



**acontis technologies GmbH**

**SOFTWARE**

# **EC-Simulator**

## **Python Programming Interface**

**Version 3.2**

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## 1 Introduction

The Python Wrapper provides a Python interface to use EC-Master, EC-Simulator and RAS Client/Server.

### 1.1 Requirements

#### Python v3.7 and above

- Python Pause. Required for ticked timing with `pause.until(...)` to lower JobTask's drift, e.g. for Distributed Clocks  
`$ pip install pause`
- PyQt5 (v5.15.1). Only required to run the GUI demo  
`$ pip install pyqt5`

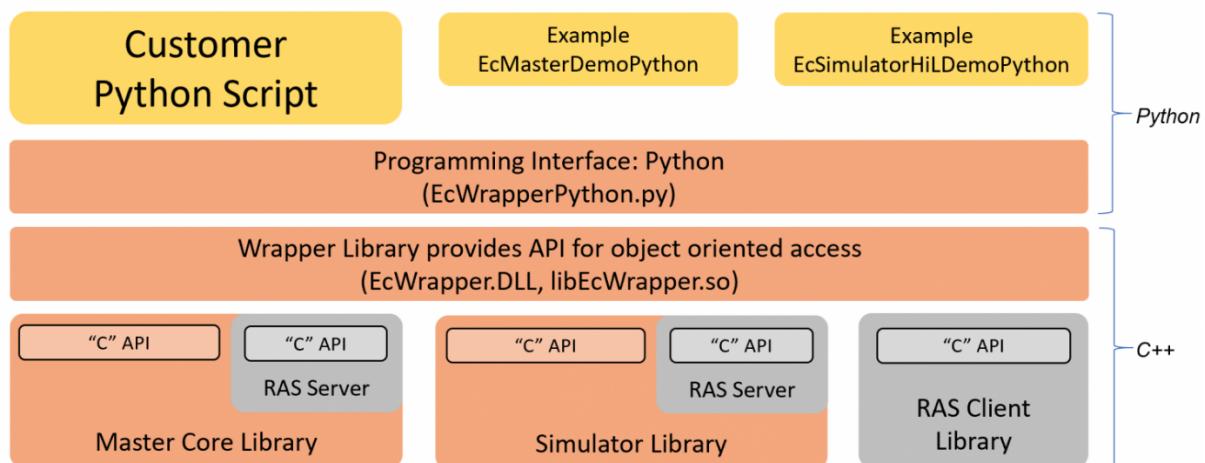
#### Windows (x86/x64)

- Microsoft Windows 7 and above
- Microsoft Visual C++ 2010 Runtime

#### Linux (x86/x64/ARM)

- Ubuntu 12.04 and above

## 1.2 Architecture



The architecture contains 4 basic layers:

**Customer Python Script or our examples (EcMasterDemoPython, ...)**

- Demo application, written in Python

**Programming Interface (EcWrapperPython)**

- Provides an object oriented API written in Python

### **Wrapper Library (EcWrapper)**

- Native wrapper library, which provides API for object oriented access

### **Native Libraries**

- Master Core Library
- Simulator Library
- RAS Client Library

## 2 Programmers Guide

### 2.1 Sample Scripts

There are currently 2 scripts available:

**EcMasterDemoPython.bat**

Starts the console demo application

**EcMasterDemoPythonInteractive.bat**

Starts the interactive demo application

The scripts will start the demo application. The interactive demo application waits for user input where the user can enter the following commands:

```
# Write variable
demo.processImage.variables.Slave_1005__EL2008_.Channel_1.Output.set(1)

# Read variable
demo.processImage.variables.Slave_1005__EL2008_.Channel_1.Output.get()

# Print properties of variable
demo.processImage.variables.Slave_1005__EL2008_.Channel_1.Output.dmp()

# Stop the demo:
demo.stopDemo()
```

### 2.2 Sample Code

The Python demo application contains of 3 modules:

**EcDemoApp.py:**

Console demo application

**EcDemoAppGui.py:**

Gui demo application, based on Qt5

**EcDemoAppInteractive.py:**

Interactive demo application

### 2.3 Wrapper

#### 2.3.1 Modules

The Python Wrapper contains of 5 modules:

**EcWrapperPython.py**

```
class CEcWrapperPython
    EC-Wrapper base class
```

```
class CEcMasterPython
    EC-Master
```

```
class CEcMasterMbxGatewayClientPython
    Mailbox Gateway Client for EC-Master
```

```

class CEcMasterMbxGatewayServerPython
    Mailbox Gateway Server for EC-Master

class CEcSimulatorPython
    EC-Simulator

class CEcSimulatorRasServerPython
    RAS Server for EC-Simulator

class CEcRasClientPython
    RAS Client for EC-Master / EC-Simulator

```

**EcMotionPython.py**

```

class CEcMotionPython
    EC-Motion interface

EcWrapperPythonTypes.py
    Python types

EcWrapper.py
    CPython interface (internal)

EcWrapperTypes.py
    CPython types (internal)

```

### 2.3.2 Return code vs. exception handling

The most of all API functions returns a return code for error handling. This behaviour can be changed to throw an exception in error case by simply setting:

```
CEcWrapperPython.EnableExceptionHandling = True # default is False
```

