CellSensor System

User Manual

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Contents

1. Introduction

This document includes important installation, safety, maintenance and basic configuration instructions for wireless Outotec CellSensor^{TM} electrolytic cell voltage and temperature measurement system. It is written for metallurgists, process engineers, electricians and instrumentation staff or whoever is working with the system. Reader should have basic knowledge on the industrial instrumentation, control systems and data communication. Also basic PC computer skills are assumed.

It is strongly recommended that the manual is carefully and completely read before operating the system. Failure of following the instructions may lead to serious personal injury or damage of equipment and avoid warranty.

The manual includes

- an introduction to the structure and operation of the CellSensor system
- instructions for operator and electrical safety
- instructions for installation, commissioning and maintenance of the system components
- description of the data interfaces

All tasks described in this document are to be performed according local regulations, safety rules and procedures that apply. Make sure that you are qualified to perform any tasks or modifications described in this document. Changes to the settings not described in this manual or any other changes ror service to the device electronics, materials or structures are to be carried out by Outotec or a vendor authorized by Outotec only.

The CellSensor^{TM} system is designed for advanced monitoring of copper, zinc, nickel, cobalt and aluminum electro-refining and –winning cells and processes. Do not use it for any other purpose or in other processes.

This manual is compatible with CellSensor System version 1.1 and higher.

Outotec CellSensor^{TM} and CellSense^{TM} are trademarks of Outotec Oyj and incorporate technologies that are protected by international patents with exclusive rights to Outotec Oyj.

1.1 Contact Information

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2. CellSensor System

Outotec CellSensor system is a powerful data collection system for electro-refining and -winning cells, based on robust and reliable wireless communication and powered by the low cell bus bar voltage. The system provides accurate, calibration free and superior quality measurements for

- Cell voltage (V), and
- Cell electrolyte temperature (^{o}C or F)

Truly wireless sensors located next to cells minimize the required cabling and associated maintenance and make the installation simple and clean.

CellSensor system provides unrivalled functionality. Instant cell by cell short circuit detection based on cell voltage measurements allows improved current efficiency, reduced energy consumption, increased production and permanent cathode longevity. Electrolyte temperature monitoring and control of each *individual cell* enables enhanced cathode quality and plating time, early action for process disturbances and electrolyte flow based problems and optimised additive consumption.

The proprietary wireless network is based on the architectures of IEEE 802.15.4 and it takes care of reliable and robust transfer of data acquired by CellSensors. The network is formed and maintained automatically between the devices. The data is stored at CellSense Server PC for convenient data presentation through web based and user friendly CellSense monitoring system. Interfacing of third party systems such as Historians or DCS systems is also possible with OPC, ODBC or web browser.

2.1 System Components

The system consists of three types of wireless devices and a Server PC.

- **CellSensor (CS)** – Measurement sensor device installed to an electrolytic cell. Labelled with network address, e.g. 0103, 0F0A. (See 2.2.3 for network addressing)
- **Coordinator (CN)** – Network Coordinator routing data from CellSensors to Gateway devices. Labelled as CN-XX, where XX is the network address of the device.
- **Gateway (GW)** – Central linking device transferring measurement data of CellSensors via Coordinators to Server PC over USB cable. Labelled as GW-XX, where XX is the network address of the device.
- **CellSense Server PC** – Measurement data presentation and storage and data interface server to third party systems. Hosts also CellSense monitoring system and web based user interface.

All the wireless devices are physically similar but the functionality is different depending on their role in the system. The role is defined in the configuration of each device. The type of each device can be identified by the address label attached to the device and wiring used.

The general structure of the system and location of the components in a tank or cell house is shown in Figure 1 below.

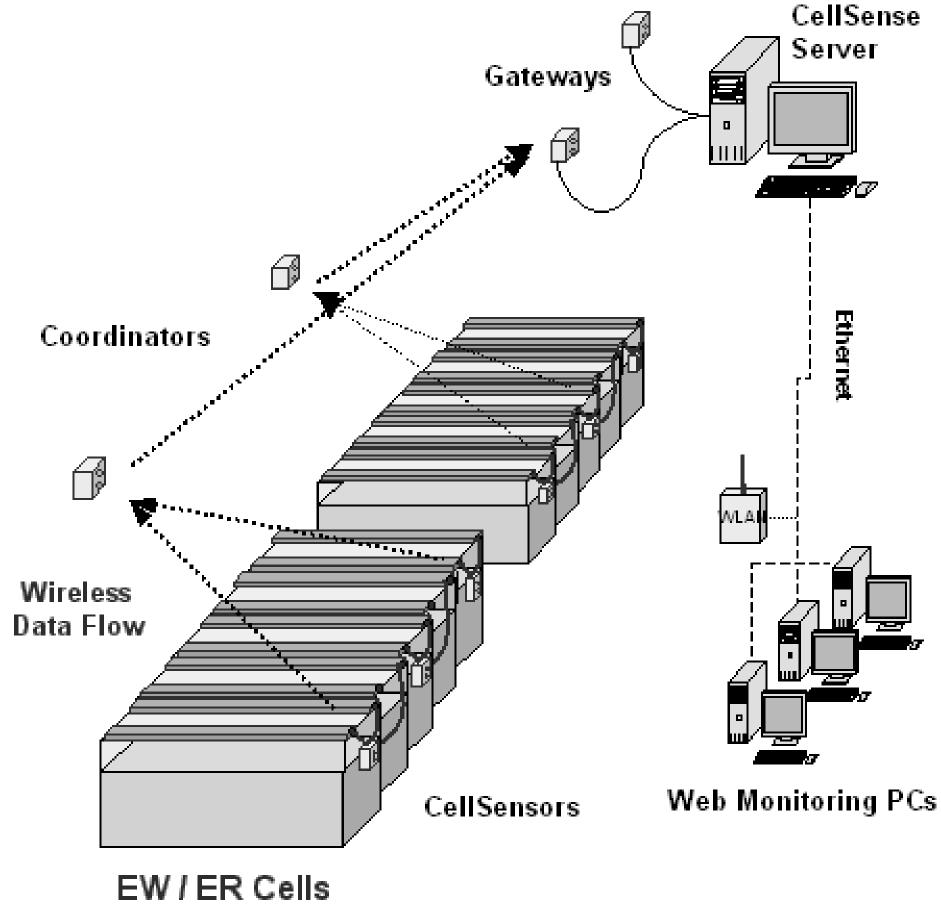


Figure 1. General Structure of the CellSensor System

CellSensor (CS)

CellSensor device is attached to an electrolytic cell with a simple mounting mechanism. Each unit is capable of measuring the cell voltage and electrolyte temperature of either one cell or two adjacent cells.

Installation of the device is simple. The device is connected to the cell bus bars with short lead wires of about 4 mm^2 cross section (AWG 12). CellSensor is powered by the low cell bus voltage it measures. The temperature probe is placed into the cell and connected to the CellSensor. The system requires no calibration which furthermore simplifies the installation and maintenance. Once the CellSensor is powered, the wireless measurement data transmission is started automatically.

A typical CellSensor mounted on a commercial cell is presented on the Figure 2.

Figure 2. CellSensor Device Installed to an Electrolytic Cell

As shown in the general block diagram in Figure 3, CellSensor device consists of a small electronics Printed Circuit Board (PCB) with

- Powerful on-board signal processing (microprocessor)
- Integrated antenna for communication over 2.4 GHz ISM radio (IEEE 802.15.4)
- Voltage booster for power management
- Two input terminals
  - T1 for bus bar cable connections
  - T2 for temperature probe connections
- Holder for back-up battery
- LEDs for status display
- Ambient temperature sensor for automatic temperature compensation and diagnostics

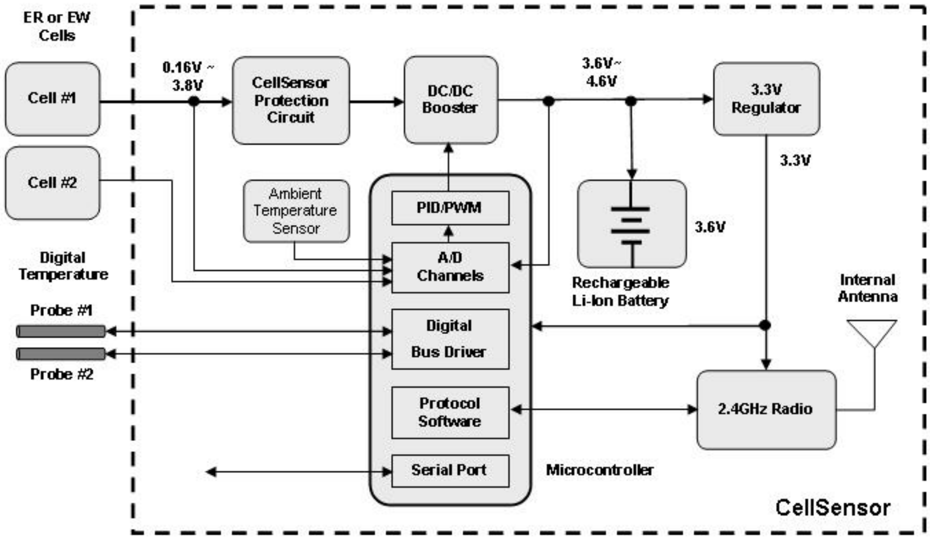


Figure 3. Block Diagram of the CellSensor Device

The CellSensor board is capsulated and protected in with an IP65-sealed polycarbonate box (168x140x80) mounted on a profiled stainless steel (AISI316) backing plate. The plate is used for attaching the CellSensor to the cell.

Refer to chapter 4 and Appendix 2 for proper installation and wiring options of the device.

Input Terminals and Push Buttons

Input terminals T1 (voltage) and T2 (temperature), battery plug J5, communication port (Gateway) J3 and Reset button are shown in Figure 4 below.

In Figure 4 the standard bus bar cables with colour scheme are shown (shipped with the CellSensor devices) and the communication wires of the two temperature probes are properly connected. Back-up battery is also connected with battery plug J5. Communication port is used only by the Gateway device (the pin order is defined in the Appendix 4).

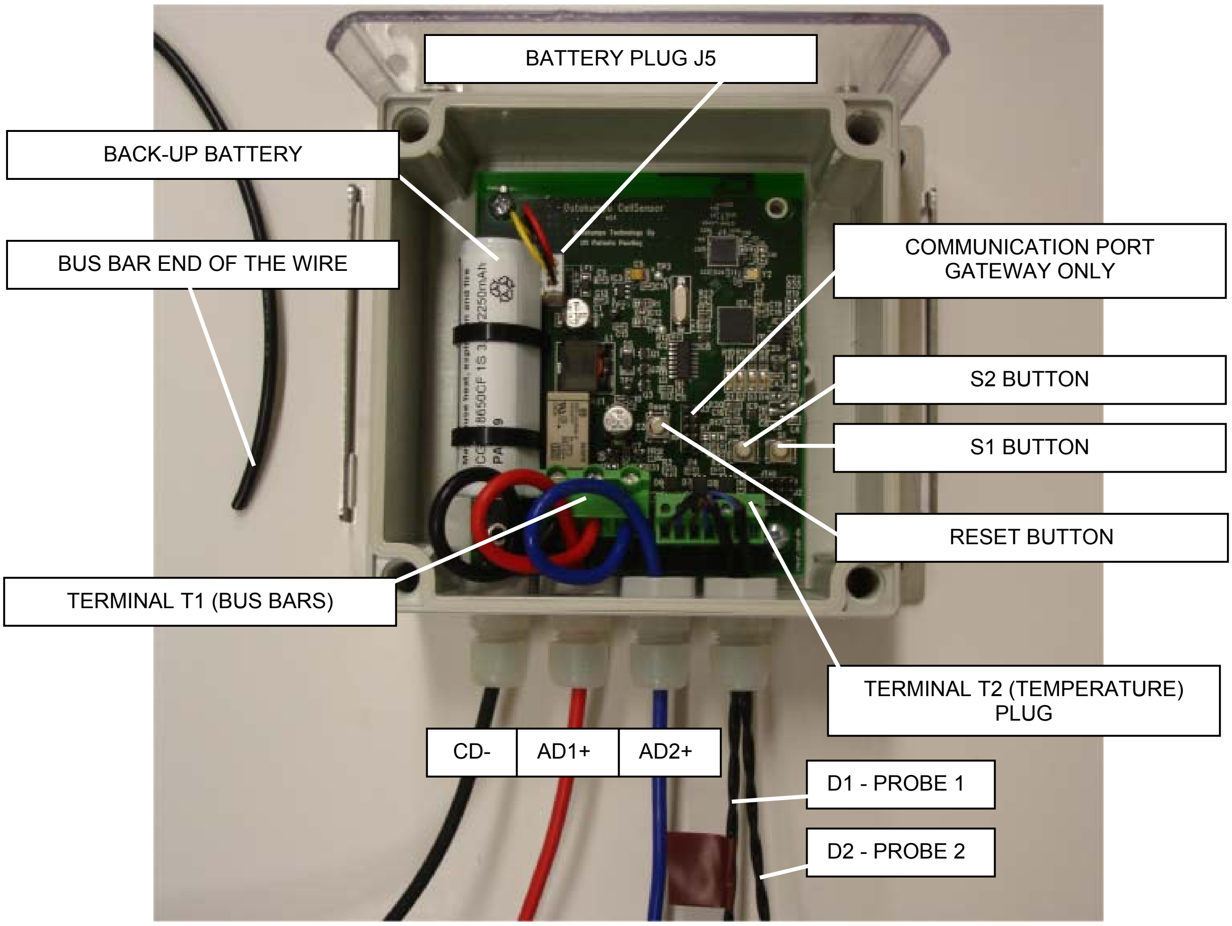


Figure 4. Input Terminals, Battery Plug, Communication Port and Push Buttons of the CellSensor, Coordinator and Gateway devices.

Terminal T1 is used to measure the cell voltages and also to power up the device. The port is classified for CAT I voltage measurements and it should not be connected and used for CAT II-IV rated measurements. The maximum continuous input voltage for the T1 terminals is 25 V.

Ports of the voltage terminal T1 are described in Table 1 below. T1 is not used by Coordinator or Gateway devices.

Table 1. Description of Cell Voltage Terminal T1 of CellSensor

T1 Port	Cable	Description
CD-	Black	Common Ground AD1+ and AD2+ are measured against CD- Voltage Booster Ground
AD1+	Red	Voltage Input Channel 1 (0 – 2.5 V (ER) or 0 – 8 V (EW)) Voltage Input for powering the CellSensor device
AD2+	Blue	Voltage Input Channel 2 (0 – 2.5 V or 0 – 8 V)

Refer to Appendix 2 for different and correct wiring alternatives.

Ports of the temperature terminal T2 are described in the Table 2. T2 is not used by Coordinator or Gateway devices.

Table 2. Description of Temperature Terminal T2 of CellSensor

T2 Port	Probe Wire	Description
D1	Probe 1 – Brown	Probe 1 channel (signal)
D2	Probe 2 – Brown	Probe 2 channel (signal)
D3	NA	Not Used
GND	Probe 1, 2 – Blue	Common ground
V+	NA	Not Used

The functionality of the push buttons Reset, S1 and S2 are described in the Table 3 below. The push buttons provide restricted and local interface to interact with CellSensor System devices (set network address, channel, transmit data, reset (boot), etc.). The buttons can be used anytime during the system component is running.

