PEMS Testing of Porsche Model Year 2018 Vehicles

Report Pursuant to Paragraph 33.e and Paragraph 33.f of the DOJ and California Third Partial Consent Decree

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Project:	USA PEMS-Measurements

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Table 1-1: Abbreviations

Amb.	Ambient Conditions (Pressure, Temperature, Relative Humidity)
AT	Automatic Transmission
AVL	AVL List GmbH
AWD	All Wheel Drive
CO	Carbon Monoxide
CO_2	Carbon Dioxide
EFM	Exhaust Flow Meter
FID	Flame Ionization Detector
FTP75	EPA Federal Test Procedure
LDT	Light Duty Truck
LDV	Light Duty Vehicle
MBtech	MB-technology NA LLC and MBtech Group GmbH & Co. KGaA
MY	Model Year
PC	Passenger Car
PEMS	Portable Emissions Measurement System
PHEV	Plug-In Hybrid Electric Vehicle
Porsche	Dr. Ing. h.c. F. Porsche AG and Porsche Cars North America, Inc.
NO	Nitrogen Monoxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides (sum of NO + NO_2)
SUV	Sport Utility Vehicle
TCC	Emission Compliance Lab and Test Center in Oxnard, California
THCs	Total Hydrocarbon
TWC	Three-Way-Catalytic Converter
USC	University of Southern California

1 Executive Summary

MB Technology NA LLC ("MBtech") was retained as an independent Third-Party Emissions Tester by Porsche Cars North America, Inc. to conduct emission testing on certain model year ("MY") 2017, 2018, and 2019 Porsche light duty vehicles using a portable emission measurement system ("PEMS"). In 2018, MBtech conducted PEMS testing on five MY2018 Porsche serial-production light-duty gasoline vehicles provided by Porsche. MBtech carried out all testing required under paragraph 33.a and 33.b of the DOJ and California Third Partial Consent Decree. The vehicle models tested included a Panamera (LK2), Macan (vehicle with the highest project sales), Macan Turbo, Cayenne and Cayenne S E-Hybrid. Dr. Ing. h.c. F. Porsche AG and Porsche Cars North America, Inc. (together, "Porsche") were not involved in any of the vehicle testing and had no influence on the evaluation of the results summarized in this report.

Emission measurements were performed using a portable emissions measurement system (PEMS) and a flame ionization detector (FID) manufactured by AVL List GmbH ("AVL"). Three pre-defined routes reflecting a diversity of topological characteristics, driving patterns and ambient temperatures and pressures were driven for each test vehicle. These routes included an urban, highway and high altitude driving scenario. The urban route was located in Downtown Los Angeles. The highway route started in Los Angeles and ended at the Ontario Convention Center. The final route started and ended at the Ontario Convention Center and went up and down Mount Baldy.

Following the PEMS measurements under real driving conditions, correlation tests were then conducted on a chassis dynamometer at the Emission Compliance Lab and Test Center ("TCC") in Oxnard, California. The PEMS and FID devices, as well as the dynamometer's emission laboratory analyzers, were used in parallel during correlation testing. A FTP75 chassis dynamometer certification test cycle was run for all five vehicles after the PEMS measurements had been completed.

There is a total amount of 20 on-road measurements and six tests on the chassis dynamometer. The PEMS measured the gaseous emissions of carbon monoxide (CO), carbon dioxide (CO_2) and nitrogen oxides (NO_x); whereas NOx is the sum of nitrogen monoxide (NO) and nitrogen dioxide (NO_2). The FID analyzer measured the hydrocarbons (THC) for all vehicles. The ambient pressure, temperature, humidity and altitude were also recorded for all on-road measurements through an external GPS and humidity sensor measuring device.

The following report provides the test data of all PEMS measurements and correlation test results on the chassis dynamometer and describes all test methods used.

2 Methodology

2.1 Vehicles Tested

PEMS testing was conducted with five production-series light-duty gasoline vehicles provided by Porsche. Each vehicle tested belongs to a different test group, as depicted below in Figure 2-1. These vehicles included a passenger vehicle and four sport utility vehicles (SUV). The vehicle models tested included one Panamera (LK2), one Macan (vehicle with the highest project sales), one Macan Turbo, one Cayenne and one Cayenne S E-Hybrid.

No.	Models in test group	MY2018
1	Carrera Turbo, Turbo S (991 II)	x
2	Boxster, Cayman, Boxster S, Cayman S (982 S)	x
3	Carrera, Carrera S, GTS (991 II)	x
4	Panamera Turbo (LK5) (G2)	x
5	Panamera (LK2) (G2), Panamera S (LK3) (G2)	x
6	Macan (185 kW)	x
7	Cayenne (E2 II)	x
8	Macan Turbo (Turbo S)	x
9	Cayenne S E-Hybrid (E2 II)	x
10	Macan S, GTS, Cayenne S, GTS (E2 II)	x
11	Cayenne Turbo, Turbo S (E2 II)	x
12	Panamera PHEV (LK3) (G2)	x
13	Panamera Turbo S PHEV (G2)	x

Figure 2-1: Porsche Test Groups MY2018

2.2 PEMS Test Routes

Three pre-defined routes were selected to perform PEMS testing on the five vehicles. The test routes were defined within main areas in Southern California, primarily, Los Angeles and the Inland Empire. These three routes reflected the diversity in topological characteristics, driving patterns and ambient conditions that are expected to be representative of typical vehicle operations within the area. Each route was driven once per vehicle unless (i) unforeseen deviations from the original route occurred; (ii) a vehicle was stuck in heavy traffic for a prolonged period of time during emission measurements; (iii) data was deemed invalid due to reasons further explained in this report; or (iv) a second test was performed to validate a prior measurement. Unforeseen deviations can also include, but are not limited to road closures. All PEMS measurement results, whether repeated or not, are included in this report. The order of the test routes was adapted to the traffic situation in the Los Angeles area and was not fixed in advance.

The *"Los Angeles Route"* started and ended at the parking lot from the University of Southern California's (USC's) Religious Center. The complete route is approx. 15.2 miles in distance long. Most of the route is representative of urban driving affected by dense traffic conditions except for approx. 3.3 miles toward the end of the route, which is on the 110 South Highway. A topographical map of this route is depicted below in *Figure 2-2*.

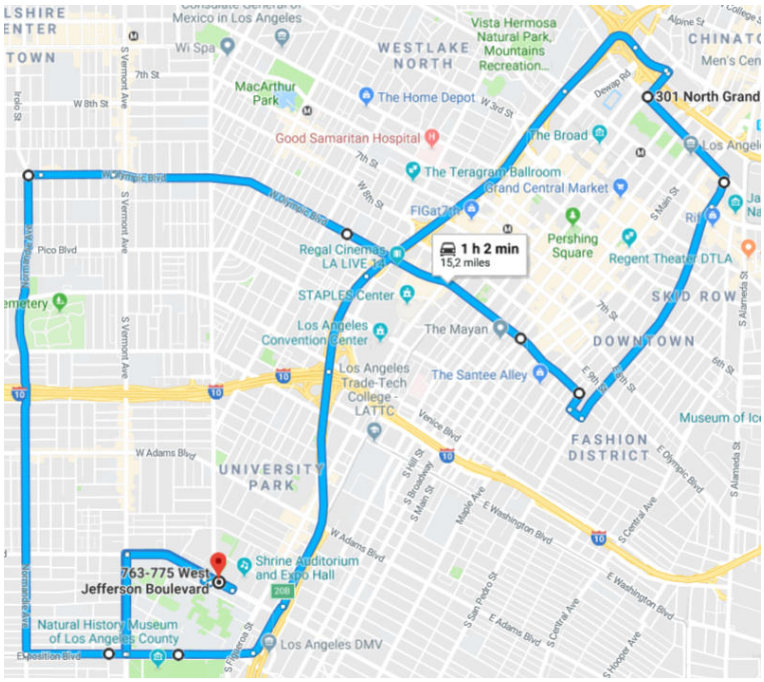

Figure 2-2: Topographic Map of Urban Driving Route in Downtown Los Angeles

The *"Highway Route"* shown below in *Figure 2-3* is approx. 45 miles long and comprised of approx. 95% highway and approx. 5% urban driving. The route starts at the same starting and ending location as the "*Los Angeles Route*", which is at USC's main campus. The route primarily follows interstate I-10E until reaching exit 54 (N Vineyard). The end point of this route is a parking lot near the Ontario Convention Center.

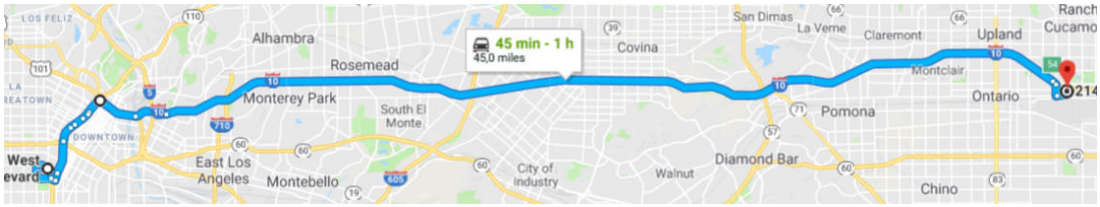

Figure 2-3: Topographic Map of Highway Driving Route in Los Angeles

The third route driven is the *"Mt. Baldy Route"* shown in *Figure 2-4* and is approx. 45.5 miles long. This route is representative of rural and uphill/downhill driving that includes significant

variations in altitude, grade and ambient temperature and pressure. The starting and end point of the route was at a parking lot near the Ontario Convention Center.

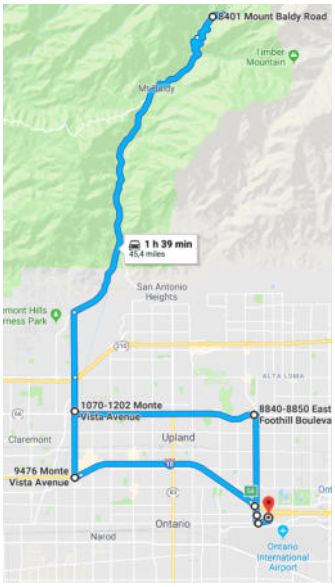

Figure 2-4: Topographic Map of Rural and Uphill/Downhill Driving Route in Los Angeles Foothills

2.3 Instruments and Elements Used for PEMS Measurements

2.3.1 Devices

Each tested vehicle was equipped with an AVL M.O.V.E 492 GAS PEMS iS system ("Gas PEMS") manufactured by AVL. The Gas PEMS was responsible for measuring carbon dioxide (CO_2), carbon monoxide (CO) and nitrogen oxides (NO_x), which is a combination of nitrogen monoxide (NO) and nitrogen dioxide (NO_2) measurements. The Gas PEMS was installed according to the manufacturer's recommendations. This included providing an isolated power source such as a generator or batteries, system controller and an ambient enclosure.

In addition to the Gas PEMS, all vehicles were equipped with an AVL M.O.V.E 4925 FID iS and an exhaust flow meter (EFM) to measure total hydrocarbons (THCs) and the exhaust gas volume flow respectively. The PEMS, FID and EFM were always mounted on the car hitch of each individual vehicle.

2.3.2 Fuels

All five test vehicles had their fuel tanks emptied and refilled with standard fuel (91 RON) from the same batch.

2.4 Correlation Testing

Laboratory chassis dynamometer testing was performed on all vehicles at the Emission Compliance Lab and Test Center in Oxnard, California. These tests are used to validate the PEMS system by comparing the results of the PEMS with the dynamometer. Both the PEMS and the dynamometer emission laboratory's analyzers have been used in parallel during correlation tests. A FTP75 chassis dynamometer certification test cycle was run for all five vehicles, which is a cycle based on the Los Angeles route shown in *Figure 2-2* (California Air Resource Board).

2.5 Emissions Testing Procedure

All five vehicles tested underwent the same procedure in order to execute proper PEMS measurements. A flow chart of the exact procedure used for PEMS measurements in this project is depicted below in *Figure 2-5*. First, exhaust pipe adapters were installed onto the vehicles and smoke checks were carried out to ensure that there were no leaks from the pipes. After exhaust pipe adapters were mounted, all measurement systems, such as the PEMS, FID and EFM, were mounted along with auxiliary components, such as a battery, an inverter and connections. Once the vehicle was set up, pre-checks were performed to ensure the measurement systems were operating correctly. If successful, pre-calibrations were carried out and PEMS measurements were done on the street. Directly after each PEMS measurement trip, post-calibrations were run to help correct drifts. Measurements were analyzed after completion. Once PEMS measurements were completed and analyzed, the vehicles were taken to a chassis dynamometer laboratory for correlation tests. After all tests have been completed, all measurement equipment was removed from the vehicle and a report was prepared.

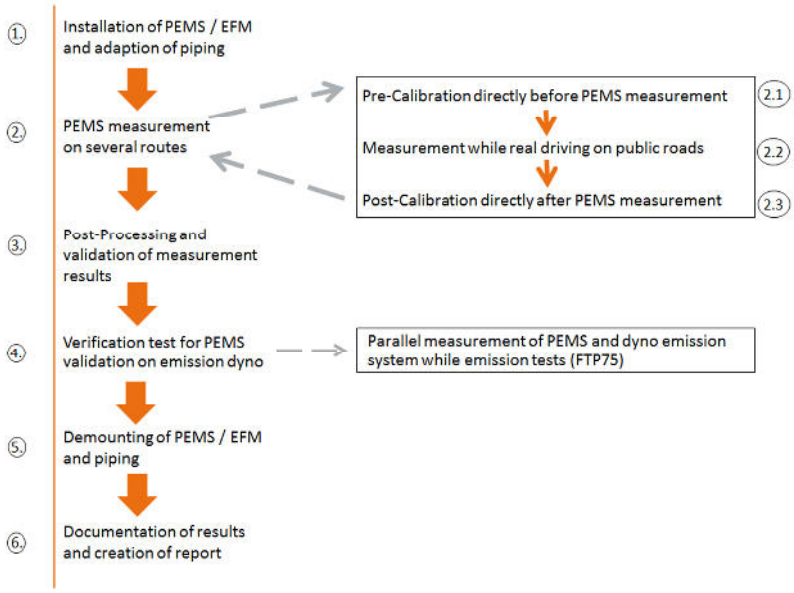

Figure 2-5: PEMS Measurement Procedure

2.6 Data Analysis and Emission Calculations

Data analysis was performed with AVL CONCERTO FOR PEMS 4 R8.2. The post-processing of data was executed with CONCERTO Workfile PEMS_Rel_10_B192.

3 Results and Discussion

3.1 Emission Measurements Summary Table

The following tables summarize the emissions from all the routes and vehicles tested.

Table 3-1: Emission Overview for Model Year 2018 Measurements

Cayenne S E-Hybrid		Emissions				Test		
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]	Battery-level at start
04/23/2018	LA Downtown (1)*	549,9	0,095	0,006	0,006	3743	15,59	< 20%
04/27/2018	LA Downtown (2)	472,5	0,000**	0,011	0,004	3550	15,52	< 20%
04/26/2018	Highway (1)***	540,0	4,081	0,009	0,032	8474	44,05	< 20%
04/27/2018	Highway (2)	378,7	2,580	0,002	0,023	3781	43,88	< 20%
04/26/2018	Mt. Baldy (1)	497,1	15,832	0,004	0,087	5045	43,66	< 20%
05/01/2018	Mt. Baldy (2)****	515,6	12,063	0,004	0,050	5098	43,56	< 20%
05/01/2018	FTP75 (PEMS)	492,2	0,224	0,038	0,028	2530	10,96	< 20%
05/01/2018	FTP75 (Dyno)	457,0	0,283	0,032	0,024			
05/29/2018	Mt. Baldy (3)	392,2	7,494	0,010	n.a.*****	6019	43,37	100%
05/30/2018	FTP75 (PEMS)	485,9	0,152	0,071	0,012	2464	11,00	< 20%
05/30/2018	FTP75 (Dyno)	451,1	0,189	0,065	0,037			

Macan		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/02/2018	LA Downtown	500,4	0,365	0,016	0,001	3822	15,75
05/03/2018	Highway	356,1	0,152	0,015	0,001	4203	44,32
05/03/2018	Mt. Baldy	443,7	0,281	0,013	0,002	5292	43,97
05/04/2018	FTP75 (PEMS)	366,8	0,444	0,010	0,005	2609	11,03
05/04/2018	FTP75 (Dyno)	367,6	0,528	0,008	0,026		

*: Deviation of driving route from the original route due to road closure

**: Negative concentration values were measured due to analyzer drift

***: Vehicle stuck in heavy highway traffic for a prolonged period of time (more than 1 hour)

****: A second measurement for validation of the first results

*****: Invalid data because of zero calibration loss after restart of FID system

Cayenne		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/07/2018	LA Downtown	663,7	0,226	0,023	0,001	4188	15,12
05/08/2018	Highway (1)******	397,7	0,288	0,012	n.a.	3363	43,13
05/09/2018	Highway (2)	393,7	0,210	0,012	0,001	3427	43,19
05/10/2018	Mt. Baldy	522,9	0,550	0,026	0,003	4920	42,70
05/11/2018	FTP75 (PEMS)	462,2	0,255	0,038	0,007	2519	10,60
05/11/2018	FTP75 (Dyno)	438,1	0,279	0,037	0,030		

Macan Turbo		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/18/2018	LA Downtown	528,8	0,207	0,010	0,002	3423	15,79
05/17/2018	Highway	443,8	0,364	0,008	0,002	4738	44,35
05/17/2018	Mt. Baldy	512,3	0,880	0,015	0,009	5375	44,69
05/21/2018	FTP75 (PEMS)	476,6	0,736	0,008	0,006	2486	10,97
05/21/2018	FTP75 (Dyno)	475,1	0,861	0,005	0,023		

Panamera (LK2)		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/22/2018	LA Downtown	444,9	0,522	0,011	0,004	3428	15,71
05/23/2018	Highway	299,3	3,555	0,003	0,005	3458	44,18
05/23/2018	Mt. Baldy	460,4	7,023	0,008	0,008	5633	44,35
05/25/2018	FTP75 (PEMS)	420,3	0,592	0,019	0,007	2489	10,82
05/25/2018	FTP75 (Dyno)	413,4	0,583	0,018	0,020		

******: Measurement was repeated because no data were received from FID (data loss as a result of connection cut off between FID system and system control during the measurement).

3.2 Cayenne S E-Hybrid

The following table summarizes the emission measurement results from the Cayenne S E-Hybrid vehicle.

The high-voltage battery was almost discharged during all measurements.

Additionally, there was a measurement for the Mt. Baldy route with a fully loaded high-voltage battery on May 29th.

Table 3-2: Emission Overview Porsche - Cayenne S E-Hybrid

Cayenne S E-Hybrid		Emissions				Test		
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]	Battery-level at start
04/23/2018	LA Downtown (1)*	549,9	0,095	0,006	0,006	3743	15,59	< 20%
04/27/2018	LA Downtown (2)	472,5	0,000**	0,011	0,004	3550	15,52	< 20%
04/26/2018	Highway (1)***	540,0	4,081	0,009	0,032	8474	44,05	< 20%
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05/30/2018	FTP75 (PEMS)	485,9	0,152	0,071	0,012	2464	11,00	< 20%
05/30/2018	FTP75 (Dyno)	451,1	0,189	0,065	0,037			

*: Deviation of driving route from the original route due to road closure

**: Negative concentration values were measured due to analyzer drift

***: Vehicle stuck in heavy highway traffic for a prolonged period of time (more than 1 hour)

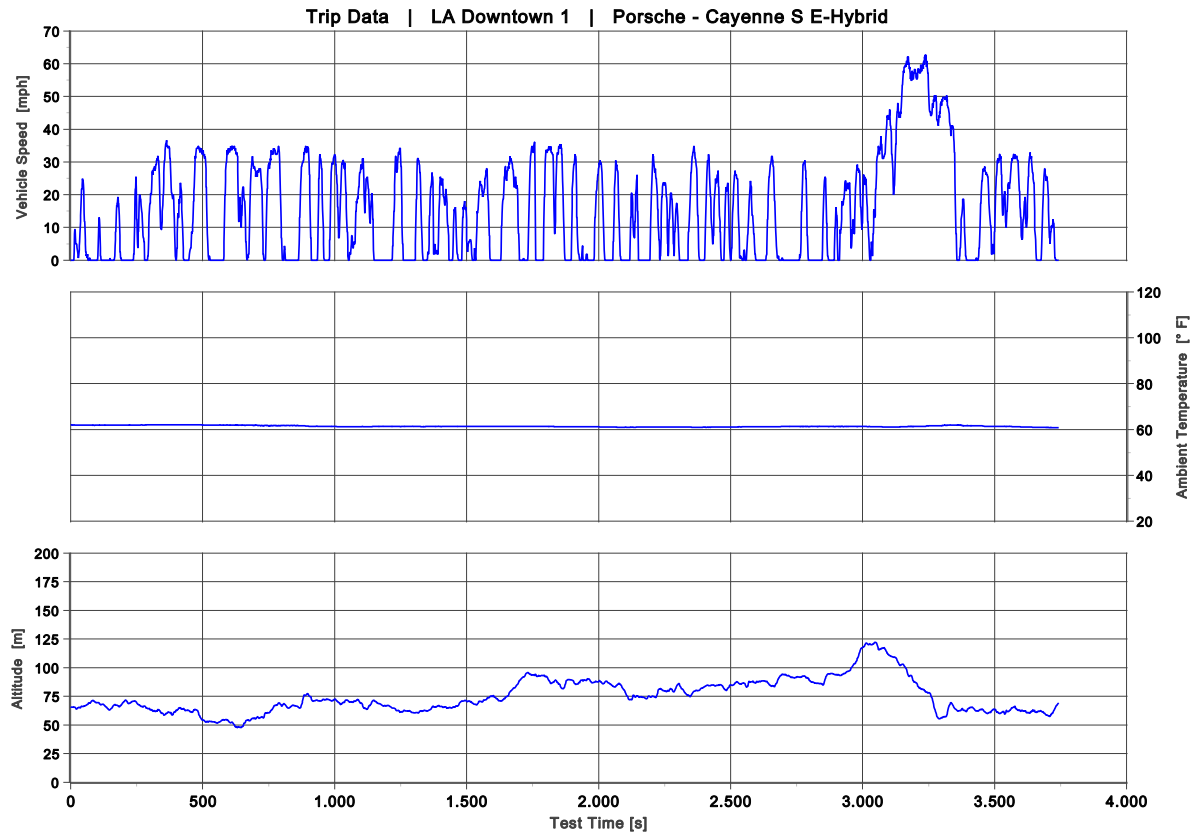
****: A second measurement for validation of the first results

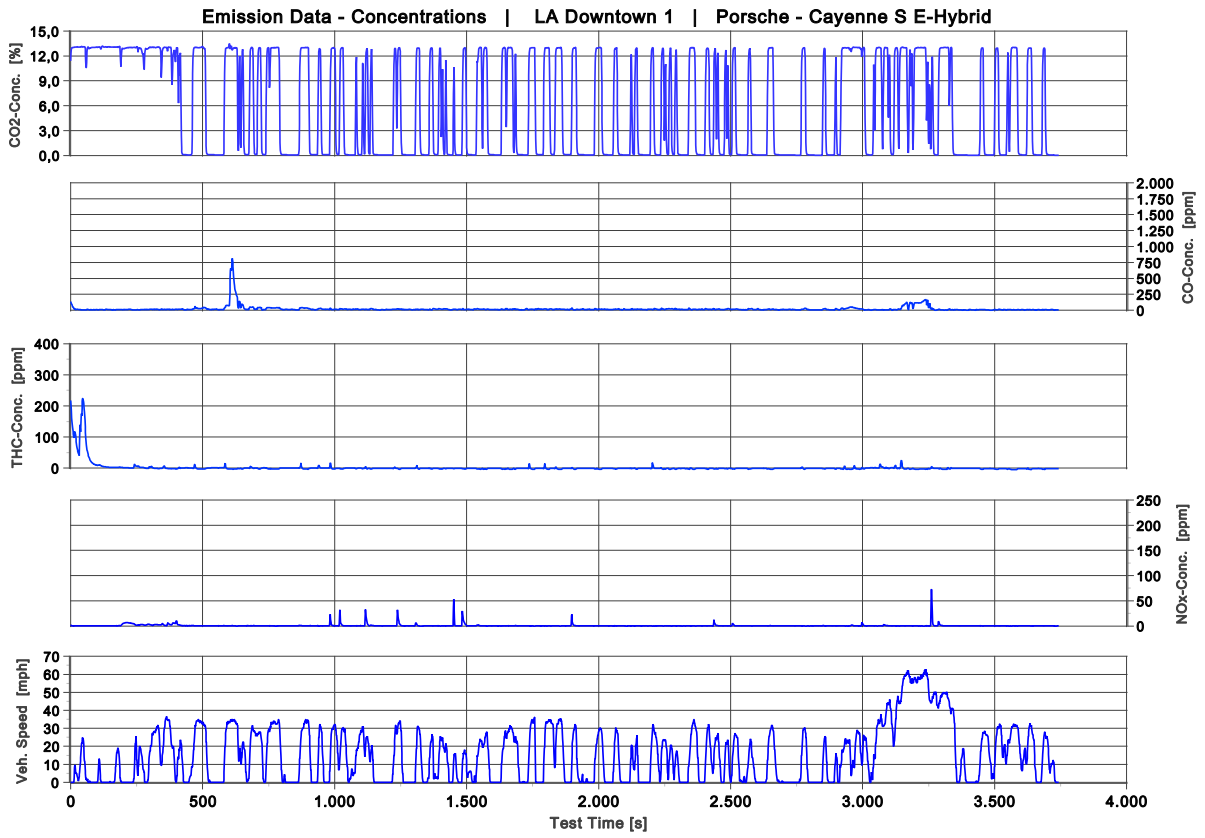
*****: Invalid data because of zero calibration loss after restart of FID system

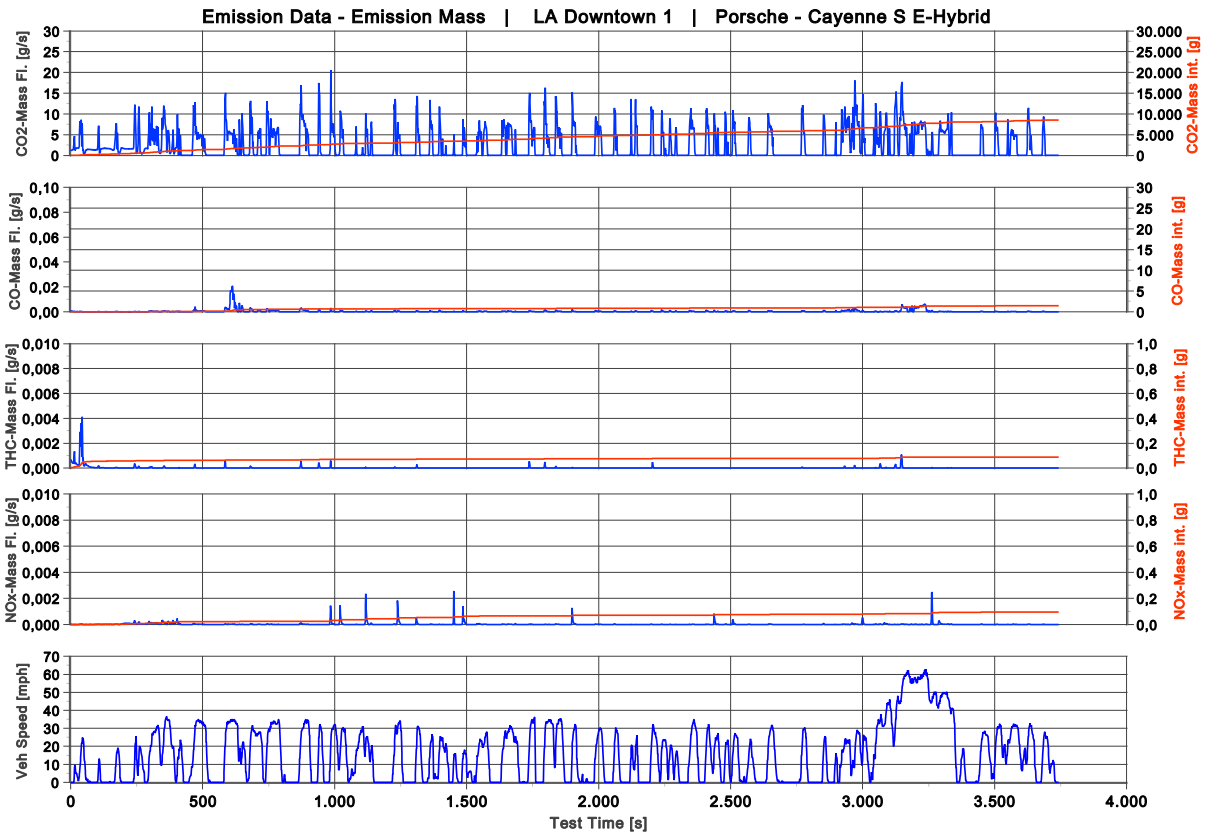
3.2.1 LA Downtown (1)

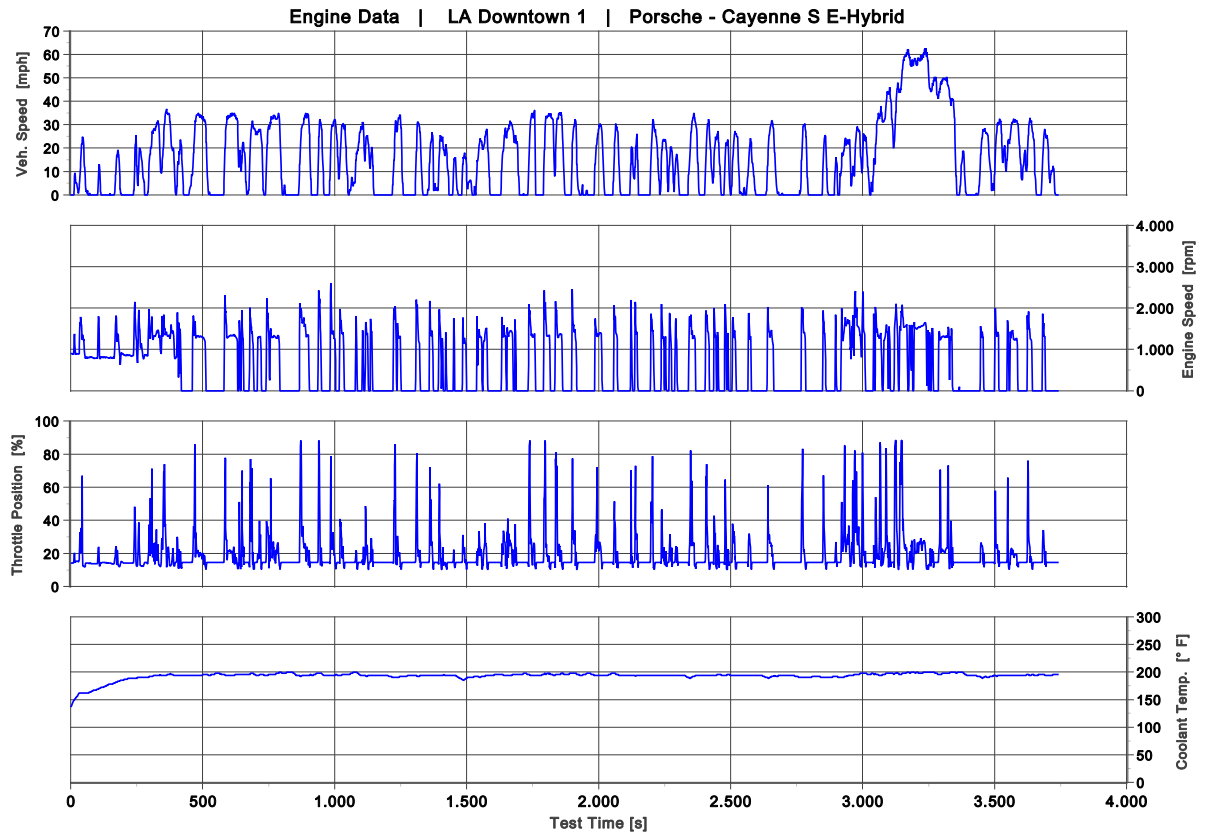
Table 3-3: LA Downtown (1) Trip Summary for Cayenne S E-Hybrid

Test Data			
Test Name:	2018-04-23_CayenneS-E-Hybrid_LA-Downtown		
Department:	MBtech	Test Date:	04/23/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	549,9
CO		[g/mi]	0,095
NO_x		[g/mi]	0,006
THC		[g/mi]	0,006
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3743
Distance		[mi]	15,59
Average Speed		[mph]	15,0
Average Ambient Temperature		[°F]	61,4


Trip Data | LA Downtown 1 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Concentrations | LA Downtown 1 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
THC-Conc. [ppm]
400
300
200
100
0
NOx-Conc. [ppm]
250
200
150
100
50
0
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

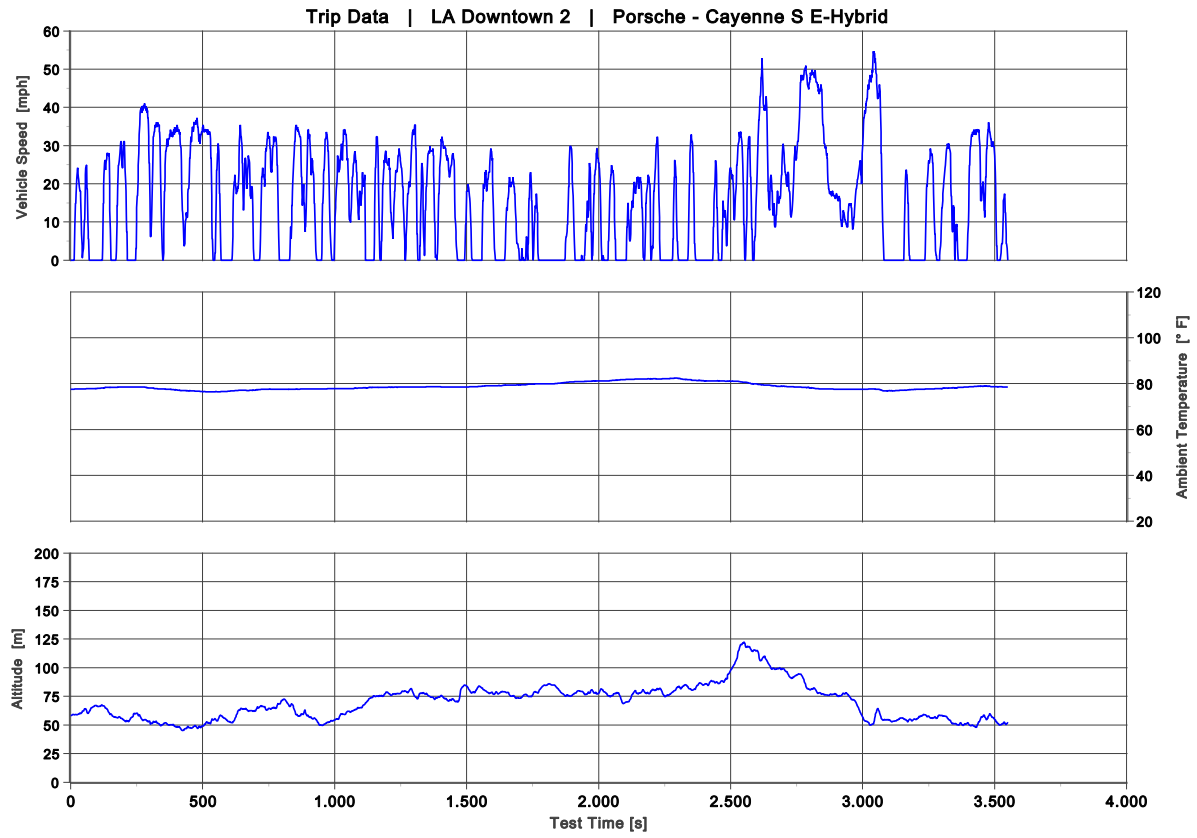

Emission Data - Emission Mass | LA Downtown 1 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh Speed [mph]
Test Time [s]

