DSGF®
Radiation-Based Detector with GEN2000®
Electronics and Frequency Output for
Density Measurement
## Revision history

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Initial release. Formerly 241742.</td>
<td>051201</td>
</tr>
<tr>
<td>1.1</td>
<td>Updated CD part number, removed part number from back page</td>
<td>061227</td>
</tr>
<tr>
<td>1.2</td>
<td>Electronics revision</td>
<td>090306</td>
</tr>
<tr>
<td>1.3</td>
<td>Added certification information and IECex label</td>
<td>090814</td>
</tr>
<tr>
<td>1.4</td>
<td>Changed company name, logo, and website</td>
<td>110301</td>
</tr>
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</table>

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GEN2000™ is a trademark of VEGA Americas, Inc.

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## Explanation of symbols

Table 2 lists the symbols that the manual and instrument use.

**Table 2: Explanation of symbols**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
</table>
| ![Radiation notice] | Radiation notice  
In the manual, information concerning radioactive materials or radiation safety information is found in the accompanying text. |
| ![Caution] | Caution  
In the manual, warnings concerning potential damage to the equipment or bodily harm are found in the accompanying text. |
| ![AC current or voltage] | AC current or voltage  
On the instrument, a terminal to which or from which an alternating (sine wave) current or voltage may be applied or supplied. |
| ![DC current or voltage] | DC current or voltage  
On the instrument, a terminal to which or from which a direct current voltage may be applied or supplied. |
| ![Potentially hazardous voltages] | Potentially hazardous voltages  
On the instrument, a terminal on which potentially hazardous voltage exists. |
User’s comments

VEGA values your opinion! Please fill out this page so that we can continually improve our technical documentation.


Date: __________________

Customer Order Number: __________________

How we can contact you (optional if you prefer to remain anonymous):

Name: __________________________

Title: __________________________

Company: __________________________

Address: __________________________

________________________
________________________

Did you find errors in this manual? If so, specify the error and page number.

Did you find this manual understandable, usable, and well organized? Please make suggestions for improvement.

Was information you needed or would find helpful not in this manual? Please specify.

Please send this page to:

VEGA Americas, Inc.
Director of Engineering
4241 Allendorf Drive
Cincinnati, OH 45209-1599
Nuclear materials notice

This equipment contains radioactive source material that emits gamma radiation. Gamma radiation is a form of high-energy electromagnetic radiation. Only persons with a specific license from the U.S. NRC (or other regulating body) may perform the following to the source holder:

- Dismantle
- Install
- Maintain
- Relocate
- Repair
- Test

VEGA Field Service engineers have the specific license to install and commission nuclear gauges, and can instruct you in the safe operation of your density gauge. To contact VEGA Field Service, call 513-272-0131. Users outside the U.S. and Canada may contact their local representative for parts and service.

Note

Special instructions concerning your source holder are found in the envelope that was shipped with the source holder and the “Radiation Safety for U.S. General and Specific Licensees, Canadian and International Users”. Please refer to this document for radiation safety information.
Unpacking the equipment

CAUTION!

Make sure that you are familiar with radiation safety practices in accordance with your U.S. Agreement State, U.S. NRC, or your country’s applicable regulations before unpacking the equipment.

- Unpack the unit in a clean, dry area
- Inspect the shipment for completeness, by checking against the packing slip
- Inspect the shipment for damage during shipment or storage
- If the detector is included as a separate package in the shipment, inspect the assembly for damage that may have occurred during shipment or storage
- If there was damage to the unit during shipment, file a claim against the carrier and report the damage in detail. Any claim on the VEGA for shortages, errors in shipment, etc., must be made within 30 days of receipt of the shipment
- If you need to return the equipment, see the section “Returning equipment for repair to VEGA” in the “Diagnostics and Repair” chapter
- After you unpack the equipment, inspect each source holder in the shipment to assure that the operating handle is in the OFF position. In the event that you find the handle in the ON position, place it in the OFF position immediately and secure it.

Note

Most source holder models accept a lock. Call VEGA Field Service immediately for further instructions, at 513-272-0131, if the source holder has one of the following conditions:

- Does accept a lock and there is no lock on it
- The lock is not secured
- You are unable to secure the lock
- The operating handle does not properly move into the off position
Storing the equipment

Storing the source holder
If you must store the source holder, adhere to the following guidelines:

- Store in a clean, dry area.
- Verify that the source holder shutter is in the OFF or CLOSED position.
- Check the current local regulations (U.S. NRC, Agreement State, or other) to determine if this area must have any restrictions.

Storing the detector
If you must store the detector, adhere to the following guidelines:

- Avoid storage at temperatures below freezing.
- Store the detector indoors in an area that has temperature-control between 10 °C and 35 °C (50 °F and 95 °F) and less than 50% relative humidity.
- Store equipment in dry conditions until installation.

