Antec Scientific
Industrieweg 12
2382 NV Zoeterwoude
The Netherlands

DECADE Elite/Lite

Communication Protocol

175.0016, Edition 5, 2020

T +31 71 5813333 | info@AntecScientific.com | www.AntecScientific.com

ISO 9001 certified

Intended use

The DECADE Elite Electrochemical Detector is used in combination with (Ultra) High Performance Liquid Chromatography for the electrochemical detection of suitable analytes in liquid samples. With this technique the amount of electroactive substances in mobile phase can be quantified. The instrument can be used for the chromatographic analysis of a wide range of electroactive analytes in the fields of for example:

- Bioanalytical analyses
- Food analyses
- Environmental analyses

For research purposes only. **While clinical applications may be shown, this instrument is not tested by the manufacturer to comply with the In Vitro Diagnostics Directive.**

Operation of an electrochemical detector can involve the use of hazardous materials including corrosive fluids and flammable liquids. The instrument should only be operated by users with the following expertise:

- Completed degree as chemical laboratory technician or comparable vocational training
- Fundamental knowledge of liquid chromatography
- Participation in an installation of the system performed by the manufacturer or a company authorized by the manufacturer and suitable training on the system and chromatography software.
- Knowledge and experience in the safe handling of toxic and corrosive chemicals and knowledge of the application of fire prevention measures prescribed for laboratories.

Information on safety practices is provided with your instrument and operation manuals. Before using your instrument or accessories, you must thoroughly read these safety practices. This manual is written for laboratory technicians who use the DECADE Elite detector for (U)HPLC analysis.

Unskilled, improper, or careless use of this instrument can create fire hazards, or other hazards which can cause death, serious injury to personnel, or severe damage to equipment and property. Observe all relevant safety practices at all times. Only use the device for applications that fall within the scope of the specified intended use. Else the protective and safety equipment of the device could fail.

WEEE directive

All equipment of Antec Leyden which are subjected to the WEEE directive shipped after August 13, 2005 are compliant with the WEEE marking requirements. Such products are labelled with the “crossed out wheelie”, depicted on the left site.

The symbol on the product indicates that the product must not be disposed as unsorted municipality waste.

Collection & recycling information
Please ship the instrument back to the manufacturer (Antec Leyden, the Netherlands) at the end-of-life time of the product. The manufacturer will take care of the proper disposal and recycling of the instrument at its facilities.

Shipping address for the end-of-life products:

Antec Leyden B.V.
Industrieweg 12
2382NV Zoeterwoude
The Netherlands

In case of questions, or if further information is required about the collection & recycling procedure, please contact your local distributor.

ROHS directive

The DECADE Elite is ROHS compliant and in conformity with Directive 2011/65/EU Restricted use of Hazardous Substances in electrical and electronic Equipment (ROHS).

Antec Leyden is an ISO 9001:2008 certified company.

Warning Symbols

The following symbols are used in this guide:

This sign warns about the risk of electric shock. It calls attention to a procedure or practice which, if not adhered to, could result in loss of life by electrocution. Do not proceed beyond a danger sign until the indicated conditions are fully understood and met.

The warning sign denotes a hazard. It calls attention to a procedure or practice which, if not adhered to, could result in severe injury, loss of life or damage or destruction of parts or all of the equipment. Do not proceed beyond a warning sign until the indicated conditions are fully understood and met.

The caution sign denotes a hazard. It calls attention to a procedure or practice which, if not adhered to, could result in damage or destruction of parts or all of the equipment and/or erratic results. Do not proceed beyond a cautions sign until the indicated conditions are fully understood and met.

The biohazard sign draws attention to the fact that use of biological materials, viral samples may carry a significant health risk.

The toxic hazard sign draws attention to the fact that use of toxic solvents or samples may carry a significant health risk.

ıe attention sign signals relevant information. Read this formation.

ıe note sign signals additional information. It provides dvice or a suggestion that may support you in using the quipment.

Safety instructions

Adhere to the following standard quality control procedures and the following equipment guidelines when using the DECADE Elite detector. The following safety practices are intended to ensure safe operation of the instrument.

Working environment & safety

The intended use of the instrument is to detect electroactive substances in liquid samples in combination with a (U) HPLC system in a GLP-approved environment. Operators using the system should have the appropriate education an extensive understanding of GLP rules and be skilled in the art. Use this system ONLY for the intended use. Use of the system for any other purpose will cause unsafe situations.

System Operation

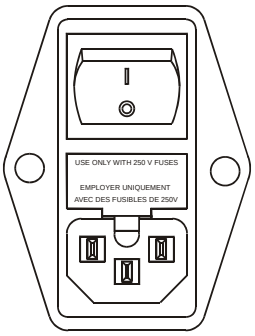
To assure optimal performance keep of the detector we recommend that the instrument is checked regularly and maintenance procedures are carried out. Preventive maintenance contracts are available for that
Purpose. Please contact your local dealer or the nearest sales office for more information.

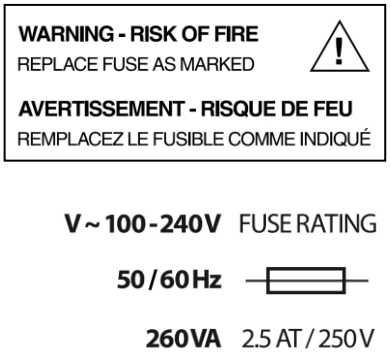
Electrical safety

The removal of protective panels on the instrument can result in exposure to potentially dangerous voltages. Therefore, disconnect the instrument from all power sources before disassembly.

Untrained personnel should not open the instrument, **this may only be done by authorized service engineers**. Replace or repair faulty insulation on power cords immediately after discovery of the fault. Check that the actual power voltage is the same as the voltage for which the instruments are wired. Make sure power cords are connected to correct voltage sources: grounded AC power source, line voltage 100 – 240 VAC. The instrument should be connected to a protective earth via a ground socket. The DECADE Elite must only be used with appliances and power sources with proper protective grounding to prevent damage through build-up of static electricity. The power

source should exhibit minimal power transients and fluctuations. If necessary connect to a filtered mains socket.





Replace blown fuses with fuses of proper type and rating as indicated on the rear panel and as listed in the list of accessories and spares (appendix D). The fuse holder is integrated in the mains connector. Ensure that the instrument is never put in operation with fuses of a different type. This could cause fire. Only use manufacturer-supplied I/O cable(s) to connect with other devices. Thoroughly connect shielding to common. Manufacturer will not accept any liability for damage, direct or indirect, caused by connecting this instrument to devices and with cables which do not meet relevant safety standards.

Solvents

The solvents used may be flammable, toxic or corrosive. The room in which the system is installed should be well ventilated to prevent that solvent vapors cause poisoning or ignite and cause a fire. Use of open fire in the vicinity of this system must be strictly prohibited. Do not install the system in the same room with any other equipment that emits or could potentially emit sparks. Provide protective equipment near the instrument, when solvent gets into the eyes or on the skin, it must be flushed away immediately. Provide equipment, such eye wash stations and safety showers, as close to system as possible. Use proper eye and skin protection when working with solvents. Additional safety requirements or protection may be necessary depending on the chemicals used in combination with this equipment. Make sure that you understand the hazards associated with the chemicals used and take appropriate measures with regards to safety and protection.
Sample containers (vials) should be sealed to minimize any risks related to solvent vapor.

Biological Hazard

When you analyze biological fluids you need possible precautions and treat all specimens as potentially infectious. Always wear protective
And gloves when handling toxic or biologically infectious samples to prevent bio hazards or hazards while working with the DECADE Elite. If necessary the instrument must be decontaminated before decommissioning or shipment of the instrument for repair to Antec or its representatives. When shipped to Antec every instrument has to be accompanied with a decontamination form which should be completely filled in and signed by the customer. Without this decontamination form the instrument will not be processed by Antec (either repaired or disposed).

Waste disposal

Perform periodic leak checks on LC tubing and connections. Do not close or block the drain in the oven compartment. Do not allow flammable and/or toxic solvents to accumulate. Follow a regulated, approved waste
Disposal program. Never dispose of flammable and/ toxic solvents through the municipal sewage system.

Applications: quality control

It is recommended that you routinely run several quality control samples. Quality control samples should represent low, average and high levels of a compound. Make sure that quality control sample results are within
An acceptable range, and evaluate precision from day to day and run to run. Data collected when quality control samples are out of range may not be valid. Do not report this data until you are certain that system
Performance is acceptable. Apart from use of quality control samples, we Recommend that you use blanks. The blanks will help you assess whether carry-over is within an acceptable range and monitor the integrity of your data.

Using the DECADE Elite in other ways than indicated in the manual or defined by good laboratory practice may result in erratic or unsafe operation.

Table of contents

C H A P T E R 1

Introduction

This detector enables you to perform (U)HPLC applications using electrochemical detection. The DECADE Elite includes a highly stable Faraday-shielded oven compartment accommodating column and flow cell.

