# 01_QuickStart

March 27, 2020

## 1 asammdf Quick Start & Reference.

A one page introduction to `asammdf` for Measurement Data Format (MDF) data analysis.

For engineers wanting to drink from a fire hose or already experienced with Python data analysis.

Replaces some or all of the functionality of these tools with a fullly opensource, free, analysis stack:

- AVL CONCERTO 5™
- MathWorks® Vehicle Network Toolbox™
- ETAS Measure Data Analyzer (MDA V8)
- National Instruments DIAdem
- Vector CANape & vSignalyzer

[1]:
```
%matplotlib inline
import asammdf
import seaborn as sns
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
```

## 2 Create MDF File

- Create a [0, 10)s time vector with 100Hz sampling rate (10 ms raster)
- Create a simple MDF file with two channels:
  - "EngineSpeedCmd" 0.5 Hz sinewave with amplitude=10, & dc offset=600.
  - "EngineSpeed" 0.5 Hz sinewave with amplitude=5, phi=pi/8, & dc offset=600.

### 2.0.1 Generate Engine Speed signals

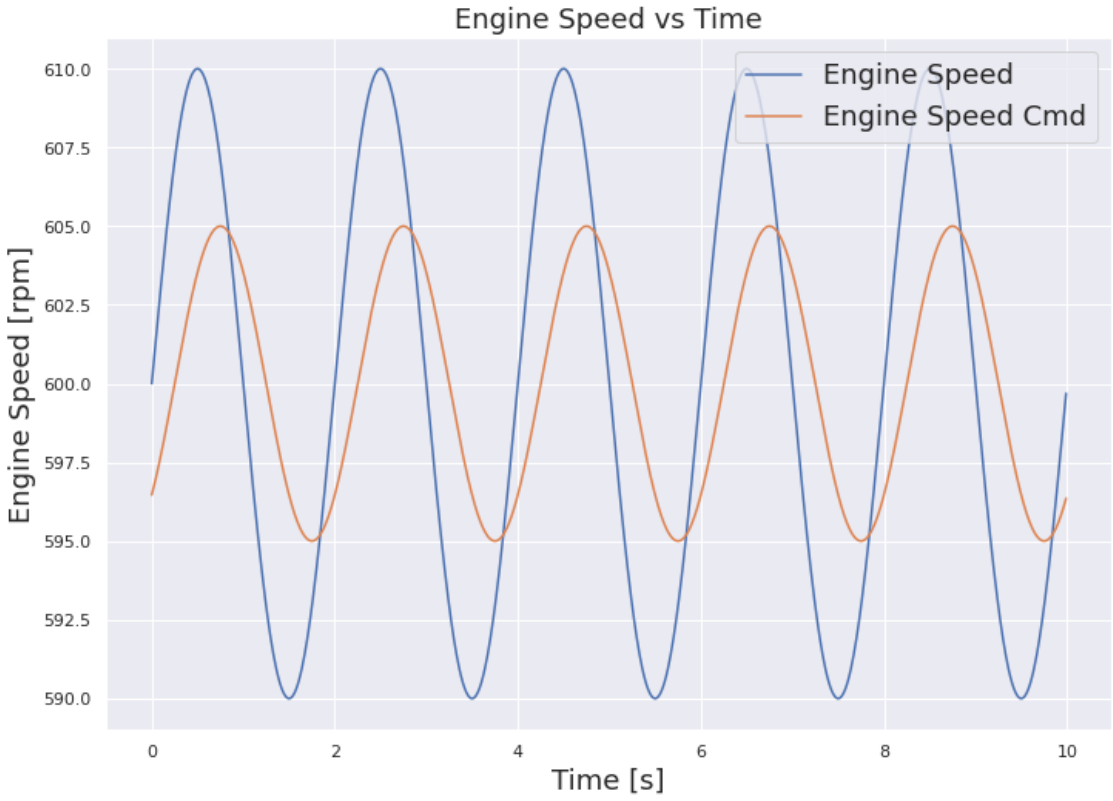
[2]:
```
# Time Vector
t0=0  # [s]
tf=10 # [s]
f_sample = 100 # [Hz]
dT = 1/f_sample # [s]
timestamps = np.arange(t0, tf, dT)
# Engine Speed
A = 10
```

```
f_signal = 0.5
dc_offset = 600
engine_speed_cmd = A*np.sin(2*np.pi*f_signal*timestamps)+dc_offset
engine_speed = A*0.5*np.sin(2*np.pi*f_signal*(timestamps-0.25))+dc_offset
```

### 2.0.2 Plot engine speed signal.

Direct plotting with matplotlib & seaborn.

