Cell Density Monitoring System

Operating Instructions

HAMILTON®

Hamilton Warranty

Please refer to the General Terms of Sales (GTS).

Important note

Contents of this operating instruction can be modified without previous announcement. Technical modifications reserved. Greatest possible care was used on the correctness of the information in this operating instruction. If errors should be discovered nevertheless, Hamilton Bonaduz AG is pleased to be informed about it. Regardless of this, Hamilton Bonaduz AG cannot assume liability for any errors in this operating instruction or for their consequences.

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1 Preface

Welcome to the World of Hamilton Precision Instruments.

Congratulations on your purchase of a Hamilton Cell Density Monitoring System comprising a Control Unit (Arc View Controller, Cell Density ComBox, Cell Density Integration Kit) and an Incyte and/or Dencytee Unit. The sensors are designed for monitoring permittivity (Incyte) and turbidity (Dencytee). This technology enables the online monitoring of viable and total cell density during biotechnological processes. For the first time you can monitor cells in real-time, obtain actionable data, and automate process adjustment. A standard measuring loop consists of a Sensor Unit (i.e. a sensor with a Pre-amplifier), which is connected to the Control Unit. With the Control Unit, it is also possible to view Arc sensors wirelessly, like pH and DO, on just one display. Proper handling and maintenance of this monitoring technology will increase the lifespan of the system. To learn about proper care and maintenance, please take the time to read this manual, including the warranty information.

2 General Information

2.1 Intended Use

The Cell Density Monitoring System is designed to measure permittivity with the Incyte sensor and turbidity with the Dencytee sensor in a liquid medium. These measurements may be used for the control of bioprocesses within the defined specifications (see specifications sheets www.hamiltoncompany.com). The permittivity measurement may be correlated to the viable cell density, and the turbidity measurement may be correlated to the total cell density. In addition to permittivity Incyte also measures conductivity. This measurement should not be used for the control of bioprocesses.

2.2 About this Operating Instruction

These Operating Instructions will help users to operate the Cell Density Monitoring System correctly and safely. To achieve that goal, this document describes the different components of the system and how they function. The Operating Instructions describe both the hardware and software of the Cell Density Monitoring System in a depth enabling the user to operate the system. After introducing the various parts, it is shown step by step how to operate the system. After reading the Operating Instructions, users should be capable of installing and operating the Cell Density Monitoring System. Following information are highlighted within this document:

⚠ ATTENTION! Essential information for avoiding personal injury or damage to the equipment.

🗍 NOTE: Important instructions or interesting information.

3 Liability

The liability of Hamilton Bonaduz AG is detailed in the document "General Terms and Conditions of Sale and Delivery," Hamilton is expressly not liable for direct or indirect losses arising from the use of the sensors. It must in particular be insured in this conjunction that malfunctions can occur on account of the inherently limited useful life of sensors contingent upon their relevant applications. The user is responsible for the calibration, maintenance and regular replacement of the sensors. In the case of critical sensor applications, Hamilton recommends using back-up measuring points in order to avoid consequential damages. The user is responsible for taking suitable precautions in the event of a product failure. The sensor is not intended as a safety device.

4 Safety Precautions and Hazards

⚠ ATTENTION! Read the following safety instructions carefully before installing and operating the Cell Density Monitoring System.

4.1 General Precautions

For safe and correct use of Incyte and Dencytee, it is essential that both operating and service personnel follow generally accepted safety procedures as well as the safety instructions given in this document, the operating instruction of the Cell Density Monitoring System. The specification given (see specifications sheets www.hamiltoncompany.com) as regards temperature; pressure etc. may under no circumstances be exceeded. Inappropriate use or misuse can be dangerous. Cleaning, assembly and maintenance should be performed by personnel trained in such work.

SAFETY PRECAUTIONS AND HAZARDS

Before removing the sensor from the measuring setup, always make sure that no process medium can be accidentally spilled. When removing and cleaning the sensor, it is recommended to wear safety goggles and protective gloves. If the system cannot be repaired by the operator, it has to be sent back to Hamilton for inspection. Necessary precautions should be taken when transporting the sensors. For repair or shipment the System should be sent back in the original reusable packaging box. Every Incyte or Dencytee sensor sent back for repair must be decontaminated. If the conditions described in these operating instructions are not adhered to or if there is any inappropriate interference with the equipment, all of our manufacturer's warranties become obsolete.

4.2 Operation of the Cell Density Monitoring System

The Cell Density Monitoring System must be used for the intended applications, and in optimum safety and operational conditions. The specifications (such as temperature or pressure) defined in the section entitled 'Technical Specification' (Chapter 15) must not be exceeded under any circumstances.

Make sure that the process connections and O-rings are not damaged when screwing a sensor into the process. O-rings are consumable parts which must be exchanged regularly (at least once per year). Even when all required safety measures have been complied with, potential risks still exist with respect to leaks or mechanical damage to the armature. Wherever there are seals or screws, gases or liquids may leak out undetected. Always make sure that no process medium can be accidentally spilled before removing the sensor from its measurement set up. Do not put stress on the system by vibration, bending or torsion.

You may leave the pre-amplifier connected to the sensor during cleaning in place (CIP) and sterilization in place (SIP). Stand clear of the pre-amplifier during CIP and SIP procedures as it may become very hot. The pre-amplifier is not autoclavable. Dismount it prior to autoclavation to avoid damages to the electronics.

4.3 Electrical Safety Precautions

Only use the power supply provided with the Arc View Controller, or the ComBox. Do not connect it to a power source of any voltage beyond the range stated in the specifications. Failure to do so may lead to malfunction or damage of the system or impair user safety.

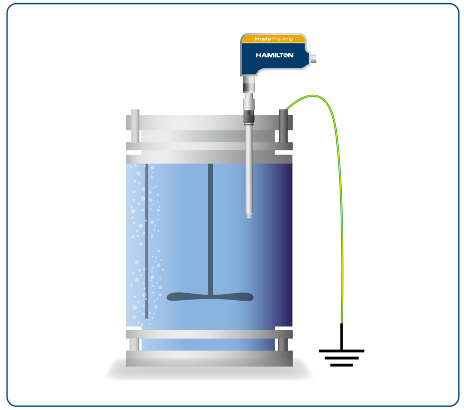
⚠ ATTENTION! Disconnect from power the Arc View Controller and ComBox prior to mounting and dismounting a Sensor Unit.

In areas having significant electronic noise, Incyte sensors and preamps may require grounding.

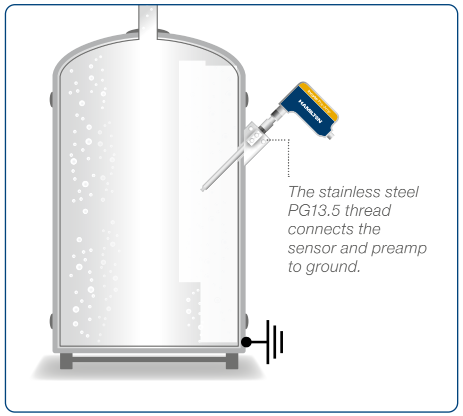
Locations having electronic noise may cause interference to your permittivity readings. Grounding the Incyte sensor and preamp should alleviate the interference.

- If the headplate of a benchtop bioreactor is not grounded, connect an earth ground wire to it.
- For large metallic bioreactors it is not necessary to ground the Incyte sensor or preamp if the bioreactor is already grounded.
- For large bioreactors without a ground (e.g. glass lined reactors) connect a ground wire to the fitting the Incyte sensor is mounted to.

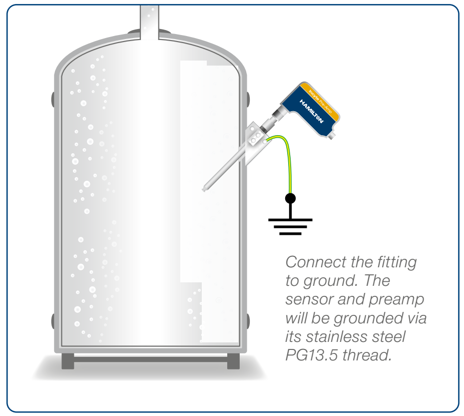
⚠ ATTENTION! Only use the Hamilton M 12 / M 12 (5 pole) cable to connect Control and Sensor Unit.



Connect the headplate to ground. The sensor and preamp will be grounded via its stainless steel PG13.5 thread.



The Tank is grounded.



The Tank is not grounded.

Figure 1: Grounding

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4.4 Chemical, Radioactive or Biological Hazard Precautions

Selection of the appropriate biological safety level and implementation of the required biosafety measures for working with the Cell Density Monitoring System is the sole responsibility of the user.

If working with hazardous liquids observe and carry out the maintenance procedures, paying attention to cleaning and decontamination. If parts or the complete Cell Density Monitoring System become contaminated with biohazardous, radioactive or chemical material, it should be cleaned. Failure to observe and carry out the maintenance procedures may impair the reliability and correction functioning of the system.

Avoid damaging the power cord. Do not bend it excessively, step on it, or place heavy objects on it. A damaged cord can easily become a shock or fire hazard. Never use a power cord after it has become damaged.

5 Product Description

5.1 Why Measuring Cell Density?

Continuous monitoring of bioprocesses is required for both process control and optimization. The control of the environmental conditions including pH or dissolved oxygen is well established but does not provide information on the cell physiology. Parameters relating to cell physiology are usually monitored offline after daily sampling of the culture. This method is time-consuming and provides only discrete information on the bioprocess. Incyte and Dencytee sensors offer an alternative for directly monitoring viable and total cell density in real time.

The Incyte sensor enables real-time, and online measurement of permittivity, which correlates with the viable cell density. The measurement is not influenced by changes in the media, or by the presence of microcarriers, dead cells, and cellular debris. The Incyte sensor has been especially designed for monitoring the culture of mammalian and insect cells. It may also be used for controlling yeast culture and high-density bacterial fermentation. Online monitoring of permittivity with Incyte enables the early detection of process deviations without sampling and supports timely process adjustment.

The Dencytee sensor allows the real-time, and online measurement of turbidity, which correlates with the total cell density. The turbidity of a cell suspension refers to the optical density of the cell suspension measured at a wavelength of 880 nm. Monitoring total cell density with Dencytee is particularly suitable after inoculation when cells are expanding quickly but concentrations are low, making capacitance-based readings less reliable. The turbidity measurement is performed in the infra-red range and is therefore insensitive to changes in media color.

Used in combination Incyte and Dencytee provide a complete and real-time characterization of the cell population for better bioprocess control.

5.2 The Theory of Permittivity Measurement (Incyte)

5.2.1 The Dual-Frequency Measurement Mode

In an alternating electrical field viable cells behave like small capacitors, but not dead cells or cellular debris (Figure 1A). The charge of these small capacitors is measured by the Incyte sensor and reported as permittivity in pF/cm.

The permittivity of viable cells is measured at a frequency specific of the cell type (fmes): usually 1 MHz for mammalian cells and bacteria, and 2 MHz for yeast (Figure 1B). It is continuously and automatically corrected for the background permittivity measured at high frequency (fhigh). This is the standard Dual-Frequency Measurement Mode. The permittivity measured by Incyte is specific to viable cells and correlates with the viable cell density, especially during the exponential growth phase.

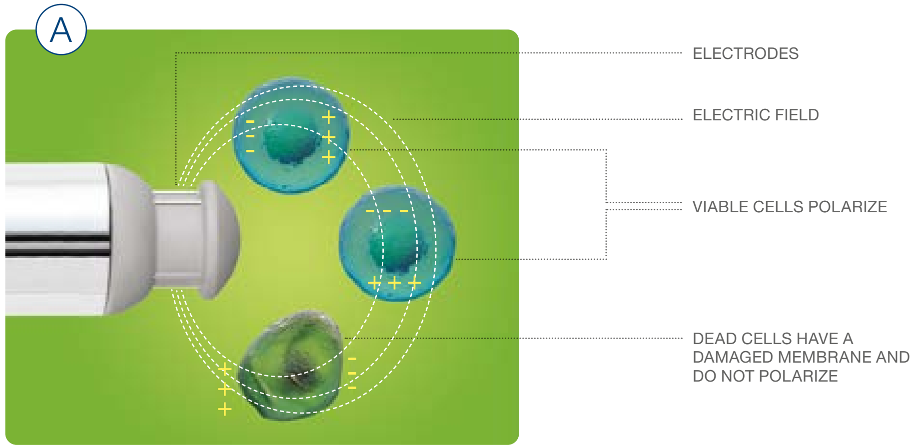
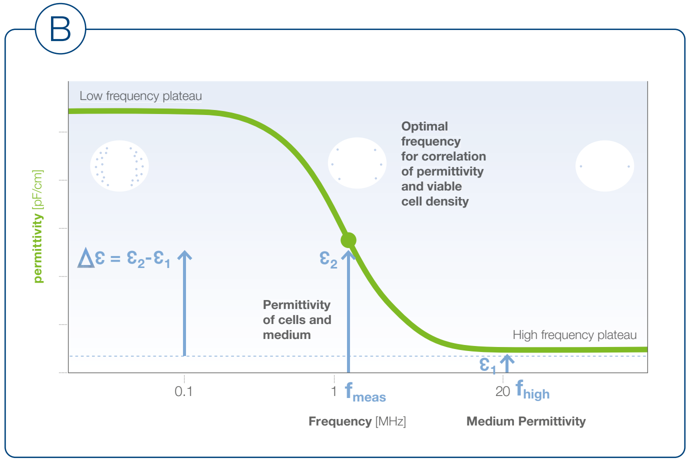


Figure 1: Incyte measurement principle.

A: Viable but not dead cells exhibit a permittivity signal.



B: In the dual measurement mode the permittivity of viable cells is measured at a frequency specific to the cell type (f_{mes}) and corrected by the background permittivity measured at high frequency (f_{high}).

5.2.2 The Frequency Scan Mode

The polarization behavior of cells varies strongly at different frequencies, as shown in Figure 1B. Cells fully polarize at low frequency whereas they hardly polarize at high frequency. The Incyte Scan measures the permittivity signal at 17 different frequencies between 0.3 and 10 MHz (Figure 2) and provides additional information especially on the cells physiology.

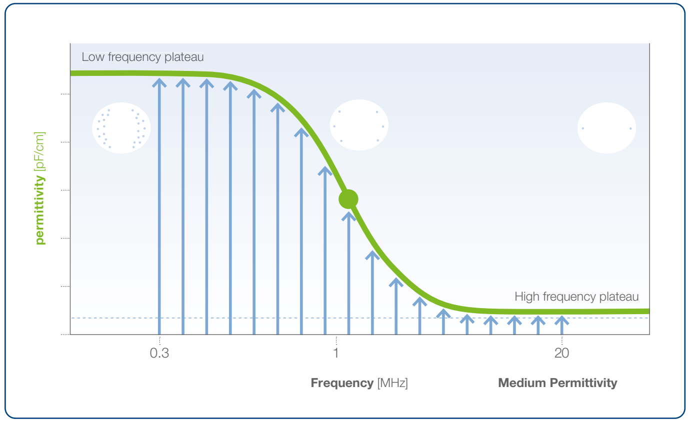


Figure 2: The ideal frequency spectrum of mammalian cells, called beta-dispersion.

The analysis of the Incyte Scan provides additional information on the cell physiology[1]. During the Incyte Scan the most relevant parameters - $\Delta\varepsilon max$, fc, and α - are automatically calculated and displayed on the Arc View Controller (Figure 3). The characteristic frequency, fc, provides an indication of the average cell diameter. If fc decreases, it indicates that the cell diameter increases during the culture. On the contrary, a shift of fc towards the higher frequency range indicates that the cell size reduces. The height of the low frequency plateau, $\Delta\varepsilon max$, correlates with the viable cell density. It increases as the cells grow. The slope (α) of the beta-dispersion at the characteristic frequency fc provides an indication of the distribution of the cell diameter. A steep slope, i.e. a large α indicates an homogenous culture.

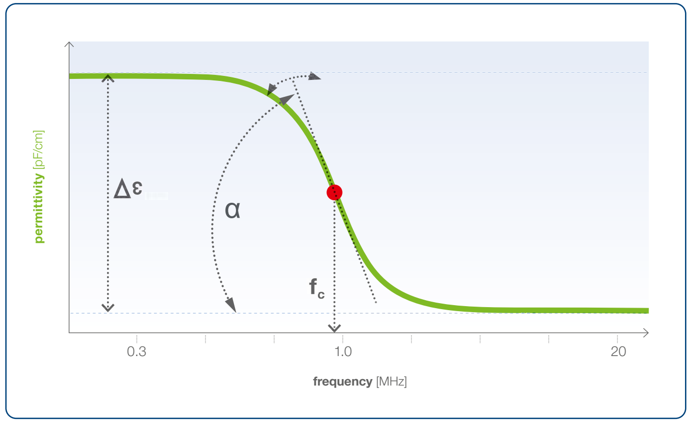


Figure 3: Data Interpretation of the beta-dispersion, gained from an Incyte Scan.

5.3 The Theory of Turbidity Measurement

Turbidity is commonly used to estimate the concentration of a cell suspension, especially in microbiology. The Dencytee sensor provides online measurement of the turbidity of a cell suspension, based on optical density (Figure 4). This measurement correlates with the total cell density in a bioprocess. The sensor emits light through a 5 mm window onto a light detector. Cells in suspension absorb and scatter light so less light is read by the detector. The measurement is made at NIR (near infra-red) wavelengths so it is insensitive to changes in media color. All particles that scatter light at 880 nm will be detected, including living and dead cells.

[1] Ansorge S, Esteban G, Schmid G. On-line monitoring of infected Sf-9 insect cell cultures by scanning permittivity measurements and comparison with off- line biovolume measurements. Cytotechnology. 2007;55(2-3):115-124. doi:10.1007/s10616-007-9093-0.

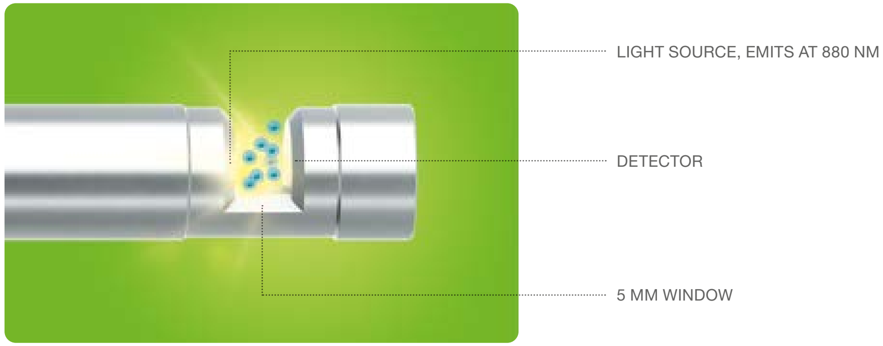
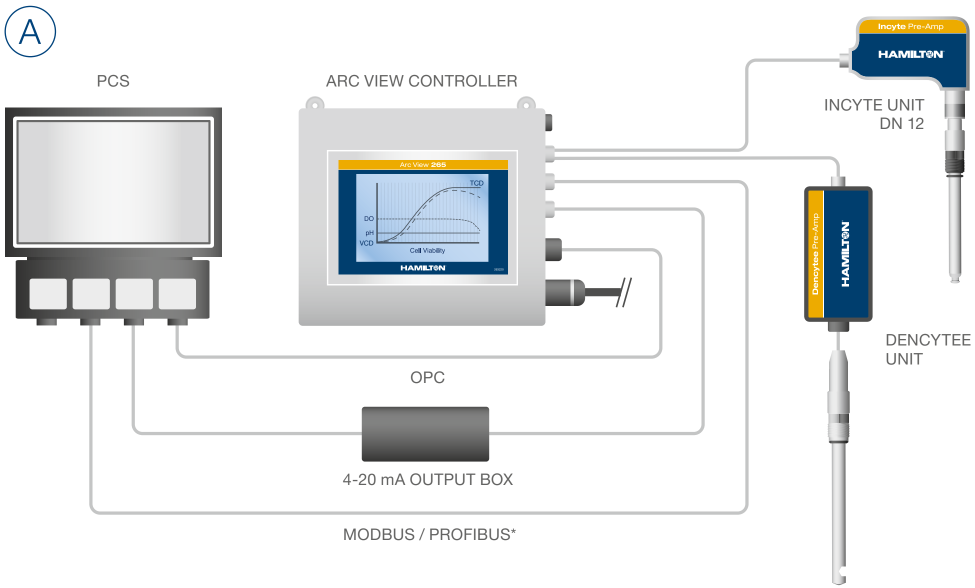


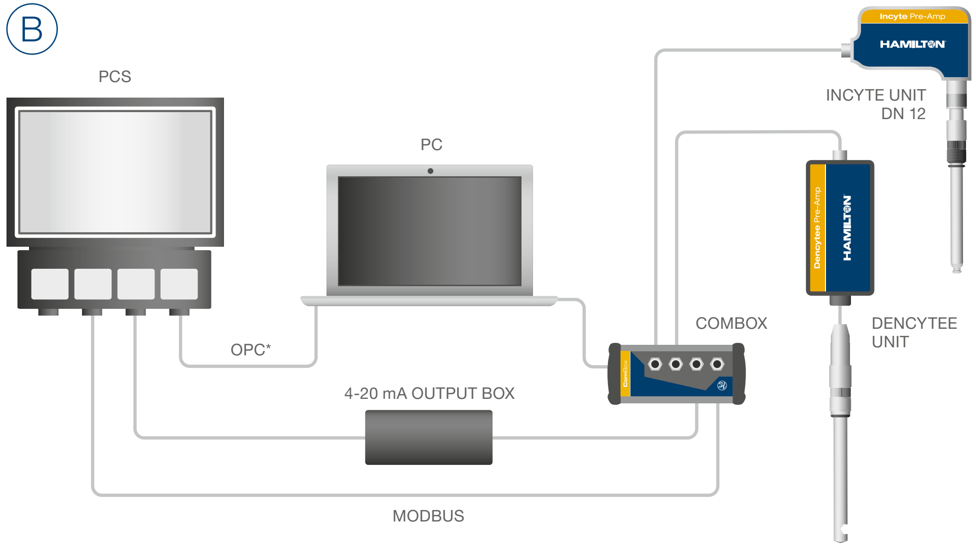
Figure 4: Measurement principle of Dencytee sensors.

5.4 Hardware Description

A standard measuring loop consists of a Sensor Unit connected to the Control Unit (Figure 5). It is recommended to measure in parallel turbidity with Dencytee and permittivity with Incyte in order to collect information on both total and viable cell density.



*By Modbus-Profibus DP Module, only for Arc View 465 (XL)



In order to enable a OPC connection between a Combox and the PCS via OPC only one Box can be installed per PC.

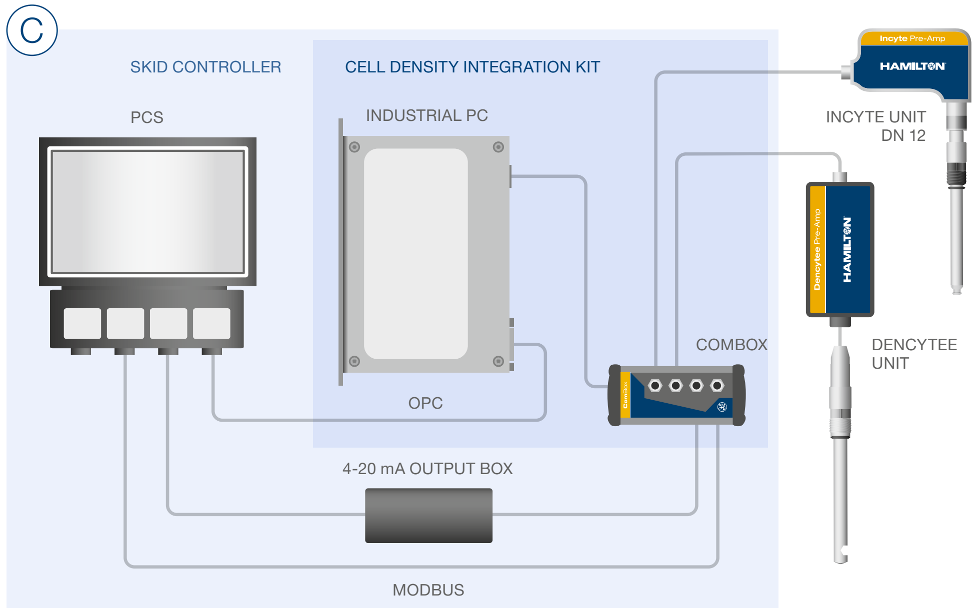


Figure 5: Overview of the Cell Density Monitoring System (A: Arc View Controller, B: ComBox, C: Cell Density Integration Kit), connected to a process control system (PCS).

5.4.1 Control Unit

5.4.1.1 Arc View Controller

The Arc View Controller (Figure 6) allows recording and plotting the measurements of up to four connected Sensor Units. It stores the measurements in Culture Files and the calibration data of all Sensor Units that have been connected. Hamilton Arc sensors, especially pH and dissolved oxygen sensors, may be visualized and recorded in parallel via a wireless connection. Most connection ports are available on the right hand side panel (Figure 6). The Arc View Controller 265 holds two M12 plugs on the side panel for the connection of two Sensor Units. They are labeled as Channel. The Arc View Controller 465 is a four channel Controller and has two more M12 plugs for connecting additional Sensor Units. The AUX and Modbus M12 connectors, and the Ethernet plug may be used to connect the Arc View Controller to the process control system. The USB ports may be used to connect a USB stick and export the recorded log files. It also serves to connect the Arc Wireless Converter MB (Ref 243498) or BT (Ref 243499) required to log Arc sensors.

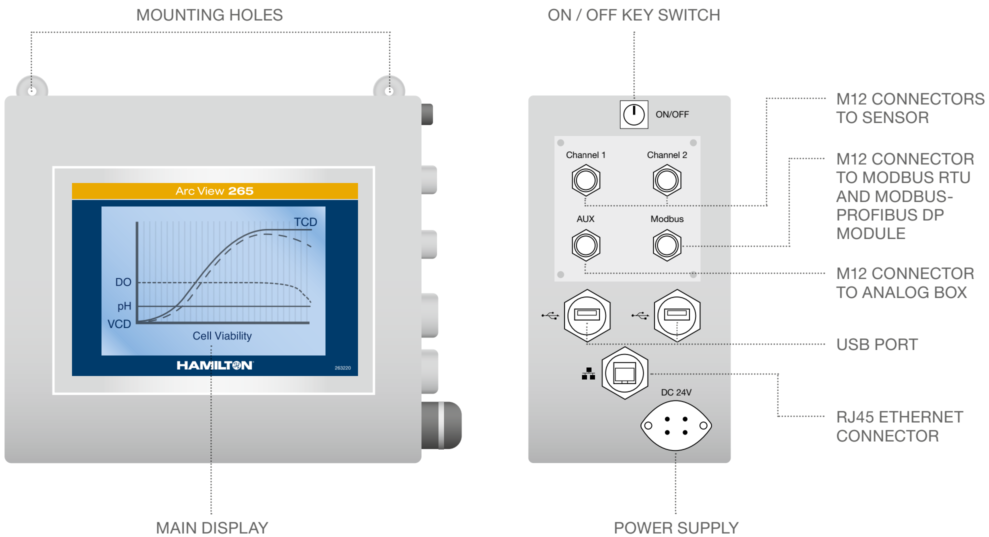


Figure 6: Arc View Controller 265, front and side panel.

⚠ ATTENTION! Instead of using the key switch it is recommended to plug/unplug the Arc View Controller, if the serial number is below 1500/5500.

5.4.1.2 ComBox

The ComBox (Figure 7) allows recording and plotting the measurements of up to two connected Sensor Units on a personal computer. The measurements in Culture Files and the calibration data of all Sensor Units that have been connected are recorded on the PC. Hamilton Arc sensors, especially pH and dissolved oxygen sensors, may be visualized and recorded in parallel via a wireless connection, the Arc Wireless Converter MB (Ref 243498) or BT (Ref 243499) has to be connected to an USB Port.

The connection ports are available on top of the ComBox (Figure 7). It holds two M12 plugs for the connection of two Sensor Units. They are labeled as Channel. The AUX and Modbus M12 connectors may be used to connect the ComBox to the process control system.

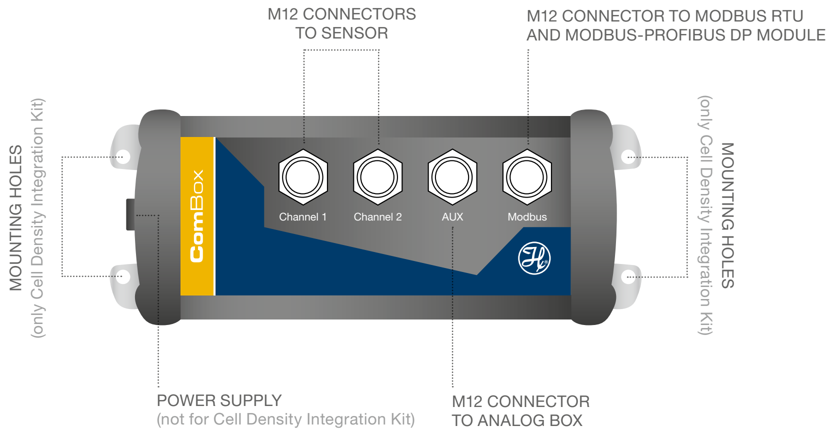


Figure 7: ComBox, top panel

5.4.1.3 Cell Density Integration Kit

The Cell Density Integration Kit (Figure 8) allows the complete integration of Incyte and Dencytee sensors into the process control system either by Modbus, OPC or 4-20 mA.

The kit comprises an industrial PC, to run the required Software and a ComBox, to communicate to the Sensor Units and the process control system. The connection ports are available on top of the ComBox (Figure 7). It holds two M12 plugs for the connection of two Sensor Units. They are labeled as Channel. The AUX and Modbus M12 connectors may be used to connect the ComBox to the process control system.

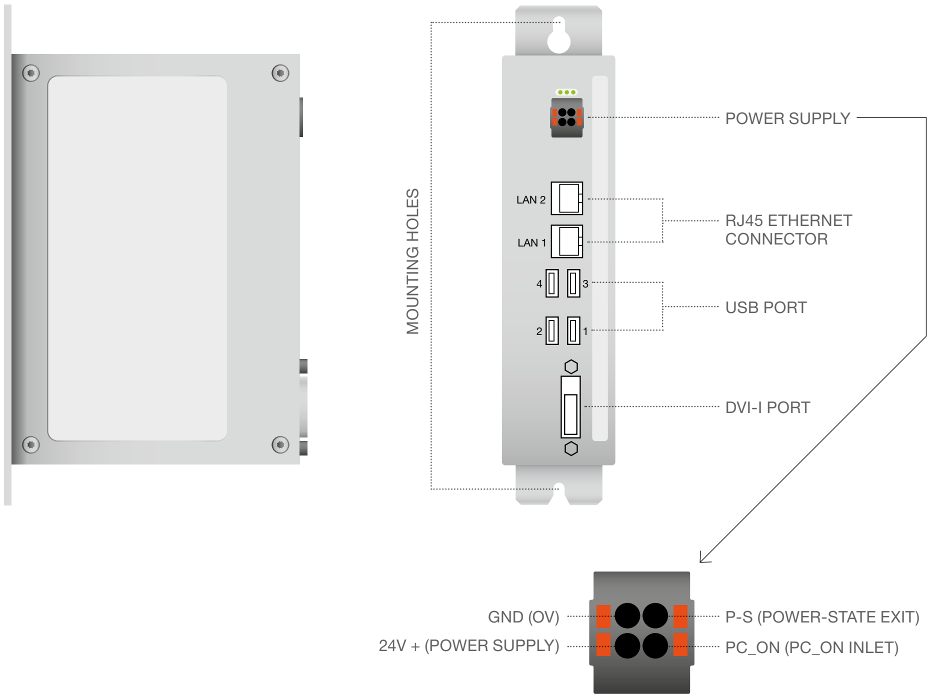


Figure 8: Cell Density Integration Kit comprising the industrial PC and ComBox

NOTE: The connector is specified for 8 A and accepts a cable cross-section upto 1,5 mm^2.

5.4.2 Incyte Sensor Unit

An Incyte Sensor Unit consists of a Pre-amplifier and a Sensor (Figure 9). The Pre-amplifier and the Sensor have been factory calibrated as a pair. They are connected together via a VP11 connector. A status LED, indicating whether the sensor is ready for measurement is available on top of the Incyte pre-amplifier. The Incyte Sensor Unit is available with a shaft diameter of 12 mm (DN12) or 25 mm (DN25). The measurement tip is made of PEEK and contains four platinum electrodes for permittivity measurement. All wetted parts are USP Class VI certified.

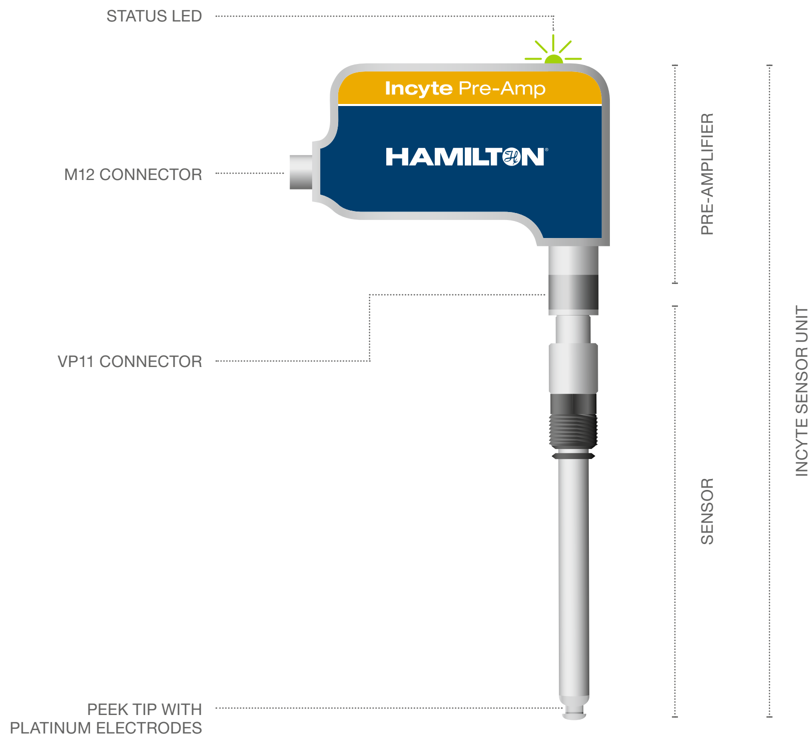


Figure 9: Incyte Sensor Unit assembled.

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5.4.3 Dencytee Sensor Unit

A Dencytee Sensor Unit consists of a Pre-amplifier and a Sensor (Figure 10). They are linked together via a connecting cable with a VP8 connector. The measurement window has an optical path length of 5 mm. The seal-less, sapphire window design assures the highest level of sterility, cleanability and sensor integrity. All wetted parts are USP Class VI certified.

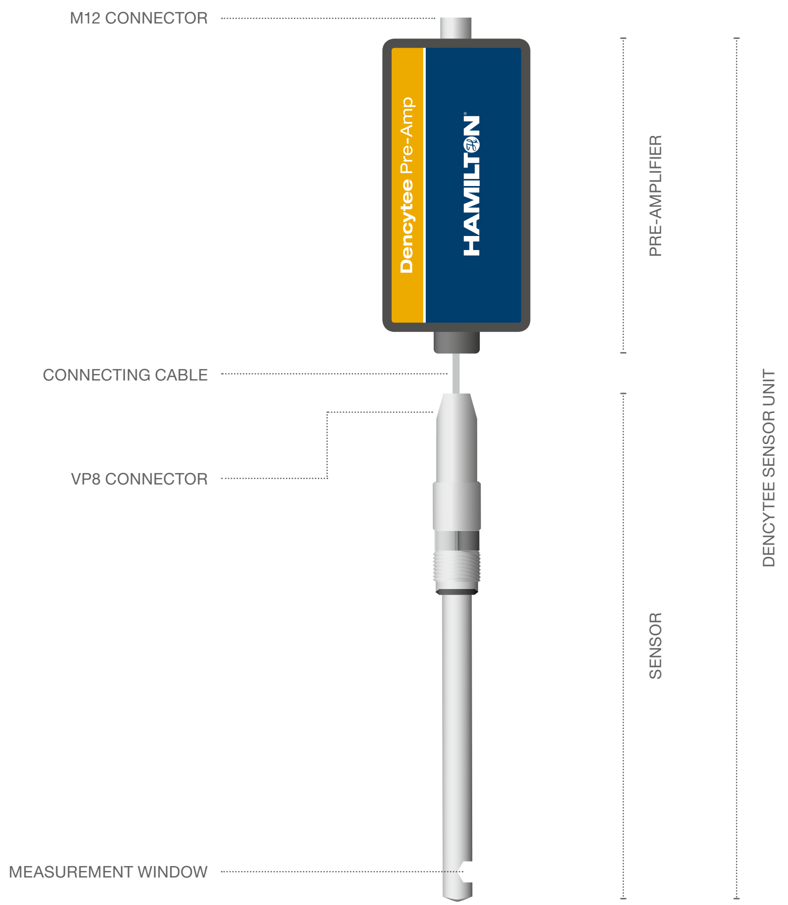

Figure 10: Picture of the assembled Dencytee Unit.

