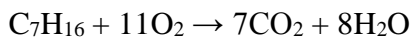


**APPENDIX A****Basic chemical balance equations for combustion of the fuel**

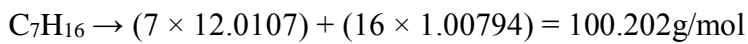
Molecular Masses

C – 12.0107g/mol

H – 1.00794g/mol

O – 15.999 g/mol

N – 14.007 g/mol



Air is 78.09% Nitrogen and 20.95% Oxygen

$$78.09/20.95 = 3.727$$

$$\text{O}_2 = 2 \times 15.999 = 31.998\text{g/mol}$$

$$\text{N}_2 = 2 \times 14.007 = 28.014\text{g/mol}$$

$$\text{Required Mass of Air} = 11 \times ((28.014 \times 3.727) + 31.998) = 1500.605\text{g/mol}$$

$$\text{Ratio} = 1500.605/100.202 = 14.976:1$$

This calculation neglects the formation of nitrogen compounds such as NO and NO₂. Other gases present in air are also not included in the mass calculation.



APPENDIX B

	FE570 2012	FE501 2014	FE450 2014	FC450 2014	
Design	1-cylinder, 4-stroke, water-cooled	1-cylinder, 4-stroke, water-cooled	1-cylinder, 4-stroke, water-cooled	1-cylinder, 4-stroke, water-cooled	
Displacement	565.5	510.4	449.3	449.3	cm ³
Stroke	72	72	63.4	63.4	mm
Bore	100	95	95	95	mm
Compression Ratio	11.8:1	11.8:1	11.8:1	12.6:1	
Idle Speed	1700 - 1800	1950 - 2050	1950 - 2050	2250-2350	rpm
Control	OHC, 4 valves controlled via rocker arm, intake, exhaust cam roller	OHC, 4 valves controlled via rocker arm, intake, exhaust cam roller	OHC, 4 valves controlled via rocker arm, intake cam slider, exhaust cam roller	OHC, 4 valves controlled via rocker arm, intake cam slider, exhaust cam roller	
Valve diameter, intake	38	40	40	40	mm
Valve diameter, exhaust	32	33	33	33	mm
Crankshaft bearing	2 cylinder bearings	2 grooved ball bearings	2 grooved ball bearings	2 grooved ball bearings	
Connecting rod bearing	Needle bearing	Slide bearing	Slide bearing	Slide bearing	
Piston pin bearing	Not a bearing bush - DLC-plated piston pins	Not a bearing bush - DLC-plated piston pins	Not a bearing bush - DLC-plated piston pins	Not a bearing bush - DLC-plated piston pins	
Pistons	Forged light alloy	Forged light alloy	Forged light alloy	Forged light alloy	
Piston rings	1 - compression ring, 1 - oil scraper ring	1 - compression ring, 1 - oil scraper ring	1 - compression ring, 1 - oil scraper ring	1 - compression ring, 1 - oil scraper ring	
Primary transmission	33:76	32:76	32:76	32:76	
Transmission ratio					
1st gear	14:36	14:36	14:36	16:32	
2nd gear	17:32	17:32	17:32	18:30	
3rd gear	19:28	19:28	19:28	20:28	
4th gear	22:26	22:26	22:26	22:26	
5th gear	24:23	24:23	24:23	-	
6th gear	26:24	26:21	26:21	-	



