What is TcFlexMeter?

TcFlexMeter is a flexible metering and data logger based on TwinCAT.

Configuration instead of programming.
A machine should be monitored

measuring technicians have to equip a machine with sensors

The data acquisition can be configured by an easy to use graphical user interface

The Beckhoff controller processes the data and stores it on a local SQL Server
Use cases

1. Configuration
Use cases

2. Data acquisition
Key features

- Easy to use
- Based on TwinCAT
- Extendable
- MS SQL
TcFlexMeter

- TcFlexMeter is based on the TcWind Framework

TcWind Framework

- Beckhoff product TF8310
- Used by our costumers
- Database and logging implementation
- Status codes and parameter management
- Good experience in performance and stability
**Parts of TcFlexMeter / general definitions**

- **Configurator**
- **Logger**
- **Storage**

**Windows Application**
- Simplified interface for TwinCAT
- Fits perfectly to measurement requirements

**TwinCAT 3.1 RT Application**
- C++ components
- Hardware configuration of inputs
- Time sync
- Data acquisition
- Data processing

**Data storage**
- Microsoft SQL Server
  - 2014 & 2016
  - Express
  - Standard
- TcWind schema
- Data warehouse
Example of use
Create Project

Steps:
- Open new project
- Add a new target
- Select route target
Create Project

Steps:

- Open new project
- Add a new target
- Select route target
Steps:

- Open new project
- Optional: Broadcast Search target
- Select Route
Steps:
- Scan for terminals
Scan Hardware

Steps:

- Scan for terminals
Configure Terminals

Steps:

- Select input type
- Configure object
  - Channel Name
  - Sample Time
  - ...
- Activate configuration
Steps:
- Select input type
- **Configure object**
  - Channel Name
  - Sample Time
  - ...
- Activate configuration
Configure Terminals

Steps:
- Select input type
- Configure object
  - Channel Name
  - Sample Time
  - ...
- Activate configuration
Features – Configuration Process

Live Data:
- TwinCAT ScopeView integration
- Online monitoring of signals
Features – Configuration Process

Live Data:

- TwinCAT ScopeView integration
- Online monitoring of signals
Configuration process
Configuration process

- Easy to use
- No programming experience required
- One stand alone application for the configuration process
- Configurator on engineering system

User input → Create TwinCAT project → Activate project on logger

The TwinCAT project is hidden from the users
Configuration process – remote

Engineering System
- TwinCAT 3.1 XAE
- TcFlexMeter Configurator

Beckhoff System
- TwinCAT 3.1 Runtime
- TwinCAT Wind Framework
- SQL Server

Independent from engineering after configuration
Configuration process – local

Input devices
- Computer with remote desktop
- Monitor with keyboard and mouse

Beckhoff system
- TcFlexMeter Configurator
- TwinCAT 3.1 XAE
- TwinCAT 3.1 Runtime
- TwinCAT Wind Framework
- SQL Server

Independent from engineering any time
From programming to parametrizing

TcFlexMeter Configurator is a simplified frontend for TwinCAT 3.1 and Visual Studio

Configuration and parametrizing
Specialized application for measuring and logging

Configuration and programming
Flexibly not limited
Data Acquisition
Logger Modules

Base functions
- EtherCAT Diagnostics
- Database Interface
- Time Synchronisation

Input types
- Digital
- Analog
- Custom

Instances for input channels
- Digital
- Analog
- Custom

$n \rightarrow$ Software Limit
TcFlexMeterObjects and IO

EL3208 – 8 Channel

EL3751 – 1 Channel

EL1252 – 2 Channel

Analog 0..8

Analog 0..1

Digital 0..2
Recording Modes

Cycle Time

EtherCAT Communication Frame

Oversampling

Sampling in sync

Timestamping

64 Bit timestamp (R)  64 Bit timestamp (F)

EL3208 – 8 Channel

EL3751 – 1 Channel

EL1252 – 2 Channel

TcFlexMeter - Birger Evenburg
EtherCAT Measurement Modules
DIN rail-mountable IP 20 modules
EtherCAT measurement modules in connector-compatible metal housings
Signal processing in the EtherCAT measurement modules

- Analog electrical signal
- High-quality, stable and robust input electronics
- Analog-to-digital conversion in 24-bit resolution
- 2 freely parameterisable filters up to the 39th order
- Decimation unit
- TrueRMS Integrator/Differentiator
- Scaler
- PDO transport via EtherCAT
### ELM3xxx series – 24bit, 10 kSps and diagnostic

