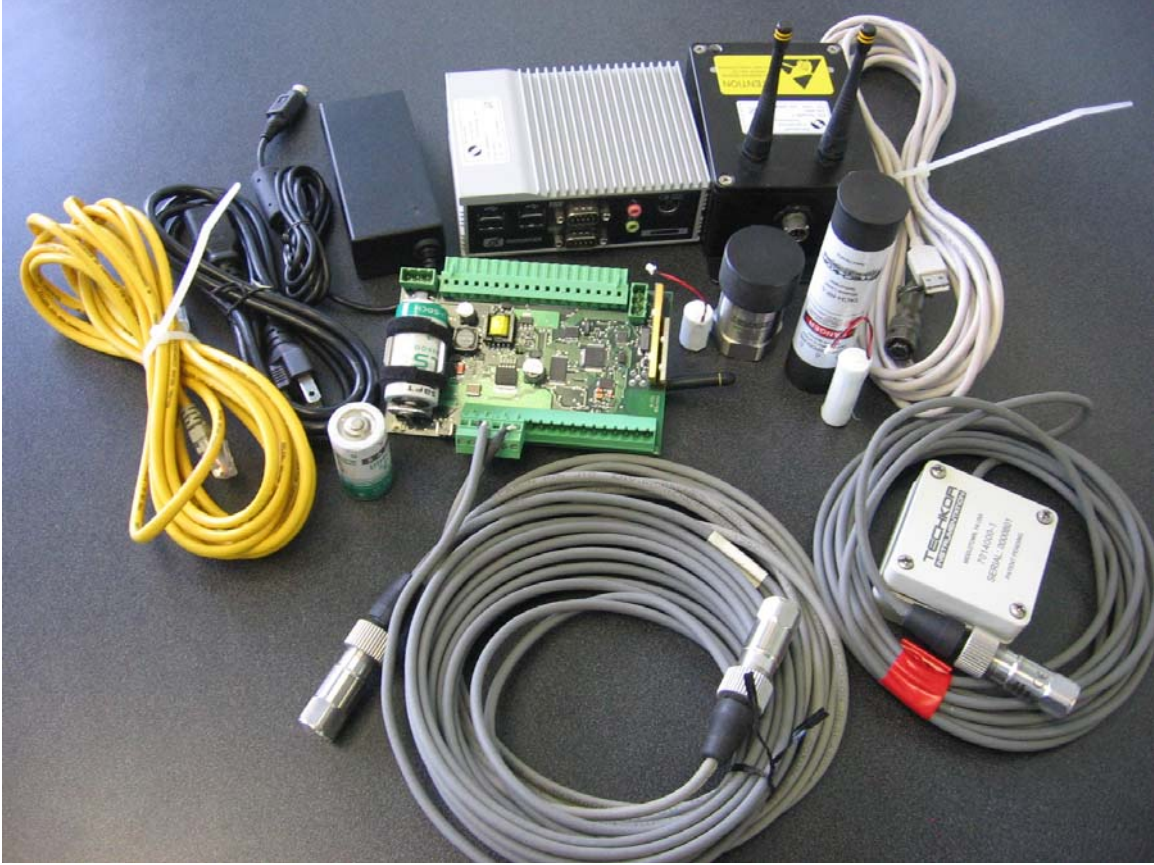


Maintenance Watchdog™ A5

Startup Manual



© 1999-2010, Techkor Instrumentation

Compatible with:
Sensor Firmware Revision A.5

*Printed in the United States of
America*

Maintenance Watchdog™ A.5

Startup Manual

Wireless Condition Monitoring System

© 1999-2010, Techkor Instrumentation
All Rights Reserved

Information in this document is subject to change without notice. Companies, names, and data used in examples herein are fictitious unless otherwise noted. No part of this document may be reproduced or transmitted in any form or by any means, electronics or mechanical, for any purpose, without the express written permission of Techkor Instrumentation.

Techkor and the Techkor Cube are trademarks of Techkor Instrumentation, A Division of Advanced Conversion Technology
Maintenance Watchdog is a trademark of Techkor Instrumentation, A Division of Advanced Conversion Technology
Acrobat is a Trademark of Adobe Systems
Entek and Odyssey are trademarks of Rockwell Automation
Windows, and Excel are trademarks of Microsoft Corporation

Techkor Instrumentation
A Division of Advanced Conversion Technology, Inc.
2001 Fulling Mill Road
Middletown, PA 17057-0070
USA
Main Number: 717-939-2300, Fax: 717-939-7170
Web: <http://www.techkor.com>

Table of Contents

Warning and Disclaimer	III
Introduction and Getting Started	4
Section I. Initial System Configuration	5
1.1. Data Controller and Wireless Access Point Installation	5
1.2. Networking IP Configuration	5
Section II. Data Controller Configuration	9
2.1. Data Controller Configuration using WEB Interface	9
2.1.1. Network parameters	10
2.1.2. Time parameters	10
2.1.3. Controller parameters	10
2.1.4. Target data base	11
2.2. Data Controller Configuration using keyboard and monitor	11
2.2.1. Network parameters	13
2.2.2. Time parameters	15
2.2.3. Data Controller parameters	17
2.2.4. Target data base parameters	20
Section III. Maintenance Watchdog Desktop Application	21
3.1. Maintenance Watchdog Desktop Application Installation	21
3.2. Starting Maintenance Watchdog Desktop Application	22
3.3. Verifying Equipment	23
3.4. Adding Accelerometers to the System	23
3.5. Refresh Devices	23
Section IV. Migrating to more complex environments	25
4.1. Expanding Maintenance Watchdog	25
4.1.1. Adding additional Wireless Access Points	25
4.1.2. Adding Wireless Repeaters	26
4.1.3. Adding Accelerometers	26
4.1.4. Adding Laser Tachometers	26
4.1.5. Adding Client Data Controllers	26
4.2. Use Windows Computer for Database	26
4.3. Maintenance Watchdog A.5 WEB Interface	26
4.3.1. Connecting Maintenance Watchdog A.5 WEB Interface	27
Section V. Third party interfaces	28
5.2. Maintenance Watchdog Desktop Text Export	28
Appendix II. Installing a Wireless Accelerometer	30
Appendix III, Battery Life	32
Factors that affect battery life:	32
Appendix IV, Operational Distances of Radio Links	34

Warning and Disclaimer

Techkor Instrumentation assumes no liability for damages, whether direct or consequential, arising out of the use, or inability to use, this product.

This product is not designed to operate indefinitely. The user assumes full responsibility for all maintenance and testing of the product necessary to ensure proper operation. Any testing situation should have proper backup and redundant systems in place to ensure the safety and quality of the information generated.

The information contained in this literature is based on our experience to date and is believed to be accurate and reliable. However, Techkor Instrumentation assumes no responsibility for the use of such information. The information contained herein is intended as a guide for use by persons having technical skill and at their own discretion and risk.

Introduction and Getting Started

Welcome to the Maintenance Watchdog™ A.5 wireless vibration monitoring system. This manual will provide you with all of the information required to understand, install, configure, and operate your system. The manual is broken up into several sections. Section I covers the Initial System Configuration, Section II covers Maintenance Watchdog Desktop installation, Section III covers Data Controller Configuration, Section IV covers migrating to more complex environments, and Section V covers third party interfaces. If at any time during the installation you require assistance, contact technical assistance at 717-939-2300.



Section I. Initial System Configuration

Stand-alone configuration is the simplest configuration and is recommended for the initial installation. This enables the user to get the system up and running without having to deal with any enterprise networking issues. Once the system is operational it is a relatively straightforward procedure to migrate the system to an enterprise network. MS Windows XP/7 computer with an Ethernet card and MS Internet Explorer 7 (8), a Data Controller 7044000-1, a USB Access Point 7043000-1 with USB Cable 7016010-1, a CROSSOVER cable, a wireless sensor 7034000-1 are required for this configuration.

1.1. Data Controller and Wireless Access Point Installation

Connect the Wireless Access Point 7043000-1 to the Data Controller 7044000-1 using USB Cable 7016010-1. Using the Ethernet CROSSOVER cable, connect the Data Controller 7044000-1 to the computer. Apply power to the Data Controller and computer. Follow Appendix I.

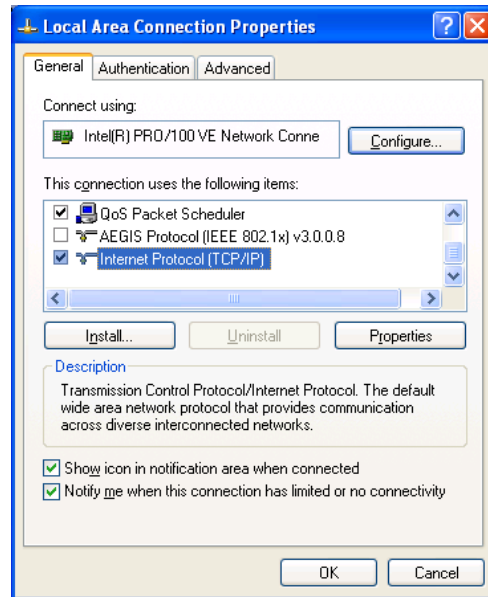
1.2. Networking IP Configuration

The next step is to get the Data Controller 7044000-1 and the computer to talk to each other. Unless otherwise requested all Data Controller's 7044000-1 have a factory set IP address of *192.168.0.32*.

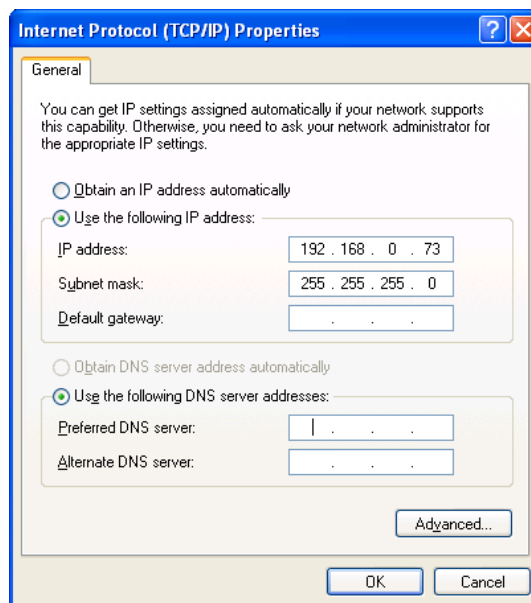
NOTE: It is very important to remember your Data Controller's IP address. It is recommended that the IP address be written in the Data Controller's comment field.

The next step is to set the IP address and subnet mask on the computer to IP address within *192.168.0.255* subnet (for example *192.168.0.73*) so that it can communicate with the Data Controller 7044000-1.