Table 3. Description of the Push Buttons

Button	Action	
	CellSensor	**Coordinator / Gateway**
Reset	Restart of the device	Restart of the device
S1	Manual command to transmit data.	Not in use
S2	Manual command to switch to Boosting Mode. If the input voltage is out of operating are, device switches immediately back to Power-Saving Mode	Not in use
1. Push Reset 2. Reset + S1 3. Release Reset 4. Release S1*	Enter network setup mode / Check network configuration -Network address	Enter setup mode / Check network configuration -Network address - Channel

* **Do not unnecessarily make any change to device settings!** These settings are critical to system performance and function. Consult Outotec support in any concerns before any configuration change. See Chapter 6.3 instructions for changing the configuration with push buttons.

Voltage Booster and System Modes

The innovative voltage booster in CellSensor makes it power self-sufficient and a true wireless device. It is powered by the energy harvested from the "endless" power source – electrolytic cell. The booster is able to boost the input voltage, or cell voltage, from as low as 0.16 to above 4.0 V, so that the CellSensor will be able to work with wide range of electrolytic cells and also cells under very bad condition (low cell voltage).

The two operational modes of the CellSensor device are shown in Figure 5. The active mode is indicated for the user by the LEDs on board (see Diagnostics chapter 5.2).

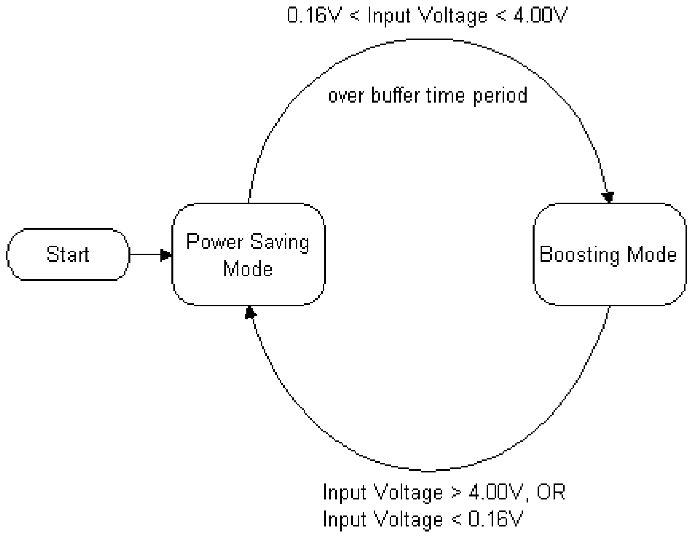


Figure 5. The Operating Modes of the CellSensor Device.

When the input voltage is between the normal operating range (0.16 V – 4.0 V) the CellSensor is in **boosting mode**, which is the normal mode of the device. In boosting mode the device is powered by the booster directly.

A rechargeable Li-Ion battery is equipped as a backup power supply in case the external power source becomes unavailable. During the boosting mode the battery will be charged by the booster circuitry and kept full. The output voltage of the booster is controlled and regulated by the on-board microprocessor with advanced high speed digital PID controller.

The battery will be automatically switched in when CellSensor enters **power-saving mode**. This will happen in two conditions:

- if the cell is powered down e.g. during cathode harvest, maintenance and cut-in/cut-off of other sections in the rectifier circuit during operation
- if the self diagnostic of the CellSensor indicates a poor tap contact condition (see Diagnostics)

Entering power-saving mode is automatic. The CellSensor continues to measure and report the temperature and voltage normally but with slightly decreased scan rate. The mode is automatically switched back to boosting mode when the input voltage recovers back to normal operating range and the tap contact condition is good. Continuous power-saving mode can last up to 5-7 months depending on the scan rate and data transmission intervals specified for the mode.

Voltage Measurement Range and Resolution

The voltage measurement range is not depended on the normal booster input voltage operating range (0.16 – 4.0 V) or the system mode. CellSensor device measures and transmits the voltage data normally in both system modes.

There are two voltage measurement range options available depending on electrolytic cell the CellSensor is measuring.

- For Copper Refining (ER): 0 – 2.5 V
- For other electro-refineries (EW) 0 – 8.0 V

The resolution of the voltage measurement is 0.0024 V.

Temperature Probe

A calibration free and high precision digital temperature sensor is used for the electrolyte temperature measurement. It measures temperature from -55°C to +125°C and has a guaranteed accuracy of ±0.5°C with a resolution of 0.0625°C over -10°C to 85°C range.

The temperature probe is a one-meter long and 6 mm diameter stainless steel (AISI316) tube coated with polypropylene, which makes it chemically resistant to the electrolyte. The temperature sensing element is located at the end of the probe tube and it is protected by a polypropylene cap filled with silica glue. The sensing component is a small footprint digital semiconductor device that is linked with two wires (blue-signal, brown-ground) to the T2 terminal of CellSensor (see Appendix 2 for wiring). The microprocessor of the CellSensor contains customized drivers to optimise the sensor performance and the measurement quality.

The probe is delivered as a straight tube. During the installation the probe is formed (e.g. bent) to suit the cell design with standard instrumentation tools. Installation and commissioning of the temperature probe is plug and play. Once the temperature probe is formed to suit the cell and is attached properly to the terminals of a CellSensor, it automatically starts the transmission of the temperature data.

Data Acquisition and Filtering

CellSensor device is very closely located and electrically floating to measurement point, which guarantees high precision and quality measurements. The noise caused by the harsh tank or cell house environment (strong magnetic fields, dirty bus bars, short circuits between anode and cathode, etc.) is minimized because of short wiring and closely performed digitalisation with high frequency sampling. The CellSensor measurements require no calibration and it automatically compensates for the effect of the ambient temperature changes to the measuring device electronics.

The CellSensor samples cell voltage and temperature with the scan rates that are defined by the user (default 15 seconds, minimum 3 seconds). CellSensor transmits the voltage and temperature measurements in case either the following conditions apply after each measurement scan:

- Scanned measurement value has changed over 1% from the previous value
- Time of the last report has exceeded 1 minute

The CellSensor activates its radio only for the period of data transmission.

Diagnostics

Each CellSensor device monitors its status continuously:

- Bus bar cable tap contact quality (1 = Good, 0 = Poor (Alarm))
- Battery voltage (V)
- Communication link status (1 = Good, 0 = Lost (Alarm))
- Ambient temperature (^{o}C or F)

The diagnostic information is routed up to CellSense Server and is available through all data view and interface options. The diagnostic data is updated once per minute.

CellSensor device is also equipped with four LEDs on board to present the operating mode and status locally for the user. See chapter 5, Diagnosing the System, for more detailed information.

Coordinator (CN)

CellSensors can associate only with Coordinator devices.

A Coordinator has three functions in the CellSensor Network:

- Master of the CellSensors attached to it
- Manage the PAN it forms (Personal Area Network by IEEE 802.15.4)
- Route the measurement data up to Gateway device.

Coordinator keeps the radio always on and receives the measurement and diagnostic data each attached CellSensor send. The information is placed in a small buffer and forwarded to Gateway device once the buffer gets full or the buffer timer expires.

Figure 6. Coordinator Device Mounted on a Tank House Wall. External Power is fed from the PSU to Coordinator with an external cable.

Each Coordinator is able to manage up to 200 CellSensors up to 50-200 meter range. The communication range depends on the tank house shape, equipment and materials. The maximum number of the Coordinators in the CellSensor Network is 40.

The amount of Coordinators required by a CellSensor system depends not only by the number CellSensors installed and communication range, but also for making sure that fully redundant communication paths are available for each CellSensor. Each CellSensor should always be able to reach at least two Coordinators.

Coordinator devices should be located e.g. on the walls of a tank or cell house, typically about 2 – 5 meter high to ensure good communication coverage and non-hindrance to moving cranes or other equipment and tools.

Coordinators are powered by mains connected to external and small Power Supply Unit (PSU) (see Chapter 4 for specification and Appendix 2 for wiring).

Gateway (GW)

Coordinator device can associate with a Gateway device, that is connected with CellSense Server PC over USB cable. Like Coordinator, the Gateway device includes external and small PSU (Power Supply Unit) for powering the device (see Chapter 4 for specification and Appendix 2 for wiring).

There can be up to two Gateway devices in the CellSensor Network.

A Gateway device has three functions in the CellSensor network:

- Receive data routed by Coordinator devices and push them to CellSense Server PC
- Manage the PAN it forms (Personal Area Network by IEEE 802.15.4)
- Manage the Coordinators attached to it

Gateway keeps the radio always on and receives the data routed by Coordinator devices and buffers them in a small buffer. The buffered data is pushed to the USB once the buffer gets full or when the buffer timer expires.

Figure 7. Gateway Device (smallest box) mounted on the wall of a cell house.

Communication Cable and Options

By default, the communication between Gateway and CellSense Server PC is over USB line that is shipped with the Gateway device. The Gateway serial port supports TTL, so an USB cable with integrated TTL converter in the USB plug is connected to the serial port. The USB plug can be connected to any USB port of PC or extended with another USB cable or extender device. See Appendix 4 for the cable and Gateway serial port specification.

In special cases a RS232 cable with integrated TTL converter can be used and shipped on special request. This option is needs to applied if serial to Ethernet converters are used between the Gateway and CellSense Server PC.

The recommendation for the maximum single USB line length is 5 meters. In case longer distance is required, the following options are available:

- Use active USB extender(s) or Hubs
- Use fiber optic converters for USB line (in case the line is really long)
- Use serial to Ethernet converter to enable Ethernet connection with the Gateway device. This option requires serial cable (RS232/TTL) to be instead of USB cable.

CellSense Server PC

CellSense Server PC is a standard server class PC running Windows 2003 Server OS. CellSense Server has several important functions in the system.

- Runs CellSensor Driver to read, store and publish the CellSensor measurement data
  - Configuration of the driver (see chapter 4.5)
- Hosts CellSense Monitoring System
  - Raw measurement data refining into more clear status information
  - Web Based User Interface
- Provides data interface for third party systems over Ethernet
  - OPC Server
  - ODBC

Power Supply Unit (PSU)

Coordinator and Gateway devices are powered external and small Power Supply Units (PSU). Each Coordinator and Gateway devices has own PSU, which contains terminal X1 for mains, X2 for powering the Coordinator or Gateway device, 5 VDC power supply G1 and main switch S1.

The input for the PSU X1 is 100 – 240 VAC / 50-60 Hz (0.2 – 0.4 A). Use external fuse or circuit breaker (0.5 A) that is closely located to PSU on the mains line.

Power cable from the Coordinator or Gateway is connected to terminal X2 which has 5VDC output. Refer also to Appendix 2 for the wiring diagram.

2.2 CellSensor Wireless Network

CellSensor Wireless Network (CWN) is a proprietary network protocol. The CWN has been developed in order to achieve following objectives:

- Large system scale
- High node density
- High data volume
- Tolerance for very strong magnetic field interference
- High Reliability and scalability
- Low data transfer latency
- Fast and easy set-up
- Sufficient diagnostic information

The CWN is based on IEEE 802.15.4-2006 standard for its robust design on Physical and Medium Access Control level, as shown in Figure 9. The network is optimised for the upstream data throughput and network level redundancy is implemented to achieve reliable data communication.

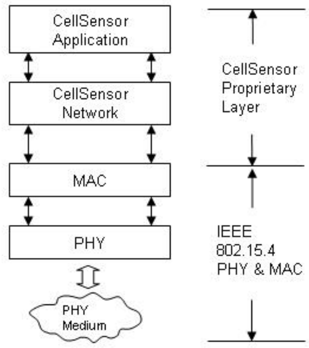


Figure 9. CellSensor Wireless Network (CWN) Protocol Stack

Personal Area Network (PAN)

CWN is formed by multiple PANs by IEEE 802.15.4 (Personal Area Network). Each Coordinator or Gateway forms and manages a PAN in CellSensor network and has communication coverage from tens of meters up to two hundred meters, depending on the actual environment. Each PAN operates on one of the 16 channels available in 2.450 GHz ISM Band (see Figure 11).

Data Flow and Routing

The CWN is designed and optimised for up-stream data flow to provide reliable measurement data and with minimum latency time from the CellSensor to CellSense Server PC.

The main principle of the data flow is presented in the Figure 10 below.

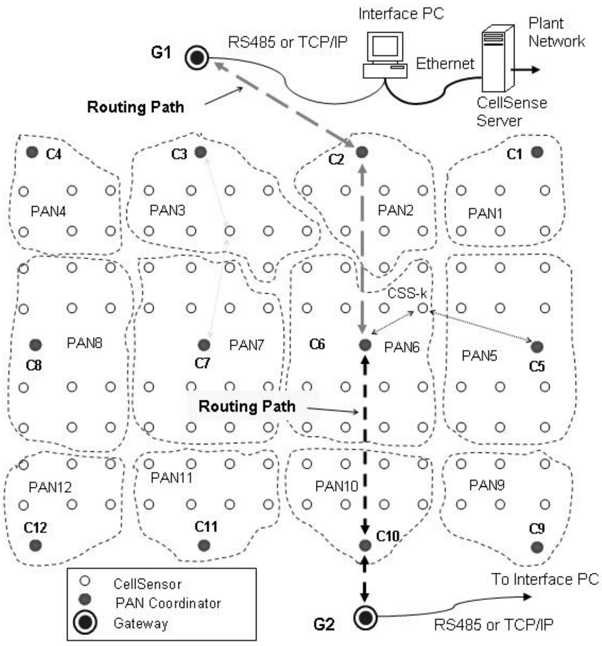


Figure 10. Data Flow Diagram and Principle of the CellSensor Wireless Network

CellSensor devices can transmit data only with Coordinator devices. Also Coordinator devices can only send data to Gateway devices. Gateway is connected with CellSense Server via USB cable (See chapter 2.1.2).

On-power up a CellSensor performs a network scan to search Coordinator devices in range and associates the one with best radio link quality. The channel of the Coordinator (PAN) is shown by the LEDs on power up (see chapter 5.2). If no Coordinator devices are found CellSensor will continue to scan periodically for Coordinator devices.

If the link with the Coordinator device breaks for some reason (e.g. crane temporarily blocking the link), the CellSensor will re-scan the network for alternative Coordinator to transmit the data. Provided that the network layout is properly designed, meaning that each CellSensor device is able to reach at least two Coordinators, the network redundancy and robustness for environmental changes is guaranteed.

From the network perspective, Coordinator devices act similarly than CellSensor devices. Coordinator devices will associate only with Gateway devices.

Addressing

Each device in the CellSensor Network has a unique 16-bit network address, which is also labelled on the circuit board.

The address and map file of the CellSensor Driver is pre-configured before installation and shipment, but can be changed later on if necessary. See chapter 5.3 for instructions on changing the device addresses.

CellSensor

Every time a CellSensor transmits data it includes its address to the packet. The address is used by the CellSensor Driver to identify the source of the data at CellSense Server PC. The driver translates the 16-bit device address into exact cell location (section, cell) with a map file on the CellSense Server PC. The map file is a simple text file defining the link between CellSensor device addresses and their exact location at the cells (see chapter 4.5.2.5 for description of the map file structure).

CellSensor address consists of four hex value and it is set according to location of the unit in the tank or cell house. The valid address range is 0100 – EEEE. The address is labelled on the CellSensor device.

