

December 2009

## Modbus Device Directory Approaches 1000 Devices

## Wastewater Treatment Plant Upgrade

Since launching the Modbus Device Directory in 2003, the options for identifying appropriate devices for projects involving Modbus networking have grown almost four-fold.

Users can search for appropriate devices using one filter for device type and another to limit devices to wired or wireless (or include both). Device types include AC/DC drive controls, controllers, HMI hardware or software, I/O interfaces or modules, sensors, monitoring hardware, network gateways, and various software product types such as OPC, SCADA and test and simulation software.

Users can also limit their search to devices that have been testing for conformance to the Modbus protocol.

Once identifying a selection of products for a project, all the information necessary to contact the supplier is right at hand. If the supplier is a Modbus member, a spec. sheet can be downloaded directly from the device listing.

Check out the directory at [www.modbus.org/devices.php](http://www.modbus.org/devices.php). Contact [info@modbus.org](mailto:info@modbus.org) to list your device or for assistance identifying the right device for your application.

Two Modbus Organization member companies, **ProSoft Technology, Inc.** and **Schneider Electric** worked with local systems integrators to bring a wastewater renewal project in Finland to satisfactory completion.


The original automation system from 1992 of the central wastewater treatment plant of Lapuan Jätevesi Oy was brought up to date in 2008. The automation renewal project included the controllers, the SCADA software and the communication network where nine RadioLinX industrial Ethernet radios are involved for safe and reliable transfer of process and control data.

Wastewater treatment is a basic public service that affects all of us: It is vital to keep our living environment hygienic and healthy and our watercourses clean. Behind the scenes, the wastewater treatment process combines microbiology and chemistry with mechanical engineering, instrumentation, and automation techniques that offer high performance in a progressive way.

The central wastewater treatment plant of Lapuan Jätevesi Oy, a Finnish company located in Lapua, west of Finland, receives household wastewater and industrial wastewater from different locations: Atria, Lapuan Nahka, Kation and Metso Power, among others. The Lapuan Jätevesi Oy treats the wastewater from three locations: Lapua, Nurmo and Kuortane. It also maintains municipal wastewater transfer pipelines from Nurmo and Kuortane to Lapua and the central wastewater treatment plant in Lapua. This is where the automation system had to be renewed.



The wastewater treatment process starts with the primary treatment where the influent sewage water is strained to remove all large objects, and the oxygen level of the water is increased to facilitate microbial activity; microbes clean the water by feeding on its impurities. *(continued on page 5)*



**Wishing you all peace  
and good fortune  
in the new year!**

## Meet Some of Our Members...

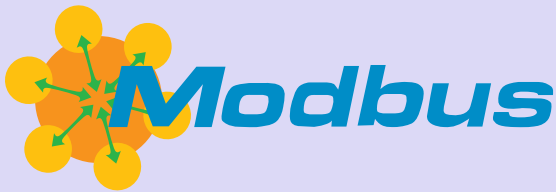


**Korenix** ([www.korenix.com](http://www.korenix.com)) has developed a reputation for supplying hardened, cost-effective, Ethernet networking products for industrial and rugged applications. Its award-winning JetPoE and JetBox, flagship products are widely used for industrial automation, and outdoor markets such as IP surveillance, and intelligent transportation.

The JetBox series of industrial networking computers consolidates an industrial computer, router, managed switch integrated with the interfaces of a serial server and digital I/O to make the network simple. In addition, it is equipped with value-added software and a Modbus gateway to adapt to SCADA systems and make industrial control easy.

Korenix recently released its new JetBox 5300-w embedded Linux computer for front-end industrial control applications  
*(profiled on page 6).*

Shouldn't your company be a member?



### The Modbus Organization Mission

The Modbus Organization, Inc. is a group of independent users and suppliers of automation devices that seeks to drive the adoption of the Modbus communication protocol suite and the evolution to address architectures for distributed automation systems across multiple market segments. Modbus Organization also provides the infrastructure to obtain and share information about the protocols, their application, and certification to simplify implementation by users resulting in reduced costs.

**Control Solutions** ([www.csimn.com](http://www.csimn.com)), founded in 1995, was a spin-off from a contract design and product development company founded in the late 1980s. The company has been developing networked control products since then, specializing in



**CONTROL SOLUTIONS, INC.**

building automation, facility management, and commercial automation. Control Solutions offers a line of off-the-shelf embedded control products with BACnet, LonWorks, Modbus, and SNMP connectivity. Control Solutions also provides custom programming for standard hardware and customized hardware solutions. The company's engineers each have over 20 years of experience in embedded controls technology. All products are designed and made in the USA, manufactured under ISO-9000:2000.

