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CISS - Connected Industrial Sensor Solution

Demo Python Script – Operating Instructions
Version 2.0

Table of Contents

1 General Information

CISS is a multi-sensor IoT device with eight sensors. It is developed for industrial retrofit applications such as condition monitoring and predictive maintenance.

This document is the operating instructions for the python script. It explains how to install, configure and use the script. The **CISS Demo Python Script** is available to download in the webpage. The Python script includes some example implementations of the USB interface. It shows how to configure the CISS and how to get data. Please download and see the script. It can speed up your CISS integration into your gateway/solution.

This document refers to CISS demo python script **version v03.01.00**.

Please ensure that the CISS is working correctly by reading the operating instructions document (available to download) carefully before using the device in your application.

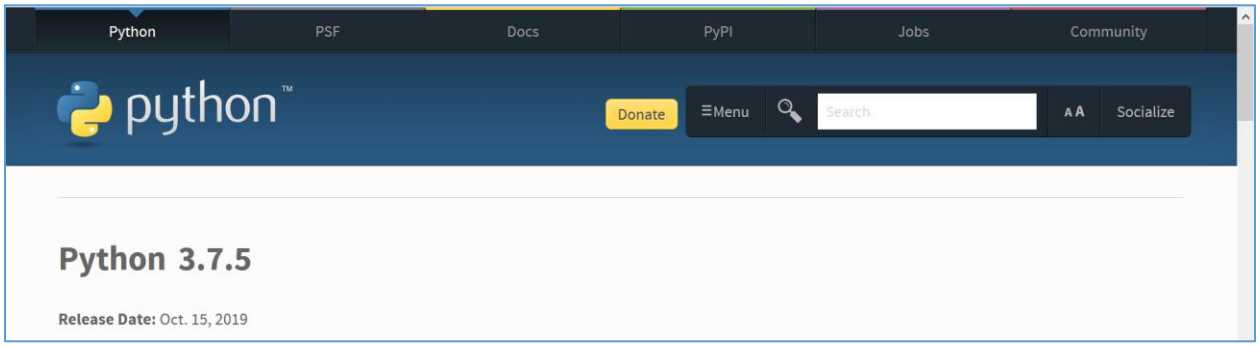
1.1 Definition of special notices

Note: Indicates important notes, information, tips about the communication of the device. Please pay attention to this points.
➔ **Always follow these instructions**

2 Download and Installation

2.1 Install the Python Environment

Download and install the Python Version 3.x (e.g. Python 3.7.5) from the official website: https://www.python.org/downloads



Please ensure that the following modules are installed within your Python environment

- **pySerial**
- Signal
- Config Parser
- Csv
- Os

To install missing modules (e.g. “pySerial”) which are needed to run the example Demo Python Script, please

- Start a “Command Shell” under Windows (cmd.exe)
- Use the following command to install additionally needed Python modules (e.g. “pySerial”)

C:\Python37\python.exe -m pip install pyserial

2.2 Download the Demo Python Script

The actual version of the demo Python script is available on the website under downloads. Here is the direct link: https://www.bosch-connectivity.com/products/connected-industrial-sensor-solution/downloads/

Please download the zip file and save in your computer. The zip file is including all required files. Please unzip it and configure as shown in the next section.

3 Configuring the ini File

In the downloaded files there is an ini file called “CISS_Configuration.ini”. If this file is missing, you can run the script once and it will be created automatically. The ini file includes all the configuration. It can be changed by the user to configure the CISS before starting the script. The script reads this file and sends related commands to configure the CISS.

The ini file can be opened with any text editor (e.g. Notepad). It looks like below screenshot. It has some information text behind ‘#’ sign. This are explanations for the user. The first parameter to set is the USB port (e.g. “port = COM4”).

