

# InVue® GV148 Liquid Chemical Concentration Monitor

*User Guide*



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## INTRODUCTION

Entegris, Inc. provides the enclosed product manual for the user's information.

Prior to using this manual, the user should verify with the product manufacturer that the user has the most recent copy of the product manual.

This manual is owned by Entegris, Inc., an affiliated company, or its suppliers and title shall not pass to the user with use of the manual.

## LIABILITY OWNERSHIP

Read the following carefully before continuing:

In no event shall Entegris or its suppliers be liable for any damages whatsoever (including, without limitation, damages for loss of business profits, business interruption, loss of business information or any pecuniary loss) arising out of the use or inability to use this manual, even if Entegris has been advised of the possibility of such damages.

## GENERAL MANUAL NOTES

### CHANGES TO THE MANUAL

The manufacturer reserves the right to make changes to the product covered in this manual to improve performance, reliability, or manufacturability.

Although every effort has been made to ensure accuracy of the information contained in this manual, the manufacturer assumes no responsibility for inadvertent errors. Contents of the manual are subject to change without notice.

## INTENDED AUDIENCE

This manual is intended for technicians familiar with the proper handling of chemical and other potentially hazardous materials. Users must also be familiar with installing and using software on a computer running the Windows® operating system.

## INTENDED USE/SCOPE

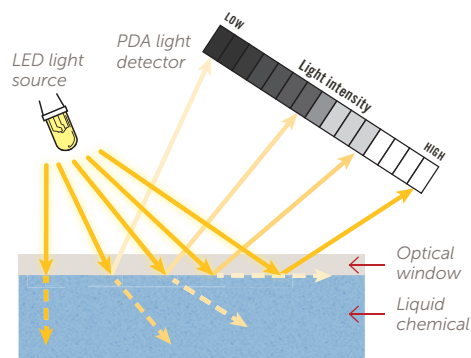
This manual is intended to be used by experienced technicians for the planning, installation, and operation of the described InVue® GV148 liquid concentration monitor.

This manual contains basic safety information for the installation and use of the InVue GV148 liquid concentration monitor.

**⚠ WARNING: Mishandling products exposed to a hazardous substance may result in death or serious injury. Always follow the recommendations and guidelines provided by the chemical suppliers and manufacturers. Always wear appropriate personal protection equipment as required for the chemicals in use. Refer to the Material Safety Data Sheet (MSDS) for each chemical.**

## PRINCIPLE OF OPERATION

Light from an LED is directed toward the optical window in contact with the liquid chemical. The light is reflected off the liquid based on its refractive index and directed towards the light detector. The intensity of the light detection determines the refractive index of the fluid.



## SAFETY

**⚠ DANGER:** Failure to follow these safety instructions may lead to fire, electric shock, chemical exposure, or other injuries, or damage to property. Read all safety information before usage.

### CONTACTING SUPPLIER WITH EMERGENCY HEALTH ISSUES

Please contact the manufacturer with any emergency safety and health concerns.

**⚠ WARNING:** Safety is designed into every product. When followed, these minimum guidelines provide an acceptable level of safety for operating and maintaining the system but are not a substitute for determining internal safety procedures.

FAILURE to comply with the safety precautions or warnings indicated in this manual violates the safety standards that form a part of the intended use of this equipment. The manufacturer assumes no liability for the user's failure to comply with these requirements.

**⚠ WARNING:** Use of controls, adjustments or procedures other than those specified in this manual without consulting a competent safety professional may result in exposure to potential hazards. Always follow established industrial safety practices when operating the equipment.

**⚠ CAUTION:** End of life statement. Decommissioning of the system, or any part of the system shall be in a manner that is consistent with appropriate regulations and guidelines.

**⚠ WARNING:** Chemicals are not supplied with this equipment. Refer to the chemical suppliers' MSDS for specific health and safety information.

**⚠ WARNING:** Wear chemical-resistant garments and eye protection. Use additional personal protective equipment (PPE) as directed by facility safety personnel, the MSDS or chemical safety guidelines.

**⚠ CAUTION:** Only technically qualified personnel should install equipment.

**⚠ CAUTION:** DO NOT use this equipment in any manner not specified by the manufacturer. If the equipment is used in a manner other than as specified in this document, the safety protections may be impaired.

**⚠ CAUTION:** Fittings and components damage easily; handle all components with extreme care. DO NOT scratch or overtighten any component.

**⚠ CAUTION:** EQUIPMENT DAMAGE HAZARD! Turn off power before connecting or disconnecting any cable to the device or damage may occur.

**⚠ CAUTION:** Since the monitor uses a light source to indicate the refractive index, ambient light around the device should be minimized.

## HANDLING

The InVue GV148 liquid concentration monitor is manufactured with strict assembly, test, and inspection processes to ensure a high-quality product and protection from unintended chemical release. As with all chemical handling systems, the monitor has chemical connection points that must be handled with care.

Do not loosen any screws on the mechanism unless specifically directed to do so by an Entegris applications engineer. Use care to prevent any damage to the unit that could result in chemical leakage.

## CHEMICAL LEAKS

In the event of a suspected or confirmed chemical leak from the InVue GV148 liquid concentration monitor, please follow the instructions below:

1. Determine chemical currently in use with monitor.
2. Obtain (material) safety data sheet.
  - a. Determine if any compatible materials may come in contact with leaking material.
  - b. Isolate incompatibles with barriers including spill containment.
  - c. Identify appropriate chemical protection requirements including gloves, face and eye protection, and chemical protective clothing to prevent exposure to or contact with chemicals.
  - d. Determine if the chemical has permissible exposure limits or short-term exposure limits:
    - Identify limits requiring respiratory protection.
    - Ensure appropriate monitoring devices are available to measure air levels.
3. Only personnel properly trained in the cleanup of hazardous material spills should conduct cleanup activities. Consult local authorities or identified hazardous materials emergency response agencies or contractors for assistance if the facility does not have trained personnel for spill cleanup or containment.
4. Ensure adequate monitoring and protective equipment is available for cleanup of hazardous materials.
5. Obtain supplies for cleanup and containment compatible with the chemical.
6. Obtain compatible containers to collect spilled material and cleanup materials.
7. Ensure adequate ventilation is provided where a buildup of vapors could occur. If flammable material is in use:
  - a. Monitor area for flammable levels with appropriate monitoring devices.
  - b. Isolate all power sources or potential sources of sparks.
  - c. Use intrinsically safe tools and monitoring equipment.
8. Isolate monitor from power sources to prevent fluids from flowing through unit during cleanup of leak or spill.
  - a. When disconnecting nitrogen and/or any pressurized gas, wear appropriate PPE including gloves, then close the facility gas supply to prevent gas release when disconnecting lines. De-energize/ depressurize before disconnecting/ opening the line.
9. If material is contained in the tubing or the monitor, provide collection container under the lines or monitor during removal to collect chemical and prevent additional spills.
10. Decontaminate surfaces with appropriate decontamination materials per chemical manufacturer recommendation.
11. Contain cleanup materials and contaminated debris and equipment.
12. Dispose of materials in accordance with local, state, and national regulatory requirements.
13. Provide any required service to the equipment and verify all spilled material is collected and cleaned from surfaces.
14. Replace any equipment and secure lines in accordance with normal maintenance and service requirements.
15. Confirm air levels are safe.
16. Return equipment to service per standard procedures.

## SPECIFICATIONS

<b>Materials of construction</b>	Flow cell body	Polytetrafluoroethylene (PTFE)*
	Optical window	Single-crystal sapphire*
	Cable jacket	Polyvinylchloride (PVC)
	Bonnet, enclosure	Polyvinylidene fluoride (PVDF)
	Mounting plate	Polypropylene (PP)
<b>Electrical</b>	Cable connection	19 pin Turck® male
	Current rating	1.0 A at start-up; 0.5 A during operation
	Main voltage input	24 VDC ±10%
	Digital IO voltage input	12 – 24 VDC
	Short protection**	Yes
	External LEDs	4
	Analog outputs	4 – 20 mA concentration, fluid temperature, refractive index (RI)
	Discrete digital inputs	2
	Discrete digital outputs	2, 80 mAdc maximum (each)
	Re-zero	Digital input, serial command, or HMI software
<b>Serial communication</b>	RS485	2-wire or 4-wire
	RS422	4-wire
	Operating system compatibility	Windows 7 or 10
	Network compatible	Yes
<b>Pressure and thermal</b>	Maximum pressure	80 psig at 40°C (104°F)
	Process fluid temperature range	20° to 40°C (68° to 104°F)
	Ambient temperature range	20° to 35°C (68° to 95°F)
	Storage temperature range	-15° to 40°C (5° to 104°F)
<b>RI Measurement</b>	RI range***	1.32 to 1.40 nD
	Accuracy	±2 × 10 <sup>-4</sup> nD (@ 20°C [68°F] from 1.332987 to 1.4000 nD)
	Repeatability	5 × 10 <sup>-5</sup> nD (in clear fluid @ 20°C [68°F])
	Precision	3 × 10 <sup>-6</sup> nD (in DI water @ 20°C [68°F])
	Response time	<3 sec unaveraged response to 63% of steady state change
	Drift	<5 × 10 <sup>-5</sup> nD/30 days (in DI water @ 20°C [68°F])
	Pressure sensitivity (typical)	8 × 10 <sup>-7</sup> nD/psig in DI water (typical in DI water @ 20°C [68°F])
<b>ROHS compliant</b>	Yes	
<b>Enclosure</b>	IP54	
<b>Orientation</b>	Any	

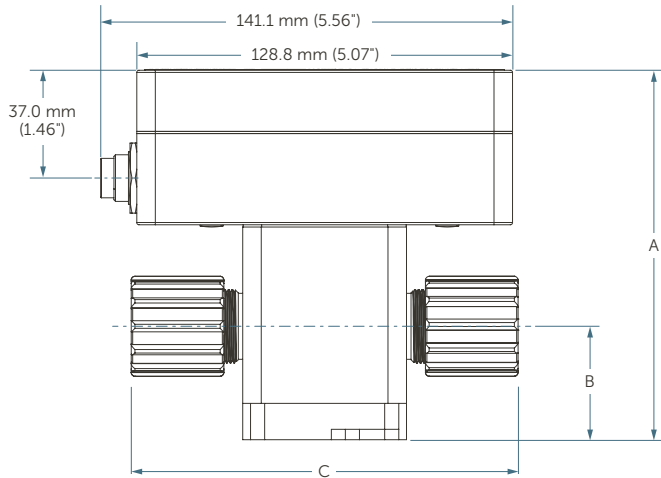
\*Wetted components.

\*\*See Electrical Connections Step 1.