APPENDIX C

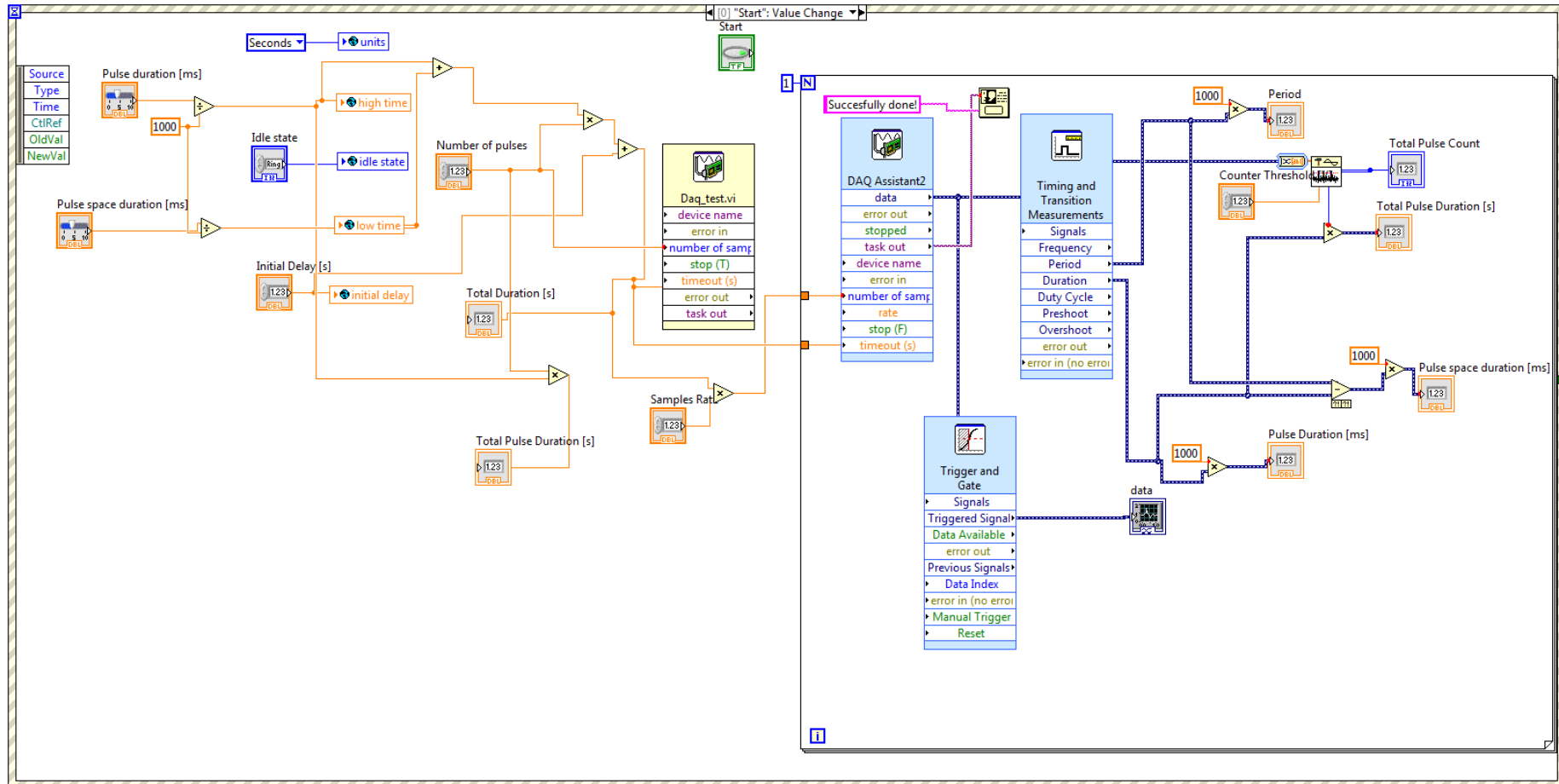


Figure 58 Block diagram of built Application



APPENDIX D

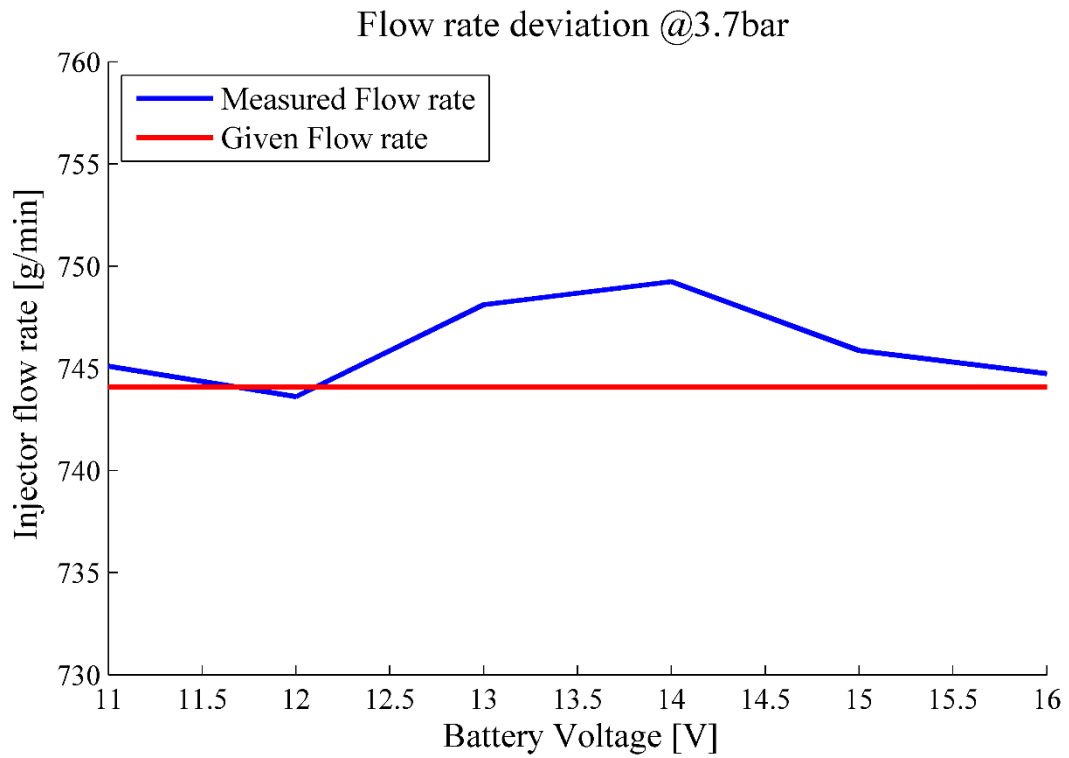


Figure 59 Flow rate deviation for measured injector

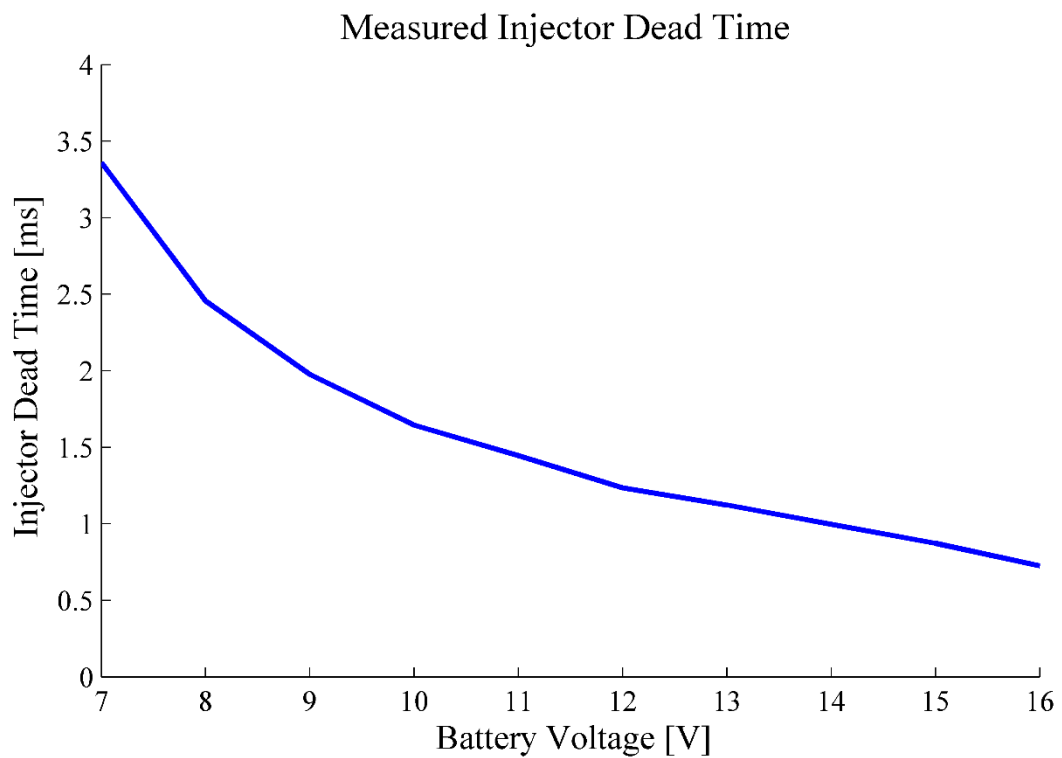


Figure 60 Measured Injector Dead Time



APPENDIX E

Table 11 Injection Windows

Engine Speed			Injection Time					
RPM	RPS	ms per rev	Cycle Window [ms]	60% Duty [ms]	65% Duty [ms]	70% Duty [ms]	75% Duty [ms]	80% Duty [ms]
1000	16.67	60.00	120.00	72.00	78.00	84.00	90.00	96.00
1500	25.00	40.00	80.00	48.00	52.00	56.00	60.00	64.00
2000	33.33	30.00	60.00	36.00	39.00	42.00	45.00	48.00
2500	41.67	24.00	48.00	28.80	31.20	33.60	36.00	38.40
3000	50.00	20.00	40.00	24.00	26.00	28.00	30.00	32.00
3500	58.33	17.14	34.29	20.57	22.29	24.00	25.71	27.43
