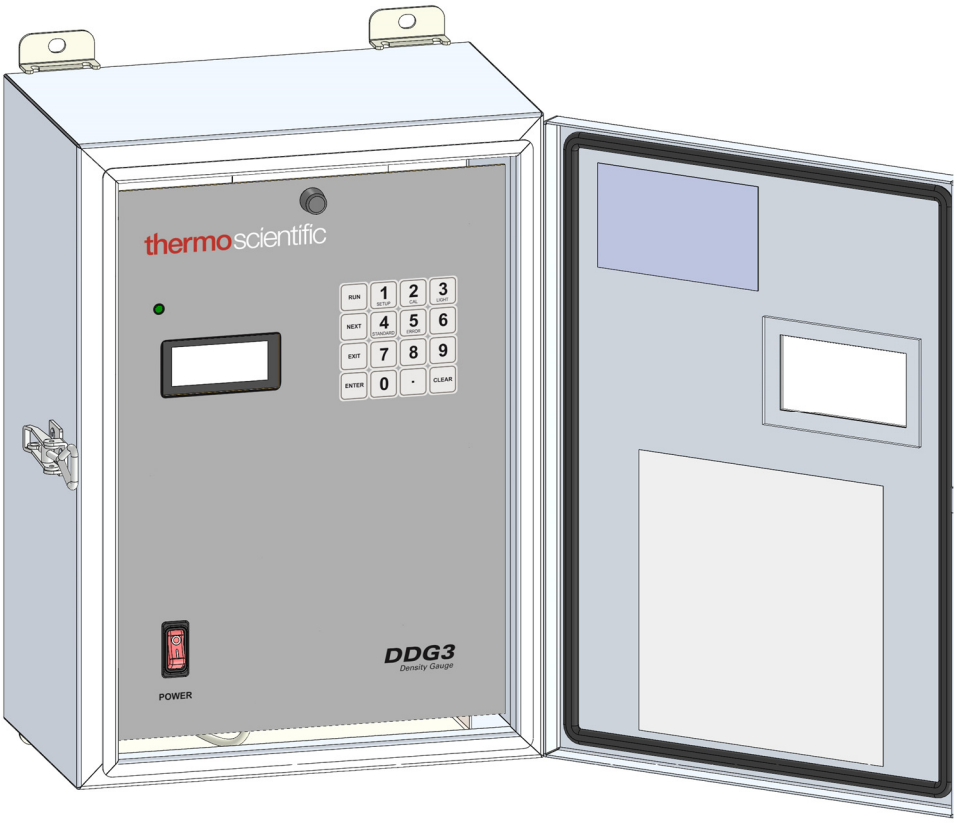
Thermo Fisher Scientific
High Performance Density Gauge



46560 Rev 6

thermoscientific

Table of Contents

Safety

For safety, and optimal product performance, follow the instructions in the manual.

Symbols

The following symbols are used in this manual and on the product.

WARNING. Failure to observe could result in death or serious injury.

RISK OF ELECTRIC SHOCK. The system is powered by AC mains voltage. Also voltages inside the detector head may be as be as high as 1500VDC.

RADIATION HAZARD. This symbol is marked on the source housing

General Safety Precautions

Safety precautions when installing, operating, or maintaining the density gauge:

WARNING. Failure to follow safe installation and servicing procedures could result in death or serious injury. Only qualified personnel should perform installation and maintenance in accordance with the instructions in this manual.

WARNING. Do not attempt to defeat safety interlocks in the source housing. The source housing must be serviced only by licenced and qualified radiation safety personnel.

WARNING. Mains on cables and inside enclosures can cause electrical shock. Power must be properly isolated when checking electrical connections and when removing or inserting printed circuit boards.

Radiation Safety

The Density Gauge is an approved and certified radiation device. However each client needs to be licensed to handle radioisotopes. Thermo Fisher can assist with all necessary information

The Source Housing comes with one of the following sources:

Source Type	Half Life	Energy
Cs-137	30 years	660 KeV
Co-60	5.3 years	1.17 Mev, 1.33 Mev
Ba-133	10.5 years	356 KeV

The activity of radioactive material used is selected for each application, but is in the range 3 to 500 mCi (111 to 18500 MBq). A typical application uses 20 mCi (740 MBq) of Cs-137.

General rules for reducing radiation exposure are:

1. Minimize the time spent near radiation.
2. Maximize the distance from radiation.
3. Use of a shielding material (i.e. lead)

Under normal operating conditions where the source holder is mounted on a pipe filled with material the expected radiation level around the source holder is similar to natural background radiation. The maximum radiation levels around the Source Holder (using a 20 mCi source) are given in the following figure. Note that normal background radiation is 0.1-0.4uSv/hr:

If the Density Gauge Source Holder is not mounted on a pipe, ensure that handle is locked in the BEAM OFF position. Levels directly in front of the holder can be as high as 600 uSv/hr in the BEAM ON position.

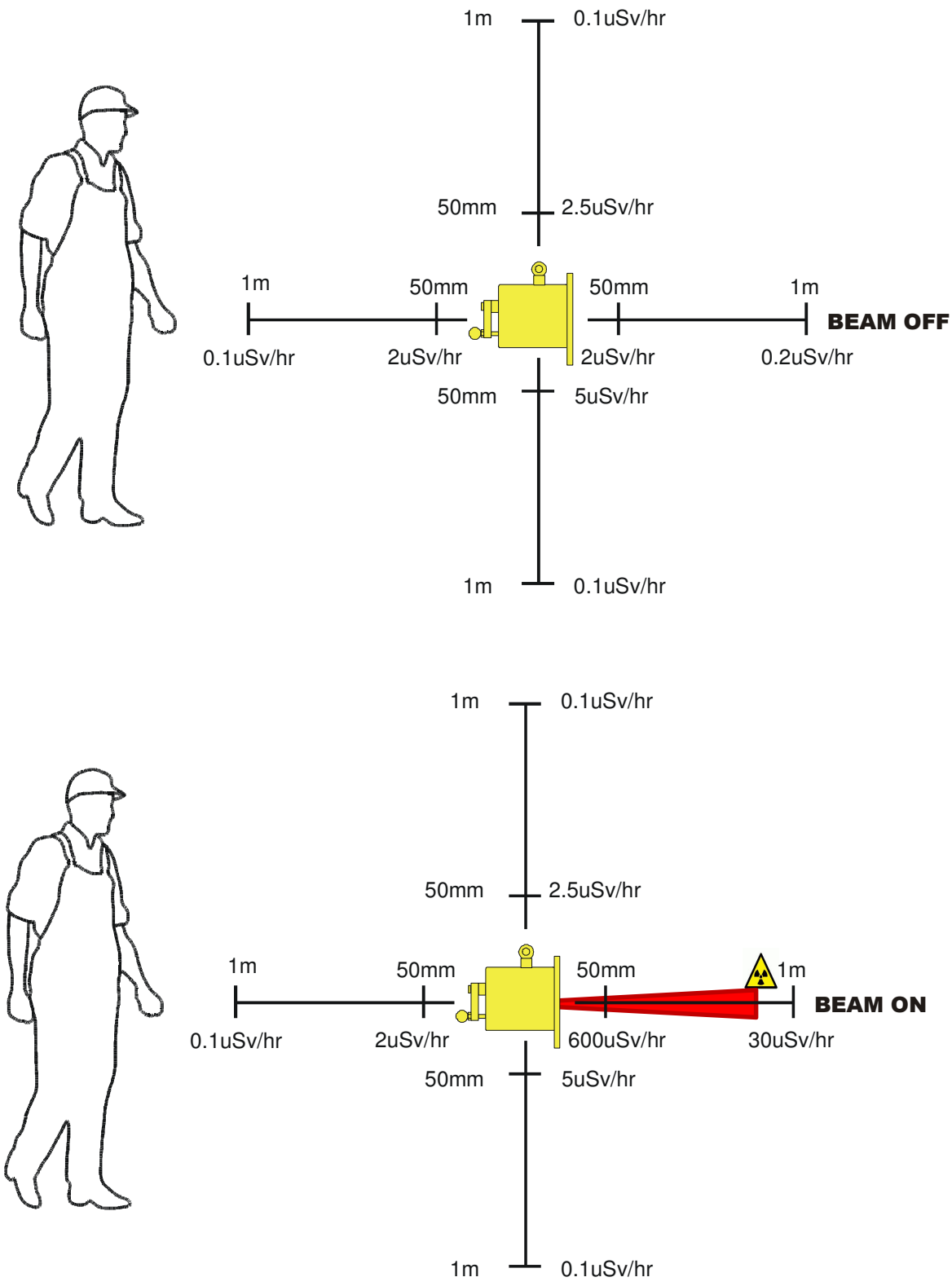


Figure 1 – Radiation levels/distance

Introduction

Overview

The density gauge is a Nucleonic Density Gauge that measures the density of material transported in a pipe using an energy absorption technique. It consists of the following major assemblies:

- the source holder
- the detector, and
- a digital controller

Theory of Operation

Density is measured via energy attenuation of ionizing radiation. A radioactive source is contained in a lead-filled, steel-encased housing is mounted on one side of a pipe with a scintillation detector mounted on the opposite side. Gamma energy emitted by the source passes through the pipe and the process material. As the density of the process material changes, the amount of energy reaching the detector also changes. By converting this energy reading to a density measurement, the system achieves a highly accurate result, enabling rapid response to variations in density.