Certifications

This gauge is designed for certification compliance from the following agencies:

- ATEX Standard
- CCOE (India)
- CEPEL/INMETRO (Brazil)
- CSA
- FM Standard
- GOST-B Standard
- GOST-R Standard
- IECex
- JIS (Japan)
- KTL (Korea)
- NEPSI (China)
Safety Information for EX Areas

Please note the EX-specific safety information for installation and operation in EX areas.

Figure 1: IECex Label
### Specifications

**Table 3: Specifications list**

<table>
<thead>
<tr>
<th>System Accuracy</th>
<th>±1% of span typical</th>
<th>Accuracy depends on specific application parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Sources</td>
<td>Cesium-137</td>
<td>0.66MeV gamma radiation emitter, 30.2 year half life</td>
</tr>
<tr>
<td></td>
<td>Cobalt-60</td>
<td>1.2 &amp; 1.3MeV gamma radiation emitter, 5.3 year half life</td>
</tr>
<tr>
<td>Power Requirements*</td>
<td>AC</td>
<td>100–230VAC ±10% (90–250VAC) at 50/60 Hz, at 15W (without heater) or 25W (with optional heater) maximum power consumption.</td>
</tr>
<tr>
<td></td>
<td>DC</td>
<td>20–60VDC (24VDC±10% for CE compliance) (less than 100mV, 1/1,000 Hz ripple) at 10VA maximum power consumption.</td>
</tr>
<tr>
<td>Wiring</td>
<td>#14–#22AWG (1.63–0.643mm)</td>
<td></td>
</tr>
<tr>
<td>Signal Cable</td>
<td>Maximum length</td>
<td>1,000m (3,280ft)</td>
</tr>
<tr>
<td>GEN2000™ Electronics Housing</td>
<td>4-wire hookup with DC</td>
<td>#18–#22 AWG (1.02–0.643mm) four conductor shielded</td>
</tr>
<tr>
<td></td>
<td>Certification to CSA and UL standards</td>
<td>• Designed to meet National Electric Code (U.S. &amp; Canada)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Class I, Groups A, B, C &amp; D, Div 1 &amp; 2</td>
</tr>
<tr>
<td></td>
<td>CENELEC certification</td>
<td>EExd II C T5 (pending)</td>
</tr>
<tr>
<td></td>
<td>Enclosure rating</td>
<td>NEMA 4X IP-66</td>
</tr>
<tr>
<td></td>
<td>Ambient temperature</td>
<td>−20 °C ... +60 °C (−4 °F ... +140 °F), option for lower temperatures available</td>
</tr>
<tr>
<td></td>
<td>Humidity</td>
<td>0–95%, non-condensing</td>
</tr>
<tr>
<td></td>
<td>Vibration</td>
<td>Tested to IEC 68-2-6, IEC 68-2-27 and IEC 68-2-36</td>
</tr>
<tr>
<td></td>
<td>Material</td>
<td>Cast aluminum ASTM A 357</td>
</tr>
<tr>
<td></td>
<td>Paint</td>
<td>Polyester Powder Coating</td>
</tr>
<tr>
<td>Weight</td>
<td>Detector housing</td>
<td>5.44kg (12lb)</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>LED indication</td>
<td>+6V, Memory Corruption, CPU Active, Auxiliary, &amp; High Voltage</td>
</tr>
</tbody>
</table>

* Power specifications change if an internal heater kit is used. See page 41.
Typical applications

Density
The DSGF can measure the density (mass per volume) of liquids and slurries through a pipe or vessel wall without contact to the material.

Percent solids
The DSGF can measure the Percent of solids in a carrier, when you enter the known density value of both the carrier and the solids into the software.

Cut detection or interface detection
The DSGF can detect the interface between liquids flowing in a pipe, when the liquids differ in density.
Where to find help

If you need help finding information, check the Index and Table of Contents within this manual. Also, refer to the Smart Pro Reference manual for information on calibration and operation with the Smart Pro.

VEGA Customer Service

VEGA Customer Service has Field Service Engineers located across the U.S. for on-site service to the U.S. and Canada. In many cases, a Field Service Engineer is at your plant for the start up of your gauge. In addition, Field Service Engineers regularly assist customers over the phone.

If you have a question or need help, call Customer Service during office hours. If your problem is an emergency (for example, line shut down because of VEGA’s equipment), you can reach us 24-hours a day.

Table 4: Contact information

<table>
<thead>
<tr>
<th>Contact Information</th>
<th>Telephone Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday through Friday 8:00 A.M. - 5:00 P.M. EST (Eastern Standard Time)</td>
<td>1-513-272-0131</td>
</tr>
<tr>
<td>Emergencies: Follow the voice mail instructions</td>
<td>1-513-272-0131</td>
</tr>
<tr>
<td>Fax</td>
<td>1-513-272-0133</td>
</tr>
</tbody>
</table>

In addition, VEGA provides field service for customers outside the U.S. and Canada. Customers outside the U.S. and Canada can contact their local VEGA representative for parts and service.