### 2.3.3 API with “out” or “ref” parameters

The Python Wrapper API is based on C# code. C# supports `out` and `ref` keywords for parameters. This is not supported in Python and is solved by simply submitting `CEcWrapperPythonOutParam` or `CEcWrapperPythonRefParam` to those functions:

```

# This function has an "out" parameter "out_oSbStatus"
def GetScanBusStatus(self, out_oSbStatus):
    # ...
    return

# Create "out" parameter
out_oStatus = CEcWrapperPythonOutParam()
# Call function
pythonWrapper.GetScanBusStatus(out_oStatus)
# Get the "out" parameter value
oStatus = out_oStatus.value
# Now, the "oStatus" object can be used
print(oStatus.dwresultCode)

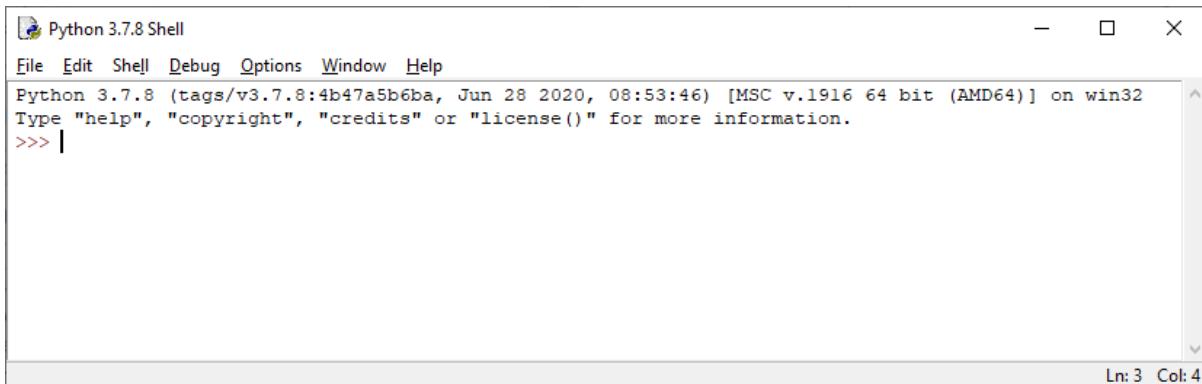
```

## 2.4 Supported IDEs

### 2.4.1 Python Shell IDLE

This is the default IDE.

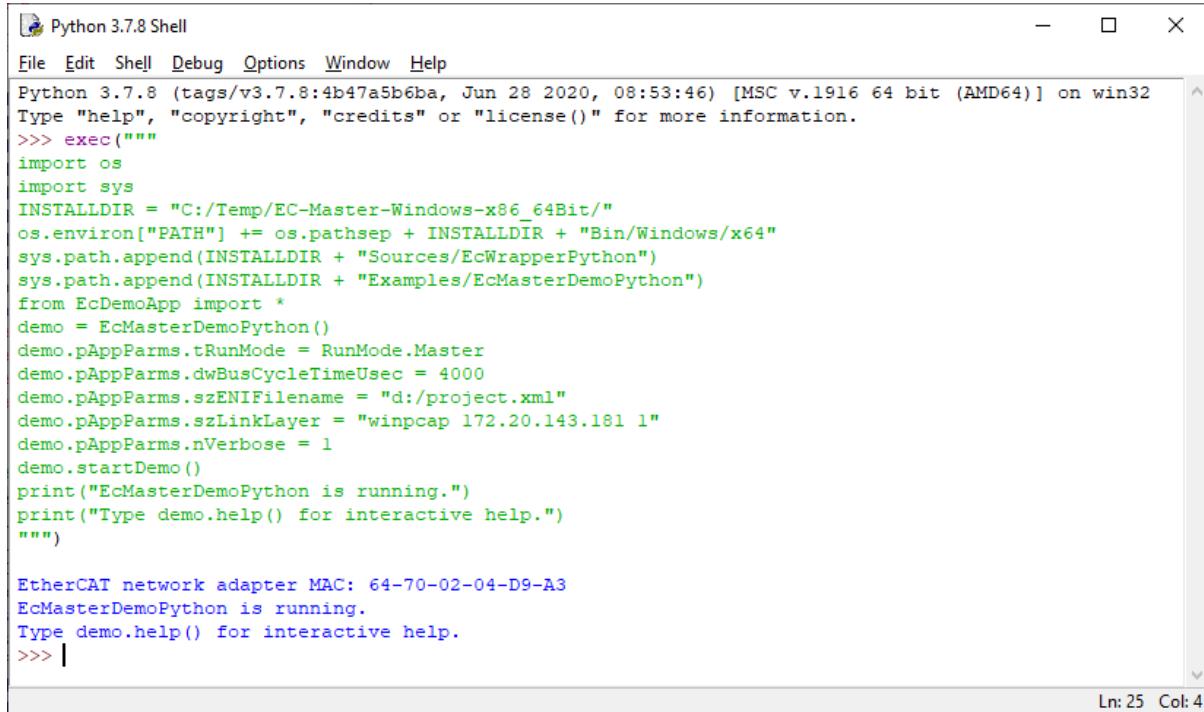
It can be started from Windows Start Menu or by calling **C:/Python/Lib/idlelib/idle.py**:



In this shell, the user can simply copy&paste the sample code from: **Examples/EcMasterDemoPython/EcDemoAppInteractive.py**

```
exec("""
import os
import sys
INSTALLDIR = "C:/Program
Files/acontis_technologies/EC-Master-Windows-x86_64Bit/"
os.environ["PATH"] += os.pathsep + INSTALLDIR + "Bin/Windows/x64"
sys.path.append(INSTALLDIR + "Sources/EcWrapperPython")
sys.path.append(INSTALLDIR + "Examples/EcMasterDemoPython")
from EcDemoApp import *
demo = EcMasterDemoPython()
demo.pAppParms.tRunMode = RunMode.Master
demo.pAppParms.dwBusCycleTimeUsec = 4000
demo.pAppParms.szENIFilename = "ENI.xml"
demo.pAppParms.szLinkLayer = "winpcap 127.0.0.0 1"
demo.pAppParms.nVerbose = 3
demo.startDemo()
print("EcMasterDemoPython is running.")
print("Type demo.help() for interactive help.")
""")
```

