pyModbusTCP Documentation

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CONTENTS

CHAPTER

ONE

QUICK START GUIDE

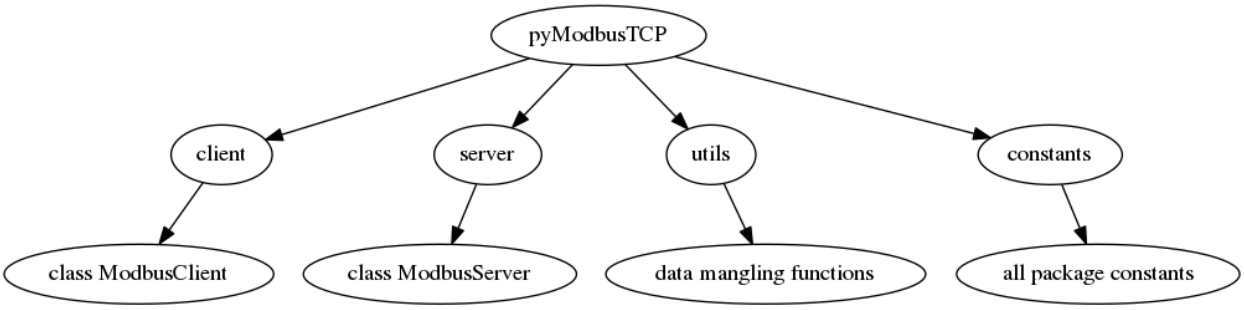
1.1 Overview of the package

pyModbusTCP give access to modbus/TCP server through the ModbusClient object. This class is define in the client module.

Since version 0.1.0, a server is available as ModbusServer class. This server is currently in test (API can change at any time).

To deal with frequent need of modbus data mangling (for example convert 32 bits IEEE float to 2x16 bits words) a special module named utils provide some helpful functions.

Package map:



1.2 Package setup

from PyPi:

```
# install the last available version (stable)
sudo pip3 install pyModbusTCP
# or upgrade from an older version
sudo pip3 install pyModbusTCP --upgrade

# you can also install a specific version (here v0.1.10)
sudo pip3 install pyModbusTCP==v0.1.10
```

from GitHub:

```
git clone https://github.com/sourceperl/pyModbusTCP.git
cd pyModbusTCP
```

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```
# here change "python" by your python target(s) version(s) (like python3.9)
sudo python setup.py install
```

1.3 ModbusClient: init

Init module from constructor (raise ValueError if host/port error):

```
from pyModbusTCP.client import ModbusClient

try:
    c = ModbusClient(host='localhost', port=502)
except ValueError:
    print("Error with host or port params")
```

Or with properties:

```
from pyModbusTCP.client import ModbusClient

c = ModbusClient()
c.host = 'localhost'
c.port = 502
```

1.4 ModbusClient: TCP link management

Since version 0.2.0, "auto open" mode is the default behaviour to deal with TCP open/close.

The "auto open" mode keep the TCP connection always open, so the default constructor is:

```
c = ModbusClient(host="localhost", auto_open=True, auto_close=False)
```

It's also possible to open/close TCP socket before and after each request:

```
c = ModbusClient(host="localhost", auto_open=True, auto_close=True)
```

Another way to deal with connection is to manually set it. Like this:

```
c = ModbusClient(host="localhost", auto_open=False, auto_close=False)

# open the socket for 2 reads then close it.
if c.open():
    regs_list_1 = c.read_holding_registers(0, 10)
    regs_list_2 = c.read_holding_registers(55, 10)
    c.close()
```

1.5 ModbusClient: available modbus requests functions

See http://en.wikipedia.org/wiki/Modbus for full table.

Domain	Function name	Function code	ModbusClient function
Bit	Read Discrete Inputs	2	*read_discrete_inputs()*
	Read Coils	1	*read_coils()*
	Write Single Coil	5	*write_single_coil()*
	Write Multiple Coils	15	*write_multiple_coils()*
Register	Read Input Registers	4	*read_input_registers()*
	Read Holding Registers	3	*read_holding_registers()*
	Write Single Register	6	*write_single_register()*
	Write Multiple Registers	16	*write_multiple_registers()*
	Read/Write Multiple Registers	23	*write_read_multiple_registers()*
	Mask Write Register	22	n/a
File	Read FIFO Queue	24	n/a
	Read File Record	20	n/a
	Write File Record	21	n/a
	Read Exception Status	7	n/a
Diagnostic	Diagnostic	8	n/a
	Get Com Event Counter	11	n/a
	Get Com Event Log	12	n/a
	Report Slave ID	17	n/a
	Read Device Identification	43	*read_device_identification()*

1.6 ModbusClient: how-to debug

If need, you can enable debug log for ModbusClient like this:

```
import logging

from pyModbusTCP.client import ModbusClient

# set debug level for pyModbusTCP.client to see frame exchanges
logging.basicConfig()
logging.getLogger('pyModbusTCP.client').setLevel(logging.DEBUG)

c = ModbusClient(host="localhost", port=502)
```

when debug level is set, all debug messages are displayed on the console:

```
c.read_coils(0)
```

will give us the following result:

```
DEBUG:pyModbusTCP.client:(localhost:502:1) Tx [8F 8A 00 00 00 06 01] 01 00 00 00 01
DEBUG:pyModbusTCP.client:(localhost:502:1) Rx [8F 8A 00 00 00 04 01] 01 01 00
```

1.7 utils module: Modbus data mangling

When we have to deal with the variety types of registers of PLC device, we often need some data mangling. Utils part of pyModbusTCP can help you in this task. Now, let's see some use cases.

- deal with negative numbers (two's complement):

```
from pyModbusTCP import utils

list_16_bits = [0x0000, 0xFFFF, 0x00FF, 0x8001]

# show "[0, -1, 255, -32767]"
print(utils.get_list_2comp(list_16_bits, 16))

# show "-1"
print(utils.get_2comp(list_16_bits[1], 16))
```

More at http://en.wikipedia.org/wiki/Two%27s_complement

- convert integer of val_size bits (default is 16) to an array of boolean:

```
from pyModbusTCP import utils

# show "[True, False, True, False, False, False, False, False]"
print(utils.get_bits_from_int(0x05, val_size=8))
```

- read of 32 bits registers (also know as long format):

```
from pyModbusTCP import utils

list_16_bits = [0x0123, 0x4567, 0xdead, 0xbeef]

# big endian sample (default)
list_32_bits = utils.word_list_to_long(list_16_bits)
# show "['0x1234567', '0xdeadbeef']"
print([hex(i) for i in list_32_bits])

# little endian sample
list_32_bits = utils.word_list_to_long(list_16_bits, big_endian=False)
# show "['0x45670123', '0xbeefdead']"
print([hex(i) for i in list_32_bits])
```

- IEEE single/double precision floating-point:

```
from pyModbusTCP import utils

# 32 bits IEEE single precision
# encode : python float 0.3 -> int 0x3e99999a
# display "0x3e99999a"
print(hex(utils.encode_ieee(0.3)))
# decode: python int 0x3e99999a -> float 0.3
# show "0.300000011921" (it's not 0.3, precision leak with float...)
print(utils.decode_ieee(0x3e99999a))
```

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```
# 64 bits IEEE double precision
# encode: python float 6.62606957e-34 -> int 0x390b860bb596a559
# display "0x390b860bb596a559"
print(hex(utils.encode_ieee(6.62606957e-34, double=True)))
# decode: python int 0x390b860bb596a559 -> float 6.62606957e-34
# display "6.62606957e-34"
print(utils.decode_ieee(0x390b860bb596a559, double=True))
```

CHAPTER

TWO

PYMODBUSTCP MODULES DOCUMENTATION

Contents:

2.1 Module pyModbusTCP.client

pyModbusTCP Client

This module provide the ModbusClient class used to deal with modbus server.

2.1.1 class ModbusClient

class pyModbusTCP.client.**ModbusClient**(*host='localhost'*, *port=502*, *unit_id=1*, *timeout=30.0*, *auto_open=True*, *auto_close=False*)

Modbus TCP client.

__init__(*host='localhost'*, *port=502*, *unit_id=1*, *timeout=30.0*, *auto_open=True*, *auto_close=False*)

Constructor.

Parameters

- **host** (*str*) – hostname or IPv4/IPv6 address server address
- **port** (*int*) – TCP port number
- **unit_id** (*int*) – unit ID
- **timeout** (*float*) – socket timeout in seconds
- **auto_open** (*bool*) – auto TCP connect
- **auto_close** (*bool*) – auto TCP close)

Returns

Object ModbusClient

Return type

ModbusClient

property auto_close

Get or set automatic TCP close after each request mode (True = turn on).

property auto_open

Get or set automatic TCP connect mode (True = turn on).

`close()`

Close current TCP connection.

`custom_request(pdu)`

Send a custom modbus request.

Parameters
pdu (*bytes*) – a modbus PDU (protocol data unit)

Returns
modbus frame PDU or None if error

Return type
bytes or None

`property host`

Get or set the server to connect to.

This can be any string with a valid IPv4 / IPv6 address or hostname. Setting host to a new value will close the current socket.

`property is_open`

Get current status of the TCP connection (True = open).

`property last_error`

Last error code.

`property last_error_as_txt`

Human-readable text that describe last error.

`property last_except`

Return the last modbus exception code.

`property last_except_as_full_txt`

Verbose human-readable text that describe last modbus exception.

`property last_except_as_txt`

Short human-readable text that describe last modbus exception.

`on_tx_rx(frame: bytes, is_tx: bool)`

Call for each Tx/Rx (for user purposes).

`open()`

Connect to modbus server (open TCP connection).

Returns
connect status (True on success)

Return type
bool

`property port`

Get or set the current TCP port (default is 502).

Setting port to a new value will close the current socket.

`read_coils(bit_addr, bit_nb=1)`

Modbus function READ_COILS (0x01).

Parameters

- **bit_addr** (*int*) – bit address (0 to 65535)
- **bit_nb** (*int*) – number of bits to read (1 to 2000)

Returns
bits list or None if error

Return type
list of bool or None

read_device_identification(*read_code=1*, *object_id=0*)

Modbus function Read Device Identification (0x2B/0x0E).

Parameters

- **read_code** (*int*) – read device id code, 1 to 3 for respectively: basic, regular and extended stream access, 4 for one specific identification object individual access (default is 1)
- **object_id** (*int*) – object id of the first object to obtain (default is 0)

Returns
a DeviceIdentificationResponse instance with the data or None if the requests fails

Return type
DeviceIdentificationResponse or None

read_discrete_inputs(*bit_addr*, *bit_nb=1*)

Modbus function READ_DISCRETE_INPUTS (0x02).

Parameters

- **bit_addr** (*int*) – bit address (0 to 65535)
- **bit_nb** (*int*) – number of bits to read (1 to 2000)

Returns
bits list or None if error

Return type
list of bool or None

read_holding_registers(*reg_addr*, *reg_nb=1*)

Modbus function READ_HOLDING_REGISTERS (0x03).

Parameters

- **reg_addr** (*int*) – register address (0 to 65535)
- **reg_nb** (*int*) – number of registers to read (1 to 125)

Returns
registers list or None if fail

Return type
list of int or None

read_input_registers(*reg_addr*, *reg_nb=1*)

Modbus function READ_INPUT_REGISTERS (0x04).

Parameters

- **reg_addr** (*int*) – register address (0 to 65535)
- **reg_nb** (*int*) – number of registers to read (1 to 125)

Returns
registers list or None if fail

Return type
list of int or None

property timeout

Get or set requests timeout (default is 30 seconds).

The argument may be a floating point number for sub-second precision. Setting timeout to a new value will close the current socket.

property unit_id

Get or set the modbus unit identifier (default is 1).

Any int from 0 to 255 is valid.

property version

Return the current package version as a str.

write_multiple_coils(*bits_addr*, *bits_value*)

Modbus function WRITE_MULTIPLE_COILS (0x0F).

Parameters

- **bits_addr** (*int*) – bits address (0 to 65535)
- **bits_value** (*list*) – bits values to write

Returns
True if write ok

Return type
bool

write_multiple_registers(*regs_addr*, *regs_value*)

Modbus function WRITE_MULTIPLE_REGISTERS (0x10).