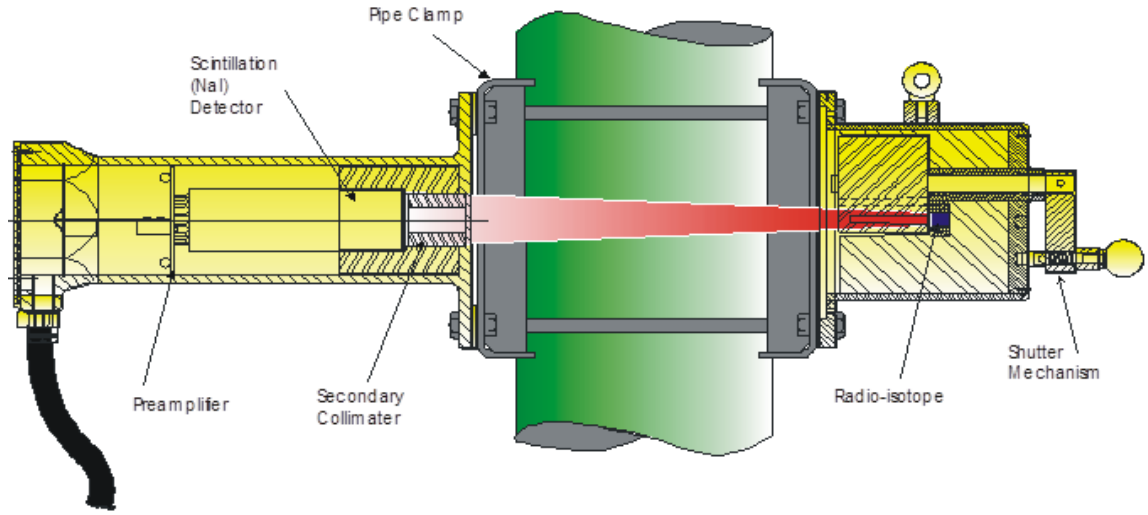


Figure 2 – Operating principle of the source holder and detector

Application Data

Applications	
	Process Control
	Plant mass balance
	Thickner underflow measurement
	Cyclone and spiral feed control
	Material characterization
	Concentration determination
	Quality control
	Process Control

Industries	
	Petrochemical
	Mineral processing
	Coal handling and washing
	Food processing
	Paper and pulp
	Water treatment
	Petrochemical
	Dredging

Measurements	
	SG (g/cc)
	Solids (%) (By mass)
	SG (g/l) (Dry solids per l)
	Mass Flow Rate (Tonnes per hour)
	Total Mass (Tonnes)
	Solids Volume Flow Rate(m3 per hour)
	Total Solids Volume (m3)
Precision	Precision 0.002g/cc (30 seconds)
Calibration	Standardisation on process fluid
	Single or Multi point calibration

Technical Specifications

Technical Specifications	
Controller	Stainless Steel 1.6mm enclosure 415 x 300 x 200 mm
	IP66 rating (Dust and Water Tight)
	0-55C
	16 bit 32MHz RISC Microprocessor
	Internal 256K Memory/16K Data
	Analogue I/O 12 bit resolution
	4 line transflective backlit LCD
	LED indicators for maintenance
	16 key tactile membrane keypad
Power Supply	24VDC or 110VAC or 230VAC 50/60 Hz, 10 W
	Wide range voltage tolerance (+-10%)
	2A 230VAC Circuit breaker
Inputs	Two 4-20 mA current inputs (flow & temp compensation)
Outputs	Two 4-20 mA programmable isolated outputs
	Dry relay contact for totalisers
	Dry relay contact for Alarm/Limit
	Rating 250 VAC, 2 A max
Protocols	MODBUS RTU, MODBUS TCP, ETHERNET I/P, PROFINET, HART
Source and Detector	Epoxy coated steel
	Narrow Beam
	Cs-137 or Co-60 or Ba-133 source
	Manual lockout shutter
	10-1000m cable length
	Standard clamps for pipe diameters 40 to 600mm
	Non-standard clamps from 15mm to 1000mm

Installation

WARNING. Failure to follow these installation procedures could result in death or serious injury.

WARNING. The source holder is heavy (refer to the installation drawing). Use safe lifting techniques and ensure that the source and detector are mounted securely.

WARNING. Ensure that the source housing is locked off in BEAM OFF – SAFE before handling.

Mechanical Installation

Refer to the Installation Drawing at the back of the manual, and the following figures. The source housing and detector are mounted on opposite sides of a pipe using a mounting clamp. For small pipe diameters (<75mm ID) a Z-BEND should be used for mounting the source holder and detector. The DDG3 controller is wall mounted vertically out of direct sunlight. It comes standard with a 10m cable (longer options available), and should be situated close enough to coordinate sampling. The electronics controller enclosure has a 55C/ IP66 rating. However sunshades are recommended for equipment protection and optimal screen visibility in extreme conditions.