[3]:
```
sns.set(
    rc={
        "figure.figsize": (11.69, 8.27), # A4 paper size.
        "figure.facecolor": "w",
        "figure.edgecolor": "k",
        "axes.labelsize": 18,
        "axes.titlesize": 18,
        "legend.fontsize": 18,
    }
)
plt.plot(timestamps, engine_speed_cmd, timestamps, engine_speed)
plt.xlabel("Time [s]")
plt.ylabel("Engine Speed [rpm]")
plt.title("Engine Speed vs Time")
plt.legend(
    {"Engine Speed Cmd", "Engine Speed"},
    loc='upper right'
);
plt.savefig(
    "EngineSpeedPlot.png",
    transparent=False,
    bbox_inches='tight'
);
```




## 2.1 Generate `asammdf.Signal` & save `MDF` file.

Convert the `numpy` arrays into `asammdf.Signal`s & save.

### 2.1.1 `Signal` Object

[4]:
```
asammdf.Signal?
```

[5]:
```
engine_speed_cmd_sig = asammdf.Signal(
    samples=engine_speed_cmd,
    timestamps=timestamps,
    unit='rpm',
    name='EngineSpeedCmd',
    conversion=None,
    comment='Swept sine plant identification, X(t)',
    raw=True,
    master_metadata=None,
    display_name='Engine Speed Command',
    attachment=(),
    source=None,
    bit_count=None,
    stream_sync=False,
```

```
    invalidation_bits=None,
    encoding=None,
)
engine_speed_sig = asammdf.Signal(
    samples=engine_speed,
    timestamps=timestamps,
    unit='rpm',
    name='EngineSpeed',
    conversion=None,
    comment='Swept sine plant identification, Y(t)',
    raw=True,
    master_metadata=None,
    display_name='Engine Speed',
    attachment=(),
    source=None,
    bit_count=None,
    stream_sync=False,
    invalidation_bits=None,
    encoding=None,
)
signals = [
    engine_speed_cmd_sig,
    engine_speed_sig,
]
```

### 2.1.2 `MDF` Object

[6]:
```
asammdf.MDF?
```

Write the file directly in and out of a context manager.

[7]:
```
with asammdf.MDF(version="4.10") as mdf:
    mdf.append(signals, "Created by Python")
    # save new file
    mdf.save("quickstart_example.mf4", overwrite=True)
```

[8]:
```
mdf = asammdf.MDF(version="4.10")
mdf.append(signals, "Created by Python")
    # save new file
mdf.save("quickstart_example.mf4", overwrite=True)
mdf.close()
```

`fsspec` example.

> Filesystem Spec is a project to unify various projects and classes to work with remote filesystems and file-system-like abstractions using a standard pythonic interface. - https://filesystem-spec.readthedocs.io/en/latest/

This allows reading & writing directly from S3, Azure Datalakes, Google Storage, and others.

[9]:
```
import fsspec
with fsspec.open("quickstart_example_fs.mf4", "wb") as fid:
    with asammdf.MDF(version="4.10") as mdf:
        mdf.append(signals, "Created by Python")
        # save new file
        mdf.save(fid, overwrite=True)
```

## 3 Read & Analyze MDF

[10]:
```
%matplotlib inline
import asammdf
import seaborn as sns
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib as mpl
```

Open a file with and without `fsspec`.

[11]:
```
with fsspec.open("quickstart_example_fs.mf4", "rb") as fid:
    mdf = asammdf.MDF(fid)
```

[12]:
```
mdf = asammdf.MDF("quickstart_example.mf4")
```

List the channels in the database.