CISS_Configuration.ini - Notepad

File Edit Format View Help

```
## Bosch Connected Devices and Solutions
## Configuration ini File for the CISS python script
## The python script generates different .csv log files with CISS data

[CISS_configuration]

################################################################################
## Set the USB port of the CISS. Example in Windows: port = COM4, example in Linux: port = /dev/ttyACM0
################################################################################

port = COM4

################################################################################
## Device Name: please give a name to your CISS device. This will be used e.g. in log file names
## please use one word without space or many_word_with_like_this
################################################################################

DeviceName = myCISS

################################################################################
## Python print values to the screen. If you set this as true, the python script will print the values to the screen
## please note that in Accelerometer_2KHz_Mode this will be disabled. No data printing to the screen.
################################################################################

PrintToScreen = true



################################################################################
## Select Accelerometer Range. Allowed values: 2, 4, 8 or 16 (i.e. 16 means 16g)
################################################################################

AccelerometerRange = 16
```

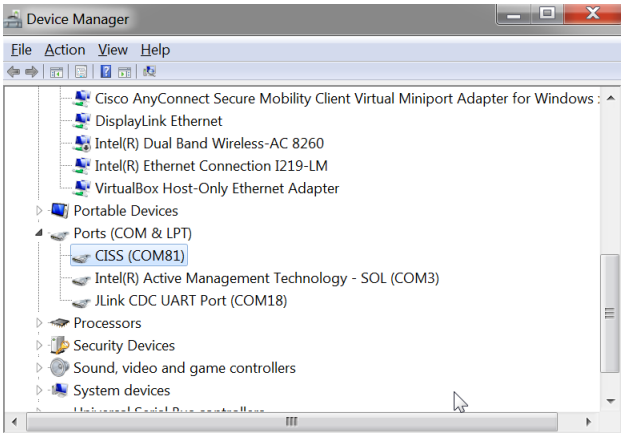
3.1 Set the USB Port

The parameter *port* is used to set the USB port.

- Example in Windows: port = COM4
- Example in Linux: port = /dev/ttyACM0

In windows please open the Device Manager to check the COM port of the connected CISS. This COM port number will be written in the ini file.

In Linux please use related command to find out the USB port that the CISS is connected.



3.2 Set the Device Name

If there are several CISSes are used, it can be useful to give a unique name to each device. The Device name is a text field that the user defines as a name for the CISS. The name is used in log file names. The name can be the name of your process or the machine. Or the Device ID of the CISS can be entered here. Please use one word without space or many_words_like_this.

- Example: *DeviceName = myCISS*

3.3 Print to Screen Flag

There is a flag called *PrintToScreen*. If the user sets this as true, the python script will print the values to the screen.

Please note that in Accelerometer_2KHz_Mode this will be automatically disabled. No data printing to the screen.

- Example: *PrintToScreen = true*

3.4 Set Accelerometer Range

CISS accelerometer range is adjustable. It can be set to ±2g, ±4g, ±8g or ±16g. The parameter AccelerometerRange is used to set this value. It is enough to give the number e.g. 16 (not 16g).

- Example: *AccelerometerRange = 16*

3.5 Set the Sampling Rates

The sampling rate of the sensors inside the CISS can be configured. There are two parameters to configure the sampling rates. The *InertialSamplingRate* sets the sampling rate for accelerometer, magnetometer and gyroscope sensors. And *EnvironmentalSamplingRate* sets the sampling rate for temperature, humidity, pressure and light sensors.

Parameter	Sensors	Range
InertialSamplingRate	accelerometer, magnetometer and gyroscope	A value between 10ms and 600000ms (10 minutes)
EnvironmentalSamplingRate	temperature, humidity, pressure and light sensors	a value between 1000ms (1 second) and 600000ms (10 minutes)

- Example: *InertialSamplingRate = 10*
- Example: *EnvironmentalSamplingRate = 1000*

Please note that the values are always in millisecond (ms). As example;

- Value 1000 means → 1000ms = 1s = 1Hz
- Value 100 means → 100ms = 0.1s = 10Hz
- Value 10 means → 10ms = 0.01s = 100Hz

3.6 Mode Selection

The script has four different mode. Only one of them can be active. Please activate (make true) ONLY ONE of the four modes. All available modes are:

- RawDataStreaming_Mode,
- Accelerometer_2KHz_Mode,
- TimeAggregation_Mode,
- EventDetection_Mode

3.6.1 Raw Data Streaming Mode

Raw Data Streaming mode streams the data coming from the sensor without any modification. The script saves the data in csv files in the “RawData_LogFiles” directory. The sampling rates that configured in the ini file are used here to sample the data. The user can enable/disable each sensor for this mode.

Note: Please note that the acoustic/noise sensor is not implemented via USB. It is only available via BLE. So it is not possible to get noise data from the CISS with this python script.

To enable this mode set the value as true.