... and the demo is running.



```

Python 3.7.8 Shell
File Edit Shell Debug Options Window Help
Python 3.7.8 (tags/v3.7.8:4b47a5b6ba, Jun 28 2020, 08:53:46) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>> exec("""
import os
import sys
INSTALLDIR = "C:/Temp/EC-Master-Windows-x86_64Bit/"
os.environ["PATH"] += os.pathsep + INSTALLDIR + "Bin/Windows/x64"
sys.path.append(INSTALLDIR + "Sources/EcWrapperPython")
sys.path.append(INSTALLDIR + "Examples/EcMasterDemoPython")
from EcDemoApp import *
demo = EcMasterDemoPython()
demo.pAppParms.tRunMode = RunMode.Master
demo.pAppParms.dwBusCycleTimeUsec = 4000
demo.pAppParms.szENIFilename = "d:/project.xml"
demo.pAppParms.szLinkLayer = "winpcap 172.20.143.181 1"
demo.pAppParms.nVerbose = 1
demo.startDemo()
print("EcMasterDemoPython is running.")
print("Type demo.help() for interactive help.")
""")

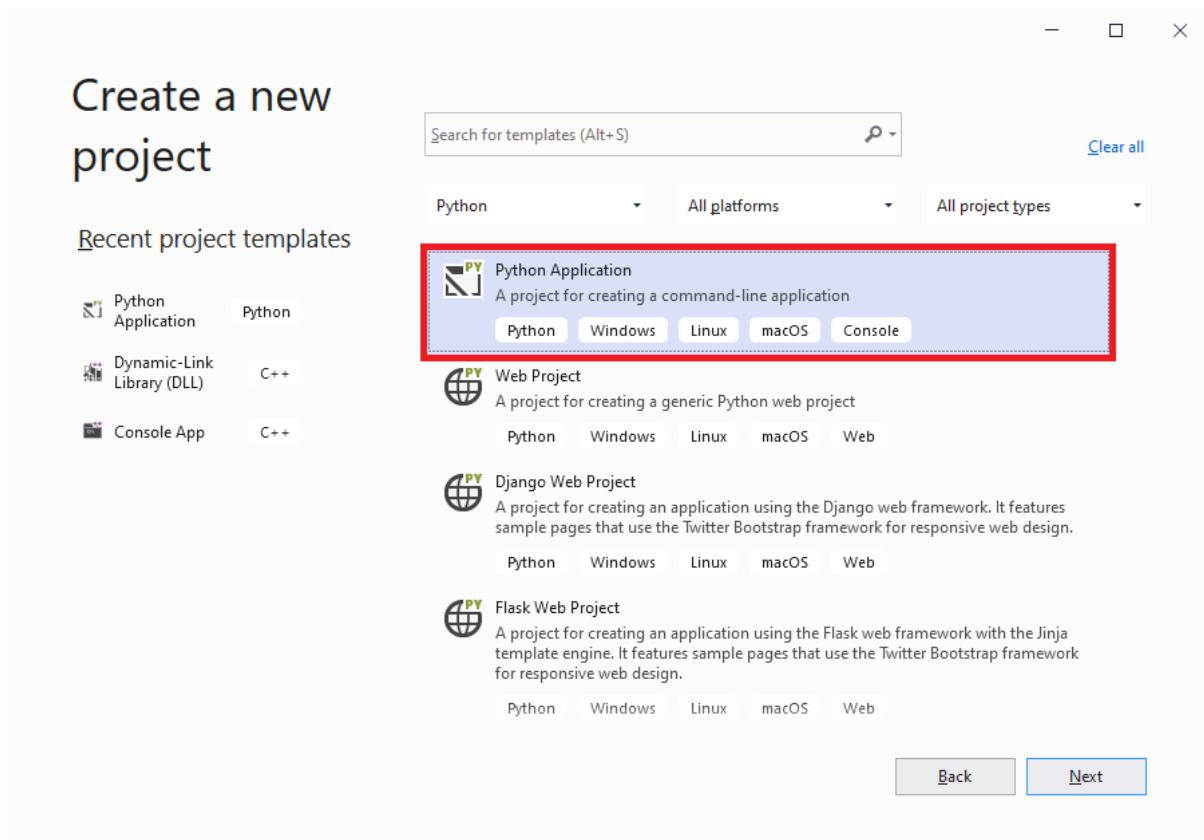
EtherCAT network adapter MAC: 64-70-02-04-D9-A3
EcMasterDemoPython is running.
Type demo.help() for interactive help.
>>> |

```

Ln: 25 Col: 4

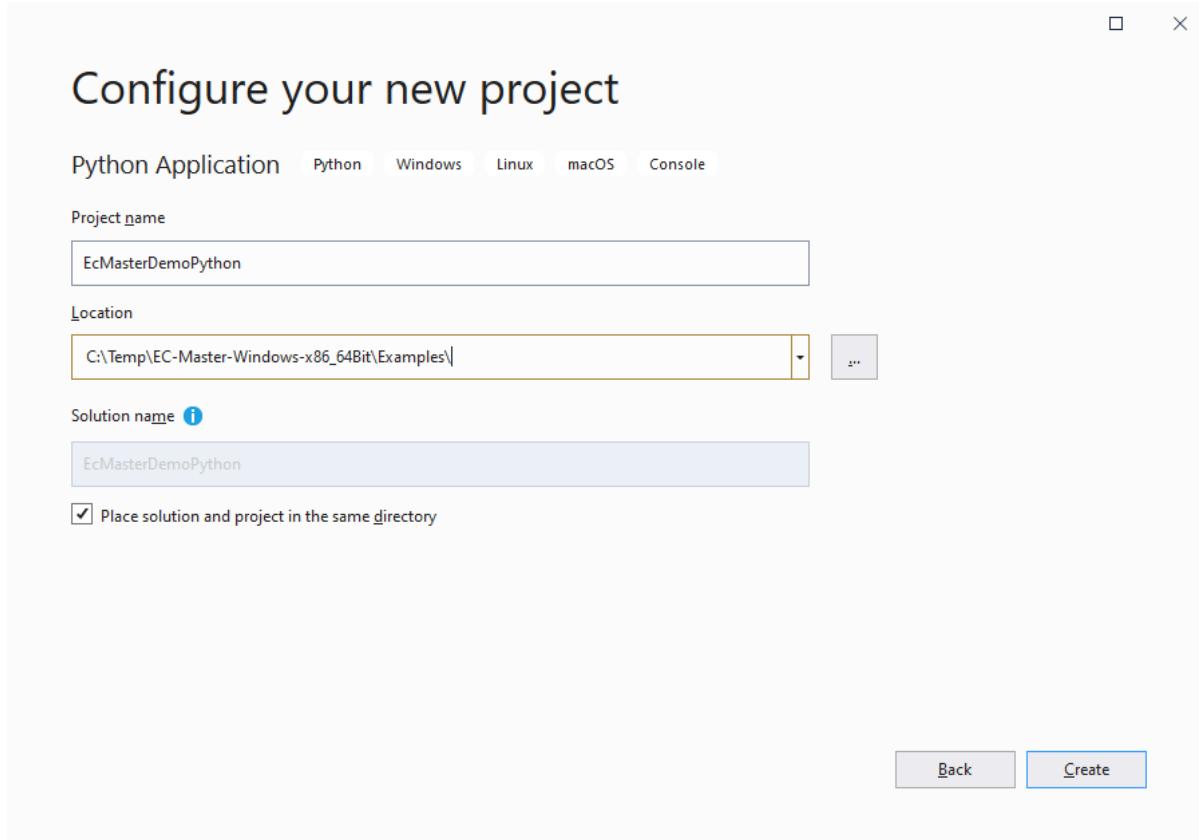
## 2.4.2 Visual Studio 2019

Create a new project:

