

Connecting a PLC to a SQL Database

Level 4	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended
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Original Application Note

Original document is the German version of this document.

Translation

All non-German language versions of this document are translations of the original application note.

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DANGER!
DANGEROUS ELECTRICAL VOLTAGE!

Before commencing the installation

- Installation requires qualified electrician.
- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 part 100) may work on this device/ system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or to the potential equalizing. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the technical data, otherwise this may cause malfunction and dangerous operation.
- Emergency-Stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency switching off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state, desk-top devices or portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency switching off devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks, etc.).

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Content

1	What is SQL?	6
2	MsSQL	7
2.1	MsSQL-Server Installation	7
2.2	MsSQL-Server Configuration	11
2.3	Establish a connection to the MsSQL-Server	15
3	MySQL	18
3.1	MySQL-Server Installation	18
4	SQL in AWS (Amazon Web Service)	22
4.1	MySQL:	22
4.2	MsSQL:	22

1 What is SQL?

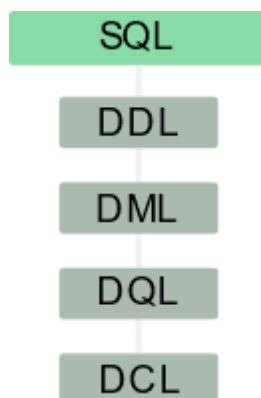
SQL (Structured Query Language) is a database-language to create relational database structures. It is designed to add, change or delete data in an easy way. SQL is standardized, but there are still some "SQL-dialects" and that's why a 100% compatibility between different systems cannot be guaranteed. The most known free databases are MySQL and PostgreSQL. But also the MsSQL database from Microsoft is a widespread but commercial database.

Relational databases are characterized by the fact that elements of the real life can be mapped in a data-model. They consist of tables which saves their data in rows and columns. The columns are called attribute and the rows are also called tuple.

Attribut 1	Attribut 2	Attribut 3
Wert	Wert	Wert
Wert	Wert	Wert

SQL commands can be divided into four categories:

- DDL: Data Definition Language (Daten Definitions Sprache)
 - Create databases
 - e.g. "CREATE TABLE", "DROP INDEX", ...
- DML: Data Manipulation Language (Daten Manipulations Sprache)
 - Write, change and delete data inside the database
 - e.g. "INSERT INTO", "DELETE FROM", ...
- DQL: Data Query Language (Daten Abfrage Sprache) - Kein allgemeiner Standard
 - Retrieving data with conditions
 - e.g. SELECT FROM
- DCL: Data Control Language (Daten-Kontroll-Sprache)
 - Rights management and transaction control
 - e.g. "GRANT ON TO", "REVOKE", ...



There are some libraries available to realize a database connection from a PLC. These libraries can also be used on EATON PLCs. Only the CODESYS V3 version is considered below. Two libraries from the CODESYS Store (license needed) and a library from EATON (which was converted from old CODESYS V2 to V3) were tested. In addition, you can find a SQL4automation connector in the CODESYS Store which can also be used for a database connection. Further information on this can be found here: [SQL4automation - Funktionen - SPS S7 | SQL4Automation](#)

Eaton PLCs which support these SQL libraries:

Device/Database	MsSQL		MySQL
	CodeSys V3 library	Eaton library	CoDeSys V3 library
XV100	X	X	X
XV300	X	X	X
XC300	X	X	X

The following descriptions and tests were carried out with the CODESYS 3.5.16 BF4 and the devices XC303, XV303 and XV102 with runtime version 3.5.16.60.

2 MsSQL

The MsSQL library for connecting a PLC to an MsSQL database can be downloaded from the CODESYS store. It can be tested for 30minutes without functional restrictions. For an unlimited use you can purchase a license certificate in the CODESYS store.

There is also a user guide available that explains the most important steps from installing the server to connecting to the database from the PLC via the function blocks. In this case the library version 1.4.0.5 was used.

For examples and libraries see: [MsSQL - Files for Application Note \(Part 1\) & MsSQL - Files for Application Note \(Part 2\)](#)

There is also a documentation for the MsSQL library from EATON. It refers to CODESYS V2, but it can be transfered 1:1 to CODESYS V3.

See: [MsSQL - Files for Application Note \(Part 1\) & MsSQL - Files for Application Note \(Part 2\)](#)

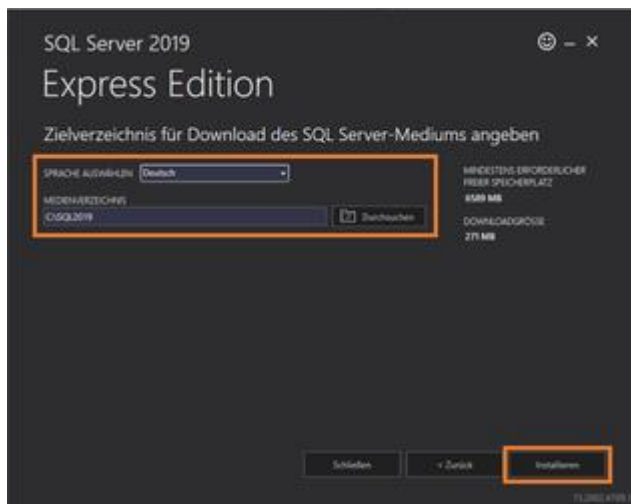
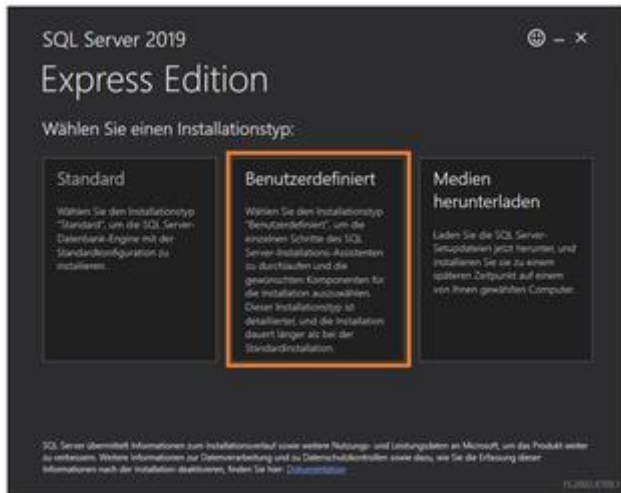
2.1 MsSQL-Server Installation

The Microsoft SQL-Server available in different version on the Microsoft website (free Express Edition oder chargeable Enterprise Edition). The main differences between these versions are the size of the database, the number of possible users and the required memory. The most important steps when installing an MsSQL server are listed below. Therefor the SQL Server 2019 Express Edition was used.