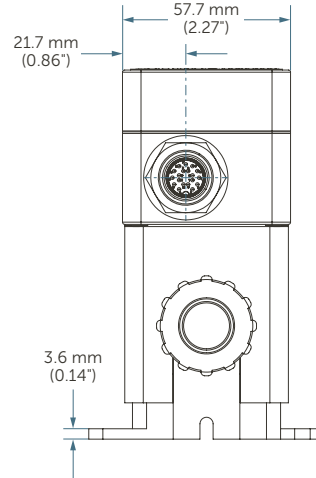
\*\*\*For fluids with an RI above/below, please consult your local Entegris salesperson.

## DIMENSIONS

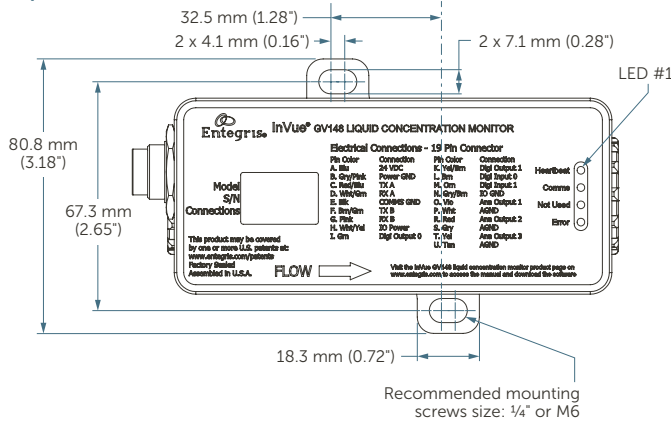
Front View



Side View



Top View



### LED Status Codes

The monitor has 4 LEDs on the top of the cover to help indicate visual status of the product.

LED	FUNCTION
#1	Processor heartbeat
#2	Communication in process
#3	Reserved
#4	Device error condition

Inlet/outlet port connection	DIMENSIONS		
	A	B	C
1/4" Flaretek® tube fitting	114.6 mm (4.51")	33.0 mm (1.30")	111.0 mm (4.37")
3/8" Flaretek tube fitting	117.7 mm (4.64")	34.7 mm (1.37")	113.5 mm (4.47")
1/2" Flaretek tube fitting	120.9 mm (4.76")	36.3 mm (1.43")	119.6 mm (4.71")
3/4" Flaretek tube fitting	126.6 mm (4.99")	38.9 mm (1.53")	132.6 mm (5.22")
1" Flaretek tube fitting	126.6 mm (4.99")	38.9 mm (1.53")	154.9 mm (6.10")
1/2" PrimeLock® tube fitting	120.9 mm (4.76")	36.3 mm (1.43")	122.9 mm (4.84")
1" PrimeLock tube fitting	126.6 mm (4.99")	38.9 mm (1.53")	149.6 mm (5.89")
1/4" Pillar tube fitting	114.6 mm (4.51")	33.0 mm (1.30")	100.5 mm (3.96")
3/8" Pillar tube fitting	117.7 mm (4.64")	34.7 mm (1.37")	112.5 mm (4.43")
3/4" Pillar tube fitting	126.6 mm (4.99")	38.9 mm (1.53")	134.5 mm (5.29")

## HARDWARE INSTALLATION

This section covers site requirements, tools, and equipment to install the InVue GV148 liquid concentration monitor. Technical support is available for all installation types.

**NOTE:** All components are shipped in protective packaging to prevent damage during transport. If damage is found, please file a damage claim with the transportation carrier and contact customer support immediately.

**CAUTION:** Avoid particulate contamination. Do not unwrap any cleanroom-packaged item until immediately before installation.

**WARNING:** Only technically qualified personnel should install the system. Wear chemical resistant garments and eye protection. Chemicals are not supplied with this equipment. Obtain a chemical MSDS for each chemical used with the system and follow all safety requirements.

**CAUTION:** Fittings and components damage easily; handle them with extreme care. Do not scratch or overtighten any part.

## FACILITY REQUIREMENTS

- Computer: MS Windows 7 or 10
- Display: Recommended 1024 x 768
- Input power: 24 VDC
- Optional: 4-20 mA analog measurement device
- Basic wiring tools
- Line pressure: 0-60 psig (0 to 4.1 bar)
- Reference chemical: DI water or other reference chemical used for calibration
- Fluid lines and fittings: Standard 3/4" tubing and 3/4" Flaretek connections.

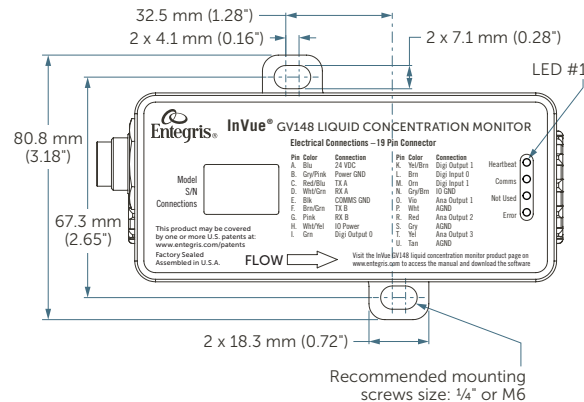
**NOTE:** For detailed Flaretek and PrimeLock tube fitting assembly instructions, visit [www.entegris.com](http://www.entegris.com). For detailed Super 300 Type Pillar assembly instructions, contact Nippon Pillar Packaging Company, Ltd.

**NOTE:** Additional sizes available upon request.

**WARNING:** Installation location must provide adequate exhaust ventilation and monitoring. The installation location should incorporate secondary containment and spill detection. Facility must have appropriate alarm and shutdown procedures for the chemical in use.

## MOUNTING REQUIREMENTS

See dimensional details for mounting geometry below. Use M6 or 1/4" threaded fasteners with appropriate flat washers.



## MECHANICAL INSTALLATION

### Step 1: Location

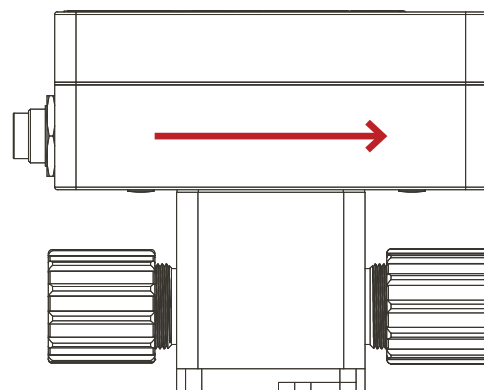
Location of the monitor should comprise a steady process fluid stream from the principal flow to prevent sediment and bubbles from collecting on the sensor.

Note: Provide minimal flow pulses. Strong pressure pulses in the flow stream may cause erratic readings. A pressure regulating device may improve monitor operation and performance.

### Step 2: Installation

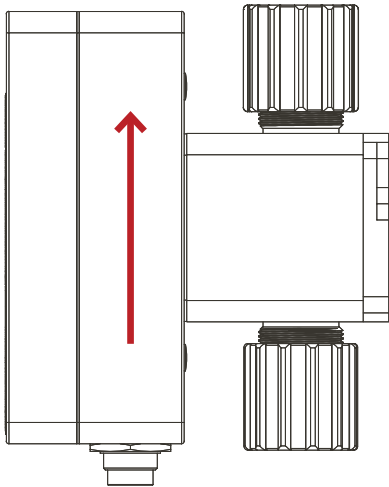
**CAUTION:** The monitor has a directional flow mark. Verify process flow is passing in the correct direction.

1. Optimum mounting of the in-line fluid monitor is in this orientation:



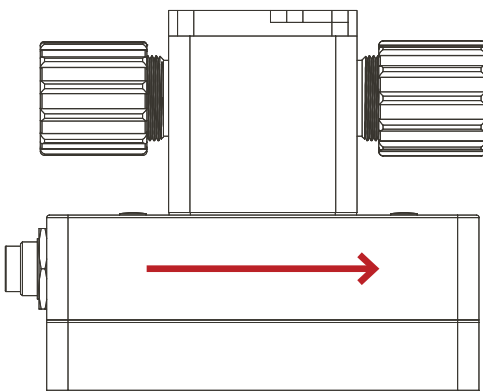


2. For improved bubble rejection, mounting should be in this orientation:



3. For maximum bubble rejection, mounting should be in this orientation:

**NOTE: This orientation is not recommended for sediment carrying media.**



### Step 3: Connect Fluid Lines

1. Attach tubing using standard installation procedure for Flaretek, PrimeLock, and Super Type 300 Pillar connections.

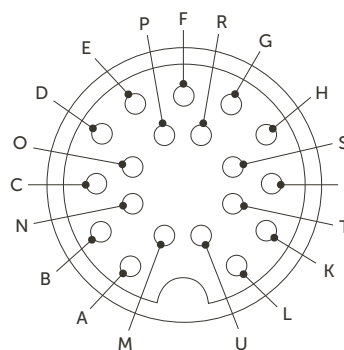
**NOTE: For detailed Flaretek and PrimeLock tube fitting assembly instructions, visit [www.entegris.com](http://www.entegris.com). For detailed Super 300 Type Pillar assembly instructions, contact Nippon Pillar Packaging Company, Ltd.**

## ELECTRICAL CONNECTIONS

### Connect Wiring

**NOTE: The wiring table below references the 19-pin PVDF male Turck connector on the device (see image below). To connect to the device, multiple cable options are available with specific wiring diagrams. Please contact Entegris for details.**

PIN	FUNCTION
A	24 VDC power input
B	Power supply ground
C	TX-A
D	RX-A
E	Comms ground
F	TX-B
G	RX-B
H	Digital IO power 12-24 VDC
I	Digital output 0, system alarm
K	Digital output 1, future use
L	Digital input 0, RI re-zero
M	Digital input 1, Selection between primary and secondary temperature compensation coefficients
N	Digital IO ground
O	Analog output 1, concentration
P	Analog ground
R	Analog output 2, fluid temperature
S	Analog ground
T	Analog output 3, refractive index
U	Analog ground

