



# **PEMS Testing of Porsche Model Year 2017 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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## List of Abbreviations

Table 1-1: Abbreviations

Amb.	Ambient Conditions (Pressure, Temperature, relative Humidity)
AT	Automatic Transmission
AVL	AVL List GmbH
AWD	All Wheel Drive
CE-CERT	College of Engineering - Center for Environmental Research & Technology
CO	Carbon Monoxide
CO <sub>2</sub>	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
Porsche	Dr. Ing. h.c. F. Porsche AG and Porsche Cars North America, Inc.
NO	Nitrogen Monoxide
NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Nitrogen Oxides (sum of NO + NO <sub>2</sub> )
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 of certain model year (“MY”) 2017, 2018, and 2019 Porsche light duty vehicles using a portable emission measurement system (“PEMS”). In 2017, MBtech conducted PEMS testing of five MY2017 Porsche serial-production light-duty gasoline vehicles provided by Porsche. The testing was done as stated under paragraph 33.a and also 33.b of the DOJ and California Third Partial Consent Decree. MBtech chose the same methods for its testing under 33.b that were required for the testing under 33.a. The vehicle models tested included a 911 Carrera, Panamera Turbo, Cayenne Turbo S, Macan and a Macan GTS (vehicle with highest projected sales). 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 results summarized in this report. Porsche employees merely assisted with the installation of the PEMS system on the 911 Carrera, but Porsche employees were not involved in the actual testing or the evaluation of results.

MBtech worked with the University of California Riverside, College of Engineering—Center for Environmental Research and Development (CE-CERT) in Riverside, California on this project to assist with preparing the vehicles for testing and setting up the PEMS mounting system.

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 emission laboratory’s 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 24 on-road measurements and 6 tests on the chassis dynamometer. The PEMS measured the gaseous emissions carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>) and nitrogen oxides (NO<sub>x</sub>) as sum of nitrogen monoxide (NO) and nitrogen dioxide

(NO<sub>2</sub>). The FID measured the hydrocarbons (THC) for all the vehicles except the sports car (911 Carrera) due to safety concerns and lack of space. For all the on-road measurements, the ambient pressure, temperature, humidity and the altitude level were also recorded.

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 pertained to a different test group as depicted below in Figure 2-1. These vehicles included a sports car, a passenger vehicle and three sport utility vehicles (SUV). The vehicle models tested included one 911 Carrera, one Panamera Turbo, one Cayenne Turbo S, one Macan and one Macan GTS (vehicle with highest projected sales).

No.	Models in test group	MY2017
1	Carrera Turbo, Turbo S (991 II)	<input checked="" type="checkbox"/>
2	Boxster, Cayman, Boxster S, Cayman S (982 S)	<input checked="" type="checkbox"/>
3	Carrera, Carrera S, GTS (991 II)	<input checked="" type="checkbox"/>
4	Panamera Turbo (LK5) (G2)	<input checked="" type="checkbox"/>
5	Panamera (LK2) (G2), Panamera S (LK3) (G2)	<input checked="" type="checkbox"/>
6	Macan (185 kW)	<input checked="" type="checkbox"/>
7	Cayenne (E2 II)	<input checked="" type="checkbox"/>
8	Macan Turbo (Turbo S)	<input checked="" type="checkbox"/>
9	Cayenne S e-hybrid (E2 II)	<input checked="" type="checkbox"/>
10	Macan S, GTS, Cayenne S, GTS (E2 II)	<input checked="" type="checkbox"/>
11	Cayenne Turbo, Turbo S (E2 II)	<input checked="" type="checkbox"/>
12	Panamera PHEV (LK3) (G2)	<input type="checkbox"/>
13	Panamera Turbo S PHEV (G2)	<input type="checkbox"/>

Figure 2-1: Porsche Test Groups MY2017

### 2.2 PEMS Test Routes

Three pre-defined routes were selected to perform PEMS testing on 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. Each route was driven once per vehicle unless unforeseen deviations from the original route occurred, which meant the route needed to be repeated. Unforeseen deviations include, but are not limited to road closures. Road closures were especially a common occurrence in Downtown LA. Therefore, 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.14.7 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*.

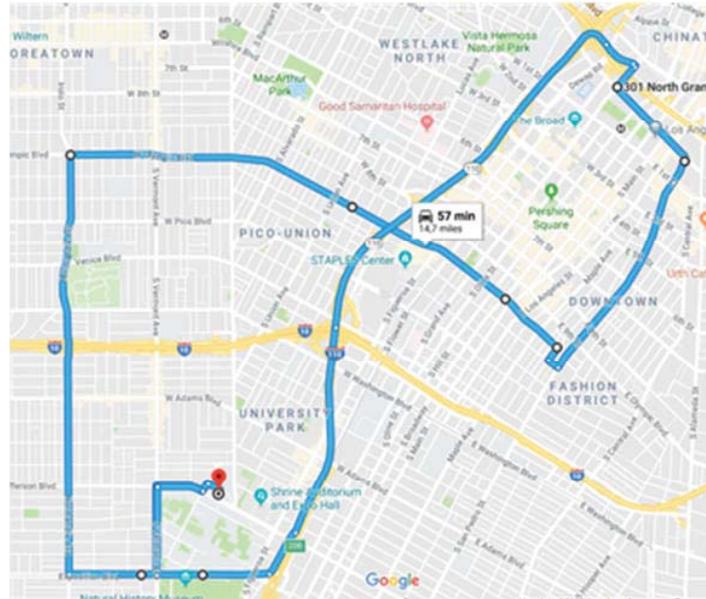


Figure 2-2: Topographic Map of Urban Driving Route in Downtown Los Angeles

The “Highway Route” shown below in *Figure 2-3* is approx. 44 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.

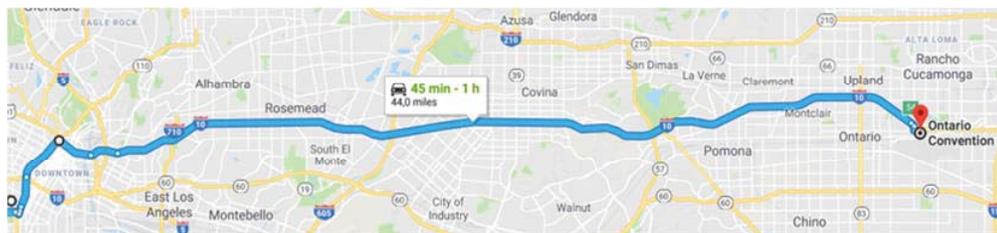


Figure 2-3: Topographic Map of Highway Driving Route in Los Angeles

The third route driven is the “Mt. Baldy Route” shown in *Figure 2-4* and is approx. 36.8 miles long. This route is representative of rural and uphill/downhill driving that includes large variations in altitude, grades, and lower ambient temperatures and pressures. The starting and end point of the route was at a parking lot near the Ontario Convention Center.

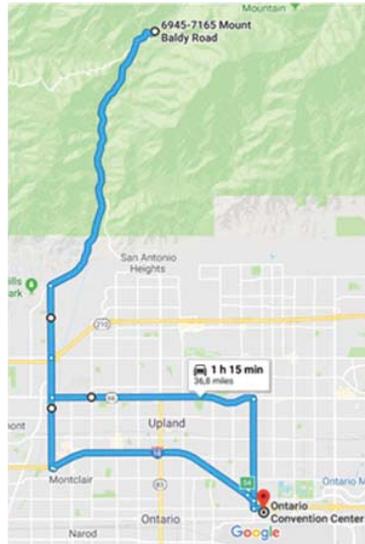


Figure 2-4: Topographic Map of Rural and Uphill/Downhill Driving Route in Los Angeles Foothills

## 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<sub>2</sub>), carbon monoxide (CO) and nitrogen oxides (NO<sub>x</sub>), in which nitrogen monoxide (NO) and nitrogen dioxide (NO<sub>2</sub>) are summarized. 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, except for the 911 Carrera, were equipped with an AVL M.O.V.E 4925 FID iS. This device was able to measure total hydrocarbons (THCs). The FID was not installed on the 911 Carrera for safety reasons and due to space constraints.

All vehicles were also equipped with an exhaust flow meter (EFM) to help measure the exhaust volume flow.

All vehicles had the PEMS, FID (with the exception of the 911 Carrera) and EFM mounted on their car hitches respectively.

### **2.3.2 Fuels**

All five test vehicles had their fuel tanks emptied and refilled with standard fuel (91 RON) from a barrel.

## **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 CE-CERT**

The University of California Riverside, College of Engineering—Center for Environmental Research and Development (CE-CERT) in Riverside, California supported MBtech. In particular, CE-CERT assisted with preparing the vehicles for testing, including QA/QC validation and setting up the PEMS mounting system. Testing vehicles were securely stationed and prepared at the CE-CERT facility.

## **2.6 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 adaptations were installed onto the vehicles. After exhaust pipes were mounted, all measurement systems were installed on the car such as the PEMS, FID and EFM, battery, inverter, and connections. Once the vehicle was set up, pre-calibrations were performed to ensure the analyzers were operating correctly. If successful pre-tests were carried out, then PEMS measurements were carried out 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 on the vehicle was demounted and a report was prepared.

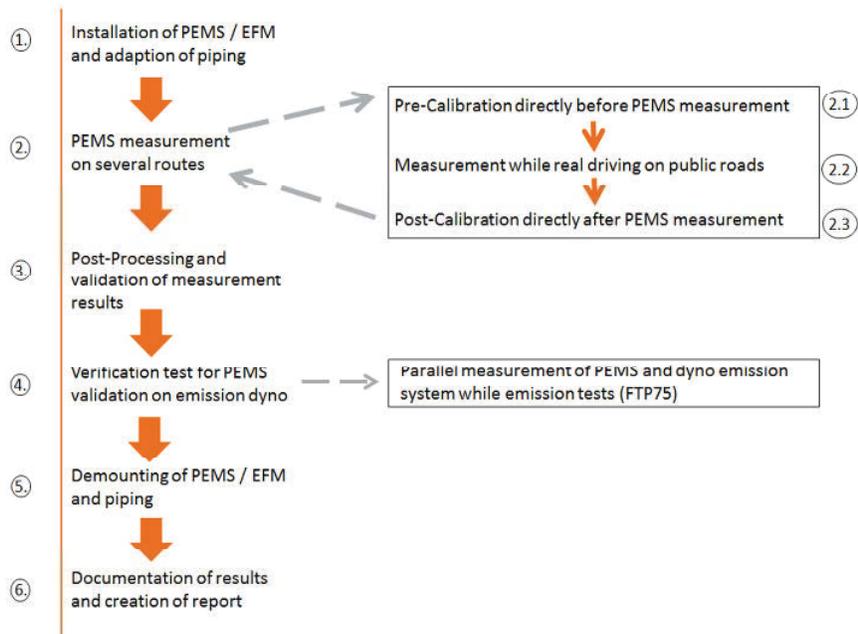


Figure 2-5: PEMS Measurement Procedure

## 2.7 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 below summarize the emissions from all the routes and vehicles tested.

Table 3-1: Emission Overview for Model Year 2017

Cayenne Turbo S		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
10/28/17	LA Downtown	593,23	0,990	0,005	0,027	3221	15,52
10/28/17	Highway 1*	397,81	2,913	0,013	0,062	3527	45,94
11/02/17	Highway 2	411,31	2,806	0,018	0,055	4015	44,16
10/27/17	Mt. Baldy	526,07	4,419	0,034	0,115	5639	43,88
11/04/17	FTP75 (PEMS)	488,14	0,379	0,030	n.a.	2532	10,75
11/04/17	FTP75 (Dyno)	504,56	0,449	0,029	0,041		

Cayenne Turbo S (2)**		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
12/01/17	LA Downtown	654,58	0,852	0,006	0,006	3600	15,46
12/01/17	Highway	521,81	1,155	0,016	0,036	6257	43,97
11/30/17	Mt. Baldy	556,50	4,515	0,020	0,137	5403	43,72
12/07/17	FTP75 (PEMS)	508,90	0,691	0,008	0,057	2495	10,74
12/07/17	FTP75 (Dyno)	525,44	0,809	0,020	0,056		

Macan		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/08/17	LA Downtown 1*	404,48	0,305	0,008	0,003	3130	17,56
11/09/17	LA Downtown 2	463,74	0,105	0,024	0,001	3698	15,92
11/08/17	Highway	338,27	0,157	0,006	0,006	3098	45,14
11/08/17	Mt. Baldy	417,89	0,162	0,031	0,009	6414	44,82
11/10/17	FTP75 (PEMS)	375,32	0,199	0,012	0,018	2506	11,08
11/10/17	FTP75 (Dyno)	357,49	0,221	0,010	0,018		

\*: Deviation of driving route from original route

\*\* : Retaking of the measurements after break down of the FID module on the first FTP75

Macan GTS		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/11/17	LA Downtown	600,98	0,282	0,011	0,002	4113	15,75
11/11/17	Highway	427,67	0,585	0,009	0,009	4979	44,88
11/13/17	Mt. Baldy	490,94	0,879	0,058	0,038	5341	44,62
11/15/17	FTP75 (PEMS)	471,65	0,587	0,020	0,035	2511	10,95
11/15/17	FTP75 (Dyno)	447,54	0,565	0,017	0,028		

911 Carrera***		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/18/17	LA Downtown 1*	492,75	0,004	0,008	n.a.	4691	16,02
11/22/17	LA Downtown 2*	658,24	0,002	0,025	n.a.	3097	15,53
11/22/17	LA Downtown 3	578,17	0,001	0,028	n.a.	2772	15,71
11/18/17	Highway 1	341,30	0,049	0,014	n.a.	3771	45,09
11/22/17	Highway 2	309,42	0,046	0,014	n.a.	2817	44,85
11/18/17	Mt. Baldy 1	373,11	0,289	0,034	n.a.	5152	44,69
11/23/17	Mt. Baldy 2	330,75	0,202	0,034	n.a.	4822	44,50
11/22/17	FTP75 (PEMS)	313,94	0,163	0,032	n.a.	2490	10,93
11/22/17	FTP75 (Dyno)	339,58	0,222	0,036	0,054		

Panamera Turbo		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/27/17	LA Downtown	507,03	0,000	0,012	0,000	3218	15,51
11/27/17	Highway	354,44	0,162	0,008	0,008	3727	44,22
11/23/17	Mt. Baldy	491,67	0,141	0,019	0,014	4705	43,80
11/29/17	FTP75 (PEMS)	418,16	0,041	0,032	0,031	2507	10,74
11/29/17	FTP75 (Dyno)	410,87	0,060	0,040	0,036		

\*: Deviation of driving route from original route

\*\*\*: Repetition of all measurements (2 or 3) because of repairs on the Gas PEMS after measurements (1)

### 3.2 Cayenne Turbo S

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

Table 3-2: Emission Overview Porsche - Cayenne Turbo S

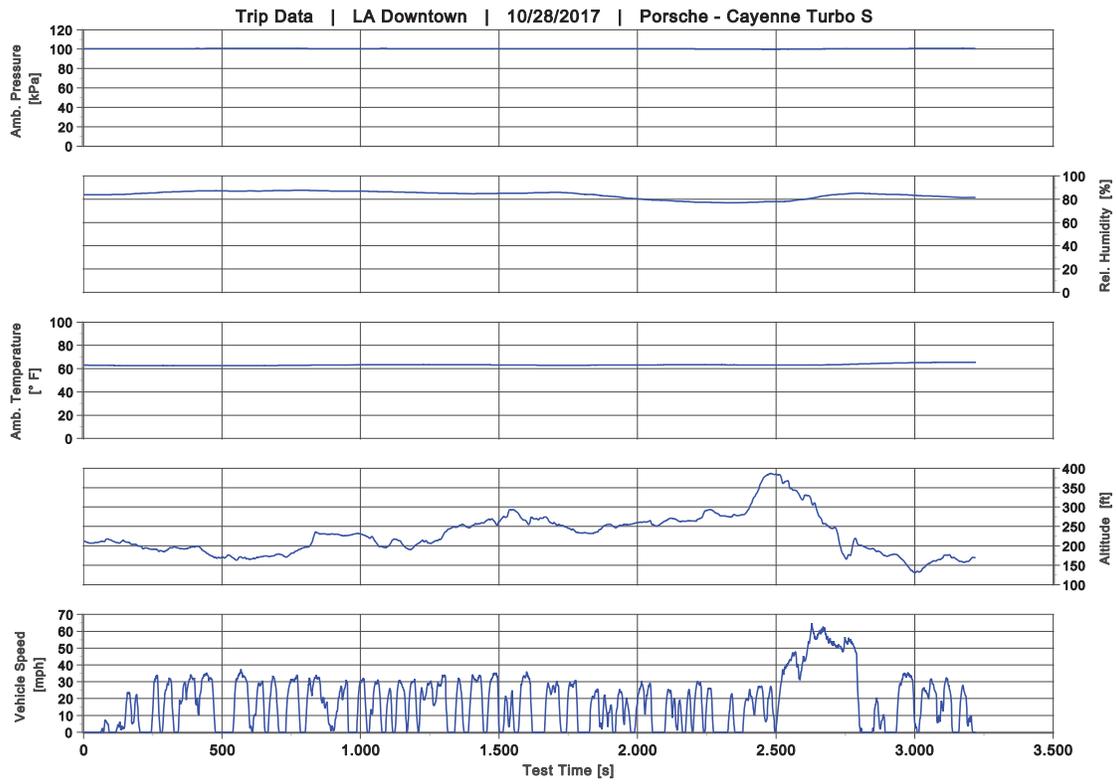
Cayenne Turbo S		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
10/28/17	LA Downtown	593,23	0,990	0,005	0,027	3221	15,52
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11/02/17	Highway 2	411,31	2,806	0,018	0,055	4015	44,16
10/27/17	Mt. Baldy	526,07	4,419	0,034	0,115	5639	43,88
11/04/17	FTP75 (PEMS)	488,14	0,379	0,030	n.a.	2532	10,75
11/04/17	FTP75 (Dyno)	504,56	0,449	0,029	0,041		

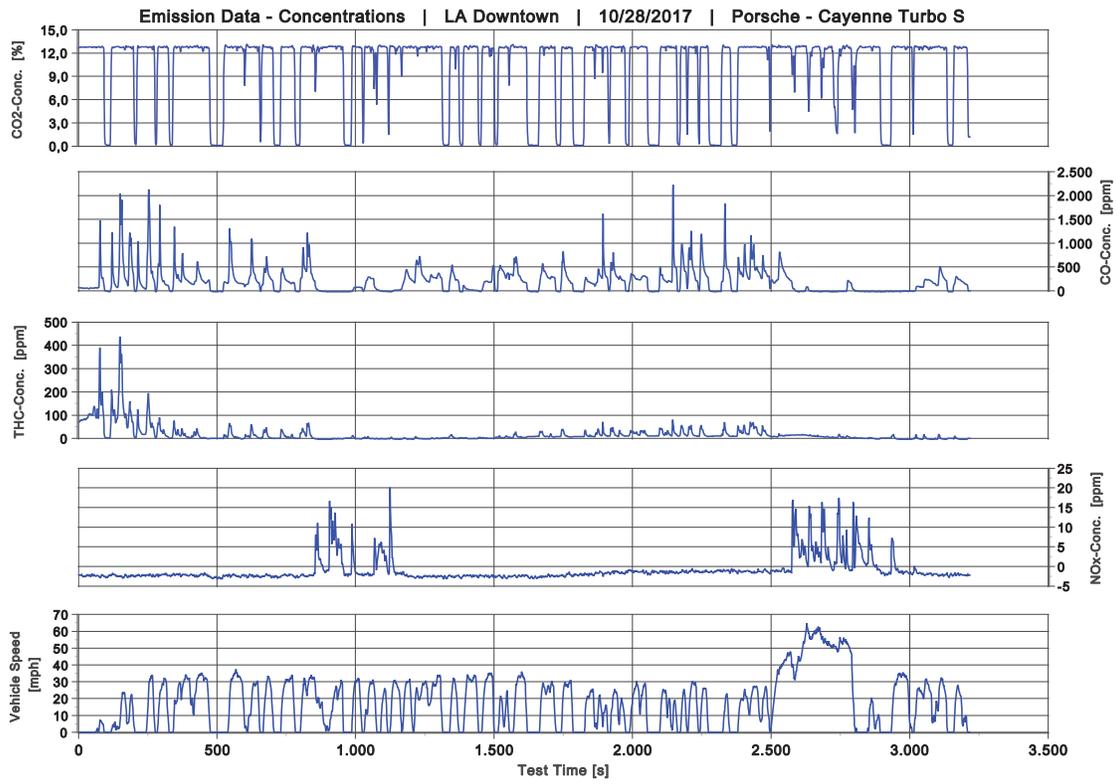
\*: Deviation of driving route from original route

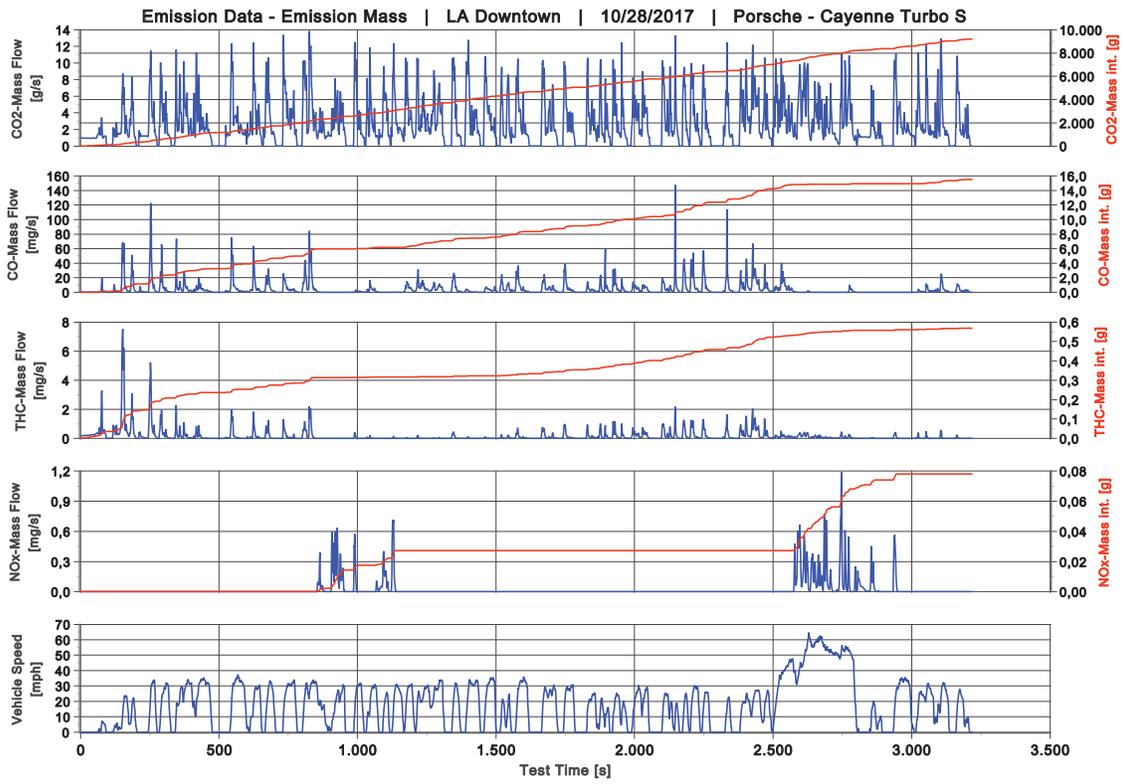
### 3.2.1 LA Downtown

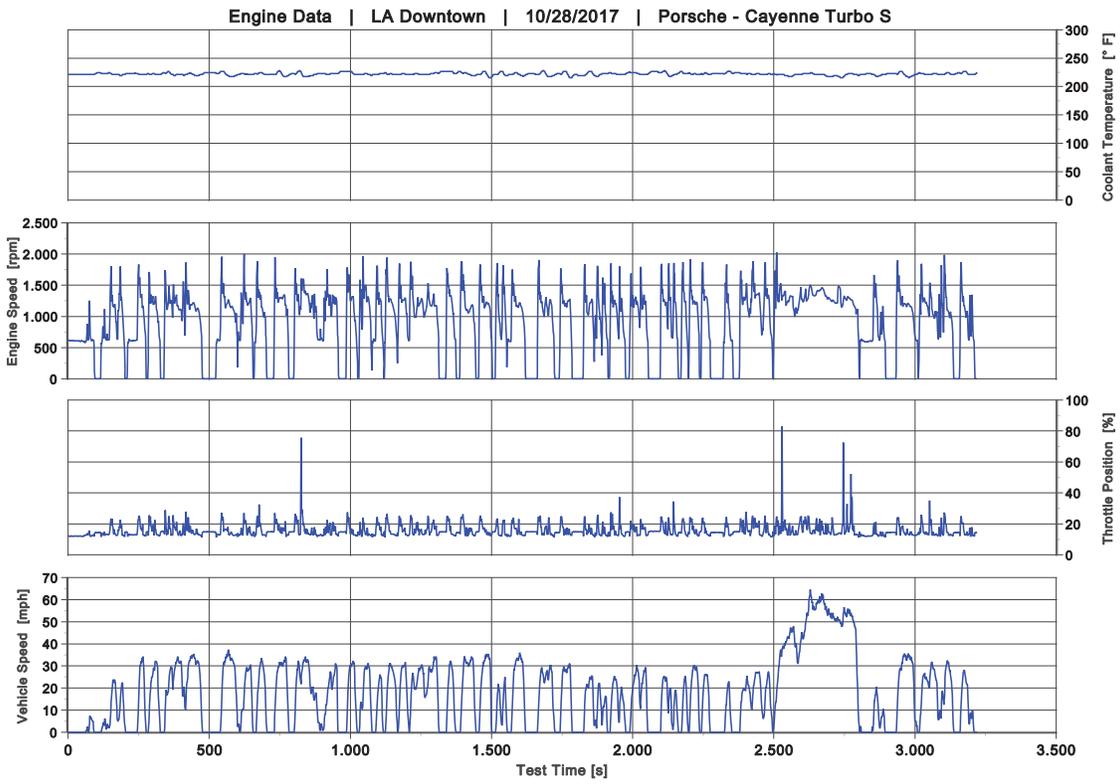
Table 3-3: LA Downtown Trip Summary for Cayenne Turbo S

Test Data			
Test Name:	2017-10-28 Cayenne-Turbo-S LA-Downtown		
Department:	MBtech	Test Date:	10/28/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 1800
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	593,23	
CO	[g/mi]	0,990	
NO <sub>x</sub>	[g/mi]	0,005	
THC	[g/mi]	0,027	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3221	
Distance	[mi]	15,52	
Average Speed	[mph]	17,3	
Average Ambient Temperature	[°F]	63,3	









### 3.2.2 Highway (1)

Table 3-4: Highway (1) Trip Summary for Porsche - Cayenne Turbo S

Test Data			
Test Name:	2017-10-28 Cayenne-Turbo-S Highway1		
Department:	MBtech	Test Date:	10/28/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 1800
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	397,81	
CO	[g/mi]	2,913	
NO <sub>x</sub>	[g/mi]	0,013	
THC	[g/mi]	0,062	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3527	
Distance	[mi]	45,94	
Average Speed	[mph]	46,9	
Average Ambient Temperature	[°F]	67,6	

Deviation from original route:

The deviation started at 1072s test time and ended at 1424s test time.

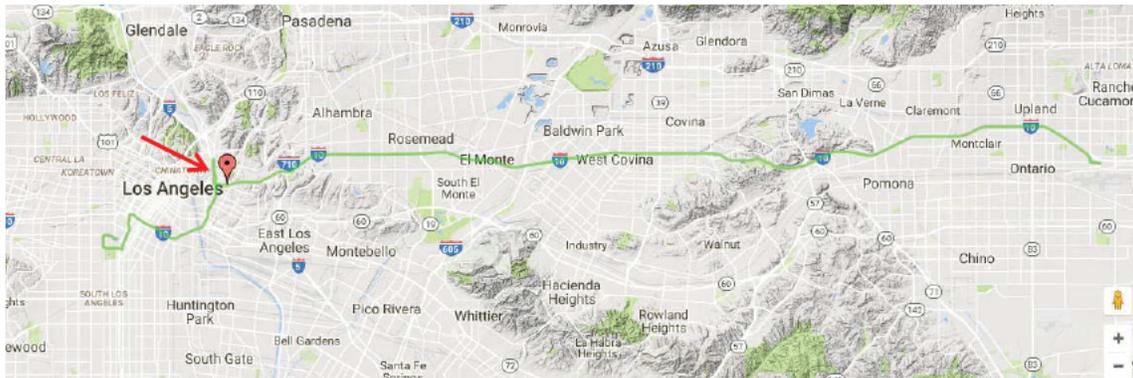


Figure 3-1: Highway (1) Route Deviations for Cayenne Turbo S

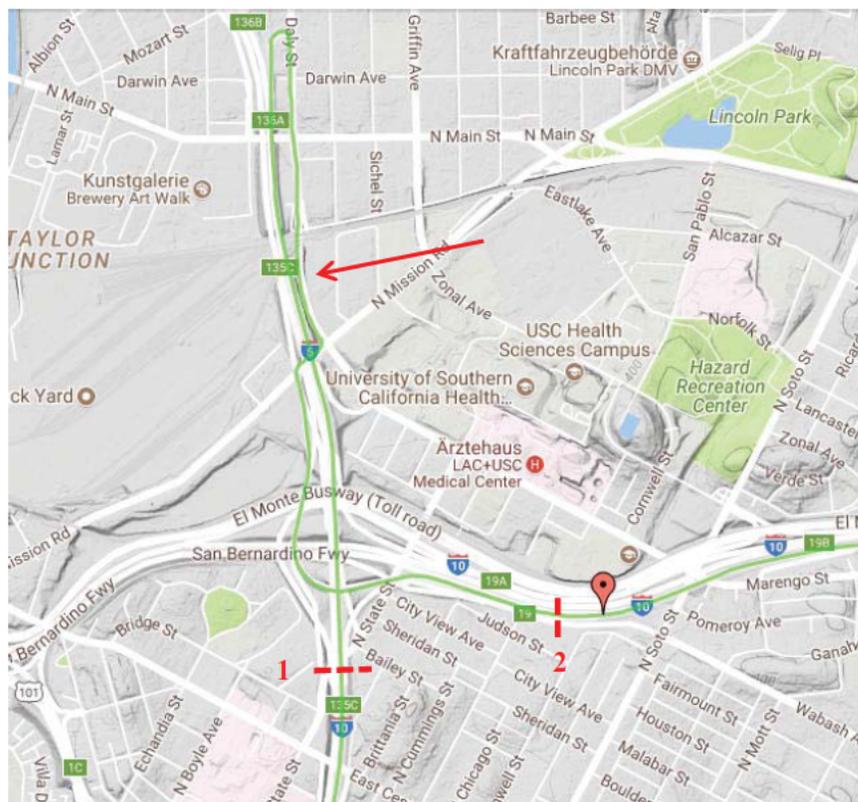
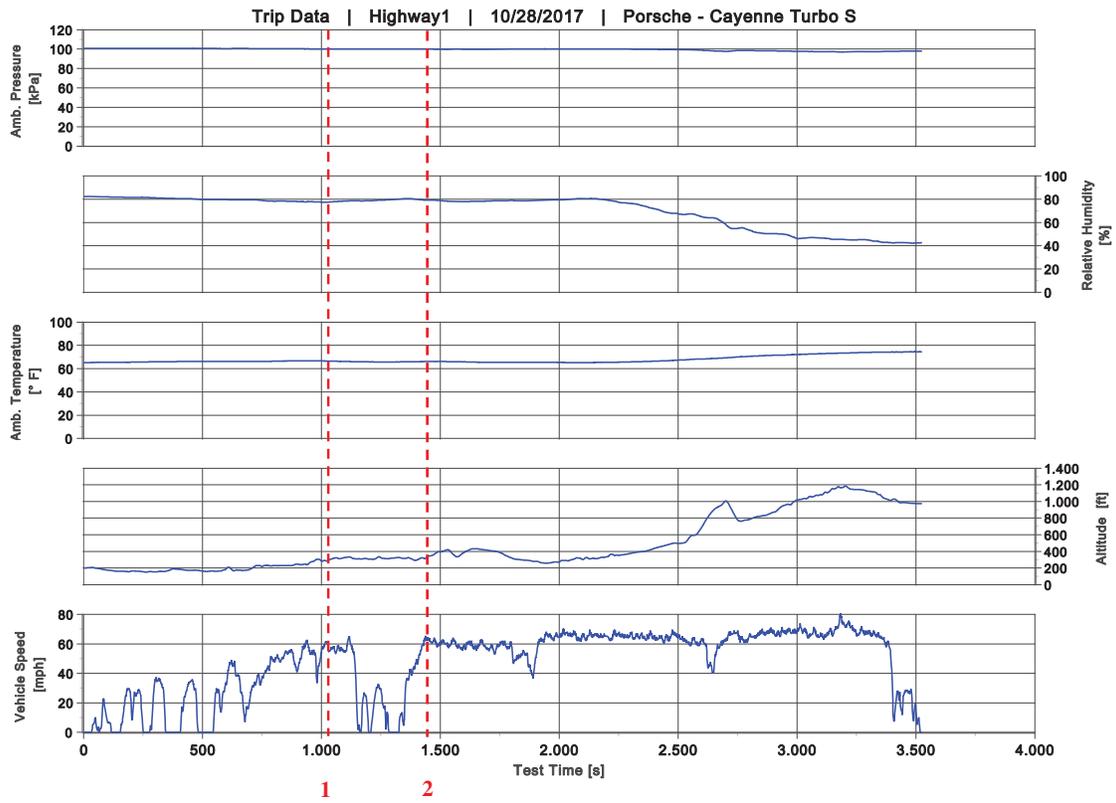
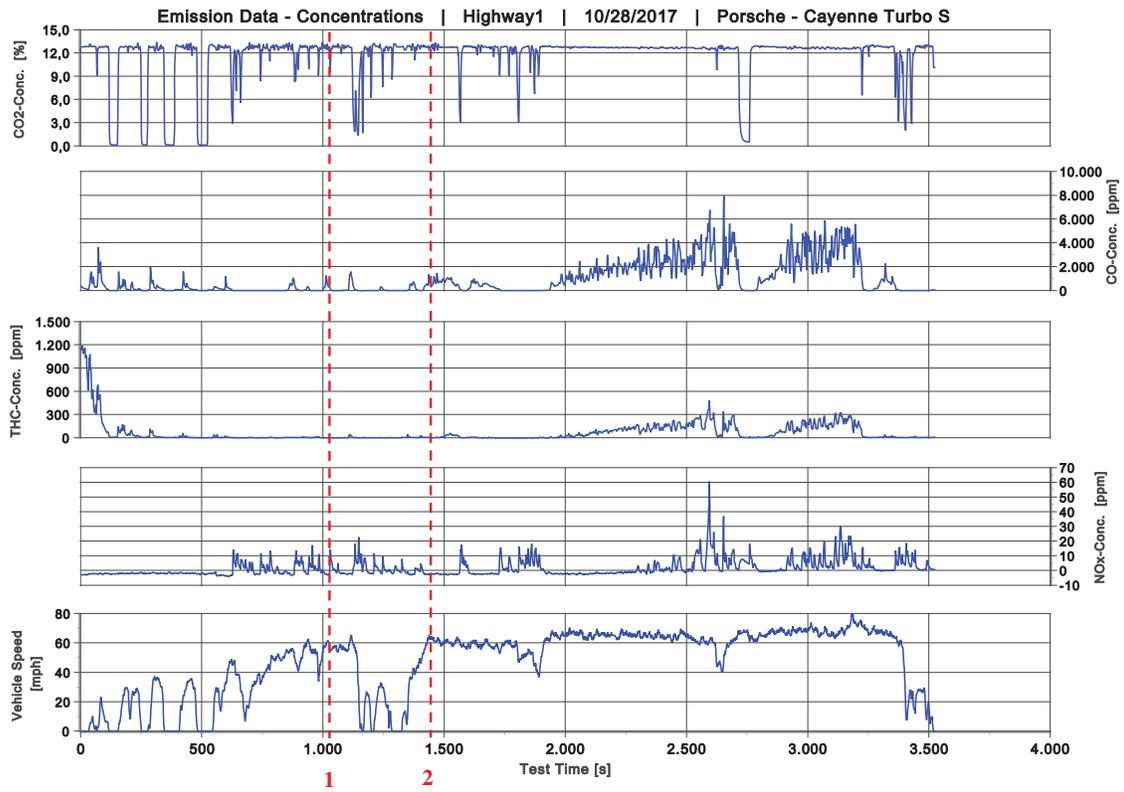
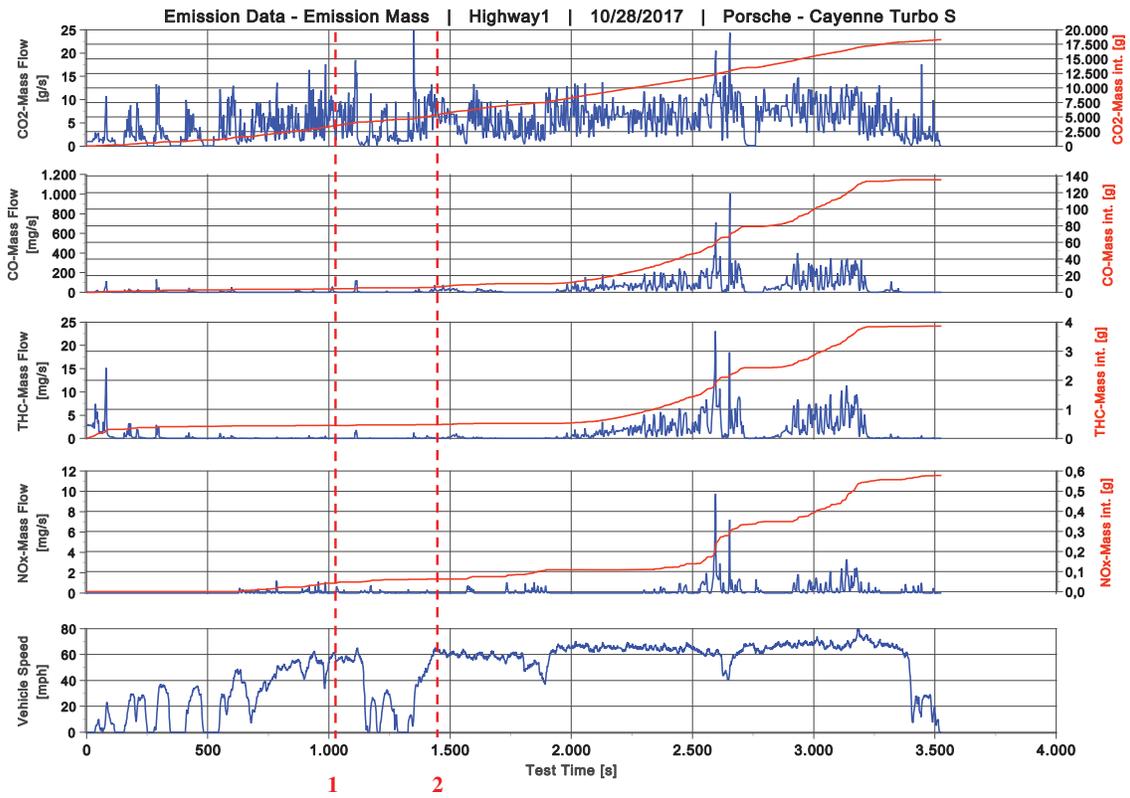
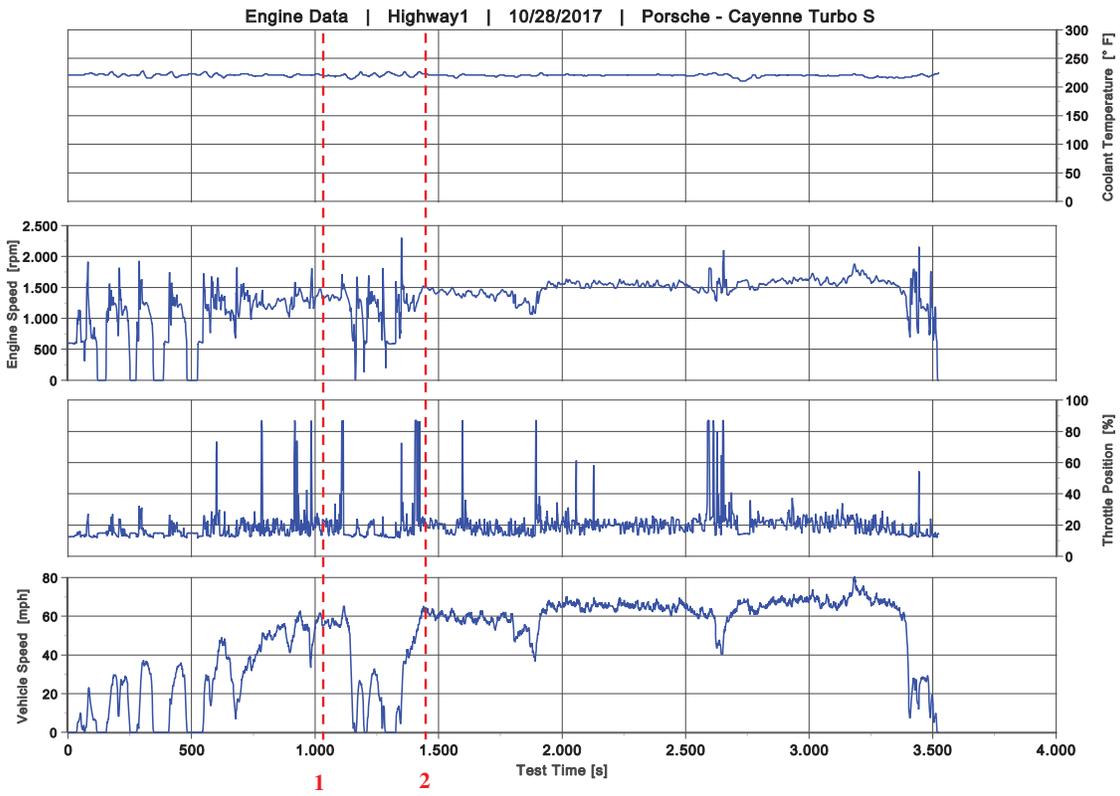