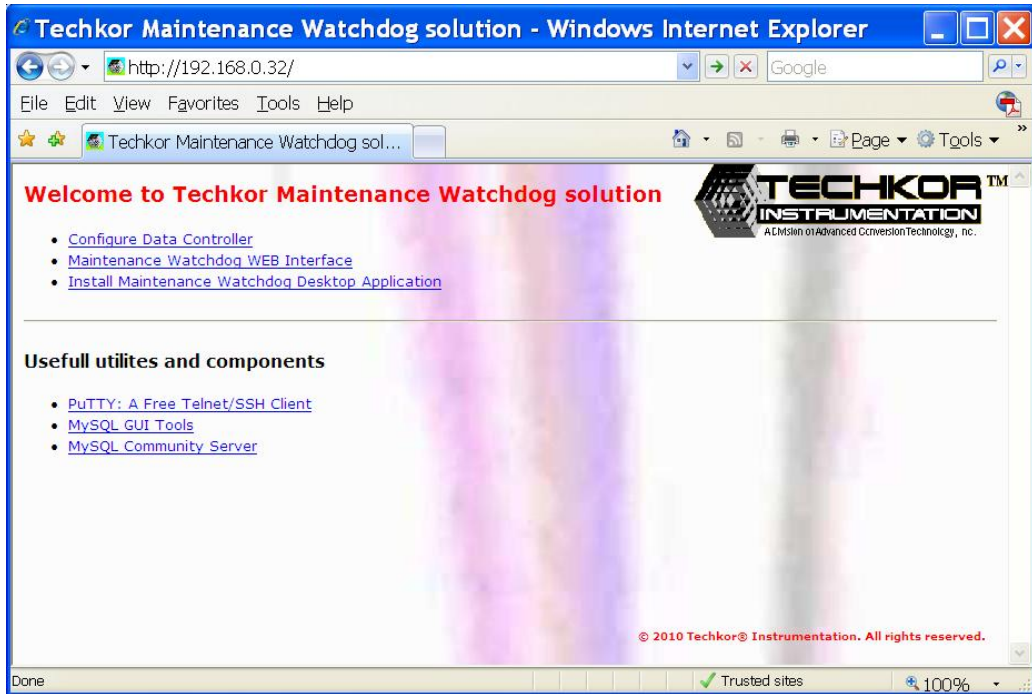
Set the computers IP address by selecting Start/Control Panel/Network Connections and highlight Local Area Connection and right click and select Properties to bring up the following screen.



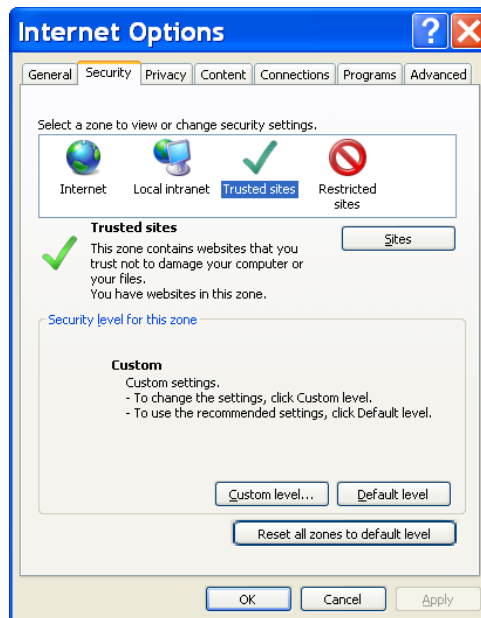
Highlight the Internet Protocol (TCP/IP) line and select the Properties button. Select the “Use the following IP address:” button and enter in the IP address, 192.168.0.73, as shown below. After entering this IP address the Subnet mask information should automatically appear. Click OK and continue.



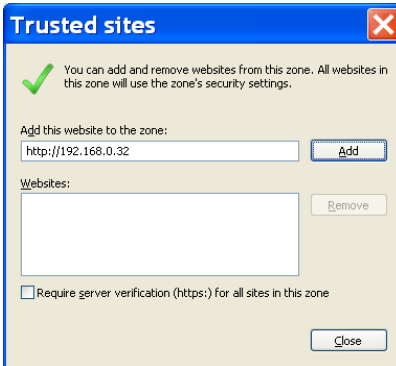
The computer should be ready to connect to the Data Controller at this time. Start *Internet Explorer* and enter <http://192.168.0.32> in the address field. Data Controller startup page should appear.



Select Tools->Internet Options from *Internet Explorer* main menu. Select Trusted sites from Security tab and press button Sites.



Add <http://192.168.0.32> in to the list by pressing button Add on Trusted sites dialog. *Note:* Require server verification (https:) check box should be unchecked.



Close Trusted sites and Internet Options dialogs. Now you can use Data Controller's *WEB Interface* to configure and to control Maintenance Watchdog A.5 system.

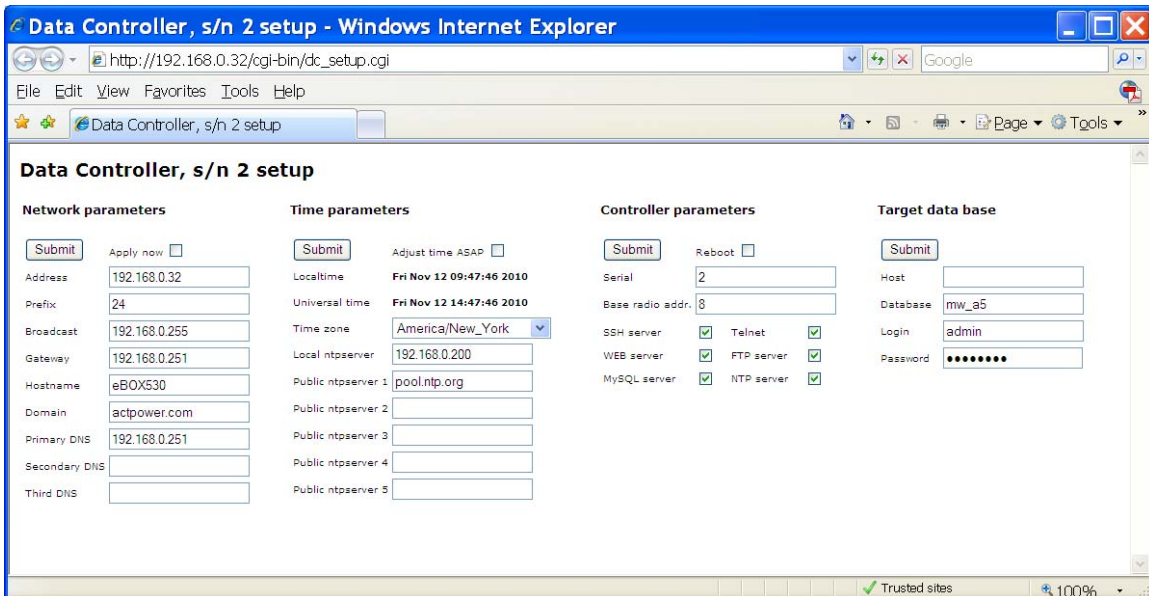
Section II. Data Controller Configuration

2.1. Data Controller Configuration using WEB Interface

Open Data Controller startup page (<http://192.168.0.32>). Click link [Configure Data Controller](#) to open WEB Interface Window.



Password Verification Dialog should appear. Enter User name *admin* and enter password, provided in the Data Controller *startup parameters list*. Data Controller setup page appears.



2.1.1. Network parameters

Address	- IP address of Data Controller
Prefix	- network mask, number of 1-bites from the left
Broadcast	- broadcast address for subnet
Gateway	- gateway IP
Hostname	- Data Controller host name
Domain	- domain name, if exists and is used
Primary DNS	- primary domain names server IP address, if exists
Secondary DNS	- secondary domain names server IP address, if exists
Third DNS	- third domain names server IP address, if exists

Button Submit applies changes to the Data Controller's Network parameters.
Checkbox Apply now forces changes to take effect immediately.

Note: if you change IP address and Checkbox Apply now is on, old address still is in effect until Data Controller reboot. To check new address will be in effect already before reboot. In other words, both IP will be in effect before Data Controller reboot.

2.1.2. Time parameters

Local time	- displays current Data Controller's local time
Universal time	- displays current universal time
Time zone	- defines Data Controller's Time Zone
Local ntpserver	- IP of local ntp server, if exists
Public ntpserver 1	- network name of 1 public ntp server, if used
Public ntpserver 2	- network name of 2 public ntp server, if used
Public ntpserver 3	- network name of 3 public ntp server, if used
Public ntpserver 4	- network name of 4 public ntp server, if used
Public ntpserver 5	- network name of 5 public ntp server, if used

Button Submit applies changes to the Data Controller's Time parameters.
Checkbox Apply now forces time adjustment immediately.

Note: specifying names of NTP servers assumes DNS system working.

2.1.3. Controller parameters

Serial	- Data Controller Serial number
Base radio address	- Data Controller radio address base
SSH server	- starts sshd daemon on startup
Telnet	- turns on telnet service on startup
WEB server	- starts WEB on startup
FTP server	- turns on FTP service on startup
NTP server	- starts ntpd daemon on startup

MySQL server - starts mysqld on startup

Button Submit applies changes to the Data Controller's Network parameters.

Checkbox Reboot initiates Data Controller reboot.

Note: if you stop WEB server and reboot, you lose abilities to use WEB interface and to reconfigure Data Controller through WEB interface. It is recommended to turn off any of the system services only if you are sure of what you are doing.

2.1.4. Target data base

Host - IP address (or name) of Target Database Host
Database - Database name
Login - User ID, used by Data Controller to post data in to the database
Password - password, used by Data Controller to post data in to the database

Target data base parameters specify database location and credentials for Data Controller scripts. Empty Host field is equivalent of *localhost*. It means Data Controller's local database is used.

Note: 7044000-1 Data Controller holds 5 databases, named as *mw_a5*, *mw_a5_0*, *mw_a5_1*, *mw_a5_2*, *mw_a5_3*, *mw_a5_4*. Credentials for all of them are identical and are:

Login: *mw_admin*

Password: as specified in the Data Controller *startup parameters list*.

Default database name is *mw_a5*.

