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1 Introduction

The FieldTalk™ Modbus Master® Library, Java™ Edition provides connectivity to Modbus slave compatible devices and applications.

Typical applications are Modbus based Supervisory Control and Data Acquisition Systems (SCADA), Modbus data concentrators, Modbus gateways, User Interfaces and Factory Information Systems (FIS). It also helps publishing plant floor data on the web using Java applets and Java servlets.

Features:

- Robust design suitable for industrial applications
- Full implementation of Bit Access and 16 Bits Access Function Codes as well as a subset of the most commonly used Diagnostics Function Codes
- Standard Modbus bit and 16-bit integer data types (coils, discretes & registers)
- Support for 32-bit integer and float data types, including Daniel/Enron protocol extensions
- Support for the Extended Lufkin Automation (ELAM) Modbus protocol
- Configurable word alignment for 32-bit types (big-endian, little-endian)
- Support of Broadcasting
- Failure and transmission counters
- Transmission and connection time-out supervision
- Detailed transmission and protocol failure reporting with Exception classes
- Thread-safe implementation to support concurrent programming

1.1 Prerequisites

The package is designed for the Java 2 Platform Standard Edition. It is also compatible with the J2ME Foundation and TINI SDK 1.11 platforms.

The standard Java API does not provide any support for serial ports. However serial port support is available in the form of a Java extension, which must be installed and
licensed separately to the JDK and JRE. The Communications API is not part of the supply of FieldTalk.

The serial versions of this package are based on the Java Communications API 2.0. This API is a Java extension, implemented in the package javax.comm.

The Java Communication API is available from different sources:

1. SUN’s Java Communications API 2.0 for Windows can be found in the lib sub-directory of this package.


4. An excellently performing package for a large variety of platforms is the SerialPort package from Solutions Consulting at http://www.serialio.com. Using this package, poll cycles of less than 10 ms can be achieved!

**Note:**

Without proper installation of a Java Communications API, the serial versions of the FieldTalk package cannot be used!

### 1.2 Library Structure

The library is organised into one class for each Modbus protocol flavour and a common base class, which applies to all Modbus protocol flavours. Because the two serial-line protocols Modbus ASCII and Modbus RTU share some common code, an intermediate base class implements the functions specific to the serial protocols.

The base class MbusMasterFunctions contains all protocol unspecific functions, in particular the data and control functions defined by Modbus. All Modbus protocol flavours inherit from this base class.
The class `MbusAsciiMasterProtocol` implements the Modbus ASCII protocol, the class `MbusRtuMasterProtocol` implements the Modbus RTU protocol. The class `MbusTcpMasterProtocol` implements the MODBUS/TCP protocol. Support for the Extended Lufkin Automation (ELAM) Modbus protocol is realized by the class `MbusElamMasterProtocol`.

In order to use one of the four Modbus protocols, the desired Modbus protocol flavour class has to be instantiated:

```java
MbusRtuMasterProtocol mbusProtocol = new MbusRtuMasterProtocol();
```

After a protocol object has been declared and opened, data and control functions can be used:

```java
mbusProtocol.writeSingleRegister(slaveId, startRef, 1234);
```
2 What You should know about Modbus

2.1 Some Background

The Modbus protocol family was originally developed by Schneider Automation Inc. as an industrial network for their Modicon programmable controllers.

Since then the Modbus protocol family has been established as vendor-neutral and open communication protocols, suitable for supervision and control of automation equipment.

2.2 Technical Information

Modbus is a master/slave protocol with half-duplex transmission.

One master and up to 247 slave devices can exist per network.

The protocol defines framing and message transfer as well as data and control functions.

The protocol does not define a physical network layer. Modbus works on different physical network layers. The ASCII and RTU protocol operate on RS-232, RS-422 and RS-485 physical networks. The Modbus/TCP protocol operates on all physical network layers supporting TCP/IP. This compromises 10BASE-T and 100BASE-T LANs as well as serial PPP and SLIP network layers.

Note:

To utilise the multi-drop feature of Modbus, you need a multi-point network like RS-485. In order to access a RS-485 network, you will need a protocol converter which automatically switches between sending and transmitting operation. However some industrial hardware platforms have an embedded RS-485 line driver and support enabling and disabling of the RS-485 transmitter via the RTS signal. FieldTalk supports this RTS driven RS-485 mode.

2.2.1 The Protocol Functions

Modbus defines a set of data and control functions to perform data transfer, slave diagnostic and PLC program download.

FieldTalk implements the most commonly used functions for data transfer as well as some diagnostic functions. The functions to perform PLC program download and other device specific functions are outside the scope of FieldTalk.

All Bit Access and 16 Bits Access Modbus Function Codes have been implemented. In addition the most frequently used Diagnostics Function Codes have been implemented. This rich function set enables a user to solve nearly every Modbus data transfer problem.

The following table lists the available Modbus Function Codes in this library:
### What You should know about Modbus

#### 2.2.2 How Slave Devices are identified

A slave device is identified with its unique address identifier. Valid address identifiers supported are 1 to 247. Some library functions also extend the slave ID to 255, please check the individual function's documentation.

Some Modbus functions support broadcasting. With functions supporting broadcasting, a master can send broadcasts to all slave devices of a network by using address identifier 0. Broadcasts are unconfirmed, there is no guarantee of message delivery. Therefore broadcasts should only be used for uncritical data like time synchronisation.

#### 2.2.3 The Register Model and Data Tables

The Modbus data functions are based on a register model. A register is the smallest addressable entity with Modbus.

The register model is based on a series of tables which have distinguishing characteristics. The four tables are:

<table>
<thead>
<tr>
<th>Function Code</th>
<th>Current Terminology</th>
<th>Classic Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Read Coils</td>
<td>Read Coil Status</td>
</tr>
<tr>
<td>2</td>
<td>Read Discrete Inputs</td>
<td>Read Input Status</td>
</tr>
<tr>
<td>5</td>
<td>Write Single Coil</td>
<td>Force Single Coil</td>
</tr>
<tr>
<td>15 (0F hex)</td>
<td>Write Multiple Coils</td>
<td>Force Multiple Coils</td>
</tr>
<tr>
<td>16 Bits Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Read Multiple Registers</td>
<td>Read Holding Registers</td>
</tr>
<tr>
<td>4</td>
<td>Read Input Registers</td>
<td>Read Input Registers</td>
</tr>
<tr>
<td>6</td>
<td>Write Single Register</td>
<td>Preset Single Register</td>
</tr>
<tr>
<td>16 (10 hex)</td>
<td>Write Multiple Registers</td>
<td>Preset Multiple Registers</td>
</tr>
<tr>
<td>22 (16 hex)</td>
<td>Mask Write Register</td>
<td>Mask Write 4X Register</td>
</tr>
<tr>
<td>23 (17 hex)</td>
<td>Read/Write Multiple Registers</td>
<td>Read/Write 4X Registers</td>
</tr>
<tr>
<td>Diagnostics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Read Exception Status</td>
<td>Read Exception Status</td>
</tr>
<tr>
<td>Vendor Specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 (64 hex)</td>
<td>Read Log History</td>
<td></td>
</tr>
<tr>
<td>Advantech</td>
<td>Send/Receive ADAM 5000/6000 ASCII commands</td>
<td></td>
</tr>
<tr>
<td>Table</td>
<td>Classic Terminology</td>
<td>Modicon Register Table</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Discrete outputs</td>
<td>Coils</td>
<td>0:00000</td>
</tr>
<tr>
<td>Discrete inputs</td>
<td>Inputs</td>
<td>1:00000</td>
</tr>
<tr>
<td>Input registers</td>
<td>Input registers</td>
<td>3:00000</td>
</tr>
<tr>
<td>Output registers</td>
<td>Holding registers</td>
<td>4:00000</td>
</tr>
</tbody>
</table>

The Modbus protocol defines these areas very loose. The distinction between inputs and outputs and bit-addressable and register-addressable data items does not imply any slave specific behaviour. It is very common that slave devices implement all tables as overlapping memory area.

For each of those tables, the protocol allows a maximum of 65536 data items to be accessed. It is slave dependant, which data items are accessible by a master. Typically a slave implements only a small memory area, for example of 1024 bytes, to be accessed.

### 2.2.4 Data Encoding

Classic Modbus defines only two elementary data types. The discrete type and the register type. A discrete type represents a bit value and is typically used to address output coils and digital inputs of a PLC. A register type represents a 16-bit integer value. Some manufacturers offer a special protocol flavour with the option of a single register representing one 32-bit value.

All Modbus data function are based on the two elementary data types. These elementary data types are transferred in big-endian byte order.

Based on the elementary 16-bit register, any bulk information of any type can be exchanged as long as that information can be represented as a contiguous block of 16-bit registers. The protocol itself does not specify how 32-bit data and bulk data like strings is structured. Data representation depends on the slave’s implementation and varies from device to device.

It is very common to transfer 32-bit float values and 32-bit integer values as pairs of two consecutive 16-bit registers in little-endian word order. However some manufacturers like Daniel and Enron implement an enhanced flavour of Modbus which supports 32-bit wide register transfers. FieldTalk supports Daniel/Enron 32-bit wide register transfers.

The FieldTalk Modbus Master Library defines functions for the most common tasks like:

- Reading and Writing bit values
- Reading and Writing 16-bit integers
What You should know about Modbus

- Reading and Writing 32-bit integers as two consecutive registers
- Reading and Writing 32-bit floats as two consecutive registers
- Reading and Writing 32-bit integers using Daniel/Enron single register transfers
- Reading and Writing 32-bit floats using Daniel/Enron single register transfers
- Configuring the word order and representation for 32-bit values

2.2.5 Register and Discrete Numbering Scheme

Modicon PLC registers and discretes are addressed by a memory type and a register number or a discrete number, e.g. 4:00001 would be the first reference of the output registers.

The type offset which selects the Modicon register table must not be passed to the FieldTalk functions. The register table is selected by choosing the corresponding function call as the following table illustrates.

<table>
<thead>
<tr>
<th>Master Function Call</th>
<th>Modicon Register Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>readCoils(), writeCoil(), forceMultipleCoils()</td>
<td>0:00000</td>
</tr>
<tr>
<td>readInputDiscretes</td>
<td>1:00000</td>
</tr>
<tr>
<td>readInputRegisters()</td>
<td>3:00000</td>
</tr>
<tr>
<td>writeMultipleRegisters(), readMultipleRegisters(),</td>
<td>4:00000</td>
</tr>
<tr>
<td>writeSingleRegister(), maskWriteRegister(),</td>
<td></td>
</tr>
<tr>
<td>readWriteRegisters()</td>
<td></td>
</tr>
</tbody>
</table>

Modbus registers are numbered starting from 1. This is different to the conventional programming logic where the first reference is addressed by 0.

Modbus discretes are numbered starting from 1 which addresses the most significant bit in a 16-bit word. This is very different to the conventional programming logic where the first reference is addressed by 0 and the least significant bit is bit 0.

The following table shows the correlation between Discrete Numbers and Bit Numbers:

<table>
<thead>
<tr>
<th>Modbus Discrete Number</th>
<th>Bit Number</th>
<th>Modbus Discrete Number</th>
<th>Bit Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 (hex 0x8000)</td>
<td>9</td>
<td>7 (hex 0x0080)</td>
</tr>
<tr>
<td>2</td>
<td>14 (hex 0x4000)</td>
<td>10</td>
<td>6 (hex 0x0040)</td>
</tr>
<tr>
<td>3</td>
<td>13 (hex 0x2000)</td>
<td>11</td>
<td>5 (hex 0x0020)</td>
</tr>
<tr>
<td>4</td>
<td>12 (hex 0x1000)</td>
<td>12</td>
<td>4 (hex 0x0010)</td>
</tr>
<tr>
<td>5</td>
<td>11 (hex 0x0800)</td>
<td>13</td>
<td>3 (hex 0x0008)</td>
</tr>
<tr>
<td>6</td>
<td>10 (hex 0x0400)</td>
<td>14</td>
<td>2 (hex 0x0004)</td>
</tr>
<tr>
<td>7</td>
<td>9 (hex 0x0200)</td>
<td>15</td>
<td>1 (hex 0x0002)</td>
</tr>
<tr>
<td>8</td>
<td>8 (hex 0x0100)</td>
<td>16</td>
<td>0 (hex 0x0001)</td>
</tr>
</tbody>
</table>

When exchanging register number and discrete number parameters with FieldTalk functions and methods you have to use the Modbus register and discrete numbering scheme. (Internally the functions will deduct 1 from the start register value before transmitting the value to the slave device.)
2.2.6 The ASCII Protocol

The ASCII protocol uses an hexadecimal ASCII encoding of data and a 8 bit checksum. The message frames are delimited with a ‘:’ character at the beginning and a carriage return/linefeed sequence at the end.

The ASCII messaging is less efficient and less secure than the RTU messaging and therefore it should only be used to talk to devices which don’t support RTU. Another application of the ASCII protocol are communication networks where the RTU messaging is not applicable because characters cannot be transmitted as a continuous stream to the slave device.

The ASCII messaging is state-less. There is no need to open or close connections to a particular slave device or special error recovery procedures.

A transmission failure is indicated by not receiving a reply from the slave. In case of a transmission failure, a master simply repeats the message. A slave which detects a transmission failure will discard the message without sending a reply to the master.

2.2.7 The RTU Protocol

The RTU protocol uses binary encoding of data and a 16 bit CRC check for detection of transmission errors. The message frames are delimited by a silent interval of at least 3.5 character transmission times before and after the transmission of the message.

When using RTU protocol it is very important that messages are sent as continuous character stream without gaps. If there is a gap of more than 3.5 character times while receiving the message, a slave device will interpret this as end of frame and discard the bytes received.

The RTU messaging is state-less. There is no need to open or close connections to a particular slave device or special error recovery procedures.

A transmission failure is indicated by not receiving a reply from the slave. In case of a transmission failure, a master simply repeats the message. A slave which detects a transmission failure will discard the message without sending a reply to the master.

2.2.8 The MODBUS/TCP Protocol

MODBUS/TCP is a TCP/IP based variant of the Modbus RTU protocol. It covers the use of Modbus messaging in an ‘Intranet’ or ‘Internet’ environment.

The MODBUS/TCP protocol uses binary encoding of data and TCP/IP’s error detection mechanism for detection of transmission errors.

In contrast to the ASCII and RTU protocols MODBUS/TCP is a connection oriented protocol. It allows concurrent connections to the same slave as well as concurrent connections to multiple slave devices.

In case of a TCP/IP time-out or a protocol failure, a master shall close and re-open the connection and then repeat the message.
3 How to integrate the Protocol in your Application

3.1 Serial Protocols

Let’s assume we want to talk to a Modbus slave device with slave address 1.
The registers for reading are in the reference range 4:00100 to 4:00119 and the registers for writing are in the range 4:00200 to 4:00219. The discretes for reading are in the reference range 0:00010 to 0:00019 and the discretes for writing are in the range 0:00020 to 0:00029.

1. Import the library package

    import com.focus_sw.fieldtalk.*;

2. Device data profile definition

Define the data sets which reflects the slave’s data profile by type and size:

    short[] readRegSet = new short[20]
    short[] writeRegSet = new short[20]
    boolean[] readBitSet = new boolean[20]
    boolean[] writeBitSet = new boolean[20]

If you are using floats instead of 16-bit shorts define:

    float[] readRegSet = new float[10]
    float[] writeRegSet = new float[10]

Note that because a float occupies two 16-bit registers the array size is half the size it would be for 16-bit shorts!

If you are using 32-bit ints instead of 16-bit shorts define:

    int[] readRegSet = new int[10]
    int[] writeRegSet = new int[10]

Note that because an int occupies two 16-bit registers the array size is half the size it would be for 16-bit shorts!

3. Declare and instantiate a protocol object

    MbusRtuMasterProtocol mbus = new MbusRtuMasterProtocol();

4. Open the protocol port

    mbus.openPort("COM1", 19200, MbusRtuMasterProtocol.DATABITS_8,
                 MbusRtuMasterProtocol.STOPBITS_1,
                 MbusRtuMasterProtocol.PARITY_EVEN);

5. Perform the data transfer functions

- To read register values:

    mbus.readMultipleRegisters(1, 100, readRegSet);
• To write a single register value:

```java
mbus.writeSingleRegister(1, 200, writeRegSet);
```

• To write a single float value:

```java
mbus.writeSingleRegister(1, 210, 3.141F);
```

• To write multiple register values:

```java
mbus.writeMultipleRegisters(1, 200, writeRegSet);
```

• To read boolean (discrete) values:

```java
mbus.readCoils(1, 10, readBitSet);
```

• To write a single boolean (discrete) value:

```java
mbus.writeCoil(1, 20, true);
```

• To write multiple boolean (discrete) values:

```java
mbus.forceMultipleCoils(1, 20, writeBitSet);
```

6. Close the protocol port if not needed any more

```java
mbus.closePort();
```

7. Error Handling

Serial protocol errors like slave device failures, transmission failures, checksum errors and

time-outs throw appropriate exceptions, which are all derived from the IOException and

BusProtocolException class. The following code snippet can handle these errors:

```java
try
{
    mbus.readMultipleRegisters(1, 100, dataSetArray);
} catch (BusProtocolException e)
{
    Has to be caught before IOException!
    Protocol error management, something is wrong
    with the slave device or the bus.
} catch (IOException e)
{
    If this occurs after we checked for a BusProtocolException
    then it signals that the local I/O subsystem failed, which is
    fatal.
}
```

An automatic retry mechanism is available and can be enabled with mbus.setRetryCnt(3)

before opening the protocol port.
3.2 TCP/IP Protocols

Let’s assume we want to talk to a Modbus slave device with unit address 1 and IP address 10.0.0.11.

The registers for reading are in the reference range 4:00100 to 4:00119 and the registers for writing are in the range 4:00200 to 4:00219. The discretes for reading are in the reference range 0:00010 to 0:00019 and the discretes for writing are in the range 0:00020 to 0:00029.