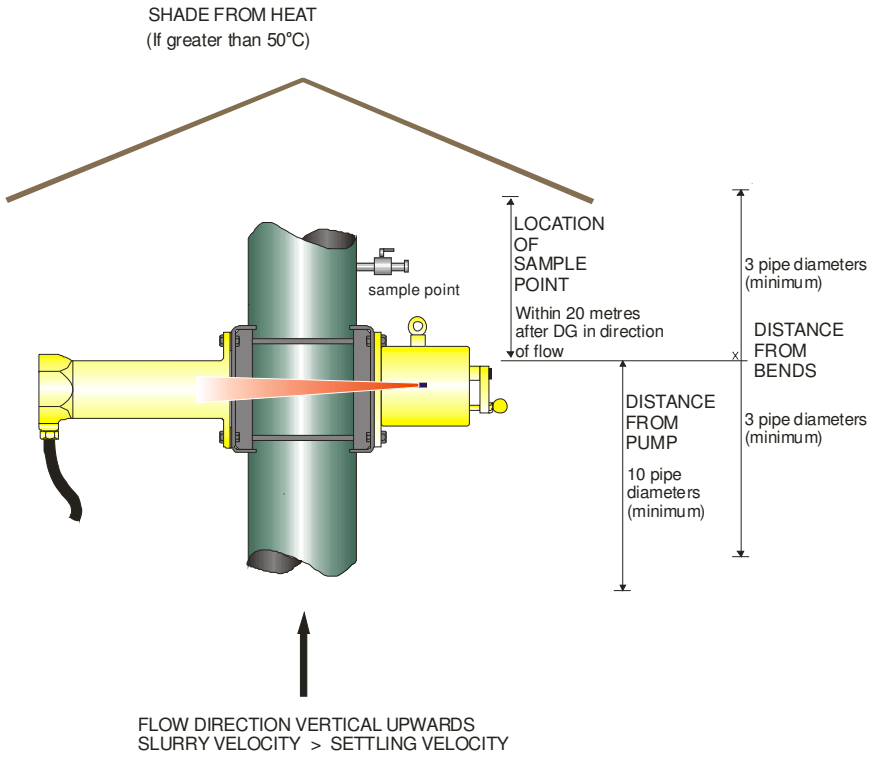


Figure 3 – Location of the source holder and detector

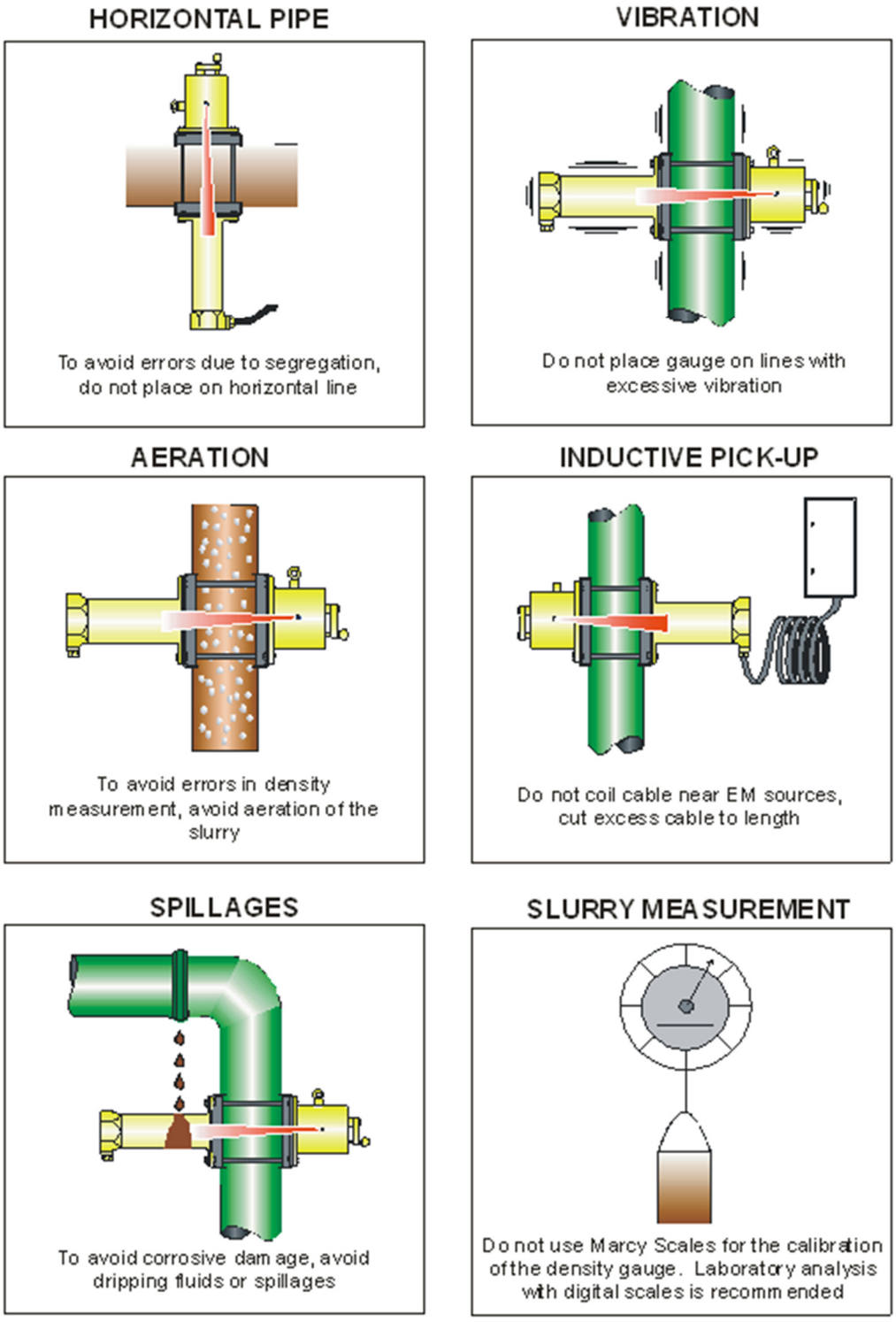


Figure 4 – Installation recommendations

Electrical Installation

WARNING. Mains voltage on cables and inside enclosures can cause electrical shock. Power must be properly isolated when checking electrical connections and accessing enclosures.

Refer to the installation Wiring Diagram at the back of the manual. Check the nameplate for the installation voltage. The controller comes in the following variants:

- 230VAC
- 110VAC
- 24VDC

The maximum power requirement is less than 10W. The circuit breaker is rated at 2A. Spade terminals are required to connect directly to the inlet filter in the enclosure. Glands provided in the enclosure are used to maintain the IP rating.
In addition, the head cable must be connected to the phoenix connector on the printed circuit board.
Other input and output connections are optional and will vary with each installation. Refer to the technical specifications for their ratings.

Operation

To configure and operate the gauge, please carry out the instructions in this section, in the sequence written

Navigation

There is a 16 button keypad in the controller, and a menu inside of the control cabinet (refer to then back of this manual):

Figure 5 - Keypad

The following menu options are available:

- **RUN**
- **SETUP**
- **CAL**
- **LIGHT**
- **STANDARD, and**
- **ERROR**

NEXT is used to cycle though the current options available,
EXIT is used to escape from a selection,
ENTER is used to make a selection, and
CLEAR is used to erase data.

Initialization

When the system is first powered on, the green power LED above the display should illuminate and the system reports the software version:

DDG3 Vx.xx

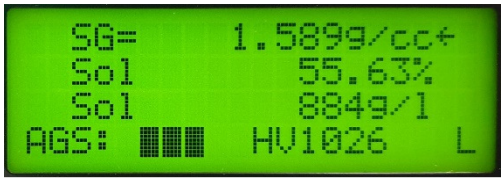


Figure 6 – Top level menu

Use **RUN/NEXT** to cycle through the display lines, and **ENTER/NEXT** to select the preferred measurand. This enables the selection of any three displays. The bottom line is the status line and shows the gauge AGS state and errors if there are any.

Keylock Option

Press and hold the decimal place **"."**. to lock the gauge. L is shown on the bottom of the screen after a long beep. Use the same process to unlock the gauge. With Keylock On, users lose access to the SETUP, STANDARDISE or CALIBRATE menus which will prevent accidental erasure of configuration, standardisation or calibration data.

Density

SETUP/Density menu/ENTER. Set the following as required

Option	Description
Avg Time	The gauge will continuously compute a rolling average result. Selecting a longer averaging time, results in more precision but slower response. Start with a shorter time (10s), this may be increased later on for improved precision
Filter	Set the adaptive filter%. Process variations exceeding this SG% reset the rolling average. Default is 0% (Off). If a quick step response is required, then start with a large value 50% and reduce to 5%.
Peak is	Select Wide to include all valid counts, or Narrow to only include counts that are close to the peak of the isotope detected. In the normal case, select Wide. If there are other background sources, resulting in more than 100 counts with the beam off then select Narrow

High Voltage

SETUP/HiVolt menu/ENTER. Set the following as required

Option	Description
HiVolt=	The high voltage set at the detector head. This voltage is the result of normal AGS operation. This voltage can also be manually set using the "HiVolt is" and "HiVolt man" options. This is also shown on the main screen.
Source =	Select the correct source type per the source housing.
Hi Volt is	Normally select Auto. • Off – High Voltage Off • Man – Manually set the HV to "HiVolt man" (500V-1500V) • Auto – Allow the system to search and find the optimal HV value.
Hi Volt man	This is the manual high voltage setting.
AGS	Searching/Refining/Set/Reset This shows the current AGS state. The normal progression is 1. Searching (1 bar) 2. Refining (2 bars) 3. Locked (3 bars) If Locked, then the Hi Volt will be automatically tracking, and the AgsErr, should be close to zero. You can reset the AGS by pressing Enter. AGS lock on should take less than 2 minutes, provided there is at least 1000 counts. You can observe the AGS state by the number of bars on the front screen.

Once configured, cycle the power to re-start the AGS search with the new parameters. If the gauge is configured correctly the displayed count rate should be updating and reading consistent results.