2.2. Data Controller Configuration using keyboard and monitor

Connect keyboard and monitor to the Data Controller. On login prompt enter login id *admin* and press Enter. On password prompt, enter password as specified in the Data Controller *startup parameters list* and press Enter.

```
Main rootfs for eBOX530-820-FL
Kernel 2.6.25-P486U-LM on an i686

eBOX530 login: admin
Password: █
```

On successful login status screen appears. Enter *setup* on command prompt.

```

5V:          +5.12 V (min = +4.51 V, max = +5.49 V)
5VSB:       +5.14 V (min = +4.51 V, max = +5.50 V)
VBAT:       +3.28 V (min = +0.61 V, max = +3.60 V)
CPU temp.:  +45.0 C (high = -1.0 C, hyst = +83.0 C) sensor = diode
SYS temp.:  +45.0 C (high = +120.0 C, hyst = +115.0 C) sensor = thermistor
beep_enable:enabled

RPC Software
RUSER      PID %CPU %MEM    ELAPSED COMMAND
root       786  0.3  2.5      44:04 /usr/local/mysql/libexec/mysqld --basedir=
root       807  0.1  0.1      44:03 /bin/bash /usr/mw_a5/scripts/usb_rpc_watch
root       817  0.0  0.1      44:03 /bin/bash /usr/mw_a5/scripts/auto_online
root       860  1.3  0.1      44:03 /usr/mw_a5/rpc_a5_usb -a 13 -u 1

Filesystem      Size  Used Avail Use% Mounted on
/dev/sda1        72G  1.1G  67G   2% /

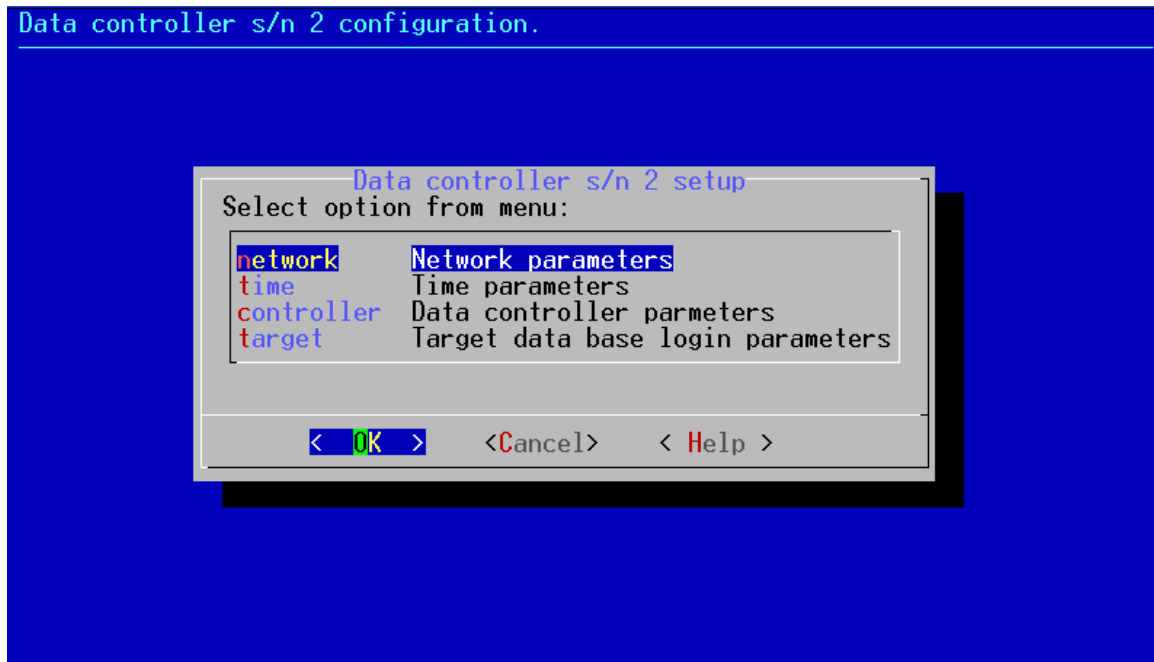
File descriptors
total    free     max
274      0       102036

Mem:          total      used      free      shared  buffers  cached
-/+ buffers/cache:  71140    955880    990372
Swap:         0          0          0

Network
IP 192.168.0.32
-bash-3.2$ setup

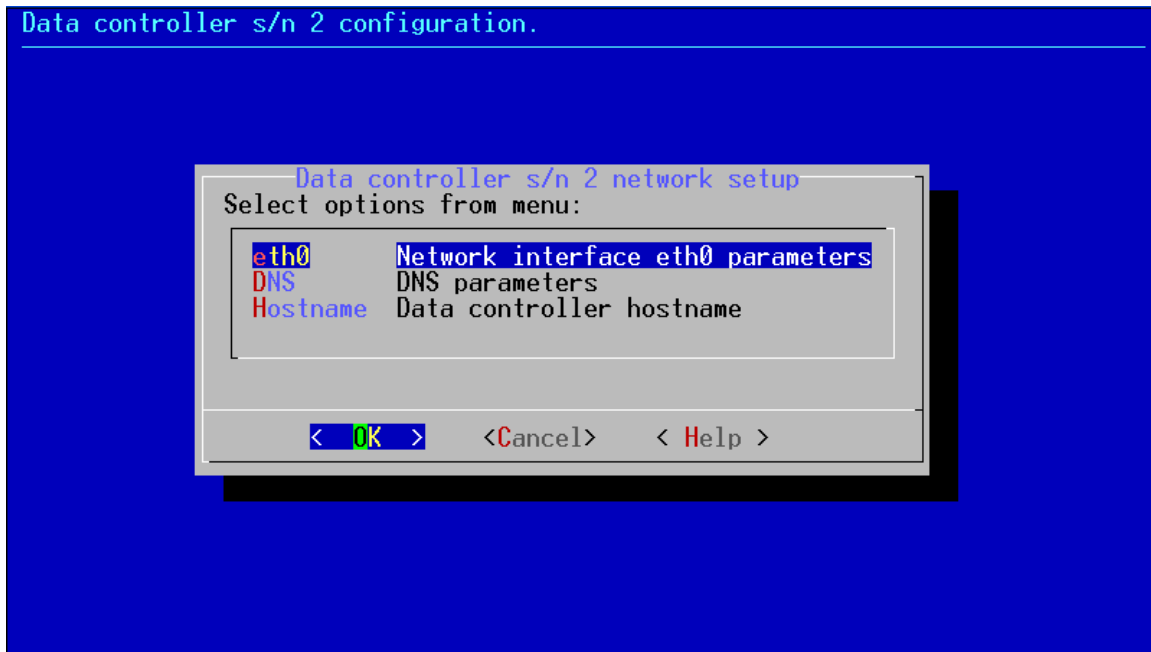
```

Main configuration dialog appears:



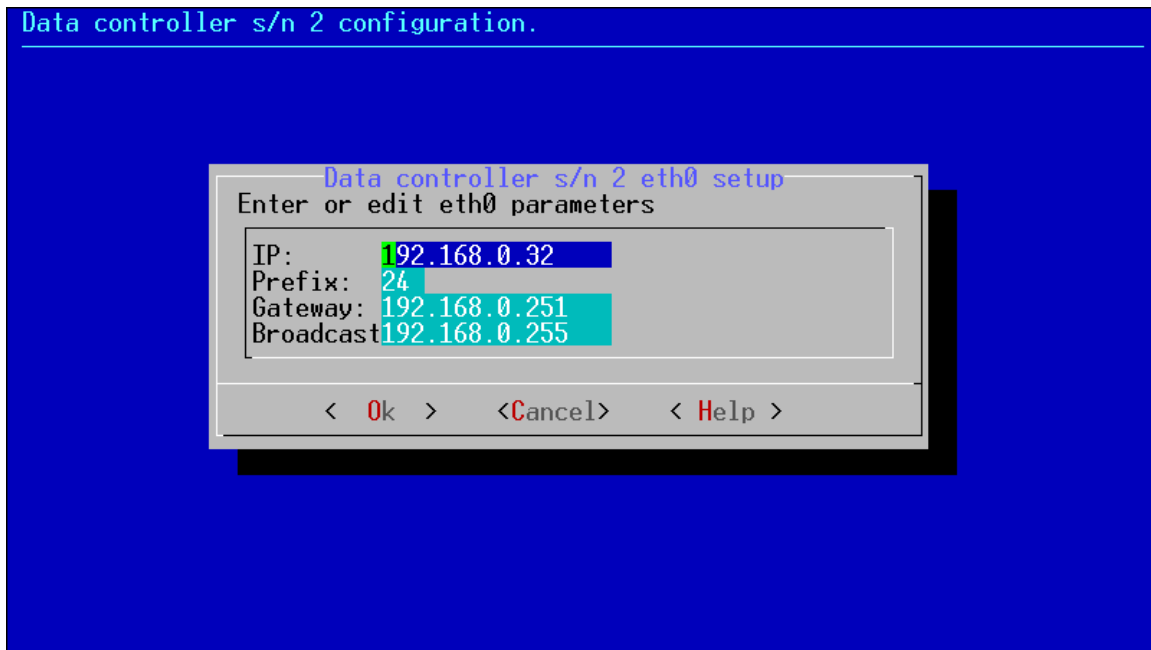
You can select *network parameters* configuration, *time* parameters configuration, *controller* parameters configuration and *target data base* parameters configuration from this dialog. Use arrows keys to navigate between parameters. Use <Tab> key to navigate to < Ok >, <Cancel> or <Help> items.

2.2.1. Network parameters



You can select network interface *eth0* parameters configuration, *DNS* configuration or Data Controller *Hostname* editing.

2.2.1.1. Network interface eth0 parameters

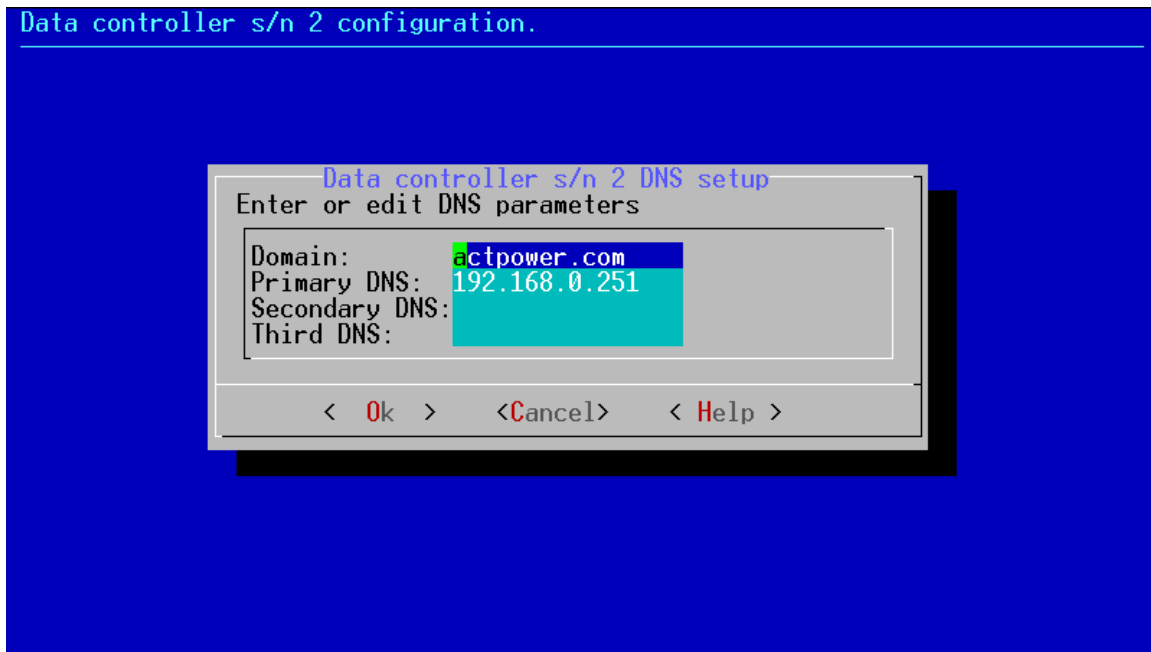


Where:

- IP - IP address of Data Controller
- Prefix - network mask, number of 1-bites from the left
- Gateway - gateway IP
- Broadcast - broadcast address for subnet

Pressing Enter key on <Ok> item saves edited parameters. Pressing Enter key on <Cancel> leaves dialog without saving parameters.