The company recently released a new resource for graphical programming for Modbus, BACnet, LonWorks, and SNMP I/O devices, which has its own web site: [www.graphical-programming.com](http://www.graphical-programming.com).



Since 1984, **ACKSYS Communications & Systems** ([www.acksys.com](http://www.acksys.com)) has specialized in designing and supplying data communication equipment, including wireless network solutions, serial Modbus-to-Modbus TCP data gateways, serial device servers (Ethernet, USB, and WiFi), media converters, serial communication controllers, MIL-STD-1553 and HDLC for avionics test and simulation.



ACKSYS products are available through an extensive distributor network, spanning 20 countries across the globe.

ACKSYS's commitment to helping its customers maximize their capital investments is impressive. The company bases its work on three major factors:

- Choosing components with guaranteed sustainability and/or second sources
- Checking the obsolescence potential of strategic products every six months
- Monitoring availability of crucial parts for at least five years after a product ceases to be manufactured.

### Modbus Newsletter

This is the newsletter of the Modbus Organization, the international non-profit organization devoted to the evolution and support of the Modbus protocols. For more information about membership and other services, please refer to our website: [www.modbus.org](http://www.modbus.org)

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# Modbus Discussion

## Q&A

### From the Modbus Discussion Forum...

#### Modbus TCP/IP Implementation...

**On December 1, Arun wrote:**

I am implementing the Modbus protocol for TCP/IP. Per the TCP/IP implementation guidelines, I understood that a slave can handle up to 16 connections simultaneously.

I believe this can be implemented using multi-threading concept. But can a slave device (for example, a PLC or embedded controller) handle 16 such threads in parallel without any issues? And another question, is there any other way to implement this without multi-threading?

**Curt Wuollet replied:**

Some can, some can't, some can't even handle one connection decently. Back-to-back packets will upset some. But TCP/IP itself handles a lot of the issues. For the threading, etc. issues, I suggest you look at any number of OSS tools and implementations to see how this is handled in a more or less standard fashion. It's pretty much cookbook stuff and it's a bad idea to go rogue. Many, many examples to look at.

**Russ commented:**

If by "implementing" you mean rolling your own, I would first ask "why?"

All slave devices are not created equal, so do not count on 16 channels on every one that you end up with. A lot of slave devices have limited processing power and will choke, stall,

or die if you attempt to read/write too fast.

Yes, if it supports 16, that means 16 simultaneous, but I would recommend that you set up your Master device to use fewer. Normally one for reads and one for writes, one for data-grams, if needed.

Only look at multi-threading if you MUST have the extra speed and then use it on demand if the Slave can handle it.

**M. Griffin suggested:**

There is nothing to stop a Modbus TCP server (slave) from handling as many simultaneous connections as it wants. The limitations of any particular PLC will be due to the internal software and resource limits. Some PLCs can only handle four connections at a time. If the Modbus TCP server is a program running on a PC, there is no reason why it couldn't handle as many connections as the operating system will allow.

The thing to keep in mind is that as far as communications are concerned, the PLC is handling "connections," not "threads." Each client (master) would make one connection to the PLC. The client would send a command, wait for a response, send the next command, wait for a response, etc. It would then normally wait some period of time (the polling rate) before repeating the sequence of commands. As far as the communications are concerned, there

should only be one request or response in the pipeline between each client and the server.

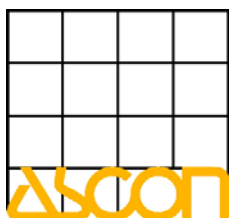
As far as implementing the software is concerned, you can do it synchronously, threaded, or asynchronously. However, keep in mind this is an internal software implementation and does not affect how the messages go out on the wire (other than how many simultaneous conversations you can keep going).

Synchronous software is for where you need the simplest possible implementation and don't need multiple simultaneous conversations (e.g., between a client and a couple of servers).

As far as threaded versus asynchronous is concerned, asynchronous has less overhead but threaded software is more common, because that is what most programmers are familiar with.

All you have said about your application is that you are implementing the protocol. It is difficult therefore to go into much more detail. If you want to say what you are doing (client or server, embedded or on a computer, how many connections you want to be able to handle, etc.) then we can talk about it more if you wish.