<table>
<thead>
<tr>
<th>Model</th>
<th>Channels</th>
<th>Resolution</th>
<th>Max. sampling rate</th>
<th>Connection techn.</th>
<th>U (±20 mV ... ±60 V)</th>
<th>I (±20 mA)</th>
<th>Meas. bridge SG</th>
<th>IEPE</th>
<th>Resistance 5kΩ</th>
<th>Potentiometer</th>
<th>Temperature RTD</th>
<th>Temperature TC</th>
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</table>
Data calculation chain

Fieldbus: EtherCAT
A/D sampling → Fieldbus communication

FlexMeterObjects
Value scaling → Statistic calculation
Cyclic logging

TcWind
Database interface → SQL

TcFlexMeter - Birger Evenburg
### Input Objects: Internal structure

#### Analog

<table>
<thead>
<tr>
<th>Terminal diagnostics</th>
<th>Over rage</th>
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<tbody>
<tr>
<td></td>
<td>Under range</td>
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<tr>
<td>Scaling</td>
<td>Unit</td>
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<tr>
<td>Statistics</td>
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<td>Average</td>
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<td>Deviation</td>
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<tr>
<td>RAW values</td>
<td>Minimum</td>
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<tr>
<td>Data storage</td>
<td>To data storage</td>
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<tr>
<td></td>
<td>Interface</td>
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</tbody>
</table>

#### Speed (EL1252)

<table>
<thead>
<tr>
<th>Terminal diag</th>
<th>Terminal state</th>
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<tr>
<td>Value calc.</td>
<td>Flags to RPM</td>
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<tr>
<td>Scaling</td>
<td>Unit</td>
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<tr>
<td>Statistics</td>
<td>Maximum</td>
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<td>Data storage</td>
<td>To data storage</td>
</tr>
<tr>
<td></td>
<td>Interface</td>
</tr>
</tbody>
</table>
Channel options

Generic
- Channel Name
- Sample Time (10kHz, 1kHz, …, 25 Hz, 1Hz)
- Different statistic calculations

Object specific (analog/digital/…)
- Analog → Scale and offset
- Speed → Pulses per revolution, modulo, …

Terminal specific
- Interface types for EL3751
- Hardware filter
Data Processing
Mean calculation, long-term evaluation
Statistical treatment of signals
Computation of arithmetic, root mean square, …
Free configuration of mean computation steps
Free configuration of storage intervals
Simultaneous storage cycles
- Capturing of process signals
- RAW scaled values
- Continuous long-term recording and storage
- Storing digital, analog, cyclically, on change, ...
- Count and time chronology
- Simultaneous storage cycles
TcFlexMeter / TcWind database

RT

TcWindDatabase

Non RT

TcWindView

TcWDatabase

[ADS Client]

TwinCAT Database Server

SQL Server

TcFlexMeterObject Analog
TcFlexMeterObject Analog
TcFlexMeterObject Digital
TcFlexMeterObject Analog
TcFlexMeterObject Digital
TcFlexMeterObject Custom

ADS Router

RT

Non RT
Congregate data from multiple sources into a single database so a single query engine can be used to present data. 
Extensibility
Data Calculation Chain – Extensions

Fieldbus: EtherCAT

A/D sampling → Fieldbus communication → Value handling

FlexMeterObjects

Statistic calculation → Cyclic logging

TcWind

Database interface → SQL

Custom → Custom
Plugin System – Dependency

<table>
<thead>
<tr>
<th>Configurator Plugin (.dll)</th>
<th>TcFlexMeterObject (.sys / TcCom)</th>
<th>Terminal (.xml)</th>
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<tbody>
<tr>
<td></td>
<td>TcFxAnalogStandardObject</td>
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<td>Analog input</td>
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<td>TcFxDigitalStandardObject</td>
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</table>

TcFxAnalogStandardObject
TcFxAnalogOversamplingObject
TcFxDigitalStandardObject
Components
- Layout for driver depended options
- Logic for TwinCAT 3.1 configuration
- Collect user inputs
- Link between terminal and TcComObject
- Define terminal revisions
- Mapping information
- CoE information

→ New Terminal can be added in XML
- Configuration with parameter
- Data processing logic in C++
- No code generation while configuration process
- Integration in automation project possible
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