The DECADE Elite has 3 operational measurement modes: DC, SCAN and PULSE mode. Furthermore, a Service, Diag(nostics) and Config(uration) mode are available. In addition, crucial parameters can be controlled by either relays or TTL. The DECADE Elite can support up to 4 flow cells (optional), which makes it possible to perform 4 independent measurements with one detector.

The DECADE Elite is available in different colors. The DECADE Lite is a “light” version of the Elite, it is for single flow cell operations in DC mode only.

This manual covers the installation, set-up and operation of the DECADE Elite only. Detailed operation instructions for other peripheral LC equipment and parts such as flow cells, pumps, auto samplers, valves, column heaters etc. are given in the manuals accompanying those accessories.

Multi-cell control is implemented in our communication protocol. A unique board ID is therefore embedded in the communication command structure to be able to address each individual sensor board.

The DECADE Lite (Single flow cell DC mode only) has one operational measurement mode available, the DC mode. Furthermore it supports only one flow cell. In table I the main differences between the different types of instruments are summarized.

Table I. Main differences in functionality of DECADE Elite versus DECADE Lite.

	DECADE Elite	DECADE Lite
Measurement modes	DC, PULSE and SCAN	DC
Max potential	+/- 2.50 V	+/- 2.50 V
WE activate function	n.a	n.a.
Multi-cell	SCC, 1 cell DCC, 2 cells TCC, 3 cells	SCC, 1 cell

For detailed information about the different instruments please refer to the corresponding user manuals. This document contains detailed information of the communication protocol between detector and host-PC. It contains six chapters:

- Configuration of the communication via LAN & USB
- Protocol command structure
- Cyclic Redundancy Checksum (CRC)
- Data acquisition mode
- Programming of time files in remote mode
- EEPROM programming

For the physical layer currently communication over LAN & USB is used at a fixed baud rate of 921600 bps is used. The protocol is set up in such a way that it can be used without change to accommodate any technology for the physical layer as long as the communication speed requirement is met.

Instrument Identification

The type of instrument connected to the host-PC can be identified with the following RS 232 command. See next chapter for detailed information about the command syntax.

Parameter	Command (hex)	Type	Value / Remarks
Remote connect	15	Action	Set detector in REMOTE mode
Detector online	84	Get	Value Instrument 0 No instrument online 5 DECADE Elite 6 DECADE Lite 7 ROXY Note that a DECADE II responds with: 1, 2, 3, or 4.

C H A P T E R 2

Configuration LAN & USB

The DECADE Elite is equipped with an USB (socket type B) and LAN (socket type RJ45) communication port. The USB port is only used as a service port for uploads of new embedded software updates. The LAN port is used for parametric control and data-acquisition. The USB port and the LAN port have to be configured for communication with the DECADE Elite.

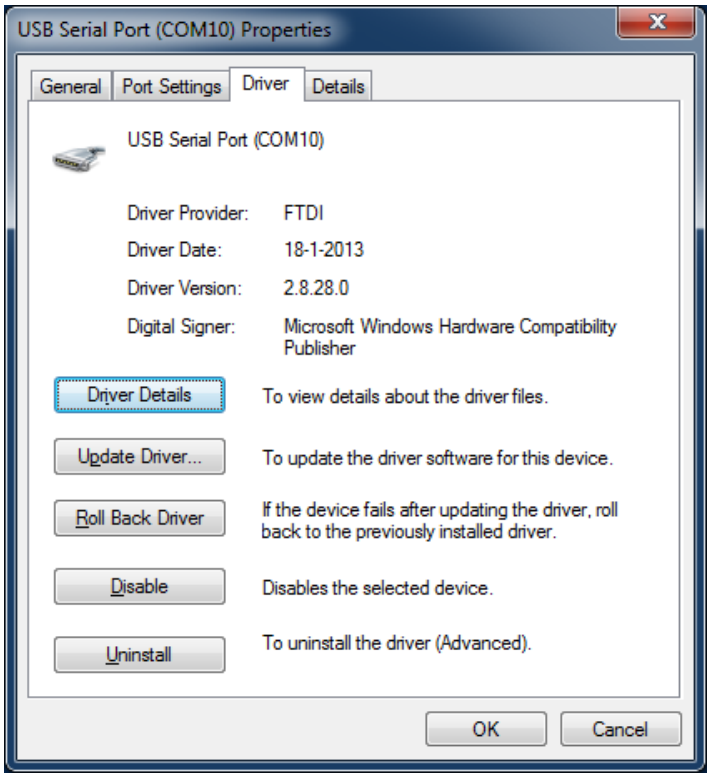
The DECADE Elite uses a fixed baud rate for communication over LAN and USB of 921600. The baud rate is not a settable parameter.

USB

Communication over the USB port is based on a USB-to-serial UART interface using the FT232R chip from FTDI (Future Technology Devices International Ltd). The FT232R is fully compliant with the USB 2.0 specification. To be able to communicate with the device via USB a Windows device driver for the FTDI chip has to be installed on the PC. When the PC connected to the instrument is connected to the internet the driver will be automatically installed. If not the driver can be downloaded from the FTDI site:

http://www.ftdichip.com/FTDrivers.htm

After installation a serial USB port will be available in the Windows OS (see screen dump below).



LAN

Communication over LAN is based on a Lantronix Xport device which is an so-called embedded ethernet device server which provides 10Base-T or 100Base-TX (Auto-Sensing) serial-to-ethernet connectivity. More information about the Xport can be found on the Lantronix website:

http://www.lantronix.com/device-networking/embedded-device-servers/xport.html

Network configuration

The Lantronix Xport has to be configured (IP settings, baud rate etc.) for communication with the detector. Configuration of the Xport, in principle, need to be performed only once, during installation of the instrument. The Xport configuration is stored in non-volatile memory and is retained without power. The Xport device performs a reset after you change and store the configuration.

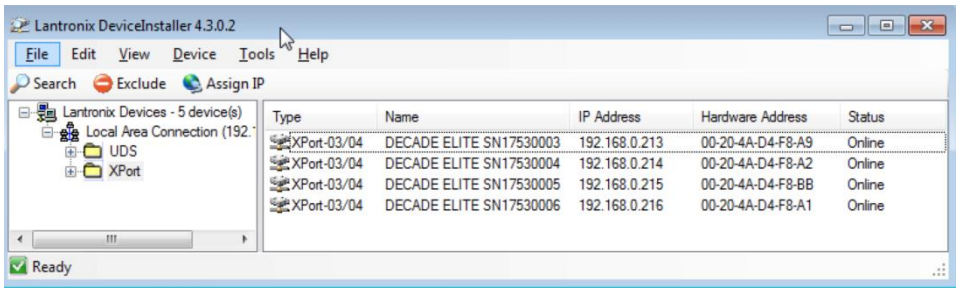
In this paragraph, we describe how to configure the XPort using Web Manager, the Lantronix's browser-based configuration tool. The Web manager can be accesses using the Lantronix 'deviceInstaller' software. This software tool and all relevant documentation for the Xport can be downloaded from the Lantronix website:

http://www.lantronix.com/support/downloads/?p=XPORT

On the Lantronix site also the latest FW revisions can be downloaded for the Xport. However do not perform a FW upgrade of the Xport device without a notification or consulting Antec. Upgrading the FW of the Xport might affect the internal serial communication in the detector with the Xport and might lead to a malfunctioning detector due to incompatibility issues.

To enable network communication with the detector configure the Xport by executing the follow the steps below:

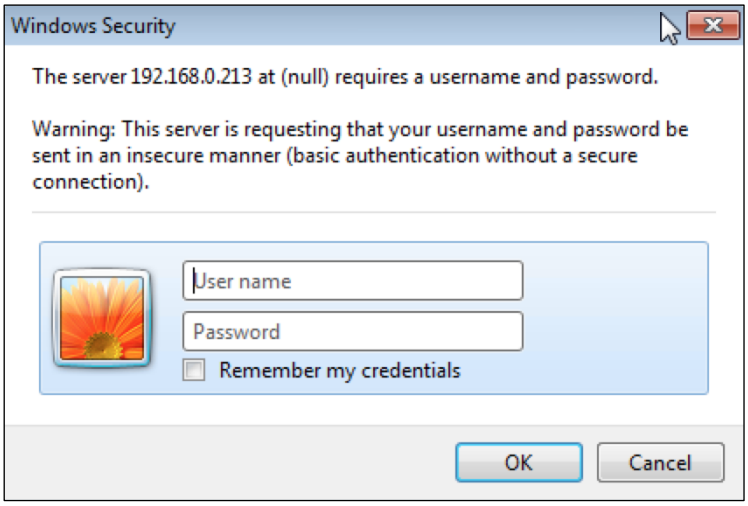
- Install the DeviceInstaller software on the PC.
- Start the DeviceInstaller software.
- Click the search button to find all available Lantronix devices.