1. Import the library package

```java
import com.focus_sw.fieldtalk.*;
```

2. Device data profile definition

Define the data sets which reflects the slave’s data profile by type and size:

```java
short[] readRegSet = new short[20]
short[] writeRegSet = new short[20]
boolean[] readBitSet = new boolean[20]
boolean[] writeBitSet = new boolean[20]
```

If you are using floats instead of 16-bit shorts define:

```java
float[] readRegSet = new float[10]
float[] writeRegSet = new float[10]
```

Note that because a float occupies two 16-bit registers the array size is half the size it would be for 16-bit shorts!

If you are using 32-bit ints instead of 16-bit shorts define:

```java
int[] readRegSet = new int[10]
int[] writeRegSet = new int[10]
```

Note that because an int occupies two 16-bit registers the array size is half the size it would be for 16-bit shorts!

3. Declare and instantiate a protocol object

```java
MbusTcpMasterProtocol mbus = new MbusTcpMasterProtocol();
```

4. Open the protocol port

```java
mbus.openConnection("10.0.0.11");
```

5. Perform the data transfer functions

- To read register values:
  ```java
  mbus.readMultipleRegisters(1, 100, readRegSet);
  ```

- To write a single register value:
  ```java
  mbus.writeSingleRegister(1, 200, writeRegSet);
  ```

- To write a single float value:
mbus.writeSingleRegister(1, 210, 3.141F);

- To write multiple register values:
  mbus.writeMultipleRegisters(1, 200, writeRegSet);

- To read boolean (discrete) values:
  mbus.readCoils(1, 10, readBitSet);

- To write a single boolean (discrete) value:
  mbus.writeCoil(1, 20, true);

- To write multiple boolean (discrete) values:
  mbus.forceMultipleCoils(1, 20, writeBitSet);

6. Close the connection if not needed any more

mbus.closeConnection();

7. Error Handling

TCP/IP protocol errors like slave failures, TCP/IP connection failures and time-outs throw appropriate exceptions, which are all derived from the IOException and BusProtocolException class. The following code snippet can handle these errors:

```java
try {
    mbus.readMultipleRegisters(1, 100, dataSetArray);
} catch (BusProtocolException e) {
    Protocol error management, something is wrong with the slave device but the connection is still alive.
} catch (IOException e) {
    If this occurs after we checked for a BusProtocolException then it signals that the the TCP/IP connection was lost or closed by the remote end. Before using further data and control functions the connection has to be re-opened successfully.
}
```

3.3 Examples

- Serial Example (p. ??)
- Multithreaded Example (p. ??)
- MODBUS/TCP Example (p. ??)
- Applet Example with Cyclic Polling (p. ??)
4 Design Background

FieldTalk is based on a programming language neutral but object oriented design model. This design approach enables us to offer the protocol stack for the languages C++, C#, Visual Basic .NET, Java and Object Pascal while maintaining similar functionality.

The Java edition is using the Java 2 Platform Standard Edition API and the Java Communications API. This enables compatibility with most VM implementations.

During the course of implementation, the usability in automation, control and other industrial environments was always kept in mind.
5 Module Documentation

5.1 Data and Control Functions for all Modbus Protocol Flavours

This Modbus protocol library implements the most commonly used data functions as well as some control functions.

This Modbus protocol library implements the most commonly used data functions as well as some control functions. The functions to perform PLC program download and other device specific functions are outside the scope of this library.

All Bit Access and 16 Bits Access Modbus Function Codes have been implemented. In addition the most frequently used Diagnostics Function Codes have been implemented. This rich function set enables a user to solve nearly every Modbus data transfer problem.

The following table lists the supported Modbus function codes:

<table>
<thead>
<tr>
<th>Function Code</th>
<th>Current Terminology</th>
<th>Classic Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bit Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Read Coils</td>
<td>Read Coil Status</td>
</tr>
<tr>
<td>2</td>
<td>Read Discrete Inputs</td>
<td>Read Input Status</td>
</tr>
<tr>
<td>5</td>
<td>Write Single Coil</td>
<td>Force Single Coil</td>
</tr>
<tr>
<td>15 (0F hex)</td>
<td>Write Multiple Coils</td>
<td>Force Multiple Coils</td>
</tr>
<tr>
<td>16 Bits Access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Read Multiple Registers</td>
<td>Read Holding Registers</td>
</tr>
<tr>
<td>4</td>
<td>Read Input Registers</td>
<td>Read Input Registers</td>
</tr>
<tr>
<td>6</td>
<td>Write Single Register</td>
<td>Preset Single Register</td>
</tr>
<tr>
<td>16 (10 Hex)</td>
<td>Write Multiple Registers</td>
<td>Preset Multiple Registers</td>
</tr>
<tr>
<td>22 (16 hex)</td>
<td>Mask Write Register</td>
<td>Mask Write 4X Register</td>
</tr>
<tr>
<td>23 (17 hex)</td>
<td>Read/Write Multiple Registers</td>
<td>Read/Write 4X Registers</td>
</tr>
<tr>
<td>Diagnostics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Read Exception Status</td>
<td>Read Exception Status</td>
</tr>
<tr>
<td>Vendor Specific</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 (64 hex)</td>
<td>Read Log History</td>
<td></td>
</tr>
<tr>
<td>Advantech</td>
<td>Send/Receive ADAM 5000/6000 ASCII commands</td>
<td></td>
</tr>
</tbody>
</table>

Remarks:

When passing register numbers and discrete numbers to FieldTalk library functions you have to use the the Modbus register and discrete numbering scheme. See Register and Discrete Numbering Scheme (p.7). (Internally the functions will deduct 1 from the start register value before transmitting the value to the slave device.)

All master data and control functions are designed thread-safe. All methods of a particular
MbusMaster... object can only be accessed by one thread at the same time. In addition, access to the register array objects is synchronized to allow concurrent access. This enables one thread to update a register array while a second thread is sending the data to a Modbus slave. In this case the update thread must also synchronize his access to the register array by embedding the access into a synchronized(regArr) clause.

Using multiple instances of a MbusMaster... class enables concurrent protocol transfer on different communication channels (e.g. multiple TCP/IP sessions in separate threads or multiple COM ports in separate threads).

## 5.2 Serial Protocols

The two serial protocol flavours are implemented in the MbusRtuMasterProtocol and MbusAsciiMasterProtocol class.

### Classes

- class **MbusAsciiMasterProtocol**
  
  Modbus ASCII Master Protocol class.

- class **MbusRtuMasterProtocol**
  
  Modbus RTU Master Protocol class.

- class **MbusElamMasterProtocol**
  
  Extended Lufkin Automation Modbus Master Protocol.

### 5.2.1 Detailed Description

The two serial protocol flavours are implemented in the MbusRtuMasterProtocol and MbusAsciiMasterProtocol class. These classes provide functions to open and to close serial port as well as data and control functions which can be used at any time after a protocol has been opened. The data and control functions are organized different conformance classes. For a more detailed description of the data and control functions see section **Data and Control Functions for all Modbus Protocol Flavours** (p. 14).

Using multiple instances of a MbusRtuMasterProtocol or MbusAsciiMasterProtocol class enables concurrent protocol transfers on multiple COM ports (They should be executed in separate threads).

See sections **The RTU Protocol** (p. 8) and **The ASCII Protocol** (p. 8) for some background information about the two serial Modbus protocols.

See section **Serial Protocols** (p. 9) for an example how to use the MbusRtuMasterProtocol class.
5.3 TCP/IP Protocols

The library provides two flavours of TCP/IP based Modbus protocols.

Classes

- class `MbusTcpMasterProtocol`
  
  MODBUS/TCP Master Protocol class.

- class `MbusRtuOverTcpMasterProtocol`
  
  Encapsulated Modbus RTU Master Protocol class.

5.3.1 Detailed Description

The library provides two flavours of TCP/IP based Modbus protocols. The MODBUS/TCP master protocol is implemented in the class `MbusTcpMasterProtocol`. The `MbusTcpMasterProtocol` class provides functions to establish and to close a TCP/IP connection to the slave as well as data and control functions which can be used after a connection to a slave device has been established successfully. For a more detailed description of the data and control functions see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).

Using multiple instances of a `MbusTcpMasterProtocol` class enables concurrent protocol transfers using multiple TCP/IP sessions. They should be executed in separate threads.

See section The MODBUS/TCP Protocol (p. 8) for some background information about MODBUS/TCP.

See section TCP/IP Protocols (p. 11) for an example how to use the `MbusTcpMasterProtocol` class.

5.4 Device and Vendor Specific Modbus Functions

Some device specific or vendor specific functions and enhancements are supported.

Custom Function Codes

- synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException

  Vendor Specific Modbus function 100 (64 hex), Read History Log.

Advantec ADAM 5000/6000 Series Commands

- String `adamSendReceiveAsciiCmd` (String commandStr) throws IOException, BusProtocolException
Send/Receive ADAM 5000/6000 ASCII command.

5.4.1 Detailed Description

Some device specific or vendor specific functions and enhancements are supported.

5.4.2 Function Documentation

```java
synchronized void readHistoryLog ( int slaveAddr, int channelNo, int resolution, short readArr[] ) throws IOException, BusProtocolException [inherited]
```

Vendor Specific Modbus function 100 (64 hex), Read History Log.

**Parameters:**

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `channelNo` A/D channel Number (Range: 1 - 10)
- `resolution` Resolution in minutes (Range: 1 - 60)
- `readArr` Buffer with log data received. The length of the array determines how many data points are read (Range: 1 - 125).

**Exceptions:**

- `IllegalStateException` Port or connection is closed
- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException` (p. 20) A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

**Note:**

No broadcast supported

```java
String adamSendReceiveAsciiCmd ( String commandStr ) throws IOException, BusProtocolException [inherited]
```

Send/Receive ADAM 5000/6000 ASCII command.

Sends an ADAM 5000/6000 ASCII command to the device and receives the reply as ASCII string. (e.g. "$01M" to retrieve the module name)

**Parameters:**

- `commandStr` Buffer which holds command string. Must not be longer than 255 characters. A possible trailing CR is removed.
5.5 Error Management

This module documents all the exception classes, error and return codes reported by the various library functions.

Classes

- class BusProtocolException
  Communication Error.

- class ChecksumException
  Checksum error.

- class InvalidFrameException
  Invalid frame error.

- class InvalidReplyException
  Invalid reply error.

- class EvaluationExpiredException
  Evaluation expired error.

- class MbusIllegalAddressException
  Illegal Data Address exception response.

- class MbusIllegalFunctionException
  Illegal Function exception response.

- class MbusIllegalValueException
  Illegal Data Value exception response.

- class MbusResponseException
  Modbus exception response.

- class MbusSlaveFailureException
  Slave Device Failure exception response.

- class ReplyTimeoutException
  Reply time-out.
5.5.1 Detailed Description

This module documents all the exception classes, error and return codes reported by the various library functions.
6 Java Class Documentation

6.1 BusProtocolException Class Reference

Communication Error.

Inheritance diagram for BusProtocolException:

```
BusProtocolException
  |________________________|
  |                       |
  V                       
ChecksumException        
  |________________________|
  |                       |
  V                       
EvaluationExpiredException
  |________________________|
  |                       |
  V                       
InvalidFrameException
  |________________________|
  |                       |
  V                       
InvalidReplyException
  |________________________|
  |                       |
  V                       
MbusResponseException
  |________________________|
  |                       |
  V                       
ReplyTimeoutException
  |________________________|
  |                       |
  V                       
MbusIllegalAddressException
  |________________________|
  |                       |
  V                       
MbusIllegalFunctionException
  |________________________|
  |                       |
  V                       
MbusIllegalValueException
  |________________________|
  |                       |
  V                       
MbusSlaveFailureException
```

Public Member Functions

- **BusProtocolException** (String text)
  
  Constructs a *BusProtocolException* (p. 20) with the specified detail message.

- **BusProtocolException** ()
  
  Constructs a *BusProtocolException* (p. 20) without a detail message.

Static Public Member Functions

- static long *getCounter* ()
  
  Returns how often this exception has been triggered.

- static void *resetCounter* ()
  
  Resets exception counter.

6.1.1 Detailed Description

Communication Error. Errors derived from class indicate either communication faults or Modbus exceptions reported by the slave device.

**See also:**

IOException

6.1.2 Constructor & Destructor Documentation

**BusProtocolException** ( String text )

Constructs a *BusProtocolException* (p. 20) with the specified detail message.
Parameters:

*text*  The detail message.

### 6.1.3 Member Function Documentation

```java
static long getCounter( ) [static]
```

Returns how often this exception has been triggered.

**Returns:**

Counter value

Reimplemented in `ChecksumException` (p. 22), `InvalidFrameException` (p. 26), `InvalidReplyException` (p. 27), `EvaluationExpiredException` (p. 25), `MbusIllegalAddressException` (p. 79), `MbusIllegalFunctionException` (p. 80), `MbusIllegalValueException` (p. 81), `MbusResponseException` (p. 104), `MbusSlaveFailureException` (p. 152), and `ReplyTimeoutException` (p. 177).

### 6.2 ChecksumException Class Reference

Checksum error.

Inheritance diagram for ChecksumException:

```
BusProtocolException
    |
    v
ChecksumException
```

**Public Member Functions**

- `ChecksumException()`  
  *Constructs a ChecksumException* (p. 21).

**Static Public Member Functions**

- `static long getCounter()`  
  *Returns how often this exception has been triggered.*

- `static void resetCounter()`  
  *Resets exception counter.*
6.2.1 Detailed Description

Checksum error. Signals that the checksum of a received frame is invalid. A poor data link typically causes this error.

See also:

BusProtocolException (p. 20)

6.2.2 Member Function Documentation

static long getCounter ( ) [static]

Returns how often this exception has been triggered.

Returns:

Counter value

Reimplemented from BusProtocolException (p. 21).

6.3 Converter Class Reference

Conversion Routines.

Public Member Functions

• Converter (boolean swapMode)
  
      Creates a Converter (p. 22) object.

• void floatsToShorts (float[] floatArr, short[] shortArr)

      Binary conversion from a float array to a short array.

• void intsToShorts (int[] intArr, short[] shortArr)

      Binary conversion from a int array to a short array.

• void shortsToInts (short[] shortArr, int[] intArr)

      Binary conversion from a short array to a int array.

• void shortsToFloats (short[] shortArr, float[] floatArr)

      Binary conversion from a short array to a float array.
Static Public Attributes

- static final boolean BIG_ENDIAN = false
  
  Big endian conversion.

- static final boolean LITTLE_ENDIAN = true
  
  Little endian conv.

6.3.1 Detailed Description

Conversion Routines. Utility class which provides functions to convert between different binary data representations.

6.3.2 Constructor & Destructor Documentation

Converter ( boolean swapMode )

Creates a Converter (p. 22) object.

Parameters:

  swapMode BIG_ENDIAN: most significant word is the 0th element, LITTLE_ENDIAN: least significant word is the 0th element.

6.3.3 Member Function Documentation

void floatsToShorts ( float[] floatArr, short[] shortArr )

Binary conversion from a float array to a short array.

Note:

  The short array must be twice as large as the float array!

Exceptions:

  ArrayStoreException Array size mismatch

void intsToShorts ( int[] intArr, short[] shortArr )

Binary conversion from a int array to a short array.
Note:
The short array must be twice as large as the int array!

Exceptions:

*ArrayStoreException* Array size mismatch

```java
void shortsToInts ( short[] shortArr, int[] intArr )
```

Binary conversion from a short array to a int array.

Note:
The short array must be twice as large as the int array!

Exceptions:

*ArrayStoreException* Array size mismatch

```java
void shortsToFloats ( short[] shortArr, float[] floatArr )
```

Binary conversion from a short array to a float array.

Note:
The short array must be twice as large as the float array!

Exceptions:

*ArrayStoreException* Array size mismatch

### 6.4 EvaluationExpiredException Class Reference

Evaluation expired error.

Inheritance diagram for EvaluationExpiredException:

```
BusProtocolException
     |
  ^ EvaluationExpiredException
```
**Public Member Functions**

- **EvaluationExpiredException ()**
  
  *Creates a new EvaluationExpiredException (p. 24) instance.*

**Static Public Member Functions**

- **static long getCounter ()**
  
  *Returns how often this exception has been triggered.*

- **static void resetCounter ()**
  
  *Resets exception counter.*

**6.4.1 Detailed Description**

Evaluation expired error. This version of the library is a function limited evaluation version and has now expired.

**See also:**

BusProtocolException (p. 20)

**6.4.2 Member Function Documentation**

```java
static long getCounter () [static]
```

Returns how often this exception has been triggered.

**Returns:**

Counter value

Reimplemented from **BusProtocolException** (p. 21).

**6.5 InvalidFrameException Class Reference**

Invalid frame error.

Inheritance diagram for InvalidFrameException:

```
BusProtocolException

InvalidFrameException
```
Public Member Functions

- **InvalidFrameException ()**
  
  Creates a new InvalidFrameException (p. 25) instance.

Static Public Member Functions

- static long **getCounter ()**
  
  Returns how often this exception has been triggered.

- static void **resetCounter ()**
  
  Resets exception counter.

6.5.1 Detailed Description

Invalid frame error. Signals that a received frame does not correspond either by structure or content to the specification or does not match a previously sent query frame. A poor data link typically causes this error.

See also:

BusProtocolException (p. 20)

6.5.2 Member Function Documentation

**static long getCounter ( ) [static]**

Returns how often this exception has been triggered.

**Returns:**

Counter value

Reimplemented from BusProtocolException (p. 21).

6.6 InvalidReplyException Class Reference

Invalid reply error.

Inheritance diagram for InvalidReplyException:
Public Member Functions

- `InvalidReplyException()`
  
  Creates a new `InvalidReplyException` (p. 26) instance.

Static Public Member Functions

- `static long getCounter()`
  Returns how often this exception has been triggered.

- `static void resetCounter()`
  Resets exception counter.

6.6.1 Detailed Description

Invalid reply error. Signals that a received reply does not correspond to the specification.

See also:

- `BusProtocolException` (p. 20)

6.6.2 Member Function Documentation

`static long getCounter()` [static]

Returns how often this exception has been triggered.

Returns:

- Counter value

Reimplemented from `BusProtocolException` (p. 21).