Parameters

- **regs_addr** (*int*) – registers address (0 to 65535)
- **regs_value** (*list*) – registers values to write

Returns
True if write ok

Return type
bool

write_read_multiple_registers(*write_addr*, *write_values*, *read_addr*, *read_nb=1*)

Modbus function WRITE_READ_MULTIPLE_REGISTERS (0x17).

Parameters

- **write_addr** (*int*) – write registers address (0 to 65535)
- **write_values** (*list*) – registers values to write
- **read_addr** (*int*) – read register address (0 to 65535)
- **read_nb** (*int*) – number of registers to read (1 to 125)

Returns
registers list or None if fail

Return type
list of int or None

write_single_coil(*bit_addr*, *bit_value*)

Modbus function WRITE_SINGLE_COIL (0x05).

Parameters

- **bit_addr** (*int*) – bit address (0 to 65535)
- **bit_value** (*bool*) – bit value to write

Returns
True if write ok

Return type
bool

write_single_register(*reg_addr*, *reg_value*)

Modbus function WRITE_SINGLE_REGISTER (0x06).

Parameters

- **reg_addr** (*int*) – register address (0 to 65535)
- **reg_value** (*int*) – register value to write

Returns
True if write ok

Return type
bool

2.1.2 class DeviceIdentificationResponse

class pyModbusTCP.client.**DeviceIdentificationResponse**(*conformity_level: int = 0*, *more_follows: int = 0*, *next_object_id: int = 0*, *objects_by_id: ~typing.Dict[int, bytes] = <factory>*)

Modbus TCP client function read_device_identification() response struct.

Parameters

- **conformity_level** (*int*) – this represents supported access and object type
- **more_follows** (*int*) – for stream request can be set to 0xff if other objects are available (0x00 in other cases)
- **next_object_id** (*int*) – the next object id to be asked by following transaction
- **objects_by_id** (*dict*) – a dictionary with requested object (dict keys are object id as int)

__init__(*conformity_level: int = 0*, *more_follows: int = 0*, *next_object_id: int = 0*, *objects_by_id: ~typing.Dict[int, bytes] = <factory>*) → None

2.2 Module pyModbusTCP.server

pyModbusTCP Server

This module provide the class for the modbus server, it's data handler interface and finally the data bank.

2.2.1 class ModbusServer

class pyModbusTCP.server.**ModbusServer**(*host='localhost'*, *port=502*, *no_block=False*, *ipv6=False*, *data_bank=None*, *data_hdl=None*, *ext_engine=None*, *device_id=None*)

Modbus TCP server

__init__(*host='localhost'*, *port=502*, *no_block=False*, *ipv6=False*, *data_bank=None*, *data_hdl=None*, *ext_engine=None*, *device_id=None*)

Constructor

Modbus server constructor.

Parameters

- **host** (*str*) – hostname or IPv4/IPv6 address server address (default is 'localhost')
- **port** (*int*) – TCP port number (default is 502)
- **no_block** (*bool*) – no block mode, i.e. start() will return (default is False)
- **ipv6** (*bool*) – use ipv6 stack (default is False)
- **data_bank** (DataBank) – instance of custom data bank, if you don't want the default one (optional)
- **data_hdl** (DataHandler) – instance of custom data handler, if you don't want the default one (optional)
- **ext_engine** (*callable*) – an external engine reference (ref to ext_engine(session_data)) (optional)
- **device_id** (DeviceIdentification) – instance of DeviceIdentification class for read device identification request (optional)

class ClientInfo(*address=''*, *port=0*)

Container class for client information

exception DataFormatError

Exception raise by ModbusServer for data format errors.

exception Error

Base exception for ModbusServer related errors.

class MBAP(*transaction_id=0*, *protocol_id=0*, *length=0*, *unit_id=0*)

MBAP (Modbus Application Protocol) container class.

class ModbusService(*request*, *client_address*, *server*)

exception NetworkError

Exception raise by ModbusServer on I/O errors.

class PDU(*raw=b''*)

PDU (Protocol Data Unit) container class.

class ServerInfo

Container class for server information

class SessionData

Container class for server session data.

property is_run

Return True if server running.

start()

Start the server.

This function will block (or not if no_block flag is set).

stop()

Stop the server.

2.2.2 class DataHandler

class pyModbusTCP.server.**DataHandler**(*data_bank=None*)

Default data handler for ModbusServer, map server threads calls to DataBank.

Custom handler must derive from this class.

__init__(*data_bank=None*)

Constructor

Modbus server data handler constructor.

Parameters
data_bank (DataBank) – a reference to custom DefaultDataBank

read_coils(*address*, *count*, *srv_info*)

Call by server for reading in coils space

Parameters

- **address** (*int*) – start address
- **count** (*int*) – number of coils
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

read_d_inputs(*address*, *count*, *srv_info*)

Call by server for reading in the discrete inputs space

Parameters

- **address** (*int*) – start address
- **count** (*int*) – number of discrete inputs
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

read_h_regs(*address*, *count*, *srv_info*)

Call by server for reading in the holding registers space

Parameters

- **address** (*int*) – start address
- **count** (*int*) – number of holding registers
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

read_i_regs(*address*, *count*, *srv_info*)

Call by server for reading in the input registers space

Parameters

- **address** (*int*) – start address
- **count** (*int*) – number of input registers
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

write_coils(*address*, *bits_l*, *srv_info*)

Call by server for writing in the coils space

Parameters

- **address** (*int*) – start address
- **bits_l** (*list*) – list of boolean to write
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

write_h_regs(*address*, *words_l*, *srv_info*)

Call by server for writing in the holding registers space

Parameters

- **address** (*int*) – start address
- **words_l** (*list*) – list of word value to write
- **srv_info** (ModbusServer.ServerInfo) – some server info

Return type
Return

2.2.3 class DataBank

class pyModbusTCP.server.**DataBank**(*coils_size=65536*, *coils_default_value=False*, *d_inputs_size=65536*, *d_inputs_default_value=False*, *h_regs_size=65536*, *h_regs_default_value=0*, *i_regs_size=65536*, *i_regs_default_value=0*, *virtual_mode=False*)

Data space class with thread safe access functions

__init__(*coils_size=65536*, *coils_default_value=False*, *d_inputs_size=65536*, *d_inputs_default_value=False*, *h_regs_size=65536*, *h_regs_default_value=0*, *i_regs_size=65536*, *i_regs_default_value=0*, *virtual_mode=False*)

Constructor

Modbus server data bank constructor.