The first two hex values define the section and the last two the cell. In case the CellSensor is measuring two cells, then the cell address refers either one of the cells and mapping file is configured to produce two measurements from this address.

For example, a CellSensor with address 0201 would be located at cell 1 of the section 2, or 0F0A would be located at cell 10 (A) of section 15 (F). If CellSensor addressed 0201 above was measuring two cells (cell 1 and 2) the map file includes configuration for the CellSensor Driver to handle the data for the both cells.

Coordinator and Gateway

Although Coordinator and Gateway devices do not produce any measurement data they have network addresses also. These addresses are required for the network to operate properly, route the data and for diagnostic purposes. The network addresses of the Coordinator and Gateway devices are not included in the map file and they do not incorporate information of the real location at the tank or cell house.

Coordinators utilize addresses ranging from 0010 to 00FE. The label of the Coordinator includes CN tag followed by the last two hex values of its network address (e.g. CN-11, CN-FE, CN-1A).

Gateways address range is 0001 to 000E. The label of the Coordinator includes GW tag followed by the last two hex values of its network address (e.g. GW-01, GW-02, GW-0B).

Radio Features

The transmission power of the CellSensor system devices is 0 dBm at maximum. DSSS (Direct Sequence Spread Spectrum) is utilized on the 2.450 GHz globally unlicensed ISM band (2.400 – 2.483 GHz). The band provides 16 channels for device communications and access is by CSMA/CA method similar to Wi-Fi systems (Carrier Sense Multiple Access with Collision Avoidance).

Each of the 16 sub channels occupy 3 MHz and are centered 5 MHz from each other, giving a 2 MHz gap between pairs of channels. The capacity of each sub channel is 250 kbps. The default network duty cycle of the CellSensor device is low because of the reporting rules applied for transmission of the data.

CellSensor device activates the radio only for the duration of the radio transmission. Coordinator and Gateway devices have their radio always on.

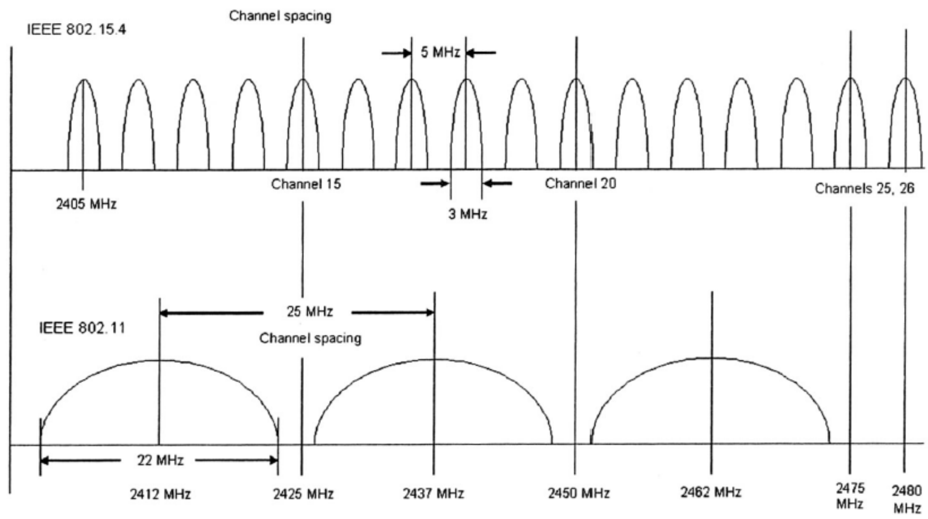


Figure 11. The 16 sub channels of IEEE 802.15.4 and Wi-Fi (802.11) channels used in North Americas.

Coexistence with Wi-Fi Networks (802.11)

Since the 2.450 GHz ISM band is globally available for many other wireless devices and systems, such as Wi-Fi, co-operation, -existence and robustness of these systems is considered in the CellSensor system design and also by IEEE 802.15.4.

As CellSensor can utilize varying selection of channels available and is a low duty cycle system with very low transmission power, CellSensor system can be well configured to guarantee un-interrupted and reliable data transmission and also low inference for other systems.

For instance, as shown in lower part of Figure 11, the Wi-Fi systems operate typically one of the three wide channels allocated for them by 802.11 on 2.450 GHz band. Therefore, a set of channels can be determined for the CellSensor system components that do not over lap the Wi-Fi channel used. There are always few channels available that are not used by Wi-Fi at all (15, 20, 25 and 26 for typical Noth American Wi-Fi systems (802.11b)).

3. Operating Safety

Before installing, operating or maintaining the CellSensor System please familiarize yourself with these important safety and operating instructions described in this section. By following these instructions you enable full utilization of the system, prevent unnecessary equipment malfunctions and most importantly provide safety for the users working with the system and its components.

Warning sign presented below on any of the system component requires special attention on safe operating of the component and system. Following the instructions of the manual is strictly required.

Failure in following these instructions may lead serious personal injury, damage of the equipment and avoid warranty!

General instructions:

- Only trained and authorized persons are allowed to install, operate and maintain the system components
- All the work, materials and design applied for the system components must comply the effective local regulations, safety rules and procedures that may apply
- The permitted actions for operating and maintaining the CellSensor system are specifically described in this manual. Never try to open, remove or modify any other parts or components from the system, or use the system components against the instructions. The instructions cover only the normal use of the system components.
- Do not unnecessarily make any change to device settings. These settings are critical to system performance, safety and functionality. Consult Outotec support in any concerns before any configuration changes.
- Make sure you know how to power down the components in case of emergency (see chapter 5) or whenever necessary
- Do not replace any component or part of the system with a component or spare part not approved by Outotec.
- Make sure that system component is powered down before any maintenance is performed to the components
- Do not connect any other devices, wires, voltage/current or equipment than what is specified and described in this manual to the input terminals of the system components.
- Do not use any of the system components if it has sustained or there is reason to suspect for any type of damage

- Mount the devices and route all the cables in such a way that no safety risk is caused for the operators or other persons at the plant.
- Do not connect any other communication cable than what has been supplied with the system to the J3 port pins (Gateway device)! Use only the pins, signals and signal levels described in the appendix 3. See Appendix 3 for port and port specification.

If you are in doubt of safety of the equipment, switch off the electric power and report your findings immediately!

3.1 Electrical Safety

The CellSensor system fulfils the Low Voltage Directive (LVD) and other relevant European Union safety regulations.

The CellSensor is electrically floating between the cell bus bars and the potentials of bus bars are connected with short wires to CellSensor terminal T1. The voltage level inside the CellSensor box and on terminals of T1 are determined by the input voltage, which equals the cell voltage. The input voltage level depends on the type, configuration and design of the electrolytic cell and produced metal. Typical cell voltages range from 0.3 to 0.6 V in copper refineries and from 1.2 to 3.9 V in different electro-winning plants.

The normal operating range for CellSensor input voltage is 0.16 – 4.0 V (voltage booster operating area). Because each CellSensor is capable of measuring two cells, the normal operating voltage levels inside the CellSensor box are between 0.16 – 8.0 V. The voltage level of microprocessor circuitry is always 3.3 V.

The normal current draw of CellSensor is 0.010 – 0.200 A depending on the input voltage. If a CellSensor device has been in power-saving mode for a long time and battery has depleted to low levels, the current draw can temporarily increase to 0.2 – 2.0 A for the duration of re-charge.

Depending on the electrical connections and layout between electrolytic cells the input voltage can temporarily increase over normal values e.g. during cathode harvests or cell maintenance. **Always find out and be aware of the possibility of having exceptionally high cell voltage levels present before opening the CellSensor box cover.**

As the cells are electrically connected in series, the potential of a cell bus bar can be high to plant grounding (even 700 V). Follow carefully the local safety regulations and minimize the length of the bus bar wires to prevent possibility for short circuited connection to the grounding due to lose wire or some other improbable event or accident.

The nominal voltage of the mains power supply for PSUs of Coordinator and Gateway devices and CellSense Server PC is 115 or 230 VAC. The mains voltage is connected to external PSU (Power Supply Unit) of Gateway and Coordinator devices. The voltage between the PSU and Coordinator/Gateway box is 5 VDC.

Bus Bar Wires

A huge electrical current is passing through each electrolytic cell and bus bars (typically 17 000 – 40 000 A).

- Always apply extra caution and care when working with bus bar wires
- Do not let the wires that are connected to different bus bars connect to each other (short circuit) in any circumstances
- **Do not touch or disconnect the wires of terminal T1 before making sure that they ALL have been disconnected from the bus bars first!**
- Always connect the wires to terminal T1 before connecting them to bus bars. Make sure that the wire is tightly and properly connected to T1 and it is not short circuited with other terminals of T1 or T2

Short circuiting the bus bar wires may lead to serious personal injury, equipment damage or fire.

3.2 Battery Safety

Each CellSensor device includes a re-chargeable Li-Ion back-up battery unit (Panasonic CGR18650CF1S1P with Fey GmbH safety circuit, 3.6V / 2350 mAh).

- **The CellSensor is carefully designed and tested to use the battery supplied with CellSensor device**

  DO NOT REPLACE OR USE ANY OTHER BATTERY WITH THE DEVICE!
- In case the battery needs to be replaced with a valid spare battery, follow the instructions of chapter 6.1 and 6.4 tightly
- Connect the battery only to designated connector (J5) on board.
- The battery plug can be connected to connector J5 only in one way. Do not use extra force to plug in the battery.
- Do not connect any other power source to J5 connector of **CellSensor Device** than the battery, that was supplied with the device or as a spare.
- The maximum operating temperature of the battery is 60 ^{o}C. If the ambient temperature increases above this limit, disconnect the battery.
- Do not deform, puncture, short circuit, disassemble or modify the battery
- Do not alter the battery for water or any other liquid
- Do not heat the battery or throw it into fire
- Do not leave the battery in high temperatures. Store it under 40 ^{o}C.
- Do not subject the battery to strong impact or throw it

The battery is equipped with an integrated and approved protection circuit to prevent under or over voltage and provide protection for short circuit condition of the battery wires. The advanced battery loading algorithm on board takes care of the automatic and safe charging of the battery in proper operating conditions (ambient temperature).

4. Installation

4.1 Main Principles of Installation

Each CellSensor system is designed to match the layout of the electro-refinery and to guarantee best performance through optimised structure of the system. The CellSensor system is designed, configured and tested before shipment to the site (addressing, scan rates, voltage ranges, etc.).

The CellSensors include the bus bar cables readily attached to terminal T1 of CellSensor (2 m / bus bar). The bus bar end of the cable is un-finished and must be prepared during the installation to suit the tapping method used. Coordinator and Gateway devices include the external PSU (Power Supply Units) boxes with internal cabling (5 VDC supply from PSU to device).

The operation of wireless devices starts automatically when the devices are powered on. All the software is loaded on the CellSense Server PC hard disk with initial configuration.

Usually the CellSense Server PC requires some changes and fine tuning in software parameters and server settings after first power-up (IP addressing, user names and privileges, domain settings, etc.).

Location of System Components

CellSensor

CellSensor devices are attached to the electrolytic cell. The design, space availability and layout of electro-refining cells vary from plant to plant, so the strategy of mounting the CellSensor device to a cell must be designed and agreed separately.

CellSensor device provides two standard options for mounting. A hook bracket to mount the device by hanging it over the cell edge or a set of holes on the back-plate for screw or tap based mounting to the cell wall.

CellSensor can also be mounted to some structure close to cell or even to the basement. In such case special attention needs to be paid on the electrical safety between bus bars and grounding of the electro-refinery (see chapter 3 for safety instructions).

Normal mounting orientation of CellSensor device is:

- Back plate facing to the cell
- Cable fittings facing down and roof cover facing up

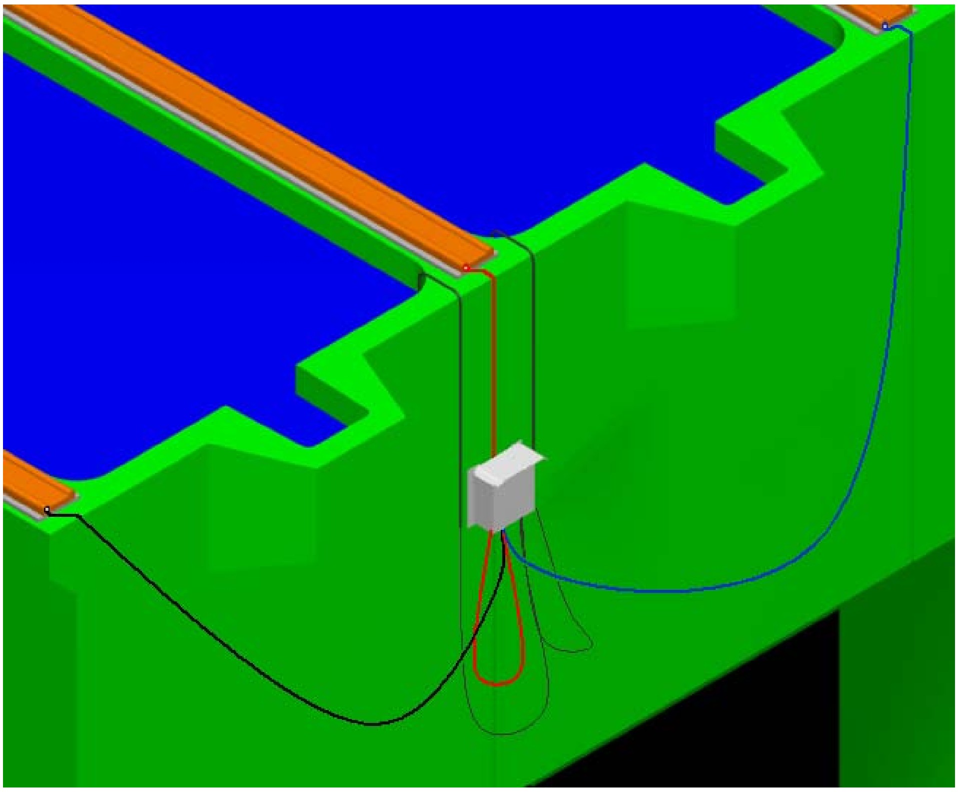


Figure 12. A CellSensor Mounted and Wired Properly to the Cell. **Wiring Case for an EW Cell displayed**, see other wiring options from Appendix 2.

Coordinator, Gateway and PSU

Coordinator and Gateway devices and their PSUs (Power Supply Unit) should be located on open space on the walls of the tank or cell house in such a way that they are easy to connect to mains and that their radio coverage is good.

The clearance between a Coordinator or Gateway and wall should be more than 0.3 m to guarantee good radio signal (See chapter 4.4 for mounting of Coordinator devices)

Non-hindrance to moving cranes of other equipment or work performed on the cells must be considered.

The mains power of a Coordinator or Gateway (110/230 VAC) is connected to PSU terminal X1. The mains power line should be fused (0.5 A) or equipped with an external circuit breaker. There is a 10 meter internal power cable between PSU and Coordinator device (5 VDC), which can be extended if required. Therefore, PSU can be located in different location than Coordinator, e.g. closer to electric supplies and places for more convenient access for switching on/off the Coordinator devices.

Gateway devices should be centrally located to Coordinators to minimize the routing of measurement data. They should also be close to CellSense Server PC for USB or Ethernet connection (USB connection can be extended by suitable converters if necessary).