5.5 Outline of the Control Unit Software

5.5.1 Run Menu

The Run Menu (Figure 11) appears automatically upon starting the Arc View Controller or ComBox. It provides all the relevant information on a sensor connected to one of the Control Unit Channels. The sensor status is shown as a status LED in the Channel Tab: The Main Graph shows the measurements of the sensor connected to the selected channel over time. The measurement values are also indicated on top of the Main Graph.

The Run Menu provides access to additional menus.

- The Main Menu is accessible with the Menu Button located on the bottom right hand side of the screen.
- Four additional Settings Menus (Unit, Measure, F-Scan and Culture) are available using the buttons located on the left hand side of the screen.
- The Graph Arc Settings Menu is used to start recording additional Arc sensors usually pH or dissolved oxygen.
- The Multi-View Tab enables displaying simultaneously sensors connected to different channels. It is also possible to overlay a running culture with an existing Culture File.

NOTE: A light blue tab in the run menu indicates that the function is activated, to deactivate press the tab again. It turns to dark blue.

PRODUCT DESCRIPTION

Figure 11: Run Menu overview.

PRODUCT DESCRIPTION

5.5.2 Sensor Channel Tab

The Channel Tab (Figure 12) is used to view the measurements of the Sensor Unit connected to the selected channel. The status LED indicates whether the Sensor Unit is ready for measurement. The floppy icon indicates whether the measurements are currently recorded in a Culture File. Recording is indicated by the floppy icon without the red mark (x).

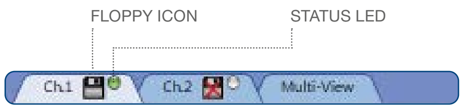

Figure 12: Sensor Channel Tab.

5.5.3 Main Menu

The Main Menu (Figure 13) provides access to functions that may not be required on a daily basis such as calibration, user level settings, export of culture files, or connection to a process control system.

The Explorer is used to export recorded Culture Files to a USB stick.

The Administrator Menu enables following functionality:

- Password control: this functionality allows modifying both the user level and the administrator level password. (see Chapter 9.1)
- General settings: in this menu, it is possible to manage the general settings of the system such as touch screen calibration and setting of time and date (see Chapter 9.2).
- Network applications: this functionality manages network applications such as remote access; OPC server and file sharing system (see Chapter 9.4).
- Manage licenses: this interface allows the installation of new licenses (see Chapter 9.5).
- Administrator files: this functionality allows the export of the Controller's data files (see Chapter 9.6).
- Update system: this enables the update of the Arc View Controller (see Chapter 9.7).

NOTE: Update system functionality is not available for ComBox.

The About Menu contains the hardware and firmware version of the complete measurement loop including Control Unit and Sensor Units.

The Calibration Menu contains the Sensor Unit calibration and verification (called Validate / Check Unit Calibration) procedures.

In the Advanced Settings Menu, all adjustments to connect the Control Unit to a process control system may be defined.

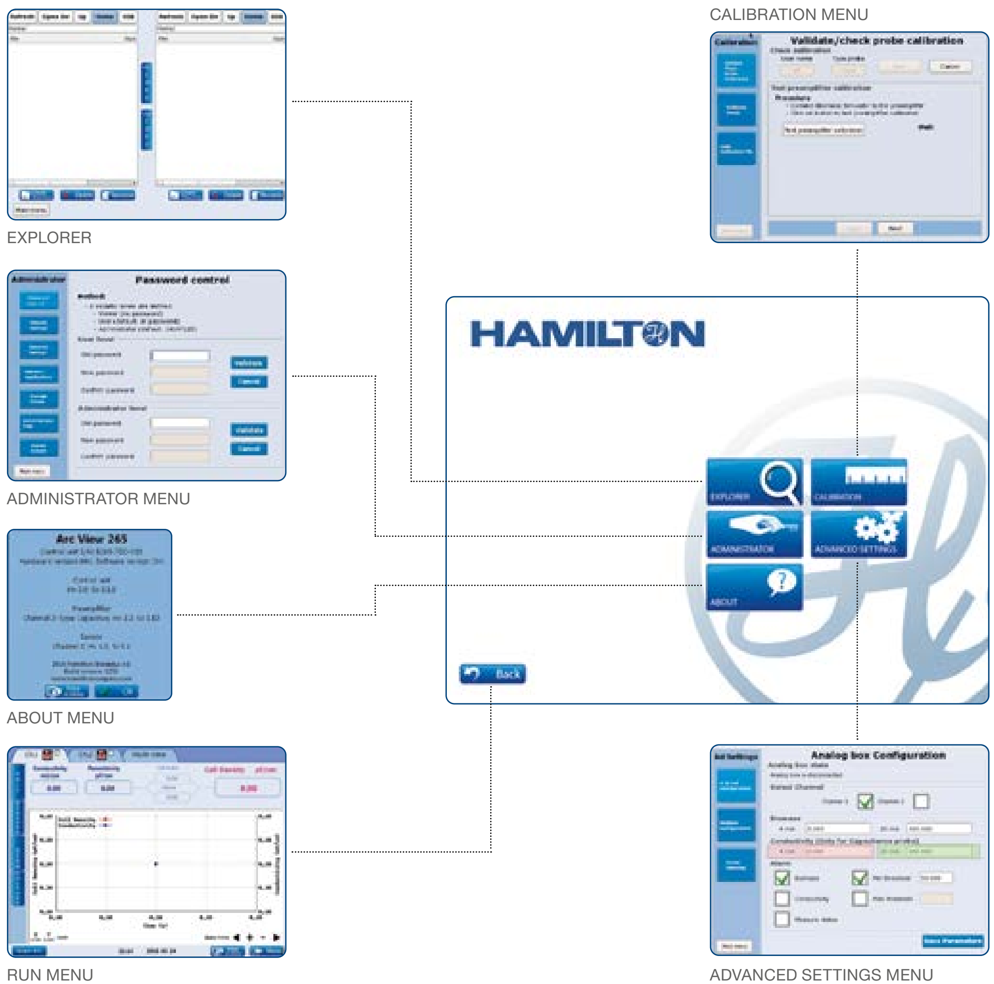

Figure 13: Structure of the Main Menu.

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5.5.4 Unit Settings Menu

The Unit Setting Menu (Figure 14) contains all relevant information of the Sensor Unit connected to the selected channel, including

- Sensor Unit type
- Pre-amplifier information, notably the calibration lifetime
- Sensor information, e.g. the number of sterilization cycles and the calibration lifetime

Figure 14: Unit Settings Menu.

5.5.5 Measure Settings Menu

In the Measure Settings Menu (Figure 15) all relevant adjustments for the bioprocess may be set. In Measure Settings Menu it is possible to

- Run a product calibration using the Mark Zero Button
- Select the measure mode
- Set the Cell Density Unit and Cell Density Factor, which characterize the correlation of the permittivity measurement with an offline cell density measurement (for Incyte only).

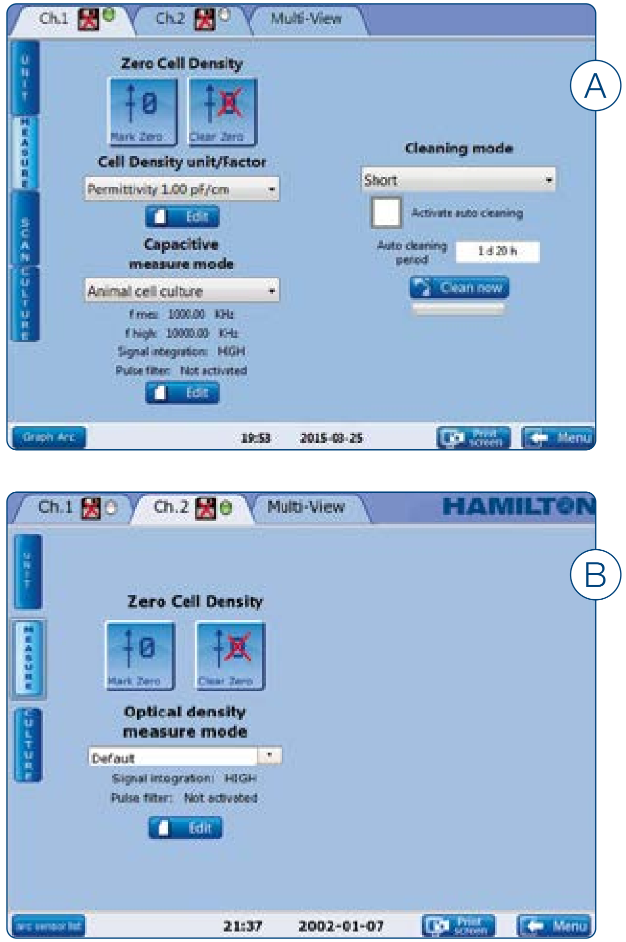

Figure 15: Measure Settings Menu of Incyte (A) and Dencytee (B).

5.5.6 Incyte Frequency Scan Settings Menu

The Incyte Frequency Scan may be activated in the Frequency Scan Settings Menu (Figure 16). The product calibration of the Frequency Scan may also be performed in this Menu using the Mark Zero Button. It consists of a product calibration of the permittivity measurement at every frequency used in the Frequency Scan.

Figure 16: Scan display.

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5.5.7 Culture Settings Menu

The Culture Settings Menu (Figure 17) controls all steps required to create a Culture Files:

- Start recording measurements with the Record Button
- Set the inoculation time to log the inoculation time in the Culture File
- Add comments to log manually any event in the Culture File
- End recording to stop logging the measurements in a Culture File

If a recording has been started, the Culture Settings Menu also contains key information relative to the culture started and the Culture File in which the measurements are logged.

Figure 17: Culture Settings Menu.

6 Installation

6.1 Install the Control Unit

6.1.1 Install the Arc View Controller

1. Inspect the workplace environment for:
   - Compliance to technical specification
   - Providing enough space to perform the next steps
2. Unpack the Arc View Controller from the packaging

Figure 18: Open packaging of the Arc View Controller.

3. Inspect the Controller and accessories for shipping damage or missing parts:
   The packaging should contain the Arc View Controller, one test report, the operating instructions, power supply, with 5 country specific cables.

NOTE: The ordered licenses are installed on the Arc View Controller.

4. The Arc View Controller may be installed on a bench besides the bioreactor, or mounted on a wall. Please refer to the hardware specifications (Chapter 16.1.1) to choose the appropriate mounting elements to fix the controller.
5. Mount the power supply and connect it to the Arc View Controller (Figure 6).
   The Controller will automatically start up.
6. Switch off the Arc View Controller using the Key Switch (Figure 6).

NOTE: It is recommended to perform a Installation Qualification.

NOTE: It is recommended to connect the Arc View Controller to an Uninterruptible Power Supply (UPS) to ensure continuous recording of data, nevertheless the Controller restarts after power shutdown automatically at the last setting and continues recording. After a power shut down the Sensor Unit may require some time for new equilibration.

6.1.2 Install the ComBox

1. Inspect the workplace environment for:
   - Compliance to technical specification
   - Providing enough space to perform the next steps
2. Unpack the ComBox from the packaging

Figure 19: Open packaging of the ComBox.

3. Inspect the ComBox and accessories for shipping damage or missing parts: The packaging should contain the ComBox, a power supply, with 5 country specific cables, the operating instructions and a USB stick with the Software and ordered licenses
4. The ComBox has to be installed on a bench besides the bioreactor
5. Connect the power supply to the ComBox (Figure 7)
6. Switch on the PC and, install the Software (see chapter 9.7.1.2) and connect the ComBox by USB, start the Software
7. Initialize the M12 connectors (see chapter 9.2.5)
8. Re-start the software and install the licenses (see chapter 9.5)

NOTE: It is recommended to perform a Installation Qualification.

6.1.3 Install the Cell Density Integration Kit

1. Inspect the workplace environment for:
   - Compliance to technical specification
   - Providing enough space to perform the next steps
2. Unpack the ComBox from the packaging

Figure 20: Open packaging of the Cell Density Integration Kit.

INSTALLATION

3. Inspect the ComBox and accessories for shipping damage or missing parts: The packaging should contain the ComBox, industrial PC (Software and licenses are pre-installed) and the operating instructions
4. The Cell Density Integration kit has to be installed inside a skid cabinet
5. Connect the industrial PC via the 4-pole connector with the power supply of the cabinet (Figure 8)
6. Connect the USB cable of the ComBox to the industrial PC
7. The ComBox has to be powered with 24 V via the Modbus Connector (Pin 1 and 3, see chapter 12.1.1)
8. Ground the ComBox using the thread on the top

NOTE: It is recommended to perform a Installation Qualification.

6.2 Mount the Sensor in the Bioreactor

1. Unpack your sensor and Pre-amplifier from the protective box
2. Inspect the unit for shipping damage or missing parts. The packaging should contain the sensor, the Pre-amplifier and the calibration certificate

Figure 21: Incyte Sensor Unit.

3. Select the most appropriate port for mounting the sensor (Figure 22). Choose a position where gas bubbles may not interfere with the measurement, for example in ports opposite to the sparger or at a significant distance. Gas bubbles interfere with the measurement and may cause reading errors. The electrodes of the Incyte sensor have to be kept at least 1 cm away from any solid parts, especially metallic ones. The electric field may be subject to interference and the measurement may be affected.

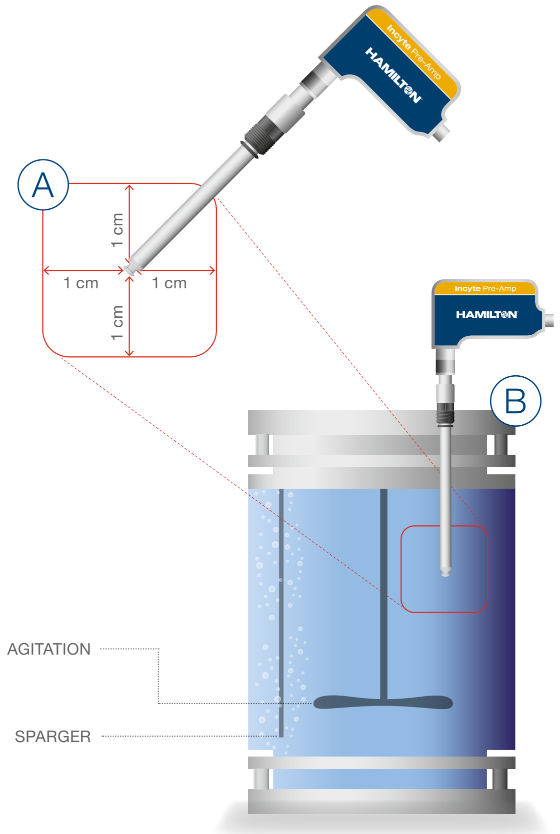

Figure 22: Mounting restrictions, A: Space requirements / B: Reactor mounting restrictions.

4. Insert the sensor in the port. Do not scratch the platinum electrodes while inserting them.
5. Verify the sensor orientation to make sure that the Pre-amplifier can be mounted conveniently. The orientation notch of the sensor head is oriented opposite to the Pre-amplifier cable (Figure 23).

INSTALLATION

NOTE: For mounting from a side-port ensure that the notch of the sensor head is mounted in a horizontal position facing upwards. Any angle of inclination may lead to an influence of the measurement.

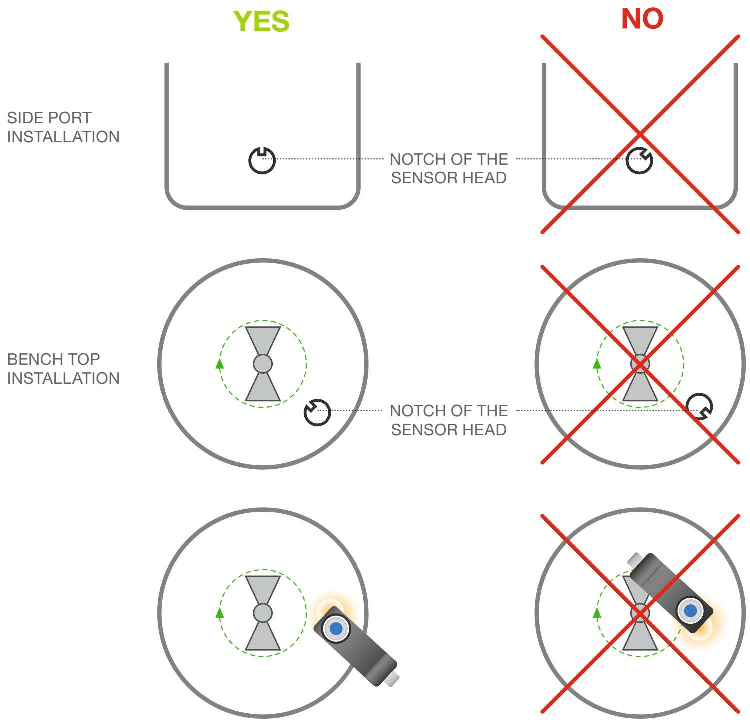

Figure 23: Mounting position of the Pre-amplifier.

NOTE: The vessel should be pressure-less and cold when removing the sensor. The wear of safety goggles and protective gloves is prescribed.

6. Tighten the connection nut by hand.

NOTE: Various housings are available to custom fit your sensor in your installation.

INSTALLATION

6.3 Connect the Sensor Unit to the Control Unit

1. Switch off the Arc View Controller.
2. Verify that the sensor's male VP connector and the Pre-amplifier's female VP connector are dry and clean.
3. Align the sensor VP head and the Pre-amplifier connector and insert the Sensor in the Pre-amplifier.
4. Hand-tighten the connector ring of the Pre-amplifier to ensure a robust and waterproof seal (Figure 25).
5. Align the pins of the M12 connector and connect the Arc View Controller to the Pre-amplifier using the Sensor Unit Cable.

⚠ ATTENTION! Make sure that the connector ring is tightened by hand. Never use a wrench or another tool to tighten or loosen the ring.

⚠ ATTENTION! Do not use the Pre-amplifier as a lever to screw or unscrew the sensor. This may cause mechanical damage in the preamplifier. Always use the PG13.5 thread instead (Figure 20).

⚠ ATTENTION! Please ensure a stable position of the Dencytee Pre-amplifier in a way that the cable is not bend.

6. Switch on the Arc View Controller. Wait at least 30 sec. until the Status LED on the main screen turns green (Figure 11) and an automated firmware update starts. The status LED of the Incyte Pre-amplifier (Figure 9) flashes green during this procedure.

NOTE: When receiving a new Sensor Unit, make sure to first connect it to the Arc View Controller in order to transfer the calibration data. Do not use the Pre-amplifier with another sensor before the calibration data has been transferred. If you do so the calibration data will be lost.

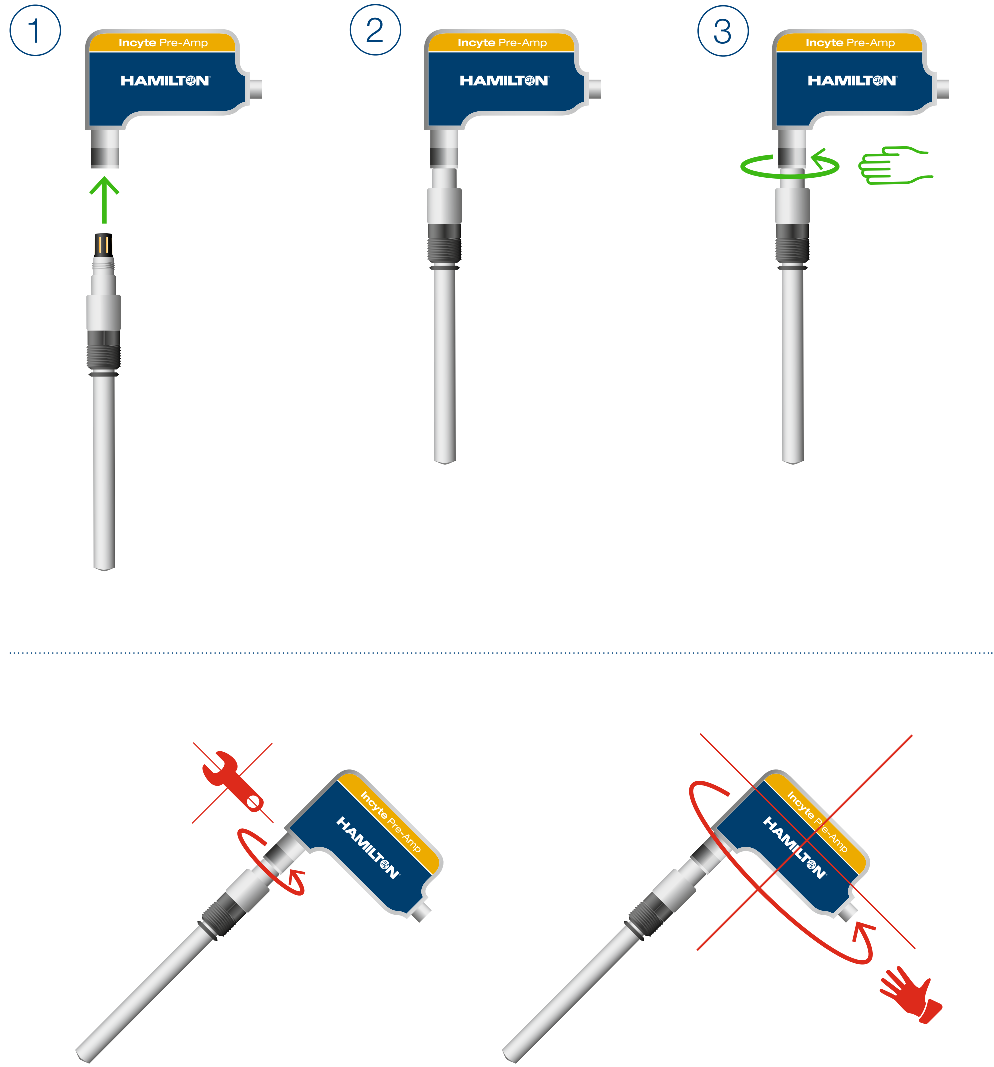

Figure 24: Connection of a Sensor Unit.

OPERATION OF INCYTE

7 Operation of Incyte

7.1 Choose the Measurement Mode

1. Go to the Measure Settings Menu (Figure 15). Choose the measurement mode, from the predefined settings:
   - Cell culture > fmes = 1000kHz, fhigh = 10MHz, signal integration = HIGH
   - Yeast/fungi > fmes = 2000kHz, fhigh = 10MHz, signal integration = HIGH
   - Bacteria > fmes = 1000kHz, fhigh = 10MHz, signal integration = HIGH
2. Enter the User password if one has been defined. Press OK.
3. Please refer to Chapter 7.12.3 to create your own measurement mode.

7.2 Addition of Arc Sensors

It is possible to record and plot Arc sensor measurements in parallel to cell density (Figure 25). That means in addition to the wired Incyte or Dencytee Unit, each Channel can also concurrently support two Arc Sensors. Cell density is monitored on Chart A. Another measurement may be shown additionally on Chart A (e.g. Arc pH, Arc DO or the conductivity measurement of Incyte). The remaining measurements will appear on Chart B. Chart A is shown as the Main Graph per default.

NOTE: The measurement values transmitted over wireless communication are not intended to be used for process control.

Figure 25: Run Menu when Arc DO (Chart A) and Arc pH (Chart B) sensors are monitored in parallel to Incyte (A). The Frequency Scan has been activated (B).

NOTE: The Graph Arc requires Arc Sensors, the Arc Wireless Converter MB (Ref 243498) or BT (Ref 243499) and Arc Wi Sensor Adapter 1G MB (Ref 242170), Arc Wi Sensor Adapter 2G MB (Ref 243030), Arc Wi Sensor Adapter 1G BT (Ref 243460) or Arc Wi Sensor Adapter 2G BT (Ref 243470).

1. Mount the Arc Wi Sensor Adapter between the Arc sensor and the Arc Cable VP 8 (Figure 26).

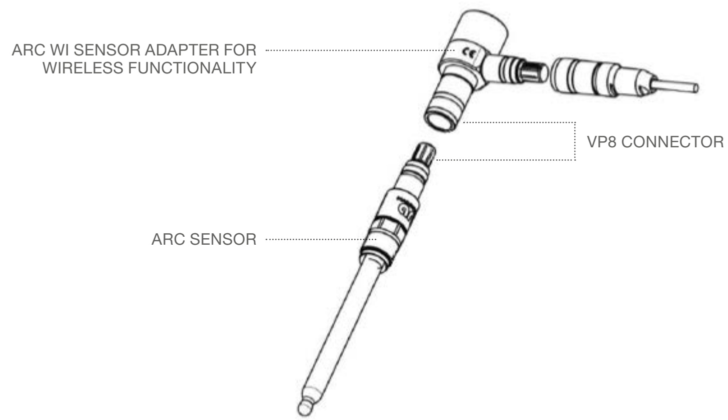

Figure 26: Mounting an Arc Sensor.

2. Plug the Arc Wireless Converter MB or BT in one of the USB Ports on the side panel of the Arc View Controller.
3. Press the button Graph Arc on the bottom left hand corner of the Run Menu (Figure 11). The Arc View Controller will automatically scan for sensors. The Arc Wireless Converter MB or BT is flashing in red during this process. The Graph Arc display opens (Figure 27). The cell density measurement is set on Chart A per default.
4. Choose the second parameter to be shown on Chart A and press OK. The remaining parameters may be shown on Chart B.

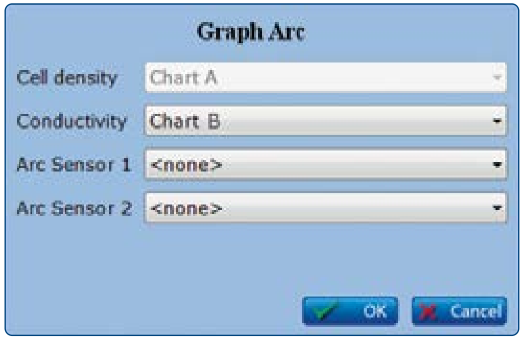

Figure 27: Graph Arc Menu.

5. Chart A is displayed per default on the main graph (Figure 23). Chart B is shown in the lower left corner. Press the Exchange Chart Button (Figure 23) to switch the display of the two charts. Chart B is not visible if the Incyte Scan mode is activated. It may be exchanged with Chart A on the Main Graph using the Exchange Chart Button.

7.3 Start Recording Measurements in a Culture File

1. Verify that the Status Indicator on the Run Menu of the Arc View Controller (Figure 11) and the status LED of the Pre-amplifier are green (Figure 9).
2. Go to the Culture Settings Menu and press the Record Button (Figure 17).
3. Enter the User password if one has been defined. Press OK.
4. Follow the guided procedure to start recording the Culture file. Define the directory to save the file, per default it is the home directory. Select the acquisition time, enter the optional name of the Culture file. Add possible comments and the user name.

5. The Record Button is now disabled, and the information relative to the Culture and the Culture File appears in the Culture Settings Menu. The Floppy Icon on the Channel Tab (Figure 12) also confirms that the measurements are being recorded.
6. Start the Frequency scan if required (Chapter 7.12.2).

7.4 Perform a Product Calibration and Set the Inoculation Time

NOTE: Even though the Dual Frequency Measurement Mode reduces the influence of medium and medium changes on the measurement, it is usual to do a product calibration, i.e. a zero-adjustment before inoculation. The product calibration may be done automatically, which is the preferred setting. If the background signal is known the product calibration may be done manually or adjusted over time (see Chapter 7.12.4).

1. Equilibrate the Incyte Sensor in culture medium, for at least 30 minutes prior to product calibration and inoculation.
2. Verify on the Main Graph that the cell density measurement is stable.
3. Go to the Measure Settings Menu and press the Mark Zero Button to perform a product calibration (Figure 15).
4. Enter the User password if one has been defined. Press OK.
5. Select automatic. The cell density measurement is now compensated for an offset shown in the measurement values above the Main Graph on the Run Menu.
6. To assign the inoculation time, go to the Culture Settings Menu and press the Inoculate Button (Figure 17). The time on the Main Graph will be reset to zero. A new time scale is added to the Culture File to track the real culture time.
7. Enter the User password if one has been defined. Press OK.

7.5 Add a Comment to the Culture File

During recording, a comment may be added at any time to the Culture File. This functionality may be used to track offline samplings.

1. Go to the Culture Settings Menu and press the Comments Button (Figure 17).

2. Enter the User password if one has been defined. Press OK.
3. Enter the title and the description of the comment. Both information are recorded in the Culture File but only the title is shown on the Main Graph.

7.6 Customize the Main Graph

In the Run Menu it is possible to adjust the visualization settings of the Main Graph.

- Press the Auto Scale Button to set an automated scaling.
- Press the Follow Button, to track the current cell density measurements.
- To display a certain part of the graph, move the graph to the left or the right using the Move Right and Move Left Buttons.
- Click on the Zoom In Button to enlarge a detail in the graph and use the Zoom Out Button to set back.
- Click on the X Scale or Y Scale Buttons to scale a specific area of the Main Graph between Xmin and Xmax respectively Ymin and Ymax. Both Y axes may be scaled independently by selecting axis 2.
- Clear the graph at the end of the Culture by pressing the Clear Button.

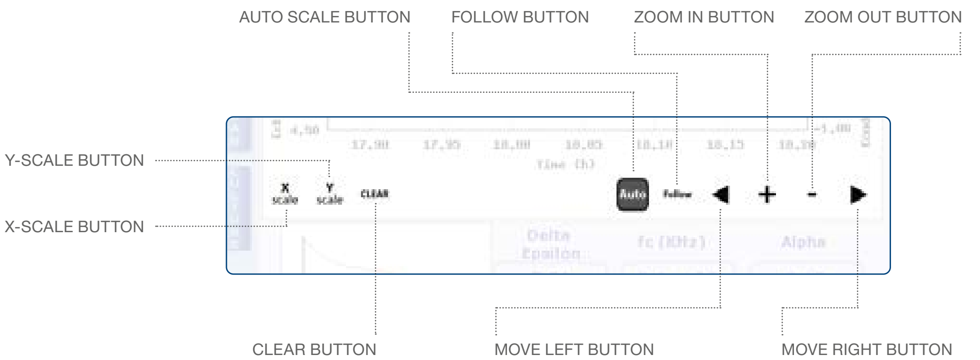

Figure 28: Visualization Settings of the Main Graph.

OPERATION OF INCYTE

7.7 Setup a Multi View Graph

In the Multi-View Tab (Figure 29), it is possible to plot the measurements of several channels on the same graph. In addition the current measurements may be plotted in parallel to a previously recorded Culture File.

NOTE: In the Multi-View Graph you can display two of five measurements at the same time.

1. Go to the Multi-View Tab and select Graph 1.
2. Tick the Display Graph Check Box and enter a Title.
3. Select the Channel(s) to be displayed.
4. Select a recorded Culture File to be viewed.
5. Select the Measurements to be compared, e.g. cell density, Incyte Scan or conductivity (σ). If using the Incyte scan the following values are also available fc, Δε, and α.
6. After definition of the Multi-View, the chosen Measurements are plotted on the Multi-View Graph. All current measurement values are displayed on the upper right area.

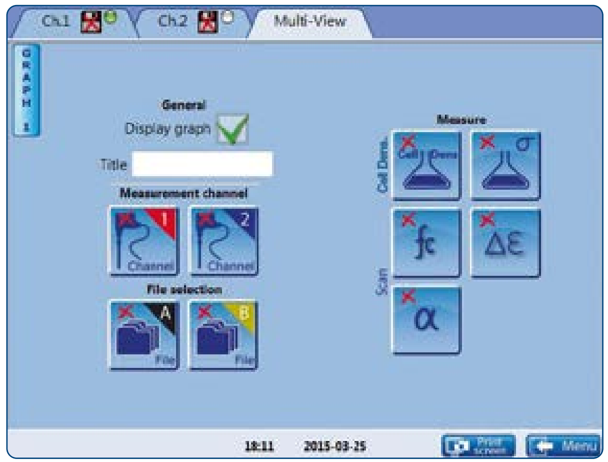

Figure 29: Multi View setup.

OPERATION OF INCYTE

7.8 Stop Recording the Culture File

1. Go to the Culture Settings Menu and press the End Recording Button (Figure 17).
2. Enter the User password if one has been defined. Press OK.
3. Export the culture file (Chapter 7.10).
4. Dismount the Sensor (Chapter 7.9).

7.9 Dismount the Sensor Unit

1. Switch off the Arc View Controller using the Key Switch.
2. Disconnect the Sensor Unit Cable from the Pre-amplifier.
3. Loosen the connector ring of the Pre-amplifier by hand and remove the Pre-Amplifier from the Sensor (Figure 24).
4. Loosen the thread of the sensor manually and remove the sensor from the bioreactor.

> ⚠ **ATTENTION: Make sure that the connector ring is loosen by hand. Never use a wrench or another tool to tighten or loosened the ring.**

> ⚠ **ATTENTION: Do not use the Pre-amplifier as a lever to screw or unscrew the sensor. This may cause mechanical damage in the preamplifier. Always use the PG13.5 thread instead (Figure 24).**

7.10 Export a Culture File

1. Go to the Main Menu and press the Explorer Button (Figure 13). The Explorer (Figure 30) displays simultaneously two directories; the Arc View Controller Home per default. Select USB for the second directory.
2. Enter the User password if one has been defined. Press OK.
3. Plug a USB Stick on the side panel of the Arc View Controller (Figure 7) or PC, if using the ComBox (Figure 8). Click on the refresh, select the USB stick and press open dir.
4. Select the Culture File in the home directory and press the Copy Button.
5. Refresh the USB directory, and verify that the Culture File has been transferred successfully.
6. Delete the Culture File copied to free storage space.
7. If needed, the Culture File may be renamed, by selecting the file and pressing the Rename Button.
8. It is possible to create a new directory by pressing the Create Directory Button.

> NOTE: Screenshots (see Chapter 11.4.1) are also stored in the Arc View Controller Home directory.

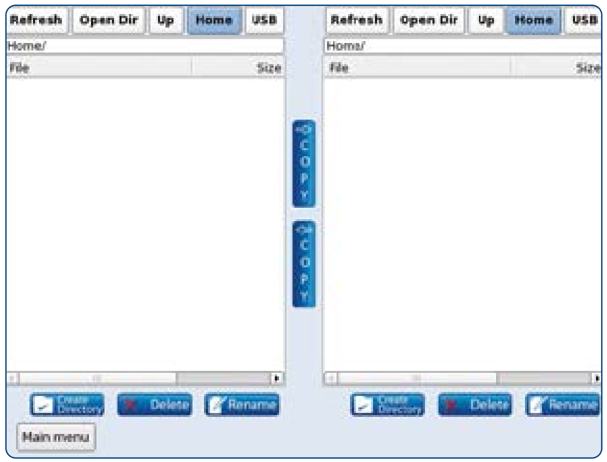

Figure 30: Explorer Menu.

7.11 Import a Culture File in an Excel Spreadsheet

1. Open Microsoft Excel and select the Data Tab.
2. In the area Get External Data press the From Text Icon.
3. Choose the Culture file and click open.
4. Mark the column Date and use a User-defined Format to display the time recordings: yyyy.mm.dd.hh.mm.ss.
5. Select the columns Record and Culture time and define the format as Numbers.