2.2.1.2. DNS parameters

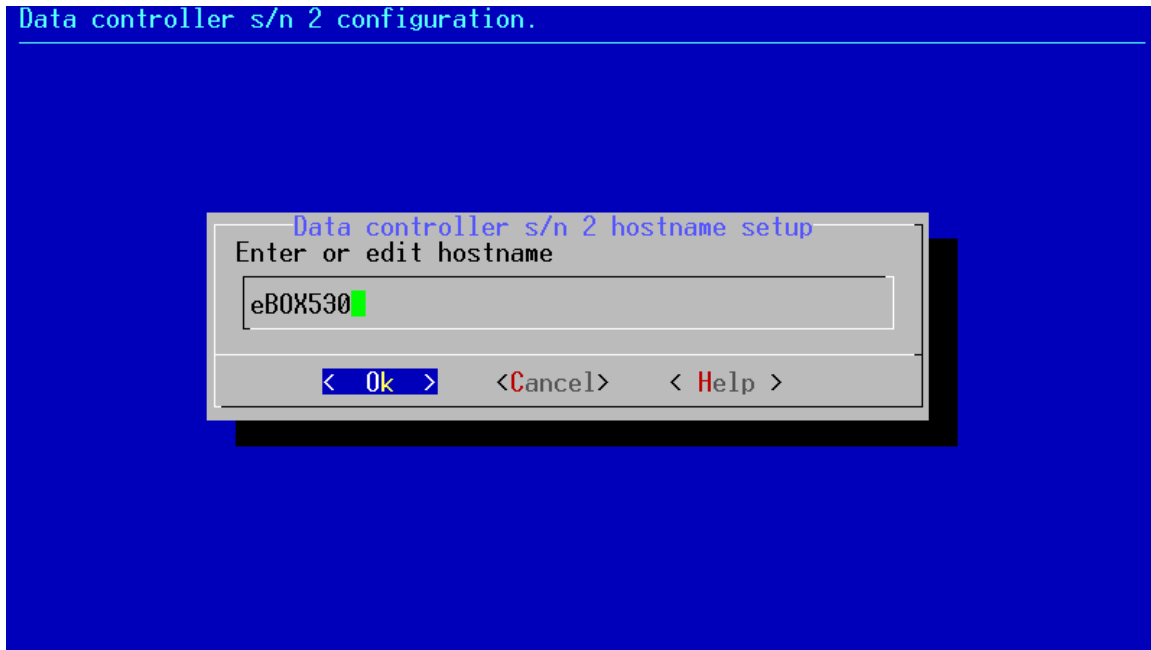


Where:

- Domain - domain name, if exists and is used
- Primary DNS - primary domain names server IP address, if exists
- Secondary DNS - secondary domain names server IP address, if exists
- Third DNS - third domain names server IP address, if exists

Pressing Enter key on <Ok> item saves edited parameters. Pressing Enter key on <Cancel> leaves dialog without saving parameters.

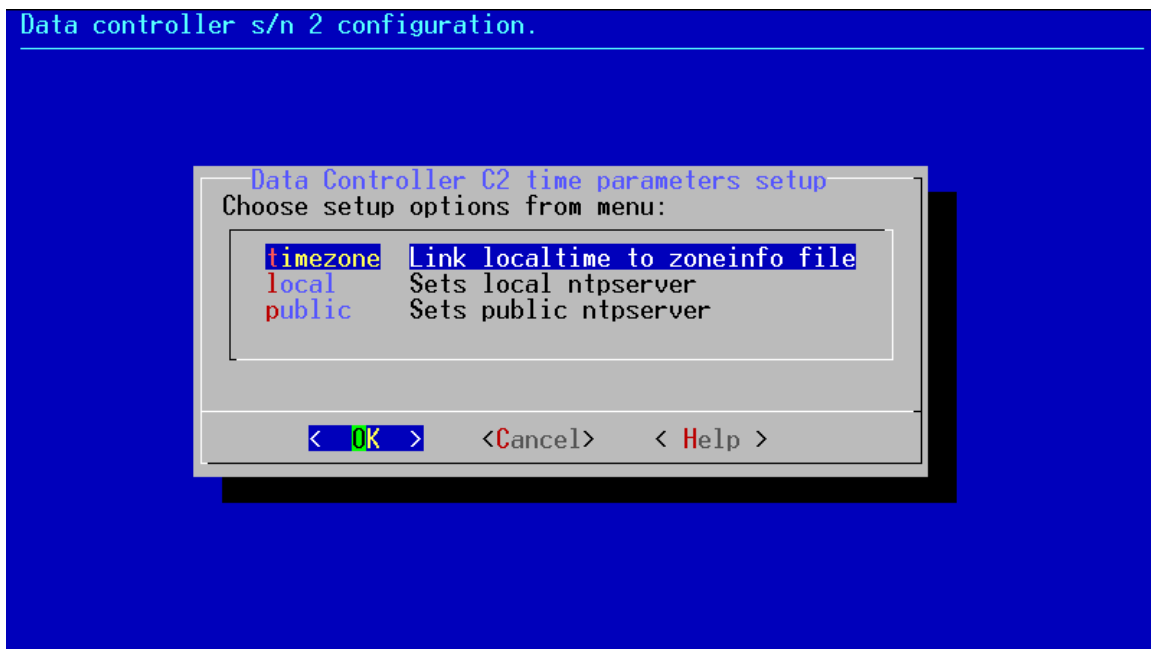
2.2.1.3. Hostname



Hostname - Data Controller host name

Pressing Enter key on <Ok> item saves edited hostname. Pressing Enter key on <Cancel> leaves dialog without saving.

2.2.2. Time parameters



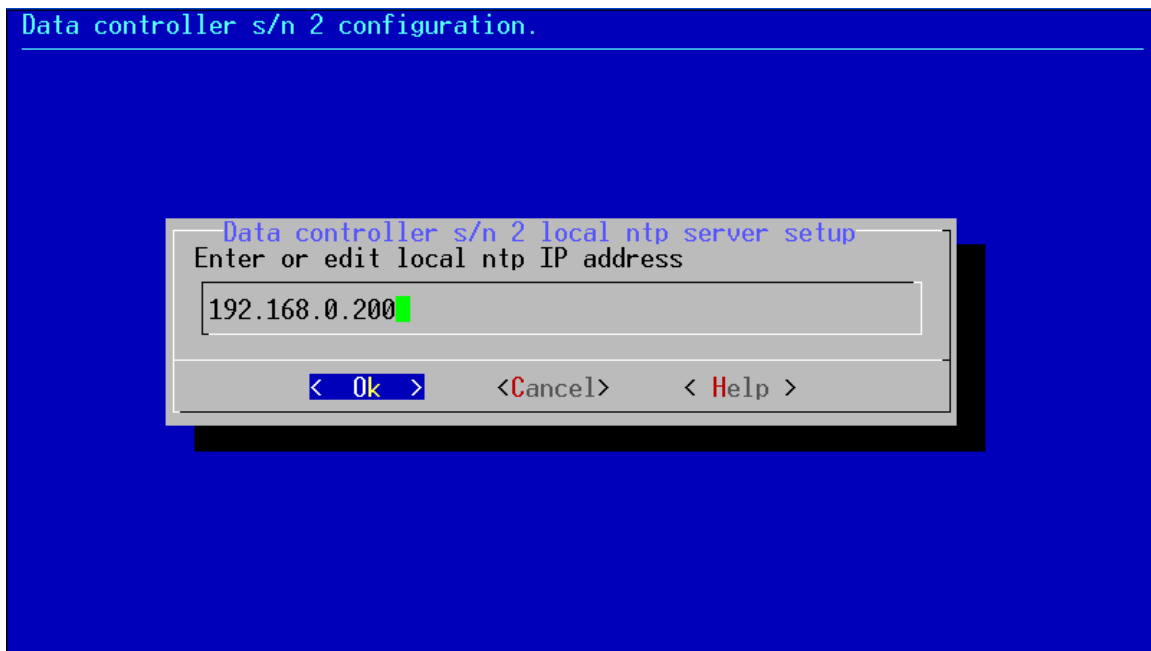
You can select *timezone*, *local* and *public* ntp servers setups.

2.2.2.1. Timezone



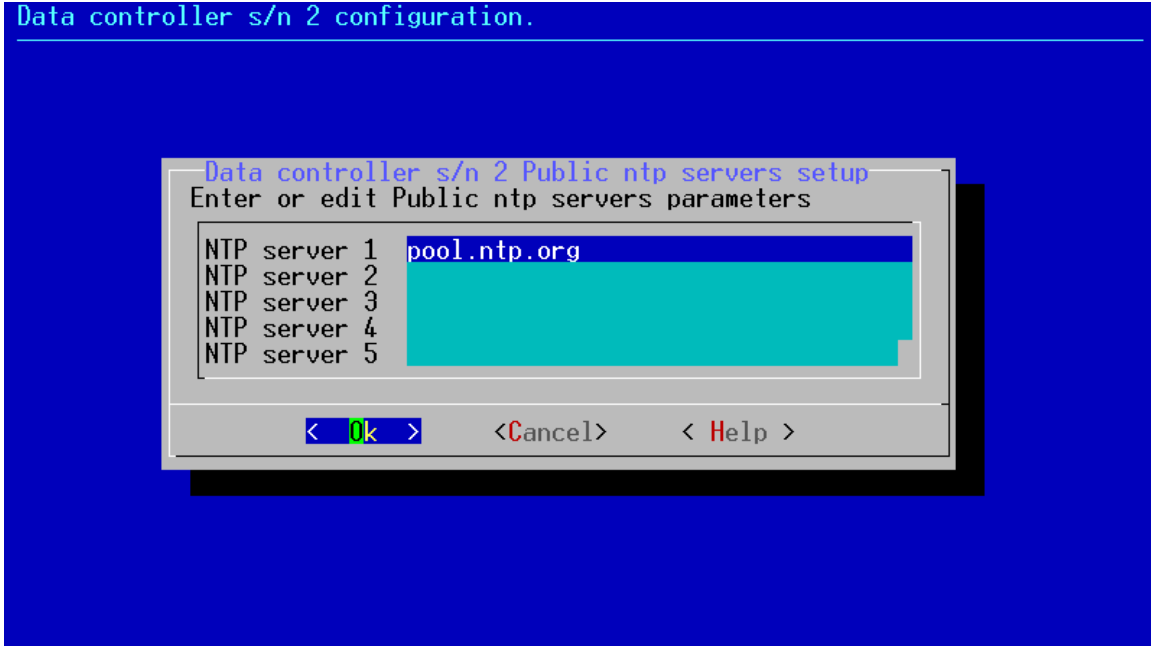
Use <Space> to select directory or file.