CellSense Server PC

The CellSense Server PC should be located in clean and conditioned room with access to plant Ethernet network and connection to Gateway devices.

Required Tools

The basic installation of CellSensor system components does not require special tools or devices. A basic set of normal plant maintenance and instrumentation tools like pliers, side cutters, adjustable spanners, screw drivers, pipe bending tool, welding machine and hand drill are enough to mount and start-up of devices.

Usage of standard multimeter device (e.g. Fluke) is also recommended in certain steps of the installation.

4.2 Steps of Installation

The main steps and order of installation are:

1. Unpacking of the system components
2. Preparation of CellSensor devices
   - Bus bar connection
   - Bus bar cables
   - Installation of any assisting mounting accessories (plates, hooks, holes, etc)
3. Preparation of Coordinator and Gateway devices
   - Attachment of mounting rack
   - Power distribution
   - Installation of communication cable between Gateway and CellSense Server PC
4. Preparation of Temperature Probes
   - Bending of Probes to suit cell design
   - Connection of probe wires to CellSensor device
5. Mounting and power up of Coordinators and Gateways
6. Mounting and power up of CellSensors
7. Installation of CellSense Server PC, license module and final configuration

4.3 Preparation

Bus Bar Wiring

There are many options to connect CellSensor bus bar wires to bus bars.

The most common, easy and low cost method is to tap the cable with screw to the end of a bus bar. The main steps of preparing this type of connection is generally described in this section.

Figure 13. Bus Bar Tap with Screw.

1. Drill holes to the bus bars and prepare threads matching the screws used to tap the cable
   - Use only stainless steel screws (AISI316) for tap connections
   - Connect bus bars wires only to main bus bars in Outotec DoubleContact™ bus bar systems
2. Cut the bus bar cables of CellSensor to adequate length
   - The bus cable type is 4 mm^2 (AWG 12) copper (PVC)
   - Each cable should reach well the bus bar connection point
   - Route cables in such a way that no safety risk is caused for the operators.
   - Each cable should have a route that causes minimum disturbance for the operators and are least vulnerable for damage
   - Make sure that if cable gets accidentally loose or is cut, it will not have a chance to get short circuited to plant grounding
   - Do not coil the cable between the bus bar and CellSensor
3. Prepare the cable terminals
   - Clamp the suitable terminals to the bus bar wires for screw mounting

The contact between the electrical wire and the bus bar is susceptible to deterioration. The CellSensor utilizes its on-board computation power to identify and alarm the bad tap contacts for on-demand fix of the loose tap contacts.

Installation of Mounting Accessories

Depending on the mounting method chosen, prepare and mount the extra assisting equipment, like back-plates for screw based mounting, holes for the screws, supporting frames, etc. to the cell.

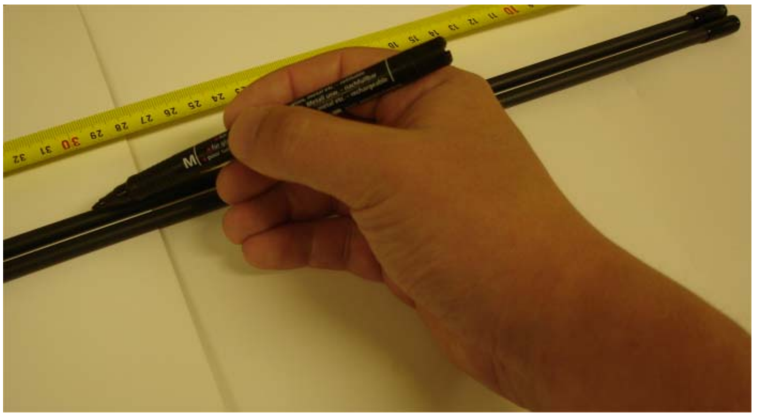
In case hook bracket is utilized, attach hooks to the back-plates of the CellSensor devices. Place the bracket to the back plate in a way that the holes of the bracket match the wings of the back plate. Tighten the brackets by bending the small attaching steel wings with pliers.

Temperature Probe

Temperature probe is shipped as a one meter straight probe. Because the designs of electrolytic cells are different from refinery to refinery and locations suitable for the probe placement vary, the final forming is done at site before commissioning.

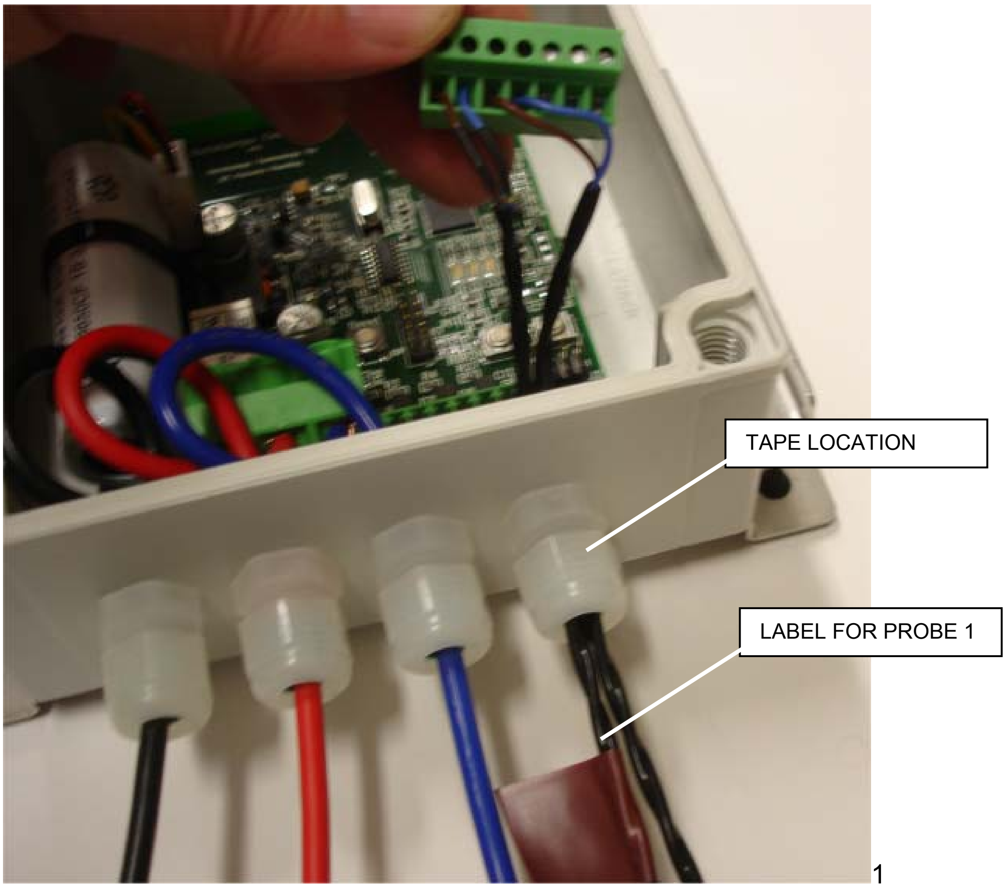
The forming, or bending, of the probe is done with a standard tube bending tool used e.g. for preparing instrumentation air pipe lines. The diameter of the temperature probe is 6 mm.

1. Design the mounting location and method, e.g.
   - Hanging around cell overflow edge
   - Utilizing an external support for mounting
2. Measure and mark the places where the probe needs to be bend and also the amount (angle) of bending required. Use coloured marker.



3. Bend probes according to markings with tube bending tool (6 mm pipe).

4. Pass the probe wires through the rightmost cable fitting. Use soft electric tape or similar to tie the wires firmly together from 5-8 cm wire ends. Locate the tape area to fitting when passing the wires through.

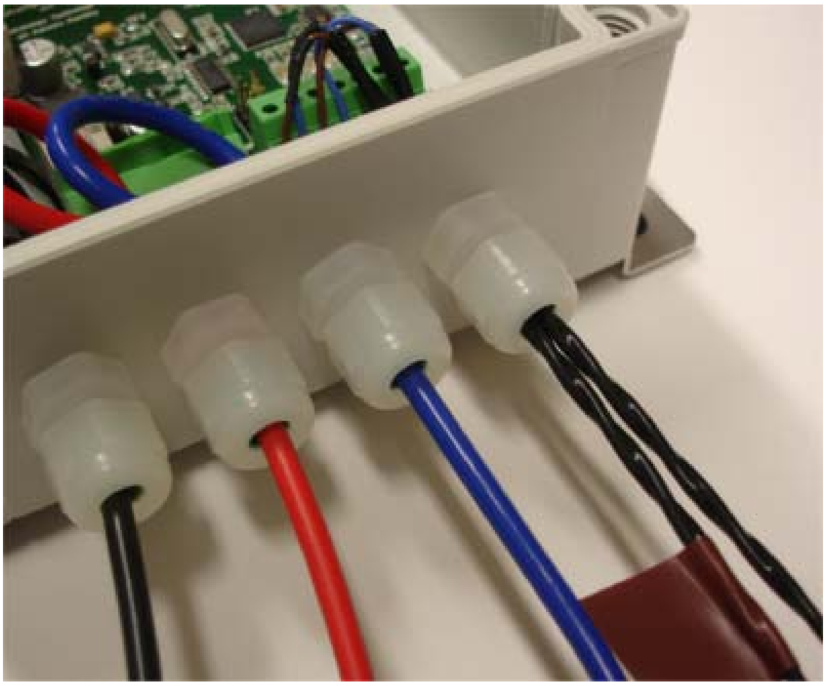


1

5. Remove the terminal T2 plug and connect the probe wires to the T2 terminals (refer also to Appendix 2 and project documents for correct wiring)

- Blue wire either to D1 (probe 1) or D2 (probe 2)
- Brown wire to GND next to terminal where Blue wire is connected
- **Note.** Label the probe wire connected to D1 (probe 1). This helps in placing the probes correctly to cells during mounting of the devices.

6. Connect the terminal T2 plug to the header



7. Tighten the cable fitting properly and test that the fitting seals the cabinet properly in order to avoid damages due to e.g. condensate

The probe can also be attached to T2 terminal during the mounting of the CellSensor devices at the cells. See also Table 2 of chapter 2.1 for Terminal 2 Description.

Note. It is beneficial to consider a light plastic tube or steel U-bar around the probe in the areas where it might be subject for mechanical damage (e.g. due to cranes, movable pumping stations, etc.).

Power Distribution and Racks for Coordinators and Gateways

Coordinator and Gateway devices operate on external 110/230 VAC power, because they are located high on the refinery walls. Standard mains power needs to be supplied to the designed mounting spots of the PSU units of these devices. Use external fuse (0.5 A) or circuit breakers in mains line supplying the PSU, which should be closely located (recommendation).

Design the routes for the internal power cables between PSUs and their Coordinator or Gateway devices.

Also light mounting racks need to be prepared to mount the devices to walls and to provide **at least 0.3 meter clearance from the wall**. This is to guarantee good radio performance for these devices. Utilize suitable plastic material (e.g. polypropylene) for the environment or AISI316 for the mounting racks.

Attach Coordinator and Gateway devices to the racks.

Some example mounting racks are shown in the Figures 7 and 8 of chapter 2.1.

Communication Cable between Gateway and Server PC

Prepare and mount the USB cable connecting the Gateway and CellSense Server PC according to local standards. Connect the USB cable to any free USB port of the CellSense Server.

4.4 Mounting of Devices

Once the system components are prepared according to instructions of chapter 4.3 they are ready to be mounted. If possible, the Coordinator and Gateway devices should be mounted and powered up first.

CellSensor

Mounting of the CellSensor device is done according to following procedure:

1. Open the CellSensor box
2. **IMPORTANT!** Connect the battery plug to battery connector (J5) and wait that LEDs flash twice. Disconnect the battery. This step is to guarantee that CellSensor device is in proper and safe state before it is attached to the cell.
3. Connect to bus bar wires to bus bars. **Make sure that the wires are connected in right order to bus bars** (see Appendix 2 and your project documentation). The black coloured wire must be connected to lowest potential bus bar. Refer also the cable routing instructions presented in chapter 4.3.1.
4. Mount the CellSensor device to cell
5. Place temperature probes to cells. Make sure that the probes are placed in right order to the cells (utilize the label described in the chapter 4.3.3, Appendix 2 and your project documentation)
6. Check that voltages are according to wiring plan on T1 terminals by measuring with a multimeter device (e.g. Fluke)
7. Connect the battery to battery plug J5
8. Wait and monitor CellSensor to power up (~5 seconds) with information provided by the LEDs. See chapter 5.2.1 for more detailed information on the LEDs.
9. Close the CellSensor box

Coordinator

Mounting of the Coordinator device is done according to following procedure:

1. Mount the Coordinator and PSU to designed places
2. Open the PSU box and make sure that PSU main switch is in OFF (0) position.

3. Mount and route the internal power cable emerging from the Coordinator. Pass the cable through the right-hand cable fitting and tighten it properly. Connect the cable wires to PSU terminals 3 and 4 of X2. See Appendix 2 for wiring diagram.
4. Pass the mains cable through the left-hand cable fitting and tighten it properly. Connect the mains cable wires to PSU terminals 1 and 2 of X1.
5. Switch the power ON (1) with the PSU mains switch
6. Close the PSU box

Gateway

Mounting of the Gateway device is done according to following procedure:

1. Mount the Gateway and PSU to designed places
2. Open the PSU box and make sure that PSU main switch is in OFF (0) position.
3. Mount and route the internal power cable emerging from the Coordinator. Pass the cable through the right-hand cable fitting and tighten it properly. Connect the cable wires to PSU terminals 3 and 4 of X2. See Appendix 2 for wiring diagram.
4. Pass the mains cable through the left-hand cable fitting and tighten it properly. Connect the mains cable wires to PSU terminals 1 and 2 of X1.
5. Mount, extend if necessary and connect the USB cable emerging from the Gateway unit to a free USB port of the CellSense Server PC
6. Connect the mains power to PSU terminal X1
7. Switch the power ON (1) with the PSU mains switch
8. Close the PSU box

Server PC

The CellSense Server PC should be mounted to clean and air conditioned room with UPS electric supply and plant Ethernet connection available. Optimally the PC should be close to Gateway device for USB connection, but can be extended by utilization of suitable signal converter devices available (See also chapter 2.1.3.1).

4.5 Configuration of Software

CellSensor system incorporates few licensed software components on the CellSense Server PC. All software is installed, pre-configured and tested before shipment, commissioning and start-up of the CellSensor system.

- **CellSensor Driver** – Reads the data from the Gateway over USB or Ethernet (virtual COM port) and provides it for the CellSense user interface. Driver provides also OPC Server and ODBC interfaces for third party system communications (e.g. Historians and DCS systems).
- **CellSense Monitoring System** – Provides a real time and web based monitoring view for easy access to CellSensor measurement data. The

system performs also advanced data processing to display the cell status information instead of plain measurement values. Please refer to CellSense manual for more information.

USB License Module

All software components require a license to run, which is contained in a USB module. The existence of the license is periodically monitored by the software. Do not remove the license module when CellSensor or CellSense software is running.

The license specifies the scope of electrolytic cell data it can handle with the software and options enabled for the system. The scope of the license is always logged to the driver log file ([CellSense folder]\log) on CellSensor Driver start up and defined in your CellSense and CellSensor License Agreement.