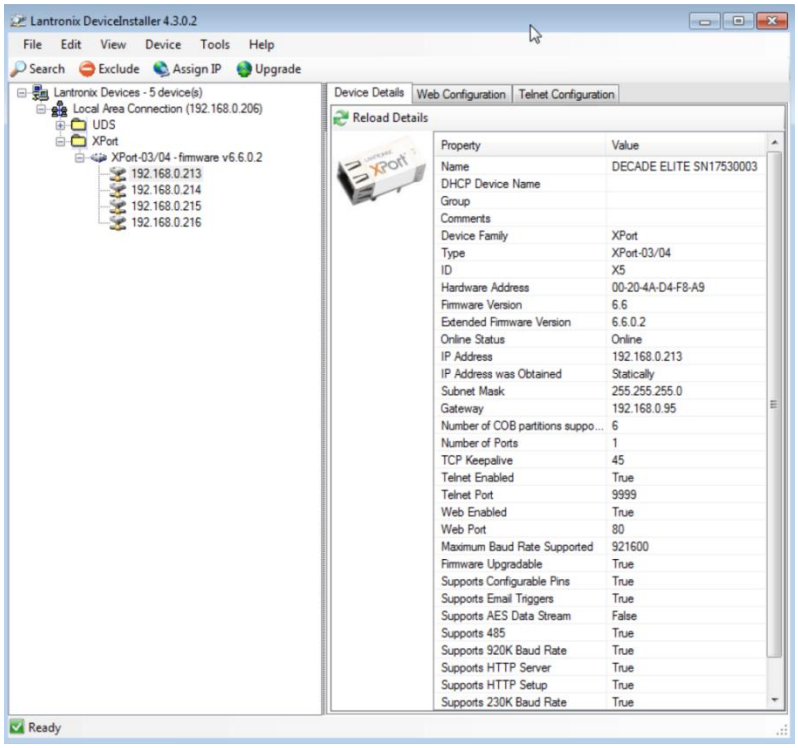
On the right-side in the Device installer window all available Xport devices are shown. Every detector has a Xport with an unique MAC address with which it can be identified on the network using the DeviceInstaller software. The MAC hardware address can be found on the detectors serial number label and is also printed on a label on the Xport device itself.

- Double click on the device you want to configure to access the Xport Configuration manager of the selected the device.
- Click the encircled green button with the arrow to access the configuration menu.

- A login screen will pop-up. By (factory) default the Xport is configured with the password: 3171 and leave the user name blank (so no user name). Fill in this information and click OK.



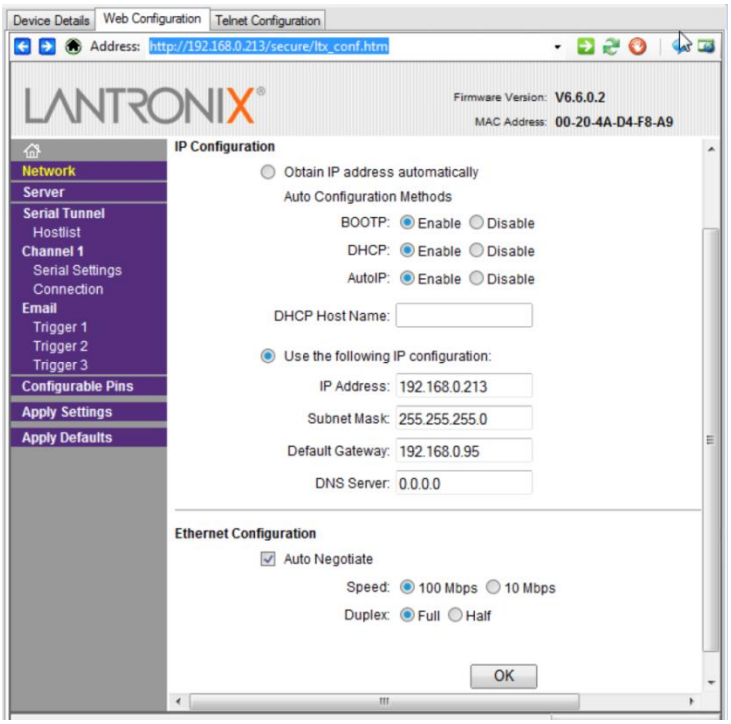
- The tab with the device details will open after login.



- Click on the Web configuration tab and subsequently goto the Network menu (menu on the left side) to set-up the IP configuration.

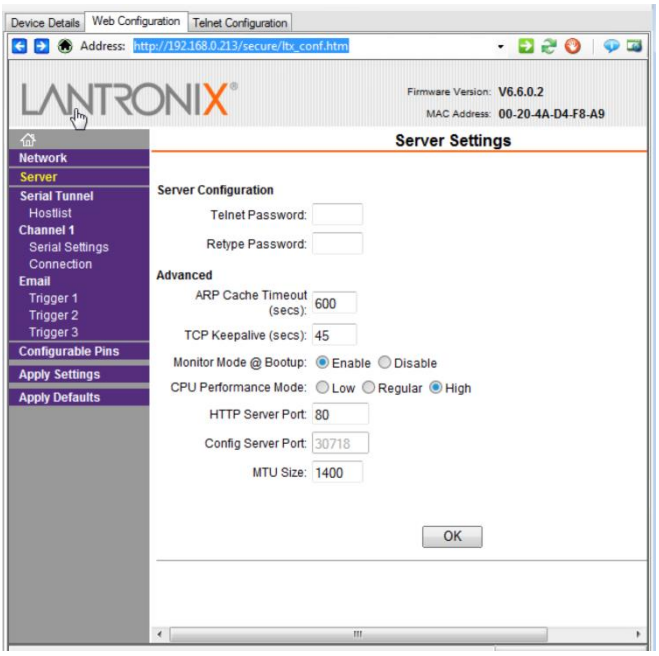
- Choose manual IP configuration and type in the designated IP address of the device and Net mask. The detector must be connected directly to a PC network card via a crossed LAN cable and may not be connected to a company network. See chapter 2 of the user manual (p/n 175.0010) for details about the installation of the detector.

To insure stable and error-free communication only use the manufacturer-supplied LAN connectivity kit to connect the DECADE Elite to LAN. Create a small dedicated local area network to connect the DECADE Elite to the PC. Do not connect the DECADE Elite over a company Local Area Network. If needed a second network adapter with a different (unique) IP address range can be applied.

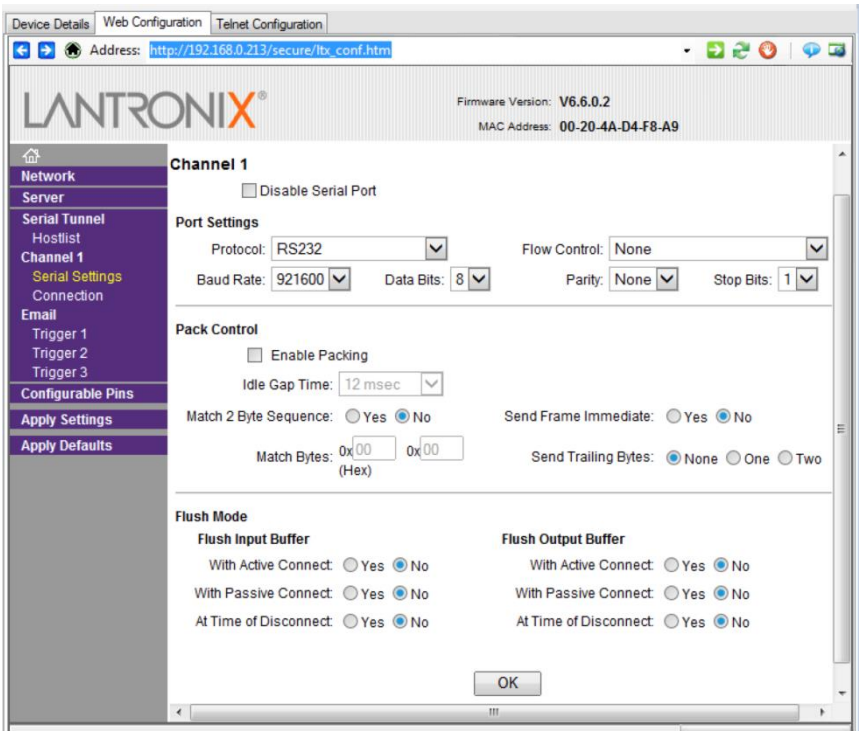


- Proceed with configuration of the server settings (left menu).
- Check if the CPU performance mode is set to 'HIGH' (factory default setting).
- It is strongly advised not to change the factory password. If access restriction for some reason is required using another password, type in required password in the corresponding fields.

It is strongly advised not to change the factory password. If access restriction for some reason is required using another password, make sure to write down the password for reference and store it on a secure location. Without the correct password access to the Xport configuration menu is not possible anymore and the device needs to be reset to factory defaults at the manufacturer.