Parameters

- **coils_size** (*int*) – Number of coils to allocate (default is 65536)
- **coils_default_value** (*bool*) – Coils default value at startup (default is False)
- **d_inputs_size** (*int*) – Number of discrete inputs to allocate (default is 65536)
- **d_inputs_default_value** (*bool*) – Discrete inputs default value at startup (default is False)
- **h_regs_size** (*int*) – Number of holding registers to allocate (default is 65536)
- **h_regs_default_value** (*int*) – Holding registers default value at startup (default is 0)
- **i_regs_size** (*int*) – Number of input registers to allocate (default is 65536)
- **i_regs_default_value** (*int*) – Input registers default value at startup (default is 0)
- **virtual_mode** (*bool*) – Disallow all modbus data space to work with virtual values (default is False)

get_coils(*address*, *number=1*, *srv_info=None*)

Read data on server coils space

Parameters

- **address** (*int*) – start address
- **number** (*int*) – number of bits (optional)
- **srv_info** (ModbusServer.ServerInfo) – some server info (must be set by server only)

Returns
list of bool or None if error

Return type
list or None

get_discrete_inputs(*address*, *number=1*, *srv_info=None*)

Read data on server discrete inputs space

Parameters

- **address** (*int*) – start address
- **number** (*int*) – number of bits (optional)
- **srv_info** (*ModbusServerInfo*) – some server info (must be set by server only)

Returns
list of bool or None if error

Return type
list or None

`get_holding_registers`(*address*, *number=1*, *srv_info=None*)

Read data on server holding registers space

Parameters

- **address** (*int*) – start address
- **number** (*int*) – number of words (optional)
- **srv_info** (*ModbusServerInfo*) – some server info (must be set by server only)

Returns
list of int or None if error

Return type
list or None

`get_input_registers`(*address*, *number=1*, *srv_info=None*)

Read data on server input registers space

Parameters

- **address** (*int*) – start address
- **number** (*int*) – number of words (optional)
- **srv_info** (*ModbusServerInfo*) – some server info (must be set by server only)

Returns
list of int or None if error

Return type
list or None

`on_coils_change`(*address*, *from_value*, *to_value*, *srv_info*)

Call by server when a value change occur in coils space

This method is provided to be overridden with user code to catch changes

Parameters

- **address** (*int*) – address of coil
- **from_value** (*bool*) – coil original value
- **to_value** (*bool*) – coil next value
- **srv_info** (*ModbusServerInfo*) – some server info

`on_holding_registers_change`(*address*, *from_value*, *to_value*, *srv_info*)

Call by server when a value change occur in holding registers space

This method is provided to be overridden with user code to catch changes

Parameters

- **address** (*int*) – address of register
- **from_value** (*int*) – register original value
- **to_value** (*int*) – register next value

- **srv_info** (*ModbusServerInfo*) – some server info

set_coils(*address*, *bit_list*, *srv_info=None*)

Write data to server coils space

Parameters

- **address** (*int*) – start address
- **bit_list** (*list*) – a list of bool to write
- **srv_info** (*ModbusServerInfo*) – some server info (must be set by server only)

Returns
True if success or None if error

Return type
bool or None

Raises
ValueError – if bit_list members cannot be converted to bool

set_discrete_inputs(*address*, *bit_list*)

Write data to server discrete inputs space

Parameters

- **address** (*int*) – start address
- **bit_list** (*list*) – a list of bool to write

Returns
True if success or None if error

Return type
bool or None

Raises
ValueError – if bit_list members cannot be converted to bool

set_holding_registers(*address*, *word_list*, *srv_info=None*)

Write data to server holding registers space

Parameters

- **address** (*int*) – start address
- **word_list** (*list*) – a list of word to write
- **srv_info** (*ModbusServerInfo*) – some server info (must be set by server only)

Returns
True if success or None if error

Return type
bool or None

Raises
ValueError – if word_list members cannot be converted to int

set_input_registers(*address*, *word_list*)

Write data to server input registers space

Parameters

- **address** (*int*) – start address

- **word_list** (*list*) – a list of word to write

Returns
True if success or None if error

Return type
bool or None

Raises
ValueError – if word_list members cannot be converted to int

2.2.4 class DeviceIdentification

class pyModbusTCP.server.**DeviceIdentification**(*vendor_name=b''*, *product_code=b''*, *major_minor_revision=b''*, *vendor_url=b''*, *product_name=b''*, *model_name=b''*, *user_application_name=b''*, *objects_id=None*)

Container class for device identification objects (MEI type 0x0E) return by function 0x2B.

__init__(*vendor_name=b''*, *product_code=b''*, *major_minor_revision=b''*, *vendor_url=b''*, *product_name=b''*, *model_name=b''*, *user_application_name=b''*, *objects_id=None*)

Constructor

Parameters

- **vendor_name** (*bytes*) – VendorName mandatory object
- **product_code** (*bytes*) – ProductCode mandatory object
- **major_minor_revision** (*bytes*) – MajorMinorRevision mandatory object
- **vendor_url** (*bytes*) – VendorUrl regular object
- **product_name** (*bytes*) – ProductName regular object
- **model_name** (*bytes*) – ModelName regular object
- **user_application_name** (*bytes*) – UserApplicationName regular object
- **objects_id** (*dict*) – Objects values by id as dict example: {42:b'value'} (optional)

2.3 Module pyModbusTCP.utils

This module provide a set of functions for modbus data mangling.

2.3.1 Bit functions

pyModbusTCP utils functions

pyModbusTCP.utils.**byte_length**(*bit_length*)

Return the number of bytes needs to contain a bit_length structure.