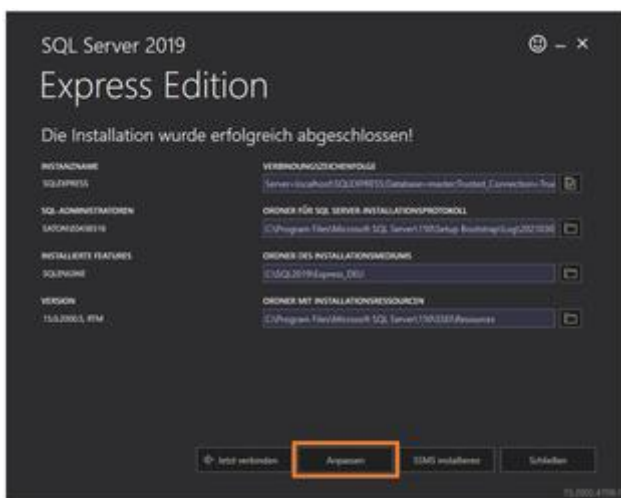
Download-link: [SQL Server Downloads | Microsoft](#)

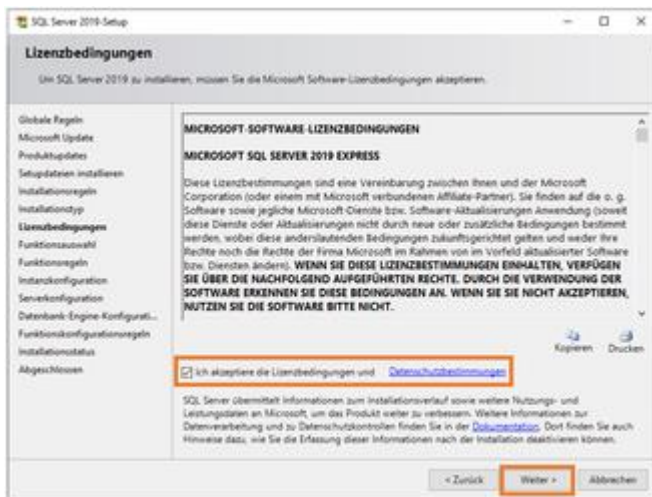
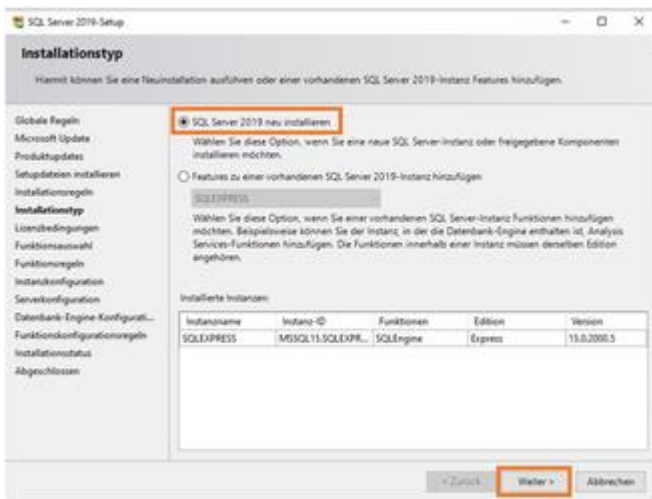
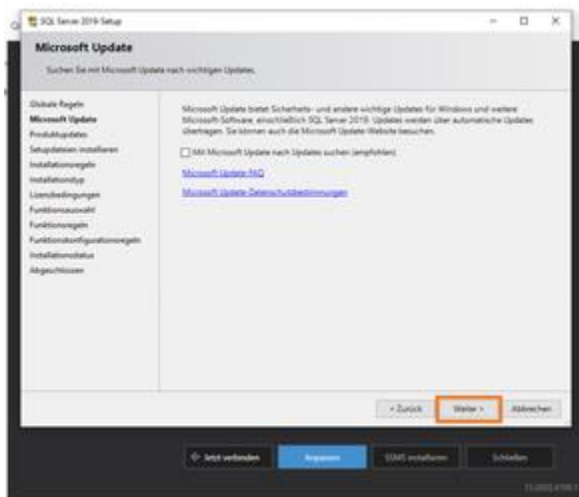
Installation-Exe see: [MySQL - Files for Application Note \(Part 1\)](#) & [MySQL - Files for Application Note \(Part 2\)](#)

Choose user-defined Installation:

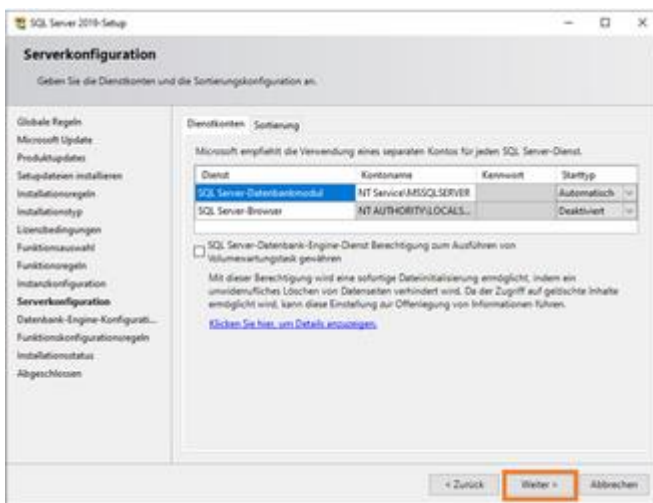
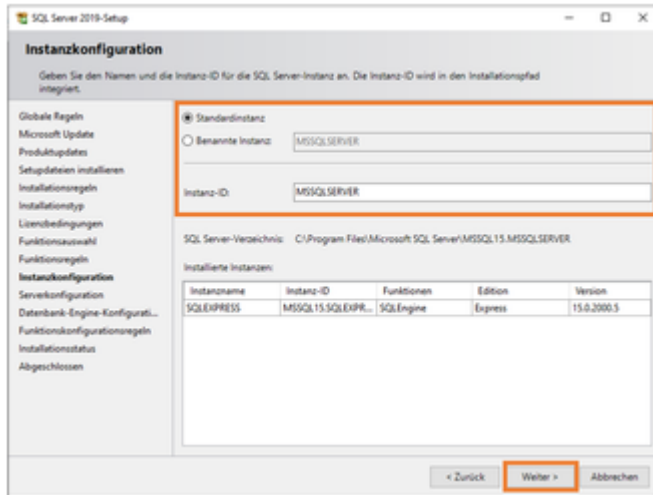


