

Fortschritt-Berichte VDI ^{Diss. 169}

Reihe 12

Verkehrstechnik/
Fahrzeugtechnik

M.Sc. İpek Saraç,
Stuttgart

Nr. 717

On-Board Diagnostics of Fully Variable Valve Actuator Systems in Spark-Ignited Combustion Engines

Technische Universität Darmstadt
FG Fahrzeugtechnik

**Inventarnummer:
1902**

VDI verlag

Table of Contents

List of Symbols.....	VII
List of Abbreviations.....	VIII
List of Notations.....	X
Abstract.....	XI
1. Introduction.....	1
1.1 Motivation and Objectives.....	1
1.2 Overview and Contributions.....	3
2. Fundamentals of Variable Valve Actuation.....	6
2.1 Conventional Internal Combustion Engines and Camshaft.....	6
2.2 Variable Valve Actuation.....	7
2.3 Electro-Hydraulic Valve Actuation.....	9
2.4 Test Bench Setup.....	12
2.5 Summary and Conclusions.....	16
3. Model-Based Approach to Diagnostics of Fully Variable Valve Actuators.....	17
3.1 Diagnostics Problem.....	17
3.2 Model-Based Fault Detection and Isolation.....	19
3.3 Model-Based Approach to Diagnosis of Fully Variable Valve Actuators.....	21
3.4 Summary and Conclusions.....	24
4. FVV Engine Operating Characteristics.....	25
4.1 Operating Point Selection Criteria.....	25
4.1.1 Fuel Economy vs. Drivability.....	26
4.1.2 Emissions.....	27
4.2 Valve Parameters.....	28
4.3 Dethrottling.....	30
4.4 Internal EGR.....	33
4.5 Full Variable Valve Engine Operating Points.....	38
4.5.1 Approach.....	38
4.5.2 Selection Method.....	40
4.6 Summary and Conclusions.....	46
5. Analysis of Actuator Faults.....	48
5.1 Motivation.....	48
5.2 Classification of Fault Cases.....	49
5.3 Fault Generation and Analysis Approach.....	51
5.4 Special Fault Cases.....	54

5.4.1	Fault of Any Valve Actuator Causing Cylinder to Misfire	54
5.4.2	Fault of Any Valve Actuator Causing Cylinder to Knock	54
5.4.3	Exhaust Valve Does Not Open	54
5.5	Analysis of Fault Cases	54
5.5.1	Fault of Exhaust Valve Opening ($f_{EVO-Late}$)	54
5.5.2	Fault of Exhaust Valve Closing ($f_{EVC-Late}$, $f_{EVC-Early}$)	57
5.5.3	Fault of Intake Valve Opening ($f_{IVO-Late}$)	59
5.5.4	Fault of Intake Valve Closing ($f_{IVC-Late}$, $f_{IVC-Early}$)	61
5.5.5	Fault of Intake Valve Lift ($f_{IVL-Low}$, $f_{IVL-High}$)	62
5.5.6	Fault of Exhaust Valve Lift ($f_{EVL-Low}$, $f_{EVL-High}$)	64
5.6	Summary and Conclusions	66
6.	Diagnosis of Fully Variable Valve Actuators	71
6.1	Overview on Sensors	71
6.2	Measurement Method	74
6.3	Mass Air Flow (MAF) Sensor	75
6.3.1	Pulsations and MAF Precision	78
6.3.2	Cylinder-individual Measurement Capability	83
6.3.3	MAF Sensor Air Adaptation/Fault Detection Capability	92
6.3.4	MAF Sensor Summary and Results	97
6.4	Manifold Absolute Pressure (MAP) Sensor	98
6.4.1	MAP Sensor Fourier Series Modeling	101
6.4.2	MAP Delay Calculation and Phasing	108
6.4.3	Fault Detection and Isolation with MAP Sensor	112
6.4.4	MAP Adaptive Threshold	133
6.4.5	Block Diagram of the MAP Signal Modeling Concept	135
6.5	Knock and Rail Pressure Sensors	137
6.6	Summary and Conclusions	141
7.	Conclusions and Outlook	144
Appendices		148
A.	The Effect of Internal EGR on Combustion	148
B.	Fault Modes Effect Analysis of Electro-Hydraulic Valve Actuation System	149
C.	Influence of Valve Parameters on HFM Signal	154
D.	MAP Sensor Model Using Quadratic Regression	157
Bibliography		161