In case more CellSensors are transmitting data than the license entitles, the CellSensor Driver will stop and log license violation to the log file. In such an event decrease the number of CellSensors in the system or contact Outotec support.

Installation of the License Module

The license is shipped as an USB module shown in Figure 13. The attached label contains important information about the license (serial and key number and customer identification).

Drivers for the USB license module are installed automatically during the CellSensor Driver setup.

Figure 13. USB License Module with License Information Plate. Have the Module always in USB port of the CellSense Server PC while the CellSensor Driver or CellSense software is running.

CellSensor Driver

Installation

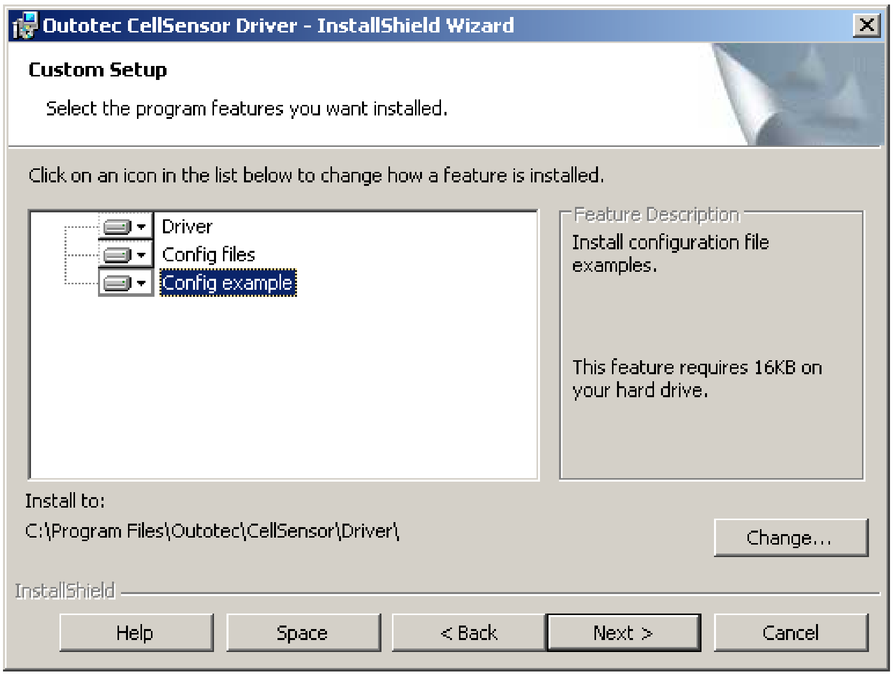
To install the CellSensor Driver:

1. Insert the CellSense Installation CD to PC and run X:\Software\CellSensor\CellSensor Driver v[version number].exe

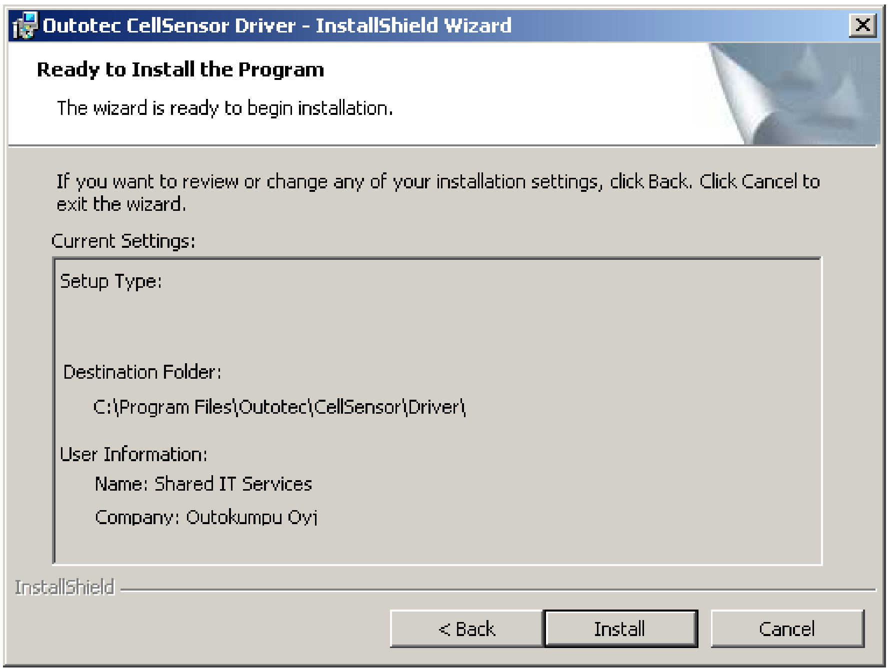
   (X is the drive letter of the CD or DVD drive of the PC, it can vary depending on the PC settings).

2. Windows Installer starts to install the driver. Click Next.

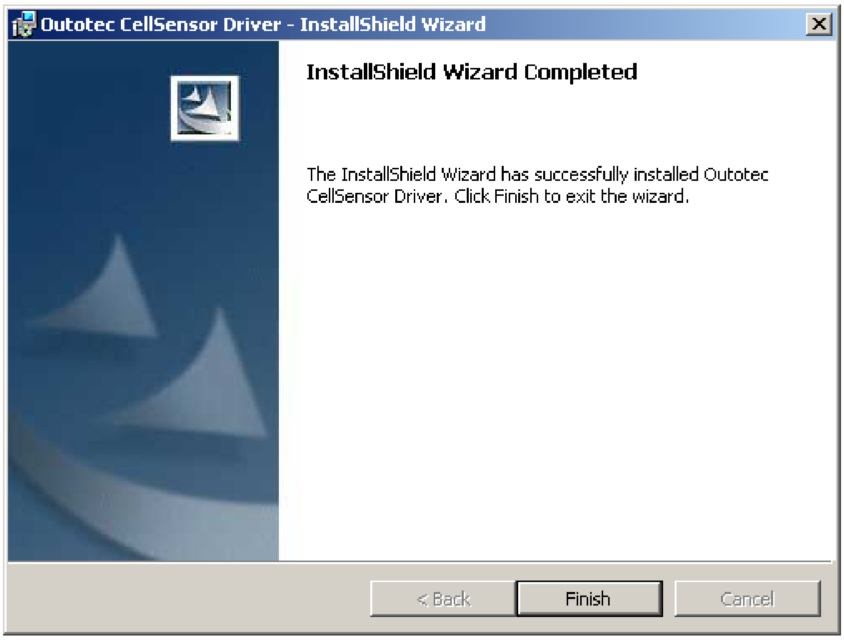
3. Select the parts to be installed, click next.



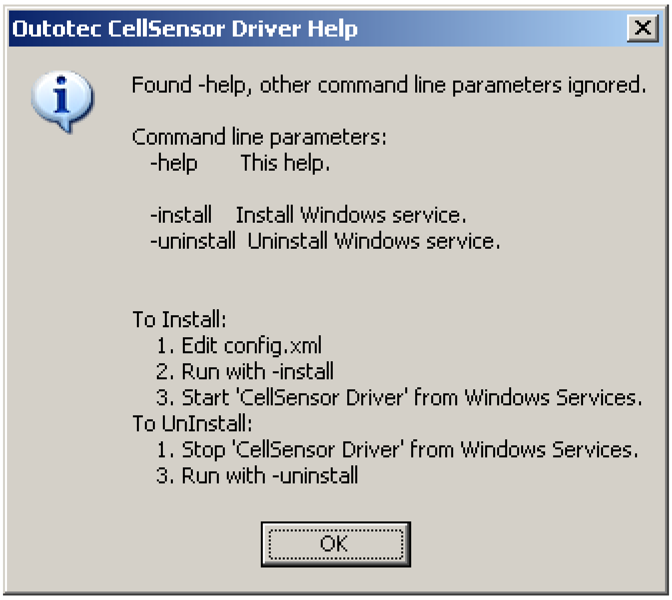
4. Click Install



5. Wait Installer to install the Driver. Click Finish (This takes a while as USB module drivers are installed now).



6. Open Command Prompt to configure the driver. Start → Run… → cmd and click OK.
7. Browse c.\Program Files\Outotec\CellSensor\Driver\
8. **Make sure that USB license module is in the USB port**
9. Type CellSensorDriver.exe –help
10. Follow the instructions displayed for finishing the installation.



COM Port

CellSensor Driver reads the data from the Gateway device over COM port to which the communication cable is connected. The COM port number and parameters are defined in the driver configuration file (see chapter 4.5.2.2). In case CellSensor system consists two Gateways, they have own COM ports for communications.

If default USB cable connection is used between Gateway device and CellSense Server PC, the virtual COM port is created automatically during the Driver installation. The COM port numbers and properties can be checked from Start → Settings → Control Panel → Administrative Tools → Computer Management as seen in the Figure 14 below (COM8).

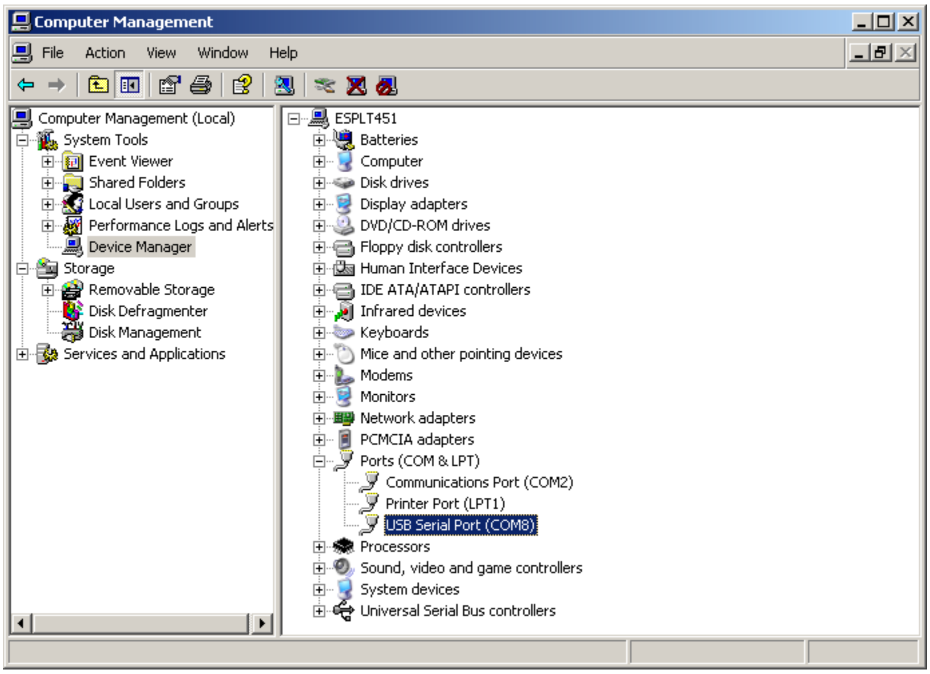


Figure 14. COM Ports of the CellSense Server PC can be checked and modified with Computer Management Console.

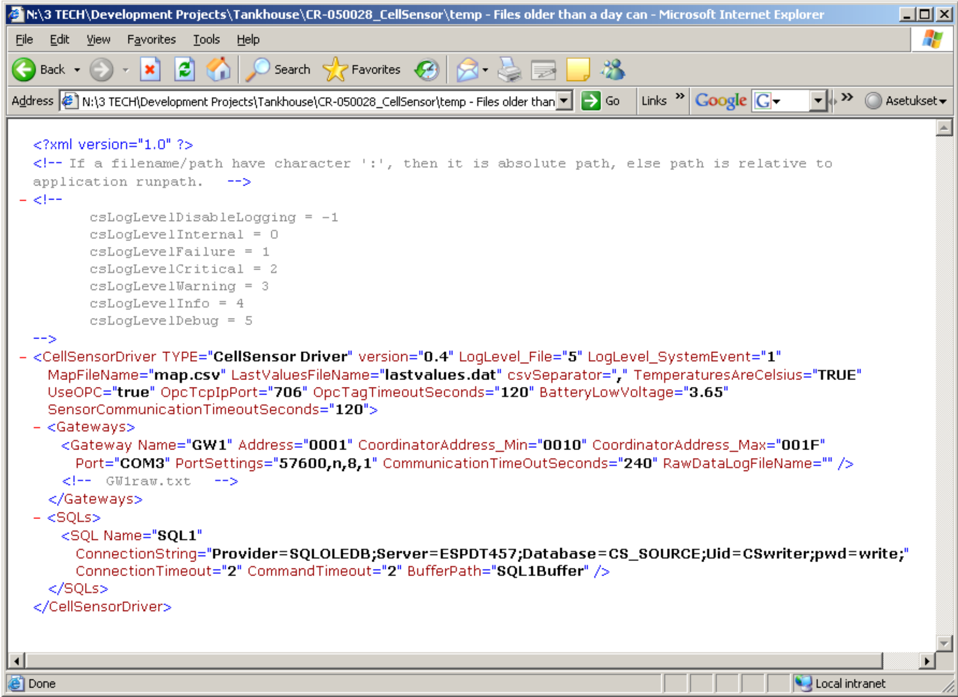
If RS232 connection is used then the serial COM port number is used by the Driver.

If Serial to Ethernet converter is used between the Gateway device and CellSense Server PC then the setup utility of the converter device needs to be run and virtual COM port installed. The CellSensor driver will communicate with this virtual COM port over Ethernet to the Gateway.

Configuration of the Driver

CellSensor Driver requires some parameters to run properly. These parameters are set in the C:\Program Files\Outotec\CellSensor\Driver\config.xml file and can be edited with Notepad editor for instance. Driver reads the configuration file on start-up, so any changes applied to the file requires re-start of the Driver (see chapter 5.1.3). The configuration file is configured and tested before the shipment and commissioning.