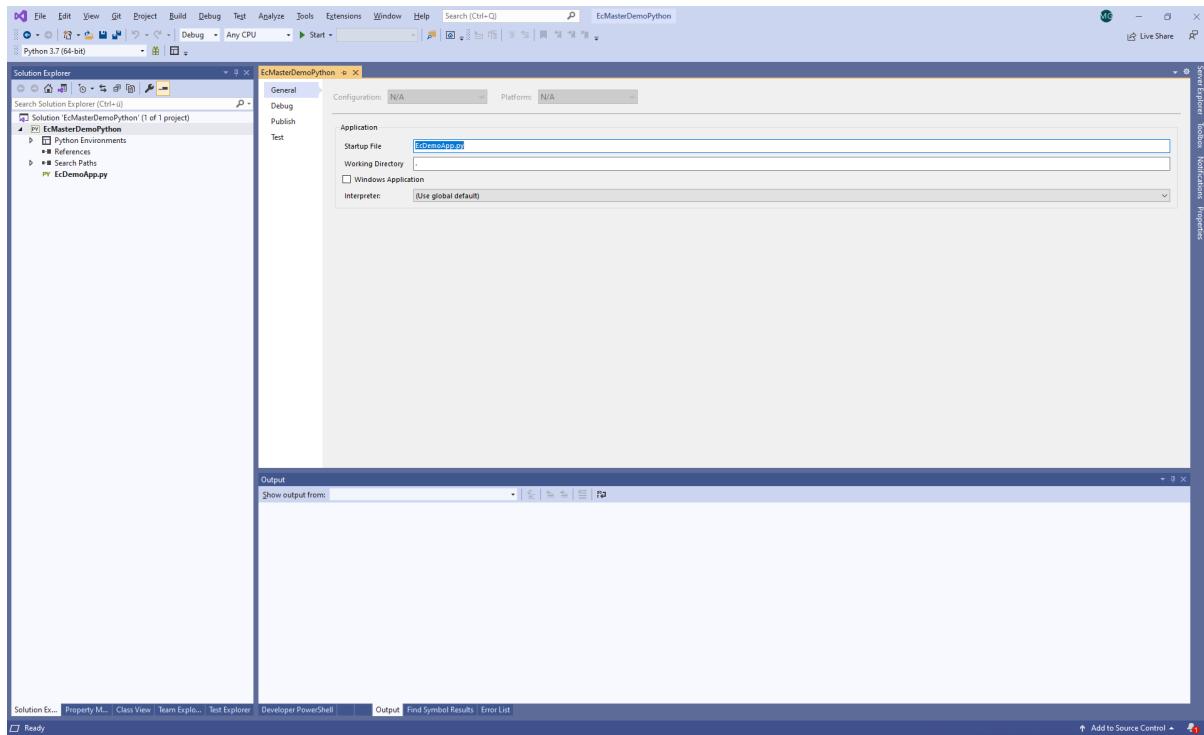


**Configure the project:**

- Replace the generated file EcMasterDemoPython.py with the existing EcDemoApp.py.

**Configure project *General* settings:**

- Startup File: EcDemoApp.py

**Configure project *Debug* settings:**

- Search Paths:

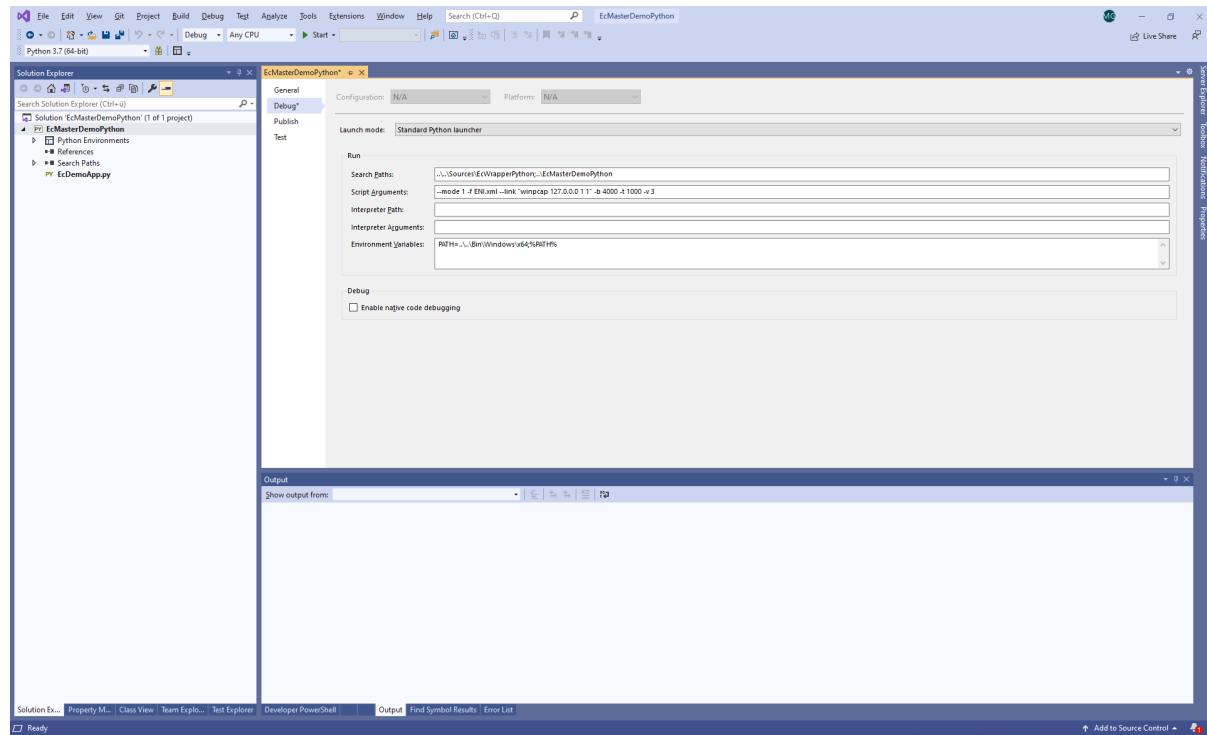
```
.../.../Sources/EcWrapperPython;../EcMasterDemoPython
```