The file (Figure 31) is composed of three parts. The Header contains general information on the Culture. The Events list contains all significant events and modifications that happened while the culture file was recorded. The Measurement table with the following measurement values:

- Date
- Record time (h): time in hours since the start of recording
- Culture time (h): time in hours since the inoculation
- Comment: contains start recording, inoculation, comments and stop recording
- Raw permittivity measurements
- Cell density value correlated to the product calibration and cell factor

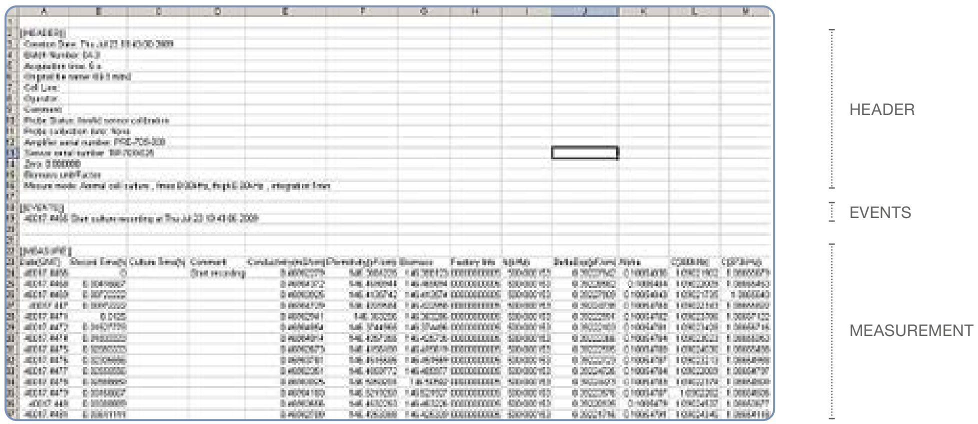

Figure 31: Culture File.

OPERATION OF INCYTE

7.12 Further Measurement Settings

7.12.1 Set the Cell Factor

The measured permittivity may be correlated to offline measurements, by defining a cell factor.

1. Go to the Measure Tab (Figure 15) and press the Cell Density Unit / Factor Button.
2. Enter the User password if one has been defined. Press OK.
3. Choose a UnitFactor from the drop-down list and press edit. Insert the Cell Factor. To learn how to calculate the cell factor refer to Chapter 18.2.
4. The Cell Factor is displayed as measurement value on top of the Main Graph (Figure 11). Per default the cell factor is 1.

NOTE: The Permittivity Factor 1.00 pF/cm is the factory value, which cannot be changed. This is the factor the measurement is relying on. The UnitFactors are the correlated customer factors.

7.12.2 Start the Incyte Scan

NOTE: The Scan License is required to use the Incyte Scan option.

1. Go to the Scan Settings Menu (Figure 6) and activate the Frequency Scan.
2. Enter the User password if one has been defined. Press OK.
3. The curve of the Frequency Scan is displayed in the Run Menu, below the Main Graph. $\Delta\varepsilon max$, fc and α are calculated and shown as well (Figure 32).
4. Equilibrate the sensor in the culture medium for at least 30 minutes.
5. Go to the Scan Settings Menu (Figure 6) and press the Mark Zero Button to perform the product calibration of the Frequency Scan.

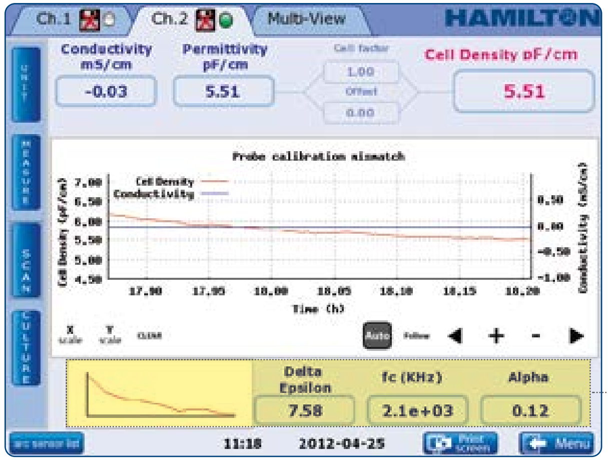

Figure 32: Run Menu with activated Incyte Frequency Scan.

7.12.3 Define the Custom Measurement Mode

The measurement frequencies, integration time and pulse filter may be adjusted to define a custom Measurement Mode.

1. Go to the Measure Tab (Figure 15) and select MeasureMode1 in the drop down menu. Press the Edit Button.
2. Enter the User password if one has been defined. Press OK.
3. Enter a new name for the measure mode. Define the measurement frequency (fmes) and the background frequency (fhigh) (Figure 33).
4. Select the integration time, which creates a moving average over a defined number of measurements:
   - NONE: 1 measurement - Integration time : 6 sec
   - LOW: 3 measurement3 - Integration time : 18 sec
   - MEDIUM: 22 measurements - Integration time : 2.2 min
   - HIGH: 111 measurements : Integration time : 11.1 min (default)
   - SUPER HIGH: 333 measurements - Integration time : 33.3 min
   - Custom, whereas 6 sec is the minimum time
5. If required activate the Pulse filter. The Pulse filter is only necessary for media with a high content of solid particles.

6. Press the Save Button.

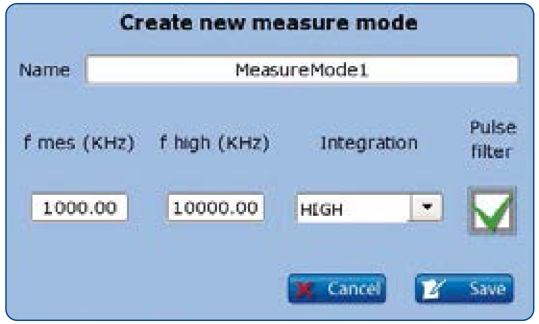

Figure 33: Custom Measurement Mode.

7.12.4 Perform a Manual Product Calibration

1. Go to the Measure Settings Menu and press the Mark Zero Button to perform a product calibration (Figure 15).
2. Enter the User password if one has been defined. Press OK.
3. Select manual and compensate the cell density measurement manually. Enter the known permittivity of the background. The cell density measurement is now compensated for an offset shown in the measurement values above the Main Graph on the Run Menu.

7.13 Use Sensor Cleaning (Probe Cleaning)

The Sensor Cleaning is deactivated per default. It is only required if cell adhesion at the sensor tip is noticed. The Cleaning function reduces the attachment of cells and may be required in few processes, i.e. in long-term cell culture or fermentation of filamentous fungi. Use the cleaning mode with caution and only if adhesion of cells at the platinum electrodes is noticed or suspected. Start with SHORT cleaning time and a long Auto-Cleaning Period, at least 12 h. Increase cleaning time / decrease the Auto-Cleaning Period only if no improvement is observed.

1. Enter the Advanced Settings Menu and select Probe cleaning.
2. Enter the User password if one has been defined. Press OK.

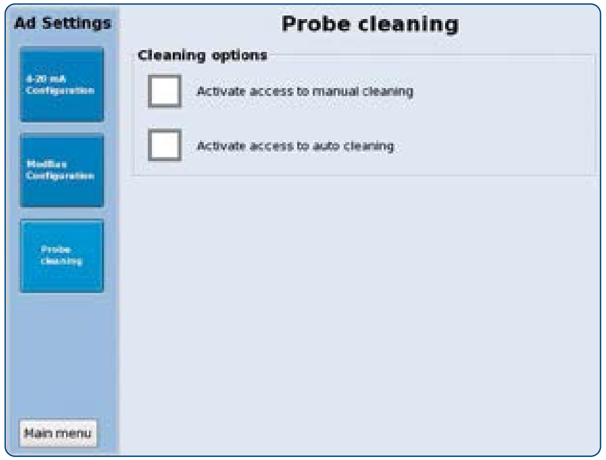

Figure 34: Sensor Cleaning.

3. Choose between the Manual or Auto Cleaning. The auto cleaning consists of periodic cleaning cycles, which start automatically after defined period whereas in the manual cleaning mode the user starts a cleaning cycle manually.
4. Go to the Run Menu and press the Measure Button.
5. Select the duration of the Cleaning: short (cleaning time 30 s) or long (cleaning time 2 min).
6. Enter the User password if one has been defined. Press OK.
7. Activate the Auto-Cleaning (Figure 35) and define the Auto-Cleaning Period, i.e. the time between two Auto-Cleaning cycles.
8. Alternatively, press Clean now to start a Cleaning cycle manually directly.
9. Confirm the password request, without entering any code (see Chapter 9.1).

NOTE: Measurements are unavailable during a cleaning cycle. The status LED on the Pre-amplifier (Figure 9) is flashing green during this procedure. The sensor may need time for equilibration after the cleaning cycle.

Figure 35: Selection of the cleaning mode.

8 Operation of Dencytee

8.1 Choose the Measurement Mode

1. Go to the Measure Settings Menu (Figure 15). Choose the measurement mode, from the predefined settings of Measure Mode 1, 2 or 3, which are a combination of pulse filter and signal integration.
2. Enter the User password if one has been defined. Press OK.
3. To create an own measurement mode see Chapter 8.12

8.2 Addition of Arc Sensors

It is possible to record and plot Arc sensor measurements, in parallel to cell density (Figure 36). That means in addition to the wired Incyte or Dencytee Unit, each channel can also concurrently support two Arc Sensors. Cell density is monitored on Chart A. Another measurement may be shown additionally on Chart A (e.g. Arc pH, Arc DO). The remaining measurements will appear on Chart B. Chart A is shown as the Main Graph per default.

OPERATION OF DENCYTEE

NOTE: The measurement values transmitted over wireless communication are not intended to be used for process control.

Figure 36: Cell Density Graph with Arc DO, and Arc pH records.

NOTE: The Graph Arc requires Arc Sensors, the Arc Wireless Converter MB (Ref 243498) or BT (Ref 243499) and Arc Wi Sensor Adapter 1G MB (Ref 242170), Arc Wi Sensor Adapter 2G MB (Ref 243030), Arc Wi Sensor Adapter 1G BT (Ref 243460) or Arc Wi Sensor Adapter 2G BT (Ref 243470).

1. Mount the Arc Wi Sensor Adapter between the Arc sensor and the Arc Cable VP 8 (Figure 37).

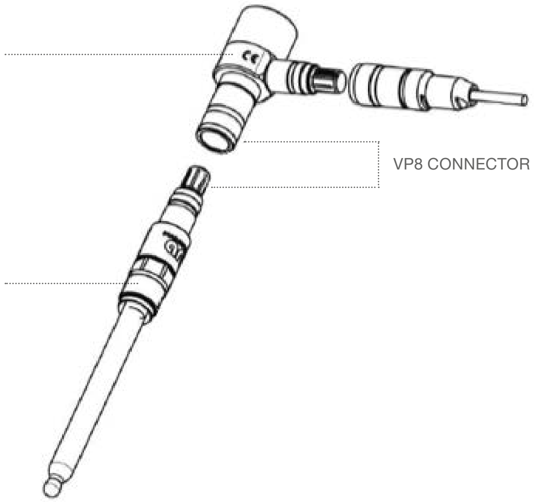

Figure 37: Mounting an Arc Sensor.

2. Plug the Arc Wireless Converter MB or BT in one of the USB Ports on the side panel of the Arc View Controller.
3. Press the button Graph Arc on the bottom left hand corner of the Run Menu (Figure 11). The Arc View Controller will automatically scan for sensors. The Arc Wireless Converter MB or BT is flashing in red during this process. The Graph Arc display opens (Figure 38). The cell density measurement Dencytee is set on Chart A per default.
4. Choose the second parameter to be shown on Chart A and press OK. The remaining parameters will be shown on Chart B.

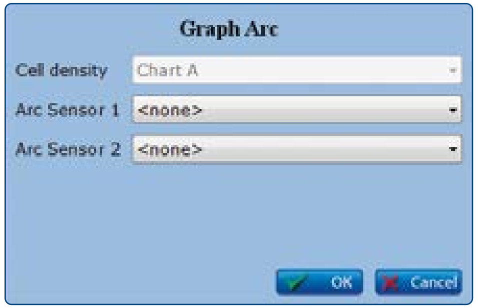

Figure 38: Graph Arc Menu.

5. Chart A is displayed per default on the main graph (Figure 36). Chart B is shown in the lower left corner. Press the Exchange Chart Button (Figure 36) to switch the display of the both charts.

8.3 Start Recording Measurements in a Culture File

1. Verify that the Status Indicator on the Run Menu of the Arc View Controller (Figure 11) is green.
2. Go to the Culture Settings Menu and press the Record Button (Figure 17).
3. Enter the User password if one has been defined. Press OK.
4. Follow the guided procedure to start recording the Culture file. Define the directory to save the file, per default it is the home directory. Select the acquisition time, enter the optional name of the Culture file. Add possible comments and the user name.
5. The Record Button is now disabled, and the information relative to the Culture and the Culture File appears in the Culture Settings Menu. The Floppy Icon on the Channel Tab (Figure 12) also confirms that the measurements are being recorded.

OPERATION OF DENCYTEE

8.4 Perform Product Calibration and Set the Inoculation Time

NOTE: Even though our measurement principle is not influenced by the media color, it is usual to do a product calibration, i.e. a zero-adjustment before inoculation.

1. Equilibrate the Incyte Sensor in culture medium, for at least 30 minutes prior to product calibration and inoculation.
2. Verify on the Main Graph that the cell density measurement is stable.
3. Go to the Measure Settings Menu and press the Mark Zero Button to perform a product calibration (Figure 15).
4. Enter the User password if one has been defined. Press OK.
5. Select automatic. The cell density measurement is now compensated for an offset shown in the measurement values above the Main Graph on the Run Menu.
6. To assign the inoculation time, go to the Culture Settings Menu and press the Inoculate Button (Figure 17). The time on the Main Graph will be reset to zero. A new time scale is added to the Culture File to track the real culture time.

8.5 Add a Comment to the Culture File

During recording, a comment may be added any time to the Culture File. This functionality may be used to track offline samplings.

1. Go to the Culture Settings Menu and press the Comments Button (Figure 17).
2. Enter the User password if one has been defined. Press OK.
3. Enter the title and the description of the comment. Both information are recorded in the Culture File but only the title is shown on the Main Graph.

OPERATION OF DENCYTEE

8.6 Customize the Main Graph

In the Run Menu it is possible to adjust the visualization settings of the Main Graph.

- Press the Auto Scale Button to set an automated scaling.
- Press the Follow Button, to track the current cell density measurements.
- To display a certain part of the graph, move the graph to the left or the right using the Move Right and Move Left Buttons.
- Click on the Zoom In Button to enlarge a detail in the graph and use the Zoom Out Button to set back.
- Click on the X Scale or Y Scale Buttons to scale a specific area of the Main Graph between Xmin and Xmax respectively Ymin and Ymax. Both Y axes may be scaled independently by selecting axis 2.
- Clear the graph at the end of the Culture by pressing the Clear Button.

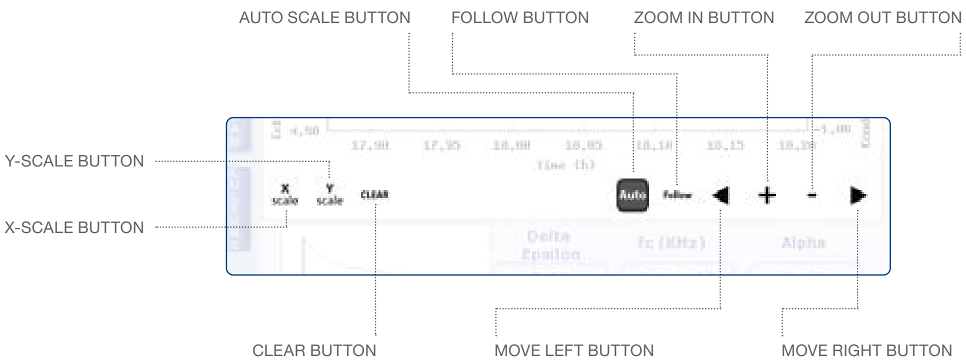

Figure 39: Adjustments on the Main Graph.

8.7 Setup a Multi View Graph

In the Multi-View Tab (Figure 40), it is possible to plot Incyte and Dencytee measurements in the same graph. In addition the current data may be plotted in parallel to the graph of a previous recorded culture file

NOTE: When setting up of the Multi-View, be aware that only 2 types of curves can be displayed on a single graph.

1. Go to the Multi-View Tab and select Graph 1 (Figure 40), enter a title to label the Multi-View graph.
2. Tick the display graph button and select the channel to be displayed.
3. Select a recorded culture file in the File selection.
4. Define the measurement type, e.g. cell density.
5. After definition of the Multi-View, all measurements are plotted in the defined Multi-View Graph.

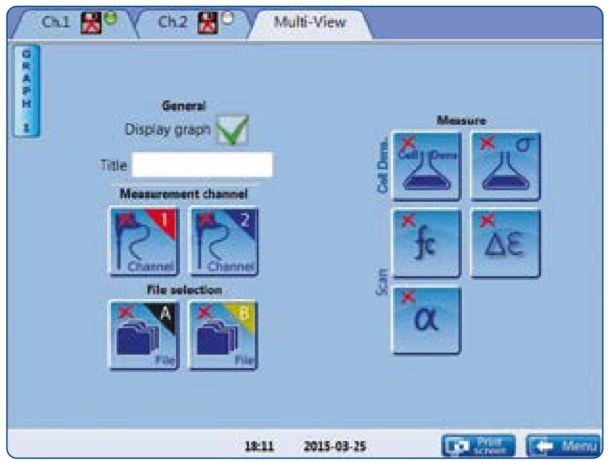

Figure 40: Multi View setup.

8.8 Stop Recording the Culture File

1. Go to the Culture Settings Menu and press the End Recording Button (Figure 17).
2. Enter the User password if one has been defined. Press OK.
3. Export the culture file (Chapter 8.10).
4. Dismount the Sensor (Chapter 8.9).

8.9 Dismount the Sensor Unit

1. Switch off the Arc View Controller using the Key Switch.
2. Disconnect the Sensor Unit Cable from the Pre-amplifier.
3. Loosen the connector ring of the Pre-amplifier by hand and remove the Pre-Amplifier from the Sensor (Figure 24).
4. Loosen the thread of the sensor manually and remove the sensor from the bioreactor.

⚠ **ATTENTION! Make sure that the connector ring is loosen by hand. Never use a wrench or another tool to tighten or loosen the ring (Figure 24).**

8.10 Export a Culture File

1. Go to the Main Menu and press the Explorer Button (Figure 13). The Explorer (Figure 41) displays simultaneously two directories; the Arc View Controller Home per default. Select USB for the second directory.
2. Enter the User password if one has been defined. Press OK.
3. Plug a USB Stick on the side panel of the Arc View Controller (Figure 7) or PC, if using the ComBox (Figure 8). Click on the refresh, select the USB stick and press open dir.
4. Select the Culture file in the home directory and press the Copy Button.

5. Refresh the USB directory, and verify that the Culture file has been transferred successfully.
6. Delete the Culture file copied to free storage space.
7. If needed, the Culture file may be renamed, by selecting the file and pressing the Rename Button.
8. It is possible to create a new directory by pressing the Create Directory Button.

NOTE: Screenshots (see Chapter 11.4.1) are also stored in the Arc View Controller Home directory.

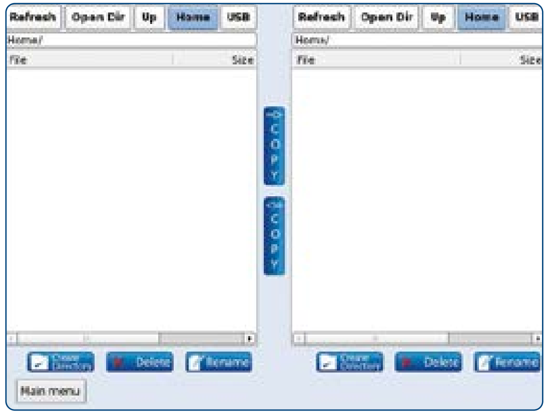

Figure 41: Explorer Menu.

8.11 Import the Culture File in an Excel Spreadsheet

1. Open Microsoft Excel and select the Data Tab.
2. In the area Get External Data press the From Text Icon.
3. Choose the Culture file and click open.
4. Mark the column Date and use a User-defined Format to display the time recordings: yyyy.mm.dd.hh.mm.ss.
5. Select the columns Record and Culture time and define the format as Numbers.

The file (Figure 42) is composed of three parts. The Header contains general information on the Culture. The Events list contains all significant events and modifications that happened while the culture file was recorded. The Measurement table with the following measurement values:

- Date
- Record time (h): time in hours since the start of Recording
- Culture time (h): time in hours since the inoculation
- Comment: contains start recording, inoculation, comments and stop recording
- Raw turbidity measurements
- Cell density value correlated to the product calibration and cell factor a

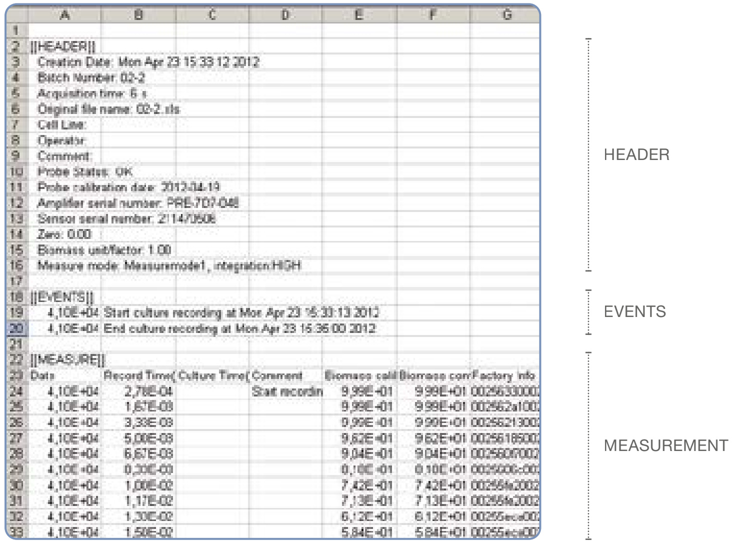

Figure 42: Culture File

8.12 Define the Custom Measurement Mode

The measurement, integration time and pulse filter may be adjusted to define the custom Measurement Mode.

1. Go to the Measure Tab (Figure 15) and select MeasureMode1 in the drop down menu. Press the Edit Button.
2. Enter the User password if one has been defined. Press OK.
3. Enter a new name for the measure mode (Figure 43).
4. Select the integration time, this creates a moving average over a defined number of measurements
    - NONE: 1 measurement - Integration time : 6 sec
    - LOW: 3 measurement3 - Integration time : 18 sec
    - MEDIUM: 22 measurements - Integration time : 2.2 min
    - HIGH: 111 measurements : Integration time : 11.1 min (default)
    - SUPER HIGH: 333 measurements - Integration time : 33.3 min
    - Custom, whereas 6 sec is the minimum time
5. Activate the Pulse filter. The pulse filter is only necessary for media with a high content of solid particles.
6. Press the Save Button.

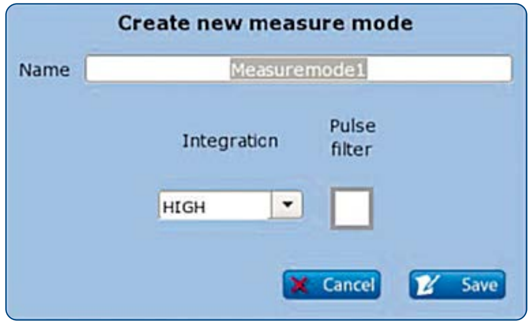

Figure 43: Create new measure mode.

9 Administrator Menu

From the Administrator Menu all system settings are accessible, including password control, network settings and applications, general settings, like the touch screen calibration (only Arc View Controller), the possibility to install licenses or update the system and transfer the Administrator Files.

NOTE: To enter the Administrator Menu, a password is requested, enter the code 14147125 and press ok.

ADMINISTRATOR MENU

9.1 Definition of the User Level

To limit the access to the Arc View Controller, following User Level may be defined (Figure 44):

- Viewer: permission to see the Run Menu, no password needed
- User: permission to change the Run Settings, a User password may be defined
- Administrator: complete access to the Arc View Controller, default code 14147125

NOTE: As soon as a User Level password is defined, there is no possibility to delete it.

Figure 44: Definition of the User Level.

9.1.1 Change the Administrator Password

1. Enter the Administrator Menu.
2. Press the Password Control button.
3. Insert the existing password in the old password-box of the Administrator level and define a new one, confirm it and press validate.

NOTE: Please note the new administrator password.

9.1.2 Define the User Level

1. Enter the Administrator Menu.
2. Press the Password Control button.
3. Leave the old password-box of the User level empty and define a new one, confirm it and press validate.

NOTE: Please note the new user password.

9.2 Adjust the General Settings

In the General Settings (Figure 45) it is possible to perform a touch screen calibration, adjust the decimal separator in the Culture file, activate the continuous plotting of the cell density measurement (without recording), adjust the time and date settings. Additionally it is possible to initialize the M12 connectors and activate the Cell Density Integration Kit option.

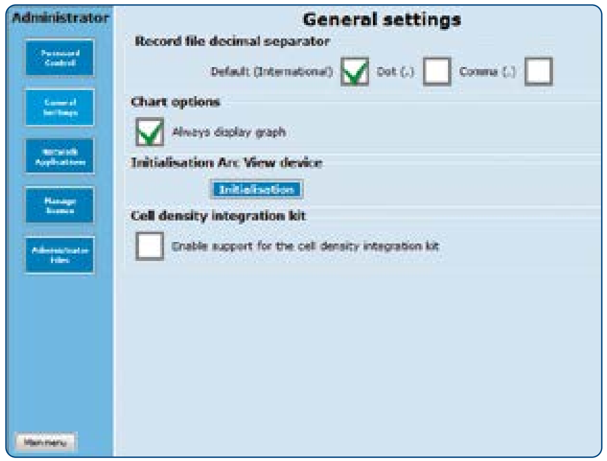

Figure 45: Adjustment of the general settings.

ADMINISTRATOR MENU

9.2.1 Touch Screen Calibration

1. Enter the Administrator Menu and press general settings button.
2. Select touch screen calibration and follow the instructions on the Main Display.

NOTE: Available for the Arc View Controller only.

9.2.2 Adjustment of the Decimal Separator in the Culture File

If the decimal separate output is not compatible to the output software, e.g. Windows Excel, the record file may be adjusted.

1. Enter the Administrator Menu and press general settings button.
2. Select the decimal separator to be dot or comma, per default international is selected.

9.2.3 Continuous Display of Graphed Data

Always display the graph may be activated, to plot the current measurements without recording.

1. Enter the Administrator Menu and press general settings button.
2. Activate the Chart options and the graph is plotted continuously.

9.2.4 Adjustment of Date and Time Settings

NOTE: Available only for the Arc View Controller and Cell Density Integration Kit (if screen connected).

Time and date may be adjusted if displayed incorrect.

1. Enter the Administrator Menu and press general settings button.
2. Press set time and adjust date, time and time-zone (offset to UTC).
3. Press OK, the Control Unit requests for a re-start to change the date and time settings.

9.2.5 Initialize the Arc View M12 Connectors

NOTE: You can use 1 of the combinations below for Channel assignment (including Aux and Modbus channels):
1. M12 cable plus Pre-amplifier with sensor attached
2. M12 cable plus Pre-amplifier with Cal Simulator attached
3. M12 cable plus Pre-amplifier only

Initialize the M12 connectors after a Software update (see Chapter 9.7.1), or the re-set of the factory settings (see Chapter 9.7.2), This ensures that the Sensor Units are correctly detected.

1. Enter the Administrator Menu and press general settings button.
2. Press Initialization of the Control Unit and follow the instructions on the main display.

9.2.6 Enable the Cell Density Integration Kit Option

NOTE: This procedure enables the verification and calibration by Modbus, but disables this possibility on the screen. It is only required if the procedure should run via Modbus, e.g. if the system is integrated in a process control system.

1. Enter the Administrator Menu and press the general settings button.
2. Activate the Cell Density Integration Kit option

ADMINISTRATOR MENU

9.3 Read the Network Settings

NOTE: Available only for the Arc View Controller and Cell Density Integration Kit (if screen connected).

In the Network Settings it is possible to read the Serial Number (Device Name) of the Arc View Controller and Cell Density Integration Kit, as well as the max address, IP address, subnet mask and gateway address (Figure 42). This information is relevant for the connection of the Arc View Controller and Cell Density Integration Kit to the process control system via OPC or the integration of the Controller or Kit in a network.

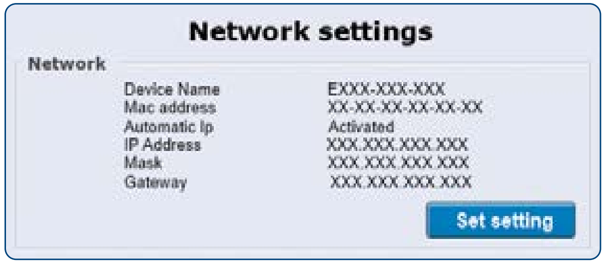

Figure 46: Network Settings display.

The Network Settings page lets you configure the network configuration of your device. In order to use the networking features of the device, an IP address must be assigned. Depending on the configuration of the network where you intend to install the device, one of the following cases applies:

- Manual IP addressing (checkbox not selected)
- Automatic IP addressing (checkbox selected)

Manual IP addressing means that the IP configuration is given by the network administrator. The relevant information (IP address of your device, subnet mask, gateway) must be entered in the corresponding fields. Depending on your company's policy, you should not take an unassigned IP address randomly for your device since it may result in networking problems.

Dynamic addressing means that the IP configuration is given by a service, called DHCP, running on the network. This is the default configuration and is suitable in most cases.

NOTE: Check, when troubleshooting dynamic IP addressing:
- Cabling
- DHCP service is running on the physical network where your Control Unit is connected.
- Check with your system administrator if the policy requires a manual entry of the device's MAC address in the DHCP configuration. The MAC address is written on the small sticker with barcode located on the main board. In addition the MAC address is shown in the Network Settings View.

9.4 Adjust the Network Applications

In the Network Applications it is possible to activate share data files for the integration in a Windows network. Additionally the OPC communication (see Chapter 12.2) may be enabled (Figure 47).

Figure 47: Activate the Network Applications.

ADMINISTRATOR MENU

9.4.1 Activate Share Data Files

NOTE: Available only for the Arc View Controller and Cell Density Integration Kit (if screen connected).

1. Enter the Administrator Menu and press the Network Applications button.
2. Activate the share data files to enable the integration of the Control Unit into a Windows Network.
3. Set Up the integration in the local network, using the Network Settings (see Chapter 9.3).

9.4.2 Activate OPC Communication

1. Enter the Administrator Menu and press the Network Applications button.
2. Activate OPC to allow OPC communication to the process control system (see Chapter 12.2).

9.5 Install a License

NOTE: The ordered licenses are installed on the Arc View Controller.
The ordered licenses are stored on the USB stick provided with the ComBox.

1. Enter the Administrator Menu and press manage license.
2. Connect the USB stick with the new license on one of the USB ports at the right panel (Figure 6) of the Arc View Controller, or a PC where the ComBox is connected.
3. Click the load license button and select the license and press ok (Figure 48).

NOTE: After installation of the OPC license a re-start is requested.

Figure 48: License Menu.

9.6 Transfer Administrator Files

The Administrator files (Figure 49) may be transferred for storage in an external hard drive or used for trouble shooting purposes.

Figure 49: Transfer the administrator files.

ADMINISTRATOR MENU

9.6.1 Export the Log Files

NOTE: Available only for the Arc View Controller and Cell Density Integration Kit (if screen connected).

1. Enter the Administrator Menu and press Administrator Files.
2. Connect a USB stick on one of the USB ports at the right panel (Figure 6) of the Arc View Controller, or the industrial PC of the Cell Density Integration Kit.
3. Follow the instructions on the Main Display. The log files may be needed for trouble shooting the system.

9.6.2 Erase Temporary Files

NOTE: Available only for the Arc View Controller and Cell Density Integration Kit (if screen connected).

1. Enter the Administrator Menu and press Administrator Files.
2. Press Erase temporary files to clean the memory of the Arc View Controller, or the industrial PC of the Cell Density Integration Kit.
3. Follow the instruction on the main display of the Control Unit.

9.6.3 Export Culture Data

NOTE: This function is available starting with Software Version 3.8.

1. Enter the Administrator Menu and press Administrator Files.
2. Select the Channel, to export the corresponding data, and enter the initial and final date for the export.
3. Connect a USB stick on one of the USB ports at the right panel (Figure 6) of the Arc View Controller or the PC, where the ComBox is Installed and follow the instruction on the Main Display of the Control Unit.

9.7 Update or Re-Set the Arc View Controller or Cell Density Integration Kit

In the Update System Menu (Figure 50), it is possible to re-set the Control Unit to the factory Software, or update the system.

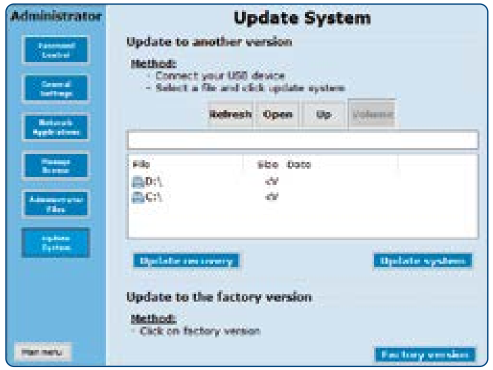

Figure 50: Update System Setting.

NOTE: The settings are reset to factory when updating the Control Unit.

9.7.1 Software Update of the Control Unit

9.7.1.1 Software Update of the Arc View Controller or Cell Density Integration Kit

1. Please check our Homepage www.hamiltoncompany.com/arc_view_update for new updates. Save the file on an USB stick.
2. Enter the Administrator Menu and press Update system.
3. Connect the USB stick to the Arc View Controller and select the update file. Activate the system update.

4. Follow the instructions of the Main Display.
5. After the update is finished initialize the M12 Connectors (see Chapter 9.2.5).

9.7.1.2 Software installation/update of the ComBox

NOTE: Prior to the update, save the current data.

9.7.1.2.1 Procedure for one ComBox per PC

1. Please check our Homepage www.hamiltoncompany.com/arc_view_update for the newest Software version.
2. Download.
3. Execute the "Combox_Setup.exe".
4. Follow the instructions on the screen, until the Software is installed.
5. Connect the ComBox and close the Installer Software.
6. Start the Software and initialize the M12 connectors (see Chapter 9.2.5), close the Software.
7. Start the Software and install the licenses (see Chapter 9.5).

9.7.1.2.2 Procedure for two ComBoxes per PC

1. Follow steps 1 and 5 in Chapter 9.7.1.2.1.
2. Duplicate folder "C:\Program Files (x86)\Hamilton\CellDensityComBox".
3. Adjust the folder name, while adding the number of the box, e.g. "...ComBox_2".
4. Create a shortcut for the "interface_Biomas_rack_V2.exe" in the new folder.
5. Save shortcut on the desktop under the defined name (in this case ...2).
7. Connect ComBox 2 and start Software 2.
8. Switch to the first Software, initialize the Channels (see Chapter 9.2.5) and install the licenses (see Chapter 9.5).
9. Switch to the second Software, initialize the Channels (see Chapter 9.2.5) and install the licenses (see Chapter 9.5).

NOTE: If you have more than two ComBoxes, repeat the procedure for the amount of ComBoxes available.

9.7.2 Re-Set the Arc View Controller or Cell Density Integration Kit

In case of Software failure, it is possible to re-set the factory settings.

1. Enter the Administrator Menu and press Update system.
2. Connect a USB Keyboard and a USB Mouse to the USB connections of the Arc View Controller (Figure 6), or industrial PC of the Cell Density Integration Kit (Figure 8).
3. Press factory version, to re-set the factory setting of the Control Unit.
4. Follow the instructions on the Main Display.
5. After the system is re-set initialize the M12 Connectors (see Chapter 9.2.5).

9.7.3 Update Recovery of the Arc View Controller

In case of script update, it is possible to perform a recovery update process instead of a complete software update.

NOTE: This functionality is only available for Arc View Controller.

1. Connect the USB stick with the scripts (provided by Hamilton) to the Arc View Controller.
2. Enter the Administrator Menu select the .zip file, which contains the recovery scripts and press Update recovery. The software now checks for completeness of the data and copies the files to the recovery partition.
3. Upon completion the Arc View Controller requires two re-starts, which which have to be confirmed after pressing Update recovery.

NOTE: If a wrong file is selected a instruction for the correct procedure will be displayed on the Controller screen.

10 Maintenance

10.1 Daily Maintenance

As a daily routine, at least prior to every run, the Status Indication on the Arc View Controller may be checked (Figure 12). The Indicator should be green, if not please refer to Chapter 11.1.

10.2 Weekly Maintenance

The Weekly Maintenance should be performed on a weekly basis or at the end of a Culture.