2.2.2.2. Local NTP server



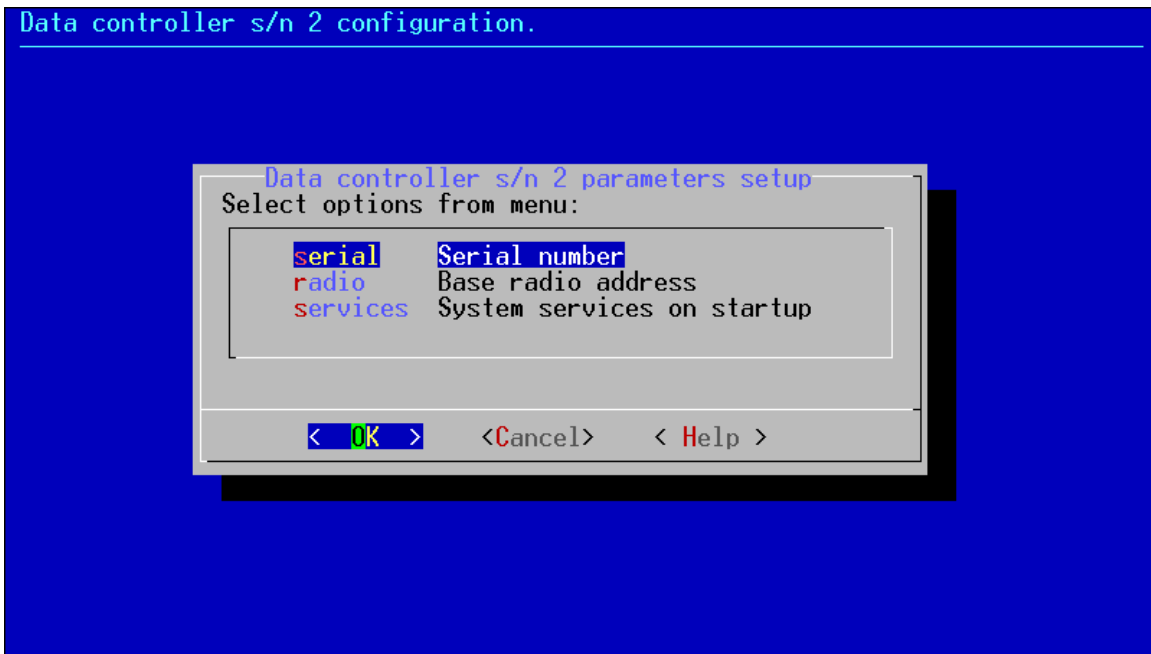
Enter or edit local NTP server IP. Local means NTP server within your network.

2.2.2.3. Public NTP servers



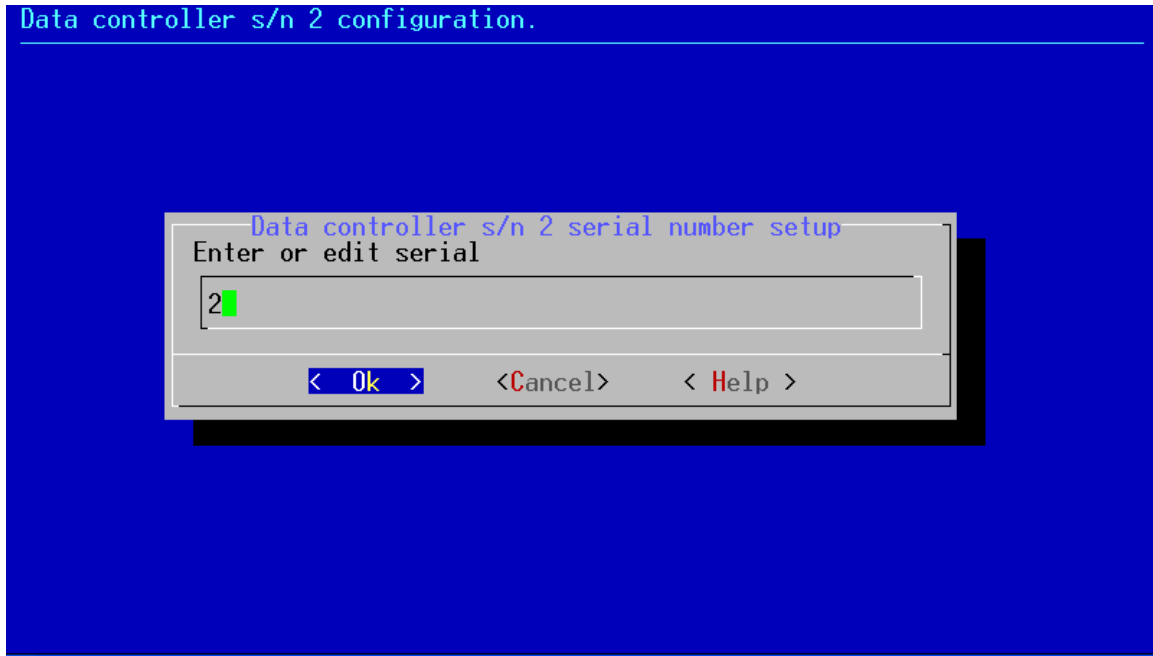
Use this dialog to specify up to 5 public NTP servers.
Note: specifying names of servers assumes DNS system working.

2.2.3. Data Controller parameters



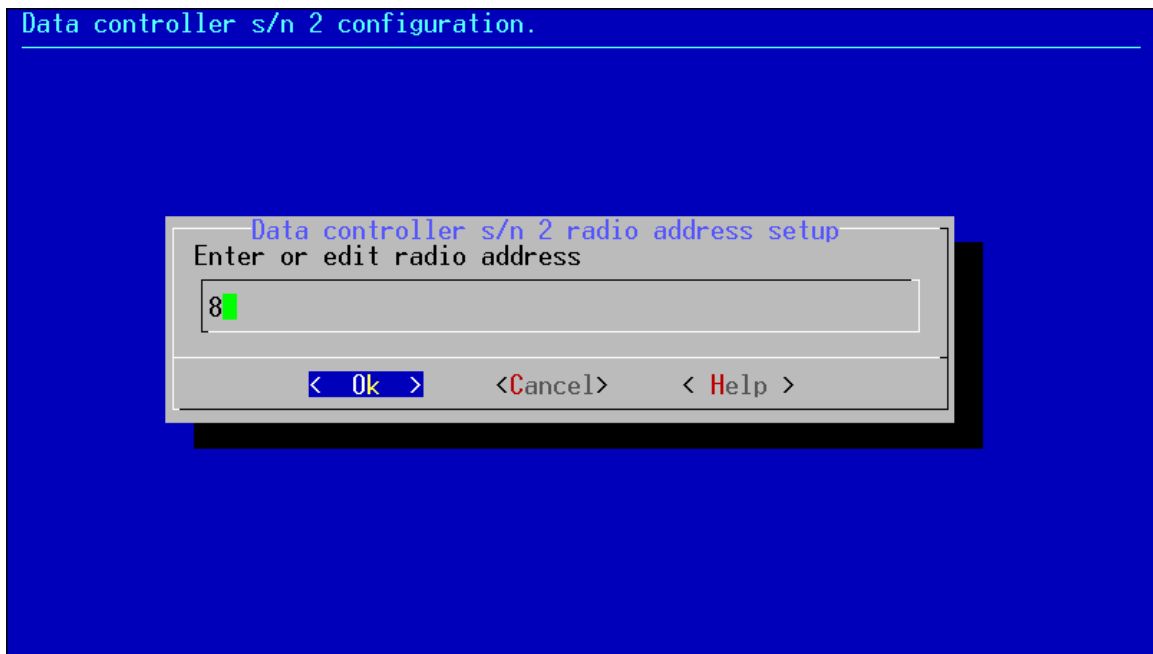
You can select Data Controller serial number setup, base radio address setup and data controllers services to start on startup.

2.2.3.1. Serial number



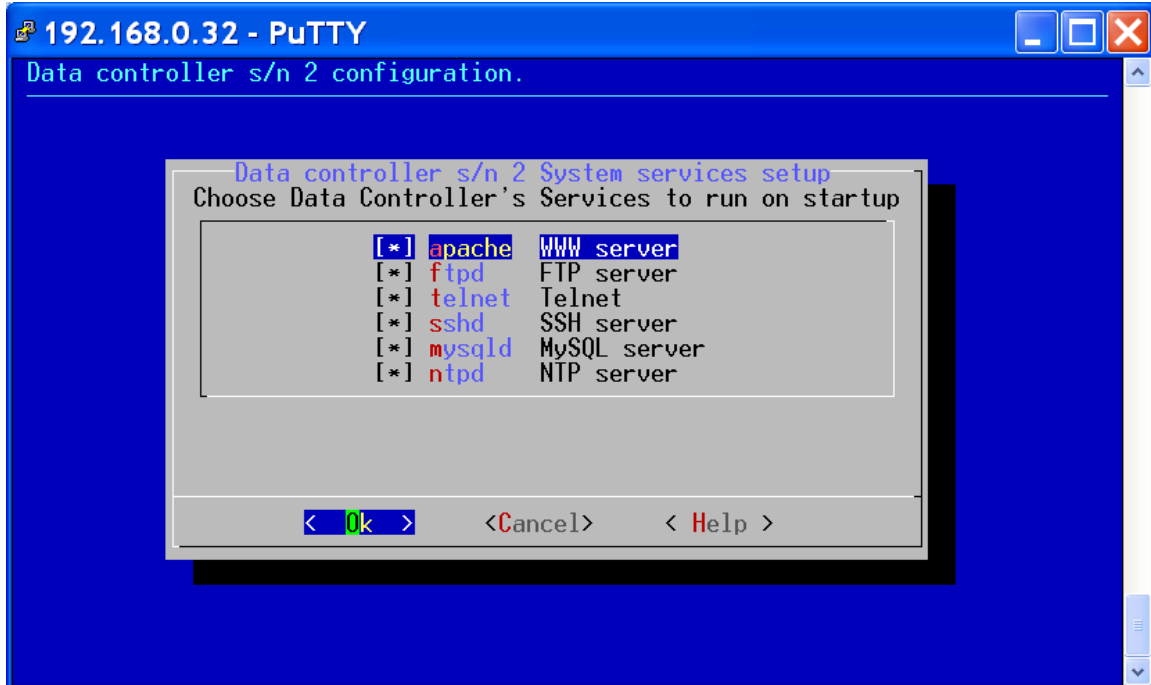
You can edit serial number of Data Controller.

3.2.3.2. Base radio address



You can edit base radio address of Data Controller.