6.7 Logger Class Reference

`Logger` (p. 27) class.
Public Member Functions

- **Logger** (String categoryName)
  
  Creates a new **Logger** (p. 27) instance.

Static Package Functions

- [static initializer]
  
  Create static context and loads logger.properties configuration file.

Print and Output Routines

- synchronized void `println` (String text)
  
  Prints a log message.

- synchronized void `println` (String text, int val1)
  
  Prints a log message including 1 integer parameter.

- synchronized void `println` (String text, int val1, int val2)
  
  Prints a log message including 2 integer parameters.

- synchronized void `println` (String text, int val1, int val2, int val3)
  
  Prints a log message including 3 integer parameters.

- synchronized void `println` (String text, int val1, int val2, int val3, int val4)
  
  Prints a log message including 4 integer parameters.

- synchronized void `printHexDump` (byte[] dataArr, int ofs, int len)
  
  Prints an array of bytes in hexadecimal notation.

- synchronized void `printAsciiDump` (byte[] dataArr, int ofs, int len)
  
  Interprets the data bytes as ASCII characters and outputStream.prints them.

Logger Configuration

- static synchronized void `loggerEnable` ()
  
  Enables logging to stdout.

- static synchronized void `loggerDisable` ()
  
  Disables logging.

- static synchronized void `categoryEnable` (String categoryName)
  
  Enabled log outputs for this category.
6.7.1 Detailed Description

Logger (p. 27) class. Used for debugging and performance analysis.
Logging can be enabled and configured via an optional logger.properties file and program-
matically during run-time. The logger.properties is searched in the current directory.
Sample logger.properties file:

```
#
# Logger configuration file
#

# Set to true to enable logging in principle
logger.enable=true

# Exception category
logger.category.EXCP=true

# Function category
logger.category.FUNC=true

# Send category
logger.category.SEND=true

# Receive category
logger.category.RECV=true
```

See also:

PrintStream

6.7.2 Constructor & Destructor Documentation

Logger ( String categoryName )

Creates a new Logger (p. 27) instance.

Parameters:

categoryName A log category name (typically 4 letters)

6.7.3 Member Function Documentation

static synchronized void categoryEnable ( String categoryName ) [static]
Enabled log outputs for this category.

Parameters:

\textit{categoryName} The log category name

\texttt{static synchronized void categoryDisable ( String \textit{categoryName} ) [static]}

Disables log outputs for this category.

Parameters:

\textit{categoryName} The log category name

\texttt{synchronized void println ( String \textit{text} )}

Prints a log message.

Parameters:

\textit{text} Log text

\texttt{synchronized void println ( String \textit{text}, \textit{int val1} )}

Prints a log message including 1 integer parameter.

Parameters:

\textit{text} Log text
\textit{val1} Integer value

\texttt{synchronized void println ( String \textit{text}, \textit{int val1}, \textit{int val2} )}

Prints a log message including 2 integer parameters.

Parameters:

\textit{text} Log text
\textit{val1} Integer value
\textit{val2} Integer value
synchronized void println ( String text, int val1, int val2, int val3 )

Prints a log message including 3 integer parameters.

Parameters:
- text Log text
- val1 Integer value
- val2 Integer value
- val3 Integer value

synchronized void println ( String text, int val1, int val2, int val3, int val4 )

Prints a log message including 4 integer parameters.

Parameters:
- text Log text
- val1 Integer value
- val2 Integer value
- val3 Integer value
- val4 Integer value

synchronized void printHexDump ( byte[] dataArr, int ofs, int len )

Prints an array of bytes in hexadecimal notation.

Parameters:
- dataArr Data bytes to outStream.print as chars
- ofs Subarray offset
- len Number of bytes to outStream.print

synchronized void printAsciiDump ( byte[] dataArr, int ofs, int len )

Interprets the data bytes as ASCII characters and outStream.prints them.

Parameters:
- dataArr Data bytes to outStream.print as chars
- ofs Subarray offset
- len Number of bytes to outStream.print
6.8 MbusAsciiMasterProtocol Class Reference

Modbus ASCII Master Protocol class.

Inheritance diagram for MbusAsciiMasterProtocol:

```
MbusMasterFunctions
   |
   v
MbusSerialMasterProtocol
   |
   v
MbusAsciiMasterProtocol
```

Public Member Functions

- synchronized void `openProtocol` (String portName, int baudRate, int dataBits, int stopBits, int parity) throws IOException, PortInUseException, UnsupportedCommOperationException
  
  *Opens a Modbus ASCII serial port with specific port parameters.*

- synchronized void `closeProtocol` () throws IOException
  
  *Closes the serial port and releases any system resources associated with the port.*

- boolean `isOpen` ()
  
  *Returns whether the port is open or not.*

Static Public Attributes

- static final int `DATABITS_7` = SerialPort.DATABITS_7
  
  *7 data bits*

- static final int `DATABITS_8` = SerialPort.DATABITS_8
  
  *8 data bits*

- static final int `STOPBITS_1` = SerialPort.STOPBITS_1
  
  *1 stop bit*

- static final int `STOPBITS_1_5` = SerialPort.STOPBITS_1_5
  
  *1.5 stop bits*

- static final int `STOPBITS_2` = SerialPort.STOPBITS_2
  
  *2 stop bits*

- static final int `PARITY_NONE` = SerialPort.PARITY_NONE
  
  *no parity*
• static final int `PARITY_ODD` = SerialPort.PARITY_ODD
  odd parity

• static final int `PARITY_EVEN` = SerialPort.PARITY_EVEN
  even parity

• static final int `PARITY_MARK` = SerialPort.PARITY_MARK
  mark parity

• static final int `PARITY_SPACE` = SerialPort.PARITY_SPACE
  space parity

**Bit Access**

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

• synchronized void `readCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  *Modbus function 1 (01 hex), Read Coil Status/Read Coils.*

• synchronized void `readInputDiscretes` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  *Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.*

• synchronized void `writeCoil` (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
  *Modbus function 5 (05 hex), Force Single Coil/Write Coil.*

• synchronized void `forceMultipleCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  *Modbus function 15 (0F hex), Force Multiple Coils.*

**Register Access (16-bit, 32-bit and floating point)**

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)

• synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  *Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.*

• synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  *Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.*
• synchronized void **readMultipleRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex), Read Input Registers.

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.

• synchronized void **writeSingleRegister** (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException
  
  Modbus function 6 (06 hex), Preset Single Register/Write Single Register.

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

• synchronized void **maskWriteRegister** (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException
  
  Modbus function 22 (16 hex), Mask Write Register.

• synchronized void **readWriteRegisters** (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException
  
  Modbus function 23 (17 hex), Read/Write Registers.

**Diagnostics**

• synchronized byte **readExceptionStatus** (int slaveAddr) throws IOException, BusProtocolException
Modbus function 7 (07 hex), Read Exception Status.

Custom Function Codes

- synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException
  
  Vendor Specific Modbus function 100 (64 hex), Read History Log.

Protocol Configuration

- synchronized void `setTimeout` (int timeOut)
  
  Configures time-out.

- int `getTimeout` ()
  
  Returns the operation time-out value.

- synchronized void `setPollDelay` (int pollDelay)
  
  Configures poll delay.

- int `getPollDelay` ()
  
  Returns the poll delay time.

- synchronized void `setRetryCnt` (int retryCnt)
  
  Configures the automatic retry setting.

- int `getRetryCnt` ()
  
  Returns the automatic retry count.

Transmission Statistic Functions

- synchronized long `getTotalCounter` ()
  
  Returns how often a transmit/receive cycle has been executed.

- synchronized void `resetTotalCounter` ()
  
  Resets total transmit/receive cycle counter.

- synchronized long `getSuccessCounter` ()
  
  Returns how often a transmit/receive cycle was successful.

- synchronized void `resetSuccessCounter` ()
  
  Resets successful transmit/receive counter.
Slave Configuration

- `void configureStandard32BitMode ()`
  Configures all slaves for Standard 32-bit Mode.

- `synchronized void configureStandard32BitMode (int slaveAddr)`
  Configures a slave for Standard 32-bit Register Mode.

- `void configureSingleReg32BitMode ()`
  Configures all slaves for Single Register 32-bit Mode.

- `synchronized void configureSingleReg32BitMode (int slaveAddr)`
  Configures all slaves for Single Register 32-bit Mode.

- `void configureCountFromOne ()`
  Configures the reference counting scheme to start with one for all slaves.

- `synchronized void configureCountFromOne (int slaveAddr)`
  Configures a slave’s reference counting scheme to start with one.

- `void configureCountFromZero ()`
  Configures the reference counting scheme to start with zero for all slaves.

- `synchronized void configureCountFromZero (int slaveAddr)`
  Configures a slave’s reference counting scheme to start with zero.

- `void configureLittleEndianInts ()`  
  Disables word swapping for int data type functions for all slaves.

- `synchronized void configureLittleEndianInts (int slaveAddr)`  
  Disables word swapping for int data type functions on a per slave basis.

- `void configureBigEndianInts ()`  
  Configures int data type functions to do a word swap for all slaves.

- `synchronized void configureBigEndianInts (int slaveAddr)`  
  Enables int data type functions to do a word swap on a per slave basis.

- `void configureLittleEndianFloats ()`  
  Disables float data type functions to do a word swap for all slaves.

- `synchronized void configureLittleEndianFloats (int slaveAddr)`  
  Disables float data type functions to do a word swap on a per slave basis.

- `void configureSwappedFloats ()`  
  Configures float data type functions to do a word swap for all slaves.

- `synchronized void configureSwappedFloats (int slaveAddr)`
6.8.1 Detailed Description

Modbus ASCII Master Protocol class. This class realizes the Modbus ASCII master protocol. It provides functions to open and to close serial port as well as data and control functions which can be used at any time after the protocol has been opened. The data and control functions are organized different conformance classes. For a more detailed description of the data and control functions see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).

It is possible to instantiate multiple instances of this class for establishing multiple connections on different serial ports (They should be executed in separate threads).

All functions have been implemented thread-safe. It is also possible to instantiate multiple instances for establishing multiple connections on different serial ports.

See also:

- Data and Control Functions for all Modbus Protocol Flavours (p. 14), Serial Protocols (p. 15)
- MbusRtuMasterProtocol (p. 105), MbusElamMasterProtocol (p. 55), MbusTcpMasterProtocol (p. 153)

6.8.2 Member Function Documentation

```java
synchronized void openProtocol ( String portName, int baudRate, int dataBits, int stopBits, int parity ) throws IOException, PortInUseException, UnsupportedCommOperationException
```

Opens a Modbus ASCII serial port with specific port parameters.

This function opens the serial port. After a port has been opened data and control functions can be used.

Note:

The default time-out for the data transfer is 1000 ms.
The default poll delay is 0 ms.
Automatic retries are switched off (retry count is 0).
The Modbus standard requires two stop bits if no parity is chosen. This library is not enforcing this but it is a recommended configuration.

Parameters:

- `portName` Serial port identifier (e.g. "COM1", "/dev/ser1 or /dev/ttyS0")
- `baudRate` The port baudRate in bps (typically 1200 - 19200)
- `dataBits` DATABITS_7: 7 data bits, DATABITS_8: data bits
stopBits  STOPBITS_1: 1 stop bit, STOPBITS_1_5: 1.5 stop bits, STOPBITS_2: 2 stop bits
parity  PARITY_NONE: no parity, PARITY_ODD: odd parity, PARITY_EVEN: even parity, PARITY_MARK: mark parity, PARITY_SPACE: space parity

Exceptions:

IOException  An I/O error occurred
UnsupportedCommOperationException  A communication parameter is not supported
PortInUseException  Port is already used by somebody else
InvalidParameterException  A parameter is invalid

Reimplemented from MbusSerialMasterProtocol (p. 134).

synchronized void closeProtocol ( ) throws IOException  [virtual, inherited]

Closes the serial port and releases any system resources associated with the port.

Exceptions:

IOException  An I/O error occurred

Implements MbusMasterFunctions (p. 82).

boolean isOpen ( ) [virtual, inherited]

Returns whether the port is open or not.

Return values:

true  = open
false  = closed

Implements MbusMasterFunctions (p. 103).

synchronized void readCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 1 (01 hex), Read Coil Status/Read Coils.
Reads the contents of the discrete outputs (coils, 0:00000 table).
synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException { [inherited]

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes. Reads the contents of the discrete inputs (coils, 1:00000 table).

Parameters:

```
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef   Start reference (Range: depends on configuration setting)
bitArr     Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).
```

Exceptions:

```
IOException   An I/O error occurred
IllegalArgumentException   A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.
```

Note:

No broadcast supported
synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException [inherited]

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
bitAddr  Coil address (Range: depends on configuration setting)
bitVal  true sets, false clears discrete output variable

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException [inherited]

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
BusProtocolException  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException [inherited]

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers. Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
regArr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.

Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
int32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
float32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException [inherited]

Modbus function 4 (04 hex), Read Input Registers.
Read the contents of the input registers (3:00000 table).
Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `startRef` Start reference (Range: depends on configuration setting)
- `regArr` Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException` (p. 20) A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException [inherited]
```

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data. Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `startRef` Start reference (Range: depends on configuration setting)
- `int32Arr` Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException` (p. 20) A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data. Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
float32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal ) throws IOException, BusProtocolException [inherited]

Modbus function 6 (06 hex), Preset Single Register/Write Single Register. Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr Register address (Range: depends on configuration setting)
regVal Data to be sent

Exceptions:
IllegalStateException Port or connection is closed
IOException An I/O error occurred
IllegalArgumentException  A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers. Writes values into a sequence of output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef Start reference (Range depends on configuration setting)
regArr Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IllegalArgumentException Port or connection is closed
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

Writes int values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException { inherited }

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.
Writes float values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void maskWriteRegister ( int slaveAddr, int regAddr, short andMask, short orMask ) throws IOException, BusProtocolException [inherited]

Modbus function 22 (16 hex), Mask Write Register.
Masks bits according to an AND & an OR mask into a single output register (holding register, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) OR (orMask AND (NOT andMask))

Parameters:
- **slaveAddr** Modbus address of slave device or unit identifier (Range: 1 - 255)
- **regAddr** Register address (Range: depends on configuration setting)
- **andMask** Mask to be applied as a logic AND to the register
- **orMask** Mask to be applied as a logic OR to the register

Exceptions:
- **IllegalStateException** Port or connection is closed
- **IOException** An I/O error occurred
- **IllegalArgumentException** A parameter is out of range
- **BusProtocolException** (p. 20) A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

Note:
- No broadcast supported

synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr ) throws IOException, BusProtocolException [inherited]

Modbus function 23 (17 hex), Read/Write Registers.
Combines reading and writing of the output registers in one transaction (holding registers, 4:00000 table).

Parameters:
- **slaveAddr** Modbus address of slave device or unit identifier (Range: 1 - 255)
- **readRef** Start reference for reading (Range: depends on configuration setting)
- **readArr** Buffer which will contain the data read. The length of the array determines how many registers are read (Range: 1-125).
- **writeRef** Start reference for writing (Range: depends on configuration setting)
- **writeArr** Buffer with data to be sent. The length of the array determines how many registers are sent (Range: 1-121).
Exceptions:

- **IllegalStateException** Port or connection is closed
- **IOException** An I/O error occurred
- **IllegalArgumentException** A parameter is out of range
- **BusProtocolException** (p. 20) A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException, BusProtocolException [inherited]
```

Modbus function 7 (07 hex), Read Exception Status.
Reads the eight exception status coils within the slave device.