1. Check the Status Indicator on the Arc View Controller (Figure 12). The Indicator should be green.
2. Decontaminate the sensor by Sterilization in Place, Cleaning in Place or Autoclavation.
3. Press the increment sterilization button (Figure 14) in the Unit Tab after autoclavation.
4. If needed perform the Manual Cleaning Procedure (see Chapter 10.3).
5. Download the recent Culture Files if not yet done.

NOTE: Incyte and Dencytee Sensors need to be replaced at least after 100 Autoclavation, Sterilization-in place, or Cleaning-in-place cycles. The Status Indicator on the Arc View Controller turns orange and a request to replace the sensor appears. Failure to do so may lead to measurement errors.

⚠ **ATTENTION! The pre-Amplifier is not autoclavable. Dismount it prior to autoclavation to avoid damages to the electronics Please refer to Chapter 7.9 and 8.9 for instructions. Protect the sensor's male connector with aluminum foil to prevent condensed vapors from reaching the electrical contacts during sterilization.**

10.3 Manual Cleaning Procedure at Process End for Cell Density Sensors

Manual cleaning may be needed, when a thick biofilm sticks on the sensor.

10.3.1 Incyte Sensors

1. After decontamination, immerse the PEEK sensor tip in Sodium Sulfite ($Na_2 SO_3$), 15 g/L.
2. Connect the pre-amplifier (see Chapter 6.3) and perform 2 cycles of short cleaning (see Chapter 7.13).
3. Remove the Sensor from the solution and rinse the residual sodium sulfite with deionised water.
4. Perform the Sensor Unit Verification procedure (see Chapter 10.5).

10.3.2 Dencytee Sensors

1. After decontamination, emerse the Dencytee Sensor for 30 minutes in 1% (v/V) acetic acid and afterwards 30 min in 1% (w/v) NaOH at room temperature.
2. Rinse the Sensor with deionized water.
3. Perform the Sensor Unit Verification procedure (see Chapter 10.5).

10.4 Yearly Maintenance

1. Perform the Weekly Maintenance.
2. Perform the Sensor Verification procedure.
3. Export the temporary data (see Chapter 9.6.3).
4. Delete the temporary files (see Chapter 9.6.2).
5. Update the Control Unit with the latest Software Update (see Chapter 9.7.1).

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10.5 Sensor Unit Verification

NOTE: Verification just available on screen if Cell Density Integration Kit option not activated.

A report of the verification is automatically created and stored (explorer or local hard disk). All tolerances and acceptance criteria are shown in the report.

10.5.1 Verification of an Incyte Sensor Unit

NOTE: The Capacitance Simulator (Ref 243743) and Hamilton 12880 µS/cm Conductivity Standard (Ref 238988), formerly called Solution A, as well as a thermometer are needed to perform the Sensor Unit Verification.

1. Connect the Incyte Unit, power on the Control Unit and equilibrate for at least 30 minutes prior to starting the Verification procedure.
2. Go to the Main Menu and enter the Calibration Menu (Figure 13). Select the Verify / Check Unit Calibration to start the Verification procedure.
3. Select the channel. The Sensor type is automatically detected.
4. Enter the user name and press start.
5. Connect the Capacitance Simulator and press Test Pre-amplifier Calibration to run the Verification procedure (Figure 51). The successful Verification is indicated. If this procedure fails it is recommended to perform a calibration.

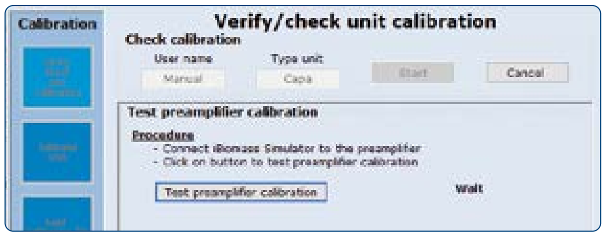

Figure 51: Testing the pre-amplifier calibration.

6. Connect the Incyte Sensor to the Pre-amplifier.
7. Select the Manual temperature correction mode. The Automatic mode is disabled.
8. Pour Hamilton 12880 µS/cm Conductivity Standard in a clean beaker. Make sure the sensor mounting instructions are followed (Figure 22).
9. Measure the temperature of the Standard with an external thermometer. Enter the conductivity value according to the temperature correction table on the bottle of the Conductivity Standard.
10. Press Test Sensor Calibration to carry on with the Verification (Figure 52). The successful Verification is indicated. If this procedure fails it is recommended to perform a calibration (see Chapter 10.6.1).

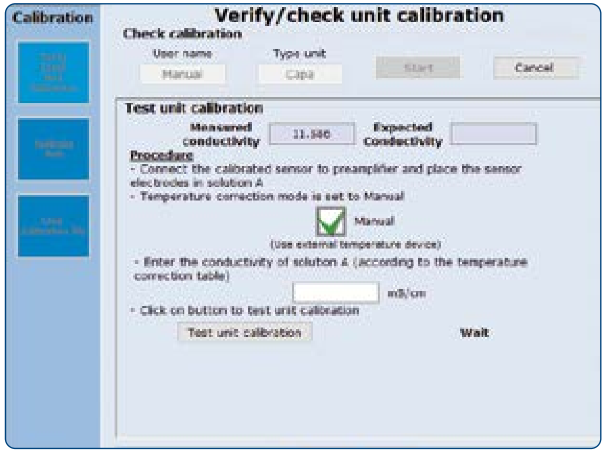

Figure 52: Checking the Sensor calibration.

10.5.2 Verification of a Dencytee Sensor Unit

⚠ ATTENTION! Make sure that the Val/Cal Solution (Ref 243886) is not expired and avoid contamination or dilution. Mix well prior to usage.

1. Connect a Dencytee Sensor Unit and power on the Control Unit. Equilibrate the Val/Cal Solution (Ref 243886) at 23°C +/- 1°C for at least 30 min prior to starting the Verification procedure.

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2. Go to the Main Menu and enter the Calibration Menu (Figure 13). Select the Verify / Check Unit Calibration to start the Verification procedure.
3. Select the channel. The Sensor type is automatically detected.
4. Enter the user name and press start.
5. Make sure that the light path is clean, dust-free and placed in the dark. Press Measure in air to run the Verification procedure (Figure 53).
6. Insert the sensor directly in the bottle of the Val/Cal solution. Make sure that the light path is well immersed and placed in the dark. Press Measure in solution (Figure 53). The successful Verification is indicated. If this procedure fails it is recommended to perform a calibration (see Chapter 10.6.2).

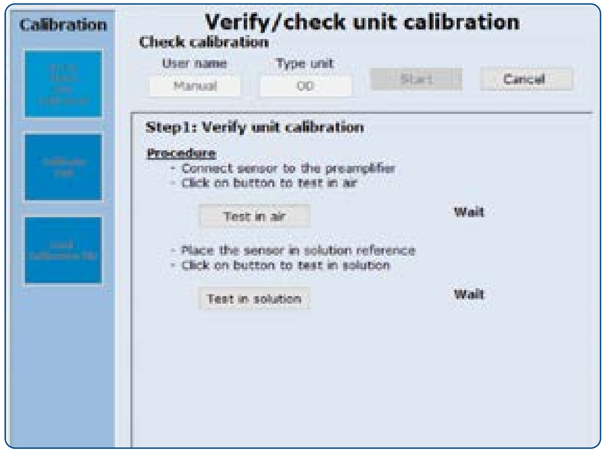

Figure 53: Testing the pre-amplifier calibration.

10.6 Calibration of a Sensor Unit

NOTE: Calibration just available on screen if Cell Density Integration Kit option not activated.

Calibration of a Sensor Unit is required if the Sensor Unit Verification did not passed successfully.

10.6.1 Calibrate an Incyte Sensor Unit

The Calibration procedure of an Incyte Sensor Unit is a five-step guided procedure. It takes about an hour to perform this procedure. The Val/Cal Kit for Standard Sensors (Ref 243740), Low Conductivity "LC" (Ref 243713) or High Conductivity "HC" (Ref 243714) is needed to perform a Incyte Sensor Unit Calibration.

⚠ **ATTENTION! Do not disconnect the Unit from the Arc View Controller, or the Sensor from the pre-amplifier during the Calibration procedure.**

NOTE: Make sure to prepare following equipment in addition to the Val/Cal Kit: stirrer-plate, thermometer

1. Connect the Incyte Unit, power on the Control Unit and equilibrate for at least 30 minutes prior to starting the Calibration procedure.
2. Go to the Main Menu and enter the Calibration Menu (Figure 13). Select Calibrate Unit to run the Calibration procedure.
3. Select the channel. The Sensor type is automatically detected.
4. Enter the user name and press start (Figure 54).

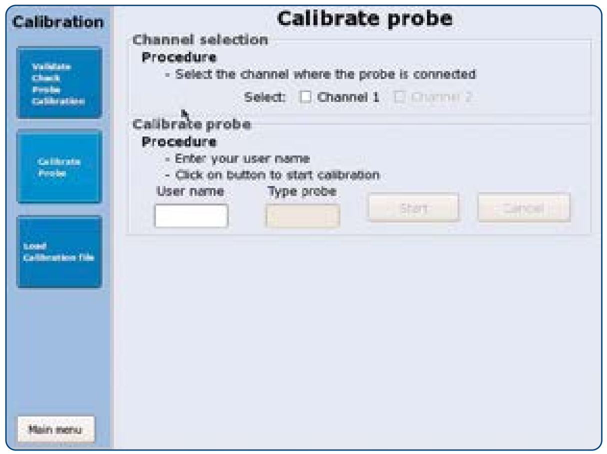

Figure 54: Start of the Sensor Unit calibration.

5. Connect the Capacitance Simulator and press Test Pre-amplifier Calibration to proceed with the Calibration procedure. The successful test is indicated. If this procedure fails it is recommended to contact the local representative.
6. Replace the Simulator with the Incyte Sensor and press Measure in air to calibrate at zero conductivity. If this procedure fails it is recommended to contact the local representative.
7. Select Manual temperature correction mode. The Automatic mode is disabled.
8. Pour Hamilton 12880 µS/cm Conductivity Standard in a clean beaker. Make sure the sensor mounting instructions are followed (Figure 22).
9. Measure the temperature of the Standard with an external thermometer. Enter the conductivity value according to the temperature correction table on the bottle of the Conductivity Standard.
10. Press Calibrate sensor constant to start the Calibration (Figure 55). The successful Calibration is indicated. If this procedure fails it is recommended to contact the local representative.

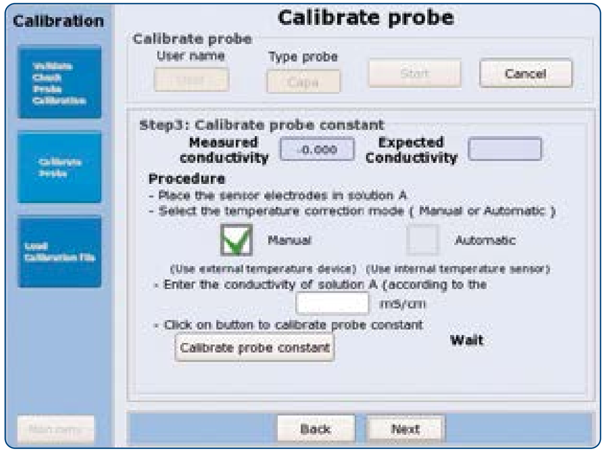

Figure 55: Calibration of the Sensor constant.

11. Rinse the Sensor with deionized water.
12. Pour 150 mL deionized water in a clean beaker. In the following steps 1 to 30 mL of Solution B is added gradually to the deionized water. Press start (Figure 56).
13. Add the required amount of Solution B. Press Start.

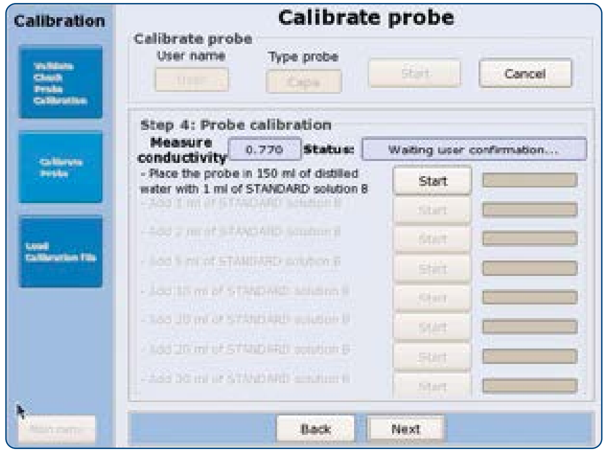

Figure 56: Incyte Sensor calibration.

15. The successful Calibration is indicated. If this procedure fails it is recommended to contact the local representative.
16. Choose the directory, where the Calibration Report should be stored and press Generate Calibration Report (Figure 57). The valid calibration is automatically saved in the memory of the Pre-amplifier.

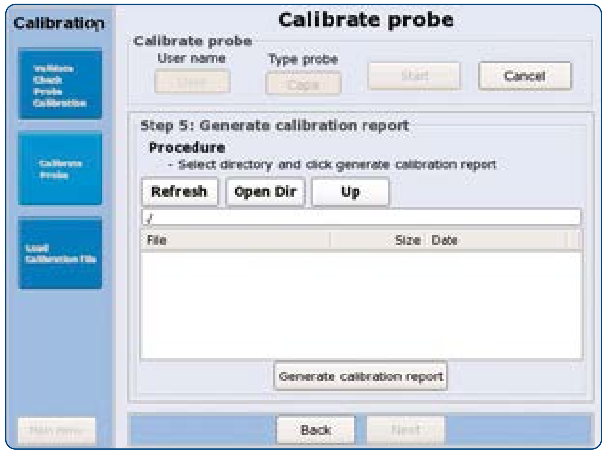

Figure 57: Generation of a Calibration Report.

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10.6.2 Calibrate a Dencytee Sensor Unit

> ⚠ **ATTENTION! Make sure that the Val/Cal Solution (Ref 243886) is not expired and avoid contamination or dilution. Mix well prior to usage.**

1. Connect a Dencytee Sensor Unit and power on the Control Unit. Equilibrate the Val/Cal Solution (Ref 243886) at 23°C +/- 1°C for at least 30 min prior to starting the Calibration procedure.
2. Go to the Main Menu and enter the Calibration Menu (Figure 13). Select Calibrate Unit to run the Calibration procedure.
3. Select the channel. The Sensor type is automatically detected.
4. Enter the user name.
5. Make sure that the light path is clean, dust-free and placed in the dark. Press Measure in air to proceed with the Calibration procedure (Figure 53).
6. Insert the sensor directly in the bottle of the Val/Cal solution. Make sure that the light path is well immersed and placed in the dark. Press Measure in solution (Figure 53).
7. The successful Calibration is indicated. If this procedure fails it is recommended to contact the local representative.
8. Choose the directory, where the Calibration Report should be stored and press Generate Calibration Report (Figure 57). The valid calibration is automatically saved in the memory of the Pre-amplifier.

10.7 Transfer a Calibration Files to the Arc View Controller

Upon request the calibration of a new Sensor Unit may be done at Hamilton. This new Unit is shipped with the calibration data on an USB stick. It is possible to transfer this Calibration File to the Arc View Controller without connecting the Sensor Unit.

1. Go to the Main Menu and enter the Calibration Menu (Figure 13). Select Load Calibration Files (Figure 58).
2. Connect the USB stick to the Control Unit (Figure 6, 7, 8) and choose the directory. Press Load file.

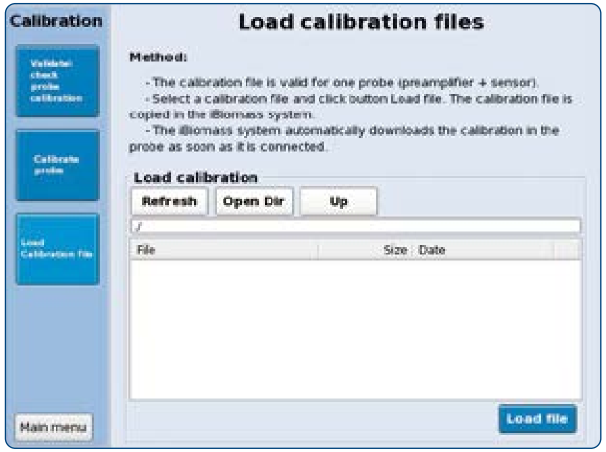


Figure 58: Upload of calibration files.

10.7.1 Clean and Back Up the Arc View Controller

To keep the storage space of the Control Unit free, the temporary data may be transferred to an USB stick and deleted.

1. Export the temporary data (see Chapter 9.6.3).
2. Delete the temporary files (see Chapter 9.6.2).

10.7.2 Update the Control Unit

1. Please check our Homepage www.hamiltoncompany.com/arc_view_update for recent updates at least once a year.
2. Update the Control Unit (see Chapter 9.7.1 and 9.7.2).

11 Troubleshooting

11.1 Self-Diagnostic of the Sensor Unit

The Sensor Unit is running a self-diagnosis continuously. The Status Indicator on the Control Unit (Figure 12). and the Incyte Status LED on the Incyte Pre-amplifier (Figure 9) report direct feedback.

The feedback output is similar to a traffic light. A green Status Indicator means everything works as excepted. An orange Status Indicator shows a warning, that the measurement may be not correct. A red indication gives an error that the system has stopped working (Table 1).

Notification on the Control Unit	Status Indicator	Status LED (Incyte)	Description
SENSOR: ok	Green	Green	The Sensor Unit is working as expected.
Simulator connected	Green	Green	The permittivity simulator is connected to the Pre-amplifier.
SENSOR: cleaning state	Green	Flashing green	The Pre-amplifier is applying a cleaning cycle, no measurement available.
AMPLIFIER: temperature security activated	Green	Flashing green	The Pre-amplifier temperature is too high, the security fuse is activated, no measurement available.
SENSOR: Out of range measurement	Green	Flashing green	The measurement is out of range.
AMPLIFIER: not found	Gray	Green	No communication between Sensor Unit and Arc View Controller, please contact the local representative.
SENSOR: sterilization count overflow	Orange	Orange	The Sensor has been sterilized more than 100 times. Please contact your local representative.
AMPLIFIER : total duration of use overflow	Orange	Orange	The Pre-amplifier has been used more than 6 months continuously. Please perform a verification.
SENSOR: invalid sensor calibration	Orange	Orange	The current sensor has not been calibrated with the Pre-amplifier.
SENSOR: invalid calibration	Orange	Orange	The sensor serial number is not valid.
SENSOR: total duration overflow	Orange	Orange	The sensor has been used more than 6 months continuously. Please perform a verification.
SENSOR: out of calibration range	Orange	Orange	The measurement is out of the calibration range.
SENSOR: not found	Red	Red	No Sensor connected to the Pre-amplifier.
BOX: not connected	Grey	Grey	ComBox is not connected to the PC.

Table 1: Status Table.

11.2 Re-Set the Factory Settings

It is possible to re-set the factory settings, in case of Software failure. See Chapter 9.7.2.

11.3 Verification and Calibration Error

11.3.1 Verification Error

It is recommended to perform a Calibration (Chapter 10.6), if the Verification of an Incyte or Dencytee Unit fails (see Chapter 10.5).

11.3.2 Calibration Error

If a calibration of a Dencytee Unit fails (see Chapter 10.6.2) re-start the Control Unit and perform a Calibration again. Please contact your local representative, if the Calibration fails again after re-start of the Controller.

Please contact your local representative, if the Calibration of an Incyte Unit fails.

TROUBLESHOOTING

TROUBLESHOOTING

11.4 Getting Technical Support

If any troubles are observed, which you cannot solve based on this operation instruction, please contact Hamilton Technical Support for further help: techsupport.pa.ch@hamilton.ch or the local Hamilton representative.

For diagnosis of the measurement loop further data may be needed, it is explained in chapters 11.4.1 to 11.4.3 to get the relevant information.

11.4.1 Create Print Screens

🗍 NOTE: Integrated print screen functionality only available with Arc View Controller.

It is possible to create print screens on certain unexpected events.

1. Press the Print Screen Button in the Run Menu (Figure 11) The image is automatically recorded in the home directory.
2. Transfer the Screen Shoot to a USB stick (see Chapter 7.10 and 8.10).

11.4.2 System Information

The System information gives information about the current Soft- and Hardware version of the complete Measuring Loop.

1. Press the About Button in the Main Manu (Figure 13) and press print screen (Figure 59).
2. Transfer the Screen Shoot to a USB stick (see Chapter 7.10 and 8.10).

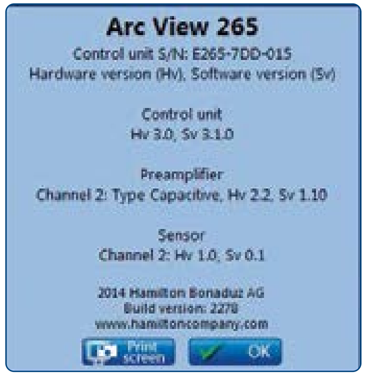


Figure 59: General information menu of the Arc View Controller.

11.4.3 System Data

The log files contain the relevant information about the measurement loop, including error codes. Please send the log files to the technical support for trouble shooting.

See Chapter 9.6.1

11.5 Remove Corrupt Files

In case of Software failure the deletion of corrupt files may be required.

🗍 NOTE: Connect a keyboard to the USB connector of the Arc View Controller prior to system start.

🗍 NOTE: A USB stick is required to remove the files from the Arc View Controller and store them for safety reasons, to ensure minimal loss of data.

TROUBLESHOOTING

⚠ ATTENTION! Remove the files stepwise and run a system start after each step to confirm if the Software is working stable:
- **move temporary files (stored culture files and calibration/verification reports)**
- **move log files (recent/running culture files)**
- **move configuration files (all configuration data and settings) - this requires the new set up of channel initialization, the OPC or 4- 20 mA communication**

1. Switch on the Arc View Controller
2. Select Evo Recovery with the arrow key, as soon as the possibility is displayed, the software will now boot in the recovery mode and shows a selection menu.
3. Select possibility «4. File recovery» by typing 4 and confirming with the enter key
4. Enter the administrator password and confirm with enter. A new selection menu will be shown.
5. Select the possibilities stepwise and confirm with enter, by skipping step 4 as, as this is only required to transfer error-logs (please see chapter 11.6).
6. Wait until the procedure is finished and the system has re-started
7. In case the Software is not running stabile perform the next step

NOTE: The data is saved on the USB stick in the folder: Arc-View_backup

11.6 Transfer Error-Log-Files from the Arc View Controller

If case the Software fails a tool will create Error-Log-Files. These files are relevant information for the Technical Support.

NOTE: Connect a keyboard to the USB connector of the Arc View Controller prior to system start.

NOTE: A USB stick is required to remove the files from the Arc View Controller.

1. Switch on the Arc View Controller.
2. Select Evo Recovery with the arrow key, as soon as the possibility is displayed, the software will now boot in the recovery mode and shows a selection menu.
3. Select possibility «4. File recovery» by typing 4 and confirming with the enter key.
4. Enter the administrator password and confirm with enter. A new selection menu will be shown.
5. Select «4: Move crash reports» by typing 4 and confirming with the enter key.
6. Wait until the procedure is finished and the system has re-started.
7. Remove the USB drive. The error report is now located on the USB drive and is a file ending with «.dmp», like «interface_Biomass_rack_V2.exe.X.dmp», whereas X may be a 4 or 5 digit number. There may be up to two files like this.

11.7 Returning a System for Repair

Please contact Hamilton Technical Support for return of the Instrument. You have to assign a RGA-number clearly written on the packaging. Please be aware that we are not responsible for any damages during transportation, if the material is not shipped in original wrapping and suitable protected.

NOTE: Please ensure that the material is properly decontaminated prior to wrapping.

12 Connection of the Control Unit to the Process Control System

In this chapter it is explained, how to connect the Control Unit to the process control system by:

- Modbus communication
- OPC communication
- 4-20 mA Output signal

12.1 Connect by Modbus communication

12.1.1 Preparation of the Control Unit

NOTE: The Control Unit acts as Modbus slave (Modbus server), all cell density measurements can be read by a Modbus master (client). The present implementation of the Modbus protocol uses the RTU mode over a RS-485 serial line.

1. Enter the Advanced Settings and select the Modbus Configuration

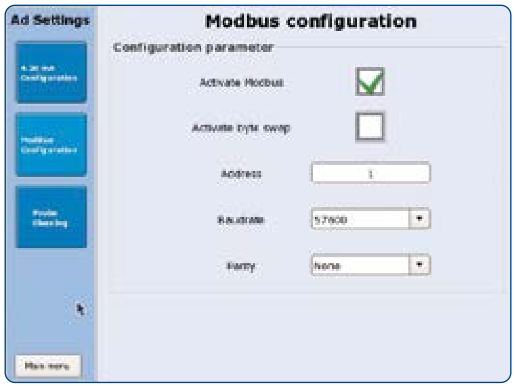
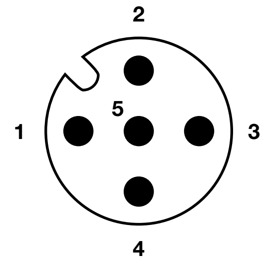


Figure 60: Menu for Modbus Configuration.

CONNECTION OF THE CONTROL UNIT
TO THE PROCESS CONTROL SYSTEM

2. Connect an open-end M12 cable to the Modbus Connector (Figure 61) on the right side of the Controller and configure the Modbus parameters (Figure 60).



Pin	Function
1	+24 V
2	RS-485 A
3	GND
4	RS-485 B
5	n.c.

Figure 61: Female M12 connector description.

12.1.2 Preparation of the Modbus Connection

12.1.2.1 Definition of the Return Time

The return time depends on the type of Modbus requests.

Modbus request	Reading	Writing one register or multiple registers once (next write must be on different registers)	Writing the same register or the same multiple registers twice in a row
Return time	200ms	200ms	1s

Table 2: Modbus return time.

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.2 Overview of the Available Data

The Control Unit provides for each channel three sets of information on Modbus.

Standard cell density data:

- Sensor SN
- Amplifier SN
- Amplifier Status (integer type format)
- Conductivity
- Cell density
- Measure index
- Amplifier status (float type format)

Incyte Scan data:

- Delta Epsilon
- Fc
- Alpha
- Fscan Epsilon (not available with standard licenses)
- Spectro index

Capacitance at all frequencies of the Incyte Scan:

- Fscan - Index
- Scan frequencies list (frequency)
- Scan C(f) list (permitivity)

Each one of the three data sets (standard cell density, Incyte Scan data, permittivity at all frequencies of the Incyte Scan) has its own index which is incremented at each valid measurement. An index increment stopped for a long time means there is no communication between the Arc View Controller and amplifier, e.g. if the pre-amplifier is not connected.

To preserve data integrity, the Modbus master must request the entire data set in only one frame. The system guarantees the data set index tallies with only one measurement.

NOTE: If the master reads data separately with an undefined time between requests, the Arc View Controller could change registers during this time and so the index could not tally with only a single measurement.

12.1.2.3 Definition of 32 Bit Data Type

The Modbus protocol defines registers of 16 bit words. The registers are transmitted in big-endian format. The float values and unsigned long values are 32 bit sized; therefore they are mapped into two registers. These 32 bit values are transmitted low word (16 bit) first whereas the bytes inside the words are sent with big-endian format.

For example:

- Floating point representation: 97.18467
- Hexadecimal representation 0x42C25E8D (IEEE 754 Standard)
- The float value in the register table:

Registers	Value
86	0x5E8D
87	0x42C2

Table 3: Register Values.

Modbus answer frame (slave address = 1):

- 0x01 | 0x04 | 0x5E | 0x8D | 0x42 | 0xC2 | 0xC9 | 0x76

Activate the byte swap option in the Modbus configuration screen allow to swap the byte in the word. The answer frame with this option is:

- 0x01 | 0x04 | 0x8D | 0x5E | 0xC2 | 0x42 | 0xC9 | 0x76

CONNECTION OF THE CONTROL UNIT
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12.1.2.4 Definition of Modbus Exceptions

If the slave cannot serve a request, it returns an exception with the following error codes:

Error code	Name	Description
0x01	Illegal Function	The function code received in the query is not an allowable action for the slave.
0x02	Illegal Data Address	The data address received in the query is not an allowable address for the slave.
0x03	Illegal Data Value	A value contained in the query data field is not an allowable value for the slave.
0x06	Slave Device Busy	The slave is engaged in processing a long-duration program command and transmits the message later when the slave is free.

Table 4: Definitions of Modbus Exceptions.

12.1.2.5 Pre-Amplifier Status Codes

The following table lists the possible status code for Modbus registers amplifier status.

Status	Code	Amplifier led indicator	Description
SENSOR: not found	0	Red	No sensor connected to the Pre-amplifier.
SENSOR: sterilization count overflow	1	Orange	The sensor has been sterilized more than 100 times. Please contact the local representative.
AMPLIFIER : total duration of use overflow	4	Orange	The preamplifier has been used more than 1 year continuously. Please perform a Pre-amplifier check.
PROBE: invalid sensor calibration	5	Orange	The current sensor has not been calibrated with the Pre-amplifier.
SENSOR: invalid calibration	6	Orange	The current sensor has not been calibrated with the Pre-amplifier. The sensor serial number is not valid.
SENSOR: total duration overflow	7	Orange	The sensor has been used more than 6 months continuously. Please perform a verification.
PROBE: out of calibration range	8	Orange	The measurement is out of the calibration range.
PROBE: cleaning state	9	Flashing green	The Pre-amplifier is applying specific voltage to clean the sensor, no measurement available.
AMPLIFIER: temperature security activated	10	Flashing green	The Pre-amplifier temperature is too high, the security fuse is activated, no measurement available.
PROBE: Out of range measurement	11	Flashing green	The measurement is out of range.
PROBE: ok	12	Green	The unit is working as expected.
Biomass simulator connected	13	Green	The Simulator is connected to the Pre-amplifier.
SENSOR: total sterilization time overflow	14	Orange	The automatic sterilization counter has reached the maximum value (100).
SENSOR: overtime reached-calib/check needed	15	Orange	The sensor has been used more than 1 year since the last calibration. Please perform a calibration.
AMPLIFIER: overtime reached/check needed	16	Orange	The Pre-Amplifier has been used more than 1 year since the last calibration Please perform a calibration.
AMPLIFIER: not found	17	Off	No Pre-Amplifier is connected to the channel.
bootloader	18	Red flashing	Pre-Amplifier firmware updating.

Table 5: Pre-amplifier Status Code.

NOTE: Some status codes are only available for Incyte Sensors.

12.1.2.6 Calibration and Validation via Modbus

Dencytee and Incyte units can be calibrated and validated via Modbus if the Cell Density Integration Kit mode is enabled (see Chapter 9.2.6).

Since calibration and validation are both procedures with multiple steps involved, an individual state machine that can be controlled via Modbus is used for the four use cases:

- Calibration of Incyte Unit
- Validation of Incyte Unit
- Calibration of Dencytee Unit
- Validation of Dencytee Unit

12.1.2.6.1 General Concepts

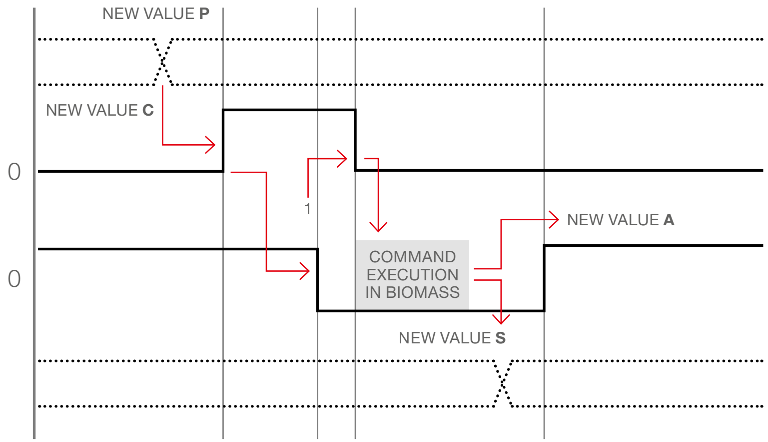
12.1.2.6.1.1 Controlling the State Machine via Modbus

Parameter Modbus Master

Command Modbus Master

Acknoledge Control Unit

State Control Unit



Default value for **P** is **0** / Default value for **A** is **1**

CONNECTION OF THE CONTROL UNIT
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The state machine of one measurement channel can be controlled using four Modbus registers.

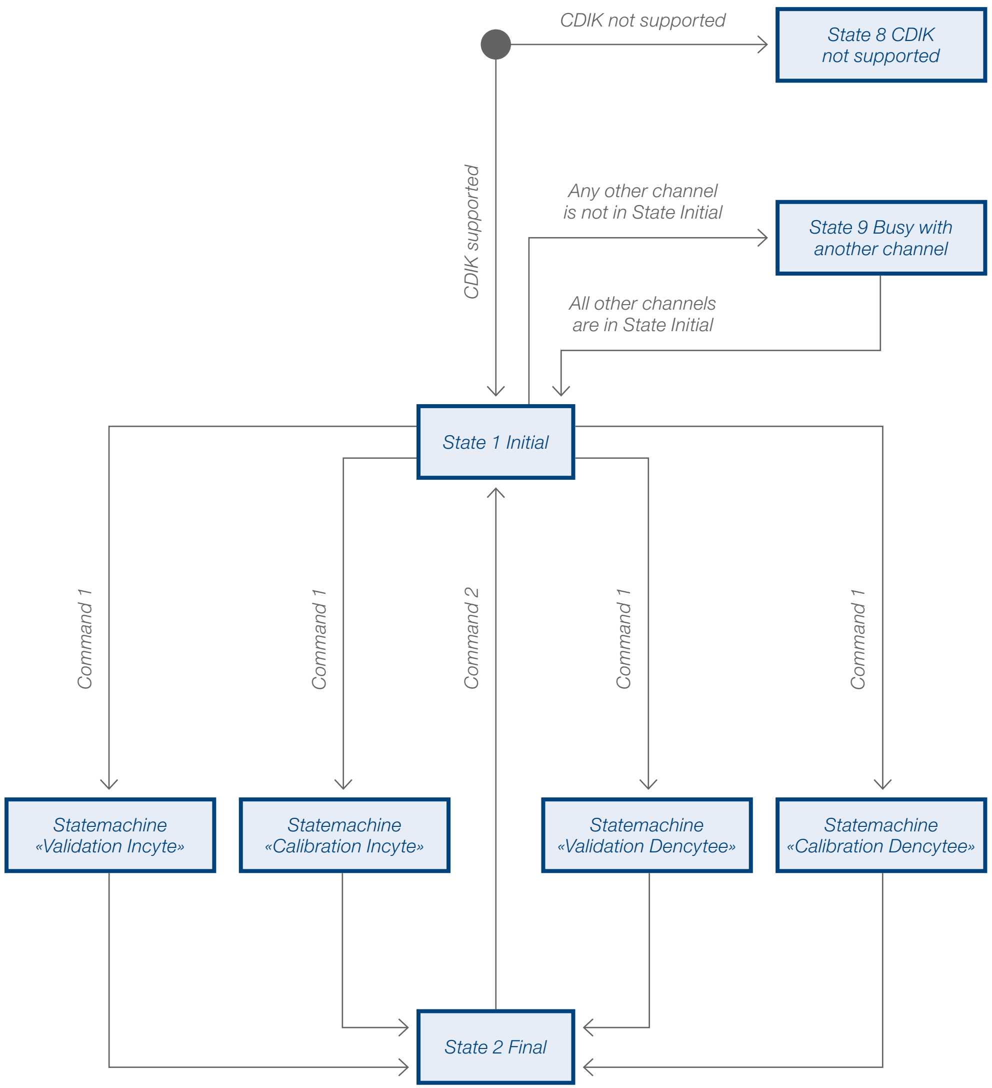
- Parameter: Register for passing an input argument to the state machine (e.g. nominal conductivity of currently used calibration standard)
- Command: Register for command codes that trigger state transitions in the state machine.
- Acknowledge: Status register controlled by the software in order to signal the state of processing the command.
- State: Register that returns the current state of the state machine

A state transition involves the following typical steps:

- Modbus Master writes the parameter (if required)
- Modbus Master writes the command; the software confirms reception of the command by setting Acknowledge to 0.
- Modbus Master resets the command to 0 in order to start execution of the command in the software.
- Once execution of a command is finished, the software writes the new state to the State register and resets the Acknowledge register to 1 in order to indicate readiness for a new command.