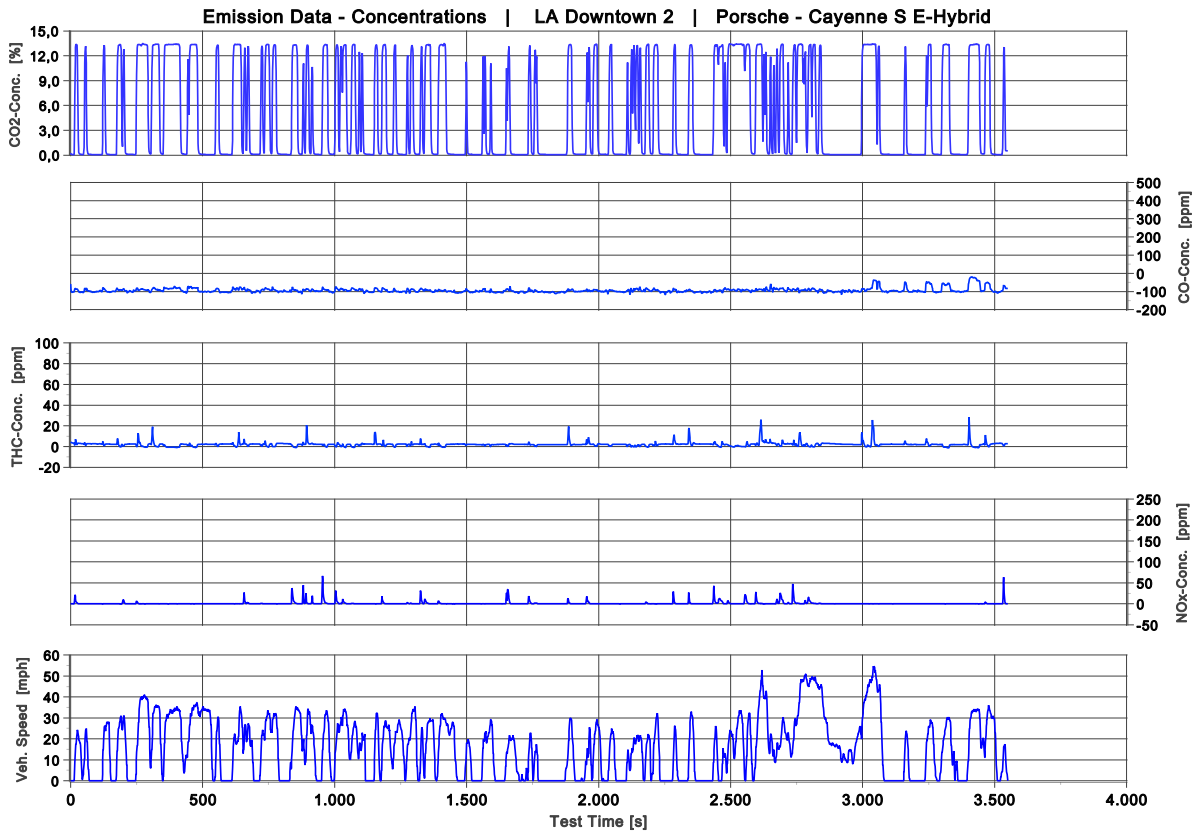

Engine Data | LA Downtown 1 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

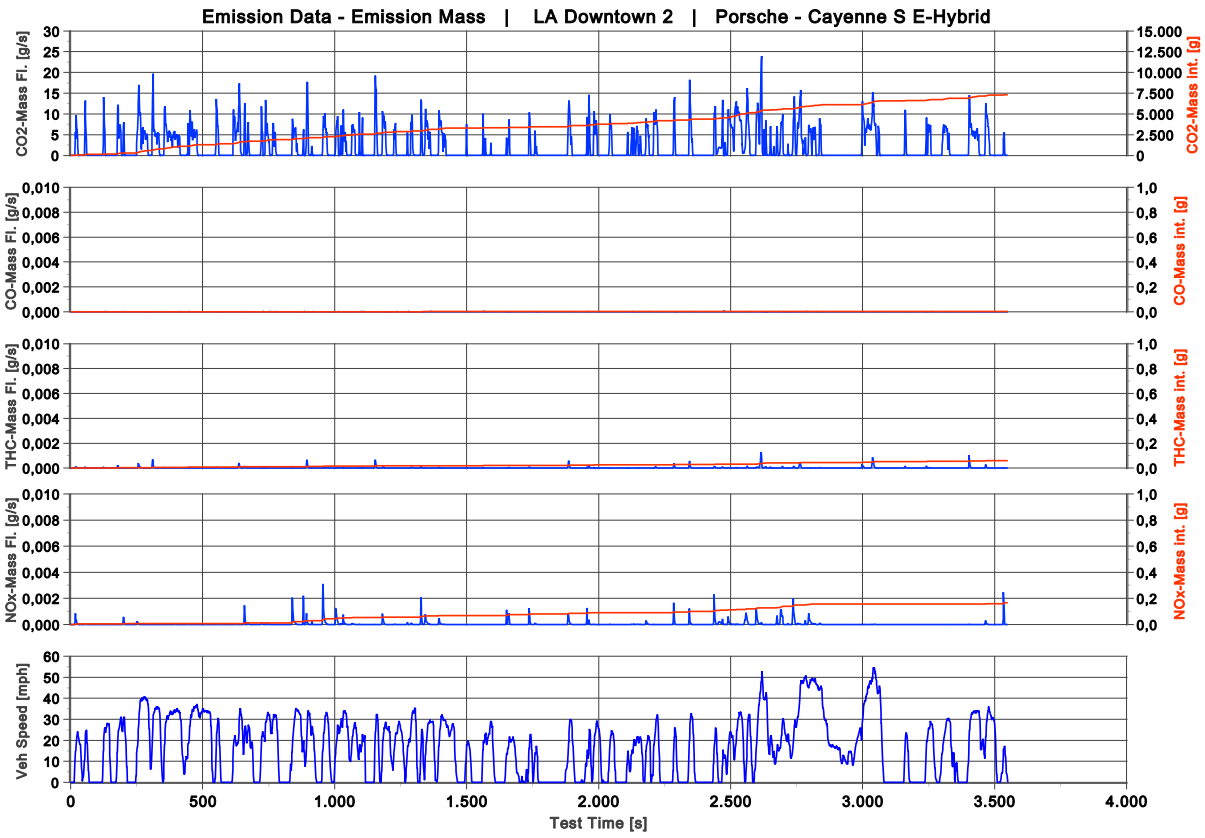
3.2.2 LA Downtown (2)

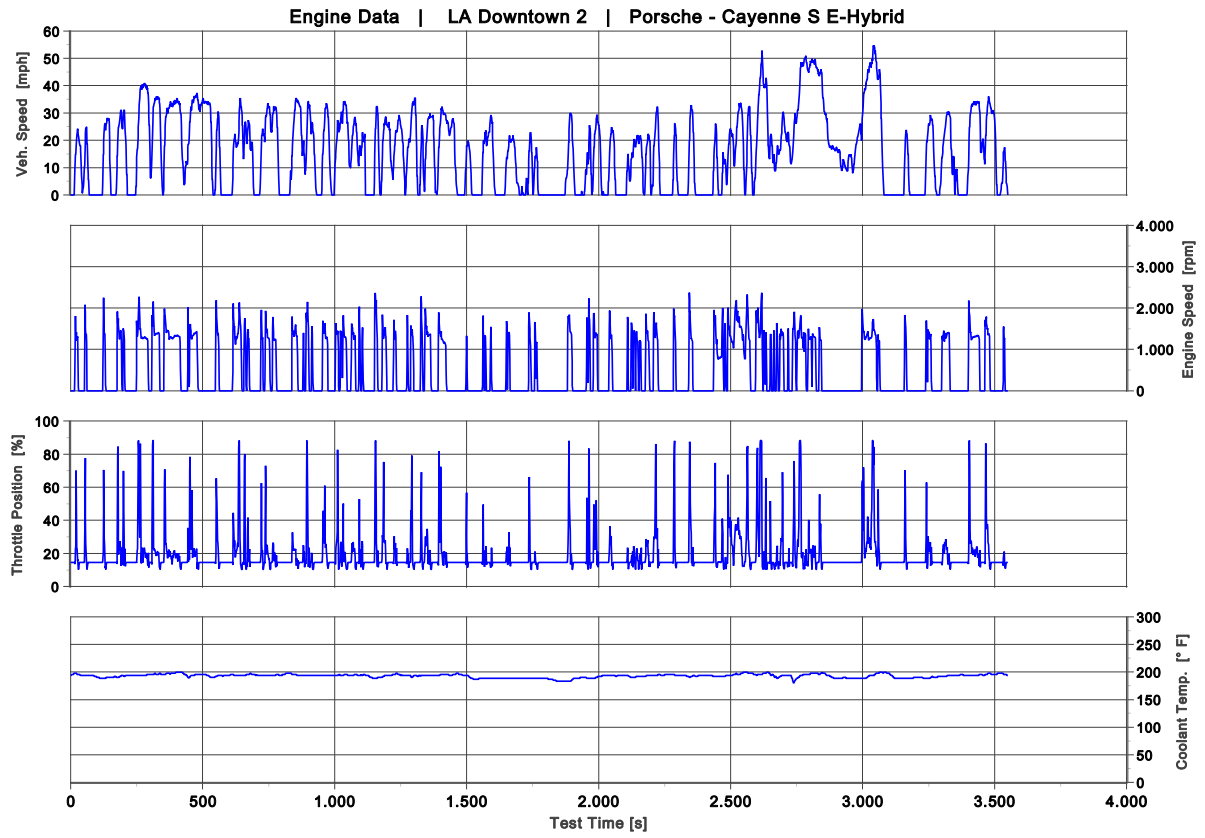
Table 3-4: LA Downtown (2) Trip Summary for Cayenne S E-Hybrid

Test Data			
Test Name:	2018-04-27_CayenneS-E-Hybrid_LA-Downtown		
Department:	MBtech	Test Date:	04/27/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	472,5
CO		[g/mi]	0,000
NO_x		[g/mi]	0,011
THC		[g/mi]	0,004
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3550
Distance		[mi]	15,52
Average Speed		[mph]	15,7
Average Ambient Temperature		[°F]	78,8


Trip Data | LA Downtown 2 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Concentrations | LA Downtown 2 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
500
400
300
200
100
0
-100
-200
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
250
200
150
100
50
0
-50
Veh. Speed [mph]
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Emission Mass | LA Downtown 2 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh Speed [mph]
Test Time [s]

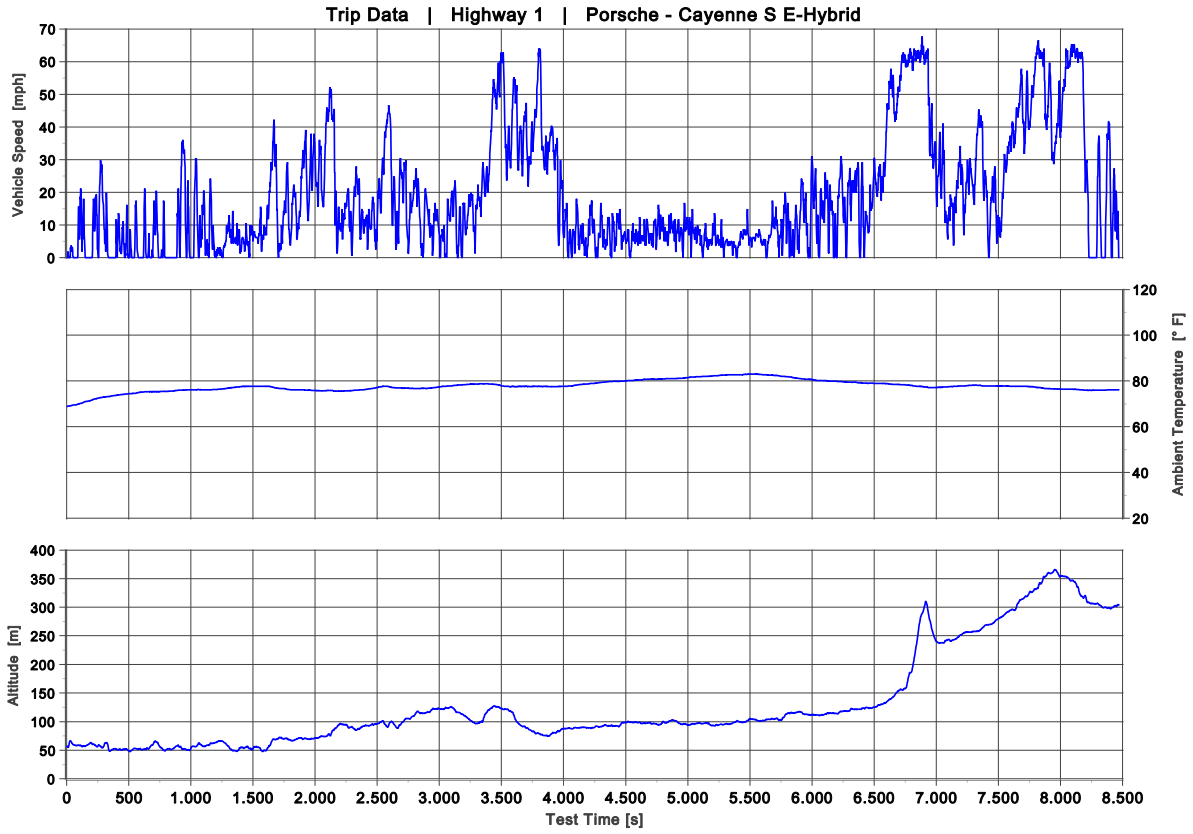

Engine Data | LA Downtown 2 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

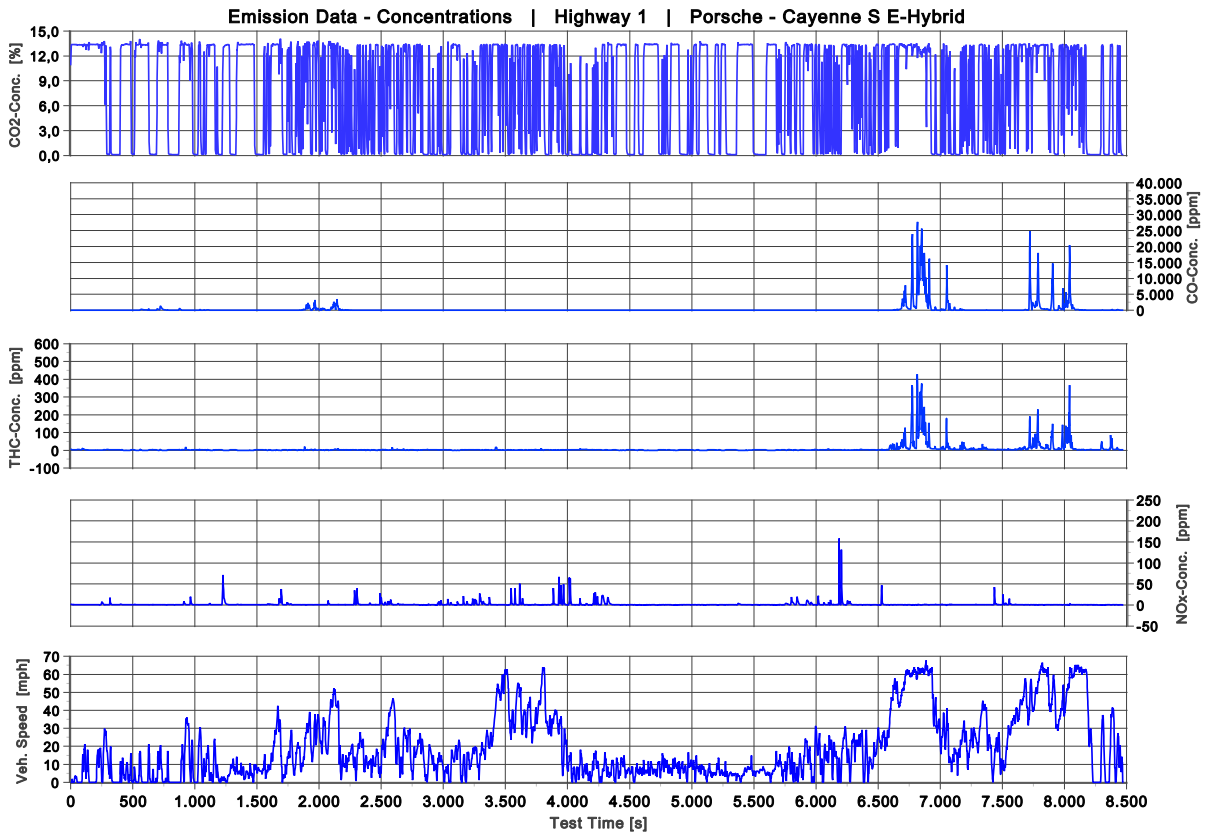
3.2.3 Highway (1)

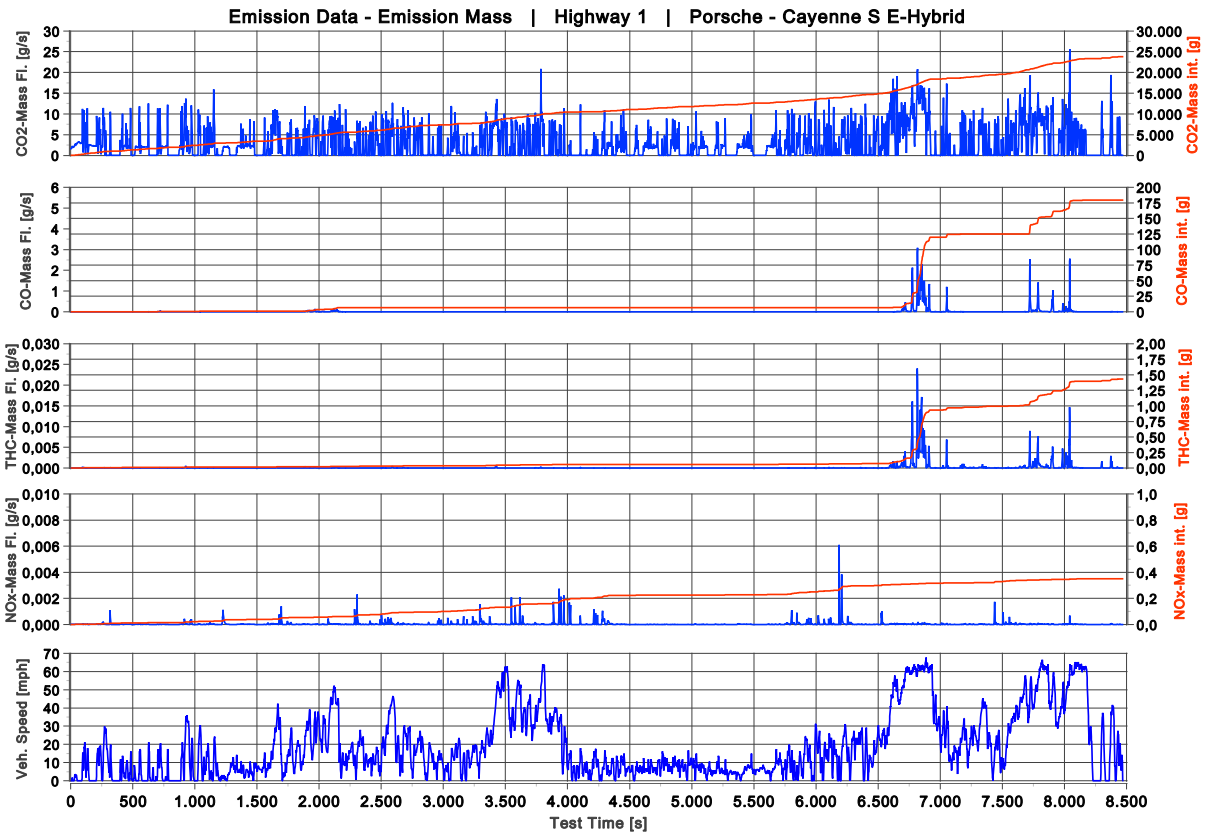
Table 3-5: Highway (1) Trip Summary for Porsche - Cayenne S E-Hybrid

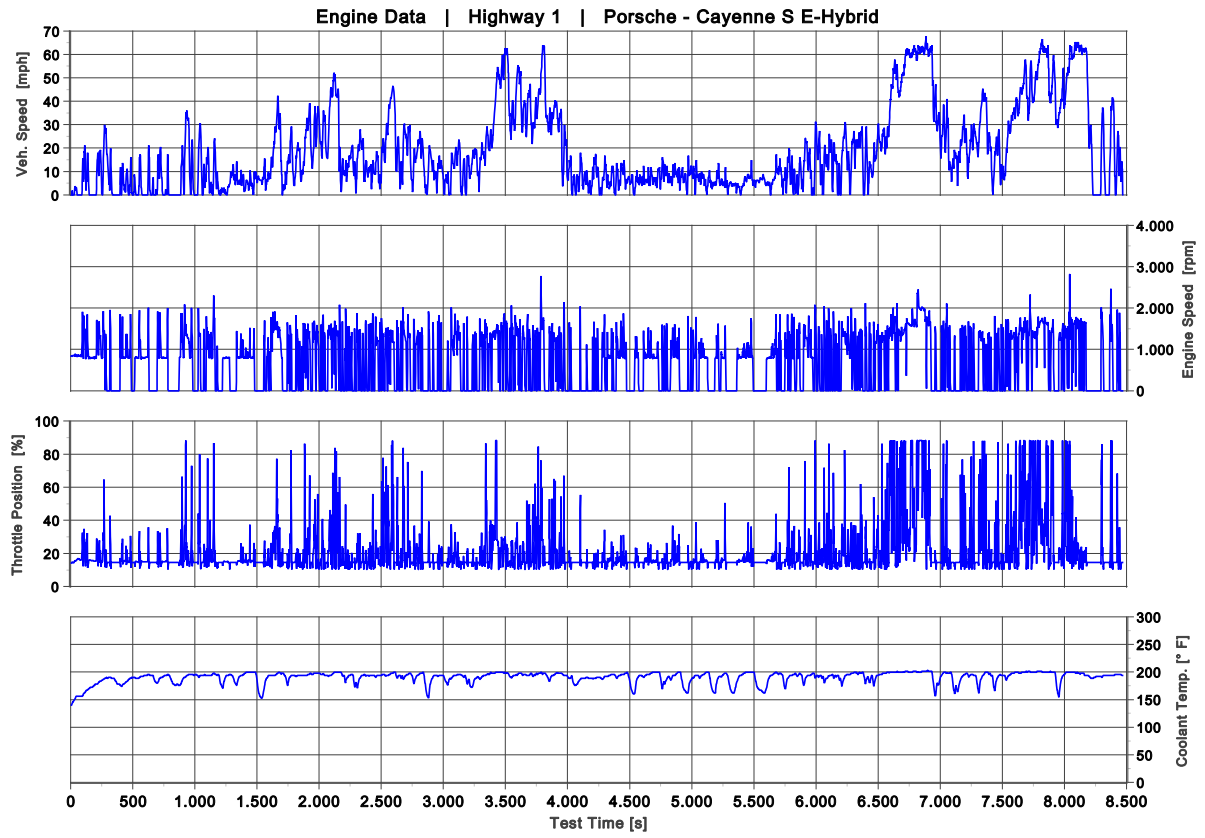
Test Data			
Test Name:	2018-04-26_CayenneS-E-Hybrid_Highway		
Department:	MBtech	Test Date:	04/26/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	540,0
CO		[g/mi]	4,081
NO_x		[g/mi]	0,009
THC		[g/mi]	0,032
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	8474
Distance		[mi]	44,05
Average Speed		[mph]	18,7
Average Ambient Temperature		[°F]	77,8

The measurement was not representative because the vehicle was stuck in heavy highway traffic which prolonged the duration of the test by more than 1 hour and increased the total emissions measured per mile of distance travelled. The measurement was repeated (see Highway 2 at pp. 30-34).


Trip Data | Highway 1 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
350
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
6.500
7.000
7.500
8.000
8.500
Test Time [s]


Emission Data - Concentrations | Highway 1 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
600
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
6.500
7.000
7.500
8.000
8.500
Test Time [s]

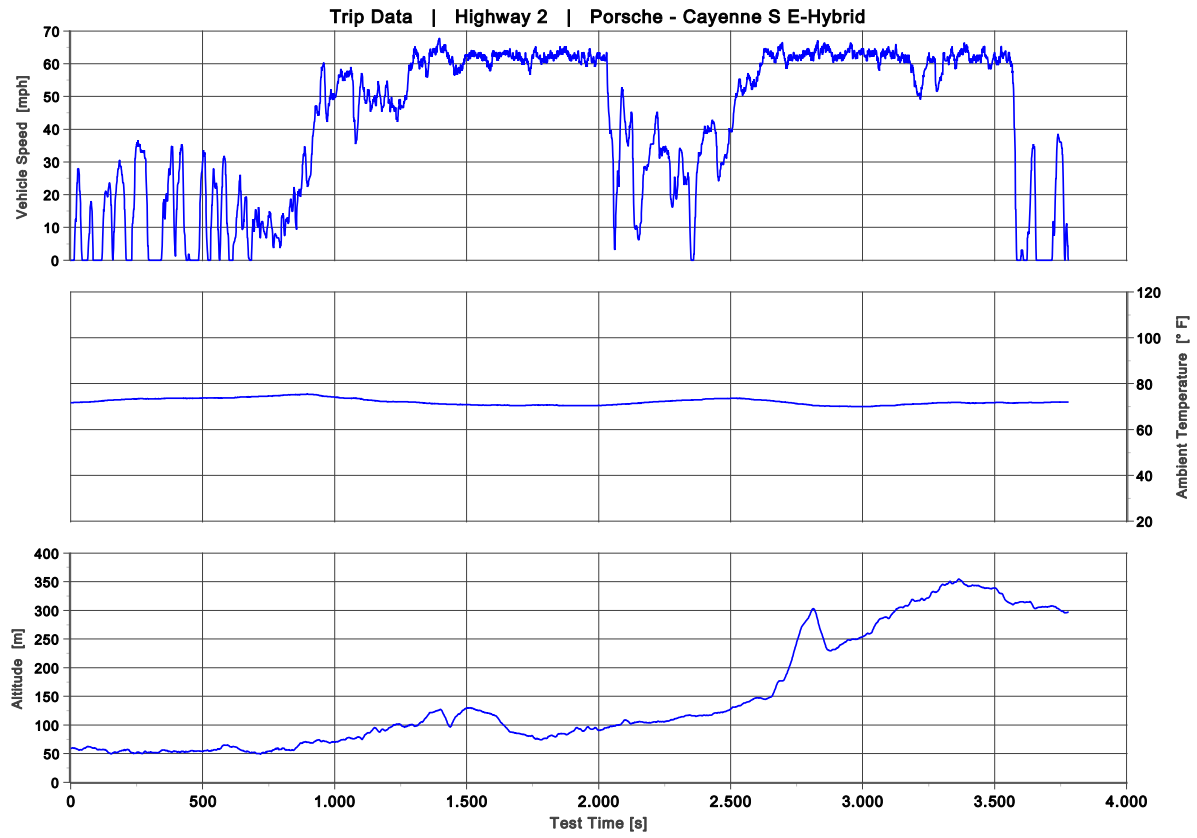

Emission Data - Emission Mass | Highway 1 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

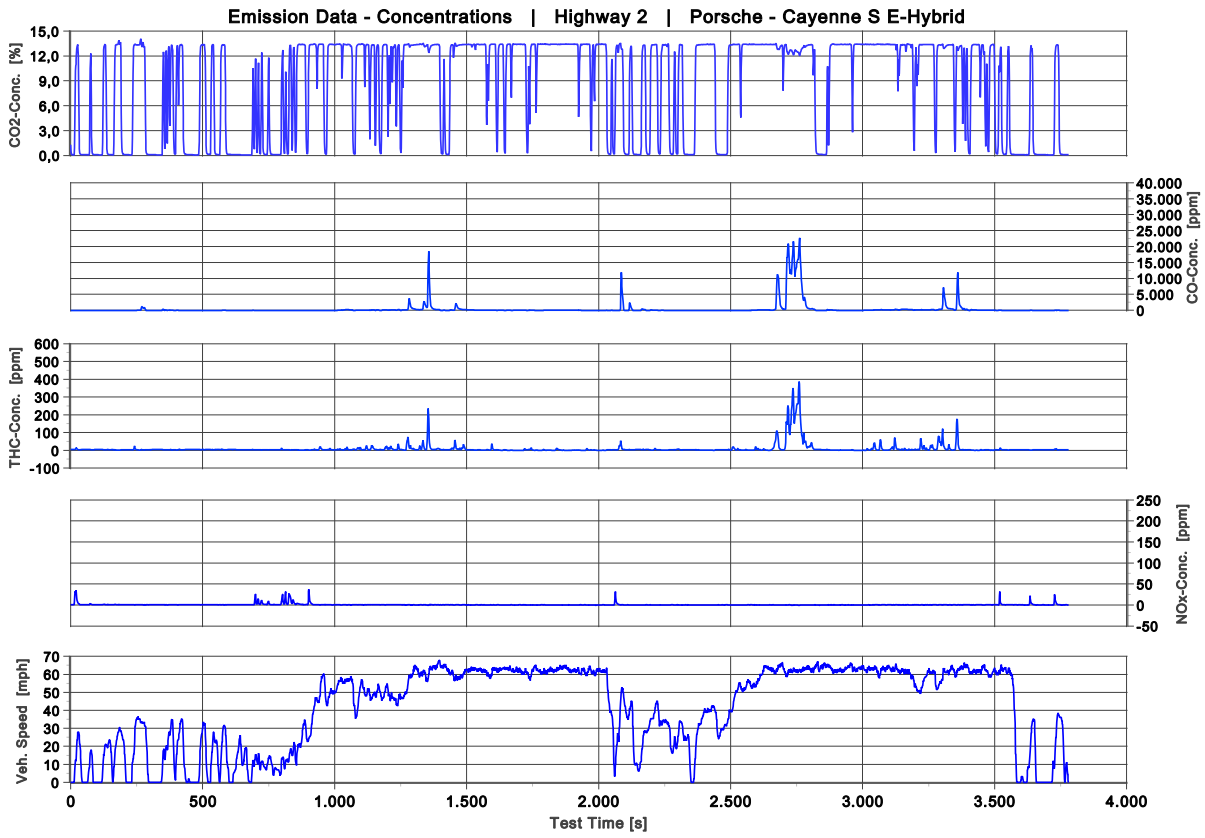

Engine Data | Highway 1 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
6.500
7.000
7.500
8.000
8.500
Test Time [s]

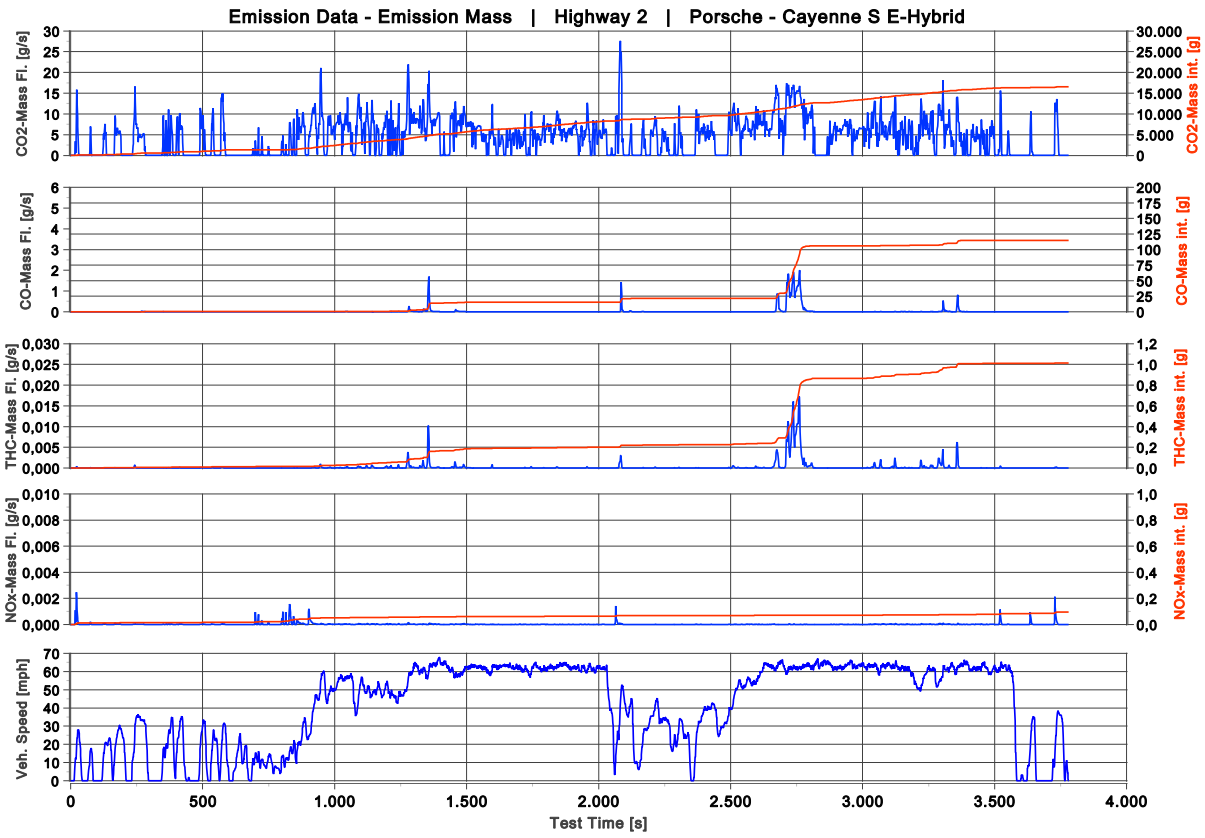
3.2.4 Highway (2)

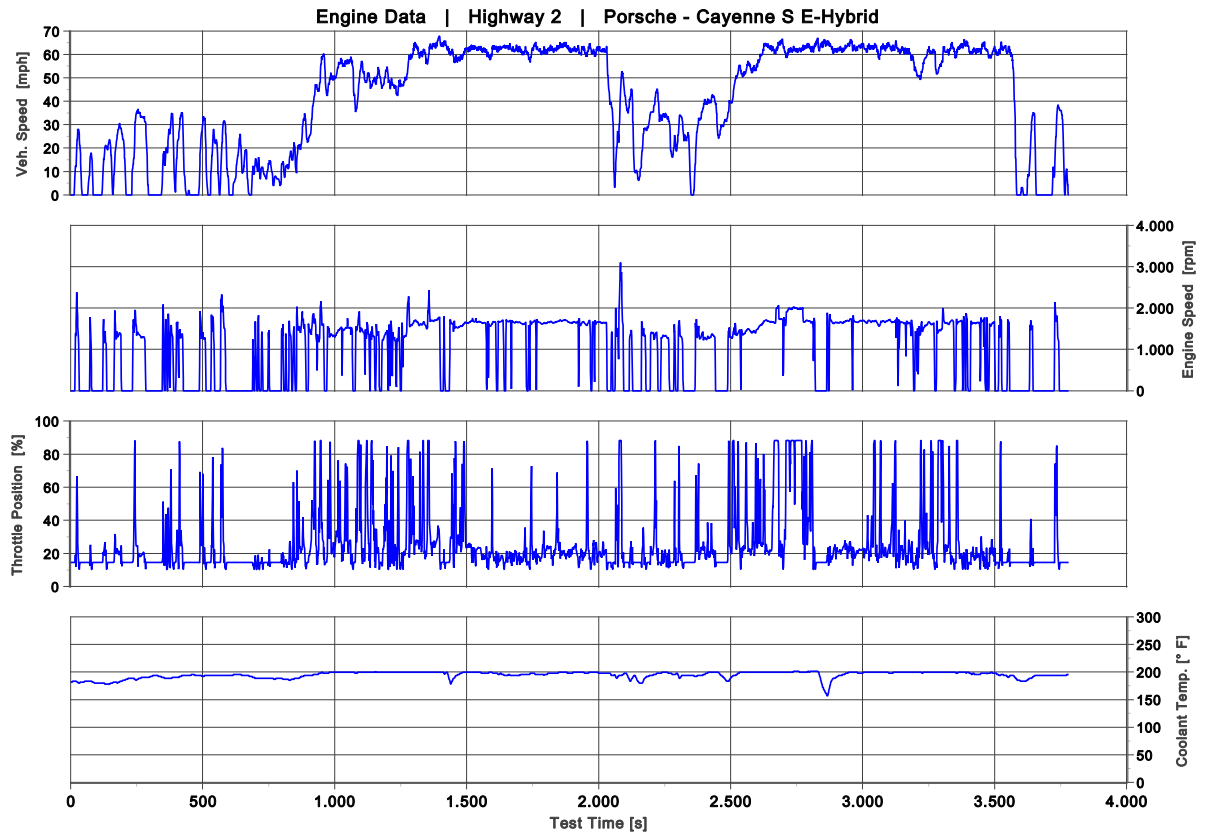
Table 3-6: Highway (2) Trip Summary for Cayenne S E-Hybrid

Test Data			
Test Name:	2018-04-27_CayenneS-E-Hybrid_Highway		
Department:	MBtech	Test Date:	04/27/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	378,7
CO		[g/mi]	2,580
NO_x		[g/mi]	0,002
THC		[g/mi]	0,023
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3781
Distance		[mi]	43,88
Average Speed		[mph]	41,8
Average Ambient Temperature		[°F]	72,2


Trip Data | Highway 2 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
350
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Concentrations | Highway 2 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
600
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Emission Mass | Highway 2 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