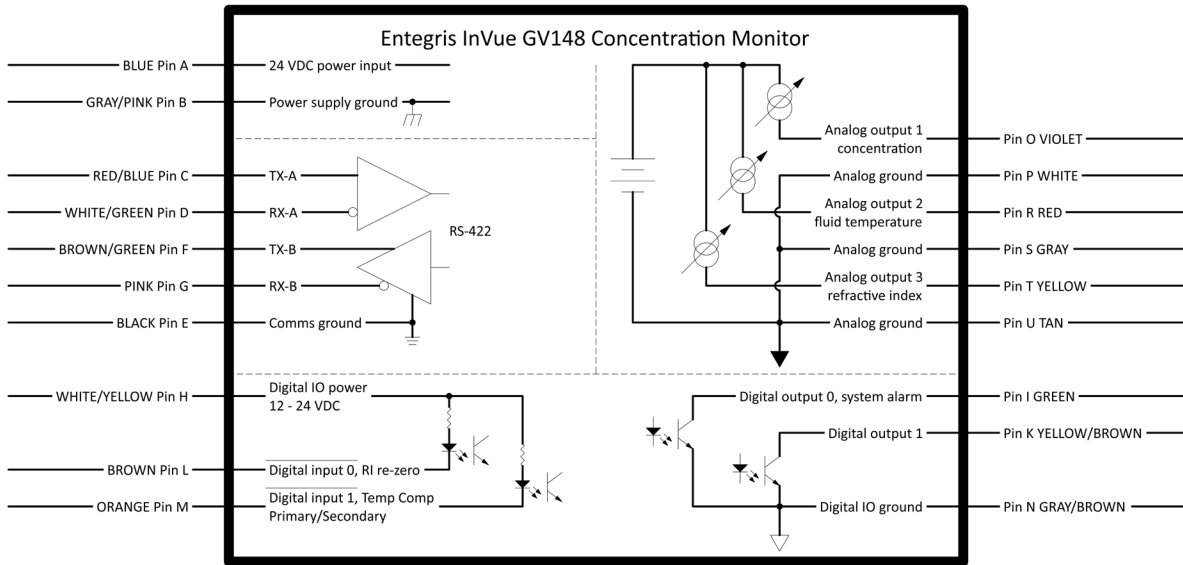


**CAUTION:** All grounds (power supply ground, comms ground, digital IO ground, the three analog grounds) are individually unique. Do not short grounds together.

**CAUTION:** If the power supply and serial comms grounds become common and >+15 VDC is applied to the serial communication Transmit/Receive (TX/X) pins, irreversible damage to the unit may occur.

**CAUTION:** 4 – 20 mAdc analog outputs are self powered. Analog outputs are always on. Isolate all unused connections.

**NOTE:** Analog output usage is optional. Analog outputs are used for analog data logging of refractive indexes, concentration, and sensor fluid temperatures. To reduce signal noise, ground separately from power supply ground.



1. Connect the power [A] and ground [B]
2. Connect the digital IO power [H] and digital IO ground [N]
 

**NOTE:** Digital IO usage is optional. Digital IO is used for re-zero command, temperature compensation selection, and alarm notification. To reduce signal noise, ground separately from power supply ground.
3. Connect digital inputs and outputs for re-zero command [L], temperature compensation selection [M], and alarm detection [I].
  - Digital inputs [L and M] are optically isolated, sinking inputs (pull signal to digital IO ground to energize)
  - Digital outputs [I and K] are optically isolated, open collector, 80 mAdc maximum (output pulls load to digital IO ground when energized)
4. Connect analog outputs and grounds for reading of concentration [O and P], fluid temperature [R and S], and refractive index [T and U]

5. Connect serial communications

**NOTE:** GV148 HMI software is required to fully utilize the features of the GV148 monitor. Configure the serial interface for RS422 or RS485 to use the GV148 HMI software.

- RS422 serial communication requires a 4-wire connection [C, D, F, and G]
- RS485 serial communication requires a 2-wire connection [C and D together, F and G together]

**NOTE:** To reduce signal noise, usage of the Comms Ground [E] is recommended, but not made common to the power supply ground.

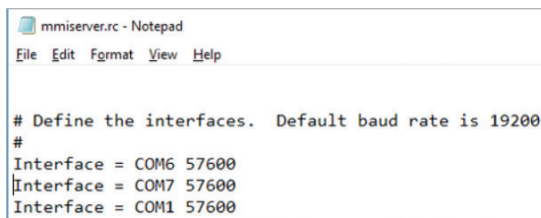
## SOFTWARE OPERATION

The HMI (human machine interface) user software is used to communicate with the GV148 liquid concentration monitor. Entegris GV148 HMI software files are available for download from the Entegris website.

### INSTALLING THE HMI SOFTWARE

To operate the concentration monitor, communication must be established using a host computer, laptop, or similar system using the supplied software. To configure the software and establish communication:

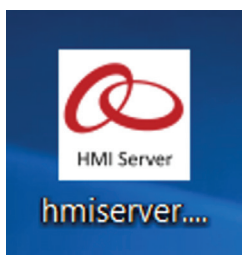
1. Connect device to serial port or USB to serial port adapter. Windows will configure hardware for usage.
2. Using Windows Device Manager, confirm com port number.
3. Place the HMI software folder in an appropriate directory.
4. Open the folder and using Windows Notepad or WordPad, open file {hmiserver.rc}.
5. Edit the com port number determined in Step 2 and save.
6. Confirm the Baud Rate as 57600.



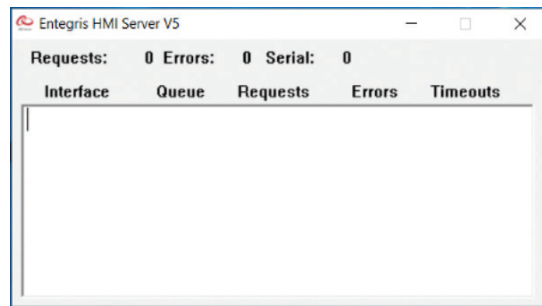
```

# Define the interfaces. Default baud rate is 19200
#
Interface = COM6 57600
Interface = COM7 57600
Interface = COM1 57600
    
```

7. Click the icon to start HMI server.



8. The server will open.



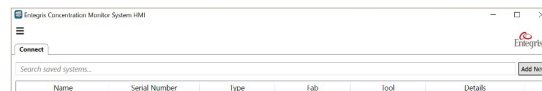
9. Click the InVue GV148 icon to start HMI software and open the "Connect" tab.



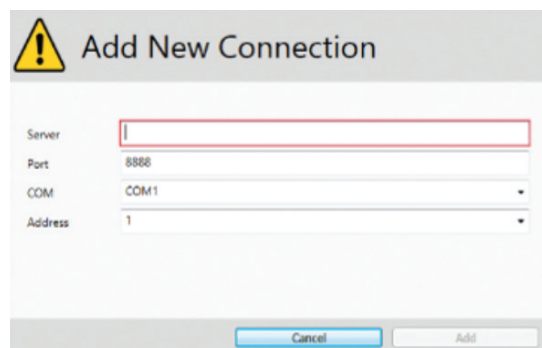
### CONNECT TAB

The Connect tab establishes communication between the concentration monitor and the HMI software.

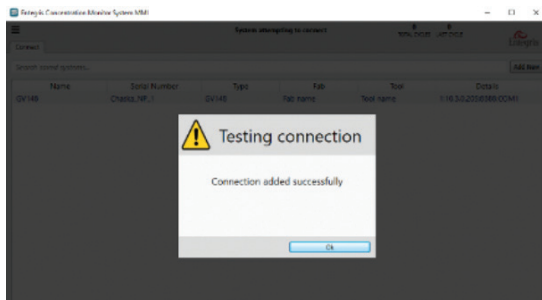
1. Press "Add New".



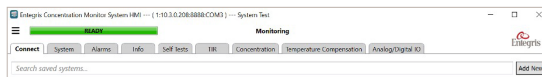
2. The Add New Connection information box opens.



3. Enter "localhost" for server, the COM port number from the server setup and {1} for the address.
4. Press "Add".
5. Verify connection.



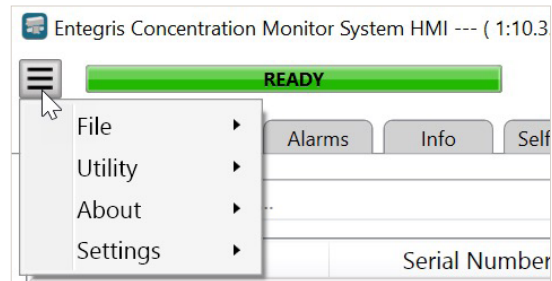
6. Press "OK".
7. Double-click on the listed device.
8. Communication established.



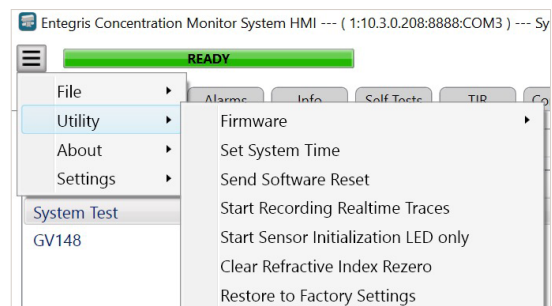
9. Once HMI is connected to a specific device, all connections will be listed in the field below with the latest connection at the top.

## MENU FEATURES

1. Select the menu icon to view the Menu Features

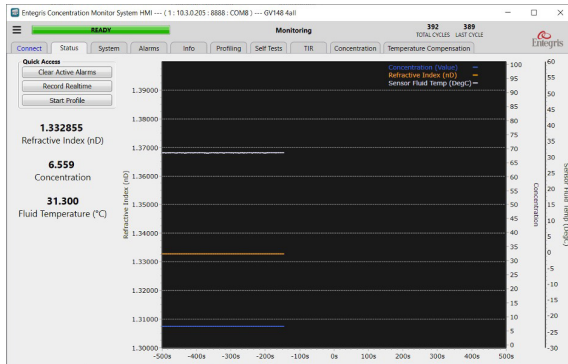


2. Utility has several useful functions



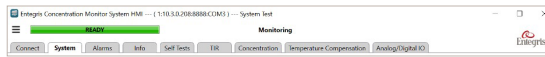
- a. Downloading new Firmware to the device
  - b. Set the devices System Time
  - c. Recording Realtime Traces (Reference the Systems Tab section for more information)
  - d. Start Sensor Initialization LED only
  - e. Clear the RI re-zero
  - f. Factory reset
3. The About feature displays the firmware version
  4. Settings is used to configure the Realtime Graph resolution

## HMI TOP MENU



There are four sections to the *HMI* top menu:

### 1. Status Information displayed on every page.

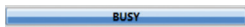


- Monitor name and connection information
- Collapsed menu icon (the three horizontal bars)
- Graphic status

Ready – Monitor is ready and monitoring.



Busy – Monitor is in operation.



Warning – Monitor operation has triggered a warning.

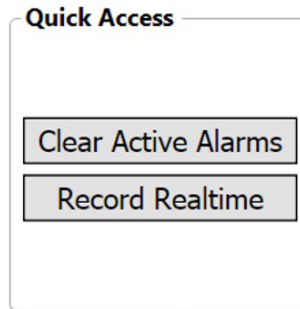


Error – Monitor operation has triggered an error.