The configuration file structure is shown in the Figure 15 below. Description of the parameters are provided in the Table 5.



```
<?xml version="1.0" ?>
<!-- If a filename/path have character ':', then it is absolute path, else path is relative to
application runpath.   -->
- <!--
        csLogLevelDisableLogging = -1
        csLogLevelInternal = 0
        csLogLevelFailure = 1
        csLogLevelCritical = 2
        csLogLevelWarning = 3
        csLogLevelInfo = 4
        csLogLevelDebug = 5
-->
- <CellSensorDriver TYPE="CellSensor Driver" version="0.4" LogLevel_File="5" LogLevel_SystemEvent="1"
   MapFileName="map.csv" LastValuesFileName="lastvalues.dat" csvSeparator="," TemperaturesAreCelsius="TRUE"
   UseOPC="true" OpcTcpIpPort="706" OpcTagTimeoutSeconds="120" BatteryLowVoltage="3.65"
   SensorCommunicationTimeoutSeconds="120">
 - <Gateways>
     <Gateway Name="GW1" Address="0001" CoordinatorAddress_Min="0010" CoordinatorAddress_Max="001F"
       Port="COM3" PortSettings="57600,n,8,1" CommunicationTimeOutSeconds="240" RawDataLogFileName="" />
     <!--  GW1raw.txt   -->
   </Gateways>
 - <SQLs>
     <SQL Name="SQL1"
       ConnectionString="Provider=SQLOLEDB;Server=ESPDT457;Database=CS_SOURCE;Uid=CSwriter;pwd=write;"
       ConnectionTimeout="2" CommandTimeout="2" BufferPath="SQL1Buffer" />
   </SQLs>
</CellSensorDriver>
```

Figure 15. The configuration file of the CellSensor Driver (config.xml)

Table 5. Description of the CellSensor Driver Configuration Parameters

Parameter	Description	Value / Type
TYPE	Internal parameter Do not change	"CellSensor Driver"
Version	Version Number Internal parameter Do not change	Version number (real)
LogLevel_File	Logging Level (description of the levels in the file)	0,1,2,3,4,5 default: 3
LogLevel_SystemEvent	Logging Level to System Log (description of the levels in the file)	0,1,2,3,4,5 default: 1
MapFileName	Name of the Map File Must correspond the map file name	"[map file name]" default: "map.csv"
LastValuesFileName	Internal parameter Do not change	"lastvalues.dat"
csvSeparator	Separator used in csv files	","
TemperaturesAreCelsius	Temperature Units	"TRUE" → Celsius "FALSE" → Fahrenheit
UseOPC	OPC Server in use	"TRUE" → enabled "FALSE" → disabled

BatteryVoltageLow	Low Warning Limit for Battery	3.0 – 3.9 (real) default: 3.65
SensorCommTimeOut*	Timeout for no data from a CellSensor. CommunicationLink alarm is raised if no data is received during the timeout interval. In seconds.	default 120 (integer)
Name	Descriptive name for the Gateway. Information only. If two Gateways are configured, names must be different	"[Gateway name]" default "GW1"
Address	Gateway network address (See the label on the Gateway)	0001-000E (hex,16-bit)
CoordinatorAddress_Min	Smallest Coordinator network address allowed in the system	0010-00FE (hex,16-bit)
CoordinatorAddress_Max	Highet Coordinator network address allowed in the system	0010-00FE (hex,16-bit)
Port	COM Port (virtual or real depending whether USB/Serial/Ethernet is used) for which the Gateway is connected	"COM[COM Port Number]" default: "COM3"
PortSettings	COM Port Settings Will be set to the COM port on Driver start up.	"[baudrate], [parity], [data bits], [stop bits]" default: "57600,n,8,1"
CommTimeOut*	Timeout for no data from Gateway in seconds. Driver re-starts on timeout. In seconds.	default 240 (integer)
RawDataLogFileName	Internal parameter Do not change	"[Name]datalog.dat"
SQLName	Descriptive Name for SQL Connection. Information only.	"[SQL Connection Name]" default: "SQL1"
ConnectionString	SQL Connection String describing the SQL access.	See Figure 16 for an example.

ConnectionTimeOut	SQL timeout (connect) in seconds	default: 60 (integer)
CommandTimeOut	SQL command timeout (queries, etc.) in seconds	default: 60 (integer)
BufferPath	Internal parameter **Do not change or modify the content**	“[SQLName]buffer”

*Abbreviated

Enabling / Disabling OPC Server

To enable and disable the OPC Server interface:

1. Stop the CellSensor Driver. See chapter 5.2.3.2 for instructions.
2. Open Notepad Start → Run… → Type Notepad and click OK
3. Select File → Open… and browse C:\Program Files\Outotec\CellSensor\Driver\config.xml → Open
4. Find parameter useOPC
5. Change value FALSE to TRUE if you want to **enable the interface**. Change value TRUE to FALSE if you want to **disable the interface**.

   Do not edit anything else in the file!

6. Save the file. File → Save.
7. Close the file
8. Start the CellSensor Driver. See chapter 5.2.3.1 for instructions.

Map File

Map file links the CellSensor network addresses with the cell or cells that each CellSensor device is measuring (see chapter 2.2.3). It also contains the OPC tags that are created for the OPC Server on CellSensor Driver start-up for each CellSensor measurement. The OPC tags can be freely edited with the map file, but it is important to adhere the OPC standard (http://www.opcfoundation.org). See chapter 7.2 for the default tag names used for CellSensor measurements and diagnostics.

Driver reads the map file on start-up, so any changes applied to the file requires re-start of the Driver (see chapter 5.1.3). The map file is configured and tested before the shipment and commissioning.

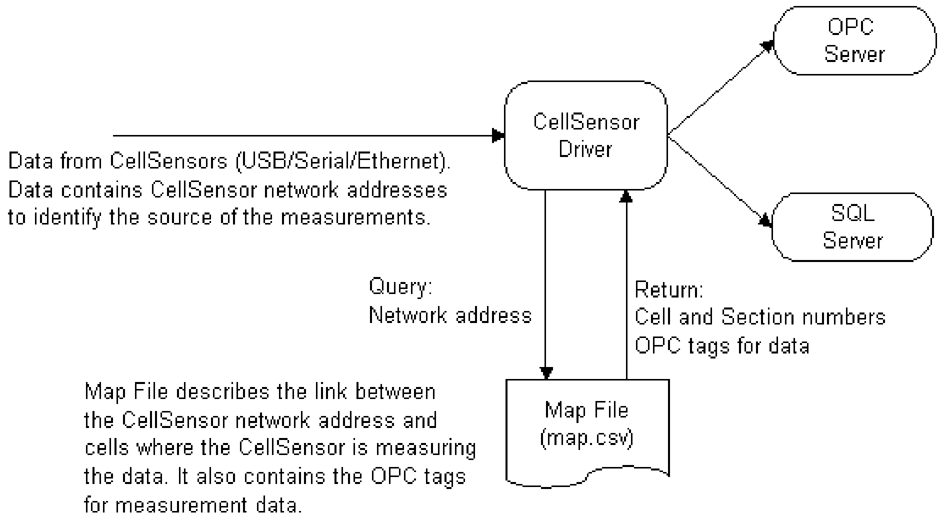


Figure 16. The Principle of the Map File in Data Flow

Map file is a simple csv (comma separated file) file residing at C:\Program Files\Outotec\CellSensor\Driver folder.

Each line of the file describes one CellSensor device, so there is one line for each CellSensor in the system in the map file.

The parameters of a line of the file describing one CellSensor device are shown in the Table 6 below.

Table 6. Description of a Single Line (a CellSensor) of the Map File Parameters

Index	Description	Value / Type
1	CellSensor Network Address Labelled on the CellSensor	0100 – EEEE (hex, 16 bit)
2	Section Number	Integer
3	Cell Number 1. See Appendix 2 for wiring options. This number is for cell where temperature probe 1 is located.	Integer
4	Sensor Number In case more than one CellSensor are installed to a cell, Sensor Number is used to identify different sensors located in the same cell.	1 = First Sensor (e.g. on overflow side) 2 = Second Sensor (e.g. on feed side) (Integer)
5	Cell Number 2. See Appendix 2 for wiring options. This number is for cell where temperature probe 2 is located.	Integer

6	Sensor Number In case more than one CellSensor are installed to a cell, Sensor Number is used to identify different sensors located in the same cell.	1 = First Sensor (e.g. on overflow side) 2 = Second Sensor (e.g. on feed side) (Integer)
7	Not in use (reserved for future)	“”
8	Not in use (reserved for future)	“”
9	OPC Tag for Cell Number 1 Voltage	[OPC Tag Name] (String)
10	OPC Tag for Cell Number 1 Temperature	[OPC Tag Name] (String)
11	OPC Tag for Cell Number 2 Voltage	[OPC Tag Name] (String)
12	OPC Tag for Cell Number 2 Temperature	[OPC Tag Name] (String)
13	Not in use (reserved for future)	“”
14	Not in use (reserved for future)	“”
15	OPC Tag for Communication Link Diagnostics	[OPC Tag Name] (String)
16	OPC Tag for Battery Voltage Diagnostics	[OPC Tag Name] (String)
17	OPC Tag for Battery Low Warning Diagnostics	[OPC Tag Name] (String)
18	OPC Tag for Cell Number 1 Bad Tap Contact Quality Status Warning Diagnostics	[OPC Tag Name] (String)
19	OPC Tag for Cell Number 2 Bad Tap Contact Quality Status Warning Diagnostics	[OPC Tag Name] (String)
20	OPC Tag for CellSensor Ambient Temperature Diagnostics	[OPC Tag Name] (String)

Note. If parameter value is 0 for index 3-6, then the measurement values for the item are not stored to SQL Server. If the parameter value for index 2 (Section Number) is 0 then none of the measurements for the CellSensor are written to SQL Server. This has no effect on the OPC Server. The value are written to OPC Server normally, provided that OPC Server is enabled.

OPC Server

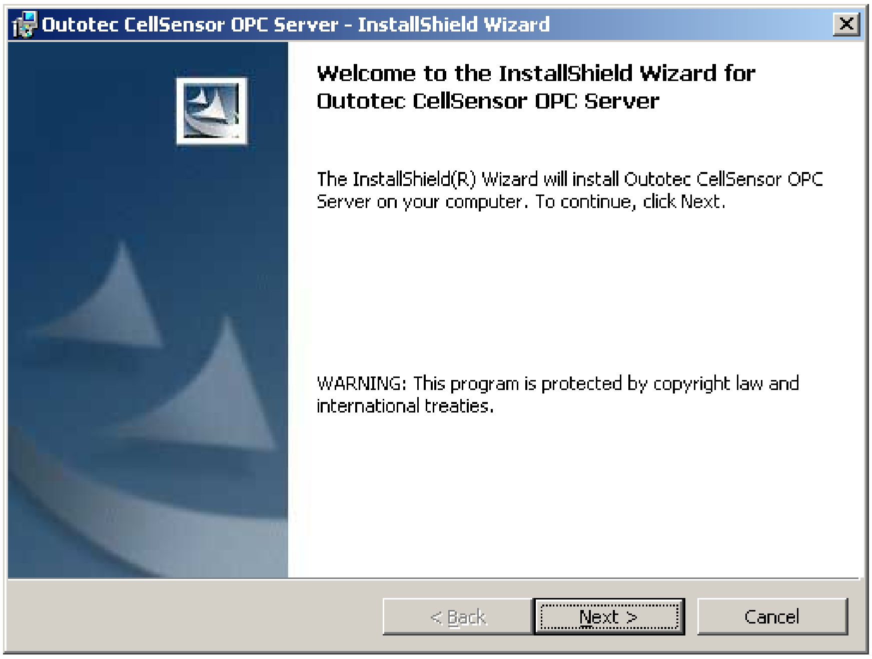
Installation

To install the OPC Server for CellSensor Driver:

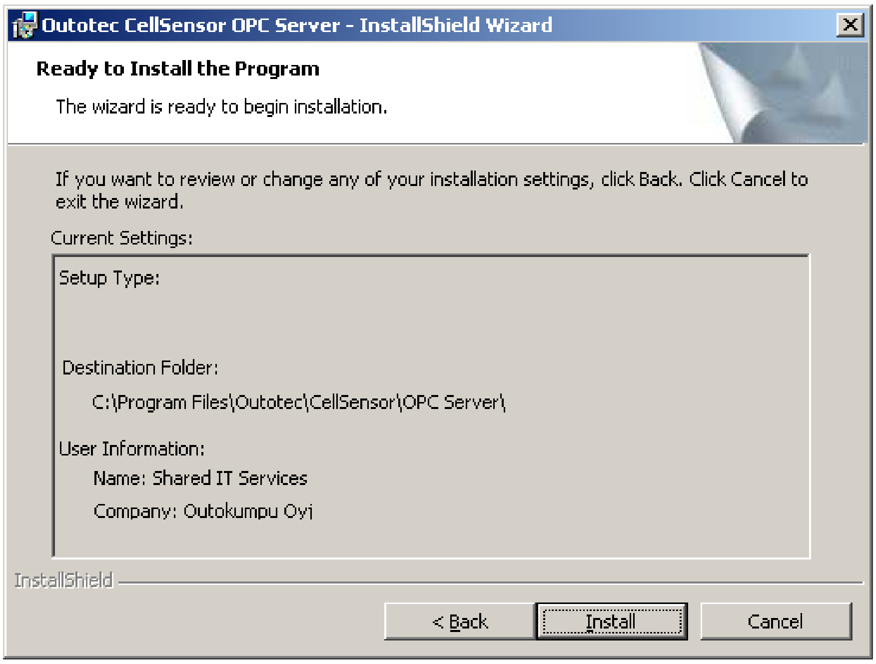
1. Insert the CellSense Installation CD to PC and run X:\Software\CellSensor\CellSensor OPC Server v[version number].exe

   (X is the drive letter of the CD or DVD drive of the PC, it can vary depending on the PC settings).

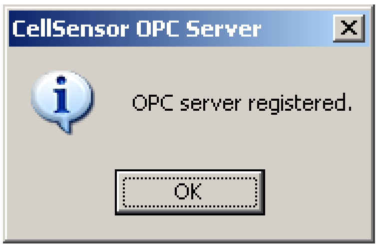
2. Windows Installer starts to install the driver. Click Next.



3. Click Install wait OPC Server to be installed.



4. Click Finish (Installation is ready)
5. Open Command Prompt to configure OPC Server. Start → Run… → cmd and click OK.
6. Browse c.\Program Files\Outotec\CellSensor\OPC Server\
7. Type CellSensorOPCServer.exe regserver to register the OPC Server



5. Operating the System

Read the safety instructions of chapter 3 carefully through before operating system.

5.1 Starting and Stopping of the System Components

CellSensor

Power Up

1. Open the CellSensor box
2. Connect the battery to battery plug J5
3. Wait and monitor CellSensor to power up (~5 seconds). The progess of the start-up sequence is shown by the LEDs. See chapter 5.2.1 for more detailed information on the LEDs.
4. Close the CellSensor box

Reset

1. Open the CellSensor box
2. Push Reset button on the CellSensor PCB board (middle and on top of the T1 and T2 terminals)
3. Wait and monitor CellSensor to power up (~5 seconds). The progress of the start-up sequence is shown by the LEDs. See chapter 5.2.1 for more detailed information on the LEDs.
4. Close the CellSensor box

Power Down

1. Open the CellSensor box
2. Push Reset button on the CellSensor PCB board (middle and on top of the T1 and T2 terminals).
3. Disconnect the battery from the battery plug J5
4. Close the CellSensor box

Start up Sequence

On start-up, CellSensor goes through a chain of procedures to initialise the device. The progress of the sequence is informed by the LEDs on board. The normal start-up time is approximately 5 seconds.

On power up all LEDs flash twice, after which yellow LED is visible for the duration of the network scan for Coordinator devices. If a Coordinator is found, its channel is informed by the LEDs as a 4 bit number (each LED represents a bit). See chapter 5.2.2 Table 4 for more detailed information.

After successful network scan, CellSensor will enter power saving mode until the cell voltage has been in normal range for a buffer time period (see 2.1.1.2).

In case no Coordinator is found, CellSensor will enter Power Saving Mode (all LEDs off). CellSensor will perform frequent re-scan of the network automatically (yellow LED visible) and also check the input voltage level (green LED flashes once).

Coordinator and Gateway

Power Up

1. Open the PSU box
2. Switch the mains switch to ON (1) position
3. Close the PSU box

Power Down

1. Open the PSU box
2. Switch the mains switch to OFF (0) position
3. Close the PSU box

Be always aware of the effects of powering down Coordinator or Gateway devices.

Powering down of the Coordinator forces all associated CellSensors to switch automatically to another Coordinator in the range. Therefore, it will have no effect on the data flow, in case another Coordinator can be located and it has capacity to handle the new CellSensors.

The location of the Coordinators should always be designed so that every CellSensor is able to reach at least two Coordinators well. The more a CellSensor is able to reach the more redundant and reliable the system is.