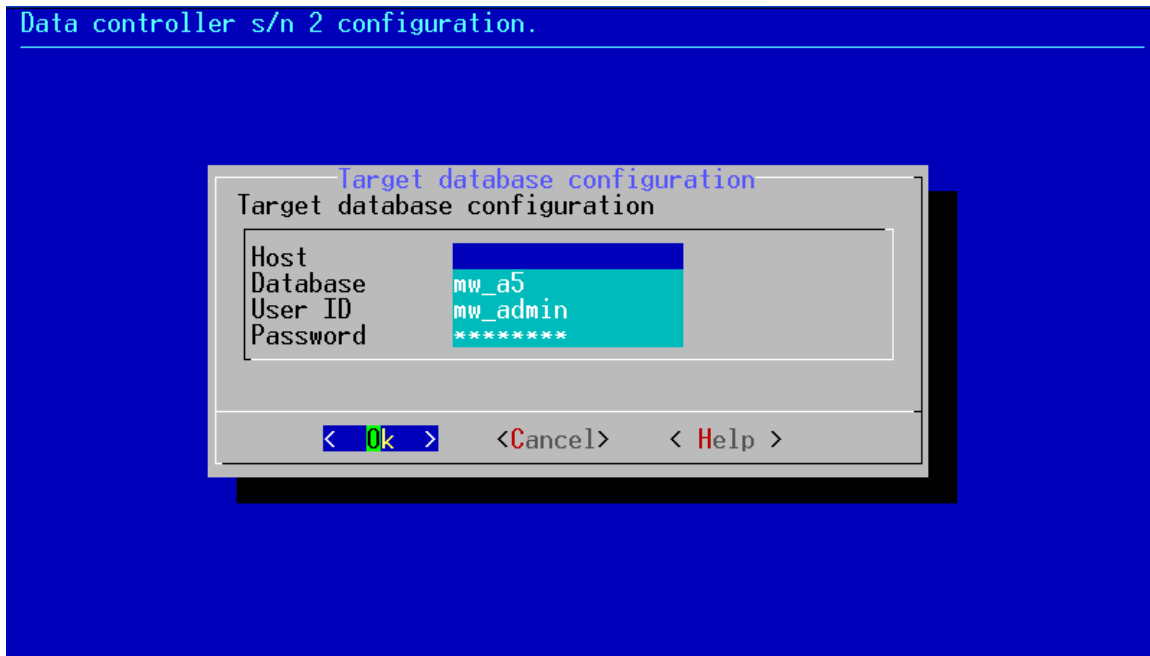
2.2.3.3. System services on startup



WEB server	- starts WEB server daemon on startup
FTP server	- turns on FTP service on startup
Telnet	- turns on telnet service on startup
SSH server	- starts sshd daemon on startup
MySQL server	- starts mysqld on startup
NTP server	- starts ntpd daemon on startup

Note: if you stop WEB server and reboot, you lose abilities to use WEB interface and to reconfigure Data Controller through WEB interface. It is recommended to turn off any of the system services only if you are sure of what you are doing.

2.2.4. Target data base parameters



- Host - IP address (or name) of Target Database Host
- Database - Database name
- Login - User ID, used by Data Controller to post data in to the database
- Password - password, used by Data Controller to post data in to the database

Target data base parameters specify database location and credentials for Data Controller scripts. Empty Host field is equivalent of *localhost*. It means Data Controller's local database is used.

Note: 7044000-1 Data Controller holds 5 databases, named as *mw_a5*, *mw_a5_0*, *mw_a5_1*, *mw_a5_2*, *mw_a5_3*, *mw_a5_4*. Credentials for all of them are identical and are:

Login: admin

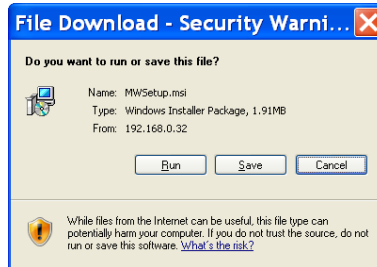
Password: as specified in the Data Controller *startup parameters list*.

Default database name is *mw_a5*.

Section III. Maintenance Watchdog Desktop Application

3.1. Maintenance Watchdog Desktop Application Installation

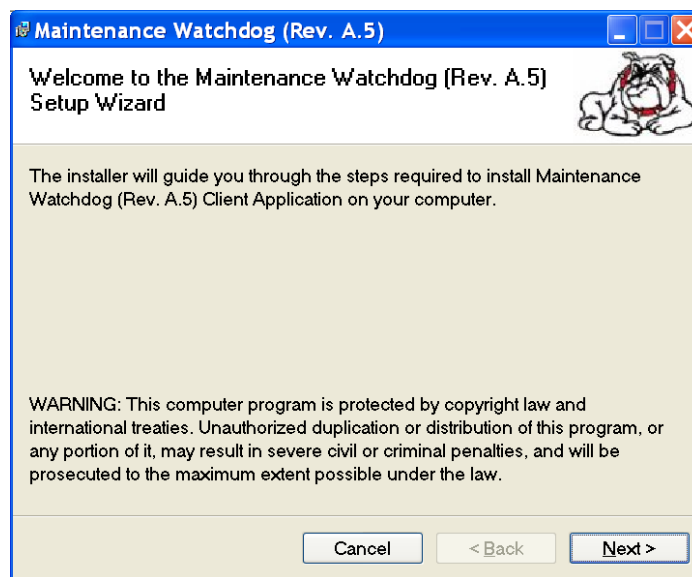
Open Data Controller startup page (<http://192.168.0.32>). Click link [Install Maintenance Watchdog Desktop Application](#) to install Window application.



Click Run on *File Download* security warning and on *Internet Explorer* security warning.

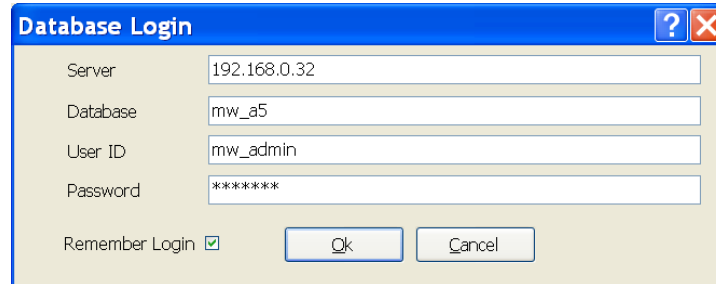


Follow all steps of Installation Wizard by pressing button Next.



3.2. Starting Maintenance Watchdog Desktop Application

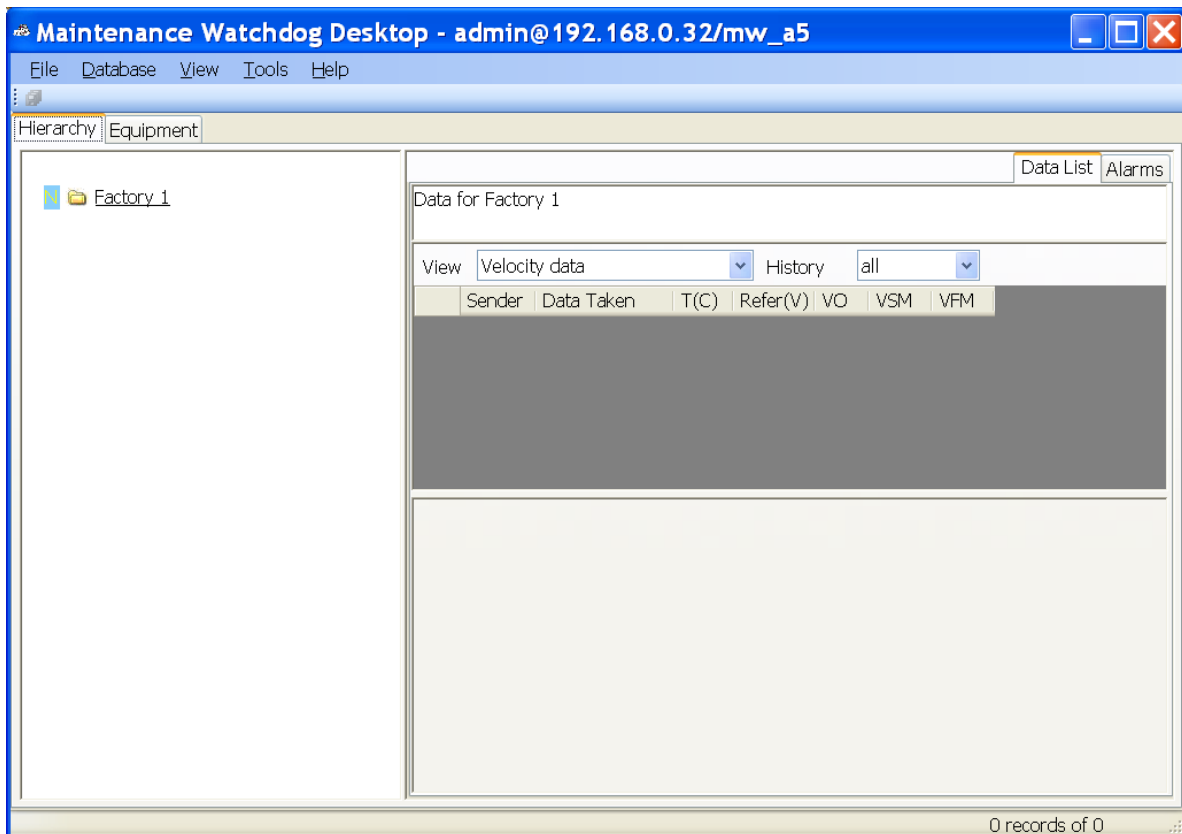
You can launch Desktop application from *Start menu*:
Maintenance Watchdog (Rev. A.5)->Maintenance Watchdog Desktop.
Enter login parameters in the *Database Login* dialog.



Where:

- Server: Data Controller IP (*192.168.0.32*)
- Database: Default Database name (*mw_a5*)
- User ID: Default MW Administrator user name (*mw_admin*)
- Password: provided in the Data Controller *startup parameters list*

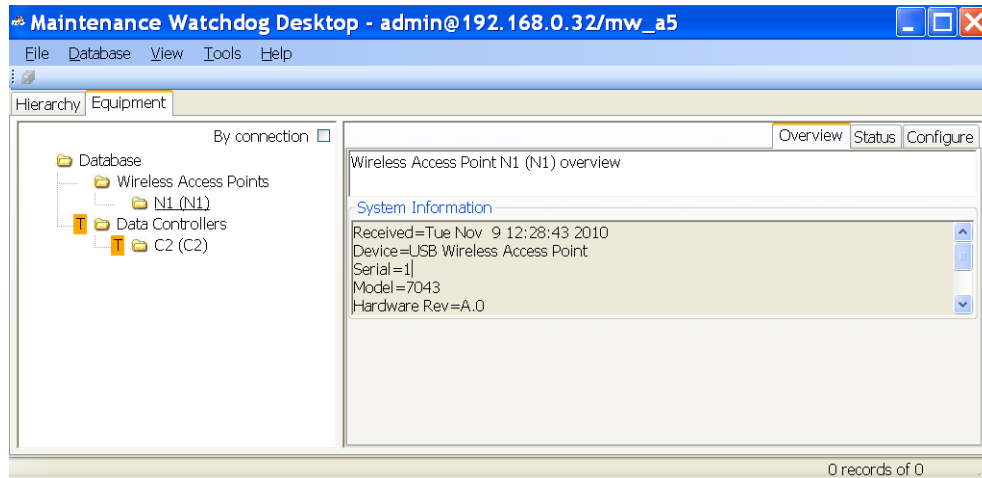
Main window of Maintenance Watchdog Desktop:



F1 initiate Help.