Density Calculation

The gauge calculates density according to the following equation:

$$SG = Dens\ STD + \frac{10}{M * l} * \left[\ln\left(Cr\ STD * CCR\right) - \ln CR\right]$$

SG	the calculated density
$Dens\ STD$	the density of the liquid
M	Slurry constant
l	Internal diameter of pipe in mm
$Cr\ STD$	the standard count rate
CCR	decay ratio (how much the source has decayed since standardization)
CR	is the current count rate

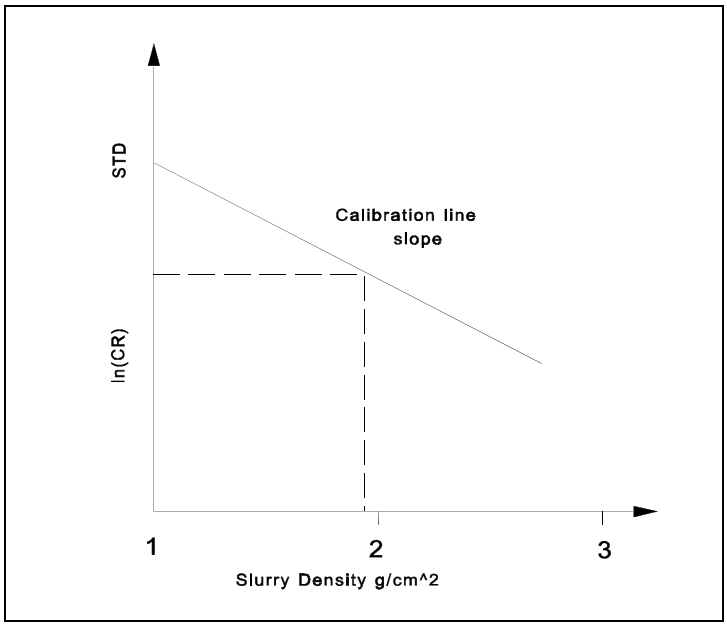


Figure 7 – Calibration line

Standardisation

Standardisation is the process used to measure the standard count rate of the carrier fluid/liquid which is the y intercept of the calibration line. Standardisation is recommended every 3 months. Standardisation accounts for many factors like source strength, pipe wall thickness and alignment. It is recommended that the standardisation time is greater than or equal to the calibration time.

The standardisation consists of 10 measurements of a specified duration, and if the results are consistent the average count rate is stored. The beeper will sound at the start and end of each measurement. This can be used to prompt sampling.

STANDARD/ENTER

Option	Description
StdAgeDay	This is the number of days since standardisation. It is zeroed during standardisation and automatically incremented by the system clock.
STD Cr	This value is the number of counts value computed by the gauge which is the average of 10 measurements.
Dens STD	This is where the user can enter the density of the carrier fluid/liquid.
Std time	The time period for each measurement.
Measure new STD Cr?	Select this to initiate the standardisation.

Standardisation Process

1. Fill the pipe with liquid
2. Enter Density of the liquid
3. **Measure new STD Cr?/ENTER**
4. Accept the new count rate

Remote Standardisation

This can be controlled using the Standardisation Request register. Status is monitored with the Operating Mode register.

Step	Standardisation Request	Operating Mode	Description
a.		**0**	Normal running condition.
b.	**1**	**1**	Standardisation has commenced. Commence sampling.
c.		**2**	Standardisation is complete, results shown. .
d.	**2 or 3**		Select 2 to Accept, 3 to Reject
e.		**0**	Normal running condition

Calibration

Calibration is used to calculate the new slurry constant M which is the slope of the calibration line. Up to 4 calibration points may be entered at the same time. Calibration is recommended every 6 months.

The calibration process works just like the standardisation process with 10 measurements. The beeper will sound at the start and end of each measurement. This can be used to prompt sampling.

CAL/ENTER

Option	Description
Pipe ID	Input the Inner diameter l of the pipe in mm
SL Constant	The value for M (between 0.01 and 0.15) is automatically calculated during the calibration process
Cal time	The time period for each measurement
Calc New Calib?	Calculate the new SL constant M from the following table

Measured count rate	User entered SG
Cr 1	SG1
Cr 2	SG2
Cr 3	SG3
Cr 4	SG4

M is the average calculated for all of these points. Any Cr value with the corresponding SG set to zero is ignored. Note that the SG can be adjusted and the SL Constant recomputed at any time. This gives the option of using an approximate density and then inputting the final lab result at a later date.

Calibration Process

1. Fill the pipe with slurry.
2. Select a Cr to measure and press Enter
3. Take a physical sample continuously during the full calibration
4. Input the SG corresponding to the measured Cr.
5. **Calc New Calib?/ENTER**. This updates the SL Constant.

Remote Calibration

This can be controlled using the Calibration Request register. Status is monitored with the Operating Mode register.

Step	Calibration Request	Operating Mode	Description
a.		**0**	Normal running condition.
b.	**1-4**	**3-6**	Calibration of points 1-4 has commenced. Commence sampling.
c.		**7**	Calibration is complete, results shown
d.	**5 or 6**		Select 5 to Accept, 6 to Reject.
e.	**7**		Select 7 to update SL constant.
f.		**0**	Normal running condition.

Solids Calculation

The following data is required to allow the system to make solids calculations computations (such as % solids).

SETUP/Solids calc menu/ENTER

Option	Description
%Sol	Displays the current calculated percentage of solids (by weight)
Dens LIQ	Enter the density of the liquid with no solids
Dens SOL	Enter the density of the dry solids

Flow Input (Optional)

The flow input is used to connect the gauge to a flow meter using a 4-20 mA current loop input so that a flow rate can be input. This enables volume and mass flow to be calculated and displayed. Alternatively flow rate may be simulated manually, if the flow rate is constant.

SETUP/Flow Input Menu/ENTER

Option	Description
Flw=	Displays the flow rate in m3/hr
Flow mA	Displays the mA sensed at the flow input
Flow is	This enables the user to select the way flow is provided from the following • Off • Man • Auto (this is from the current loop input)
Flow man	This enables the user to program the manual value in Engineering Units
Flw@4mA	This is the value in Engineering Units corresponding to 4mA
Flw@20mA	This is the value in Engineering Units corresponding to 20mA

Configuration process Manual

1. This process if for when the flow rate is constant and no flow meter is available
2. Select Flow is Manual.
3. Go to Flow man and select a simulated output (in engineering units).

Configuration process Auto

1. Configure the current loop lower limit Flw@4mA (in engineering units)
2. Configure the current loop upper limit Flw@20mA (in engineering units)
3. Select Flow is to Auto.
4. Check that Flow is, the flow current input, and the value output by the flow meter throughout the flow rate range.

Temperature Compensation Input (Optional)

The temperature input is used to connect the gauge to a temperature sensor using a 4-20 mA current loop input so that the liquid temperature can be input. Temperature Compensation is used in the chemical industry where it is necessary to correct the density measurements of a liquid back to the density that it would have been if it had been at the reference temperature, which was used for calibration.

SG(TRef) = SG(T) * SVR

Where

SG(TRef)	=	Density of the Liquid at Tref
SG(T)	=	Density of the liquid as measured by the Density Gauge.
SVR	=	Specific volume ratio of the liquid at the temperature (T).

SETUP/Temp Input menu/ENTER

Option	Description
Temp=	Displays the temperature in C
Temp mA	Displays the mA sensed at the Temp input
Temp is	This enables the user to select the way temp is provided from the following • Off • Man • Auto (this is from the current loop input)
Temp man	This enables the user to program the manual value in Engineering Units
Temp@4mA	This is the value in Engineering Units corresponding to 4mA
Temp@20mA	This is the value in Engineering Units corresponding to 20mA

SETUP/Temp comp menu/ENTER

This is used to input the SVR at three temperatures. The system uses a parabolic curve fitting function to apply this correction to the density. 1.0 (the default) represents no correction.

Temperature	Svr
Tlo	Svr@Tlo
Tmn	Svr@Tmn
Thi	Svr@Thi

Current Loop Outputs

There are two current loop outputs for connection to the control system. They are programmable to output any measurement required, both are identical in function and may be accessed from the setup menu.

SETUP/Output x menu/ENTER

Option	Description
Outx=	This is the Measurement value for Output x in Engineering Units
Outx mA=	This is the current loop value for Output x in mA
Outx is	This enables the user to select the measurement type for Outx from the following • Off • Man • SG • %Sol • g/l • CntRate • Tonnes
Outx man	This enables the user to program the manual value in Engineering Units
Ox@4mA	This is the value in Engineering Units corresponding to 4mA
Ox@20mA	This is the value in Engineering Units corresponding to 20mA

Configuration process

1. Select Outx is Manual.
2. Configure the current loop lower limit 0x@4mA (in engineering units)
3. Configure the current loop upper limit 0x@20mA (in engineering units)
4. Go to Outx man and select a simulated output (in engineering units)
5. Check that Outx=, the actual current output, and the value measured by the control system agree as you simulate the span.
6. Finally select Outx is to the actual measurement type required.