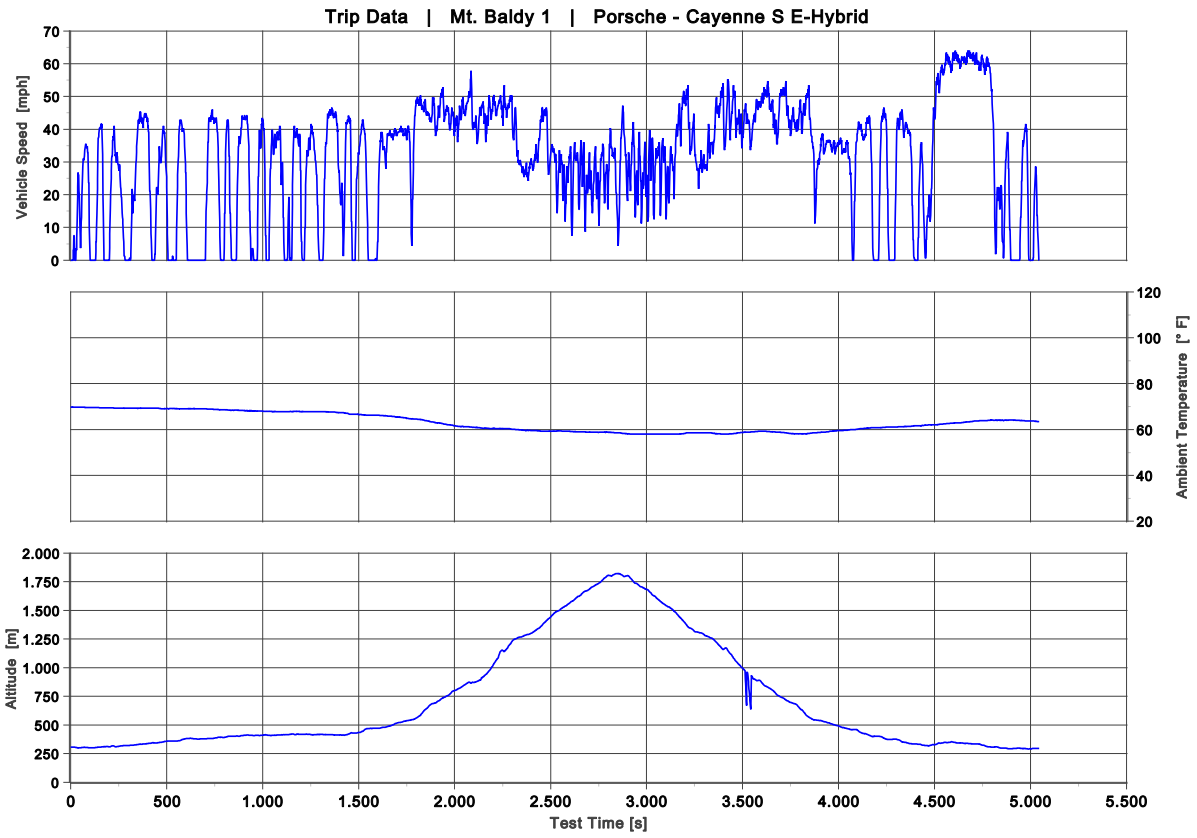

Engine Data | Highway 2 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

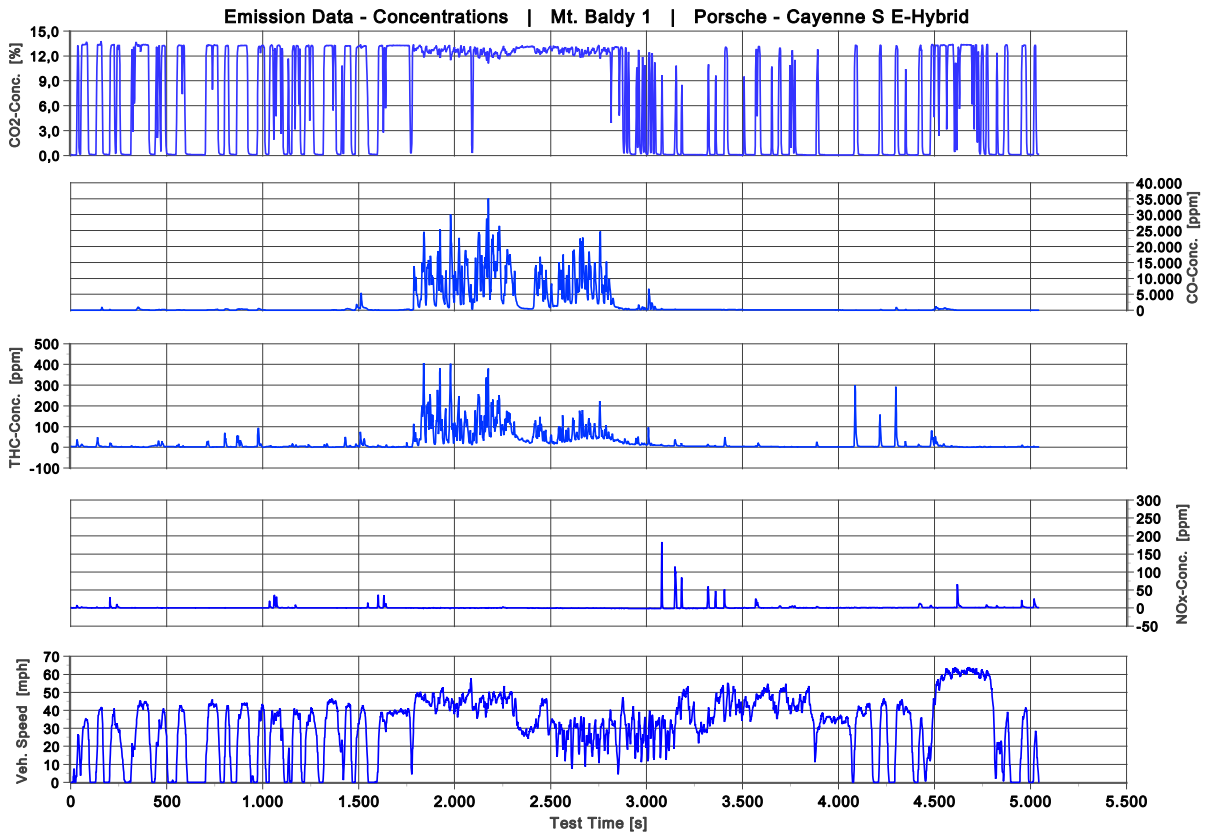
3.2.5 Mt. Baldy (1)

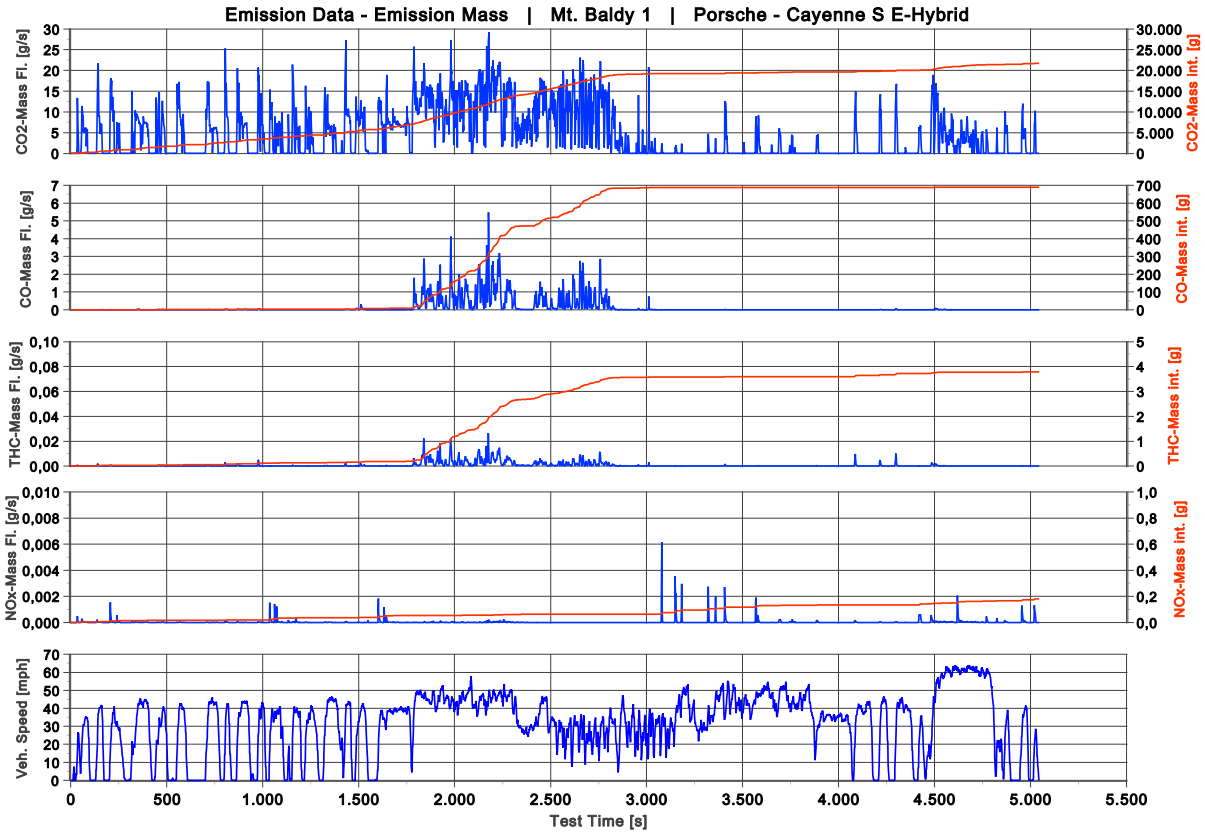
Table 3-7: Mt. Baldy (1) Trip Summary for Porsche - Cayenne S E-Hybrid

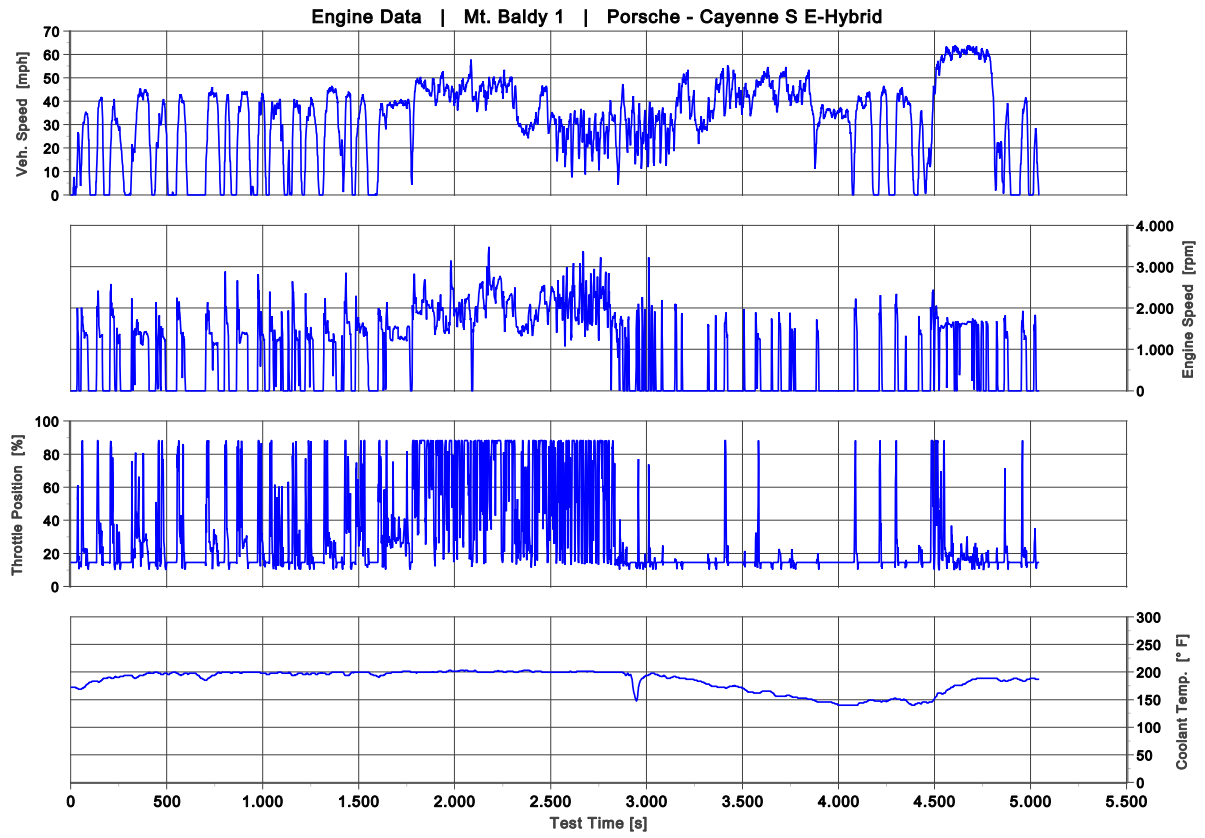
Test Data			
Test Name:	2018-04-26_CayenneS-E-Hybrid_Mt.-Baldy		
Department:	MBtech	Test Date:	04/26/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	497,1
CO		[g/mi]	15,832
NO_x		[g/mi]	0,004
THC		[g/mi]	0,087
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	5045
Distance		[mi]	43,66
Average Speed		[mph]	31,2
Average Ambient Temperature		[°F]	63,1

Nearly all the CO emissions appear during the uphill driving part of the route (see “Emission Data” charts). The battery charge decreased below the working point and therefore the hybrid operating strategy requested a recharge. That led to high engine load and high CO emissions (see “Engine Data” chart).


Trip Data | Mt. Baldy 1 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Concentrations | Mt. Baldy 1 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
300
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy 1 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

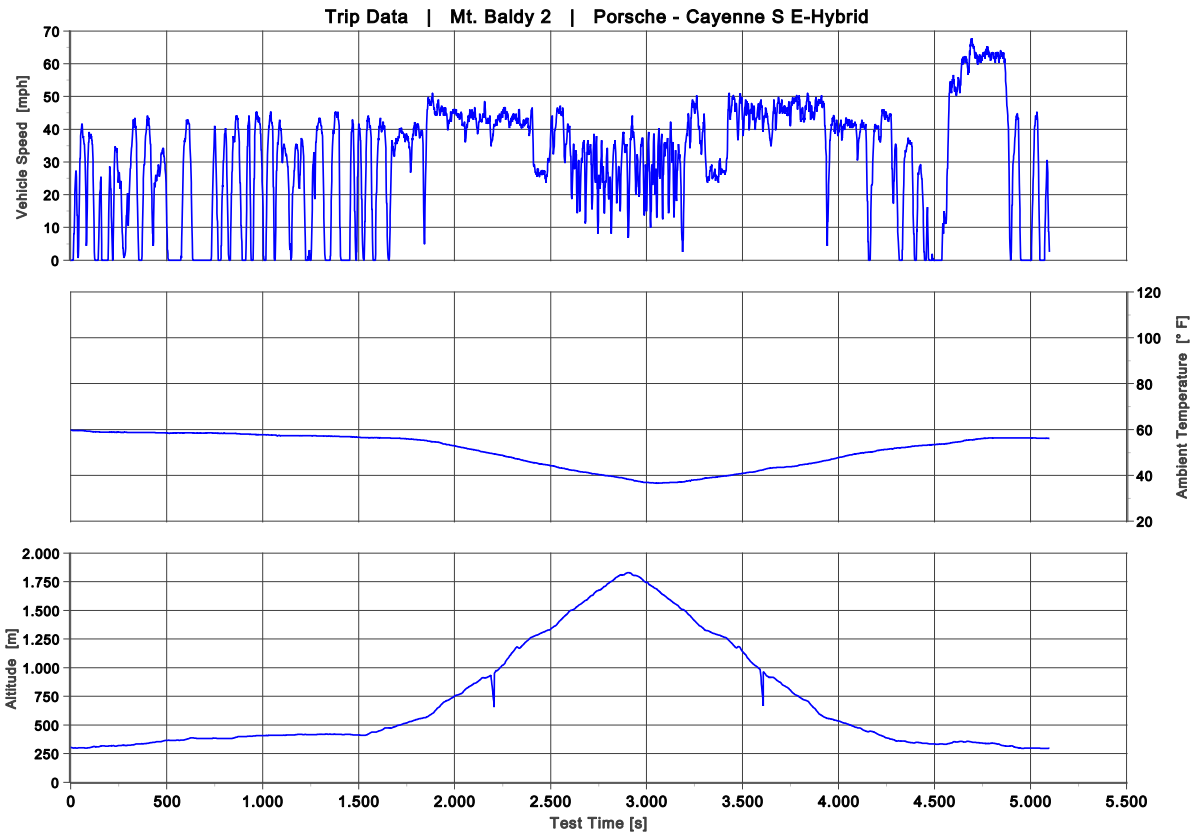

Engine Data | Mt. Baldy 1 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]

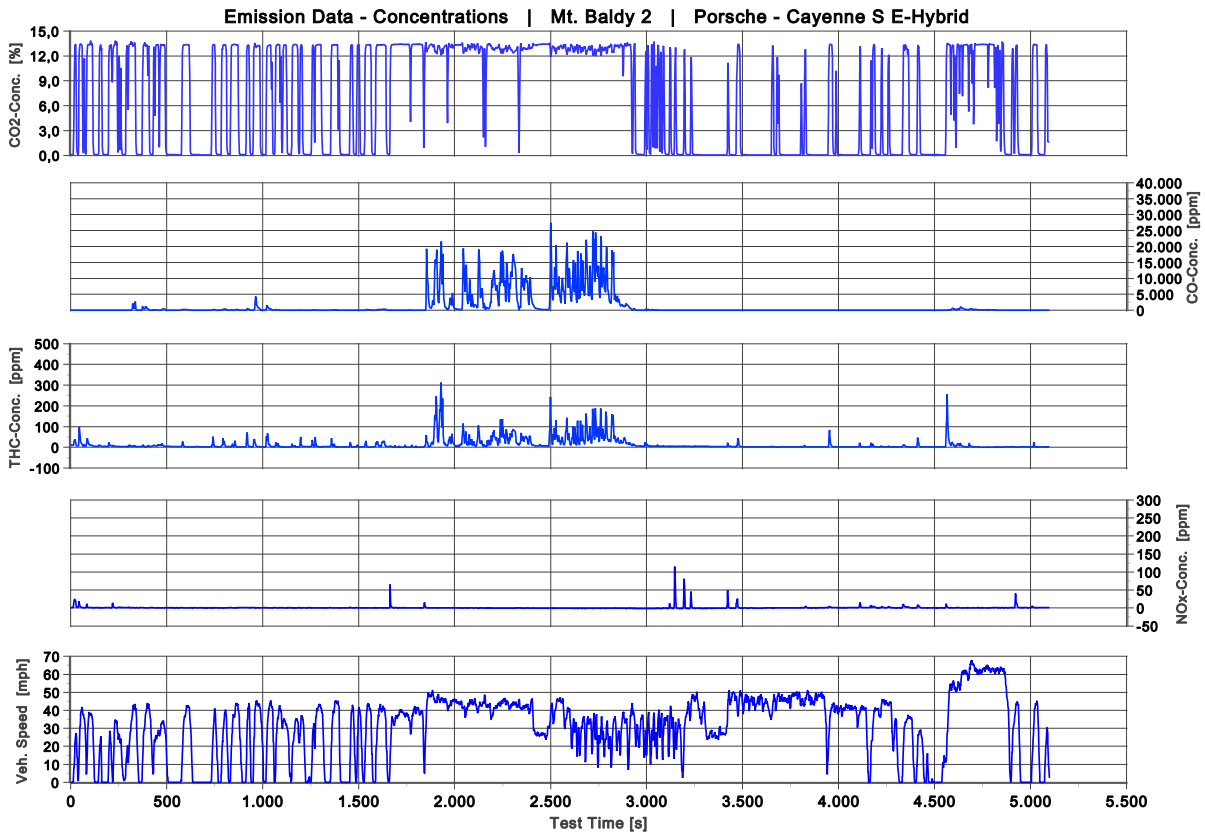
3.2.6 Mt. Baldy (2)

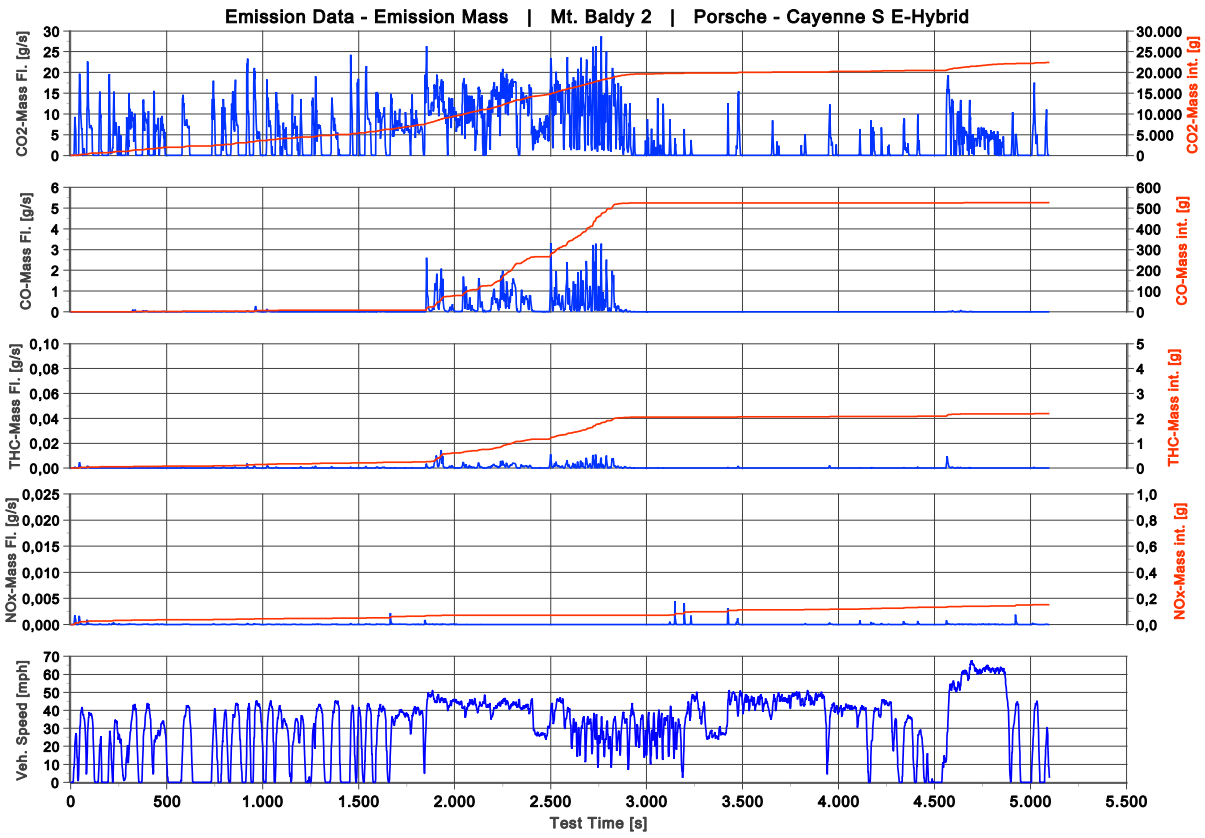
Table 3-8: Mt. Baldy (2) Trip Summary for Porsche - Cayenne S E-Hybrid

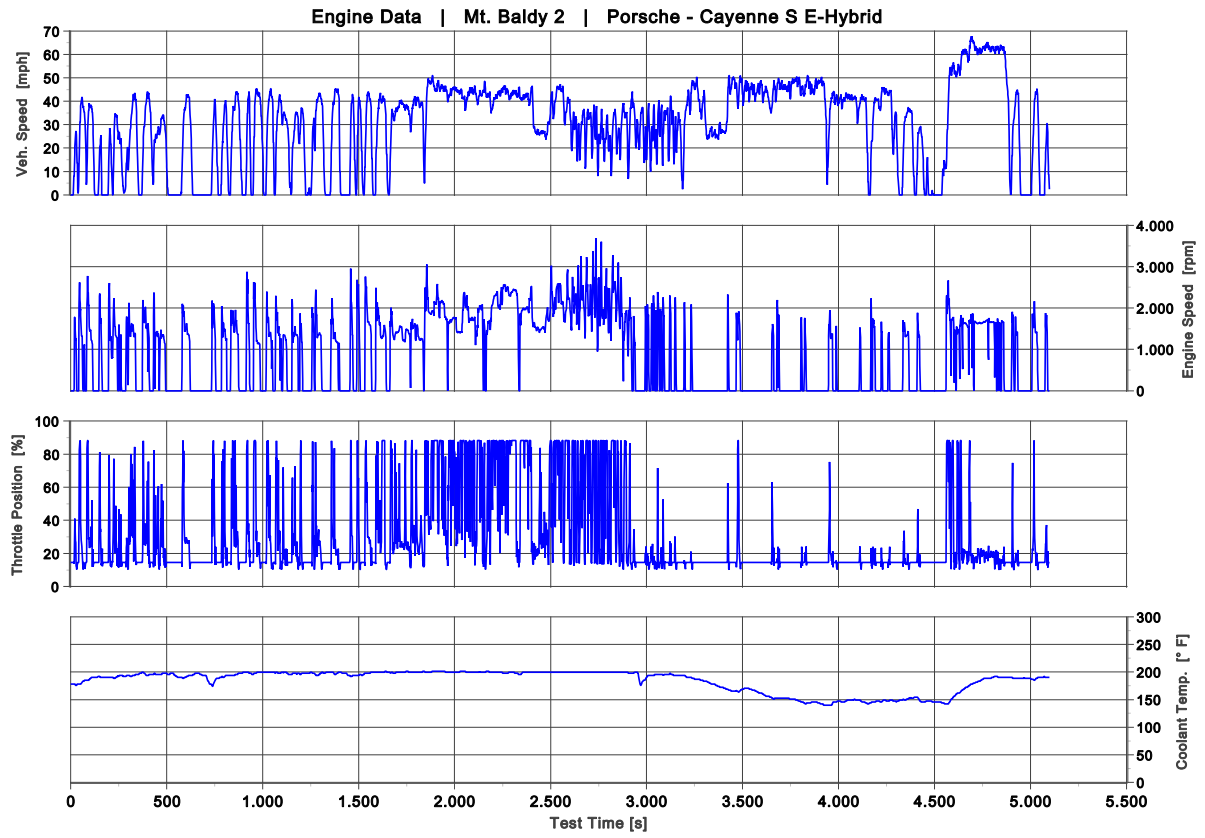
Test Data			
Test Name:	2018-05-01_CayenneS-E-Hybrid_Mt.-Baldy		
Department:	MBtech	Test Date:	05/01/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	515,6
CO		[g/mi]	12,063
NO_x		[g/mi]	0,004
THC		[g/mi]	0,050
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	5098
Distance		[mi]	43,56
Average Speed		[mph]	30,8
Average Ambient Temperature		[°F]	50,9

Nearly all the CO emissions appear during the uphill driving part of the route (see “Emission Data” charts). The battery charge decreased below the working point and therefore the hybrid operating strategy requested a recharge. That led to high engine load and high CO emissions (see “Engine Data” chart).


Trip Data | Mt. Baldy 2 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Concentrations | Mt. Baldy 2 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
300
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy 2 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy 2 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]

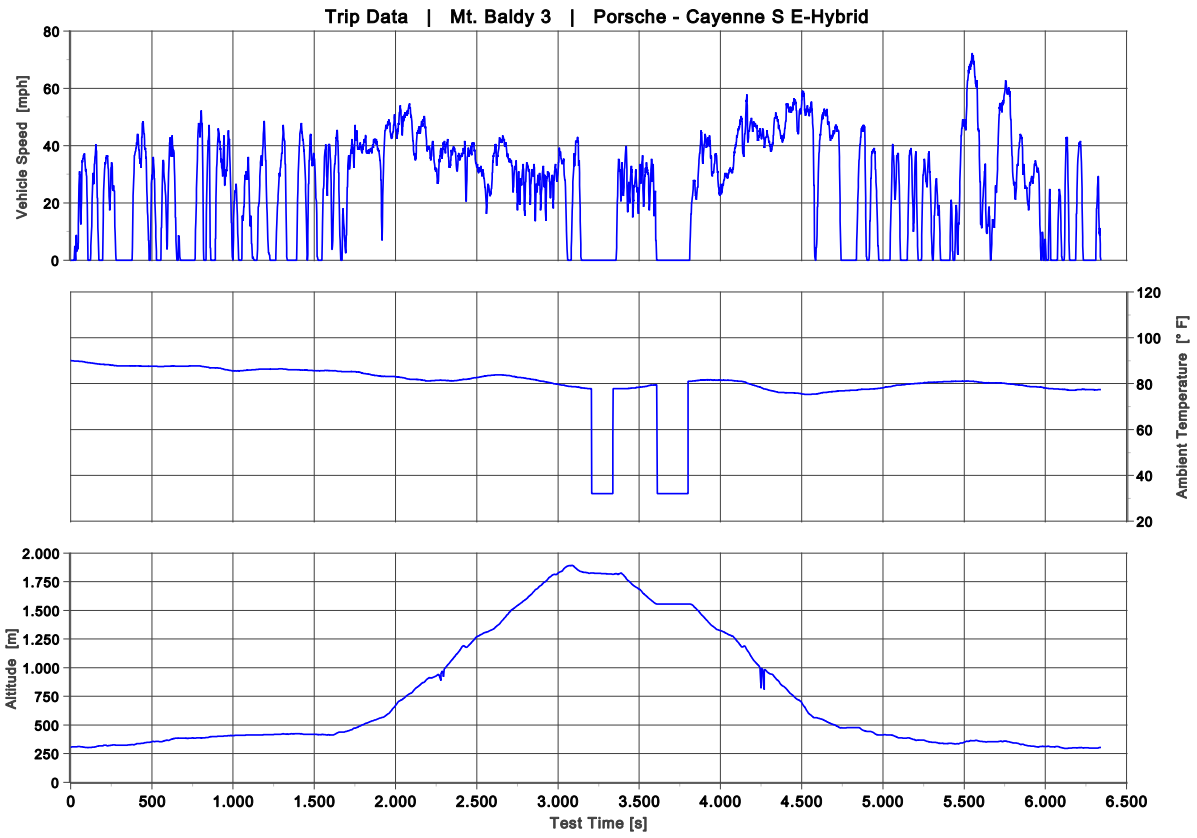
3.2.7 Mt. Baldy (3)

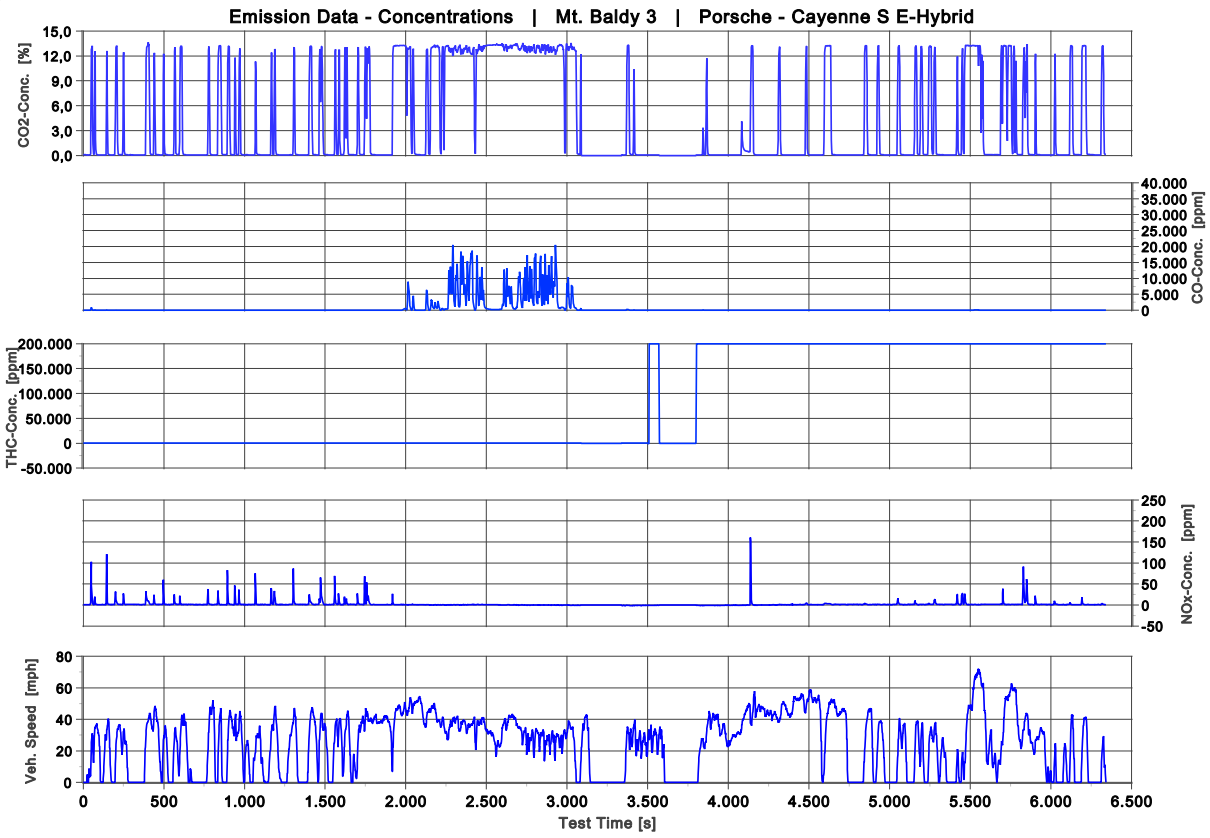
Table 3-9: Mt. Baldy (3) Trip Summary for Cayenne S E-Hybrid

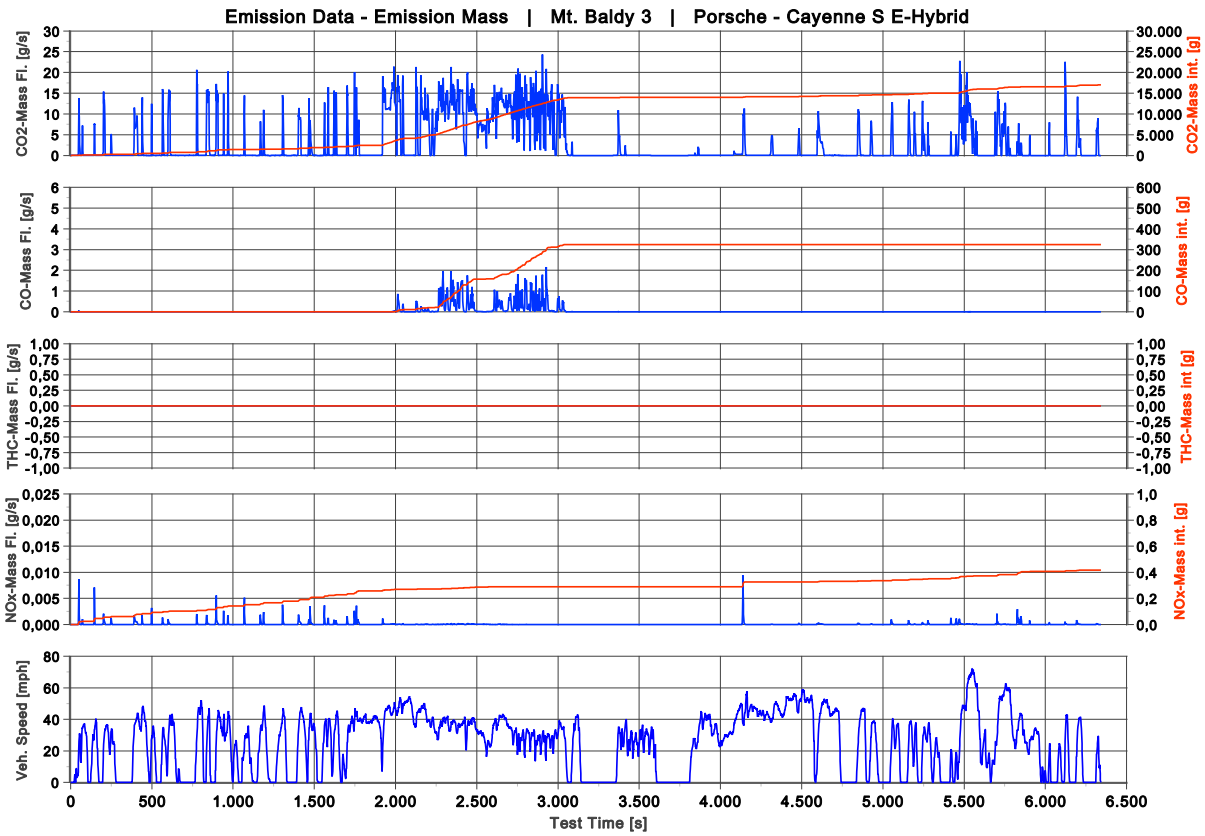
Test Data			
Test Name:	2018-05-29_CayenneS-E-Hybrid_Mt.Baldy		
Department:	MBtech	Test Date:	05/29/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	340
Vehicle Modell:	Cayenne S E-Hybrid	Nominal Torque [Nm]:	700
VIN:	WP1AE2A29JLA72363	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	PHEV	Mileage [mi]:	ca. 1700
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	392,2
CO		[g/mi]	7,494
NO_x		[g/mi]	0,010
THC		[g/mi]	n.a.*****
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	6019
Distance		[mi]	43,37
Average Speed		[mph]	26,4
Average Ambient Temperature		[°F]	81,9

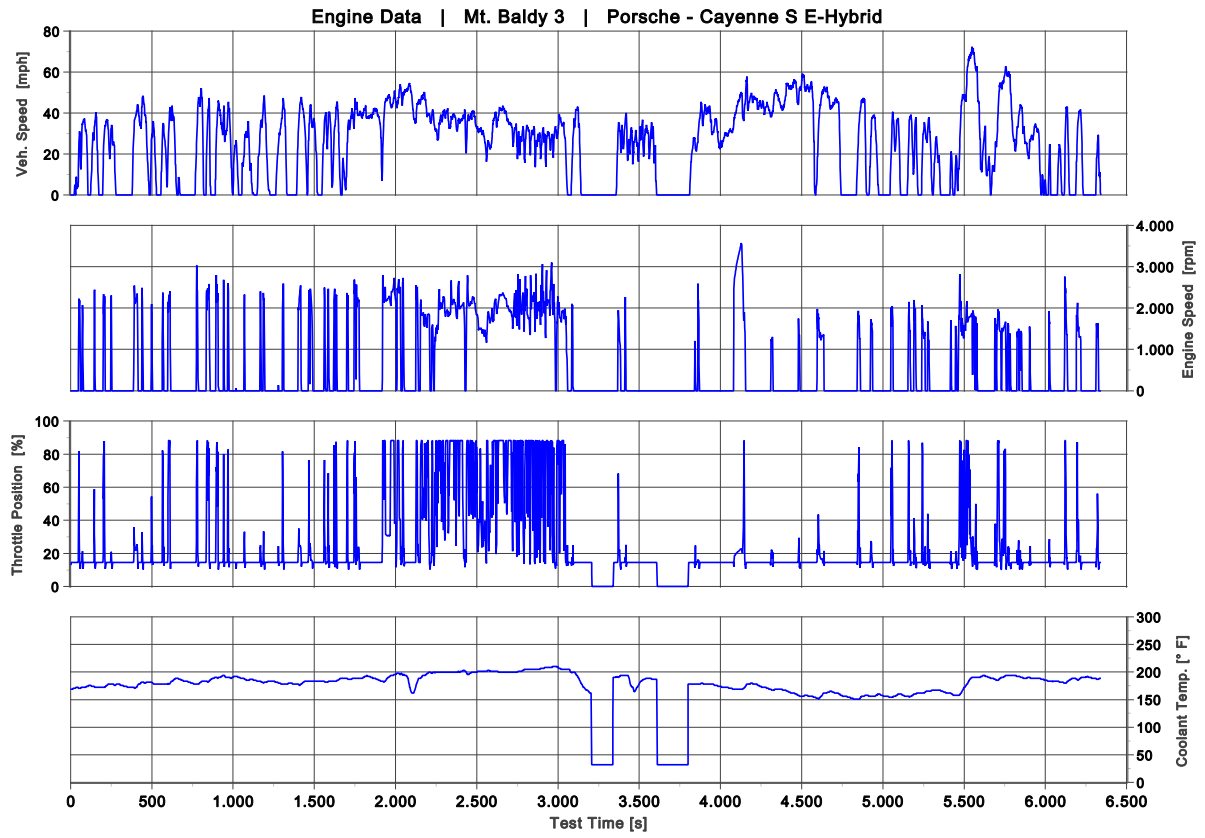
Nearly all the CO emissions appear during the uphill driving part of the route (see “Emission Data” charts). The battery charge decreased below the working point and therefore the hybrid operating strategy requested a recharge. That led to high engine load and high CO emissions (see “Engine Data” chart). Starting the test with a fully charged hi-voltage battery decreased the amount of CO emissions.