- Script Arguments:

```
--mode 1 -f ENI.xml --link "winpcap 127.0.0.0 1 1" -b 4000 -t 1000 -v 3
```

- Environment Variables:

```
PATH=.../.../Bin/Windows/x64;%PATH%
```

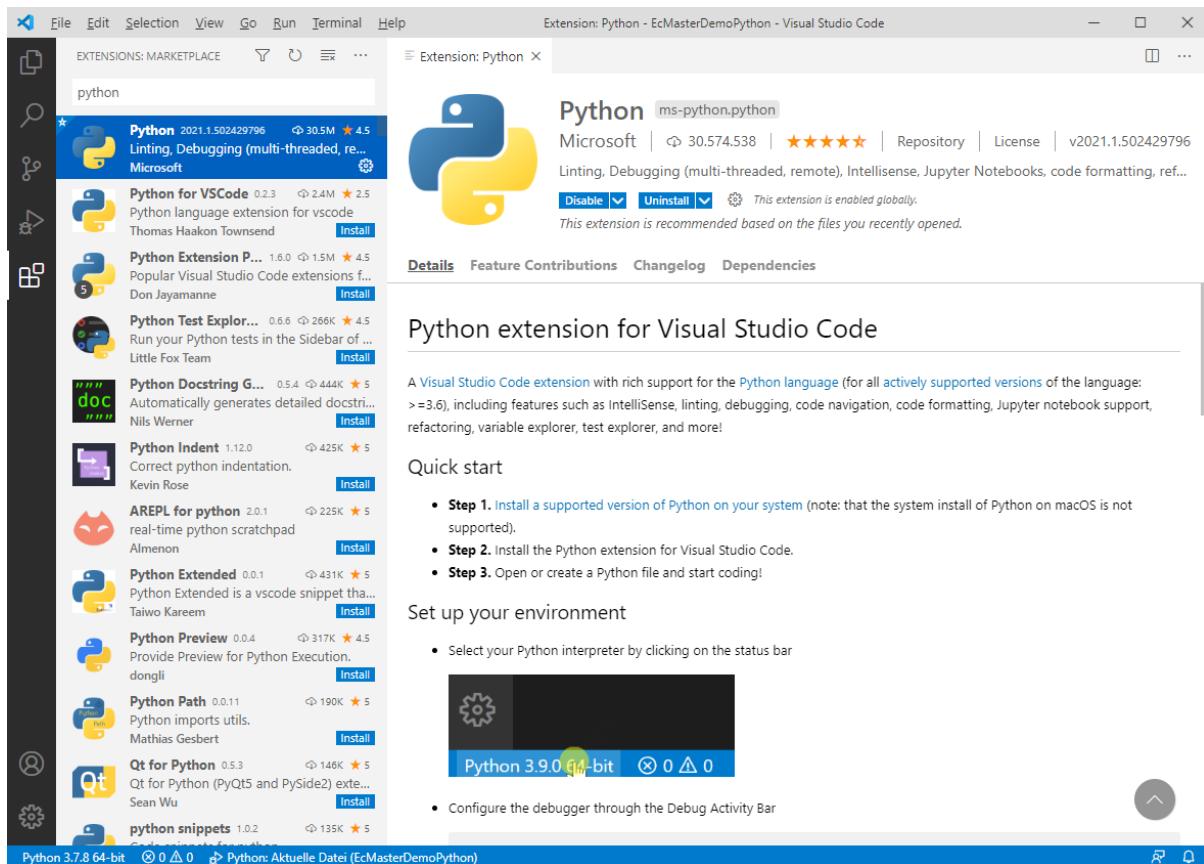


**Press Start and the demo is running:**

```
C:\Program Files (x86)\Microsoft Visual Studio\Shared\Python37_64\python.exe
Connection at Port D: no (to 0xFFFFFFFF)
Connection at Port B: no (to 0xFFFFFFFF)
Connection at Port C: no (to 0xFFFFFFFF)
Line Crossed.....: no
Line Crossed Flags..: 0x00
Cfg Station Address.: 0x03F4 (1012)
PD IN   Byte.Bit offset: 0.0.0   Size: 160 bits
PD OUT  Byte.Bit offset: 0.0.0   Size: 160 bits
*****
Slave ID.....: 0x0000000C
Bus Index.....: -65524
Bus AutoInc Address.: 0xFF4 (65524)
Bus Station Address.: 0x03F5 (1013)
Bus Alias Address...: 0x03F3 (1011)
Vendor ID.....: 0x0000AFFE = VIPA Gesellschaft fuer Visualisierung und Prozessautomatisierung mbH
Product Code.....: 0x0531EC00 = Unknown
Revision.....: 0x00000012 Serial Number: 1260
ESC Type.....: Beckhoff ET1100 (0x11) Revision: 0 Build: 2
Connection at Port A: yes (to 0x00000007)
Connection at Port D: no (to 0xFFFFFFFF)
Connection at Port B: no (to 0xFFFFFFFF)
Connection at Port C: no (to 0xFFFFFFFF)
Line Crossed.....: no
Line Crossed Flags..: 0x00
Cfg Station Address.: 0x03F5 (1013)
PD IN   Byte.Bit offset: 20.0.0   Size: 1112 bits
PD OUT  Byte.Bit offset: 20.0.0   Size: 1016 bits
*****
EcMasterDemoPython runtime: 1.0s ...
Press any key to continue . . .
```