Totaliser Output

This option allows the user to output to a set of relay contacts, which may be used to output totals measured by the system such as total volume or mass to a counting system:

SETUP/Totaliser Menu/ENTER

Option	Description
Total is	This enables the user to select the measurement type to be output on the totalizer contacts • Off • Solids m3 • Pulp m3 • Tonnes
Step Size	This is the step size for one contact closure. Note that the totaliser frequency must be less than 1Hz

Alarm/Fault Output

This option allows the user to output to a set of relay contacts that closes when an alarm is set. When the process is between the upper and lower value, the alarm is off. This may be configured to act as a fault output.

SETUP/Alarm menu/ENTER

Option	Description
Alarm=	This displays the current alarm state (On/Off)
Alarm is	This enables the user to select the measurement type for the Alarm from the following • Off • Man • SG • %Sol • g/l • Tonnes
Alarm man	The value to force into the alarm
AlarmLo	The Alarm lower limit
AlarmHi	The Alarm upper limit

Configuration process

1. Select Alarm is manual.
2. Configure AlarmLo limit (in engineering units)
3. Configure AlarmHi limit (in engineering units)
4. Go to Alarm man and select a simulated output in engineering units
5. Check that the Alarm=, the contacts and the value measured by the control system agree as you simulate the span.
6. Finally select Alarm is to the actual measurement value required for the Alarm.

NETWORK Connection

The gauge natively supports MODBUS RTU and MODBUS TCP
The MODBUS register table for both methods identical, and is at the end of this manual.

MODBUS RTU

The gauge supports MODBUS RTU (Using RS-485 via connector TB6 and TB7). The settings are 19200, n, 8, 1. The device number (1-255) is set through the Gauge Address menu.

MODBUS TCP

The gauge also supports MODBUS TCP via the internal Ethernet Jack. The IP address is configured using the Gauge Address Menu. The complete MODBUS table is attached at the rear of this manual.

Other Protocols

The gauge also supports HART, ETHERNET I/P and PROFINET using protocol converters that are installed in the rear of the enclosure. The MODBUS register table is identical. Users will need to program the plant side of their device to suit the plant control network. This may be done using a web interface. By default the converter IP address is set to **192.168.1.100**.

Maintenance and Troubleshooting

WARNING. Ensure that the source housing is locked off in BEAM OFF – SAFE before handling

WARNING. Mains on cables and inside enclosures can cause electrical shock. Power must be properly isolated when checking electrical connections and removing or inserting printed circuit boards.

Factory Reset

To perform a factory reset, hold the CLEAR button down during power up. All non-volatile constants will be reset to default. The gauge will report **Params cleared.**

Detector

The AM744 preamplifier board, and Integral Line Assembly (ILA) are located in the detector head. These are accessed by removing the detector cap (6 screws) and releasing the spring inside the detector head. The cable can be unplugged and the AM744/ILA assembly slid out. The ILA unplugs from the AM744 preamplifier.

Controller

The front panel is fitted into the controller housing. It can be accessed by turning the fastener at the top of panel, and lowering the panel forward. All cabling enters through glands mounted in the bottom of the enclosure and is terminated via quick disconnect terminals that can be unplugged. LEDs indicate the status of the board for diagnostic reasons.

LED Diagnostics

These LEDs should always be on

LED	Meaning	Colour
POWER LED 5mm	Power on (Reverse side of board)	GREEN
POWER OK	24VDC Power OK	GREEN
HEAD	40VDC power to HEAD	GREEN
5V	5 Regulated power OK	GREEN
3V3	3V3 Processor power OK	GREEN
L1+5V	Loop1 5V OK	GREEN
L1+24V	Loop1 24V OK	GREEN
L2+5V	Loop2 5V OK	GREEN
L2+24V	Loop2 24V ON	GREEN

With TB1 disconnected (Current Loop connector), the following LEDs should also be on

LED	Meaning	Colour
LOOP FAULT	Current Loop 1 is open circuit	AMBER
LOOP FAULT	Current Loop 2 is open circuit	AMBER

When the both current loops are connected, these additional LEDs will illuminate instead of the AMBER LEDs.

LED	Meaning	Colour
LOOP1 IN	Loop 1 IN is active	GREEN
LOOP2 IN	Loop 2 IN is active	GREEN
ACTIVE1	Loop 1 Out is active	GREEN
ACTIVE2	Loop 2 Out is active	GREEN

Fault Reporting

The gauge has the ability to report a number of faults through bus Fault Word. The faults are also reported on the status line in the display. This is the list of possible faults and their interpretation. Use this table in conjunction with the fault diagnosis checklist. The faults are not latched, and should be used in conjunction with the Fault Finding Checklist.

REPORTED FAULT TABLE			
Fault Bit	**Fault**	**Meaning**	**Resolution**
1	CPU RECOVERY	CPU/Software Fault	Controller or Software Fault
2	INTERNAL EEPROM CRC	CPU EERPROM Checksum Fault	Controller or Software Fault
4	WATCHDOG RESET	CPU/Software Fault	Controller or Software Fault
8	TIMER	CPU/Software Fault	Controller or Software Fault
16	HIGH COUNTS	>200K for wide, >40K for Narrow	Excess Count rate for application
32	LOW COUNTS	1-500 counts	Insufficient count rate for application
64	NO LOCK	Gauge failed to lock on within 5 minutes	System fault, Cabling, Detector, Controller.
128	NO HEAD CONTROL	No Head signal detected	System fault, Cabling, Detector, Controller
256	CURRENT LOOP1 ERROR	Input out of 4-20mA range	Check Current loops and settings
512	CURRENT LOOP2 ERROR	Input out of 4-20mA range	Check Current loops and settings
1024	CALIBRATION OVERDUE	200 days since calibration	Calibrate Gauge
2048	STANDARD OVERDUE	100 days since standardisation	Standardise Gauge
4096	EXTERNAL EEPROM CRC	External Flash Fault	Controller or Software Fault
8192	HEAD LIFE	ILA Head Voltage too high	Replace ILA/Detector

Fault Diagnosis Checklist

Symptom	Step	Procedure	Action
No Power	1.	Check mains supply.	**Restore mains.**
	2.	Check circuit breaker.	**Cycle and reset circuit breaker.**
	3.	Check power at board.	**If power is good, replace front panel.**
No Display	1.	Re-power controller.	**If power is good, replace front panel.**
Count-Rate Too Low, No Head Control	1.	Check source handle is in the BEAM ON position.	**Rotate the handle to BEAM ON.**
	2.	Check HEAD LED on controller board.	**Recheck terminations at controller and detector.**
AGS Won't Lock	1.	Check High Voltage Parameters	**Cycle Power, Reset AGS.**
		As above for no count-rate	**Replace AM744 board. Replace ILA, Replace front panel.**
Count-Rate Too High	1.	Check for slurry in pipe. AGS not locked.	**Restore slurry in Pipe. Reset AGS.**
Density Reads Incorrectly	1.	Check count rate.	**Treat the count rate symptom first.**
	2.	Check standard count rate in STANDARD	**Enter correct count rates. Standardise the Density Gauge.**
	3.	Check slurry constant in CALIBRATE.	**Enter correct slurry constant. Calibrate the Density Gauge.**
% Solids Reads Incorrectly	1.	Check count rate and density.	**Treat count rate and density issues first.**
	2	Check % Solids menu	**Ensure that they are entered correctly.**
No 4-20ma Output	1.	Check LED Diagnostics.	**Recheck terminations and wiring on controller. Recheck 4-20 mA output configuration menu.**
No Flow Input	1.	Check LED Diagnostics.	**Recheck terminations and wiring on controller. Recheck 4-20 mA input menu.**
No Totaliser	1.	Check flow input present.	**Connect flow input. Recheck totaliser configuration menu.**
No Temp Comp.	1.	Check LED Diagnostics.	**Recheck terminations and wiring on controller. Recheck SVR and temp configuration menu.**