After successful installation of the installer, the installation and configuration of the SQL server takes place:

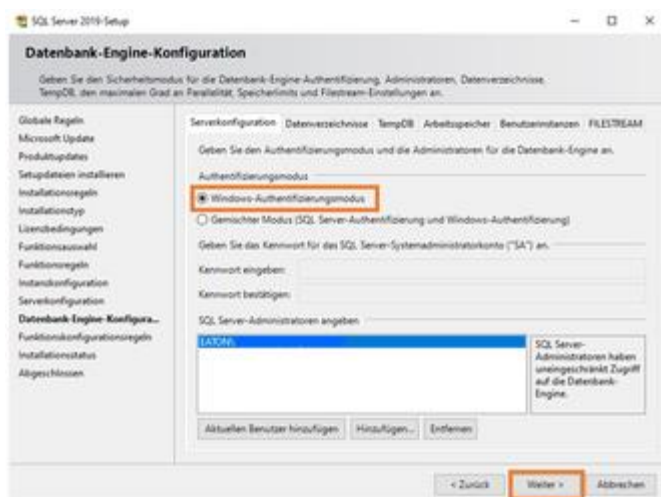




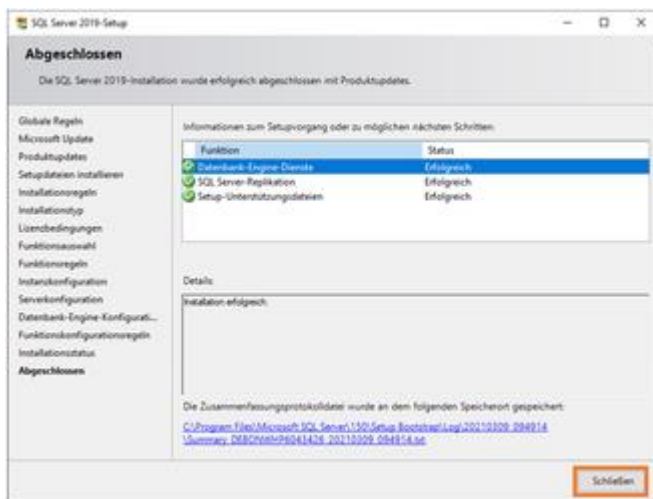
Renaming the SQL Server instance:



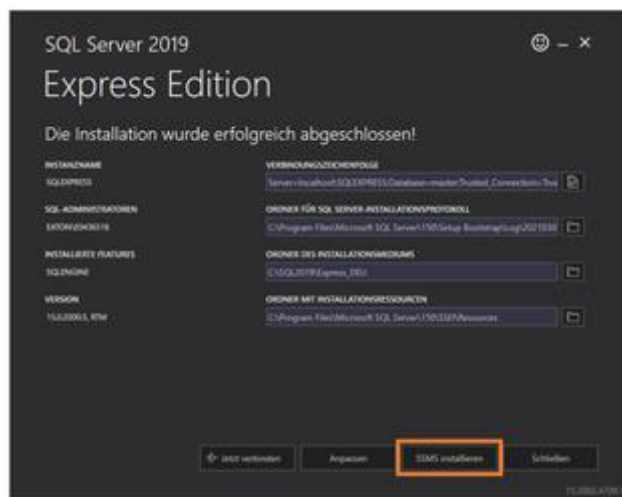
We select the Windows authentication mode as authentication mode. This means we can use the same username and password to log on to the SQL server as we use to log on to Windows.



After the successful installation of the SQL Server, the setup can be completed.

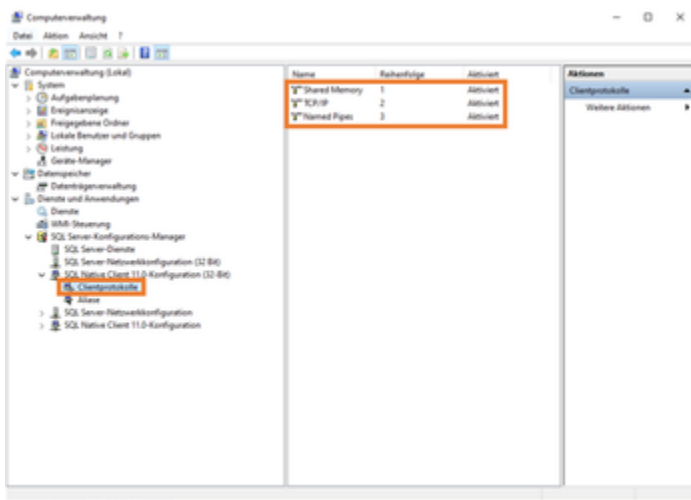


An important tool for using a SQL Server is the Microsoft SQL Server Management Studio (SSMS). With this tool you can establish a connection to the server and read/write data.



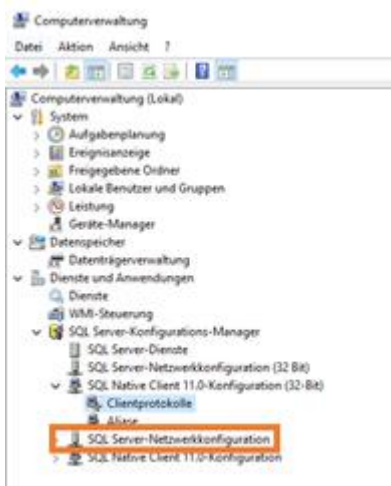
2.2 MsSQL-Server Configuration

In order to configure the server for external access (from the PLC), you will have to open the computer management and activate all three client protocols.