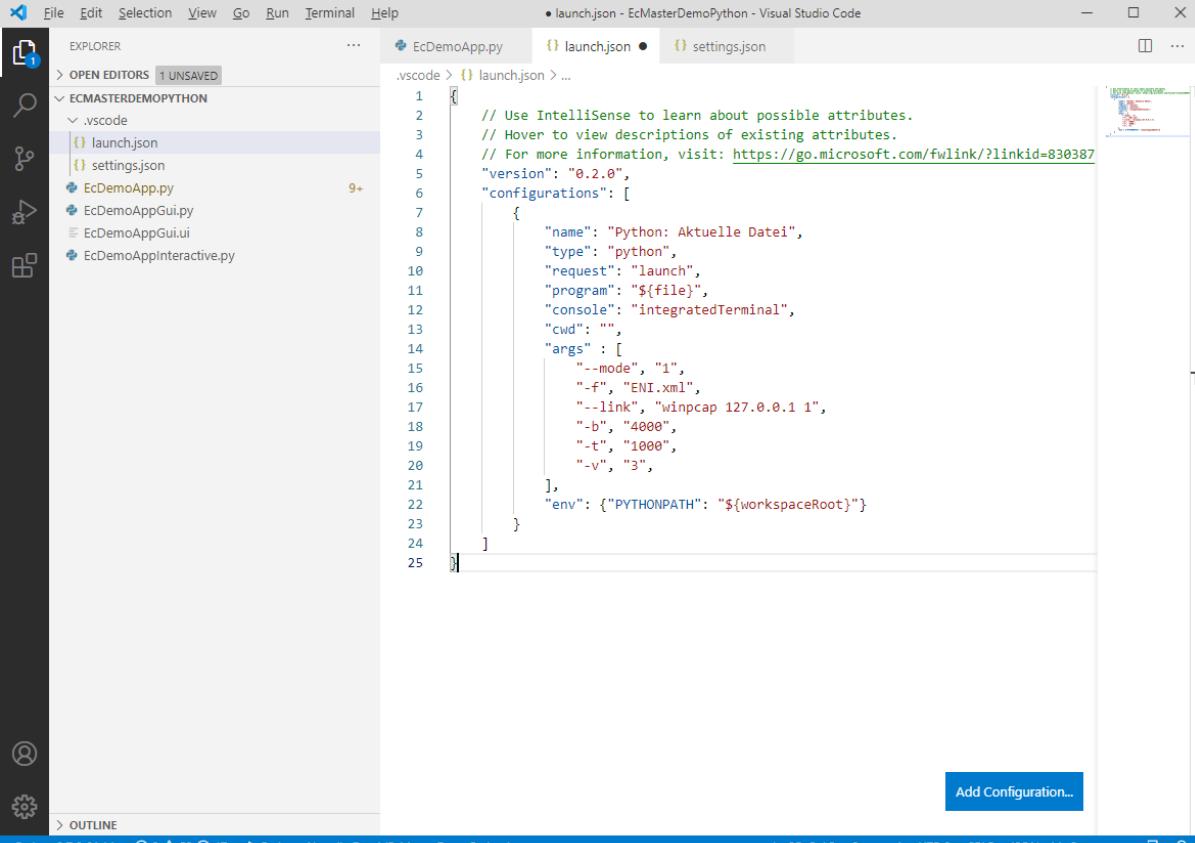
### 2.4.3 Visual Studio Code

Install python extension by open extension tab and enter *python*:



Open folder **Examples/EcMasterDemoPython** and configure the **launch.json**:

```
{
  "version": "0.2.0",
  "configurations": [
    {
      "name": "Python: Aktuelle Datei",
      "type": "python",
      "request": "launch",
      "program": "${file}",
      "console": "integratedTerminal",
      "cwd": "",
      "args": [
        "--mode", "1",
        "-f", "ENI.xml",
        "--link", "winpcap 127.0.0.1 1",
        "-b", "4000",
        "-t", "1000",
        "-v", "3"
      ],
      "env": { "PYTHONPATH": "${workspaceRoot}" }
    }
  ]
}
```



The screenshot shows the Visual Studio Code interface with the following details:

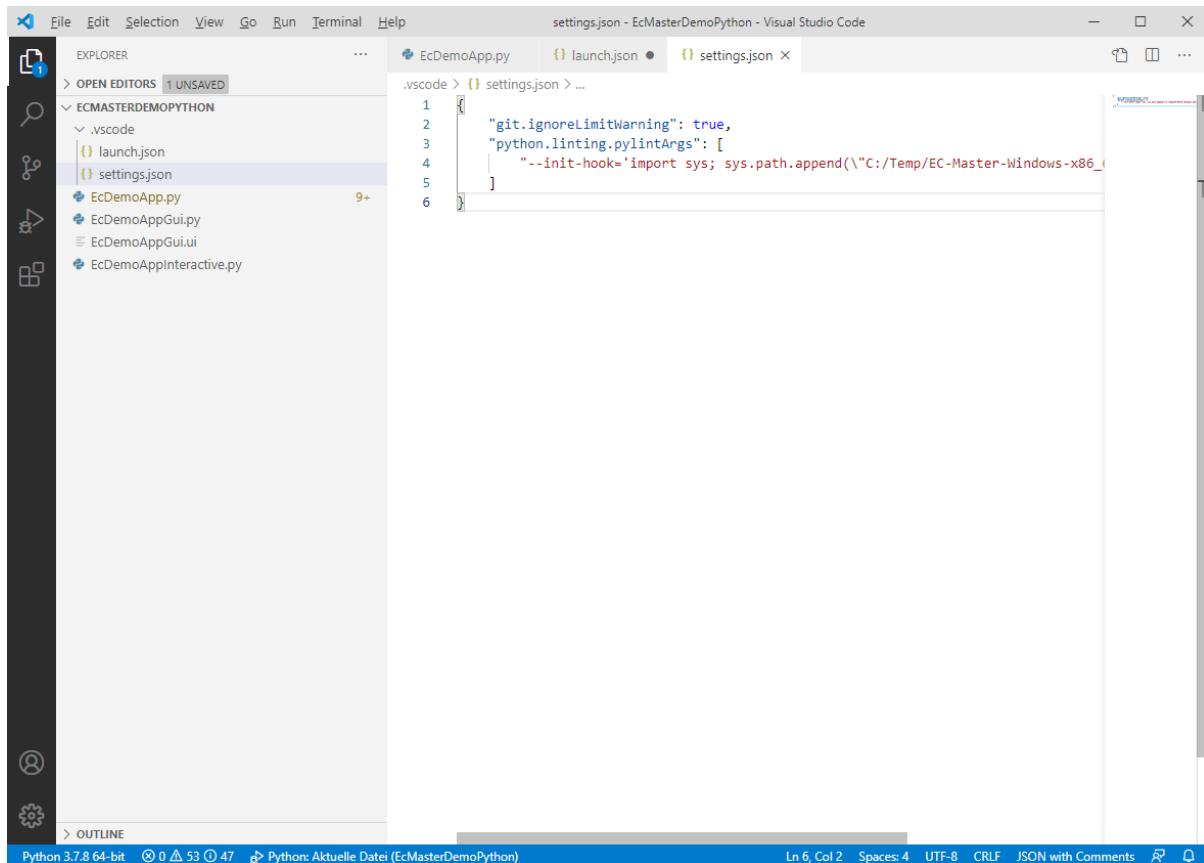
- File Bar:** File, Edit, Selection, View, Go, Run, Terminal, Help.
- Explorer:** Shows the project structure under "ECMASTERDEMOPYTHON".
- Editor:** The "launch.json" file is open, showing its contents. The code is as follows:

```
// Use Intellisense to learn about possible attributes.
// Hover to view descriptions of existing attributes.
// For more information, visit: https://go.microsoft.com/fwlink/?linkid=830387
"version": "0.2.0",
"configurations": [
    {
        "name": "Python: Aktuelle Datei",
        "type": "python",
        "request": "launch",
        "program": "${file}",
        "console": "integratedTerminal",
        "cwd": "",
        "args": [
            "--mode", "1",
            "-f", "ENI.xml",
            "--link", "winpcap 127.0.0.1 1",
            "-b", "4000",
            "-t", "1000",
            "-v", "3"
        ],
        "env": {"PYTHONPATH": "${workspaceRoot}"}
    }
]
```