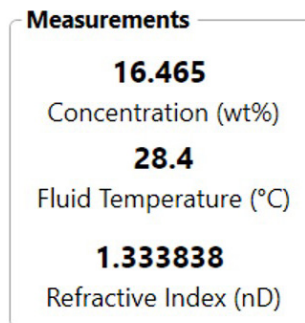
- Written monitor status
- Individual page tabs

### 2. Quick Access Group.

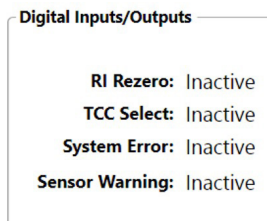
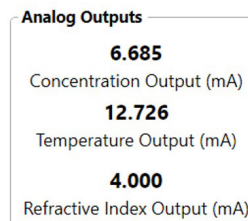


- **Clear Active Alarms** – clears active information, warning and error postings.
- **Record Realtime** – starts and ends recording of refractive index, concentration, and fluid temperature to a (\*.csv file). For recording instructions, see “Data Logging Using Record Realtime” on page 14.

### 3. Realtime Monitoring Data – Data display for the Concentration, Fluid Temperature, and Refractive Index.



### 4. Real-time monitoring data for analog outputs and digital inputs/outputs.



### SYSTEM TAB

The *System* page allows the user to set and change variables that affect system operations of the monitor. This includes concentration outputs, temperature outputs, refractive index outputs, and re-zero parameters.

Connect	System	Alarms	Info	Se
Serial Address	<input type="text" value="1"/>			
Serial Trigger Enable	<input type="button" value="Enable"/>			
Concn 4mA Output	<input type="text" value="0.00"/> wt%			
Concn 20mA Output	<input type="text" value="100.00"/> wt%			
Temp 4mA Output	<input type="text" value="15.00"/> Degrees			
Temp 20mA Output	<input type="text" value="40.00"/> Degrees			
RI 4mA Output	<input type="text" value="1.332987"/> nD			
RI 20mA Output	<input type="text" value="1.400000"/> nD			
Serial Termination Resistor	<input type="button" value="Disable"/>			
Sensor Averaging	<input type="text" value="1.6"/> seconds			
Digital Input RI Rezero Value	<input type="text" value="1.332987"/> nD			
Primary Chem # for TCC	<input type="button" value="#1 - DI"/>			
Secondary Chem # for TCC	<input type="button" value="#6 - Default Ch"/>			
RI Rezero Stability Max	<input type="text" value="0.000020"/> nD			
Temp Rezero Stability Max	<input type="text" value="0.02"/> Degrees			
Concentration Offset	<input type="text" value="0.000"/> wt%			

#### 4-20 mA Output Setup

The InVue GV148 liquid concentration monitor can be used with a 4-20 mA analog device to accurately interpret signals for concentration, refractive index, and temperature.

The 4-20 mA analog outputs will allow the end user to input values beyond the published product specifications. Inputting such values only affects 4-20 mA scaling and will not increase or decrease the readable RI range, temperature, or concentration.

1. Enter the 4 mA and 20 mA value for each output type.

Concn 4mA Output	<input type="text" value="0.00"/> wt%
Concn 20mA Output	<input type="text" value="100.00"/> wt%
Temp 4mA Output	<input type="text" value="15.00"/> Degrees
Temp 20mA Output	<input type="text" value="40.00"/> Degrees
RI 4mA Output	<input type="text" value="1.332987"/> nD
RI 20mA Output	<input type="text" value="1.400000"/> nD

2. Select "Apply" to send values to monitor.

#### Re-zero Stability Settings

The GV148 monitor can perform an RI re-zero (see page 17 for more details). During the re-zero process, the user can specify the desired RI and temperature stability values which are measured as 1 standard deviation of the readings during the re-zero period. If the RI or temperature deviates more than the user values, the re-zero result will fail. Recommended values are 0.00002 nD and 0.01°C.

**NOTE: allowing higher and higher instability could indicate erratic chemical system behavior and could influence the validity of the final re-zero value.**

1. Enter the RI and temperature stability maximum values
2. Select "Apply" to send values to monitor

RI Rezero Stability Max	<input type="text" value="0.000020"/> nD
Temp Rezero Stability Max	<input type="text" value="0.01"/> Degrees

#### Data Logging Using Record Realtime

*Record Realtime* records concentration, refractive index, and fluid temperature values to a {\*.csv} file.

1. In the *Quick Access Menu*, select "Record Realtime" to set the parameters of the data log.

**Record Realtime Traces**

Start recording traces to: GV148\_RTTRACE\_Development\_Only\_9\_26\_2021\_114727.csv

Path: C:\Users\tgast\Documents\

Change file location:

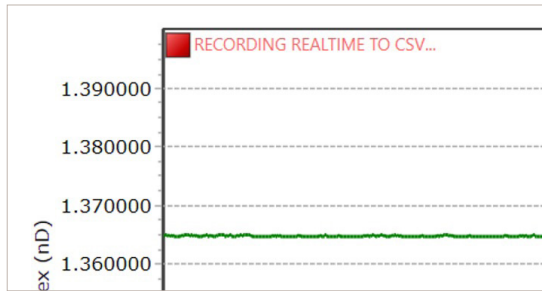
Enter new filename:

Duration:  Seconds  Indefinite

Sampling Rate:  Seconds (intervals of 1 s)

2. Set the duration of the record and sampling rate to the desired parameters.
3. Assign the file location and file name.
4. Select "Record".

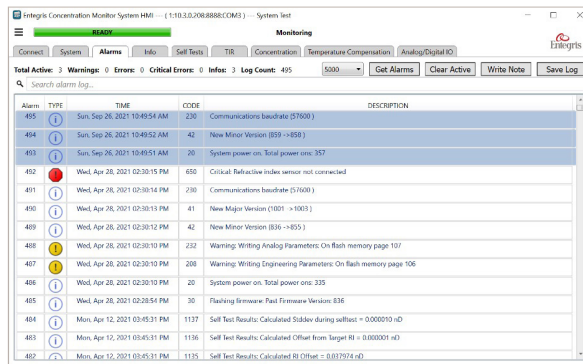
5. The HMI will indicate data is being recorded and if a timed duration was set, a timer will count down.



**NOTE:** At any time, the recording can be stopped by pressing "Stop Recording". If the duration is set to "Indefinite", the HMI will record until it is manually stopped.

### ALARMS TAB

The *Alarms* page allows the user to see recorded events and alarms that affect monitor operation. Alarms are stored in the device memory so that a history can be kept.

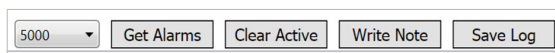


There are four sections to the *Alarms* page:

1. *Active* alarm information displays total current alarms, including warnings, errors, critical errors, information posts, and log counts.



2. *Alarm* page commands including:



- **25 ▼** – requests number of alarms to be retrieved and displayed, up to 5000 maximum.

- **Get Alarms** – command to retrieve and display alarms from memory.
- **Clear Active** – clears all active alarms.
- **Write Note** – allows the user to add a note into the alarm log file.
- **Save Log** – saves the alarms log to a (\*.csv file).

3. *Search alarm log* allows the user to enter a keyword to search through the log record of the alarms displayed.



4. *Display* field shows the alarms. Alarms can be arranged by double-clicking the header of each category.

Alarm	TYPE	TIME	CODE	DESCRIPTION
495	(i)	Sun, Sep 26, 2021 10:49:54 AM	230	Communications baudrate (57600)
494	(i)	Sun, Sep 26, 2021 10:49:52 AM	42	New Minor Version (859 -> 858)
493	(i)	Sun, Sep 26, 2021 10:45:51 AM	20	System power on, Total power on: 327
492	(C)	Wed, Apr 28, 2021 02:30:15 PM	650	Critical: Refractive index sensor not connected
491	(i)	Wed, Apr 28, 2021 02:30:14 PM	230	Communications baudrate (57600)
490	(i)	Wed, Apr 28, 2021 02:30:13 PM	41	New Major Version (1001 -> 1003)
489	(i)	Wed, Apr 28, 2021 02:30:12 PM	42	New Minor Version (836 -> 835)
488	(W)	Wed, Apr 28, 2021 02:30:10 PM	232	Warning: Writing Analog Parameters: On flash memory page 107
487	(W)	Wed, Apr 28, 2021 02:30:10 PM	208	Warning: Writing Engineering Parameters: On flash memory page 106
486	(i)	Wed, Apr 28, 2021 02:30:10 PM	20	System power on, Total power on: 335
485	(i)	Wed, Apr 28, 2021 02:28:54 PM	30	Flashing firmware: Prod Firmware Version: 836
484	(i)	Mon, Apr 12, 2021 03:45:31 PM	1137	Self Test Results: Calculated Sddev during selftest = 0.000010 nD
483	(i)	Mon, Apr 12, 2021 03:45:31 PM	1136	Self Test Results: Calculated Offset from Target RI = 0.000001 nD
482	(i)	Mon, Apr 12, 2021 03:45:31 PM	1135	Self Test Results: Calculated RI Offset = 0.002974 nD

- **Alarm** – displays the alarm number in numerical order.
- **Type** – graphic display of the alarm type

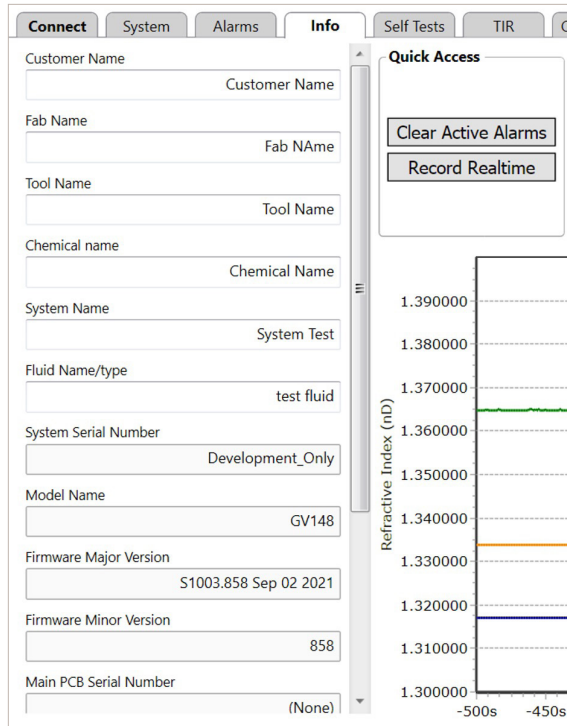
ALARM TYPE	ACTION	SOLUTION
(C) Critical Error	Monitor is disabled.	Clear error. If problem persists, contact Entegris support.
(S) System Error	Monitor stops after completing current function.	Clear error. If problem persists, contact Entegris support.
(W) System Warning	Event occurred. Normal operation continues.	Clear warning. Investigate cause of warning.
(i) Information	Event occurred. Normal operation continues.	No effect. Alarm log only.