When calling with a question, if possible, please have the following information ready:

- ✔ VEGA Customer Order (C.O.) Number—Locate on the engraved label on the source holder
- ✔ Sensor serial number—Locate on the sensor housing inside the external housing
System overview

The DSGF detector uses VEGA’s GEN2000™ electronics. The GEN2000 is VEGA’s newest compact electronics that support 4 … 20 mA HART protocol, frequency, or field bus output. The DSGF system consists of three main components:

- Source holder
- DSGF detector assembly
- Smart Pro or Smart Pro Pac electronics

![Diagram](image)

*Figure 2: System overview*

The following statements describe the source holder:

- A cast or welded steel device that houses a radiation-emitting source capsule
- Directs the radiation in a narrow collimated beam through the process pipe or vessel
- Shields the radiation elsewhere
- The model chosen for each particular system depends on the source capsule inside and the radiation specification requirements
- A shutter on the source holder either completely shields the radiation (source off) or allows it to pass through the process (source on)
The following statements describe the functions of the DSGF detector assembly:

- Mounts opposite the source holder
- Inside the housing is a scintillation material
- The scintillation material produces light in proportion to the intensity of its exposure to radiation
- A photomultiplier tube detects the scintillator’s light and converts it into voltage pulses
- The microprocessor receives these voltage pulses after amplification and conditioning by the photomultiplier tube
- The microprocessor and associated electronics convert the pulses into a calibratable output to the Smart Pro electronics
- The Smart Pro electronics receives and reads the input and converts it into process units
- Several outputs are available on the Smart Pro, including a 4 … 20 mA output of the process variable. Refer to the Smart Pro Reference manual for more information.
Principles of operation

VEGA’s DSGF is a nuclear gauge that receives a narrow beam of radiation, through the process material, from the source holder.

The amount of radiation that the detector senses is in proportion to the amount of the material’s mass. Since the radiation source and detector are always the same distance apart and the volume of process liquid is constant, the only possible change in mass is the density of the process. The lighter the density of material, the more radiation passes through to the detector. The heavier the density of material, the less radiation passes through to the detector.

The Smart Pro calibrates the DSGF output and associates the detector readings, known as counts (the detector frequency output), with the density of the material in engineering units. The output range of the Smart Pro with the DSGF is a 4 ... 20 mA current loop signal, in proportion to the density of the process.

Communicating with the gauge

Use either a Smart Pro or Smart Pro Pac to enable the following:

- Setup
- Calibration
- Operation
Chapter 2: Installation

Location considerations

When the DSGF was ordered, the source was sized for optimal performance. Notify VEGA prior to installation of the gauge if the location of the gauge is different from the original order location. Proper location of the density gauge can sometimes mean the difference between satisfactory and unsatisfactory operation.

![Note]

Try to locate the source holder in such a place that process material will not coat it. This ensures the continuing proper operation of the source ON/OFF mechanism. Many regulatory agencies (for example, the U.S. NRC) require periodic testing of the ON/OFF mechanism. Refer to the “Radiation Safety for U.S. General and Specific Licensees, Canadian and International Users”, that came with the source holder and the appropriate current regulations for details.

Vertical pipe with upward flow

Mount the measuring assembly on a vertical pipe with upward flow of the process material. This position provides the best possible self-cleaning action, with a minimum possibility of gas or heavy solids collecting in the measuring section. You can mount the gauge on a horizontal pipe but a vertical flow is preferable. Keep the velocity above five feet per second to avoid build-up on the pipe walls and to keep the heavier solids in suspension. This is particularly true in sludge applications.

Pump considerations

Mounting the DSGF near a pump can be good or bad depending on the application. Check with VEGA application engineers for a recommendation on your application.

No line hammering

The design of the DSGF requires operation in low-vibration conditions. Install it in a location with no line hammering or excessive vibration. Quickly changing flow conditions may cause line hammering. If necessary, you can physically mount the DSGF apart from the vessel or pipe, but notify VEGA at the time of the order to ensure proper source size and shielding.
Installation

Stable temperature

Mount the DSGF on a portion of the line where the temperature of the process material is relatively stable. Process temperature change results in a density change that may affect the gauge indication. The amount of the effect depends upon the following:

- Sensitivity of the gauge
- Temperature coefficient of the process material

Temperature compensation is available, but requires an VEGA temperature probe in the process as an input to the Smart Pro.

No air entrainment

Mount the DSGF on a portion of the line where there is no possibility of air or gas entrainment and where the pipe is always full of process material.

Air or gas entrainment in the process, or a partially full pipe, results in an erroneous gauge indication because the density of the air measures along with the density of the process material.

Re-cal considerations

The DSGF requires periodic recalibration. Use process, absorber plates, or other easily repeatable reference fluid, such as water, for this re-cal. You must be able to empty or fill the pipe with water if you plan to re-cal with absorber plates or water. Often, you can purge the measuring section of a pipe by rerouting the process material through a bypass section.