Figure 3-2: Zoom of Highway (1) Route Deviations for Cayenne Turbo S





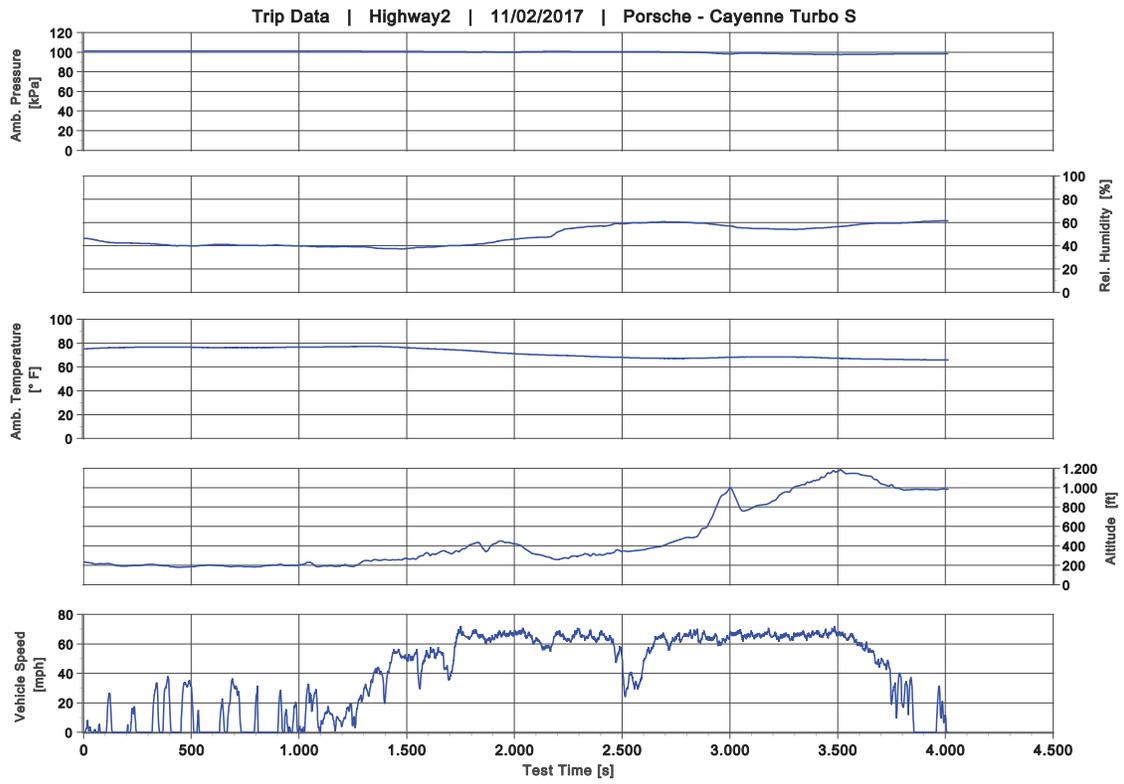


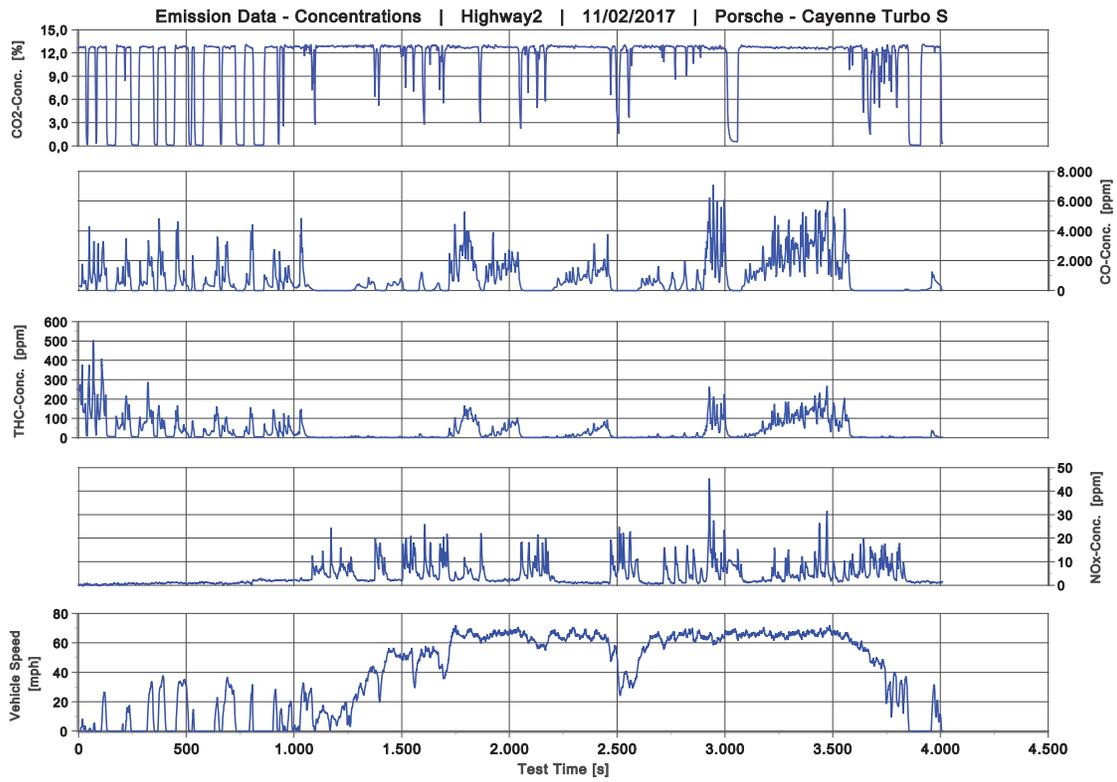


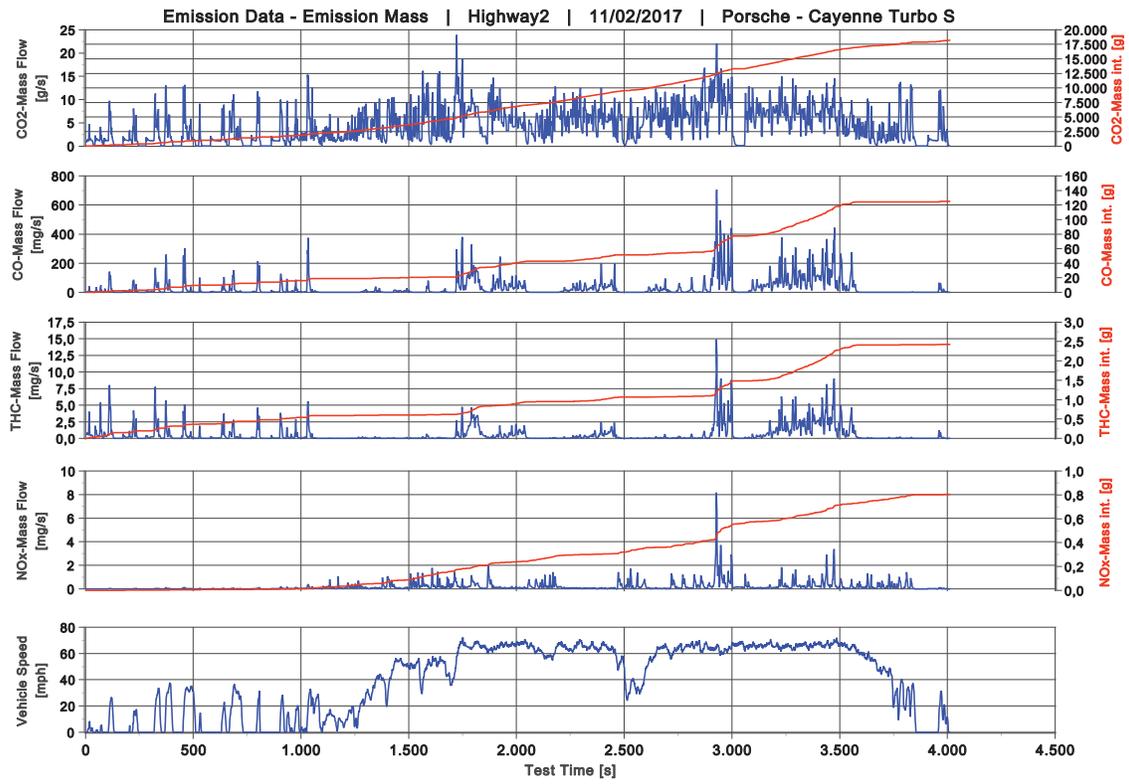
### 3.2.3 Highway (2)

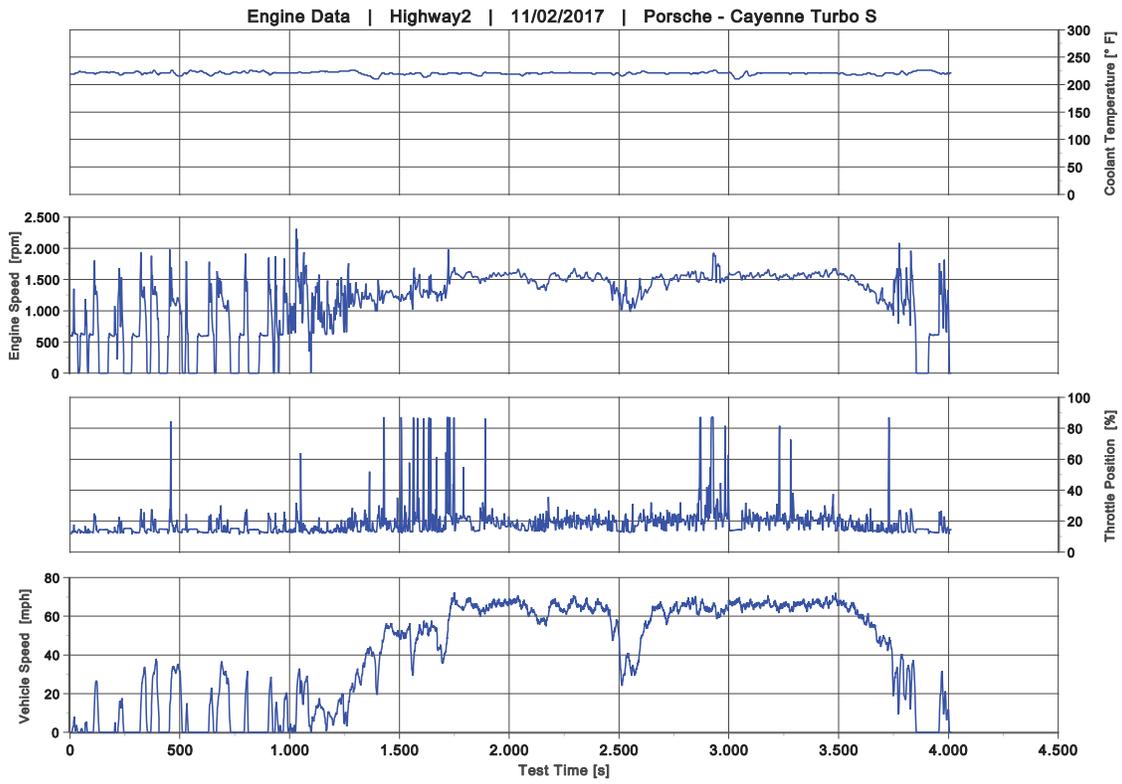
Table 3-5: Highway (2) Trip Summary for Cayenne Turbo S

Test Data			
Test Name:	2017-11-02 Cayenne-Turbo-S Highway2		
Department:	MBtech	Test Date:	11/02/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 1800
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	411,31	
CO	[g/mi]	2,806	
NO <sub>x</sub>	[g/mi]	0,018	
THC	[g/mi]	0,055	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4015	
Distance	[mi]	44,16	
Average Speed	[mph]	39,6	
Average Ambient Temperature	[°F]	71,8	







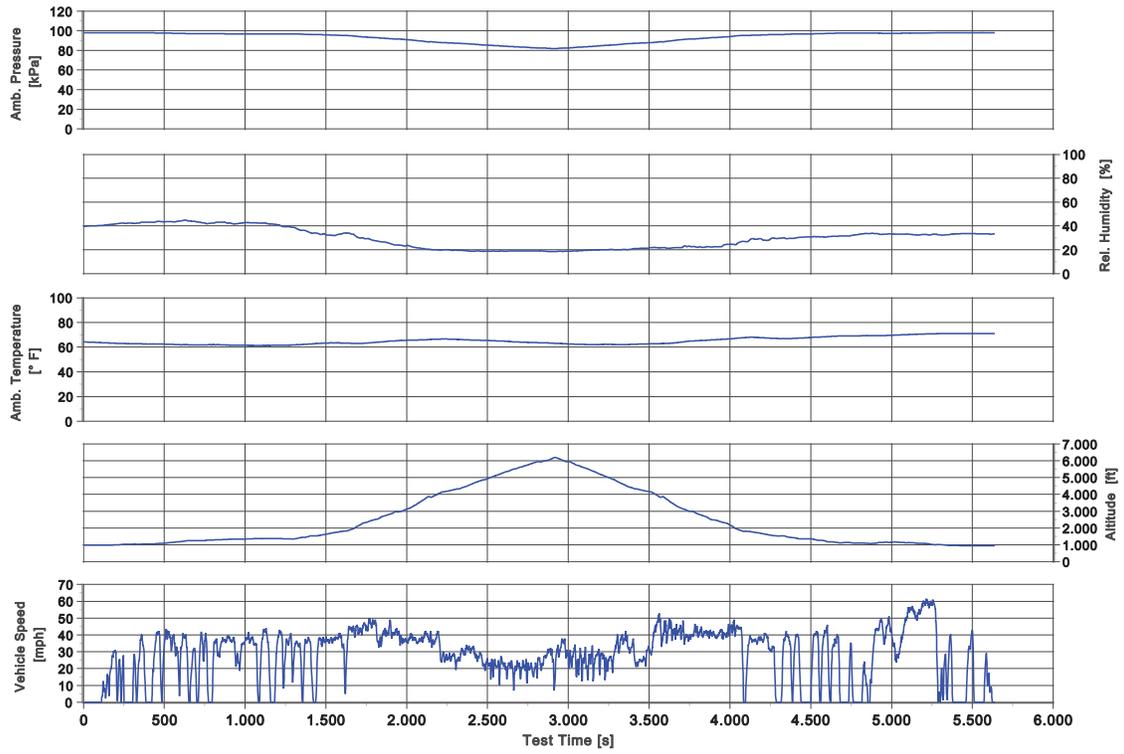


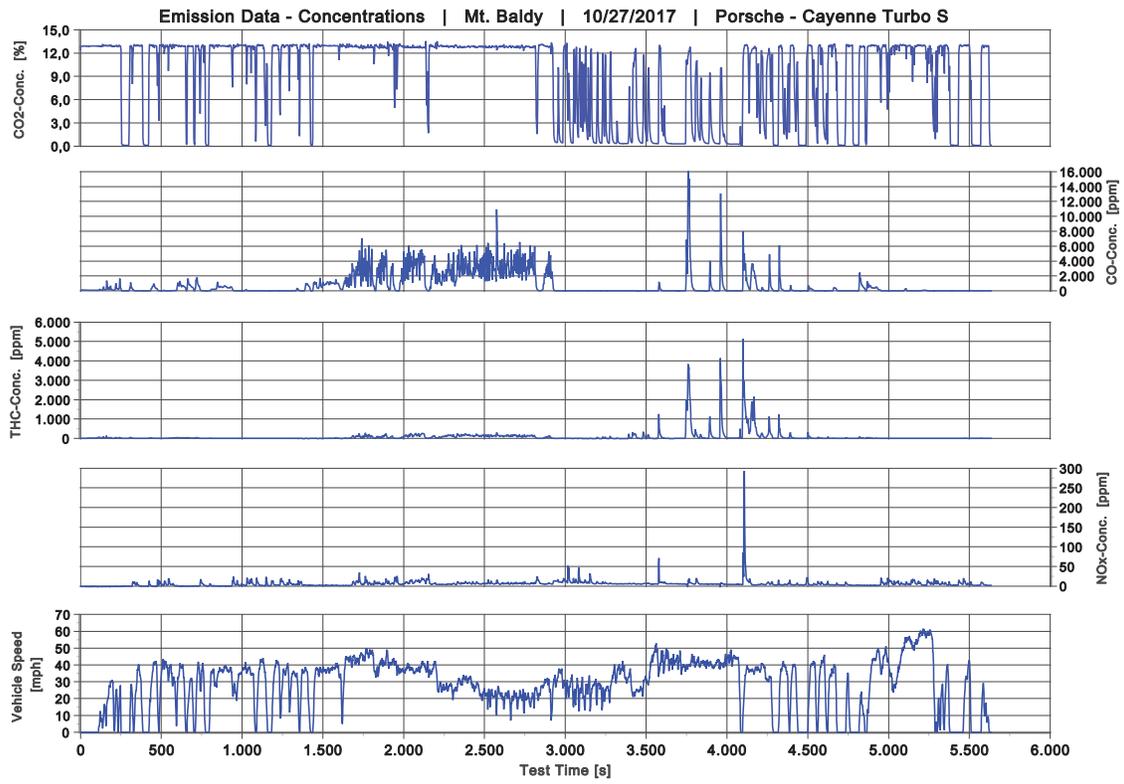
### 3.2.4 Mt. Baldy

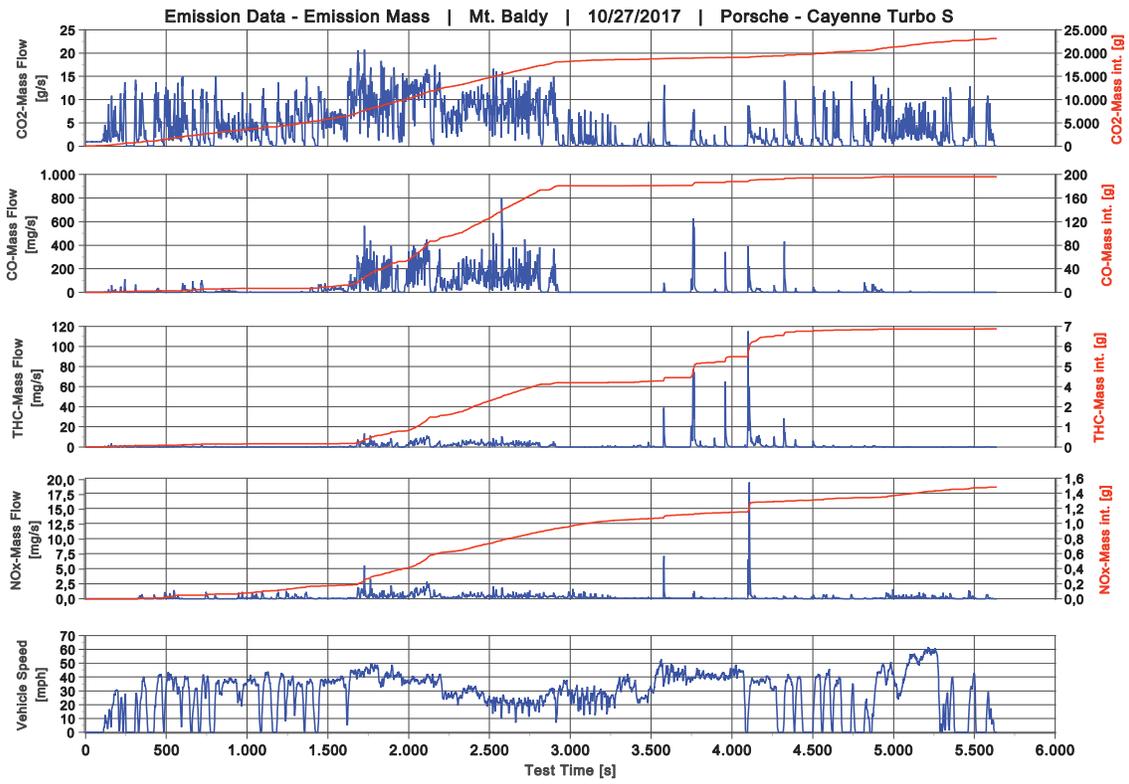
Table 3-6: Mt. Baldy Trip Summary for Porsche - Cayenne Turbo S

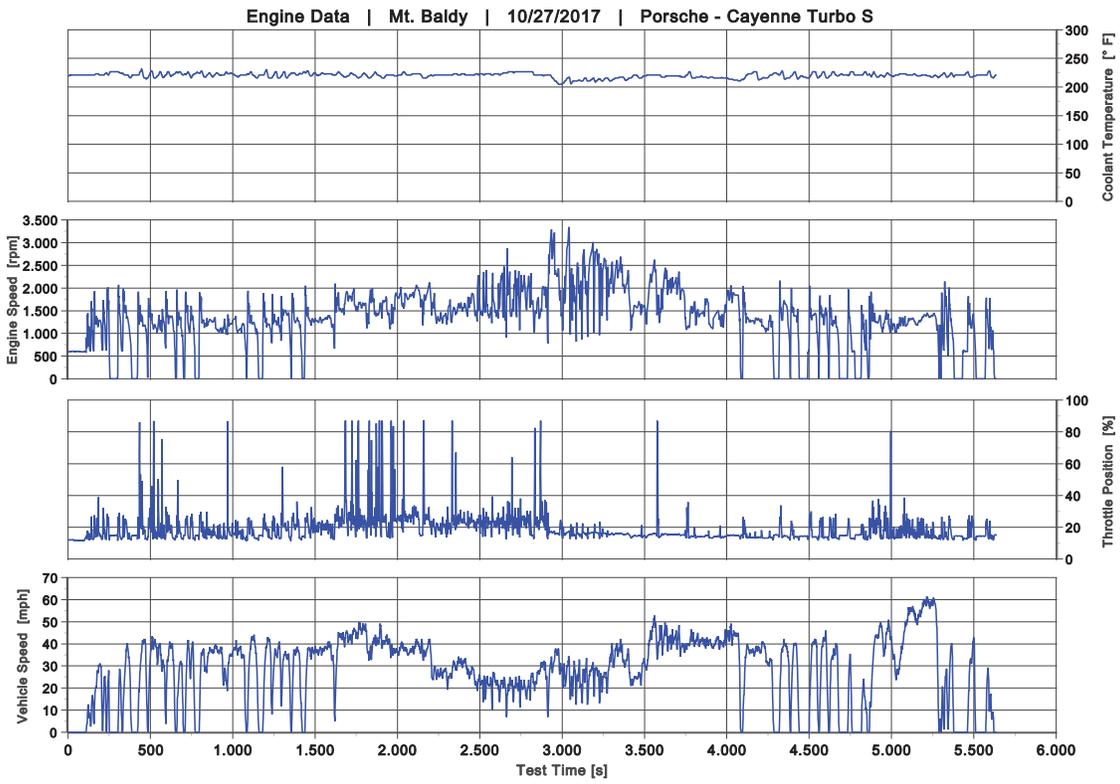
Test Data			
Test Name:	2017-10-27 Cayenne-Turbo-S Mt.-Baldy		
Department:	MBtech	Test Date:	10/27/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 1800
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	526,07	
CO	[g/mi]	4,419	
NO <sub>x</sub>	[g/mi]	0,034	
THC	[g/mi]	0,115	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	5639	
Distance	[mi]	43,88	
Average Speed	[mph]	28,0	
Average Ambient Temperature	[°F]	65,1	

Trip Data | Mt. Baldy | 10/27/2017 | Porsche - Cayenne Turbo S









### 3.3 Cayenne Turbo S (Retake)

The following table summarizes the emission measurement results from the repeated Cayenne Turbo S vehicle. The retake measurements were necessary because the FID module broke down on the first FTP75, therefore it needed to be replaced.

Table 3-7: Emission Overview Porsche - Cayenne Turbo S (Retake)

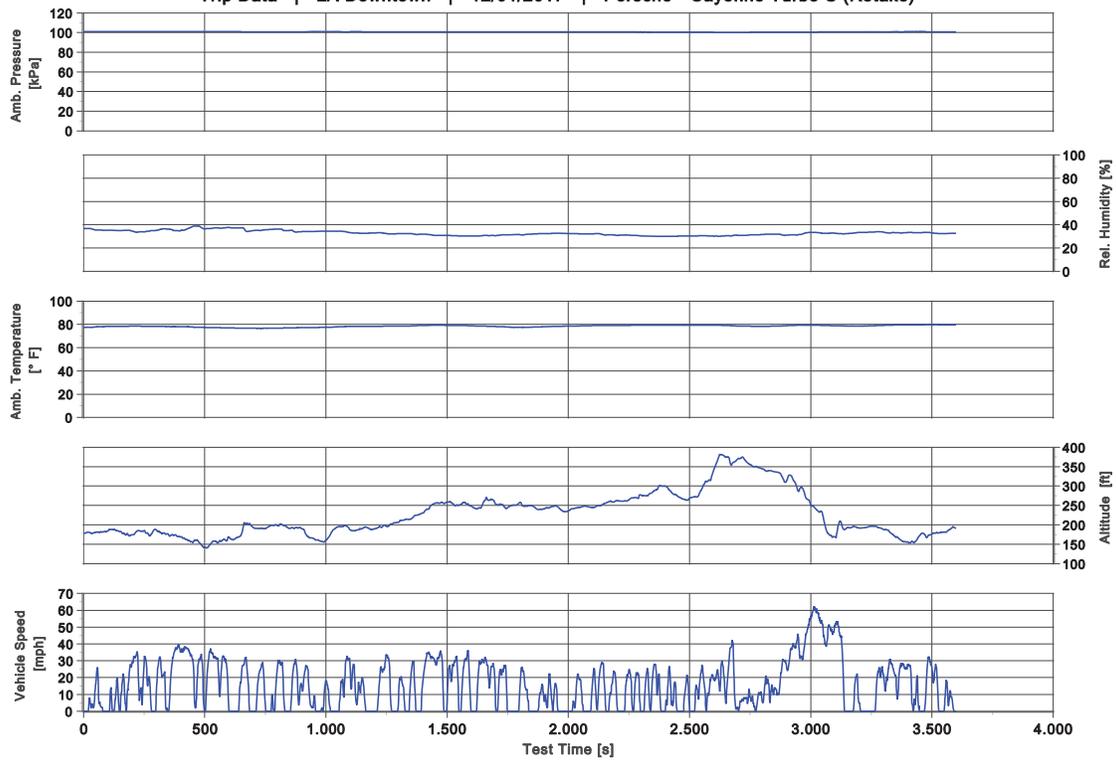
Cayenne Turbo S (2)		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
12/01/17	LA Downtown	654,58	0,852	0,006	0,006	3600	15,46
12/01/17	Highway	521,81	1,155	0,016	0,036	6257	43,97
11/30/17	Mt. Baldy	556,50	4,515	0,020	0,137	5403	43,72
12/07/17	FTP75 (PEMS)	508,90	0,691	0,008	0,057	2495	10,74
12/07/17	FTP75 (Dyno)	525,44	0,809	0,020	0,056		

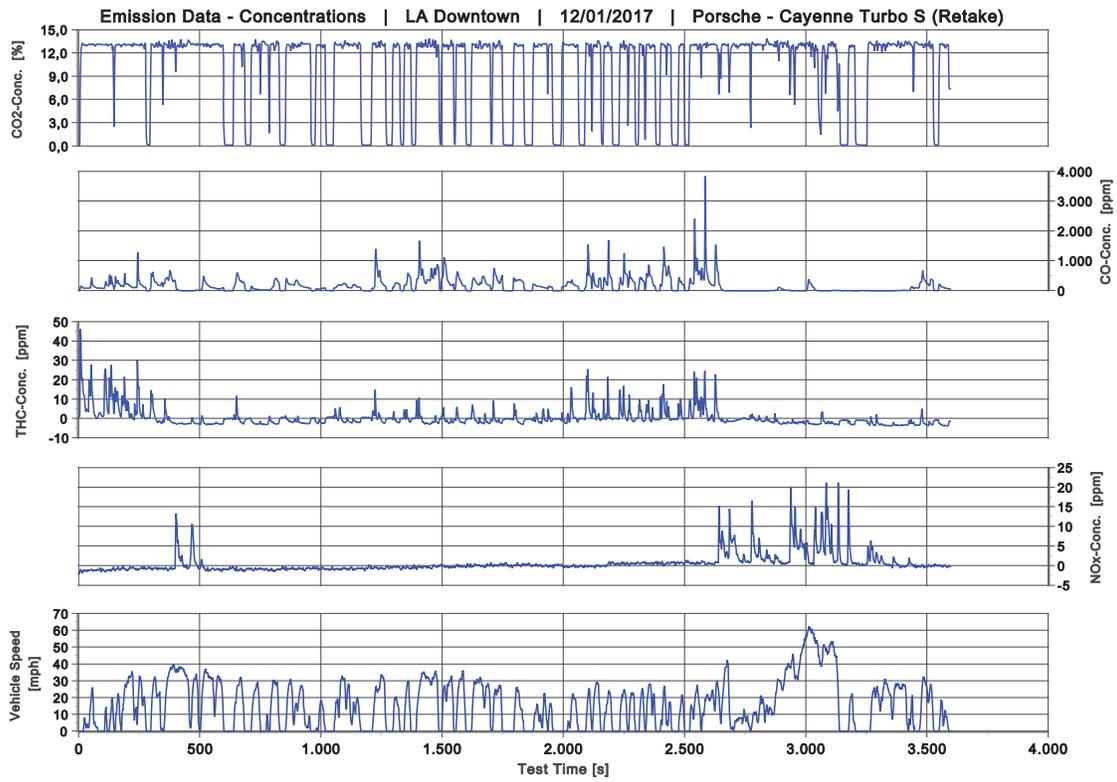
### 3.3.1 LA Downtown

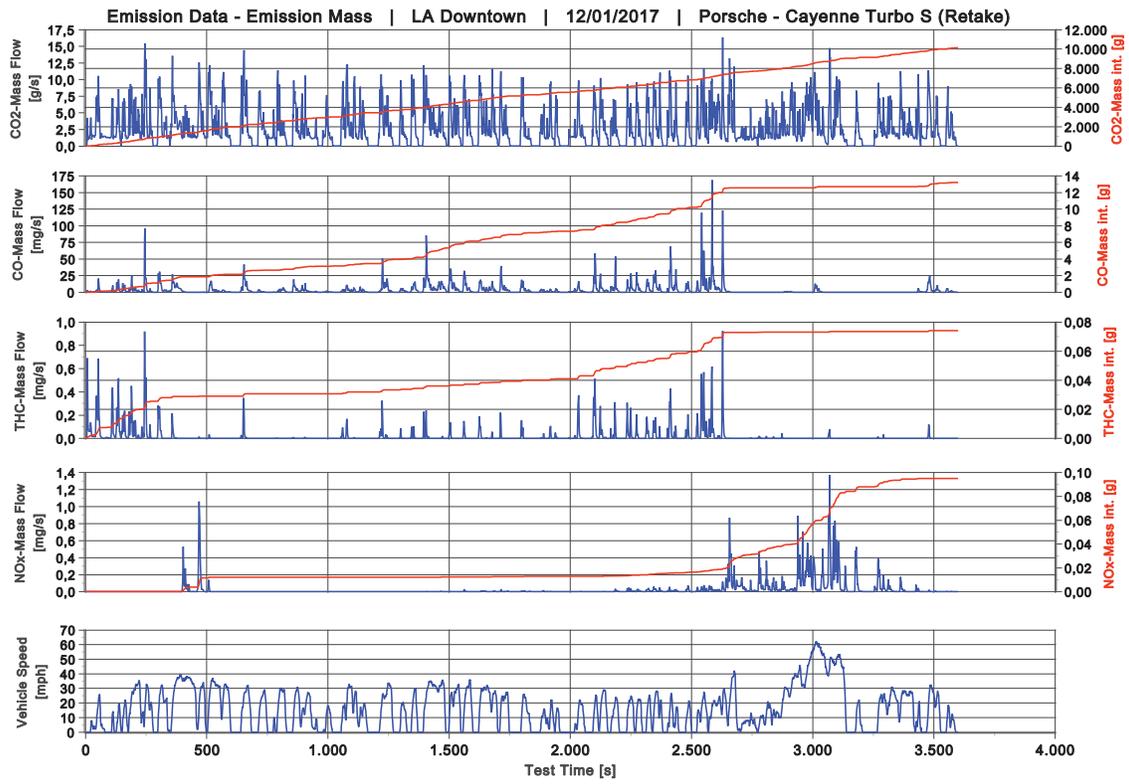
Table 3-8: LA Downtown Trip Summary for Cayenne Turbo S (Retake)

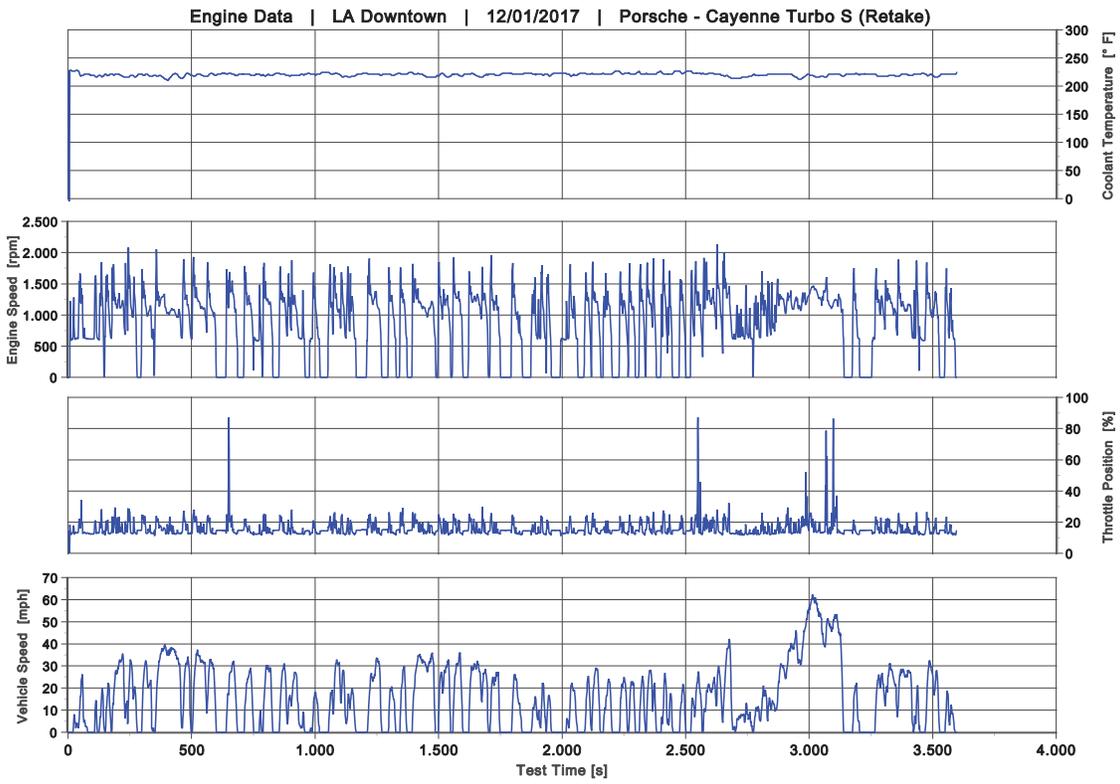
Test Data			
Test Name:	2017-12-01 Cayenne-Turbo-S-2 LA-Downtown		
Department:	MBtech	Test Date:	12/01/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 2200
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	654,58	
CO	[g/mi]	0,852	
NO <sub>x</sub>	[g/mi]	0,006	
THC	[g/mi]	0,006	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3600	
Distance	[mi]	15,46	
Average Speed	[mph]	15,5	
Average Ambient Temperature	[°F]	78,4	

Trip Data | LA Downtown | 12/01/2017 | Porsche - Cayenne Turbo S (Retake)