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.6.1.2 The main state machine



The main state machine for every single measurement channel looks as depicted in this chapter. If CDIK mode is switched off when starting the software, the state machine will transition automatically to state 8 “not supported”. If CDIK (Cell Density Integration Kit) mode is switched on when starting the software, the state machine will be in state 1 “Initial”.

At any time only one calibration or validation process on one channel can be active. As soon as a calibration or validation on any measurement channel is started, the state machines of the other channels will automatically transition to state 9 “Busy with another channel”.

Every calibration / validation has a specific sub-state machine that will be described in chapters 12.1.2.6.2 – 12.1.2.6.5.

When the calibration or validation is completed the state machine of the corresponding measurement channel will be in state 2 “Final”. After resetting the state machine to state 1 “Initial” the state machines of the other measurement channels will transition automatically from state 9 “Busy” to 1 “Initial”.

State	Command	Next State	Description
1	1	10	Start a calibration or validation. The command code is always 1, the sensor type and the action (validation or calibration) is specified by selecting the corresponding Modbus register (see Chapter 12.1.2.6.1.3). Make sure the sensor is connected to the Pre-amplifier
2	2	1	Reset the state machine to the initial state in order to resume normal operation
8	–		Not Supported: CDIK mode is switched off
9	–		Busy: A calibration/validation is active on another measurement channel

12.1.2.6.1.3 Modbus registers for CDIK, Arc View Controller 265 and PC software

The following table defines the Modbus registers used for controlling the state machines for the two measurement channels depending on the type of sensor and action (calibration or validation).

Note that Parameter and Command have to be read and written as Modbus Holding Registers (Modbus function codes 0x03 and 0x10). Acknowledge and State have to be read as Modbus Input Registers (Modbus function code 0x04).

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

	Parameter (Holding Reg.)	Command (Holding Reg.)	Acknowledge (Input Reg.)	State (Input Reg.)
Channel 1				
Validation Incyte	12	11	38	39
Calibration Incyte	14	13	40	41
Validation Dencytee	44	43	388	389
Calibration Dencytee	46	45	390	391
Channel 2				
Validation Incyte	28	27	84	85
Calibration Incyte	30	29	86	87
Validation Dencytee	60	59	435	436
Calibration Dencytee	62	61	437	438

12.1.2.6.1.4 Modbus registers for Arc View Controller 465

The following table defines the Modbus registers used for controlling the state machines for the four measurement channels depending on the type of sensor and action (calibration or validation).

Note that Parameter and Command have to be read and written as Modbus Holding Registers (Modbus function codes 0x03 and 0x10). Acknowledge and State have to be read as Modbus Input Registers (Modbus function code 0x04).

	Parameter (Holding Reg.)	Command (Holding Reg.)	Acknowledge (Input Reg.)	State (Input Reg.)
Channel 1				
Validation Incyte	12	11	38	39
Calibration Incyte	14	13	40	41
Validation Dencytee	82	81	730	731
Calibration Dencytee	84	83	732	733
Channel 2				
Validation Incyte	28	27	84	85
Calibration Incyte	30	29	86	87
Validation Dencytee	98	97	777	778
Calibration Dencytee	100	99	779	780

	Parameter (Holding Reg.)	Command (Holding Reg.)	Acknowledge (Input Reg.)	State (Input Reg.)
Channel 3				
Validation Incyte	44	43	130	131
Calibration Incyte	46	45	132	133
Validation Dencytee	114	113	824	825
Calibration Dencytee	116	115	826	827
Channel 4				
Validation Incyte	60	59	176	177
Calibration Incyte	62	61	178	179
Validation Dencytee	130	129	871	872
Calibration Dencytee	132	131	873	874

12.1.2.6.1.5 General error states

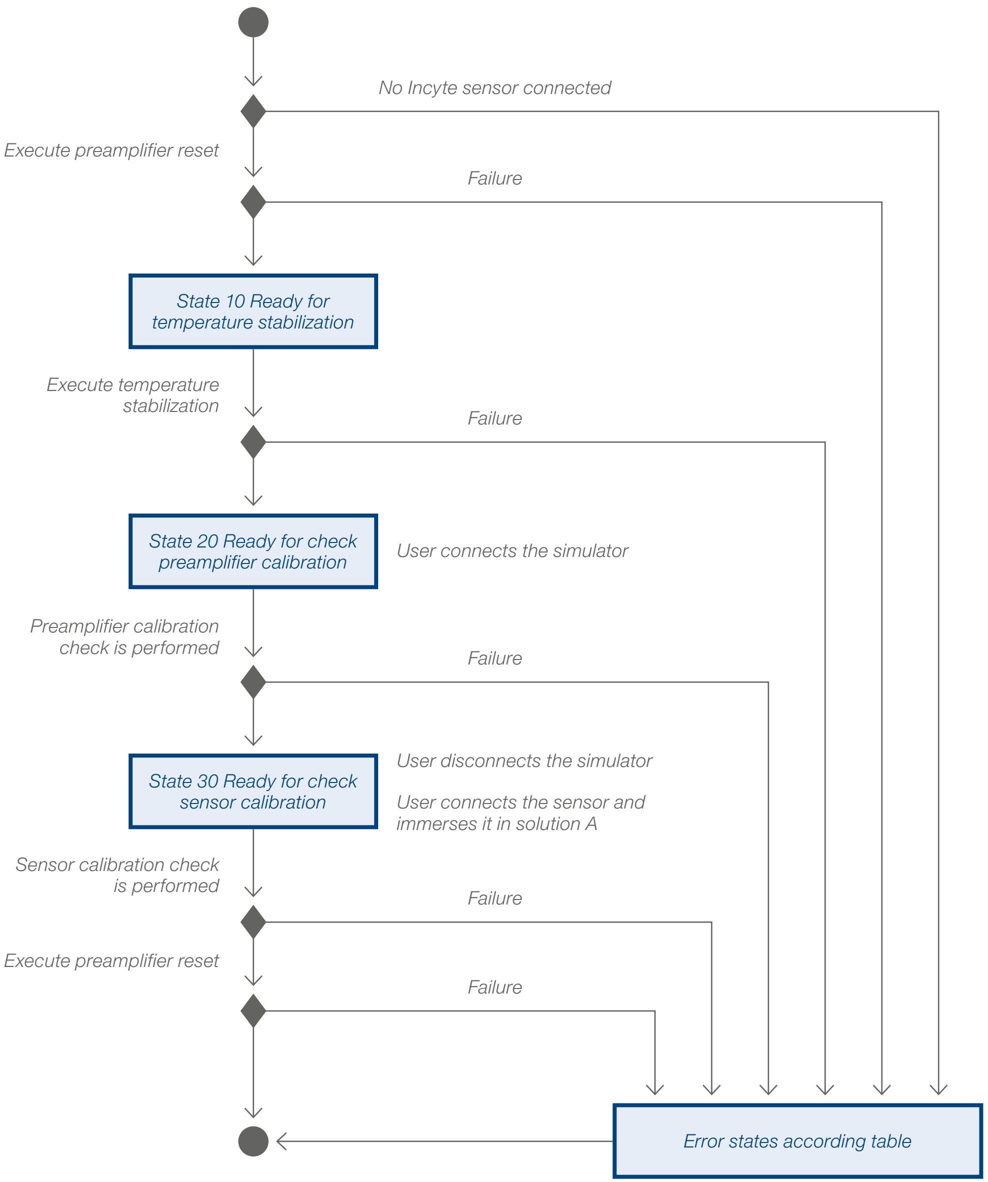
During calibration and validation errors will be indicated by a transition to an error state. Error states have a state number of 900 and above. With command 3 a transition to state 2 “Final” is possible.

In any state if an invalid command is invoked the state machine transitions to state 999 “Invalid command”.

State	Command	Next State	Description
9xx	3	2	States numbered from 900 to 999 are error states. The command 3 “Cancel” transitions from any error state to the state 2 “Final”. Some error states allow repeating the step that has led to the error. This will be mentioned in the corresponding error state description
900	3	2	Wrong sensor type
997	3	2	Error while resetting the sensor or preamplifier
998	3	2	Generic error while communicating with the sensor / preamplifier
999	3	2	Invalid command

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.6.2 Validation Incyte Unit



12.1.2.6.2.1 Table of states

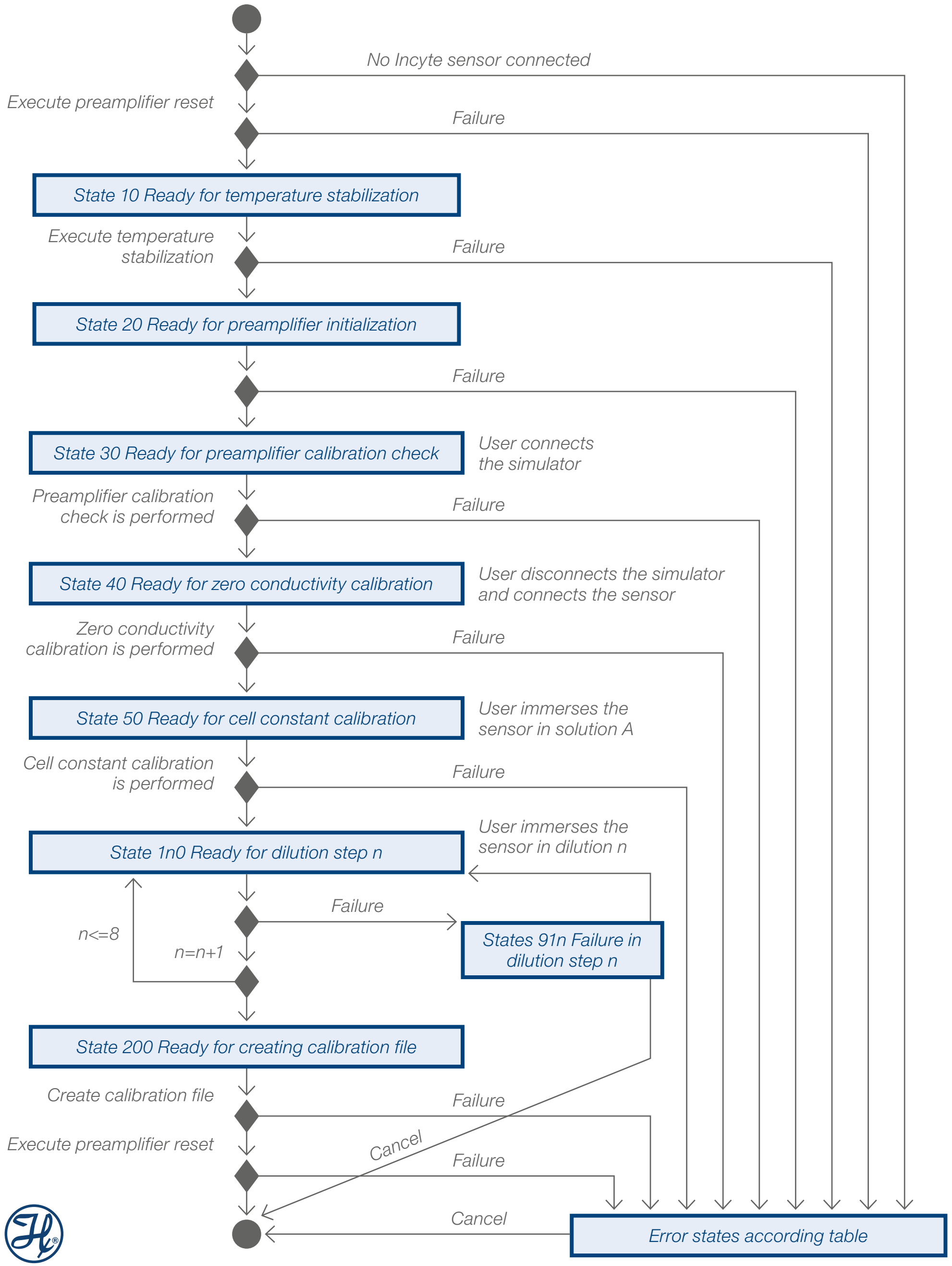
State	Command	Next State	Description
10	10	20	Temperature stabilization of the preamplifier
20			User has to connect the Incyte simulator to the preamplifer
20	20	30	Calibration check of the preamplifier
30			User disconnects the Incyte simulator and connects the Incyte sensor. The sensor is immersed in solution A. The conductivity of solution A at the current temperature has to be determined using the table on the bottle
30	30	2	Check sensor calibration **Parameter:** conductivity of solution A at current temperature The conductivity has to be written as a 16 Bit integer value in the unit µS/cm to the corresponding Modbus register
2			The user removes the sensor from Solution A

12.1.2.6.2.2 Error states

State	Command	Next State	Description
901	3	2	Error while reading the preamplifier's temperature
902	3	2	Preamplifier temperature is out of specified range
903	3	2	Preamplifier temperature is not stable
904	3	2	Preamplifier calibration is invalid
905	3	2	Sensor/Preamplifier is not calibrated
920	3	2	Preamplifier/sensor calibration is invalid

CONNECTION OF THE CONTROL UNIT
TO THE PROCESS CONTROL SYSTEM

12.1.2.6.3 Calibration Incyte Unit



12.1.2.6.3.1 Table of states

State	Command	Next State	Description
10	10	20	Temperature stabilization of the preamplifier. **Acknowledge**: The type of calibration is returned 1 = Standard 2 = High conductivity 3 = Low conductivity
20	20	30	Initialize Preamplifier
30			User has to connect the Incyte simulator to the preamplifer
30	30	40	Calibration check of the preamplifier
40			User disconnects the Incyte simulator and connects the Incyte sensor
40	40	50	Calibrate zero conductivity in air
50			The sensor is immersed in solution A. The conductivity of solution A at the current temperature has to be determined using the table on the bottle
50	50	110	Calibration of cell constant **Parameter:** conductivity of solution A at current temperature The conductivity has to be written as a 16 Bit integer value in the unit µS/cm to the corresponding Modbus register
110			The user immerses the sensor in de-ionized water and adds solution B according the calibration type (see 12.1.2.6.3.2)
110	110	120	Calibration of dilution step 1. If this step fails, it can be repeated (see 12.1.2.6.3.3)
120			User adds solution B according the calibration type (see 12.1.2.6.3.2)
120	120	130	Calibration of dilution step 2. If this step fails, it can be repeated (see 12.1.2.6.3.3)
130			User adds solution B according the calibration type (see 12.1.2.6.3.2)
			…
180			User adds solution B according the calibration type (see 12.1.2.6.3.2)
180	180	200	Calibration of dilution step 8. If this step fails, it can be repeated (see 12.1.2.6.3.3)
200			The user removes the sensor from Solution B
200	200	2	Calibration file is created

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.6.3.2 Dilution steps for different calibration types

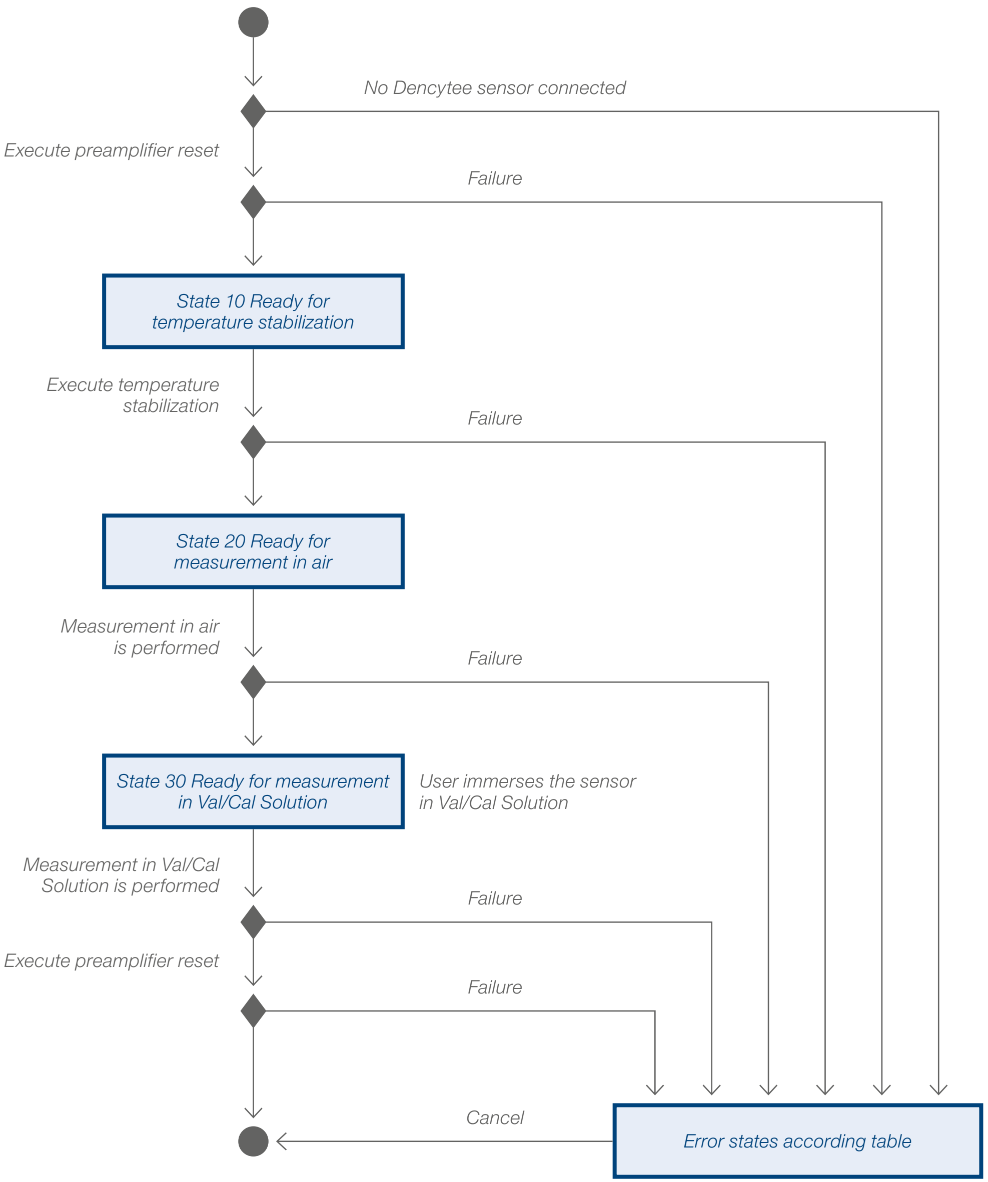
Part of the Incyte calibration is a series of measurements in different conductivity dilutions. Solution B is added to a beaker with 150ml de-ionized water in 8 steps according the following table. The dose is specific for the calibration type of the Incyte unit (can be read in state 10, see Chapter 12.1.2.6.3.1)

	Addition of Solution B per dilution step [ml]		
	Standard calibration	**High conductivity calibration**	**Low conductivity calibration**
Dilution step 1	1	1	0.5
Dilution step 2	1	2	1
Dilution step 3	2	2	1.5
Dilution step 4	5	5	2
Dilution step 5	10	15	5
Dilution step 6	20	20	10
Dilution step 7	20	30	10
Dilution step 8	30	40	20

12.1.2.6.3.3 Error states

State	Command	Next State	Description
901	3	2	Error while reading the preamplifier's temperature
902	3	2	Preamplifier temperature is out of specified range
903	3	2	Preamplifier temperature is not stable
904	3	2	Preamplifier is not calibrated or calibration is invalid
905	3	2	Error while initializing sensor
906	3	2	Error while calibrating zero conductivity
907	3	2	Conductivity out of range
908	3	2	Calibration in conductivity standard failed
909	3	2	Failure in dilution step 1. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	110	
910	3	2	Failure in dilution step 2. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	120	
911	3	2	Failure in dilution step 3. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	130	
912	3	2	Failure in dilution step 4. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	140	
913	3	2	Failure in dilution step 5. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	150	
914	3	2	Failure in dilution step 6. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	160	
915	3	2	Failure in dilution step 7. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	170	
916	3	2	Failure in dilution step 8. Incyte calibration can be cancelled with command 3. Dilution step can be repeated with command 4
	4	180	
917	3	2	Conductivity is not stable
918	3	2	Error while writing calibration file

12.1.2.6.4 Validation Dencytee



12.1.2.6.4.1 Table of states

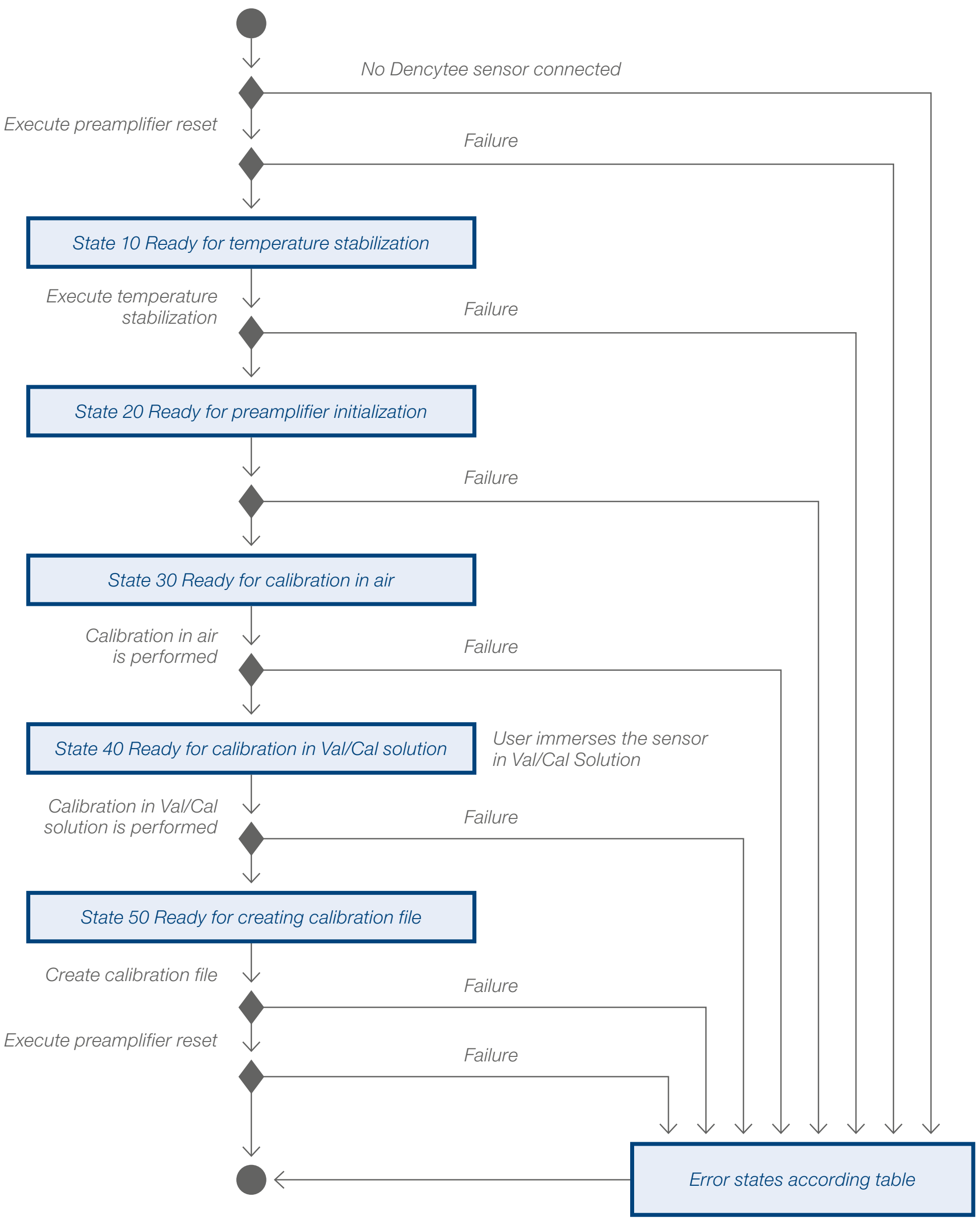
State	Command	Next State	Description
10	10	20	Temperature stabilization of the preamplifier
20			Make sure the light path is clean, dust-free and dark
20	20	30	Measurement in air
30			User immerses the sensor in the Val/Cal Solution OD
30	30	2	Measurement in Val/Cal Solution
2			User removes the sensor from Val/Cal Solution

12.1.2.6.4.2 Error states

State	Command	Next State	Description
920	3	2	Error while reading the preamplifier's temperature
921	3	2	Preamplifier temperature is out of specified range
922	3	2	Preamplifier temperature is not stable
923	3	2	External interference light detected
928	3	2	Error while measuring in air
929	3	2	Error while measuring in Val/Cal solution
930	3	2	Preamplifier/sensor calibration is invalid

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.6.5 Calibration Dencytee



12.1.2.6.5.1 Table of states

State	Command	Next State	Description
10	10	20	Temperature stabilization of the preamplifier
20	20	30	Initialize Preamplifier
30			Make sure the light path is clean, dust-free and dark
30	30	40	Calibration in air
40			User immerses the sensor in the Val/Cal Solution OD
40	40	50	Calibration in Val/Cal Solution
50			User removes the sensor from Val/Cal Solution
50	50	2	Calibration file is created

12.1.2.6.5.2 Error states

State	Command	Next State	Description
920	3	2	Error while reading the preamplifier's temperature
921	3	2	Preamplifier temperature is out of specified range
922	3	2	Preamplifier temperature is not stable
923	3	2	External interference light detected
924	3	2	Error while initializing sensor
925	3	2	Error while calibrating in air
926	3	2	Error while calibrating in Val/Cal Solution
927	3	2	Error while writing calibration file

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12.1.2.7 Modbus Tables Arc View Controller 265, ComBox and Cell Density Integration Kit

12.1.2.7.1 Input Registers Tables (Read only)

12.1.2.7.1.1 Read the Modbus Commands

All measurements and readable information which comes from the sensors are memorized in the Modbus input registers table. The Modbus function code 0x04 is used to read this table. It allows reading 1 to 125 contiguous input registers from the Control Unit. The request specifies the starting address and the number of registers to be read. In the Modbus frame, registers are addressed starting at zero. For example, input registers numbered 1-16 are addressed as 0-15 inside the frame.

12.1.2.7.1.2 Incyte Input Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Gateway serial number	001		string	6
Measures - Ch 1				
Sensor serial number	007		string	6
Amplifier serial number	013		string	6
Amplifier status	019		word 16bits	1
Conductivity	020	mS/cm	float32	2
Permittivity	022	pF/cm	float32	2
Measure Index	024		unsigned long	2
Amplifier Status - float format	026		float32	2
Reserved	028		float32	2
Reserved	030		float32	2
Reserved	032		float32	2
Reserved	034		float32	2
Reserved	036		float32	2
Acknowledge Val. Incyte	038		word 16bits	1
State Val. Incyte	039		word 16bits	1
Acknowledge Cal. Incyte	040		word 16bits	1
State Cal. Incyte	041		word 16bits	1

Function	Register address	Unit	Data type	Data Size (registers)
Spectro - Ch 1				
DeltaEpsilon	042		float32	2
Fc	044		float32	2
Alpha	046		float32	2
FscanEpsilon	048		float32	2
Spectro index	050		unsigned long	2
Reserved	052		Word 16bits	1
Measures - Ch 2				
Sensor serial number	053		string	6
Amplifier serial number	059		string	6
Amplifier status	065		word 16bits	1
Conductivity	066	mS/cm	float32	2
Permittivity	068	pF/cm	float32	2
Measure Index	070		unsigned long	2
Amplifier Status - float format	072		float32	2
Reserved	074		float32	2
Reserved	076		float32	2
Reserved	078		float32	2
Reserved	080		float32	2
Reserved	082		float32	2
Acknowledge Val. Incyte	084		word 16bits	1
State Val. Incyte	085		word 16bits	1
Acknowledge Cal. Incyte	086		word 16bits	1
State Cal. Incyte	087		word 16bits	1
Spectro - Ch 2				
DeltaEpsilon	088		float32	2
Fc	090		float32	2
Alpha	092		float32	2
FscanEpsilon	094		float32	2
Spectro index	096		float32 / ul	2
Reserved	098		word 16bits	1
Info-Fscan-Ch1				
Reserved	99		word 16bits	1

Function	Register address	Unit	Data type	Data Size (registers)
Reserved	100		word 16bits	1
Reserved	101		word 16bits	1
index-Fscan-ch1	102		unsigned long	2
Freq-FSCAN-Ch1(30 points)				
Scan-Freq-Pt0	104	Hz	float 32 bits	2
Scan-Freq-Pt1	106	Hz	float 32 bits	2
Scan-Freq-Pt2	108	Hz	float 32 bits	2
Scan-Freq-Pt3	110	Hz	float 32 bits	2
Scan-Freq-Pt4	112	Hz	float 32 bits	2
Scan-Freq-Pt5	114	Hz	float 32 bits	2
Scan-Freq-Pt6	116	Hz	float 32 bits	2
Scan-Freq-Pt7	118	Hz	float 32 bits	2
Scan-Freq-Pt8	120	Hz	float 32 bits	2
Scan-Freq-Pt9	122	Hz	float 32 bits	2
Scan-Freq-Pt10	124	Hz	float 32 bits	2
Scan-Freq-Pt11	126	Hz	float 32 bits	2
Scan-Freq-Pt12	128	Hz	float 32 bits	2
Scan-Freq-Pt13	130	Hz	float 32 bits	2
Scan-Freq-Pt14	132	Hz	float 32 bits	2
Scan-Freq-Pt15	134	Hz	float 32 bits	2
Scan-Freq-Pt16	136	Hz	float 32 bits	2
Scan-Freq-Pt17	138	Hz	float 32 bits	2
Scan-Freq-Pt18	140	Hz	float 32 bits	2
Scan-Freq-Pt19	142	Hz	float 32 bits	2
Scan-Freq-Pt20	144	Hz	float 32 bits	2
Scan-Freq-Pt21	146	Hz	float 32 bits	2
Scan-Freq-Pt22	148	Hz	float 32 bits	2
Scan-Freq-Pt23	150	Hz	float 32 bits	2
Scan-Freq-Pt24	152	Hz	float 32 bits	2
Scan-Freq-Pt25	154	Hz	float 32 bits	2
Scan-Freq-Pt26	156	Hz	float 32 bits	2
Scan-Freq-Pt27	158	Hz	float 32 bits	2
Scan-Freq-Pt28	160	Hz	float 32 bits	2

Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt29	162	Hz	float 32 bits	2
C(f)-FSCAN-Ch1(30 points)				
Scan-C(f)-Pt0	164	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	166	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	168	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	170	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	172	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	174	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	176	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	178	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	180	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	182	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	184	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	186	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	188	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	190	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	192	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	194	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	196	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	198	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	200	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	202	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	204	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	206	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	208	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	210	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	212	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	214	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	216	pF/cm	float 32 bits	2
Scan-C(f)-Pt27	218	pF/cm	float 32 bits	2
Scan-C(f)-Pt28	220	pF/cm	float 32 bits	2
Scan-C(f)-Pt29	222	pF/cm	float 32 bits	2
Info-Fscan-Ch2				

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Function	Register address	Unit	Data type	Data Size (registers)
Reserved	224		word 16bits	1
Reserved	225		word 16bits	1
Reserved	226		word 16bits	1
index-Fscan-ch2	227		unsigned long	2
Freq-FSCAN-Ch2(30 points)				
Scan-Freq-Pt0	229	Hz	float 32 bits	2
Scan-Freq-Pt1	231	Hz	float 32 bits	2
Scan-Freq-Pt2	233	Hz	float 32 bits	2
Scan-Freq-Pt3	235	Hz	float 32 bits	2
Scan-Freq-Pt4	237	Hz	float 32 bits	2
Scan-Freq-Pt5	239	Hz	float 32 bits	2
Scan-Freq-Pt6	241	Hz	float 32 bits	2
Scan-Freq-Pt7	243	Hz	float 32 bits	2
Scan-Freq-Pt8	245	Hz	float 32 bits	2
Scan-Freq-Pt9	247	Hz	float 32 bits	2
Scan-Freq-Pt10	249	Hz	float 32 bits	2
Scan-Freq-Pt11	251	Hz	float 32 bits	2
Scan-Freq-Pt12	253	Hz	float 32 bits	2
Scan-Freq-Pt13	255	Hz	float 32 bits	2
Scan-Freq-Pt14	257	Hz	float 32 bits	2
Scan-Freq-Pt15	259	Hz	float 32 bits	2
Scan-Freq-Pt16	261	Hz	float 32 bits	2
Scan-Freq-Pt17	263	Hz	float 32 bits	2
Scan-Freq-Pt18	265	Hz	float 32 bits	2
Scan-Freq-Pt19	267	Hz	float 32 bits	2
Scan-Freq-Pt20	269	Hz	float 32 bits	2
Scan-Freq-Pt21	271	Hz	float 32 bits	2
Scan-Freq-Pt22	273	Hz	float 32 bits	2
Scan-Freq-Pt23	275	Hz	float 32 bits	2
Scan-Freq-Pt24	277	Hz	float 32 bits	2
Scan-Freq-Pt25	279	Hz	float 32 bits	2
Scan-Freq-Pt26	281	Hz	float 32 bits	2
Scan-Freq-Pt27	283	Hz	float 32 bits	2

Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt28	285	Hz	float 32 bits	2
Scan-Freq-Pt29	287	Hz	float 32 bits	2
C(f)-FSCAN-Ch2(30 points)				
Scan-C(f)-Pt0	289	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	291	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	293	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	295	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	297	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	299	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	301	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	303	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	305	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	307	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	309	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	311	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	313	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	315	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	317	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	319	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	321	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	323	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	325	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	327	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	329	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	331	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	333	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	335	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	337	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	339	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	341	pF/cm	float 32 bits	2
Scan-C(f)-Pt27	343	pF/cm	float 32 bits	2
Scan-C(f)-Pt28	345	pF/cm	float 32 bits	2
Scan-C(f)-Pt29	347	pF/cm	float 32 bits	2

Table 6: Incyte Input Registers.

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12.1.2.7.1.3 Dencytee Input Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Gateway serial number	351		string	6
Measures - Ch 1				
Sensor serial number	357		string	6
Amplifier serial number	363		string	6
Amplifier status	369		word 16 bits	1
Reserved	370		float 32	2
Biomass	372		float 32	2
Measure Index	374		unsigned long	2
Amplifier Status – float format	376		float 32	2
Reserved	378		float 32	2
Reserved	380		float 32	2
Reserved	382		float 32	2
Reserved	384		float 32	2
Reserved	386		float 32	2
Acknowledge Val. Dencytee	388		word 16 bits	1
State Val. Dencytee	389		word 16 bits	1
Acknowledge Cal. Dencytee	390		word 16 bits	1
State Cal. Dencytee	391		word 16 bits	1
Reserved	392		float32	2
Reserved	394		float 32	2
Reserved	396		float 32	2
Reserved	398		float 32	2
Reserved	400		float 32	2
Reserved	402		float 32	2
Measures - Ch 2				
Sensor serial number	404		string	6
Amplifier serial number	410		string	6
Amplifier status	416		word 16 bits	1
Reserved	417		float 32	2
Biomass	419		float 32	2
Measure Index	421		unsigned long	2
Amplifier Status – float format	423		float 32	2
Reserved	425		float 32	2
Reserved	427		float 32	2
Reserved	429		float 32	2
Reserved	431		float 32	2
Reserved	433		float 32	2
Acknowledge Val. Dencytee	435		word 16 bits	1
State Val. Dencytee	436		word 16 bits	1
Acknowledge Cal. Dencytee	437		word 16 bits	1
State Cal. Dencytee	438		word 16 bits	1
Reserved	439		float32	2
Reserved	441		float 32	2
Reserved	443		float 32	2
Reserved	445		float 32	2
Reserved	447		float 32	2
Reserved	449		float 32	2

Table 7: Dencytee input register.

12.1.2.7.2 Holding Registers (read and write)

12.1.2.7.2.1 Read and Write Function Code

Writing holding registers allow changing configuration and performs several actions.

- Use 0x06 standard function code to write single holding register.

This function code is used to write a single holding register in the Control Unit. The Request PDU specifies the address of the register to be written. Registers are addressed starting at zero. Therefore register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the register contents have been written.

- Use 0x10 standard function code to write holding registers.

This function code is used to write a block of contiguous registers (1 to 123 registers) in the

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Control Unit. The data to be written is specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

- Use 0x03 standard function code to read Holding Registers

This function code is used to read the contents of a contiguous block of holding registers in the Control Unit. The Request PDU specifies the starting register address and the number of registers. In the PDU registers are addressed starting at zero. Therefore registers numbered 1-16 are addressed as 0-15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte.