Powering down a Gateway device shuts down ALL of the measurement data traffic unless there is a redundant Gateway unit present. Therefore, shut downs of the Gateway units should be minimized.

CellSensor Driver

CellSensor Driver is run as a Windows service and is automatically started and handled by Windows.

To monitor, start, stop or restart driver select Start → Settings → Control Panel. In Control panel select Administrative Tools → Services.

CellSensor Driver is visible on the Windows Service list as shown in the Figure 17 below. The service status is shown in the service window's Status column.

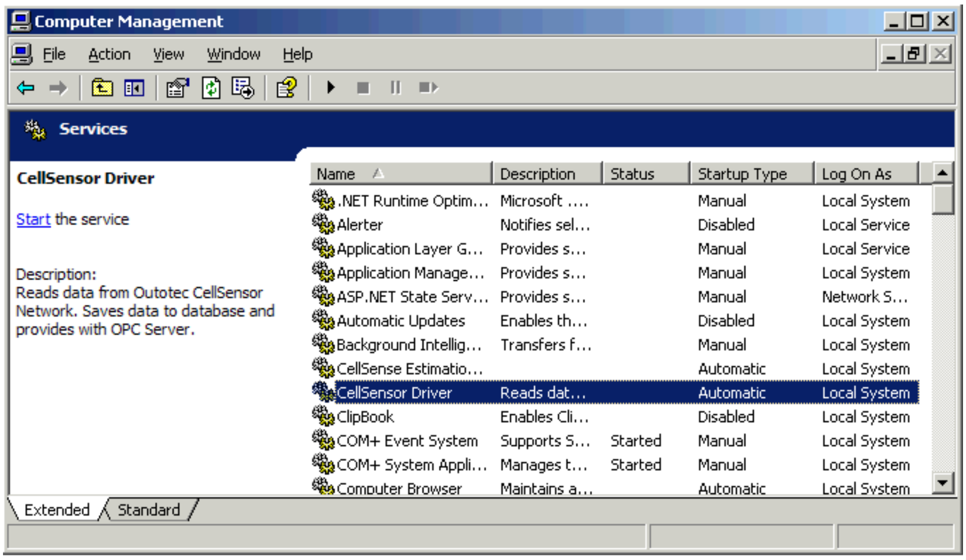


Figure 17. CellSensor Driver is managed through Windows service management console.

Start

Select CellSensor Driver on the service list and click start button on the top tool bar or start link on the left pane

Stop

Select CellSensor Driver on the service list and click stop button on the top tool bar or stop link on the left pane

Restart

Select CellSensor Driver on the service list and click restart button on the top tool bar or restart link on the left pane

5.2 Diagnosing the System

The CellSensor system incorporates advanced and versatile diagnostic functions for:

- Guaranteeing measurement data validity
- Status monitoring
- System maintenance and troubleshooting

LED Status

CellSensor, Coordinator and Gateway units have four LEDs (orange, yellow, green, red) for displaying the status, configuration and activity information locally for the users.

Status During Normal Operation

LED status indicators during normal operation are described for all CellSensor system components in the table 7 below.

Table 7. Description for LED status

LED				DEVICE STATE		
Orange	Yellow	Green	Red	CellSensor	Coordinator	Gateway
		Flashing		Boosting Mode	NA	NA
Off	Off	Off (Flash 1-2 times/min)	Off	Power-saving Mode***	NA	NA
			Flashing	Lost Link to Coordinator	NA	NA
On				Network Scan	Network Scan	NA
	Flashing			Boosting Mode Coordinator Not Found on Power-Up	NA	NA
Flash →	Flash →	Flash →	Flash.	Data Send	NA	NA
		On		NA	OK	OK
		On	On	NA	Gateway Not Found	No Data Received**
Switching*		On		NA	Receiving Data	Receiving Data
(On / Off)	Switching*	On	(On / Off)	NA	Sending Data	Sending Data
Flash			Flash	Configuration Mode****	Configuration Mode****	Configuration Mode****

* Rate depends on the data traffic. Data is received/send when LED toggles the value (On→Off or Off→On)
** In 2 minutes from any Coordinator
*** Rate depends on the measurement scan interval
**** See chapter 6.3 for checking the parameters or changing the configuration

Channel Association (on Power Up)

On Power up CellSensor, Coordinator and Gateway devices go through a power up sequence to initialise themselves. On of the main steps of the sequence is to scan the surrounding area for Coordinator or Gateway devices and select the best of them in case more than one is found.

The channel number of the Coordinator (for CellSensor) or Gateway (for Coordinator), for which the device associates is displayed on right on start-up. The four LED is are used as bits to represent channel number from 11 to 26 according to table 8 below. Since every Coordinator and Gateway typically occupy different channels in their range, it is easy identify to which device CellSensor or Coordinator is associating.

Table 8. The Channel Numbers Indicated by the CellSensor and Coordinator Devices on Start-Up.

LED				Associated Channel
Orange	**Yellow**	**Green**	**Red**	
			On	11
		On		12
		On	On	13
	On			14
	On		On	15
	On	On		16
	On	On	On	17
On				18
On			On	19
On		On		20
On		On	On	21
On	On			22
On	On		On	23
On	On	On		24
On	On	On	On	25
Flash.	←Flash	←Flash	←Flash	26

Diagnostic Data

Each CellSensor device monitors and transmits continuously diagnostic data up to CellSense Server. The diagnostic data is meant to provide information on the health of the devices, validity of the transmitted measurements and support in troubleshooting.

All of the Diagnostic Data is available through CellSense web interface, OPC Server or ODBC.

Bus Bar Tap Contact Status

CellSensor monitors to quality of the bus bar tap contacts (interface between bus bar wire and the bus bar) with an advanced estimation algorithm. The wire might be loose or cable broken for instance.

Should such an event occur, CellSensor alarms it by raising a “TapContactQuality” alarm Bit: 1 = alarm, 0 = ok) until problem is fixed. This alarm does not stop transmission of the data.

The alarm can be used in maintenance and to link it with voltage measurement quality validation (not to be trusted) for the duration of the alarm.

The alarm will set the quality of the voltage measurements bad in the OPC Server.

Communication Link

In case data is not received from a CellSensor for two minutes a “CommunicationAlarm” is raised to inform user that the CellSensor is not able transmit for some reason (Bit: 1=alarm, 0 = ok).

The alarm will set the quality of the voltage and temperature measurements bad in the OPC Server. The last value received by the CellSensor Driver is presented.

Battery Voltage

The level of the back-up battery is continuously monitored by the CellSensor. “BatteryVoltage” is transmitted as a real number to CellSense Server. Also, “BatteryLow Alarm” is raised in the battery voltage decreases below low limit value (CellSensor Driver configuration file parameter).

This information can be utilized to check the battery charge levels for the duration of long shut downs or in troubleshooting.

The battery is always and automatically re-charged and kept charged when the cell is normally in production.

Ambient Temperature

Ambient temperature “AmbientTemperature” of each CellSensor is constantly measured for the many internal and safety purposes required by CellSensor. Ambient temperature is also transmitted to CellSense Server PC for general monitoring purposes as a real value.

CellSensor Driver

Status and execution of the CellSensor Driver can be monitored and diagnosed with log file and from Windows service management console.

Log File

CellSensor Driver updates log file during its execution. A new log file is generated when the Driver starts as

C:\Program Files\Outotec\CellSensor\Driver\log.txt.

The Driver writes useful information on the general system, like license information, USB/serial port status, initialisation issues, etc. on Driver start-up. Therefore, it is a useful tool for troubleshooting and checking the system performance after parameter changes for instance.

The detail of the information written to log file depends on the CellSensor Driver parameter LogLevel_File. Different levels are described in the Table 9 below.

Table 9. Log Levels of CellSensor Driver.

Level	Description
-1	Logging is disabled
0	Internal. Only internal events, warnings and failures are reported. Minimum level.
1	Failure. Driver failures are reported
2	Critical. Critical events are reported
3	**Warning. Any warnings are reported. Default level**
4	Info. Driver reports successes and progress of events as it executes. Should be used temporarily only as the log file grows fast due to amount of information logged.
5	Debug. Driver reports very detailed information on its execution for debugging purposes. Should be used in very special occasions only as the log file grows very fast due to amount of information logged.

If logging level 3 is used it contains the levels 0-2 as well, 4 contains 0-3 and so on.

The log file can be opened with a text editor, like notepad or Microsoft Word.

Windows System Log

The same information that is written to the log file can be forwarded to Windows System log. The logging level is defined by the parameter LogLevel_SystemEvent and adhere to levels described in Table 9.

It is recommended and good policy to keep the Windows System log level either at 0 or 1 levels to not fill the system log with not too critical event data.

Running Status

Running status of the CellSensor driver is monitored by the Windows service management console. See chapter 5.1.3.

6. Maintenance

Read the safety instructions of chapter 3 carefully through before maintaining the system.

CellSensor system is light to maintain system due to simple structure, self-diagnostics and powering. The features of the system enable on demand maintenance for the components (act when the system indicates to do so).

Anyhow, it is recommended to perform a visual check of the devices frequently (e.g. once per 1-3 months) to keep the system in good condition.

- Check the bus bar cable condition and taps
- Check the box mounting
- Check the status of the devices with LED information. See chapter 5.2.1
- Check the condition of the temperature probes

6.1 Replacing Components and Devices

This chapter provides instructions for replacing system components with a spare. Before replacement make sure that the spare component is original and valid (especially battery model). Refer also chapter 6.4 for product disposal information.

CellSensor

A CellSensor device is replaced with a spare unit according to following procedure:

For the CellSensor to be removed

1. Open the CellSensor box
2. Push Reset button on the CellSensor PCB board (middle and on top of the T1 and T2 terminals).
3. Disconnect the battery from the battery plug J5
4. Disconnect the bus bar wires
5. Remove the temperature probes from the cells
6. Dismount the CellSensor box
7. Disconnect the temperature probe wires from the terminal T2

For the new CellSensor follow the standard instructions of preparing and mounting a CellSensor device as described in the chapters 4 and 5.

Utilize the temperature probes of the old device in case they are operating properly.

Temperature Probe

1. Open the CellSensor box
2. Push Reset button on the CellSensor PCB board (middle and on top of the T1 and T2 terminals).
3. Pull the plug of the terminal T2 off from the header.
4. Remove the probe from the cell
5. Disconnect the temperature probe to be removed from the terminal T2 and pull the probe wire out via the cable fitting

For the new temperature probe follow the standard instructions of preparing and mounting a temperature probe to a CellSensor device as described in the chapters 4 and 5.

Battery

CellSensor utilizes re-chargeable Li-Ion battery for back-up power. The battery is re-charged whenever necessary and there is proper voltage present in the cell. Therefore, changing of the battery is not part of the normal maintenance procedures required for the system and should only be done when necessary (e.g. failure of the battery).

Follow the instructions of the chapters 3.2 and 6.4 upon disposal of the failed battery and safe handling of the battery pack.

1. Open the CellSensor box
2. Push Reset button on the CellSensor PCB board (middle and on top of the T1 and T2 terminals)
3. Disconnect the battery from the battery plug J5 and remove it from the battery holder
4. Plug the new battery to plug J5
5. Close the CellSensor box

Coordinator

For the Coordinator to be removed

1. Open the PSU box
2. Switch the mains switch to OFF (0) position
3. Disconnect the internal power cable from terminal X2 and pull them out from the PSU box
4. Dismount the Coordinator

For the new Coordinator follow the standard instructions of preparing and mounting the device as described in the chapters 4 and 5.

Utilize the old cabling for internal powering if reasonable.

Gateway

For the Gateway to be removed

1. Open the PSU box
2. Switch the mains switch to OFF (0) position
3. Disconnect the internal power cable from terminal X2 and pull them out from the PSU box
4. Disconnect the USB cable from the CellSense Server PC
5. Dismount the Gateway

For the new Gateway follow the standard instructions of preparing and mounting the device as described in the chapters 4 and 5.

Utilize the old cabling for internal powering if reasonable.

6.2 Relocation of the CellSensors

In case a CellSensor device needs to moved from a one cell to another cell, please follow the instructions of chapters 6.1 and 4 for removing and mounting of the device.

Once the CellSensor device is mounted on the new cell, the new configuration must be informed for the CellSensor Driver. There are two options for this:

- Modify the map file (easier), or
- Modify the CellSensor network address according to new location (see chapter 6.3) and map file

To modify the map file you need the CellSensor Device network address (labelled on the device or it can be checked with push buttons on board (see chapter 6.3.2)):

1. Stop the CellSensor Driver. See chapter 5.2.3.2 for instructions.
2. Open Notepad Start → Run… → Type Notepad and click OK
3. Select File → Open… and browse C:\Program Files\Outotec\CellSensor\Driver\map.csv → Open
4. Find the line corresponding the network address
5. Change the line values to match the new location at the tank or cell house (section, cell numbers, OPC tags, etc.)

   Do not edit anything else in the file!

6. Save the file. File → Save.
7. Close the file
8. Start the CellSensor Driver. See chapter 5.2.3.1 for instructions.

In case the network address of the CellSensor device was changed you need to add a new line (copy one line as a template) and edit it according to the new network address and plant location.

6.3 Changing Network Setup

The network setup of the CellSensor, Coordinator and Gateway devices can be modified with push buttons on the CellSensor board.

For CellSensor device only network address can be altered.

For Coordinator and Gateway devices network address and channel number can be changed.

The system is configured and addressed before shipment, so generally altering of the network settings should not be necessary.

Do not unnecessarily modify the network configuration settings!

Entering Setup Mode

To enter setup mode, push Reset Button down and then S1. Then release Reset, after which yellow and green LEDs start to flash simultaneously. Finally, release the S1 and the Device enters network setup mode (yellow and red LEDs flash).

Checking the Existing Configuration

CellSensor

In Setup mode, the existing configuration of a CellSensor can be checked according to following procedure. The 16-bit network address is shown in four 4-bit sequences. As an example address **020A** is checked here from a CellSensor.

1. Enter setup mode
2. Push S1 once
3. The first 4 bits are displayed (O=off, Y=off, G=off, R=off) → bit value: 0000, hex value: **0**
4. Push S1 once. Green LED flashes twice.
5. The next 4 bits are displayed (O=off, Y=off, G=on, R=off) → bit value: 0010, hex value: **2**
6. Push S1 once. Green LED flashes twice.
7. The next 4 bits are displayed (O=off, Y=off, G=off, R=off) → bit value: 0000, hex value: **0**
8. Push S1 once. Green LED flashes twice.
9. The last 4 bits are displayed (O=on, Y=off, G=on, R=off) → bit value: 1010, hex value: **A**
10. Push S1 once
11. Orange and Red LEDs are ON to show that procedure is finished
12. Push S1 once. Green LED flashes twice

13. Push Reset to re-start the device

Coordinator and Gateway

In Setup mode, the existing configuration of a Coordinator or Gateway can be checked according to following procedure. When compared to CellSensor, he 16-bit network address is shown in two 4-bit sequences, because the first 8 bits of the address are always zero. So latter 8 bits are displayed.

Channel (11-26) can also be set on configuration. Use table 8 of chapter 5.2.1.3 for identifying the channel number from the LED information.

As an example **address 001E** is checked here from a Coordinator that is operating on **channel 15**.