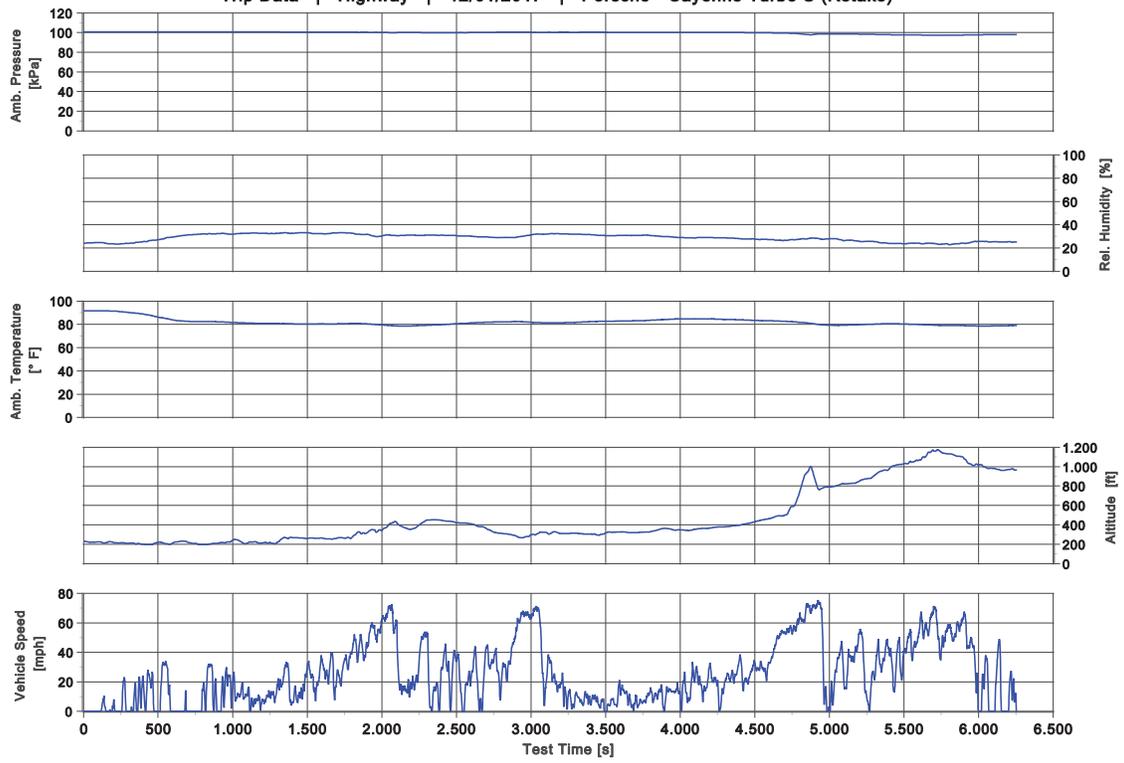


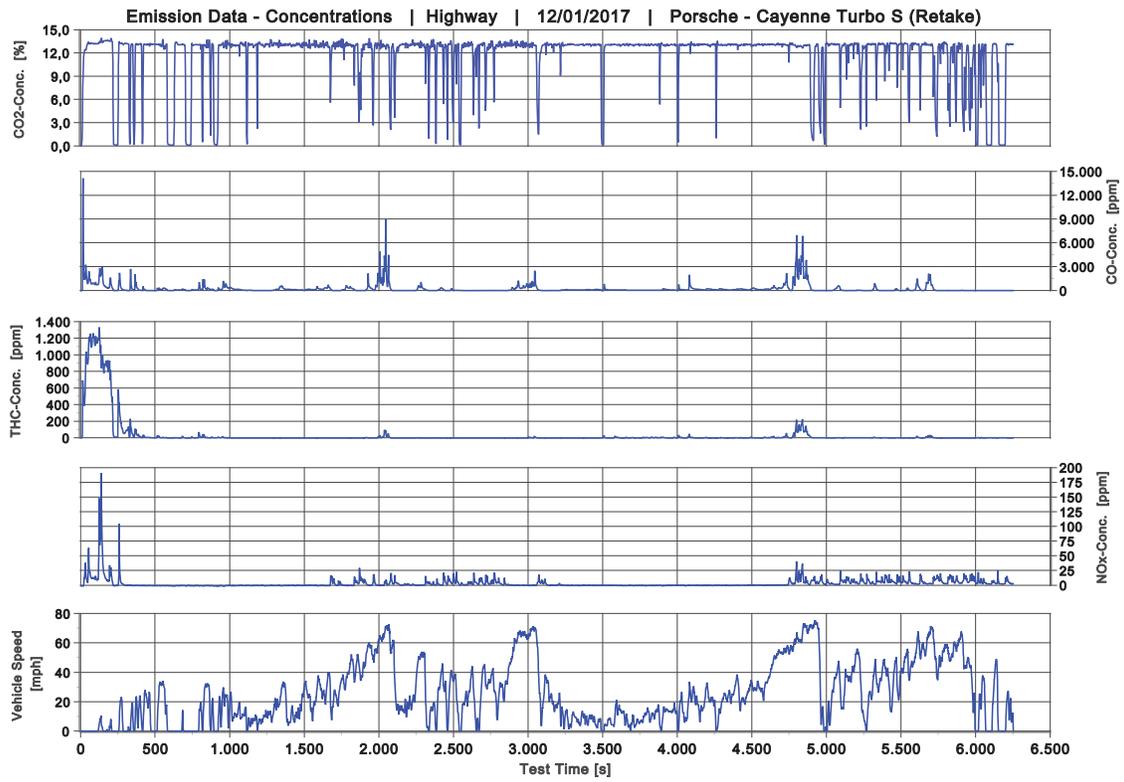
### 3.3.2 Highway

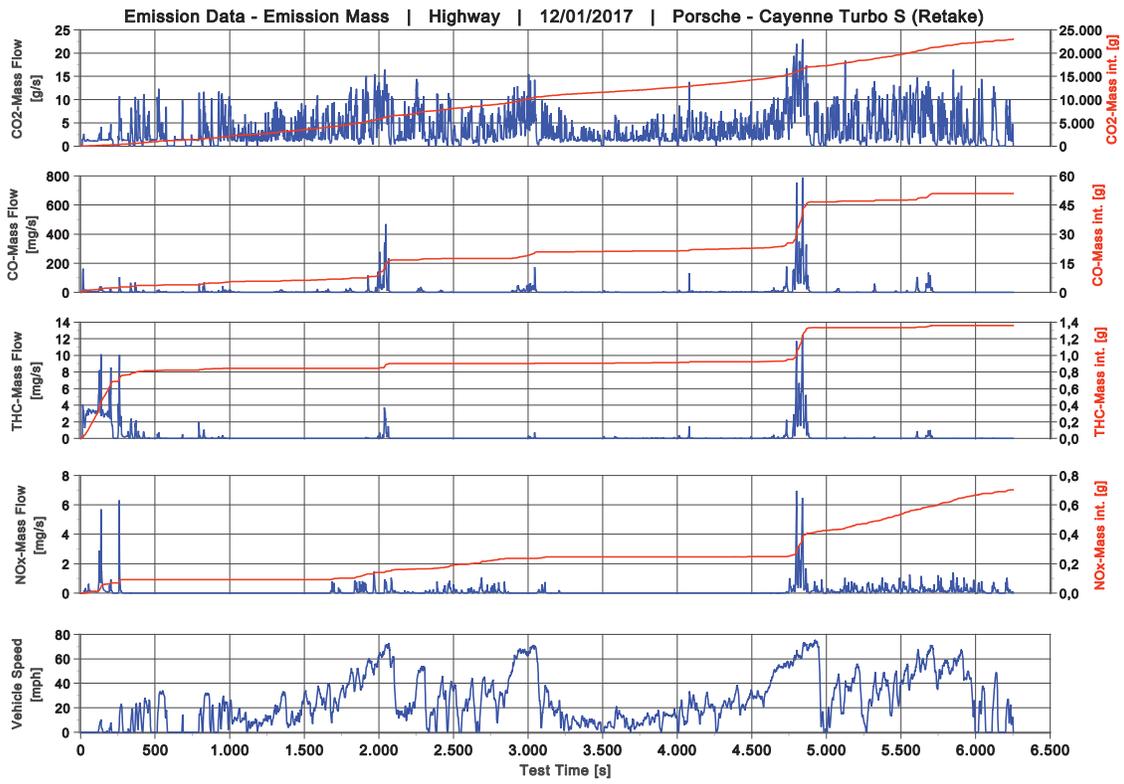
Table 3-9: Highway Trip Summary for Cayenne Turbo S (Retake)

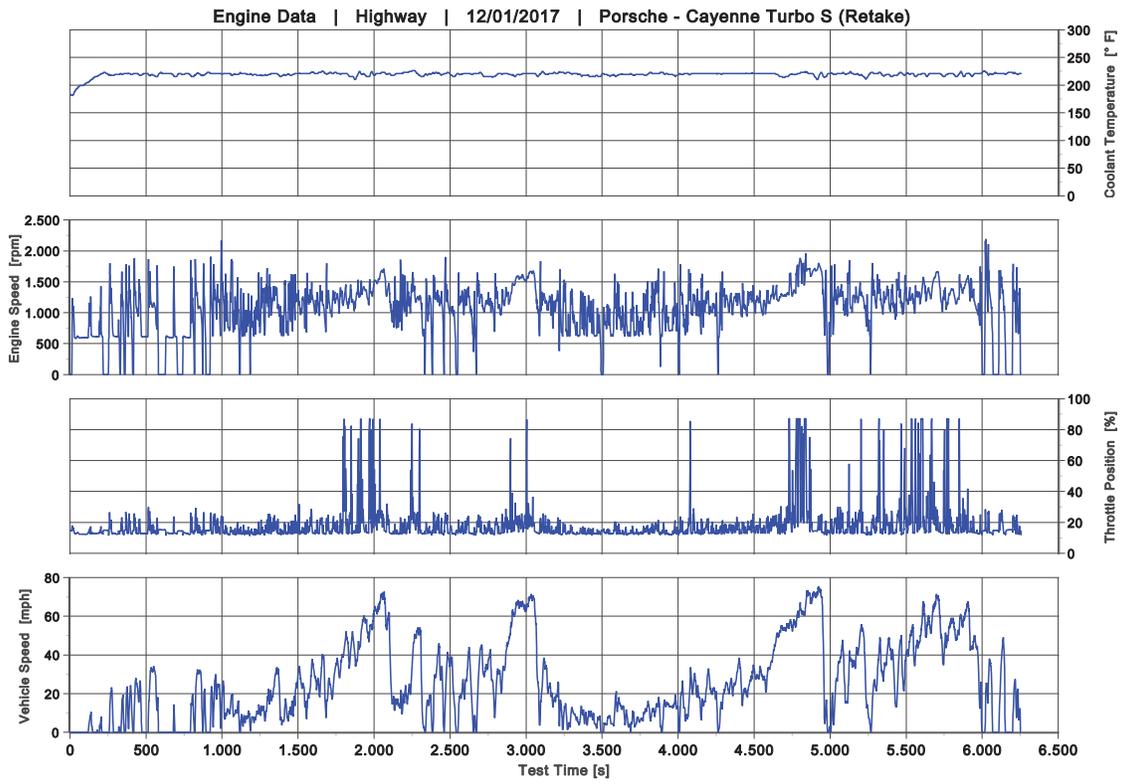
Test Data			
Test Name:	2017-12-01 Cayenne-Turbo-S-2 Highway		
Department:	MBtech	Test Date:	12/01/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 2200
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	521,81	
CO	[g/mi]	1,155	
NO <sub>x</sub>	[g/mi]	0,016	
THC	[g/mi]	0,036	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	6257	
Distance	[mi]	43,97	
Average Speed	[mph]	25,3	
Average Ambient Temperature	[°F]	82,0	

Trip Data | Highway | 12/01/2017 | Porsche - Cayenne Turbo S (Retake)







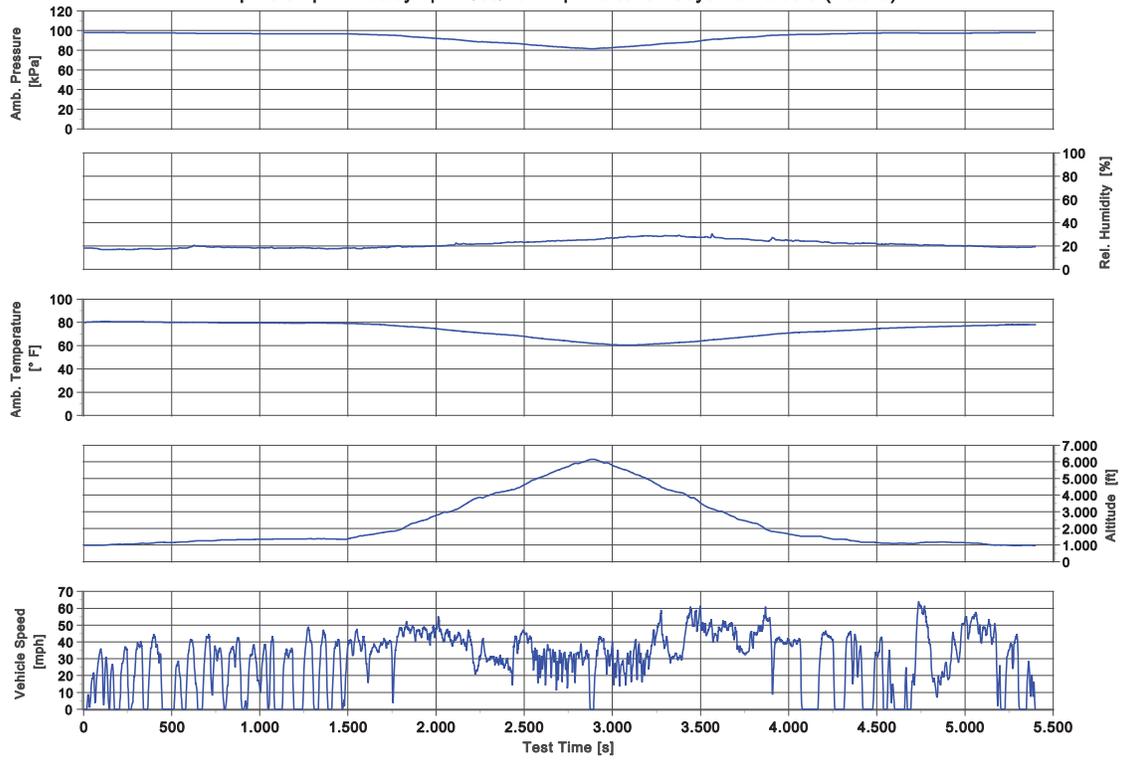


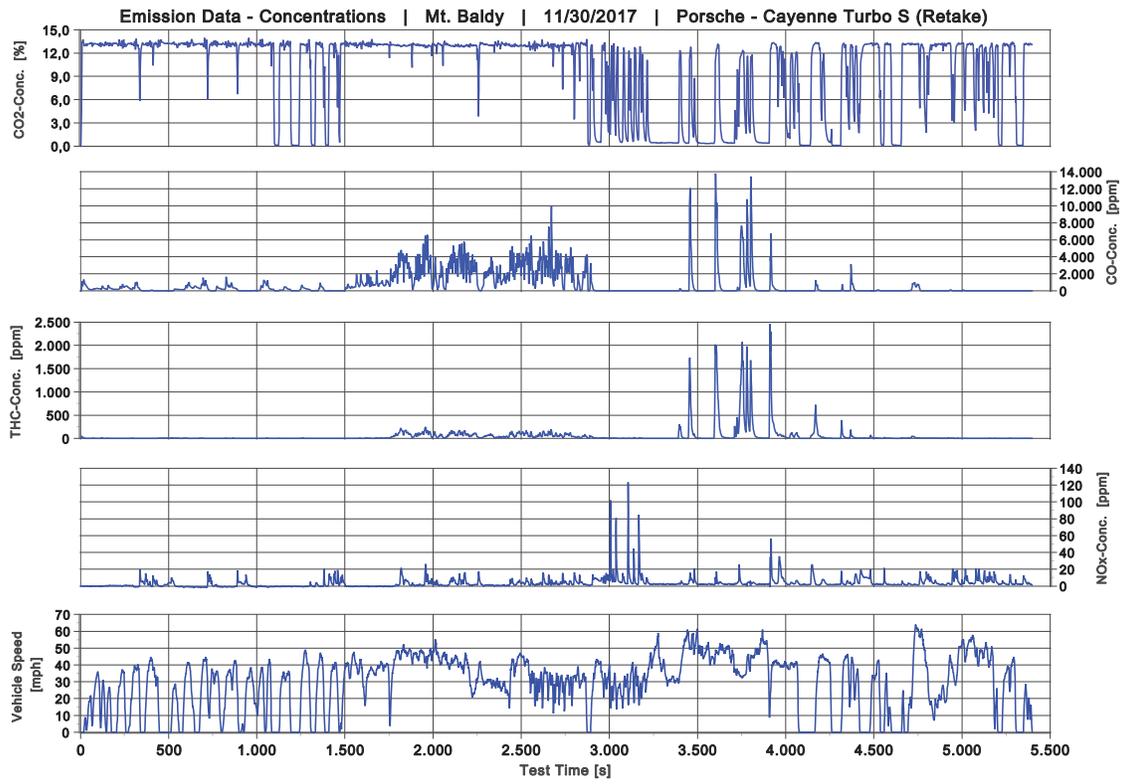
### 3.3.3 Mt. Baldy

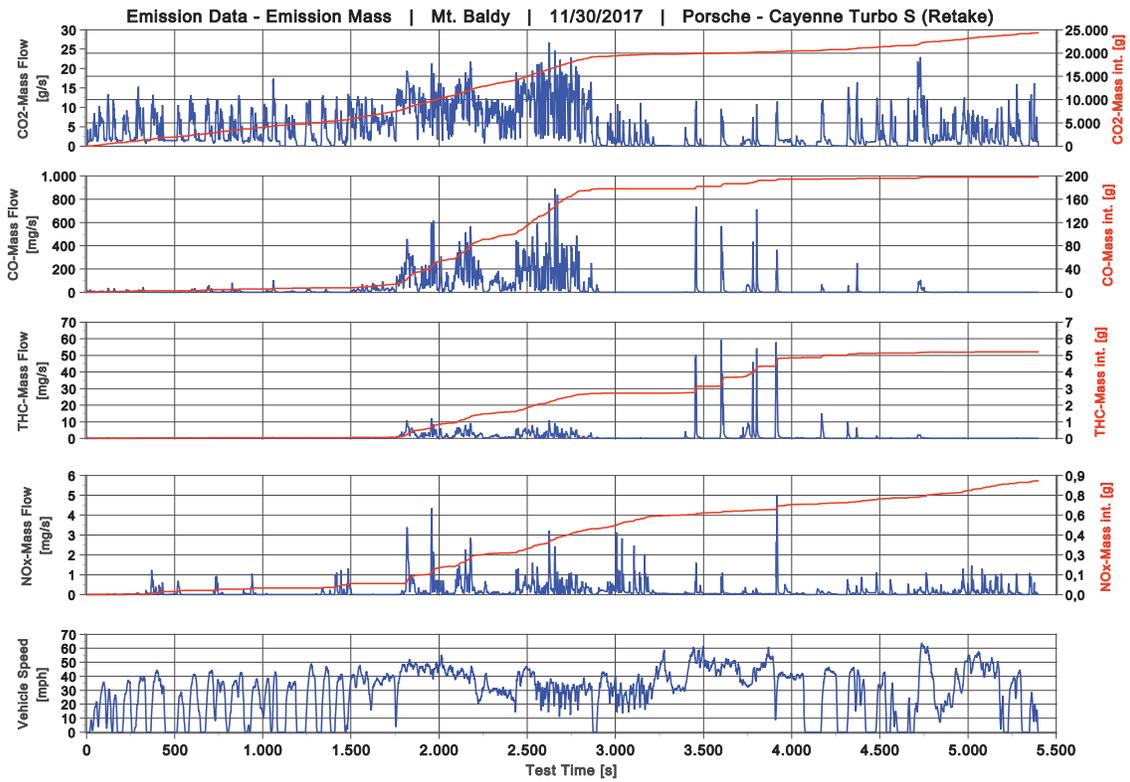
Table 3-10: Mt. Baldy Trip Summary for Cayenne Turbo S (Retake)

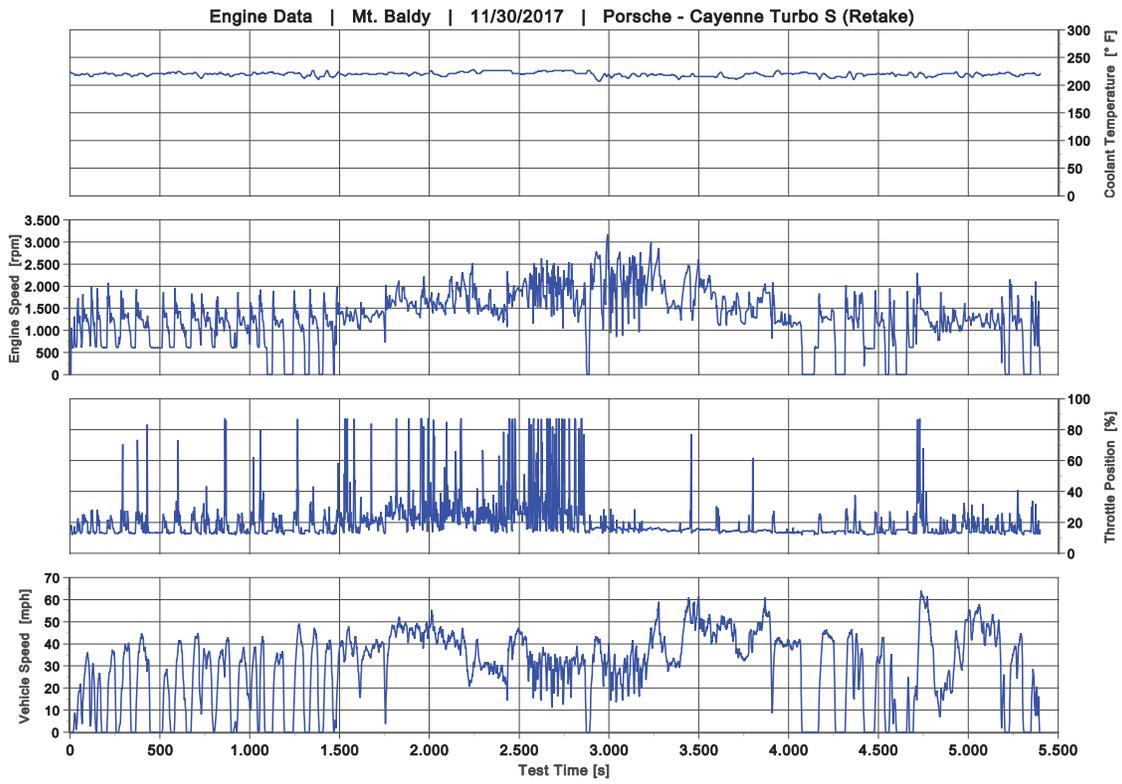
Test Data			
Test Name:	2017-11-30 Cayenne-Turbo-S-2 Mt.Baldy		
Department:	MBtech	Test Date:	11/30/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	419
Vehicle Modell:	Cayenne Turbo S	Nominal Torque [Nm]:	800
VIN:	██████████	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. 2200
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	556,50	
CO	[g/mi]	4,515	
NO <sub>x</sub>	[g/mi]	0,020	
THC	[g/mi]	0,137	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	5403	
Distance	[mi]	43,72	
Average Speed	[mph]	29,1	
Average Ambient Temperature	[°F]	73,3	

Trip Data | Mt. Baldy | 11/30/2017 | Porsche - Cayenne Turbo S (Retake)









### 3.4 Macan

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

Table 3-11: Emission Overview Porsche - Macan

Macan		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/08/17	LA Downtown 1*	404,48	0,305	0,008	0,003	3130	17,56
11/09/17	LA Downtown 2	463,74	0,105	0,024	0,001	3698	15,92
11/08/17	Highway	338,27	0,157	0,006	0,006	3098	45,14
11/08/17	Mt. Baldy	417,89	0,162	0,031	0,009	6414	44,82
11/10/17	FTP75 (PEMS)	375,32	0,199	0,012	0,018	2506	11,08
11/10/17	FTP75 (Dyno)	357,49	0,221	0,010	0,018		

\*: Deviation of driving route from original route

### 3.4.1 LA Downtown (1)

Table 3-12: LA Downtown (1) Trip Summary for Macan

Test Data			
Test Name:	2017-11-08 Macan LA-Downtown1		
Department:	MBtech	Test Date:	11/08/2017
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:	██████████	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. 5700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	404,48	
CO	[g/mi]	0,305	
NO <sub>x</sub>	[g/mi]	0,008	
THC	[g/mi]	0,003	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3130	
Distance	[mi]	17,56	
Average Speed	[mph]	20,2	
Average Ambient Temperature	[°F]	64,1	

**Deviation from original route:**

The deviation started at 2301s test time and ended at 2552s test time.

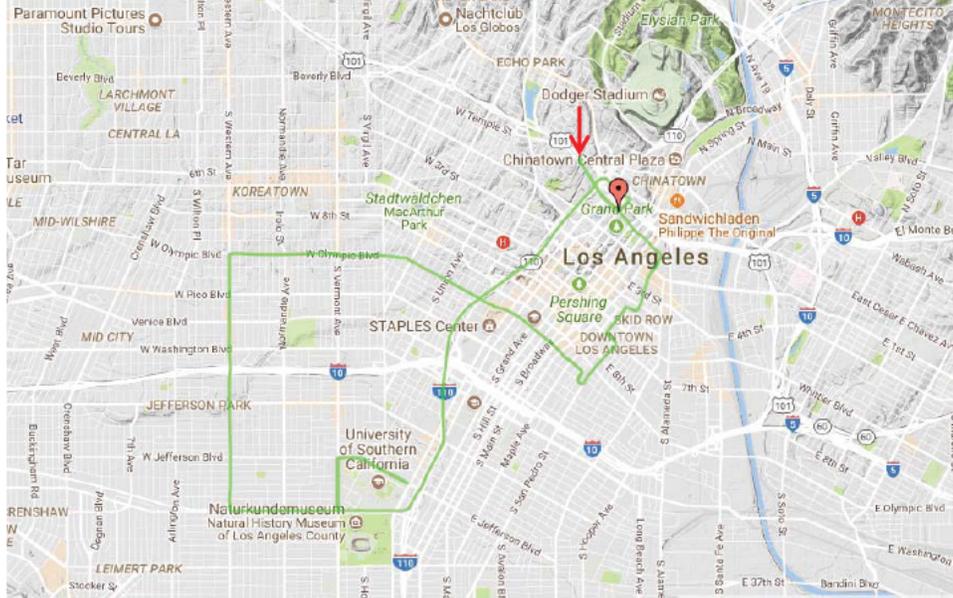


Figure 3-3: LA Downtown (1) Route Deviation for Macan

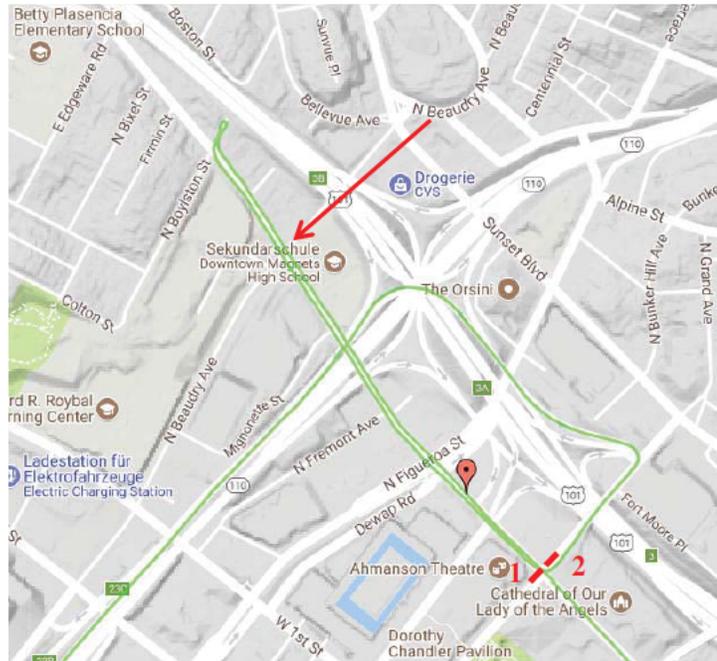
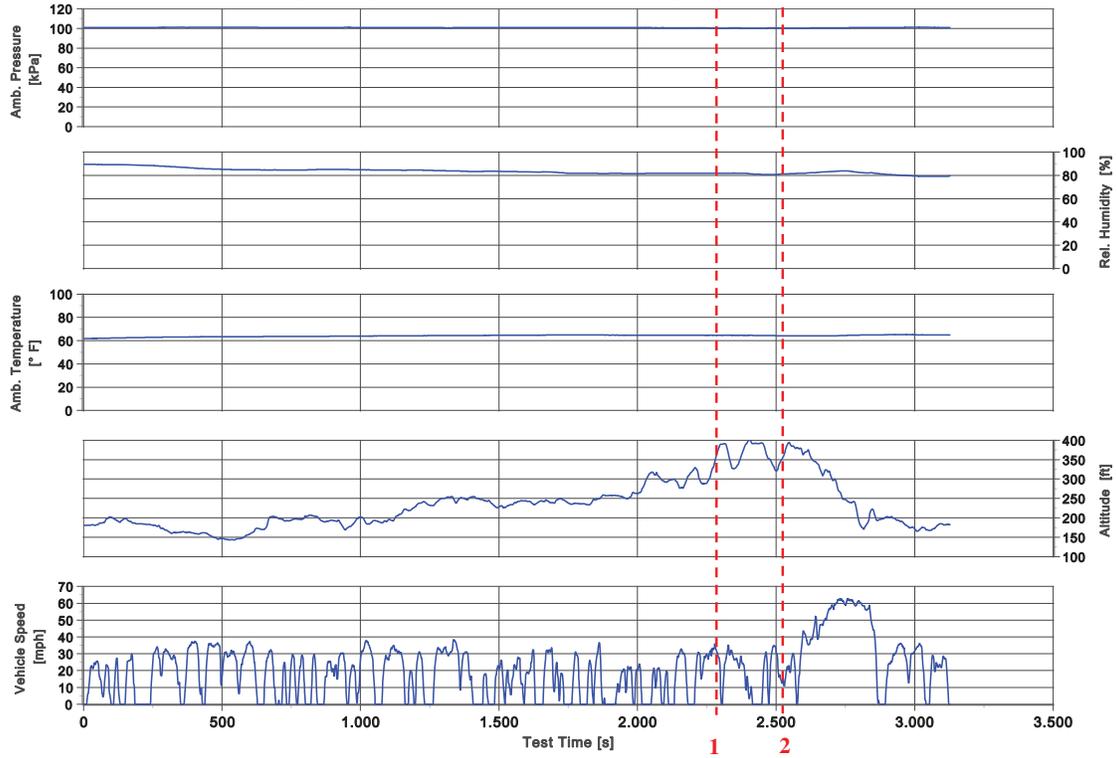
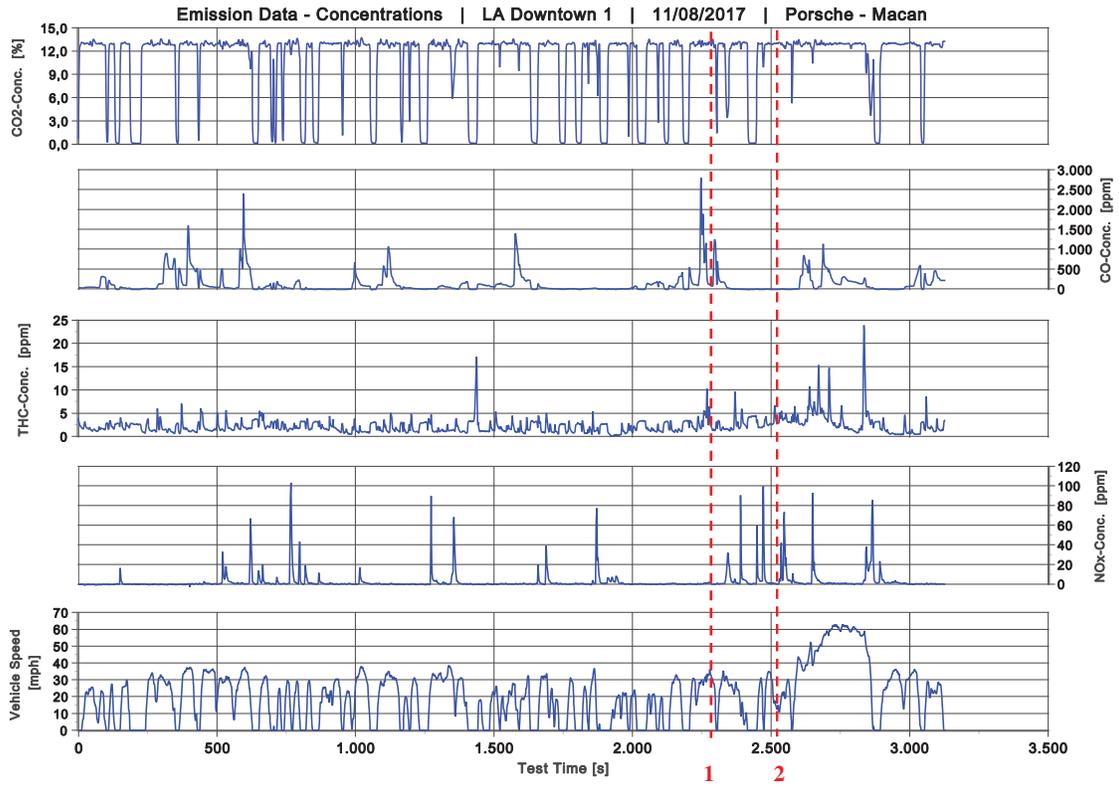
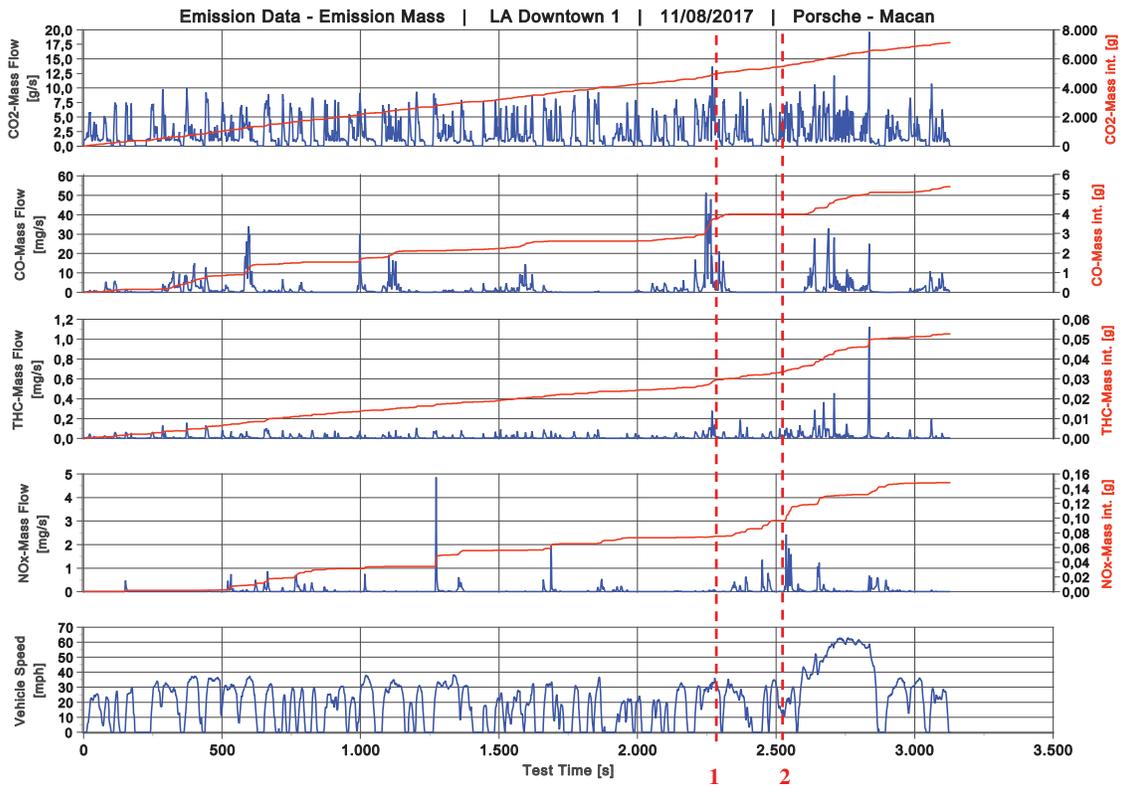


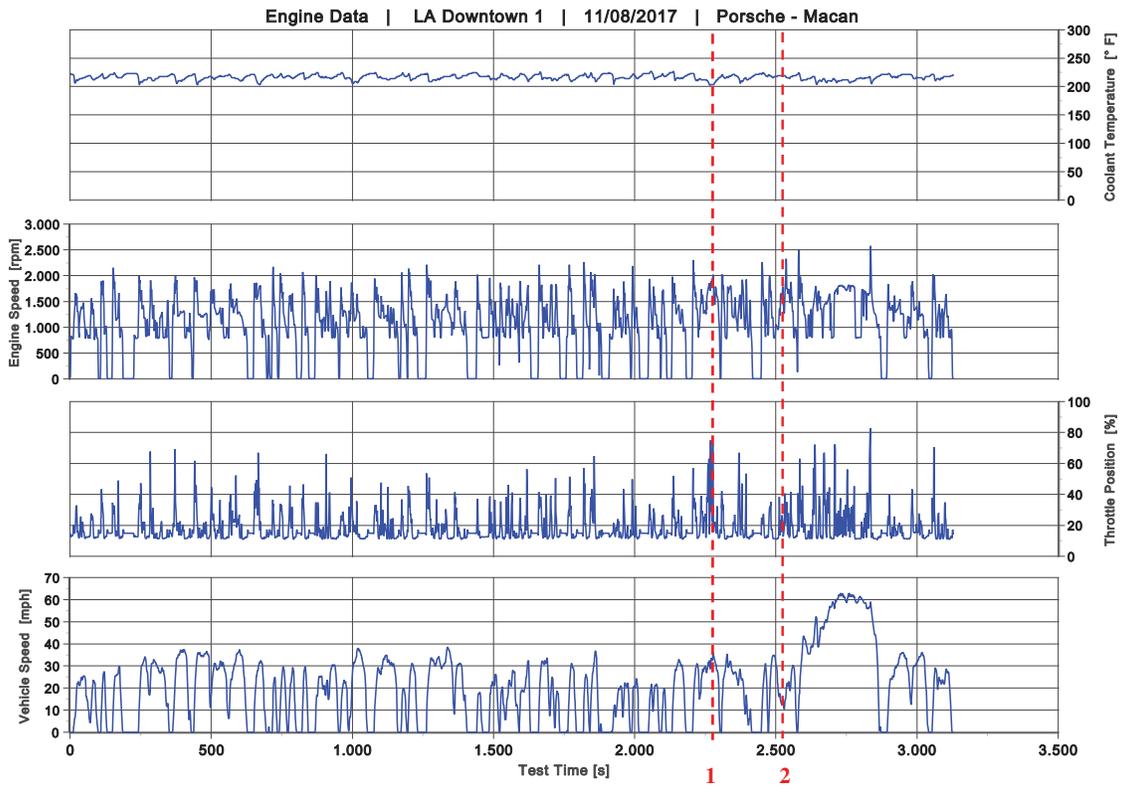
Figure 3-4: Zoom of LA Downtown (1) Route Deviation for Macan