Protect insulation

If insulation is between the measuring assembly and the process, protect the insulation from liquids. The absorption of a liquid, such as water, can affect the gauge indication because the DSGF measurement includes the density of the liquid in the insulation.

Avoid source cross-talk

When multiple adjacent pipes or vessels have nuclear gauges, you must consider the orientation of the source beams so that each detector senses radiation only from its appropriate source. The best orientation, in this case, is for the source holders to be on the inside with radiation beams pointing away from each other.
Mounting the measuring assembly

You can mount the density gauge on the pipe by positioning the detector housing and source holder brackets with the bolts that VEGA provides. If the pipe has insulation, the DSGF and source holder should have external support to prevent crushing of the insulation.

**Note**
The handle on the source holder operates a rotating shutter. When installing or removing the assembly from the pipe, you must turn the handle to the closed or Off position and lock the handle with the combination lock that VEGA provides.

Wiring the equipment

VEGA provides detailed Interconnect drawings for the DSGF.

**Note**
If the instructions on the drawing differ from the instructions in this manual, use the drawing. It may contain special instructions specific to your order.

Use the drawing notes and the steps that follow to make the input and output connections. Make the connections at the removable terminal strips mounted on the CPU board. Access the CPU board by removing the explosion-proof housing cap.

**Note**
Not all connections are required for operation. See Table 5 for terminal names and positions.

VEGA provides an internal and external ground screw for connection of the power Earth ground wire. After removing the top cover, the location of the internal ground screw is at the front of the housing. The location of the external ground screw is next to the conduit entry.
Installation

Figure 4: External and internal Earth ground

Figure 5: DSG Perforated View
Figure 6: Interconnect diagram

Figure 7: Interconnect connections
### Table 5: Terminal names and descriptions

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>L1</td>
<td>Power input</td>
</tr>
<tr>
<td>2</td>
<td>L2</td>
<td>Power input</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>6</td>
<td>Freq+</td>
<td>Measurement signal output</td>
</tr>
<tr>
<td>7</td>
<td>Freq–</td>
<td>Measurement signal output</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>11</td>
<td>Aux+</td>
<td>Auxiliary input frequency signal</td>
</tr>
<tr>
<td>12</td>
<td>Aux–</td>
<td>Auxiliary input frequency signal</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Not used</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Not used</td>
</tr>
</tbody>
</table>

**Note**

The power input terminals are polarity independent.
SmartPro and ProPac connections

The measurement signal from pins 6 and 7 go to a VEGA SmartPro or ProPac. The measurement signal is 0/100 kHz, maximum, true digital, and satisfies RS-422 and RS-423.

See the table below for interconnect information.

<table>
<thead>
<tr>
<th>From DSGF</th>
<th>To Smart Pro</th>
<th>To Smart Pro Pac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pin 6</td>
<td>TB 4-1</td>
<td>TB 1-4</td>
</tr>
<tr>
<td>Pin 7</td>
<td>TB 4-2</td>
<td>TB 1-5</td>
</tr>
<tr>
<td>Shield wire</td>
<td>TB 4-3</td>
<td>TB 1-12</td>
</tr>
</tbody>
</table>

Power

The AC power source voltage input is 100–230VAC±10% (90–250VAC) at 50/60 Hz, at 15VA maximum power consumption. Do not share AC power with transient producing loads.

The DC power source voltage input is 20–60VDC (less than 100mV, 1/1,000 Hz ripple) at 15VA maximum power consumption.

Note

The DSGF can accept either AC or DC input power, but not both at the same time.

CAUTION!

DO NOT APPLY POWER until a thorough check of all the wiring is complete!

Use wire between #14–#22AWG (1.63–0.643mm) for power wiring.

Switch for CE compliance

For CE compliance, install a power line switch no more than one meter from the operator control station.
Installation

Conduit

Conduit runs must be continuous and you must provide protection to prevent conduit moisture condensation from dripping into any of the housings or junction boxes. Use sealant in the conduit, or arrange the runs so that they are below the entries to the housings and use weep holes where permitted.

You must use a conduit seal-off in the proximity of the housing when the location is in a hazardous area. Requirements for the actual distance must be in accordance with local code.

If you use only one conduit hub, plug the other conduit hub to prevent the entry of dirt and moisture.
Commissioning the gauge

The process of commissioning the gauge includes the following:

- Taking appropriate radiation field tests
- Checking the pre-programmed setup parameters
- Calibrating on process
- Verifying the functionality of the gauge

VEGA Field Service Engineers typically commission the gauge. It is necessary to remove the source holder lock the first time the gauge takes measurements in the field. Only persons with a specific license from the U.S. NRC, Agreement State, or other appropriate nuclear regulatory body may remove the source holder lock.

**Note**

Users outside the U.S. must comply with the appropriate nuclear regulatory body regulations in matters pertaining to licensing and handling the equipment.

Can you remove the source holder lock?

If you are in doubt whether you have permission to remove the source holder lock…Do not!