*****: Invalid data because of zero calibration loss after restart of FID system


Trip Data | Mt. Baldy 3 | Porsche - Cayenne S E-Hybrid
Vehicle Speed [mph]
80
60
40
20
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
6.500
Test Time [s]


Emission Data - Concentrations | Mt. Baldy 3 | Porsche - Cayenne S E-Hybrid
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
200.000
150.000
100.000
50.000
0
-50.000
NOx-Conc. [ppm]
250
200
150
100
50
0
-50
Veh. Speed [mph]
80
60
40
20
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
6.500
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy 3 | Porsche - Cayenne S E-Hybrid
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy 3 | Porsche - Cayenne S E-Hybrid
Veh. Speed [mph]
Engine Speed [rpm]
Throttle Position [%]
Coolant Temp. [° F]
Test Time [s]

3.3 Macan

The following table summarizes the emission measurement results from the Macan vehicle.

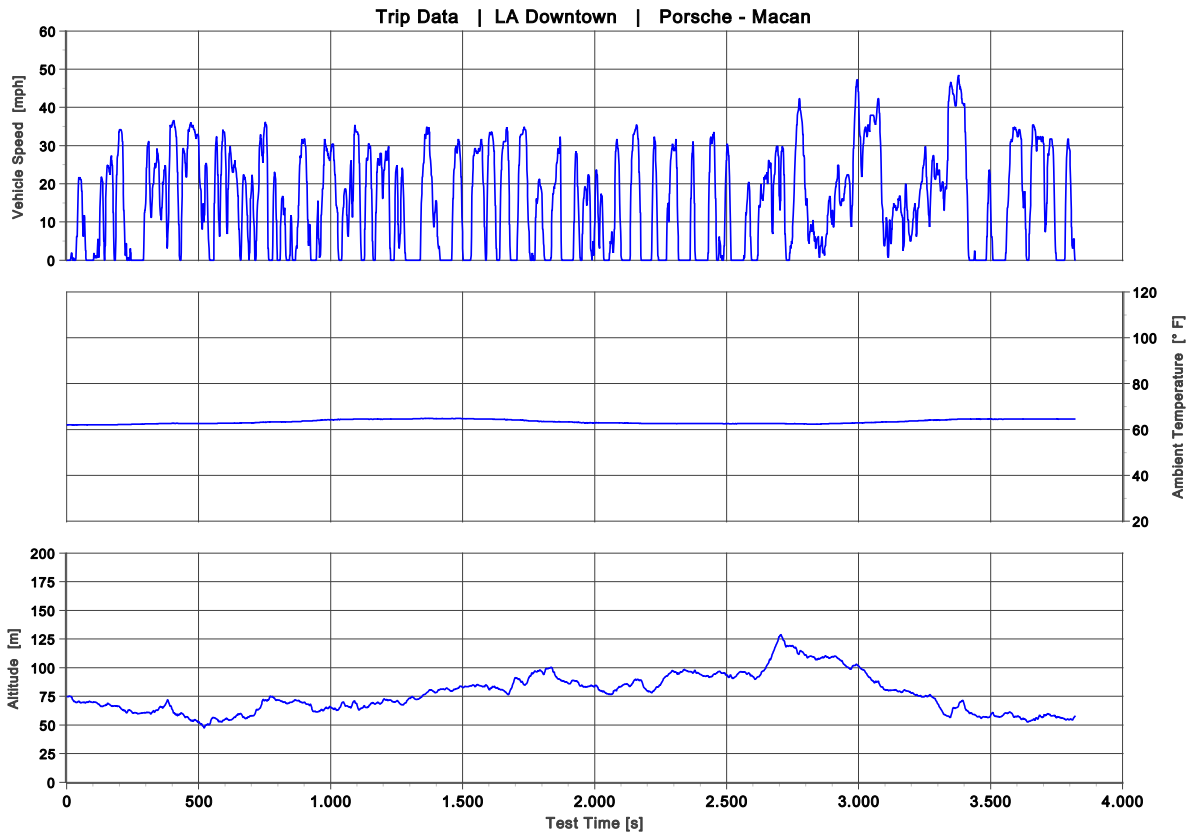
Table 3-10: Emission Overview Porsche - Macan

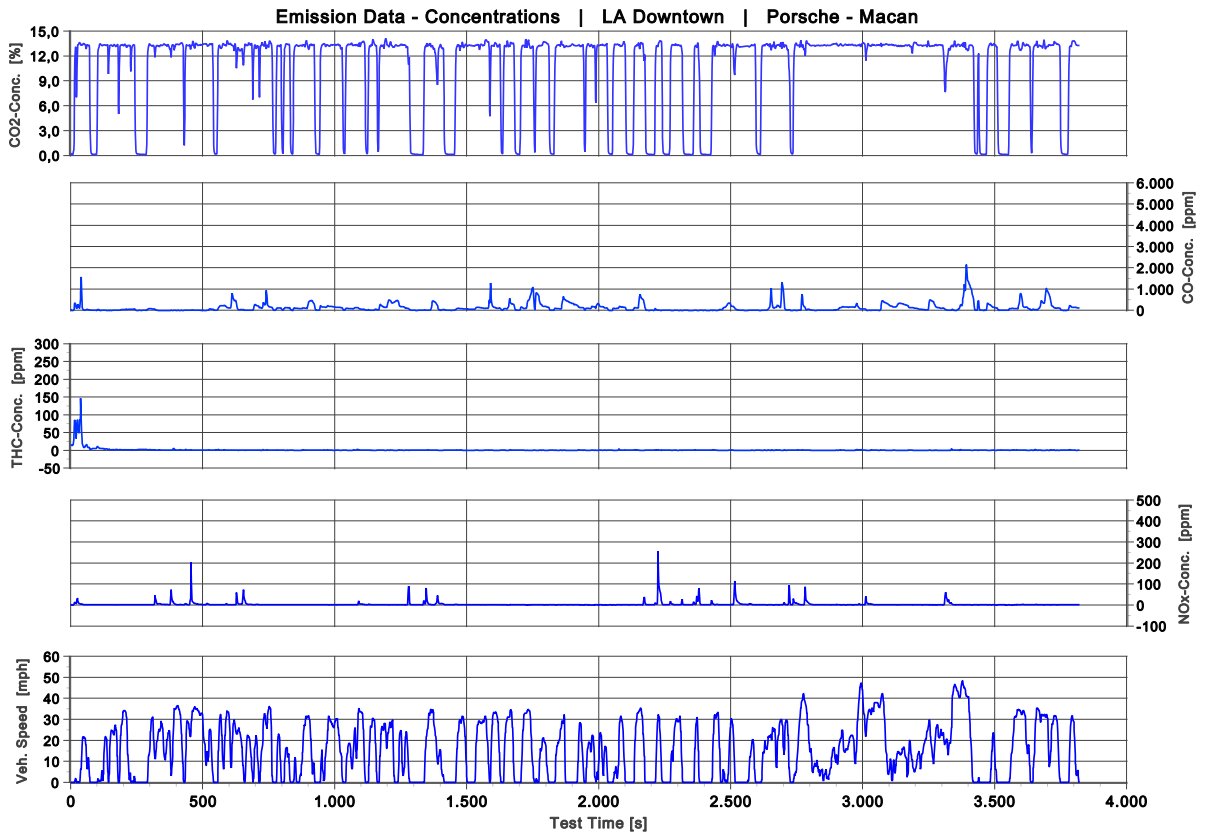
Macan		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/02/2018	LA Downtown	500,4	0,365	0,016	0,001	3822	15,75
05/03/2018	Highway	356,1	0,152	0,015	0,001	4203	44,32
05/03/2018	Mt. Baldy	443,7	0,281	0,013	0,002	5292	43,97
05/04/2018	FTP75 (PEMS)	366,8	0,444	0,010	0,005	2609	11,03
05/04/2018	FTP75 (Dyno)	367,6	0,528	0,008	0,026		

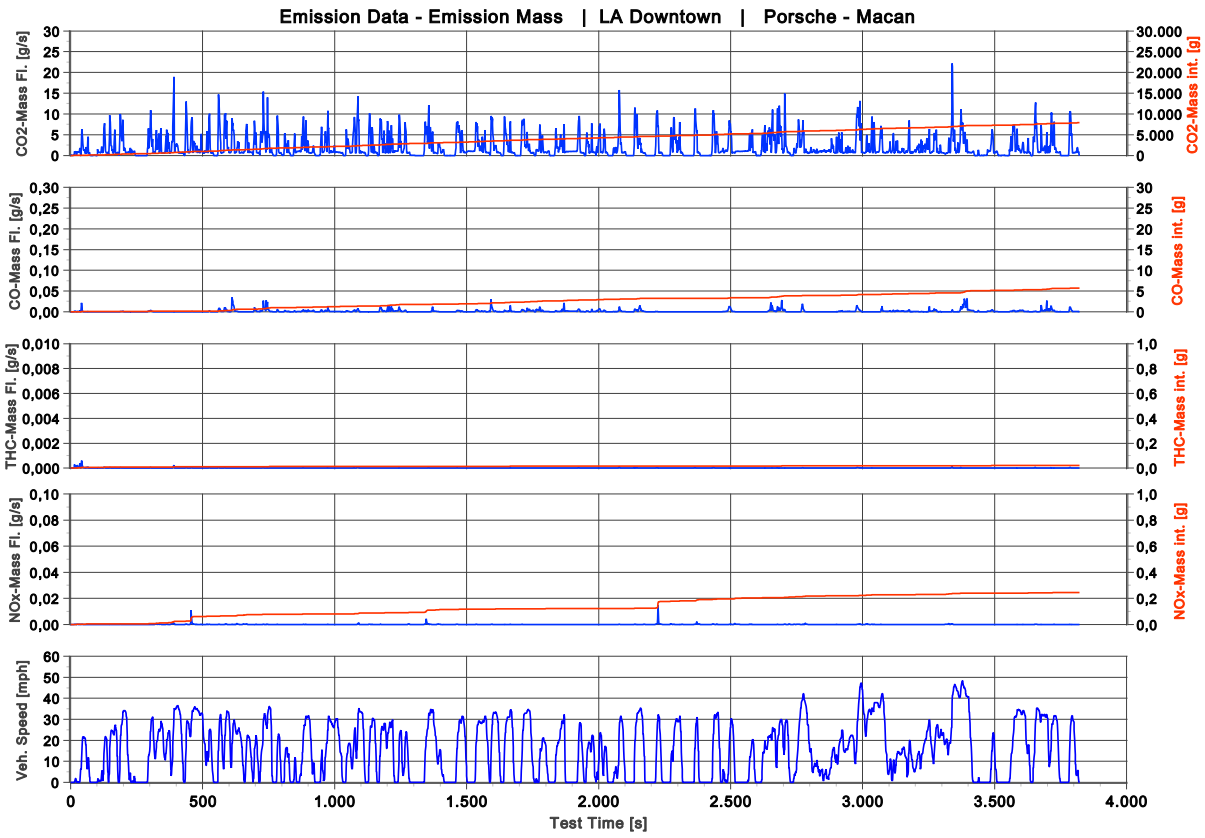
3.3.1 LA Downtown

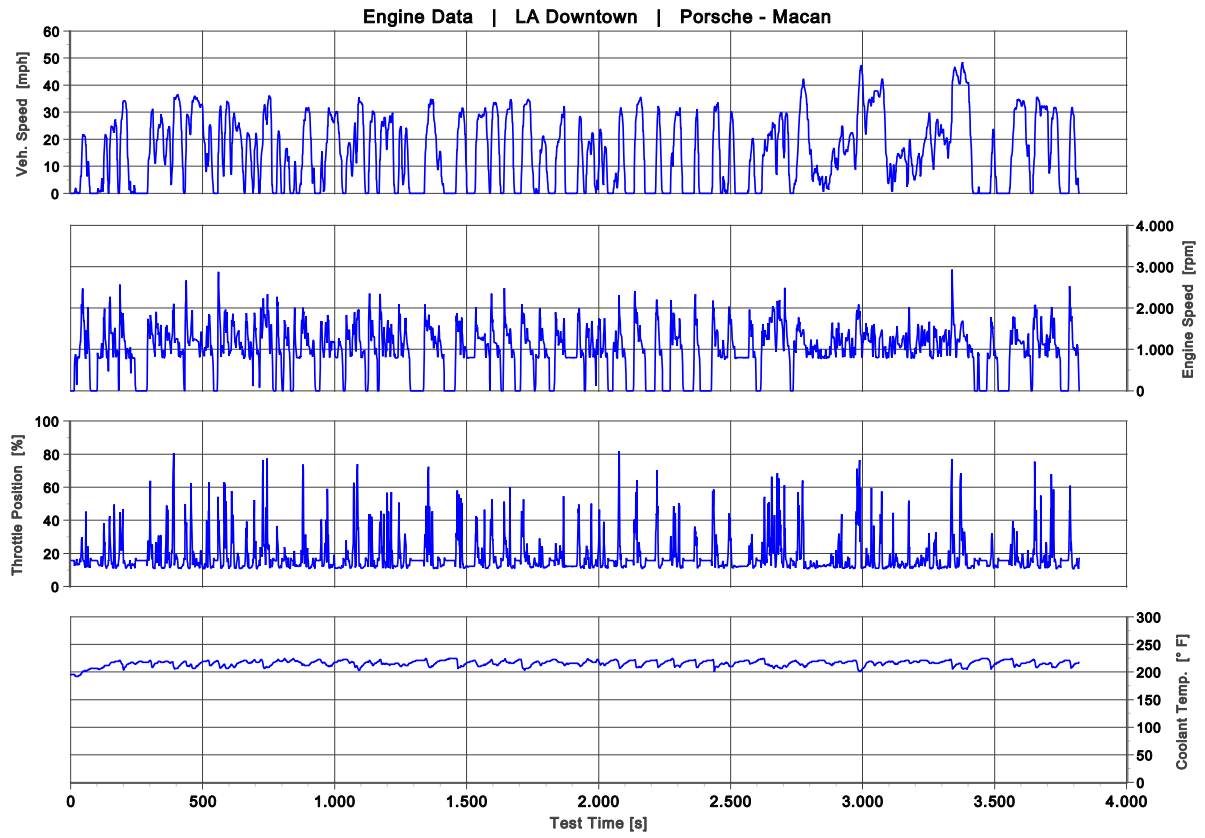
Table 3-11: LA Downtown Trip Summary for Macan

Test Data			
Test Name:	2018-05-02_Macan_LA-Downtown		
Department:	MBtech	Test Date:	05/02/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	WP1AA2A52JLB00994	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 4100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	500,4
CO		[g/mi]	0,365
NO_x		[g/mi]	0,016
THC		[g/mi]	0,001
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3822
Distance		[mi]	15,75
Average Speed		[mph]	14,8
Average Ambient Temperature		[°F]	63,4


Trip Data | LA Downtown | Porsche - Macan
Vehicle Speed [mph]
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]


Emission Data - Concentrations | LA Downtown | Porsche - Macan
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
300
250
200
150
100
50
0
-50
NOx-Conc. [ppm]
500
400
300
200
100
0
-100
Veh. Speed [mph]
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

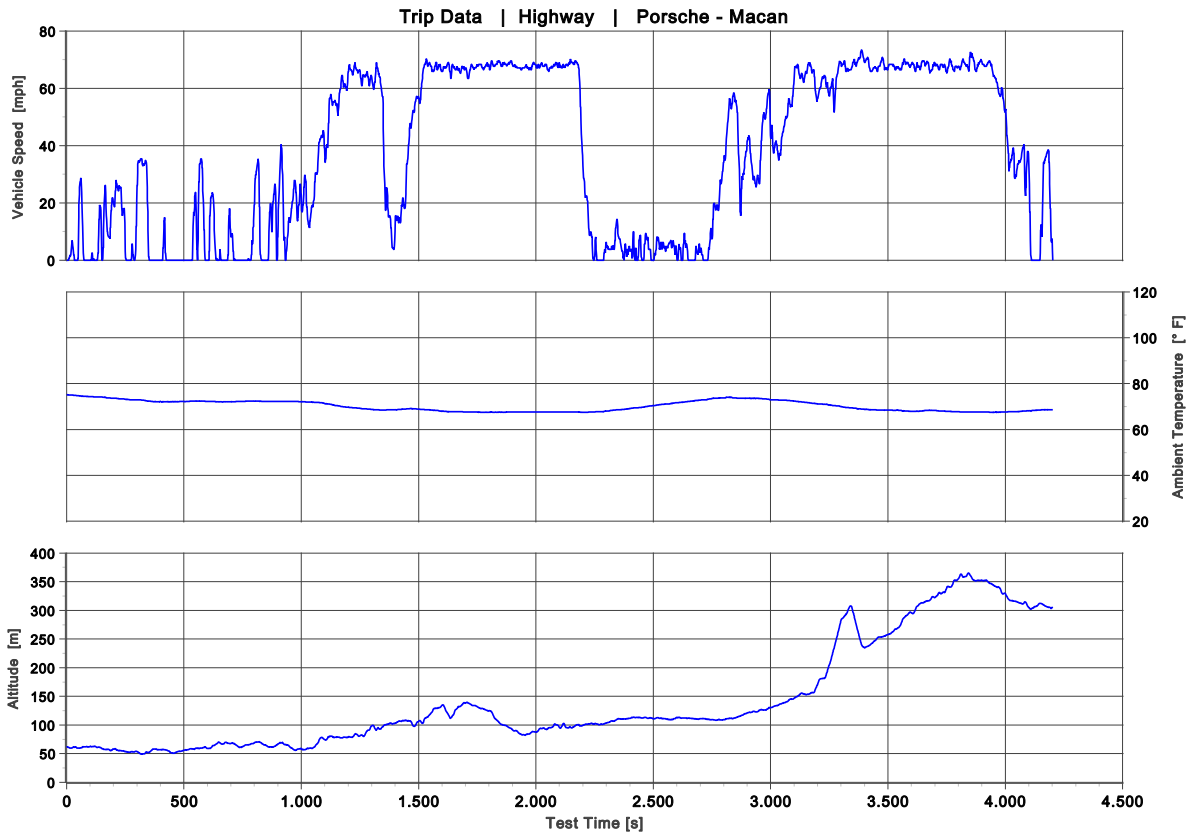

Emission Data - Emission Mass | LA Downtown | Porsche - Macan
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

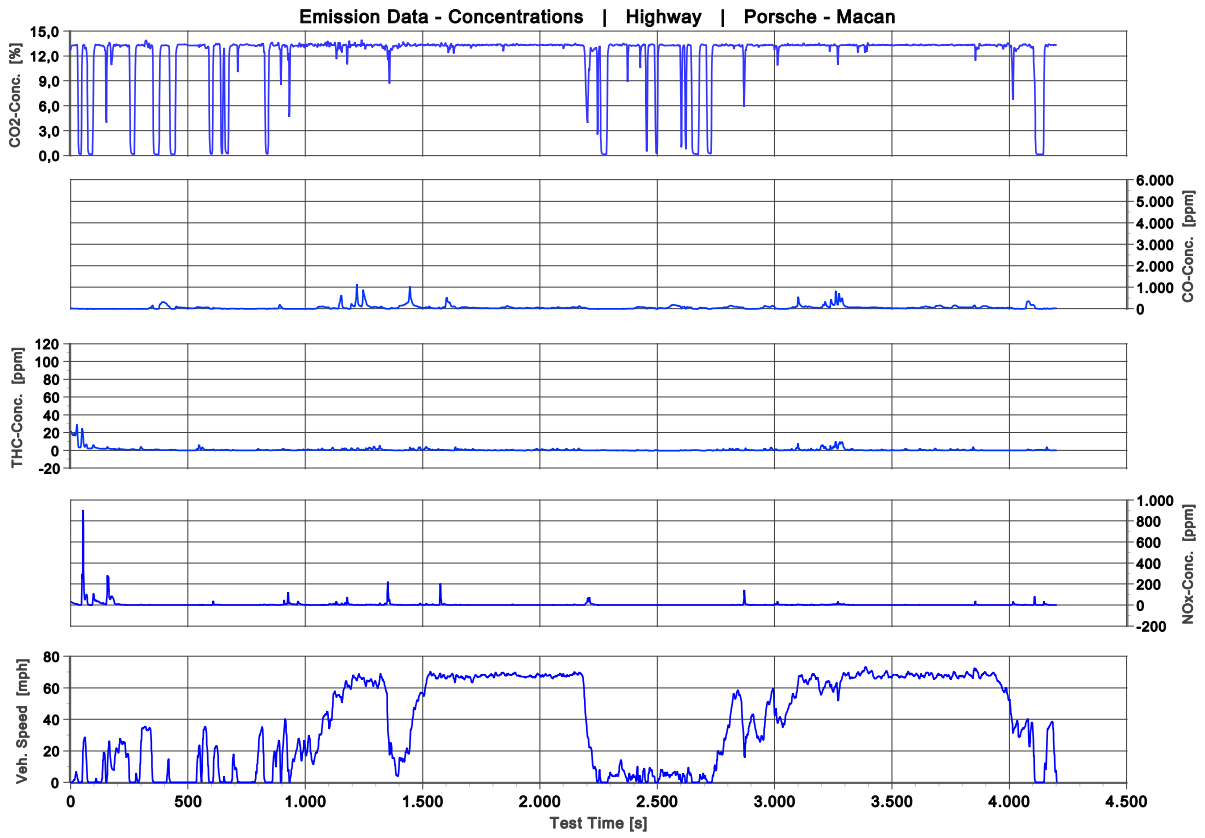

Engine Data | LA Downtown | Porsche - Macan
Veh. Speed [mph]
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
Test Time [s]

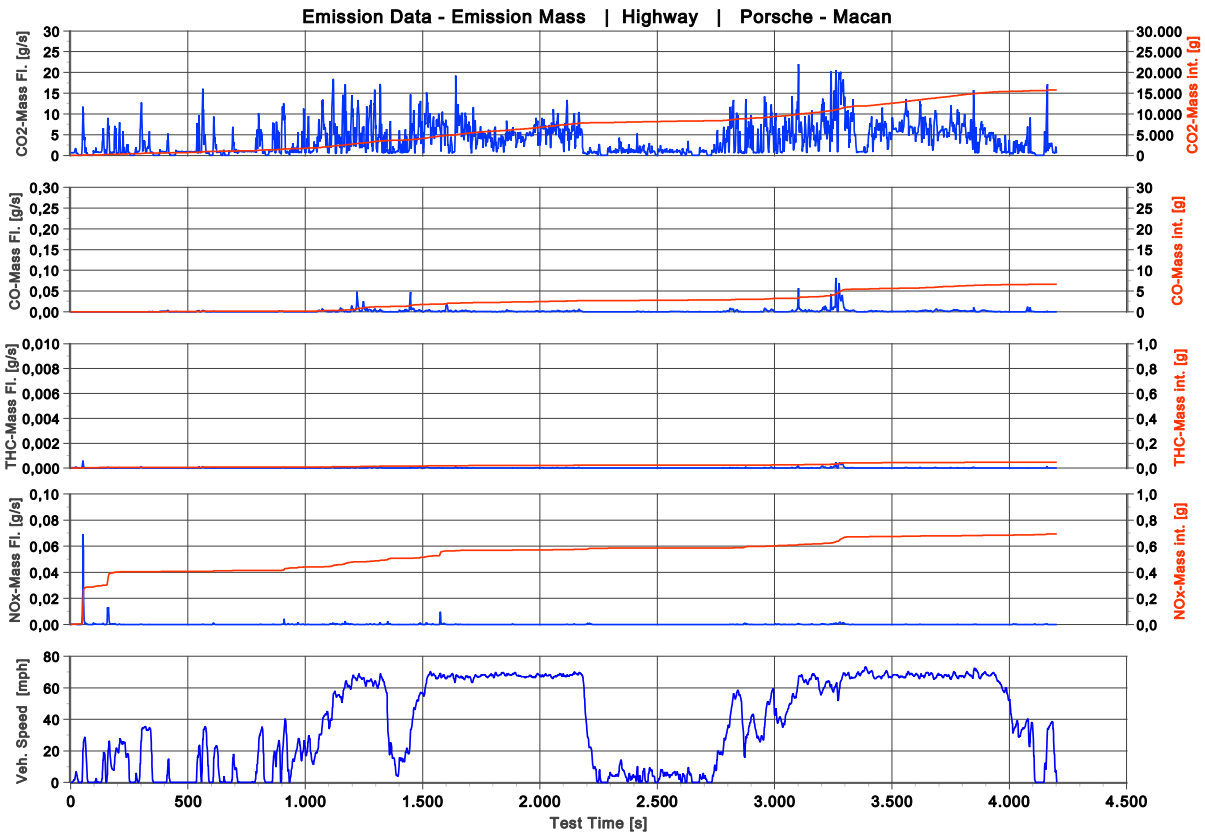
3.3.2 Highway

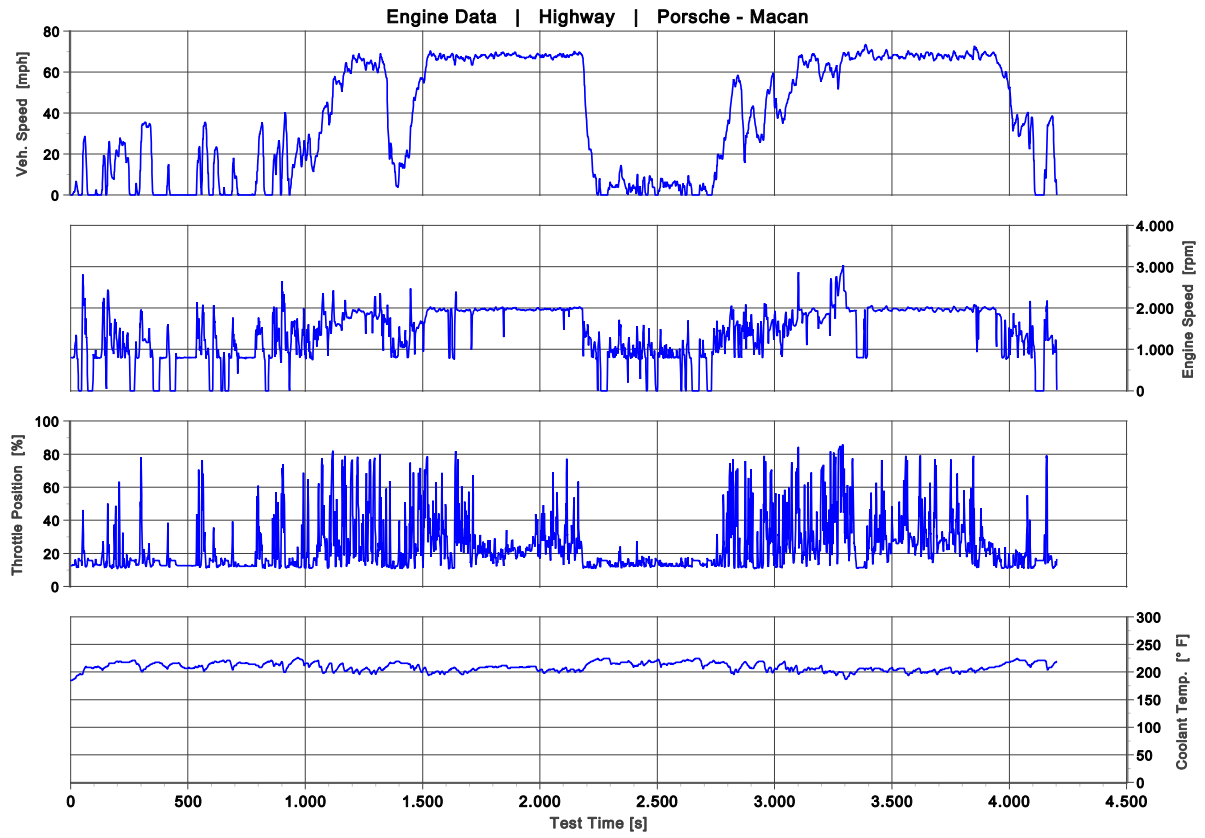
Table 3-12: Highway Trip Summary for Macan

Test Data			
Test Name:	2018-05-03_Macan-Highway		
Department:	MBtech	Test Date:	05/03/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	WP1AA2A52JLB00994	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 4100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	356,1
CO		[g/mi]	0,152
NO_x		[g/mi]	0,015
THC		[g/mi]	0,001
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	4203
Distance		[mi]	44,32
Average Speed		[mph]	38,0
Average Ambient Temperature		[°F]	70,3


Trip Data | Highway | Porsche - Macan
Vehicle Speed [mph]
0
20
40
60
80
Ambient Temperature [° F]
20
40
60
80
100
120
Altitude [m]
0
50
100
150
200
250
300
350
400
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Test Time [s]


Emission Data - Concentrations | Highway | Porsche - Macan
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
120
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
1.000
800
600
400
200
0
-200
Veh. Speed [mph]
80
60
40
20
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Test Time [s]

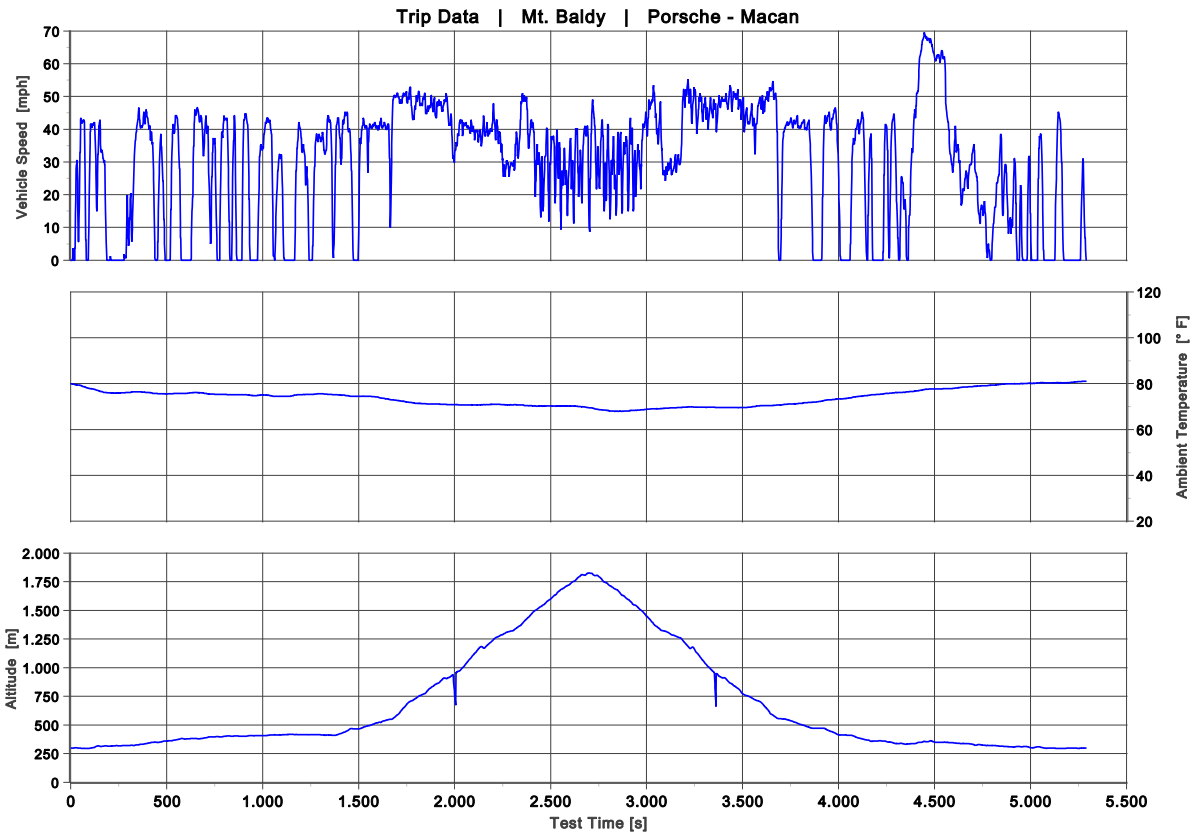

Emission Data - Emission Mass | Highway | Porsche - Macan
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

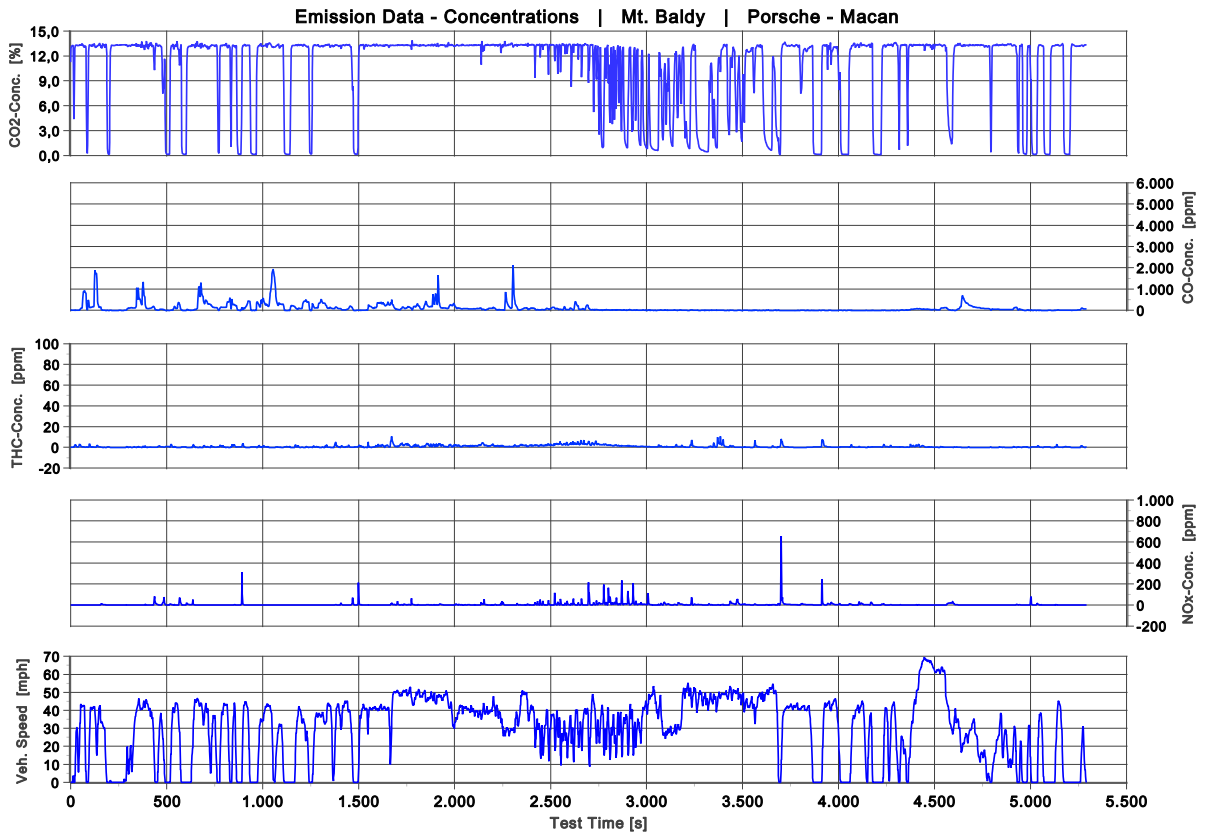

Engine Data | Highway | Porsche - Macan
Veh. Speed [mph]
Engine Speed [rpm]
Throttle Position [%]
Coolant Temp. [° F]
Test Time [s]
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500