3.3. Verifying Equipment

Go to the Equipment tab In the Desktop application. Under hierarchy level Database should be seeing Access Points and Data Controllers grouping levels. Each of those levels should contain appropriate devices. Serial numbers should reflect actual devices serial numbers. Serial number of device could be verified under Overview tab from the right side of hierarchy.



3.4. Adding Accelerometers to the System

We have finally reached the point where we can watch the sensors log in. Before beginning, verify the following:

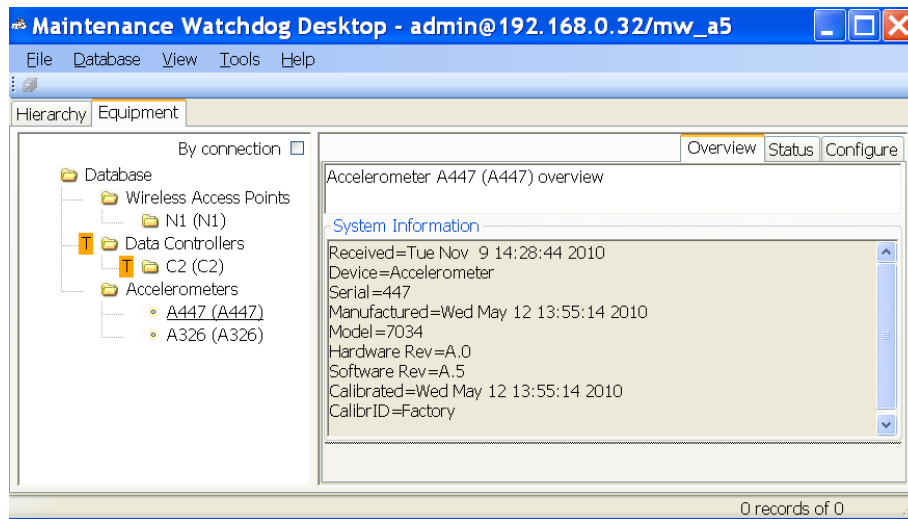
- All sensors to be operated are within range of the access point
- Wireless Access Point is connected to the Data Controller
- Data Controller is connected to the computer
- Desktop application is running on the computer and refresh (F5) works
- Take one sensor and manually reset the sensor and then plug in the battery.

3.5. Refresh Devices

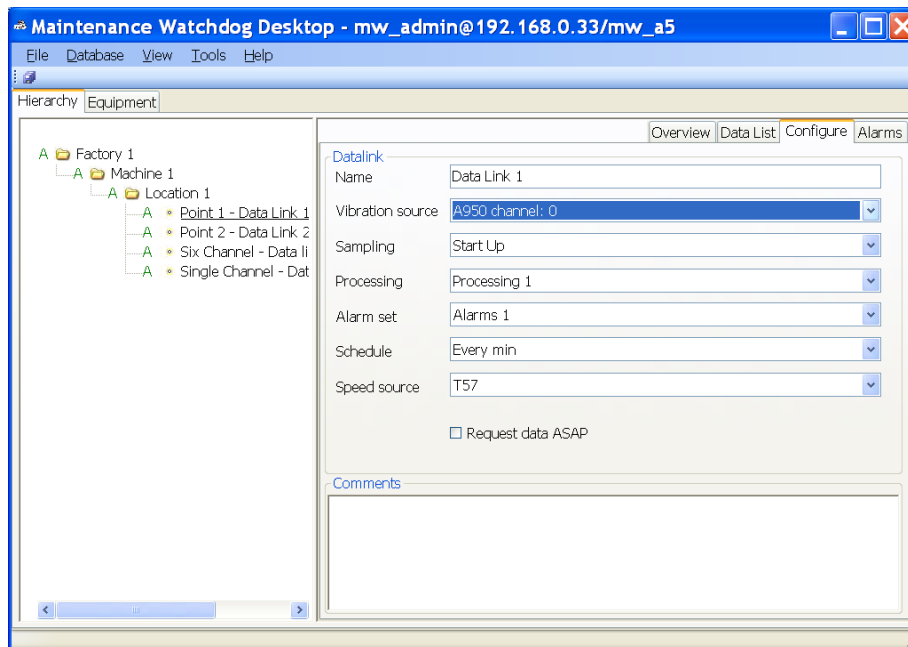
Go to the Equipment tab on the Desktop application. Refresh the content of Equipment by hitting "F5" (Database Refresh menu item hot key). Each sensor that has been powered up should appear in the Equipment hierarchy as shown below.

It is recommended to start and configure one sensor at a time.

For a two-sensor system the Equipment tab would look like the following. It may take up to two minutes for the sensors to log in.



Newly added sensor will connect to access point every 30 seconds until it is reconfigured and scheduled. Now you can bind sensors to the *Hierarchy* location points and schedule-configure them. Go to the *Hierarchy* tab and create (or select) Point within hierarchy. Create or select Datalink under *Configure* tab. Bind *Vibration source* (newly added accelerometer), select schedule **Every min** and apply changes to the database. You should see data every minute under *Data List* tab.



See *Maintenance Watchdog A.5 Desktop* help for details.

Section IV. Migrating to more complex environments

4.1. Expanding Maintenance Watchdog

The *Maintenance Watchdog* system can be expanded to handle larger and more complex configurations by one of the following actions.

Adding Wireless Access Points: A cellular grid of coverage can be obtained by adding wireless access points. Up to 4 wireless access points 7043000-1 can be connected to the Data Controller 7044000-1 to provide overlapping coverage for wireless accelerometers. More than one data controller can be used in the system.

Adding Wireless Repeaters: The Wireless Access Point 7043000-1 can be used as *Wireless Active Repeater*, when it is battery powered or DC powered. USB interface can be used to power 7043000-1 device from DC USB power supply.

Adding Accelerometers: The *Maintenance Watchdog* system can handle hundreds of sensors. By adding sensors to the already existing wireless sensor network, the *Maintenance Watchdog* system can be expanded to cover a large number of machines.

Adding Laser Tachometers: Laser tachometer can be added to a system to gather running speed of machines. A single tachometer can be bound to more than one data point and the system will automatically request a running speed whenever data is scheduled.

Adding Client Data Controllers: The network data controllers can be operated directly on an enterprise network, by properly configuring the IP settings. Client data controllers deliver data to the master data controller, which holds data base

The following sections detail these expansions.

4.1.1. Adding additional Wireless Access Points

Up to four 7043000-1 *USB Wireless Access Points (WAP)* can be connected to the 7044000-1 Data Controller. Up to 64 7043000-1 *WAP* units (including 7043000-1 *WAP* units in *Repeater Mode*) can be used within common radio zone. Any newly added WAP has static radio address within range 1-64. Static radio address is calculated as $A=BA+PN*8+1$, where BA is Data Controller's base radio address, PN – USB port number (1-4).

Note: Techkor Wireless protocol is described in the document **Protocol A.5**

4.1.2. Adding Wireless Repeaters

7043000-1 USB Wireless Access Point (WAP) can be added in to the system as *Active Repeater*. It can be battery powered or USB power supply can be used. Up to 7 *Active Repeaters* can be connected to the one *7043000-1 USB Wireless Access Point*.

Note: for A4 customers it is possible to upgrade A4 repeater to A5 firmware.

4.1.3. Adding Accelerometers

Any additional Accelerometer can be included in to the system as described in 3.4.

4.1.4. Adding Laser Tachometers

7033000-1 Laser Tachometer can be included in to the system similarly as Accelerometer. Tachometer should be bound to the Data Link with existing vibration source (accelerometer).

4.1.5. Adding Client Data Controllers

Additional 7044000-1 Data Controller can be added in to the system as Client Data Controllers. Target Database Parameters should be set to direct data flow to the master Data Controller. Base Radio Address should be set accordingly 4.1.1.

4.2. Use Windows Computer for Database

MySQL Database Engine is developed for very wide range of common operational systems, including Microsoft Windows. There is no problem to transfer Maintenance Watchdog A5 database to the Windows computer. Techkor Instrumentation does not provide free customer support for such configurations.

4.3. Maintenance Watchdog A.5 WEB Interface

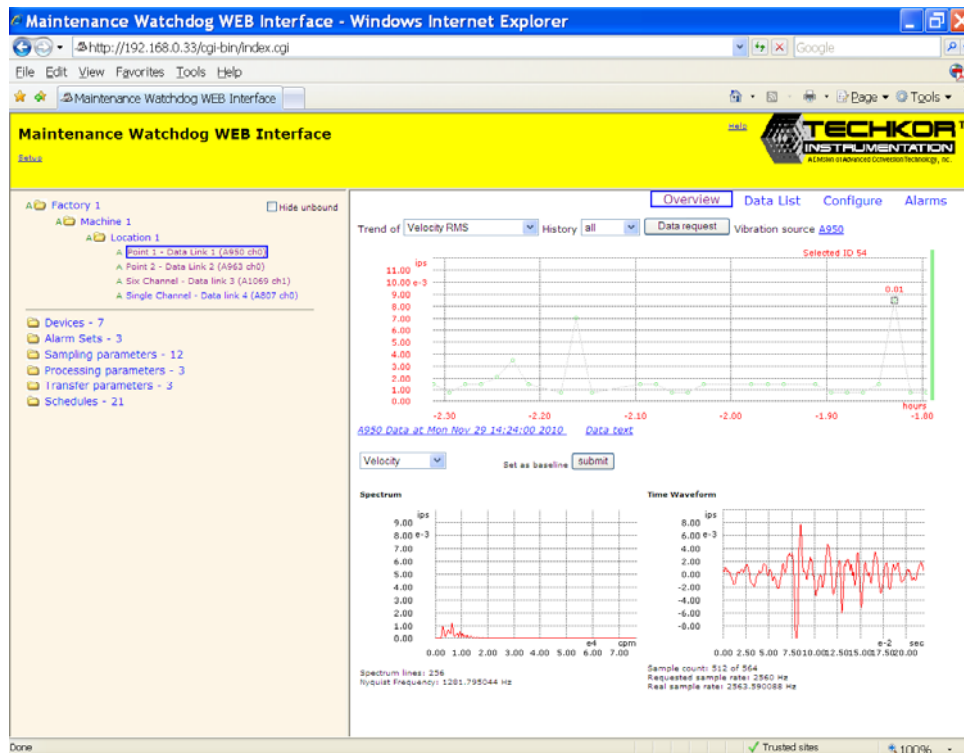
Maintenance Watchdog Web Interface provides capability to control Vibration Data over http protocol. Internet Explorer 7 or higher should be used for this.