The license sets limits on what the user can do with the gauge. Licenses fall into two categories:

1. General
2. Specific

It is up to the user to review the license to determine if they have the appropriate permission to perform any of the following tasks to the source holder:

- Disassemble
- Install
- Relocate
- Repair
- Test
- Unlock
Installation

You can remove the source lock if installation of the gauge is in the U.S. and you have the specific license to remove the source holder lock. Confirm that your license specifically states that you have the permission to perform this operation and then contact VEGA Field Service Radiation Safety for the combination.

Do not remove the lock if the gauge has a general license tag, installation is in the U.S., and you do not have the specific license that gives you permission to remove the lock. You can verify whether the gauge is a general license gauge by checking the source holder for the general license tag. If it is not there, it is not a general license device.

If you do not have permission to remove the source holder lock, an VEGA Field Service Engineer or another person with this specific license must remove it for you.
Installation

Field service commissioning call checklist

In many U.S. installations, an VEGA Field Service Engineer commissions the gauge. To reduce service time and costs, use this checklist to ensure the gauge is ready for commission before the Field Service Engineer arrives:

- Mount the source holder and detector per the VEGA certified drawings.
- Allow access for future maintenance.
- Make all wiring connections per the certified drawings and the “Wiring the Equipment” section in this manual. Tie in the wiring from the Smart Pro analog output to the DCS/PLC/chart recorder.
- Ensure that the AC power to the DSGF is a regulated transient-free power source. UPS type power is the best.
- If using DC power, verify that the ripple is less than 100mV.

Note
The equipment warranty is void if there is damage to the DSGF due to incorrect wiring not checked by the VEGA Field Service Engineer.

- Have process ready for calibration
- When possible, it is best to have process available near both the low and high end of the measurement span. A density change of at least 0.1SpG is a common requirement.
- When possible, have the material that you use for periodic recalibration of the gauge available. Frequently this is water.
- If you cannot meet any of these process conditions, you can still calibrate the gauge; however, it is not as accurate.
- Do not remove the lock on the source holder. Notify VEGA Field Service if there is damage to the lock or it is missing.
Installation

Notes
Chapter 3: Calibration

Use the Smart Pro or Smart Pro Pac (the software in both operates identically) to calibrate the DSGF. Refer to the *Smart Pro Reference* for instructions to use the Smart Pro software. To perform the calibration, you must be familiar with the Smart Pro topics:

- Navigating through the Smart Pro screens
- Security access level
- Product Code
- Saving to EEPROM

This section provides a summary of the calibration procedure for a standard density. Refer to the *Smart Pro Reference* and the *Smart Pro Mini Guide to Fast Startups* for more details.

Memory backup

To set the EEPROM in write-protect mode, remove the jumper from pins (JP17) on the SmartPro or ProPac CPU board. The CPU saves in three different memory areas. These areas are:

- Lower RAM (active)—battery maintained
- Upper RAM (with battery-backup)—copy of lower RAM for backup
- EEPROM (non-volatile)—copy of lower RAM for redundant backup

Lower RAM is the memory that the gauge uses during operation.

The upper RAM and EEPROM data do not download unless the operator explicitly commands it to do so. The operator performs this procedure if trying to recover from a memory corruption.
Process calibration

Calibration establishes reference points that relate the detector output to actual (or known) values of the process.

You must make an initial calibration before the gauge can make measurements of any accuracy. Perform the initial calibration after the installation and commission the gauge at the actual field site.

Before using the DSGF to make measurements, you must perform the following:

- Calibrate it to relate the detection of radiation from the source to the density of the process material
- Periodically, you must re-cal the system on process to adjust for changes over time

You do not need to repeat the initial calibration as long as certain critical process and equipment conditions remain the same. See "When a new initial calibration may be necessary" on page 29.

Initial process calibration

The calibration of a DSGF is a "two-point" calibration, with known density process samples near both the high and low end of the span read by the DSGF gauge. Use the Smart Pro or Pro Pac electronics to perform the calibration.

Smart Pro Note

Refer to the Smart Pro Mini Guide to Fast Startups for systematic calibration instructions. In addition, Chapter 3 of the Smart Pro Reference provides detailed information on the calibration process. Be sure to follow the instructions for a density gauge as indicated on the flow chart in the beginning of the Smart Pro Mini Guide to Fast Startups.

The span setting, data collection of high and low samples, and calculation of the two-point calibration establish the "endpoints" of the calibration curve (density vs. raw counts on a graph). The calibration curve is non-linear, due to the measurement method of radiation transmission. The linearizer determines the shape of the curve between the endpoints.

Note

When performing calibration or any other procedure that affects the output of the gauge, be sure to disable the gauge from your distributed control system’s (DCS) automatic control.
Set process span

The Smart Pro (or Pro Pac) calculates the process span based on the lowest (Min Reading) and the highest density (Max Reading) that you want the DSGF to measure. Enter the low and high densities in the Smart Pro SETUP MENU 2 OF 4 under the SET GAGE SPAN screen.