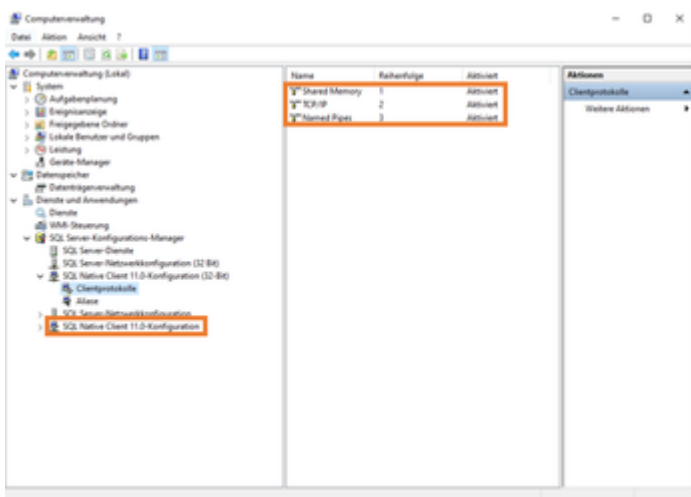


With a double-click on the TCP/IP protocol you can define further properties such as the default-port of the SQL server. By default, the port is set to 1433.

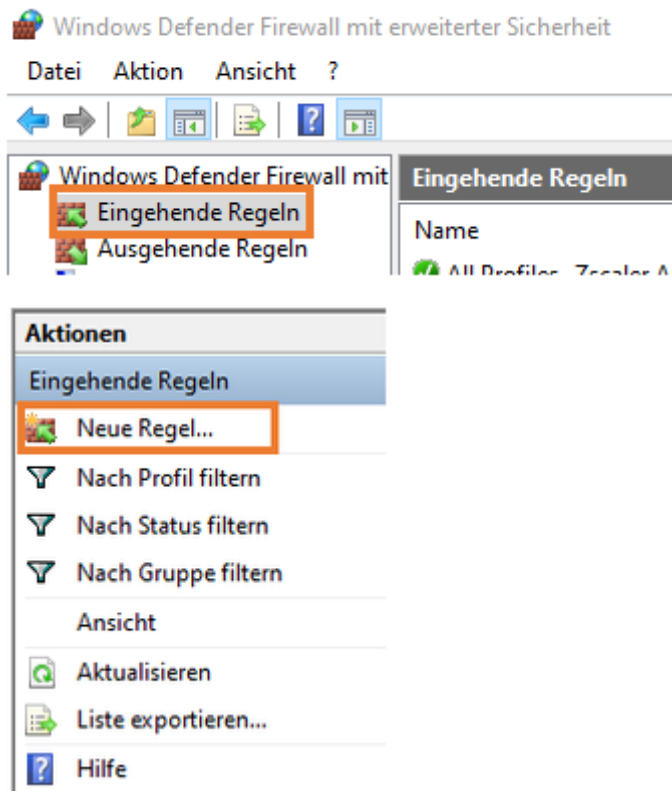
In the SQL Server network configuration, you can also define which IP addresses can get access to the SQL Server.



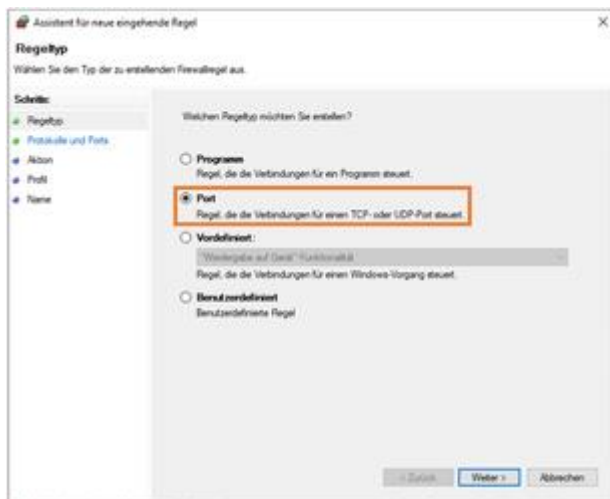
If you have installed a 64-bit SQL Server, you must also activate all three protocols in the SQL Native Client 11.0 configuration.



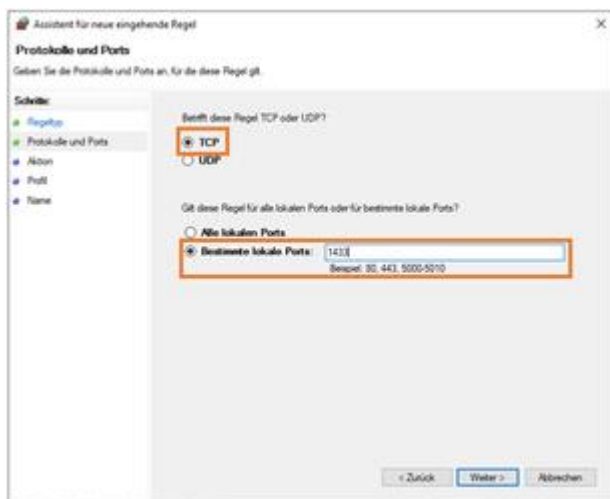
In addition, the port for the connection to the SQL server must be released in the firewall. A new "Incoming rule" is defined for this.



