**Reg. Office:** Via San Marino 21, 10134 Torino, Italy
**Shipping address:** Via San Marino 21, 10134 Torino, Ita
**Tel:** +39 011 19720518 **Fax:** +39 011 19720519
otbioelettronica.it - mail@otbioelettronica.it

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# Novecento+
# Configuration protocol – v2.3

Commands to get information about the bioelectrical signal amplifier Novecento+ or to set it into a particular mode can be submitted with a command composed by 2 bytes. The GET commands are followed by an answer on 20 bytes, the content of the answer depends on the command sent.
The 2 bytes composing the command are listed in the following table:

| Seq. Num. | BYTE NAME | DESCRIPTION |
|---|---|---|
| 1 | COMMAND_BYTE | Command to request information or set a mode |
| 2 | CRC8 | Eight bits CRC |

To configure the device and start the communication with Novecento+, it is necessary to provide a command string composed by 15 bytes. The string sets the acquisition parameters and the detection mode of every input.
The 15 bytes are listed in the following table:

| Seq. Num. | BYTE NAME | DESCRIPTION |
|---|---|---|
| 1 | ACQ_SETT_A | Start/stop acquisition, start/stop recording, Active Inputs and Sampling frequency for AUX channels |
| 2 | ACQ_SETT_B | |
| 3 | AN_OUT_A | Select the input source, gain and channel for the analog output |
| 4 | AN_OUT_B | |
| 5 | IN1_CONF | Configuration for the ten IN inputs: high pass filter, resolution, sampling frequency, detection mode |
| 6 | IN2_CONF | |
| 7 | IN3_CONF | |
| 8 | IN4_CONF | |
| 9 | IN5_CONF | |
| 10 | IN6_CONF | |
| 11 | IN7_CONF | |
| 12 | IN8_CONF | |
| 13 | IN9_CONF | |
| 14 | IN10_CONF | |
| 15 | CRC8 | Eight bits CRC |

Details about each byte is provided in the following pages.

COMMAND_BYTE description:

Any command requiring information from the device, generates an answer on 20 bytes with the first byte echoing the command send. The following 19 bytes depend on the command. In case of wrong CRC following the command, the last of the 20 bytes is 0xFF and the corresponding command is not executed.

| 0 | 0 | COMM5 | COMM4 | COMM3 | COMM2 | COMM1 | COMM0 |
|---|---|---|---|---|---|---|---|

bit 5-0 **COMM<5:0>:** Command to get or set something.

**000000 = Stops data transfer, set the Novecento+ in idle mode.**
No answer to this command.

**000001 = Request the current hardware configuration.**
The answer to this command is in the format 0x01, IN1PrType, IN2PrType, IN3PrType, IN4PrType, IN5PrType, IN6PrType, IN7PrType, IN8PrType, IN9PrType, IN10PrType, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00. Where INXPrType is a code from 0 to 15 describing the type of probe physically connected to the corresponding input of the Novecento+. In particular:
0: No probe connected
1: 8-channels probe
2: 16-channels probe
3: 32-channels probe
4: 40-channels probe
5: 64-channels probe
6: 96-channels probe
7 to 15: reserved

**000010 = Request the firmware version.**
The answer to this command is in the format 0x02, 0x4E, 0x6F, 0x76, 0x65, 0x63, 0x65, 0x6E, 0x74, 0x6F, 0x2B, 0x20, 0x76, 0x31, 0x2D, 0x30, 0x32, 0x00, 0x00, 0x00. If read as plain text it results as “Novecento+ v1.02”.

**000011 = Request the battery level.**

The answer to this command is in the format: 0x03, BatLevPerc followed by a sequence of 18 byte equal to 0.

**000100 = Reset the Novecento+**

No answer to this command.

**000101 = Request the Serial Number.**

The answer to this command is in the format: 0x03, BatLevPerc followed by a sequence of 18 byte equal to 0.

**000110 = Set the Trigger OUT low**

If the Trigger OUT has to be used to synchronize the acquisition with other instruments, the recording has to be started when the trigger channel has a transition. I other words is the Novecento+ that generates a signal indicating to the computer when the data has to be recorded. To start this procedure the TRIG OUT has to be driven

High = The user wants to start data storing on PC

Low = The user wants to stop data storing on PC

No answer to this command.

**000111 = Set the Trigger OUT high**

No answer to this command.

ACQ_SETT_A BYTE description:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **ACQ** | **0** | **AUXFS1** | **AUXFS0** | **0** | **0** | **IN10ON** | **IN9ON** |

bit 7 **ACQ:** Acquisition bit:

1 = data sampling and transfer is active

0 = data sampling and transfer is not active

bit 5-4 **AUXFS<1:0>:** Sampling frequency for AUX channels:

11 = 8000 Hz

10 = 4000 Hz

01 = 2000 Hz

00 = 500 Hz

bit 1 **IN10ON:** Input 10 ON bit:

1 = The IN 10 is active

0 = The IN 10 is not active

bit 0 **IN9ON:** Input 9 ON bit:

1 = The IN 9 is active

0 = The IN 9 is not active

ACQ_SETT_B BYTE description:

| IN8ON | IN7ON | IN6ON | IN5ON | IN4ON | IN3ON | IN2ON | IN1ON |
|---|---|---|---|---|---|---|---|

bit 7-0 **INXON:** Input X ON bit:

1 = The IN X is active

0 = The IN X is not active

AN_OUT_A description:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **0** | **0** | **AN_GAIN1** | **AN_GAIN0** | **AN_IN3** | **AN_IN2** | **AN_IN1** | **AN_IN0** |

bit 5-4 **AN_GAIN<1:0>:** Gain for the analog output:

11 = the analog output gain is 16

10 = the analog output gain is 4

01 = the analog output gain is 2

00 = the analog output gain is 1

bit 3-0 **AN_IN<3:0>:** Source input for analog output select bits:

1010 = the analog output signal came from IN10

1001 = the analog output signal came from IN9

1000 = the analog output signal came from IN8

0110 = the analog output signal came from IN7

0101 = the analog output signal came from IN6

0100 = the analog output signal came from IN5

0011 = the analog output signal came from IN4

0010 = the analog output signal came from IN3

0001 = the analog output signal came from IN2

0000 = the analog output signal came from IN1

AN_OUT_B description:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **0** | **AN_CH6** | **AN_CH5** | **AN_CH4** | **AN_CH3** | **AN_CH2** | **AN_CH1** | **AN_CH0** |

bit 6-0 **AN_CH<6:0>:** Source channel for analog output:
Considering the input selected by the AN_IN<3:0> bits, this number indicates which channels of that input have to be provided at the ANALOG OUT BNC on the rear panel.
**NOTE:** 0 indicates the first channel, 1 the second channel etc…

INX_CONF BYTE description:

| MODE1 | MODE0 | GAIN1 | GAIN0 | HPF | HRES | FSAMP1 | FSAMP0 |
|---|---|---|---|---|---|---|---|

bit 7-6 **MODE<1:0>:** Working mode

11 = Test mode. Sends ramps on all channels

10 = Impedance check.

10 = Not used

00 = Monopolar. All the channels are acquired with respect to the reference.

bit 5-4 **GAIN<1:0>:** Preamp gain, there are differences depending on the resolution:

11 = preamp gain is 8. If HRES=1 the resolution is 71.5 nV and range +/- 300mV. If HRES=0 the resolution is 286.1 nV and range +/-9.375 mV.

10 = preamp gain is 6. If HRES=1 the resolution is 95.4 nV and range +/-400mV. If HRES=0 the resolution is 381.5 nV and range +/-12.5 mV.

01 = preamp gain is 4. If HRES=1 the resolution is 143 nV and range +/- 600mV. If HRES=0 the resolution is 572.2 nV and range +/-18.75 mV.

00 = if HRES=1, the preamp gain is 2, the resolution is 286.1 nV and range +/- 1200mV. If HRES=0 the preamp gain is 8, resolution is 286.1 nV and range +/- 9.375 mV.

bit 3 **HPF:** High pass filter

1 = High pass filter implemented by the microcontroller subtracting the exponential moving average, obtained by:

$$Average\_ChX[t] = (1-\alpha)\ Average\_ChX[t-1] + \alpha\ ChX[t]$$

Where α is equal to $1/2^5$ for MODE = 0, 1 or 2. It is equal to 1/2 in case of Impedance check.

For the standard modes, this result in a high pass filter with a cut-off frequency of 10.5 Hz, when sampling the signals at 2000 Hz. More in general the cut-off frequency is Fsamp/190.

0 = DC signals (to be used with the high resolution)

bit 2 **HRES:** High resolution

1 = samples on 24 bits

0 = samples on 16 bits

bit 1-0 **FSAMP<1:0>:** Sampling frequency

11 = 8000 Hz

10 = 4000 Hz

01 = 2000 Hz

00 = 500 Hz

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# Accessories channels

In addition to the signals acquired from the inputs on the Novecento+ front panel and the auxiliary inputs on the back panel, four accessory channels are transferred from quattrocento to the computer. The accessory channels have a resolution of 32 bits and are sampled at 8000 Hz.
The channels content is:
**Accessory channel 1:** it the sampling on 32 bits of an internal counter incremented by a 100 kHz clock. It is a value that increments constantly. It has to be considered as an unsigned DWORD, in the range 0 – 4294967295. It can be used to check if some samples have been lost or delayed in the transfer/save process. It is reset when Novecento+ is turned on and it rollovers when reach the maximum value after about 11 hours and 56 minutes. If the Novecento is not turned off, this value can provide information about the time passed between consecutive acquisitions.

**Accessory channel 2**: contains different information including the state of digital signals represented on single bits and other information on group of bits. Few bits are not used, considering the 32 bits enumered from 0 to 31, these are the used bits:
- Bit0: it is the TRIGGER level when used as input
- Bit2: it is the level of the $VACQ_{EN}$ signal who controls the enable of the voltage for the probes
- Bit3-4: code on 2 bits who define the sturt-up phases in the probes configuration
- Bit6: it is the TRIGGER level when used as output
- Bit7: LED Status green component
- Bit8: LED Status yellow component
- Bit9: reports the presence of the external 12V
- Bit10: LED Battery green component
- Bit11: LED Battery yellow component
- Bit12: reports that the probes power supply is derived from the external 12V
- Bit13: reports the buzzer state
- Bit16-31: 16 bit digital value who is provided to the D/A converter for the Analog Output

**Accessory channel 3:** it the sampling on 32 bits of an internal counter incremented by a 50 MHz clock used to trigger a new 2 ms block. It can have values between 0 and 99999.

**Accessory channel 4:** it the sampling on 32 bits of an internal counter incremented by a 50 MHz clock used to trigger a new write on the D/A converter for the Analog output. It can have values between 0 and 99999.