The measurement span was set at VEGA's factory, based on information received at the time of the order. If you move the DSGF from its intended location, or are measuring on a different span, you must modify the span setting. In any case, it is a good practice to verify that the setting is correct.

Caution

Changing the gauge span may require the entry of a new linearizer curve. Contact VEGA Field Service before changing the gauge measurement span.
Calibration

Cal Lo on Process

Setting the low density for calibration requires measurement with the DSGF of the low process sample and entry of the actual density. This sets the low end (sometimes referred to in the U.S. as zero) of the calibration curve. Perform this procedure either before or after setting the high density, but after entering the process span correctly in the SET GAGE SPAN screen, from the SETUP MENU 2 OF 4.

Note

You must perform data collection for the low and high density within ten days of each other for a good calibration. The low and high values must be more than 10% of the process span apart for the most accurate calibration.

Increasing the process span usually increases the gauge accuracy.

Before starting the cal low data collection:

☑ Fill vessel or pipe with low process
☑ Have actual density (or percent solids) value in process units for this sample, from the lab, ready to enter
☑ Verify on screen 502 that the Smart Pro is receiving the frequency input from the DSGF.

Procedure 1: Cal Lo on Process

1. Enter the correct password to reach the security access level 1
2. Be certain the correct Product Code has been selected
3. From the MAIN MENU, press the SELECT and ENTER keys to progress through these screens:
   CALIBRATE SYSTEM
   CALIBRATE GAGE
   SELECT CHANNEL (choose Channel #1)
   MORE CAL FUNCTIONS (three times)
   CAL LO ON PROCESS
4. On the CAL LO ON PROCESS, the DSGF measures the sample and displays a countdown
   When 0 seconds are left, press ENTER to continue
5. When prompted, enter the actual product value
6. Connect the JP17 jumper.
7. Save the results in EEPROM.
8. Disconnect the JP17 jumper.
Cal Hi on Process

Setting the high density for calibration requires measurement with the DSGF of the high process sample and entry of the actual density. This sets the gain of the calibration curve. Perform this procedure either before or after setting the low density, but after entering the process span correctly in the **SET GAGE SPAN** screen, from the **SETUP MENU 2 OF 4**.

**Note**

Perform data collection for the low and high density within ten days of each other for a good calibration. The low and high values must be more than 10% of the process span apart for the most accurate calibration.

Increasing the process span usually increases the gauge accuracy.

Before starting the cal high data collection:

- Fill vessel or pipe with high process
- Have actual density (or percent solids) value for this sample from the lab ready to enter
- Verify on screen **502** that the Smart Pro is receiving the frequency input from the DSGF.

**Procedure 2: Cal Hi on process**

1. Enter the correct password to reach the security access level 1
2. Verify that the correct Product Code has been selected
3. From the main menu, use the SELECT and ENTER keys to progress through these screens:
   - **CALIBRATE SYSTEM**
   - **CALIBRATE GAGE**
   - **SELECT CHANNEL** (choose Channel #1)
   - **MORE CAL FUNCTIONS** (1 time)
   - **CAL HI ON PROCESS**
4. On the **CAL HI ON PROCESS** screen, the DSGF measures the sample and displays a countdown. When 0 seconds are left, press ENTER to continue
5. At the prompt, enter the actual product value and press ENTER
6. Connect write-protect jumper JP-17
7. Save the results in EEPROM
Calibration

Calculate calibration with “Two Point Cal”

After collecting the high and low-density calibration data, the Smart Pro can make the calibration calculation.

Procedure 3: Two Point cal

1. From the CHANNEL #1 menu, move through:
   MORE CAL FUNCTIONS
   TWO POINT CAL

2. From the TWO POINT CAL prompt, select YES
   The Smart Pro uses the Cal Lo and Cal Hi data points to calculate the calibration

3. Connect write-protect jumper JP-17

4. Save the results in EEPROM

When a two-point calibration is impossible

In some installations, it is impossible to attain the high and low process conditions required for a two-point calibration. Calibration of the system is still possible with expert assistance. In this case, contact VEGA Field Service for advice at (513) 272-0131.

When a new calibration may be necessary

Under most circumstances, you do not need to repeat the calibration procedure. The system requires only periodic re-cal to compensate for drifts over time. However, certain events can necessitate a new initial calibration. These events are as follows:

- Measurement of a new process application (contact VEGA for recommendation)
- Requirement of a new measurement span by the process
- Entry of a new measurement span setting in the software
- Installation of a new radiation source holder with the DSGF
- Moving the DSGF to another location (in U.S. only specifically licensed persons may relocate the gauge)
- Pipe size, schedule, or any other change in process piping
- Build up or erosion of pipe is excessive so that you cannot compensate by re-cal

Periodic re-cal

Re-cal adjusts the system by resetting one point of the calibration curve to an independently measured or known sample.

The frequency of re-cal depends on several factors, including desired accuracy of the reading.