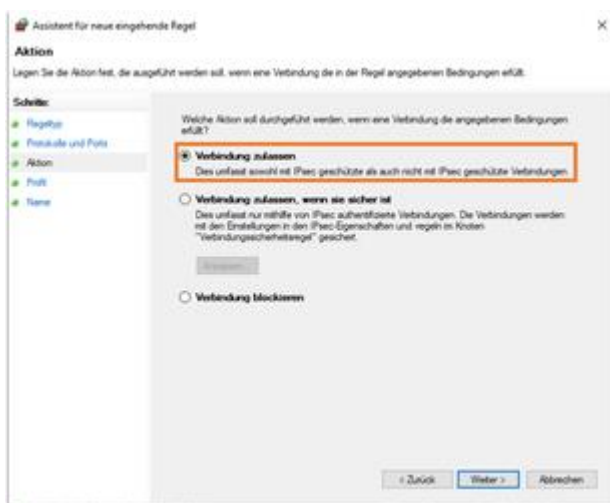
Rule-type: Port



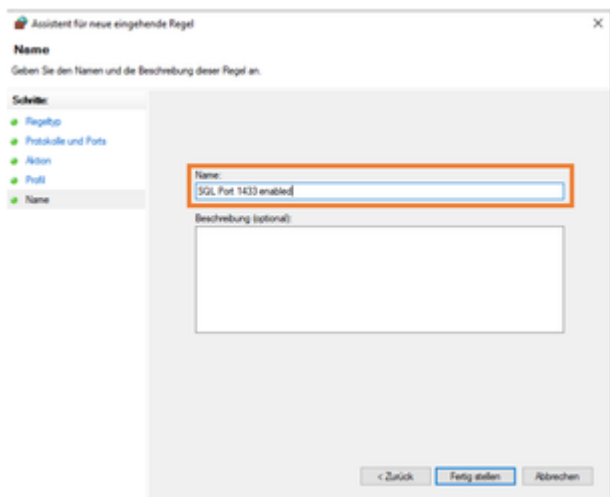
For TCP we choose port 1433 - default port for SQL server. If you have changed the default-port in previous settings, you will have to insert the correct port here.



Incoming connections via the configured port should be permitted.

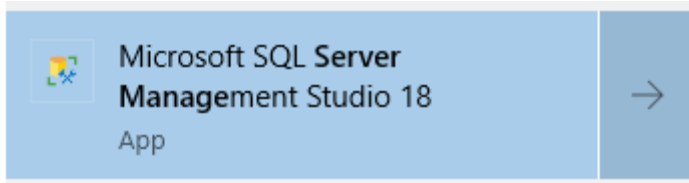


Finally you will have to define a name for the rule.

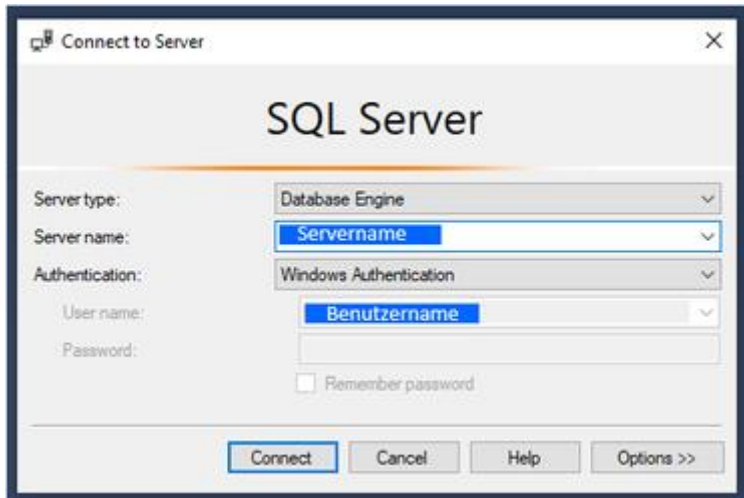


2.3 Establish a connection to the MsSQL-Server

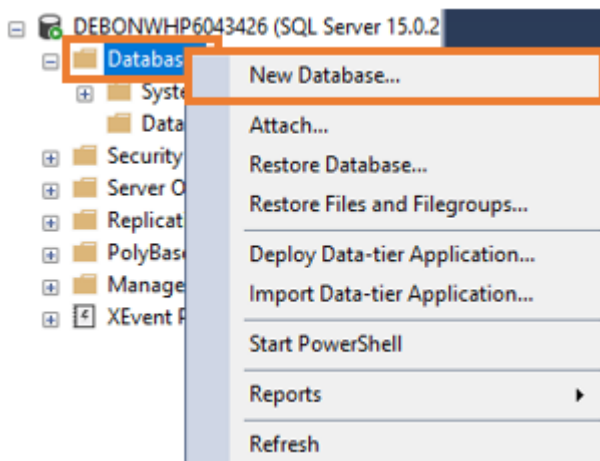
Start the SQL Server Management Studio to establish a first connection to the SQL server.