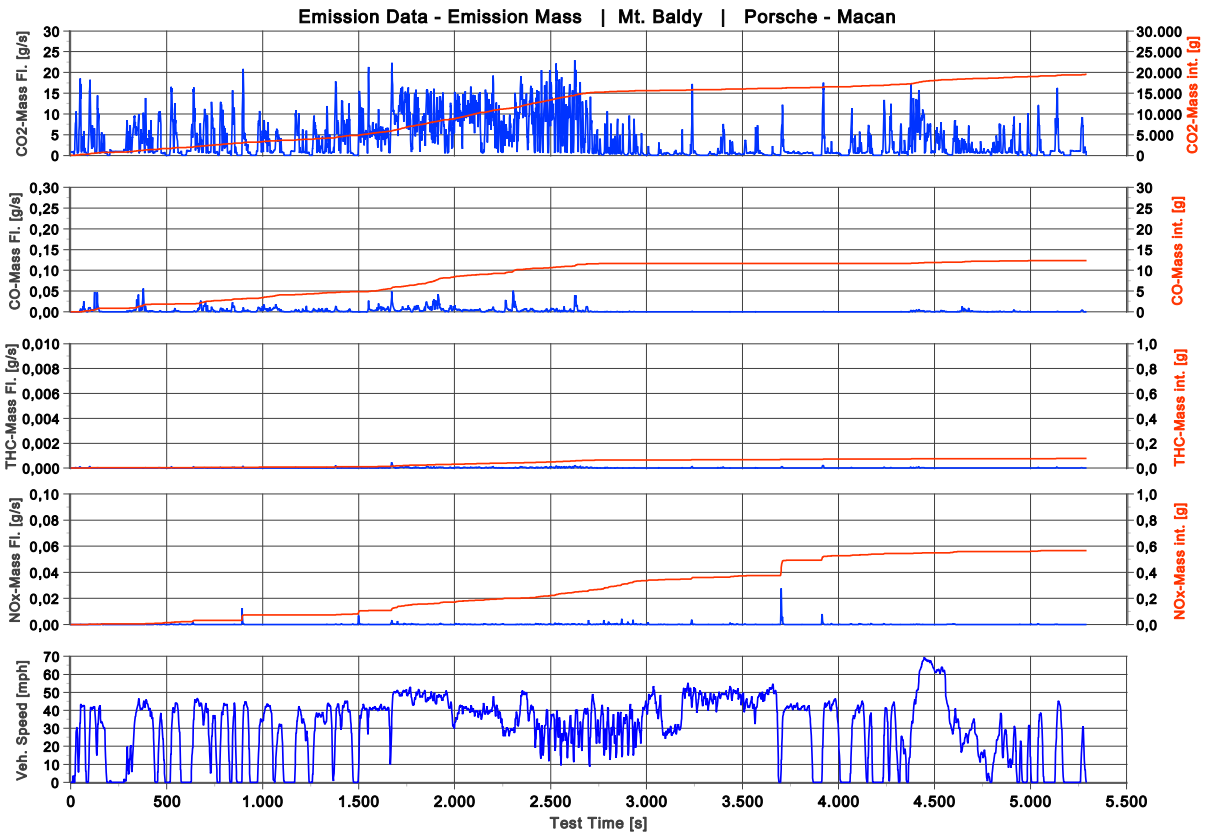
3.3.3 Mt. Baldy

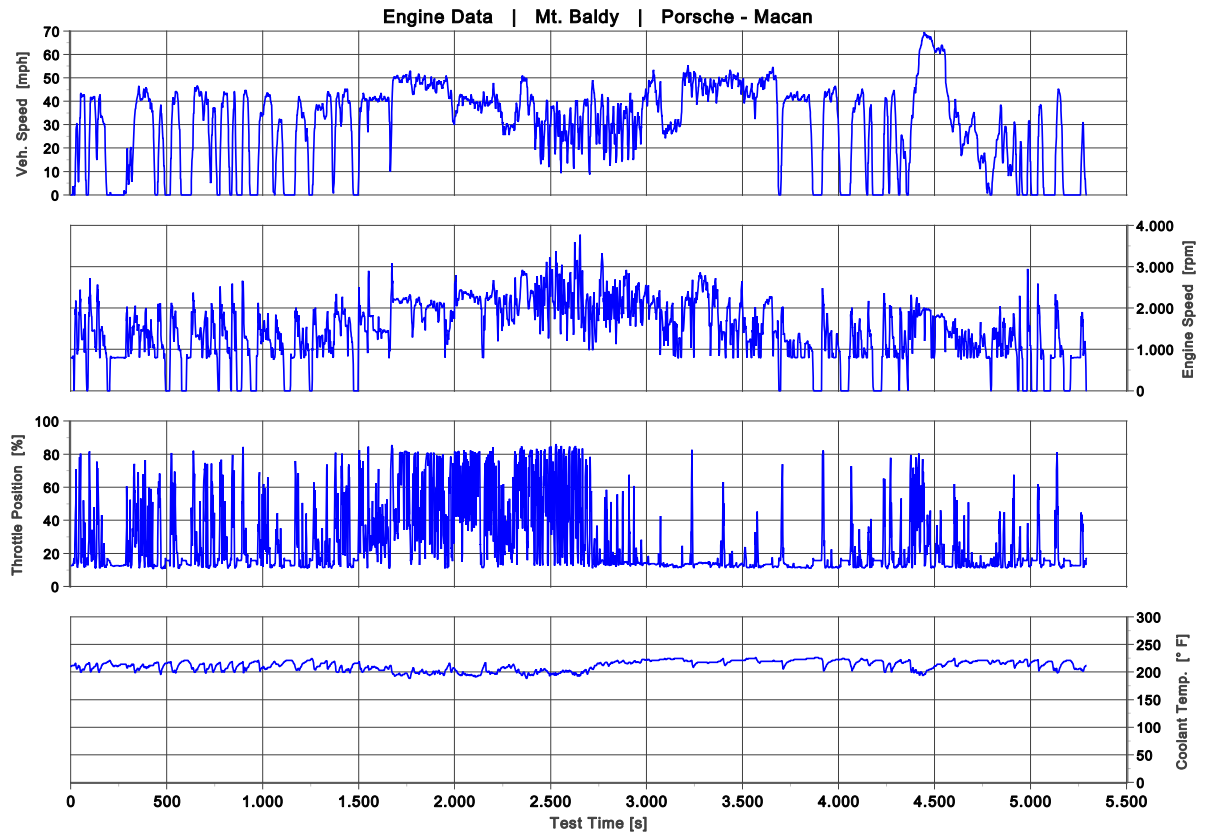
Table 3-13: Mt. Baldy Trip Summary for Macan

Test Data			
Test Name:	2018-05-03_Macan_Mt.-Baldy		
Department:	MBtech	Test Date:	05/03/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	WP1AA2A52JLB00994	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 4100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	443,7
CO		[g/mi]	0,281
NO_x		[g/mi]	0,013
THC		[g/mi]	0,002
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	5292
Distance		[mi]	43,97
Average Speed		[mph]	29,9
Average Ambient Temperature		[°F]	73,9


Trip Data | Mt. Baldy | Porsche - Macan
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Concentrations | Mt. Baldy | Porsche - Macan
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
1.000
800
600
400
200
0
-200
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy | Porsche - Macan
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy | Porsche - Macan
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]

3.4 Cayenne

The following table summarizes the emission measurement results from the Cayenne vehicle.

Table 3-14: Emission Overview Porsche – Cayenne

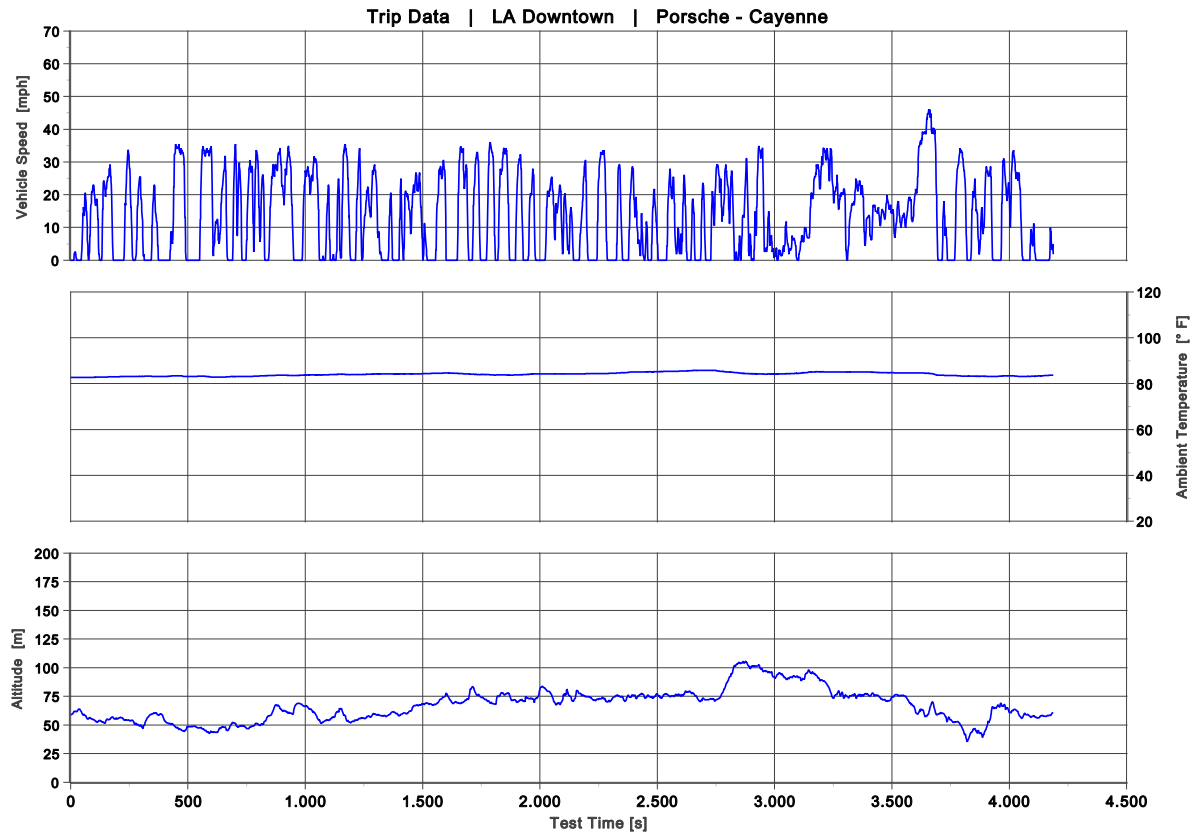
Cayenne		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/07/2018	LA Downtown	663,7	0,226	0,023	0,001	4188	15,12
05/08/2018	Highway (1)******	397,7	0,288	0,012	n.a.	3363	43,13
05/09/2018	Highway (2)	393,7	0,210	0,012	0,001	3427	43,19
05/10/2018	Mt. Baldy	522,9	0,550	0,026	0,003	4920	42,70
05/11/2018	FTP75 (PEMS)	462,2	0,255	0,038	0,007	2519	10,60
05/11/2018	FTP75 (Dyno)	438,1	0,279	0,037	0,030		

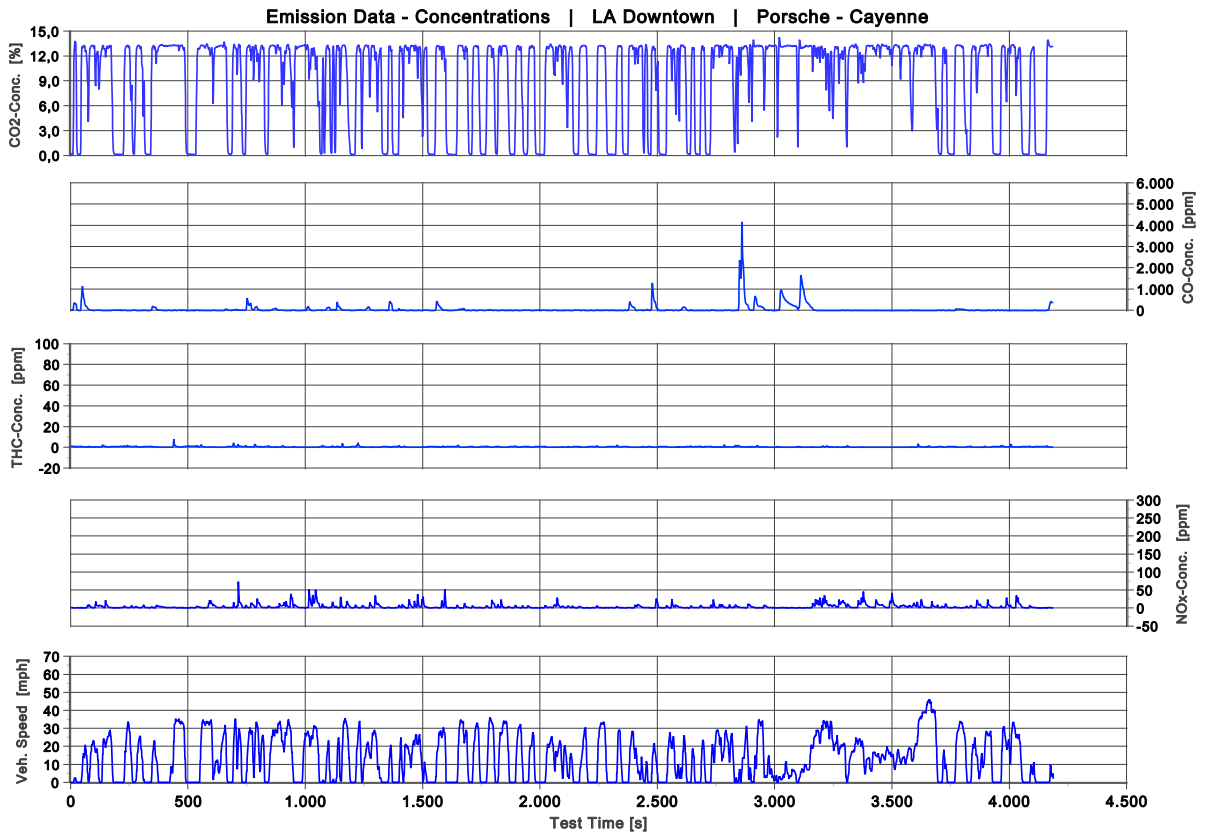
******: Measurement was repeated because no data were received from FID (data loss as a result of connection cut off between FID system and system control during the measurement).

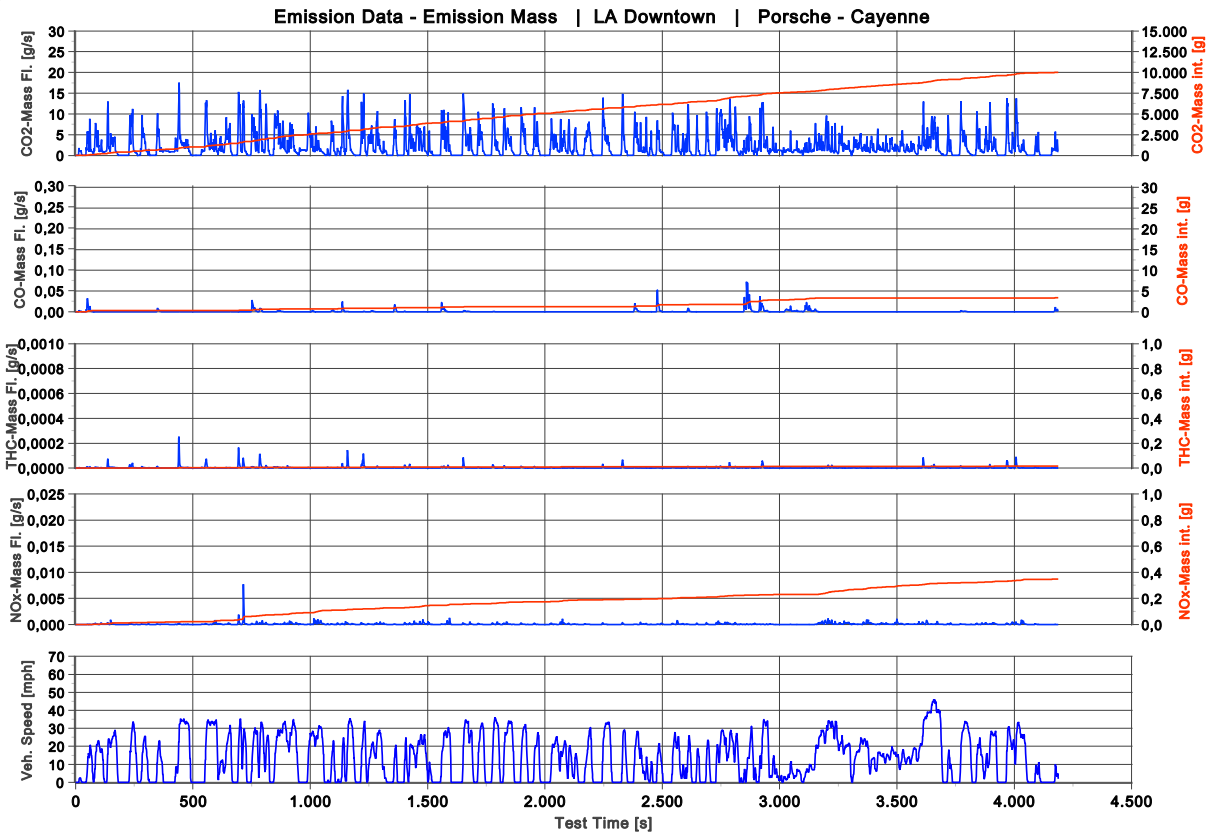
3.4.1 LA Downtown

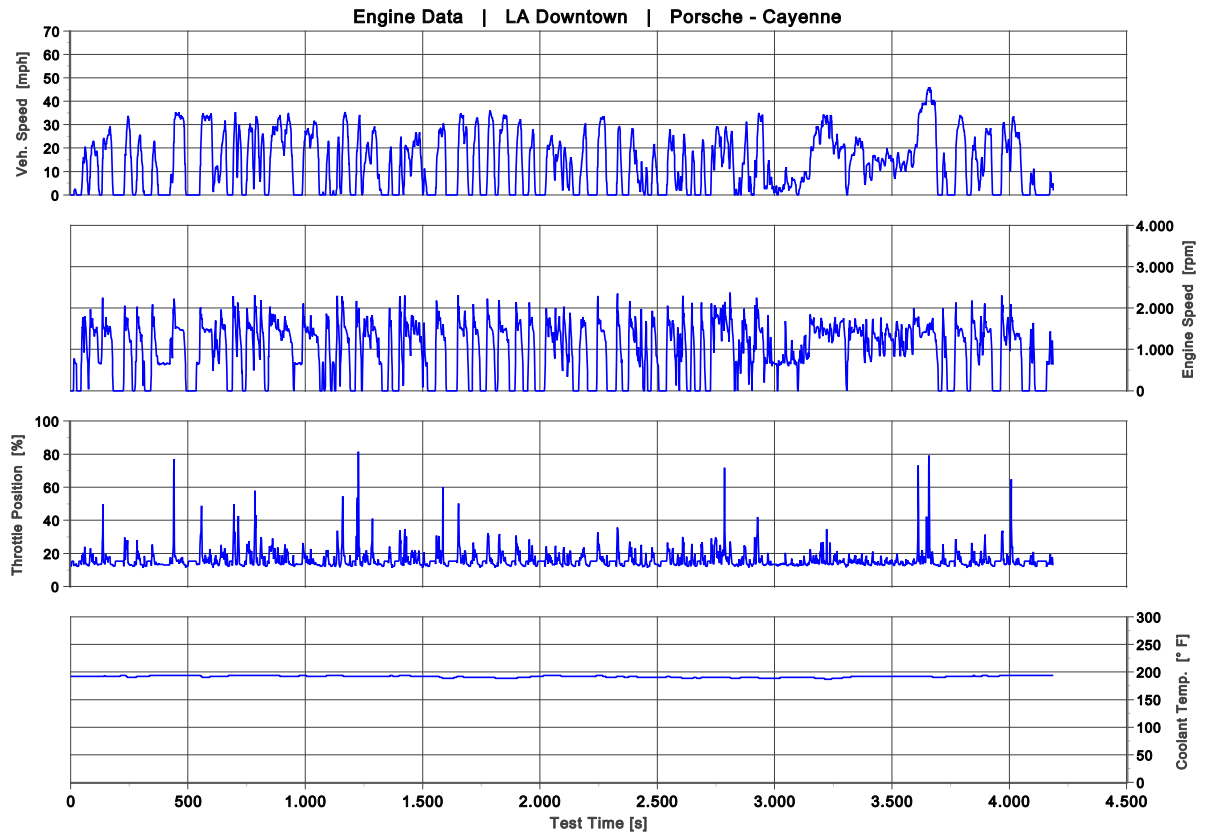
Table 3-15: LA Downtown Trip Summary for Cayenne

Test Data			
Test Name:	2018-05-07_Cayenne_LA-Downtown		
Department:	MBtech	Test Date:	05/07/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	250
Vehicle Modell:	Cayenne	Nominal Torque [Nm]:	450
VIN:	WP1AA2A26JKA04684	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1300
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	663,7
CO		[g/mi]	0,226
NO_x		[g/mi]	0,023
THC		[g/mi]	0,001
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	4188
Distance		[mi]	15,12
Average Speed		[mph]	13,0
Average Ambient Temperature		[°F]	84,1


Trip Data | LA Downtown | Porsche - Cayenne
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Test Time [s]


Emission Data - Concentrations | LA Downtown | Porsche - Cayenne
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
300
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Test Time [s]


Emission Data - Emission Mass | LA Downtown | Porsche - Cayenne
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

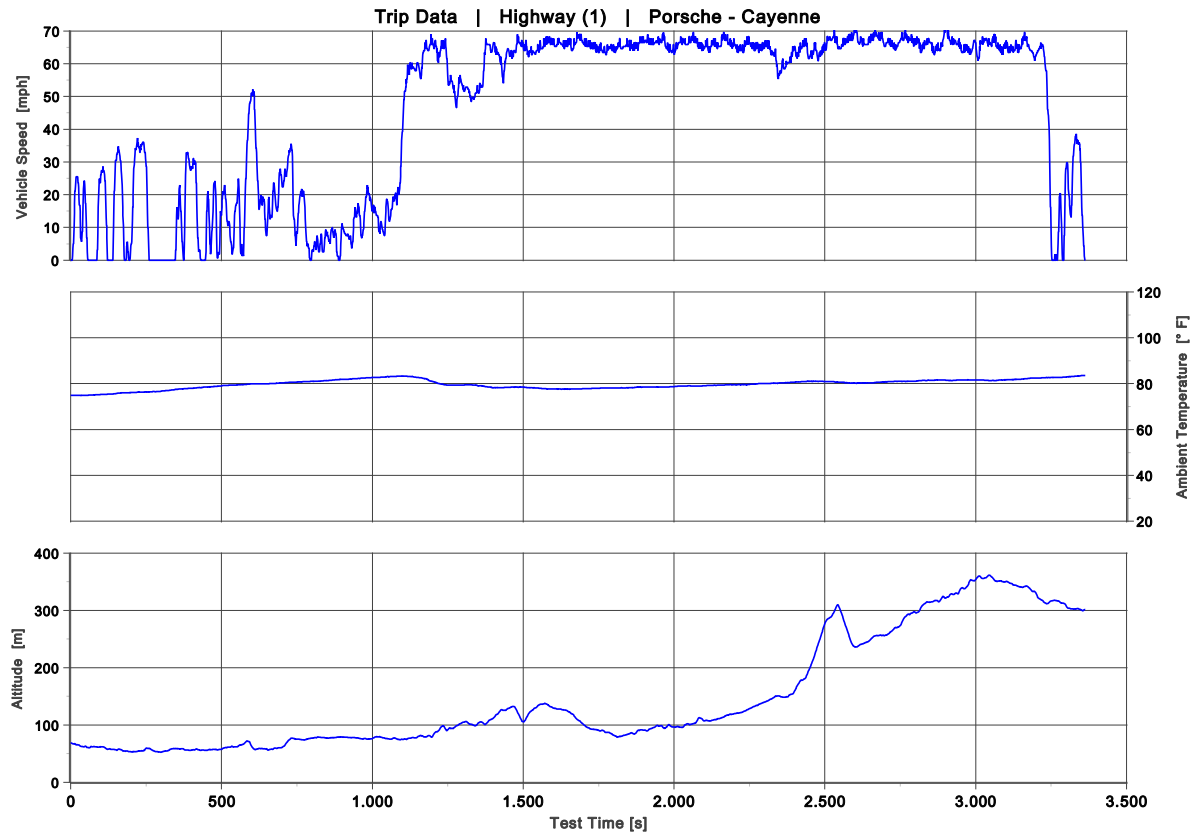

Engine Data | LA Downtown | Porsche - Cayenne
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
Test Time [s]

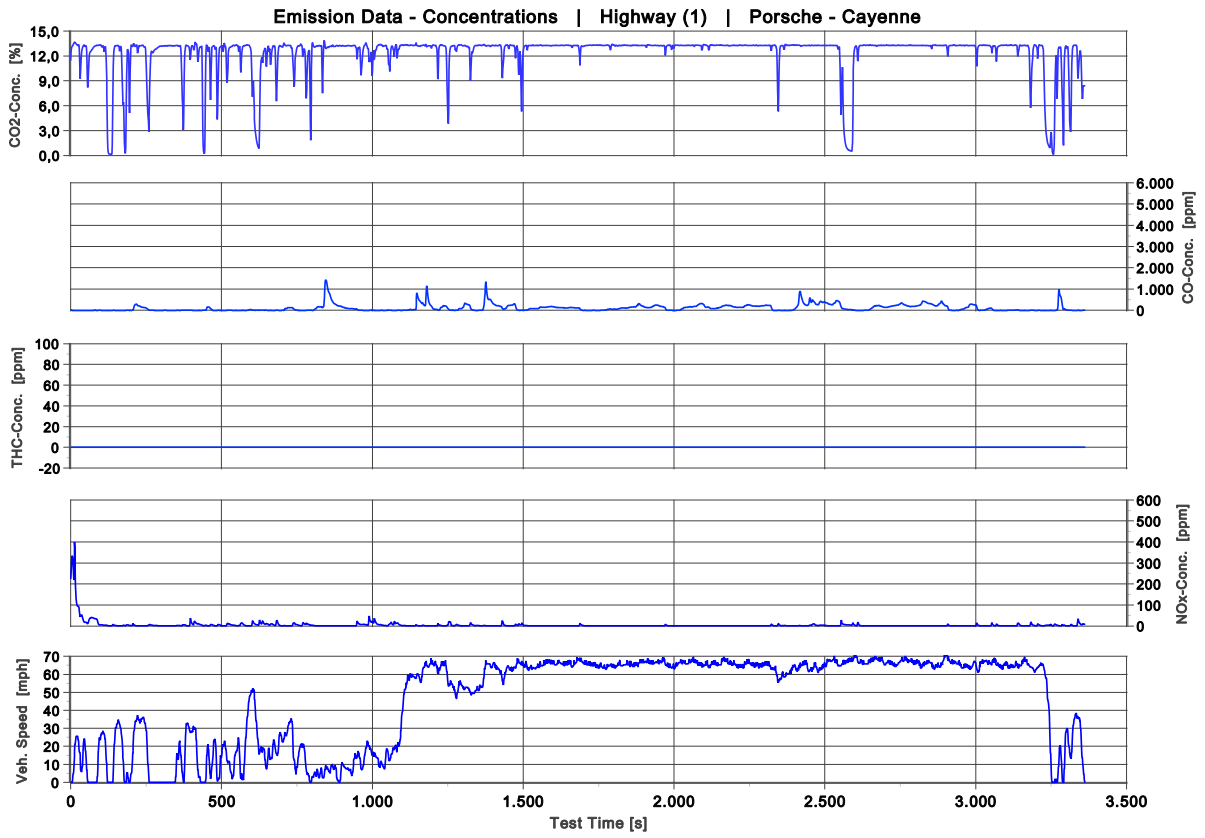
3.4.2 Highway (1)

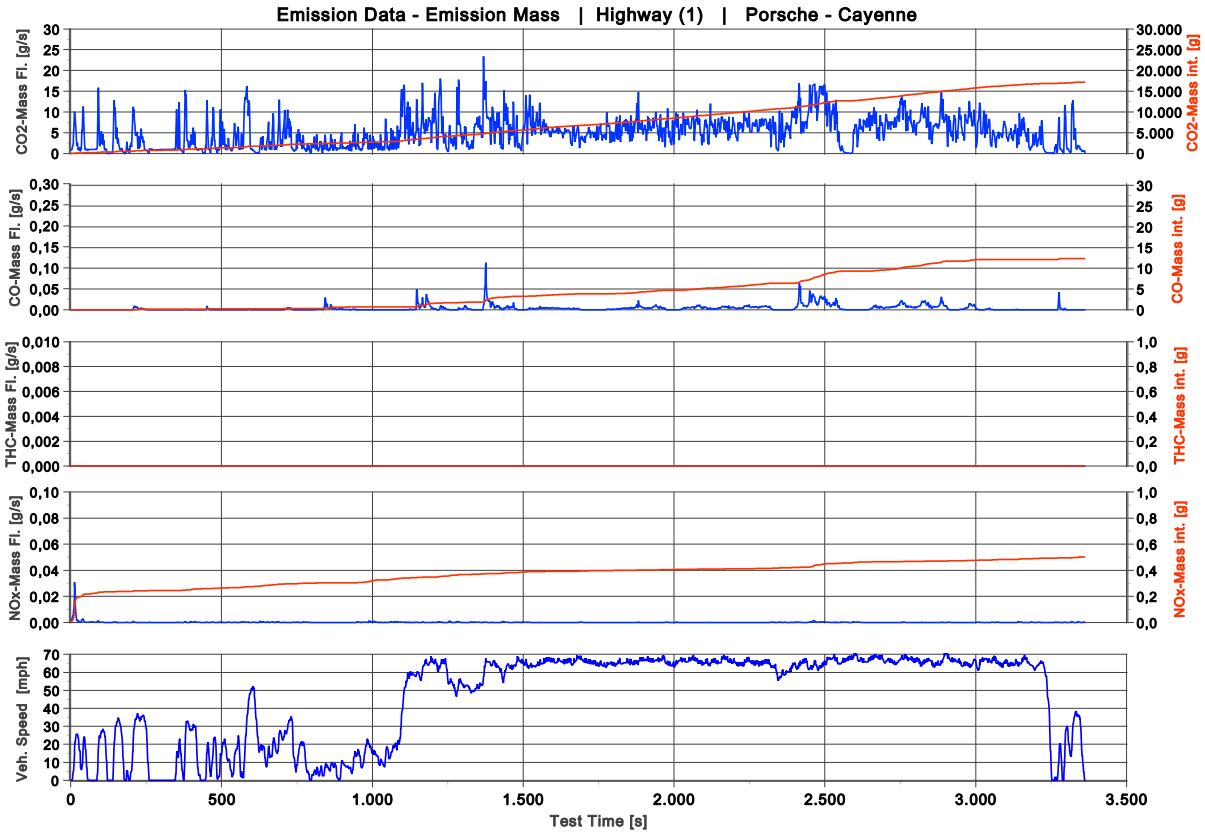
Table 3-16: Highway (1) Trip Summary for Cayenne

Test Data			
Test Name:	2018-05-08_Cayenne_Highway(1)		
Department:	MBtech	Test Date:	05/08/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	250
Vehicle Modell:	Cayenne	Nominal Torque [Nm]:	450
VIN:	WP1AA2A26JKA04684	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1300
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	397, 7
CO		[g/mi]	0,288
NO_x		[g/mi]	0,012
THC		[g/mi]	n.a. ******
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3363
Distance		[mi]	43,13
Average Speed		[mph]	46,2
Average Ambient Temperature		[°F]	79,8

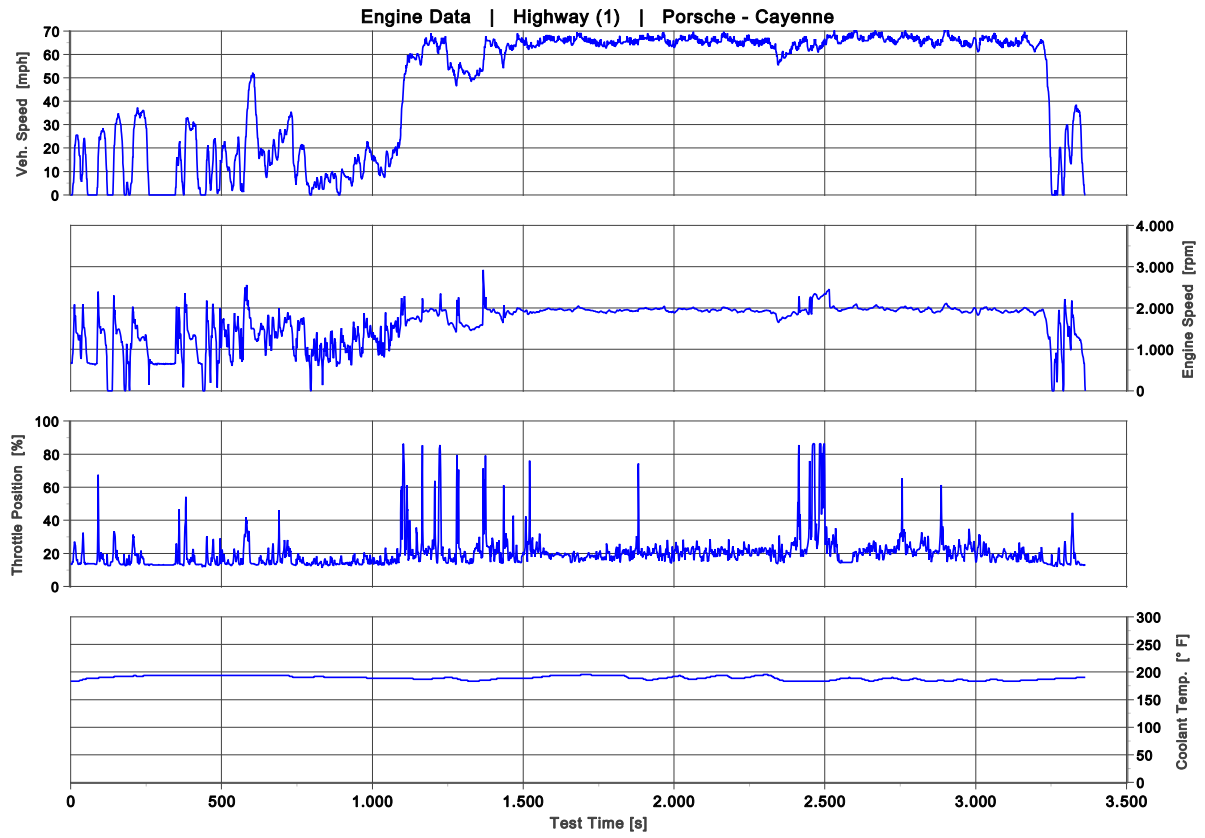
******: Measurement was repeated because no data were received from FID (data loss as a result of connection cut off between FID system and system control during the measurement).


Trip Data | Highway (1) | Porsche - Cayenne
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
300
200
100
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]


Emission Data - Concentrations | Highway (1) | Porsche - Cayenne
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
600
500
400
300
200
100
0
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]



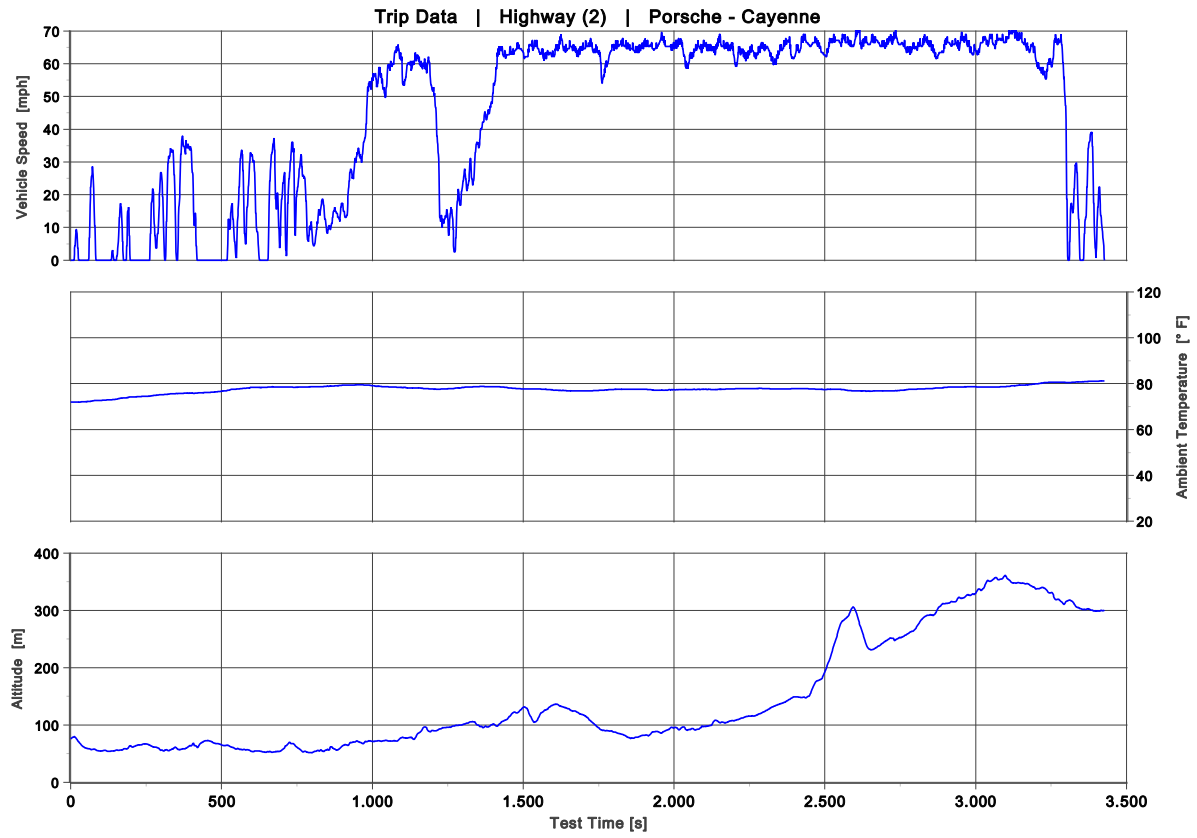
Measurement was repeated (Highway 2) because no THC emissions data were received from FID (data loss as a result of connection cut off between FID system and system control during the measurement).