Parameters
bit_length (*int*) – the number of bits

Returns
the number of bytes

Return type
int

pyModbusTCP.utils.**get_bits_from_int**(*val_int*, *val_size=16*)

Get the list of bits of val_int integer (default size is 16 bits).

Return bits list, the least significant bit first. Use list.reverse() for msb first.

Parameters

- **val_int** (*int*) – integer value
- **val_size** (*int*) – bit length of integer (word = 16, long = 32) (optional)

Returns
list of boolean "bits" (the least significant first)

Return type
list

pyModbusTCP.utils.**reset_bit**(*value*, *offset*)

Reset a bit at offset position.

Parameters

- **value** (*int*) – value of integer where reset the bit
- **offset** (*int*) – bit offset (0 is lsb)

Returns
value of integer with bit reset

Return type
int

pyModbusTCP.utils.**set_bit**(*value*, *offset*)

Set a bit at offset position.

Parameters

- **value** (*int*) – value of integer where set the bit
- **offset** (*int*) – bit offset (0 is lsb)

Returns
value of integer with bit set

Return type
int

pyModbusTCP.utils.**test_bit**(*value*, *offset*)

Test a bit at offset position.

Parameters

- **value** (*int*) – value of integer to test
- **offset** (*int*) – bit offset (0 is lsb)

Returns
value of bit at offset position

Return type
bool

pyModbusTCP.utils.**toggle_bit**(*value*, *offset*)

Return an integer with the bit at offset position inverted.

Parameters

- **value** (*int*) – value of integer where invert the bit
- **offset** (*int*) – bit offset (0 is lsb)

Returns
value of integer with bit inverted

Return type
int

2.3.2 Word functions

pyModbusTCP utils functions

pyModbusTCP.utils.**long_list_to_word**(*val_list*, *big_endian=True*, *long_long=False*)

Long (32 bits) or long long (64 bits) list to word (16 bits) list.

By default long_list_to_word() use big endian order. For use little endian, set big_endian param to False. Input format could be long long with long_long param to True.

Parameters

- **val_list** (*list*) – list of 32 bits int value
- **big_endian** (*bool*) – True for big endian/False for little (optional)
- **long_long** (*bool*) – True for long long 64 bits, default is long 32 bits (optional)

Returns
list of 16 bits int value

Return type
list

pyModbusTCP.utils.**word_list_to_long**(*val_list*, *big_endian=True*, *long_long=False*)

Word list (16 bits) to long (32 bits) or long long (64 bits) list.

By default, word_list_to_long() use big endian order. For use little endian, set big_endian param to False. Output format could be long long with long_long. option set to True.

Parameters

- **val_list** (*list*) – list of 16 bits int value
- **big_endian** (*bool*) – True for big endian/False for little (optional)
- **long_long** (*bool*) – True for long long 64 bits, default is long 32 bits (optional)

Returns
list of 32 bits int value

Return type
list

2.3.3 Two's complement functions

pyModbusTCP utils functions

pyModbusTCP.utils.**get_2comp**(*val_int*, *val_size=16*)

Get the 2's complement of Python int val_int.

Parameters

- **val_int** (*int*) – int value to apply 2's complement
- **val_size** (*int*) – bit size of int value (word = 16, long = 32) (optional)

Returns
2's complement result

Return type
int

Raises
ValueError – if mismatch between val_int and val_size

pyModbusTCP.utils.**get_list_2comp**(*val_list*, *val_size=16*)

Get the 2's complement of Python list val_list.

Parameters

- **val_list** (*list*) – list of int value to apply 2's complement
- **val_size** (*int*) – bit size of int value (word = 16, long = 32) (optional)

Returns
2's complement result

Return type
list

2.3.4 IEEE floating-point functions

pyModbusTCP utils functions

pyModbusTCP.utils.**decode_ieee**(*val_int*, *double=False*)

Decode Python int (32 bits integer) as an IEEE single or double precision format.

Support NaN.

Parameters

- **val_int** (*int*) – a 32 or 64 bits integer as an int Python value
- **double** (*bool*) – set to decode as a 64 bits double precision, default is 32 bits single (optional)

Returns
float result

Return type
float

pyModbusTCP.utils.**encode_ieee**(*val_float*, *double=False*)

Encode Python float to int (32 bits integer) as an IEEE single or double precision format.

Support NaN.

Parameters

- **val_float** (*float*) – float value to convert
- **double** (*bool*) – set to encode as a 64 bits double precision, default is 32 bits single (optional)

Returns
IEEE 32 bits (single precision) as Python int

Return type
int

2.3.5 Misc functions

pyModbusTCP utils functions

pyModbusTCP.utils.**crc16**(*frame*)

Compute CRC16.

Parameters
frame (*bytes*) – frame

Returns
CRC16

Return type
int

pyModbusTCP.utils.**valid_host**(*host_str*)

Validate a host string.

Can be an IPv4/6 address or a valid hostname.

Parameters
host_str (*str*) – the host string to test

Returns
True if host_str is valid

Return type
bool

CHAPTER

THREE

PYMODBUSTCP EXAMPLES

Here some examples to see pyModbusTCP in some use cases

3.1 Client: minimal code

```
#!/usr/bin/env python3

""" Minimal code example. """

from pyModbusTCP.client import ModbusClient

# read 3 coils at @0 on localhost server
print('coils=%s' % ModbusClient().read_coils(0, 3))
```

3.2 Client: read coils

```
#!/usr/bin/env python3

""" Read 10 coils and print result on stdout. """

import time

from pyModbusTCP.client import ModbusClient

# init modbus client
c = ModbusClient(host='localhost', port=502, auto_open=True)

# main read loop
while True:
    # read 10 bits (= coils) at address 0, store result in coils list
    coils_l = c.read_coils(0, 10)

    # if success display registers
    if coils_l:
        print('coil ad #0 to 9: %s' % coils_l)
    else:
        print('unable to read coils')
```

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```
    # sleep 2s before next polling
    time.sleep(2)
```

3.3 Client: read holding registers