- **Time** – displays the time the alarm occurred.
- **Code** – displays the code number associated with the alarm.
- **Description** – describes the event that occurred.

### INFO TAB

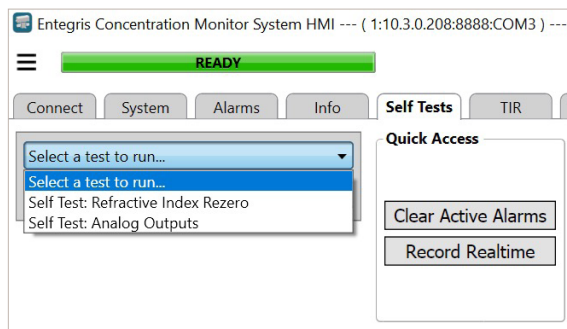
The *Information* page is mostly read-only information that is assigned during manufacturing regarding PCBs, sensors, firmware, monitor cycles, volumes, and resettable cycles and volumes.

**NOTE:** The user should add monitor identification and location descriptions like Customer Name, Fab Name, Tool Name, etc. These identifying markers are used as references on the Connect page and in saved profiles.



### SELF TESTS TAB

The *Self Tests* page allows the user to perform self-diagnostic tests to check the functionality of the system or perform standard routines like re-zero. Follow the instructions given in the *Test Description* for each test.



### Refractive Index Re-zero from the HMI

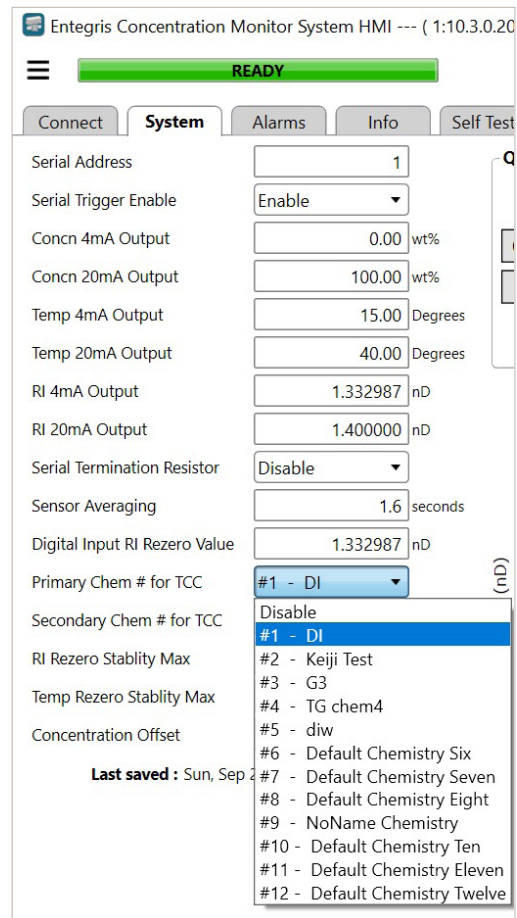
The re-zero function calibrates the refractive index measurement to a known baseline. The typical baseline for DI water is [IoR = 1.332987].

**CAUTION:** Process lines that cannot use DI water may use another reference chemical of a known concentration or Index of Refraction.

**CAUTION:** The monitor and fluid lines must be free of air bubbles.

**CAUTION:** In order to accomplish an accurate Refractive Index Re-zero Self Test, a Primary or Secondary Chemistry (TCC) value should be defined via the Coefficients Generator located on the *Temperature Compensation* tab.

1. Select the "Systems" tab.
  - a. Enable either "Primary Chemistry (TCC)" or "Secondary Chemistry (TCC)" to select a chemistry.





- b. Ensure the desired value of "RI Rezero Stability Max" is within the defined Upper Limit and Lower Limit

- Default value is 0.000020 nD

Parameter	Value	Unit
Serial Address	1	
Serial Trigger Enable	Enable	
Concn 4mA Output	0.00	wt%
Concn 20mA Output	100.00	wt%
Temp 4mA Output	15.00	Degrees
Temp 20mA Output	40.00	Degrees
RI 4mA Output	1.332987	nD
RI 20mA Output	1.400000	nD
Serial Termination Resistor	Disable	
Sensor Averaging	1.6	seconds
Digital Input RI Rezero Value	1.332987	nD
Primary Chem # for TCC	#1 - DI	
Secondary Chem # for TCC	#6 - Default Ch	
RI Rezero Stability Max	0.000020	nD
Temp Rezero Stability Max	0.01	Degrees
Concentration Offset	0.000	wt%

- c. Ensure the desired value of "Temp Rezero Stability Max" is within the defined Upper Limit and Lower Limit

- Default value is 2.00 Degrees

Parameter	Value	Unit
Serial Address	1	
Serial Trigger Enable	Enable	
Concn 4mA Output	0.00	wt%
Concn 20mA Output	100.00	wt%
Temp 4mA Output	15.00	Degrees
Temp 20mA Output	40.00	Degrees
RI 4mA Output	1.332987	nD
RI 20mA Output	1.400000	nD
Serial Termination Resistor	Disable	
Sensor Averaging	1.6	seconds
Digital Input RI Rezero Value	1.332987	nD
Primary Chem # for TCC	#1 - DI	
Secondary Chem # for TCC	#6 - Default Ch	
RI Rezero Stability Max	0.000020	nD
Temp Rezero Stability Max	0.01	Degrees
Concentration Offset	0.000	wt%

2. Select "Self Tests" tab

- a. Select "Select a test to run..." drop-down menu
- b. Select "Self Test: Refractive Index Rezero"

Parameter	Value	Unit
Serial Address	1	
Serial Trigger Enable	Enable	
Concn 4mA Output	0.00	wt%
Concn 20mA Output	100.00	wt%
Temp 4mA Output	15.00	Degrees
Temp 20mA Output	40.00	Degrees
RI 4mA Output	1.332987	nD
RI 20mA Output	1.400000	nD
Serial Termination Resistor	Disable	
Sensor Averaging	1.6	seconds
Digital Input RI Rezero Value	1.332987	nD
Primary Chem # for TCC	#1 - DI	
Secondary Chem # for TCC	#6 - Default Ch	
RI Rezero Stability Max	0.000020	nD
Temp Rezero Stability Max	0.01	Degrees
Concentration Offset	0.000	wt%

- c. Enter the "Input: RI Value to Rezero".  
(In the case of DI water, enter 1.332987.)

Self Test: Refractive Index Rezero

Start

Input: RI Value to Rezero  nD

Result: Pre Avg RI  nD

Result: Post Avg RI  nD

**Test Description:**  
This self-test will run for ~40 seconds. It will calculate an offset between the measured RI and target RI value. The offset is then applied to the RI reading. During the self-test, the RI & Temperature must be within the user defined stability maximum values.

\*\* Results are also posted to the alarm log \*\*

- d. Confirm monitor status is Ready before pressing "Start".

Entegris Concentration Monitor System HMI --- (

READY

Connect System Alarms Info

Self Test: Refractive Index Rezero

Start

Input: RI Value to Rezero  nD

Result: Pre Avg RI  nD

Result: Post Avg RI  nD

**Test Description:**  
This self-test will run for ~40 seconds. It will calculate an offset between the measured RI and target RI value. The offset is then applied to the RI reading. During the self-test, the RI & Temperature must be within the user defined stability maximum values.

\*\* Results are also posted to the alarm log \*\*

- The test will run for approximately 40 seconds and is designed to calculate an offset between the desired RI and actual measured RI.

Self Test: Refractive Index Rezero

TEST IN PROGRESS Cancel Start

Last Run : Sun, Sep 26, 2021 12:26:28 PM

Input: RI Value to Rezero  nD

Result: Pre Avg RI  nD

Result: Post Avg RI  nD

**Test Description:**  
This self-test will run for ~40 seconds. It will calculate an offset between the measured RI and target RI value. The offset is then applied to the RI reading. During the self-test, the RI & Temperature must be within the user defined stability maximum values.

\*\* Results are also posted to the alarm log \*\*

- e. Upon completion, the test will either show Pass or Fail. The test field will fill in with statistics.

Self Test: Refractive Index Rezero

PASS Start

Last Run : Sun, Sep 26, 2021 12:26:28 PM

Input: RI Value to Rezero  nD

Result: Pre Avg RI  nD

Result: Post Avg RI  nD

**Test Description:**  
This self-test will run for ~40 seconds. It will calculate an offset between the measured RI and target RI value. The offset is then applied to the RI reading. During the self-test, the RI & Temperature must be within the user defined stability maximum values.

\*\* Results are also posted to the alarm log \*\*

- Results of the Rezero Self Test will also be posted to the Alarm Log viewable on the "Alarms" tab

Alarm	Type	Time	Code	Description
501	(i)	Sun, Sep 26, 2021 12:27:17 PM	1130	Self Test Results: Calculated Slope during self-test = 0.00000 nD
500	(i)	Sun, Sep 26, 2021 12:27:17 PM	1130	Self Test Results: Calculated Offset from Target RI = 0.00000 nD
499	(i)	Sun, Sep 26, 2021 12:27:16 PM	1135	Self Test Results: Calculated RI Offset = 0.019064 nD
498	(i)	Sun, Sep 26, 2021 12:27:16 PM	1134	Self Test Input: Target RI = 1.332987 nD
497	(i)	Sun, Sep 26, 2021 12:27:16 PM	1131	Self Test Passed: Reflective Index Hezero
496	(i)	Sun, Sep 26, 2021 12:26:28 PM	1130	Self Test Started: Reflective Index Hezero

### Analog Outputs

This *Self Test* sets the analog outputs either high or low so that their output could be checked with an external measuring device.

1. To test the analog output, set it to low or high and press "Start".
2. Measure the output with appropriate device during this 30 second cycle.
3. At the end of the 30 seconds, the outputs will revert to represent their normal values.