Spares

Parts Breakdown Structure

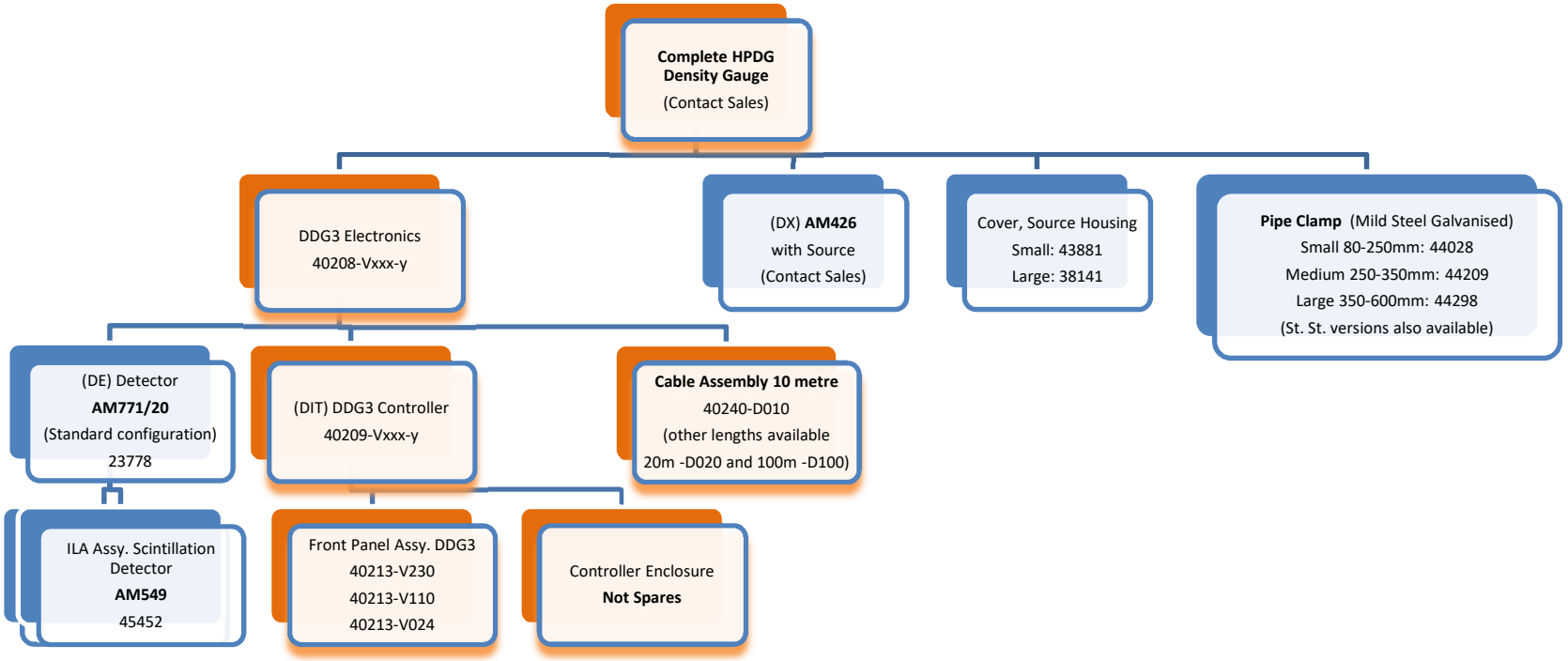


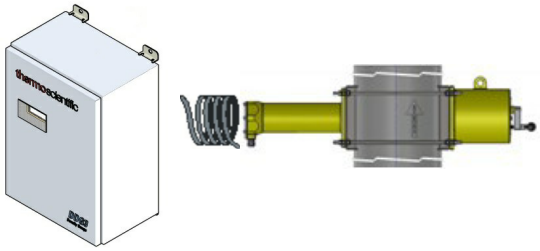
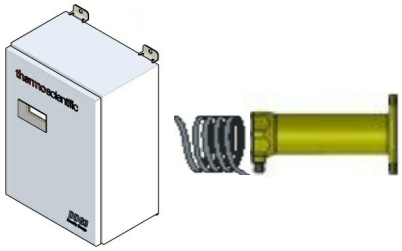
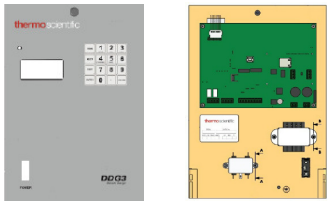
Figure 8 – Parts Breakdown Structure

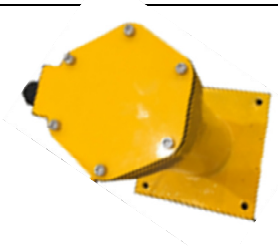
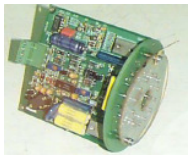
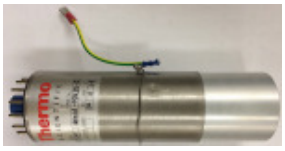
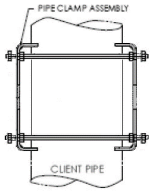
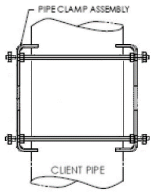
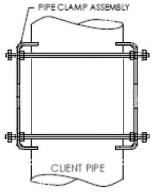
PART Number Structure

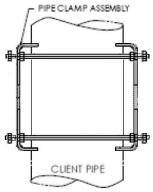
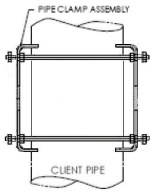
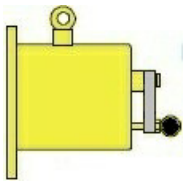
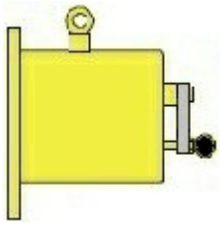
40209-Vxxx-y DDG3 Controller
40208-Vxxx-y DDG3 Electronics

Where
xxx = the voltage (230, 110 or 024)
y = the protocol (Blank=MODBUS default, E=Ethernet IP, H=HART, P=PROFINET)

Parts List

Part Number	Description	Spares Name	Photo
Contact Sales	AM870 HPDG complete Product	Contact Sales	
40208-V230 40208-V110 40208-V024 40208-V230-E 40208-V110-E 40208-V024-E 40208-V230-H 40208-V110-H 40208-V024-H 40208-V230-P 40208-V110-P 40208-V024-	Density Gauge Electronics - standard controller (transmitter), standard detector (50mm aperture, 2" ILA) and 10m cable	KIT, DDG3 + AM771/20 + 10M	
40209-V230 40209-V110 40209-V024 40209-V230-E 40209-V110-E 40209-V024-E 40209-V230-H 40209-V110-H 40209-V024-H 40209-V230-P 40209-V110-P 40209-V024-P	Density Gauge DDG3 Controller Suffixes: -VXXX (Voltage) Default MODBUS -E (Ethernet I/P) -H (Hart) -P (Profinet)	ASSY, DENSITY GAUGE CONTROLLER	
40213-V230 40213-V110 40213-V024	DDG3 PCBA and Keypad Assembly	ASSY, FRONT PANEL (DDG3)	

23778	AM771/ standard detector assembly (50mm aperture, 2" ILA, painted mild steel housing)	ASSY, DETECTOR (DG/2)	 
23747	AM744 HV Dynode and Preamp Assembly	ASSY, PREAMP/DYNODE (DG/2)	
45452	AM549 ILA (Scintillation Detector)	ASSY, 2" ILA	
44208	Pipe clamp - Small - suit 80 to 225mm OD pipes (Mild Steel Galvanised)	PIPE CLAMP, 80 TO 225 (HPDG)	 
44209	Pipe clamp - Medium - suit 250 to 350mm OD pipes (Mild Steel Galvanised)	PIPE CLAMP, 250 TO 350 (HPDG)	
44209	Pipe clamp - Medium - suit 250 to 350mm OD pipes (Mild Steel Galvanised)	PIPE CLAMP, 250 TO 350 (HPDG)	

44209	Pipe clamp - Medium - suit 250 to 350mm OD pipes (Mild Steel Galvanised)	PIPE CLAMP, 250 TO 350 (HPDG)	
44298	Pipe clamp - Large - suit 375 to 600mm OD pipes (Mild Steel Galvanised)	PIPE CLAMP, 375 TO 600 (HPDG)	
Contact Spares.	Source Housing (small) with Source	AM426/xx Source sizes 10 to 100mCi	 
43881	Source Housing Cover - Small	COVER, HPDG SOURCE HOUSING	 
Contact Spares	Source Housing (large) with Source	AM426/xx Source sizes 200 to 500mCi	
38141	Source Housing Cover - Large	COVER, SOURCE HOUSING 200NB	 

Contact

Manufacturer

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Email (Service) service.auadl@thermofisher.com
Website: http://www.thermoscientific.com