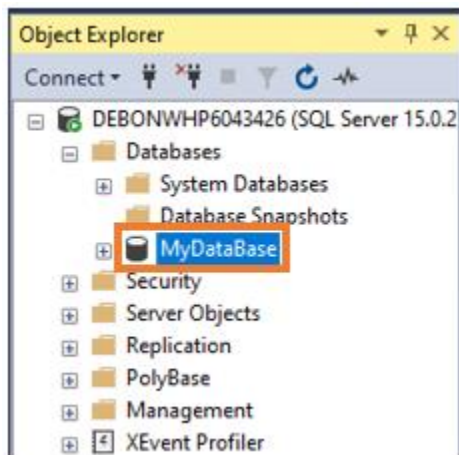
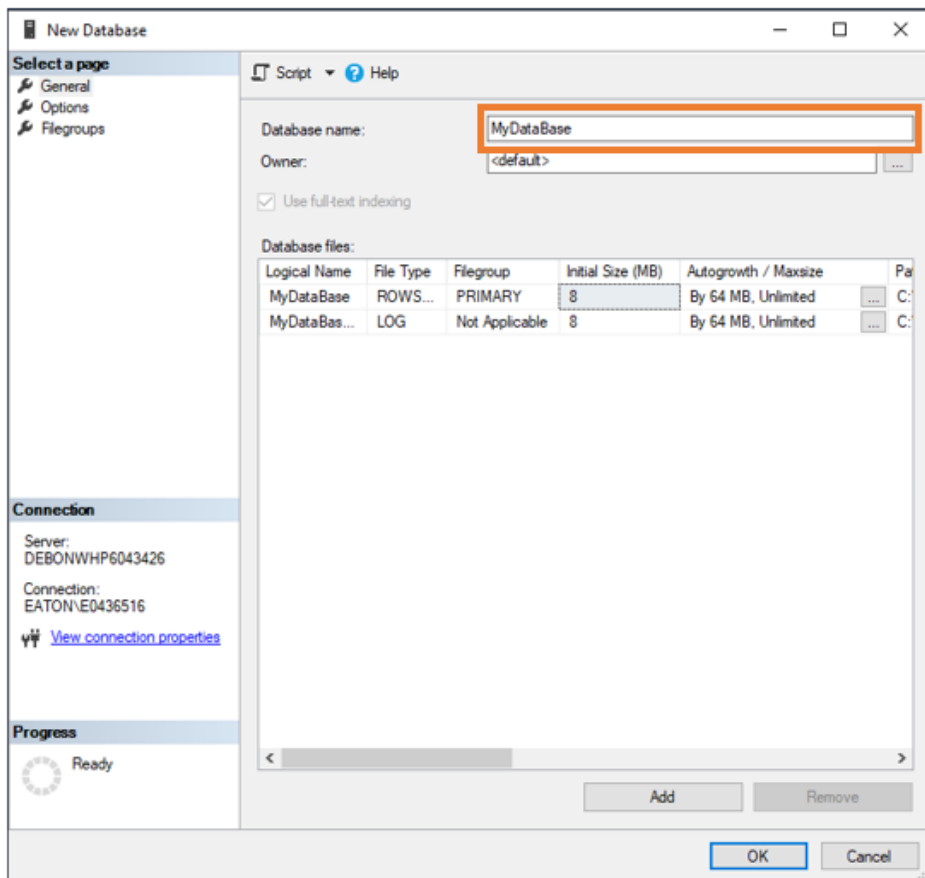


Put in the correct server and username and establish a connection.

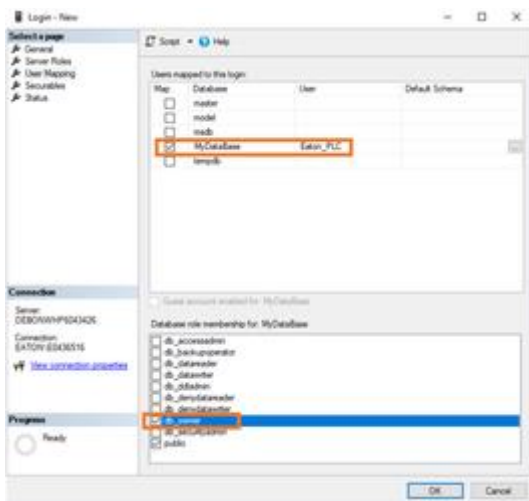
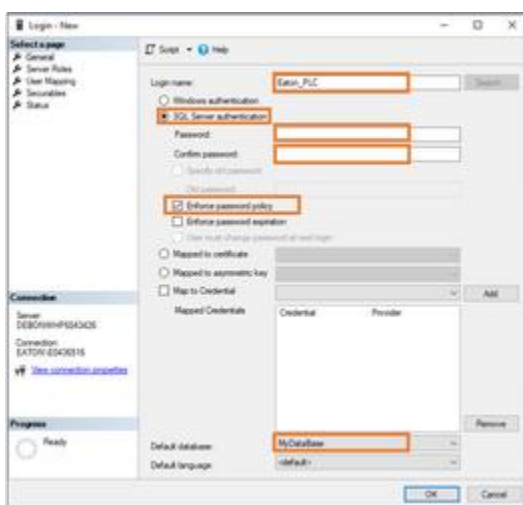
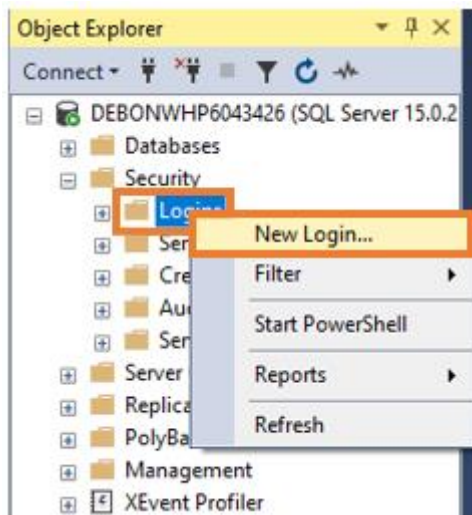


Add a new database:

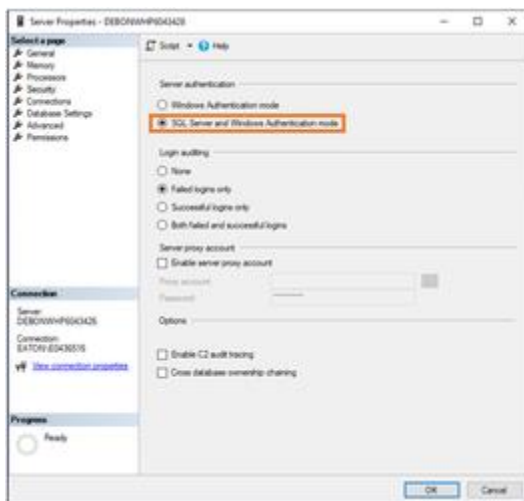
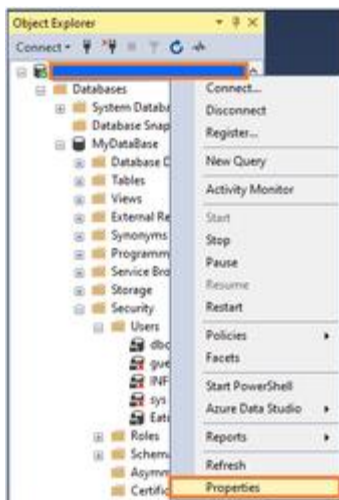




Create a new login which can be used for the connection from the PLC.



Change the server authentication to "SQL Server and Windows Authentication mode":



After successfully configuring the authentication, a connection can be established from the PLC to the SQL server. Therefore you can use the provided demo-projects.