12.1.2.7.2.2 Incyte Holding Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Channel 1				
Mark Zero auto	1		word 16bits	1
Clear Zero auto	2		word 16bits	1
Recepy number Unit Factor	3		word 16bits	1
Recepy number Measure Mode	4		word 16bits	1
Activate Manual Cleaning	5		word 16bits	1
Activate auto Cleaning	6		word 16bits	1
Recepy number Cleaning	7		word 16bits	1
Reserved	8		word 16bits	1
Offset zero	9	pF/cm	Float 32bits	2
Command Val. Incyte	11		word 16bits	1
Parameter Val. Incyte	12		word 16bits	1
Command Cal. Incyte	13		word 16bits	1
Parameter Cal. Incyte	14		word 16bits	1
Reserved	15		word 16bits	1
Reserved	16		word 16bits	1
Channel 2				
Mark Zero auto	17		word 16bits	1
Clear Zero auto	18		word 16bits	1
Recepy number Unit Factor	19		word 16bits	1
Recepy number Measure Mode	20		word 16bits	1
Activate Manual Cleaning	21		word 16bits	1
Activate auto Cleaning	22		word 16bits	1
Recepy number Cleaning	23		word 16bits	1
Reserved	24		word 16bits	1
Offset zero	25	pF/cm	Float 32bits	2
Command Val. Incyte	27		word 16bits	1
Parameter Val. Incyte	28		word 16bits	1
Command Cal. Incyte	29		word 16bits	1
Parameter Cal. Incyte	30		word 16bits	1
Reserved	31		word 16bits	1
Reserved	32		word 16bits	1

Table 8: Incyte holding registers table.

12.1.2.7.2.3 Dencytee Holding Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Channel 1				
Mark Zero auto	33		word 16bits	1
Clear Zero auto	34		word 16bits	1
Recepy number Unit Factor	35		word 16bits	1
Recepy number Measure Mode	36		word 16bits	1
Reserved	37		word 16bits	1
Reserved	38		word 16bits	1
Reserved	39		word 16bits	1
Reserved	40		word 16bits	1
Offset zero	41	pF/cm	Float 32bits	2
Command Val. Dencytee	43		word 16bits	1

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Function	Register address	Unit	Data type	Data Size (registers)
Parameter Val. Dencytee	44		word 16bits	1
Command Cal. Dencytee	45		word 16bits	1
Parameter Cal. Dencytee	46		word 16bits	1
Reserved	47		word 16bits	1
Reserved	48		word 16bits	1
Channel 2				
Mark Zero auto	49		word 16bits	1
Clear Zero auto	50		word 16bits	1
Recepy number Unit Factor	51		word 16bits	1
Recepy number Measure Mode	52		word 16bits	1
Reserved	53		word 16bits	1
Reserved	54		word 16bits	1
Reserved	55		word 16bits	1
Reserved	56		word 16bits	1
Offset zero	57	pF/cm	Float 32bits	2
Command Val. Dencytee	59		word 16bits	1
Parameter Val. Dencytee	60		word 16bits	1
Command Cal. Dencytee	61		word 16bits	1
Parameter Cal. Dencytee	62		word 16bits	1
Reserved	63		word 16bits	1
Reserved	64		word 16bits	1

Table 9: Dencytee holding registers table.

12.1.2.7.2.4 Allowed Values for Holding Registers

Only the following values may be written in the holding registers:

Register Name	Value(s)
Mark Zero	1
Clear Zero	1
Activate Auto Cleaning	0 to 1
Recipe Number Unit Factor	0 to 8
Recipe Number Measure Mode	0 to 3
Recipe Number Cleaning	0 to 1

Table 10: Allowed values for holding registers.

12.1.2.8 Modbus Tables Arc View Controller 465 (XL)

12.1.2.8.1 Input Registers Tables (Read only)

12.1.2.8.1.1 Read the Modbus Commands

All measurements and readable information which comes from the sensors are memorized in the Modbus input registers table. The Modbus function code 0x04 is used to read this table. It allows reading 1 to 125 contiguous input registers from the Arc View Controller. The request specifies the starting address and the number of registers to be read. In the Modbus frame, registers are addressed starting at zero. For example, input registers numbered 1-16 are addressed as 0-15 inside the frame.

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.1.2.8.1.2 Incyte Input Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Gateway serial number	001		string	6
Measures - Ch 1				
Sensor serial number	007		string	6
Amplifier serial number	013		string	6
Amplifier status	019		word 16bits	1
Conductivity	020	mS/cm	float32	2
Permittivity	022	pF/cm	float32	2
Measure Index	024		unsigned long	2
Amplifier Status - float format	026		float32	2
Reserved	028		float32	2
Reserved	030		float32	2
Reserved	032		float32	2
Reserved	034		float32	2
Reserved	036		float32	2
Acknowledge Val. Incyte	038		word 16bits	1
State Val. Incyte	039		word 16bits	1
Acknowledge Cal. Incyte	040		word 16bits	1
State Cal. Incyte	041		word 16bits	1
Spectro - Ch 1				
DeltaEpsilon	042		float32	2
Fc	044		float32	2
Alpha	046		float32	2
FscanEpsilon	048		float32	2
Spectro index	050		unsigned long	2
Reserved	052		Word 16bits	1
Measures - Ch 2				
Sensor serial number	053		string	6
Amplifier serial number	059		string	6
Amplifier status	065		word 16bits	1
Conductivity	066	mS/cm	float32	2
Permittivity	068	pF/cm	float32	2

Function	Register address	Unit	Data type	Data Size (registers)
Measure Index	070		unsigned long	2
Amplifier Status - float format	072		float32	2
Reserved	074		float32	2
Reserved	076		float32	2
Reserved	078		float32	2
Reserved	080		float32	2
Reserved	082		float32	2
Acknowledge Val. Incyte	084		word 16bits	1
State Val. Incyte	085		word 16bits	1
Acknowledge Cal. Incyte	086		word 16bits	1
State Cal. Incyte	087		word 16bits	1
Spectro - Ch 2				
DeltaEpsilon	088		float32	2
Fc	090		float32	2
Alpha	092		float32	2
FscanEpsilon	094		float32	2
Spectro index	096		float32 / ul	2
Reserved	098		word 16bits	1
Measures - Ch 3				
Sensor serial number	099		string	6
Amplifier serial number	105		string	6
Amplifier status	111		word 16bits	1
Conductivity	112	mS/cm	float32	2
Permittivity	114	pF/cm	float32	2
Measure Index	116		unsigned long	2
Amplifier Status - float format	118		float32	2
Reserved	120		float32	2
Reserved	122		float32	2
Reserved	124		float32	2
Reserved	126		float32	2
Reserved	128		float32	2
Acknowledge Val. Incyte	130		word 16bits	1
State Val. Incyte	131		word 16bits	1

Function	Register address	Unit	Data type	Data Size (registers)
Acknowledge Cal. Incyte	132		word 16bits	1
State Cal. Incyte	133		word 16bits	1
Spectro - Ch 3				
DeltaEpsilon	134		float32	2
Fc	136		float32	2
Alpha	138		float32	2
FscanEpsilon	140		float32	2
Spectro index	142		unsigned long	2
Reserved	144		Word 16bits	1
Measures - Ch 4				
Sensor serial number	145		string	6
Amplifier serial number	151		string	6
Amplifier status	157		word 16bits	1
Conductivity	158	mS/cm	float32	2
Permittivity	160	pF/cm	float32	2
Measure Index	162		unsigned long	2
Amplifier Status - float format	164		float32	2
Reserved	166		float32	2
Reserved	168		float32	2
Reserved	170		float32	2
Reserved	172		float32	2
Reserved	174		float32	2
Acknowledge Val. Incyte	176		word 16bits	1
State Val. Incyte	177		word 16bits	1
Acknowledge Cal. Incyte	178		word 16bits	1
State Cal. Incyte	179		word 16bits	1
Spectro - Ch 4				
DeltaEpsilon	180		float32	2
Fc	182		float32	2
Alpha	184		float32	2
FscanEpsilon	186		float32	2
Spectro index	188		unsigned long	2
Reserved	190		Word 16bits	1

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Function	Register address	Unit	Data type	Data Size (registers)
Info-Fscan-Ch1				
Reserved	191		word 16bits	1
Reserved	192		word 16bits	1
Reserved	193		word 16bits	1
index-Fscan-ch1	194		unsigned long	2
Freq-FSCAN-Ch1(30 points)				
Scan-Freq-Pt0	196	Hz	float 32 bits	2
Scan-Freq-Pt1	198	Hz	float 32 bits	2
Scan-Freq-Pt2	200	Hz	float 32 bits	2
Scan-Freq-Pt3	202	Hz	float 32 bits	2
Scan-Freq-Pt4	204	Hz	float 32 bits	2
Scan-Freq-Pt5	206	Hz	float 32 bits	2
Scan-Freq-Pt6	208	Hz	float 32 bits	2
Scan-Freq-Pt7	210	Hz	float 32 bits	2
Scan-Freq-Pt8	212	Hz	float 32 bits	2
Scan-Freq-Pt9	214	Hz	float 32 bits	2
Scan-Freq-Pt10	216	Hz	float 32 bits	2
Scan-Freq-Pt11	218	Hz	float 32 bits	2
Scan-Freq-Pt12	220	Hz	float 32 bits	2
Scan-Freq-Pt13	222	Hz	float 32 bits	2
Scan-Freq-Pt14	224	Hz	float 32 bits	2
Scan-Freq-Pt15	226	Hz	float 32 bits	2
Scan-Freq-Pt16	228	Hz	float 32 bits	2
Scan-Freq-Pt17	230	Hz	float 32 bits	2
Scan-Freq-Pt18	232	Hz	float 32 bits	2
Scan-Freq-Pt19	234	Hz	float 32 bits	2
Scan-Freq-Pt20	236	Hz	float 32 bits	2
Scan-Freq-Pt21	238	Hz	float 32 bits	2
Scan-Freq-Pt22	240	Hz	float 32 bits	2
Scan-Freq-Pt23	242	Hz	float 32 bits	2
Scan-Freq-Pt24	244	Hz	float 32 bits	2
Scan-Freq-Pt25	246	Hz	float 32 bits	2
Scan-Freq-Pt26	248	Hz	float 32 bits	2

Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt27	250	Hz	float 32 bits	2
Scan-Freq-Pt28	252	Hz	float 32 bits	2
Scan-Freq-Pt29	254	Hz	float 32 bits	2
C(f)-FSCAN-Ch1(30 points)				
Scan-C(f)-Pt0	256	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	258	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	260	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	262	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	264	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	266	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	268	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	270	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	272	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	274	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	276	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	278	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	280	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	282	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	284	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	286	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	288	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	290	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	292	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	294	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	296	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	298	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	300	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	302	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	304	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	306	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	308	pF/cm	float 32 bits	2
Scan-C(f)-Pt27	310	pF/cm	float 32 bits	2
Scan-C(f)-Pt28	312	pF/cm	float 32 bits	2

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Function	Register address	Unit	Data type	Data Size (registers)
Scan-C(f)-Pt29	314	pF/cm	float 32 bits	2
Info-Fscan-Ch2				
Reserved	316		word 16bits	1
Reserved	317		word 16bits	1
Reserved	318		word 16bits	1
index-Fscan-ch2	319		unsigned long	2
Freq-FSCAN-Ch2(30 points)				
Scan-Freq-Pt0	321	Hz	float 32 bits	2
Scan-Freq-Pt1	323	Hz	float 32 bits	2
Scan-Freq-Pt2	325	Hz	float 32 bits	2
Scan-Freq-Pt3	327	Hz	float 32 bits	2
Scan-Freq-Pt4	329	Hz	float 32 bits	2
Scan-Freq-Pt5	331	Hz	float 32 bits	2
Scan-Freq-Pt6	333	Hz	float 32 bits	2
Scan-Freq-Pt7	335	Hz	float 32 bits	2
Scan-Freq-Pt8	337	Hz	float 32 bits	2
Scan-Freq-Pt9	339	Hz	float 32 bits	2
Scan-Freq-Pt10	341	Hz	float 32 bits	2
Scan-Freq-Pt11	343	Hz	float 32 bits	2
Scan-Freq-Pt12	345	Hz	float 32 bits	2
Scan-Freq-Pt13	347	Hz	float 32 bits	2
Scan-Freq-Pt14	349	Hz	float 32 bits	2
Scan-Freq-Pt15	351	Hz	float 32 bits	2
Scan-Freq-Pt16	353	Hz	float 32 bits	2
Scan-Freq-Pt17	355	Hz	float 32 bits	2
Scan-Freq-Pt18	357	Hz	float 32 bits	2
Scan-Freq-Pt19	359	Hz	float 32 bits	2
Scan-Freq-Pt20	361	Hz	float 32 bits	2
Scan-Freq-Pt21	363	Hz	float 32 bits	2
Scan-Freq-Pt22	365	Hz	float 32 bits	2
Scan-Freq-Pt23	367	Hz	float 32 bits	2
Scan-Freq-Pt24	369	Hz	float 32 bits	2
Scan-Freq-Pt25	371	Hz	float 32 bits	2

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Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt26	373	Hz	float 32 bits	2
Scan-Freq-Pt27	375	Hz	float 32 bits	2
Scan-Freq-Pt28	377	Hz	float 32 bits	2
Scan-Freq-Pt29	379	Hz	float 32 bits	2
C(f)-FSCAN-Ch2(30 points)				
Scan-C(f)-Pt0	381	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	383	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	385	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	387	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	389	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	391	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	393	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	395	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	397	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	399	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	401	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	403	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	405	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	407	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	409	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	411	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	413	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	415	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	417	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	419	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	421	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	423	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	425	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	427	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	429	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	431	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	433	pF/cm	float 32 bits	2
Scan-C(f)-Pt27	435	pF/cm	float 32 bits	2

Function	Register address	Unit	Data type	Data Size (registers)
Scan-C(f)-Pt28	437	pF/cm	float 32 bits	2
Scan-C(f)-Pt29	439	pF/cm	float 32 bits	2
Info-Fscan-Ch3				
Reserved	441		word 16bits	1
Reserved	442		word 16bits	1
Reserved	443		word 16bits	1
index-Fscan-ch1	444		unsigned long	2
Freq-FSCAN-Ch3(30 points)				
Scan-Freq-Pt0	446	Hz	float 32 bits	2
Scan-Freq-Pt1	448	Hz	float 32 bits	2
Scan-Freq-Pt2	450	Hz	float 32 bits	2
Scan-Freq-Pt3	452	Hz	float 32 bits	2
Scan-Freq-Pt4	454	Hz	float 32 bits	2
Scan-Freq-Pt5	456	Hz	float 32 bits	2
Scan-Freq-Pt6	458	Hz	float 32 bits	2
Scan-Freq-Pt7	460	Hz	float 32 bits	2
Scan-Freq-Pt8	462	Hz	float 32 bits	2
Scan-Freq-Pt9	464	Hz	float 32 bits	2
Scan-Freq-Pt10	466	Hz	float 32 bits	2
Scan-Freq-Pt11	468	Hz	float 32 bits	2
Scan-Freq-Pt12	470	Hz	float 32 bits	2
Scan-Freq-Pt13	472	Hz	float 32 bits	2
Scan-Freq-Pt14	474	Hz	float 32 bits	2
Scan-Freq-Pt15	476	Hz	float 32 bits	2
Scan-Freq-Pt16	478	Hz	float 32 bits	2
Scan-Freq-Pt17	480	Hz	float 32 bits	2
Scan-Freq-Pt18	482	Hz	float 32 bits	2
Scan-Freq-Pt19	484	Hz	float 32 bits	2
Scan-Freq-Pt20	486	Hz	float 32 bits	2
Scan-Freq-Pt21	488	Hz	float 32 bits	2
Scan-Freq-Pt22	490	Hz	float 32 bits	2
Scan-Freq-Pt23	492	Hz	float 32 bits	2
Scan-Freq-Pt24	494	Hz	float 32 bits	2

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Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt25	496	Hz	float 32 bits	2
Scan-Freq-Pt26	498	Hz	float 32 bits	2
Scan-Freq-Pt27	500	Hz	float 32 bits	2
Scan-Freq-Pt28	502	Hz	float 32 bits	2
Scan-Freq-Pt29	504	Hz	float 32 bits	2
C(f)-FSCAN-Ch3(30 points)				
Scan-C(f)-Pt0	506	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	508	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	510	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	512	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	514	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	516	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	518	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	520	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	522	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	524	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	526	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	528	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	530	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	532	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	534	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	536	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	538	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	540	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	542	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	544	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	546	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	548	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	550	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	552	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	554	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	556	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	558	pF/cm	float 32 bits	2

Function	Register address	Unit	Data type	Data Size (registers)
Scan-C(f)-Pt27	560	pF/cm	float 32 bits	2
Scan-C(f)-Pt28	562	pF/cm	float 32 bits	2
Scan-C(f)-Pt29	564	pF/cm	float 32 bits	2
Info-Fscan-Ch4				
Reserved	566		word 16bits	1
Reserved	567		word 16bits	1
Reserved	568		word 16bits	1
index-Fscan-ch2	569		unsigned long	2
Freq-FSCAN-Ch4(30 points)				
Scan-Freq-Pt0	571	Hz	float 32 bits	2
Scan-Freq-Pt1	573	Hz	float 32 bits	2
Scan-Freq-Pt2	575	Hz	float 32 bits	2
Scan-Freq-Pt3	577	Hz	float 32 bits	2
Scan-Freq-Pt4	579	Hz	float 32 bits	2
Scan-Freq-Pt5	581	Hz	float 32 bits	2
Scan-Freq-Pt6	583	Hz	float 32 bits	2
Scan-Freq-Pt7	585	Hz	float 32 bits	2
Scan-Freq-Pt8	587	Hz	float 32 bits	2
Scan-Freq-Pt9	589	Hz	float 32 bits	2
Scan-Freq-Pt10	591	Hz	float 32 bits	2
Scan-Freq-Pt11	593	Hz	float 32 bits	2
Scan-Freq-Pt12	595	Hz	float 32 bits	2
Scan-Freq-Pt13	597	Hz	float 32 bits	2
Scan-Freq-Pt14	599	Hz	float 32 bits	2
Scan-Freq-Pt15	601	Hz	float 32 bits	2
Scan-Freq-Pt16	603	Hz	float 32 bits	2
Scan-Freq-Pt17	605	Hz	float 32 bits	2
Scan-Freq-Pt18	607	Hz	float 32 bits	2
Scan-Freq-Pt19	609	Hz	float 32 bits	2
Scan-Freq-Pt20	611	Hz	float 32 bits	2
Scan-Freq-Pt21	613	Hz	float 32 bits	2
Scan-Freq-Pt22	615	Hz	float 32 bits	2
Scan-Freq-Pt23	617	Hz	float 32 bits	2

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Function	Register address	Unit	Data type	Data Size (registers)
Scan-Freq-Pt24	619	Hz	float 32 bits	2
Scan-Freq-Pt25	621	Hz	float 32 bits	2
Scan-Freq-Pt26	623	Hz	float 32 bits	2
Scan-Freq-Pt27	625	Hz	float 32 bits	2
Scan-Freq-Pt28	627	Hz	float 32 bits	2
Scan-Freq-Pt29	629	Hz	float 32 bits	2
C(f)-FSCAN-Ch4(30 points)				
Scan-C(f)-Pt0	631	pF/cm	float 32 bits	2
Scan-C(f)-Pt1	633	pF/cm	float 32 bits	2
Scan-C(f)-Pt2	635	pF/cm	float 32 bits	2
Scan-C(f)-Pt3	637	pF/cm	float 32 bits	2
Scan-C(f)-Pt4	639	pF/cm	float 32 bits	2
Scan-C(f)-Pt5	641	pF/cm	float 32 bits	2
Scan-C(f)-Pt6	643	pF/cm	float 32 bits	2
Scan-C(f)-Pt7	645	pF/cm	float 32 bits	2
Scan-C(f)-Pt8	647	pF/cm	float 32 bits	2
Scan-C(f)-Pt9	649	pF/cm	float 32 bits	2
Scan-C(f)-Pt10	651	pF/cm	float 32 bits	2
Scan-C(f)-Pt11	653	pF/cm	float 32 bits	2
Scan-C(f)-Pt12	655	pF/cm	float 32 bits	2
Scan-C(f)-Pt13	657	pF/cm	float 32 bits	2
Scan-C(f)-Pt14	659	pF/cm	float 32 bits	2
Scan-C(f)-Pt15	661	pF/cm	float 32 bits	2
Scan-C(f)-Pt16	663	pF/cm	float 32 bits	2
Scan-C(f)-Pt17	665	pF/cm	float 32 bits	2
Scan-C(f)-Pt18	667	pF/cm	float 32 bits	2
Scan-C(f)-Pt19	669	pF/cm	float 32 bits	2
Scan-C(f)-Pt20	671	pF/cm	float 32 bits	2
Scan-C(f)-Pt21	673	pF/cm	float 32 bits	2
Scan-C(f)-Pt22	675	pF/cm	float 32 bits	2
Scan-C(f)-Pt23	677	pF/cm	float 32 bits	2
Scan-C(f)-Pt24	679	pF/cm	float 32 bits	2
Scan-C(f)-Pt25	681	pF/cm	float 32 bits	2
Scan-C(f)-Pt26	683	pF/cm	float 32 bits	2
Scan-C(f)-Pt27	685	pF/cm	float 32 bits	2
Scan-C(f)-Pt28	687	pF/cm	float 32 bits	2
Scan-C(f)-Pt29	689	pF/cm	float 32 bits	2

Table 11: Incyte Input Registers.

12.1.2.8.1.3 Dencytee Input Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Gateway serial number	693		string	6
Measures - Ch 1				
Sensor serial number	699		string	6
Amplifier serial number	705		string	6
Amplifier status	711		word 16 bits	1
Reserved	712		float 32	2
Biomass	714		float 32	2
Measure Index	716		unsigned long	2
Amplifier Status – float format	718		float 32	2
Reserved	720		float 32	2
Reserved	722		float 32	2
Reserved	724		float 32	2
Reserved	726		float 32	2
Reserved	728		float 32	2
Acknowledge Val. Dencytee	730		word 16 bits	1
State Val. Dencytee	731		word 16 bits	1
Acknowledge Cal. Dencytee	732		word 16 bits	1
State Cal. Dencytee	733		word 16 bits	1
Reserved	734		float32	2

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Function	Register address	Unit	Data type	Data Size (registers)
Reserved	736		float 32	2
Reserved	738		float 32	2
Reserved	740		float 32	2
Reserved	742		float 32	2
Reserved	744		float 32	2
Measures - Ch 2				
Sensor serial number	746		string	6
Amplifier serial number	752		string	6
Amplifier status	758		word 16 bits	1
Reserved	759		float 32	2
Biomass	761		float 32	2
Measure Index	763		unsigned long	2
Amplifier Status – float format	765		float 32	2
Reserved	767		float 32	2
Reserved	769		float 32	2
Reserved	771		float 32	2
Reserved	773		float 32	2
Reserved	775		float 32	2
Acknowledge Val. Dencytee	777		word 16 bits	1
State Val. Dencytee	778		word 16 bits	1
Acknowledge Cal. Dencytee	779		word 16 bits	1
State Cal. Dencytee	780		word 16 bits	1
Reserved	781		float32	2
Reserved	783		float 32	2
Reserved	785		float 32	2
Reserved	787		float 32	2
Reserved	789		float 32	2
Reserved	791		float 32	2
Measures - Ch 3				
Sensor serial number	793		string	6
Amplifier serial number	799		string	6
Amplifier status	805		word 16 bits	1
Reserved	806		float 32	2

Function	Register address	Unit	Data type	Data Size (registers)
Biomass	808		float 32	2
Measure Index	810		unsigned long	2
Amplifier Status – float format	812		float 32	2
Reserved	814		float 32	2
Reserved	816		float 32	2
Reserved	818		float 32	2
Reserved	820		float 32	2
Reserved	822		float 32	2
Acknowledge Val. Dencytee	824		word 16 bits	1
State Val. Dencytee	825		word 16 bits	1
Acknowledge Cal. Dencytee	826		word 16 bits	1
State Cal. Dencytee	827		word 16 bits	1
Reserved	828		float32	2
Reserved	830		float 32	2
Reserved	832		float 32	2
Reserved	834		float 32	2
Reserved	836		float 32	2
Reserved	838		float 32	2
Measures - Ch 4				
Sensor serial number	840		string	6
Amplifier serial number	846		string	6
Amplifier status	852		word 16 bits	1
Reserved	853		float 32	2
Biomass	855		float 32	2
Measure Index	857		unsigned long	2
Amplifier Status – float format	859		float 32	2
Reserved	861		float 32	2
Reserved	863		float 32	2
Reserved	865		float 32	2
Reserved	867		float 32	2
Reserved	869		float 32	2
Acknowledge Val. Dencytee	871		word 16 bits	1
State Val. Dencytee	872		word 16 bits	1

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Function	Register address	Unit	Data type	Data Size (registers)
Acknowledge Cal. Dencytee	873		word 16 bits	1
State Cal. Dencytee	874		word 16 bits	1
Reserved	875		float32	2
Reserved	877		float 32	2
Reserved	879		float 32	2
Reserved	881		float 32	2
Reserved	883		float 32	2
Reserved	885		float 32	2

Table 12: Dencytee input register.

12.1.2.8.2 Holding Registers (read and write)

12.1.2.8.2.1 Read and Write Function Code

Writing holding registers allow changing configuration and performs several actions.

- Use 0x06 standard function code to write single holding register.

This function code is used to write a single holding register in the Arc View Controller. The Request PDU specifies the address of the register to be written. Registers are addressed starting at zero. Therefore register numbered 1 is addressed as 0. The normal response is an echo of the request, returned after the register contents have been written.

- Use 0x10 standard function code to write holding registers.

This function code is used to write a block of contiguous registers (1 to 123 registers) in the Arc View Controller. The data to be written is specified in the request data field. Data is packed as two bytes per register. The normal response returns the function code, starting address, and quantity of registers written.

- Use 0x03 standard function code to read Holding Registers

This function code is used to read the contents of a contiguous block of holding registers in the Arc View Controller. The Request PDU specifies the starting register address and the number of registers. In the PDU registers are addressed starting at zero. Therefore registers numbered 1-16 are addressed as 0-15. The register data in the response message are packed as two bytes per register, with the binary contents right justified within each byte.

12.1.2.8.2.2 Incyte Holding Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Channel 1				
Mark Zero auto	1		word 16bits	1
Clear Zero auto	2		word 16bits	1
Recepy number Unit Factor	3		word 16bits	1
Recepy number Measure Mode	4		word 16bits	1
Activate Manual Cleaning	5		word 16bits	1
Activate auto Cleaning	6		word 16bits	1
Recepy number Cleaning	7		word 16bits	1
Reserved	8		word 16bits	1
Offset zero	9	pF/cm	Float 32bits	2
Command Val. Incyte	11		word 16bits	1
Parameter Val. Incyte	12		word 16bits	1
Command Cal. Incyte	13		word 16bits	1
Parameter Cal. Incyte	14		word 16bits	1
Reserved	15		word 16bits	1
Reserved	16		word 16bits	1
Channel 2				
Mark Zero auto	17		word 16bits	1
Clear Zero auto	18		word 16bits	1
Recepy number Unit Factor	19		word 16bits	1
Recepy number Measure Mode	20		word 16bits	1
Activate Manual Cleaning	21		word 16bits	1
Activate auto Cleaning	22		word 16bits	1
Recepy number Cleaning	23		word 16bits	1
Reserved	24		word 16bits	1

Function	Register address	Unit	Data type	Data Size (registers)
Offset zero	25	pF/cm	Float 32bits	2
Command Val. Incyte	27		word 16bits	1
Parameter Val. Incyte	28		word 16bits	1
Command Cal. Incyte	29		word 16bits	1
Parameter Cal. Incyte	30		word 16bits	1
Reserved	31		word 16bits	1
Reserved	32		word 16bits	1
Channel 3				
Mark Zero auto	33		word 16bits	1
Clear Zero auto	34		word 16bits	1
Recepy numbrer Unit Factor	35		word 16bits	1
Recepy number Measure Mode	36		word 16bits	1
Activate Manual Cleaning	37		word 16bits	1
Activate auto Cleaning	38		word 16bits	1
Recepy number Cleaning	39		word 16bits	1
Reserved	40		word 16bits	1
Offset zero	41	pF/cm	Float 32bits	2
Command Val. Incyte	43		word 16bits	1
Parameter Val. Incyte	44		word 16bits	1
Command Cal. Incyte	45		word 16bits	1
Parameter Cal. Incyte	46		word 16bits	1
Reserved	47		word 16bits	1
Reserved	48		word 16bits	1
Channel 4				
Mark Zero auto	49		word 16bits	1
Clear Zero auto	50		word 16bits	1
Recepy numbrer Unit Factor	51		word 16bits	1
Recepy number Measure Mode	52		word 16bits	1
Activate Manual Cleaning	53		word 16bits	1
Activate auto Cleaning	54		word 16bits	1
Recepy number Cleaning	55		word 16bits	1
Reserved	56		word 16bits	1
Offset zero	57	pF/cm	Float 32bits	2

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Function	Register address	Unit	Data type	Data Size (registers)
Command Val. Incyte	59		word 16bits	1
Parameter Val. Incyte	60		word 16bits	1
Command Cal. Incyte	61		word 16bits	1
Parameter Cal. Incyte	62		word 16bits	1
Reserved	63		word 16bits	1
Reserved	64		word 16bits	1

Table 13: Incyte holding registers table.

12.1.2.8.2.3 Dencytee Holding Registers Table

Function	Register address	Unit	Data type	Data Size (registers)
Channel 1				
Mark Zero auto	71		word 16bits	1
Clear Zero auto	72		word 16bits	1
Recepy number Unit Factor	73		word 16bits	1
Recepy number Measure Mode	74		word 16bits	1
Reserved	75		word 16bits	1
Reserved	76		word 16bits	1
Reserved	77		word 16bits	1
Reserved	78		word 16bits	1
Offset zero	79	pF/cm	Float 32bits	2
Command Val. Dencytee	81		word 16bits	1
Parameter Val. Dencytee	82		word 16bits	1
Command Cal. Dencytee	83		word 16bits	1
Parameter Cal. Dencytee	84		word 16bits	1
reserved	85		word 16bits	1
reserved	86		word 16bits	1
Channel 2				
Mark Zero auto	87		word 16bits	1

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Function	Register address	Unit	Data type	Data Size (registers)
Clear Zero auto	88		word 16bits	1
Recepy number Unit Factor	89		word 16bits	1
Recepy number Measure Mode	90		word 16bits	1
Reserved	91		word 16bits	1
Reserved	92		word 16bits	1
Reserved	93		word 16bits	1
Reserved	94		word 16bits	1
Offset zero	95	pF/cm	Float 32bits	2
Command Val. Dencytee	97		word 16bits	1
Parameter Val. Dencytee	98		word 16bits	1
Command Cal. Dencytee	99		word 16bits	1
Parameter Cal. Dencytee	100		word 16bits	1
Reserved	101		word 16bits	1
Reserved	102		word 16bits	1
Channel 3				
Mark Zero auto	103		word 16bits	1
Clear Zero auto	104		word 16bits	1
Recepy number Unit Factor	105		word 16bits	1
Recepy number Measure Mode	106		word 16bits	1
Reserved	107		word 16bits	1
Reserved	108		word 16bits	1
Reserved	109		word 16bits	1
Reserved	110		word 16bits	1
Offset zero	111	pF/cm	Float 32bits	2
Command Val. Dencytee	113		word 16bits	1
Parameter Val. Dencytee	114		word 16bits	1
Command Cal. Dencytee	115		word 16bits	1
Parameter Cal. Dencytee	116		word 16bits	1
Reserved	117		word 16bits	1
Reserved	118		word 16bits	1
Channel 4				
Mark Zero auto	119		word 16bits	1
Clear Zero auto	120		word 16bits	1
Recepy number Unit Factor	121		word 16bits	1
Recepy number Measure Mode	122		word 16bits	1
Reserved	123		word 16bits	1
Reserved	124		word 16bits	1
Reserved	125		word 16bits	1
Reserved	126		word 16bits	1
Offset zero	127	pF/cm	Float 32bits	2
Command Val. Dencytee	129		word 16bits	1
Parameter Val. Dencytee	130		word 16bits	1
Command Cal. Dencytee	131		word 16bits	1
Parameter Cal. Dencytee	132		word 16bits	1
Reserved	133		word 16bits	1
Reserved	134		word 16bits	1

Table 14: Dencytee holding registers table.

12.1.2.8.2.4 Allowed Values for Holding Registers

Only the following values may be written in the holding registers:

Register Name	Value(s)
Mark Zero	1
Clear Zero	1
Activate Auto Cleaning	0 to 1
Recipe Number Unit Factor	0 to 8
Recipe Number Measure Mode	0 to 3
Recipe Number Cleaning	0 to 1

Table 15: Allowed values for holding registers.

CONNECTION OF THE CONTROL UNIT
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12.2 Connect by OPC Communication

NOTE: To connect the Arc View Controller or ComBox with the process control system, the OPC License (Ref 243820) is needed. The Cell Density Integration Kit is equipped with all licenses.

12.2.1 Introduction to OPC

OPC is a standard which specifies the communication of real-time data between control devices from different manufacturers. The Arc View Controller offers an OPC XML-DA server. OPC XML-DA is the OPC Foundation's adoption of the XML (eXtensible Markup Language) set of technologies. An OPC XML-DA client is used to communicate with the Arc View Controller. The Arc View Controller takes advantage of the “OPC-XML-DA-SDK-LIN” library supplied by Softing. The library is OPC compliant.

12.2.2 Configuration of the Control Unit

Enter the Administrator Settings (Figure 47), select the Network Applications and activate OPC (Figure 62).

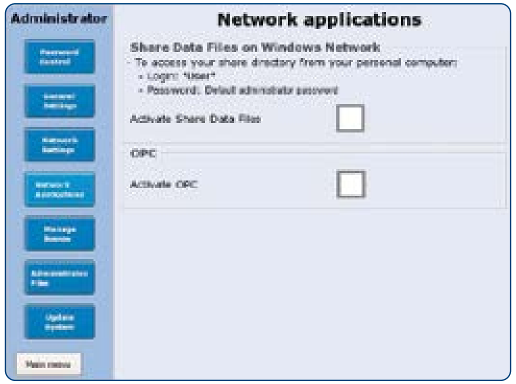

Figure 62: Activation of the OPC protocol.

The Arc View Controller OPC server provides the following data:

Arc View Controller:

- Controller name (with serial number): character string.

Sensor Unit:

- Amplifier serial number: character string.
- Sensor serial number: character string.
- Probe status: character string.
- Conductivity: floating point value.
- Permittivity: floating point value.
- Cell Density: floating point value.
- Fc (IncyteScan cutting frequency): floating point value.
- DeltaEps (IncyteScan Δε): floating point value.
- Alpha (IncyteScan α): floating point value.
- IncyteScanFrequencies: list of floating point values.
- C(f) (IncyteScan Permittivity values): list of floating point values.
- IncyteScanPermittivity (Permittivity measured by FScan method): floating point value.

NOTE: The refresh rate is about 30s for the Incyte Scan parameters and 3s for the other parameters.

CONNECTION OF THE CONTROL UNIT
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12.2.3 Configuration of the OPC Client

The connection of the OPC client to the Control Unit OPC server is made using the following URL: http://ArcViewControllerName:8079/EVOOPC/XMLDA, where «ArcViewControllerName» (ex: E265-XXX-XXX) is the name of the Control Unit that is on the sticker on the left side panel and in the about menu (Figure 13) of the software. Alternatively, you can use the IP address.

> NOTE: The Control Unit OPC server has been tested and validated with the OPC Classic Demo client, from Softing and the OPC Viewer client from CommServer. Further patches, to ensure the newest version of the bridge may be required.

12.2.4 OPC Classic Demo Client Start Guide

12.2.4.1 System Overview

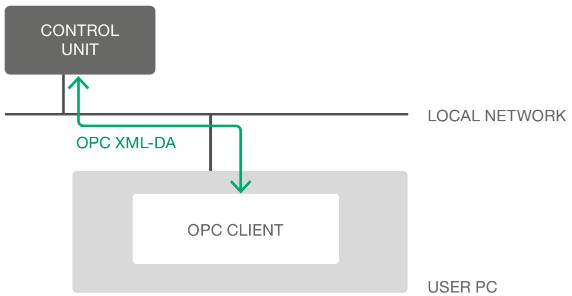

Figure 63: OPC Classic Demo System Overview.