4000	66.67	15.00	30.00	18.00	19.50	21.00	22.50	24.00
4500	75.00	13.33	26.67	16.00	17.33	18.67	20.00	21.33
5000	83.33	12.00	24.00	14.40	15.60	16.80	18.00	19.20
5500	91.67	10.91	21.82	13.09	14.18	15.27	16.36	17.45
6000	100.00	10.00	20.00	12.00	13.00	14.00	15.00	16.00
6500	108.33	9.23	18.46	11.08	12.00	12.92	13.85	14.77
7000	116.67	8.57	17.14	10.29	11.14	12.00	12.86	13.71
7500	125.00	8.00	16.00	9.60	10.40	11.20	12.00	12.80
8000	133.33	7.50	15.00	9.00	9.75	10.50	11.25	12.00
8500	141.67	7.06	14.12	8.47	9.18	9.88	10.59	11.29
9000	150.00	6.67	13.33	8.00	8.67	9.33	10.00	10.67
9500	158.33	6.32	12.63	7.58	8.21	8.84	9.47	10.11
10000	166.67	6.00	12.00	7.20	7.80	8.40	9.00	9.60
10500	175.00	5.71	11.43	6.86	7.43	8.00	8.57	9.14
11000	183.33	5.45	10.91	6.55	7.09	7.64	8.18	8.73
11500	191.67	5.22	10.43	6.26	6.78	7.30	7.83	8.35