Smart Pro Note

Refer to the “Smart Pro Reference Chapter 3, section Re-Cal / Channel #1 (Category II Functions)” for more information about choosing a method and performing the periodic re-cal.
Calibration

Notes
Chapter 4: Diagnostics and repair

Software diagnostics

Refer to the Smart Pro manual for software diagnostics information.

Hardware diagnostics

Two circuit boards in the DSGF are replaceable. Figure 8 identifies the two boards.

Figure 9: Circuit board identification
Test points

Access the test points on the CPU board by pulling the sensor assembly slightly out of the housing.

---

**Table 7: Power supply board test points and labels**

<table>
<thead>
<tr>
<th>Power Supply Test point label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Not used</td>
</tr>
<tr>
<td>H2</td>
<td>Not used</td>
</tr>
<tr>
<td>TP1</td>
<td>Isolated ground</td>
</tr>
<tr>
<td>TP2</td>
<td>Loop current test point 200mV/mA loop current. Referenced to isolated ground.</td>
</tr>
</tbody>
</table>

**Table 8: CPU board test points and labels**

<table>
<thead>
<tr>
<th>CPU Test point label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Raw input signal coming from preamp.</td>
</tr>
<tr>
<td>GND</td>
<td>Logic ground</td>
</tr>
<tr>
<td>U5 pin8</td>
<td>+5V power supply test points referenced to Logic ground.</td>
</tr>
</tbody>
</table>

---

*Figure 10: Test points and jumpers*
Diagnostics and repair

Jumpers
The DSGF uses jumpers J1–J4 on the CPU board as division values for the output frequency to the Smart Pro.

<table>
<thead>
<tr>
<th>Table 9: Jumper division values</th>
</tr>
</thead>
<tbody>
<tr>
<td>J1</td>
</tr>
<tr>
<td>J2</td>
</tr>
<tr>
<td>J3</td>
</tr>
<tr>
<td>J4</td>
</tr>
<tr>
<td>None</td>
</tr>
</tbody>
</table>

Note
Do not change the jumper from the current setting without consulting VEGA Field Service

If the DSGF does not have a jumper, the division value is one.

LED indicators
Check the basic functioning of the VEGA electronics at the instrument with LED indicators on the CPU board. They are visible when you remove the explosion proof housing cap.

See the tables on page 34 for a summary of the LED indications.
### LED summary table

#### Table 10: Power Supply Board LED summary table

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Normal condition</th>
<th>Error condition</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+6V</td>
<td>+6V DC voltage level to electronics</td>
<td>ON</td>
<td>OFF—Electronics are not receiving +6VDC voltage required for functioning</td>
<td>Verify +6V on test points. Check fuse on Power Supply board. Check power input terminals 1, 2.</td>
</tr>
<tr>
<td>+24V</td>
<td>Not used</td>
<td>ON</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relay</td>
<td>Not used</td>
<td>Off</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Table 11: CPU Board LED summary table

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
<th>Normal condition</th>
<th>Error condition</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mem</td>
<td>Not used</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>HART</td>
<td>Not used</td>
<td>ON</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>CPU</td>
<td>Central processing unit on CPU board “heartbeat”</td>
<td>Blinks at rate of 1time/sec.</td>
<td>LED does not blink. CPU not functioning.</td>
<td>Check power input. Replace CPU board.</td>
</tr>
<tr>
<td>Aux</td>
<td>Auxiliary input frequency signal indicator</td>
<td>Blinks if auxiliary input present. OFF—if no auxiliary input present.</td>
<td>None</td>
<td>Check auxiliary input wiring terminals 11 &amp; 12 with a meter for frequency signal. Check auxiliary input equipment.</td>
</tr>
<tr>
<td>HV</td>
<td>Not used</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Field</td>
<td>Radiation field indicator</td>
<td>Cycles in proportion to radiation field intensity at detector. ON for 10sec. for each mR/hr, then off for two seconds. (Can use LED 5 that blinks 1time/sec to time LED 9 for field indicator.)</td>
<td>None</td>
<td>A 1mR/hr (2.580nC/kg/hr) field is usually required for a measurement. Check for closed source shutter, buildup, and insulation.</td>
</tr>
</tbody>
</table>
Diagnostics and repair

Maintenance and repair

**Periodic maintenance schedule**

The DSGF contains no moving parts and requires very little periodic maintenance. VEGA suggests the following schedule to prevent problems and to comply with radiation regulations:

<table>
<thead>
<tr>
<th>Description</th>
<th>Frequency</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Re-cal</td>
<td>As required by process conditions, usually at least once a month</td>
<td>Smart Pro Calibration chapter</td>
</tr>
<tr>
<td>Source holder shutter check</td>
<td>Every six months unless otherwise required by applicable nuclear regulatory agency</td>
<td>Radiation safety instructions shipped separately with source holder and following instructions</td>
</tr>
<tr>
<td>Source wipe</td>
<td>Every three years unless otherwise required by applicable nuclear regulatory agency</td>
<td>Radiation safety instructions shipped separately with source holder and following instructions</td>
</tr>
</tbody>
</table>

**Spare parts**

Contact VEGA Field Service at +1 513-272-0131 for parts, service, and repairs.