- Goto the Serial Settings menu to check if the communication parameters are set correctly as depicted in the screen dump below.



- Click apply settings. After reboot the detector is configured for network communication.

As an alternative to configuration via the web browser the Xport device can also be configured via a telnet connection or terminal emulation program. For details consult the user manual on the Lantronix web site.

Communication with XPort

In Visual Basic the XPort is considered as an external socket. It has an IP address and is installed as an OCX. The communication looks like this:

Sending data:

```
Winsock1.SendData OutputString
```

Receiving data:

```
Do
  Winsock1.GetData a2, vbString
  InputString = InputString & a2
Loop Until condition
```

A somewhat more advanced example is programmed in a python script. It is in the appendix and uses the same concept.

First the socket is created:

```
s = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
s.settimeout(1)
s.connect((DEVICE_IP, port_coms))
```

Then communication starts:
Sending data:

```
s.send(Output_String)
```

Receiving:

```
while 1:
    try:
        Input_String += s.recv(512)
    except socket.timeout:
        break
print(Input_String)
```

C H A P T E R 2

Protocol command structure

The instrument communication protocol has the following characteristics:

It is a master-slave protocol. The PC is always master, the instrument is always slave and does not do anything by itself, it only responds to commands from the master. Commands have fixed lengths.
There are ‘set’, ‘get’, ‘action’ and ‘data-acquisition’ commands. The ‘data-acquisition’ command is a special case of the ‘get’ command. ASCII coding is used throughout. All numbers and characters are ASCII values.

The general command structure is:

[STX] [SENSOR ID] [SET/GET/ACTION] [COMMAND ID] ([VALUE] [UNIT]) [ETX]

Name	Value	Description
STX	02h	Start of command.
SENSOR ID	1-5	Number of addressed sensor board. This is only relevant for sensor board specific commands
SET/GET/ACTION	0-1-2	When ‘0’, a value from the value field, corresponding to the COMMAND ID, will be written to the slave. When ‘1’, a value, corresponding to the COMMAND ID, is requested from the slave. The value and unity fields will be empty, i.e. non-existing. When ‘2’, an action, corresponding to the COMMAND ID, is initiated. The value and unity fields will be empty, i.e. non-existing.
COMMAND ID	00-FF	Defines which action has to be taken or which value has to be written or read (depending on the set/get parameter).
VALUE	-99999999 to +99999999 plus a decimal point.	Contains the value set or requested. Left padded with ASCII spaces (20h) if full length is not required. Value may contain one decimal point and + or – sign.
UNIT	4 ASCII characters	Defines the unit (in ASCII) of the value, for example mV/s, pA etc. Right padded with ASCII spaces (20h) if 4 characters are not required.
ETX	03h	End of command.

A ‘set’ command always has a length of 20 bytes; a ‘get’ or ‘action’ command always has a length of 6 bytes. There are few exceptions; the following specific commands have a longer length:

5E Combined status command
73 Data acquisition variable (get data points)
7C Re-request data points
7A Read/write control board memory
1C Read/write sensor board memory

These commands will be discussed in more detail in the next chapters.

‘Set’ and ‘get’ type communication is used when a parameter value is set or requested, e.g. ‘get cell current’, ‘set pulse potential 1’, ‘get V recorder’ etc.

‘Action’ type communication is used when actions are performed, e.g. ‘mark’, ‘perform auto zero’ etc. An action has no associated value.

‘Set’ type communication

Master issues ‘set’ command (20 bytes).
Slave responds with:

Name	Value	Description
ACK	06h	Received command was correct and understood.
NACK	15h	Received message was incorrect (communication error). Incorrect length, illegal command type or command ID.
NACK0	18h	Received command was correct and understood, however the command couldn’t be executed at the time of issuing.

‘Get’ type communication

Master issues ‘get’ command (6 bytes).
Slave responds with:

Name	Value	Description
Full command		Received command was correct and understood and executed, the response contains the requested value and unit. DEVICE ID, SET/GET and COMMAND ID will be equal to the preceding ‘get’ command.
NACK	15h	Received message was incorrect (communication error). Incorrect length, illegal command type or command ID.
NACK0	18h	Received command was correct and understood, however the command couldn’t be executed at the time of issuing.

‘Action’ type communication

Master issues ‘action’ command (6 bytes).
Slave responds with:

Name	Value	Description
ACK	06h	Received command was correct and understood.
NACK	15h	Received message was incorrect (communication error). Incorrect length, illegal command type or command ID.
NACK0	18h	Received command was correct and understood, however the command couldn’t be executed at the time of issuing. For example: value not within range, incorrect unit.

‘Data-acquisition’ type communication

This is a special case of a ‘get’ command.
Master issues ‘get’ command (6 bytes).
Slave responds with:

Name	Value	Description

Full command		Received command was correct and understood and executed, the response contains the requested value and unit. DEVICE ID, SET/GET and COMMAND ID will be equal to the preceding 'get' command.
NACK	15h	Received message was incorrect (communication error). Incorrect length, illegal command type or command ID.
NACK0	18h	No points in buffer.

The format of the response to a 'get data point' command is as follows:

[STX] [SENSOR ID] [SET/GET/ACTION] [COMMAND ID] [SPACE]
([DATAPOINT]) [ETX]

The first four items and the last item are a standard header and trailer and not discussed here. The standard header is followed by one [SPACE]. After this space the data points are placed, the part between round brackets will be repeated for every data point, it has the following format:

[VALUE] [UNDERSCORE] [DATAPOINT COUNTER] [TIMER] [SPACE]

Name	**Value**	**Description**
STX	02h	Start of command.
VALUE	99999999 to +99999999 plus a decimal point	Contains the value of the data point. Left padded with zeroes if full length is not required. Value MAY contain one decimal point and always contains + or – sign.
UNDERSCORE	5Fh	Delimiter between data point and attached tag.
DATAPOINT COUNTER	000-999	Increments with steps of 1 for every new data point. It can serve as a missing data point indicator, see chapter on data-acquisition mode. Always three digits.
TIMER	000-999	Increments with steps proportional to the data rate. This timer can serve as a time base; see data-acquisition mode. Always three digits.
SPACE	20h	Delimiter between respective data points.

It is the responsibility of the master to correctly manage the responses from the slave.

CHAPTER 3

Cyclic Redundancy Checksum (CRC)

A cyclic redundancy checksum (CRC) is implemented for the data-acquisition command 73 and 7C (retrieval of buffered data points from the detector) and the combined status command 5E (array of the most important status commands of control and sensor board parameters set in the instrument).

The CRC checksum calculation (detector side) to generate a check value is optional and can be enabled or disabled with command 7D (value: 0= CRC checksum off, 1=CRC checksum on). It is advice to have the CRC option enabled and use the transmitted check values in the DAQ software (PC-side) to verify the data-integrity of incoming strings with data points (73, 7C) & parametric values (5E). For data-acquisition there is also an error correction mechanism (re-request of data points) implemented. This is explained in the next chapter in more detail.

The full command set available for the instrument is listed in the appendix (list of commands) at the end of the document.

The CRC type implemented in the DECADE Elite is a CRC-32 algorithm following the IEEE 802.3 standard with the 0x04C11DB7 polynomial:

$$x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$$

Example code can be found on the following web site:
http://cool-emerald.com/?p=704

On the following site an online checksum calculator is available for verification purposes of developed code:
http://www.zorc.breitbandkatze.de/crc.html

The checksum value is transmitted after the detector response on the get commands 7C, 73 and 5E. So after the trailer byte (ETX, 03h) 4 checksum bytes are transmitted. See the example response on a request for data points:

```
,3173└
,3173 -0.0029565_006522 └³ß~┴
```

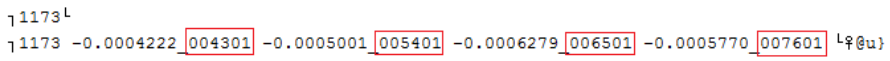
The checksum for the above string is B3DF7E15, which is added to the reply as character &HB3, &HDF, &H7E, and &H15: ³ß~┴

C H A P T E R 4

Description of data-acquisition mode

Introduction

The instrument has a data-acquisition mode. When this mode is switched on, a buffer will be filled with acquired data points at fixed intervals. The interval is determined by the data rate.To be able to position the data points correctly in time each data point contains two tags. These tags are each a 3 digit sequential number.



Example of data points and time tags (in red box) and the 32-bit checksum; 4 characters at the end.