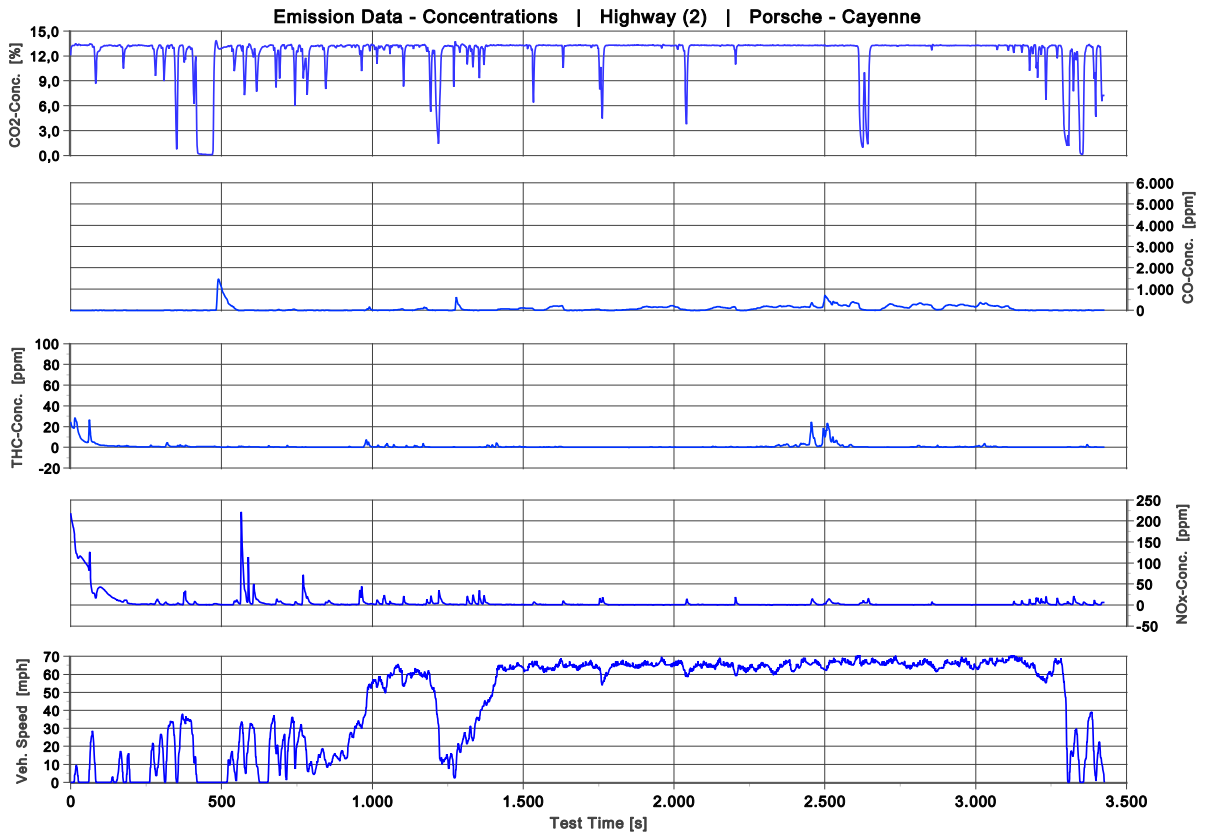

Engine Data | Highway (1) | Porsche - Cayenne
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

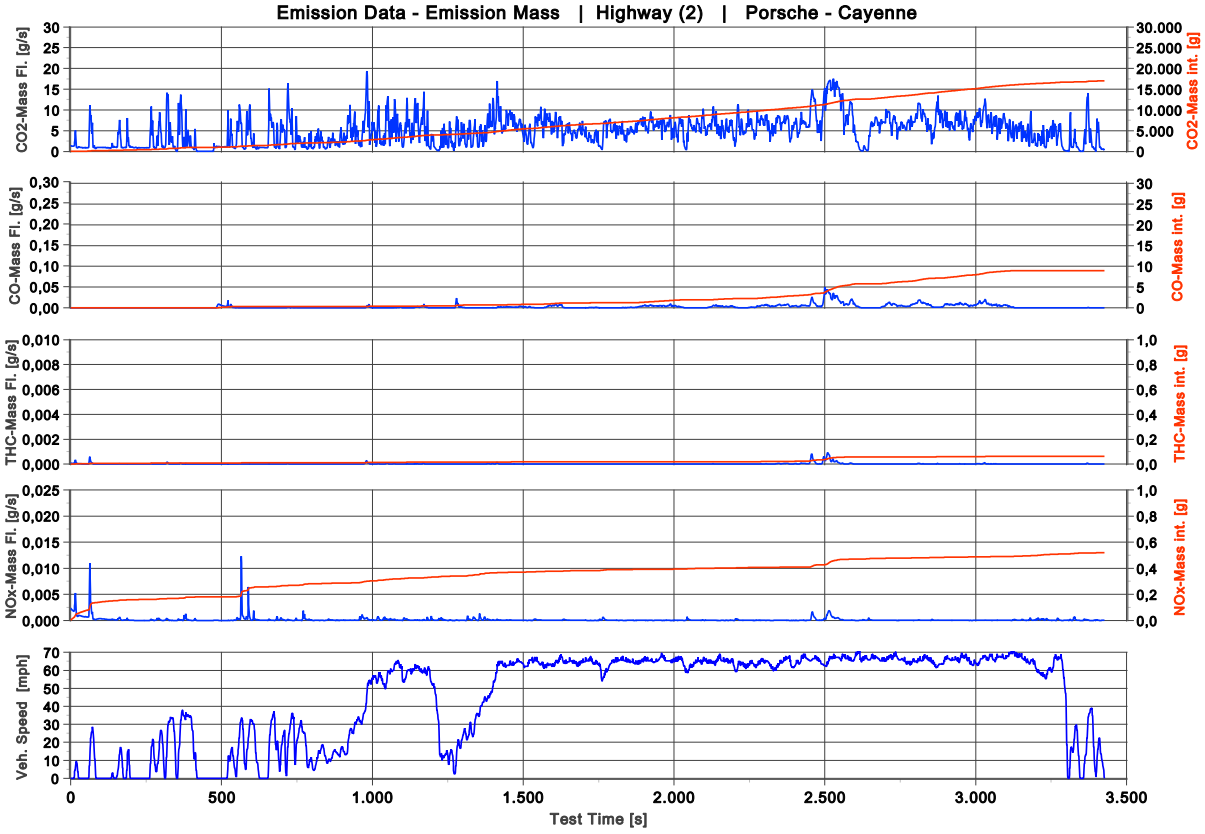
3.4.3 Highway (2)

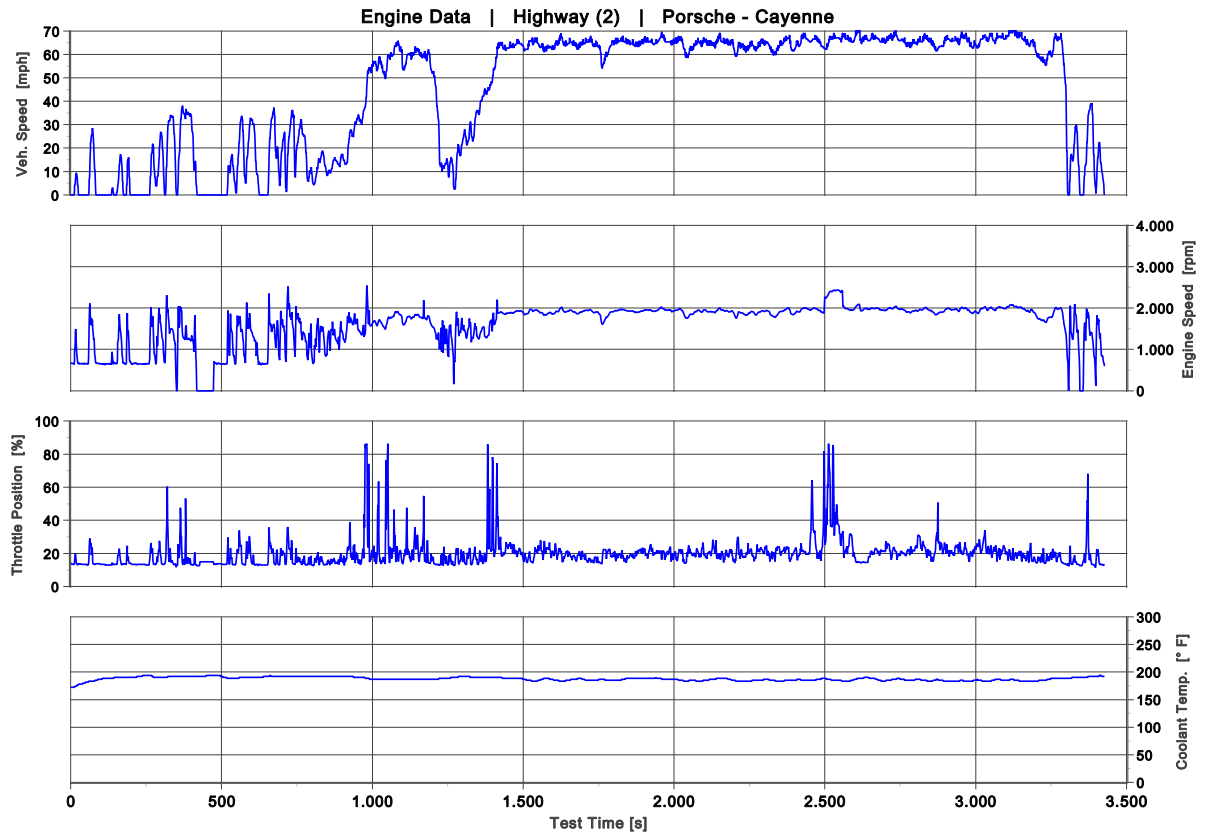
Table 3-17: Highway (2) Trip Summary for Cayenne

Test Data			
Test Name:	2018-05-09_Cayenne_Highway(2)		
Department:	MBtech	Test Date:	05/09/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	250
Vehicle Modell:	Cayenne	Nominal Torque [Nm]:	450
VIN:	WP1AA2A26JKA04684	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1300
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	393, 7
CO		[g/mi]	0,210
NO_x		[g/mi]	0,012
THC		[g/mi]	0,001
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3427
Distance		[mi]	43,19
Average Speed		[mph]	45,4
Average Ambient Temperature		[°F]	77,6


Trip Data | Highway (2) | Porsche - Cayenne
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
300
200
100
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]


Emission Data - Concentrations | Highway (2) | Porsche - Cayenne
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

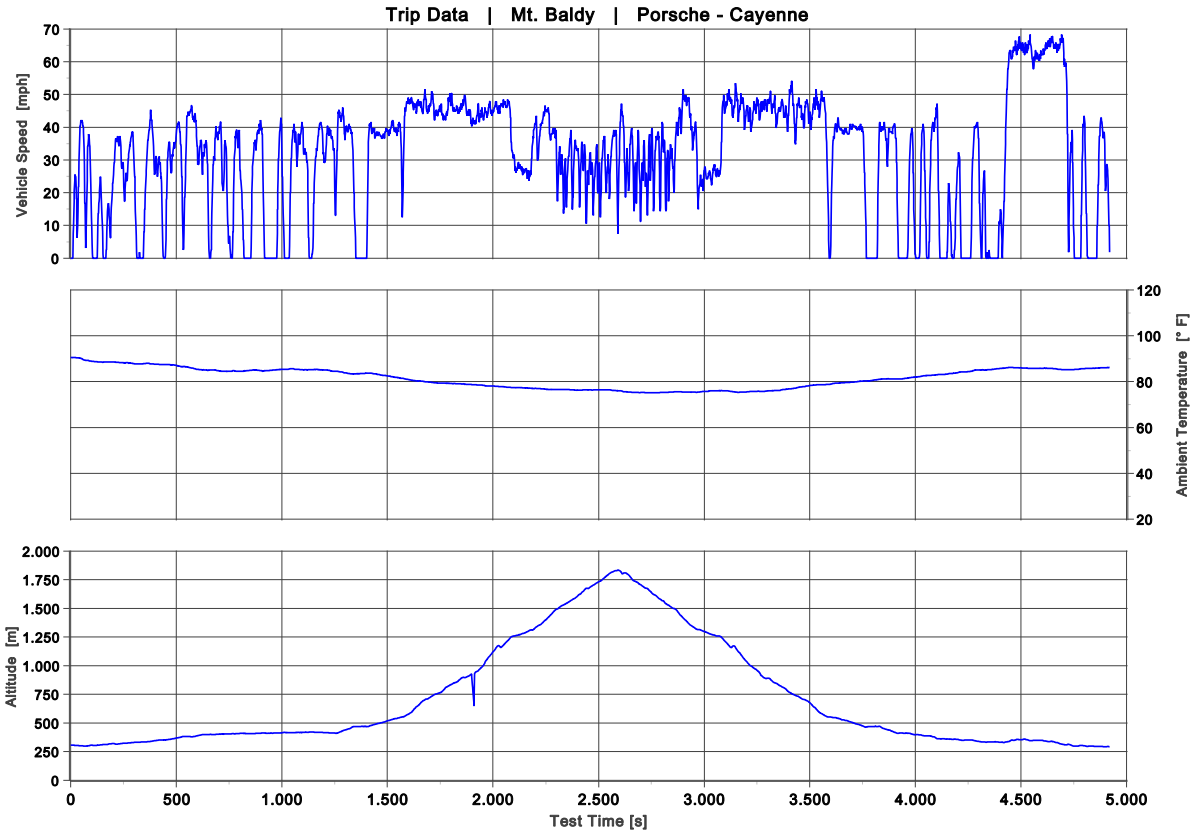

Emission Data - Emission Mass | Highway (2) | Porsche - Cayenne
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

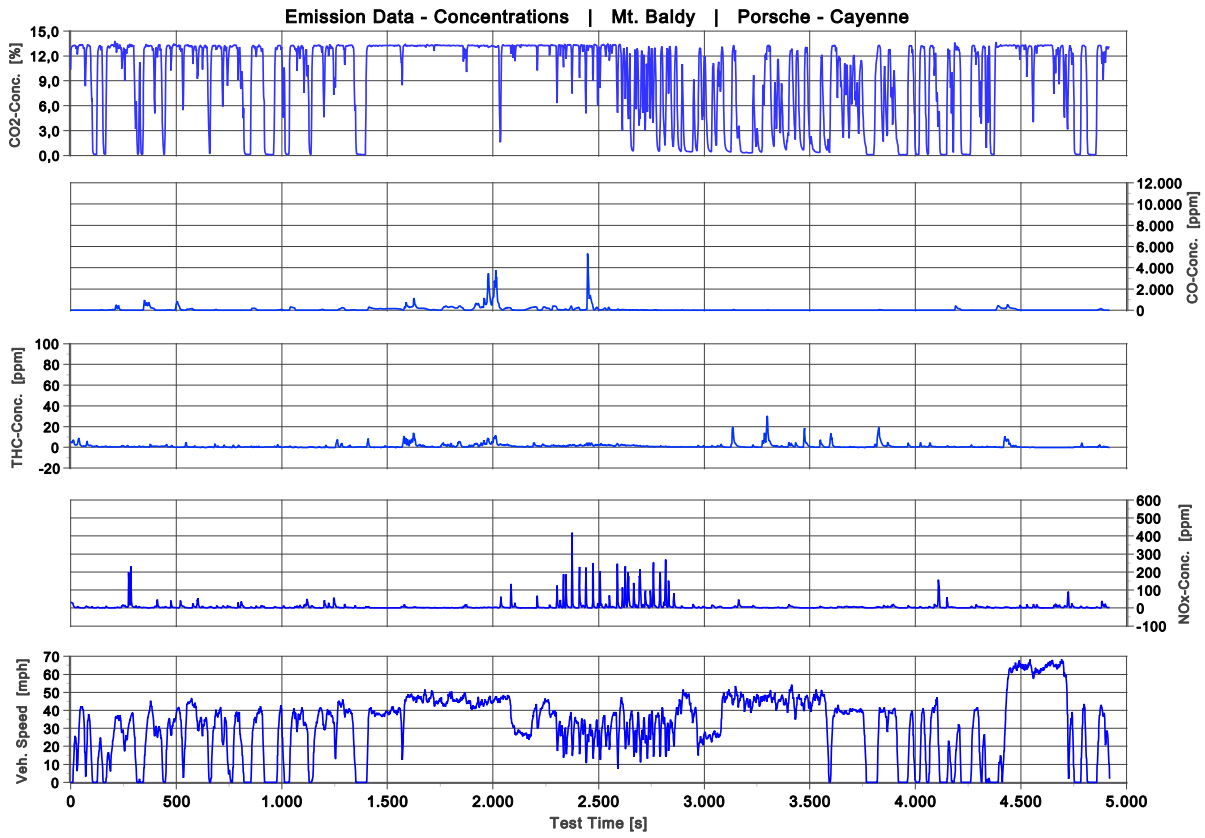

Engine Data | Highway (2) | Porsche - Cayenne
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

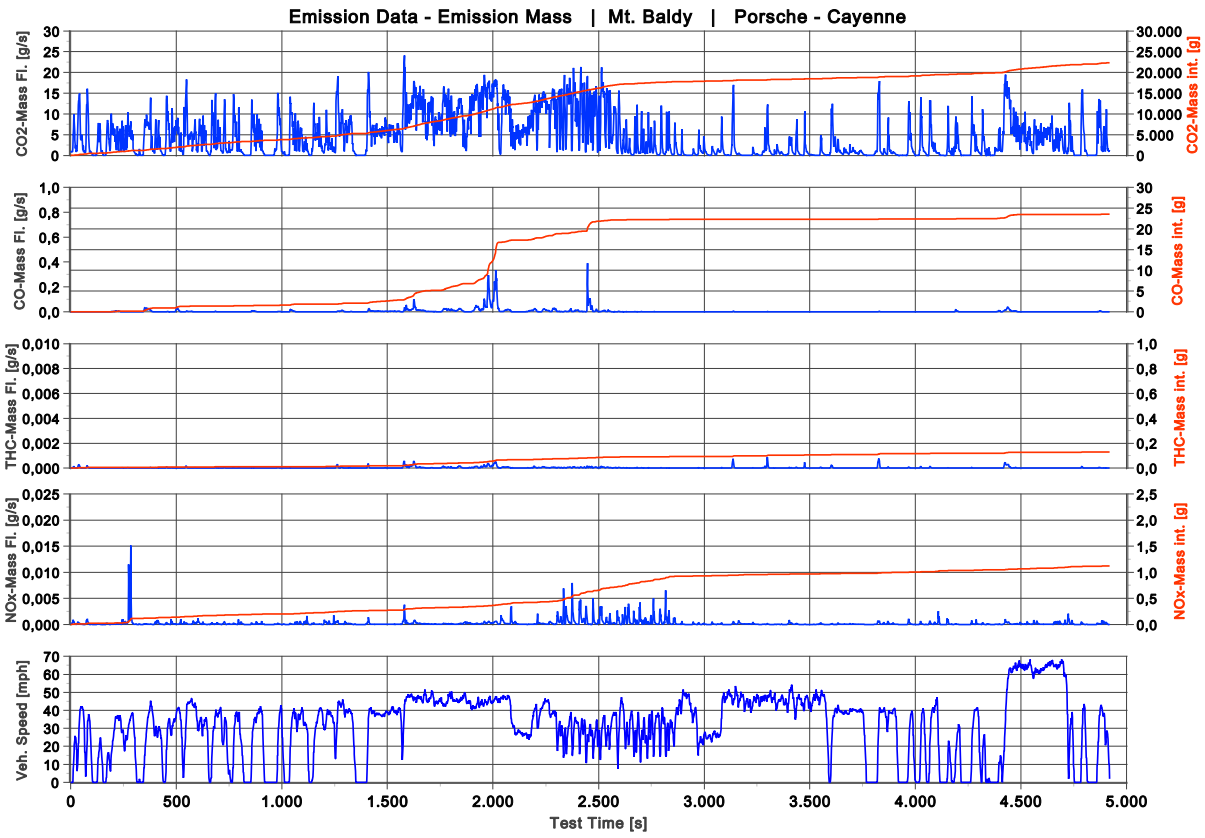
3.4.4 Mt. Baldy

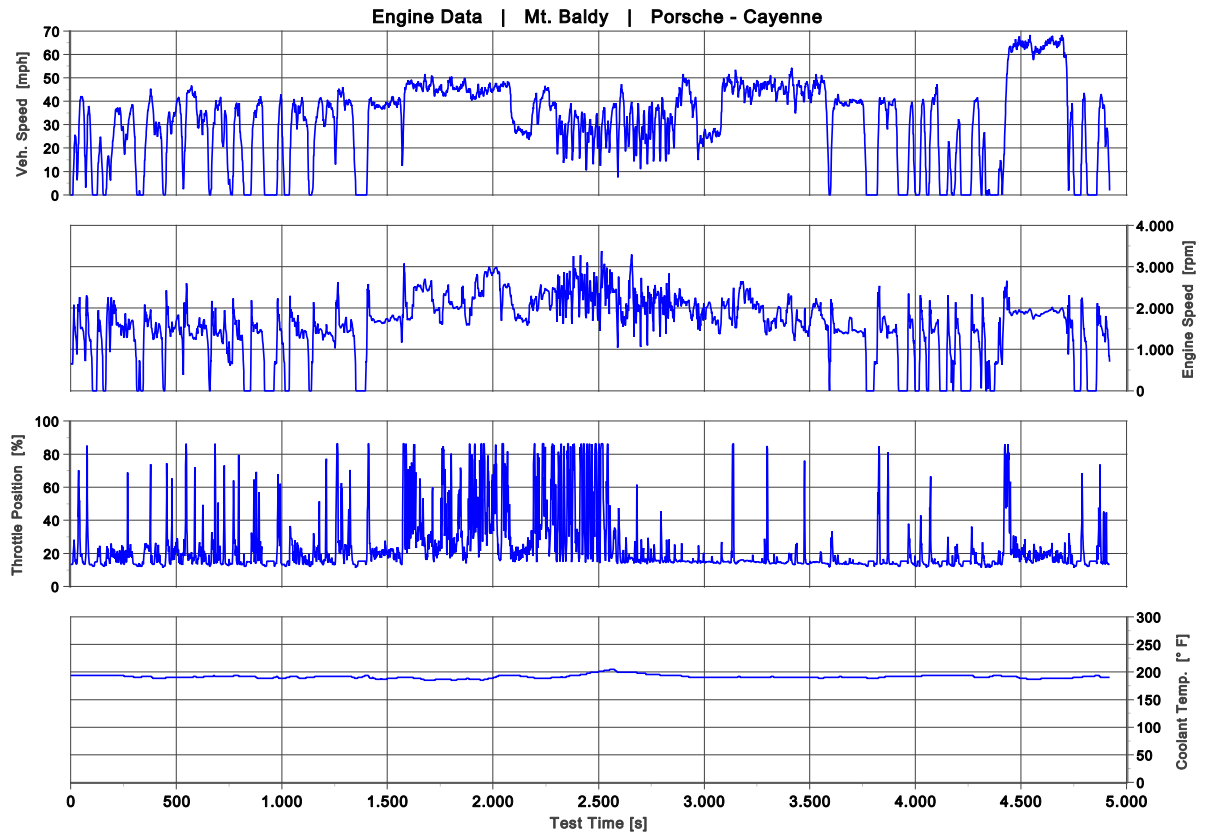
Table 3-18: Mt. Baldy Trip Summary for Cayenne

Test Data			
Test Name:	2018-05-10_Cayenne_Mt.-Baldy		
Department:	MBtech	Test Date:	05/10/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	250
Vehicle Modell:	Cayenne	Nominal Torque [Nm]:	450
VIN:	WP1AA2A26JKA04684	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1300
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	522,9
CO		[g/mi]	0,550
NO_x		[g/mi]	0,026
THC		[g/mi]	0,003
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	4920
Distance		[mi]	42,70
Average Speed		[mph]	31,2
Average Ambient Temperature		[°F]	81,6


Trip Data | Mt. Baldy | Porsche - Cayenne
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Test Time [s]


Emission Data - Concentrations | Mt. Baldy | Porsche - Cayenne
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
12.000
10.000
8.000
6.000
4.000
2.000
0
THC-Conc. [ppm]
100
80
60
40
20
0
-20
NOx-Conc. [ppm]
600
500
400
300
200
100
0
-100
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy | Porsche - Cayenne
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy | Porsche - Cayenne
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Test Time [s]

3.5 Macan Turbo

The following table summarizes the emission measurement results from the Macan Turbo vehicle.

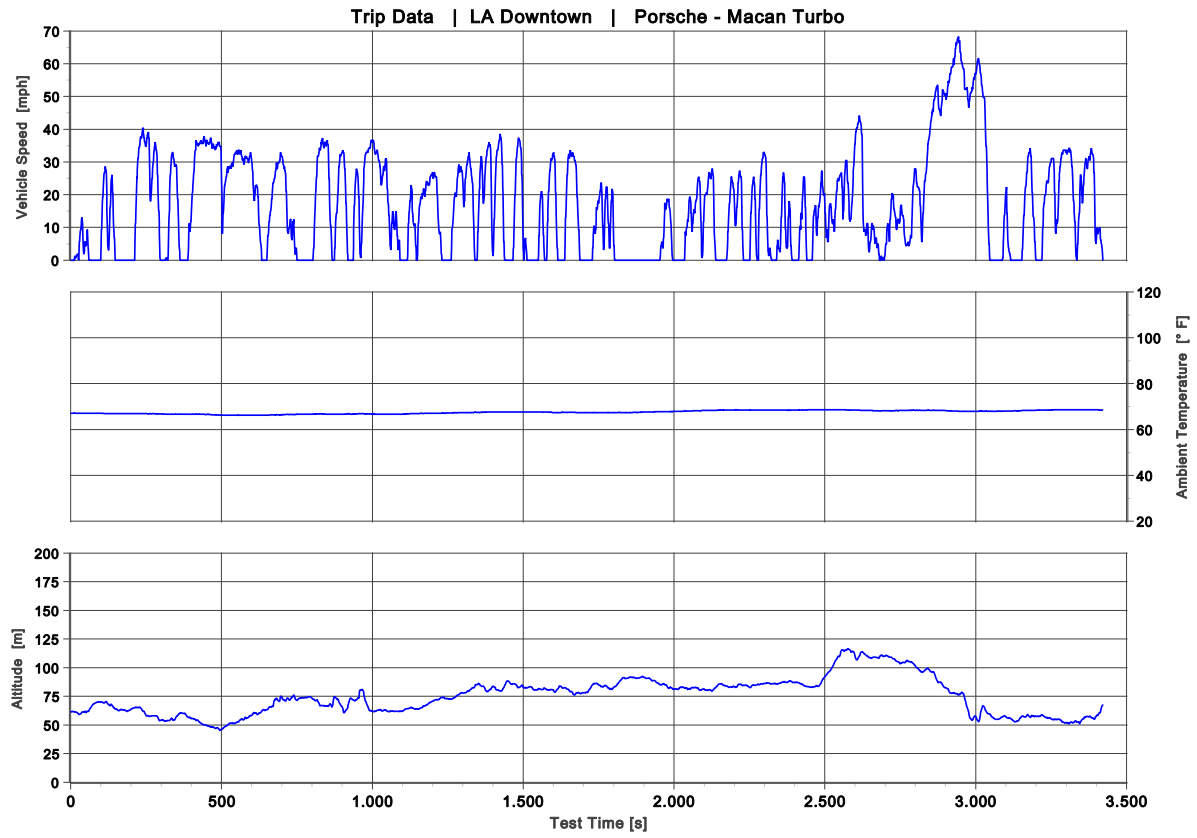
Table 3-19: Emission Overview Porsche – Macan Turbo

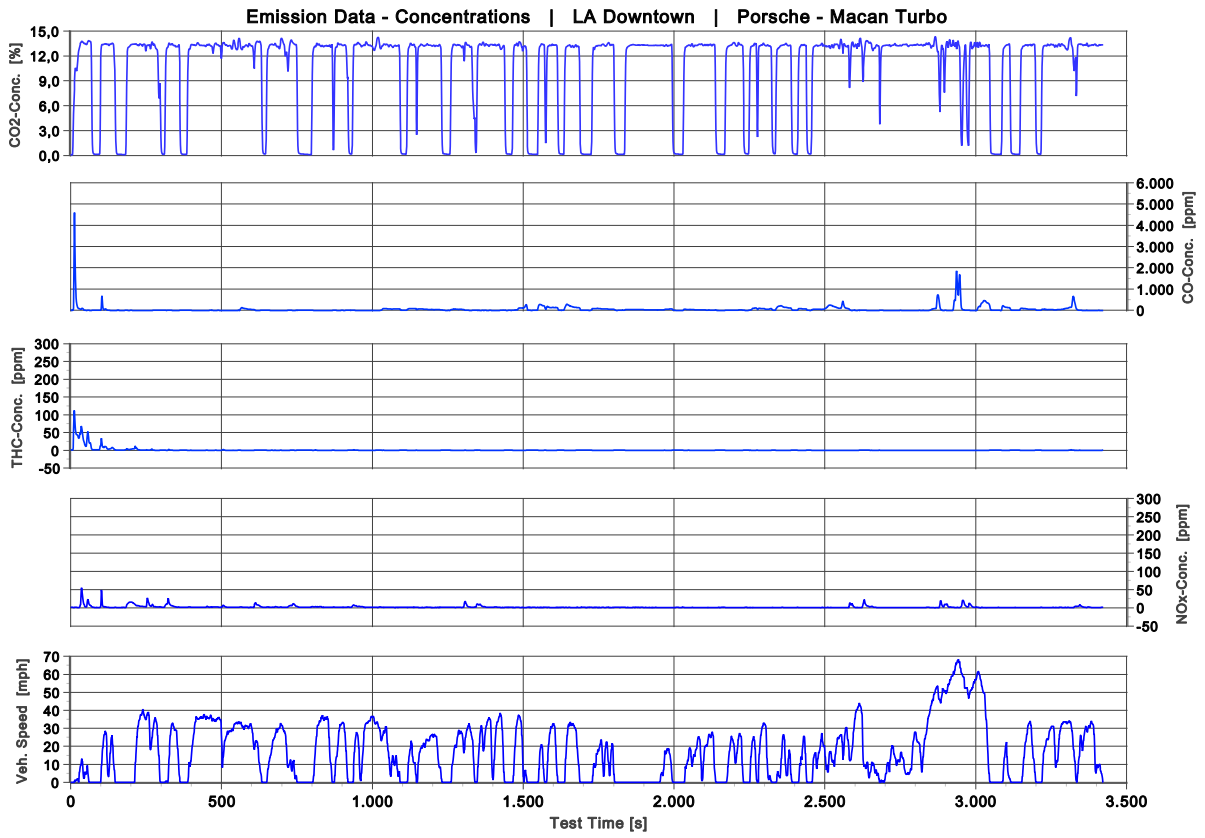
Macan Turbo		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/18/2018	LA Downtown	528,8	0,207	0,010	0,002	3423	15,79
05/17/2018	Highway	443,8	0,364	0,008	0,002	4738	44,35
05/17/2018	Mt. Baldy	512,3	0,880	0,015	0,009	5375	44,69
05/21/2018	FTP75 (PEMS)	476,6	0,736	0,008	0,006	2486	10,97
05/21/2018	FTP75 (Dyno)	475,1	0,861	0,005	0,023		

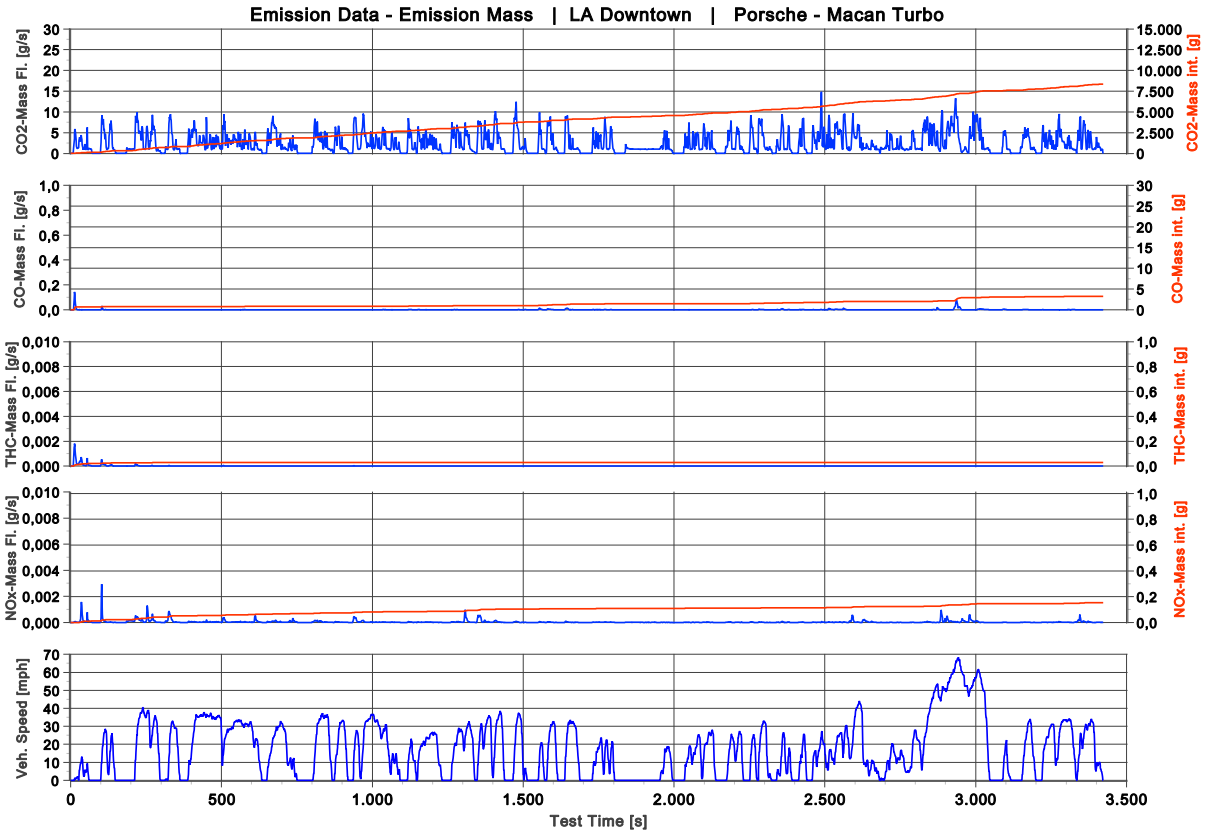
3.5.1 LA Downtown

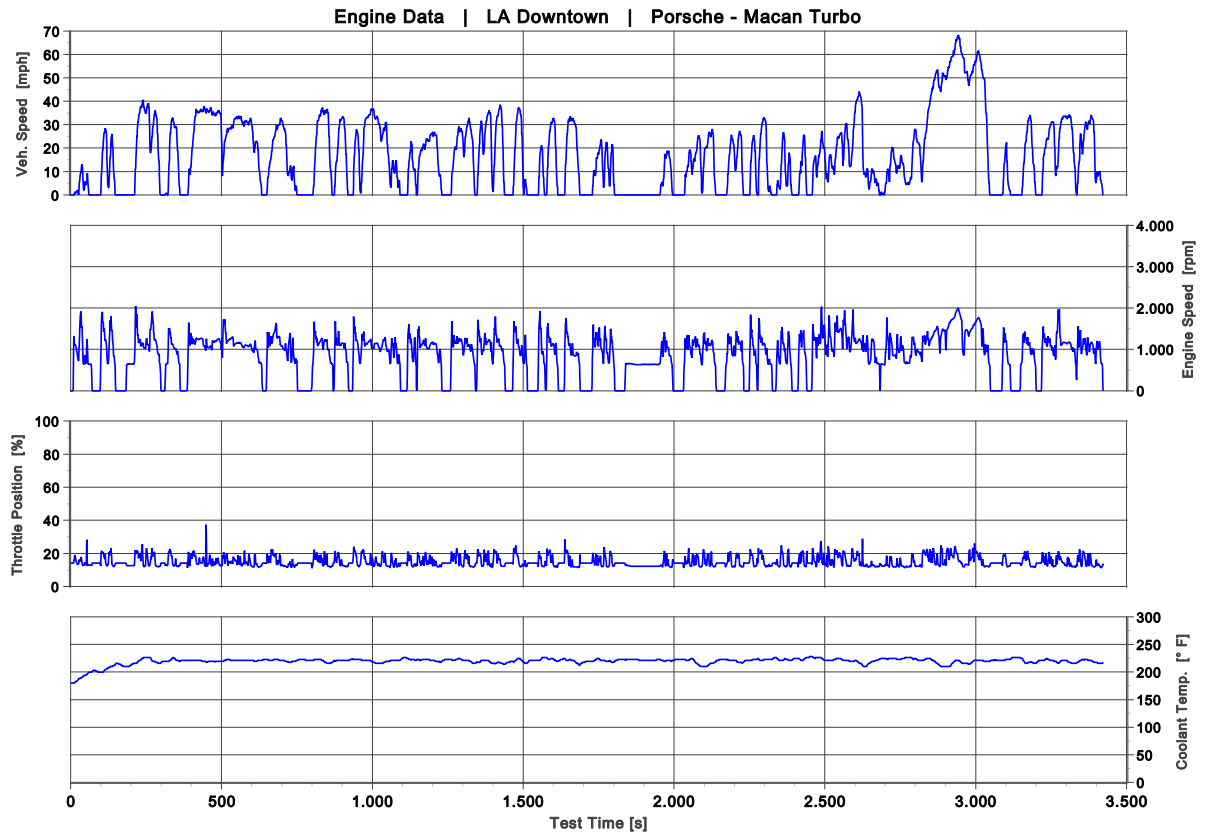
Table 3-20: LA Downtown Trip Summary for Macan Turbo