- Example: *RawDataStreaming_Mode = true*

To activate/deactivate each sensor set the following parameters as true/false

- *Accelerometer_Streaming = true*
- *Magnetometer_Streaming = false*
- *Gyroscope_Streaming = true*
- *Environmental_Streaming = true*
- *Light_Streaming = false*

3.6.2 Accelerometer 2KHz Streaming Mode

CISS has a special high speed streaming mode for the accelerometer. In this mode CISS enables only the accelerometer and streams 2000Hz data (~2000 accelerometer x,y,z values in every 1 second). All the other sensors are disabled. The user needs to activate this mode as shown below.

- Example: *Accelerometer_2KHz_Mode = true*

3.6.3 Time Aggregation Mode

The time aggregation mode is a special mode to reduce the data volume by aggregating the data in the CISS. This mode is only available for **accelerometer, gyroscope and temperature sensors**. The sensor values are aggregated in a time frame and calculated minimum, maximum, mean and standard deviation of the values are transmitted. Time aggregation mode is only available via USB. The BLE is switched off in this mode.

The CISS has fixed setting for the time aggregation mode. The settings are given in the following table.

Sensor	Sampling Rate	Aggregation Time Frame
Accelerometer	100Hz (10ms)	2000ms (2 seconds)
Gyroscope	100Hz (10ms)	2000ms (2 seconds)
Temperature	1Hz (1s)	10000ms (10 seconds)

As an example, in this mode accelerometer values are sampled with 100Hz for 2 seconds and minimum, maximum, mean and standard deviation values are calculated. After that, only the calculated values are transmitted.

The user need to activate the mode as shown below.

- Example: *TimeAggregation_Mode = true*

3.6.4 Event Detection Mode

The event detection mode is used for threshold monitoring applications. In this mode, the measured values will be compared to a configured threshold. When a threshold violation happens, CISS sends an overshoot or undershoot warning. When the threshold is exceeded by an increasing measurement value, this means overshoot. And when the measurement value decrease and pass again to the lower side of the threshold, this is considered as undershoot.

Note: Before starting this mode, the user should configure e.g. sampling rate, thresholds etc. If a certain sensor should be disabled for event detection, the threshold value can be set out of the range. CISS will not detect a threshold violation in this case.

The user need to activate the mode as shown below.

- Example: *EventDetection_Mode = true*

The user must set the thresholds for each sensor. The thresholds are shown in the following table. Please note that if a certain sensor should be disabled for event detection, the threshold value can be set out of the range. CISS will not detect a threshold violation in this case.

Threshold	Unit	Range	Remarks/Example
AccelerometerThreshold	milli g (mg)	Between 0 and 16000 (0 to 16g).	If you set the range of accelerometer lower e.g. 4g, this threshold must be in this range too. The threshold will be used for all 3-axis of the accelerometer. **Example:** *AccelerometerThreshold = 4000*
MagnetometerThreshold	micro Tesla (µT)	between 0 and 2500	CISS Magnetometer Measurement Range: ±1300µT (x and y-Axis); ±2500µT (z-Axis). This threshold will be used for all 3-axis of the magnetometer. **Example:** *MagnetometerThreshold = 500*
GyroscopeThreshold	Degree/Second (°/s)	between 0 and 2000	This threshold will be used for all 3-axis of the gyroscope. A value of 0 disables the threshold. **Example:** *GyroscopeThreshold = 55*
TemperatureThreshold	Degree Celsius (°C)	between -20°C and +80°C	**Example:** *TemperatureThreshold = 27*
HumidityThreshold	% Relative Humidity (rH)	between 20 and 90% rH	**Example:** *HumidityThreshold = 45*
PressureThreshold	hectopascal (hPa)	between 300 and 1100 hPa	**Example:** *PressureThreshold = 600*
LightThreshold		between 0 and 2112800 lux	**Example:** *LightThreshold = 350*

4 Running the Demo Python Script

There are different ini files copied in "Example ini Files" directory. They have different example configurations. Please rename them as “CISS_Configuration.ini” and use. If your system gives some ini file parsing error, please delete all the comment lines in the ini file and try again. This can help.

4.1 Running under the Windows

You can use a command shell (cmd.exe) to start the downloaded Demo Python Script (e.g. C:\Python37\python.exe CISS_DemoPythonScript.py)

As an alternative, there is a “startCISS.bat” to click and start the script. Please set your Python path in the environmental variables first or open this file with a text editor and put your python.exe path in the .bat file.