**Read the rest of this discussion and add your comments to this thread at [modbus.control.com/thread/1259677525](http://modbus.control.com/thread/1259677525)**



# Modbus Discussion

## Q&A

## More from the Modbus Discussion Forum...

### Modbus Exception on Read Only Registers...

**Enrico posted the following query:**

I'm writing source code for a slave module to connect in Modbus, but I'm in a little confusion about exception codes.

What exception code does the unit transmit if the master attempts to write a read-only register?

**Mark replied:**

AFIK, Modbus does not define any registers as "read only."

Having said that, I would expect an exception code 3: illegal data value.

I would be sure to document it for users.

HTH,

Mark ([www.peakhmi.com](http://www.peakhmi.com))

**Isaac disagreed:**

I beg to differ. The Modbus standard does define read/write for the 4 basic data registers in which "input" registers are read-only. I cite the Modbus Application Protocol Specification V1.1b ([www.modbus.org](http://www.modbus.org)), p. 6, 4.3 Modbus Data Model.

Modbus bases its data model on a series of tables that have distinguishing characteristics.

*[The four primary tables are shown at the top right.]*

"Input Registers: 16-bit word; Read-Only; This type of data can be provided by an I/O system."

I would expect Modbus Exception code 01, Illegal Function, in response to a write command to a read-only input register.. For reference, see pg 49, Modbus Application Protocol Specification V1.1b.

Modbus Exception Code 01  
Name: ILLEGAL FUNCTION  
Meaning: The function code received in the query is not an allowable action for the server (or slave). This may be because the function code is only applicable to newer devices, and was

Primary Tables	Object Type	Read/Write	Comments
Discretes Input	Single bit	Read-Only	This type of data can be provided by an I/O system
Coils	Single bit	Read-Write	This type of data can be alterable by an application program.
Input Registers	16-bit word	Read-Only	This type of data can be provided by an I/O system
Holding Registers	16-bit word	Read-Write	This type of data can be alterable by an application program.

not implemented in the unit selected. It could also indicate that the server (or slave) is in the wrong state to process a request of this type, for example because it is unconfigured and is being asked to return register values.

**Mark got back into the discussion:**

Differing allowed. I knew when I posted the reply someone would come up and say but but but.

It only made sense to me that he was referring to registers that COULD be written to marked as "read only" for his device. This is very common for slave devices that are not PLCs and use Modbus as a means to publish status information of the device.

And that he was using a WRITE function code.

If he was not using a legal function code then the reply would be illegal function and that would be that.

None of the registers that support a write function are "read only" per the spec.

Mark ([www.peakhmi.com](http://www.peakhmi.com))

**Fred Loveless responded:**

Actually Input registers 0x04 and input coils (discrete inputs) 0x02 are essentially read only. You cannot write to them from a master as there is no function code to do so. For registers that can be written to there is no way in the protocol specification to designate

them as read only.

However, in my job I have seen many devices that have implemented read-only data in holding registers. They simply return an exception code of 0x01 (Illegal Function) if you try to write to them.

Keep in mind that this is a design feature that is set by the hardware manufacturer only.

Fred Loveless  
Kepware Technologies

**Michael Griffin added:**

Read-only registers are called "Input Registers." Read-write registers are called "Holding Registers." The master can't even attempt to write to an input register, because there is no Modbus function code to do that. The protocol avoids the issue altogether by design, therefore the problem simply doesn't arise. That is why there are two types of registers.

Have a look at the list of Modbus functions. There are functions for reading both holding and input registers, and there are functions for writing to holding registers. There are no functions for writing to input registers.

**Read the whole thread & add your thoughts at [modbus.control.com/thread/1026250536](http://modbus.control.com/thread/1026250536)**

# Modbus Application Story

## Wastewater Treatment Plant Renewal

*(continued from page 1)*

During this biological treatment phase, the microbes in the wastewater are given suitable growing conditions in terms of temperature, oxygen level, and nutrition.

The next phase includes chemical secondary sedimentation, where aluminum-based chemicals are added to the water from the biological treatment to prompt flocculation of slowly-degrading organic and other materials.

In the last phase, the remaining sludge is treated by removing water from it. The water separated from the sludge is taken back to the beginning of the treatment process, and the solid sludge is taken to the Lakeuden Etappi biogas plant.

