Data Transfer between Instruments and Equipment
Communication Protocol for Serial Transmission
Technical Tutorial

1) Introduction

Most of our Instruments are available with a **Serial Data Transmission** for the output signals.

For shorter distances up to 30 m we use the **RS232 Hardware Standard** and for longer distances up to 1000 m we use the **RS485 Hardware Standard**.

For both standards RS232 and RS485 we use the same **Software Protocol.**

The software protocol defines which **Data Code** is used and defines the **Sequence of the Data Transfer**

Our systems transfer the data in **Text Format**, that means it uses **Characters (Numbers**, **Letters** and **Special Characters)** to transfer the information.

The **ASCII-Code** (American Standard Code for Information Interchange) is a worldwide used standard to define the relation between the transmitted electric impulses and the Characters.

2) General Definitions

The communication is based on a standard RS232 serial communication.

We use the RS 485 hardware in the same way as the RS 232 hardware.

Any Hardware (Computer, PLC, etc.) with a RS232C or RS485 Communication Port and any Software, which can decode ASCII characters, can be used as controlling and receiving system (here called "Computer") for out Instruments.

Settings for the Communication Ports:

9600 baud, no parity, 8 data bits, 1 stop bit (9600, n, 8, 1).

No hardware handshake.

The communication protocol **Firmware** is stored within a **Microcontroller** inside the instrument hardware.

3) Activating a Measurement

The computer sends a STX command (ASCII) and the instrument hardware responds with 6 ASCII characters for each channel, containing the measurement data. That means for n channels 6 x n characters will be sent. The details are explained in the following paragraph.

Since the conversion time for each channel is 100 ms the shortest time between two STX commands from the computer should be n x 0.1 seconds.

For example: for a 6-channel instrument the shortest time between two STX commands should be 0.6 seconds, that means the maximal frequency for 6-channel measurements is 100 per minute.

It is strongly recommended for electrochemical measurements to implement in the data processing software a “gliding average” filter algorithm with at minimum averaging of 10 single measurements.

4) Used ASCII characters in HEX format:

02 STX (Start command for the data transmission)

04 EOT (End of the data transmission)

09 Tab (Tab, separates the two measurement data for the 2 channels)

2B + (Positive sign)

2D - (Negative sign)

30 0

31 1

32 2

33 3

34 4

35 5

36 6

37 7

38 8

39 9

To get the decimal value of a number character simply subtract "30" from the HEX value

5) Communication Protocol in Detail:

Shown on the example of a 9-channel measurement

• Send out STX to activate a 9-channel measurement and get the response in the following structure:

• The first six ASCII characters contain the data from the first channel in the format:

Sign, H, T, O, D, Tab

• The second six ASCII characters contain the data from the second channel in the format:

Sign, H, T, O, D, Tab

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• The ninth six ASCII characters contain the data from the ninth channel in the format:

Sign, H, T, O, D, EOT

Sign, Hundreds, Tens, Ones, Decimal refer to mV
Example: 2D, 32, 30, 30, 31, 09 means -200.1 mV of the first channel

The following test sample was taken with a tool for testing the communication of a serial port of a PC, which can receive or send Hexadecimal numbers.

Sending: 02
Received: 2D 32 30 31 33 09 (Data Sensor 1)
Received: 2B 30 38 31 33 09 (Data Sensor 2)
Received: 2D 30 34 31 32 09 (Data Sensor 3)
Received: 2B 30 30 30 30 09 (Data Sensor 4)
Received: 2B 35 34 31 33 09 (Data Sensor 5)
Received: 2B 30 33 31 32 09 (Data Sensor 6)
Received: 2D 30 30 30 30 09 (Data Sensor 7)
Received: 2B 31 30 31 34 09 (Data Sensor 8)
Received: 2B 30 30 31 31 09 (Data Sensor 9)
All Characters shown in Hex format. Signal Data are Random values.

The **Scaling** for a sensor channel is given by the **Hardware**, the **Calibration** procedure and the **Characteristic** of the sensor.
For example for a channel with an Ion-Selective Electrode:
The transmitted data represent the electrode output signal (mV).
Ion-Selective Electrodes have a logarithmic characteristic.
The calibration procedure has given 114.3 mV for a 1 ppm calibration standard and 169.5 mV for a 10 ppm calibration standard.
The measurement signal is 134.2 mV
To get the measured Ion Concentration, the signal processing software has to perform a logarithmic interpolation between the 2 calibration points for the measuring point.