Trip Data | LA Downtown 1 | 11/08/2017 | Porsche - Macan







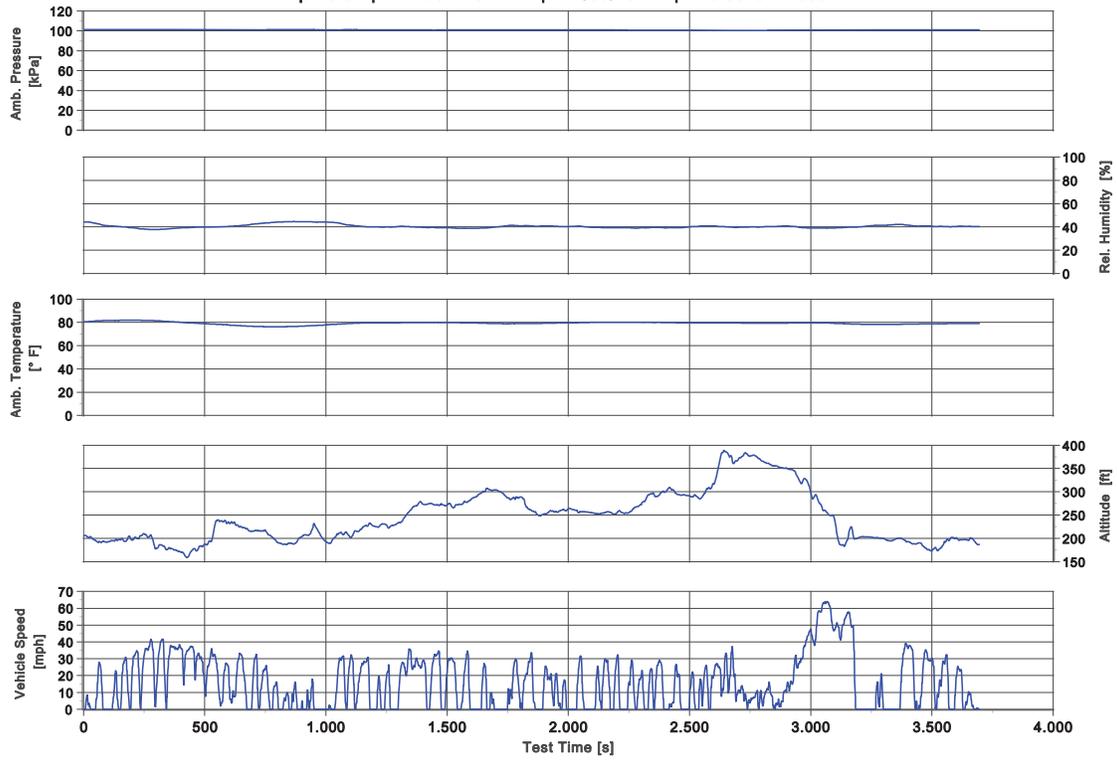


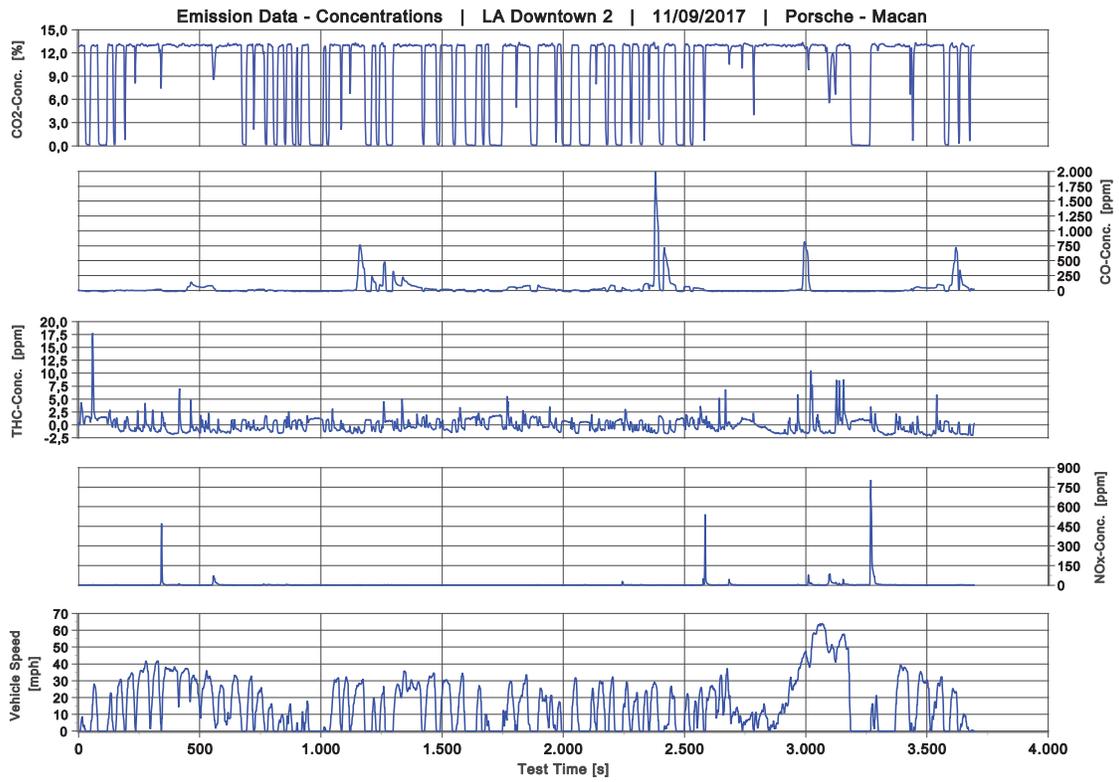
3.4.2 LA Downtown (2)

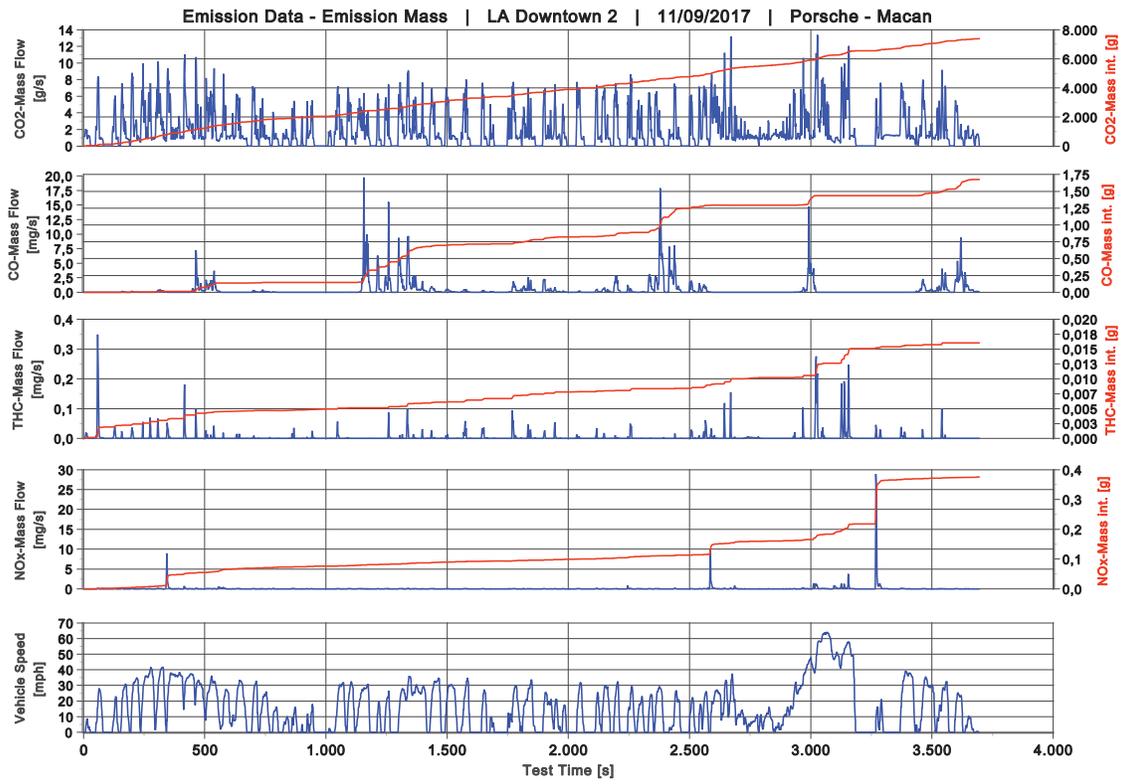
Table 3-13: LA Downtown (2) Trip Summary for Macan

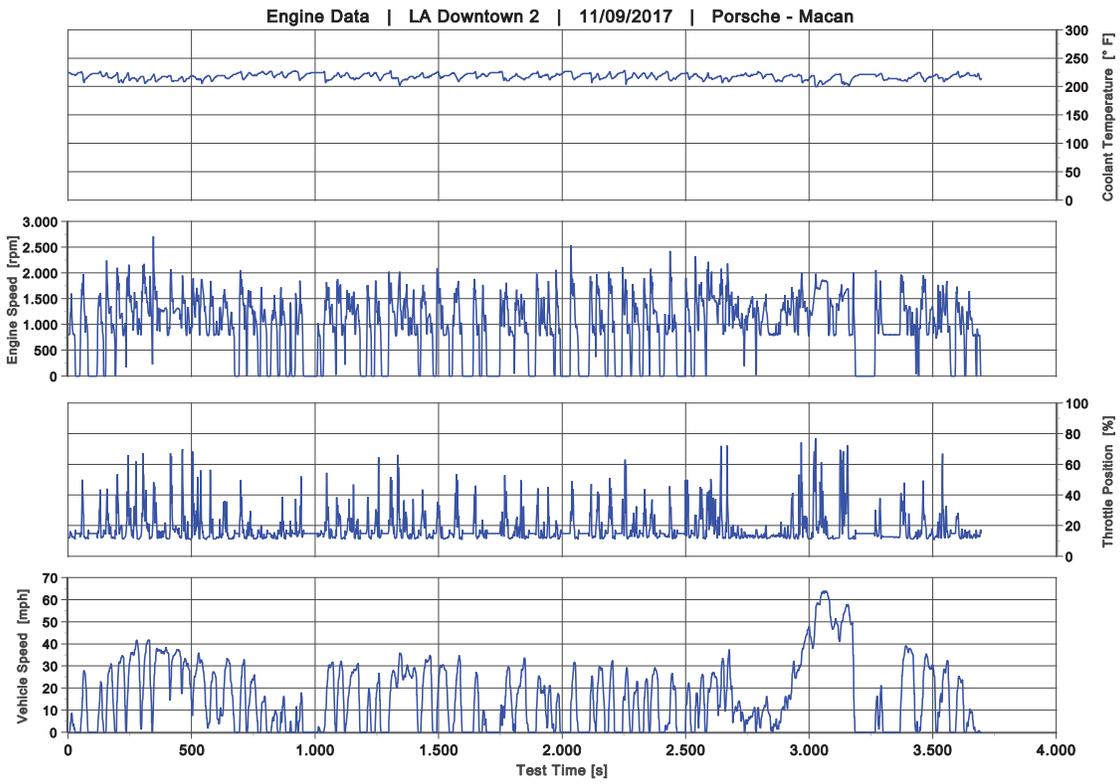
Test Data			
Test Name:	2017-11-09 Macan LA-Downtown2		
Department:	MBtech	Test Date:	11/09/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	██████████	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. 5700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	463,74	
CO	[g/mi]	0,105	
NO <sub>x</sub>	[g/mi]	0,024	
THC	[g/mi]	0,001	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3698	
Distance	[mi]	15,92	
Average Speed	[mph]	15,5	
Average Ambient Temperature	[°F]	79,2	

Trip Data | LA Downtown 2 | 11/09/2017 | Porsche - Macan







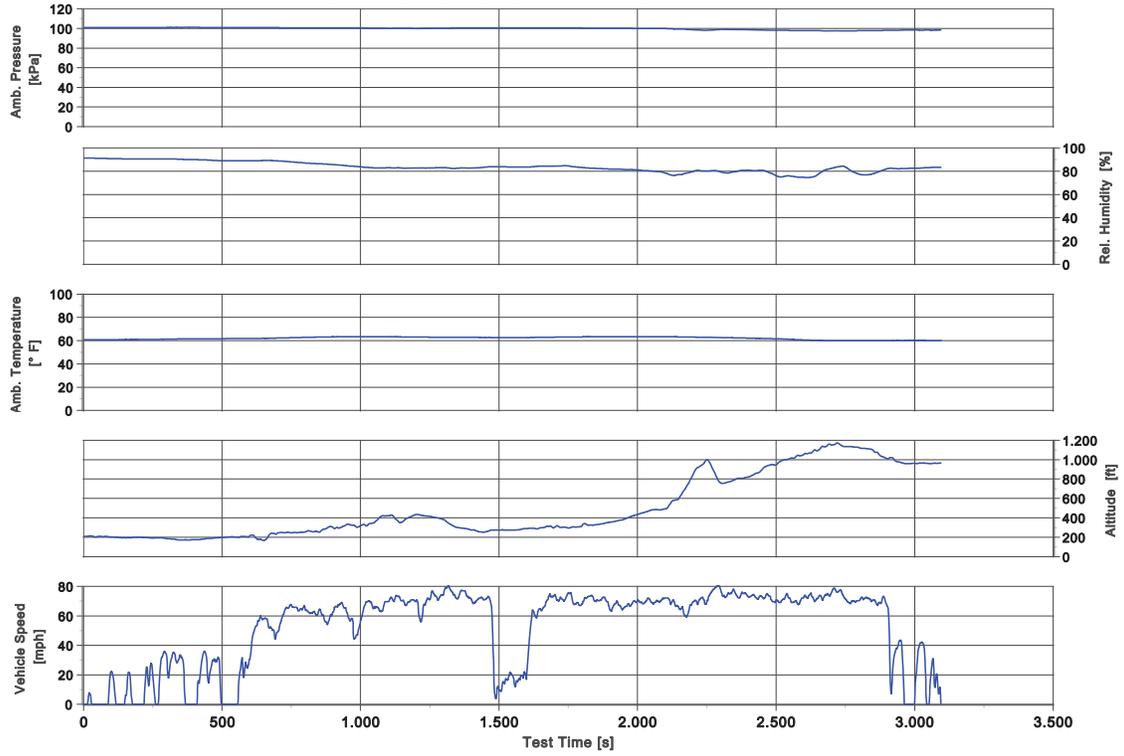


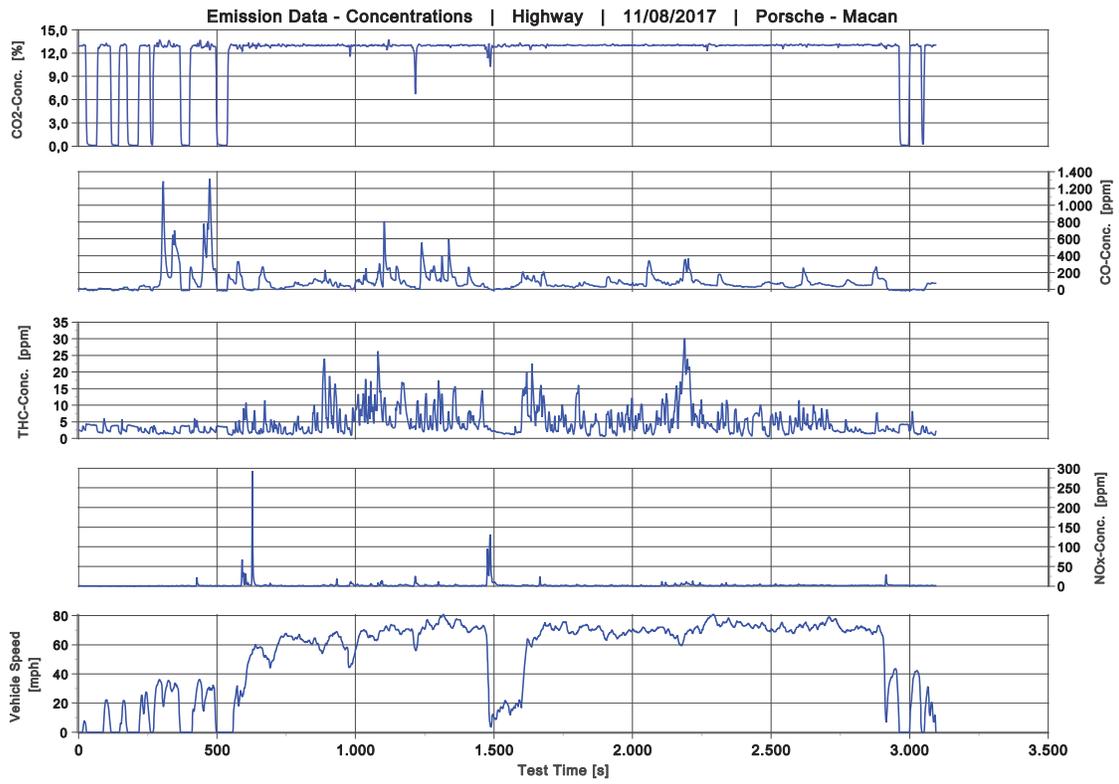
### 3.4.3 Highway

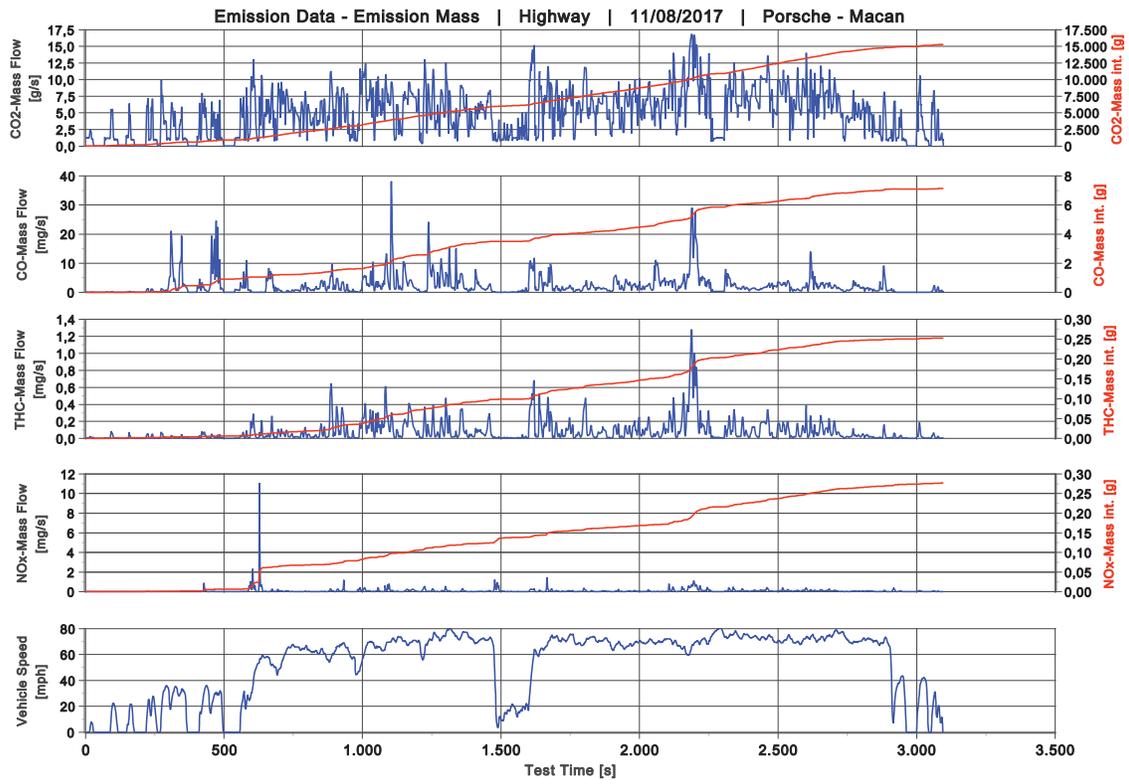
Table 3-14: Highway Trip Summary for Macan

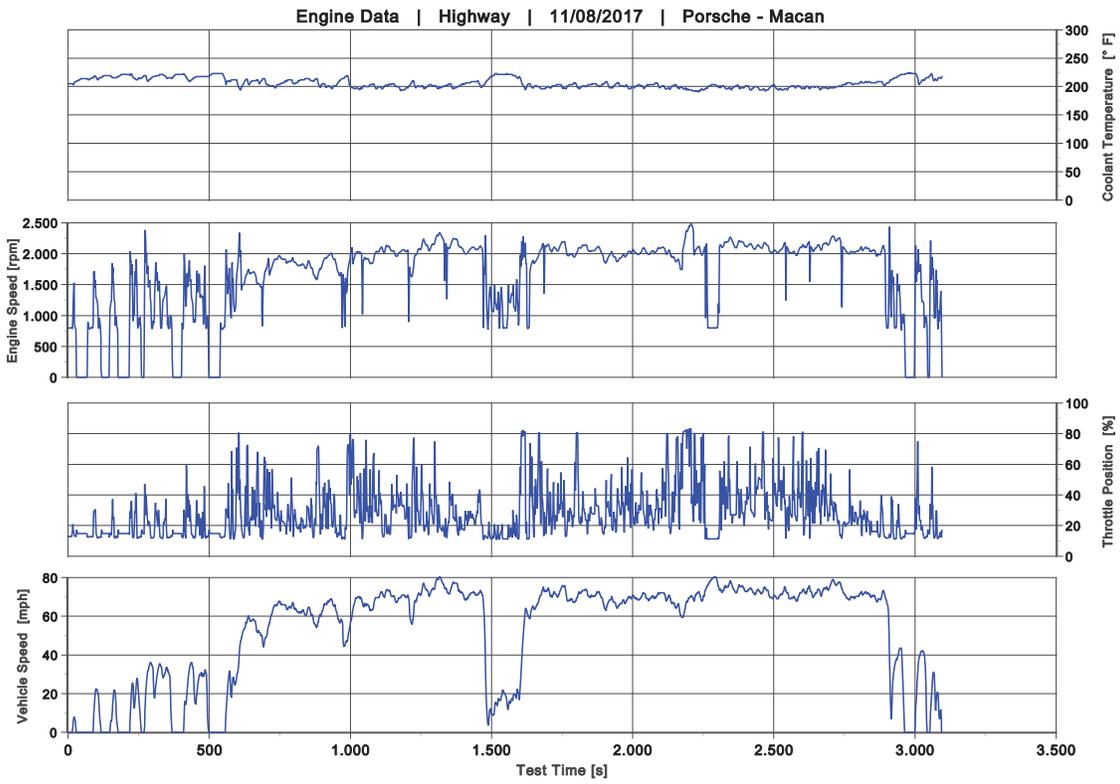
Test Data			
Test Name:	2017-11-08 Macan-Highway		
Department:	MBtech	Test Date:	11/08/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	██████████	Transmission:	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. 5700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	338,27	
CO	[g/mi]	0,157	
NO <sub>x</sub>	[g/mi]	0,006	
THC	[g/mi]	0,006	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3098	
Distance	[mi]	45,14	
Average Speed	[mph]	52,4	
Average Ambient Temperature	[°F]	62,1	

Trip Data | Highway | 11/08/2017 | Porsche - Macan







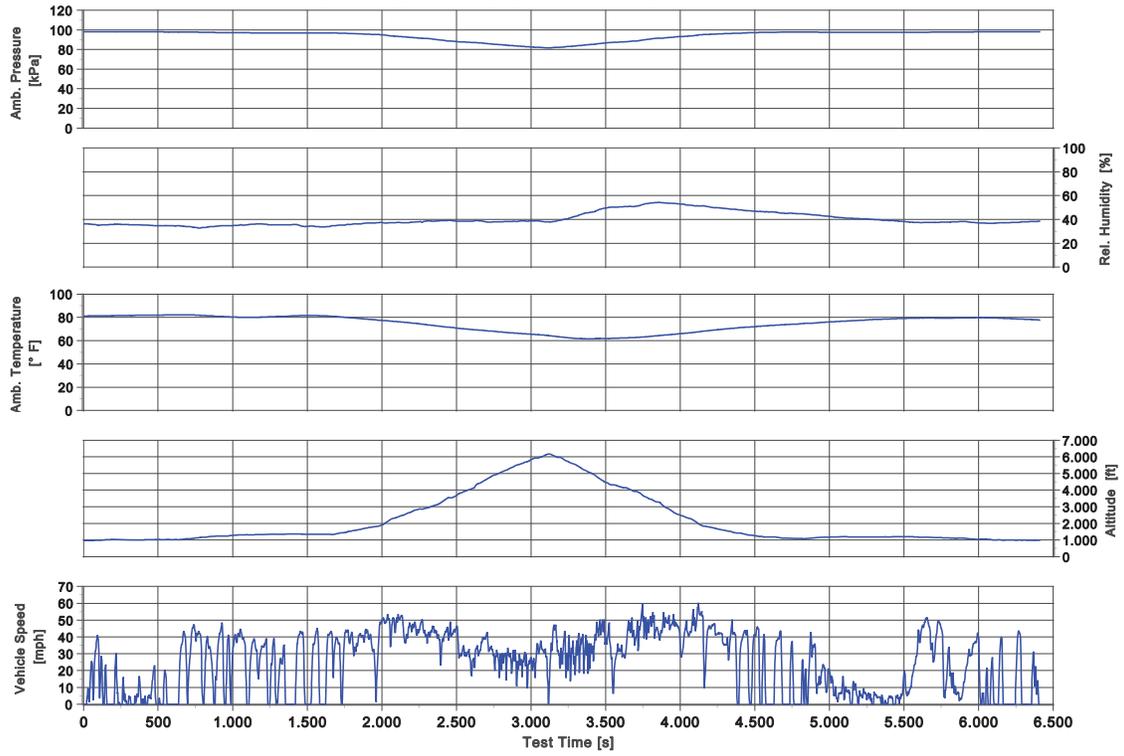


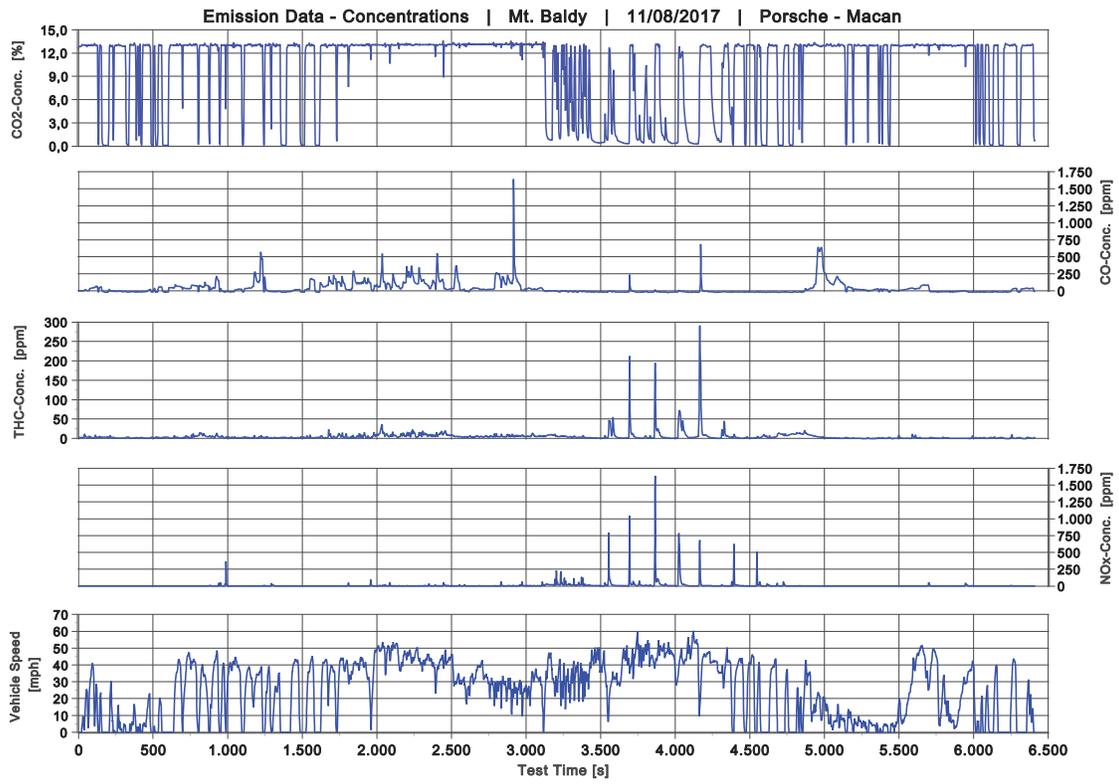
3.4.4 Mt. Baldy

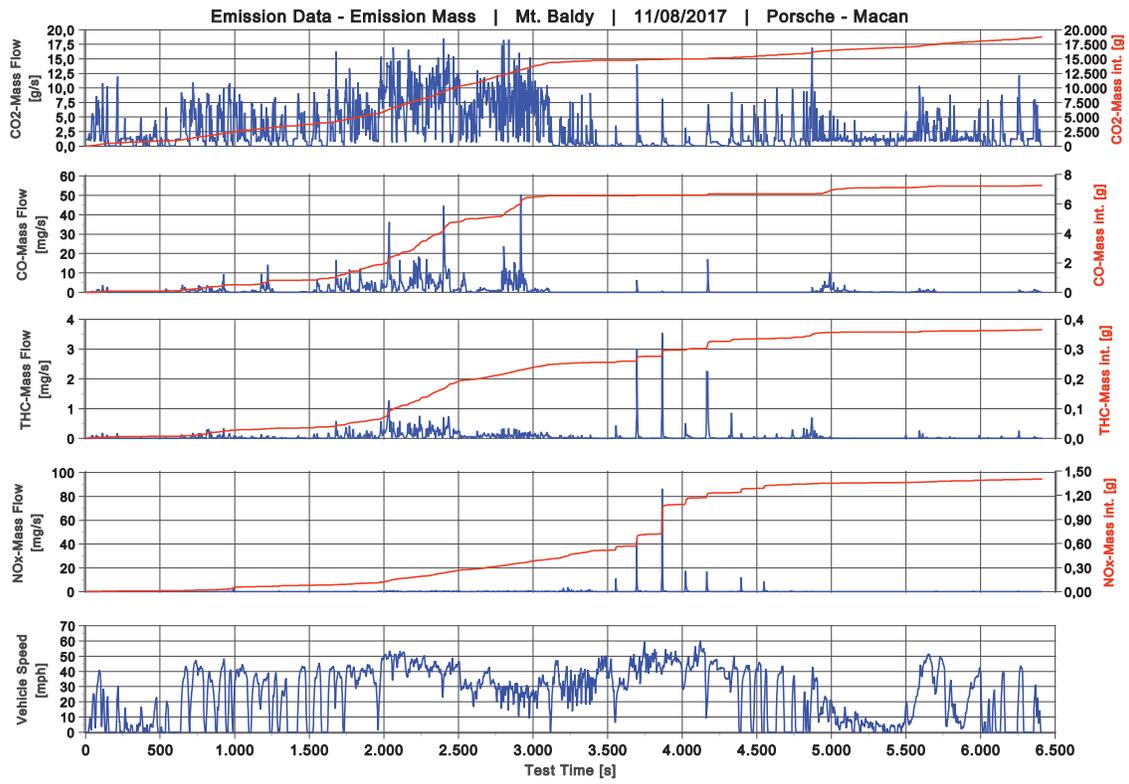
Table 3-15: Mt. Baldy Trip Summary for Macan

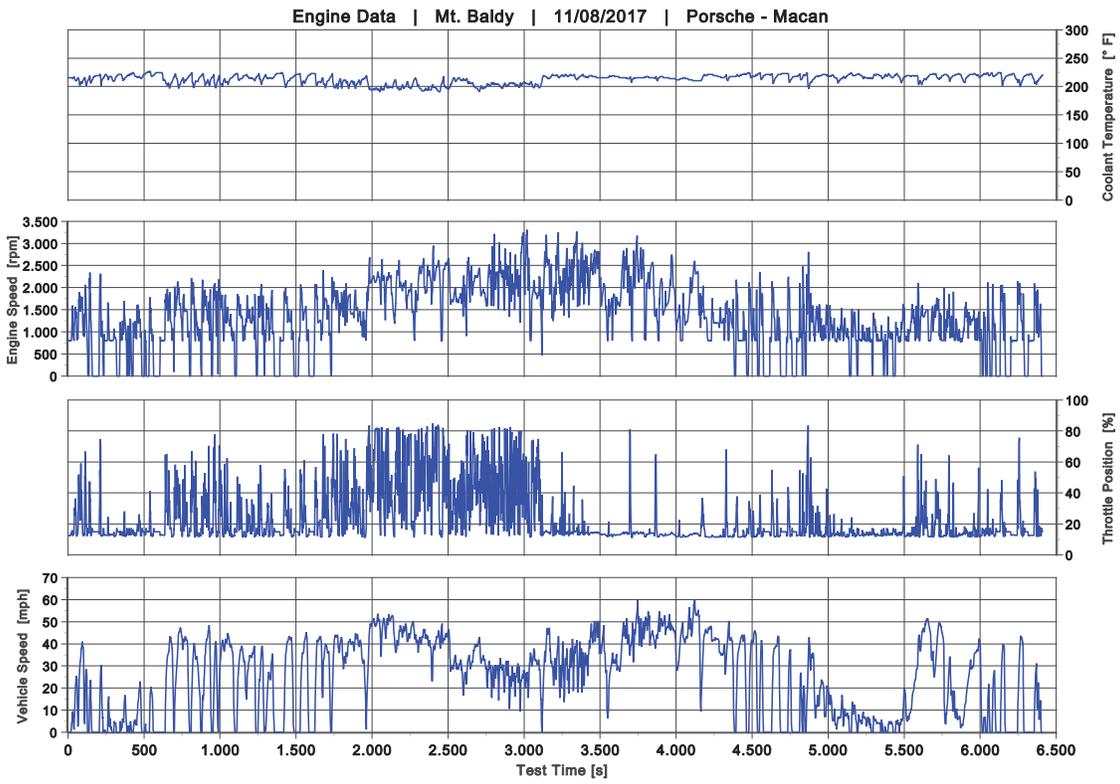
Test Data			
Test Name:	2017-11-08 Macan Mt.-Baldy		
Department:	MBtech	Test Date:	11/08/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	185
Vehicle Modell:	Macan	Nominal Torque [Nm]:	370
VIN:	[REDACTED]	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. 5700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	417,89	
CO	[g/mi]	0,162	
NO <sub>x</sub>	[g/mi]	0,031	
THC	[g/mi]	0,009	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	6414	
Distance	[mi]	44,82	
Average Speed	[mph]	25,16	
Average Ambient Temperature	[°F]	74,7	

Trip Data | Mt. Baldy | 11/08/2017 | Porsche - Macan









### 3.5 Macan GTS

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

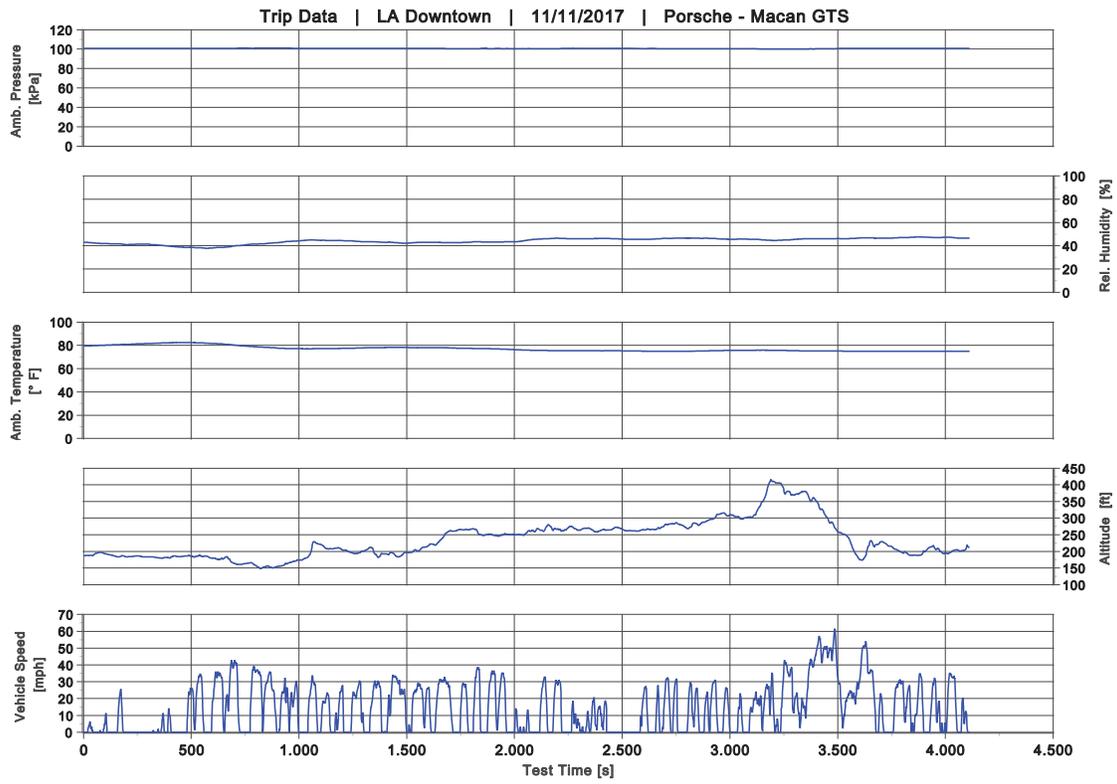
Table 3-16: Emission Overview Porsche – Macan GTS

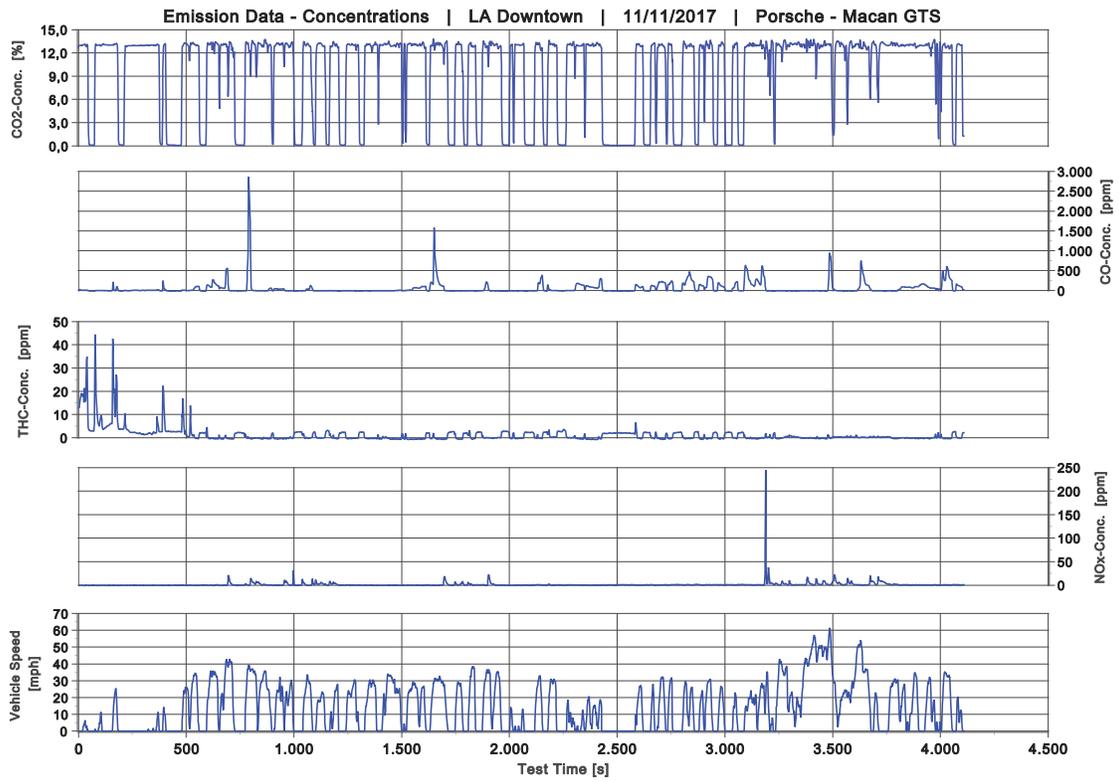
Macan GTS		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/11/17	LA Downtown	600,98	0,282	0,011	0,002	4113	15,75
11/11/17	Highway	427,67	0,585	0,009	0,009	4979	44,88
11/13/17	Mt. Baldy	490,94	0,879	0,058	0,038	5341	44,62
11/15/17	FTP75 (PEMS)	471,65	0,587	0,020	0,035	2511	10,95
11/15/17	FTP75 (Dyno)	447,54	0,565	0,017	0,028		