- Bottom Status Bar:** Python 3.7.8 64-bit, 0 errors, 47 warnings, Python: Aktuelle Datei (EcMasterDemoPython), Line 25, Column 2, Spaces: 4, UTF-8, CRLF, JSON with Comments.

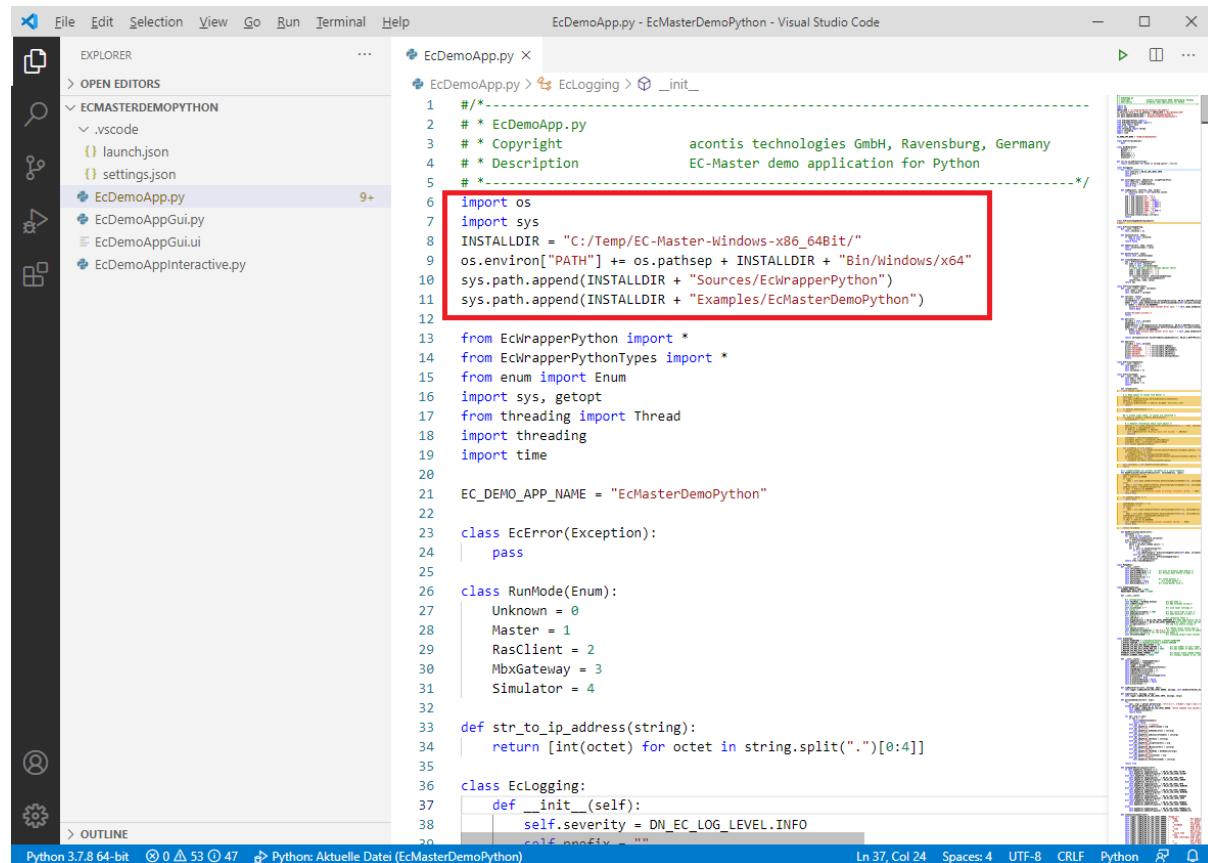
Configure linter in **settings.json**:

```
{
    "git.ignoreLimitWarning": true,
    "python.linting.pylintArgs": [
        "--init-hook='import sys; sys.path.append(\"C:/Temp/EC-Master-
        ↵Windows-x86_64Bit/Sources/EcWrapperPython\")'"
    ]
}
```



**Open EcDemoApp.py and the following lines to set environment:**

```
import os
import sys
INSTALLDIR = "C:/Temp/EC-Master-Windows-x86_64Bit/"
os.environ["PATH"] += os.pathsep + INSTALLDIR + "Bin/Windows/x64"
sys.path.append(INSTALLDIR + "Sources/EcWrapperPython")
sys.path.append(INSTALLDIR + "Examples/EcMasterDemoPython")
```