Test Data			
Test Name:	2018-05-18_Macan-Turbo_LA-Downtown		
Department:	MBtech	Test Date:	05/18/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	294
Vehicle Modell:	Macan Turbo	Nominal Torque [Nm]:	550
VIN:	WP1AF2A58JLB70632	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	528,8
CO		[g/mi]	0,207
NO_x		[g/mi]	0,010
THC		[g/mi]	0,002
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3423
Distance		[mi]	15,79
Average Speed		[mph]	16,6
Average Ambient Temperature		[°F]	67,6


Trip Data | LA Downtown | Porsche - Macan Turbo
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]


Emission Data - Concentrations | LA Downtown | Porsche - Macan Turbo
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
300
250
200
150
100
50
0
-50
NOx-Conc. [ppm]
300
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

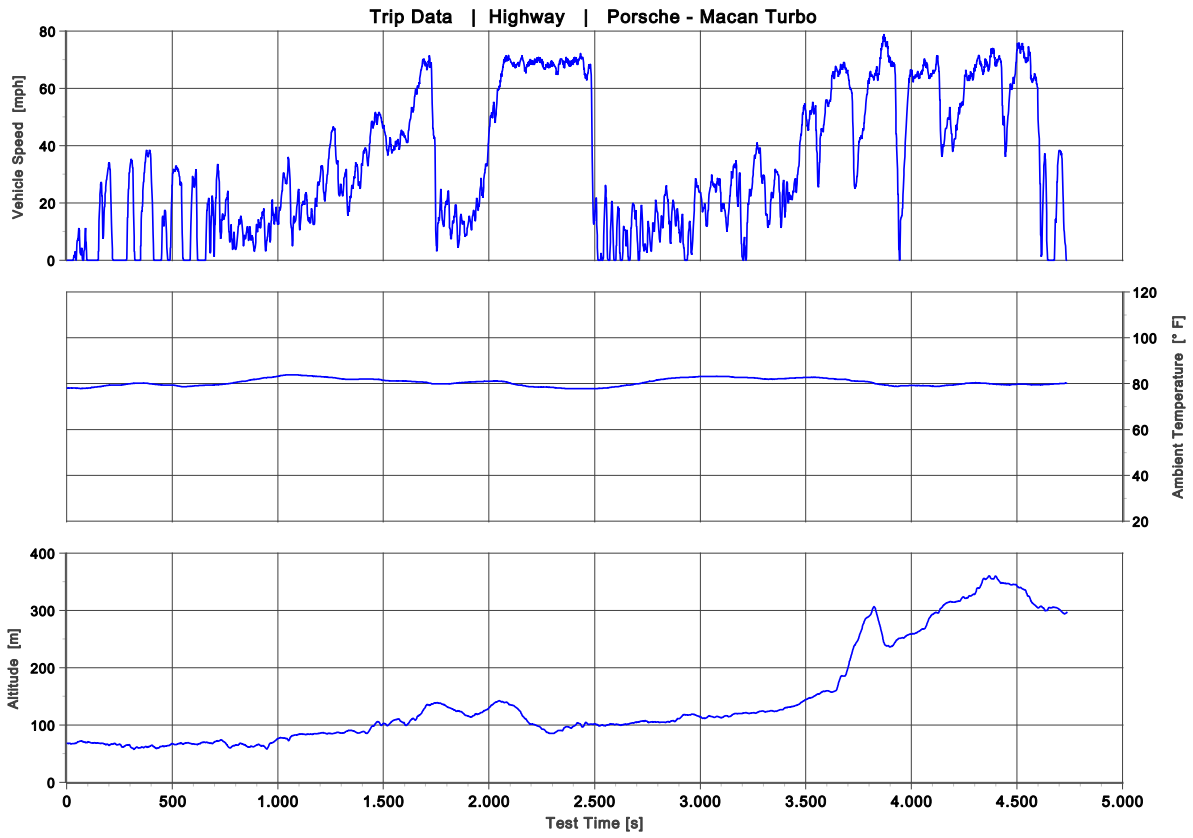

Emission Data - Emission Mass | LA Downtown | Porsche - Macan Turbo
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

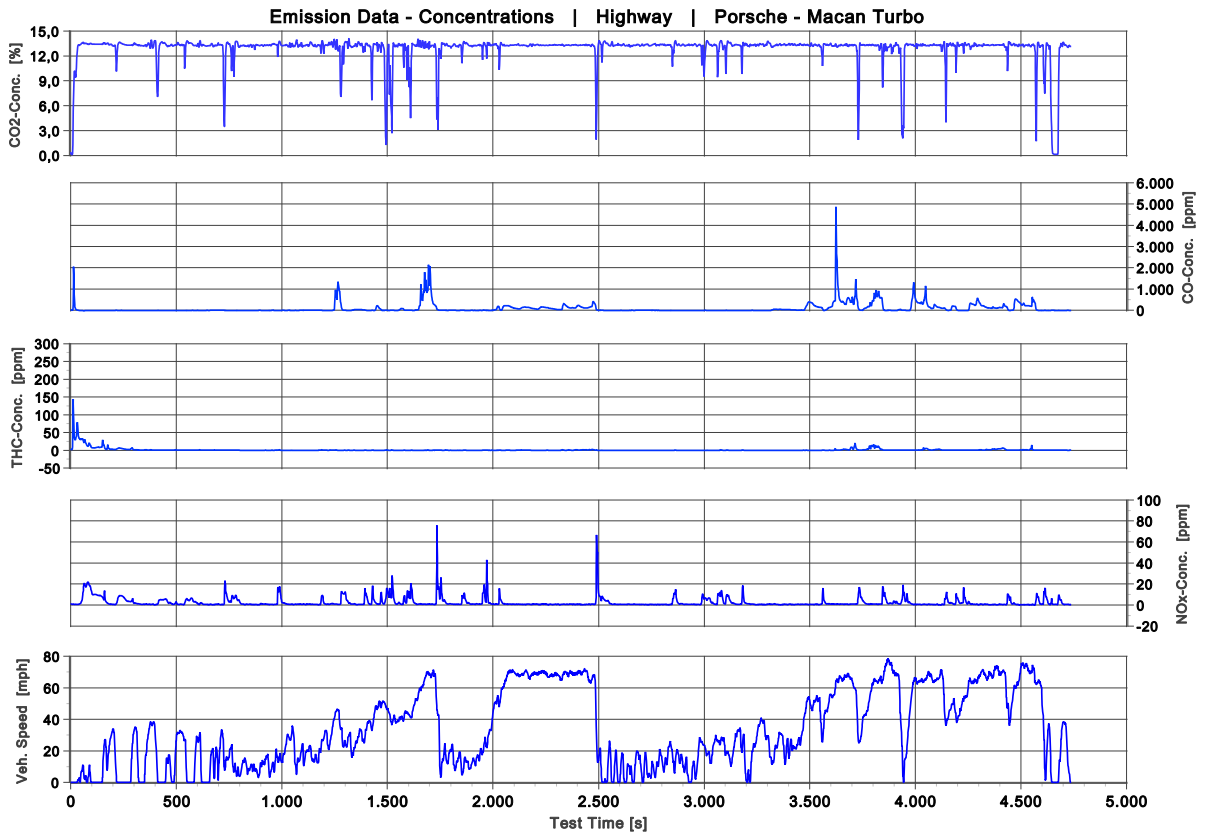

Engine Data | LA Downtown | Porsche - Macan Turbo
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

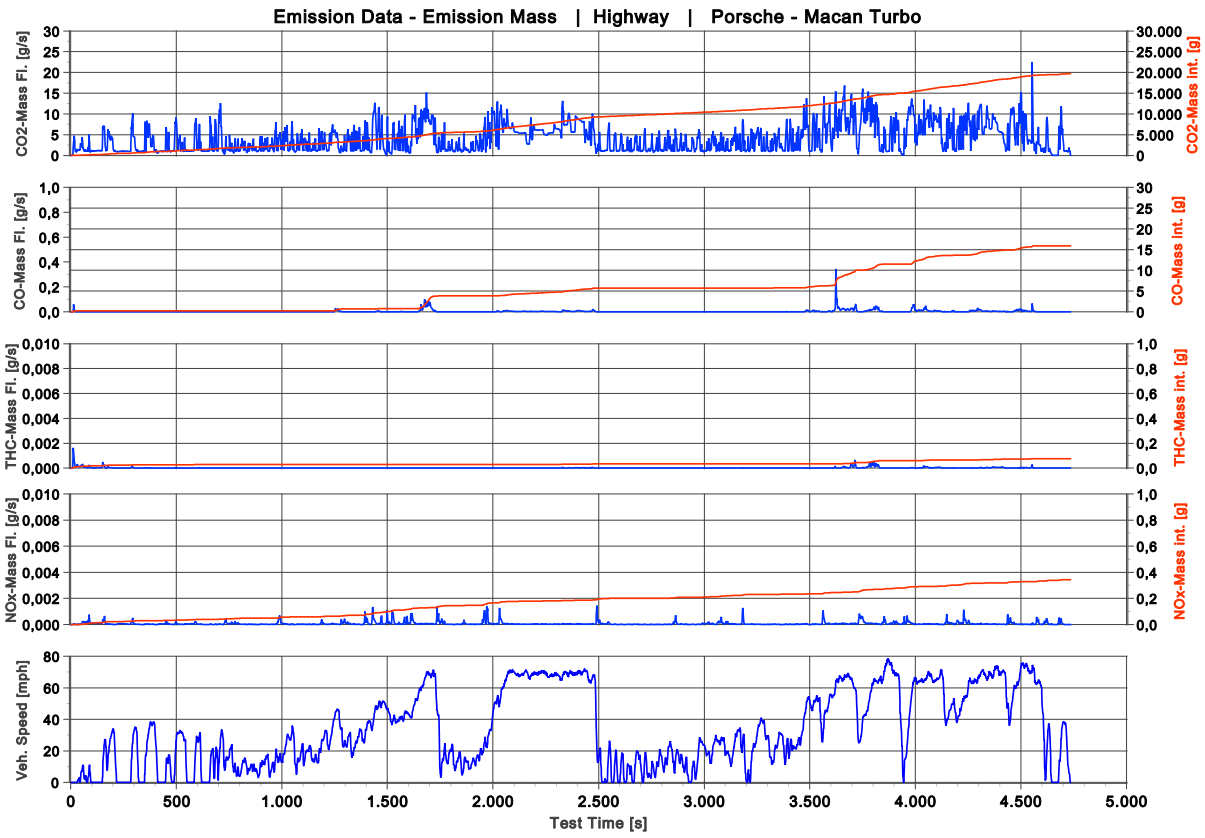
3.5.2 Highway

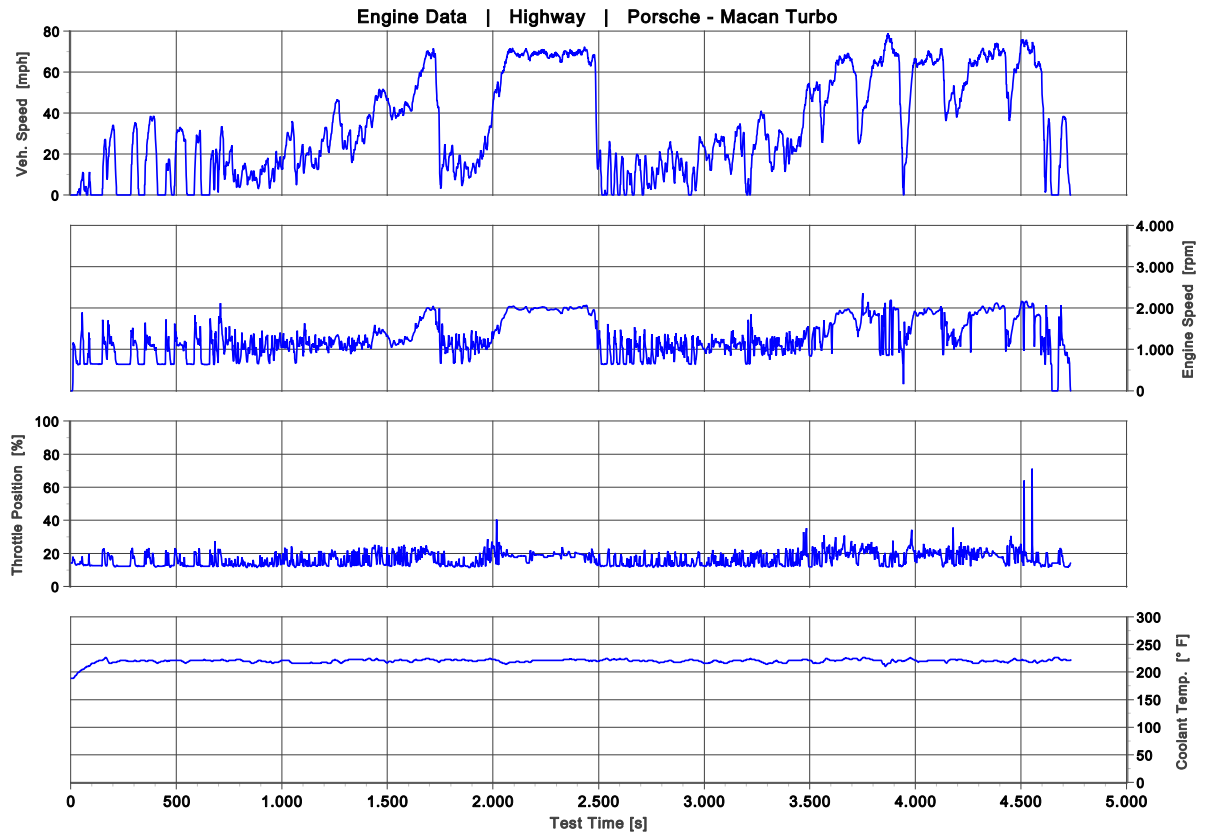
Table 3-21: Highway Trip Summary for Macan Turbo

Test Data			
Test Name:	2018-05-17_Macan-Turbo_Highway		
Department:	MBtech	Test Date:	05/17/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	294
Vehicle Modell:	Macan Turbo	Nominal Torque [Nm]:	550
VIN:	WP1AF2A58JLB70632	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	443,8
CO		[g/mi]	0,364
NO_x		[g/mi]	0,008
THC		[g/mi]	0,002
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	4738
Distance		[mi]	44,35
Average Speed		[mph]	33,7
Average Ambient Temperature		[°F]	80,6


Trip Data | Highway | Porsche - Macan Turbo
Vehicle Speed [mph]
80
60
40
20
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
300
200
100
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Test Time [s]


Emission Data - Concentrations | Highway | Porsche - Macan Turbo
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
300
250
200
150
100
50
0
-50
NOx-Conc. [ppm]
100
80
60
40
20
0
-20
Veh. Speed [mph]
80
60
40
20
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Test Time [s]

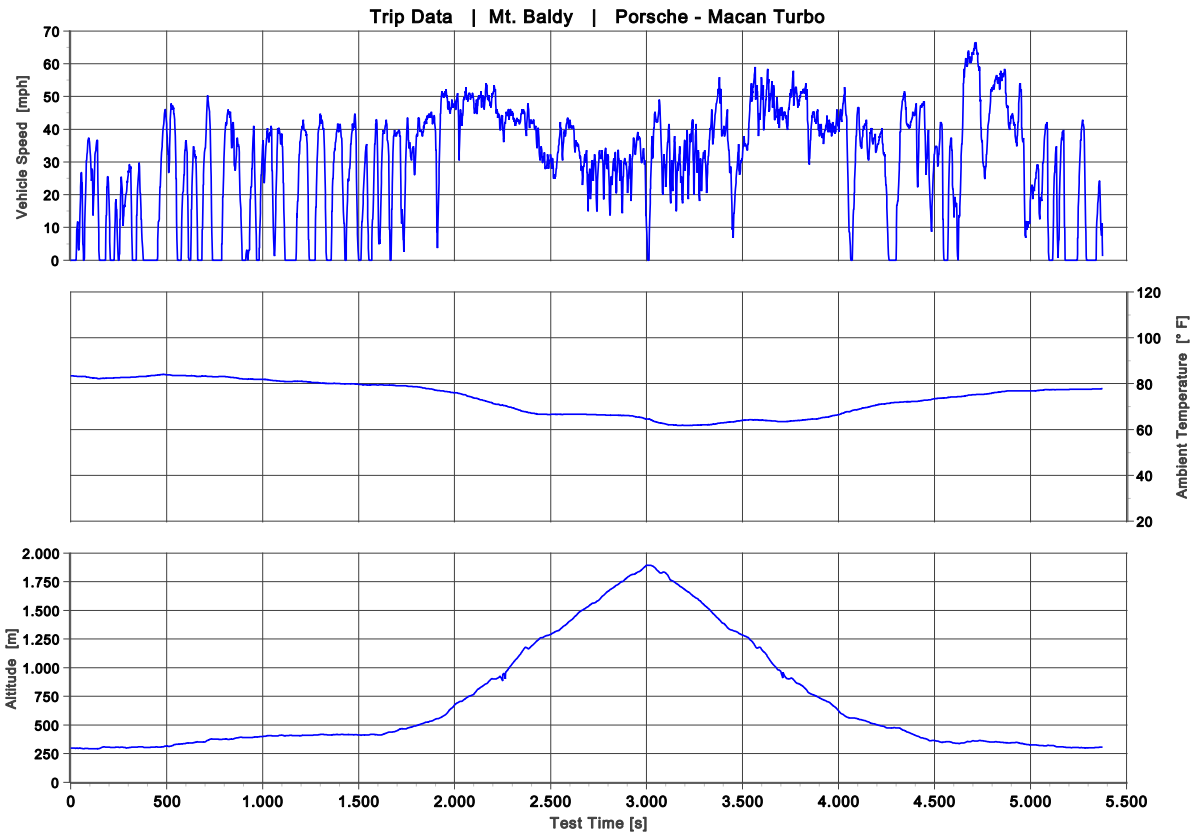

Emission Data - Emission Mass | Highway | Porsche - Macan Turbo
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

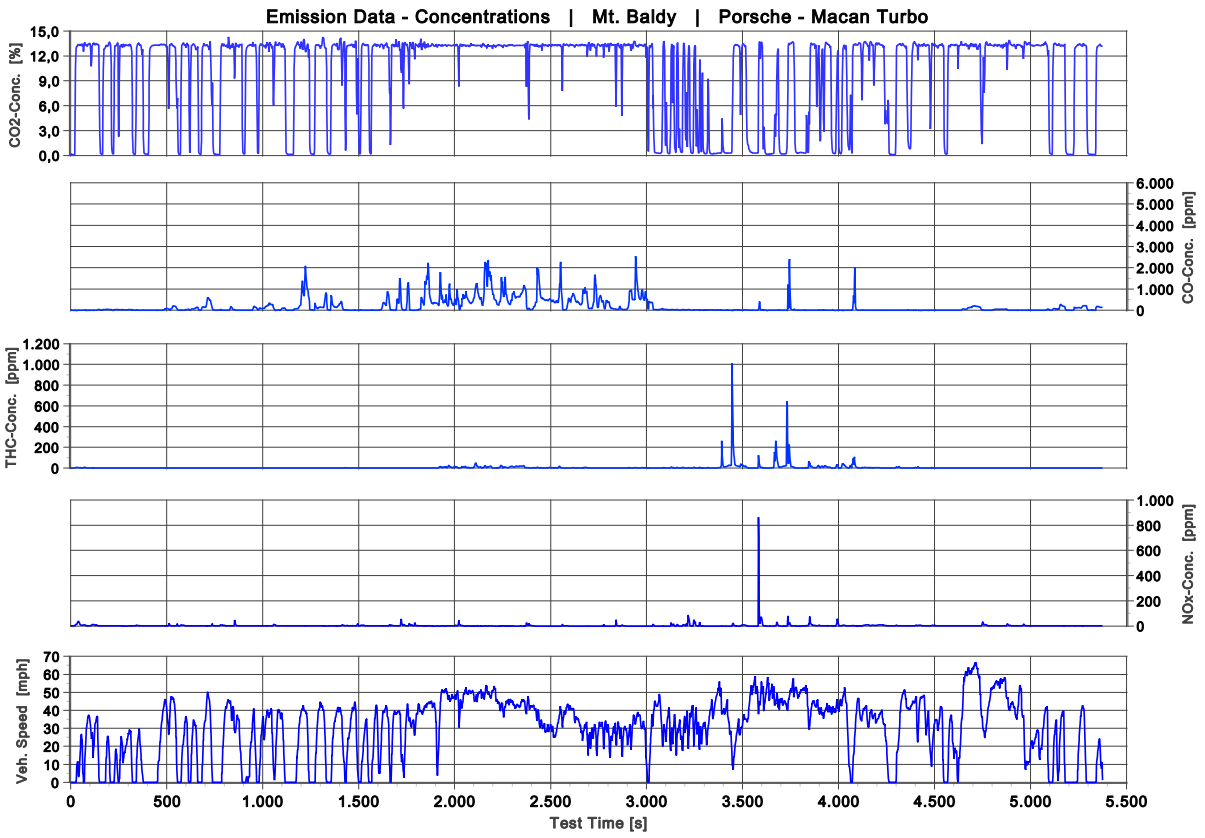

Engine Data | Highway | Porsche - Macan Turbo
Veh. Speed [mph]
Engine Speed [rpm]
Throttle Position [%]
Coolant Temp. [° F]
Test Time [s]

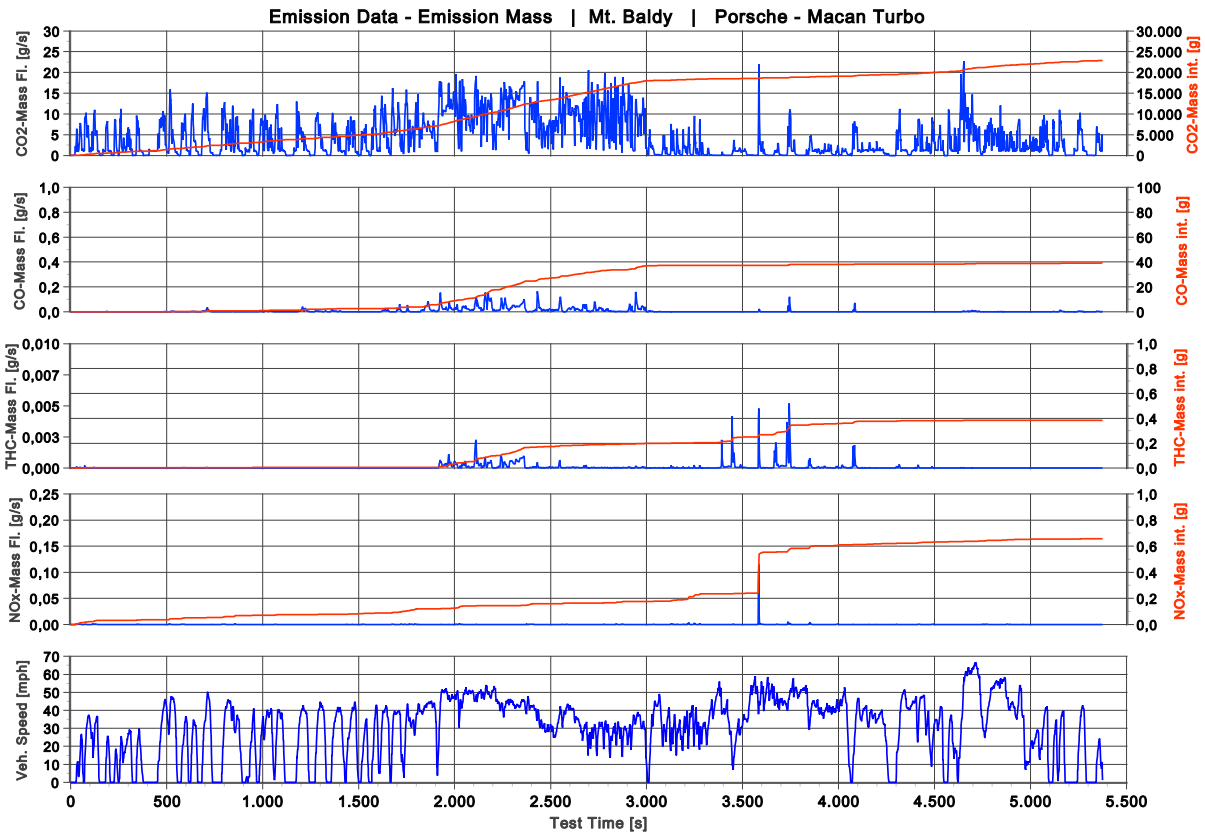
3.5.3 Mt. Baldy

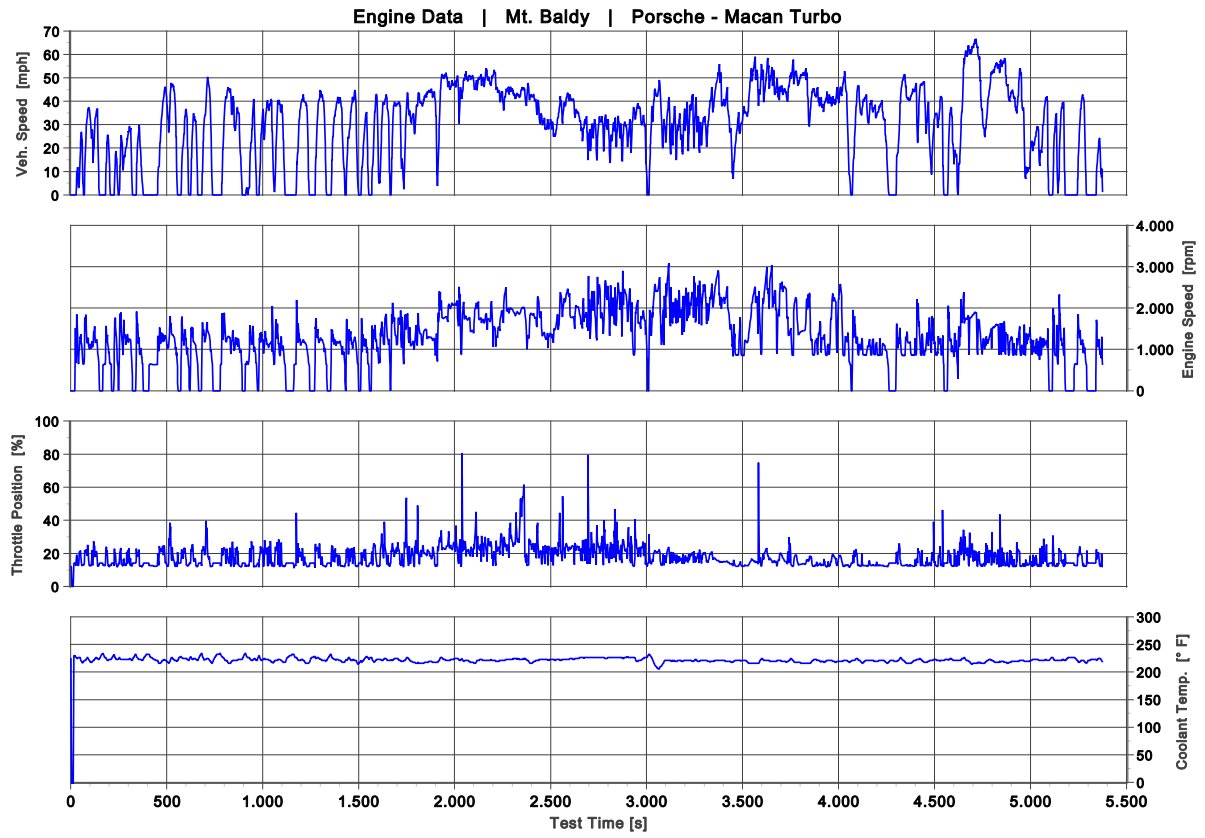
Table 3-22: Mt. Baldy Trip Summary for Macan Turbo

Test Data			
Test Name:	2018-05-17_Macan-Turbo_Mt.-Baldy		
Department:	MBtech	Test Date:	05/17/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	294
Vehicle Modell:	Macan Turbo	Nominal Torque [Nm]:	550
VIN:	WP1AF2A58JLB70632	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 2 Bin 5	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 1100
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	512,3
CO		[g/mi]	0,880
NO_x		[g/mi]	0,015
THC		[g/mi]	0,009
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	5375
Distance		[mi]	44,69
Average Speed		[mph]	29,9
Average Ambient Temperature		[°F]	73,8


Trip Data | Mt. Baldy | Porsche - Macan Turbo
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Concentrations | Mt. Baldy | Porsche - Macan Turbo
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
6.000
5.000
4.000
3.000
2.000
1.000
0
THC-Conc. [ppm]
1.200
1.000
800
600
400
200
0
NOx-Conc. [ppm]
1.000
800
600
400
200
0
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy | Porsche - Macan Turbo
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy | Porsche - Macan Turbo
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
Test Time [s]

3.6 Panamera (LK2)

The following table summarizes the emission measurement results from the Panamera (LK2) vehicle.

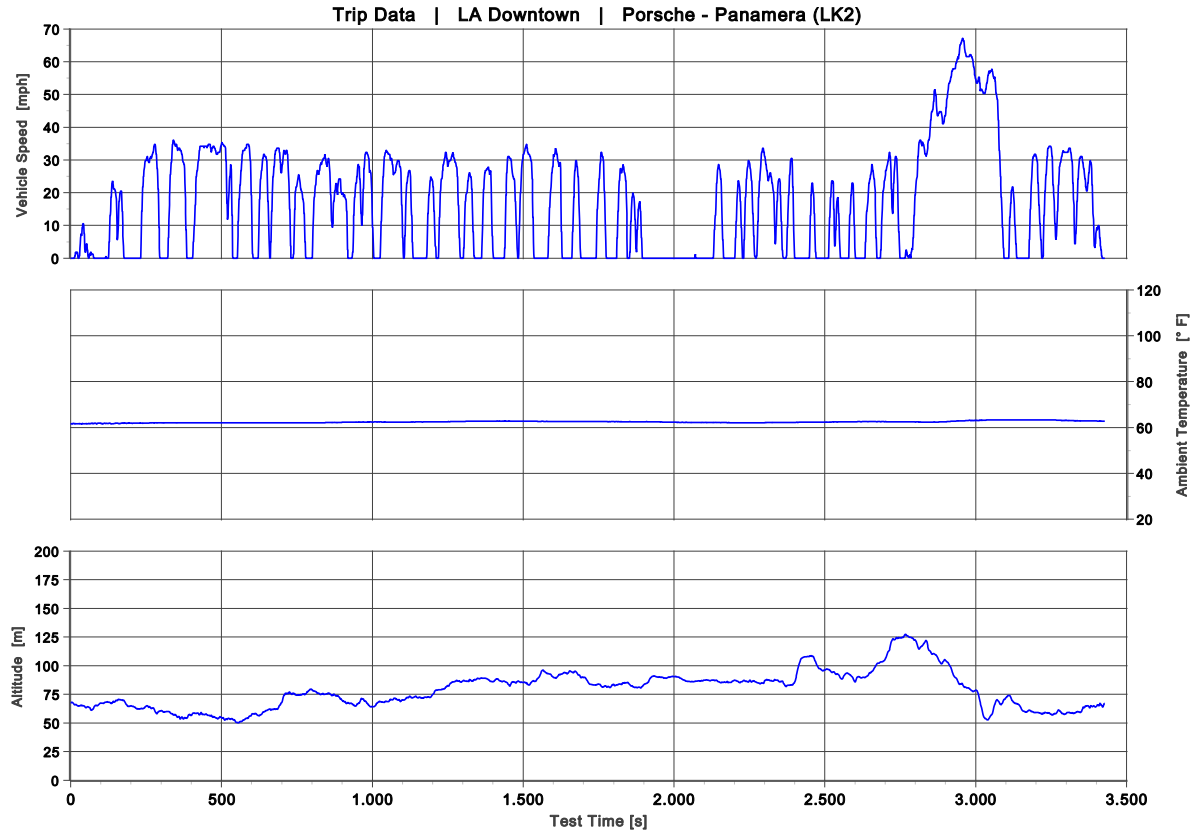
Table 3-23: Emission Overview Porsche - Panamera (LK2)

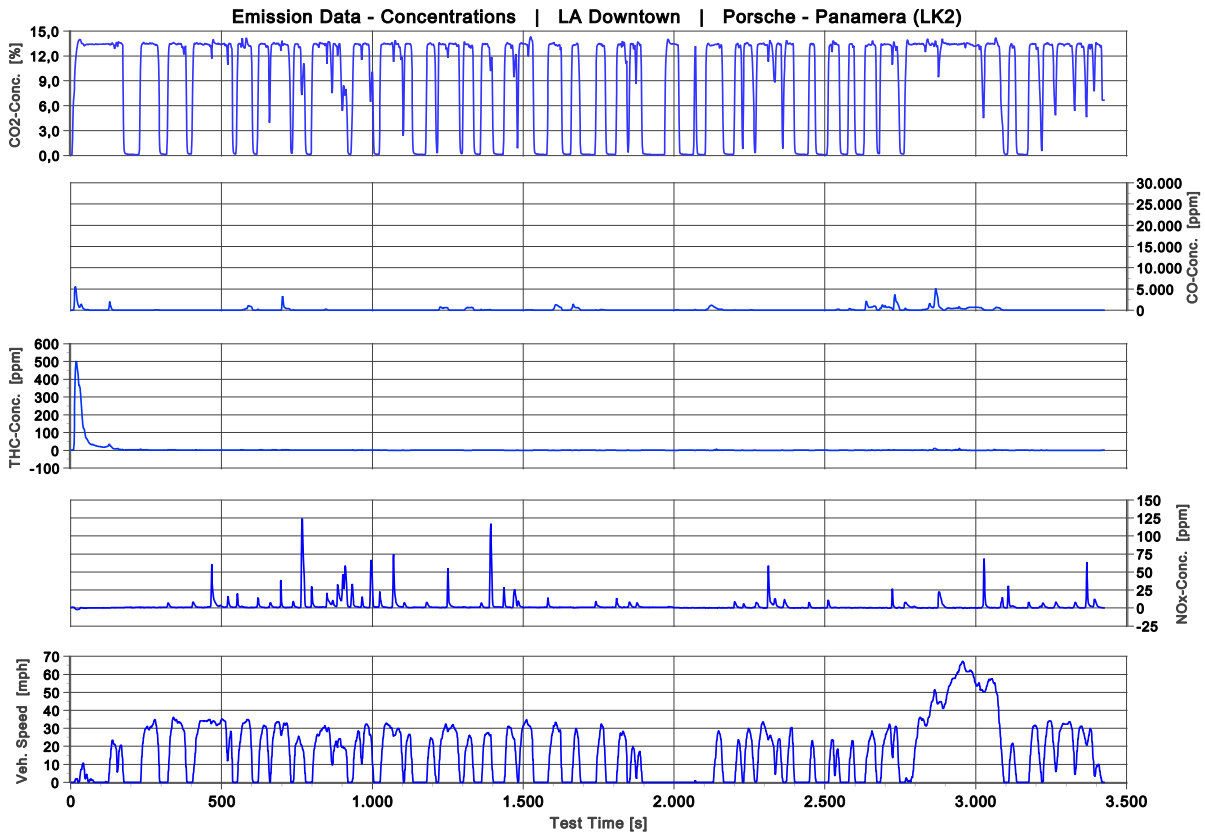
Panamera (LK2)		Emissions				Test	
Date	Route / Test	CO_2 [g/mi]	CO [g/mi]	NO_x [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
05/22/2018	LA Downtown	444,9	0,522	0,011	0,004	3428	15,71
05/23/2018	Highway	299,3	3,555	0,003	0,005	3458	44,18
05/23/2018	Mt. Baldy	460,4	7,023	0,008	0,008	5633	44,35
05/25/2018	FTP75 (PEMS)	420,3	0,592	0,019	0,007	2489	10,82
05/25/2018	FTP75 (Dyno)	413,4	0,583	0,018	0,020		