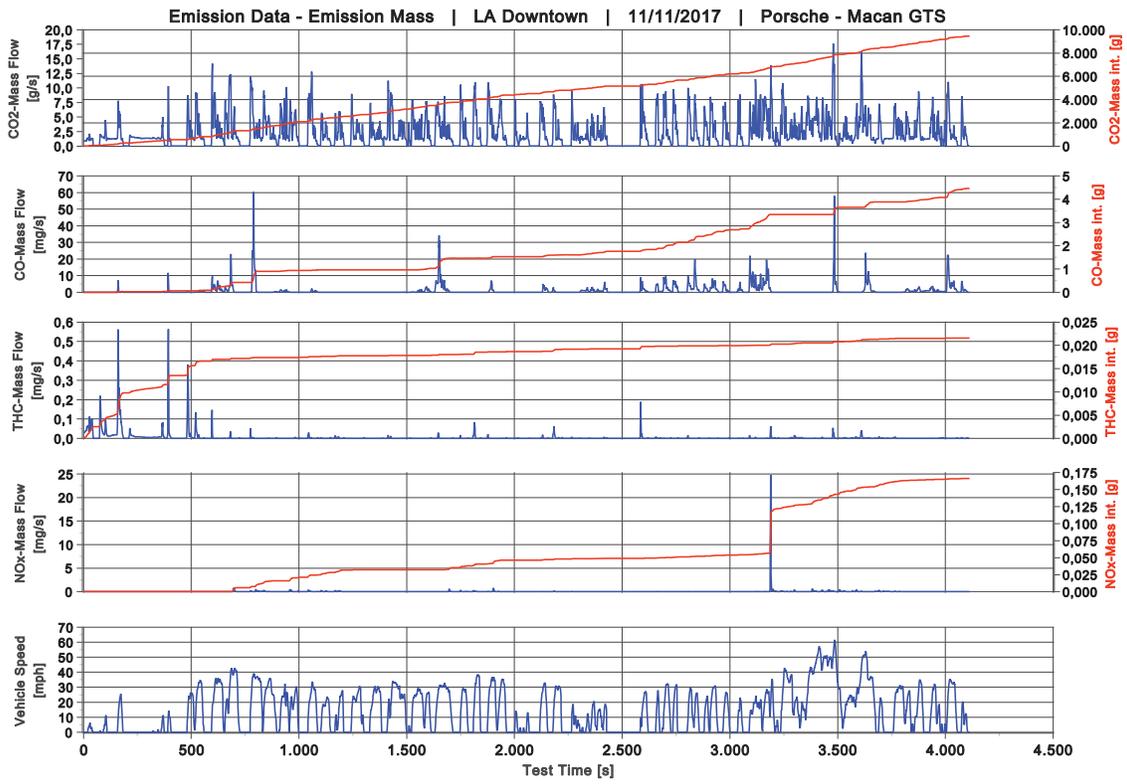
### 3.5.1 LA Downtown

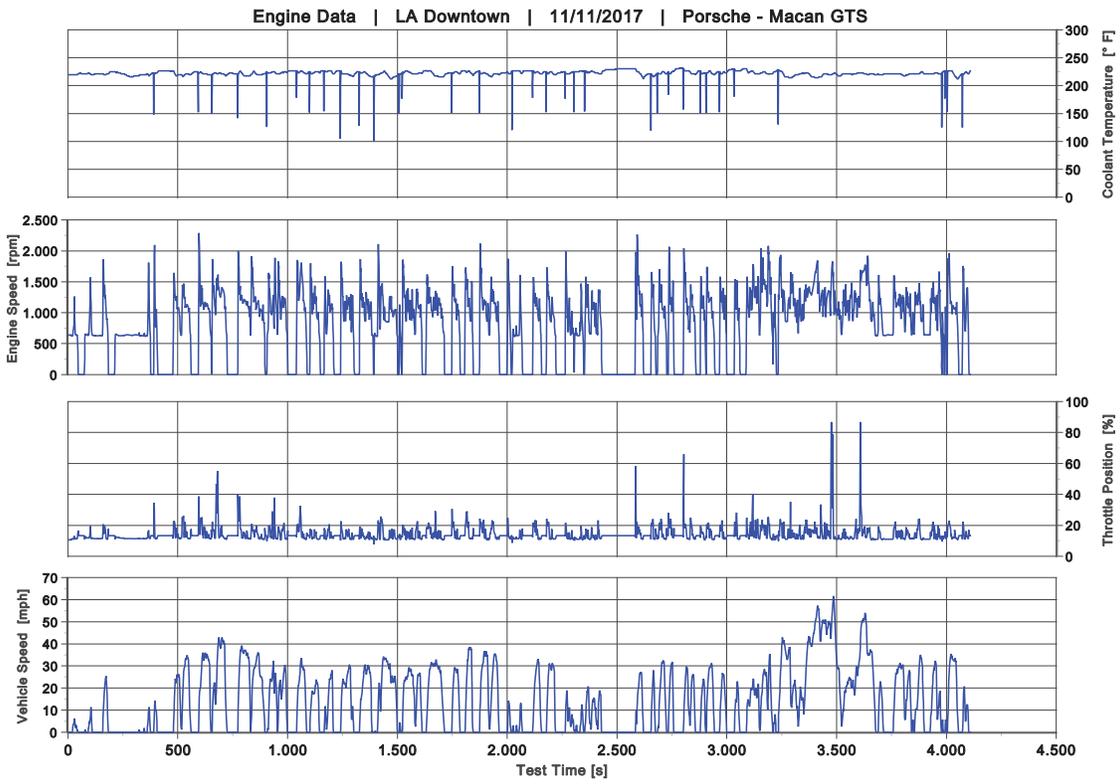
Table 3-17: LA Downtown Trip Summary for Macan GTS

Test Data			
Test Name:	2017-11-11 Macan-GTS LA-Downtown		
Department:	MBtech	Test Date:	11/11/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	265
Vehicle Modell:	Macan GTS	Nominal Torque [Nm]:	500
VIN:	██████████	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. 6900
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	600,98	
CO	[g/mi]	0,282	
NO <sub>x</sub>	[g/mi]	0,011	
THC	[g/mi]	0,002	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4113	
Distance	[mi]	15,75	
Average Speed	[mph]	13,8	
Average Ambient Temperature	[°F]	77,1	







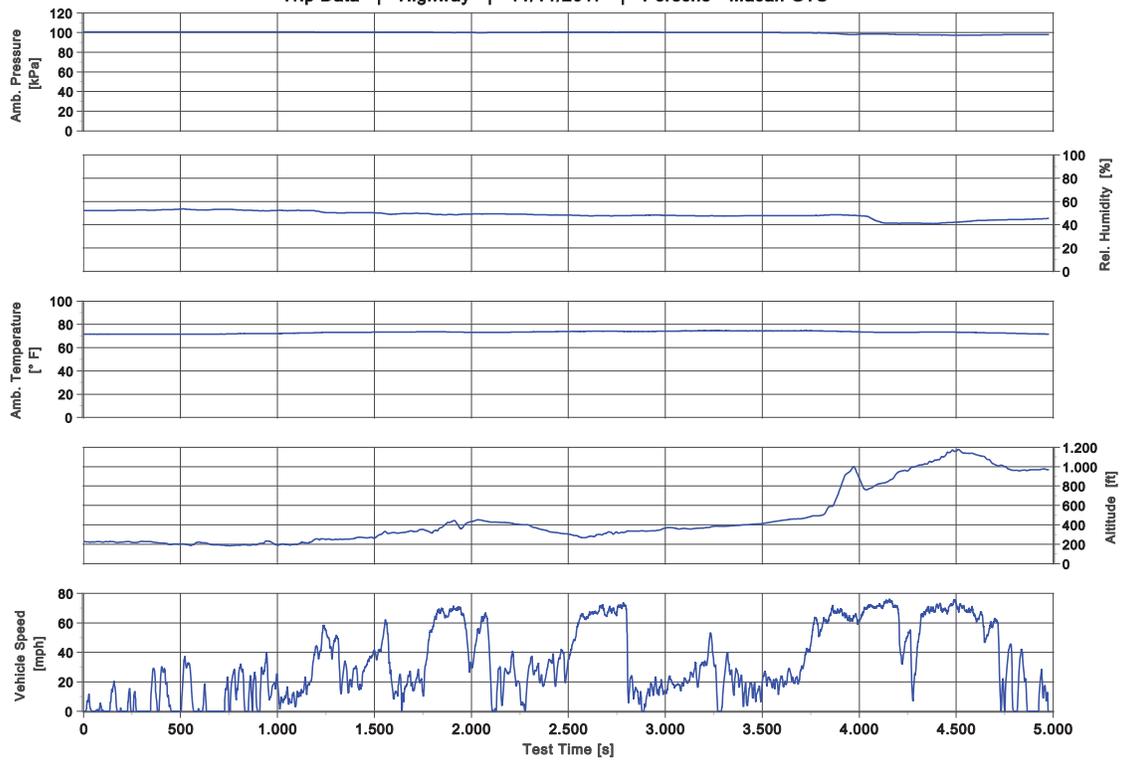


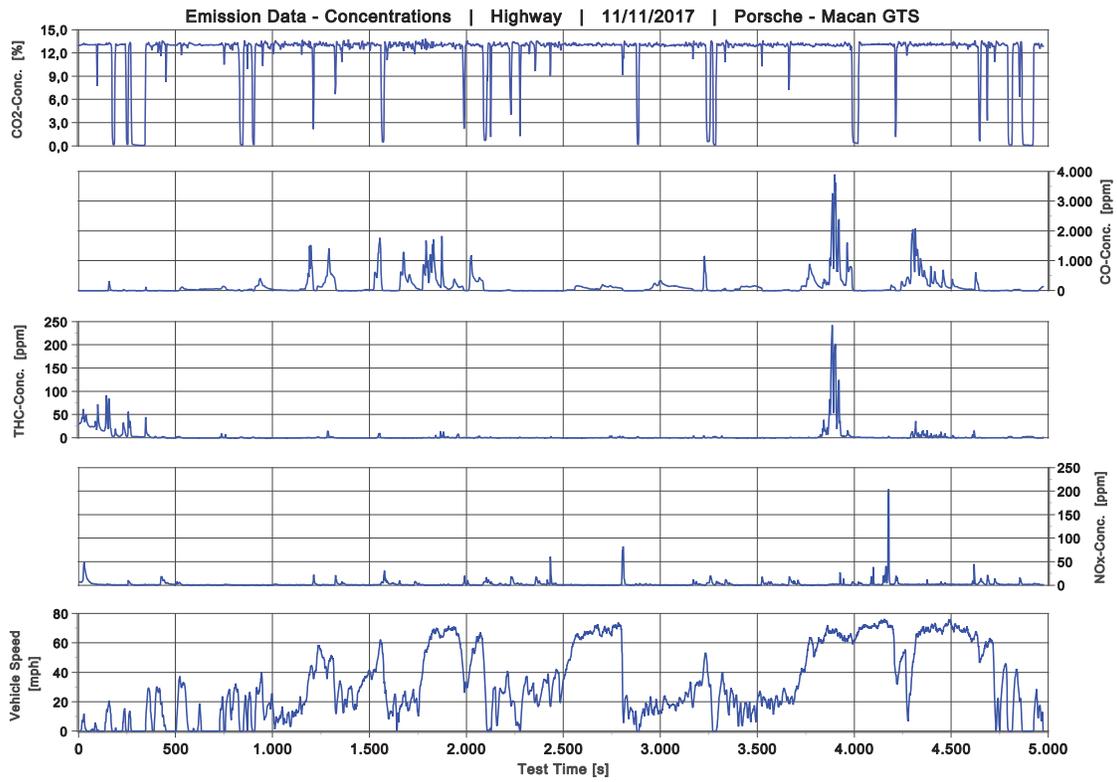
### 3.5.2 Highway

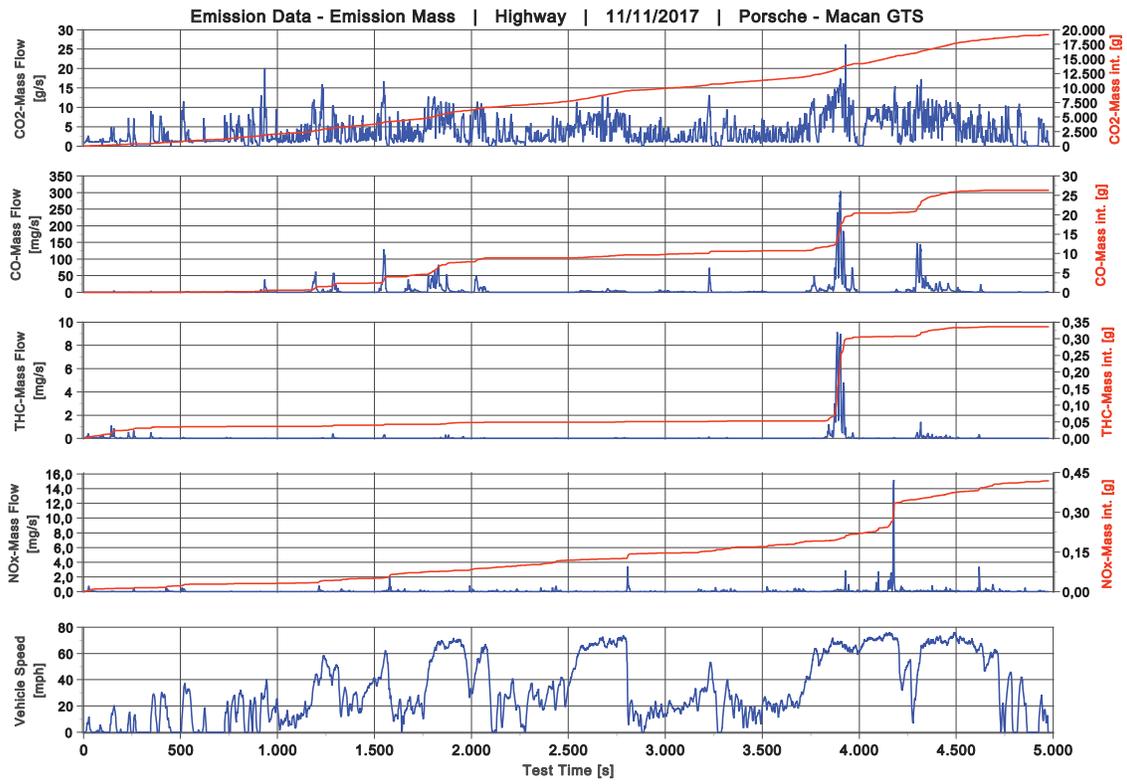
Table 3-18: Highway Trip Summary for Macan GTS

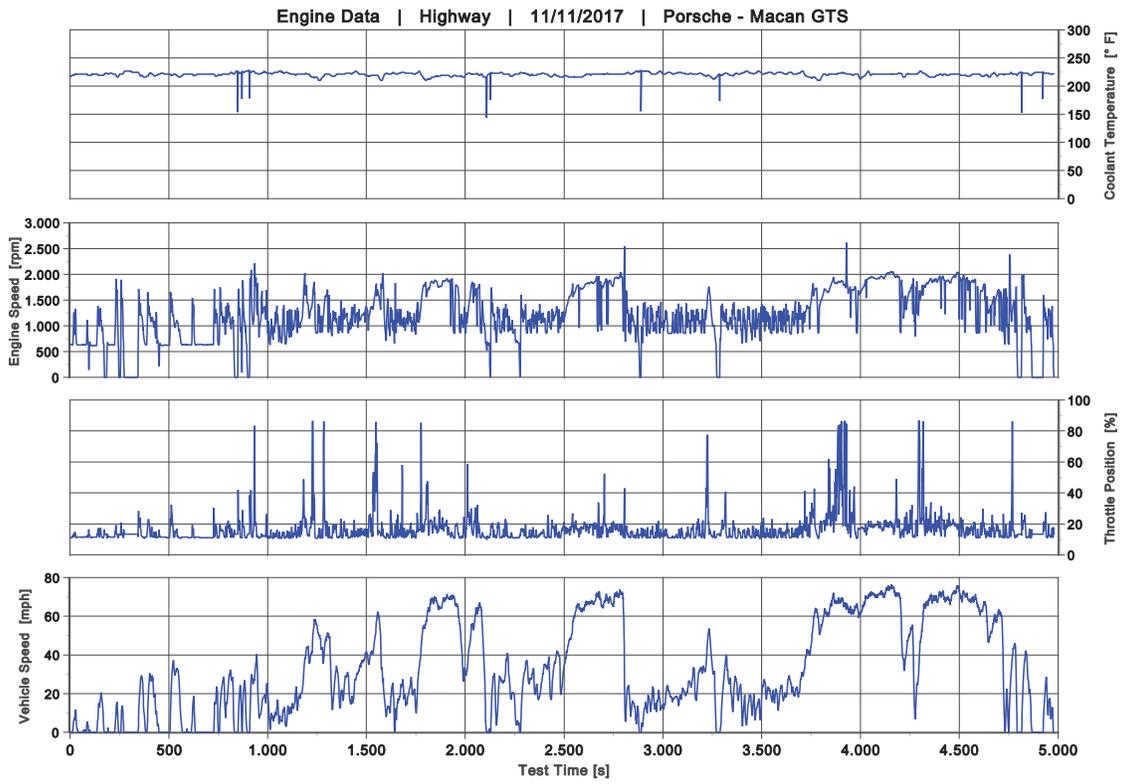
Test Data			
Test Name:	2017-11-11 Macan-GTS Highway		
Department:	MBtech	Test Date:	11/11/17
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	265
Vehicle Modell:	Macan GTS	Nominal Torque [Nm]:	500
VIN:	██████████	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. 6900
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	427,67	
CO	[g/mi]	0,585	
NO <sub>x</sub>	[g/mi]	0,009	
THC	[g/mi]	0,009	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4979	
Distance	[mi]	44,88	
Average Speed	[mph]	32,4	
Average Ambient Temperature	[°F]	73,1	

Trip Data | Highway | 11/11/2017 | Porsche - Macan GTS





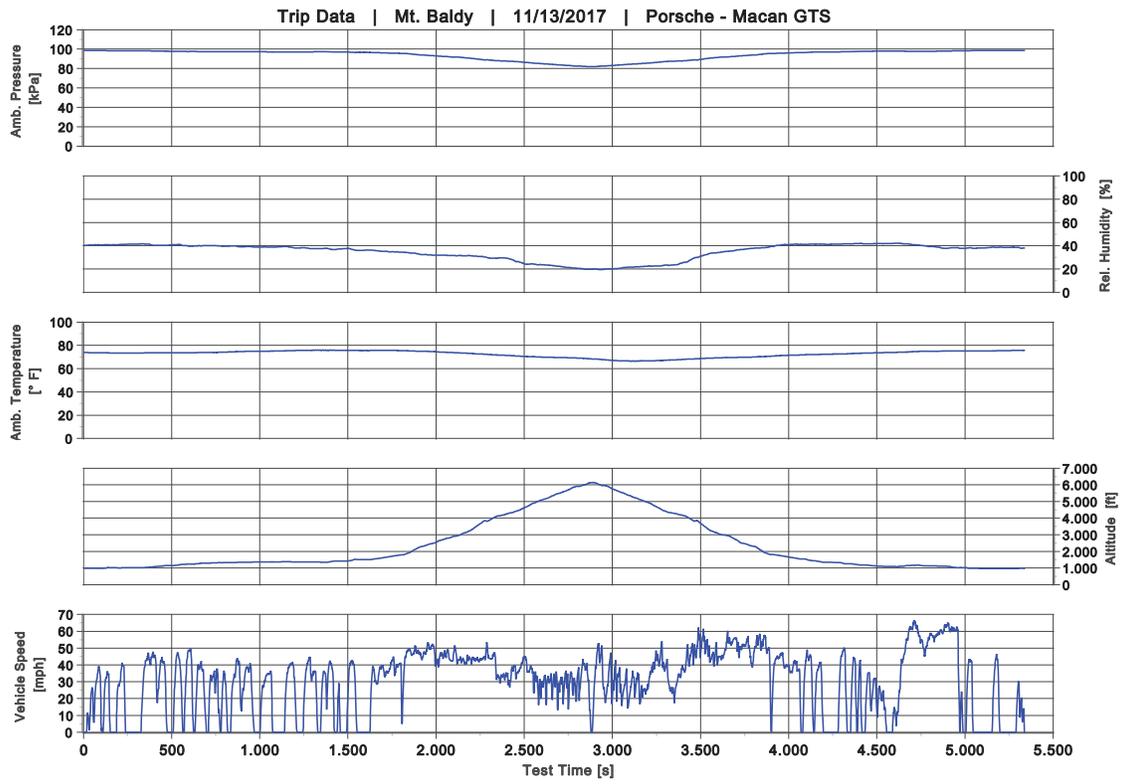


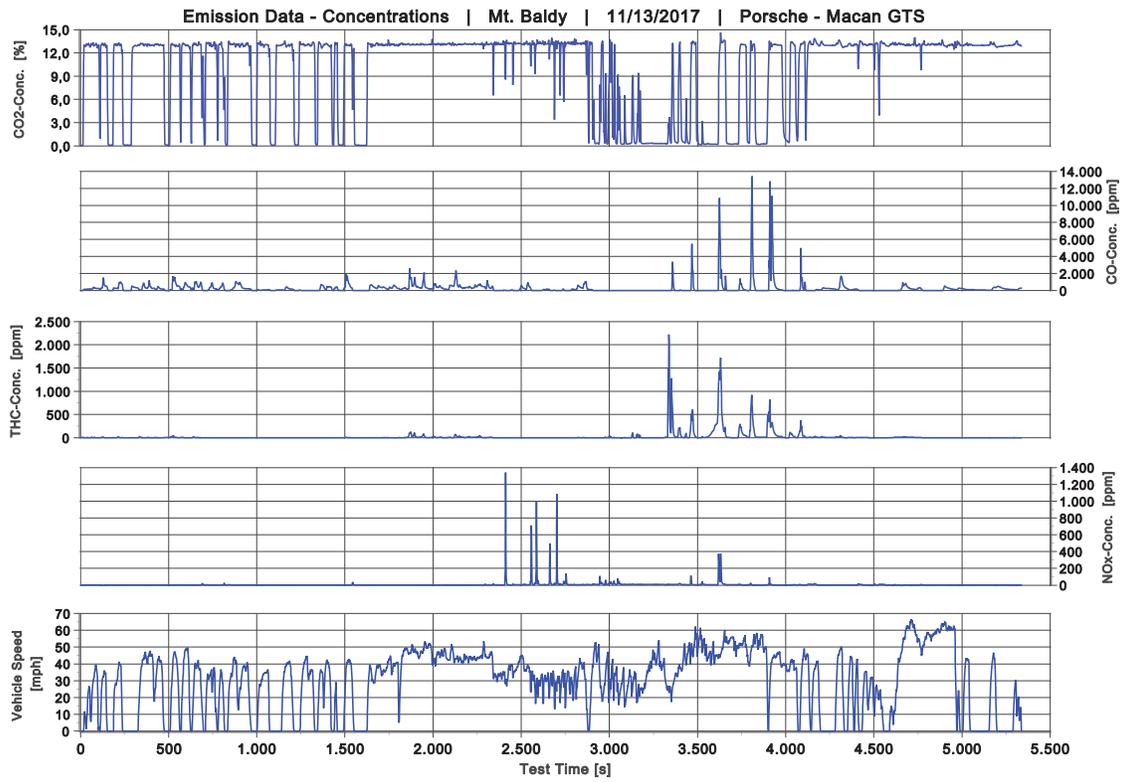


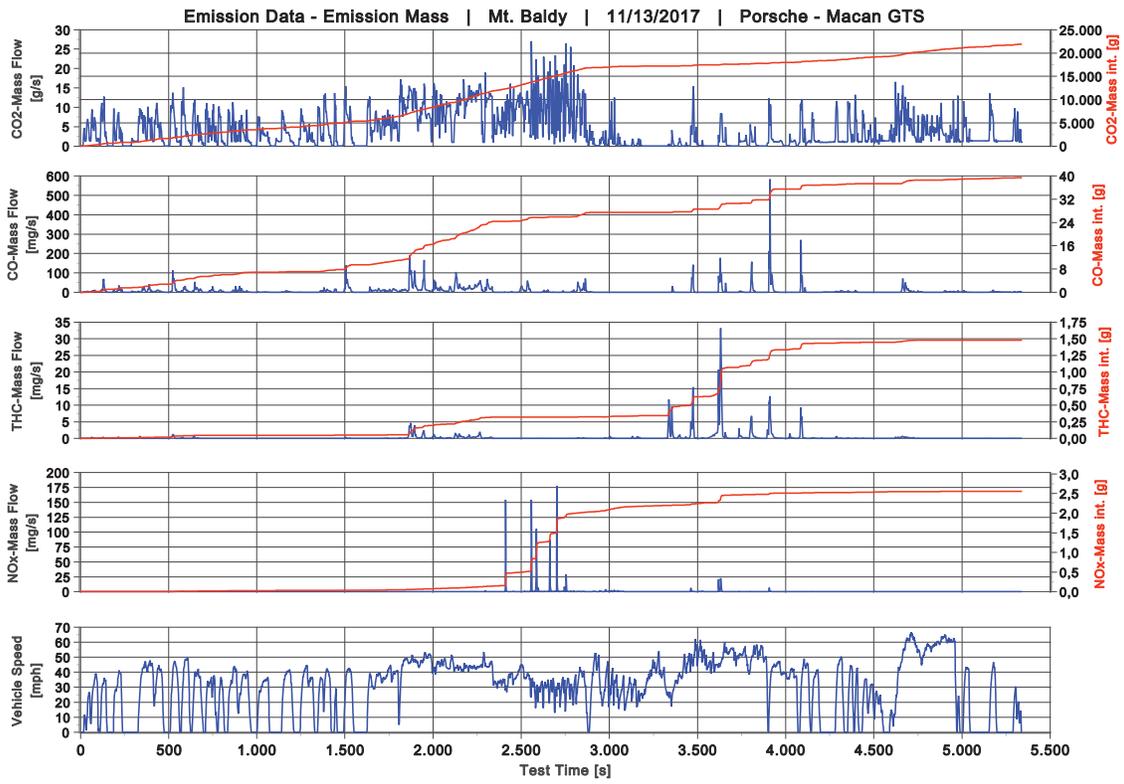
### 3.5.3 Mt Baldy

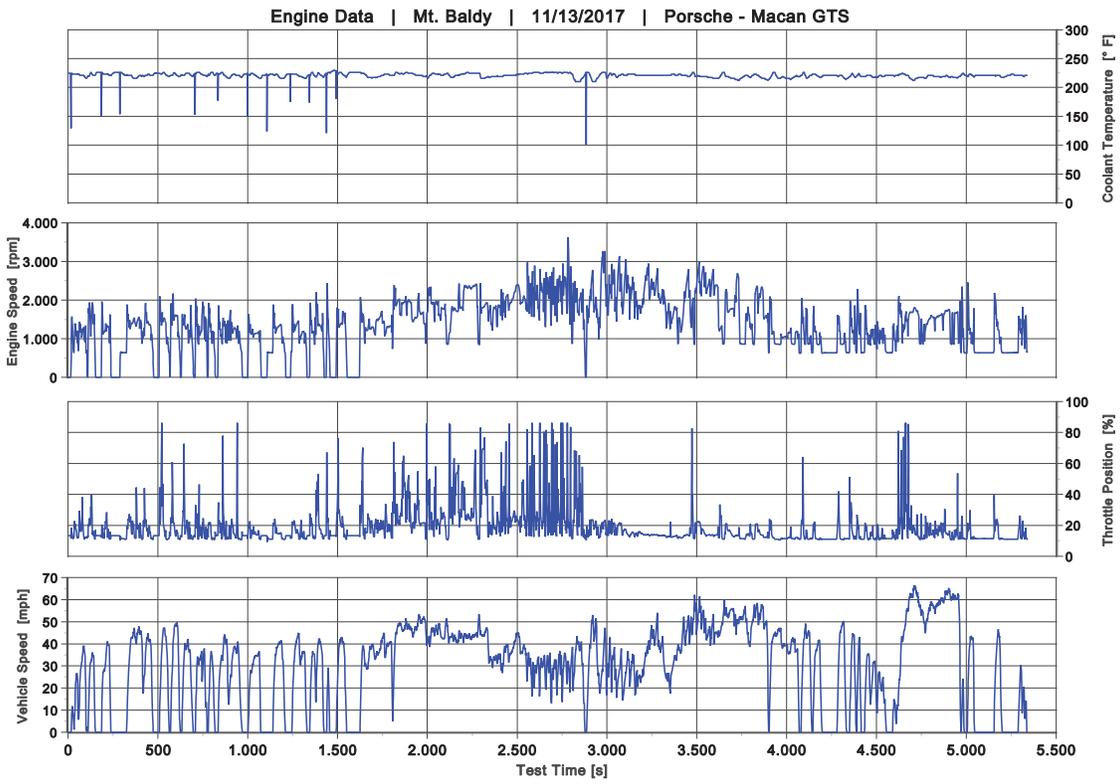
Table 3-19: Mt. Baldy Trip Summary for Macan GTS

Test Data			
Test Name:	2017-11-13 Macan-GTS Mt.-Baldy		
Department:	MBtech	Test Date:	11/13/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	LDT	Nominal Power [kW]:	265
Vehicle Modell:	Macan GTS	Nominal Torque [Nm]:	500
VIN:	██████████	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. 6900
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	490,94	
CO	[g/mi]	0,879	
NO <sub>x</sub>	[g/mi]	0,058	
THC	[g/mi]	0,038	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	5341	
Distance	[mi]	44,62	
Average Speed	[mph]	30,1	
Average Ambient Temperature	[°F]	72,6	









### 3.6 911 Carrera

The following table summarizes the emission measurement results from the 911 Carrera vehicle. After the completion of all route measurements (1), the gas PEMS needed to be repaired on the 20th and 21st of November. Route measurements needed to be repeated for the 911 Carrera due to this change. Measurements labeled with 2 or 3 represent the results after the repaired PEMS.

Table 3-20: Emission Overview Porsche – 911 Carrera

911 Carrera		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/18/17	LA Downtown 1*	492,75	0,004	0,008	n.a.	4691	16,02
11/22/17	LA Downtown 2*	658,24	0,002	0,025	n.a.	3097	15,53
11/22/17	LA Downtown 3	578,17	0,001	0,028	n.a.	2772	15,71
11/18/17	Highway 1	341,30	0,049	0,014	n.a.	3771	45,09
11/22/17	Highway 2	309,42	0,046	0,014	n.a.	2817	44,85
11/18/17	Mt. Baldy 1	373,11	0,289	0,034	n.a.	5152	44,69
11/23/17	Mt. Baldy 2	330,75	0,202	0,034	n.a.	4822	44,50
11/22/17	FTP75 (PEMS)	313,94	0,163	0,032	n.a.	2490	10,93
11/22/17	FTP75 (Dyno)	339,58	0,222	0,036	0,054		

\*: Deviation of driving route from original route

3.6.1 LA Downtown (1)

Table 3-21: LA Downtown (1) Trip Summary for 911 Carrera

Test Data			
Test Name:	2017-11-18 911-Carrera LA-Downtown1		
Department:	MBtech	Test Date:	11/18/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	492,75	
CO	[g/mi]	0,004	
NO <sub>x</sub>	[g/mi]	0,008	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4691	
Distance	[mi]	16,02	
Average Speed	[mph]	12,3	
Average Ambient Temperature	[°F]	76,5	

Deviation from original route:

The deviation started at 3130s test time and ended at 3502s test time.