1. Enter setup mode
2. Push S1 once
3. The first 4 bits of the address are displayed (O=off, Y=off, G=off, R=on) → bit value: 0001, hex value: **1**
4. Push S1 once. Green LED flashes twice.
5. The last 4 bits of the address are displayed (O=on, Y=on, G=on, R=off) → bit value: 1110, hex value: **E**
6. Push S1 once. Green LED flashes twice.
7. The channel number is displayed as a 4 bit number. (O=off, Y=on, G=off, R=on) → bit value: 0101 (see Table 8 of chapter 5.2.1.3)
8. Push S1 once.
9. Orange and Red LEDs are ON to show that procedure is finished
10. Push S1 once. Green LED flashes twice
11. Push Reset to re-start the device

Changing the Configuration

Do not unnecessarily modify the network configuration settings!

CellSensor

In Setup mode, the existing configuration of a CellSensor can be modified according to following procedure. The 16-bit network address is shown in four 4-bit sequences, which can be altered in setup mode.

As an example address **020A** is now changed to **110B** for a CellSensor.

1. Enter setup mode
2. Push S1 once
3. The first 4 bits of the old address are displayed (O=off, Y=off, G=off, R=off) → bit value: 0000, hex value: **0**

4. Use S2 to increment hex values from 0 to F according to new address. Push S2 once to increment bit value 0001 (O=off, Y=off, G=off, R=on) and hex value **1**. If S2 is pushed accidentally over the desired number push S2 until numbers start from zero again (after F).
5. Push S1 once to accept change. Green LED flashes twice.
6. The next 4 bits of the old address are displayed (O=off, Y=off, G=on, R=off) → bit value: 0010, hex value: **2**
7. Use S2 to increment the value again. Push S2 once to increment bit value 0001 (O=off, Y=off, G=off, R=on) and hex value **1**.
8. Push S1 once. Green LED flashes twice.
9. The next 4 bits of the old address are displayed (O=off, Y=off, G=off, R=off) → bit value: 0000, hex value: **0**
10. Now the number does not need to be changed.
11. Push S1 once. Green LED flashes twice.
12. The last 4 bits of the old address are displayed (O=on, Y=off, G=on, R=off) → bit value: 0000, hex value: **A**
13. Use S2 to increment the value again. Push S2 eleven times to increment bit value to 1011 (O=on, Y=off, G=on, R=on) and hex value **B**.
14. Push S1 once
15. Orange and Red LEDs are ON to show that procedure is finished
16. Push S1 once. Green LED flashes twice
17. Push Reset to re-start the device

Coordinator and Gateway

In Setup mode, the existing configuration of a Coordinator or Gateway can be modified according to following procedure. When compared to CellSensor, he 16-bit network address is shown in two 4-bit sequences, because the first 8 bits of the address are always zero. So latter 8 bits are displayed.

Channel (11-26) can also be set on configuration. Use table 8 of chapter 5.2.1.3 for identifying the channel number from the LED information.

Be aware the range of addresses allowed for Coordinator and Gateway devices:

- Coordinator address range 0010 – 00FE
- Gateway address range 0001 – 000E

Use of the proper address is critical, because device role, Coordinator or Gateway, is automatically determined by the address given to the device!

As an example a Coordinator with network **address 001E** and operating on **channel 15** is changed to operate on **channel 17**.

1. Enter setup mode
2. Push S1 once
3. The first 4 bits of the address are displayed (O=off, Y=off, G=off, R=on) → bit value: 0001, hex value: **1.** The address is not changed now, so

4. Push S1 once. Green LED flashes twice.
5. The last 4 bits of the address are displayed (O=on, Y=on, G=on, R=off) → bit value: 1110, hex value: **E.** The value is not changed now, so
6. Push S1 once. Green LED flashes twice.
7. The channel number is displayed as a 4 bit number. (O=off, Y=on, G=off, R=on) → bit value: 0101 (see Table 8 of chapter 5.2.1.3)
8. Use S2 to increment hex values from 0 to F according to new channel number (see Table 8 of chapter 5.2.1.3 for channel number translation) Push S2 twice to increment bit value from 0101 (O=off, Y=on, G=off, R=on) to 0111 (17) (O=off, Y=on, G=on, R=on). If S2 is pushed accidentally over the desired number push S2 until numbers start from zero again (after F).
9. Push S1 once.
10. Orange and Red LEDs are ON to show that procedure is finished
11. Push S1 once. Green LED flashes twice
12. Push Reset to re-start the device

6.4 Disposal of the System Components

In case any of the system components need to be disposed (e.g. due to failure of a device), the disposal must be done in accordance with local and national disposal regulations, including those governing the recovery and recycling of Waste Electrical and Electronic Equipment (WEEE). See also chapter 3.2 for more information on handling the battery.

7. Third Party Data Interfaces

7.1 OPC Server

The measurement and diagnostic data of the CellSensor device is available via OPC Server included in the CellSensor Driver.

The OPC Server is installed as a separate installation package from the CellSensor Driver installation. OPC Server can be located in different PC than CellSensor driver and it is recommended that OPC Server is installed on the same PC than OPC Client.

CellSensor OPC Server name is **OT.CellSensor.2**

The OPC Server is version 2.0 compatible.

Tag Naming Convention

By default Tags are named according to following schema:

- Measurements and Diagnostics: [Group].[Section].[Data]
- Other Data: [Group].[Data]

Tags are defined in the CellSensor Driver map file (see chapter 4.5.2.1)

The values of the items are described in the table below:

Table 10. Values for Group Item

Group Name	Description
Meas	Group for CellSensor measurements
Diag	Group for CellSensor diagnostic data
Gateway[Name]	Group for CellSensor network diagnostic data
Driver	Group for CellSensor Driver status data
OPCServer	Group for OPC status data

Section is defined as

s[Section number]

The Measurement Data Tag naming convention is according to following principle (see Table 6 of chapter 4.5.2.1):

- Cell Voltage c[Cell Number]s[Sensor Number]Vl
- Temperature c[Cell Number]s[Sensor Number]Tl

Examples:

Meas.s01.c02s01VI → Cell Voltage for Cell Number 2, Sensor 1 of Section 1.

Meas.s09.c02s01TI → Cell Temperature for Cell Number 2, Sensor 1 of Section 9.

Diagnostic Data follows the following naming convention

c[Cell Number]s[Sensor Number][Data Description]

Table 11. Items for Data Description

Group	Description
CommTimeOut	Communication Link status
BatteryVoltage	Battery Voltage (V)
ContactBad	Bus Bar Tap Contact status
BatteryLow	Battery Voltage Level Low Warning
Ambient	Ambient Temperature of the CellSensor

8. Appendix 1: Technical Specifications

SYSTEM	
FEATURES	Self-Powered Truly Wireless Voltage and Temperature Measurement System for Electrolytic Cells Suitable for Cu, Zn, Ni, Co, Al Refining Superior Data Quality through Electrically Floating Measurement and on-board Digital Data Processing Worry Free Self-Organizing and Redundant Wireless Network Simplified Installation and Maintenance due to Minimized Wiring, Network Robustness and Self Diagnostics
COMPONENTS	CellSensor, Coordinator, Gateway, CellSense Server PC
MAXIMUM SIZE	CellSensors: 1500 Coordinators: 40 Gateways: 2
OPERATING TEMPERATURE	0 – 60 ^{O}C (32 – 140 F)
HUMIDITY	10 – 90 %, non-condensing
POWER CONSUMPTION	0.070 W Typical (Full Battery) 1 W Maximum

STANDARDS	IEEE 802.15.4 LVD EN/IEC 61010 EMC EN 300 328 RF EN 301 489-1 and –17 FCC CRF 47 Parts 15 B and C 15.247 R&TTE 1999/5/EC CE
INTENDED FOR USE IN	EU, USA, Canada, Mexico, Russia, China, Japan, Australia, India, Chile, Brazil, Peru, South Korea, Philippines, Africa.

CELLSENSOR	
INPUT (OPERATING RANGE)	Cell Voltage: 0.16 – 4.0 VDC (0.02 – 2.00 A) DC and PRC (Periodically Reversed Current) Rectifiers Supported
VOLTAGE MEASUREMENT	Refining Cells: 0 – 2.5 V Electro-Winning Cells: 0 – 8 V Resolution 0.0024 V
TEMPERATURE MEASUREMENT	Range: -55 ^{O}C – 125 ^{O}C Accuracy: $\pm$0.5 ^{O}C Resolution: 0.0625 ^{O}C (-10 – 85 ^{O}C) No Calibration
BACK-UP POWER	Re-chargeable Lithium-Ion Battery Panasonic CGR18650CF1S1P (2350 mAh / 3.6V) Integrated Safety Circuit by Fey

DIAGNOSTICS	Local LEDs for Status via CellSense / OPC Server: Poor Tap Contact (Wire to Bus) Battery Low Level Communication Link Ambient Temperature
COORDINATOR AND GATEWAY	
INPUT	100 – 240 VAC, 50 – 60 Hz, 0.2 – 0.4 A 0.5 A external fuse or circuit breaker required.
NETWORK	
MODULATION	DSSS (Direct Sequence Spread Spectrum)
TRANSMISSION POWER	0 dBm
FREQUENCY	2.400 – 2.483 GHz
STANDARDS	IEEE 802.15.4
PROTECTION AND MATERIALS	
SEALING CLASS	IP65 (NEMA 4)
CASING	Polycarbonate Stainless Steel (AISI316) PVDF

TEMPERATURE PROBE	Stainless Steel (AISI316) Polypropylene Coating Wire length 1.5 m
BUS BAR WIRES	0.5 m – 2.0 m / Bus Cu – 4 mm^2 (AWG 12), PVC H07V-K-4, UL Style 1015/1283/1284
DIMENSIONS	
CELLSENSOR COORDINATOR GATEWAY	(W x D x H) (mm) 168 x 140 x 80
TEMPERATURE PROBE	(L x Diam.) (mm) 1000 x 6
CELLSENSE SERVER	
SERVER	Minimum Requirements: Intel Pentium >3 GHz or Dual Core 2 GB RAM 2 X 72 GB HDD (RAID-1) Ethernet (100/1000 Mbps)
OPERATING SYSTEM	Windows Server 2003
SOFTWARE	Microsoft SQL Server 2005 Microsoft Office 2003 Microsoft IIS Web Server (included in Win 2003) Microsoft .NET Framework 1.1 and 3.0

DATA INTERFACES	CellSense Monitoring System ODBC (SQL) OPC Server Custom Interfaces on Request

9. Appendix 2: General Wiring Diagrams

See Attached Files.

10. Appendix 3: Description of the Communication Port and USB cable

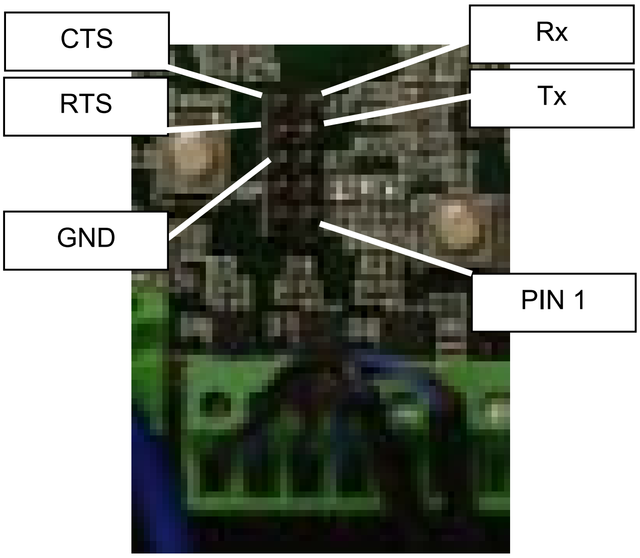
Description of the communication port J3 are defined in the Table and picture below. The port is 3.3 V TTL and it connects to CellSense Server PC with an USB cable.

The port J3 is used by Gateway devices only.

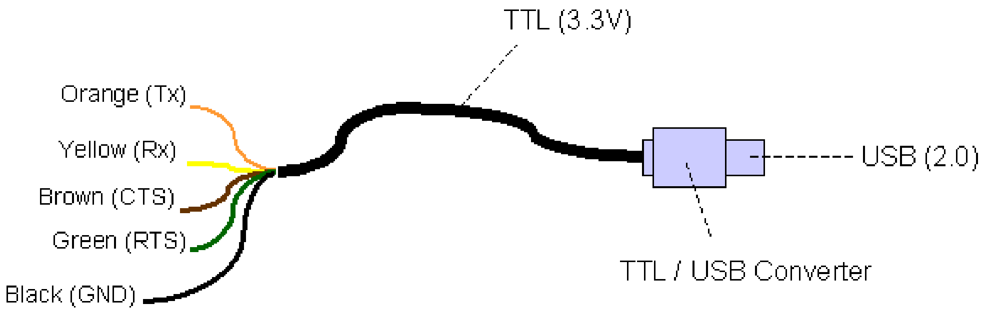
Do not connect any other cable than what has been supplied with the system to the J3 port pins! Use only the pins/signals described in the table below. Connecting wrong cables, signals or signal levels may cause malfunction of the device and avoid warranty.

J3 Pin Description

CTS (Pin 10)	Rx (Pin5)
RTS (Pin 9)	Tx (Pin 4)
GND (Pin 8)	-
-	-
-	- (Pin 1)



USB Cable type is TTL-232R-3V3 USB to Serial Cable (3.3V) with integrated FTDI Chip for TTL to USB converter in the USB plug. The USB is version 2.0 compatible. The cable and the signals are described in Figure below.



The USB adapter cable wires are connected with port J3 according to following table:

USB Adapter Wire	J3 Pin
Orange (Tx)	5 (Rx)
Yellow (Rx)	4 (Tx)
Black (GND)	8 (GND)
Brown (CTS)	9 (RTS)
Green (RTS)	10 (CTS)

11. Appendix 4: FCC Information to User

Federal Communications Commission (FCC) Statement

15.21

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

15.105(b)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
    - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Operation is subject to the following two conditions:

1) this device may not cause interference and

2) this device must accept any interference, including interference that may cause undesired operation of the device.

FCC RF Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

12. Appendix 5: IC Information to User

Industry Canada (IC) Statement

15.21

You are cautioned that changes or modifications not expressly approved by the part responsible for compliance could void the user's authority to operate the equipment.

15.105(b)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the IC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
    - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Operation is subject to the following two conditions:

1) this device may not cause interference and

2) this device must accept any interference, including interference that may cause undesired operation of the device.

IC RF Radiation Exposure Statement:

This equipment complies with IC radiation exposure limits set forth for an uncontrolled environment. End users must follow the specific operating instructions for satisfying RF exposure compliance. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

READER COMMENTS

The design team of Outotec is committed to ensure the quality and usefulness of this manual and the CellSensor system. Your comments, recommendations and suggestions will help make our continuous effort more effective.

Please take few moments to write your comments either directly on the form provided or on a photocopy of it.

Your assistance is greatly appreciated.
Thank you for choosing the CellSensor system.

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Attn:	Manager, CellSensor System
From:	______________________ ______________________ ______________________
Serial Number (License Key):	______________________
Manual:	CellSensor System User Manual Code CSS-001 Revision 1.04 (Please identify applicable software versions and individual documents)
Comments / recommendations:	______________________ ______________________ ______________________ ______________________

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