```
#!/usr/bin/env python3

""" Read 10 holding registers and print result on stdout. """

import time

from pyModbusTCP.client import ModbusClient

# init modbus client
c = ModbusClient(auto_open=True)

# main read loop
while True:
    # read 10 registers at address 0, store result in regs list
    regs_l = c.read_holding_registers(0, 10)

    # if success display registers
    if regs_l:
        print('reg ad #0 to 9: %s' % regs_l)
    else:
        print('unable to read registers')

    # sleep 2s before next polling
    time.sleep(2)
```

3.4 Client: write coils

```
#!/usr/bin/env python3

"""Write 4 coils to True, wait 2s, write False and redo it."""

import time

from pyModbusTCP.client import ModbusClient

# init
c = ModbusClient(host='localhost', port=502, auto_open=True)
bit = True

# main loop
while True:
```

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```
    # write 4 bits in modbus address 0 to 3
    print('write bits')
    print('----------\n')
    for ad in range(4):
        is_ok = c.write_single_coil(ad, bit)
        if is_ok:
            print('coil #%s: write to %s' % (ad, bit))
        else:
            print('coil #%s: unable to write %s' % (ad, bit))
        time.sleep(0.5)

    print('')
    time.sleep(1)

    # read 4 bits in modbus address 0 to 3
    print('read bits')
    print('---------\n')
    bits = c.read_coils(0, 4)
    if bits:
        print('coils #0 to 3: %s' % bits)
    else:
        print('coils #0 to 3: unable to read')

    # toggle
    bit = not bit
    # sleep 2s before next polling
    print('')
    time.sleep(2)
```

3.5 Client: add float (inheritance)

```
#!/usr/bin/env python3

""" How-to add float support to ModbusClient. """

from pyModbusTCP.client import ModbusClient
from pyModbusTCP.utils import (decode_ieee, encode_ieee, long_list_to_word,
                               word_list_to_long)


class FloatModbusClient(ModbusClient):
    """A ModbusClient class with float support."""

    def read_float(self, address, number=1):
        """Read float(s) with read holding registers."""
        reg_l = self.read_holding_registers(address, number * 2)
        if reg_l:
            return [decode_ieee(f) for f in word_list_to_long(reg_l)]
        else:
            return None
```

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```
    def write_float(self, address, floats_list):
        """Write float(s) with write multiple registers."""
        b32_l = [encode_ieee(f) for f in floats_list]
        b16_l = long_list_to_word(b32_l)
        return self.write_multiple_registers(address, b16_l)


if __name__ == '__main__':
    # init modbus client
    c = FloatModbusClient(host='localhost', port=502, auto_open=True)

    # write 10.0 at @0
    c.write_float(0, [10.0])

    # read @0 to 9
    float_l = c.read_float(0, 10)
    print(float_l)

    c.close()
```

3.6 Client: polling thread

```
#!/usr/bin/env python3

"""
modbus polling thread
~~~~~~~~~~~~~~~~~~~~~

Start a thread for polling a set of registers, display result on console.
Exit with ctrl+c.
"""

import time
from threading import Lock, Thread

from pyModbusTCP.client import ModbusClient

SERVER_HOST = "localhost"
SERVER_PORT = 502

# set global
regs = []

# init a thread lock
regs_lock = Lock()


def polling_thread():
    """Modbus polling thread."""
```

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```
    global regs, regs_lock
    c = ModbusClient(host=SERVER_HOST, port=SERVER_PORT, auto_open=True)
    # polling loop
    while True:
        # do modbus reading on socket
        reg_list = c.read_holding_registers(0, 10)
        # if read is ok, store result in regs (with thread lock)
        if reg_list:
            with regs_lock:
                regs = list(reg_list)
        # 1s before next polling
        time.sleep(1)


# start polling thread
tp = Thread(target=polling_thread)
# set daemon: polling thread will exit if main thread exit
tp.daemon = True
tp.start()

# display loop (in main thread)
while True:
    # print regs list (with thread lock synchronization)
    with regs_lock:
        print(regs)
    # 1s before next print
    time.sleep(1)
```

3.7 Server: basic usage

```
#!/usr/bin/env python3

"""
Modbus/TCP server
~~~~~~~~~~~~~~~~~

Run this as root to listen on TCP privileged ports (<= 1024).

Add "--host 0.0.0.0" to listen on all available IPv4 addresses of the host.
$ sudo ./server.py --host 0.0.0.0
"""

import argparse
import logging

from pyModbusTCP.server import ModbusServer

# init logging
logging.basicConfig()
# parse args
```

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```
parser = argparse.ArgumentParser()
parser.add_argument('-H', '--host', type=str, default='localhost', help='Host (default:␣
↪localhost)')
parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default: 502)
↪')
parser.add_argument('-d', '--debug', action='store_true', help='set debug mode')
args = parser.parse_args()
# logging setup
if args.debug:
    logging.getLogger('pyModbusTCP.server').setLevel(logging.DEBUG)
# start modbus server
server = ModbusServer(host=args.host, port=args.port)
server.start()
```

3.8 Server: with an allow list

```
#!/usr/bin/env python3

"""
An example of Modbus/TCP server which allow modbus read and/or write only from
specific IPs.

Run this as root to listen on TCP privileged ports (<= 1024).
"""

import argparse

from pyModbusTCP.constants import EXP_ILLEGAL_FUNCTION
from pyModbusTCP.server import DataHandler, ModbusServer

# some const
ALLOW_R_L = ['127.0.0.1', '192.168.0.10']
ALLOW_W_L = ['127.0.0.1']


# a custom data handler with IPs filter
class MyDataHandler(DataHandler):
    def read_coils(self, address, count, srv_info):
        if srv_info.client.address in ALLOW_R_L:
            return super().read_coils(address, count, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)

    def read_d_inputs(self, address, count, srv_info):
        if srv_info.client.address in ALLOW_R_L:
            return super().read_d_inputs(address, count, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)

    def read_h_regs(self, address, count, srv_info):
```

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```
        if srv_info.client.address in ALLOW_R_L:
            return super().read_h_regs(address, count, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)

    def read_i_regs(self, address, count, srv_info):
        if srv_info.client.address in ALLOW_R_L:
            return super().read_i_regs(address, count, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)

    def write_coils(self, address, bits_l, srv_info):
        if srv_info.client.address in ALLOW_W_L:
            return super().write_coils(address, bits_l, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)

    def write_h_regs(self, address, words_l, srv_info):
        if srv_info.client.address in ALLOW_W_L:
            return super().write_h_regs(address, words_l, srv_info)
        else:
            return DataHandler.Return(exp_code=EXP_ILLEGAL_FUNCTION)


if __name__ == '__main__':
    # parse args
    parser = argparse.ArgumentParser()
    parser.add_argument('-H', '--host', type=str, default='localhost', help='Host␣
↪(default: localhost)')
    parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default:␣
↪502)')
    args = parser.parse_args()
    # init modbus server and start it
    server = ModbusServer(host=args.host, port=args.port, data_hdl=MyDataHandler())
    server.start()
```