Parameters:

- **slaveAddr** Modbus address of slave device or unit identifier (Range: 1 - 255)

Exceptions:

- **IllegalStateException** Port or connection is closed
- **IOException** An I/O error occurred
- **IllegalArgumentException** A parameter is out of range
- **BusProtocolException** (p. 20) A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void setTimeout ( int timeOut ) [inherited]
```

Configures time-out.

This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

Note:

A port or connection must be closed in order to configure it.
Parameters:

   `timeOut`  Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

   `IllegalStateException`  Port is open
   `IllegalArgumentException`  Parameter is out of range

```java
int getTimeout() [inherited]
```

Returns the operation time-out value.

**Returns:**

   Timeout value in ms

```java
synchronized void setPollDelay(int pollDelay) [inherited]
```

Configures poll delay.

This function sets the delay time which applies between two consecutive Modbus read/write. A value of 0 disables the poll delay.

**Note:**

   A port or connection must be closed in order to configure it.

Parameters:

   `pollDelay`  Delay time in ms (Range: 0 - 100000), 0 disables poll delay

Exceptions:

   `IllegalStateException`  Port is open
   `IllegalArgumentException`  Parameter is out of range

```java
int getPollDelay() [inherited]
```

Returns the poll delay time.

**Returns:**

   Delay time in ms, 0 if poll delay is switched off
synchronized void setRetryCnt ( int retryCnt ) [inherited]

Configures the automatic retry setting.  
A value of 0 disables any automatic retries.  

Note:  
A port or connection must be closed in order to configure it.  

Parameters:  

retryCnt  Retry count (Range: 0 - 10), 0 disables retries  

Exceptions:  

IllegalArgumentException  Parameter is out of range  

int getRetryCnt ( ) [inherited]

Returns the automatic retry count.  

Returns:  
Retry count  

synchronized long getTotalCounter ( ) [inherited]

Returns how often a transmit/receive cycle has been executed.  

Returns:  
Counter value  

synchronized long getSuccessCounter ( ) [inherited]

Returns how often a transmit/receive cycle was successful.  

Returns:  
Counter value
void configureStandard32BitMode ( ) \[inherited\]

Configures all slaves for Standard 32-bit Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Remarks:
This is the default mode

synchronized void configureStandard32BitMode ( int slaveAddr ) \[inherited\]

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:
This is the default mode

void configureSingleReg32BitMode ( ) \[inherited\]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

synchronized void configureSingleReg32BitMode ( int slaveAddr ) \[inherited\]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
void configureCountFromOne( ) {inherited]

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:
This is the default mode

synchronized void configureCountFromOne( int slaveAddr ) {inherited]

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:
This is the default mode

void configureCountFromZero( ) {inherited]

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

synchronized void configureCountFromZero( int slaveAddr ) {inherited]

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
void configureLittleEndianInts() [inherited]

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the
slave also serves 32-bit data in little-endian word order.

Remarks:
This is the default mode

synchronized void configureLittleEndianInts(int slaveAddr) [inherited]

Disables word swapping for int data type functions on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the
slave also serves 32-bit data in little-endian word order.

Remarks:
This is the default mode

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

void configureBigEndianInts() [inherited]

Configures int data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. The data transfer functions
operating upon 32-bit int data types can be configured to do a word swap which enables
them to read 32-bit data correctly from a big-endian machine.

synchronized void configureBigEndianInts(int slaveAddr) [inherited]

Enables int data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. The data transfer functions
operating upon 32-bit int data types can be configured to do a word swap which enables
them to read 32-bit data correctly from a big-endian machine.

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.
void configureLittleEndianFloats ( ) [inherited]

Disables float data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the
slaves also serve 32-bit floats in little little-endian word order which is the most common
case.

Remarks:
This is the default mode

synchronized void configureLittleEndianFloats ( int slaveAddr ) [inherited]

Disables float data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the
slave also serves 32-bit floats in little little-endian word order which is the most common
case.

Remarks:
This is the default mode

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

void configureSwappedFloats ( ) [inherited]

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word
swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word
swap.

synchronized void configureSwappedFloats ( int slaveAddr ) [inherited]

Enables float data type functions to do a word swap on a per slave basis.
The data functions operating upon 32-bit float data types can be configured to do a word
swap.
Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

## 6.9 MbusElamMasterProtocol Class Reference
Extended Lufkin Automation Modbus Master Protocol.

Inheritance diagram for MbusElamMasterProtocol:

```
MbusMasterFunctions
  └── MbusSerialMasterProtocol
      └── MbusRtuMasterProtocol
          └── MbusElamMasterProtocol
```

### Public Member Functions

- **MbusElamMasterProtocol()**
  
  Creates new instance.

- synchronized void **openProtocol**(String portName, int baudRate, int dataBits, int stopBits, int parity) throws IOException, PortInUseException, UnsupportedCommOperationException
  
  Opens a Modbus serial port with specific port parameters.

- synchronized void **closeProtocol**() throws IOException
  
  Closes the serial port and releases any system resources associated with the port.

- boolean isOpen()
  
  Returns whether the port is open or not.

### Static Public Attributes

- static final int **DATABITS_8** = SerialPort.DATABITS_8
  
  8 data bits
• static final int STOPBITS_1 = SerialPort.STOPBITS_1
  1 stop bit

• static final int STOPBITS_1_5 = SerialPort.STOPBITS_1_5
  1.5 stop bits

• static final int STOPBITS_2 = SerialPort.STOPBITS_2
  2 stop bits

• static final int PARITY_NONE = SerialPort.PARITY_NONE
  no parity

• static final int PARITY_ODD = SerialPort.PARITY_ODD
  odd parity

• static final int PARITY_EVEN = SerialPort.PARITY_EVEN
  even parity

• static final int PARITY_MARK = SerialPort.PARITY_MARK
  mark parity

• static final int PARITY_SPACE = SerialPort.PARITY_SPACE
  space parity

Bit Access

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

• synchronized void readCoils (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 1 (01 hex), Read Coil Status/Read Coils.

• synchronized void readInputDiscretes (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.

• synchronized void writeCoil (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
  Modbus function 5 (05 hex), Force Single Coil/Write Coil.

• synchronized void forceMultipleCoils (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 15 (0F hex), Force Multiple Coils.
Register Access (16-bit, 32-bit and floating point)

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex), Read Input Registers.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.

- synchronized void `writeSingleRegister` (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException
  
  Modbus function 6 (06 hex), Preset Single Register/Write Single Register.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.
• synchronized void `maskWriteRegister` (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException

  `Modbus function 22 (16 hex), Mask Write Register.`

• synchronized void `readWriteRegisters` (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException

  `Modbus function 23 (17 hex), Read/Write Registers.`

**Diagnostics**

• synchronized byte `readExceptionStatus` (int slaveAddr) throws IOException, BusProtocolException

  `Modbus function 7 (07 hex), Read Exception Status.`

**Custom Function Codes**

• synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException

  `Vendor Specific Modbus function 100 (64 hex), Read History Log.`

**Protocol Configuration**

• synchronized void `setTimeout` (int timeOut)

  `Configures time-out.`

• int `getTimeout`()

  `Returns the operation time-out value.`

• synchronized void `setPollDelay` (int pollDelay)

  `Configures poll delay.`

• int `getPollDelay`()

  `Returns the poll delay time.`

• synchronized void `setRetryCnt` (int retryCnt)

  `Configures the automatic retry setting.`

• int `getRetryCnt`()

  `Returns the automatic retry count.`
Transmission Statistic Functions

- synchronized long getTotalCounter ()
  Returns how often a transmit/receive cycle has been executed.

- synchronized void resetTotalCounter ()
  Resets total transmit/receive cycle counter.

- synchronized long getSuccessCounter ()
  Returns how often a transmit/receive cycle was successful.

- synchronized void resetSuccessCounter ()
  Resets successful transmit/receive counter.

Slave Configuration

- void configureStandard32BitMode ()
  Configures all slaves for Standard 32-bit Mode.

- synchronized void configureStandard32BitMode (int slaveAddr)
  Configures a slave for Standard 32-bit Register Mode.

- void configureSingleReg32BitMode ()
  Configures all slaves for Single Register 32-bit Mode.

- synchronized void configureSingleReg32BitMode (int slaveAddr)
  Configures all slaves for Single Register 32-bit Mode.

- void configureCountFromOne ()
  Configures the reference counting scheme to start with one for all slaves.

- synchronized void configureCountFromOne (int slaveAddr)
  Configures a slave’s reference counting scheme to start with one.

- void configureCountFromZero ()
  Configures the reference counting scheme to start with zero for all slaves.

- synchronized void configureCountFromZero (int slaveAddr)
  Configures a slave’s reference counting scheme to start with zero.

- void configureLittleEndianInts ()
  Disables word swapping for int data type functions for all slaves.

- synchronized void configureLittleEndianInts (int slaveAddr)
  Disables word swapping for int data type functions on a per slave basis.
• void `configureBigEndianInts()`
  Configures int data type functions to do a word swap for all slaves.

• synchronized void `configureBigEndianInts(int slaveAddr)`
  Enables int data type functions to do a word swap on a per slave basis.

• void `configureLittleEndianFloats()`
  Disables float data type functions to do a word swap for all slaves.

• synchronized void `configureLittleEndianFloats(int slaveAddr)`
  Disables float data type functions to do a word swap on a per slave basis.

• void `configureSwappedFloats()`
  Configures float data type functions to do a word swap for all slaves.

• synchronized void `configureSwappedFloats(int slaveAddr)`
  Enables float data type functions to do a word swap on a per slave basis.

### 6.9.1 Detailed Description

Extended Lufkin Automation Modbus Master Protocol. This class realizes the Extended Lufkin Automation (ELAM) Modbus protocol. This proprietary Modbus extension allows addressing of up to 2295 slave units and the retrieval of up to 2500 registers for Modbus functions 3 and 4.

It’s implementation is based on the specification “ELAM Extended Lufkin Automation Modbus Version 1.01” published by LUFKIN Automation. The ELAM multiple instruction requests extensions are not implemented.

Tests showed the following size limits with a LUFKIN SAM Well Manager device:
Coils: 1992 for read  
Registers: 2500 to read, 60 for write

See also:
- Data and Control Functions for all Modbus Protocol Flavours (p. 14), Serial Protocols (p. 15)
- `MbusRtuMasterProtocol` (p. 105), `MbusAsciiMasterProtocol` (p. 32), `MbusTcpMasterProtocol` (p. 153)

### 6.9.2 Member Function Documentation

```java
synchronized void openProtocol ( String portName, int baudRate, int dataBits, int stopBits, int parity ) throws IOException, PortInUseException, UnsupportedCommOperationException [inherited]
```

Opens a Modbus serial port with specific port parameters.
This function opens the serial port. After a port has been opened data and control functions can be used.

**Note:**

The default time-out for the data transfer is 1000 ms.
The default poll delay is 0 ms.
Automatic retries are switched off (retry count is 0).
The Modbus standard requires two stop bits if no parity is chosen. This library is not enforcing this but it is a recommended configuration.

**Parameters:**

- **portName**  Serial port identifier (e.g. "COM1", "/dev/ser1 or /dev/ttyS0")
- **baudRate**  The port baudRate in bps (typically 1200 - 9600).
- **dataBits**  Must be DATABITS_8 for RTU
- **stopBits**  STOPBITS_1: 1 stop bit, STOPBITS_1_5: 1.5 stop bits, STOPBITS_2: 2 stop bits
- **parity**  PARITY_NONE: no parity, PARITY_ODD: odd parity, PARITY_EVEN: even parity, PARITY_MARK: mark parity, PARITY_SPACE: space parity

**Exceptions:**

- **IOException**  An I/O error occurred
- **UnsupportedCommOperationException**  A communication parameter is not supported
- **PortInUseException**  Port is already used by somebody else
- **IllegalArgumentException**  A parameter is invalid

Reimplemented from **MbusSerialMasterProtocol** (p. 134).

**synchronized void closeProtocol ( ) throws IOException**  [virtual, inherited]

Closes the serial port and releases any system resources associated with the port.

**Exceptions:**

- **IOException**  An I/O error occurred

Implements **MbusMasterFunctions** (p. 82).

**boolean isOpen ( )**  [virtual, inherited]

Returns whether the port is open or not.
Return values:

- \textit{true} = open
- \textit{false} = closed

Implements \textbf{MbusMasterFunctions} (p. 103).

\begin{verbatim}
synchronized void readCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]
\end{verbatim}

Modbus function 1 (01 hex), Read Coil Status/Read Coils.
Reads the contents of the discrete outputs (coils, 0:00000 table).

Parameters:

- \textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255)
- \textit{startRef} Start reference (Range: depends on configuration setting)
- \textit{bitArr} Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

Exceptions:

- \textit{IOException} An I/O error occurred
- \textit{IllegalArgumentException} A parameter is out of range
- \textit{BusProtocolException} (p. 20) A protocol failure occurred. See descendants of \textbf{BusProtocolException} (p. 20) for a more detailed failure list.

Note:

- No broadcast supported

\begin{verbatim}
synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]
\end{verbatim}

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.
Reads the contents of the discrete inputs (coils, 1:00000 table).

Parameters:

- \textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255)
- \textit{startRef} Start reference (Range: depends on configuration setting)
- \textit{bitArr} Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).
Exceptions:

- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException (p. 20)` A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 0 - 247)
- `bitAddr` Coil address (Range: depends on configuration setting)
- `bitVal` true sets, false clears discrete output variable

Exceptions:

- `IllegalStateException` Port or connection is closed
- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException (p. 20)` A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.
Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
regArr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.
Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex), Read Input Registers.
Read the contents of the input registers (3:00000 table).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
regArr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
**startRef**  Start reference (Range: depends on configuration setting)

**int32Arr**  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

**Exceptions:**

- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException (p. 20)**  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**

No broadcast supported

**synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException ** [inherited]

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.

Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

**Remarks:**

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

**Parameters:**

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 1 - 255)
- **startRef**  Start reference (Range: depends on configuration setting)
- **float32Arr**  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

**Exceptions:**

- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException (p. 20)**  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**

No broadcast supported
synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal )
throws IOException, BusProtocolException [inherited]

Modbus function 6 (06 hex), Preset Single Register/Write Single Register.
Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr    Register address (Range: depends on configuration setting)
regVal     Data to be sent

Exceptions:

IllegalStateException  Port or connection is closed
IOException    An I/O error occurred
IllegalArgumentException    A parameter is out of range
BusProtocolException (p. 20)    A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.
Writes values into a sequence of output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef   Start reference (Range depends on configuration setting)
regArr     Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IllegalStateException  Port or connection is closed
IOException    An I/O error occurred
IllegalArgumentException    A parameter is out of range
BusProtocolException (p. 20)    A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.
Writes int values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef Start reference (Range: depends on configuration setting)
int32Arr Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.
Writes float values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef Start reference (Range: depends on configuration setting)
float32Arr Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException An I/O error occurred

IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void maskWriteRegister ( int slaveAddr, int regAddr, short andMask, short orMask ) throws IOException, BusProtocolException [inherited]

Modbus function 22 (16 hex), Mask Write Register.

Masks bits according to an AND & an OR mask into a single output register (holding register, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) OR (orMask AND (NOT andMask))

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)

regAddr Register address (Range: depends on configuration setting)

andMask Mask to be applied as a logic AND to the register

orMask Mask to be applied as a logic OR to the register

Exceptions:

IllegalStateException Port or connection is closed

IOException An I/O error occurred

IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr ) throws IOException, BusProtocolException [inherited]

Modbus function 23 (17 hex), Read/Write Registers.
Combines reading and writing of the output registers in one transaction (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
readRef  Start reference for reading (Range: depends on configuration setting)
readArr  Buffer which will contain the data read. The length of the array determines how many registers are read (Range: 1-125).
writeRef  Start reference for writing (Range: depends on configuration setting)
writeArr  Buffer with data to be sent. The length of the array determines how many registers are sent (Range: 1-121).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException, BusProtocolException [inherited]

Modbus function 7 (07 hex), Read Exception Status.
Reads the eight exception status coils within the slave device.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range

BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void setTimeout ( int timeOut )  [inherited]

Configures time-out.
This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

Note:

A port or connection must be closed in order to configure it.

Parameters:

  timeOut  Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

  IllegalStateException  Port is open
  IllegalArgumentException  Parameter is out of range

int getTimeout ( )  [inherited]

Returns the operation time-out value.

Returns:

  Timeout value in ms

synchronized void setPollDelay ( int pollDelay )  [inherited]

Configures poll delay.
This function sets the delay time which applies between two consecutive Modbus read/write. A value of 0 disables the poll delay.

Note:

  A port or connection must be closed in order to configure it.
Parameters:

pollDelay  Delay time in ms (Range: 0 - 100000), 0 disables poll delay

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getPollDelay( ) [inherited]

Returns the poll delay time.

Returns:

Delay time in ms, 0 if poll delay is switched off

synchronized void setRetryCnt( int retryCnt ) [inherited]

Configures the automatic retry setting.
A value of 0 disables any automatic retries.

Note:

A port or connection must be closed in order to configure it.

Parameters:

retryCnt  Retry count (Range: 0 - 10), 0 disables retries

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getRetryCnt( ) [inherited]

Returns the automatic retry count.

Returns:

Retry count
synchronized long getTotalCounter( ) [inherited]

Returns how often a transmit/receive cycle has been executed.

Returns:
    Counter value

synchronized long getSuccessCounter( ) [inherited]

Returns how often a transmit/receive cycle was successful.

Returns:
    Counter value

void configureStandard32BitMode( ) [inherited]

Configures all slaves for Standard 32-bit Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Remarks:
    This is the default mode

synchronized void configureStandard32BitMode( int slaveAddr ) [inherited]

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Parameters:
    slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:
    This is the default mode
void configureSingleReg32BitMode ( ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one
32-bit Modbus register instead of two 16-bit registers.

synchronized void configureSingleReg32BitMode ( int slaveAddr ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one
32-bit Modbus register instead of two 16-bit registers.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

void configureCountFromOne ( ) [inherited]

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:

This is the default mode

synchronized void configureCountFromOne ( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode
void configureCountFromZero( ) [inherited]

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

synchronized void configureCountFromZero( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianInts( ) [inherited]

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:

This is the default mode

synchronized void configureLittleEndianInts( int slaveAddr ) [inherited]

Disables word swapping for int data type functions on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:

This is the default mode

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
void configureBigEndianInts ( ) [inherited]

Configures int data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

synchronized void configureBigEndianInts ( int slaveAddr ) [inherited]

Enables int data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianFloats ( ) [inherited]

Disables float data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slaves also serve 32-bit floats in little little-endian word order which is the most common case.

Remarks:

This is the default mode

synchronized void configureLittleEndianFloats ( int slaveAddr ) [inherited]

Disables float data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit floats in little little-endian word order which is the most common case.

Remarks:

This is the default mode
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureSwappedFloats ( ) [inherited]

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:

Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

synchronized void configureSwappedFloats ( int slaveAddr ) [inherited]

Enables float data type functions to do a word swap on a per slave basis.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:

Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

6.10  MbusIllegalAddressException Class Reference

Illegal Data Address exception response.

Inheritance diagram for MbusIllegalAddressException:

```
MbusIllegalAddressException
    BusProtocolException
    MbusResponseException
    MbusIllegalAddressException
```
Public Member Functions

- **MbusIllegalAddressException ()**
  
  Creates a new *MbusIllegalAddressException* (p. 78) instance.

Static Public Member Functions

- static long **getCounter ()**
  
  Returns how often this exception has been triggered.

- static void **resetCounter ()**
  
  Resets exception counter.

### 6.10.1 Detailed Description

Illegal Data Address exception response. Signals that an Illegal Data Address exception response (code 02) was received. This exception response is sent by a slave device instead of a normal response message if a master queried an invalid or non-existing data address.

See also:

- *MbusResponseException* (p. 103)

### 6.10.2 Member Function Documentation

#### static long getCounter () [static]

Returns how often this exception has been triggered.

**Returns:**

Counter value

Reimplemented from *MbusResponseException* (p. 104).

### 6.11 MbusIllegalFunctionException Class Reference

Illegal Function exception response.

Inheritance diagram for MbusIllegalFunctionException:
Public Member Functions

- **MbusIllegalFunctionException ()**
  
  Creates a new *MbusIllegalFunctionException* (p. 79) instance.

Static Public Member Functions

- static long **getCounter ()**
  
  Returns how often this exception has been triggered.

- static void **resetCounter ()**
  
  Resets exception counter.

6.11.1 Detailed Description

Illegal Function exception response. Signals that an Illegal Function exception response (code 01) was received. This exception response is sent by a slave device instead of a normal response message if a master sent a Modbus function which is not supported by the slave device.

See also:

*MbusResponseException* (p. 103)

6.11.2 Member Function Documentation