Appendix – Engineering Drawings

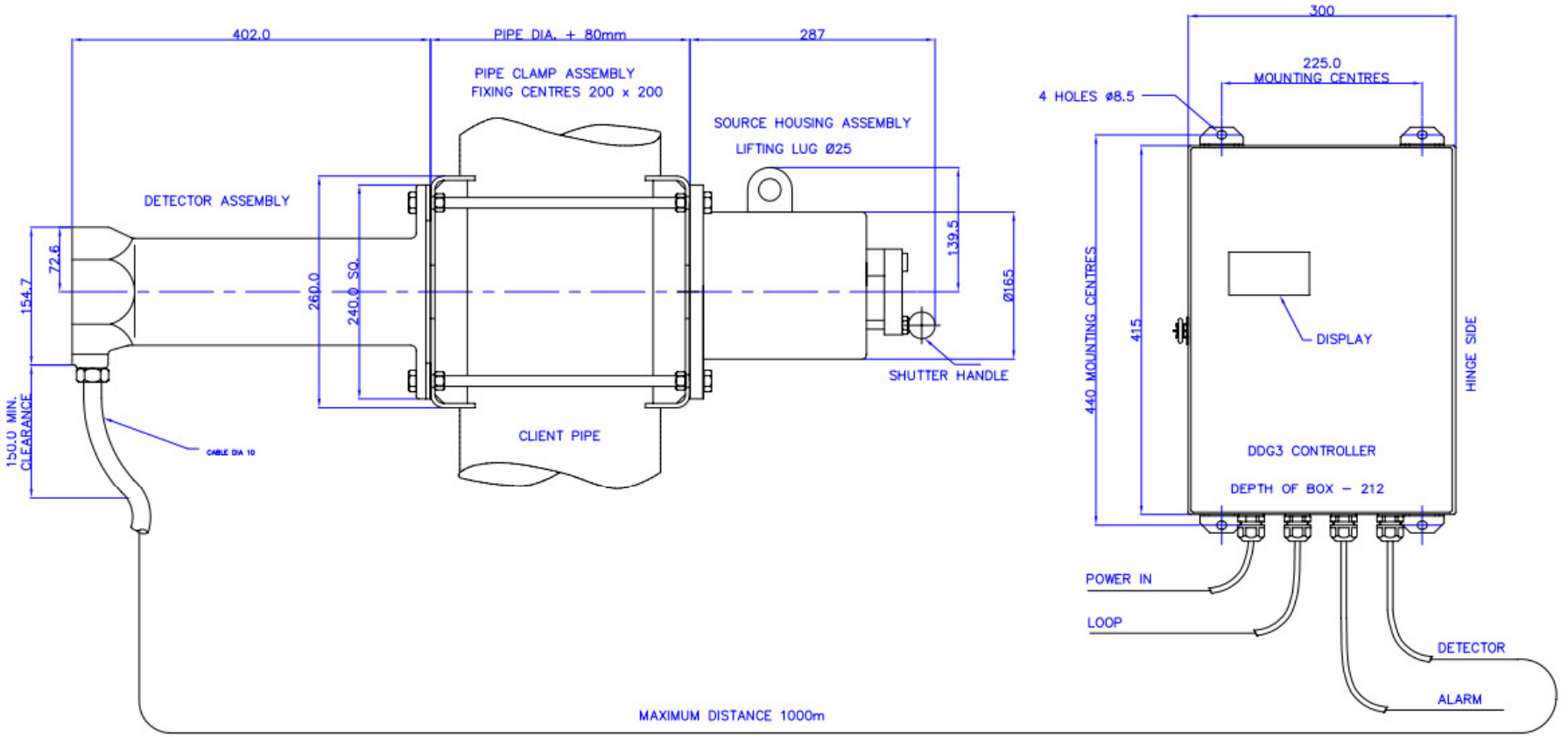
This appendix contains the following engineering drawings:

Installation Drawing

Installation Wiring Diagram/Field Wiring Diagram

Summary of Commands

MODBUS Registers



WEIGHT TABLE

SOURCE HOUSING SMALL	42kg
SOURCE HOUSING LARGE	92kg
DETECTOR ASSEMBLY	25kg
PIPE CLAMP	20kg
CONTROLLER UNIT	5kg

Notes:

1 CABLE ASSEMBLY 40240, LENGTH 10 to 1000m.
2 FOR CORRECT ALIGNMENT CLAMP BOLTS MUST BE TIGHTENED THE SAME AMOUNT

Rev	Description	ECR	Date	Drawn	Approved

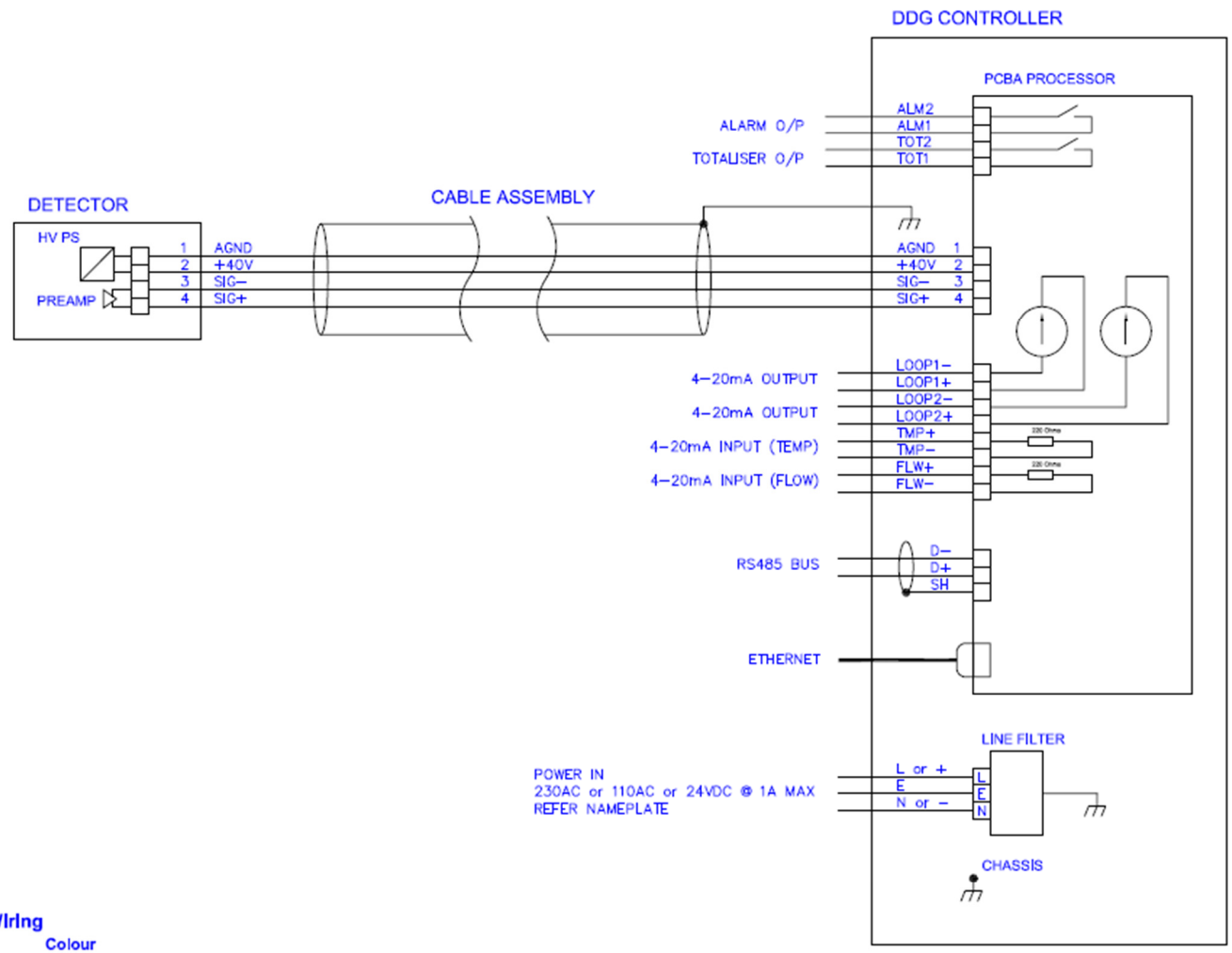
ALL DIMENSIONS IN MILIMETERS U.N.O. TOLERANCE UNLESS OTHERWISE STATED	
MATERIAL	N/A
FINISH	N/A
LINEAR	X ± 0.5, X.X ± 0.2, X.XX ± 0.1
ANG.	X ± 1.0°, X.X ± 0.5°
AUTOCAD	A3
THIRD ANGLE PROJECTION	
SHEET NO.	1 of 1
SCALE	NTS
DRAWN	P HAYLES
DATE	7 MAR 18
CHECKED	
DATE	
APPROVED	
DATE	