3 MySQL

CODESYS offers a library in the store to establish a connection to a MySQL database. In this case version 1.1.0.0 was used. The library was created and supported by the company Pfänder. Currently only a communication to a MySQL server 5.x or lower is supported. The latest version is MySQL 8.x. and is the direct successor version of MySQL 5.x.

For this library there is also a documentation and a demo-application available.

See: [MySQL - Files for Application Note.zip](#)

3.1 MySQL-Server Installation

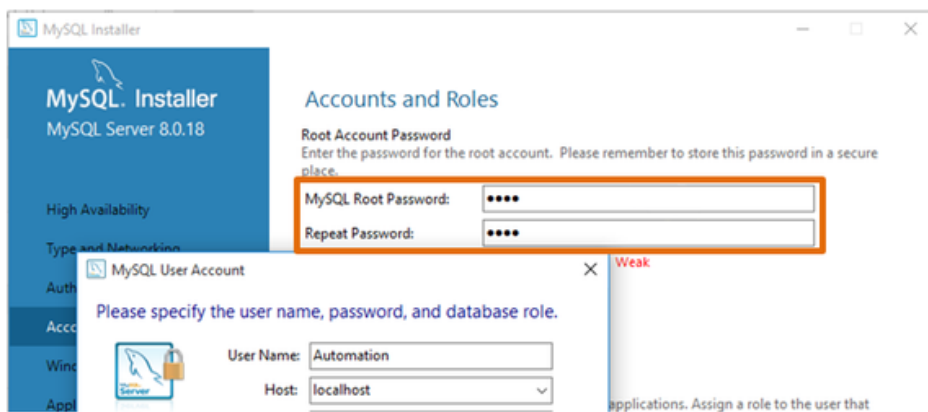
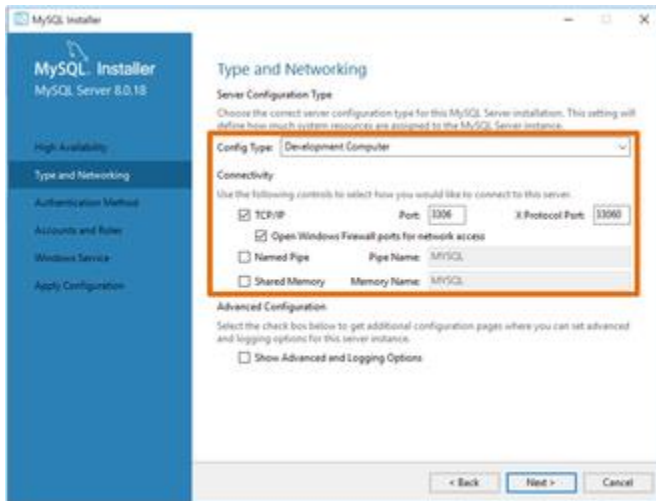
The Installationfiles can be downloaded here:

[MySQL :: Download MySQL Installer \(Archived Versions\)](#)

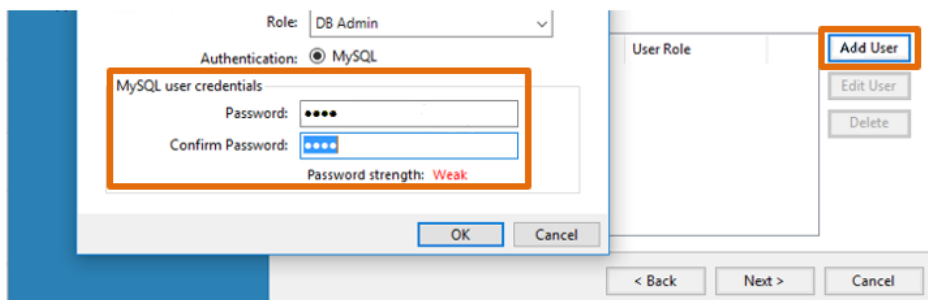
In case that no python is installed on your system, you will also have to install it:

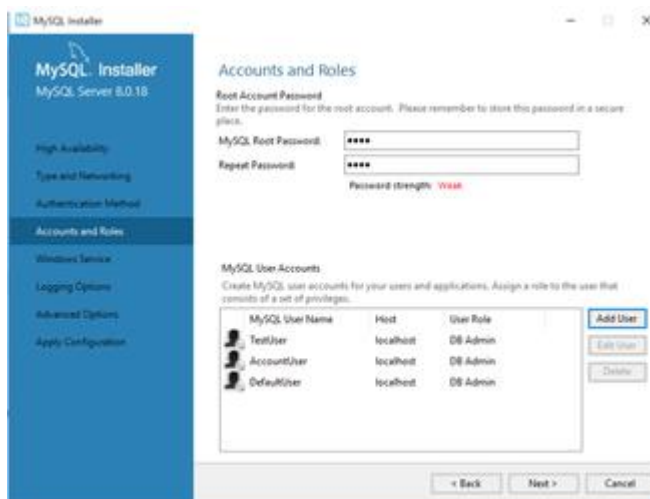
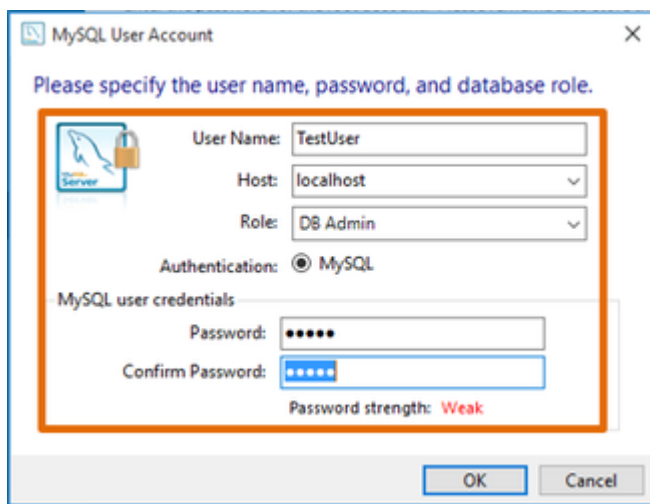
MySQL :: Download MySQL for Visual Studio