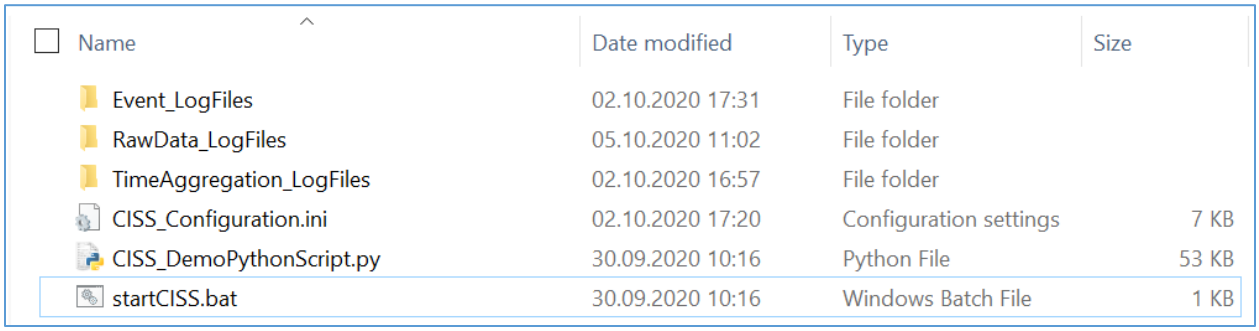
4.2 Running under the Linux

Please have a look into the documentation of your Linux distribution to install Python3 on your system. To run the script, the Kernel must support USB and the CDC driver module. Please don’t forget to set the port in the ini file. (Example: *port = /dev/ttyACM0*)

5 CISS Log Files

The script creates four different log file types. The log files are saved in following folders. The Accelerometer 2kHz Mode creates also raw-data but only for the accelerometer in high speed. The log files for this mode are also saved in “RawData_LogFiles” folder.

- RawData_LogFiles
- TimeAggregation_LogFiles
- Event_LogFiles



5.1 Log File Name

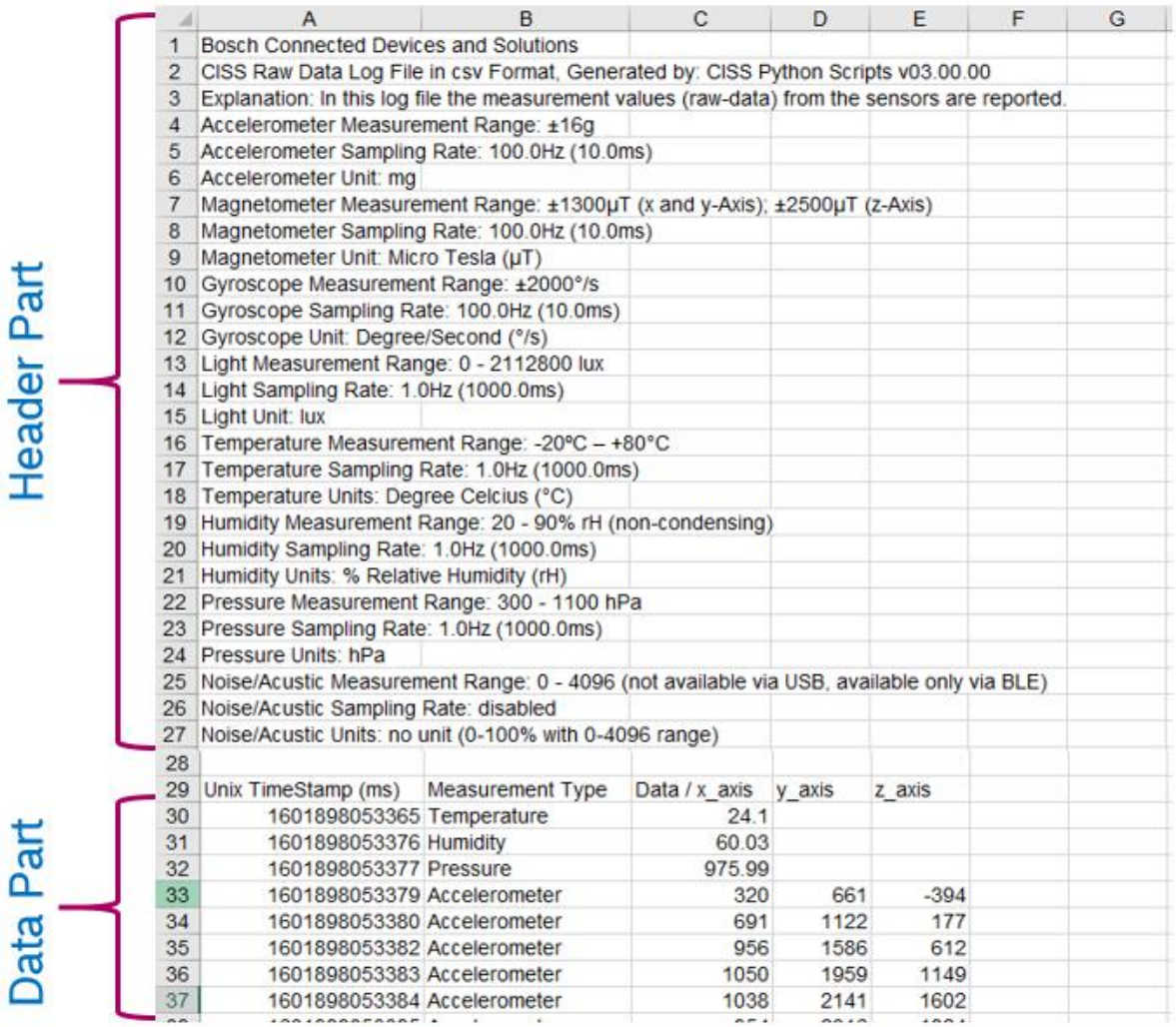
The name of the generated csv log file includes the type of the log file, DeviceName and a DateTime. The DateTime is the time of creation of the file. Example csv name: “CISS_RawData_LogFile_myCISS_02.10.2020_17.31.40.csv”