3.9 Server: with change logger

```
#!/usr/bin/env python3

"""
An example of Modbus/TCP server with a change logger.

Run this as root to listen on TCP privileged ports (<= 1024).
"""

import argparse
import logging

from pyModbusTCP.server import DataBank, ModbusServer
```

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```
class MyDataBank(DataBank):
    """A custom ModbusServerDataBank for override on_xxx_change methods."""

    def on_coils_change(self, address, from_value, to_value, srv_info):
        """Call by server when change occur on coils space."""
        msg = 'change in coil space [{0!r:^5} > {1!r:^5}] at @ 0x{2:04X} from ip: {3:<15}
↪'
        msg = msg.format(from_value, to_value, address, srv_info.client.address)
        logging.info(msg)

    def on_holding_registers_change(self, address, from_value, to_value, srv_info):
        """Call by server when change occur on holding registers space."""
        msg = 'change in hreg space [{0!r:^5} > {1!r:^5}] at @ 0x{2:04X} from ip: {3:<15}
↪'
        msg = msg.format(from_value, to_value, address, srv_info.client.address)
        logging.info(msg)


if __name__ == '__main__':
    # parse args
    parser = argparse.ArgumentParser()
    parser.add_argument('-H', '--host', type=str, default='localhost', help='Host␣
↪(default: localhost)')
    parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default:␣
↪502)')
    args = parser.parse_args()
    # logging setup
    logging.basicConfig(format='%(asctime)s %(message)s', level=logging.INFO)
    # init modbus server and start it
    server = ModbusServer(host=args.host, port=args.port, data_bank=MyDataBank())
    server.start()
```

3.10 Server: Modbus/TCP serial gateway

```
#!/usr/bin/env python3

"""
Modbus/TCP basic gateway (RTU slave(s) attached)
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

[pyModbusTCP server] -> [ModbusSerialWorker] -> [serial RTU devices]

Run this as root to listen on TCP privileged ports (<= 1024).

Open /dev/ttyUSB0 at 115200 bauds and relay it RTU messages to slave(s).
$ sudo ./server_serial_gw.py --baudrate 115200 /dev/ttyUSB0
"""
```

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```
import argparse
import logging
import queue
import struct
from queue import Queue
from threading import Event

# need sudo pip install pyserial==3.4
from serial import Serial, serialutil

from pyModbusTCP.constants import (EXP_GATEWAY_PATH_UNAVAILABLE,
                                   EXP_GATEWAY_TARGET_DEVICE_FAILED_TO_RESPOND)
from pyModbusTCP.server import ModbusServer
from pyModbusTCP.utils import crc16


# some class
class ModbusRTUFrame:
    """ Modbus RTU frame container class. """

    def __init__(self, raw=b''):
        # public
        self.raw = raw

    @property
    def pdu(self):
        """Return PDU part of frame."""
        return self.raw[1:-2]

    @property
    def slave_address(self):
        """Return slave address part of frame."""
        return self.raw[0]

    @property
    def function_code(self):
        """Return function code part of frame."""
        return self.raw[1]

    @property
    def is_valid(self):
        """Check if frame is valid.

        :return: True if frame is valid
        :rtype: bool
        """
        return len(self.raw) > 4 and crc16(self.raw) == 0

    def build(self, raw_pdu, slave_ad):
        """Build a full modbus RTU message from PDU and slave address.

        :param raw_pdu: modbus as raw value
```

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```
        :type raw_pdu: bytes
        :param slave_ad: address of the slave
        :type slave_ad: int
        """
        # [address] + PDU
        tmp_raw = struct.pack('B', slave_ad) + raw_pdu
        # [address] + PDU + [CRC 16]
        tmp_raw += struct.pack('<H', crc16(tmp_raw))
        self.raw = tmp_raw


class RtuQuery:
    """ Request container to deal with modbus serial worker. """

    def __init__(self):
        self.completed = Event()
        self.request = ModbusRTUFrame()
        self.response = ModbusRTUFrame()


class ModbusSerialWorker:
    """ A serial worker to manage I/O with RTU devices. """

    def __init__(self, port, timeout=1.0, end_of_frame=0.05):
        # public
        self.serial_port = port
        self.timeout = timeout
        self.end_of_frame = end_of_frame
        # internal request queue
        # accept 5 simultaneous requests before overloaded exception is return
        self.rtu_queries_q = Queue(maxsize=5)