12.2.4.2 Download and Installation

1. Download the OPC-Classic Demo installer for Windows from the Softing homepage. The OPC client must be installed on a user PC connected to the local network.
2. After downloading OPC-Classic Demo, run the setup and follow the instructions.
3. Once the installation is completed, run the OPC Demo Client. If the installation was successful, the following screen is displayed (Figure 64).

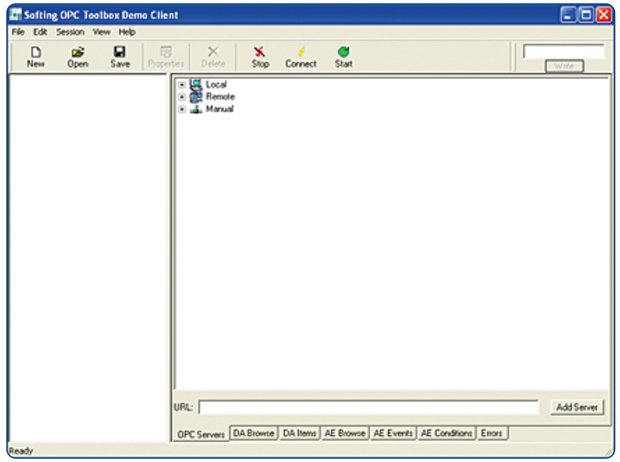

Figure 64: OPC Classic Demo client.

12.2.4.3 Connecting the OPC Classic Demo Client to the Control Unit

1. Connect the Control Unit and the PC (with the OPC client) to the local network.
2. Connection of the OPC client on the PC to the integrated OPC server in the Control Unit using the following URL: http://ArcViewControllerName:8079/EVOOPC/XMLDA, where “ArcViewControllerName” (ex: E265-XXX-XXX) is the name of the Control Unit that is on the sticker on the left side panel and in the About Menu (Figure 13) of the software. Alternatively, the IP address of the device may be used. In the example below, the IP address 192.168.128.181 was used. Enter the OPC Server URL in the associated text control and press add server (Figure 65).

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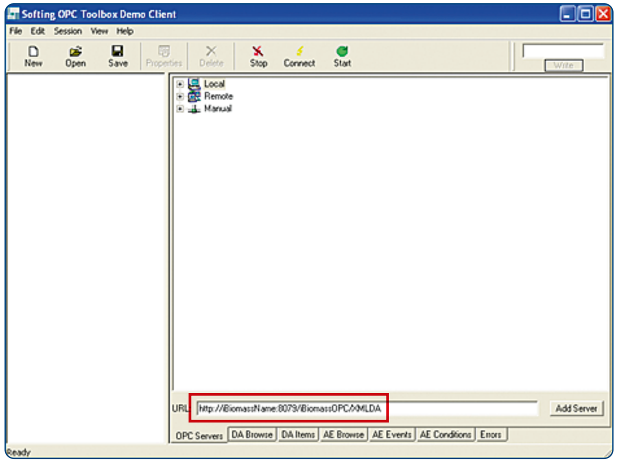

Figure 65: Insertion of the Arc View Controller URL.

3. If the OPC Server URL is correct, the following screen (Figure 66) is displayed with a green light beside the OPC server:

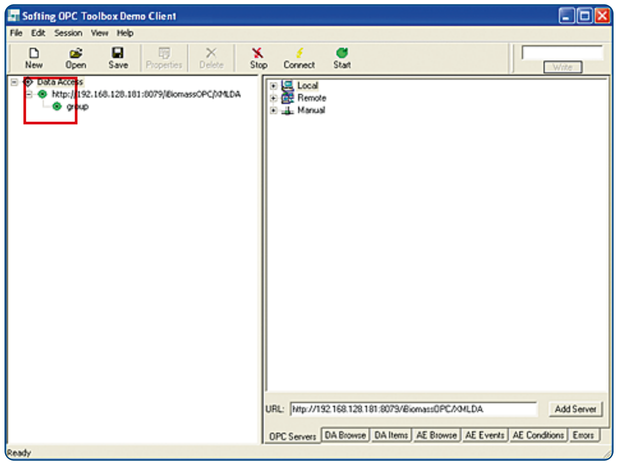

Figure 66: Connected Arc View Controller in the Classic Demo.

4. Select the DA Browse tab to do the data selection (Figure 67).

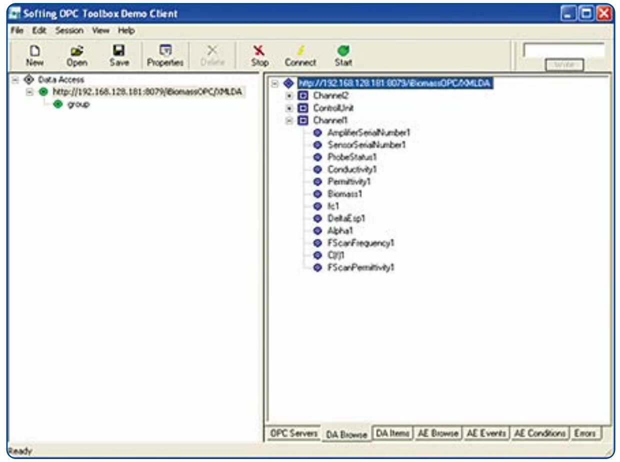

Figure 67: Data selection in the DA Browse tab.

5. Double click on each item that needs to be monitored. Each selected item is added to the list (Figure 68).

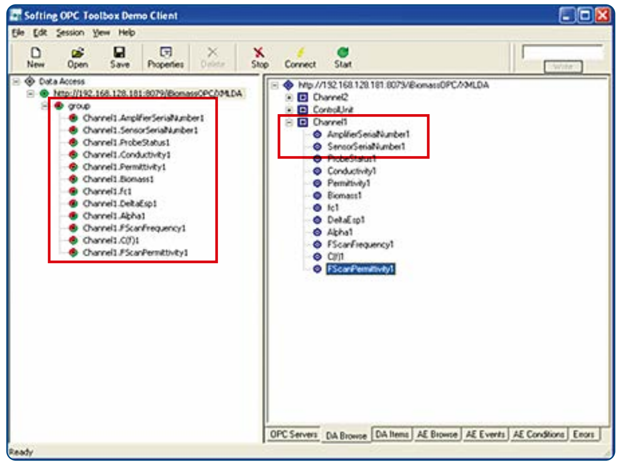

Figure 68: Item selection in the DA Browse tab.

6. To observe the data evolution select the DA Items tab to see the evolution of the data selection (Figure 69).

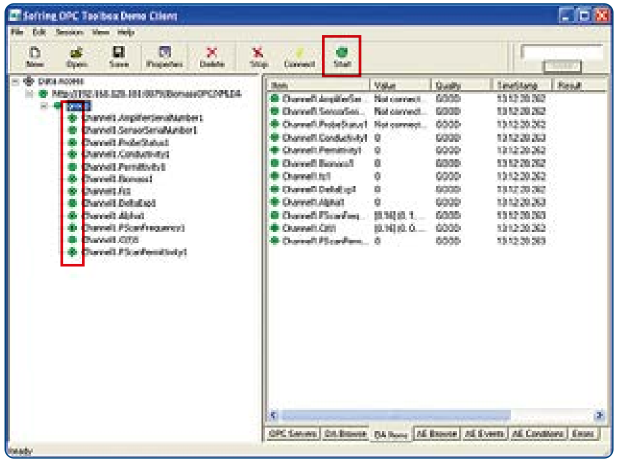

Figure 69: Connected Arc View Controller with the Tool Box Demo Client.

⚠ ATTENTION! If there is a red light besides the items, activate the OPC server on your Arc View Controller (see Chapter 9.4).

CONNECTION OF THE CONTROL UNIT
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12.2.5 Softing OPC Bridge Start Guide

12.2.5.1 System Overview

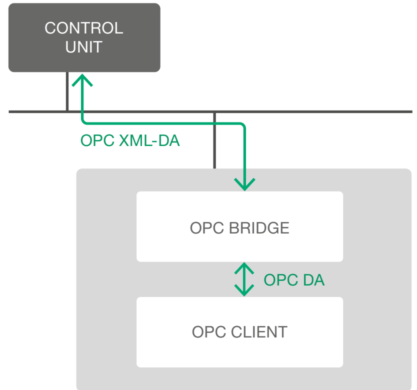

Figure 70: System Overview of the Softing OPC bridge.

12.2.5.2 Download and Installation

1. Purchase the dataFEED OPC Suite for Windows, available from Softing.
2. After downloading dataFEED OPC Suite, run the setup and follow the instructions.
3. Start the dataFEED OPC Suite Configurator on the Windows start menu (Start => Programs => Softing OPC Easy Connect => dataFEED OPC Suite => Configurator).
4. Select the Tab Data Source on the left side and click on OPC Server (Figure 71).

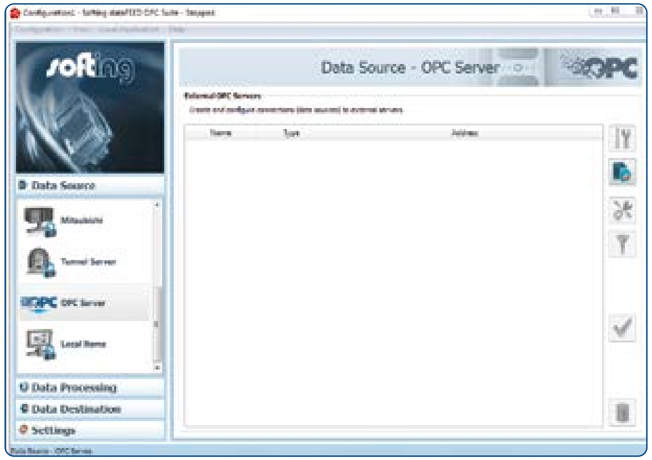

Figure 71: Starting with the OPC Bridge.

5. Click on the add a new data source button. The OPC Server Wizard starts on the widget (Figure 72).
6. Click next.

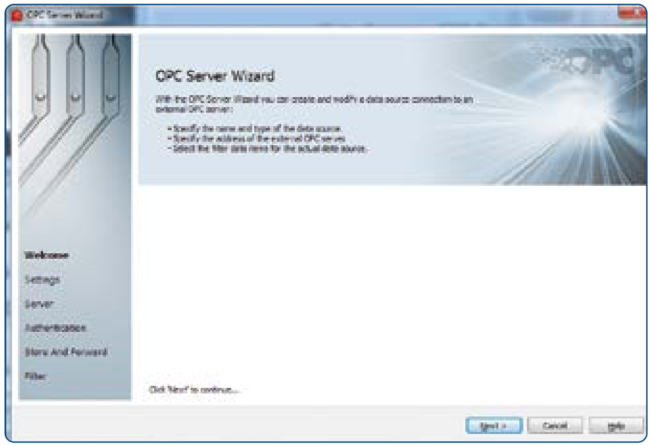

Figure 72: OPC Server Wizard.

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7. Enter a name for the data source and select Server Type XML-DA (Figure 73).

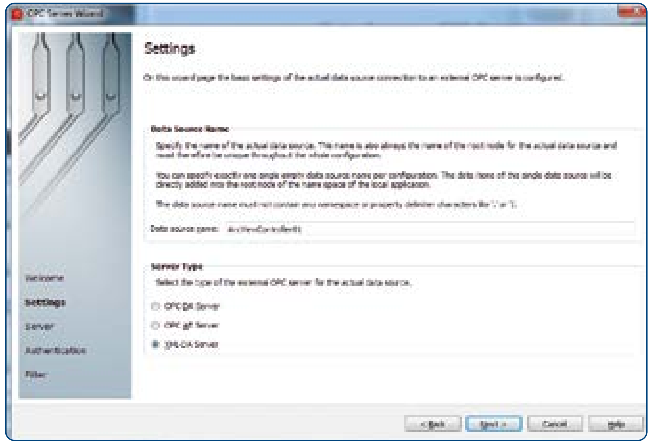

Figure 73: Definition of the data source and the server type.

8. Connect the Control Unit to the local network. Connect the PC to the local network, the connection of the OPC client to the Control Unit OPC server is made using the following URL: http://ArcViewControllerName:8079/EVOOPC/XMLDA, where "ArcViewControllerName" (ex: E265-XXX-XXX) is the name of the Control Unit that is on the sticker on the left side panel and in the About Menu (Figure 13) in the Controller software. Alternatively, the IP address of the device may be used. In the example below, the IP address 172.16.125.102 was used (Figure 74). Enter the URL and proceed.

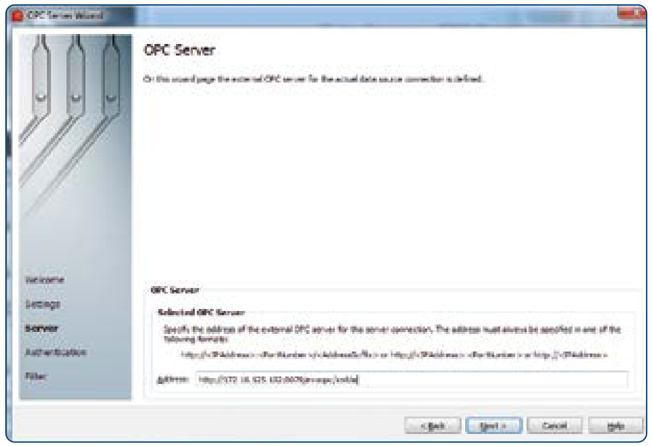

Figure 74: Definition of the Control Unit URL.

9. Test the connection (Figure 75).

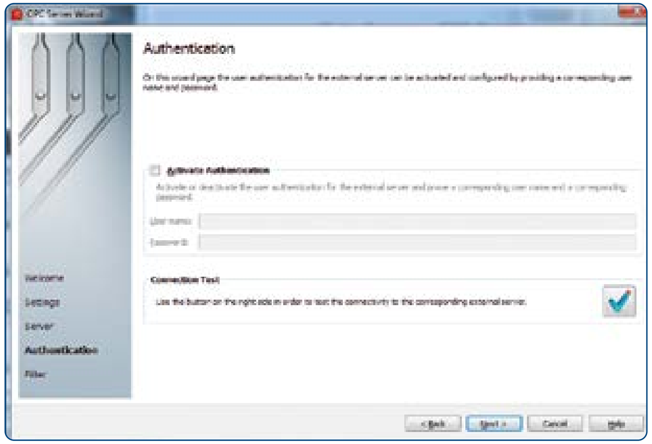

Figure 75: Validating the server connection.

10. If the configuration was successful the following text (Figure 76) is written on the terminal.

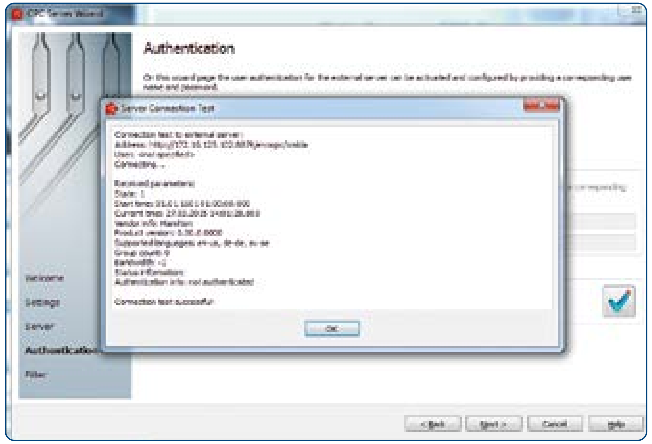

Figure 76: Successful validation of the server connection.

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11. Finish the valid bridge configuration without further adjustments (Figure 77).

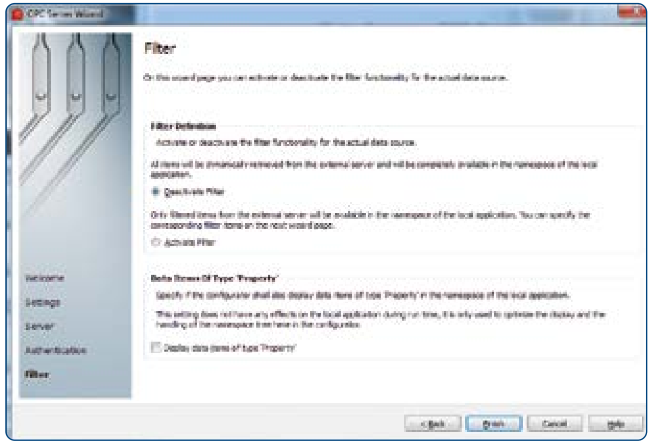

Figure 77: ending the valid bridge configuration.

12. Confirm the new settings to save them. If the configuration was successful, the screen should look like the following (Figure 78).

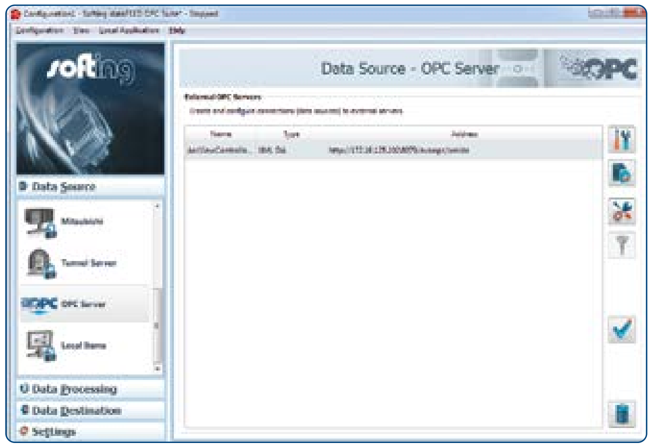

Figure 78: Data Source Window of the OPC connection.

13. Select Data Destination and choose OPC Client.

14. Copy the Class ID of the OPC Data Access (Figure 79).

Figure 79: Choose the OPC Client Data Destination.

15. Start the OPC Bridge (local application => start). The settings are disabled and the programm icon (upper left corner) is green (Figure 80).

Figure 80: Starting the OPC Bridge.

CONNECTION OF THE CONTROL UNIT
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16. In order to test the bridge start the Softing OPC Classic Demo Client. Select the OPC Server Tab and select the DA server (Figure 81).

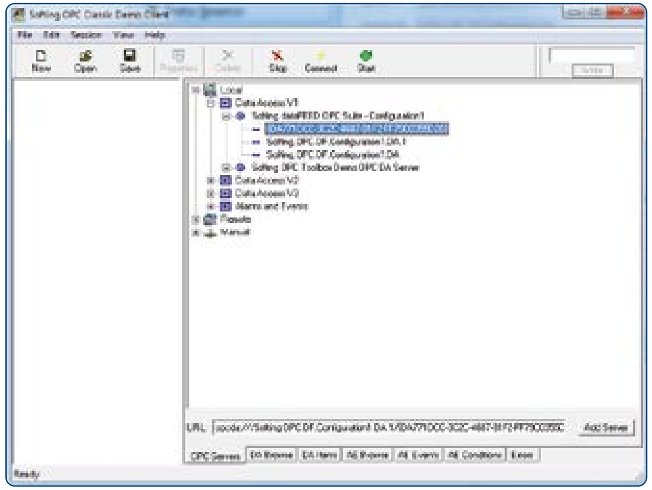

Figure 81: Selection of the DA Server.

17. The Server is added to the left terminal and with an green status indication (Figure 82).

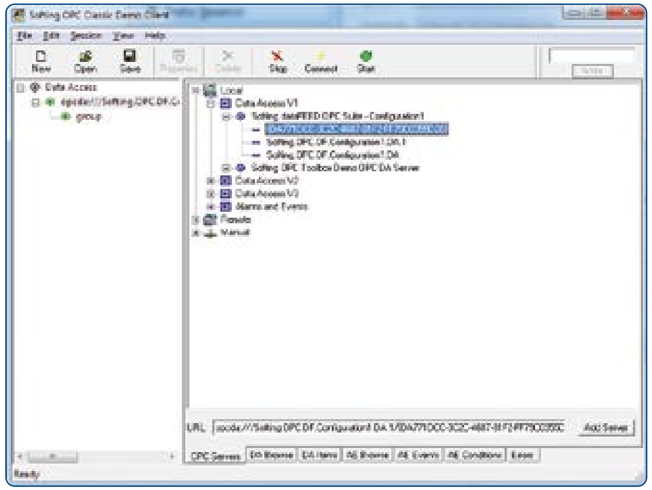

Figure 82: Activation of the DA Server.

18. Select the available DA items (types of information) in the tab DA Browse with right click and the selection add item (Figure 83).

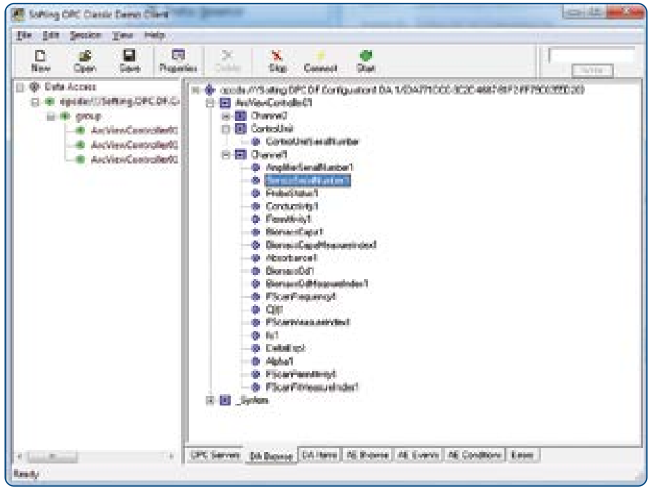

Figure 83: Selection of the DA Items.

19. Display the selected DA Item values in the Tab DA Items (Figure 84).

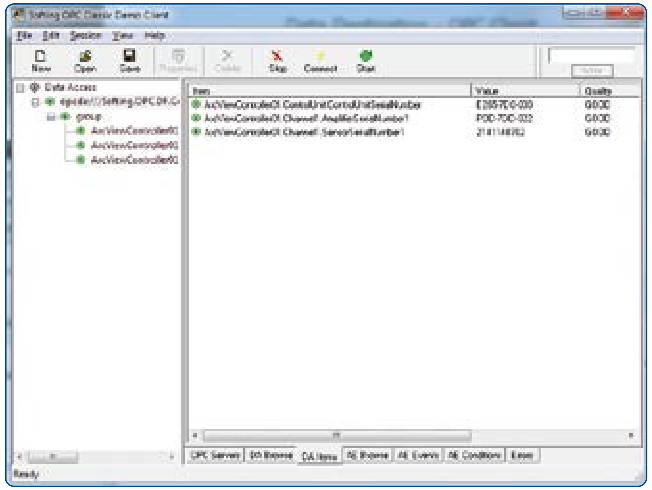

Figure 84: Display of the selected DA Item values.

CONNECTION OF THE CONTROL UNIT
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The OPC DA bridge is now functional and communicates with the OPC server of the Control Unit. It may be connected with the favorite OPC DA client.

12.3 Connecting the 4-20 mA Output Box

NOTE: Please be aware that the 4-20 mA Output Box (Ref 243850) is needed.

The Analog Output Box is specially designed to connect the Control Unit to the Process Control Systems with 4-20 mA input cards. It has 4 outputs for cell density, 4 outputs for conductivity (both 4-20 mA current sources) and 4 alarms (open drain). The Analog Output Box is designed in a DIN rail for being installed in the cabinet. Refer to figure 61 to see the M12 Pin assignment.

12.3.1 Electrical Installation

1. Connect the Arc 4-20 mA Output Box to the AUX M12 connector of the Control Unit (Figure 85).

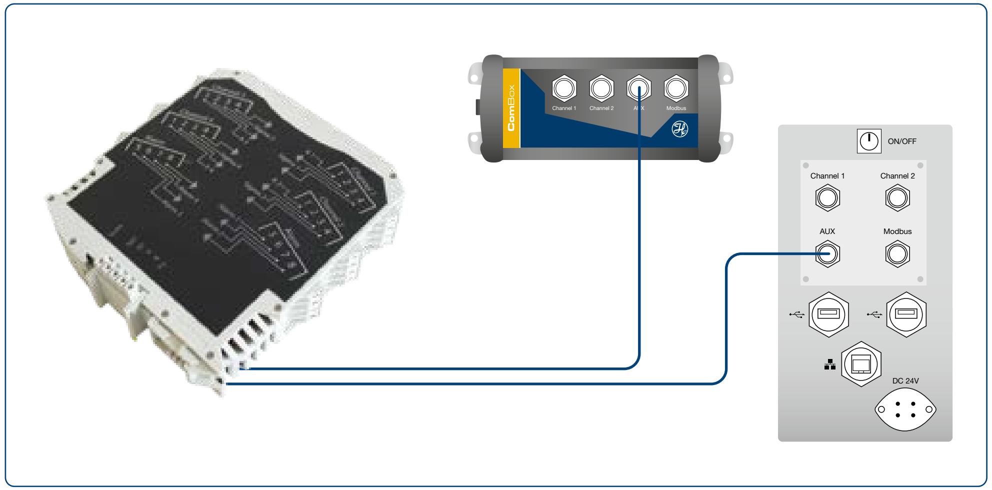

Figure 85: Connecting the 4-20mA Analog Box with the Arc View and ComBox.

2. Connect the outputs of the 4-20mA Output Box to the passive inputs of the process control system (process control system is a current sink) (Figure 86, Figure 87, Figure 88).
    - X (1/2/3/4) represents the cell density on Channel 1/2/3/4
    - Sigma (1/2/3/4) represents the conductivity on Channel 1/2/3/4
    - Alarm (1/2/3/4) represents the alarm of Channel 1/2/3/4

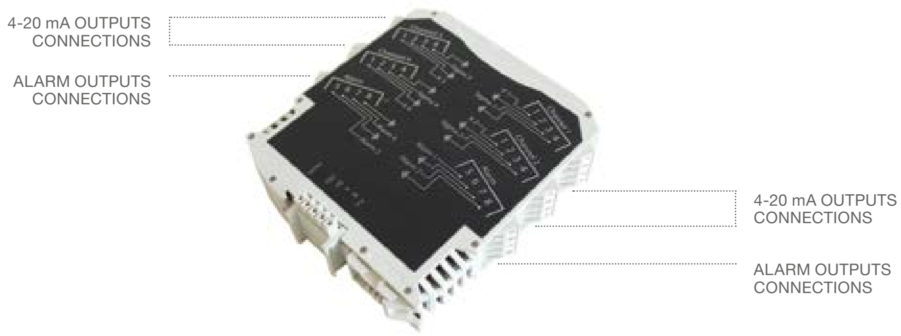

Figure 86: Port Configuration of the 4-20 Box.

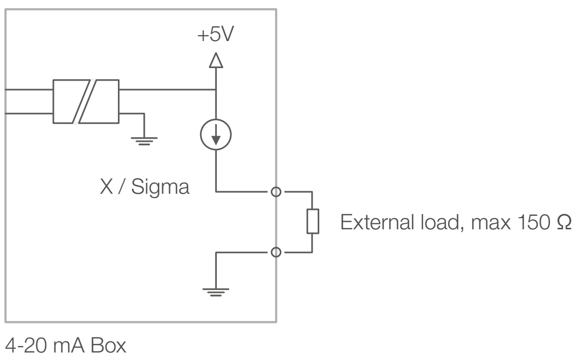

Figure 87: Schematic diagram of an analog output.

3. To use the alarm output, which is an open drain output, connect an external relay to the Alarm output.

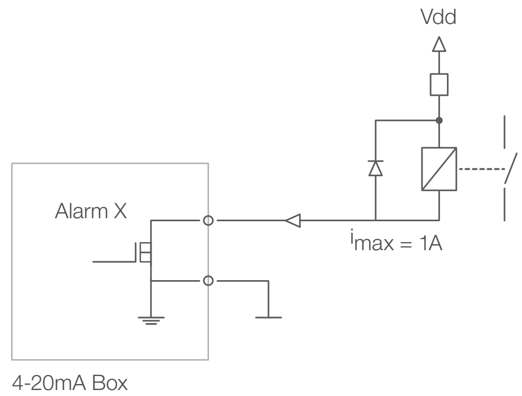

Figure 88: schematic diagram to connect an external relay to the Alarm output.

The channel and port overview is shown in table 17.

Channel	Pin	Description	Measurement
1	1	X1	Cell Density Channel 1
	2	⏚	Ground Cell Density Channel 1
	3	Sigma 1	Conductivity Channel 1
	4	⏚	Ground Condcutivity Channel 1
2	1	X2	Cell Density Channel 2
	2	⏚	Ground Cell Density Channel 2
	3	Sigma 2	Conductivity Channel 2
	4	⏚	Ground Condcutivity Channel 2
3	1	X3	Cell Density Channel 3
	2	⏚	Ground Cell Density Channel 3
	3	Sigma 3	Conductivity Channel 3
	4	⏚	Ground Condcutivity Channel 3
4	1	X4	Cell Density Channel 4
	2	⏚	Ground Cell Density Channel 4
	3	Sigma 4	Conductivity Channel 4
	4	⏚	Ground Condcutivity Channel 4

Table 17: Channel and port overview.

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12.3.2 Software Configuration

1. Go to the Advanced settings (Figure 13) and select the 4-20 mA Configuration (Figure 85).
2. Select the Channel to configure the output range after 4-20 mA current output. Enter the cell density measurement values for 4 mA and 20 mA output (Figure 89).

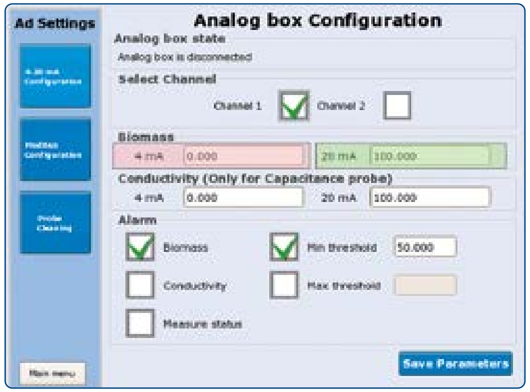

Figure 89: Software configuration of the 4-20 mA Box for Cell Density measurements.

3. Enter the conductivity measurement values for 4 mA and 20 mA output (Figure 90).

🗍 NOTE: Conductivity measurement is just available for Incyte Sensors.

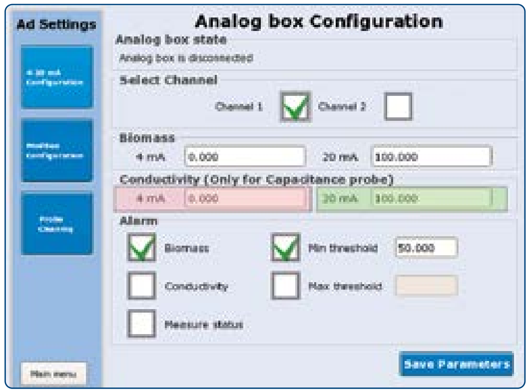

Figure 90: Software Configuration of the 4-20 mA Box for conductivity.

4. Select a trigger for the alarm output. Choose from cell density, conductivity or measurement status. and define the minimal and maximal threshold, where an alarm should be triggered (Figure 91).

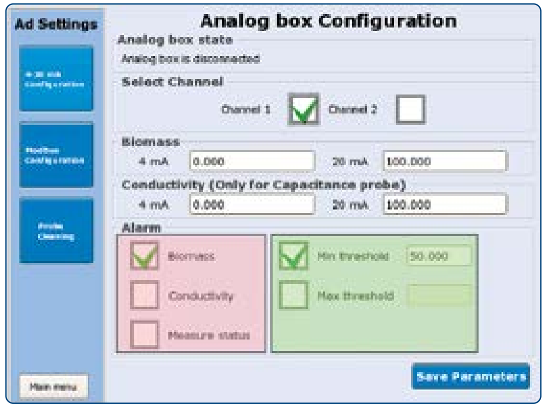

Figure 91: Set Up of the Alarms.

12.4 Connect by Profibus Communication

12.4.1 Profibus General Information

The Arc View Controller Modbus-Profibus DP Module is already pre-configured. The ID for the Card must be set correctly. The GSD file provided must be filed to the process control system for it to recognize the Module. The GSD file is available at: www.hamiltoncompany.com/arc_view_update

⚠ ATTENTION! The Arc View Controller Modbus-Profibus DP Module is only available for Arc View Controller 465 and Arc View Controller 465 XL.

🗍 NOTE: Please be aware that the Modbus-Profibus module(Ref 243889) and M12 / open end cables (5 m, Ref 243851, 10 m, Ref 243852) are needed.

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12.4.1.1 Ground the Modbus-Profibus module

NOTE: If the terminal 3 is not connected, the Modbus is in a floating state. Normally (with short cables) this is not an issue but if EMI (EMC) issues are present it may cause a problem. IIn this case terminal 3 should be connected together with the PWR supply GND to hold the bus line to a defined potential (Figure 92).

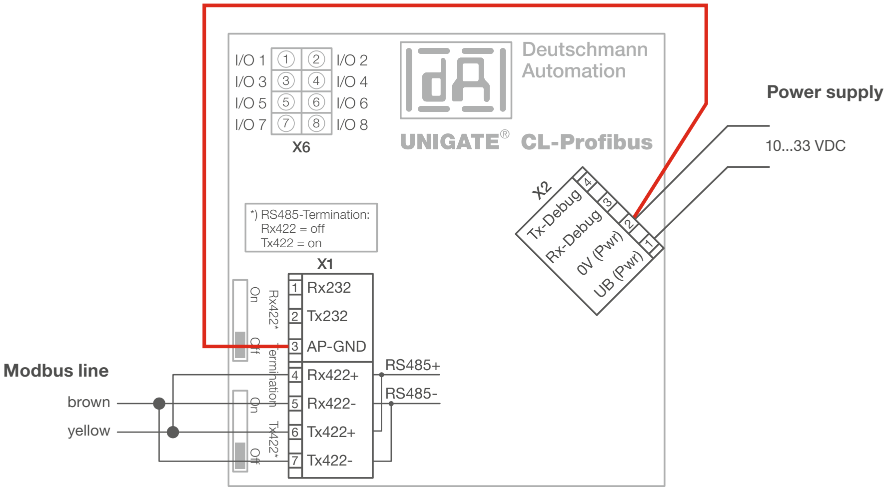

Figure 92: Overview of the Modbus-Profibus module

12.4.2 Profibus Interface

12.4.2.1 Overview

The following information is always available in the Profibus output buffer:

Incyte:

- Amplifier Status Incyte (word, 2 Bytes)
- Conductivity (float, 4 Bytes)
- Permittivity (float, 4 Bytes)
- Measure Index Incyte (unsigned long, 4 Bytes)
- Delta Epsilon (float, 4 Bytes)
- Fc (float, 4 Bytes)
- Alpha (float, 4 Bytes)
- FScanEpsilon (float, 4 Bytes)
- SpectroIndex (unsigned long, 4 Bytes)

Dencytee:

- Amplifier Status Dencytee (word, 2 Bytes)
- Biomass (float, 4 Bytes)
- Measure Index Dencytee (unsigned long, 4 Bytes)

12.4.2.2 Input Buffer

The input buffer must be at least 8 byte and contain the function code and the sensor type (see page 9, Function codes) for every channel:

Byte Number	Type	Content
0	byte	Sensor type Channel 1
1	byte	Function code Channel 1
2	byte	Sensor type Channel 2
3	byte	Function code Channel 2
4	byte	Sensor type Channel 3
5	byte	Function code Channel 3
6	byte	Sensor type Channel 4
7	byte	Function code Channel 4

Table 18: Input buffer table

12.4.2.3 Output Buffer

The following table defines the content of the output buffer for each channel. The data is re-freshed continously and depends on the defined sensor type (defined in the input buffer). The corresponding Modbus Registers and lengths in the Arc View Controller are defined in brackets.

For data requested by a function code one byte-array per channel is reserved in the output.