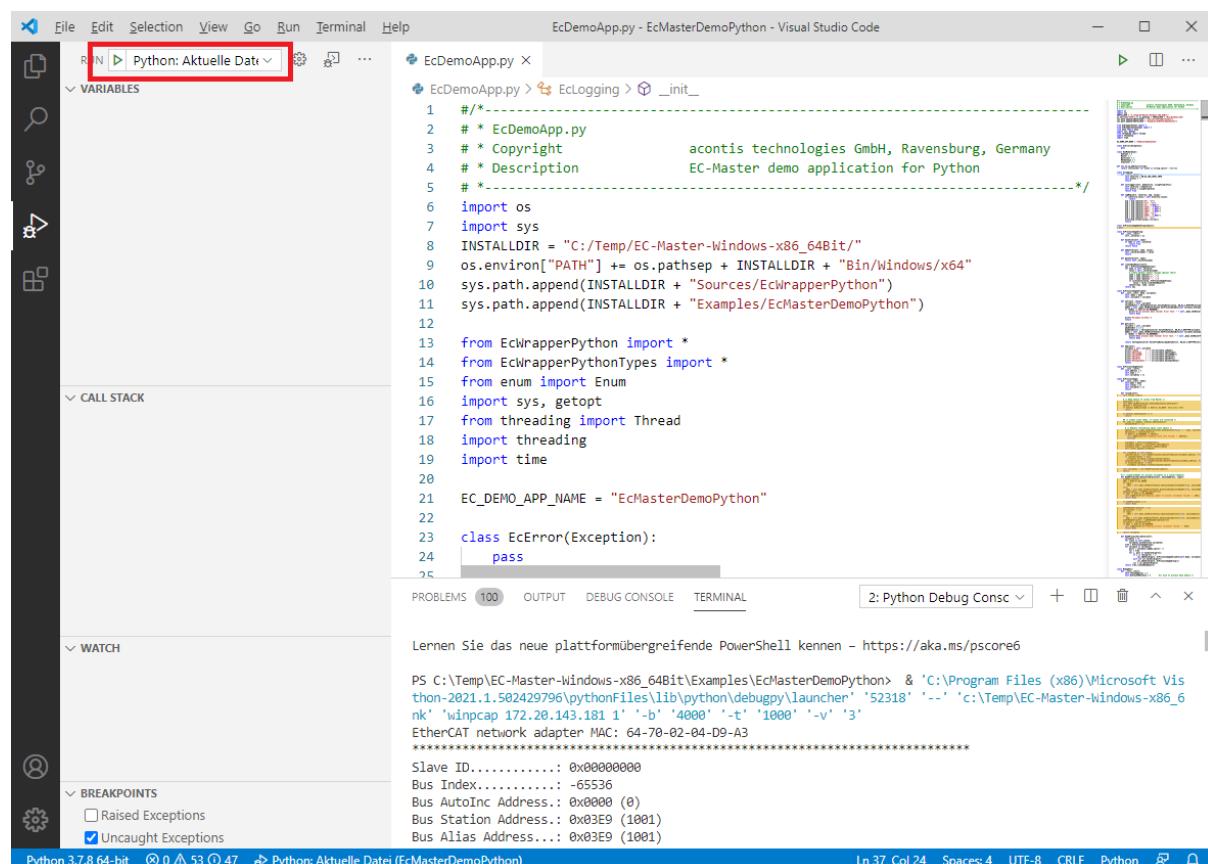


```

1  #!/*
2  # * EcDemoApp.py
3  # * Copyright      acontis technologies GmbH, Ravensburg, Germany
4  # * Description    EC-Master demo application for Python
5  # */
6  import os
7  import sys
8  INSTALLDIR = "C:/Temp/EC-Master-Windows-x86_64Bit/"
9  os.environ["PATH"] += os.pathsep + INSTALLDIR + "Bin/Windows/x64"
10 sys.path.append(INSTALLDIR + "Sources/EcWrapperPython")
11 sys.path.append(INSTALLDIR + "Examples/EcMasterDemoPython")
12
13 from EcWrapperPython import *
14 from EcWrapperPythonTypes import *
15 from enum import Enum
16 import sys, getopt
17 from threading import Thread
18 import threading
19 import time
20
21 EC_DEMO_APP_NAME = "EcMasterDemoPython"
22
23 class EcError(Exception):
24     pass
25
26 class RunMode(Enum):
27     Unknown = 0
28     Master = 1
29     RasClient = 2
30     MbxGateway = 3
31     Simulator = 4
32
33 def str_to_ip_address(string):
34     return [int(octet) for octet in string.split(".")[0:4]]
35
36 class EcLogging:
37     def __init__(self):
38         self.severity = DN_EC_LOG_LEVEL.INFO
39         self.prefix = ""
40

```

**Start debugging and the demo output will be written into the terminal:**



```

Python: Aktuelle Datei (EcMasterDemoPython)
Lernen Sie das neue plattformübergreifende PowerShell kennen - https://aka.ms/pscore6
PS C:\Temp\EC-Master-Windows-x86_64Bit\Examples\EcMasterDemoPython> & 'C:\Program Files (x86)\Microsoft Visual Studio-2021.1.582429\96\python\files\lib\python\debugpy\launcher' '52318' '--' 'c:\Temp\EC-Master-Windows-x86_64Bit\Examples\EcMasterDemoPython\EcDemoApp.py'
EtherCAT network adapter MAC: 64-70-02-04-D9-A3
*****
Slave ID.....: 0x00000000
Bus Index.....: -65536
Bus AutoInc Address.: 0x0000 (0)
Bus Station Address.: 0x03E9 (1001)
Bus Alias Address...: 0x03E9 (1001)

```

### 3 FAQ

PyQt5 cannot be installed on Ubuntu 14.04 x64, because it requires Python 3.5. How can I install it?

It can be installed by calling

```
$ sudo apt-get install python3-pyqt5
```

I installed Python and the demo crashes with strange errors. What can I do?

This might be a problem of mixing x86 with x64 binaries. Verify that if you have installed the Python runtime for x64 bit, please install also EC-Master for x64 bit.