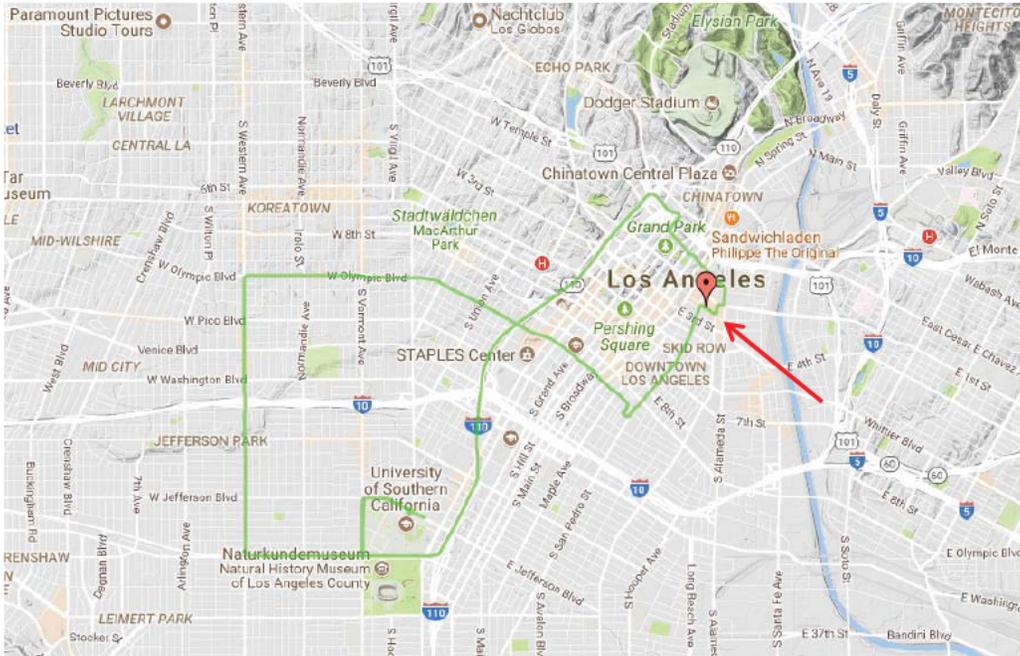


Figure 3-5: LA Downtown (1) Route Deviation for 911 Carrera

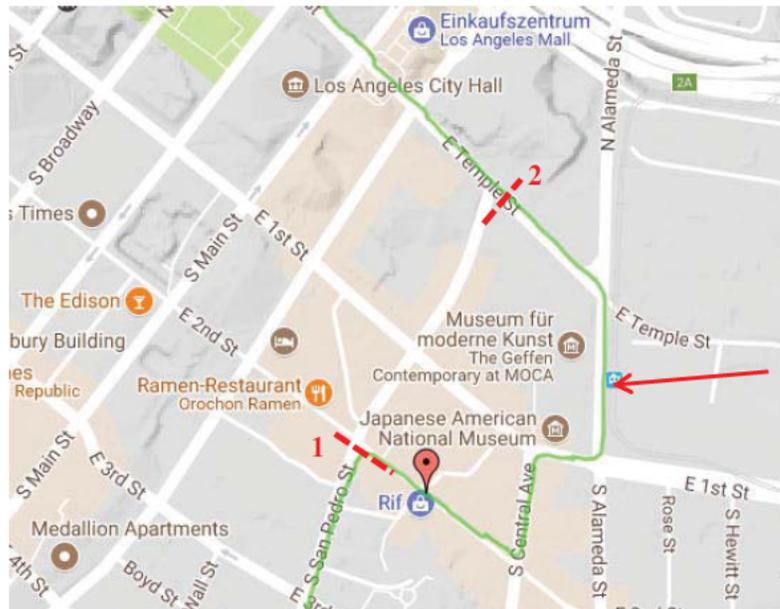
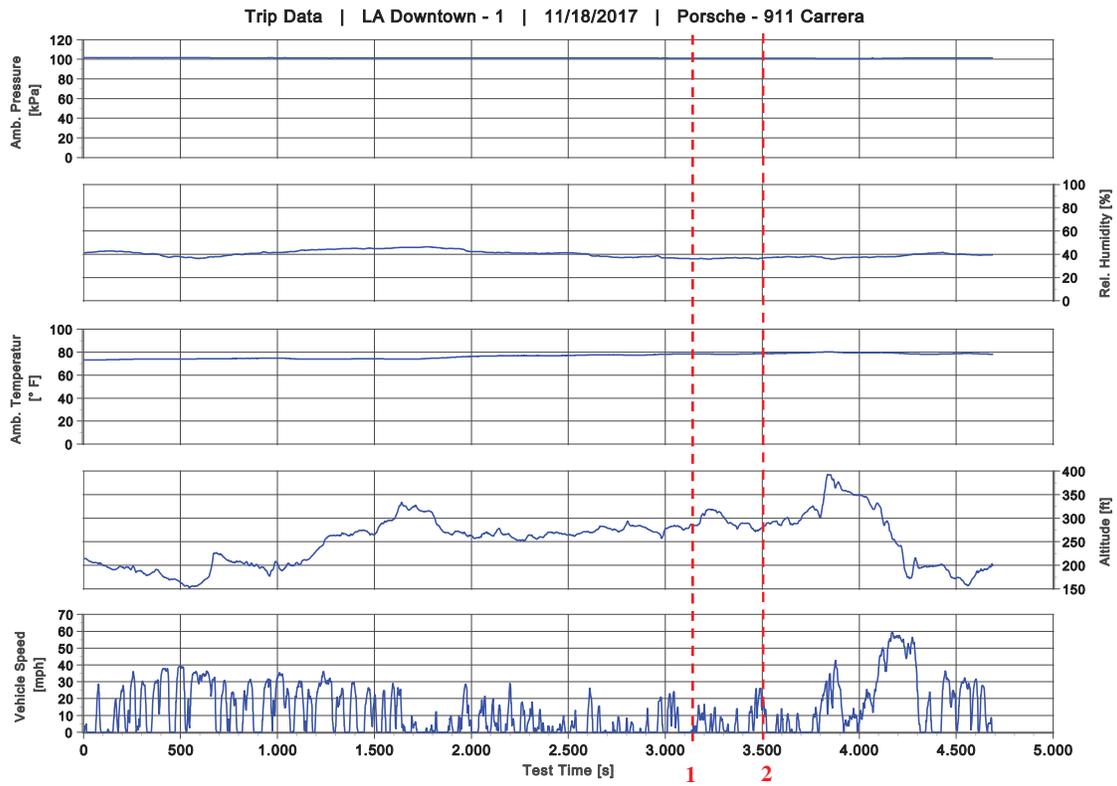
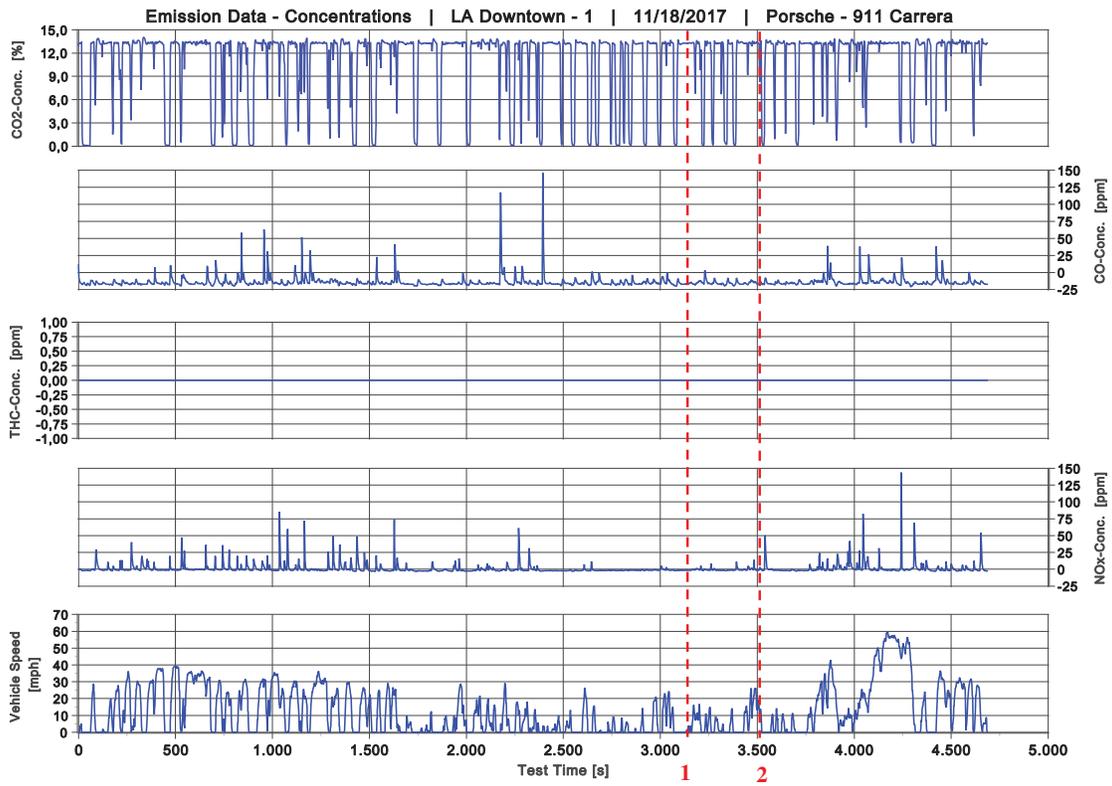
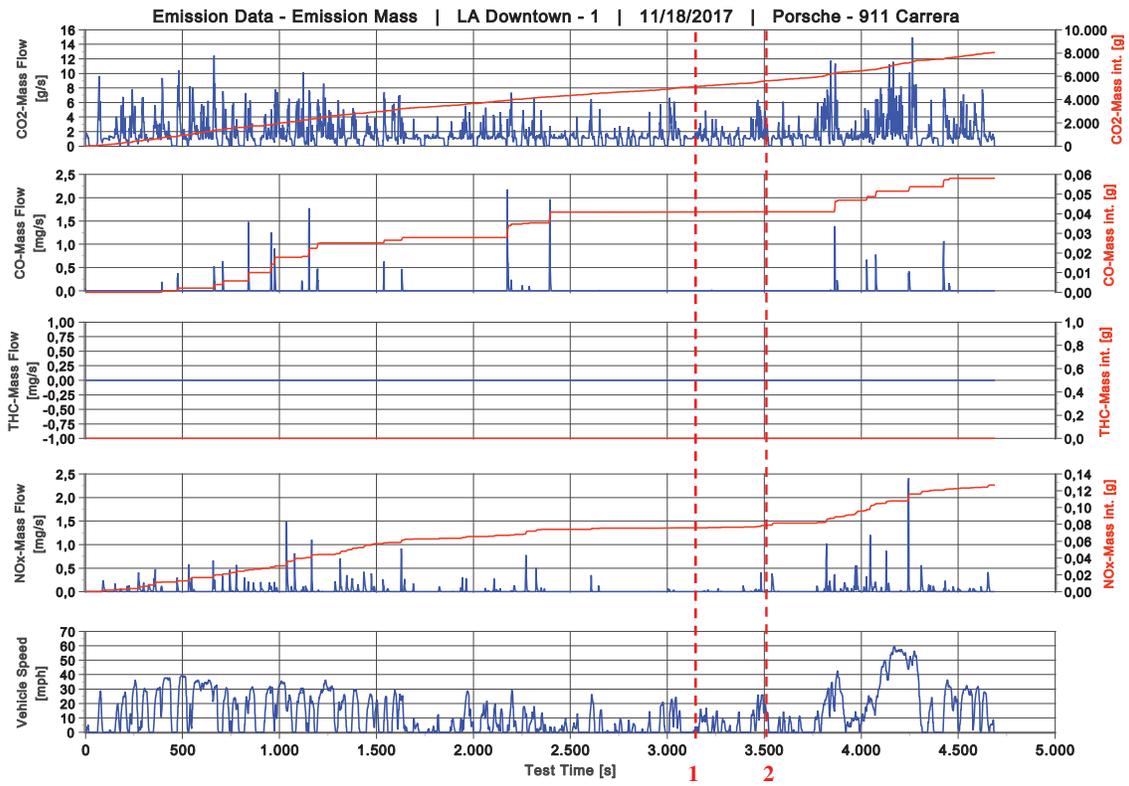
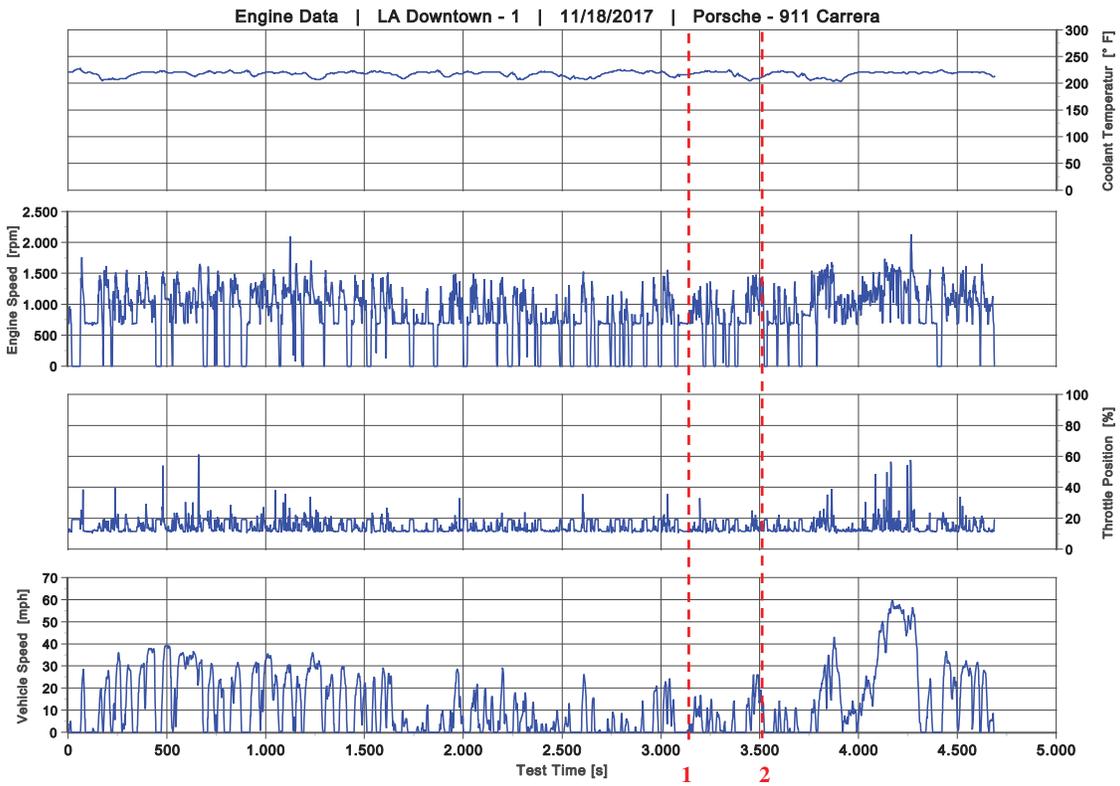


Figure 3-6: Zoom of LA Downtown (1) Route Deviation for 911 Carrera









3.6.2 LA Downtown (2)

Table 3-22: LA Downtown (2) Trip Summary for 911 Carrera

Test Data			
Test Name:	2017-11-22 911-Carrera LA-Downtown2		
Department:	MBtech	Test Date:	11/22/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	658,24	
CO	[g/mi]	0,002	
NO <sub>x</sub>	[g/mi]	0,025	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3097	
Distance	[mi]	15,53	
Average Speed	[mph]	18,0	
Average Ambient Temperature	[°F]	75,3	

**Deviation from original route:**

The deviation started at 2370s test time and ended at the end of the test at 3096s.

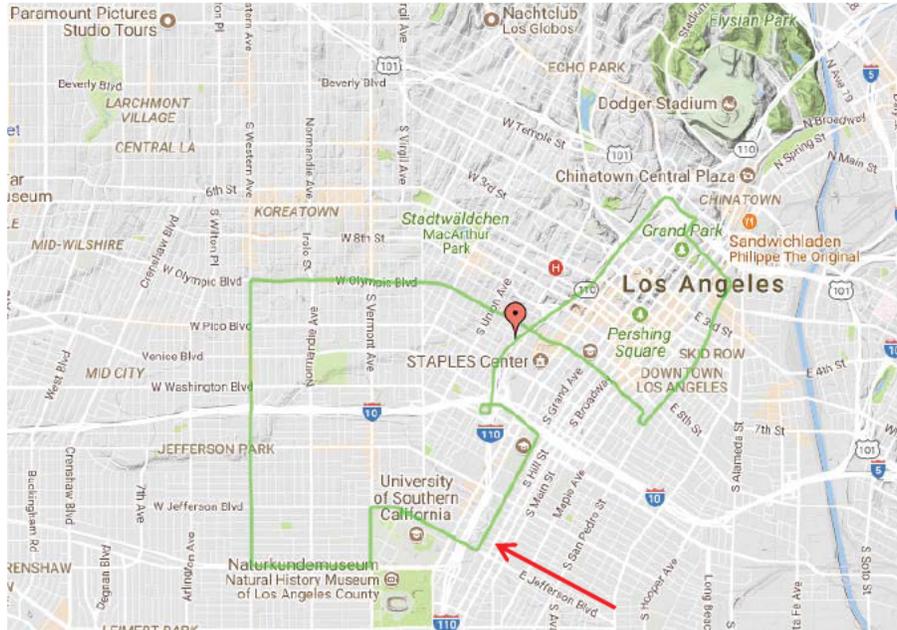


Figure 3-7: LA Downtown (2) Route Deviation for 911 Carrera

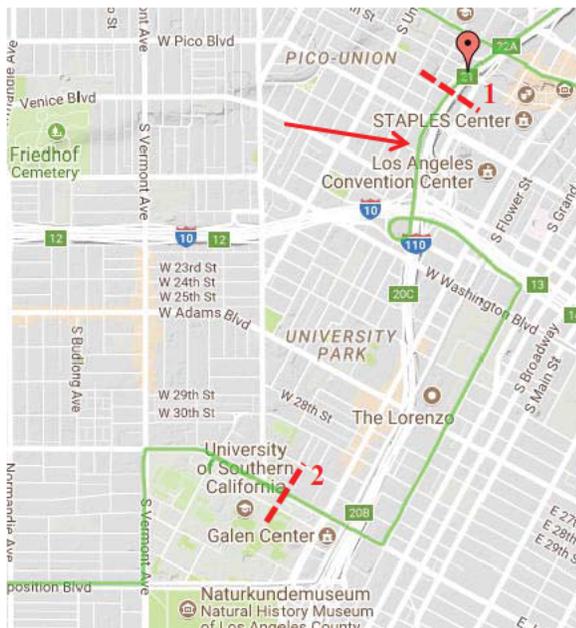
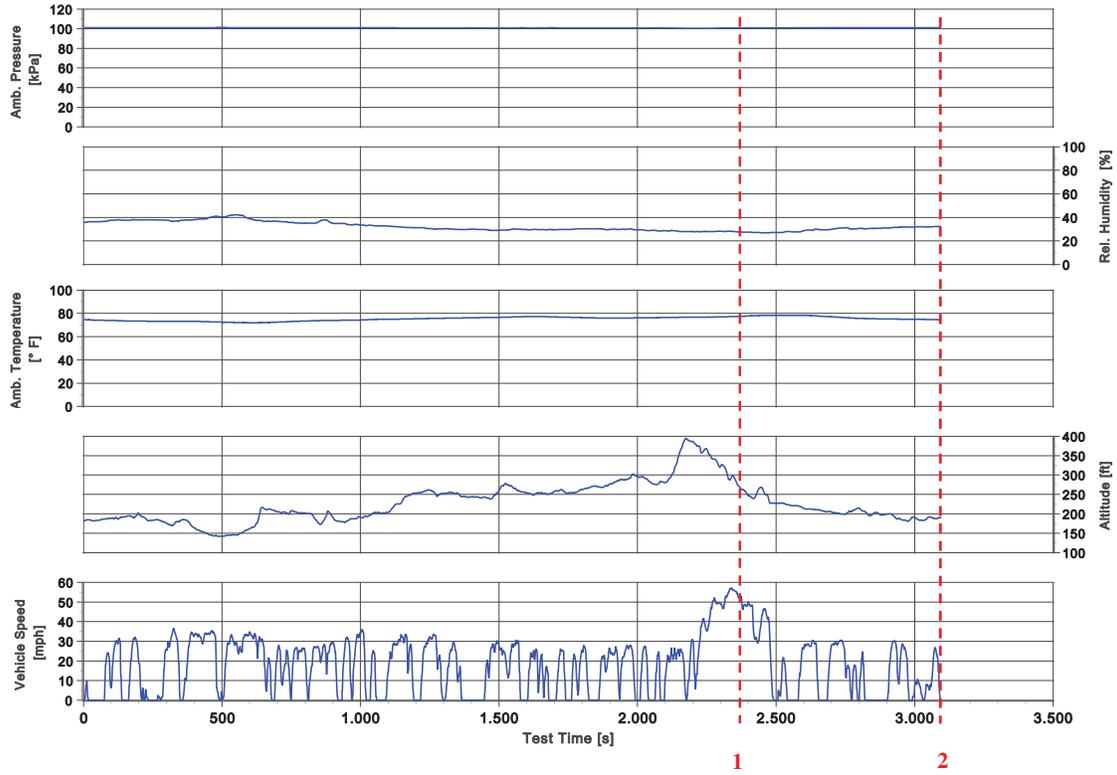
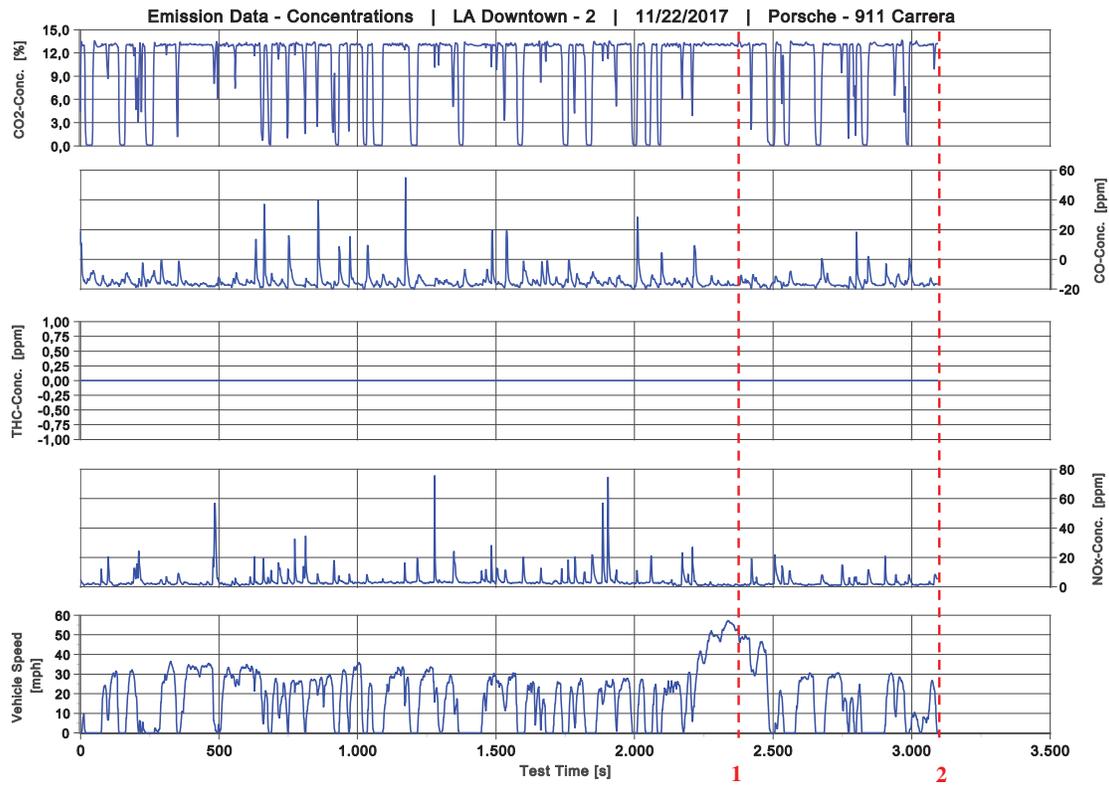
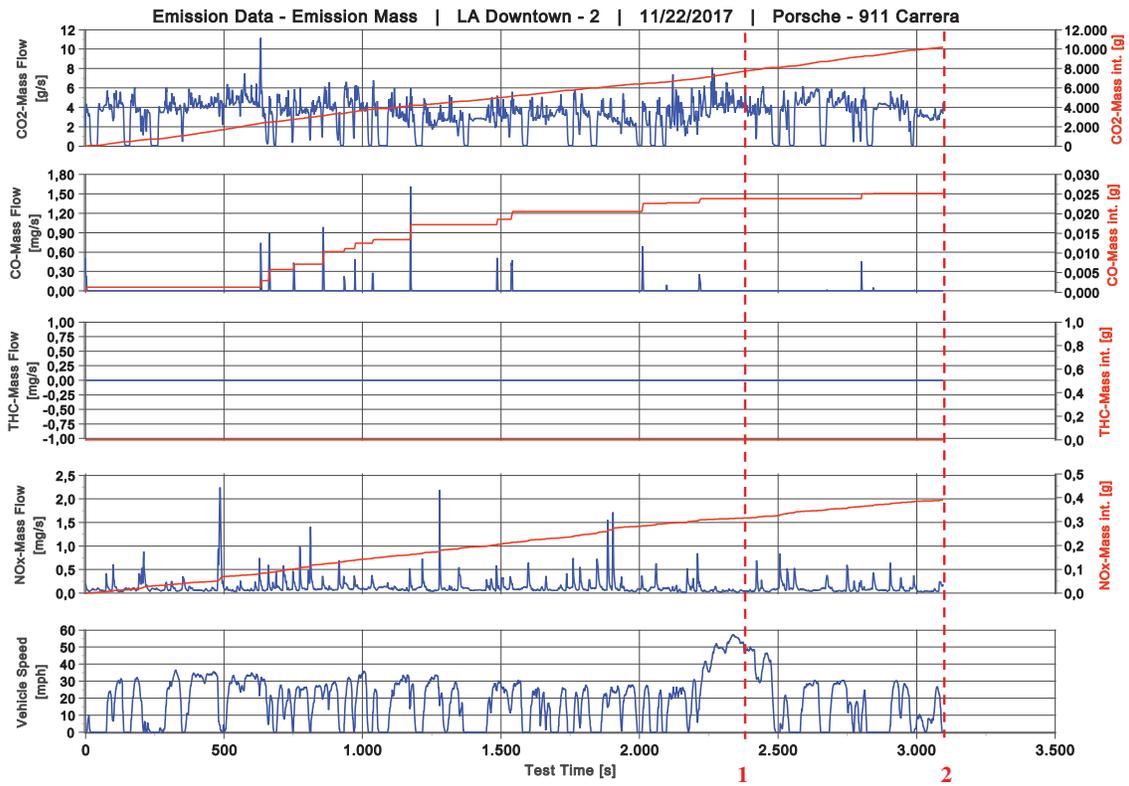


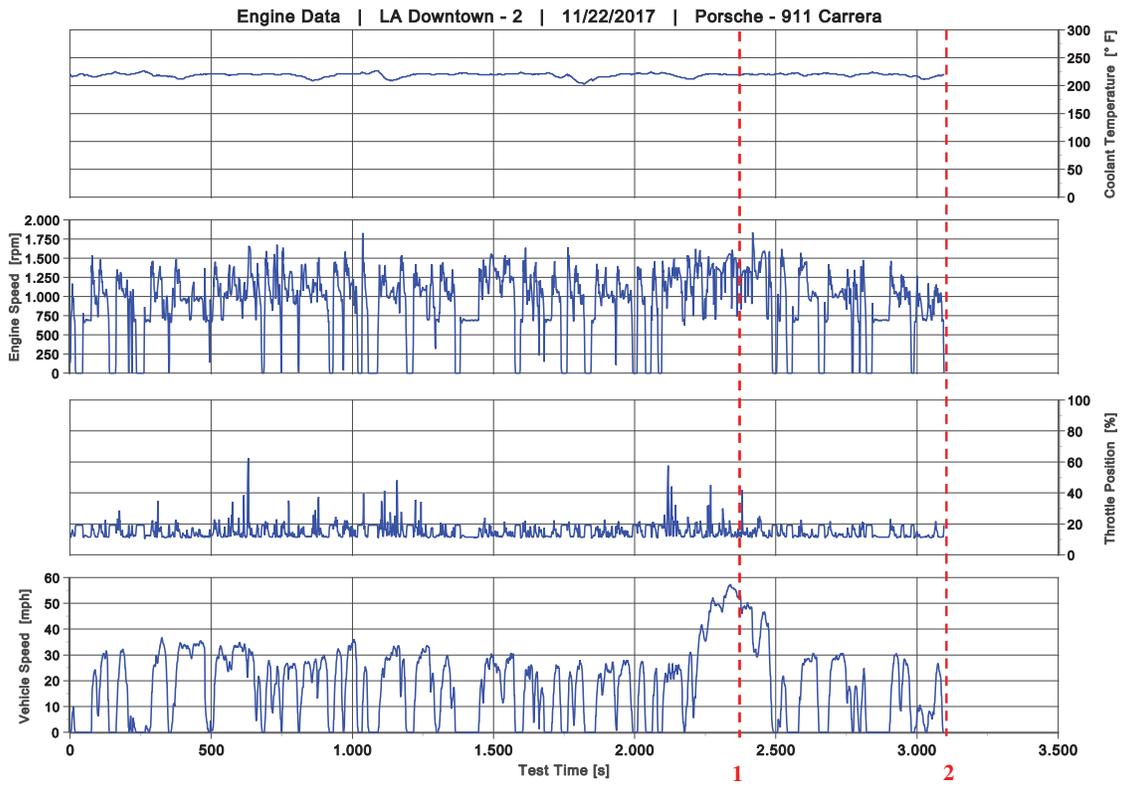
Figure 3-8: Zoom of LA Downtown (2) Route Deviation for 911 Carrera

Trip Data | LA Downtown - 2 | 11/22/2017 | Porsche - 911 Carrera







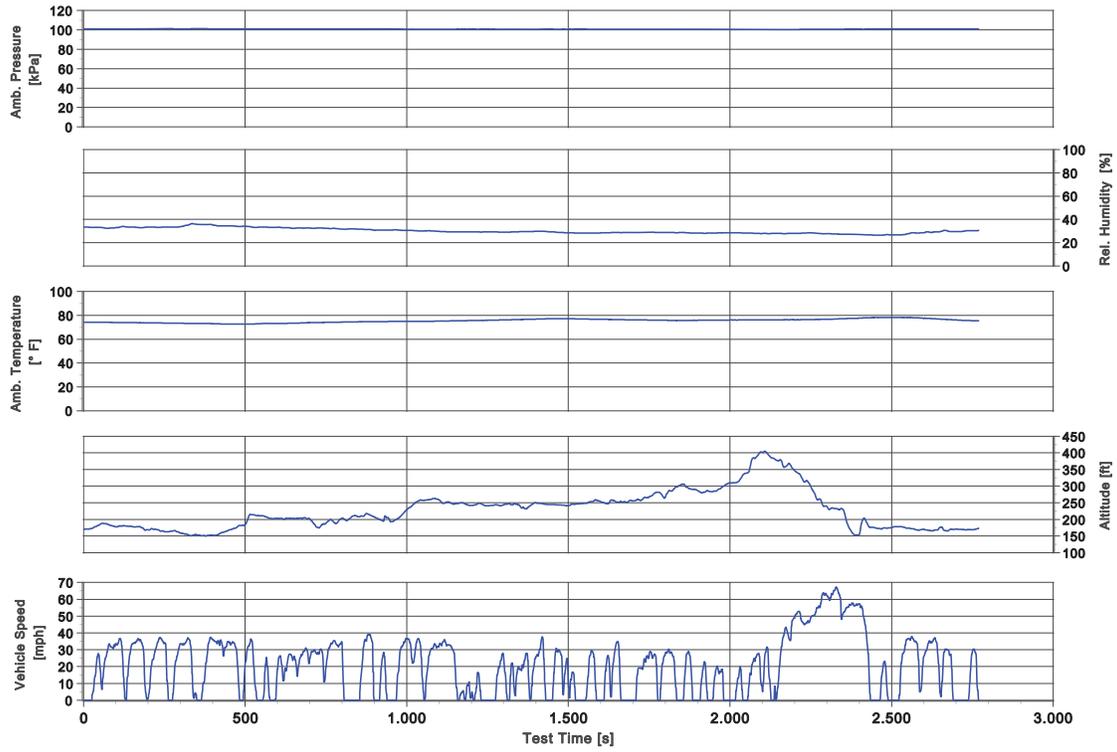


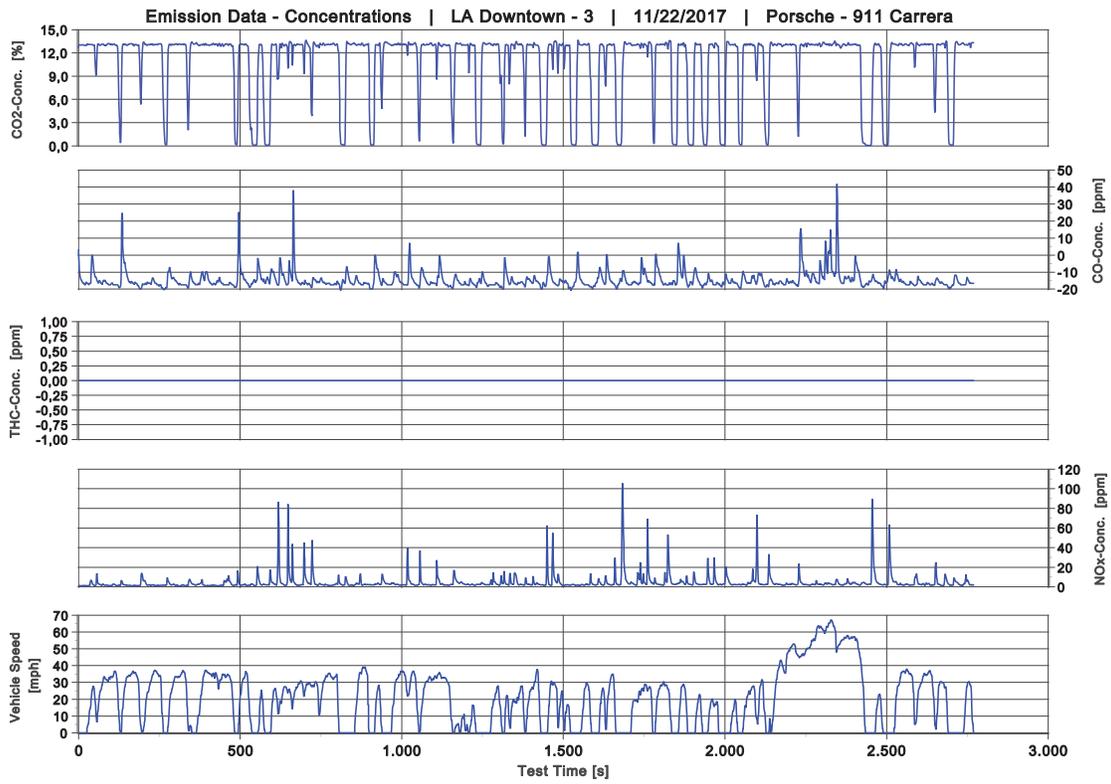
### 3.6.3 LA Downtown (3)

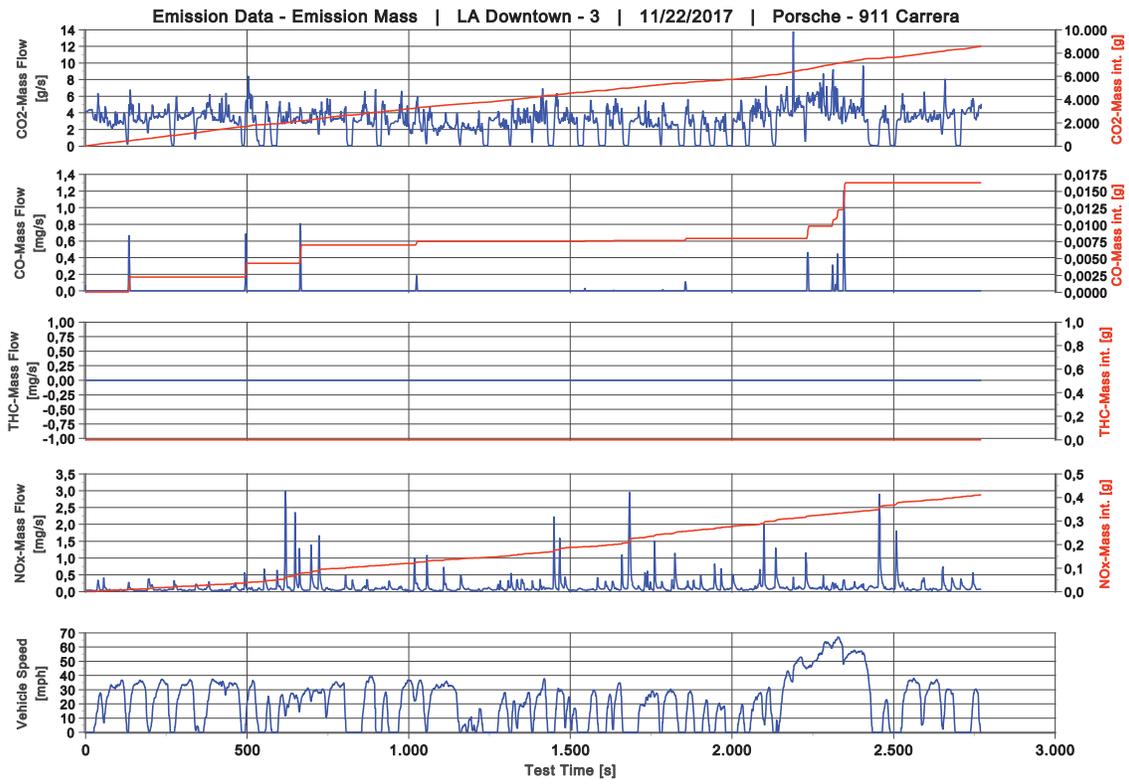
Table 3-23: LA Downtown (3) Trip Summary for 911 Carrera

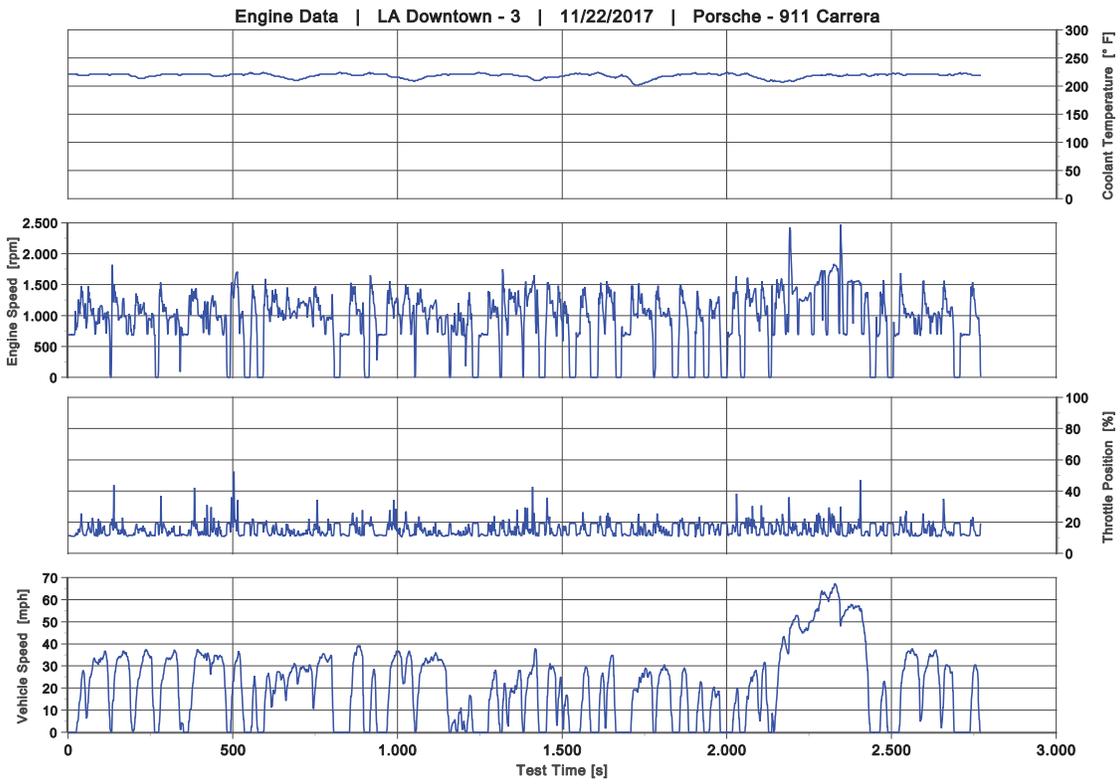
Test Data			
Test Name:	2017-11-22 911-Carrera LA-Downtown3		
Department:	MBtech	Test Date:	11/22/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	578,17	
CO	[g/mi]	0,001	
NO <sub>x</sub>	[g/mi]	0,028	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	2772	
Distance	[mi]	15,71	
Average Speed	[mph]	20,4	
Average Ambient Temperature	[°F]	75,5	

Trip Data | LA Downtown - 3 | 11/22/2017 | Porsche - 911 Carrera







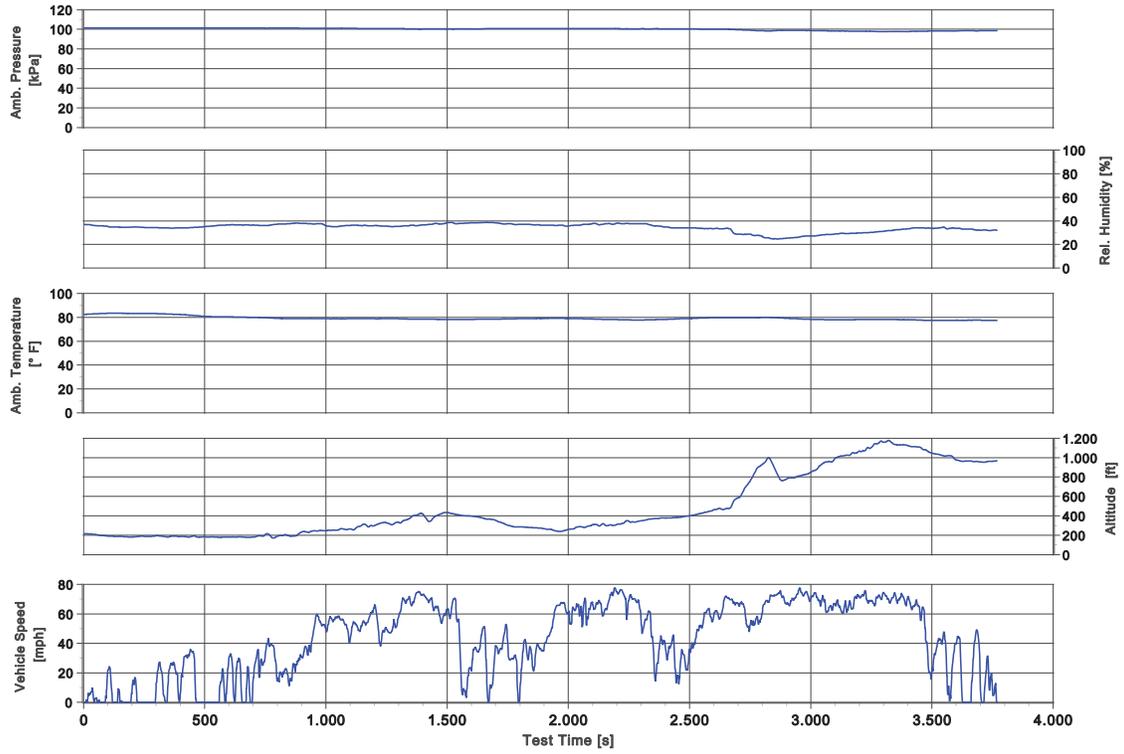


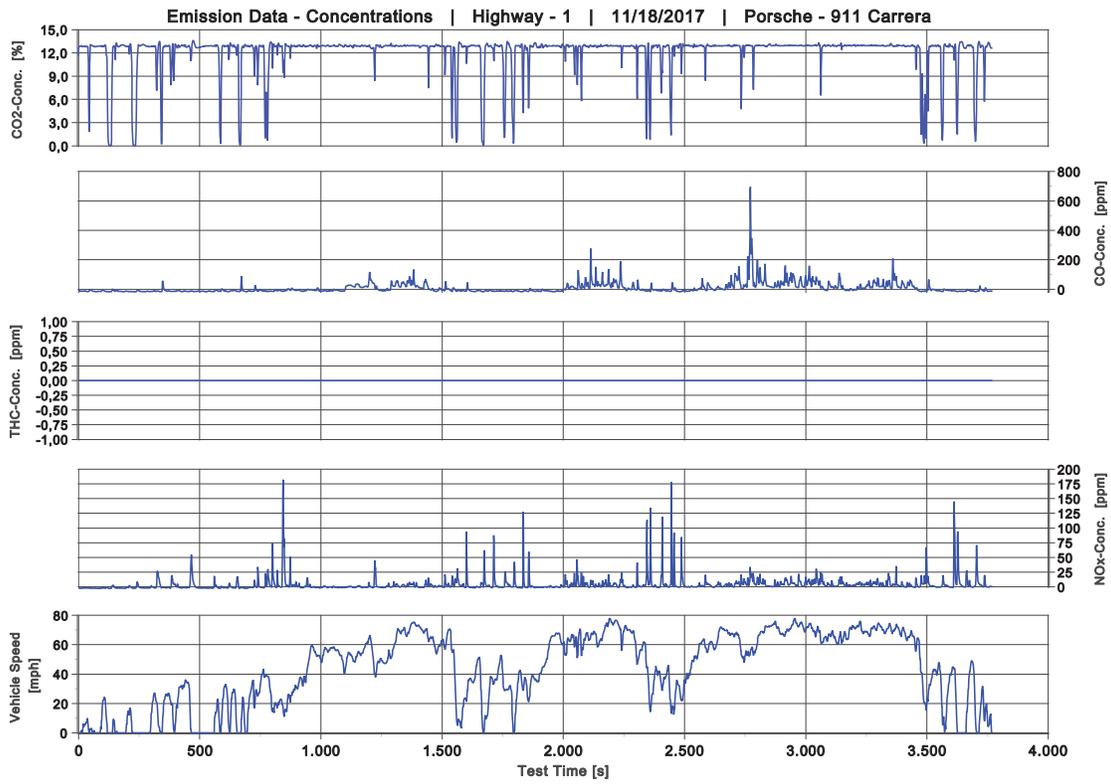
### 3.6.4 Highway (1)