APPENDIX F

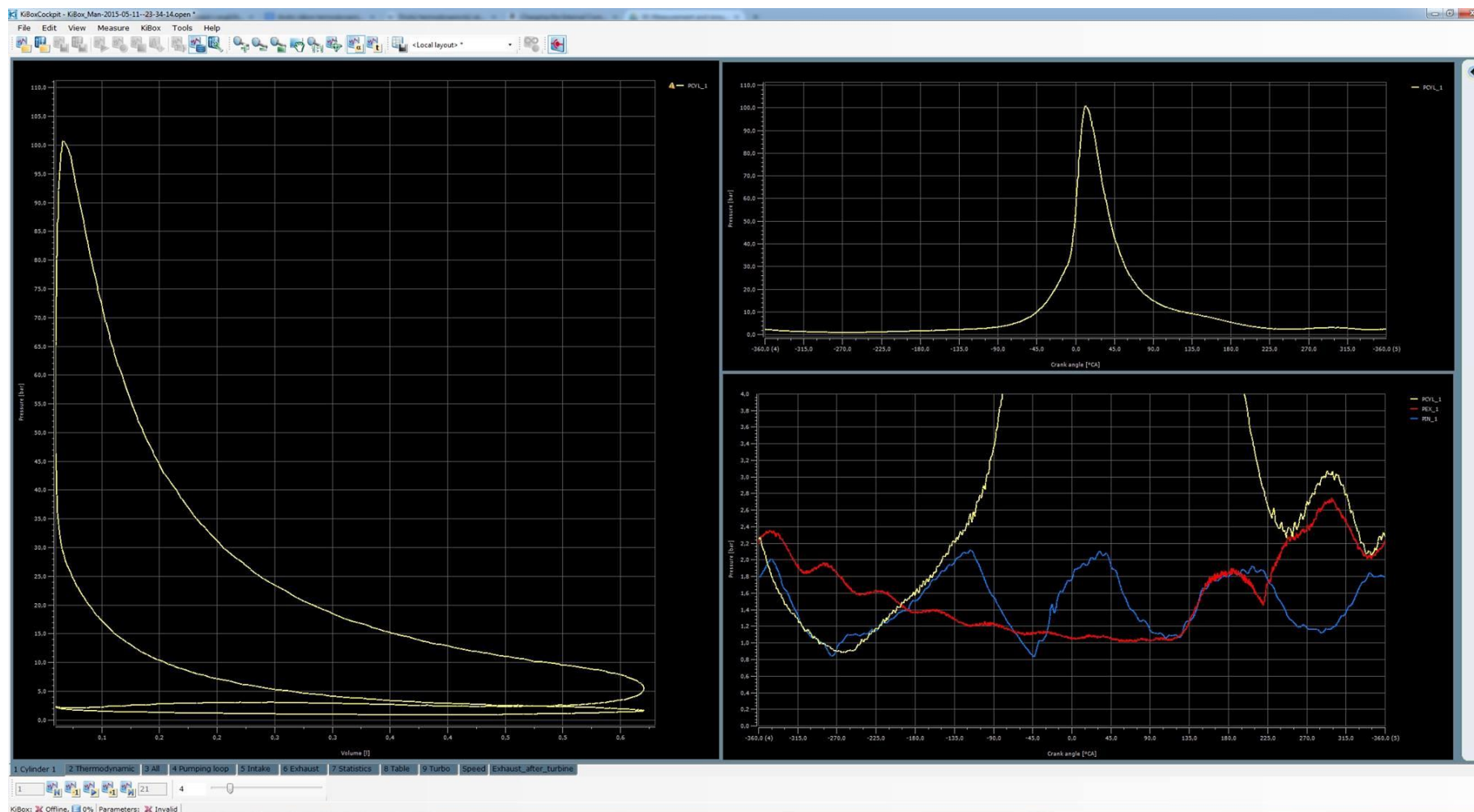


Figure 61 p-V diagram and in-cylinder pressure traces