```java
static long getCounter () [static]
```

Returns how often this exception has been triggered.

**Returns:**

Counter value

Reimplemented from *MbusResponseException* (p. 104).
6.12 MbusIllegalValueException Class Reference

Illegal Data Value exception response.

Inheritance diagram for MbusIllegalValueException:

```
BusProtocolException
   |
   V
MbusResponseException
   |
   V
MbusIllegalValueException
```

Public Member Functions

- **MbusIllegalValueException ()**
  
  Creates a new *MbusIllegalValueException* (p. 81) instance.

Static Public Member Functions

- static long **getCounter ()**
  
  Returns how often this exception has been triggered.

- static void **resetCounter ()**
  
  Resets exception counter.

6.12.1 Detailed Description

Illegal Data Value exception response. Signals that an Illegal Value exception response was (code 03) received. This exception response is sent by a slave device instead of a normal response message if a master sent a data value which is not an allowable value for the slave device.

See also:

  *MbusResponseException* (p. 103)

6.12.2 Member Function Documentation

```
static long getCounter () [static]
```

Returns how often this exception has been triggered.
Returns:
Counter value

Reimplemented from **MbusResponseException** (p. 104).

### 6.13 MbusMasterFunctions Class Reference

Base class which implements Modbus data and control functions.

Inheritance diagram for MbusMasterFunctions:

```
MbusMasterFunctions
MbusRtuOverTcpMasterProtocol
MbusSerialMasterProtocol
MbusTcpMasterProtocol
MbusAsciiMasterProtocol
MbusRtuMasterProtocol
MbusElamMasterProtocol
```

**Public Member Functions**

- **MbusMasterFunctions ()**
  * Creates new instance.

- abstract boolean **isOpen ()**
  * Returns whether the protocol has been opened or not (e.g.

- abstract void **closeProtocol ()** throws IOException
  * Closes an open protocol including any associated communication resources (com ports or sockets).

**Bit Access**

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

- synchronized void **readCoils** (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  * Modbus function 1 (01 hex), Read Coil Status/Read Coils.

- synchronized void **readInputDiscretes** (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  * Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.

- synchronized void **writeCoil** (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
Modbus function 5 (05 hex), Force Single Coil/Write Coil.

- synchronized void `forceMultipleCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  Modbus function 15 (0F hex), Force Multiple Coils.

Register Access (16-bit, 32-bit and floating point)

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex), Read Input Registers.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.

- synchronized void `writeSingleRegister` (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException
  
  Modbus function 6 (06 hex), Preset Single Register/Write Single Register.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

- synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException  
  
  Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

- synchronized void `maskWriteRegister` (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException  
  
  Modbus function 22 (16 hex), Mask Write Register.

- synchronized void `readWriteRegisters` (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException  
  
  Modbus function 23 (17 hex), Read/Write Registers.

Diagnostics

- synchronized byte `readExceptionStatus` (int slaveAddr) throws IOException, BusProtocolException  
  
  Modbus function 7 (07 hex), Read Exception Status.

Custom Function Codes

- synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException  
  
  Vendor Specific Modbus function 100 (64 hex), Read History Log.

Protocol Configuration

- synchronized void `setTimeout` (int timeOut)  
  
  Configures time-out.

- int `getTimeout` ()  
  
  Returns the operation time-out value.

- synchronized void `setPollDelay` (int pollDelay)  
  
  Configures poll delay.

- int `getPollDelay` ()  
  
  Returns the poll delay time.

- synchronized void `setRetryCnt` (int retryCnt)
Configures the automatic retry setting.

- **int** `getRetryCnt()`  
  Returns the automatic retry count.

### Transmission Statistic Functions

- **synchronized long** `getTotalCounter()`  
  Returns how often a transmit/receive cycle has been executed.

- **synchronized void** `resetTotalCounter()`  
  Resets total transmit/receive cycle counter.

- **synchronized long** `getSuccessCounter()`  
  Returns how often a transmit/receive cycle was successful.

- **synchronized void** `resetSuccessCounter()`  
  Resets successful transmit/receive counter.

### Slave Configuration

- **void** `configureStandard32BitMode()`  
  Configures all slaves for Standard 32-bit Mode.

- **void** `configureSingleReg32BitMode()`  
  Configures all slaves for Single Register 32-bit Mode.

- **void** `configureCountFromOne()`  
  Configures the reference counting scheme to start with one for all slaves.

- **void** `configureCountFromZero()`  
  Configures the reference counting scheme to start with zero for all slaves.

- **void** `configureLittleEndianInts()`  
  Disables word swapping for int data type functions for all slaves.

- **void** `configureBigEndianInts()`  
  Configures int data type functions to do a word swap for all slaves.

- **void** `configureLittleEndianFloats()`  
  Disables float data type functions to do a word swap for all slaves.

- **void** `configureSwappedFloats()`  
  Configures float data type functions to do a word swap for all slaves.
• synchronized void `configureStandard32BitMode` (int slaveAddr)
  Configures a slave for Standard 32-bit Register Mode.

• synchronized void `configureSingleReg32BitMode` (int slaveAddr)
  Configures all slaves for Single Register 32-bit Mode.

• synchronized void `configureCountFromOne` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with one.

• synchronized void `configureCountFromZero` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with zero.

• synchronized void `configureLittleEndianInts` (int slaveAddr)
  Disables word swapping for int data type functions on a per slave basis.

• synchronized void `configureBigEndianInts` (int slaveAddr)
  Enables int data type functions to do a word swap on a per slave basis.

• synchronized void `configureLittleEndianFloats` (int slaveAddr)
  Disables float data type functions to do a word swap on a per slave basis.

• synchronized void `configureSwappedFloats` (int slaveAddr)
  Enables float data type functions to do a word swap on a per slave basis.

6.13.1 Detailed Description

Base class which implements Modbus data and control functions. The functions provided by this base class apply to all protocol flavours via inheritance. For a more detailed description see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).

All functions have been implemented thread-safe.

See also:

Data and Control Functions for all Modbus Protocol Flavours (p. 14)
MbusRtuMasterProtocol (p. 105), MbusElamMasterProtocol (p. 55), MbusAsciiMasterProtocol (p. 32), MbusTcpMasterProtocol (p. 153)

6.13.2 Member Function Documentation

synchronized void `readCoils` (int `slaveAddr`, int `startRef`, boolean[] `bitArr`) throws IOException, BusProtocolException

Reads the contents of the discrete outputs (coils, 0:00000 table).
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.
Reads the contents of the discrete inputs (coils, 1:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
bitAddr  Coil address (Range: depends on configuration setting)
bitVal  true sets, false clears discrete output variable

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.
Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
regArr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
int32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
float32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException

Modbus function 4 (04 hex), Read Input Registers.
Read the contents of the input registers (3:00000 table).
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
regArr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException  (p. 20)  A protocol failure occurred. See descendants of BusProtocolException  (p. 20)  for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException  (p. 20)  A protocol failure occurred. See descendants of BusProtocolException  (p. 20)  for a more detailed failure list.

Note:

No broadcast supported
synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data. Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal ) throws IOException, BusProtocolException

Modbus function 6 (06 hex), Preset Single Register/Write Single Register.
Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr  Register address (Range: depends on configuration setting)
regVal  Data to be sent

Exceptions:
IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
**IllegalArgumentException**  A parameter is out of range

**BusProtocolException (p. 20)**  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**

Broadcast supported for serial protocols

```java
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException
```

Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers. Writes values into a sequence of output registers (holding registers, 4:00000 table).

**Parameters:**

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 0 - 247)
- **startRef**  Start reference (Range depends on configuration setting)
- **regArr**  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

**Exceptions:**

- **IllegalArgumentException**  A parameter is out of range
- **IOException**  An I/O error occurred
- **IllegalArgumentException**  Port or connection is closed

**BusProtocolException (p. 20)**  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**

Broadcast supported for serial protocols

```java
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException
```

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

Writes int values into a pairs of output registers (holding registers, 4:00000 table).

**Remarks:**

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.
Writes float values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void maskWriteRegister ( int slaveAddr, int regAddr, short andMask, 
short orMask ) throws IOException, BusProtocolException

Modbus function 22 (16 hex), Mask Write Register.
Masks bits according to an AND & an OR mask into a single output register (holding reg-
ister, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) 
OR (orMask AND (NOT andMask))

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255) 
regAddr Register address (Range: depends on configuration setting) 
andMask Mask to be applied as a logic AND to the register 
orMask Mask to be applied as a logic OR to the register

Exceptions:

IllegalStateException  Port or connection is closed 
IOException  An I/O error occurred 
IllegalArgumentException  A parameter is out of range 
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusPro-
ocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, 
int writeRef, short[] writeArr ) throws IOException, BusProtocolException

Modbus function 23 (17 hex), Read/Write Registers.
Combines reading and writing of the output registers in one transaction (holding registers, 
4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255) 
readRef Start reference for reading (Range: depends on configuration setting) 
readArr Buffer which will contain the data read. The length of the array determines 
how many registers are read (Range: 1-125). 
writeRef Start reference for writing (Range: depends on configuration setting) 
writeArr Buffer with data to be sent. The length of the array determines how many 
registers are sent (Range: 1-121).
Exceptions:

- **IllegalStateException**  Port or connection is closed
- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException**  A protocol failure occurred. See descendants of **BusProtocolException** for a more detailed failure list.

**Note:**

No broadcast supported

```java
synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException,
BusProtocolException
```

Modbus function 7 (07 hex), Read Exception Status.
Reads the eight exception status coils within the slave device.

**Parameters:**

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 1 - 255)

**Exceptions:**

- **IllegalStateException**  Port or connection is closed
- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException**  A protocol failure occurred. See descendants of **BusProtocolException** for a more detailed failure list.

**Note:**

No broadcast supported

```java
synchronized void setTimeout ( int timeOut )
```

Configures time-out.
This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

**Note:**

A port or connection must be closed in order to configure it.
Parameters:

\[ \textit{timeOut} \] Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

- \textit{IllegalArgumentException} Port is open
- \textit{IllegalArgumentException} Parameter is out of range

\textbf{int getTimeout ( )}

Returns the operation time-out value.

\textbf{Returns:}

Timeout value in ms

\textbf{synchronized void setPollDelay ( int \textit{pollDelay} )}

Configures poll delay.
This function sets the delay time which applies between two consecutive Modbus read-/write. A value of 0 disables the poll delay.

\textbf{Note:}

A port or connection must be closed in order to configure it.

Parameters:

\[ \textit{pollDelay} \] Delay time in ms (Range: 0 - 100000), 0 disables poll delay

Exceptions:

- \textit{IllegalArgumentException} Port is open
- \textit{IllegalArgumentException} Parameter is out of range

\textbf{int getPollDelay ( )}

Returns the poll delay time.

\textbf{Returns:}

Delay time in ms, 0 if poll delay is switched off
synchronized void setRetryCnt ( int retryCnt )

Configures the automatic retry setting.
A value of 0 disables any automatic retries.

Note:
A port or connection must be closed in order to configure it.

Parameters:

retryCnt  Retry count (Range: 0 - 10), 0 disables retries

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getRetryCnt ( )

Returns the automatic retry count.

Returns:
Retry count

synchronized long getTotalCounter ( )

Returns how often a transmit/receive cycle has been executed.

Returns:
Counter value

synchronized long getSuccessCounter ( )

Returns how often a transmit/receive cycle was successful.

Returns:
Counter value
void configureStandard32BitMode（ ）

Configures all slaves for Standard 32-bit Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Remarks:
This is the default mode

void configureSingleReg32BitMode（ ）

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

void configureCountFromOne（ ）

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:
This is the default mode

void configureCountFromZero（ ）

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

void configureLittleEndianInts（ ）

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.
void configureBigEndianInts ()

Configures int data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

void configureLittleEndianFloats ()

Disables float data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slaves also serve 32-bit floats in little little-endian word order which is the most common case.

void configureSwappedFloats ()

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

synchronized void configureStandard32BitMode ( int slaveAddr )

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.
Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode

\textbf{synchronized void configureSingleReg32BitMode ( int }\textit{slaveAddr })$

Configures all slaves for Single Register 32-bit Mode.

Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

\textbf{synchronized void configureCountFromOne ( int }\textit{slaveAddr })$

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode

\textbf{synchronized void configureCountFromZero ( int }\textit{slaveAddr })$

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:

\textit{slaveAddr} Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
synchronized void configureLittleEndianInts ( int slaveAddr )

Disables word swapping for int data type functions on a per slave basis. Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:
This is the default mode

Parameters:
- slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

synchronized void configureBigEndianInts ( int slaveAddr )

Enables int data type functions to do a word swap on a per slave basis. Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

Parameters:
- slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

synchronized void configureLittleEndianFloats ( int slaveAddr )

Disables float data type functions to do a word swap on a per slave basis. Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit floats in little little-endian word order which is the most common case.

Remarks:
This is the default mode

Parameters:
- slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
synchronized void configureSwappedFloats ( int slaveAddr )

Enables float data type functions to do a word swap on a per slave basis. The data functions operating upon 32-bit float data types can be configured to do a word swap.

**Note:**
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

**Parameters:**

*slaveAddr* Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

abstract boolean isOpen ( ) [pure virtual]

Returns whether the protocol has been opened or not (e.g. the port is opened or connected)

**Return values:**

*true* = connected

*false* = not connected

Implemented in **MbusSerialMasterProtocol** (p. 135), **MbusTcpMasterProtocol** (p. 159), and **MbusRtuOverTcpMasterProtocol** (p. ??).

### 6.14 MbusResponseException Class Reference

Modbus exception response.

Inheritance diagram for MbusResponseException:

