal open relay contact outputs for two alarms
- one pulse output that can be configured to be open drain npn (sinking) or 5V square wave
- one RS485 two wire communication port.

The power supply options are: 85-264VAC using three terminals, or 12VDC / 24VDC using two terminals.

NOTE: Double check which power supply option you have against the wiring before applying the power. Applying higher voltage than allowed for the option you have will damage the device.



4.4.1. Wiring the flow input

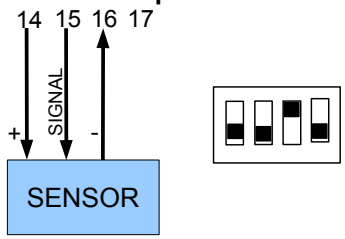
The flow input can be switched to accept pulses from open drain / collector, npn, pnp, reed switch, dry contact, waves, logical signals and coils. It has four terminals and provides power for the flow sensor, if needed. The power is 24 VDC regulated, filtered and protected, maximum current is 20 mA.

If you would like to power your pulse flow sensor from the GFC319, double check if the sensor can work with 24 VDC / max 20 mA.

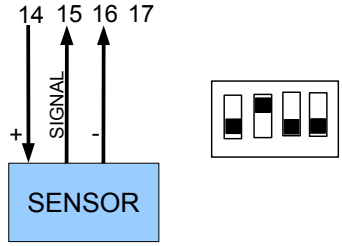
The flow input can also be switched to accept analog 4-20 mA loop power signal.

NOTE: There is no isolation between the pulse input and the analog inputs.
All inputs are isolated from all outputs and from the power.

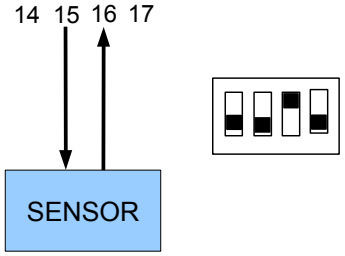
4.4.1.1. NPN Open drain / collector (sinking current)



4.4.1.2. PNP Open drain / collector (sourcing current)

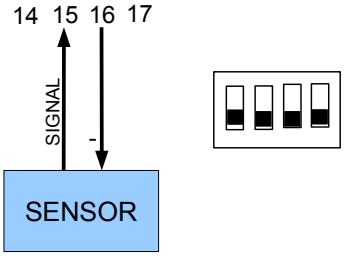


4.4.1.3. Reed switch, dry contact

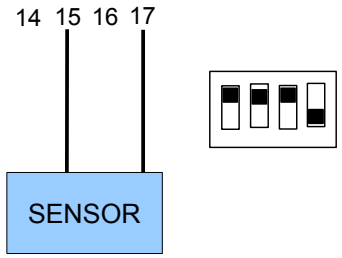


NOTE: A small capacitor in parallel may be needed. Different reed switches and dry contacts have different bouncing time. Test and evaluate carefully to determine the right capacitor.

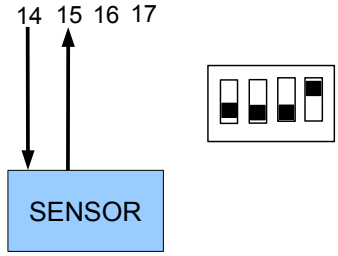
4.4.1.4. Waves (square, sine, triangle, saw etc.), Logical Signal (CMOS, TTL etc.)



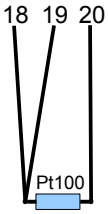
4.4.1.5. Coils



4.4.1.6. Analog 4-20 mA loop power for flow rate or differential pressure



4.4.2. Wiring the temperature input



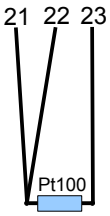
Connect a Pt100 RTD with alpha = 0.00385, three wire connection is shown.
Two wire connection is not recommended, but you can use it by shorting terminals 18 and 19. **All wires must have same length and gauge (diameter).**

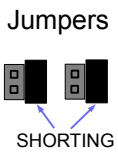
4.4.3. Wiring and configuring the temp. 2 / pressure input

This input is configured by 2 jumpers. It can accept directly a Pt100 RTD or a 4-20 mA signal.

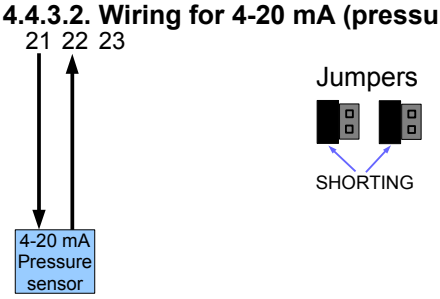
Use the configuration for temperature (Pt100 RTD) ONLY for saturated steam delta heat. For all other equations configure this input for pressure (4-20 mA).

4.4.3.1. Wiring for Pt100 RTD (temp2 for saturated steam delta heat equation ONLY)





4.4.3.2. Wiring for 4-20 mA (pressure for all other equations)

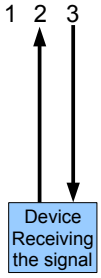


4.4.4. Wiring and configuring the analog output

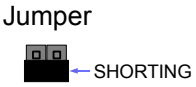
The analog output can be active or passive for 0-20 mA or 4-20 mA. The output can be only active for 0–5 V, 0 -10V, 1-5V or 2-10V.