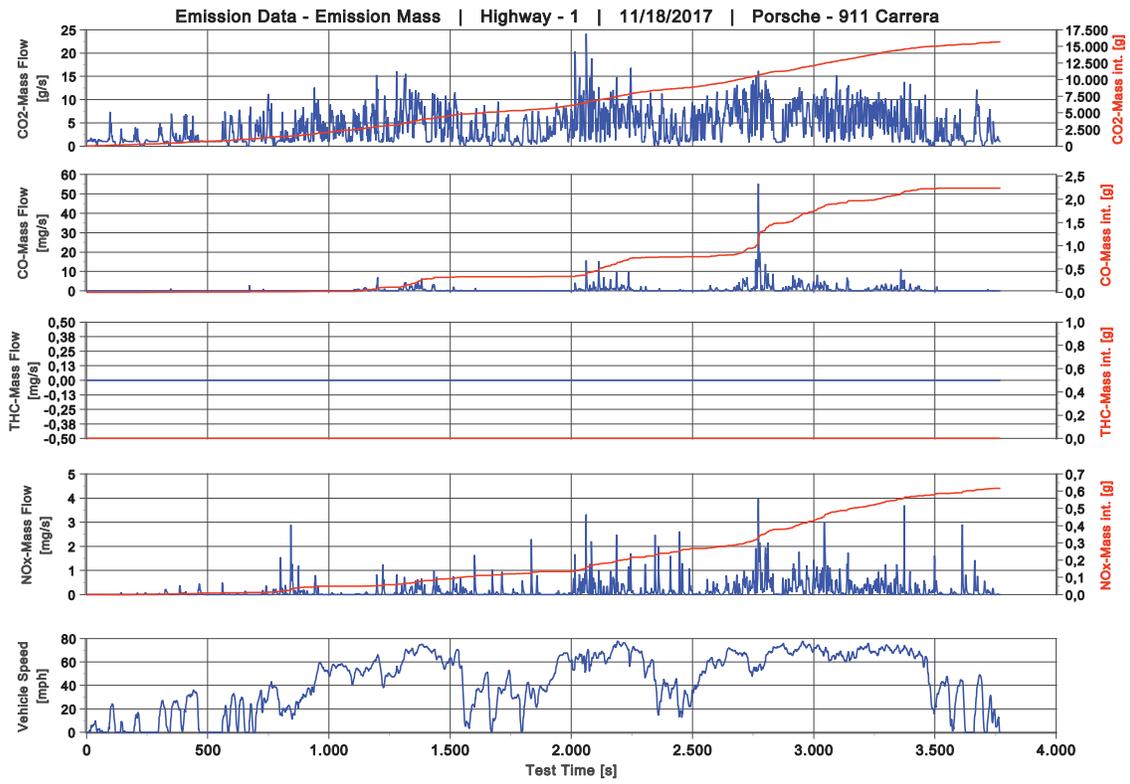
Table 3-24: Highway (1) Trip Summary for 911 Carrera

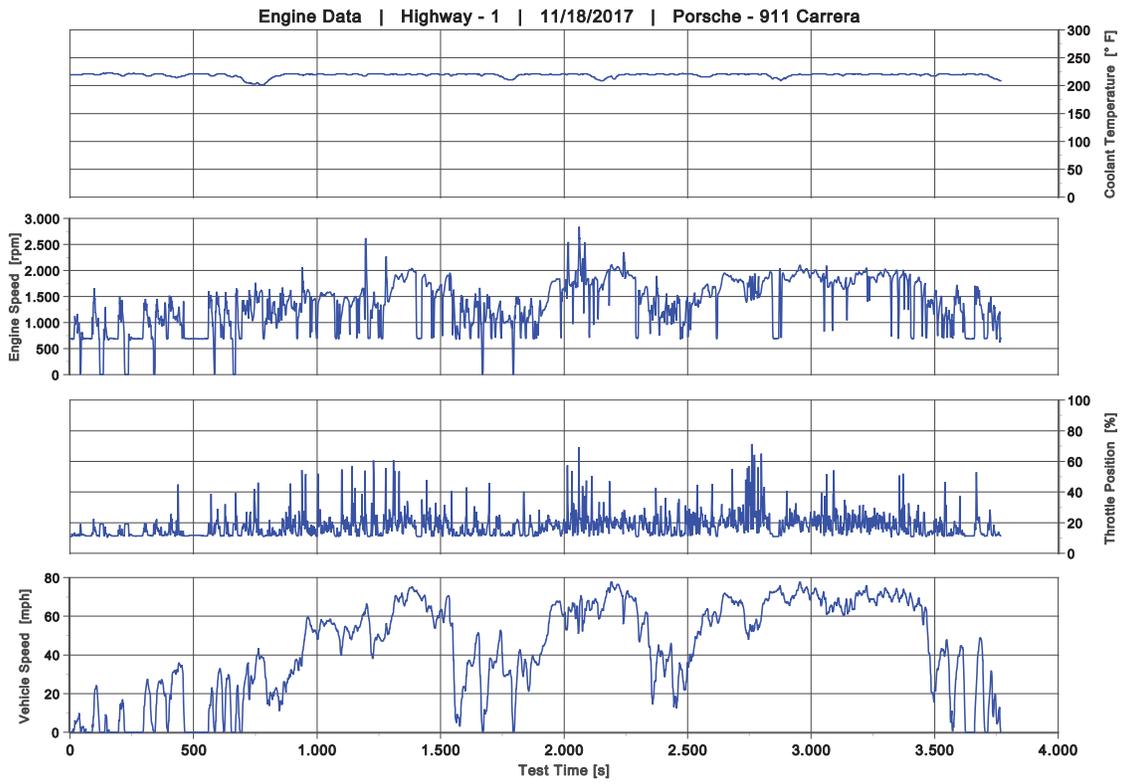
Test Data			
Test Name:	2017-11-18 911-Carrera Highway1		
Department:	MBtech	Test Date:	11/18/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	[REDACTED]	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	341,30	
CO	[g/mi]	0,049	
NO <sub>x</sub>	[g/mi]	0,014	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3771	
Distance	[mi]	45,09	
Average Speed	[mph]	43,0	
Average Ambient Temperature	[°F]	79,3	

Trip Data | Highway - 1 | 11/18/2017 | Porsche - 911 Carrera







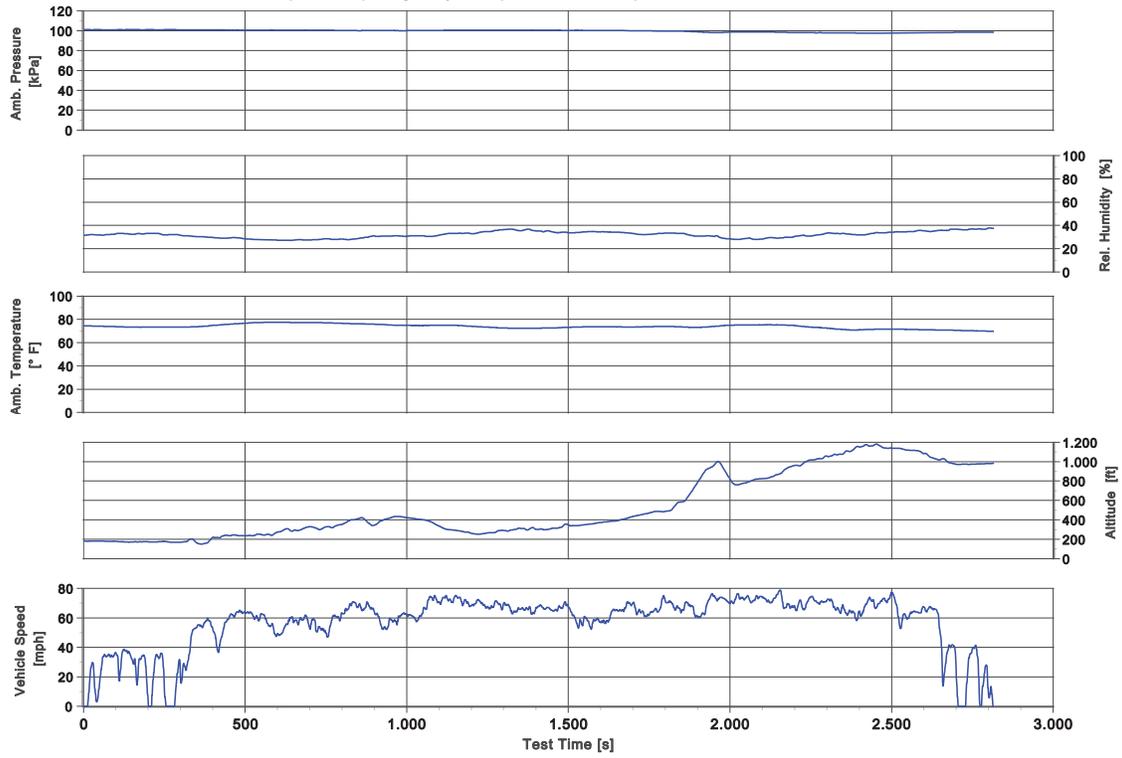


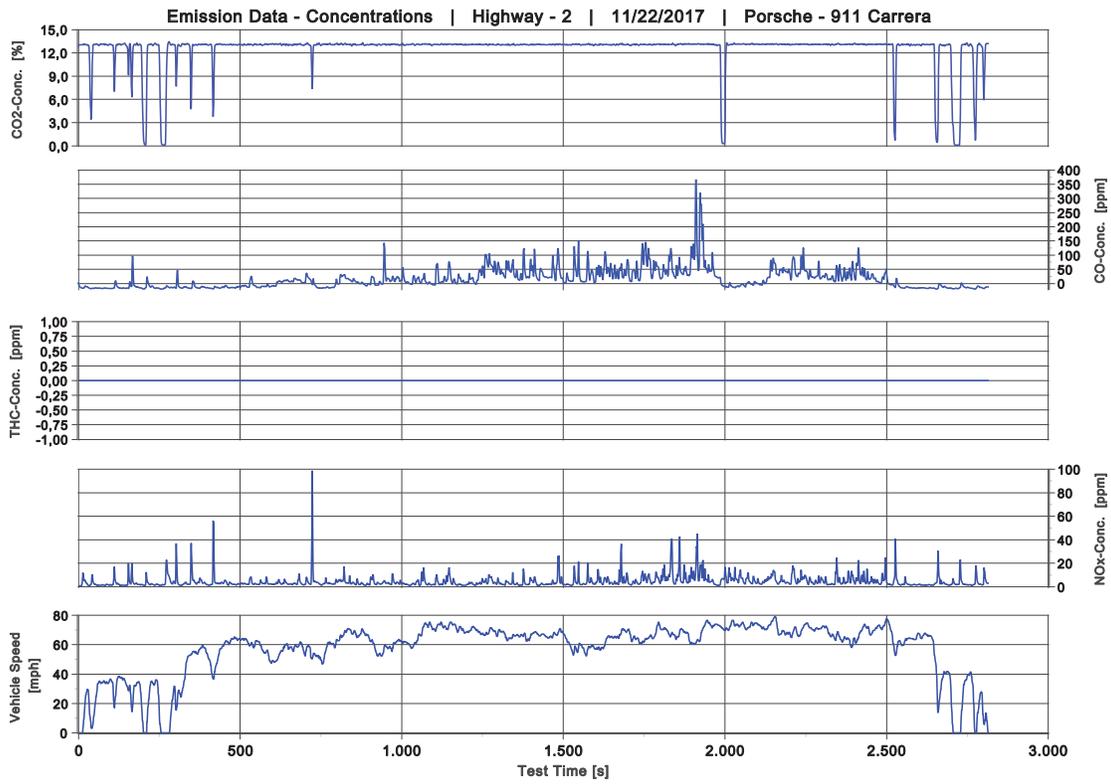
3.6.5 Highway (2)

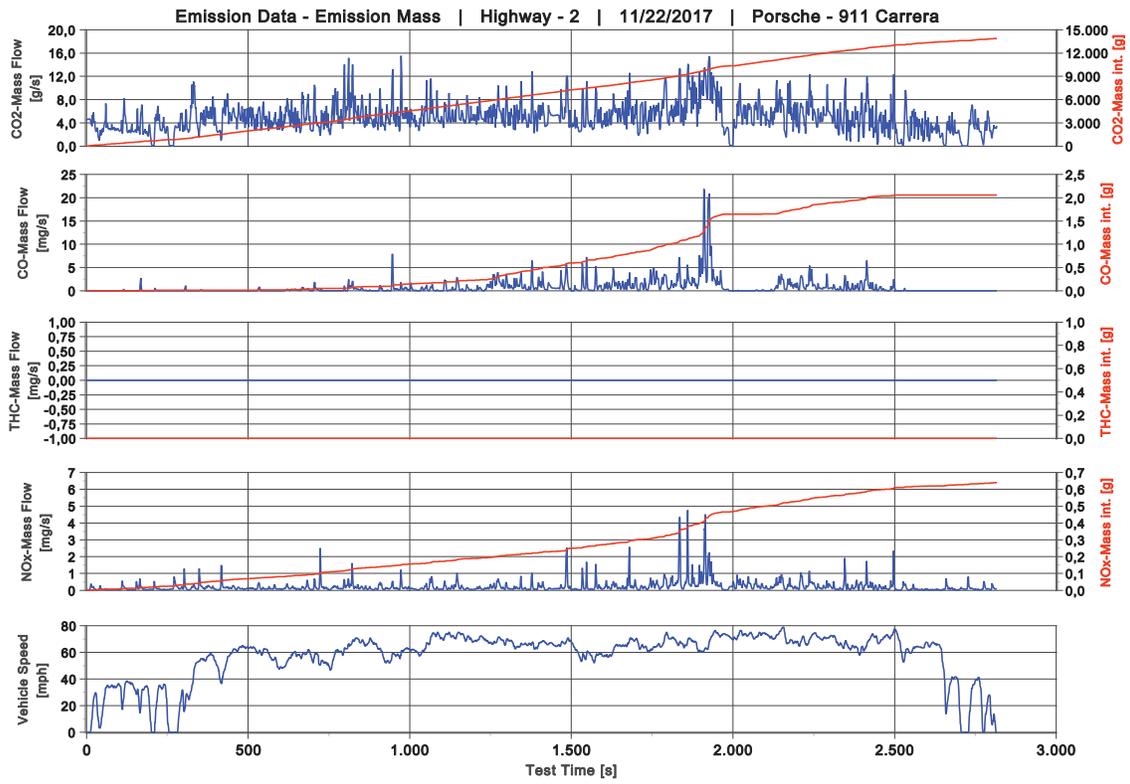
Table 3-25: Highway (2) Trip Summary for 911 Carrera

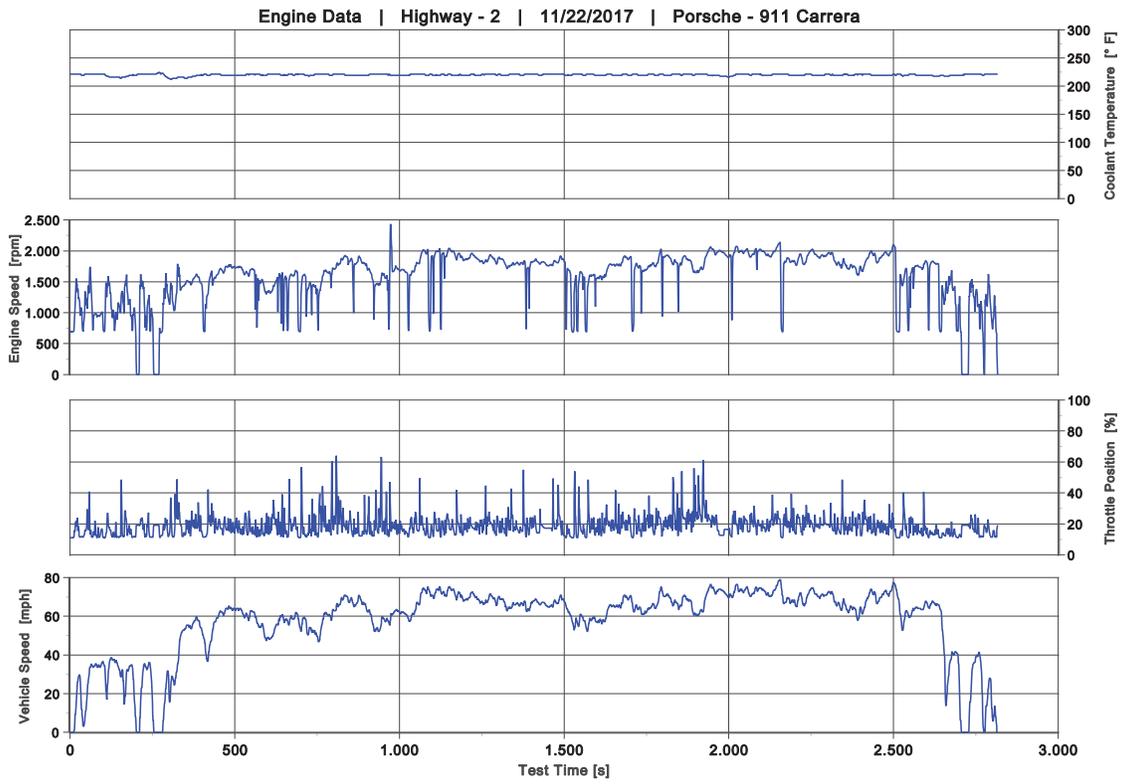
Test Data			
Test Name:	2017-11-22 911-Carrera Highway2		
Department:	MBtech	Test Date:	11/22/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	[REDACTED]	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	309,42	
CO	[g/mi]	0,046	
NO <sub>x</sub>	[g/mi]	0,014	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	2817	
Distance	[mi]	44,85	
Average Speed	[mph]	57,3	
Average Ambient Temperature	[°F]	73,8	

Trip Data | Highway - 2 | 11/22/2017 | Porsche - 911 Carrera







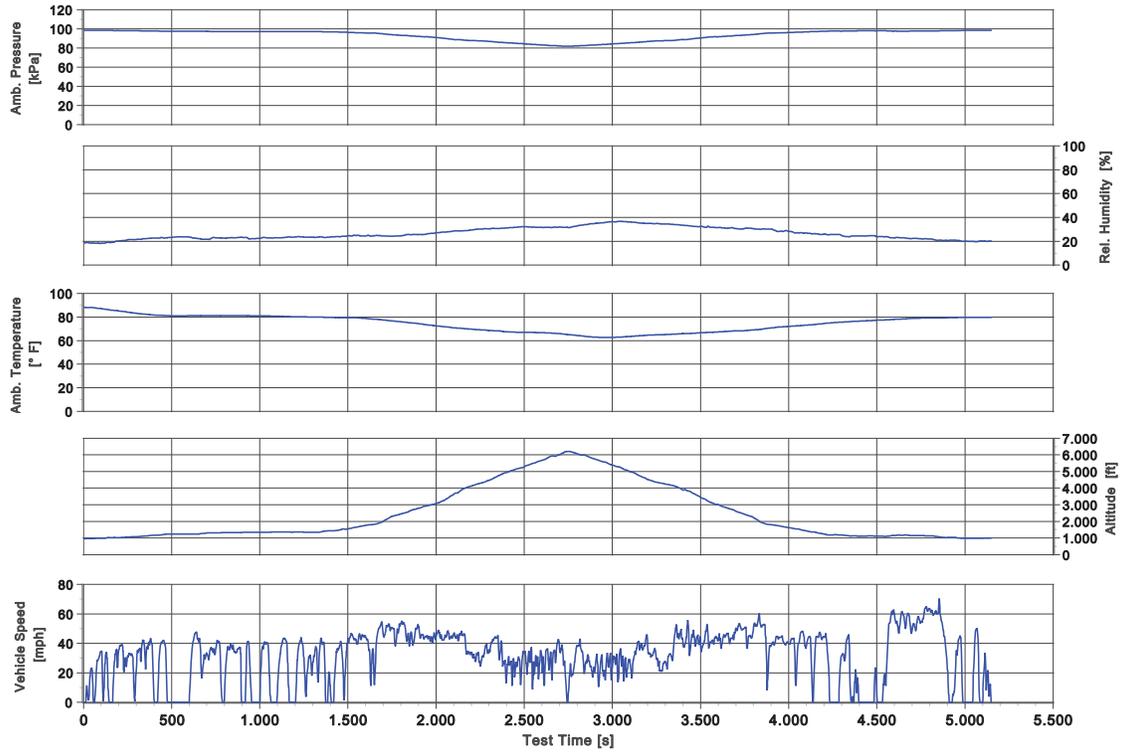


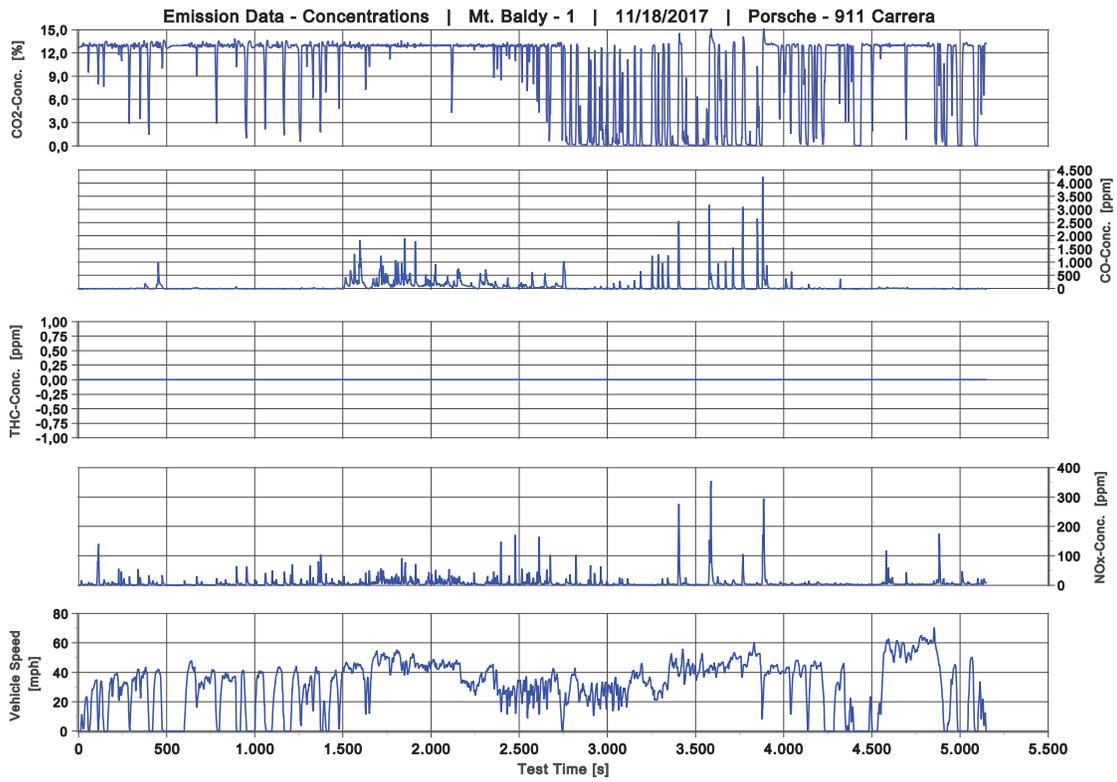
### 3.6.6 Mt Baldy (1)

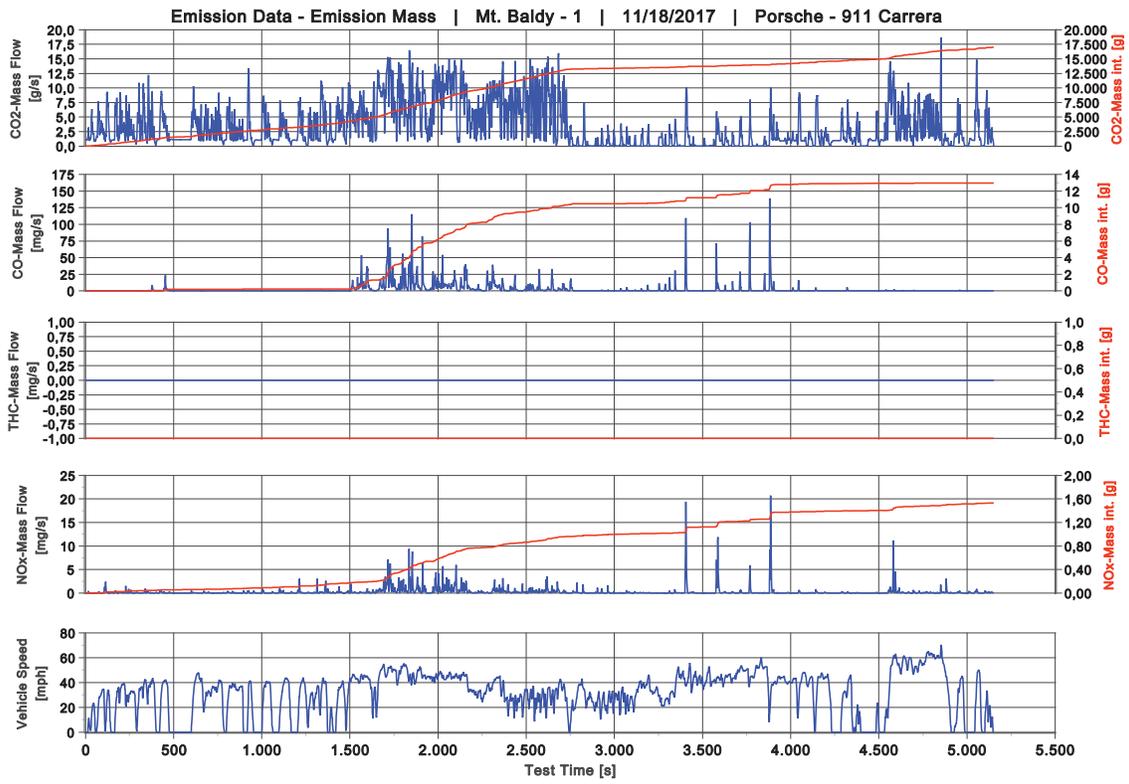
Table 3-26: Mt. Baldy (1) Trip Summary for 911 Carrera

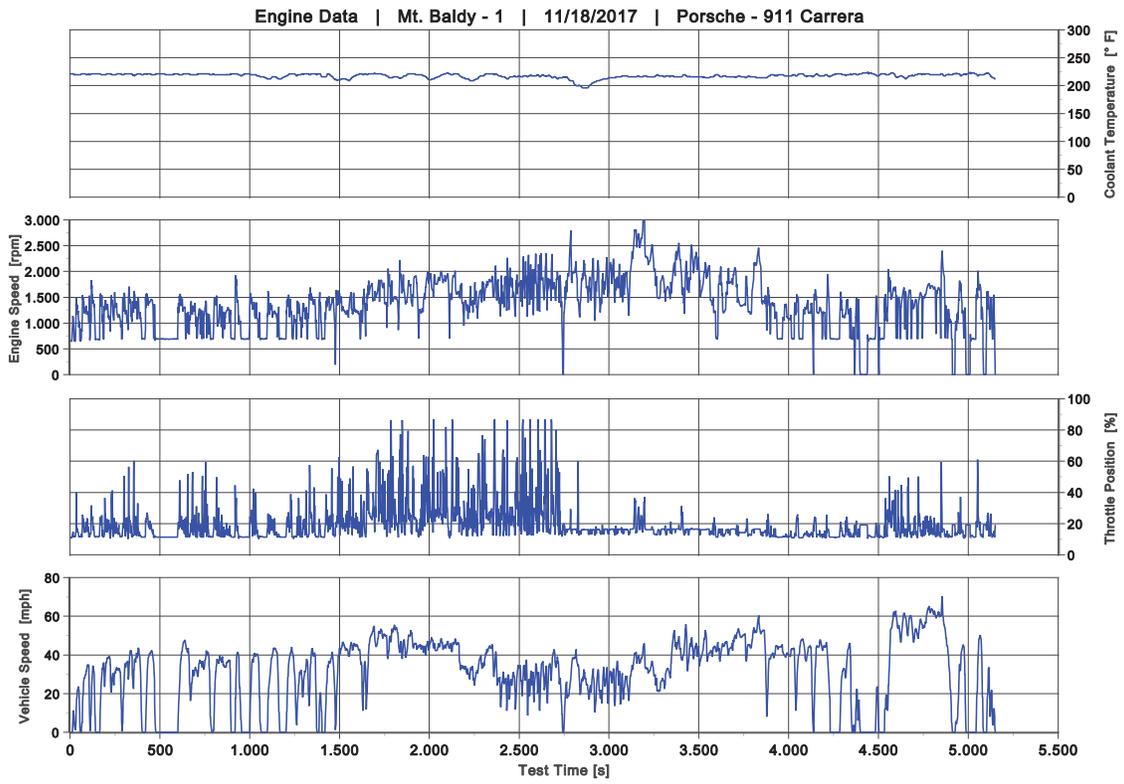
Test Data			
Test Name:	2017-11-18 911-Carrera Mt.-Baldy1		
Department:	MBtech	Test Date:	11/18/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	373,11	
CO	[g/mi]	0,289	
NO <sub>x</sub>	[g/mi]	0,034	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	5152	
Distance	[mi]	44,69	
Average Speed	[mph]	31,2	
Average Ambient Temperature	[°F]	74,6	

Trip Data | Mt. Baldy - 1 | 11/18/2017 | Porsche - 911 Carrera







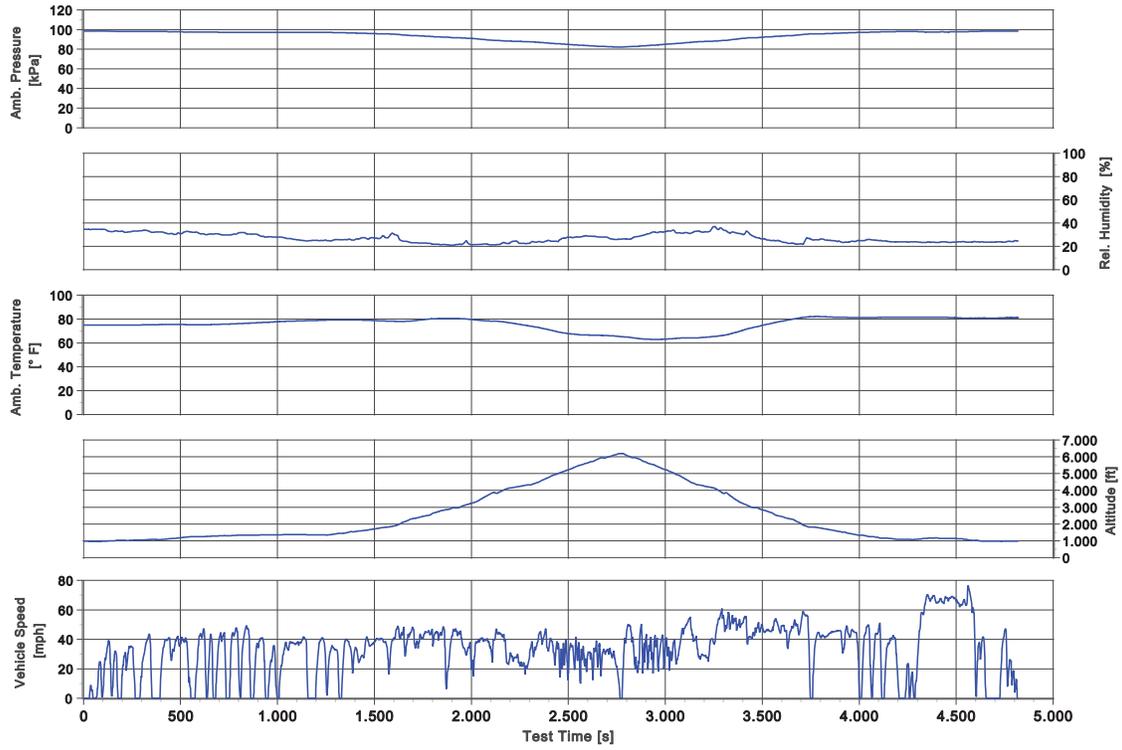


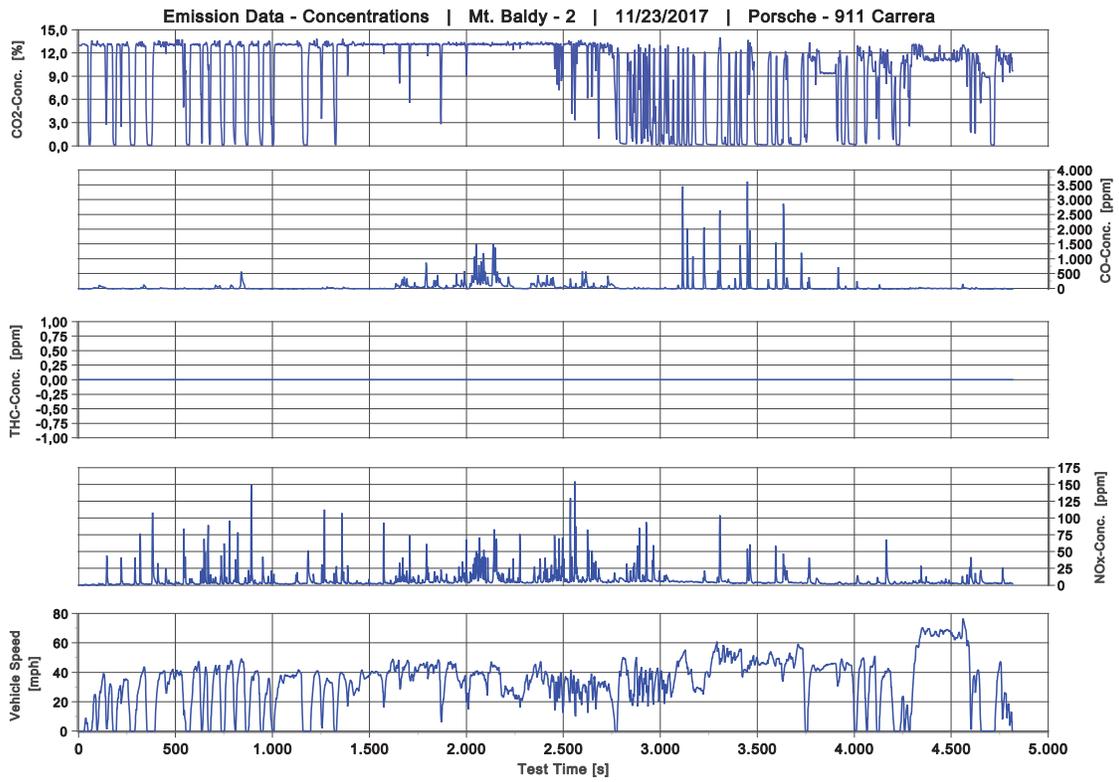
3.6.7 **Mt Baldy (2)**

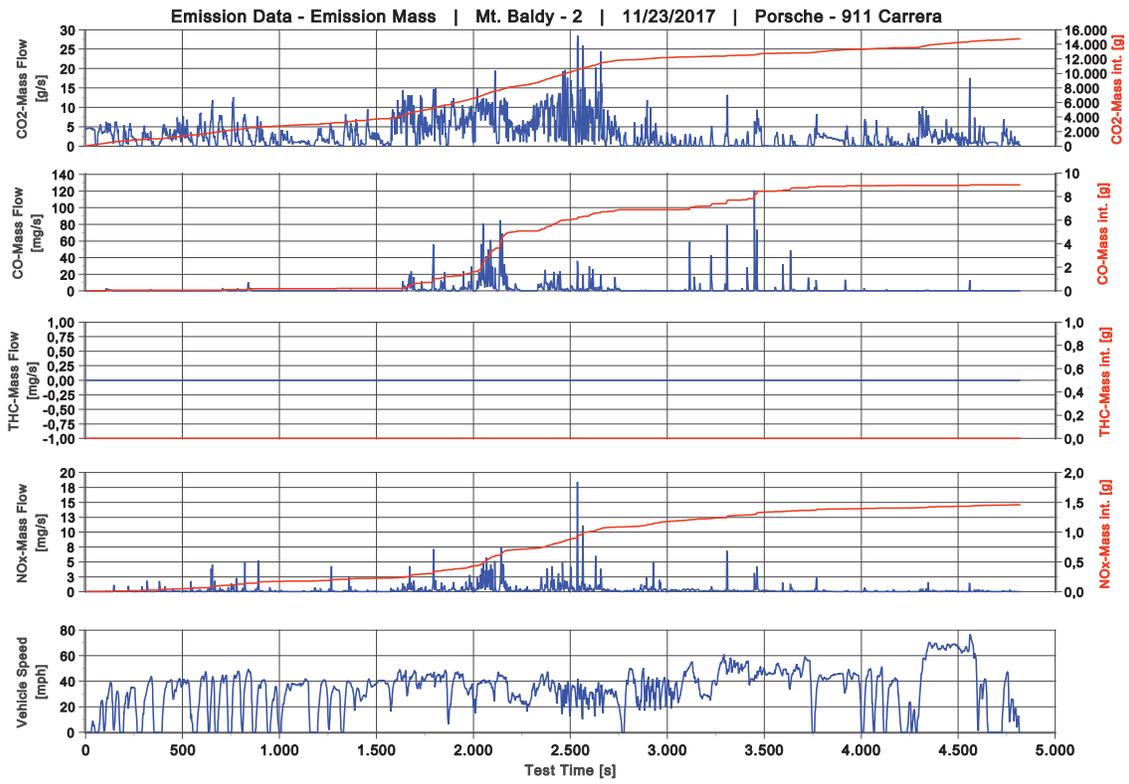
Table 3-27: Mt. Baldy (2) Trip Summary for 911 Carrera