[13]:
```
mdf.channels_db
```

[13]:
```
{'time': ((0, 0),), 'EngineSpeedCmd': ((0, 1),), 'EngineSpeed': ((0, 2),)}
```

[14]:
```
mdf.get_channel_unit("EngineSpeedCmd")
```

[14]:
```
'rpm'
```

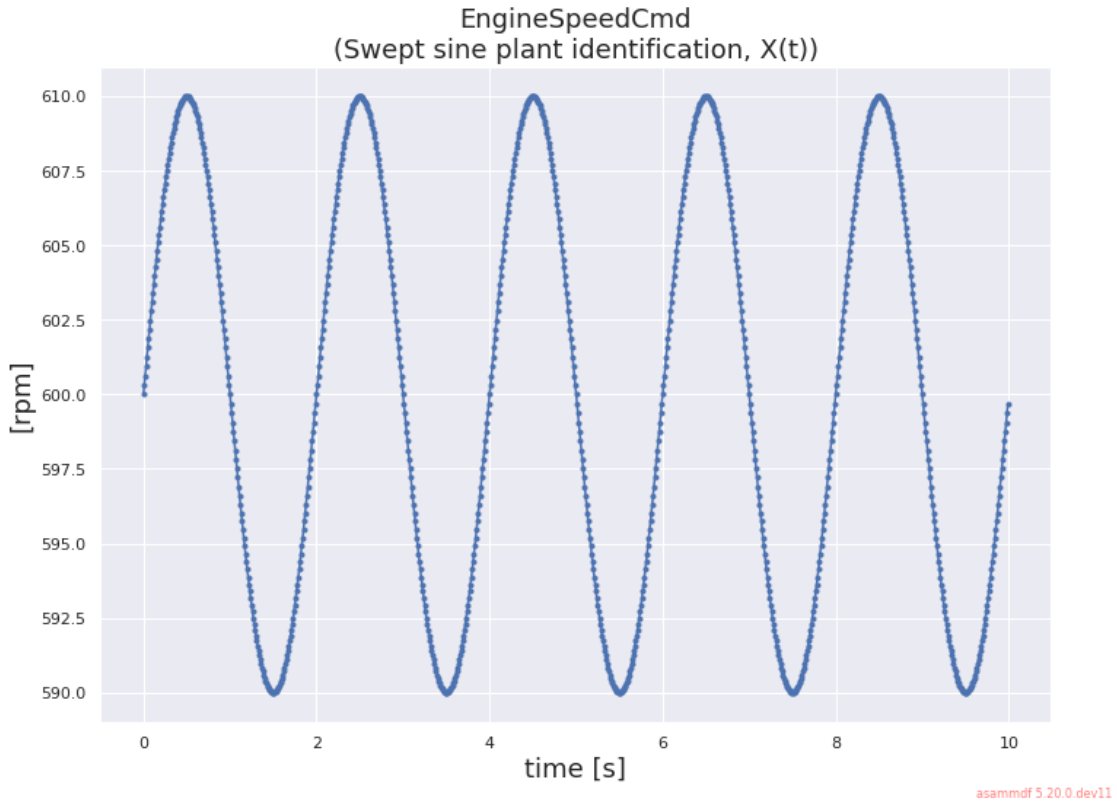
[15]:
```
mdf.get_channel_comment("EngineSpeedCmd")
```