The first tag will increment with steps of 1 for every new data point, and it can serve as a missing data point indicator to evaluate the data integrity (erratic communication etc.). The second tag increments with steps proportional to the data rate and can serve as a time base (x-value) to plot data points in a chromatogram. A timer increment of 1 corresponds with a time interval of 10 milliseconds. So at a data rate of 100 Hz the counter steps are 1, at 50 Hz the increments are 2, at 20 Hz the timer increments are 5 etc. Points are numbered from 000 to 999, then rolling over to 000 again.
For protection of data during a delay in data acquisition, the detector has a data buffer that can contain up to 6000 points. This means that after a delay of max. 1 minute at 100 Hz data rate all data points can be recovered from buffer. With a longer delay the buffer will be emptied, the data is lost and the buffer gets filled again.
To verify the integrity of the data transmission a 32 bits checksum is included at the end of each chunk of data.

Data-acquisition related host-detector commands

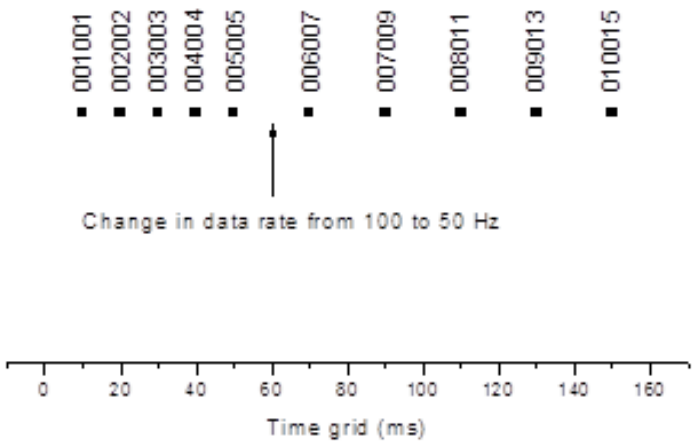
The most important data-acquisition specific commands are described below.

1. Data-acquisition filter (ADF) and data rate in DC mode

The DECADE Elite is equipped with ADF (Advanced Digital Filter) as a tool to filter the acquired signal and improve the sensitivity of the analysis (Signal-to-noise ratio). With command 72 the data-acquisition filter can be switched on/off. The filter cut-off frequency is set using the 'filter setting' command 04 for the DC mode and 88 for the Pulse mode. For the DC mode the filter setting range and corresponding data rate are listed in the table on the next page:

Filter setting DC mode (Hz)	Data rate (Hz)
RAW	100(default), 50, 20, 10, 5, 2, 1
10	100
5	50
2	20
1	20
OFF	10
0.5	10
0.2	10
0.1	10
0.05	5
0.02	2
0.01	1
0.005	1
0.002	1
0.001	1

The actual data rate of the detector is dependent on the filter setting and is fixed (with the exception of the RAW setting which will be explained later), and applies to DC mode only. This means that in case of timed event programming of the filter setting in a chromatographic method the data rate can change dynamically during a run. The timer counter tag which is transmitted with every data point during data acquisition (command 73) is therefore an important tool to correctly plot data points in a chromatogram. Data can be plotted on a grid of 10 ms, the actual interval between data points being dependent on the data rate coupled to the particular filter setting which is active. So by means of utilizing the time tag one is able to handle dynamic data rate changes during a run. See schematic example on the next page.



Plotting data using the time tag.

In case your HPLC data-acquisition software is dependent on data point parsing on a fixed data rate during a chromatographic run do not enable timed event-based programming of the detector Advanced Digital Filter in your detector control driver. This may lead to an incorrect time axis of a chromatogram.

The detector filter has 2 filter settings in the DC mode at which no filtering of data points (via the advanced digital filter algorithm) is active.

Filter OFF Data-acquisition at a data rate of 10 Hz, no filtering
RAW mode Unfiltered raw data by default at 100 Hz data rate, but in mode the data rate (command 74) is a settable parameter, and can be set to 100, 50, 30, 10, 5, 2 and 1 Hz.

In case your HPLC data-acquisition software has its own advanced filter routines, the RAW mode is an interesting option to implement. It allows acquiring raw data at different data rates, which can be optionally post-processed (filtering) by an end-user.

Pulse and Scan mode
So far the information covers the data acquisition in the DC mode only. The Pulse and Scan mode are organized differently. The Pulse mode has different filter settings, the Scan mode has no filter at all.

For the Pulse mode the following filter settings are available (command 88):

Filter setting (Hz)
OFF
0.5
0.2
0.1
0.05
0.02
0.01
0.005
0.002
0.001

In the Pulse mode the data rate is defined by the total pulse duration. In the Scan mode the data rate is fixed to 1 Hz. This is explained later on in this chapter.

2. Get data points

With get command 73 all the available data points in the buffer(s) can be requested from the detector to be transmitted to the PC. For the syntax see 'data-acquisition' type command.

3. Re-request data points (CRC)

In case a bad checksum is detected, the data points can be requested again using command 7C. The same data points including any newly added will be transmitted, together with a newly calculated checksum.

4. Data-acquisition start/stop

With the action commands 28 and 29 the data-acquisition can be started or stopped, respectively. By default the data-acquisition is off after switching the detector on. When the data-acquisition is off, the buffer will be empty, a 'get data point' will return a NACK0 and no data-acquisition takes place. When switched on, the detector starts putting data points in the buffer at the time-interval determined by the data rate, incrementing the tags as appropriate (starting at 000). Filling of the data-buffer will stop after reception of the 'stop' command. Filling of the data-buffer will start at position 0 after reception of the start command.

5. Data rate

The actual data rate can be requested with command 74. The data rate defines the time interval between data points and is defined in points per second (Hz). Under most conditions command 74 is a 'get' only parameter. For the three different measurement modes (DC/PULSE/SCAN) the data rate is determined by different factors.

In the DC mode the data rate is fixed (except for the RAW mode) and is coupled to the DC mode filter setting (see table in previous section 1). In case of the RAW mode, the data rate is a settable parameter. Allowable values are 1, 2, 5, 10, 20, 50 and 100 points per second (Hz). 10 Points per second relates to an interval of 100ms, 5 points per second relates to an interval of 200ms etc.

In PULSE mode measurements, when a new data point becomes available depends entirely on the total pulse time setting (t_{total}), which can be set by the user anywhere between 100 ms and 10000 ms in 10ms intervals. The pulse time setting is determined by the sum of all individual pulse time settings t_1 – t_5. In the PULSE mode the data rate therefore is determined by the reciprocal of the sum of all pulse time settings (t1 – t5) in seconds:

PULSE mode data rate (Hz) = $1 / t_{total} = 1 / (t_1 + t_2 + t_3 + t_4 + t_5)$
The actual PULSE mode data rate can be requested with command 74. The time tag send with each data point will also reflect the actual PULSE mode data rate and can be used as a time base to plot data points on a 10 ms grid.

Time tag = $t_{total} / 10 = (t_1 + t_2 + t_3 + t_4 + t_5) /10$

For example in case of a programmed pulse with the following time settings $t_1 = t_2 = t_3 = t_4 = t_5 = 150$ ms then $t_{total} = 750$ ms, data rate is 1.34 Hz and the time tag increments with 75 for each new data point.

In case your HPLC data-acquisition software is dependent on data point parsing on a fixed data rate during a chromatographic run do not enable/implement timed event-based programming of the detector pulse time settings in your detector control driver. This may lead to an incorrect time axis of a chromatogram.

In case t_{total} is set to its maximum of 10000 ms, the data point time tag cannot be used as a time base to plot data. In this particular case the timer increment steps will be 1000 which exceeds the three digits (000)

of the time tagtime tag. Under this setting the data should be plotted with a fixed data rate of 10000 ms during the run.

In the SCAN mode the data rate is a fixed value, 1 Hz (100 ms interval).

6. Data acquisition at high data rate

In the DC mode, a data rate up to 100 Hz can be chosen. This may result in quite large chunks of data, which takes some time to process in the device. Our experience with data acquisition is that it is better to have multiple smaller chunks. With big chunks of data there is a potential risk of accumulation, flooding and eventually blocking of the data flow.

We recommend not more than 50 data points per chunk data. So, in a system with 3 boards, at 100 Hz the data should be queried 6 times per second, calculation:

100 Hz / max 50 data points x 1 board ≥ 2 queries per second
100 Hz / max 50 data points x 3 boards ≥ 6 queries per second

7. Data-type (µV/nA)

The data-type defines the type of data put in the data-acquisition buffer. When switched to µV it reflects the voltage in µV as is shown on the LCD display, the range is +/-99999999 µV; which relates to +/-99.999999 V with a resolution of 1µV. There is no decimal point. When switched to nA it reflects the current after compensation in nA, the range is +/-9999999.9 nA to +/-0.0000001 nA. This relates to +/-9.9999999 mA and +/-0.1 fA.

Polling measurement variables during data-acquisition

For optimal operation during data-acquisition, especially at high data rates it is advised to keep the communication related to polling/requests of system parameters and individual measurement variables to a minimum, avoid superfluous polling. For polling of measurement variables a special combined status command 5E is implemented in the embedded software. With this command a large array of relevant control board and sensor board(s) measurement & system can be requested at once using only one single command.