- When passive (for current) the output needs external power coming from the device receiving the signal or from an external power supply.
- When the output is active (for current or voltage) it provides the power and the receiving device must have a passive input. No external power is needed.

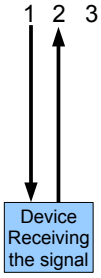
4.4.4.1. Passive output for 0-20 mA and 4-20 mA



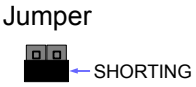
The device receiving the signal must provide power to the loop.
<u>Choose “0-20 mA” or “4-20 mA” in the “AN. OUT CFG” menu.</u>



4.4.4.2. Active output for 0-20 mA and 4-20 mA

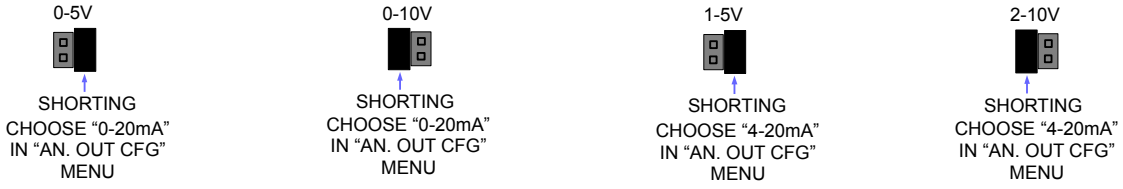


The device receiving the signal must have passive input.
<u>Choose “0-20 mA” or “4-20 mA” in the “AN. OUT CFG” menu.</u>



4.4.4.3. Voltage output wiring

Terminal 1 is “+”, terminal 2 is “-”. The device receiving the signal must have high input impedance.



4.4.5. Wiring the pulse output

The pulse output can be configured to be open drain, sinking (npn) or a 5V square wave.

4.4.5.1. Open drain

The device that will receive the pulses must have a pull-up resistor built-in or added externally to the terminals.
Terminal 4 is the open drain that will sink current, terminal 5 is the return (ground of this output)
The jumper shorting must be on the right

4.4.5.2. 5V square wave

The signal is a 5V square wave and does not need neither a pull-up, nor a pull-down at the receiving devices. Neither it needs external power. The output has a built-in series resistor of 510 ohm for protection. Terminal 4 is "+", terminal 5 is "-".
The jumper shorting must be on the left

4.4.6. Wiring the Alarm 1 output

The alarm output is a normal open relay contact on terminals 10 and 11.

4.4.7. Wiring the Alarm 2 output

The alarm output is a normal open relay contact on terminals 12 and 13.

4.4.8. Wiring the RS485 communication port

For best performance use twisted pair, preferably shielded twisted pair (STP). Connect the **A** (**D+**) signal to terminal **6** and the **B** (**D-**) wire to terminal **7**. If GFC319 is at the very end of the RS485 buss a termination of the line may be needed. If that is the case short the jumper between terminal 6 and terminal 7. Not more than one device at each end of the buss should have a termination.

The RS485 port is not isolated from the pulse and the analog inputs, but it is isolated from the power and all outputs.

4.4.9. Wiring the power

NOTE: Double check which power supply option you have against the wiring before applying the power. Applying higher voltage than allowed for the option you have will damage the device.

- 12 VDC – needs 2 wires for this option. We strongly recommend the **minus** to be connected to earth ground, if the application allows.
- 24 VDC - needs 2 wires for this option. We strongly recommend the **minus** to be connected to earth ground, if the application allows.
- 85 – 264 VAC, 47-400 Hz - needs 3 wires.
  - The **line** (115VAC or 220 VAC line) wire **must** be connected to **L** terminal.
  - The **neutral** wire **must** be connected to the **N** terminal.
  - The **earth ground** wire **must** be connected to the **G** terminal.

Always use and properly connect earth ground wire when having the 85-264 VAC option.
Always disconnect the high voltage before doing any work on GFC319.

4.5. MECHANICAL

GFC319 needs a panel area of at least 96x96 mm (3.78x3.78”).
The cut out should not exceed 90 mm (3.54”) (H) and 92 mm (3.62”) (V).
The cabinet should be deep at least 110 mm (4.33”).

5. ORDERING

At the time of order you need to specify the power supply option:

- Isolated 12VDC (9 – 18 VDC)
- Isolated 24 VDC (18 – 36VDC)
- Isolated 85 - 264 VAC.

Then you will need to specify the software options you want enabled.

For ordering please use the following G Instruments part numbers:

Description	***G Instruments PN***
GFC319 for 85 - 264V AC	30204
GFC319 for 12 V DC	30206
GFC319 for 24 V DC	30207

Example: By ordering part number GFC319-PAR, PN 30204 you will receive a GFC319 that will work with 85-264V AC and will have the pulse output, alarm 1 and alarm 2 enabled.

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