Outside the U.S., contact your local VEGA representative for parts, service, and repairs.
Field repair procedures
Very few parts are field repairable, but you can replace entire assemblies or boards. The following parts are replaceable:

- CPU circuit board
- Power supply circuit board

Use great care to prevent damage to the electrical components of the gauge. VEGA recommends appropriate electrostatic discharge procedures.

CAUTION!
NEVER remove the two screws holding down the sensor electronics. This contains the photomultiplier tube assembly. This component is easily damaged. Removing the sensor and then re-installing it can cause sensor problems.

NEVER remove the bottom cover. This protects the coupling joint of the flexible scintillator. There are no serviceable parts under the bottom cover.

Replacing a circuit board
You may have to replace a circuit board if there is damage to one of its components. Before replacing a circuit board, check the troubleshooting flowcharts or call VEGA Field Service to be sure a replacement is necessary.

Procedure 4: Replacing the CPU or power supply board

1. Turn off power to the gauge
2. Remove the housing cover
3. Remove the plastic electronics cover
4. Remove the terminal wiring connector
5. Remove the three (3) screws holding the electronics package in place
6. Carefully pull the electronics package out of the housing.
7. Remove the appropriate board from the clamshell assembly by removing the three (3) mounting nuts.

Note
If you are changing the CPU board, you must move the old firmware chip to the new board if the new board firmware is different.

8. Carefully reconnect any ribbon cables.
9. Install the electronics package in the housing.
Diagnostics and repair

10. Replace the three (3) mounting nuts.
11. Reconnect the terminal wiring connector.
12. Install the plastic electronics cover.
13. Install the housing cover.
14. Turn on the power to the unit.

**Note:** If you change the CPU board, a **New Hardware Found** error message normally appears when you connect with the HART communicator. In Ohmvie2000, click Diagnostics, **New hardware**, **New CPU**, and click **OK** for a new backup of EEPROMS.
Requesting field service

To request field service within the U.S. and Canada; call 513-272-0131 from 8:00 A.M. to 5:00 P.M. Monday through Friday. For emergency service after hours, call 513-272-0131 and follow the voice mail instructions.

Returning equipment for repair to VEGA

When calling VEGA to arrange repair service, be ready with the following information:

☑ Product model that is being returned for repair
☑ Description of the problem
☑ VEGA Customer Order (C.O.) Number
☑ Purchase order number for the repair service
☑ Shipping address
☑ Billing address
☑ Date needed
☑ Method of shipment
☑ Tax information
Returning equipment for repair

Procedure 5: To return equipment for repair

1. Call VEGA Nuclear Products Repair at 513-272-0131 between Monday and Friday, 8:00 A.M. to 5:00 P.M. United States Eastern Standard Time
2. VEGA assigns the job a material return authorization (MRA) number
   
   Please note: VEGA reserves the right to refuse any shipment that does not have a MRA number assignment.

3. Indicate the MRA on the repair service purchase order
4. Clearly mark the shipping package with the MRA number
5. Send the confirming purchase order and the equipment to:
   VEGA Americas, Inc.
   Attention: Repair Department
   4170 Rosslyn Drive
   Cincinnati, OH  45209-1599 USA

Note

You must first contact VEGA and receive a material return authorization number (MRA) before returning any equipment to VEGA. VEGA reserves the right to refuse any shipment not marked with the MRA number.
Diagnostics and repair

Notes
Appendix I: Special applications

This chapter provides application specific information for the internal heater kit for applications as low as –50 °C.

If you have other application questions, contact VEGA Field Service in the U.S. or Canada at 513-272-0131 or your local rep outside of the U.S. or Canada.

Internal heater kit for applications as low as –50 °C

A heater kit option is available for applications that require a –50 °C (–58 °F) temperature rating. With the heater option, the internal temperature of the unit rises approximately 30 °C (54 °F) degrees.

The features of the heater are as follows:

- The heater kit does not affect the functionality of the DSGF in any way. There is no requirement for special firmware
- The factory installs the internal heater kit if you order it with the DSGF
- Three different kits are available, one for 115VAC, one for 220VAC, and one for 24VDC

Table 14 lists the part numbers for the heater kits.

<table>
<thead>
<tr>
<th>Heater kit power</th>
<th>VEGA Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>115VAC</td>
<td>240723</td>
</tr>
<tr>
<td>220VAC</td>
<td>240724</td>
</tr>
<tr>
<td>24VDC</td>
<td>241912</td>
</tr>
</tbody>
</table>

Changes to specifications

Installation of the heater kit changes the power rating from the specifications on page 5 of this manual.

With the heater installed, the maximum power consumption increases to 25W. The unit is either 115VAC±10%, 220VAC±10%, instead of the standard 90–270VAC range or 24VDC.
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