The get command is build up in the following way:

5E: 84!3F!79!51!30!32!46!!!!!! 81!15!09!08!44!03!00!01!05!10!74!04!23!87!88!89!91!92!52!!!!!!

The sequence of parameters consists of:

(1) An array of 7 global commands 84, 3F, 79, 51, 30, 32, 46.
(2) An array of 19 sensor specific commands 81, 15, 09, 08, 44, 03, 00, 01, 05, 10, 74, 04, 23, 87, 88, 89, 91, 92, 52 (repeated up till 4 times depending on the number of installed sensor boards)

All parameters are separated by an exclamation mark (!). If more sensor boards are connected the sequence of (2) is repeated multiple times reflecting the status of all sensor boards. There are 5 undefined parameter positions after every array defined under (1) and (2). These positions are reserved for future extension of the parameter sequence in the embedded software if required. Below a reference table is shown with all parameters:

ID	Description	Value
84	detector online	0=detector not in remote, 5=DECADE Elite, 6=DECADE Lite in remote
3F	actual oven temperature	15.00 to 65.00 (step 1), 14.00=off
79	detector status	0=error, (1=reserved), 2=idle, 3=TF init, 4=TF running, 5=TF waiting, 6=SCAN running, 7=free TTL active
51	Electrical valve (Valco) present	0=not connected, 1=connected
30	electric valve	0=load, 1=inject
32	control board inputs	d2=handvalve, d3=statusA (not functional), d4=statusB (not functional), d5=mark (not functional), d6=free ttl (not functional), d7=door (binary coded)
46	sensor board inputs	d3=autozero, d4=start, d5=cell off, d6=reset (not functional), d7=cell on (binary coded)
81	sensor status	d0=overload, d1=I exc. MaxComp, d2=autozero active, d3=autoadjust active, d4=scan has terminated, d5= cell present, d6= PAD overload, d7= data buffer overflow (binary coded)

ID	Description	Value
15	cell on/off	0=off, 1=on
09	cell current for LCD display	-9999 to +9999 (step 1)
08	V of analog output for LCD display	-9999 to +9999 (step 1)
44	Vaux (readback potential of voltage clamp)	-10.00 to +10.00 (step 0.01)
03	DC cell potential	for DECADE Elite/Lite -2.50 to +2.50 (step 0.01)
00	main measurement mode	1=DC, 2=PULSE, 3=SCAN
01	DC current range	1, 2, 5, 10, 20, 50, 100, 200, 500
05	DC offset	-50 to +50 (step 5)
10	COMP (switch off autozero)	0=off, 1=on
74	data acquisition rate	1, 2, 5, 10, 20, 50 and 100 points per second - is a SET command only when in RAW mode and DC mode, otherwise data rates are fixed and dependent on filter setting (DC) / pulseduration (PAD)
04	DC filter setting	Raw (100 Hz), Off (0 Hz), 10, 5, 2, 1, 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, 0.005, 0.002, 0.001
23	pulse potential #1	for DECADE Elite -2.50 to +2.50 (step 0.01)
87	PULSE current range	1, 2, 5, 10, 20, 50, 100, 200, 500
88	PULSE filter setting	Off (0 Hz), 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, 0.005, 0.002, 0.001
89	PULSE offset	-50 to +50 (step 5)
91	SCAN current range	1, 2, 5, 10, 20, 50, 100, 200, 500
92	SCAN offset	-50 to +50 (step 5)
52	scan mode actual applied potential	-4900 to +4900 (step 1)

An example input and output is shown below for a detector with three sensor boards. Only for readability the output is formatted in 7 global and 3x 19 sensor specific parameters, followed by the checksum. In reality, the output is send as 1 string without formatting.

```
┐115E└
┐115E +5!+35.60øC!+2!+0!+0!+0!+0!!!!!!
+32!+1!+2.611nA!-0.005V!-0.80V!+0.80V!+1!+100pA!+0%!+1!+1!+1!+100Hz!-0.01V!+1æA!+0.02Hz!+0%!+50nA!+0%!+0mV!!!!!!
+32!+1!+2.632nA!-0.036V!-0.80V!+0.80V!+1!+100pA!+0%!+1!+1!+1!+100Hz!-0.01V!+1æA!+0.02Hz!+0%!+50nA!+0%!+0mV!!!!!!
+32!+1!+2.658nA!-0.029V!-0.80V!+0.80V!+1!+100pA!+0%!+1!+1!+1!+100Hz!-0.01V!+1æA!+0.02Hz!+0%!+50nA!+0%!+0mV!!!!!!└K@i
```

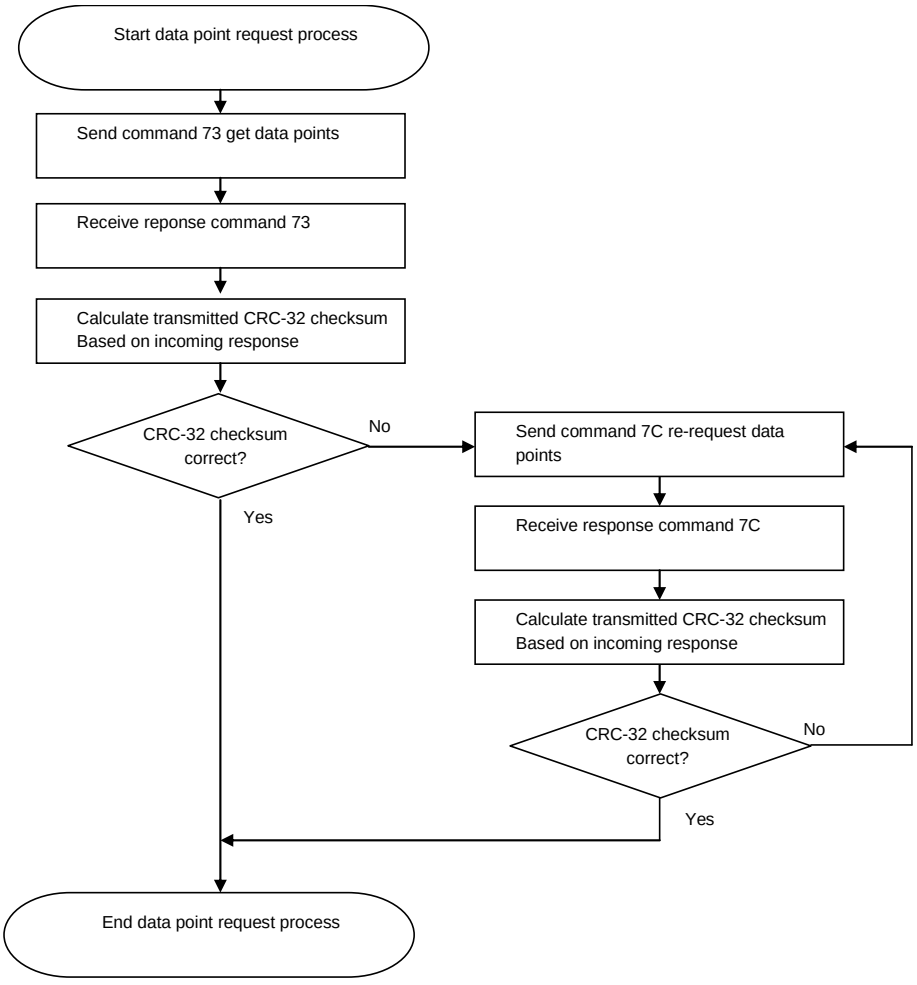
Besides data-acquisition commands 73 and 7C also command 5E has a checksum. All other commands are without checksum. In the case of an invalid checksum simply request 5E again.

For optimal operation minimize communication traffic by avoiding superfluous polling, use command 5E instead of the individual commands for the listed parameters.

CRC check and error correction

Below a short example is shown how the CRC check and error correction could be implemented in a detector control driver. The data parsing process could consist of the following steps:

(1) Request data points with data-acquisition command 73.
(2) Calculate the CRC-32 checksum on the response string from (including) STX until ETX (see chapter 3).
(3) Convert the resulting 4 bytes to ASCII characters.
(4) Check by comparing with the 4 characters attached to the response string.
(5) In case of a checksum mismatch, request to resend data with command 7C and repeat step (2) & (3). When the checksum is correct continue data-acquisition (step 1 - 4).