Entegris Concentration Monitor System HMI --- ( 1.10.0.208.8888.COM3 ) --- System Test

**READY**

Connect System **Alarms** Info

Self Test: Analog Outputs Start

Input: Self Test Duration  seconds

Input: Concentration Output

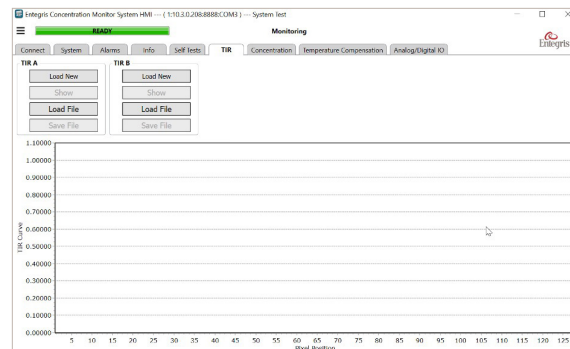
Input: Temperature Output

Input: RI Output

**Test Description:**  
 This self test will force the analog outputs low, high or its normal value to assist the user in confirming proper operation

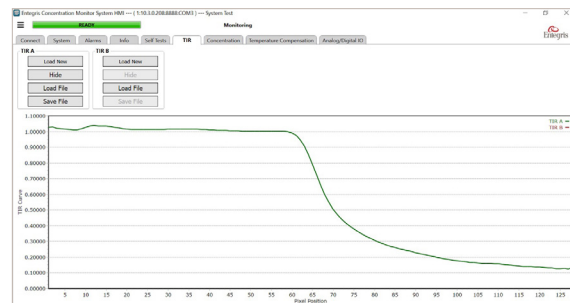
\*\* Results are also posted to the alarm log \*\*

### TOTAL INTERNAL REFLECTION (TIR) TAB



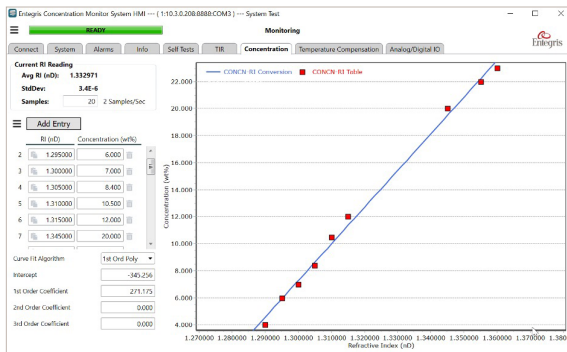
This tab allows you to view 2 TIR curves at a time. To load new TIR curves, press Load New for both TIR A and TIR B. Notice that you can now hide one or both curves.

Press Load File to display a saved or reference TIR curve for either A or B, or Save File to store on your PC



### CONCENTRATION TAB

The *Concentration* page allows the user to calibrate chemical concentration to the refractive index. There are three methods to creating and saving calibration tables: manually, directly, or from an existing file.

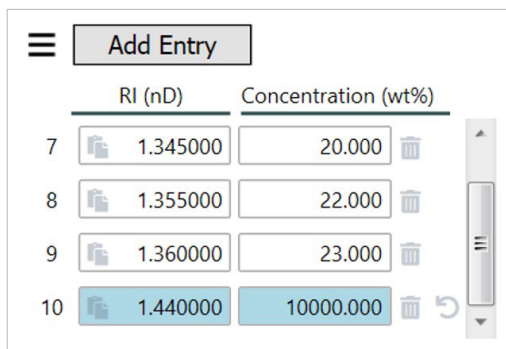


**CAUTION:** The GV148 monitor has a maximum of 30 calibration points. It is recommended that a minimum of five calibration points is set above and below the target process concentration range with the target concentration as mid-point. Concentration steps should be in increments of 0.1%.

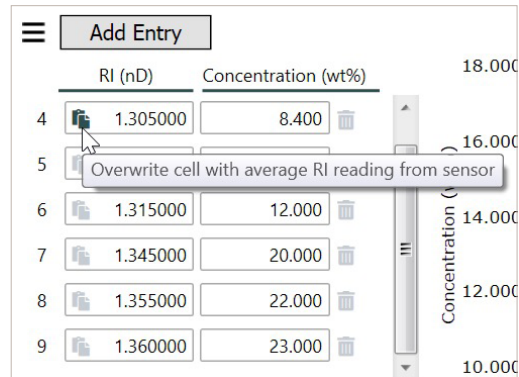
#### Creating and Saving Manually

This process requires the user to run various chemical concentrations through the monitor with corresponding refractive index readings to create the interrelation between concentration and the refractive index.

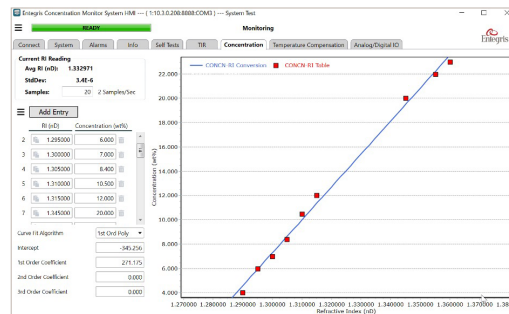
1. The default table has two rows. To expand the table, select "Add Entry". It is recommended that a minimum of five concentration points be used.



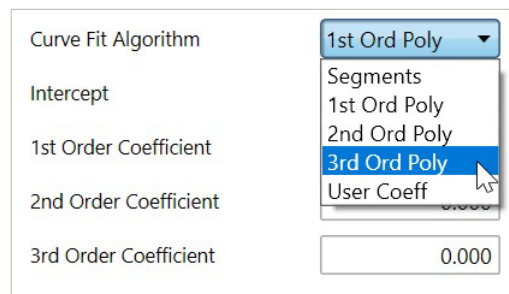
2. Introduce the desired chemical concentration at the temperature, pressure, and flow characteristics of the manufacturing process.
3. When the concentration is stable, click on the *Copy/Paste* icon in the first edit cell to enter the value.



4. Type the concentration value into the *Concentration* edit field.
5. Repeat the process for the desired number of entries.
6. As the data is collected, the chart will populate and create an algorithmic curve.



7. Different algorithms can be selected for optimum design.



8. When the desired concentration table is complete, press "Apply" to send the values to the monitor. Values shaded in blue have not been sent to the monitor.

	RI (nD)	Concentration (wt%)
4	1.305000	8.400
5	1.310000	10.500
6	1.315000	12.000
7	1.345000	20.000

The values you have entered have not been sent to the unit yet. Click 'Apply' before leaving this tab.

Curve Fit Algorithm: 2nd Ord Poly

Intercept: -2036.654

1st Order Coefficient: 2822.974

2nd Order Coefficient: -962.097

3rd Order Coefficient: 0.000

Buttons: Cancel, Apply

9. Use the trashcan icon next to the *Concentration* edit field to delete an undesired data point.

### Entering Concentration Coefficients Directly

This process applies known chemical coefficients directly by the user.

- In the *Matching Algorithm* dropdown menu, select "User Coeff".

Curve Fit Algorithm: User Coeff

Intercept: -699.000

1st Order Coefficient: 524.838

2nd Order Coefficient: 0.000

3rd Order Coefficient: 0.000

Buttons: Cancel, Apply

- Type in the coefficient values.
- Press "Apply" to send the values to the monitor.

### Loading Concentration Coefficients from a File

This process loads saved calibration values from a {\*.csv} file.

**CAUTION:** The \*.csv file must be correctly formatted to be loaded. Only the first 30 data points will be uploaded.

- Create and save the {\*.csv} file. *Column A* must contain *Refractive Index* values with the first field containing text. *Column B* must contain the corresponding *Concentration* values with the first field containing text.

	A	B
1	RI	Concentration
2	1.333	0
3	1.35	10
4	1.36	13
5	1.37	20
6	1.375	22
7	1.38	25

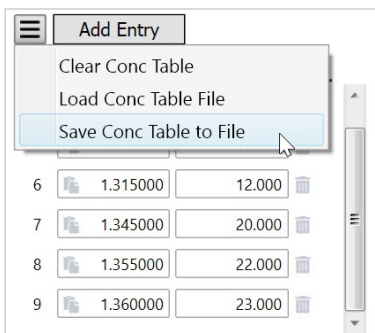
- Using the dropdown menu, select "Load Conc. Table File".

Buttons: Cancel, Apply

6	1.315000	12.000
7	1.345000	20.000
8	1.355000	22.000
9	1.360000	23.000

- Select the saved {\*.csv} file and press "Okay".
- The values will populate the plot area.
- Use the *Matching Algorithm* menu to view the order fit.
- When the fit looks correct, select "Apply" to send values to the monitor.

- To save the table, use the dropdown menu and select "Save Conc. Table to File".



- Name the {\*.csv} file and select "OK".

### TEMPERATURE COMPENSATION COEFFICIENT (TCC) TAB

The InVue GV148 monitor actively monitors and compensates for changes in the refractive index due to changes in fluid temperature by applying a linear temperature compensation model determined by the temperature compensation coefficient (TCC). There are three methods to enter the system's TCC into the monitor. They can be entered manually, loaded from a file, or generated by the HMI.

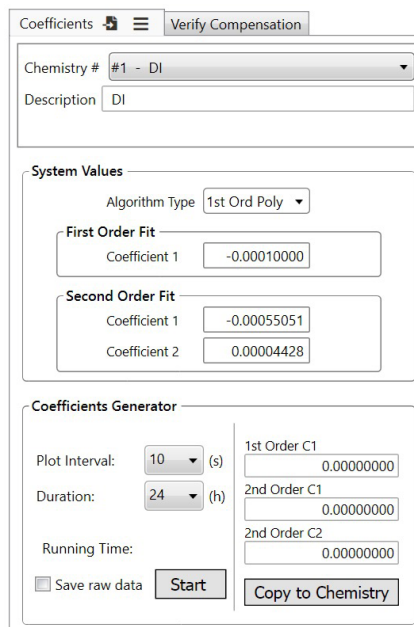


**CAUTION:** The TCC should represent the process being measured from data at various points in the expected temperature range. If it takes 24 – 48 hours of continuous process time and/or multiple chemical exchanges to realize the full temperature range, this must be included in the TCC calculation for greatest accuracy.

### Entering the TCC Manually

If the *First Order Fit* or *Second Order Fit* of the process fluid are known, enter the values on the TCC on the Temperature Compensation page in the appropriate fields.

- Select the "Coefficients" tab.



- Assign the coefficients to a chemistry number by selecting a number and enter a brief description.
- Enter the coefficient *Order Fits* in the appropriate fields.
- Press "Apply".

### Entering the TCC from a File

- To load the coefficients from a {\*.csv} file, assign a chemistry number and brief description.
- Select the dropdown menu located on the *Coefficients* tab and select "Import".

- Select the file to be loaded and press "Open".
- Press "Apply". *Order Fit* fields should fill.