5.2 Log File Format

The log files are formatted as comma separated values (*.csv). The layout of the log files are explained below with some screenshots.

5.2.1 Raw Data Log Files

The log file looks like in the following screenshot. There is a header part including different information about the device, sensors and settings. For each sensor the measurement range, sampling rate (set by user) and the measurement unit is specified.



	A	B	C	D	E	F	G
1	Bosch Connected Devices and Solutions						
2	CISS Raw Data Log File in csv Format, Generated by: CISS Python Scripts v03.00.00						
3	Explanation: In this log file the measurement values (raw-data) from the sensors are reported.						
4	Accelerometer Measurement Range: ±16g						
5	Accelerometer Sampling Rate: 100.0Hz (10.0ms)						
6	Accelerometer Unit: mg						
7	Magnetometer Measurement Range: ±1300µT (x and y-Axis); ±2500µT (z-Axis)						
8	Magnetometer Sampling Rate: 100.0Hz (10.0ms)						
9	Magnetometer Unit: Micro Tesla (µT)						
10	Gyroscope Measurement Range: ±2000°/s						
11	Gyroscope Sampling Rate: 100.0Hz (10.0ms)						
12	Gyroscope Unit: Degree/Second (°/s)						
13	Light Measurement Range: 0 - 2112800 lux						
14	Light Sampling Rate: 1.0Hz (1000.0ms)						
15	Light Unit: lux						
16	Temperature Measurement Range: -20°C – +80°C						
17	Temperature Sampling Rate: 1.0Hz (1000.0ms)						
18	Temperature Units: Degree Celcius (°C)						
19	Humidity Measurement Range: 20 - 90% rH (non-condensing)						
20	Humidity Sampling Rate: 1.0Hz (1000.0ms)						
21	Humidity Units: % Relative Humidity (rH)						
22	Pressure Measurement Range: 300 - 1100 hPa						
23	Pressure Sampling Rate: 1.0Hz (1000.0ms)						
24	Pressure Units: hPa						
25	Noise/Acustic Measurement Range: 0 - 4096 (not available via USB, available only via BLE)						
26	Noise/Acustic Sampling Rate: disabled						
27	Noise/Acustic Units: no unit (0-100% with 0-4096 range)						
28							
29	Unix TimeStamp (ms)	Measurement Type	Data / x_axis	y_axis	z_axis		
30	1601898053365	Temperature	24.1				
31	1601898053376	Humidity	60.03				
32	1601898053377	Pressure	975.99				
33	1601898053379	Accelerometer	320	661	-394		
34	1601898053380	Accelerometer	691	1122	177		
35	1601898053382	Accelerometer	956	1586	612		
36	1601898053383	Accelerometer	1050	1959	1149		
37	1601898053384	Accelerometer	1038	2141	1602		