[15]:
```
'Swept sine plant identification, X(t)'
```

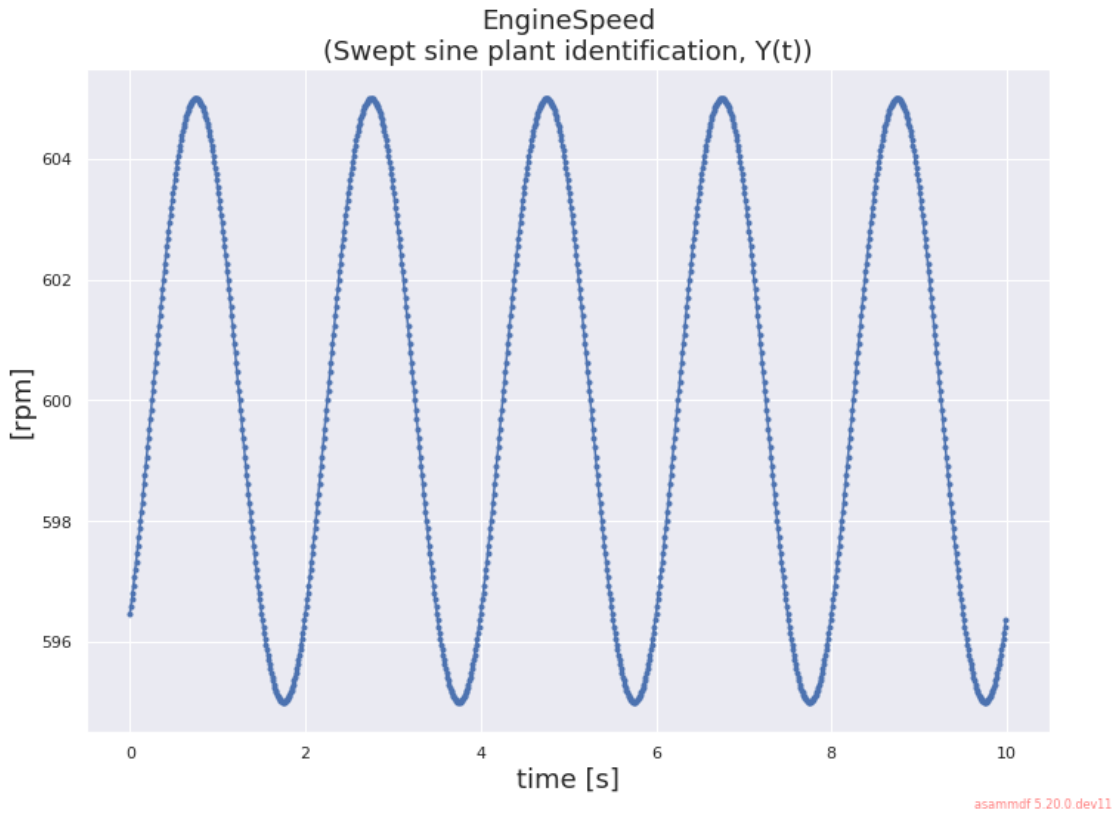
[16]:
```
sns.set(
    rc={
        "figure.figsize": (11.69, 8.27), # A4 paper size.
        "figure.facecolor": "w",
        "figure.edgecolor": "k",
        "axes.labelsize": 18,
        "axes.titlesize": 18,
```

```
        "legend.fontsize": 18,
    }
)
for channel in mdf.iter_channels():
    channel.plot()
```

```
WARNING:root:Signal plotting requires pyqtgraph or matplotlib
```




```
WARNING:root:Signal plotting requires pyqtgraph or matplotlib
```




### 3.0.1 Export to pandas.DataFrame:

[17]:
```
df = mdf.to_dataframe()
```

[18]:
```
df.describe()
```

[18]:

| | EngineSpeedCmd | EngineSpeed |
|---|---|---|
| count | 1000.000000 | 1000.000000 |
| mean | 600.000000 | 600.000000 |
| std | 7.074606 | 3.537303 |
| min | 590.000000 | 595.000000 |
| 25% | 592.928932 | 596.464466 |
| 50% | 600.000000 | 600.000000 |
| 75% | 607.071068 | 603.535534 |
| max | 610.000000 | 605.000000 |

[19]:
```
df
```

[19]:

| timestamps | EngineSpeedCmd | EngineSpeed |
|---|---|---|
| 0.00 | 600.000000 | 596.464466 |