During the installation of a MySQL server, some network- and userdefined settings have to be done:

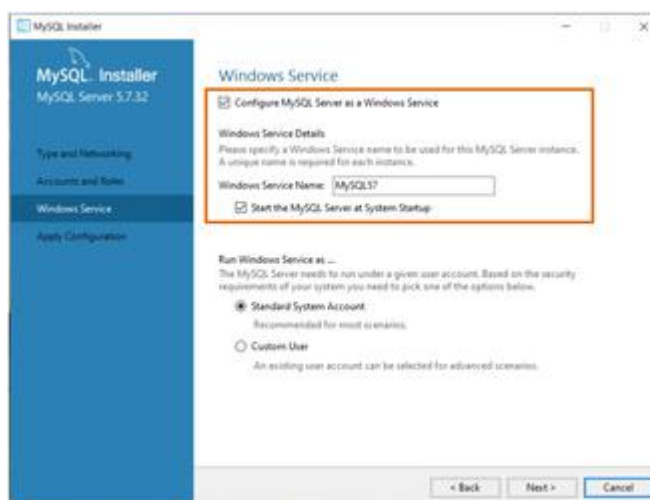


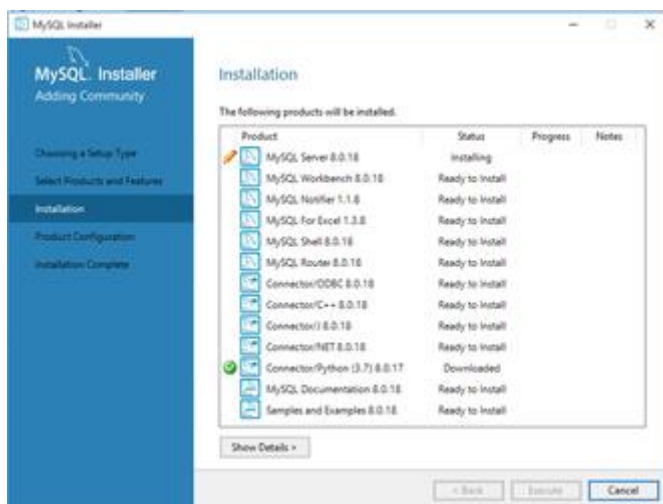
It is recommended to add an additional user, which can be used to login to the database from the PLC.



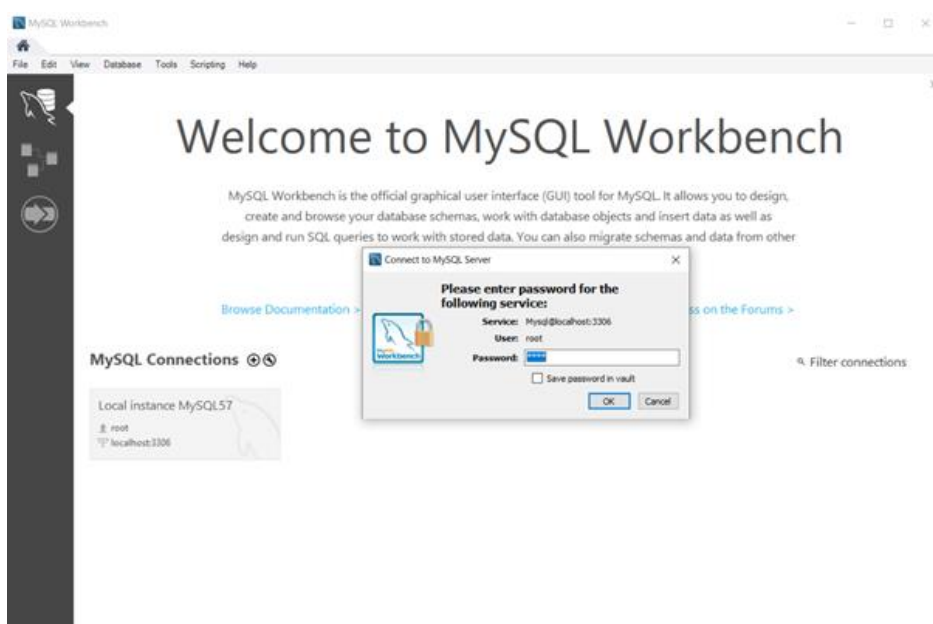


It is important that the MySQL Server is configured as Windows service, so it will be automatically started when the system is booted.





After the installation you can use the tool "MySQL Workbench" to test a connection to the database.



Or use the PLC:

MySQL Library simple visu example

MySQL Library V1.1 for CODESYS V3.5

Connection (MySQL_Open and MySQL_Close)

IP Address/Host
192.168.119.55

Port
3306

Username
Eaton_PLG

Password
1234

Database
MyDataBaseTest

Connect MySQL
Disconnect MySQL

Current step:
CONNECTED WITH DATABASE - "MyDataBaseTest"

Error:
0

Execute MySQL command (MySQL_Exec)

E[0]
CREATE TABLE kunden (kunden_id INT, kunden_name VARCHAR(50));

E[1]

E[2]

E[3]

E[4]

Execute Command

Current step:
EXECUTE DONE - AFFECTED ROWS: 0

Error:
0

4 SQL in AWS (Amazon Web Service)

A connection to databases in the RDS (Relational Database Service) from Amazon can be made with the function modules from the CODESYS Store. Functional tests with a MySQL and MsSQL database were successful.

4.1 MySQL:

- The database specified in the function-block corresponds to the SCHEMA on the server.
- If there is no SCHEMA defined, delete the name of the database in the function-block and click "Connect MySQL" → After a successful connection a new SCHEMA can be created from the PLC (e.g. CREATE SCHEMA kunden)
- Now you can disconnect from the server and type in the name of your SCHEMA as database in the function-block → Connect to the database and create a new table (e.g. CREATE TABLE kunden)
- The function-blocks only support MySQL version 5 or lower → must be taken into account when creating the database in AWS



4.2 MsSQL:

- For a connection to a MsSQL database in AWS a database must be already created
- The name of the database must be inserted into the database-box → Connect to the MsSQL database
- Now you can create a new table in the database (e.g. CREATE TABLE dbo.kunden)



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