The data part includes the raw-data coming from the sensors. It includes following columns

- **Unix TimeStamp (ms):** It is the timestamp of the data reception (stamped in the script) in UNIX timestamp format. This is a total millisecond value that can be converted to a date and time. Please search in internet for UNIX timestamp convertors for more details.
- **Measurement Type:** This column specifies the measurement type of the value. CISS has eight sensors but noise sensor is only available in BLE. So seven different measurement types are possible; Accelerometer, Magnetometer, Gyroscope, Temperature, Pressure, Humidity and Light.
- **Data / x_axis:** This is the first column of the data. If the measurement is from accelerometer, magnetometer or gyroscope, the x_axis value will be shown here. If the measurement is from temperature, pressure, humidity or light sensor, directly the value will be shown here since these sensors don't have different axis.
- **y_axis:** If the measurement is from accelerometer, magnetometer or gyroscope, the y_axis value will be shown here. If the measurement is from temperature, pressure, humidity or light sensor, it will be left empty since these sensors don't have different axis.

- **z_axis:** If the measurement is from accelerometer, magnetometer or gyroscope, the z_axis value will be shown here. If the measurement is from temperature, pressure, humidity or light sensor, it will be left empty since these sensors don't have different axis.

Note: If the user selects more than one sensor and filter the sensor values afterwards in Excel, this can be done easily by using Excel filters. (How: With your mouse select the row with Column names (Measurement Type, Unix TimeStamp, x_axis etc.) and in "Data" menu click the "Filter". After that you can select in each column what you want to filter out.)

5.2.2 Accelerometer 2kHz Mode Log Files

The format of the Accelerometer 2kHz Mode log files are exactly the same like raw-data log files. Only difference is that; in this mode there is data only for the accelerometer. So the header part is shorter and data part includes only the accelerometer data. The sampling rate of the accelerometer is automatically set to 500µs (2kHz). Please see the explanation of the columns in section 5.2.1 Raw Data Log Files.