### High-tech automation system

The central wastewater treatment plant is fully automated. The automation system from 1992 had reached the end of the road and it was time to renew the wastewater treatment plant: Requirements included.

- Ease of installation and maintenance
- Flexibility to adapt to fast-changing regulation
- Improvement of the overall solution
- Compliance with existing applications and methodologies

The whole system was renewed in collaboration with Schneider Electric and Seinäjoen Teollisuussähkö Ky. “The old automation system had served its time. We have been using it every day for the past 16 years,” Operating Chief of the plant, Vesa Hahtokari, explains. The original automation system involved six controllers from the TSX7 series, with Monitor 77/2 software environment, and used MAPWAY communication protocol.

In the new solution, six Modicon Premium controllers are implemented with Monitor Pro v7.6 and are using **Modbus TCP/IP** over wireless, using nine of ProSoft Technology’s RadioLinx industrial Ethernet radios.

About 2000 process variables are transiting over the wireless network, which is also used for programming and maintenance purposes.

### Why wireless?

A total of seven locations had to be integrated into one single tight network. The six Modicon controllers are located in different buildings on the wastewater treatment plant, and the plant has two control rooms.

**From the user point of view**, the first advantage of the wireless networking option was the cost and time savings for the installation: no need to dig trenches, no need to clean up existing cable paths.

**From the integrator point of view**, RadioLinx network was “the easiest part of the implementation. We didn’t have any problem. These radios are very easy to configure and mounting recommendations given by ProSoft Technology were very clear. Schneider Electric made some tests in their office and then explained us how to implement the wireless network on the field.”

**From Schneider Electric’s point of view**, the engineering of the network was reduced to a minimum. “When we started the project, we did not locally



have any specific RF expertise,” explains Jouni Aarnu, Application Sales and Key Account Manager, Wood and BioEnergy, at Schneider Electric Finland. “We talked to ProSoft Technology Technical Support Engineers and provided them with the basic engineering and layout of the network. They made some calculations that were necessary for this type of application and they provided us with the recommended lists of accessories for each radio location: cables, antenna, lightning protector, etc.”

*(continued on page 6)*



ProSoft Technology RadioLinx industrial Ethernet radio & Schneider Electric ConneXium 499 NES 25100

## Belden's New Eagle 20 Tofino Line of Plug-n-Protect Security Products

Belden's New Eagle 20 Tofino line combines a rugged security device with a collection of software modules that together provide industrial networking. Suitable for use by the process control and SCADA industries, Hirschmann's Eagle 20 Tofino products provide increased safety, network security and performance of industrial control systems.

As a "Plug-n-Protect" security appliance, the device is used to implement zones of security for equipment with common safety requirements and is unique because it can be installed in a live network with no special training, no preconfiguration, and no changes to the network. It is available in four variants that provide a mix of fiber and copper connectivity options.

Loadable Security Modules (LSMs) are software applications that customize the features on each security appliance on the network. Modules include Firewall, Secure Asset Management, Modbus TCPEnforcer, VPN, and Event Logger. Of particular note is the Modbus TCPEnforcer LSM, which performs detailed analysis and filtering of all Modbus TCP messages, and is the only security product certified by the Modbus Organization.

For more information about the Eagle 20 Tofino line, visit [www.belden.com](http://www.belden.com); for more information about other opportunities to integrate Tofino security, visit [www.tofinosecurity.com](http://www.tofinosecurity.com).



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### Wastewater Treatment Plant Renewal

*(continued from page 5)*

#### Long term investments

"No controller can remain the same forever. There are always some additions and changes along the way. In this industry in particular, the regulations change quite a lot over the years as well," Sales Manager Jukka Kiiltomäki from Schneider Electric says. Kiiltomäki took part in the original automation project of Lapuan Jätevesi Oy in 1992 also.

In the future, the controllers can be easily modified or complemented when necessary with additional input or output modules. On the network side, the wireless option provides an additional degree of flexibility.

*Thanks to Mika Kepponen, Schneider Electric Finland and Bruno Forgue, ProSoft Technology.*

### Korenix Unveils New JetBox5300-w Embedded Linux Computer

Korenix recently released its performance-optimized JetBox 5300-w with embedded Linux computer for front-end industrial control deployments.