    def loop(self):
        """Serial worker main loop."""
        while True:
            # get next exchange from queue
            rtu_query = self.rtu_queries_q.get()
            # send to serial
            self.serial_port.reset_input_buffer()
            self.serial_port.write(rtu_query.request.raw)
            # receive from serial
            # wait for first byte of data until timeout delay
            self.serial_port.timeout = self.timeout
            rx_raw = self.serial_port.read(1)
            # if ok, wait for the remaining
            if rx_raw:
                self.serial_port.timeout = self.end_of_frame
                # wait for next bytes of data until end of frame delay
                while True:
                    rx_chunk = self.serial_port.read(256)
                    if not rx_chunk:
                        break
```

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```
                    else:
                        rx_raw += rx_chunk
            rtu_query.response.raw = rx_raw
            # mark all as done
            rtu_query.completed.set()
            self.rtu_queries_q.task_done()

    def srv_engine_entry(self, session_data):
        """Server engine entry point (pass request to serial worker queries queue).

        :param session_data: server session data
        :type session_data: ModbusServer.SessionData
        """
        # init a serial exchange from session data
        rtu_query = RtuQuery()
        rtu_query.request.build(raw_pdu=session_data.request.pdu.raw,
                                slave_ad=session_data.request.mbap.unit_id)
        try:
            # add a request in the serial worker queue, can raise queue.Full
            self.rtu_queries_q.put(rtu_query, block=False)
            # wait result
            rtu_query.completed.wait()
            # check receive frame status
            if rtu_query.response.is_valid:
                session_data.response.pdu.raw = rtu_query.response.pdu
                return
            # except status for slave failed to respond
            exp_status = EXP_GATEWAY_TARGET_DEVICE_FAILED_TO_RESPOND
        except queue.Full:
            # except status for overloaded gateway
            exp_status = EXP_GATEWAY_PATH_UNAVAILABLE
        # return modbus exception
        func_code = rtu_query.request.function_code
        session_data.response.pdu.build_except(func_code=func_code, exp_status=exp_
↪status)


if __name__ == '__main__':
    # parse args
    parser = argparse.ArgumentParser()
    parser.add_argument('device', type=str, help='serial device (like /dev/ttyUSB0)')
    parser.add_argument('-H', '--host', type=str, default='localhost', help='host␣
↪(default: localhost)')
    parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default:␣
↪502)')
    parser.add_argument('-b', '--baudrate', type=int, default=9600, help='serial rate␣
↪(default is 9600)')
    parser.add_argument('-t', '--timeout', type=float, default=1.0, help='timeout delay␣
↪(default is 1.0 s)')
    parser.add_argument('-e', '--eof', type=float, default=0.05, help='end of frame␣
↪delay (default is 0.05 s)')
    parser.add_argument('-d', '--debug', action='store_true', help='set debug mode')
```

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```
    args = parser.parse_args()
    # init logging
    logging.basicConfig(level=logging.DEBUG if args.debug else None)
    logger = logging.getLogger(__name__)
    try:
        # init serial port
        logger.debug('Open serial port %s at %d bauds', args.device, args.baudrate)
        serial_port = Serial(port=args.device, baudrate=args.baudrate)
        # init serial worker
        serial_worker = ModbusSerialWorker(serial_port, args.timeout, args.eof)
        # start modbus server with custom engine
        logger.debug('Start modbus server (%s, %d)', args.host, args.port)
        srv = ModbusServer(host=args.host, port=args.port,
                           no_block=True, ext_engine=serial_worker.srv_engine_entry)
        srv.start()
        # start serial worker loop
        logger.debug('Start serial worker')
        serial_worker.loop()
    except serialutil.SerialException as e:
        logger.critical('Serial device error: %r', e)
        exit(1)
    except ModbusServer.Error as e:
        logger.critical('Modbus server error: %r', e)
        exit(2)
```

3.11 Server: schedule and alive word

```
#!/usr/bin/env python3

"""
Modbus/TCP server with start/stop schedule
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Run this as root to listen on TCP privileged ports (<= 1024).

Default Modbus/TCP port is 502, so we prefix call with sudo. With argument
"--host 0.0.0.0", server listen on all IPv4 of the host. Instead of just
open tcp/502 on local interface.
$ sudo ./server_schedule.py --host 0.0.0.0
"""

import argparse
import time

# need https://github.com/dbader/schedule
import schedule

from pyModbusTCP.server import ModbusServer
```

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```
def alive_word_job():
    """Update holding register @0 with day second (since 00:00).

    Job called every 10s by scheduler.
    """
    server.data_bank.set_holding_registers(0, [int(time.time()) % (24*3600) // 10])


# parse args
parser = argparse.ArgumentParser()
parser.add_argument('-H', '--host', type=str, default='localhost', help='Host (default:␣
↪localhost)')
parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default: 502)
↪')
args = parser.parse_args()
# init modbus server and start it
server = ModbusServer(host=args.host, port=args.port, no_block=True)
server.start()
# init scheduler
# schedule a daily downtime (from 18:00 to 06:00)
schedule.every().day.at('18:00').do(server.stop)
schedule.every().day.at('06:00').do(server.start)
# update life word at @0
schedule.every(10).seconds.do(alive_word_job)
# main loop
while True:
    schedule.run_pending()
    time.sleep(1)
```

3.12 Server: virtual data

```
#!/usr/bin/env python3

"""
Modbus/TCP server with virtual data
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

Map the system date and time to @ 0 to 5 on the "holding registers" space.
Only the reading of these registers in this address space is authorized. All
other requests return an illegal data address except.

Run this as root to listen on TCP priviliged ports (<= 1024).
"""

import argparse
from datetime import datetime

from pyModbusTCP.server import DataBank, ModbusServer


```

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```
class MyDataBank(DataBank):
    """A custom ModbusServerDataBank for override get_holding_registers method."""

    def __init__(self):
        # turn off allocation of memory for standard modbus object types
        # only "holding registers" space will be replaced by dynamic build values.
        super().__init__(virtual_mode=True)

    def get_holding_registers(self, address, number=1, srv_info=None):
        """Get virtual holding registers."""
        # populate virtual registers dict with current datetime values
        now = datetime.now()
        v_regs_d = {0: now.day, 1: now.month, 2: now.year,
                    3: now.hour, 4: now.minute, 5: now.second}
        # build a list of virtual regs to return to server data handler
        # return None if any of virtual registers is missing
        try:
            return [v_regs_d[a] for a in range(address, address+number)]
        except KeyError:
            return


if __name__ == '__main__':
    # parse args
    parser = argparse.ArgumentParser()
    parser.add_argument('-H', '--host', type=str, default='localhost', help='Host␣
↪(default: localhost)')
    parser.add_argument('-p', '--port', type=int, default=502, help='TCP port (default:␣
↪502)')
    args = parser.parse_args()
    # init modbus server and start it
    server = ModbusServer(host=args.host, port=args.port, data_bank=MyDataBank())
    server.start()
```

PYTHON MODULE INDEX

p

INDEX

Symbols

A

B

C

D

E

G

H

I

L

M

O

P

R

S

T

U

V

W