Header Part

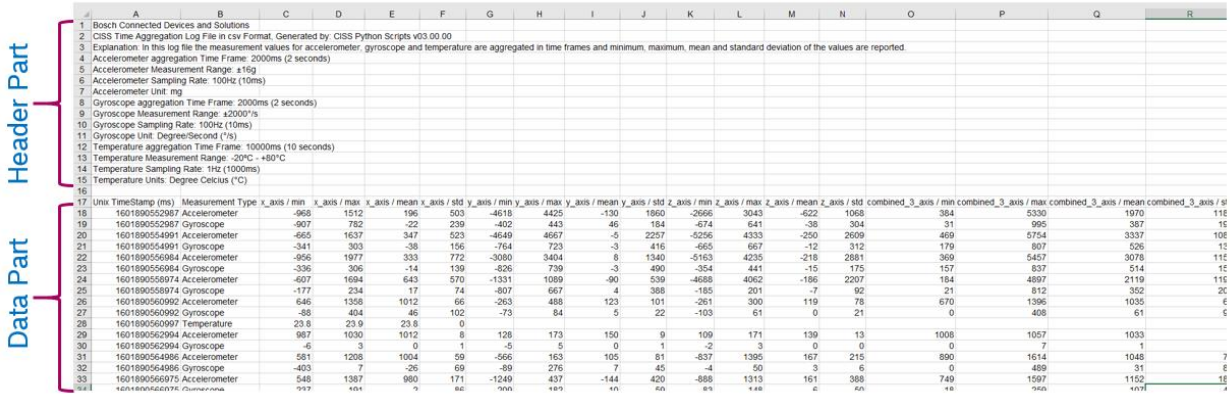
Data Part

	A	B	C	D	E	F	G
1	Bosch Connected Devices and Solutions						
2	CISS Raw Data Log File in csv Format, Generated by: CISS Python Scripts v03.00.00						
3	Special Mode: This is 2kHz_Accelerometer_Mode. All the other sensors are disabled.						
4	Explanation: In this log file the measurement values (raw-data) from the accelerometer sensor are reported.						
5	Accelerometer Measurement Range: ±16g						
6	Accelerometer Sampling Rate: 2000.0Hz (0.5ms)						
7	Accelerometer Unit: mg						
8							
9	Unix TimeStamp (ms)	Measurement Type	Data / x_axis	y_axis	z_axis		
10	1601898199533	Accelerometer	238	-765	-931		
11	1601898199533	Accelerometer	249	-774	-938		
12	1601898199533	Accelerometer	214	-755	-972		
13	1601898199534	Accelerometer	156	-735	-1052		
14	1601898199534	Accelerometer	163	-730	-1138		
15	1601898199534	Accelerometer	249	-716	-1180		
16	1601898199534	Accelerometer	251	-706	-1225		
17	1601898199534	Accelerometer	255	-696	-1278		
18	1601898199534	Accelerometer	261	-692	-1315		
19	1601898199534	Accelerometer	337	-692	-1331		
20	1601898199534	Accelerometer	327	-687	-1370		
21	1601898199534	Accelerometer	308	-687	-1419		
22	1601898199534	Accelerometer	337	-687	-1452		
23	1601898199534	Accelerometer	435	-685	-1438		
24	1601898199534	Accelerometer	525	-683	-1450		
25	1601898199534	Accelerometer	579	-675	-1456		
26	1601898199534	Accelerometer	610	-681	-1530		
27	1601898199534	Accelerometer	601	-661	-1606		
28	1601898199534	Accelerometer	591	-659	-1661		
29	1601898199534	Accelerometer	568	-642	-1688		

5.2.3 Time Aggregation Mode Log Files

The time aggregation mode is special mode to reduce the data volume by aggregating the data in CISS. This mode is only available for **accelerometer, gyroscope and temperature** sensors. The sensor values are aggregated in time frames and minimum, maximum, mean and standard deviation of each axis are calculated. The same values are calculated also for all 3-axis together. The aggregated values are transmitted by the CISS. The script write the values in the csv log file as shown in the screenshot below.

The log file has a header part with some information. The sensor settings are fixed in this mode and given in the header part. The data part includes a Unix Timestamp for the reception of the data. The “Measurement Type” specifies to which sensor the data is belonging. Following columns are showing the aggregated data in each axis and combined for all 3-axis.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Bosch Connected Devices and Solutions																	
2	CISS Time Aggregation Log File in csv Format, Generated by: CISS Python Scripts v03.00.00																	
3	Explanation: In this log file the measurement values for accelerometer, gyroscope and temperature are aggregated in time frames and minimum, maximum, mean and standard deviation of the values are reported.																	
4	Accelerometer aggregation Time Frame: 2000ms (2 seconds)																	
5	Accelerometer Measurement Range: ±16g																	
6	Accelerometer Sampling Rate: 100Hz (10ms)																	
7	Accelerometer Unit: mg																	
8	Gyroscope aggregation Time Frame: 2000ms (2 seconds)																	
9	Gyroscope Measurement Range: ±2000°/s																	
10	Gyroscope Sampling Rate: 100Hz (10ms)																	
11	Gyroscope Unit: Degree/Second (°/s)																	
12	Temperature aggregation Time Frame: 10000ms (10 seconds)																	
13	Temperature Measurement Range: -20°C - +60°C																	
14	Temperature Sampling Rate: 1Hz (1000ms)																	
15	Temperature Units: Degree Celcius (°C)																	
16																		
17	Unix TimeStamp (ms)	Measurement Type	x_axis / min	x_axis / max	x_axis / mean	x_axis / std	y_axis / min	y_axis / max	y_axis / mean	y_axis / std	z_axis / min	z_axis / max	z_axis / mean	z_axis / std	combined_3_axis / min	combined_3_axis / max	combined_3_axis / mean	combined_3_axis / st
18	1601890552987	Accelerometer	-968	1512	196	503	-4618	4425	-130	1860	-2666	3043	-622	1068	384	5330	1970	116
19	1601890552987	Gyroscope	-907	782	-22	239	-402	443	46	184	-674	641	-38	304	31	995	367	15
20	1601890554991	Accelerometer	-665	1637	347	523	-4649	4667	-5	2257	-5256	4333	-250	2609	469	5754	3337	108
21	1601890554991	Gyroscope	-341	303	-38	156	-764	723	-3	416	-665	667	-12	312	179	807	526	13
22	1601890556984	Accelerometer	-956	1977	333	772	-3080	3404	8	1340	-5163	4235	-218	2881	369	5457	3078	115
23	1601890556984	Gyroscope	-336	306	-14	139	-826	739	-3	490	-354	441	-15	175	157	837	514	15
24	1601890558974	Accelerometer	-607	1694	643	570	-1331	1089	-90	539	-4688	4062	-186	2207	184	4897	2119	119
25	1601890558974	Gyroscope	-177	234	17	74	-807	667	4	388	-185	201	-7	92	21	812	352	20
26	1601890560992	Accelerometer	646	1358	1012	66	-263	488	123	101	-261	300	119	78	670	1396	1035	6
27	1601890560992	Gyroscope	-88	404	46	102	-73	84	5	22	-103	61	0	21	0	408	61	9
28	1601890560997	Temperature	23.8	23.9	23.8	0												
29	1601890562994	Accelerometer	987	1030	1012	8	128	173	150	9	109	171	139	13	1008	1057	1033	
30	1601890562994	Gyroscope	-6	3	0	1	-5	5	0	1	-2	3	0	0	0	7	1	
31	1601890564986	Accelerometer	581	1208	1004	59	-566	163	105	81	-837	1395	167	215	890	1614	1048	7
32	1601890564986	Gyroscope	-403	7	-26	69	-89	276	7	45	-4	50	3	6	0	489	31	8
33	1601890566975	Accelerometer	548	1387	980	171	-1249	437	-144	420	-888	1313	161	388	749	1597	1152	18
34	1601890566975	Gyroscope	237	491	2	86	209	182	10	59	83	148	6	50	18	269	107	4