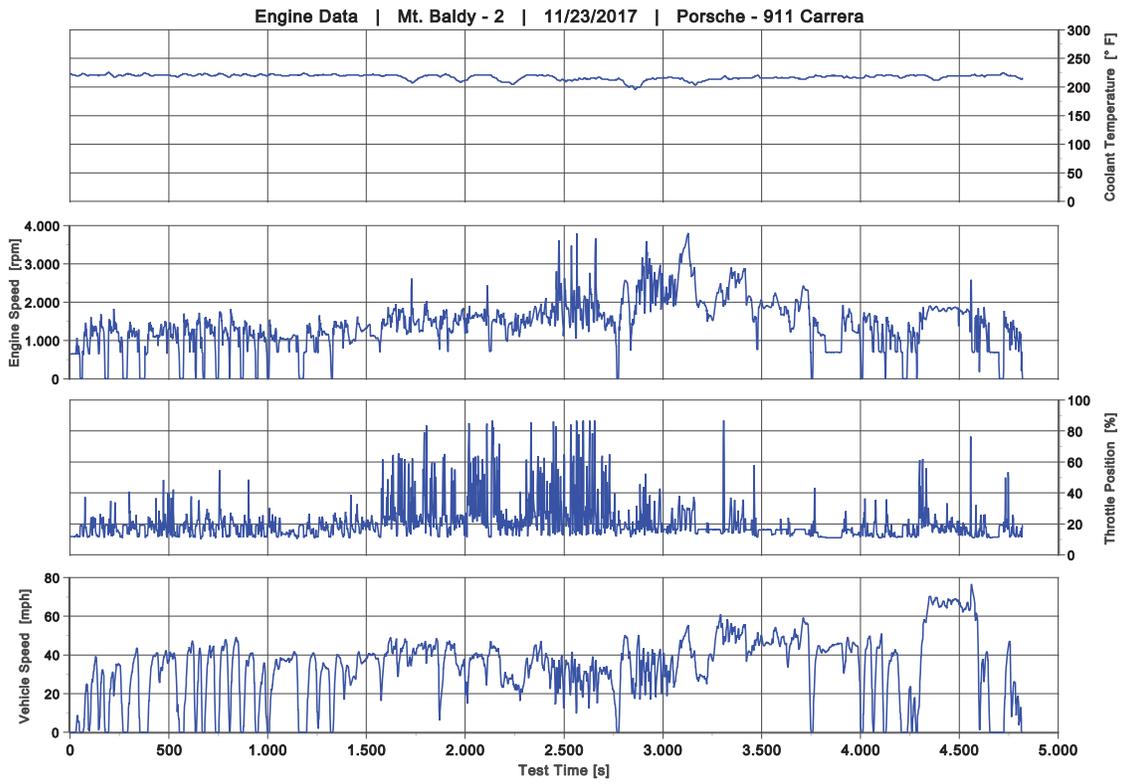
Test Data			
Test Name:	2017-11-23 911-Carrera Mt.-Baldy2		
Department:	MBtech	Test Date:	11/23/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	RWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	272
Vehicle Modell:	911 Carrera	Nominal Torque [Nm]:	450
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 160	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 5100
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	330,75	
CO	[g/mi]	0,202	
NO <sub>x</sub>	[g/mi]	0,034	
THC	[g/mi]	n.a.	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4822	
Distance	[mi]	44,50	
Average Speed	[mph]	33,2	
Average Ambient Temperature	[°F]	75,6	

Trip Data | Mt. Baldy - 2 | 11/23/2017 | Porsche - 911 Carrera









### 3.7 Panamera Turbo

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

Table 3-28: Emission Overview Porsche – Panamera Turbo

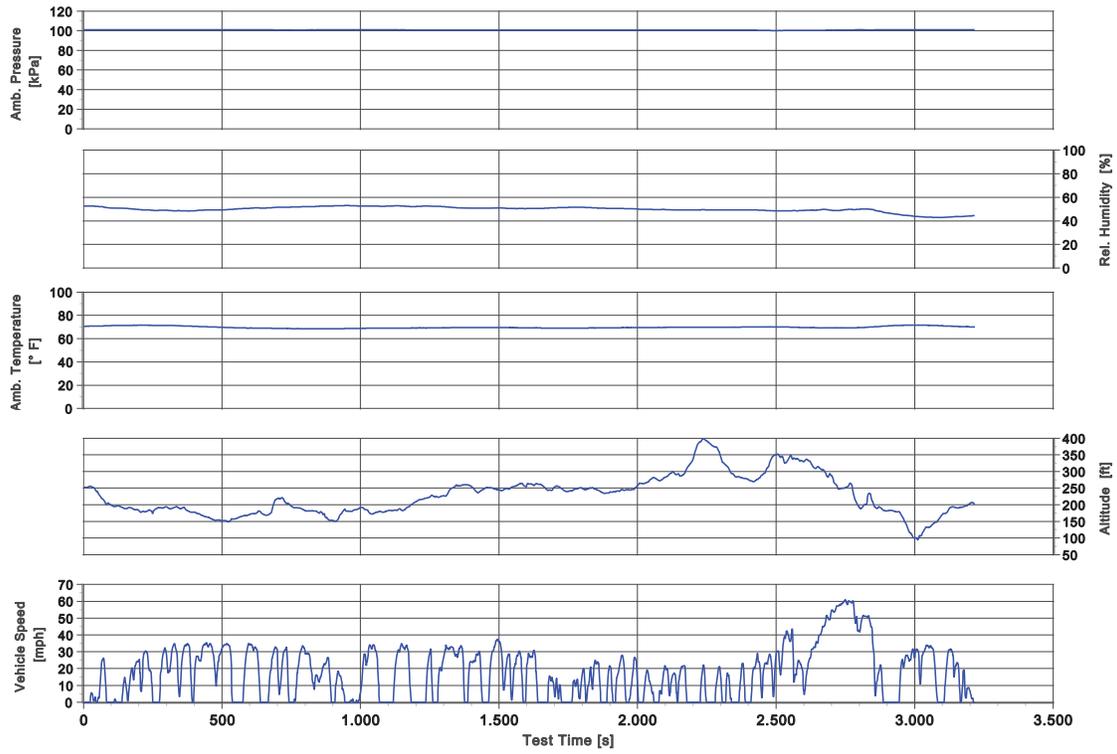
Panamera Turbo		Emissions				Test	
Date	Route / Test	CO <sub>2</sub> [g/mi]	CO [g/mi]	NO <sub>x</sub> [g/mi]	THC [g/mi]	Duration [s]	Distance [mi]
11/27/17	LA Downtown	507,03	0,000	0,012	0,000	3218	15,51
11/27/17	Highway	354,44	0,162	0,008	0,008	3727	44,22
11/23/17	Mt. Baldy	491,67	0,141	0,019	0,014	4705	43,80
11/29/17	FTP75 (PEMS)	418,16	0,041	0,032	0,031	2507	10,74
11/29/17	FTP75 (Dyno)	410,87	0,060	0,040	0,036		

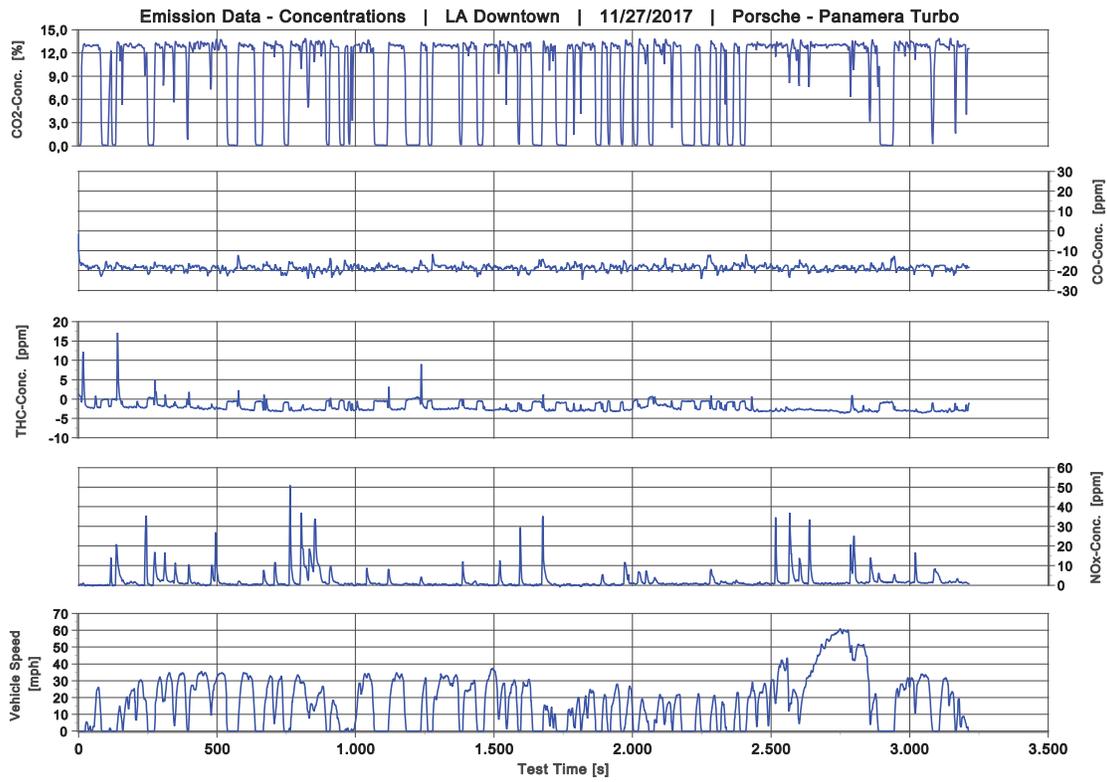
3.7.1 LA Downtown

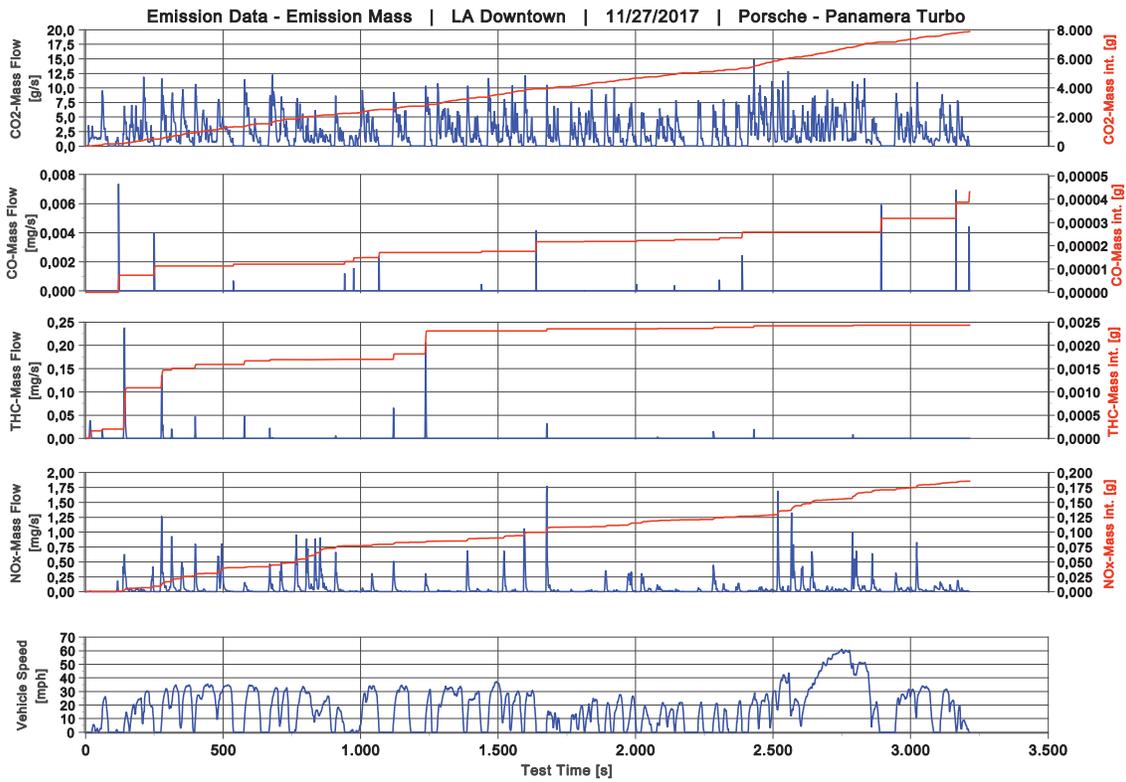
Table 3-29: LA Downtown Trip Summary for Panamera Turbo

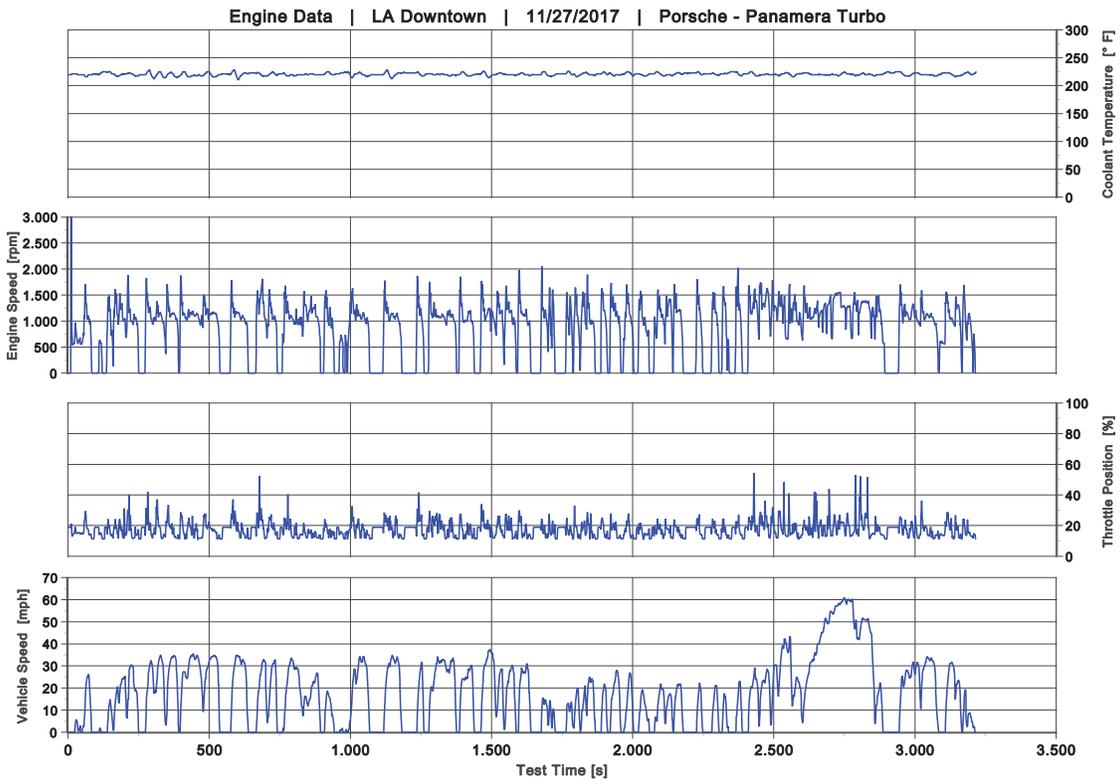
Test Data			
Test Name:	2017-11-27 Panamera-Turbo LA-Downtown		
Department:	MBtech	Test Date:	11/27/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	404
Vehicle Modell:	Panamera Turbo	Nominal Torque [Nm]:	770
VIN:	[REDACTED]	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 125	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	507,03	
CO	[g/mi]	0,000	
NO <sub>x</sub>	[g/mi]	0,012	
THC	[g/mi]	0,000	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3218	
Distance	[mi]	15,51	
Average Speed	[mph]	17,3	
Average Ambient Temperature	[°F]	69,7	

Trip Data | LA Downtown | 11/27/2017 | Porsche - Panamera Turbo







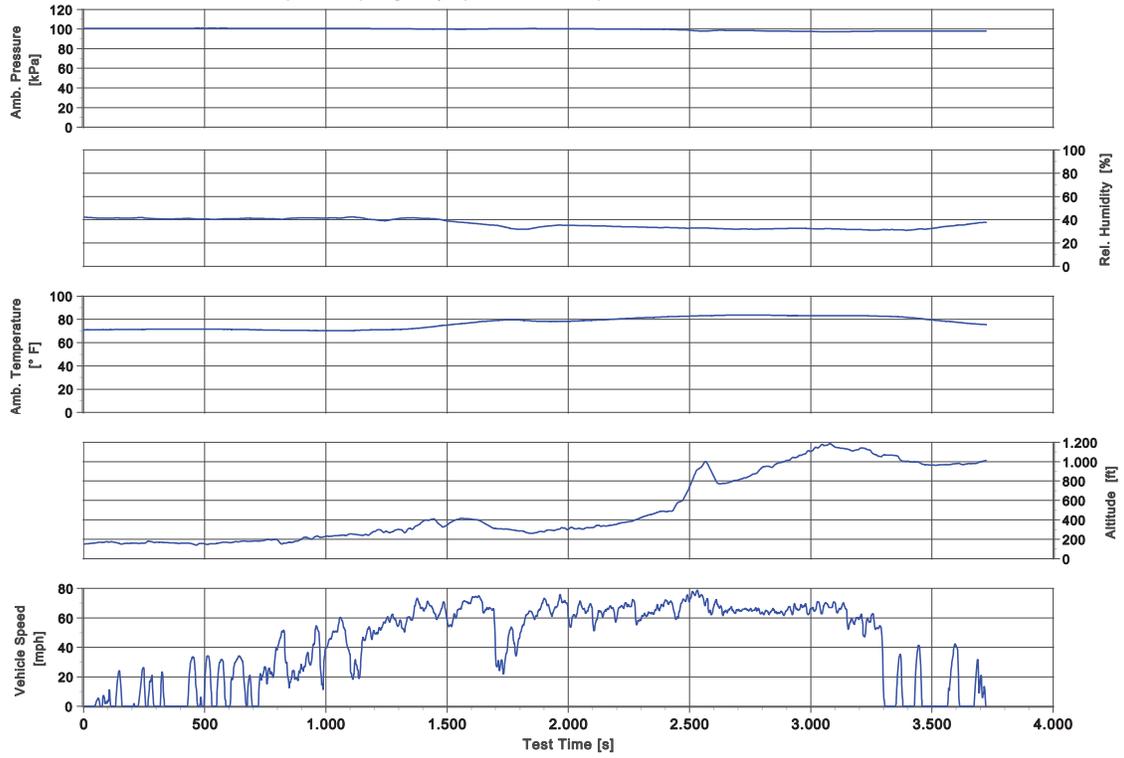


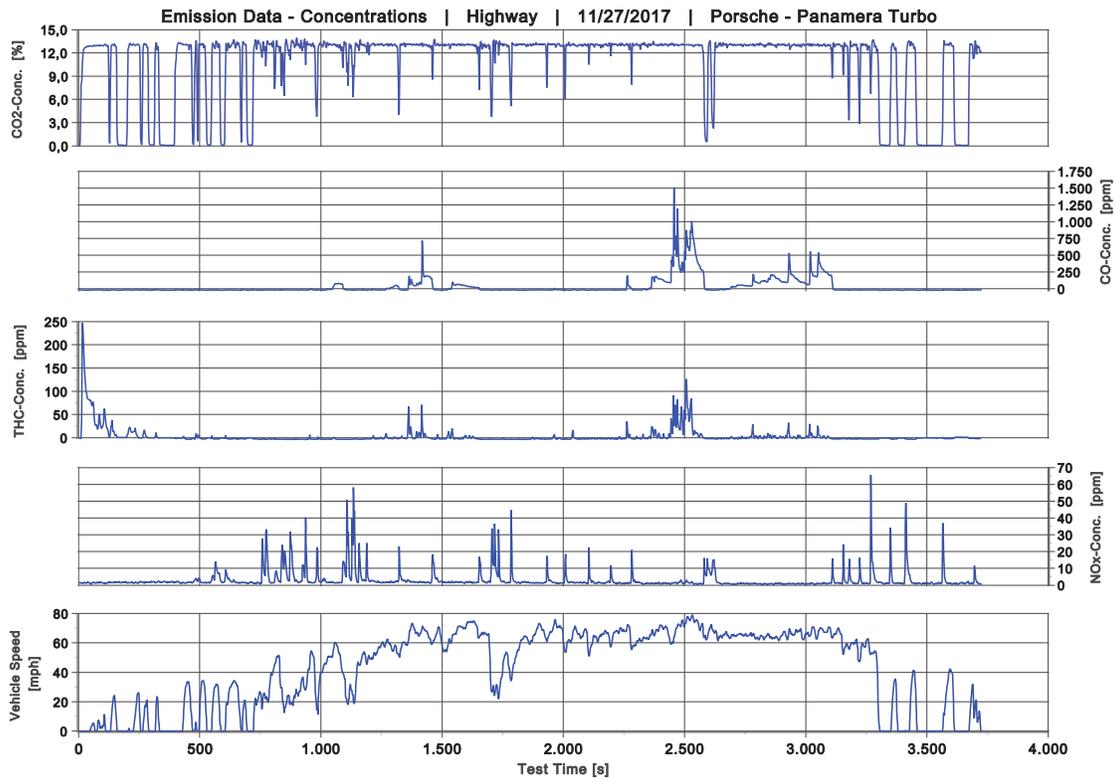
### 3.7.2 Highway

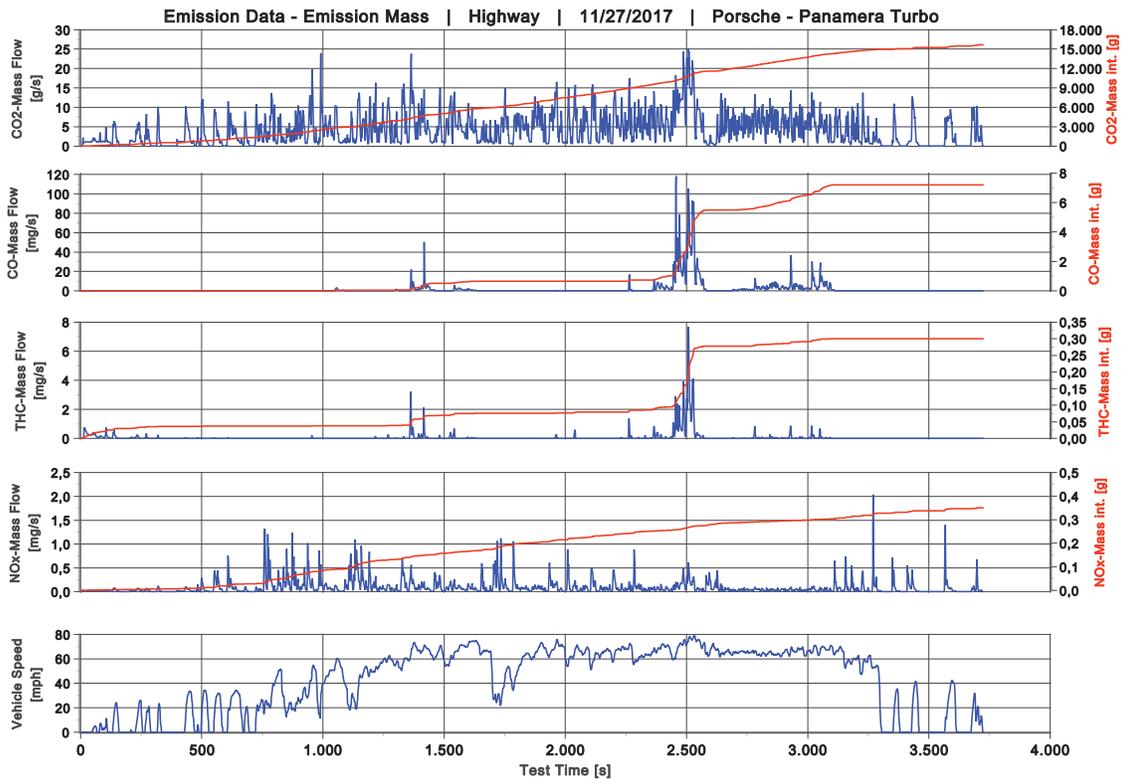
Table 3-30: Highway Trip Summary for Panamera Turbo

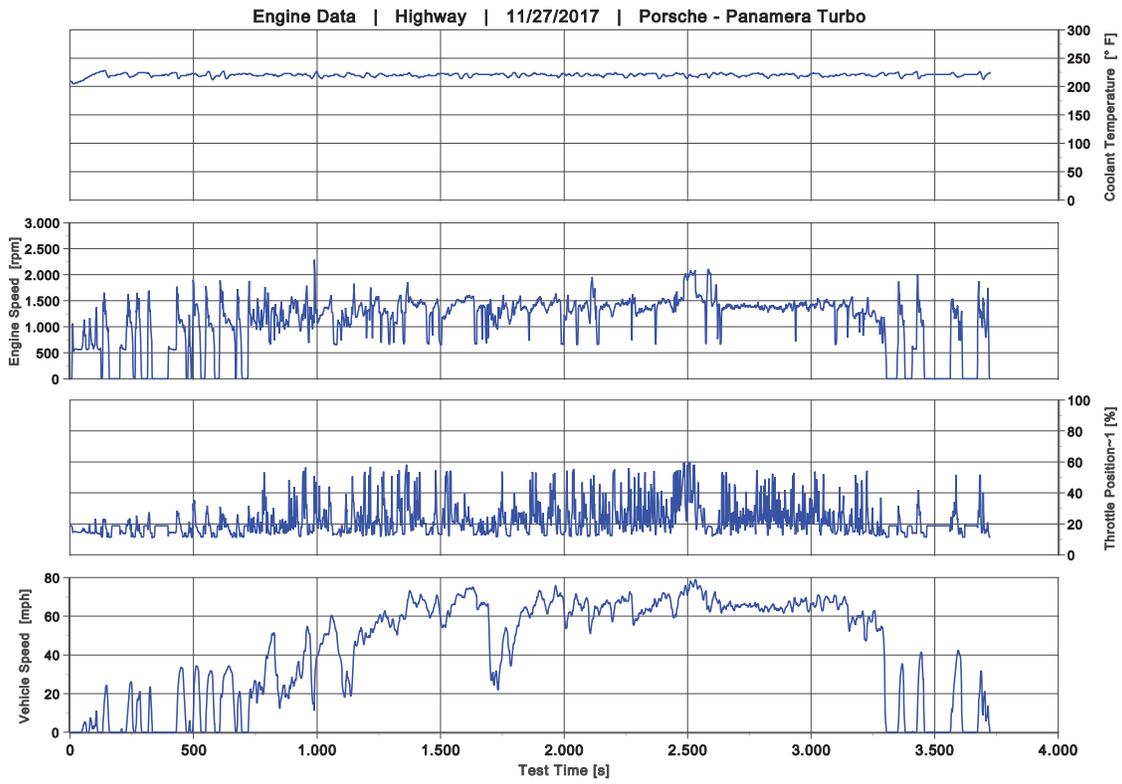
Test Data			
Test Name:	2017-11-27 Panamera-Turbo Highway		
Department:	MBtech	Test Date:	11/27/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	404
Vehicle Modell:	Panamera Turbo	Nominal Torque [Nm]:	770
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 125	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	354,44	
CO	[g/mi]	0,162	
NO <sub>x</sub>	[g/mi]	0,008	
THC	[g/mi]	0,008	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	3727	
Distance	[mi]	44,22	
Average Speed	[mph]	42,7	
Average Ambient Temperature	[°F]	77,0	

Trip Data | Highway | 11/27/2017 | Porsche - Panamera Turbo







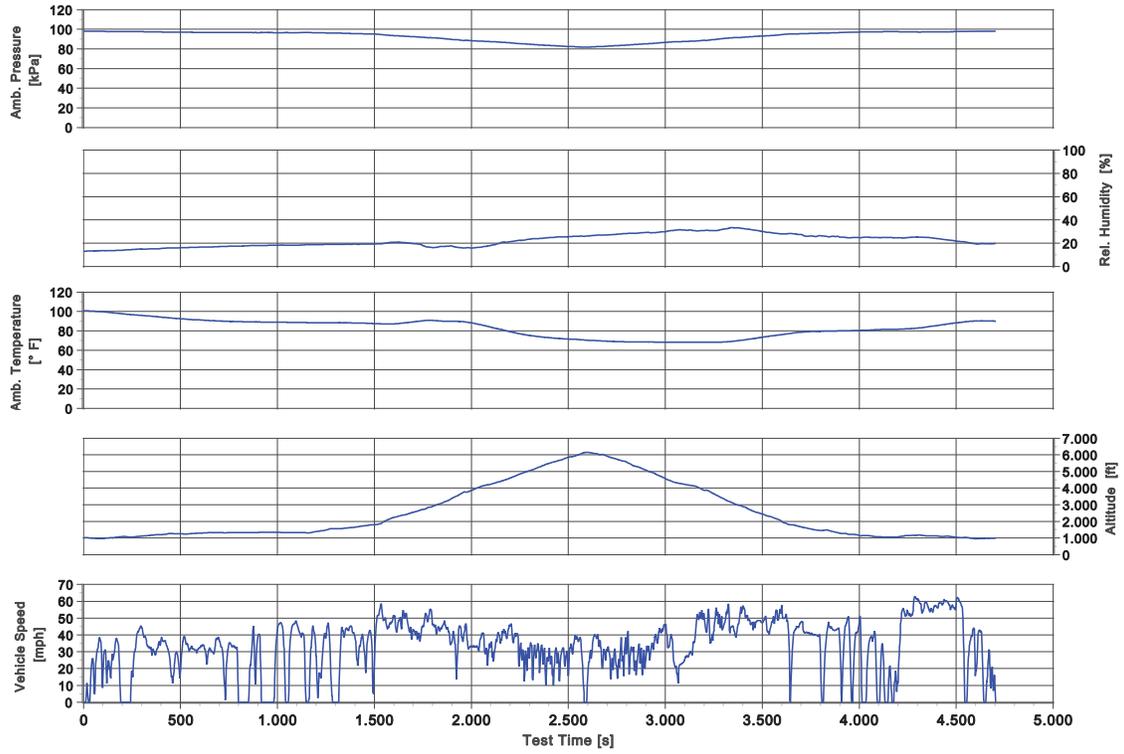


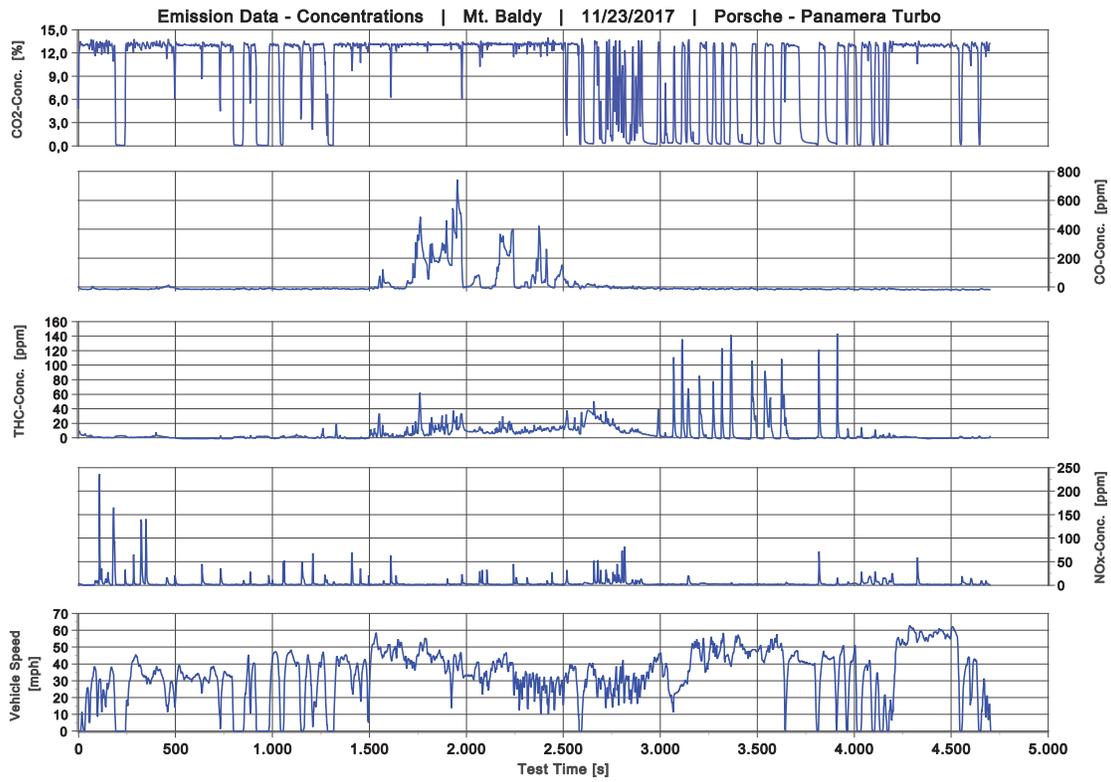
3.7.3 Mt. Baldy

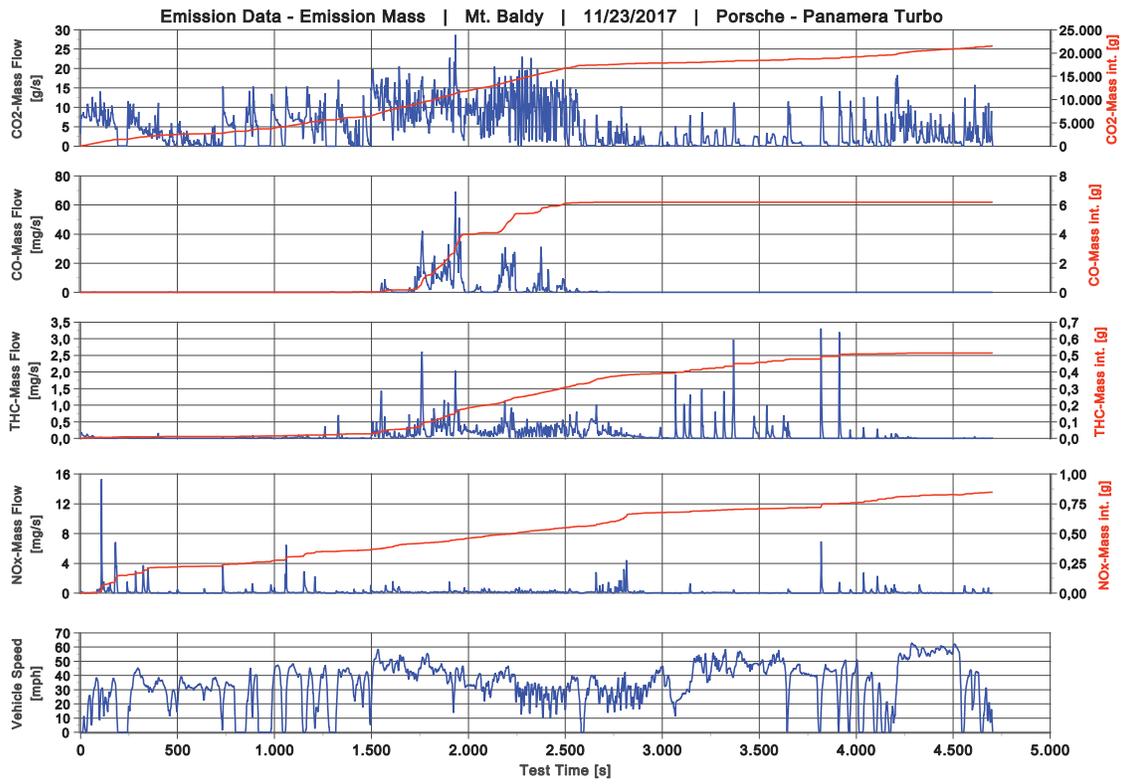
Table 3-31: Mt. Baldy Trip Summary for Panamera Turbo

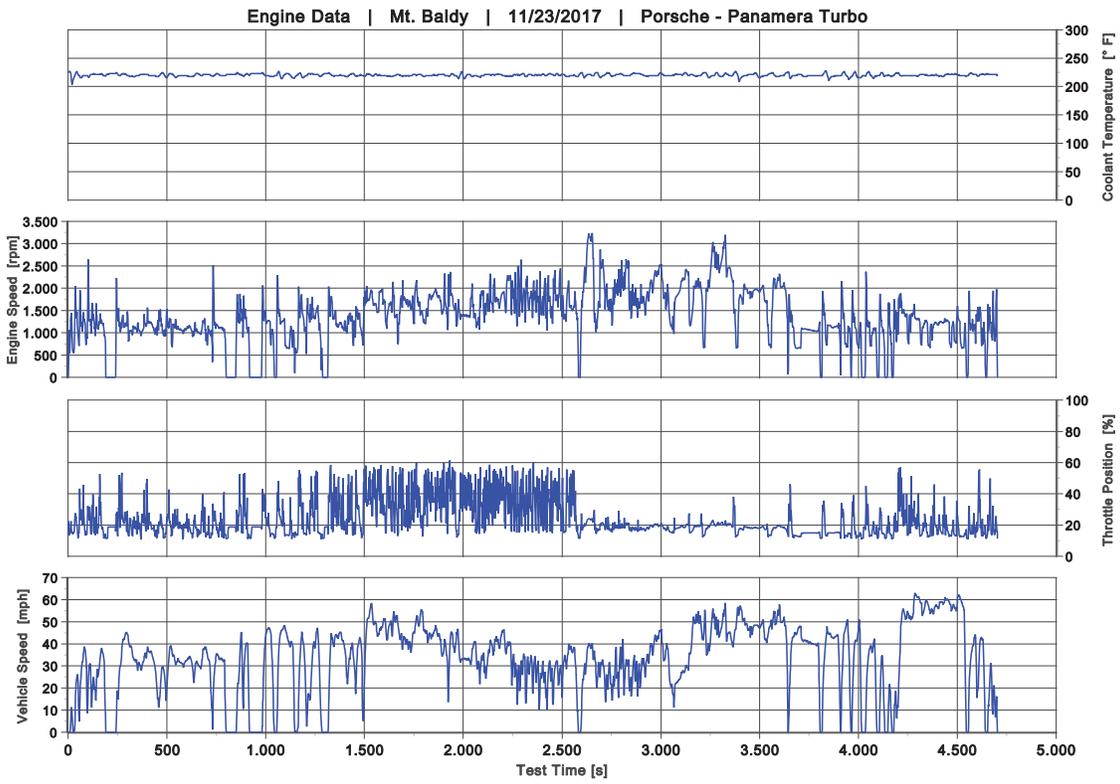
Test Data			
Test Name:	2017-11-23 Panamera-Turbo Mt.-Baldy		
Department:	MBtech	Test Date:	11/23/2017
Driving Mode:	Default	Number of Passengers:	2
Vehicle Data			
Manufacturer:	Porsche	Type of Drive:	AWD
Vehicle Type:	PC / LDV	Nominal Power [kW]:	404
Vehicle Modell:	Panamera Turbo	Nominal Torque [Nm]:	770
VIN:	██████████	Transmission:	AT
License Plate:	PCNA plate	Exhaust Gas Treatment:	TWC
Emission Class:	Tier 3 Bin 125	Type of Fuel:	Gasoline
Drive concept:	Combustion Engine	Mileage [mi]:	ca. 700
Emission Summary			
Exhaust Gas Components	Unit	Total Trip	
CO <sub>2</sub>	[g/mi]	491,67	
CO	[g/mi]	0,141	
NO <sub>x</sub>	[g/mi]	0,019	
THC	[g/mi]	0,014	
Trip Data			
	Unit	Total Trip	
Trip Duration	[s]	4705	
Distance	[mi]	43,80	
Average Speed	[mph]	33,5	
Average Ambient Temperature	[°F]	82,8	

Trip Data | Mt. Baldy | 11/23/2017 | Porsche - Panamera Turbo









## 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 911 Carrera, Panamera Turbo, Cayenne Turbo S, Macan GTS (highest projected sales) and a Macan.

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 executed.

The gaseous emissions from the test vehicles were measured with a PEMS and FID from AVL. The specific pollutants measured were CO, CO<sub>2</sub>, NO<sub>x</sub> (the sum of NO and NO<sub>2</sub>) 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 2017 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.