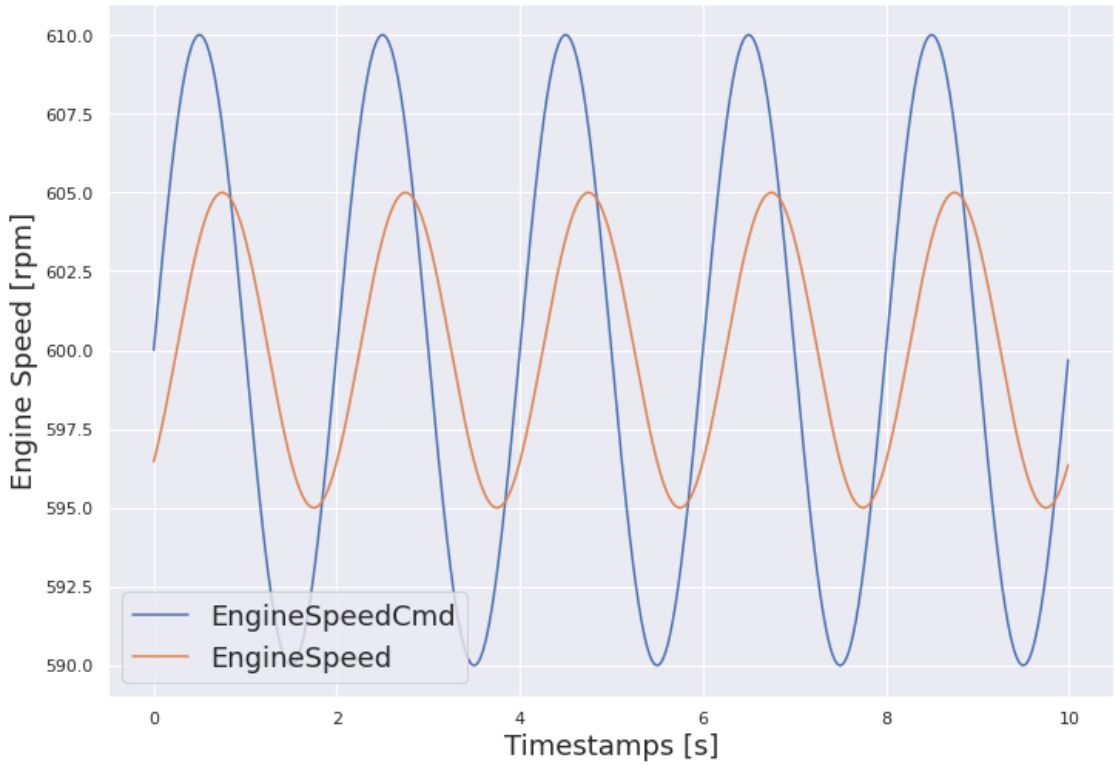
```
0.01            600.314108   596.577264
0.02            600.627905   596.693441
0.03            600.941083   596.812880
0.04            601.253332   596.935465
…                      …            …
9.95            598.435655   595.954915
9.96            598.746668   596.049225
9.97            599.058917   596.147434
9.98            599.372095   596.249445
9.99            599.685892   596.355157

[1000 rows x 2 columns]
```

Reset Index

Convert the 'timestamps' index back into a column for direct plotting from `pandas`.

[20]:
```
# Convert the
df.reset_index(inplace=True)
```

[21]:
```
df.plot(x="timestamps", y={"EngineSpeed", "EngineSpeedCmd"})
plt.ylabel("Engine Speed [rpm]")
plt.xlabel("Timestamps [s]");
```



# 4 Export

`asammdf` natively supports:

- csv
- hdf5
- mat
- parquet

[22]:
```
mdf.export?
```

[23]:
```
mdf.export(fmt="csv")
!ls *.csv
```

```
quickstart_example.ChannelGroup_0.csv
```

[24]:
```
pd.read_csv("quickstart_example.ChannelGroup_0.csv")
```

[24]:

| | timestamps | EngineSpeedCmd | EngineSpeed |
|---|---|---|---|
| 0 | 0.00 | 600.000000 | 596.464466 |
| 1 | 0.01 | 600.314108 | 596.577264 |
| 2 | 0.02 | 600.627905 | 596.693441 |
| 3 | 0.03 | 600.941083 | 596.812880 |
| 4 | 0.04 | 601.253332 | 596.935465 |
| .. | … | … | … |
| 995 | 9.95 | 598.435655 | 595.954915 |
| 996 | 9.96 | 598.746668 | 596.049225 |
| 997 | 9.97 | 599.058917 | 596.147434 |
| 998 | 9.98 | 599.372095 | 596.249445 |
| 999 | 9.99 | 599.685892 | 596.355157 |

[1000 rows x 3 columns]

[25]:
```
mdf.export(fmt="hdf5")
!ls *.hdf
```

```
quickstart_example.hdf
```

[26]:
```
mdf.export(fmt="mat")
!ls *.mat
```

```
quickstart_example.mat
```