5.2.4 Event Detection Mode Log Files

The event detection mode log files have the same header part like raw-data log files (see in 5.2.1 Raw Data Log Files). But the data part is different as shown on the screenshot below. The data part has three column. The UNIX Timestamp, Event Type and the Threshold. The UNIX time is the time when the event is received. The event type specifies which sensor has the threshold violation and if it was overshoot or undershoot. When the threshold is exceeded by an increasing measurement value, this means overshoot. And when the measurement value decrease and pass again to lower side of the threshold, this is considered as undershoot. And finally the threshold column gives the value of the threshold which is set by the user in the ini file.

27	Noise/Acustic Units: no unit (0-100% with 0-4096 range)		
28			
29	Unix TimeStamp (ms)	Event Type	Threshold
30	1601890731744	Gyroscope undershoot	55
31	1601890731764	Gyroscope overshoot	55
32	1601890731819	Gyroscope undershoot	55
33	1601890731860	Gyroscope overshoot	55
34	1601890732014	Gyroscope undershoot	55
35	1601890733071	Gyroscope overshoot	55
36	1601890733078	Magnetometer overshoot	500
37	1601890733099	Gyroscope undershoot	55
38	1601890733128	Gyroscope overshoot	55
39	1601890733138	Gyroscope undershoot	55
40	1601890733361	Gyroscope overshoot	55
41	1601890733391	Gyroscope undershoot	55
42	1601890733609	Magnetometer undershoot	500
43	1601890733705	Magnetometer overshoot	500
44	1601890733842	Magnetometer undershoot	500
45	1601890734521	Gyroscope overshoot	55
46	1601890734624	Gyroscope undershoot	55
47	1601890737308	Accelerometer overshoot	4000
48	1601890737336	Accelerometer undershoot	4000
49	1601890737386	Accelerometer overshoot	4000
50	1601890737437	Accelerometer undershoot	4000

6 Release Notes

Version 3.0.0 (Python_3 compatible)

- The Script is converted to Python_3
- Format of the csv log files are improved.
- Time Aggregation Mode is implemented
- Improvements in the script performance
- Improvements in Acceleration_2kHz_Mode performance
- Improvements in screen printing information

Version 2.3.0 (Python_2 compatible)

- Delay between a send of two CISS Commands

Version 2.1.1

- Second Demo of the Python Script creates multiple files in a separate Folder. (e.g. every minute)
- update Comment in the Script

Version 2.1.0

- First CISS Demo Script Release

For further assistance, please send an e-mail to: support@bosch-connectivity.com

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