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

Byte Number	Type	Sensor type Channel 1 = 0 (none)	Sensor type Channel 1 = 1 Incyte	Sensor type Channel 1 = 2 Dencytee
0…1	word 16bit	0x0000	Amplifier Status Capa (19/1)	Amplifier Status OD (711/1)
2…5	float	0.0f	Conductivity (20/2)	0.0f
6…9	float	0.0f	Permittivity (22/2)	Biomass (714/2)
10…13	uint32	0	Measure Index Capa (24/2)	Measure Index OD (716/2)
14…17	float	0.0f	Delta Epsilon (42/2)	0.0f
18…21	float	0.0f	Fc (44/2)	0.0f
22…25	float	0.0f	Alpha (46/2)	0.0f
26…29	float	0.0f	FScanEpsilon (48/2)	0.0f
30…33	uint32	0	SpectroIndex (50/2)	0
34…45	byte[]	0x00	Data requested by the function code for the channel	

Byte Number	Type	Sensor type Channel 2 = 0 (none)	Sensor type Channel 2 = 1 Incyte	Sensor type Channel 2 = 2 Dencytee
46…47	word 16bit	0x0000	Amplifier Status Capa (65/1)	Amplifier Status OD (758/1)
48…51	float	0.0f	Conductivity (66/2)	0.0f
52…55	float	0.0f	Permittivity (68/2)	Biomass (761/2)
56…59	uint32	0	Measure Index Capa (70/2)	Measure Index OD (763/2)
60…63	float	0.0f	Delta Epsilon (88/2)	0.0f
64…67	float	0.0f	Fc (90/2)	0.0f
68…71	float	0.0f	Alpha (92/2)	0.0f
72…75	float	0.0f	FScanEpsilon (94/2)	0.0f
76…79	uint32	0	SpectroIndex (96/2)	0
80…91	byte[]	0x00	Data requested by the function code for the channel	

Byte Number	Type	Sensor type Channel 3 = 0 (none)	Sensor type Channel 3 = 1 Incyte	Sensor type Channel 3 = 2 Dencytee
92…93	word 16bit	0x0000	Amplifier Status Capa (111/1)	Amplifier Status OD (805/1)
94…97	float	0.0f	Conductivity (112/2)	0.0f
98…101	float	0.0f	Permittivity (114/2)	Biomass (808/2)
102…105	uint32	0	Measure Index Capa (116/2)	Measure Index OD (810/2)
106…109	float	0.0f	Delta Epsilon (134/2)	0.0f
110…113	float	0.0f	Fc (136/2)	0.0f
114…117	float	0.0f	Alpha (138/2)	0.0f
118…121	float	0.0f	FScanEpsilon (140/2)	0.0f
122…125	uint32	0	SpectroIndex (142/2)	0
126…137	byte[]	0x00	Data requested by the function code for the channel	

Byte Number	Type	Sensor type Channel 4 = 0 (none)	Sensor type Channel 4 = 1 Incyte	Sensor type Channel 4 = 2 Dencytee
138…139	word 16bit	0x0000	Amplifier Status Capa (157/1)	Amplifier Status OD (852/1)
140…143	float	0.0f	Conductivity (158/2)	0.0f
144…147	float	0.0f	Permittivity (160/2)	Biomass (855/2)
148…151	uint32	0	Measure Index Capa (162/2)	Measure Index OD (857/2)
152…155	float	0.0f	Delta Epsilon (180/2)	0.0f
156…159	float	0.0f	Fc (182/2)	0.0f
160…163	float	0.0f	Alpha (184/2)	0.0f
164…167	float	0.0f	FScanEpsilon (186/2)	0.0f
168…171	uint32	0	SpectroIndex (188/2)	0
172…183	byte[]	0x00	Data requested by the function code for the channel	

Byte Number	Type	Content
184	byte	Error

Table 19: Input buffer table

The output data is refreshed every second.

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

12.4.2.4 Decoding the Return Values

Characters

According to the Modbus convention, the characters are interchanged byte-wise.
The character «01234567» will be transmitted as «10325476.»

Float, Integers

According to the Modbus convention, the 4 byte values are interchanged word/2-byte-wise. For example: the float value 2.54 has the hex representation of 0x40228f5c. The Arc View Controller puts this value as 0x8f5c 4022 on the line.

Bit Masks

When an interface error to the Arc View Controller occurs, the module makes a retry. If this retry fails, the module puts an error on byte 184 and the all other fields of the output buffer are set to 0x00.

Byte 184	Description
0x00	Everything ok
0x01	Arc View Controller replies with an error (Arc View Controller replies correctly, but the answer contains an error code)
0x02	Wrong answer (no Arc View Controller available, Arc View Controller sends an invalid message or no message)

Table 20: Return values of the Arc View Controller

The pre-amplifier status looks like this:

Hex Code	Description
0x00	**SENSOR: not found** No sensor connected to the preamplifier.
0x01	**SENSOR: sterilization count overflow** The sensor has been sterilized more than 100 times. Please contact your local representative.
0x04	**AMPLIFIER : total duration of use overflow** The preamplifier has been used more than 1 year continuously. Please perform a preamplifier check
0x05	**SENSOR: invalid sensor calibration** The current sensor has not been calibrated with the preamplifier
0x06	**SENSOR: invalid calibration** The current sensor has not been calibrated with the preamplifier. The sensor serial number is not valid.
0x07	**SENSOR: total duration overflow** The sensor has been used more than 6 months continuously. Please perform a probe check
0x08	**SENSOR: out of calibration range** The measurement is out of the calibration range.
0x09	**SENSOR: cleaning state** The preamplifier is applying specific voltage to clean the sensor, no measurement available.
0x0a	**AMPLIFIER: temperature security activated** The preamplifier temperature is too high, the security fuse is activated, no measurement available.
0x0b	**SENSOR: Out of range measurement** The measurement is out of range.
0x0c	**SENSOR: ok** The probe is working as expected.
0x0d	**Biomass simulator connected** The calibration cap is connected to the preamplifier.
0x0e	**SENSOR: total sterilization time overflow** The automatic sterilization counter has reached the maximum value (100)
0x0f	**SENSOR: overtime reached-calib/check needed** The sensor has been used more than 1 year since the last calibration. Please perform a calibration.
0x10	**AMPLIFIER: overtime reached/check needed** The amplifier has been used more than 1 year since the last calibration. Please perform a calibration.
0x11	**AMPLIFIER: not found** No preamplifier is connected to the channel.
0x12	**bootloader** Amplifier firmware updating

Table 21: Return values of the pre-amplifier

NOTE: Some status codes are only available for Incyte pre-amplifiers.

For more details about the pre-amplifier status, see the Operating Instructions Manual available at www.hamiltoncompany.com

12.4.2.5 Function codes

In the following tables, the integration of each channel with the function code in the output buffer is defined. The Modbus registers and lengths are written in brackets.

Table for Channel 1:

Code	Function	Sensor type Channel 1 = 1 (Incyte)	Sensor type Channel 1 = 2 (Dencytee)
0	No Function	Byte 34…45: 0x00	
1	Serial number Arc View reading	Byte 34…45: Gateway serial number (1/6)	
2	Serial number Sensor reading	Byte 34…45: Sensor serial number (7/6)	Byte 34…45: Sensor serial number (699/6)
3	Serial number Preamp reading	Byte 34…45: Amplifier serial number (13/6)	Byte 34…45: Amplifier serial number (705/6)
4	FScan Frequency 0-2 reading	Byte 34…37: Frequency 0 (196/2) Byte 38…41: Frequency 1 (198/2) Byte 42…45: Frequency 2 (200/2)	Byte 34…45: 0x00
5	FScan Frequency 3-5 reading	Byte 34…37: Frequency 3 (202/2) Byte 38…41: Frequency 4 (204/2) Byte 42…45: Frequency 5 (206/2)	Byte 34…45: 0x00
6	FScan Frequency 6-8 reading	Byte 34…37: Frequency 6 (208/2) Byte 38…41: Frequency 7 (210/2) Byte 42…45: Frequency 8 (212/2)	Byte 34…45: 0x00
7	FScan Frequency 9-11 reading	Byte 34…37: Frequency 9 (214/2) Byte 38…41: Frequency 10 (216/2) Byte 42…45: Frequency 11 (218/2)	Byte 34…45: 0x00
8	FScan Frequency 12-14 reading	Byte 34…37: Frequency 12 (220/2) Byte 38…41: Frequency 13 (222/2) Byte 42…45: Frequency 14 (224/2)	Byte 34…45: 0x00
9	FScan Frequency 15-17 reading	Byte 34…37: Frequency 15 (226/2) Byte 38…41: Frequency 16 (228/2) Byte 42…45: Frequency 17 (230/2)	Byte 34…45: 0x00
10	FScan Frequency 18-20 reading	Byte 34…37: Frequency 18 (232/2) Byte 38…41: Frequency 19 (234/2) Byte 42…45: Frequency 20 (236/2)	Byte 34…45: 0x00
11	FScan Frequency 21-23 reading	Byte 34…37: Frequency 21 (238/2) Byte 38…41: Frequency 22 (240/2) Byte 42…45: Frequency 23 (242/2)	Byte 34…45: 0x00
12	FScan Frequency 24-26 reading	Byte 34…37: Frequency 24 (244/2) Byte 38…41: Frequency 25 (246/2) Byte 42…45: Frequency 26 (248/2)	Byte 34…45: 0x00
13	FScan Frequency 27-29 reading	Byte 34…37: Frequency 27 (250/2) Byte 38…41: Frequency 28 (252/2) Byte 42…45: Frequency 29 (254/2)	Byte 34…45: 0x00
14	FScan-Values 0-2 reading	Byte 34…37: FScan 0 (256/2) Byte 38…41: FScan 1 (258/2) Byte 42…45: FScan 2 (260/2)	Byte 34…45: 0x00
15	FScan-Values 3-5 reading	Byte 34…37: FScan 3 (262/2) Byte 38…41: FScan 4 (264/2) Byte 42…45: FScan 5 (266/2)	Byte 34…45: 0x00
16	FScan-Values 6-8 reading	Byte 34…37: FScan 6 (268/2) Byte 38…41: FScan 7 (270/2) Byte 42…45: FScan 8 (272/2)	Byte 34…45: 0x00
17	FScan-Values 9-11 reading	Byte 34…37: FScan 9 (274/2) Byte 38…41: FScan 10 (276/2) Byte 42…45: FScan 11 (278/2)	Byte 34…45: 0x00
18	FScan-Values 12-14 reading	Byte 34…37: FScan 12 (280/2) Byte 38…41: FScan 13 (282/2) Byte 42…45: FScan 14 (284/2)	Byte 34…45: 0x00
19	FScan-Values 15-17 reading	Byte 34…37: FScan 15 (286/2) Byte 38…41: FScan 16 (288/2) Byte 42…45: FScan 17 (290/2)	Byte 34…45: 0x00
20	FScan-Values 18-20 reading	Byte 34…37: FScan 18 (292/2) Byte 38…41: FScan 19 (294/2) Byte 42…45: FScan 20 (296/2)	Byte 34…45: 0x00
21	FScan-Values 21-23 reading	Byte 34…37: FScan 21 (298/2) Byte 38…41: FScan 22 (300/2) Byte 42…45: FScan 23 (302/2)	Byte 34…45: 0x00
22	FScan-Values 24-26 reading	Byte 34…37: FScan 24 (304/2) Byte 38…41: FScan 25 (306/2) Byte 42…45: FScan 26 (308/2)	Byte 34…45: 0x00
23	FScan-Values 27-29 reading	Byte 34…37: FScan 27 (310/2) Byte 38…41: FScan 28 (312/2) Byte 42…45: FScan 29 (314/2)	Byte 34…45: 0x00

Table 22: Function Codes Channel 1

CONNECTION OF THE CONTROL UNIT
TO THE PROCESS CONTROL SYSTEM

Table for Channel 2:

Code	Function	Sensor type Channel 2 = 1 (Incyte)	Sensor type Channel 2 = 2 (Dencytee)
0	No Function	Byte 80…91: 0x00	
1	Serial number Arc View reading	Byte 80…91: Gateway serial number (1/6)	
2	Serial number Sensor reading	Byte 80…91: Sensor serial number (53/6)	Byte 80…91: Sensor serial number (746/6)
3	Serial number Preamp reading	Byte 80…91: Amplifier serial number (59/6)	Byte 80…91: Amplifier serial number (752/6)
4	FScan Frequency 0-2 reading	Byte 80…83: Frequency 0 (321/2) Byte 84…87: Frequency 1 (323/2) Byte 88…91: Frequency 2 (325/2)	Byte 80…91: 0x00
5	FScan Frequency 3-5 reading	Byte 80…83: Frequency 3 (327/2) Byte 84…87: Frequency 4 (329/2) Byte 88…91: Frequency 5 (331/2)	Byte 80…91: 0x00
6	FScan Frequency 6-8 reading	Byte 80…83: Frequency 6 (333/2) Byte 84…87: Frequency 7 (335/2) Byte 88…91: Frequency 8 (337/2)	Byte 80…91: 0x00
7	FScan Frequency 9-11 reading	Byte 80…83: Frequency 9 (339/2) Byte 84…87: Frequency 10 (341/2) Byte 88…91: Frequency 11 (343/2)	Byte 80…91: 0x00
8	FScan Frequency 12-14 reading	Byte 80…83: Frequency 12 (345/2) Byte 84…87: Frequency 13 (347/2) Byte 88…91: Frequency 14 (349/2)	Byte 80…91: 0x00
9	FScan Frequency 15-17 reading	Byte 80…83: Frequency 15 (351/2) Byte 84…87: Frequency 16 (353/2) Byte 88…91: Frequency 17 (355/2)	Byte 80…91: 0x00
10	FScan Frequency 18-20 reading	Byte 80…83: Frequency 18 (357/2) Byte 84…87: Frequency 19 (359/2) Byte 88…91: Frequency 20 (361/2)	Byte 80…91: 0x00
11	FScan Frequency 21-23 reading	Byte 80…83: Frequency 21 (363/2) Byte 84…87: Frequency 22 (365/2) Byte 88…91: Frequency 23 (367/2)	Byte 80…91: 0x00
12	FScan Frequency 24-26 reading	Byte 80…83: Frequency 24 (369/2) Byte 84…87: Frequency 25 (371/2) Byte 88…91: Frequency 26 (373/2)	Byte 80…91: 0x00
13	FScan Frequency 27-29 reading	Byte 80…83: Frequency 27 (375/2) Byte 84…87: Frequency 28 (377/2) Byte 88…91: Frequency 29 (379/2)	Byte 80…91: 0x00
14	FScan-Values 0-2 reading	Byte 80…83: FScan 0 (381/2) Byte 84…87: FScan 1 (383/2) Byte 88…91: FScan 2 (385/2)	Byte 80…91: 0x00
15	FScan-Values 3-5 reading	Byte 80…83: FScan 3 (387/2) Byte 84…87: FScan 4 (389/2) Byte 88…91: FScan 5 (391/2)	Byte 80…91: 0x00
16	FScan-Values 6-8 reading	Byte 80…83: FScan 6 (393/2) Byte 84…87: FScan 7 (395/2) Byte 88…91: FScan 8 (397/2)	Byte 80…91: 0x00
17	FScan-Values 9-11 reading	Byte 80…83: FScan 9 (399/2) Byte 84…87: FScan 10 (401/2) Byte 88…91: FScan 11 (403/2)	Byte 80…91: 0x00
18	FScan-Values 12-14 reading	Byte 80…83: FScan 12 (405/2) Byte 84…87: FScan 13 (407/2) Byte 88…91: FScan 14 (409/2)	Byte 80…91: 0x00
19	FScan-Values 15-17 reading	Byte 80…83: FScan 15 (411/2) Byte 84…87: FScan 16 (413/2) Byte 88…91: FScan 17 (415/2)	Byte 80…91: 0x00
20	FScan-Values 18-20 reading	Byte 80…83: FScan 18 (417/2) Byte 84…87: FScan 19 (419/2) Byte 88…91: FScan 20 (421/2)	Byte 80…91: 0x00
21	FScan-Values 21-23 reading	Byte 80…83: FScan 21 (423/2) Byte 84…87: FScan 22 (425/2) Byte 88…91: FScan 23 (427/2)	Byte 80…91: 0x00
22	FScan-Values 24-26 reading	Byte 80…83: FScan 24 (429/2) Byte 84…87: FScan 25 (431/2) Byte 88…91: FScan 26 (433/2)	Byte 80…91: 0x00
23	FScan-Values 27-29 reading	Byte 80…83: FScan 27 (435/2) Byte 84…87: FScan 28 (437/2) Byte 88…91: FScan 29 (439/2)	Byte 80…91: 0x00

Table 23: Function Codes Channel 2

CONNECTION OF THE CONTROL UNIT
TO THE PROCESS CONTROL SYSTEM

Table for Channel 3:

Code	Function	Sensor type Channel 3 = 1 (Incyte)	Sensor type Channel 3 = 2 (Dencytee)
0	No Function	Byte 126…137: 0x00	
1	Serial number Arc View reading	Byte 126…137: Gateway serial number (1/6)	
2	Serial number Sensor reading	Byte 126…137: Sensor serial number (99/6)	Byte 126…137: Sensor serial number (793/6)
3	Serial number Preamp reading	Byte 126…137: Amplifier serial number (105/6)	Byte 126…137: Amplifier serial number (799/6)
4	FScan Frequency 0-2 reading	Byte 126…129: Frequency 0 (446/2) Byte 130…133: Frequency 1 (448/2) Byte 134…137: Frequency 2 (450/2)	Byte 126…137: 0x00
5	FScan Frequency 3-5 reading	Byte 126…129: Frequency 3 (452/2) Byte 130…133: Frequency 4 (454/2) Byte 134…137: Frequency 5 (456/2)	Byte 126…137: 0x00
6	FScan Frequency 6-8 reading	Byte 126…129: Frequency 6 (458/2) Byte 130…133: Frequency 7 (460/2) Byte 134…137: Frequency 8 (462/2)	Byte 126…137: 0x00
7	FScan Frequency 9-11 reading	Byte 126…129: Frequency 9 (464/2) Byte 130…133: Frequency 10 (466/2) Byte 134…137: Frequency 11 (468/2)	Byte 126…137: 0x00
8	FScan Frequency 12-14 reading	Byte 126…129: Frequency 12 (470/2) Byte 130…133: Frequency 13 (472/2) Byte 134…137: Frequency 14 (474/2)	Byte 126…137: 0x00
9	FScan Frequency 15-17 reading	Byte 126…129: Frequency 15 (476/2) Byte 130…133: Frequency 16 (478/2) Byte 134…137: Frequency 17 (480/2)	Byte 126…137: 0x00
10	FScan Frequency 18-20 reading	Byte 126…129: Frequency 18 (482/2) Byte 130…133: Frequency 19 (484/2) Byte 134…137: Frequency 20 (486/2)	Byte 126…137: 0x00
11	FScan Frequency 21-23 reading	Byte 126…129: Frequency 21 (488/2) Byte 130…133: Frequency 22 (490/2) Byte 134…137: Frequency 23 (492/2)	Byte 126…137: 0x00
12	FScan Frequency 24-26 reading	Byte 126…129: Frequency 24 (494/2) Byte 130…133: Frequency 25 (496/2) Byte 134…137: Frequency 26 (498/2)	Byte 126…137: 0x00
13	FScan Frequency 27-29 reading	Byte 126…129: Frequency 27 (500/2) Byte 130…133: Frequency 28 (502/2) Byte 134…137: Frequency 29 (504/2)	Byte 126…137: 0x00
14	FScan-Values 0-2 reading	Byte 126…129: FScan 0 (506/2) Byte 130…133: FScan 1 (508/2) Byte 134…137: FScan 2 (510/2)	Byte 126…137: 0x00
15	FScan-Values 3-5 reading	Byte 126…129: FScan 3 (512/2) Byte 130…133: FScan 4 (514/2) Byte 134…137: FScan 5 (516/2)	Byte 126…137: 0x00
16	FScan-Values 6-8 reading	Byte 126…129: FScan 6 (518/2) Byte 130…133: FScan 7 (520/2) Byte 134…137: FScan 8 (522/2)	Byte 126…137: 0x00
17	FScan-Values 9-11 reading	Byte 126…129: FScan 9 (524/2) Byte 130…133: FScan 10 (526/2) Byte 134…137: FScan 11 (528/2)	Byte 126…137: 0x00
18	FScan-Values 12-14 reading	Byte 126…129: FScan 12 (530/2) Byte 130…133: FScan 13 (532/2) Byte 134…137: FScan 14 (534/2)	Byte 126…137: 0x00
19	FScan-Values 15-17 reading	Byte 126…129: FScan 15 (536/2) Byte 130…133: FScan 16 (538/2) Byte 134…137: FScan 17 (540/2)	Byte 126…137: 0x00
20	FScan-Values 18-20 reading	Byte 126…129: FScan 18 (542/2) Byte 130…133: FScan 19 (544/2) Byte 134…137: FScan 20 (546/2)	Byte 126…137: 0x00
21	FScan-Values 21-23 reading	Byte 126…129: FScan 21 (548/2) Byte 130…133: FScan 22 (550/2) Byte 134…137: FScan 23 (552/2)	Byte 126…137: 0x00
22	FScan-Values 24-26 reading	Byte 126…129: FScan 24 (554/2) Byte 130…133: FScan 25 (556/2) Byte 134…137: FScan 26 (558/2)	Byte 126…137: 0x00
23	FScan-Values 27-29 reading	Byte 126…129: FScan 27 (560/2) Byte 130…133: FScan 28 (562/2) Byte 134…137: FScan 29 (564/2)	Byte 126…137: 0x00

Table 24: Function Codes Channel 3

CONNECTION OF THE CONTROL UNIT TO THE PROCESS CONTROL SYSTEM

Table for Channel 4:

Code	Function	Sensor type Channel 4 = 1 (Incyte)	Sensor type Channel 4 = 2 (Dencytee)
0	No Function	Byte 172…183: 0x00	
1	Serial number Arc View reading	Byte 172…183: Gateway serial number (1/6)	
2	Serial number Sensor reading	Byte 172…183: Sensor serial number (145/6)	Byte 172…183: Sensor serial number (840/6)
3	Serial number Preamp reading	Byte 172…183: Amplifier serial number (151/6)	Byte 172…183: Amplifier serial number (846/6)
4	FScan Frequency 0-2 reading	Byte 172…175: Frequency 0 (571/2) Byte 176…179: Frequency 1 (573/2) Byte 180…183: Frequency 2 (575/2)	Byte 172…183: 0x00
5	FScan Frequency 3-5 reading	Byte 172…175: Frequency 3 (577/2) Byte 176…179: Frequency 4 (579/2) Byte 180…183: Frequency 5 (581/2)	Byte 172…183: 0x00
6	FScan Frequency 6-8 reading	Byte 172…175: Frequency 6 (583/2) Byte 176…179: Frequency 7 (585/2) Byte 180…183: Frequency 8 (587/2)	Byte 172…183: 0x00
7	FScan Frequency 9-11 reading	Byte 172…175: Frequency 9 (589/2) Byte 176…179: Frequency 10 (591/2) Byte 180…183: Frequency 11 (593/2)	Byte 172…183: 0x00
8	FScan Frequency 12-14 reading	Byte 172…175: Frequency 12 (595/2) Byte 176…179: Frequency 13 (597/2) Byte 180…183: Frequency 14 (599/2)	Byte 172…183: 0x00
9	FScan Frequency 15-17 reading	Byte 172…175: Frequency 15 (601/2) Byte 176…179: Frequency 16 (603/2) Byte 180…183: Frequency 17 (605/2)	Byte 172…183: 0x00
10	FScan Frequency 18-20 reading	Byte 172…175: Frequency 18 (607/2) Byte 176…179: Frequency 19 (609/2) Byte 180…183: Frequency 20 (611/2)	Byte 172…183: 0x00
11	FScan Frequency 21-23 reading	Byte 172…175: Frequency 21 (613/2) Byte 176…179: Frequency 22 (615/2) Byte 180…183: Frequency 23 (617/2)	Byte 172…183: 0x00
12	FScan Frequency 24-26 reading	Byte 172…175: Frequency 24 (619/2) Byte 176…179: Frequency 25 (621/2) Byte 180…183: Frequency 26 (623/2)	Byte 172…183: 0x00
13	FScan Frequency 27-29 reading	Byte 172…175: Frequency 27 (625/2) Byte 176…179: Frequency 28 (627/2) Byte 180…183: Frequency 29 (629/2)	Byte 172…183: 0x00
14	FScan-Values 0-2 reading	Byte 172…175: FScan 0 (631/2) Byte 176…179: FScan 1 (633/2) Byte 180…183: FScan 2 (635/2)	Byte 172…183: 0x00
15	FScan-Values 3-5 reading	Byte 172…175: FScan 3 (637/2) Byte 176…179: FScan 4 (639/2) Byte 180…183: FScan 5 (641/2)	Byte 172…183: 0x00
16	FScan-Values 6-8 reading	Byte 172…175: FScan 6 (643/2) Byte 176…179: FScan 7 (645/2) Byte 180…183: FScan 8 (647/2)	Byte 172…183: 0x00
17	FScan-Values 9-11 reading	Byte 172…175: FScan 9 (649/2) Byte 176…179: FScan 10 (651/2) Byte 180…183: FScan 11 (653/2)	Byte 172…183: 0x00
18	FScan-Values 12-14 reading	Byte 172…175: FScan 12 (655/2) Byte 176…179: FScan 13 (657/2) Byte 180…183: FScan 14 (659/2)	Byte 172…183: 0x00
19	FScan-Values 15-17 reading	Byte 172…175: FScan 15 (661/2) Byte 176…179: FScan 16 (663/2) Byte 180…183: FScan 17 (665/2)	Byte 172…183: 0x00
20	FScan-Values 18-20 reading	Byte 172…175: FScan 18 (667/2) Byte 176…179: FScan 19 (669/2) Byte 180…183: FScan 20 (671/2)	Byte 172…183: 0x00
21	FScan-Values 21-23 reading	Byte 172…175: FScan 21 (673/2) Byte 176…179: FScan 22 (675/2) Byte 180…183: FScan 23 (677/2)	Byte 172…183: 0x00
22	FScan-Values 24-26 reading	Byte 172…175: FScan 24 (679/2) Byte 176…179: FScan 25 (681/2) Byte 180…183: FScan 26 (683/2)	Byte 172…183: 0x00
23	FScan-Values 27-29 reading	Byte 172…175: FScan 27 (685/2) Byte 176…179: FScan 28 (687/2) Byte 180…183: FScan 29 (689/2)	Byte 172…183: 0x00

Table 25: Function Codes Channel 4

12.4.3 Modbus Interface

12.4.3.1 Configuration

The Arc View Controller Modbus Communication needs to be configured as described in Chapter 12.1.

13 Disposal

The design of Hamilton Sensors optimally considers environmental compatibility. In accordance with the EC guideline 2012/19/EU Hamilton Sensors, pre-amplifier and Controller that are worn out or no longer required must be sent to a dedicated collection point for electrical and electronic devices, alternatively, must be sent to Hamilton for disposal. Sensors must not be sent to an unsorted waste disposal point.

有害物質表，請參閱www.hamiltoncompany.com，
章節過程分析，符合性聲明

14 Software Versions

Version	Description
3.1	Hamilton branding and basic Arc Sensor integration (MB)
3.2	Graph and Data Logging for Arc Sensors (MB)
3.3	Manual configuration of "Network Settings", allowing Cell Factor < 1.0, set time-zone offset, Graph and Data Logging for Arc Sensors (MB and BT)
3.4	Enabling Incyte (LC) low conductivity calibration, OPC connection improved, Dencytee external light detection improved
3.5	Enabling Cell Density Integration Kit, Dencytee external light detection improved
3.6	Improved error analysis and sterilization cycle counter. Dencytee external light detection adjusted
3.7	Implementation of an overall software stabilization, including: - Protection against corruption of initialization and culture files - Disabled function to download running culture files - Possibility to delete corrupt files from the Arc View Controller - Fix of export data procedure - Possibility to perform a script recovery - Implementation of an error-logger to collect status-data in case of software malfunction
3.7.1	General improvements to increase system stability based on the error-logger, which was implemented in version 3.7. Corrections of the alarm output for the 4-20 mA Output Box
3.7.2	General improvements to increase system stability. Tolerances and measured value of verification are now available in verification report

ORDERING INFORMATION

15 Hardware Compatibility

⚠ **ATTENTION! Fogale devices are only partially compatible with Hamilton products.**

Please do not combine Hamilton labelled Pre-Amplifier and sensors with a Control Unit having a software version below 3.0.

PC Box Software (V 2.8) and licenses are not compatible with the ComBox and vice versa.

Evo200 and ibiomass cannot be updated with the current Hamilton Software.

16 Ordering Information

16.1 Controller

Choose Controller

243800	Arc View 265
243801	Arc View 465
243802	Arc View 465 XL
243810	Cell Density ComBox

Choose License*

Code	Incyte License
1	yes
0	no

Code	Incyte Scan License**
1	yes
0	no

Code	Dencytee License
1	yes
0	no

Code	OPC License
1	yes
0	no

2438xy ← **Order Code**

** Licenses are specific to the Control Unit / ** Requires Incyte License*

16.2 Cell Density Integration Kit

Ref	Description
243809	Cell Density Integration Kit

16.3 Units

Ref	Description
243710	Incyte Unit DN25 - SG
243711	Incyte Unit DN25 - DG
243712	Incyte Unit DN25 - DG BE
243700	Incyte Unit DN12 - 120
243701	Incyte Unit DN12 - 220
243702	Incyte Unit DN12 - 320
243703	Incyte Unit DN12 - 420
243704	Incyte Unit - 120 LC
243705	Incyte Unit - 220 LC
243755	Dencytee Unit - 120
243756	Dencytee Unit - 225
243757	Dencytee Unit - 325
243758	Dencytee Unit - 425

16.4 Spare Parts and Accessories

Ref	Description
242379	I-PC for CDIK
242380	CDIK ComBox
243850	4-20 mA Output Box
243851	5 m cable M12 / open end
243852	10 m cable M12 / open end
243720	Incyte Pre-Amp
243730	Incyte Sensor DN25 - SG
243731	Incyte Sensor DN25 - DG
243732	Incyte Sensor DN12 - 120
243733	Incyte Sensor DN12 - 220
243734	Incyte Sensor DN12 - 320
243735	Incyte Sensor DN12 - 420
243736	Incyte Sensor DN25 - DG BE
243716	Incyte Sensor - 120 LC
243717	Incyte Sensor - 220 LC
243760	Dencytee Pre-Amp
243750	Dencytee Sensor - 120
243751	Dencytee Sensor - 225
243752	Dencytee Sensor - 325
243753	Dencytee Sensor - 425
243870	5 m cable M12 / M12
243871	10 m cable M12 / M12
243872	20 m cable M12 / M12
243873	40 m cable M12 / M12
243820	OPC License (OPC XML-DA)
243822	Incyte License
243823	Incyte Scan License
243824	Dencytee License
243883	Arc View Controller Power Supply
243889	Arc View Controller Modbus-Profibus DP module

16.5 Calibration Tools

Ref	Description
243740	Incyte Val/Cal Kit Sol A, Sol B, Capacitance Simulator
243713	Incyte Val/Cal Kit LC Sol A, Sol B (LC), Capacitance Simulator
238988	Sol A for Incyte Calibration
243742	Sol B for Incyte Calibration
243708	Sol B for Incyte Calibration LC
243743	Capacitance Simulator
243886	Dencytee Val/Cal Sol

17 Glossary

Name	Description
Unit	Refers to sensor and pre-amplifier calibrated onto each other
Probe	Equivalent to sensor
Capacitance measurement	Measurement of the viable cell density with the Incyte sensor, based on an alternating electric field
Optical density/ turbidity measurement	Measurement of the total cell density with the Dencytee sensor, based on the turbidity of the medium
Incyte Scan/FScan/Scan	Multifrequency scanning during capacitance measurements
Calibration	Calibration of a sensor and a pre-amplifier, meaning not a correlation to biological offline measurements
ComBox	Refers to Cell Density ComBox
CDIK	Refers to Cell Density Integration Kit

Table 21: Overview of relevant terms.

FAQ

18 FAQ

18.1 General Questions

What is the Administrator Password?

The default Password is 14147125

How Should the Sensors be stored?

The recommended storage conditions are at 4 to 50°C and 80 % relative humidity. The Sensors are very robust; they do not have to be stored in a specific container or liquid.

How often do I need to calibrate the Unit?

The Sensor comes factory-calibrated. A calibration procedure must be performed when the Sensor or the Pre-amplifier is replaced.

What is the max. cable length between Unit and Arc View Controller?

The distance is theoretically unlimited because the signal is digital.

What is the effect of gas bubbles on the measurement?

Gas bubbles have two main impacts:
1. Decrease in the signal intensity, since the Sensor is not measuring in air
2. Increase of background noise

What is the effect of agitation variations on the measurement?

The agitation can influence the size of air bubbles. This number and size of air bubbles can affect the Cell Density measurement

Can I detect microorganism contamination with the Sensors?

Yes, indirectly by the effect that the contamination has on the culture, for example a faster, or slower growths, but a direct measure of the contaminants is not possible.

Do you measure % viability?

No. We measure the viable cell density with Incyte and total cell density with Dencytee. You can graph both signals on one screen to analyze the deviation of viable and total cell density.

What is the effect of anti-foam agents on the measurement?

Antifoam has no effect on Incyte Sensors. Anti-foam may interfere with the turbidity measurement of Dencytee, as it may scatter the light.

Is it possible to validate the system?

Yes, the system can be validated. Hamilton can provide IQ/OQ validation packages (Ref 243999-07). The systems have already been validated for use in GMP environment with several customers.

How big is the memory for data storage in the Arc View Controller?

The memory of the system is 16 GB which corresponds to one year of recording with a recording period of 1 second (recording of full dataset, including spectroscopy data), or 60 years of recording for a recording period of 1 minute.

Is the system software 21 CFR Part11 compliant?

No

Can I use the cell density signal to trigger actuator(s)?

Yes. You can configure the alarm outputs of the 4-20 mA Box to control pumps.

FAQ

18.2 Incyte Questions

How is the correlation Cell Factor calculated for the Incyte Sensor?

The system gives you the possibility to correlate the permittivity signal of the Incyte with a reference measurement such as Viable Cell Count (cell/ml), OD or Dry Cell Weight (g/l). The correlated value is referred to as the "Cell Density" value and is linked to the permittivity according to the following equation: Cell Density = (Permittivity – Offset) x cell factor. In order to correlate the permittivity signal with your reference measurements, you must determine the cell factor during the exponential phase of a culture by simultaneously taking your offline reference measurements and the permittivity readings. You can then build the linear relationship between the capacitance measurements (x axis) and your reference measurements (y axis): the slope of the linear correlation corresponds to the cell factor. The cell factor is cell line specific.

Can the electric field of Incyte damage/harm the cells?

No. The frequency of the electric field applied by the system is within 300 kHz and 10 MHz. These frequencies do not damage the cells.

What is the effect of cell aggregates, cell clumping on the Incyte measurement?

The proximity of cells can induce a slight decrease in the capacitance signal, up to 3-4%. It is also known that cell aggregates can create some noise on the signal which can be minimized with the system integration function which is based on a moving average calculation.

When should I use the Incyte Scan?

All calculation done during the Incyte Scan are based on a spherical model. For this reason, this scan works best is for cell culture and yeast applications. The spectroscopy module provides information related to the physiological state of the cells. It may be used to monitor key phases of processes that are typically characterized by major physiological changes in the cell population.

Can I use the Incyte Sensor with micro-carriers?

Yes, the Sensor is insensitive to micro-carriers. Incyte measures the bio volume of each cell on the microcarrier.

How is Incyte measurement influenced if the organisms are not round but cylindrical or long stretched?

The measurement is possible but calculations are based on spherical cells. That means there are 2 beta dispersion curves, one for the small dimension and one for the long dimension. The signal is the combination of those 2 curves.

Are spores detected by Incyte Sensor?

Spores are not detectable because they do not have a plasma membrane, and are too small.

Will oil drops influence the measurement of Incyte?

Oil will most likely create a surface layer on the electrodes and that will affect calibration and probably disturb the signal stability during the run. The effect at higher concentrations is not significant.

What is the effect of changes in conductivity on the Incyte measurement?

Changes in conductivity during a culture do not impact the capacitance measurement. The Sensor measures in a wide range of conductivity (2 to 50 mS/cm) and changes within that range do not affect the capacitance measurements.

What is the effect of changes in pH on the Incyte measurement?

There is no effect from pH.

Can I use the Incyte Sensor in very high cell concentrations?

Yes, there is no limitation in the higher end of concentrations.

Can I use the Incyte Sensors for offline measurements?

Yes, the Sensor may be used in stirred beaker experiments. For optimal results, it is important to make sure that there is at least 1 cm of free space around the Sensor to avoid any interactions with the electric field. The integration/moving average function may be reduced to a low integration or no integration for real-time measurements.

What can I do, if a constant high offset (> 3 pF/cm) is observed?

Please make clear zero of the dual measurement and scan after the process or ensure to mark zero prior to every inoculation.

What is the effect of solid particles on the Incyte measurement?

A content of solid particles higher than 10% (w/v) may interfere with the Incyte measurement, as the particles disturb the electrical field and may create a noise level.

NOTES

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