A practical example is shown below. In the first set of data an error occurred. This set is resend again, including the newly added data points. The checksum in the second set is correct.

```
CRC Error. Calculated: íþ└, given: îÜ-N
┐2173└
┐2173 +0.0001787_158158 +0.0011186_159159 +0.0007906_160160 +0.0002418_161161
+0.0004741_162162 +0.0004012_163163 +0.0002528_164164 +0.0002917_165165 +0.0010014_166166
+0.0003981_167167 -0.0001584_168168 +0.0005130_169169 +0.0009988_170170 +0.0009555_171171
+0.0006012_172172 -0.0004703_173173 -0.00040□5_174174 +0.0004215_175175 +0.0000538_176176
+0.0005007_177177 +0.0007685_178178 +0.0006735_179179 +0.0004969_180180 +0.0006009_181181
+0.0005042_182182 +0.0009161_183183 +0.0002899_184184 +0.0004144_185185 +0.0004014_186186
+0.0006019_187187 +0.0009024_188188 +0.0008741_189189 -0.0002661_190190 -0.0003211_191191
-0.0001711_192192 -0.0002977_193193 +0.0005538_194194 +0.0000384_195195 +0.0003049_196196
-0.0000758_197197 +0.0004950_198198 +0.0008355_199199 +0.0005545_200200 +0.0005932_201201
+0.0002570_202202 +0.0006720_203203 +0.0006801_204204 +0.0009914_205205 +0.0002216_206206
+0.0007274_207207 +0.0005484_208208 +0.0002221_209209 -0.0001699_210210 +0.0010764_211211
+0.0008923_212212 +0.0007182_213213 +0.0007346_214214 +0.0010885_215215 +0.0008442_216216
└îÜ-N
┐217C└
┐217C +0.0001787_158158 +0.0011186_159159 +0.0007906_160160 +0.0002418_161161
+0.0004741_162162 +0.0004012_163163 +0.0002528_164164 +0.0002917_165165 +0.0010014_166166
+0.0003981_167167 -0.0001584_168168 +0.0005130_169169 +0.0009988_170170 +0.0009555_171171
+0.0006012_172172 -0.0004703_173173 -0.0004065_174174 +0.0004215_175175 +0.0000538_176176
+0.0005007_177177 +0.0007685_178178 +0.0006735_179179 +0.0004969_180180 +0.0006009_181181
+0.0005042_182182 +0.0009161_183183 +0.0002899_184184 +0.0004144_185185 +0.0004014_186186
+0.0006019_187187 +0.0009024_188188 +0.0008741_189189 -0.0002661_190190 -0.0003211_191191
-0.0001711_192192 -0.0002977_193193 +0.0005538_194194 +0.0000384_195195 +0.0003049_196196
-0.0000758_197197 +0.0004950_198198 +0.0008355_199199 +0.0005545_200200 +0.0005932_201201
+0.0002570_202202 +0.0006720_203203 +0.0006801_204204 +0.0009914_205205 +0.0002216_206206
+0.0007274_207207 +0.0005484_208208 +0.0002221_209209 -0.0001699_210210 +0.0010764_211211
+0.0008923_212212 +0.0007182_213213 +0.0007346_214214 +0.0010885_215215 +0.0008442_216216
+0.0011528_217217 +0.0004438_218218 +0.0003961_219219 -0.0002696_220220 └æ/Ñ¹
```

C H A P T E R 5

Accessing EEPROM

Introduction

Each control board and sensor board has an on board EEPROM. They can be -and is- used to store hardware related parameters. Those parameters include manufacturing details (serial number, adjustment date etc.) and adjustment factors. Each sensor board thus carries it's own adjustment factors which makes 'in the field' service of a faulty sensor board easy. A board can be replaced without calibration after installation. Adjustment factors and parameters like mains frequency and LCD contrast are stored by the firmware. Manufacturing details need to be programmed by the host. This chapter details how to do that.

EEPROM read/write commands

There are two SET/GET commands available to write/read in a designated location of the control board and sensor board EEPROM memory allocated for manufacturing details such as:

- Detector serial number
- Control board serial number
- Sensor board serial number(s)

ID	Description	Value
1C	read/write sensor board memory	command for read/write of 255 characters in EEPROM memory of sensor board
7A	read/write control board memory	command for read/write of 255 characters in EEPROM memory of control board

In the factory all serial number are programmed in the corresponding EEPROM locations.

The output for a detector with 3 sensor boards will look like the example below. The ETX is not visible as the total line of 255 characters (filled with spaces) is abbreviated.

```
┐111C└
┐111C 01-00010
┐211C└
┐211C 01-00018
┐311C└
┐311C 01-00021
┐117A└
┐117A cb: 01-00008, ECD: 17530004
```

Upon a read request for the information stored in the control board EEPROM, the detector responds with:

- The control board serial number (preceded by the text ‘cb: ‘)
- A separator
- The detector serial number (preceded by the text ’ECD: ‘)
- spaces until the trailer byte (string in total 255 characters).

A P P E N D I X

List of commands

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
00	main measurement mode	S / G	1=DC, 2=PULSE, 3=SCAN, 4=DIAG, 5=SERVICE, 6=ACTIVATE		
01	DC current range	S / G	1, 2, 5, 10, 20, 50, 100, 200, 500	pA, nA, uA	50 nA
02	maximum compensation	G	2.5, 25, 250	nA, uA, mA	
03	DC cell potential	S / G	for DECADE Elite/Lite -2.50 to +2.50 (step 0.01)	V	0.50 V
04	DC filter setting	S / G	Raw (100 Hz), Off (0 Hz), 10, 5, 2, 1, 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, 0.005, 0.002, 0.001	Hz	Off
05	DC offset	S / G	-50 to +50 (step 5)	%	0 %
06	actual oven temperature	G	15 to 65 (step 1), 14=off	°C	
07	DC polarity of analog output	S / G	-1='-', +1='+'		+1 = polarity '+'
08	V of analog output for LCD display	G	-9999 to +9999 (step 1)	V	
09	cell current for LCD display	G	-9999 to +9999 (step 1)	nA, uA, mA	
0C	error number	G	See user manual on error and message screens and numbers		0
0D	message number	G	See user manual on error and message screens and		0

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
			numbers		
0E	enslave to ID1	S / G	0 = no, 1 = yes		0
0F	number of active temperature sensor	S / G	1 to maximum number of connected temperature sensors (1, 2, 3 or 4)		1
10	COMP (switch off autozero)	S / G	0=off, 1=on		0=off
11	programmed oven temperature	S / G	15 to 60 (step 1), 14=off	°C	14 = off
12	time	G	0 to 99999 (step 1)		0
13	time minutes	G	0 to 999 (step 1)		0
14	time hundreds of minutes	G	0 to 99 (step 1)		0
15	cell on/off	S / G	0=off, 1=on		0=off
1C	read/write sensor board memory	S/G	command for read/write of 255 characters in memory D3 (per sensor board)		
1E	test result of SRAM memory test	G	0=idle, 1=running, 2=test OK, 3=control brd err, 4=sensor brd 1 err, 5=sens brd 2 err, 6=sens brd 3 err, 7=sens brd 4 err , 8=sens brd 5 err		
22	total pulse time	G	100 to 10000 (step10) - based on 5-step pulse	ms	
23	pulse potential #1	S / G	for ROXY -4.90 to +4.90 (step 0.01), for DECADE Elite -2.50 to +2.50 (step 0.01)	V	0.10 V
24	pulse time #1	S / G	100 to 2000 (step 10)	ms	100 ms
25	sample time	S / G	multiples of 16.7 or 20 ms. Sample time (ts) always =< pulse time #1 (t1) - 60ms	ms	20 ms
26	pulse potential #2	S / G	for DECADE Elite -2.50 to +2.50 (step 0.01)	V	0.50 V

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
27	pulse time #2	S / G	0 to 2000 (step 10)	ms	100 ms
28	pulse potential #3	S / G	for DECADE Elite -2.50 to +2.50 (step 0.01)	V	-0.30 V
29	pulse time #3	S / G	0 to 2000 (step 10)	ms	100 ms
2A	endcycle time	S / G	0 to 99999 (step 1)		0
2B	endcycle time minutes	S / G	0 to 999 (step 1)		0
2C	endcycle time hundreds of minutes	S / G	0 to 99 (step 1)		0
2D	temperature offset correction factor LM35	S / G	-1.0 to +1.0 (step 0.1)	°C	
2E	number of connected sensor boards in system	G	1 to 5		
30	electric valve	S / G	0=load, 1=inject		0=load
32	control board inputs	G	d2=handvalve, d7=door (binary coded)		
33	control board outputs	S / G	d1=free ttl (not functional), d2=inject, d3=to pos A (not functional), d4=to pos B (not functional) (binary coded)		0= all off
34	scan rate	S / G	1, 2, 5, 10, 20, 50 (default), 100	mV/s	50 mV/s
35	scan cycle mode	S / G	0=half, 1=full, 2=continuous		0=half
36	hold / resume	S / G	0=resume, 1=hold (for DC & pulse mode time files and scan running)		0=resume
39	overload	G	0=off, 1=on		
3E	available temperature sensors	G	0 = no sensor, 1= LM35 only		
3F	actual oven temperature	G	15.00 to 65.00 (step 1), 14.00=off	°C	
40	scan mode clock (hours/minutes)	G	0 to 5999 (step 1)		