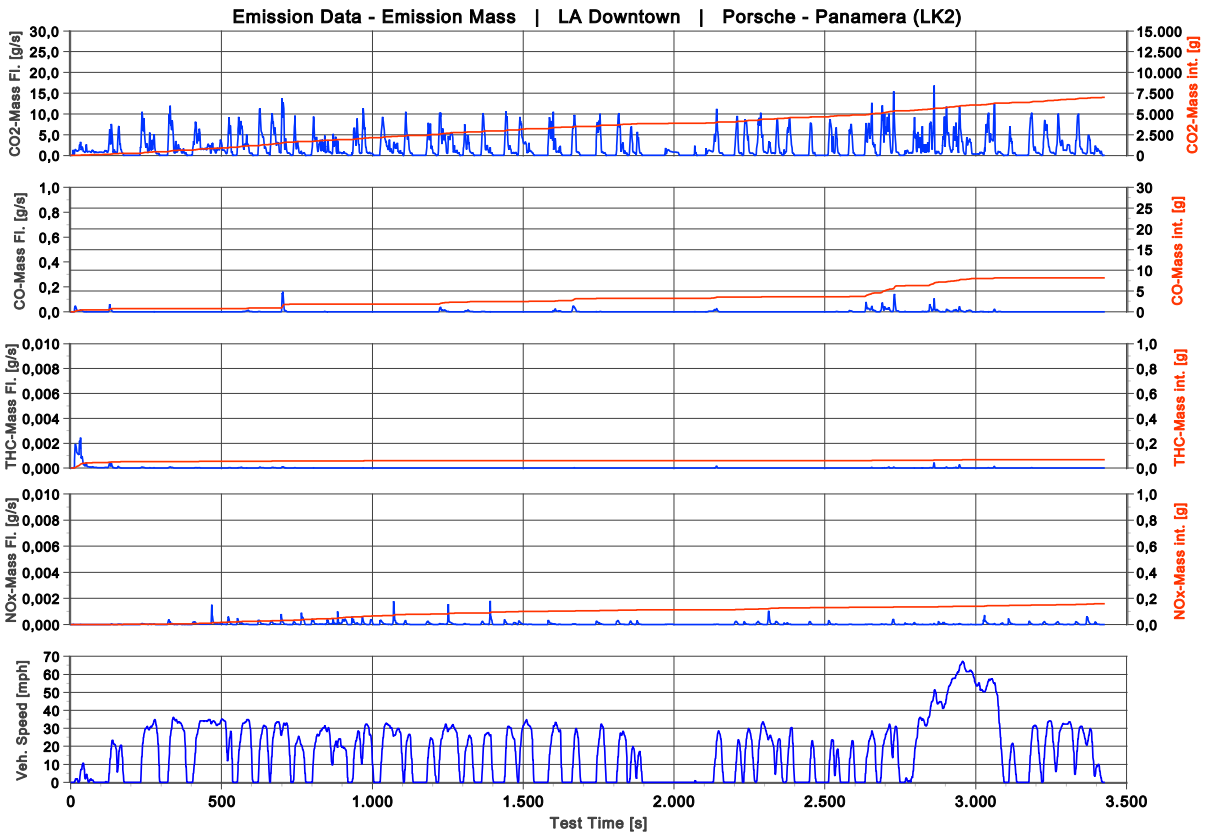
3.6.1 LA Downtown

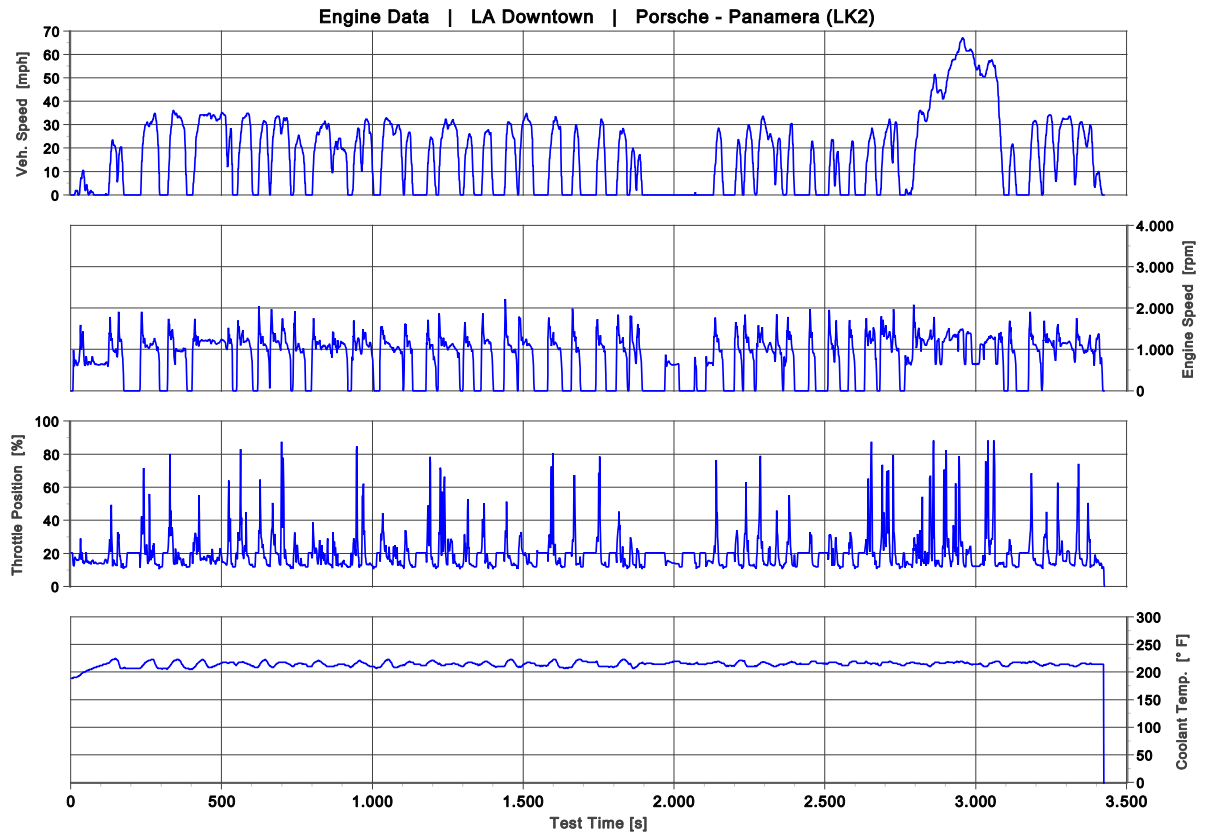
Table 3-24: LA Downtown Trip Summary for Panamera (LK2)

Test Data			
Test Name:	2018-05-22_Panamera4_LA-Downtown		
Department:	MBtech	Test Date:	05/22/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	243
Vehicle Modell:	Panamera (LK2)	Nominal Torque [Nm]:	450
VIN:	WP0AA2A79JL101935	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 70	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 6200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	444,9
CO		[g/mi]	0,522
NO_x		[g/mi]	0,011
THC		[g/mi]	0,004
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3428
Distance		[mi]	15,71
Average Speed		[mph]	16,5
Average Ambient Temperature		[°F]	62,4


Trip Data | LA Downtown | Porsche - Panamera (LK2)
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
200
175
150
125
100
75
50
25
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]


Emission Data - Concentrations | LA Downtown | Porsche - Panamera (LK2)
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
600
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
150
125
100
75
50
25
0
-25
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

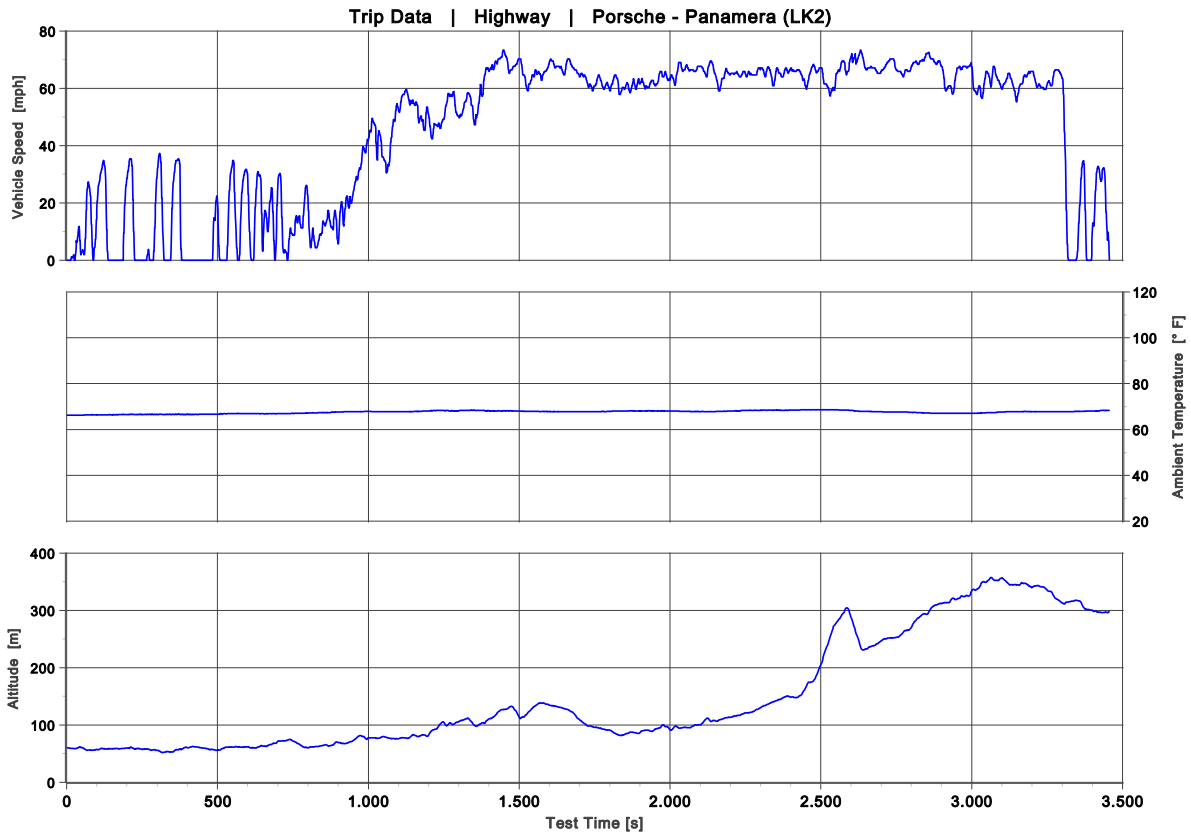

Emission Data - Emission Mass | LA Downtown | Porsche - Panamera (LK2)
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

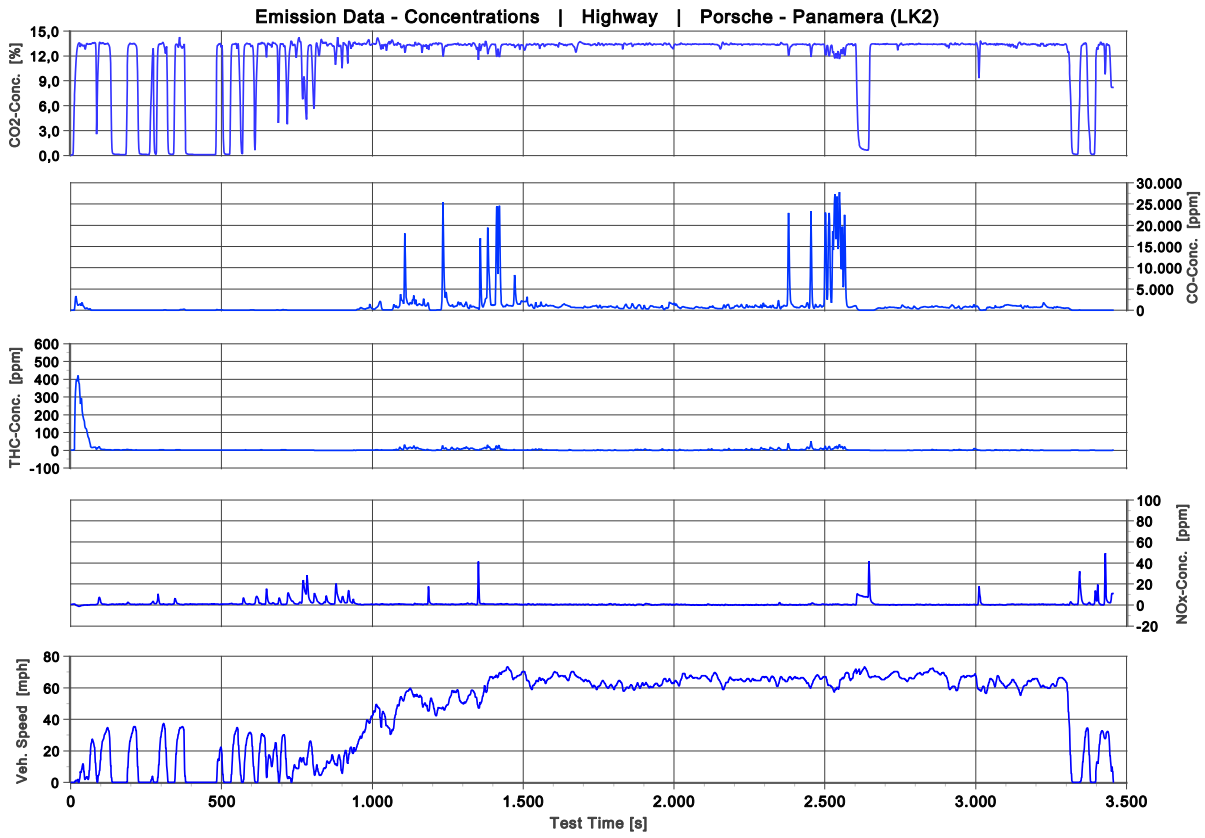

Engine Data | LA Downtown | Porsche - Panamera (LK2)
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

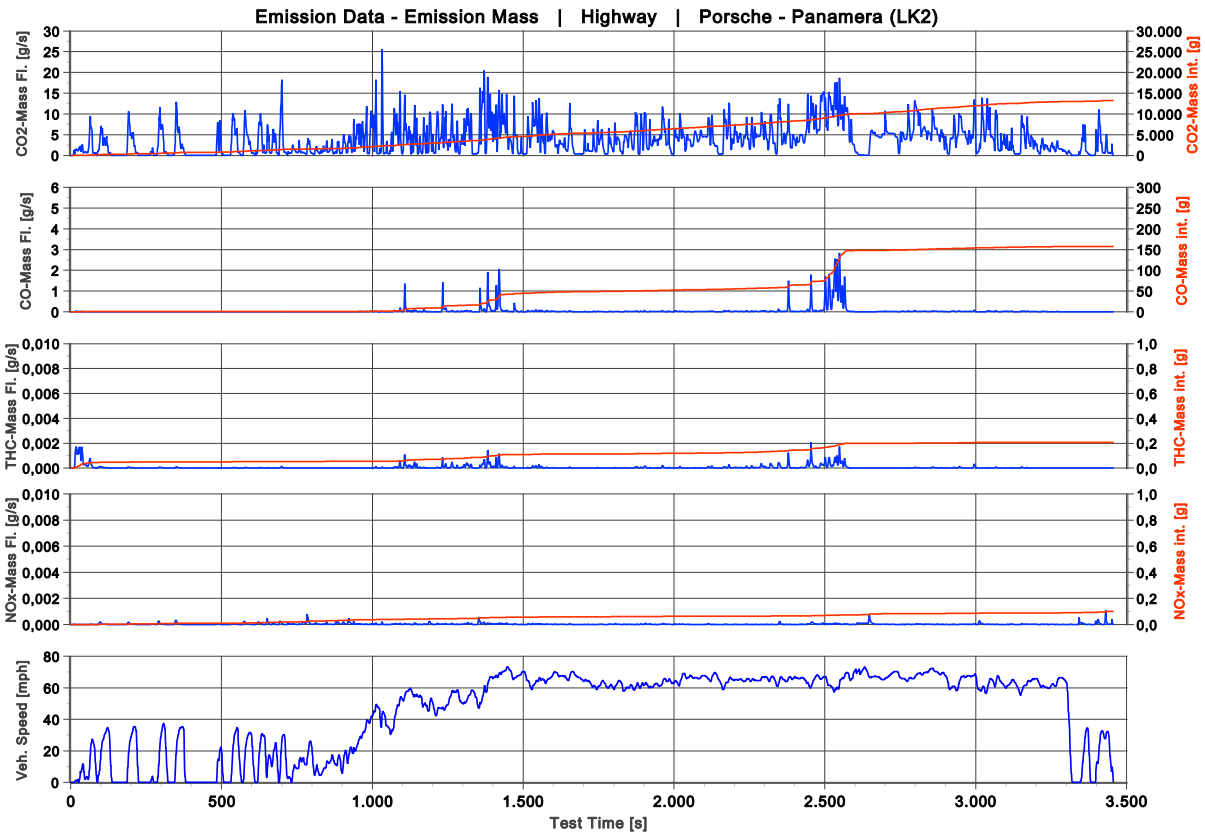
3.6.2 Highway

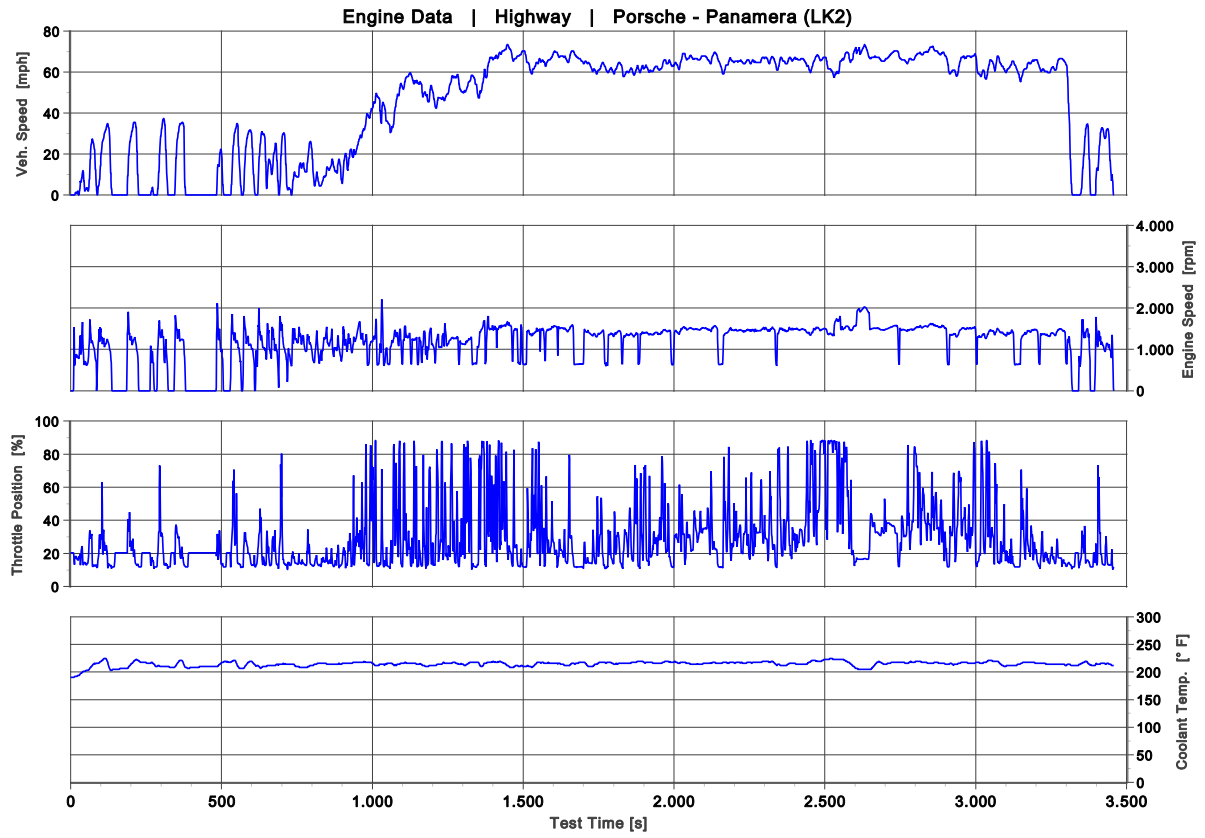
Table 3-25: Highway Trip Summary for Panamera (LK2)

Test Data			
Test Name:	2018-05-23_Panamera4_Highway		
Department:	MBtech	Test Date:	05/23/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	243
Vehicle Modell:	Panamera (LK2)	Nominal Torque [Nm]:	450
VIN:	WP0AA2A79JL101935	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 70	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 6200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	299,3
CO		[g/mi]	3,555
NO_x		[g/mi]	0,003
THC		[g/mi]	0,005
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	3458
Distance		[mi]	44,18
Average Speed		[mph]	46,0
Average Ambient Temperature		[°F]	67,6


Trip Data | Highway | Porsche - Panamera (LK2)
Vehicle Speed [mph]
80
60
40
20
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
400
300
200
100
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]


Emission Data - Concentrations | Highway | Porsche - Panamera (LK2)
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
30.000
25.000
20.000
15.000
10.000
5.000
0
THC-Conc. [ppm]
600
500
400
300
200
100
0
-100
NOx-Conc. [ppm]
100
80
60
40
20
0
-20
Veh. Speed [mph]
80
60
40
20
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

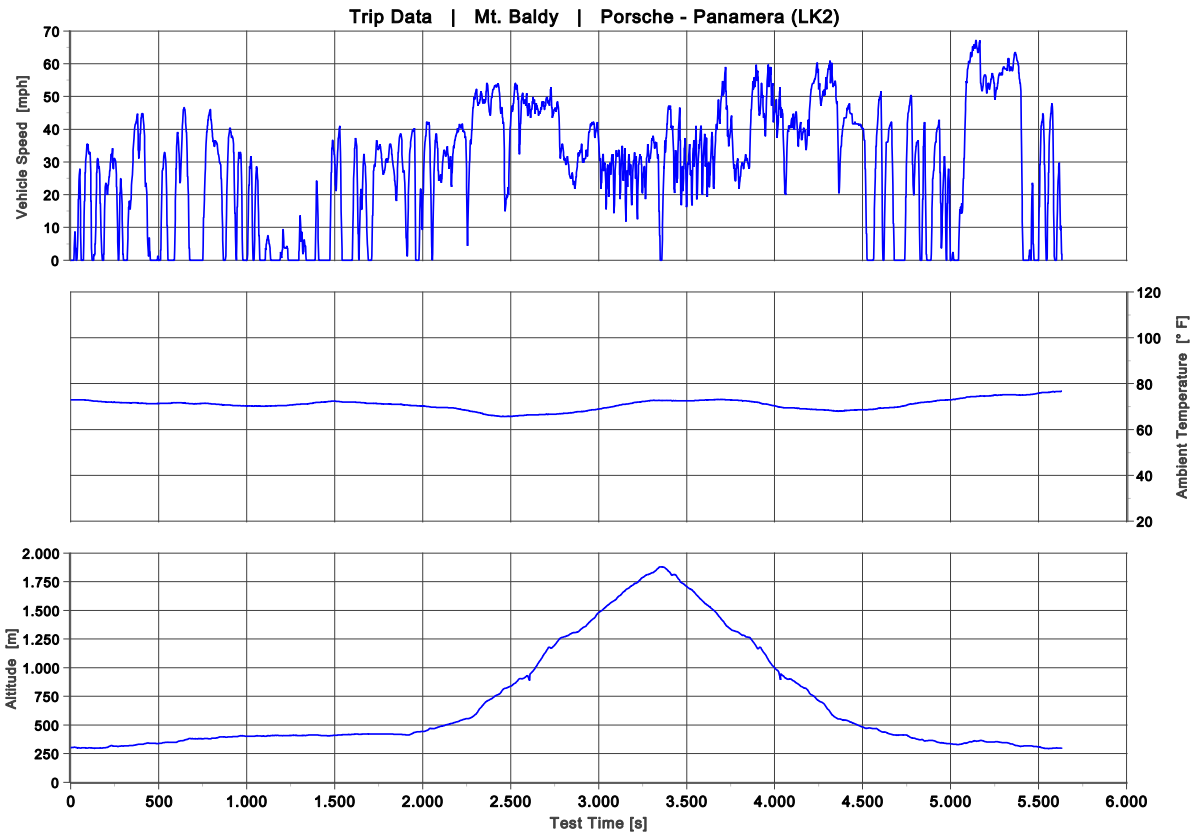

Emission Data - Emission Mass | Highway | Porsche - Panamera (LK2)
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]

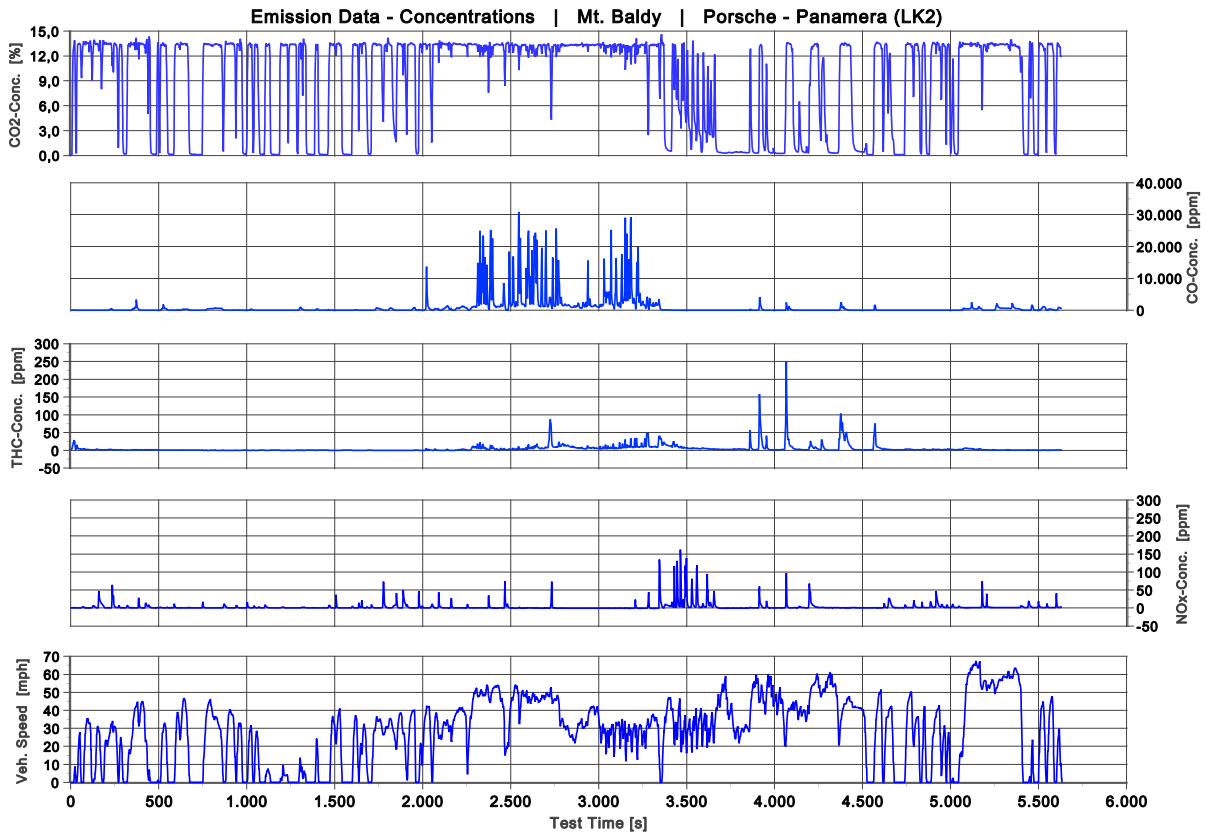

Engine Data | Highway | Porsche - Panamera (LK2)
Veh. Speed [mph]
80
60
40
20
0
4.000
3.000
2.000
1.000
0
Engine Speed [rpm]
Throttle Position [%]
100
80
60
40
20
0
300
250
200
150
100
50
0
Coolant Temp. [° F]
0
500
1.000
1.500
2.000
2.500
3.000
3.500
Test Time [s]

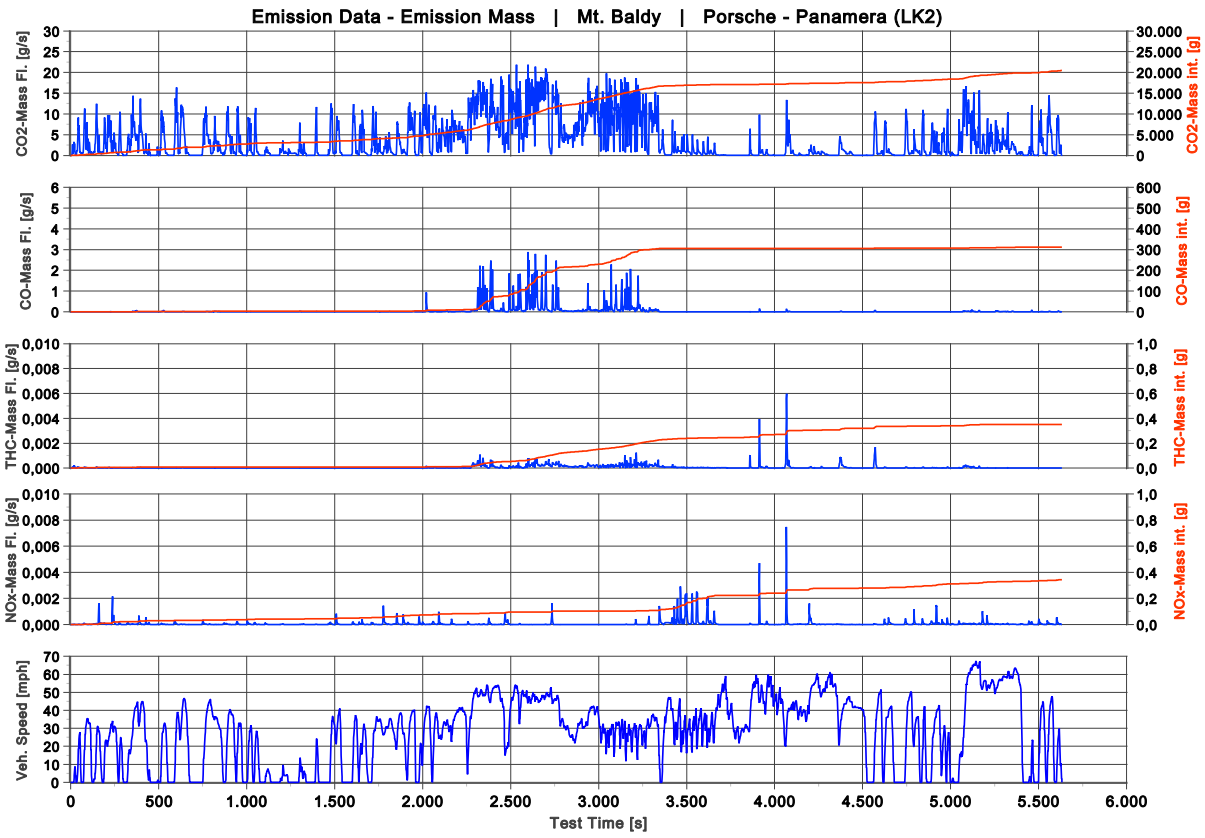
3.6.3 Mt. Baldy

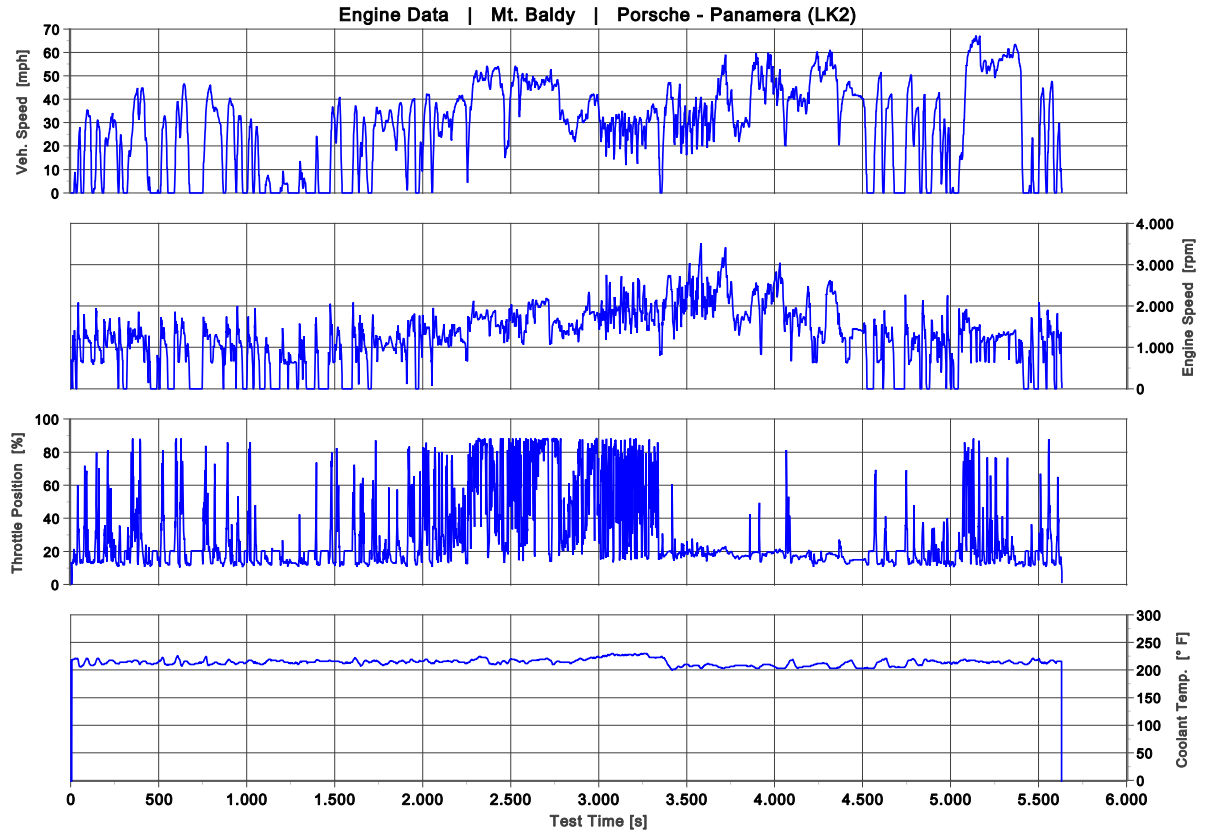
Table 3-26: Mt. Baldy Trip Summary for Panamera (LK2)

Test Data			
Test Name:	2018-05-23_Panamera4_Mt.-Baldy		
Department:	MBtech	Test Date:	05/23/2018
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	243
Vehicle Modell:	Panamera (LK2)	Nominal Torque [Nm]:	450
VIN:	WP0AA2A79JL101935	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 70	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 6200
Emission Summary			
Exhaust Gas Components		Unit	Total Trip
CO_2		[g/mi]	460,4
CO		[g/mi]	7,023
NO_x		[g/mi]	0,008
THC		[g/mi]	0,008
Trip Data			
		Unit	Total Trip
Trip Duration		[s]	5633
Distance		[mi]	44,35
Average Speed		[mph]	28,3
Average Ambient Temperature		[°F]	70,9


Trip Data | Mt. Baldy | Porsche - Panamera (LK2)
Vehicle Speed [mph]
70
60
50
40
30
20
10
0
Ambient Temperature [° F]
120
100
80
60
40
20
Altitude [m]
2.000
1.750
1.500
1.250
1.000
750
500
250
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
Test Time [s]


Emission Data - Concentrations | Mt. Baldy | Porsche - Panamera (LK2)
CO2-Conc. [%]
15,0
12,0
9,0
6,0
3,0
0,0
CO-Conc. [ppm]
40.000
30.000
20.000
10.000
0
THC-Conc. [ppm]
300
250
200
150
100
50
0
-50
NOx-Conc. [ppm]
300
250
200
150
100
50
0
-50
Veh. Speed [mph]
70
60
50
40
30
20
10
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
Test Time [s]


Emission Data - Emission Mass | Mt. Baldy | Porsche - Panamera (LK2)
CO2-Mass Fl. [g/s]
CO2-Mass int. [g]
CO-Mass Fl. [g/s]
CO-Mass int. [g]
THC-Mass Fl. [g/s]
THC-Mass int. [g]
NOx-Mass Fl. [g/s]
NOx-Mass int. [g]
Veh. Speed [mph]
Test Time [s]


Engine Data | Mt. Baldy | Porsche - Panamera (LK2)
Veh. Speed [mph]
70
60
50
40
30
20
10
0
Engine Speed [rpm]
4.000
3.000
2.000
1.000
0
Throttle Position [%]
100
80
60
40
20
0
Coolant Temp. [° F]
300
250
200
150
100
50
0
0
500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
5.500
6.000
Test Time [s]

4 Conclusion

PEMS testing was conducted by MBtech on five series-production light-duty gasoline vehicles provided by Porsche. The vehicle models tested included a Panamera (LK2), Macan (vehicle with the highest project sales), Macan Turbo, Cayenne and Cayenne S E-Hybrid.

Three pre-defined routes were used to perform PEMS testing of the five vehicles. The tests routes were defined within main areas in Southern California, primarily Los Angeles and the Inland Empire. These three routes reflected the diversity in topological characteristics, driving patterns and ambient conditions that are expected to be representative of typical vehicle operations within the area. In addition to PEMS measurements on the road, correlation tests between the PEMS and a chassis dynamometer at the Emission Compliance Lab and Test Center in Oxnard, California were carried out.

The gaseous emissions from the test vehicles were measured with a PEMS and FID from AVL. The specific pollutants measured were CO, CO_2, NO_x (the sum of NO and NO_2) and THC. Since U.S. and California law does not set forth a standard by which PEMS testing can be used to determine compliance for purposes of certification under Title II of the Clean Air Act and under California law, no emissions comparisons to current U.S. and California Regulations can be drawn.

This document confirms all five test vehicles from the model year 2018 have successfully undergone on-road testing using PEMS devices on three pre-defined routes in California. Characterization tests using the FTP75 test cycle were also successfully executed. Results of all these measurements have been compiled and delivered in the result section of this report.