```
BusProtocolException

MbusResponseException

MbusIllegalAddressException MbusIllegalFunctionException MbusIllegalValueException MbusSlaveFailureException
```

**Public Member Functions**

- **MbusResponseException** (byte id)
Creates a new `MbusResponseException` (p. 103) instance.

- `MbusResponseException ()`
  Creates a new `ResponseException` instance.

## Static Public Member Functions

- static long `getCounter ()`
  Returns how often this exception has been triggered.

- static void `resetCounter ()`
  Resets exception counter.

### 6.14.1 Detailed Description

Modbus exception response. Signals that a Modbus exception response was received. Exception responses are sent by a slave device instead of a normal response message if it received the query message correctly but cannot handle the query. This error usually occurs if a master queried an invalid or non-existing data address or if the master used a Modbus function which is not supported by the slave device.

See also:

- `BusProtocolException` (p. 20)

### 6.14.2 Constructor & Destructor Documentation

`MbusResponseException ( byte id )`

Creates a new `MbusResponseException` (p. 103) instance.

**Parameters:**

- `id` Exception code as reported by slave device.

### 6.14.3 Member Function Documentation

`static long getCounter ( ) [static]`

Returns how often this exception has been triggered.

**Returns:**

Counter value
Reimplemented from `BusProtocolException` (p. 21).
Reimplemented in `MbusIllegalAddressException` (p. 79), `MbusIllegalFunctionException` (p. 80), `MbusIllegalValueException` (p. 81), and `MbusSlaveFailureException` (p. 152).

### 6.15 MbusRtuMasterProtocol Class Reference

Modbus RTU Master Protocol class.

Inheritance diagram for `MbusRtuMasterProtocol`:

![Inheritance Diagram](image)

#### Public Member Functions

- **MbusRtuMasterProtocol ()**
  
  *Creates new instance.*

- synchronized void **openProtocol** (String portName, int baudRate, int dataBits, int stopBits, int parity) throws IOException, PortInUseException, UnsupportedCommOperationException

  *Opens a Modbus serial port with specific port parameters.*

- synchronized void **closeProtocol** () throws IOException

  *Closes the serial port and releases any system resources associated with the port.*

- boolean **isOpen** ()

  *Returns whether the port is open or not.*

#### Static Public Attributes

- static final int **DATABITS_8** = SerialPort.DATABITS_8

  *8 data bits*

- static final int **STOPBITS_1** = SerialPort.STOPBITS_1

  *1 stop bit*
• static final int STOPBITS_1_5 = SerialPort.STOPBITS_1_5
  1.5 stop bits

• static final int STOPBITS_2 = SerialPort.STOPBITS_2
  2 stop bits

• static final int PARITY_NONE = SerialPort.PARITY_NONE
  no parity

• static final int PARITY_ODD = SerialPort.PARITY_ODD
  odd parity

• static final int PARITY_EVEN = SerialPort.PARITY_EVEN
  even parity

• static final int PARITY_MARK = SerialPort.PARITY_MARK
  mark parity

• static final int PARITY_SPACE = SerialPort.PARITY_SPACE
  space parity

Bit Access

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

• synchronized void readCoils (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 1 (01 hex), Read Coil Status/Read Coils.

• synchronized void readInputDiscretes (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.

• synchronized void writeCoil (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
  Modbus function 5 (05 hex), Force Single Coil/Write Coil.

• synchronized void forceMultipleCoils (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  Modbus function 15 (0F hex), Force Multiple Coils.

Register Access (16-bit, 32-bit and floating point)

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)
• synchronized void **readMultipleRegisters** (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.*

• synchronized void **readMultipleRegisters** (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.*

• synchronized void **readMultipleRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.*

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  *Modbus function 4 (04 hex), Read Input Registers.*

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  *Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.*

• synchronized void **readInputRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  *Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.*

• synchronized void **writeSingleRegister** (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException
  
  *Modbus function 6 (06 hex), Preset Single Register/Write Single Register.*

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  *Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.*

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  *Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.*

• synchronized void **writeMultipleRegisters** (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  *Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.*

• synchronized void **maskWriteRegister** (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException
  
  *Modbus function 22 (16 hex), Mask Write Register.*
• synchronized void **readWriteRegisters** (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException

  *Modbus function 23 (17 hex), Read/Write Registers.*

**Diagnostics**

• synchronized byte **readExceptionStatus** (int slaveAddr) throws IOException, BusProtocolException

  *Modbus function 7 (07 hex), Read Exception Status.*

**Custom Function Codes**

• synchronized void **readHistoryLog** (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException

  *Vendor Specific Modbus function 100 (64 hex), Read History Log.*

**Protocol Configuration**

• synchronized void **setTimeout** (int timeOut)

  *Configures time-out.*

  • int **getTimeout** ()

    *Returns the operation time-out value.*

• synchronized void **setPollDelay** (int pollDelay)

  *Configures poll delay.*

  • int **getPollDelay** ()

    *Returns the poll delay time.*

• synchronized void **setRetryCnt** (int retryCnt)

  *Configures the automatic retry setting.*

  • int **getRetryCnt** ()

    *Returns the automatic retry count.*

**Transmission Statistic Functions**

• synchronized long **getTotalCounter** ()

  *Returns how often a transmit/receive cycle has been executed.*

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• synchronized void `resetTotalCounter()`  
  Resets total transmit/receive cycle counter.

• synchronized long `getSuccessCounter()`  
  Returns how often a transmit/receive cycle was successful.

• synchronized void `resetSuccessCounter()`  
  Resets successful transmit/receive counter.

**Slave Configuration**

• void `configureStandard32BitMode()`  
  Configures all slaves for Standard 32-bit Mode.

• synchronized void `configureStandard32BitMode(int slaveAddr)`  
  Configures a slave for Standard 32-bit Register Mode.

• void `configureSingleReg32BitMode()`  
  Configures all slaves for Single Register 32-bit Mode.

• synchronized void `configureSingleReg32BitMode(int slaveAddr)`  
  Configures all slaves for Single Register 32-bit Mode.

• void `configureCountFromOne()`  
  Configures the reference counting scheme to start with one for all slaves.

• synchronized void `configureCountFromOne(int slaveAddr)`  
  Configures a slave’s reference counting scheme to start with one.

• void `configureCountFromZero()`  
  Configures the reference counting scheme to start with zero for all slaves.

• synchronized void `configureCountFromZero(int slaveAddr)`  
  Configures a slave’s reference counting scheme to start with zero.

• void `configureLittleEndianInts()`  
  Disables word swapping for int data type functions for all slaves.

• synchronized void `configureLittleEndianInts(int slaveAddr)`  
  Disables word swapping for int data type functions on a per slave basis.

• void `configureBigEndianInts()`  
  Configures int data type functions to do a word swap for all slaves.

• synchronized void `configureBigEndianInts(int slaveAddr)`  
  Enables int data type functions to do a word swap on a per slave basis.
• void `configureLittleEndianFloats()`

   Disables float data type functions to do a word swap for all slaves.

• synchronized void `configureLittleEndianFloats(int slaveAddr)`

   Disables float data type functions to do a word swap on a per slave basis.

• void `configureSwappedFloats()`

   Configures float data type functions to do a word swap for all slaves.

• synchronized void `configureSwappedFloats(int slaveAddr)`

   Enables float data type functions to do a word swap on a per slave basis.

## 6.15.1 Detailed Description

Modbus RTU Master Protocol class. This class realizes the Modbus RTU master protocol. It provides functions to open and to close serial port as well as data and control functions which can be used at any time after the protocol has been opened. The data and control functions are organized different conformance classes. For a more detailed description of the data and control functions see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).

It is possible to instantiate multiple instances of this class for establishing multiple connections on different serial ports (They should be executed in separate threads).

All functions have been implemented thread-safe. It is also possible to instantiate multiple instances for establishing multiple connections on different serial ports.

Remarks:

The frame delimition of the RTU protocol leads to some practical limitations with Java: The RTU protocol is using silence periods in the data stream as start and end of frame detection. The specification determines a silence period of 3.5 character transmission times as an end of frame signal. If the combination of Java thread scheduler, the Communications API and the underlaying operating system are not able to transmit a message without a silence period, a sensitive slave will interpret the received message as garbage and not reply. The silence period for a baudrate of 115200 bps is 330 us, which is very difficult to obey for a non-real-time platform. In practical situations the RTU protocol should not be used at all in conjunction with high bit rates (e.g. above 9600 bps) and large message sizes (e.g. > 20 registers). Tests have shown that RTU is still usable with 115200 bps and message sizes below 20 registers as well as 9600 bps and message sizes of 125 registers on a Win32 platform. The behaviour depends very much on computer speed, operating system, Java virtual machine and Communication API. Therefore the usability of the RTU protocol has to be decided on a case to case basis. The ASCII protocol does not have this limitation and is therefore recommended to be used instead.

See also:

Data and Control Functions for all Modbus Protocol Flavours (p. 14), Serial Protocols (p. 15)
MbusElamMasterProtocol (p. 55), MbusAsciiMasterProtocol (p. 32), MbusTcpMasterProtocol (p. 153)

6.15.2 Member Function Documentation

synchronized void openProtocol ( String portName, int baudRate, int dataBits, int stopBits, int parity ) throws IOException, PortInUseException, UnsupportedCommOperationException

Opens a Modbus serial port with specific port parameters.
This function opens the serial port. After a port has been opened data and control functions can be used.

Note:
The default time-out for the data transfer is 1000 ms.
The default poll delay is 0 ms.
Automatic retries are switched off (retry count is 0).
The Modbus standard requires two stop bits if no parity is chosen. This library is not enforcing this but it is a recommended configuration.

Parameters:
portName Serial port identifier (e.g. "COM1", "/dev/ser1 or /dev/ttyS0")
baudRate The port baudRate in bps (typically 1200 - 9600).
dataBits Must be DATABITS_8 for RTU
stopBits STOPBITS_1: 1 stop bit, STOPBITS_1_5: 1.5 stop bits, STOPBITS_2: 2 stop bits
parity PARITY_NONE: no parity, PARITY_ODD: odd parity, PARITY_EVEN: even parity, PARITY_MARK: mark parity, PARITY_SPACE: space parity

Exceptions:
IOException An I/O error occurred
UnsupportedCommOperationException A communication parameter is not supported
PortInUseException Port is already used by somebody else
IllegalArgumentException A parameter is invalid

Reimplemented from MbusSerialMasterProtocol (p. 134).

synchronized void closeProtocol ( ) throws IOException [virtual, inherited]

Closes the serial port and releases any system resources associated with the port.
Exceptions:

*IOException*  An I/O error occurred

Implements *MbusMasterFunctions* (p. 82).

`boolean isOpen()` [virtual, inherited]

Returns whether the port is open or not.

**Return values:**

- `true` = open
- `false` = closed

Implements *MbusMasterFunctions* (p. 103).

`synchronized void readCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException [inherited]

Modbus function 1 (01 hex), Read Coil Status/Read Coils.
Reads the contents of the discrete outputs (coils, 0:00000 table).

**Parameters:**

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `startRef` Start reference (Range: depends on configuration setting)
- `bitArr` Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

**Exceptions:**

*IOException*  An I/O error occurred

*IllegalArgumentException*  A parameter is out of range

*BusProtocolException* (p. 20)  A protocol failure occurred. See descendants of *BusProtocolException* (p. 20) for a more detailed failure list.

**Note:**

No broadcast supported
synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.
Reads the contents of the discrete inputs (coils, 1:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException  [inherited]

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
bitAddr  Coil address (Range: depends on configuration setting)
bitVal  true sets, false clears discrete output variable

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
Broadcast supported for serial protocols
synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

slaveAddr   Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef    Start reference (Range: depends on configuration setting)
bitArr      Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

IllegalStateException   Port or connection is closed
IOException    An I/O error occurred
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.
Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr   Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef    Start reference (Range: depends on configuration setting)
regArr      Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException    An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
int32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
**startRef**  Start reference (Range: depends on configuration setting)

**float32Arr**  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

**IOException**  An I/O error occurred

**IllegalArgumentException**  A parameter is out of range

**BusProtocolException**  (p. 20)  A protocol failure occurred. See descendants of **BusProtocolException**  (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException  [inherited]
```

Modbus function 4 (04 hex), Read Input Registers.

Read the contents of the input registers (3:00000 table).

Parameters:

**slaveAddr**  Modbus address of slave device or unit identifier (Range: 1 - 255)

**startRef**  Start reference (Range: depends on configuration setting)

**regArr**  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

**IOException**  An I/O error occurred

**IllegalArgumentException**  A parameter is out of range

**BusProtocolException**  (p. 20)  A protocol failure occurred. See descendants of **BusProtocolException**  (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException  [inherited]
```

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.

Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.
Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal )
throws IOException, BusProtocolException [inherited]

Modbus function 6 (06 hex), Preset Single Register/Write Single Register.
Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr  Register address (Range: depends on configuration setting)
regVal  Data to be sent

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.
Writes values into a sequence of output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range depends on configuration setting)
regArr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
Broadcast supported for serial protocols
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

Writes int values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

Writes float values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
Broadcast supported for serial protocols

synchronized void maskWriteRegister ( int slaveAddr, int regAddr, short andMask, short orMask ) throws IOException, BusProtocolException  [inherited]

Modbus function 22 (16 hex), Mask Write Register.
Masks bits according to an AND & an OR mask into a single output register (holding register, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) OR (orMask AND (NOT andMask))

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
regAddr Register address (Range: depends on configuration setting)
andMask Mask to be applied as a logic AND to the register
orMask Mask to be applied as a logic OR to the register

Exceptions:

IllegalStateException Port or connection is closed
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported
synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr ) throws IOException, BusProtocolException [inherited]

Modbus function 23 (17 hex), Read/Write Registers. Combines reading and writing of the output registers in one transaction (holding registers, 4:00000 table).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
readRef Start reference for reading (Range: depends on configuration setting)
readArr Buffer which will contain the data read. The length of the array determines how many registers are read (Range: 1-125).
writeRef Start reference for writing (Range: depends on configuration setting)
writeArr Buffer with data to be sent. The length of the array determines how many registers are sent (Range: 1-121).

Exceptions:

IllegalStateException Port or connection is closed
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException, BusProtocolException [inherited]

Modbus function 7 (07 hex), Read Exception Status. Reads the eight exception status coils within the slave device.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)

Exceptions:

IllegalStateException Port or connection is closed
IOException An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void setTimeout ( int timeOut ) [inherited]

Configures time-out.
This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

Note:

A port or connection must be closed in order to configure it.

Parameters:

timeOut Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

IllegalStateException Port is open
IllegalArgumentException Parameter is out of range

int getTimeout ( ) [inherited]

Returns the operation time-out value.

Returns:

Timeout value in ms

synchronized void setPollDelay ( int pollDelay ) [inherited]

Configures poll delay.
This function sets the delay time which applies between two consecutive Modbus read/write. A value of 0 disables the poll delay.

Note:

A port or connection must be closed in order to configure it.
Parameters:

*pollDelay* Delay time in ms (Range: 0 - 100000), 0 disables poll delay

Exceptions:

*IllegalStateException* Port is open

*IllegalArgumentException* Parameter is out of range

```java
int getPollDelay() [inherited]
```

Returns the poll delay time.

**Returns:**

Delay time in ms, 0 if poll delay is switched off

```java
synchronized void setRetryCnt(int retryCnt) [inherited]
```

Configures the automatic retry setting.

A value of 0 disables any automatic retries.

**Note:**

A port or connection must be closed in order to configure it.

**Parameters:**

*retryCnt* Retry count (Range: 0 - 10), 0 disables retries

Exceptions:

*IllegalStateException* Port is open

*IllegalArgumentException* Parameter is out of range

```java
int getRetryCnt() [inherited]
```

Returns the automatic retry count.

**Returns:**

Retry count
synchronized long getTotalCounter( ) [inherited]

Returns how often a transmit/receive cycle has been executed.

Returns:
Counter value

synchronized long getSuccessCounter( ) [inherited]

Returns how often a transmit/receive cycle was successful.

Returns:
Counter value

void configureStandard32BitMode( ) [inherited]

Configures all slaves for Standard 32-bit Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Remarks:
This is the default mode

synchronized void configureStandard32BitMode( int slaveAddr ) [inherited]

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Parameters:
slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:
This is the default mode
void configureSingleReg32BitMode() [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

synchronized void configureSingleReg32BitMode(int slaveAddr) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureCountFromOne() [inherited]

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:

This is the default mode

synchronized void configureCountFromOne(int slaveAddr) [inherited]

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode
void configureCountFromZero() [inherited]

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

synchronized void configureCountFromZero ( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianInts() [inherited]

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:

This is the default mode

synchronized void configureLittleEndianInts ( int slaveAddr ) [inherited]

Disables word swapping for int data type functions on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:

This is the default mode

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
void configureBigEndianInts( ) [inherited]

Configures int data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

synchronized void configureBigEndianInts( int slaveAddr ) [inherited]

Enables int data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

Parameters:

  slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianFloats( ) [inherited]

Disables float data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slaves also serve 32-bit floats in little-endian word order which is the most common case.

Remarks:

  This is the default mode

synchronized void configureLittleEndianFloats( int slaveAddr ) [inherited]

Disables float data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit floats in little-endian word order which is the most common case.

Remarks:

  This is the default mode
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureSwappedFloats( ) [inherited]

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

synchronized void configureSwappedFloats( int slaveAddr ) [inherited]

Enables float data type functions to do a word swap on a per slave basis.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

6.16 MbussSerialMasterProtocol Class Reference

Base class for serial serial master protocols.

Inheritance diagram for MbussSerialMasterProtocol:

```
MbusMasterFunctions
  |
  -- MbussSerialMasterProtocol
     |
     -- MbussAsciiMasterProtocol
     |
     -- MbussRtuMasterProtocol
        |
        -- MbussElamMasterProtocol
```
Public Member Functions

- **MbusSerialMasterProtocol ()**
  
  Creates new instance.

- synchronized void **openProtocol** (String portName, int baudRate, int dataBits, int stopBits, int parity) throws IOException, UnsupportedCommOperationException, PortInUseException
  
  Opens a Modbus serial port with specific port parameters.

- synchronized void **closeProtocol** () throws IOException
  
  Closes the serial port and releases any system resources associated with the port.

- boolean **isOpen** ()
  
  Returns whether the port is open or not.

Static Public Attributes

- static final int **DATABITS_7** = SerialPort.DATABITS_7
  
  7 data bits

- static final int **DATABITS_8** = SerialPort.DATABITS_8
  
  8 data bits

- static final int **STOPBITS_1** = SerialPort.STOPBITS_1
  
  1 stop bit

- static final int **STOPBITS_1_5** = SerialPort.STOPBITS_1_5
  
  1.5 stop bits

- static final int **STOPBITS_2** = SerialPort.STOPBITS_2
  
  2 stop bits

- static final int **PARITY_NONE** = SerialPort.PARITY_NONE
  
  no parity

- static final int **PARITY_ODD** = SerialPort.PARITY_ODD
  
  odd parity

- static final int **PARITY_EVEN** = SerialPort.PARITY_EVEN
  
  even parity

- static final int **PARITY_MARK** = SerialPort.PARITY_MARK
  
  mark parity

- static final int **PARITY_SPACE** = SerialPort.PARITY_SPACE
  
  space parity
Bit Access

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

- synchronized void `readCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  *Modbus function 1 (01 hex), Read Coil Status/Read Coils.*

- synchronized void `readInputDiscretes` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  *Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.*

- synchronized void `writeCoil` (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
  
  *Modbus function 5 (05 hex), Force Single Coil/Write Coil.*

- synchronized void `forceMultipleCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  *Modbus function 15 (0F hex), Force Multiple Coils.*

Register Access (16-bit, 32-bit and floating point)

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.*

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.*

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  *Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.*

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  *Modbus function 4 (04 hex), Read Input Registers.*

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  *Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.*
• synchronized void `readInputRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException

   *Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.*

• synchronized void `writeSingleRegister` (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException

   *Modbus function 6 (06 hex), Preset Single Register/Write Single Register.*

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException

   *Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.*

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException

   *Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.*

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException

   *Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.*

• synchronized void `maskWriteRegister` (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException

   *Modbus function 22 (16 hex), Mask Write Register.*

• synchronized void `readWriteRegisters` (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException

   *Modbus function 23 (17 hex), Read/Write Registers.*

**Diagnostics**

• synchronized byte `readExceptionStatus` (int slaveAddr) throws IOException, BusProtocolException

   *Modbus function 7 (07 hex), Read Exception Status.*

**Custom Function Codes**

• synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException

   *Vendor Specific Modbus function 100 (64 hex), Read History Log.*
Protocol Configuration

- `synchronized void setTimeout (int timeOut)`
  Configures time-out.

- `int getTimeout ()`
  Returns the operation time-out value.

- `synchronized void setPollDelay (int pollDelay)`
  Configures poll delay.

- `int getPollDelay ()`
  Returns the poll delay time.

- `synchronized void setRetryCnt (int retryCnt)`
  Configures the automatic retry setting.

- `int getRetryCnt ()`
  Returns the automatic retry count.

Transmission Statistic Functions

- `synchronized long getTotalCounter ()`
  Returns how often a transmit/receive cycle has been executed.

- `synchronized void resetTotalCounter ()`
  Resets total transmit/receive cycle counter.

- `synchronized long getSuccessCounter ()`
  Returns how often a transmit/receive cycle was successful.

- `synchronized void resetSuccessCounter ()`
  Resets successful transmit/receive counter.

Slave Configuration

- `void configureStandard32BitMode ()`
  Configures all slaves for Standard 32-bit Mode.

- `synchronized void configureStandard32BitMode (int slaveAddr)`
  Configures a slave for Standard 32-bit Register Mode.

- `void configureSingleReg32BitMode ()`
  Configures all slaves for Single Register 32-bit Mode.
• synchronized void `configureSingleReg32BitMode` (int slaveAddr)
  Configures all slaves for Single Register 32-bit Mode.

• void `configureCountFromOne` ()
  Configures the reference counting scheme to start with one for all slaves.

• synchronized void `configureCountFromOne` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with one.

• void `configureCountFromZero` ()
  Configures the reference counting scheme to start with zero for all slaves.

• synchronized void `configureCountFromZero` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with zero.

• void `configureLittleEndianInts` ()
  Disables word swapping for int data type functions for all slaves.

• synchronized void `configureLittleEndianInts` (int slaveAddr)
  Disables word swapping for int data type functions on a per slave basis.

• void `configureBigEndianInts` ()
  Configures int data type functions to do a word swap for all slaves.

• synchronized void `configureBigEndianInts` (int slaveAddr)
  Enables int data type functions to do a word swap on a per slave basis.

• void `configureLittleEndianFloats` ()
  Disables float data type functions to do a word swap for all slaves.

• synchronized void `configureLittleEndianFloats` (int slaveAddr)
  Disables float data type functions to do a word swap on a per slave basis.

• void `configureSwappedFloats` ()
  Configures float data type functions to do a word swap for all slaves.

• synchronized void `configureSwappedFloats` (int slaveAddr)
  Enables float data type functions to do a word swap on a per slave basis.

### 6.16.1 Detailed Description

Base class for serial master protocols. This base class realises the Modbus serial master protocols. It provides functions to open and to close serial port as well as data and control functions which can be used at any time after the protocol has been opened. The data and control functions are organized different conformance classes. For a more detailed
description of the data and control functions see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).

It is possible to instantiate multiple instances for establishing multiple connections on different serial ports (They should be executed in separate threads).

All functions have been implemented thread-safe. It is also possible to instantiate multiple instances for establishing multiple connections on different serial ports.

See also:
Data and Control Functions for all Modbus Protocol Flavours (p. 14), Serial Protocols (p. 15)
MbusRtuMasterProtocol (p. 105), MbusElamMasterProtocol (p. 55), MbusAsciiMasterProtocol (p. 32), MbusTcpMasterProtocol (p. 153)

6.16.2 Member Function Documentation

synchronized void openProtocol ( String portName, int baudRate, int dataBits, int stopBits, int parity ) throws IOException, UnsupportedCommOperationException, PortInUseException

Opens a Modbus serial port with specific port parameters.

This function opens the serial port. After a port has been opened data and control functions can be used.

Note:
The default time-out for the data transfer is 1000 ms.
The default poll delay is 0 ms.
Automatic retries are switched off (retry count is 0).
The Modbus standard requires two stop bits if no parity is chosen. This library is not enforcing this but it is a recommended configuration.

Parameters:

portName Serial port identifier (e.g. "COM1", "/dev/ser1 or /dev/ttyS0")
baudRate The port baudRate in bps (typically 1200 - 19200)
dataBits DATABITS_7: 7 data bits (ASCII protocol only), DATABITS_8: data bits
stopBits STOPBITS_1: 1 stop bit, STOPBITS_1_5: 1.5 stop bits, STOPBITS_2: 2 stop bits
parity PARITY_NONE: no parity, PARITY_ODD: odd parity, PARITY_EVEN: even parity, PARITY_MARK: mark parity, PARITY_SPACE: space parity

Exceptions:

IOException An I/O error occurred
UnsupportedCommOperationException A communication parameter is not supported
**PortInUseException**  Port is already used by somebody else

**IllegalArgumentException**  A parameter is invalid

Reimplemented in `MbusAsciiMasterProtocol` (p. 37), and `MbusRtuMasterProtocol` (p. 111).