The RISC-based computer features low power consumption, two LAN ports, two USB ports, two RS232/422/485 and two RS232 serial ports. In addition, the compact JetBox 5300-w carries four DI and four DO channels, allowing users to integrate alarms, indicators, and sensors into complex networking with Modbus TCP devices.

The fan-less JetBox 5300-w has redundant dual power inputs and a wide operating temperature range (-40 to 80°C), providing reliable, secure data management in harsh environments, such as open-pit mines, railcars, railways, and public utilities.

For more information, visit [www.korenix.com](http://www.korenix.com)

Modbus users & suppliers get together on the Modbus Community for:

- Interactivity
- Knowledge aggregation
- Contact with Modbus users and suppliers

Discussion supported by...

**control.com®**

### Need a Modbus Device for Your Project?

Search the database at [www.modbus.org/devices.php](http://www.modbus.org/devices.php) to find the right Modbus device for your application.

# Join! Design! Test! Promote! Apply!

We're with you. The Modbus Organization exists to help suppliers and users of Modbus protocols succeed. Our members range from suppliers of Modbus-compliant products, to system integrators, end users, and educational institutions.

The common link? They all value the information and services provided by the Modbus Organization, and they all play a role in determining the future of the world's most broadly applied protocol.

**To join the Modbus Organization, order a Toolkit, or arrange conformance testing, visit our website:**

***modbus.org***

## **Designing with Modbus**

Each day, Modbus developers turn to the Modbus Organization for valued assistance with their projects:

- Start with downloading specifications and other design documents from the [modbus-ida.org](http://modbus-ida.org) website.
- To really save time, purchase the Modbus TCP Toolkit CD (FREE with general membership); it contains source code and a myriad of other resources.
- Then, if you come across technical issues that have you stumped, post your question on our active developer's forum. One of the many experienced Modbus implementers who frequent this forum will likely have your answer.

## **Conformance Testing**

When your project's done, what then? How do you know it really conforms to Modbus specifications? How do your users know?

The answer starts with running the conformance test suite included with your Modbus TCP Toolkit. This self-

test helps you check your design assumptions and catch the subtle "gotchas" that might otherwise slip through your design review.

To make the definitive statement of your company's commitment to open protocols, submit your product for testing to the independent Modbus Organization Conformance Test Lab. We'll certify your product as compliant, and post that information on the Modbus website for the world to see.

## **Visibility: Your Company & Your Products**

Your membership in the Modbus Organization also opens the door to a powerful range of visibility options to highlight your company as a supplier of Modbus-based products.

Exposure on our website, our newsletter, and through our various trade show appearances are all options that allow you to make the most of your Modbus Organization membership.

If your company is truly on the cutting edge of new technology, you'll likely also value the opportunity to participate in our technical committees. There, your company's knowledge, experience and technology can help guide future enhancements, extensions and adaptations of Modbus to keep it the world's leader for decades to come.

## **Time to Apply**

When it comes time to get your Modbus network up and running, it's comforting to know that hundreds of thousands of applications have preceded yours. But what if things don't go as planned?

The [modbus.org](http://modbus.org) users forum is ready to answer your questions and provide guidance. Thousands of users from diverse backgrounds read the forum, giving you a powerful base of experience from which to draw.

## **The Future is Yours**

So, whatever your role in the use of Modbus, consider joining the Modbus Organization. You'll get the support you need today, and have opportunities to help guide Modbus to a dynamic future.

## **The Modbus TCP Toolkit**

The Modbus TCP Toolkit provides all the necessary pieces to develop a Modbus-compliant device, including documentation, diagnostic tools, sample source code, and pre-test software to prepare for Modbus conformance certification. The toolkit is available as a benefit of membership in the Modbus Organization or can be purchased separately for US\$500 plus shipping and handling.



### **Toolkit Contents**

#### **Modbus Documentation**

- Modbus Application Protocol Specification, V 1.01b
- Modbus Messaging on TCP Implementation Guide, Rev. 1.0b

#### **Tools**

- Modbus/TCP Client Diagnostic Tool
- Modbus/TCP Server Diagnostic Tool

#### **Sample Source Code**

- Modbus/TCP Sample Client Code for Visual Basic Win32
- Modbus/TCP Sample Client Code for C/C++ Win32
- Modbus/TCP Sample Server Code for C/C++ Win32
- Modbus/TCP Sample Server Code for C VxWorks
- Modbus/TCP Sample Server Code for C++ VxWorks

#### **Conformance Testing**

- Modbus/TCP Conformance Test Software