APPENDIX G

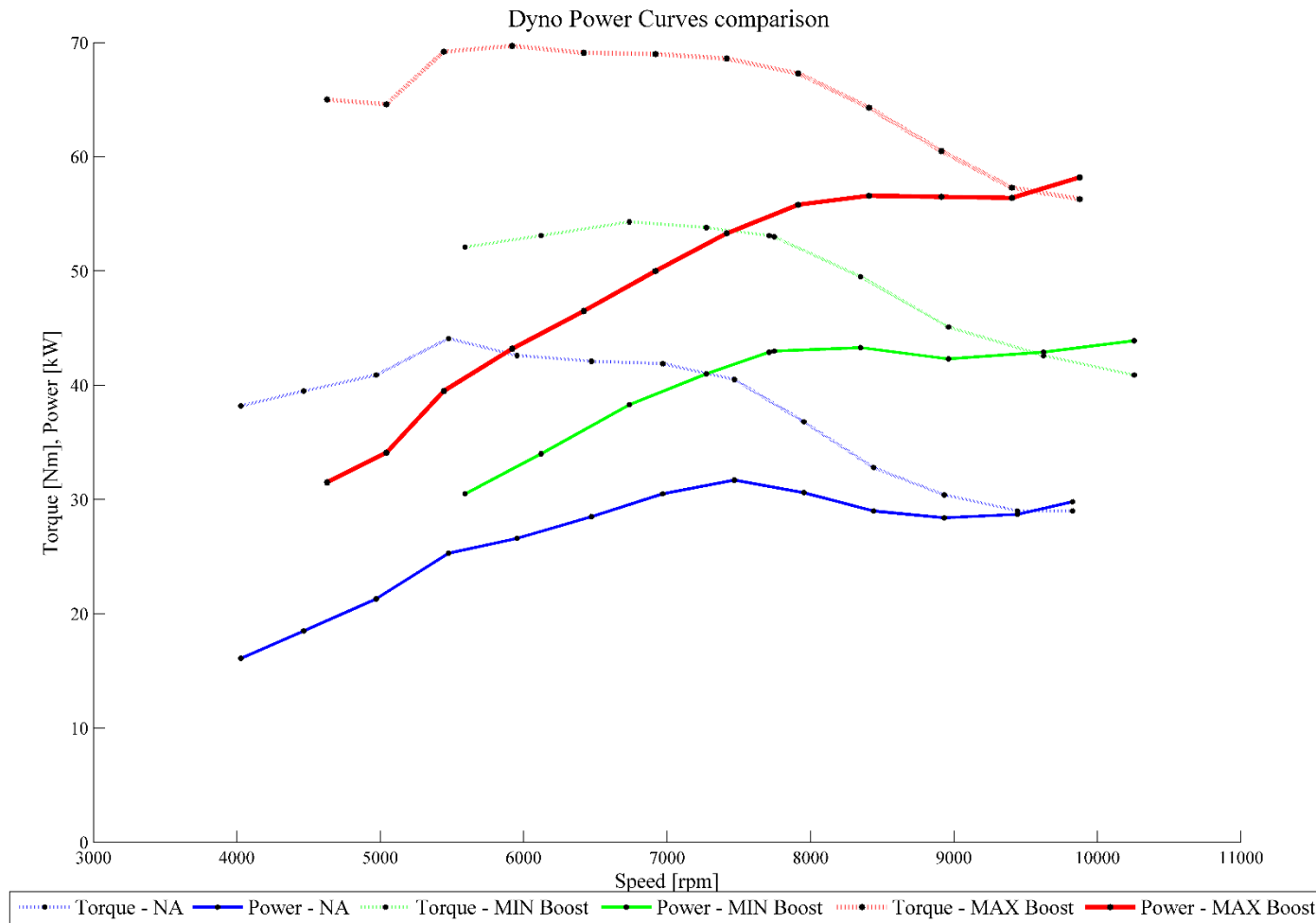


Figure 62 Dyno Comparison Power Curves