```java
synchronized void closeProtocol() throws IOException [virtual]
```

Closes the serial port and releases any system resources associated with the port.

**Exceptions:**

**IOException**  An I/O error occurred

Implements `MbusMasterFunctions` (p. 82).

```java
boolean isOpen() [virtual]
```

Returns whether the port is open or not.

**Return values:**

- `true` = open
- `false` = closed

Implements `MbusMasterFunctions` (p. 103).

```java
synchronized void readCoils(int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException [inherited]
```

Modbus function 1 (01 hex), Read Coil Status/Read Coils.

Reads the contents of the discrete outputs (coils, 0:00000 table).

**Parameters:**

- `slaveAddr`  Modbus address of slave device or unit identifier (Range: 1 - 255)
- `startRef`  Start reference (Range: depends on configuration setting)
- `bitArr`  Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

**Exceptions:**

**IOException**  An I/O error occurred
IllegalArgumentException  A parameter is out of range

BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.
Reads the contents of the discrete inputs (coils, 1:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
bitArr  Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range

BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException  [inherited]

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
bitAddr  Coil address (Range: depends on configuration setting)
bitVal  true sets, false clears discrete output variable
Exceptions:

- `IllegalStateException` Port or connection is closed
- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException (p. 20)` A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `startRef` Start reference (Range: depends on configuration setting)
- `bitArr` Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

- `IllegalStateException` Port or connection is closed
- `IOException` An I/O error occurred
- `BusProtocolException (p. 20)` A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.
Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)

regArr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException An I/O error occurred

IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.

Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)

startRef Start reference (Range: depends on configuration setting)

int32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException An I/O error occurred

IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:0000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException  A protocol failure occurred. See descendants of BusProtocolException for a more detailed failure list.

Note:
No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex), Read Input Registers.
Read the contents of the input registers (3:0000 table).

Parameters:
slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
regArr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:
IOException  An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException [inherited]

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef Start reference (Range: depends on configuration setting)
int32Arr Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException An I/O error occurred
IllegalArgumentException A parameter is out of range

BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr )
throws IOException, BusProtocolException [inherited]

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.
Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive
16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef   Start reference (Range: depends on configuration setting)
float32Arr Buffer which will be filled with the data read. The length of the array
determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusPro-
tocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal )
throws IOException, BusProtocolException  [inherited]

Modbus function 6 (06 hex), Preset Single Register/Write Single Register.
Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr   Register address (Range: depends on configuration setting)
regVal    Data to be sent

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusPro-
tocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException  [inherited]

Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers. Writes values into a sequence of output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range depends on configuration setting)
regArr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException  [inherited]

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data. Writes int values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occurred
**IllegalArgumentException** A parameter is out of range

**BusProtocolException (p. 20)** A protocol failure occured. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**
Broadcast supported for serial protocols

```java
synchronized void writeMultipleRegisters(int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
```

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

Writes float values into a pairs of output registers (holding registers, 4:00000 table).

**Remarks:**
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

**Parameters:**
- **slaveAddr** Modbus address of slave device or unit identifier (Range: 0 - 247)
- **startRef** Start reference (Range: depends on configuration setting)
- **float32Arr** Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

**Exceptions:**
- **IOException** An I/O error occured
- **IllegalArgumentException** A parameter is out of range
- **BusProtocolException (p. 20)** A protocol failure occured. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**
Broadcast supported for serial protocols

```java
synchronized void maskWriteRegister(int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException
```

Modbus function 22 (16 hex), Mask Write Register.

Masks bits according to an AND & an OR mask into a single output register (holding register, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) OR (orMask AND (NOT andMask))
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
regAddr   Register address (Range: depends on configuration setting)
andMask  Mask to be applied as a logic AND to the register
orMask   Mask to be applied as a logic OR to the register

Exceptions:

IllegalStateException  Port or connection is closed
IOException           An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException   A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr ) throws IOException, BusProtocolException
[inherited]

Modbus function 23 (17 hex), Read/Write Registers.
Combines reading and writing of the output registers in one transaction (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
readRef   Start reference for reading (Range: depends on configuration setting)
readArr   Buffer which will contain the data read. The length of the array determines how many registers are read (Range: 1-125).
writeRef  Start reference for writing (Range: depends on configuration setting)
writeArr  Buffer with data to be sent. The length of the array determines how many registers are sent (Range: 1-121).

Exceptions:

IllegalStateException  Port or connection is closed
IOException           An I/O error occurred
IllegalArgumentException A parameter is out of range
BusProtocolException   A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException, BusProtocolException [inherited]

Modbus function 7 (07 hex), Read Exception Status.
Reads the eight exception status coils within the slave device.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

No broadcast supported

synchronized void setTimeout ( int timeOut ) [inherited]

Configures time-out.
This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

Note:

A port or connection must be closed in order to configure it.

Parameters:

timeOut  Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getTimeout ( ) [inherited]

Returns the operation time-out value.
Returns:

Timeout value in ms

```java
synchronized void setPollDelay ( int pollDelay ) [inherited]
```

Configures poll delay.
This function sets the delay time which applies between two consecutive Modbus read/write. A value of 0 disables the poll delay.

**Note:**
A port or connection must be closed in order to configure it.

**Parameters:**

- `pollDelay` Delay time in ms (Range: 0 - 100000), 0 disables poll delay

**Exceptions:**

- `IllegalStateException` Port is open
- `IllegalArgumentException` Parameter is out of range

```java
int getPollDelay ( ) [inherited]
```

Returns the poll delay time.

**Returns:**

Delay time in ms, 0 if poll delay is switched off

```java
synchronized void setRetryCnt ( int retryCnt ) [inherited]
```

Configures the automatic retry setting.
A value of 0 disables any automatic retries.

**Note:**
A port or connection must be closed in order to configure it.

**Parameters:**

- `retryCnt` Retry count (Range: 0 - 10), 0 disables retries
Exceptions:

- `IllegalStateException` Port is open
- `IllegalArgumentException` Parameter is out of range

`int getRetryCnt() [inherited]`

Returns the automatic retry count.

**Returns:**
- Retry count

`synchronized long getTotalCounter() [inherited]`

Returns how often a transmit/receive cycle has been executed.

**Returns:**
- Counter value

`synchronized long getSuccessCounter() [inherited]`

Returns how often a transmit/receive cycle was successful.

**Returns:**
- Counter value

`void configureStandard32BitMode() [inherited]`

Configures all slaves for Standard 32-bit Mode.

In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

**Remarks:**
- This is the default mode
synchronized void configureStandard32BitMode ( int slaveAddr ) [inherited]

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode

void configureSingleReg32BitMode ( ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

synchronized void configureSingleReg32BitMode ( int slaveAddr ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one 32-bit Modbus register instead of two 16-bit registers.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureCountFromOne ( ) [inherited]

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:

This is the default mode
synchronized void configureCountFromOne ( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode

void configureCountFromZero ( ) [inherited]

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

synchronized void configureCountFromZero ( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianInts ( ) [inherited]

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in in little-endian word order.

Remarks:

This is the default mode
synchronized void configureLittleEndianInts ( int slaveAddr ) [inherited]

Disables word swapping for int data type functions on a per slave basis. Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

**Remarks:**

This is the default mode

**Parameters:**

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureBigEndianInts ( ) [inherited]

Configures int data type functions to do a word swap for all slaves. Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

synchronized void configureBigEndianInts ( int slaveAddr ) [inherited]

Enables int data type functions to do a word swap on a per slave basis. Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

**Parameters:**

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianFloats ( ) [inherited]

Disables float data type functions to do a word swap for all slaves. Modbus is using little-endian word order for 32-bit values. This setting assumes that the slaves also serves 32-bit floats in little little-endian word order which is the most common case.

**Remarks:**

This is the default mode
synchronized void configureLittleEndianFloats ( int slaveAddr ) [inherited]

Disables float data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the
slave also serves 32-bit floats in little little-endian word order which is the most common
case.

Remarks:

This is the default mode

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

void configureSwappedFloats( ) [inherited]

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word
swap.

Note:

Most platforms store floats in IEEE 754 little-endian order which does not need a word
swap.

synchronized void configureSwappedFloats ( int slaveAddr ) [inherited]

Enables float data type functions to do a word swap on a per slave basis.
The data functions operating upon 32-bit float data types can be configured to do a word
swap.

Note:

Most platforms store floats in IEEE 754 little-endian order which does not need a word
swap.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.
6.17 MbusSlaveFailureException Class Reference

Slave Device Failure exception response.

Inheritance diagram for MbusSlaveFailureException:

```
BusProtocolException

MbusResponseException

MbusSlaveFailureException
```

Public Member Functions

- `MbusSlaveFailureException()`
  
  Constructs a `MbusSlaveFailureException` (p. 152).

Static Public Member Functions

- `static long getCounter()`
  
  Returns how often this exception has been triggered.

- `static void resetCounter()`
  
  Resets exception counter.

6.17.1 Detailed Description

Slave Device Failure exception response. Signals that a Slave Device Failure exception response (code 04) was received. This exception response is sent by a slave device instead of a normal response message if an unrecoverable error occurred while processing the requested action. This response is also sent if the request would generate a response whose size exceeds the allowable data size.

See also:

  MbusResponseException (p. 103)

6.17.2 Member Function Documentation

```java
class MbusSlaveFailureException {
    static long getCounter() {
        // Returns how often this exception has been triggered.
    }
}
```

Returns how often this exception has been triggered.
Returns:
Counter value

Reimplemented from `MbusResponseException` (p. 104).

### 6.18 MbusTcpMasterProtocol Class Reference

MODBUS/TCP Master Protocol class.

Inheritance diagram for `MbusTcpMasterProtocol`:

```
MbusTcpMasterProtocol
  └── MbusMasterFunctions
```

#### Public Member Functions

- `synchronized void openProtocol(String hostName) throws IOException`
  Connects to a MODBUS/TCP slave.

- `synchronized void closeProtocol() throws IOException`
  Closes a TCP/IP connection to a MODBUS/TCP slave and releases any system resources associated with the connection.

- `synchronized void setPort(int portNo)`
  Sets the TCP port number to be used by the protocol.

- `int getPort()`
  Returns the TCP port number used by the protocol.

- `boolean isOpen()`
  Returns whether currently connected or not.

#### Protected Attributes

- `int portNo = 502`
  TCP port number, defaults to 502.

#### Advantec ADAM 5000/6000 Series Commands

- `String adamSendReceiveAsciiCmd(String commandStr) throws IOException, BusProtocolException`

---

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Send/Receive ADAM 5000/6000 ASCII command.

**Bit Access**

Table 0:00000 (Coils) and Table 1:0000 (Input Status)

- synchronized void `readCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  Modbus function 1 (01 hex), Read Coil Status/Read Coils.

- synchronized void `readInputDiscretes` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes.

- synchronized void `writeCoil` (int slaveAddr, int bitAddr, boolean bitVal) throws IOException, BusProtocolException
  
  Modbus function 5 (05 hex), Force Single Coil/Write Coil.

- synchronized void `forceMultipleCoils` (int slaveAddr, int startRef, boolean[] bitArr) throws IOException, BusProtocolException
  
  Modbus function 15 (0F hex), Force Multiple Coils.

**Register Access (16-bit, 32-bit and floating point)**

Table 4:00000 (Holding Registers) and Table 3:00000 (Input Registers)

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.

- synchronized void `readMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException
  
  Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException
  
  Modbus function 4 (04 hex), Read Input Registers.

- synchronized void `readInputRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException
• synchronized void `readInputRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException

    Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.

• synchronized void `writeSingleRegister` (int slaveAddr, int regAddr, short regVal) throws IOException, BusProtocolException

    Modbus function 6 (06 hex), Preset Single Register/Write Single Register.

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, short[] regArr) throws IOException, BusProtocolException

    Modbus function 16 (10 hex), Preset Multiple Registers/Write Multiple Registers.

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, int[] int32Arr) throws IOException, BusProtocolException

    Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

• synchronized void `writeMultipleRegisters` (int slaveAddr, int startRef, float[] float32Arr) throws IOException, BusProtocolException

    Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

• synchronized void `maskWriteRegister` (int slaveAddr, int regAddr, short andMask, short orMask) throws IOException, BusProtocolException

    Modbus function 22 (16 hex), Mask Write Register.

• synchronized void `readWriteRegisters` (int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr) throws IOException, BusProtocolException

    Modbus function 23 (17 hex), Read/Write Registers.

**Diagnostics**

• synchronized byte `readExceptionStatus` (int slaveAddr) throws IOException, BusProtocolException

    Modbus function 7 (07 hex), Read Exception Status.

**Custom Function Codes**

• synchronized void `readHistoryLog` (int slaveAddr, int channelNo, int resolution, short readArr[]) throws IOException, BusProtocolException

    Vendor Specific Modbus function 100 (64 hex), Read History Log.
Protocol Configuration

- **synchronized void** `setTimeout` *(int timeOut)*
  
  Configures time-out.

- **int** `getTimeout` *
  
  Returns the operation time-out value.

- **synchronized void** `setPollDelay` *(int pollDelay)*
  
  Configures poll delay.

- **int** `getPollDelay` *
  
  Returns the poll delay time.

- **synchronized void** `setRetryCnt` *(int retryCnt)*
  
  Configures the automatic retry setting.

- **int** `getRetryCnt` *
  
  Returns the automatic retry count.

Transmission Statistic Functions

- **synchronized long** `getTotalCounter` *
  
  Returns how often a transmit/receive cycle has been executed.

- **synchronized void** `resetTotalCounter` *
  
  Resets total transmit/receive cycle counter.

- **synchronized long** `getSuccessCounter` *
  
  Returns how often a transmit/receive cycle was successful.

- **synchronized void** `resetSuccessCounter` *
  
  Resets successful transmit/receive counter.

Slave Configuration

- **void** `configureStandard32BitMode` *
  
  Configures all slaves for Standard 32-bit Mode.

- **synchronized void** `configureStandard32BitMode` *(int slaveAddr)*
  
  Configures a slave for Standard 32-bit Register Mode.

- **void** `configureSingleReg32BitMode` *
  
  Configures all slaves for Single Register 32-bit Mode.
• synchronized void `configureSingleReg32BitMode` (int slaveAddr)
  Configures all slaves for Single Register 32-bit Mode.

• void `configureCountFromOne`()
  Configures the reference counting scheme to start with one for all slaves.

• synchronized void `configureCountFromOne` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with one.

• void `configureCountFromZero`()
  Configures the reference counting scheme to start with zero for all slaves.

• synchronized void `configureCountFromZero` (int slaveAddr)
  Configures a slave’s reference counting scheme to start with zero.

• void `configureLittleEndianInts`()
  Disables word swapping for int data type functions for all slaves.

• synchronized void `configureLittleEndianInts` (int slaveAddr)
  Disables word swapping for int data type functions on a per slave basis.

• void `configureBigEndianInts`()
  Configures int data type functions to do a word swap for all slaves.

• synchronized void `configureBigEndianInts` (int slaveAddr)
  Enables int data type functions to do a word swap on a per slave basis.

• void `configureLittleEndianFloats`()
  Disables float data type functions to do a word swap for all slaves.

• synchronized void `configureLittleEndianFloats` (int slaveAddr)
  Disables float data type functions to do a word swap on a per slave basis.

• void `configureSwappedFloats`()
  Configures float data type functions to do a word swap for all slaves.

• synchronized void `configureSwappedFloats` (int slaveAddr)
  Enables float data type functions to do a word swap on a per slave basis.

### 6.18.1 Detailed Description

MODBUS/TCP Master Protocol class. This class realizes the MODBUS/TCP master protocol. It provides functions to establish and to close a TCP/IP connection to the slave as well as data and control functions which can be used after a connection to a slave device has been established successfully. The data and control functions are organized different
conformance classes. For a more detailed description of the data and control functions see section Data and Control Functions for all Modbus Protocol Flavours (p. 14).
It is also possible to instantiate multiple instances of this class for establishing multiple connections to either the same or different hosts.
All functions have been implemented thread-safe. It is also possible to instantiate multiple instances for establishing multiple connections to either the same or different hosts.

See also:

Data and Control Functions for all Modbus Protocol Flavours (p. 14), TCP/IP Protocols (p. 16), MbusRtuMasterProtocol (p. 105), MbusElamMasterProtocol (p. 55), MbusAsciiMasterProtocol (p. 32)

6.18.2 Member Function Documentation

synchronized void openProtocol ( String hostName ) throws IOException

Connects to a MODBUS/TCP slave.
This function establishes a logical network connection between master and slave. After a connection has been established data and control functions can be used. A TCP/IP connection should be closed if it is no longer needed.

Note:

The default time-out for the connection is 1000 ms.
The default TCP port number is 502.

Parameters:

hostName String with IP address or host name

Exceptions:

IOException An I/O error occurred
ConnectException Connection refused by remote, no service listening
BindException Remote port in use
NoRouteToHostException No route to host
UnknownHostException Unknown host, e.g. wrong IP address or name
SecurityException Security violation

Note:

Java 1.4 or higher is needed for connection time-out to work otherwise the system’s default time-out value will be used for connections.
synchronized void closeProtocol() throws IOException [virtual]

Closes a TCP/IP connection to a MODBUS/TCP slave and releases any system resources associated with the connection.

Exceptions:

- IOException: An I/O error occurred

Implements MbusMasterFunctions (p. 82).

synchronized void setPort(int portNo)

Sets the TCP port number to be used by the protocol.

Remarks:

Usually the port number remains unchanged and defaults to 502. In this case no call to this function is necessary. However if the port number has to be different from 502 this function must be called before opening the connection with openConnection().

Parameters:

- portNo: Port number to be used when opening the connection (Range: 0 - 0xFFFF)

Exceptions:

- IllegalStateException: Connection is open
- IllegalArgumentException: Parameter is out of range

int getPort()

Returns the TCP port number used by the protocol.

Returns:

Port number used by the protocol

boolean isOpen() [virtual]

Returns whether currently connected or not.
Return values:

\[true\] = connected
\[false\] = not connected

Implements **MbusMasterFunctions** (p. 103).