4.3.1. Connecting Maintenance Watchdog A.5 WEB Interface

Open Data Controller startup page (<http://192.168.0.32>). Click link [Maintenance Watchdog WEB Interface](#) to open WEB Interface Window.



Password Verification Dialog should appear. Enter User name *mw_admin* and enter password, provided in the Data Controller *startup parameters list*. Maintenance Watchdog WEB Interface main page appears.



Note: Data Controller IP must be included in to the trusted sites list (https should be off).

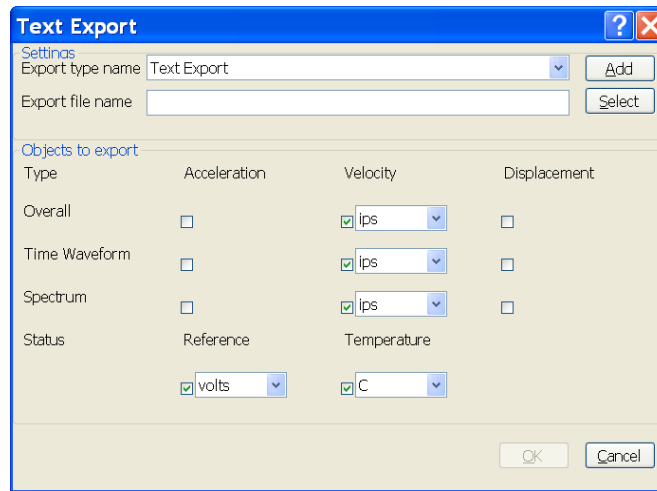
Section V. Third party interfaces

5.1 Introduction

Maintenance Watchdog software allows users to export the data in a text file that can be easily imported into a spreadsheet or other analysis tools.

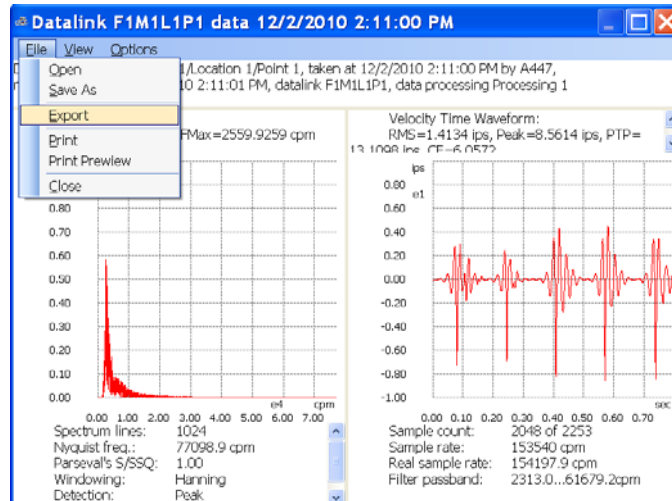
5.2. Maintenance Watchdog Desktop Text Export

By right clicking on data listing and selecting **Export** from the menu the following menu pops up. It is from this screen that a user configures what to export and where to send the data.



Select **Export file name** and press **OK**. All selected data records will be exported into single file under **Export file name**.

Export can be initiated from **Data View Form** by selecting **File->Export** menu item.



Appendix I. Antenna Considerations

The antennae of the Wireless Access Point 7043000-1 should be mounted in a vertical orientation for optimal performance of the system.

The radio waves radiate perpendicular to the antennae as shown below. With the antenna mounted vertically, the radio waves will travel parallel to the earth.



The Wireless Access Point 7043000-1 should be mounted at least 18" away from walls, poles, or other objects that can detune the antenna.

Do not place Wireless Access Point 7043000-1 on or near devices that produce large amounts of electromagnetic noise, such as a high voltage control panel or conduit.

Appendix II. Installing a Wireless Accelerometer

The wireless accelerometers can be mounted in a variety of ways. It is strongly recommended that the new users familiarize themselves with powering up, configuring, and operating these sensors before they are permanently mounted on equipment. Improperly configured sensors will require resetting, which will require physical handling of the unit.

Mounting

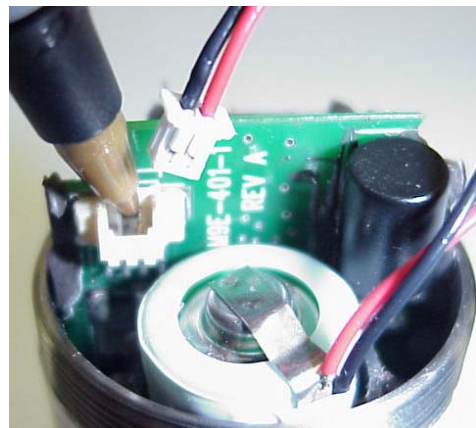
Sensors can be mounted with the ¼-28 thread on the base of the unit. A spot face tool or epoxied mounting pad should be used to provide a flat surface for the sensor base to rest on. Recommended tightening torque is 24 in-lbs. Threadlocking compounds (Loctite) may be used for a more secure mounting. Alternatively, sensors can be mounted with adhesives or magnetic bases.



Powering Up and/or Resetting the Accelerometer

Sensors should be reset every time the battery is replaced, or if the battery connector is unmated. To reset the sensor:

- Disconnect the battery
- Short the pins of the battery connector on the circuit board with screwdriver or ballpoint pen
- Reconnect the battery



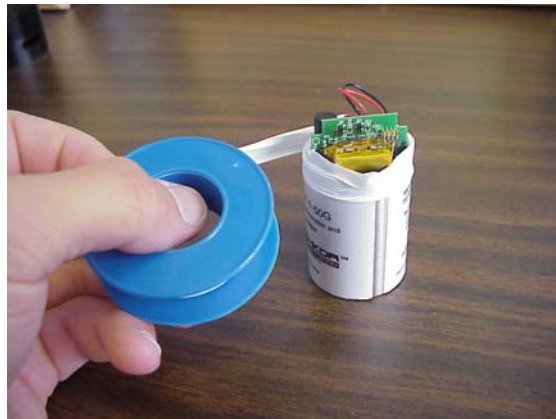
A sensor that has been powered up and not configured in the Windows Desktop software will begin to request to be configured automatically over the wireless network. This sensor must be configured within 60 minutes or it will go into a 24-hour safety sleep mode. In 24 hours it will wake up and once again begin to request to be configured for 60 minutes before going into a 24-hour safety sleep mode if it is

still not configured. If it is desired to wakeup the sensor during this safety sleep mode, it needs to be reset as described above.

Sealing the accelerometer

If the sensor is to be used in environments where moisture is a problem and a NEMA4 or IP65 rating is required, the accelerometer must be sealed according to the following procedure:

- Reset the sensor
- Connect the battery
- Wrap PTFE (Teflon) tape around the threads 3-6 times
- Screw down the lid for a snug fit
- Install the sensor
- Configure within 60 minutes



Appendix III, Battery Life

One of the most important questions concerning wireless sensors is: How long will the batteries last? It is difficult to provide an easy answer because the battery life depends upon how much the battery is used and its environment. Because the Maintenance Watchdog™ system allows the user a great deal of flexibility, the battery life answer becomes even more difficult to evaluate. It is important to understand the factors that affect the battery life and to configure the system to optimize the battery life of the monitoring system.



Factors that affect battery life:

- **Polling mode** – When polling mode is turned on, wireless sensor wakes up every 3 seconds for short time (about 20 ms). During this time receiver listens to radio band and checks for incoming packets. Turning polling off significantly increases battery life.
- **Frequency of Records** – The criticality of an asset and the time to failure should be considered when scheduling a wireless sensor. The least amount of data records that will provide a high level of surveillance should be selected. After the sensor is installed, the cost of monitoring is the \$15 for a replacement battery and the cost to physically replace the battery.
- **Length of Record** – The minimum sampling resolution required to detect possible faults should be selected so that the wireless transfer of data is minimized. A longer data record uses more battery capacity. The following are data record transport times under ideal conditions (data rate 3500bps):
 - 2048 samples (800-line FFT) = 10 seconds
 - 4096 samples (1600-line FFT) = 20 seconds
 - 8192 samples (3200-line FFT) = 40 seconds
- **Weak Radio Link** – When a sensor does not receive a handshake from the Network Access Point, it relies on packet retries to transfer data. A sensor with a weak radio link might be able to transfer data successfully, but it will use many retries to complete the message. The radio transfer for each data record is timed and recorded to provide an indication of the quality of radio link. With a weak radio link, a repeater might have to be added to optimize the radio network.

- **Repeater Usage** – Using a repeater roughly doubles the time a wireless sensor is transferring data, which cuts the battery life in half. The sensor is awake longer because the repeater relays every data packet to the Network Access Point. Finding an optimal location for the Network Access Point radio pod is important so that a minimal amount of repeaters are required.
- **Exposure to Temperature** (above 122 degrees F) – In higher temperatures, the batteries passivate (build up an internal resistance). The wireless sensors monitor the temperature and battery voltage and regulate passivation by using battery current to break down the internal resistance. For higher temperature applications, a high temperature battery is recommended. Insulation blocks can also be used in mounting the sensor to reduce the internal temperature.
- **Shelf Life and Storage** – Lithium batteries have shelf lives in excess of 10 years when properly stored. The Lithium battery will discharge its electrical capacity slowly over this period (approximately 1-2% per year). For this reason it is not practical to have Lithium products operate longer than 10 years. Any battery not used for a period of several weeks should be stored in a refrigerated environment (35F – 40F) for maximum shelf life.

Battery life calculation described in these documents:

- **Battery life time calculation for 7034000-1.doc**
- **Battery life time calculation for 7033000-1.doc**
- **Battery life time calculation for 7043000-1.doc**

Each document contains MS Word active form (like shown bellow), what is used to calculate battery life time for different conditions.

7034000-1 Battery Life time calculator

Battery Capacity, Ah	1.1
Sample Count	2048
Sample Rate, Hz	1000
Extra Sampling, %	0
Polling On	<input type="checkbox"/>
Records per day	24
Radio link Quality (0 - 1)	1
Life Time, Hours	18921
Life Time, Days	788
Life Time, Months	25.8
Life Time, Years	2.16

Appendix IV, Operational Distances of Radio Links

The transmission distances of the Maintenance Watchdog wireless products are difficult to predict for the complex environments common in industrial settings. The operational distance will be a result of many factors including:

- Line of sight
- Reflections
- Obstacles
- Walls
- Height from ground
- Interference
- Moisture content in atmosphere

A general guideline for the wireless operational distances can be found in the following table for open ground communication. Actual distances can be less or greater depending on the above factors.

WAP above 2m ground level	Sensor above 1m ground level	330 feet (100 m)
WAP above 1m ground level	Sensor above 1m ground level	250 feet (75 m)