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
42	mains frequency	S / G	50, 60	Hz	50
44	Vaux (readback potential of voltage clamp)	G	-10.00 to +10.00 (step 0.01)	V	
45	ts lock	S / G	0=ts lock off, 1=ts lock on		1=ts lock on
46	sensor board inputs	G	d3=autozero, d4=start, d5=cell off, d6=reset (not functional), d7=cell on (binary coded)		
47	sensor board outputs	S / G	d0=aux1, d1=aux2, d2=relay1, d3=relay2, d4=aux3, d5=overload, d6=aux4 (binary coded)		0
49	scan potential #1	S / G	for ROXY -4.90 to +4.90 (step 0.01), for DECADE Elite -2.50 to +2.50 (step 0.01)	V	0.00V
4A	sensor board start inputs	G	d5 = start pin sensor board 5, d4 = sensor board 4, d3 = sensor board 3, d2 = sensor board 2, d1 = sensor board 1 .		
4E	sensorboard analog output	S / G	0 = from DAC (i.e. processed and filtered), 1 = direct from I/E converter (i.e. neither processed nor filtered)		0
50	scan potential #2	S / G	for ROXY -4.90 to +4.90 (step 0.01), for DECADE Elite -2.50 to +2.50 (step 0.01)	V	1.00V
51	Electrical valve (Valco) present	G	0=not connected, 1=connected		
52	scan mode actual applied potential	G	-4900 to +4900 (step 1)	mV	
53	keyboard lock	S / G	0=off, 1=on		0=off
54	Count-down clock for noise mode (hours/minutes)	S / G	0 to 5999 (step 1)		
55	pulse and scan mode extended current	S / G	0=off, 1=on		0=off

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
	range				
56	Vout for service	S / G	-1V to +1V	V	0
57	offset value for zero IE calibration visible in LCD	S / G	-20000 to +20000 (step 1)		
58	reset zero IE calibration	S / G	0=no reset, 1=reset all calibration factors to 0		0=no reset
59	measurement resistor	S / G	0=1k, 1=100k, 2=1M, 3=10M, 4=100M		0=1k
5A	installed options	G	0=detector not in remote, 1=DECADE Elite in remote, 2=DECADE Lite in remote, 4=ROXY in remote		
5B	connector IO output mask for command #47	S / G	d0='A' (aux1), d1='A' (aux2), d2='A' (relay1), d3='A' (relay2), d4='A' (aux3), d5=1-5 or 'A' (overload), d6='A' (aux4)		AAAAAAA0
5C	connector IO input mask for command #46	S / G	d3=1-5 or 'A' (autozero), d4=1-5 or 'A' (start), d5=1-5 or 'A' (cell off), d7=1-5 or 'A' (cell on)		000AAA0A
5D	fADC	G	100 (default), 50, 20, 10, 5, 2, 1	Hz	100
5E	Combined Status Command	S	A sequence of 84,3F,79,51,30,32,46 (array of 12 incl. 5 undefined positions) and for each sensor connected: 81,15,09, 08,44,03,00,01,05,10, 74, 04, 23, 87, 88 89,91,92,52 (array of 24 incl. 5 undefined positions)		
60	LCD contrast	S / G	0 to 20 (step 1)		10
61	offset value for zero IE calibration Rmeas = 1k	S / G	-20000 to +20000 (step 1)		
62	ADC value for zero IE calibration	S / G	-20000 to +20000 (step 1)		

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
	Rmeas = 1k				
63	offset value for zero IE calibration Rmeas = 100k	S / G	-20000 to +20000 (step 1)		
64	ADC value for zero IE calibration Rmeas = 100k	S / G	-20000 to +20000 (step 1)		
65	offset value for zero IE calibration Rmeas = 1M	S / G	-20000 to +20000 (step 1)		
66	ADC value for zero IE calibration Rmeas = 1M	S / G	-20000 to +20000 (step 1)		
67	offset value for zero IE calibration Rmeas = 10M	S / G	-20000 to +20000 (step 1)		
68	ADC value for zero IE calibration Rmeas = 10M	S / G	-20000 to +20000 (step 1)		
69	offset value for zero IE calibration Rmeas = 100M	S / G	-20000 to +20000 (step 1)		
70	ADC value for zero IE calibration Rmeas = 100M	S / G	-20000 to +20000 (step 1)		
71	ADC value for zero IE calibration visible in LCD	S / G	-20000 to +20000 (step 1)		
72	data acquisition filter on/off	S / G	0=off, 1=on		1=on
73	data acquisition variable	G	-99999999 to +99999999 (step 1)	000-000 to 299-299	

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
74	data acquisition rate	S*/G	1, 2, 5, 10, 20, 50 and 100 points per second *) SET command only in DC mode in combination with RAW filter setting		Off
75	data acquisition type	S / G	0=nA, 1=uV		0=nA
76	speed of communication	G	5=921600	bps	5
77	firmware version	G	0.00 to 9.99		
79	detector status	G	0=error, (1=reserved), 2=idle, 3=TF init, 4=TF running, 5=TF waiting, 6=SCAN running, 7=free TTL active		
7A	read/write control board memory	S/G	command for read/write of 255 characters in memory D3 control board		
7C	Re-Request DAQ points	G	0=off, 1=on		
7D	Checksum calculated on DAQ transmissions.	S/G	0=off, 1=on		
80	valve present	S / G	0=none, 1=present		0=none
81	sensor status	G	d0=overload, d1=I exc. MaxComp, d2=autozero active, d3=autoadjust active, d4=scan has terminated, d5= cell present, d6= PAD overload, d7= data buffer overflow (binary coded)		
82	1V full scale adjustment factor for Analoge OUT	S / G	0.9000 to 1.1000 (step 0.0001)		1.0000
83	force Vout	S / G	0=normal operation (cell is off->Vout = 0V), 1=force Vout to active even when cell is off		0

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
84	detector online	G	0=detector not in remote, 5=DECADE Elite, 6=DECADE Lite in remote, 7=ROXY in remote		0
85	Boot version	G	000 to 999		
86	firmware checksum	G	0000000000 to 2147483647		
87	PULSE current range	S / G	1, 2, 5, 10, 20, 50, 100, 200, 500	pA, nA, uA	1 uA
88	PULSE filter setting	S / G	Off (0 Hz), 0.5, 0.2, 0.1, 0.05, 0.02, 0.01, 0.005, 0.002, 0.001	Hz	Off
89	PULSE offset	S / G	-50 to +50 (step 5)	%	0 %
90	PULSE polarity of analog output	S / G	-1='-', +1='+'		+1 = polarity '+'
91	SCAN current range	S / G	1, 2, 5, 10, 20, 50, 100, 200, 500	pA, nA, uA	50 nA
92	SCAN offset	S / G	-50 to +50 (step 5)	%	0 %
93	gain adjustment factor for clamp	S / G	0.9000 to 1.1000 (step 1)		1.0000
94	offset adjustment factor for clamp	S / G	-100 to +100 (step 1)		0
95	general selection and address (memory location) of EEPROM	S / G	0 to 'size of EEPROM', highest digit: 0 = select contr.brd. EEPROM, 1=select sens. brd. EEPROM 1, 2=select sens. brd. EEPROM 2 etc.		
96	general data to or from EEPROM address (memory location)	S / G	0 to 255 (step 1)		
A0	pulse potential #4	S / G	for DECADE Elite -2.50 to +2.50 (step 0.01)	V	0.00 V
A1	pulse time #4	S / G	0 to 2000 (step 10)	ms	0 ms
A2	pulse potential #5	S / G	for DECADE Elite -2.50 to +2.50 (step 0.01)	V	0.00 V

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
A3	pulse time #5	S / G	0 to 2000 (step 10)	ms	0 ms
ACTION COMMANDS					
08	autozero	A			
09	set outputs to active for service	A			
10	set outputs to inactive for service	A			
11	start scan	A			
12	stop scan	A			
13	marker	A			
14	start SRAM memory test	A			
15	remote connect	A			
16	remote disconnect	A			
18	get all parameters stored in control and sensor EEPROMS	A			
19	directly set +4.90V on clamp	A			
20	directly set 0V on clamp	A			
21	directly set -4.90V on clamp	A			
22	directly set +VFS (+1V) on output DAC (analog OUTP)	A			
23	directly set +0V on output DAC (BNC)	A			
24	directly set +VFS (-1V) on output DAC (analog OUTP)	A			

Id	Description of action / variable	Set, get or action	Value range	Value unit	Value default
25	perform auto adjustment on selected measurement resistor	A			
26	undo last auto adjustment action	A			
28	start data-acquisition	A			
29	stop data-acquisition	A			
30	factory reset all non-volatile memory	A			
31	get all parameters stored in non-volatile SRAM memory	A			
32	undo 'set Vout directly'	A			
33	do 'set Vout directly'	A			
36	clampfilter off	A			
37	clampfilter on	A			
43	enter multistat mode	A			
44	leave multistat mode	A			
46	start activate	A			
47	stop activate	A			