ABSTRACT

SIMPLEV Version 1.0 was improved to include hybrid vehicle simulations. This electric/series hybrid vehicle simulation code can be used with any IBM compatible personal computer and is useful for performing parametric studies of electric/hybrid vehicle performance on user input driving cycles. The program is run interactively and guides the user through all of the necessary inputs. Driveline components and the traction battery are described and defined by ASCII files which may be customized by the user. Scaling of these components is also possible. Detailed simulation results are plotted on the PC monitor and may also be output to a printer or ASCII text files. This report serves as a users' manual and documents the mathematical relationships used in the simulation.

CONTENTS

Abstract iii

Acronyms ix

Introduction 1

- Errors Corrected 2
- Function and Control Keys 2
- Wheel Slip/Skid 3
- Maximum Motor Torque During Regenerative Braking 3
- Auxiliary Power Unit 3
- User-written Files 4
- Calculated Results 4
- Output Devices 4
- Time Axis 4
- Execution Delay 4

General Description 5

- Simulation Methodology 5
- Program Termination 6
- Report Organization 7
- Executing SIMPLEV 7
  - SIMPLEV Computer Files 7
  - Hardware Requirements 9
  - Starting SIMPLEV 9
  - Input Screen 10
  - SIMPLEV Output 39
- Troubleshooting 50
  - Compiler Error Messages 52

Program Description 55

- Description of Operation 55
  - Vehicle/Powertrain Configuration 55
  - Road Load Power 55

Driveshaft/Transmission Power 58
Motor 60
Inverter/Controller 61
Battery 61
Minimum Voltage 62
Maximum Current 63
Auxiliary Power Unit 64
Battery Capacity and DOD 66
Battery Scaling 67
Energy 68
Average Battery Power 69
Average Component Efficiencies 70
Battery Efficiency 70
Average Component Losses 71
Coastdown Calculations 71
Input Parameters and Component Definition 71
Vehicle Definition 72
Vehicle File 72
Transmissions 75
Motors 78
Inverter/Controllers 81
Battery Files 83
Auxiliary Power Unit Files 85
Driving Schedule Files 88
References 91

APPENDIX

Appendix A: SIMPLEV Output Using Default Test Case From Introduction Screen A-1

FIGURES

1. SIMPLEV introduction screen displayed after executing SIMPLEV.EXT 11
2. SIMPLEV vehicle selection menu 14
3. Vehicle files listed in response to selection "U" in the SIMPLEV vehicle menu. 14
4. SIMPLEV motor menu 15
5. SIMPLEV inverter/controller menu 15
6. Scaling motor and inverter/controller selected from previous menus 17
7. Adjusting operating limits of the inverter/controller 17
8. SIMPLEV transmission menu 18
9. Scaling SIMPLEV transmission data 18
10. Information entered for continuously variable transmissions 20
11. SIMPLEV driving cycle menu 20
12. Entering road conditions in SIMPLEV 22
13. SIMPLEV battery selection menu 22
14. Battery scaling and pre-discharge options 24
15. Options regarding the operation of an APU 26
16. Modifying maximum and minimum APU engine and generator operating limits 26
17. SIMPLEV menu for changing vehicle parameters 28
18. Calculated parameters which may be selected for saving in a file 30
19. SIMPLEV screen display menu 30
20. Screen display corresponding to selection "1" on Screen Graphics Menu 31
21. Screen display corresponding to selection "2" on Screen Graphics Menu 32
22. Calculated numerical display using option 3 of the display menu or <F4> during program execution 33
23. SIMPLEV menu for selecting output devices and vehicle coastdown 35
24. Coastdown simulation display menu and options 35
25. Speed versus time coastdown display corresponding to selection "1" 36
26. Screen display corresponding to selection "2" on coastdown display menu 37
27. Screen display corresponding to selection "3". 38
28. Page 1 of SIMPLEV printed output 40

29. Page 2 of SIMPLEV printed output 41
30. Page 3 of SIMPLEV printed output 42
31. Block diagram of electric vehicle powertrain assumed for SIMPLEV 56
32. IDSEP vehicle file 73
33. IDSEP transmission file 76
34. Continuously variable transmission operating strategy 79
35. IDSEP motor file containing entire powertrain efficiency performance 80
36. IDSEP inverter file 82
37. NIF-170 battery file 84
38. Sample of SIMPLEV generator file 86
39. Sample of SIMPLEV engine file 87
40. Sample of SIMPLEV catalytic converter file 89
41. Sample of driving schedule file - SAE J227a "A" cycle 90

TABLES

1. Computer files supplied with SIMPLEV, Version 2.0 8

ACRONYMS

APU	Auxiliary Power Unit
ASCII	American Standard Code for Information Exchange
BASIC	Beginners All-purpose Symbolic Instruction Code
CO	Carbon Monoxide
CVT	Continuously Variable Transmission
DOD	Depth-of-Discharge
DOS	Disk Operating System
ELVEC	Electric Vehicle Simulation Program
EV	electric vehicle
FUDS	Federal Urban Driving Schedule
HC	Hydrocarbons
IDSEP	Improved Dual-Shaft Electric Propulsion
NO_X	Oxides of Nitrogen
PC	personal computer
RAM	Random Access Memory
SAE	Society of Automotive Engineers
SFUDS	Simplified Federal Urban Driving Schedule
SI	Standard International
SOC	State-of-Charge
TC/ABS	Traction Control/Antilock Braking System
TSR	Terminate and Stay Resident