**⚠ CAUTION: Minimum file format is a single row with three columns of data. The HMI will ignore text fields and use the first row with three numerical data points. The first numerical data point would enter as the *First Order Fit*. The second numerical data point would enter as the *Second Order Fit, coefficient 1*. The third numerical data point would enter as the *Second Order Fit, coefficient 2*.**

### Generating the TCC using the HMI

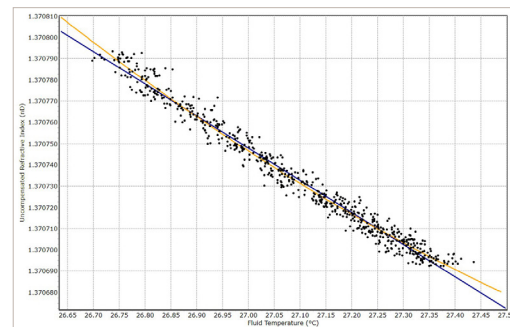
The HMI can generate TCC values using the *Generate Coefficients* section of the page.

- Confirm *Plot Interval* is set to 10 seconds.

- Confirm *Duration* is set for 24 hours.

**NOTE: It is recommended that a minimum of 24 hours be set for the monitor to incur the full range of expected thermal conditions.**

- To save the data to be generated, click on the "Save to file" box.
- Press "Start".
- As data points are collected, *First Order Fit* and *Second Order Fit* coefficients are updated, and the plot area will display the curves.



- Press "Stop" to end collection of data points.
- Select "Copy to Chemistry" to populate the coefficient edit boxes with values.
- Select "Apply" to send values to monitor.

### Importing Generation Points

If a {\*.csv} file exists from a previously saved generation of data points, the data can be imported by pressing the small black icon next to the dropdown menu on the *Coefficients* tab.

- Select a {\*.csv} file to be imported.
- The charted plot will upload with the corresponding coefficients.

## Verify Compensation

The *Verify Compensation* section tab confirms the chemistry coefficients are working correctly by generating temperature data points for the duration selected.

1. On the *Systems* tab, select the chemistry in the *Chemistry Applied TCC* menu.
2. On the *Temperature Compensation* tab, confirm the chemistry number and brief description is correct.
3. Set *Plot Interval* to record temperatures.
4. Click on the "Save to File" box to save, if desired.
5. Press "Start". The chart should begin plotting temperatures.
6. Press "Stop" to end verification.
7. If saved to file, assign a name to the {\*.csv} file and save.

**NOTE: Due to a finite response time of the temperature measurement, a rapid temperature transition will result in a brief spike in the concentration reading**

## ANALOG/DIGITAL IO TAB

Tab allows user to force analog outputs to a specific value and trim analog outputs to further refine specific values.

Concentration Trim Mode	Disable ▼
Temperature Trim Mode	Disable ▼
RI Trim Mode	Disable ▼
Concentration ForceValue	20.000 mA
Temperature ForceValue	4.000 mA
RI ForceValue	4.000 mA
Concentration: 4mA Trim	0 Counts
Concentration: 20mA Trim	0 Counts
Temperature: 4mA Trim	0 Counts
Temperature: 20mA Trim	0 Counts
RI: 4mA Trim	0 Counts
RI: 20mA Trim	0 Counts



## COMMUNICATION COMMAND SET

Contact Entegris to obtain a copy of the communications specification if you plan to communicate with the device using RS422/485 protocol.

## MAINTENANCE

The GV148 concentration monitor is designed with a cleaning port for easy access to the sensor window without sensor removal.

**⚠ WARNING:** Failure to maintain cleanliness of the sensor window will create errors in the reported IOR. Ideally, DI water is used as the reference chemical and if it does not produce the intended IOR (1.333000), the window may need to be cleaned. Even exposure to DI water could result in window contamination over time.

### MANUAL WINDOW CLEANING METHOD

**⚠ WARNING:** It is recommended that an Entegris Bottom Cap Removal Tool (part number GV148CPTOOL) and a 1/4" hex drive torque wrench (1.8 N•m [16 in•lb]) be used when cleaning the window.

This [video](#) demonstrates how to properly remove the port, manually clean the sapphire window, and reassemble the port after manual cleaning is completed.

### AUTOMATED IN SITU WINDOW CLEANING METHOD

Periodic window cleaning may be required to maintain refractive index accuracies when certain chemistries or CMP slurries are being monitored. The in situ cleaning nozzle takes the place of the bottom cap and cleaning plug located on the bottom of the GV148 monitor. Figure 1 displays an exploded view of the GV148 monitor with an in situ rinse nozzle.



Figure 1.

To implement a GV148 monitor with an in situ window cleaner within a mix-blend station or slurry delivery module, supplemental valving needs to be added to the station external to the GV148 monitor.

On either side of the GV148 monitor, 3-way isolation valves should be added to isolate the monitor from the slurry flow stream. These isolation valves are required to prevent dilution of the CMP slurry while a window cleaning cycle is implemented. Figure 2 provides a schematic representation with valve states, of a typical implementation when slurry is flowing through the GV148 unit and being monitored. Figure 3 provides schematic representation with valve states, of a typical implementation when an in situ window clean is being implemented. The 3-way isolation valves on either side of the GV148 monitor must be 1/2" orifice or larger, and the process lines going to exhaust must be 1/2" or larger. When a window cleaning cycle is implemented, both isolation valves need to be toggled to the exhaust position enabling a low resistance flow path for the atomized cleaning solution to exit the GV148 monitor.

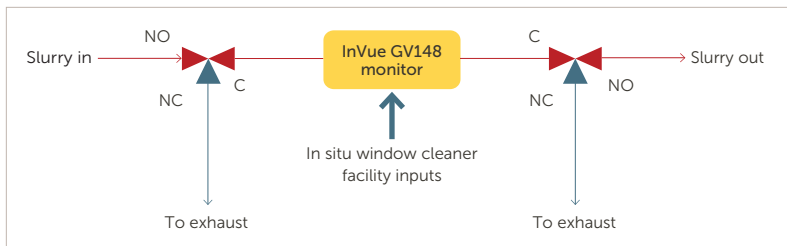


Figure 2.

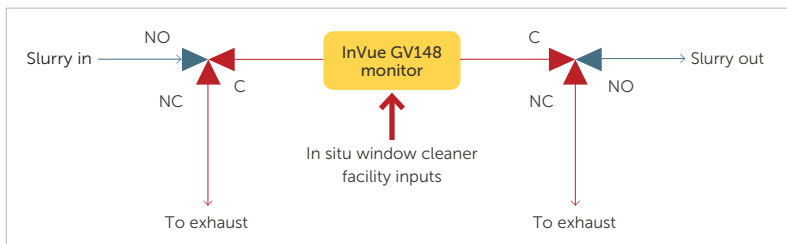


Figure 3.

For the in situ window cleaner to function correctly, N<sub>2</sub>/DI water facilities, as well as the appropriate valving and control logic, need to be incorporated into the slurry delivery/mix-blend station. Figure 4 provides a basic plumbing and instrumentation diagram (P&ID), which can be implemented to fully facilitate the in situ window cleaner.

All valves should be Entegris CR4 Series Pneumatic Valves, 1/4" orifice or larger.

N<sub>2</sub> pressure line monitoring should be Entegris NT™ Flow-Through Pressure Transducer, Model 4210, 0-100 psig.

Liquid flow control (LFC) should be Entegris InVue Integrated Flow Controller, Model 6510, 0-500 cc/min.

N<sub>2</sub> flow monitoring should be 0-100 slm variable area flowmeter or 0-100 slm mass flowmeter.

N<sub>2</sub> facilities line should have a Cv sufficiently high enough to provide 100 slm to the cleaning nozzle.

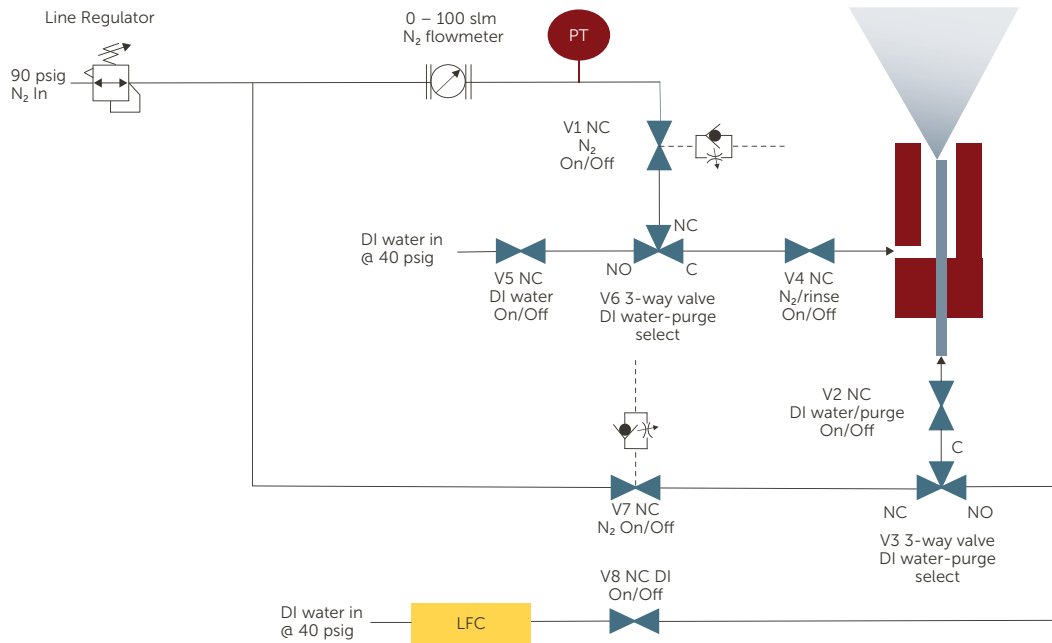


Figure 4.

Figure 5 provides the structure for a basic in situ window clean recipe that can be periodically initiated to remove any slurry build up on the GV148 sapphire window.

Cleaning step	Step time	V1	V2	V3	V4	V5	V6	V7	V8	LFC set point	Step notes
Facility Line Rinse	120 sec.		X		X	X			X	250 cc/min	Rinses in situ rinse nozzle, DI water, and N <sub>2</sub> ports of any slurry deposits prior to atomized window clean
Atomized Window Clean	300 sec.*	X	X		X		X		X	250 cc/min	Removes slurry build up from RI monitor sapphire window
Facility Line Purge	60 sec.	X	X	X	X		X	X			Purges and dries in situ rinse nozzle, DI water, and N <sub>2</sub> facility lines, GV148 monitor sapphire window

\*Step time can be reduced or extended to accommodate slurry type and amount of incurred slurry deposits

Figure 5.

Figures 6 – 8 provide highlighted P&ID's for each suggested in situ window recipe step provided in Figure 5.