```java
synchronized void readCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException [inherited]
```

Modbus function 1 (01 hex), Read Coil Status/Read Coils. Reads the contents of the discrete outputs (coils, 0:00000 table).

**Parameters:**

- **slaveAddr** Modbus address of slave device or unit identifier (Range: 1 - 255)
- **startRef** Start reference (Range: depends on configuration setting)
- **bitArr** Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).

**Exceptions:**

- **IOException** An I/O error occurred
- **IllegalArgumentException** A parameter is out of range
- **BusProtocolException** (p. 20) A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

**Note:**

No broadcast supported

```java
synchronized void readInputDiscretes ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException [inherited]
```

Modbus function 2 (02 hex), Read Inputs Status/Read Input Discretes. Reads the contents of the discrete inputs (coils, 1:00000 table).

**Parameters:**

- **slaveAddr** Modbus address of slave device or unit identifier (Range: 1 - 255)
- **startRef** Start reference (Range: depends on configuration setting)
- **bitArr** Buffer which will contain the data read. The length of the array determines how many coils are read (Range: 1-2000).
Exceptions:

- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException** (p. 20)  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void writeCoil ( int slaveAddr, int bitAddr, boolean bitVal ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 5 (05 hex), Force Single Coil/Write Coil.
Sets a single discrete output variable (coil, 0:00000 table) to either ON or OFF.

Parameters:

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 0 - 247)
- **bitAddr**  Coil address (Range: depends on configuration setting)
- **bitVal**  true sets, false clears discrete output variable

Exceptions:

- **IllegalStateException**  Port or connection is closed
- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException** (p. 20)  A protocol failure occurred. See descendants of **BusProtocolException** (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void forceMultipleCoils ( int slaveAddr, int startRef, boolean[] bitArr ) throws IOException, BusProtocolException  [inherited]
```

Modbus function 15 (0F hex), Force Multiple Coils.
Writes binary values into a sequence of discrete outputs (coils, 0:00000 table).

Parameters:

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 1 - 255)
**startRef**  Start reference (Range: depends on configuration setting)

**bitArr**  Buffer which contains the data to be sent. The length of the array determines how many coils are written (Range: 1-1968).

Exceptions:

- **IllegalStateException**  Port or connection is closed
- **IOException**  An I/O error occurred
- **BusProtocolException**  A protocol failure occurred. See descendants of **BusProtocolException** for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, short[] regArr ) throws IOException, BusProtocolException [inherited]
```

Modbus function 3 (03 hex), Read Holding Registers/Read Multiple Registers.
Reads the contents of the output registers (holding registers, 4:00000 table).

Parameters:

- **slaveAddr**  Modbus address of slave device or unit identifier (Range: 1 - 255)
- **startRef**  Start reference (Range: depends on configuration setting)
- **regArr**  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

- **IOException**  An I/O error occurred
- **IllegalArgumentException**  A parameter is out of range
- **BusProtocolException**  A protocol failure occurred. See descendants of **BusProtocolException** for a more detailed failure list.

Note:

No broadcast supported

```java
synchronized void readMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]
```

Modbus function 3 (03 hex) for 32-bit int data types, Read Holding Registers/Read Multiple Registers as int data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.
Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException  A protocol failure occurred. See descendants of BusProtocolException for a more detailed failure list.

Note:
No broadcast supported

synchronized void readMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 3 (03 hex) for 32-bit float data types, Read Holding Registers/Read Multiple Registers as float data.
Reads the contents of pairs of two consecutive output registers (holding registers, 4:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
float32Arr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex), Read Input Registers.
Read the contents of the input registers (3:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
startRef  Start reference (Range: depends on configuration setting)
regArr  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-125).

Exceptions:

IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20) A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void readInputRegisters ( int slaveAddr, int startRef, int[] int32Arr )
throws IOException, BusProtocolException  [inherited]

Modbus function 4 (04 hex) for 32-bit int data types, Read Input Registers as int data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

Remarks:
Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
**startRef**  Start reference (Range: depends on configuration setting)

*int32Arr*  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

**Exceptions:**

*IOException*  An I/O error occurred  

*IllegalArgumentException*  A parameter is out of range  

*BusProtocolException*  A protocol failure occurred. See descendants of *BusProtocolException* for a more detailed failure list.

**Note:**

No broadcast supported

```java
class ModbusProtocol
```

**synchronized void readInputRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException** [inherited]

Modbus function 4 (04 hex) for 32-bit float data types, Read Input Registers as float data.
Reads the contents of pairs of two consecutive input registers (3:00000 table) into float values.

**Remarks:**

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

**Parameters:**

*slaveAddr*  Modbus address of slave device or unit identifier (Range: 1 - 255)  

*startRef*  Start reference (Range: depends on configuration setting)  

*float32Arr*  Buffer which will be filled with the data read. The length of the array determines how many registers are read (Range: 1-62).

**Exceptions:**

*IOException*  An I/O error occurred  

*IllegalArgumentException*  A parameter is out of range  

*BusProtocolException*  A protocol failure occurred. See descendants of *BusProtocolException* for a more detailed failure list.

**Note:**

No broadcast supported
synchronized void writeSingleRegister ( int slaveAddr, int regAddr, short regVal )
throws IOException, BusProtocolException  [inherited]

Modbus function 6 (06 hex), Preset Single Register / Write Single Register.
Writes a value into a single output register (holding register, 4:00000 reference).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
regAddr  Register address (Range: depends on configuration setting)
regVal  Data to be sent

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, short[] regArr )
throws IOException, BusProtocolException  [inherited]

Modbus function 16 (10 hex), Preset Multiple Registers / Write Multiple Registers.
Writes values into a sequence of output registers (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range depends on configuration setting)
regArr  Buffer with the data to be sent. The length of the array determines how many
registers are sent (Range: 1-61).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols
synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, int[] int32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit int data types, Preset Multiple Registers/Write Multiple Registers with int data.

Writes int values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
int32Arr  Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

IOException  An I/O error occured
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occured. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

synchronized void writeMultipleRegisters ( int slaveAddr, int startRef, float[] float32Arr ) throws IOException, BusProtocolException [inherited]

Modbus function 16 (10 hex) for 32-bit float data types, Preset Multiple Registers/Write Multiple Registers with float data.

Writes float values into a pairs of output registers (holding registers, 4:00000 table).

Remarks:

Depending on the 32-bit Mode setting, an int will be transferred as two consecutive 16-bit registers (Standard) or as one 32-bit register (Daniel/Enron).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 0 - 247)
startRef  Start reference (Range: depends on configuration setting)
Buffer with the data to be sent. The length of the array determines how many registers are sent (Range: 1-61).

Exceptions:

- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException` (p. 20) A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

Broadcast supported for serial protocols

```java
synchronized void maskWriteRegister ( int slaveAddr, int regAddr, short andMask, short orMask ) throws IOException, BusProtocolException [inherited]
```

Modbus function 22 (16 hex), Mask Write Register.

Masks bits according to an AND & an OR mask into a single output register (holding register, 4:00000 reference). Masking is done as follows: result = (currentVal AND andMask) OR (orMask AND (NOT andMask))

Parameters:

- `slaveAddr` Modbus address of slave device or unit identifier (Range: 1 - 255)
- `regAddr` Register address (Range: depends on configuration setting)
- `andMask` Mask to be applied as a logic AND to the register
- `orMask` Mask to be applied as a logic OR to the register

Exceptions:

- `IllegalStateException` Port or connection is closed
- `IOException` An I/O error occurred
- `IllegalArgumentException` A parameter is out of range
- `BusProtocolException` (p. 20) A protocol failure occurred. See descendants of `BusProtocolException` (p. 20) for a more detailed failure list.

Note:

No broadcast supported
synchronized void readWriteRegisters ( int slaveAddr, int readRef, short[] readArr, int writeRef, short[] writeArr ) throws IOException, BusProtocolException [inherited]

Modbus function 23 (17 hex), Read/Write Registers.
Combines reading and writing of the output registers in one transaction (holding registers, 4:00000 table).

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)
readRef  Start reference for reading (Range: depends on configuration setting)
readArr  Buffer which will contain the data read. The length of the array determines how many registers are read (Range: 1-125).
writeRef  Start reference for writing (Range: depends on configuration setting)
writeArr  Buffer with data to be sent. The length of the array determines how many registers are sent (Range: 1-121).

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range
BusProtocolException (p. 20)  A protocol failure occurred. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized byte readExceptionStatus ( int slaveAddr ) throws IOException, BusProtocolException  [inherited]

Modbus function 7 (07 hex), Read Exception Status.
Reads the eight exception status coils within the slave device.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255)

Exceptions:

IllegalStateException  Port or connection is closed
IOException  An I/O error occurred
IllegalArgumentException  A parameter is out of range

BusProtocolException (p. 20)  A protocol failure occured. See descendants of BusProtocolException (p. 20) for a more detailed failure list.

Note:
No broadcast supported

synchronized void setTimeout ( int timeOut ) [inherited]

Configures time-out.
This function sets the time-out to the specified value. A value of 0 disables the time-out, which causes all subsequent calls to data and control functions to block.

Note:
A port or connection must be closed in order to configure it.

Parameters:

timeOut  Timeout value in ms (Range: 0 - 100000), 0 disables time-out

Exceptions:

IllegalStateException  Port is open

IllegalArgumentException  Parameter is out of range

int getTimeout ( ) [inherited]

Returns the operation time-out value.

Returns:
Timeout value in ms

synchronized void setPollDelay ( int pollDelay ) [inherited]

Configures poll delay.
This function sets the delay time which applies between two consecutive Modbus read/write. A value of 0 disables the poll delay.

Note:
A port or connection must be closed in order to configure it.
Parameters:

pollDelay  Delay time in ms (Range: 0 - 100000), 0 disables poll delay

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getPollDelay() [inherited]

Returns the poll delay time.

Returns:

Delay time in ms, 0 if poll delay is switched off

synchronized void setRetryCnt(int retryCnt) [inherited]

Configures the automatic retry setting.
A value of 0 disables any automatic retries.

Note:
A port or connection must be closed in order to configure it.

Parameters:

retryCnt  Retry count (Range: 0 - 10), 0 disables retries

Exceptions:

IllegalStateException  Port is open
IllegalArgumentException  Parameter is out of range

int getRetryCnt() [inherited]

Returns the automatic retry count.

Returns:

Retry count
synchronized long getTotalCounter( ) [inherited]

Returns how often a transmit/receive cycle has been executed.

Returns:
  Counter value

synchronized long getSuccessCounter( ) [inherited]

Returns how often a transmit/receive cycle was successful.

Returns:
  Counter value

void configureStandard32BitMode( ) [inherited]

Configures all slaves for Standard 32-bit Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Remarks:
  This is the default mode

synchronized void configureStandard32BitMode( int slaveAddr ) [inherited]

Configures a slave for Standard 32-bit Register Mode.
In Standard 32-bit Register Mode a 32-bit value is transmitted as two consecutive 16-bit Modbus registers.

Parameters:
  slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

Remarks:
  This is the default mode
void configureSingleReg32BitMode ( ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one
32-bit Modbus register instead of two 16-bit registers.

synchronized void configureSingleReg32BitMode ( int slaveAddr ) [inherited]

Configures all slaves for Single Register 32-bit Mode.
Some Modbus flavours like the Daniel/Enron protocol represent a 32-bit value using one
32-bit Modbus register instead of two 16-bit registers.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

void configureCountFromOne ( ) [inherited]

Configures the reference counting scheme to start with one for all slaves.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Remarks:

This is the default mode

synchronized void configureCountFromOne ( int slaveAddr ) [inherited]

Configures a slave’s reference counting scheme to start with one.
This renders the reference range to be 1 to 0x10000 and register #0 is an illegal register.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value
of zero configures the behaviour for broadcasting.

Remarks:

This is the default mode
void configureCountFromZero() [inherited]

Configures the reference counting scheme to start with zero for all slaves.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.
This renders the first register to be #0 for all slaves.

synchronized void configureCountFromZero(int slaveAddr) [inherited]

Configures a slave’s reference counting scheme to start with zero.
This is also known as PDU addressing.
This renders the valid reference range to be 0 to 0xFFFF.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianInts() [inherited]

Disables word swapping for int data type functions for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:
This is the default mode

synchronized void configureLittleEndianInts(int slaveAddr) [inherited]

Disables word swapping for int data type functions on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit data in little little-endian word order.

Remarks:
This is the default mode

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.
void configureBigEndianInts( ) [inherited]

Configures int data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

synchronized void configureBigEndianInts( int slaveAddr ) [inherited]

Enables int data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. The data transfer functions operating upon 32-bit int data types can be configured to do a word swap which enables them to read 32-bit data correctly from a big-endian machine.

Parameters:

slaveAddr Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureLittleEndianFloats( ) [inherited]

Disables float data type functions to do a word swap for all slaves.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slaves also serves 32-bit floats in little little-endian word order which is the most common case.

Remarks:

This is the default mode

synchronized void configureLittleEndianFloats( int slaveAddr ) [inherited]

Disables float data type functions to do a word swap on a per slave basis.
Modbus is using little-endian word order for 32-bit values. This setting assumes that the slave also serves 32-bit floats in little little-endian word order which is the most common case.

Remarks:

This is the default mode
Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

void configureSwappedFloats( ) [inherited]

Configures float data type functions to do a word swap for all slaves.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

synchronized void configureSwappedFloats( int slaveAddr ) [inherited]

Enables float data type functions to do a word swap on a per slave basis.
The data functions operating upon 32-bit float data types can be configured to do a word swap.

Note:
Most platforms store floats in IEEE 754 little-endian order which does not need a word swap.

Parameters:

slaveAddr  Modbus address of slave device or unit identifier (Range: 1 - 255). A value of zero configures the behaviour for broadcasting.

6.19 ReplyTimeoutException Class Reference

Reply time-out.

Inheritance diagram for ReplyTimeoutException:

BusProtocolException

ReplyTimeoutException
Public Member Functions

- `ReplyTimeoutException()`
  Constructs a `ReplyTimeoutException` (p. 176).

Static Public Member Functions

- `static long getCounter()`
  Returns how often this exception has been triggered.

- `static void resetCounter()`
  Resets exception counter.

6.19.1 Detailed Description

Reply time-out. Signals that a fieldbus data transfer timed out. This can occur if the slave device does not reply in time or does not reply at all. A wrong unit adress will also cause this error. In some occassions this expection is also produced if the characters received don’t constitute a complete frame.

See also:

- `BusProtocolException` (p. 20)

6.19.2 Member Function Documentation

`static long getCounter()` [static]

Returns how often this exception has been triggered.

Returns:

- Counter value

Reimplemented from `BusProtocolException` (p. 21).

6.20 Version Class Reference

`Version` (p. 177) class.
Static Public Member Functions

- static String getPackageVersion ()
  
  Returns the package version number.

Static Package Functions

- [static initializer]
  
  Prints banner to stdout.

Static Package Attributes

- static final String packageVersion = "EXPERIMENTAL"
  
  Package version.

6.20.1 Detailed Description

Version (p. 177) class. Provides functions to identify the product version.

6.20.2 Member Function Documentation

static String getPackageVersion () [static]

Returns the package version number.

Returns:

  Package version string
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Revision 4, October 2008

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