TITLE

INSTALLATION DRAWING DDG3

ThermoFisher SCIENTIFIC

PART NO./CODE NO.	DRAWING NO.	REV.
	40232	0



Wiring

No	Function	Colour
1	AGND	BK2
2	+40V	WH2
3	SIG-	BK1
4	SIG+	WH1

Notes:

1 CABLE ASSEMBLY 40240, LENGTH 10 to 1000m.

Rev	Description	ECR	Date	Drawn	Approved

ALL DIMENSIONS IN MILIMETERS U.N.O. TOLERANCE UNLESS OTHERWISE STATED

LINEAR: X ±0.5, X.X ±0.2, X.XX ±0.1

ANG.: X ±1.0°, X.X ±0.5°

MATERIAL: N/A

FINISH: N/A

AUTOCAD: A3

THIRD ANGLE PROJECTION

DRAWN: P HAYLES — DATE: 2 FEB 18

CHECKED — DATE

APPROVED — DATE

SHEET NO.: 1 of 1

SCALE: NTS

TITLE: INSTALLATION WIRING DIAGRAM DDG3

ThermoFisher SCIENTIFIC

PART NO./CODE NO.

DRAWING NO.: 40231

REV.: 0

SUMMARY OF COMMANDS

	RUN	
	SG	g/cc
	Sol	%
	Sol	g/l
	Sol	T/Hr
	Plp	m3/hr
	Sol	m3/hr
	Sol	T
	Plp	m3
	Sol	m3
	Cnts	/s

	CAL	
0	Pipe ID	mm
1	SL const	
2	Cal Time	
3	Cr 1	/s
4	Cr 2	/s
5	Cr 3	/s
6	Cr 4	/s
7	SG 1	
8	SG 2	
9	SG 3	
	SG 4	
	Calc New Calib?	

	STANDARD	
0	StdAgeDay	
1	Source is	None, Cs-137, Co-60, Ba-133
2	STD Cr	
3	Dens STD	
4	Std time	
5	Meas new STD Cr?	

	SETUP		
0	Density menu	Avg Time	s
		Filter	%
		Peak is	Wide, Narrow
1	HiVolt menu	Hi Volt=	
		Source=	None, Cs-137, Co-60, Ba-133
		Hi Volt is	Off, Man, Auto
		HiVolt man	
		AGS	Searching, Refining, Set
		AgsErr=	
2	Solids calc menu	%Sol=	
		Dens LIQ	
		Dens SOL	
3	Output 1 menu	Out1=	
		Out1 mA=	
		Out1 is	Off, Man,SG,%Sol, g/l, CntRate, Tonnes
		Out1 man	
		01@4mA	
		02@20mA	
4	Output 2 menu	Out2=	
		Out2 mA=	
		Out2 is	Off, Man,SG,%Sol, g/l, Cntrate, Solmass
		Out2 man	
		02@4mA	
		02@20mA	

5	Flow Input menu	Flw=	m3/hr
		Flow mA	
		Flow is	Off, Man, Auto
		Flow man	
		Flw@4mA	
		Flw@20mA	
6	Temp Input menu	Temp=	C
		Temp mA	
		Temp is	Off, Man, Auto
		Temp man	
		Temp@4mA	
		Temp@20mA	
7	Temp comp menu	Svr=	
		Tlo	
		Svr@Tlo	
		Tmn	
		Svr@Tmn	
		Thi	
		Svr@Thi	
8	Alarm Menu	Alarm=	
		Alarm is	Off, Man, SG,%Sol,g/l,Tonnes
		Alarm man	
		AlarmLo	
		AlarmHi	
9	Totaliser Menu	Total is	Off, Plp m3, Tonnes, Sol m3
		Step Size	
10	Gauge Address	Gauge Address	
		IP Address	
		Modbus Delay	

MODBUS REGISTERS

Register	Name	Description	Display	Dirn	Format	Multiplier	Range
	Density						
40001	SG gfcc	Total density of pulp solution	x.xxxx	R	U32	*10000	0-9.99
40003	Sol %	Percent solids in solution, by mass	xx.xxx	R	U32	*10000	0-100
40005	Sol gfl	Density in grams per litre	xxxx.x	R	U32	*100	0 - 9999
40007	Sol T/hr	Mass flow rate of solids	xxxx.xx	R	U32	*100	
40009	Plp m3/hr	Volume flow rate of pulp	xxx.xx	R	U32	*100	
40011	Sol T	Total tonnes	xxxxxxx.x	W/R	U32	*100	
40013	Plp m3	Total volume of pulp	xxxxxxx.x	W/R	U32	*100	
40015	Cnts/s	Raw measured counts	xxxxxxx	R	U32	*100	0 - 999999
40017	Sol m3	Total volume of Solids	xxxxxxx.x	W/R	U32	*100	
	System/Health						
40020	Operating Mode	Current operating mode	Integer	R	B16		0=Run, 1=Standardise, 2=Standardise Complete, 3-6 =Calibrating (for each of the 4 points), 7=Cal Complete
40021	Fault Word	Faults Register	Bool	R	B16		Bit mask for various faults refer fault table, 0 is none
40022	Alarm	Alarm State	Bool	R	B16		0=OK, 1=Alarm
40023	Command	Command to reset and test gauge	Integer	W/R	B16		0=Normal, 1=Reboot, 2=Clear Parameters
40024	Avg time	Data averaging time	Seconds	W/R	U16		1-600
40025	Filter %	Adaptive Filter	%	W/R	U16	*100	0-100. A percentage of density where the rolling average is zeroed off. 0 is none
40026	AGS State	AGS state	Integer	R	B16		0=Off, 1=Search, 2=Refine, 3=Lock, 4=Manual
40027	HV	High Voltage at head in Volts	Integer	R	U16		500-1500
	Standardise						
40030	Days since STD	Days since last standardisation	days	R	U16		0 - 65535
40031	STD time	Time for a standardisation cycle	seconds	W/R	U16		time for each of 10 standardisation measrements
40032	Standardise Request	Request a standarsisation	Integer	W/R	B16		0 = no, 1 = do it, 2 = Accept it, 3 = Reject it
40033	Calculated Std Cr	Count rate calculated	counts/s	R	U32	*100	0 - 999999
40037	Cr STD	Corrected counts used for density calcs	counts/s	R	U32	*100	0 - 999999
40039	Density Std	SG of the standard (nom 1.000)	SG	W/R	U32	*10000	0 - 9.99
	Calibrate						
40041	Days since cal	Days since last calibration	days	R	U16		0 - 65535
40042	Cal time	Time for calibration cycle	seconds	W/R	U16		time for each of 10 calibration measrements
40043	Pipe ID	Inner Diameter of pipe	mm	W/R	U16		1 - 9999mm
40044	Calibrate Request	Request a calibration	Integer	W/R	U16		0=no, 1=4 do the calibration, 5 = Accept CR, 6 = Reject it, 7 =Update SL constant
40045	Count Rate 1	CR1	counts/s	R	U32	*100	
40047	Count Rate 2	CR2	counts/s	R	U32	*100	
40049	Count Rate 3	CR3	counts/s	R	U32	*100	
40051	Count Rate 4	CR4	counts/s	R	U32	*100	
40053	SG 1	SG1		W/R	U32	*10000	
40055	SG 2	SG2		W/R	U32	*10000	
40057	SG 3	SG3		W/R	U32	*10000	
40059	SG 4	SG4		W/R	U32	*10000	
40061	Calculated SL Constant	SL constant	const	R	U32	*1000000	SL constant from cal
40063	SL const	SL constant	const	R	U32	*1000000	SL constant curently in use
	Flow						
40070	Flow Value	Flow rate (Input/output)	xxxxxxx.x	W/R	U32	*100	0 - 99999.9
40072	Sol m3/hr	Solids volume flow rate	xxxxxxx.x	W/R	U32	*100	0 - 99999.9
	Temp						
40074	Temp Value	Temperature (Input/Output)	C	W/R	U32	*100	0 - 999.99
	Configuration						
40080	Software Version		number	R	U16	*100	
40081	MAC address 1	MSW	number	R	U16		
40082	MAC address 2		number	R	U16		
40083	MAC address 3	LSW	number	R	U16		