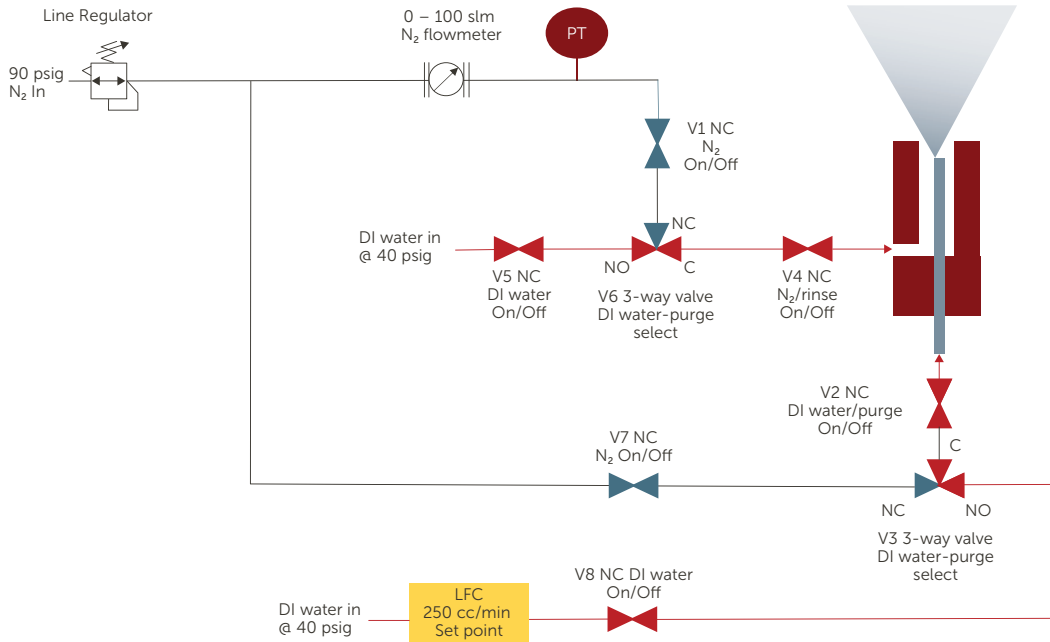


Figure 6. Facility line rinse. Highlighted P&ID.

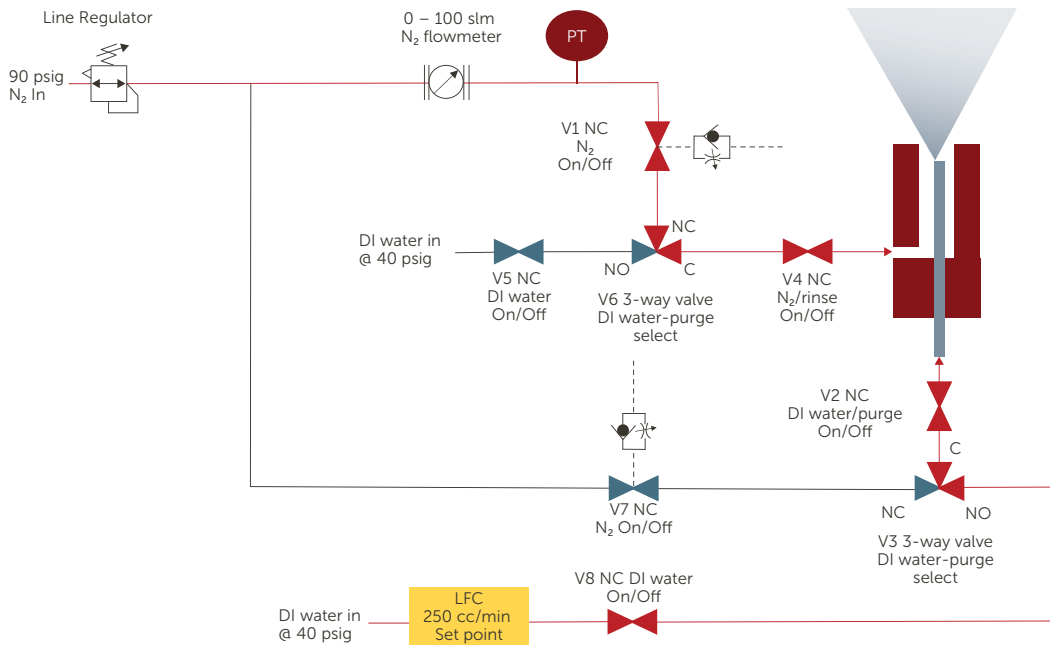


Figure 7. Atomized window clean. Highlighted P&ID.

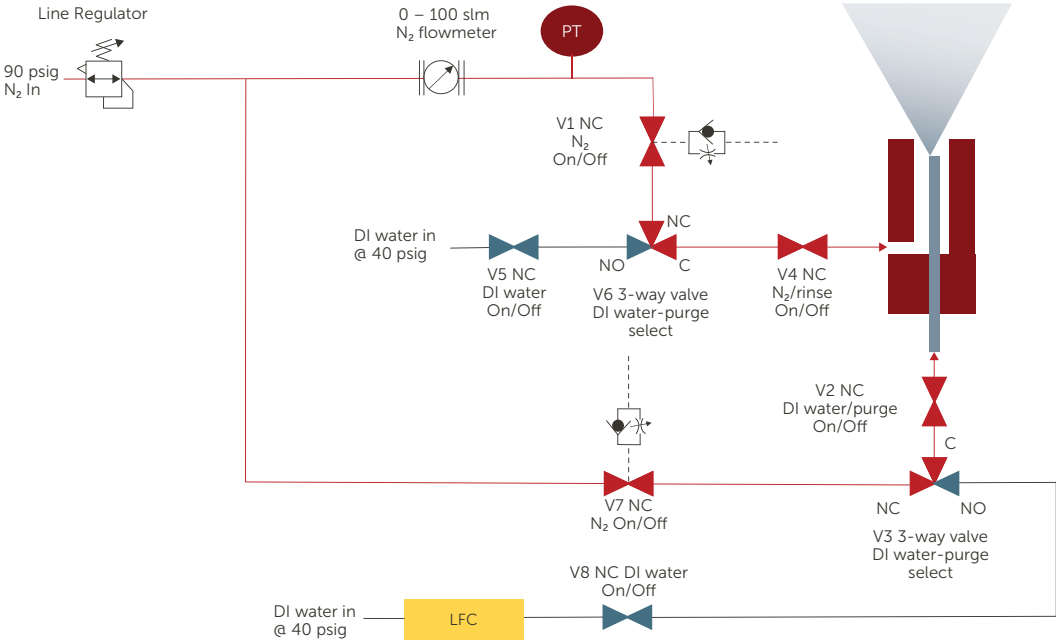


Figure 8. Facility line purge. Highlighted P&ID.

## DIAGNOSTIC GUIDE

This section covers common issues and possible solutions for the concentration monitor.

SYMPTOM	PROBABLE CAUSE	SUGGESTIONS
Refractive index and concentration reads 30001	Fluid temperature is out of specified range	Operate product within specified fluid temperature range
Refractive index and concentration reads 30002	No chemistry in flow cell	Ensure chemistry is in flowcell
	Bubble trapped on surface of sensor window	Orientate product per Mechanical Installation section (page 8)
Refractive index and concentration reads 30003 or 30004	Background light is too bright	Remove any bright light sources shining on product
		Avoid placement of product near windows to the outdoors
<p>HMI displays an explanation point for refractive index and concentration.</p> <p>Hovering mouse over it gives a message:</p> <p>“The sensor cannot obtain a valid temperature measurement. Please ensure the sensor is not in extreme temperature conditions. A temperature re-zero may be required.”</p>	Fluid temperature is out of specified range	Operate product within specified fluid temperature range
<p>HMI displays an explanation point for refractive index and concentration.</p> <p>Hovering mouse over it gives a message:</p> <p>“The sensor cannot obtain a valid reading. The sensor may be exposed to air, ensure chemistry is sufficiently being supplied to sensor.”</p>	No chemistry in flow cell	Ensure chemistry is in flowcell
	Bubble trapped on surface of sensor window	Orientate product per Mechanical Installation section (page 8)
<p>HMI displays an explanation point for refractive index and concentration.</p> <p>Hovering mouse over it gives a message:</p> <p>“The sensor cannot obtain a valid reading. The sensor may be exposed to too much light, reduce the sensor exposure to ambient light.”</p>	Background light is too bright	Remove any bright light sources shining on product
		Avoid placement of product near windows to the outdoors
HMI will not communicate with unit when using serial communication	Baud rate not 38400 or 57600	Configure .rc file for a Baud rate of 38400 or 57600
	Wiring	Verify wiring against label on product
	Server not set to localhost	When adding a new connection, make sure Server is set to localhost and Port set to 8888

## DIAGNOSTIC GUIDE

This section covers common issues and possible solutions for the concentration monitor.

SYMPTOM	PROBABLE CAUSE	SUGGESTIONS
<b>HMI will not communicate with unit when using serial communication (continued)</b>	GV148 monitor is not powered on	Verify heartbeat LED is flashing Verify product has +24V across Power GND (gray/pink) and 24 VDC wires (blue)
	HMI Server is not running or configured correctly	Verify HMI server is running Configure .rc file for the correct com port and baud rate
	Wrong serial port selected	Verify HMI Server lists the desired com port in the Interface column Configure .rc file the correct com port
	Wrong device address used	Ensure device address is correct (Default: 1) If address is not known, select address "All"
<b>Concentration reading changes incorrectly when temperature changes</b>	Improper Temperature Compensation Coefficients (TCC)	Measure TCC using Temperature Compensation tab in HMI TCC was calculated for a different chemistry or concentration
	Wrong Primary Chemistry Temperature (TCC) selected	Verify in HMI the Primary Chemistry (TCC) in HMI System tab matches chemistry being used in product
<b>Rapid temperature change causes spike in concentration reading</b>	Temperature rate-of-change is too quick	Reduce fluid temperature rate-of-change Allow for temperature to stabilize before taking concentration reading
<b>Concentrations are incorrect by small constant offset</b>	Sensor needs to be re-zeroed	Follow re-zero procedure in manual
<b>Concentrations scale incorrectly</b>	Chemical calibration is incorrect	Verify accuracy of concentration table in Concentration tab of HMI
	4 – 20 mA output scaling is incorrect	Verify accuracy of 4 – 20 mA output scaling in System tab of HMI

For technical support or further assistance, please contact your authorized Entegris representative.

## ORDERING INFORMATION

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For current ordering information reference our product data sheet on [entegris.com](https://www.entegris.com).

## TECHNICAL SUPPORT

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For technical Support, contact Entegris at +1 800 394 4084. Please have the complete model number, chemical, and application information when calling.

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Warranty service is available at the Entegris factory. To expedite the return of the product, contact Entegris at +1 800 394 4084. A Return Merchandise Authorization (RMA) number, MSDS requirements, and a product packaging and return procedure will be provided at that time.

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