4.5 Tri-Mode Hybrid SBW AWS Conversion
Mechatronic Control Systems
for Future Automotive Vehicles

4.5.1 Foreword

The steering of an automotive vehicle is achieved, not only by means of hand wheel (HW) but also by varying actual values of the angular velocity and sense of rotation of all the electro-mechanical/mechano-electrical (E-M/M-E) steered, motorised and/or generatorised wheels (SM&GW) for AWD × AWS vehicles. The high-tech improved tri-mode hybrid SBW AWS conversion made significant progress during the 1990s. One evolutionary factor behind this has been the increasing requirements for active safety as well as ride comfort and road handling (RC&RH) of vehicles.

A major contribution to this progress is the introduction and fast-growing application rate of electrically powered and mechatronically controlled R&P steering gears.

The automotive world is moving toward an all-electric vehicle (AEV) in every respect other than actual conventional SBW AWS conversion, DBW AWD propulsion, BBW AWB dispulsion, and ABW AWA suspension. Enthusiasm for AEV, a feature of the early 1990s, has declined.

Fig. 4.110 Principle layout of the Fijalkowski engine with the two-in-one silent, electronically-commutated, magnetoelectrically-excited, brushless and high-temperature superconductor AC-DC/DC-AC macrocommutator composite-flywheel onboard generator/starter motor [FIJALKOWSKI 1999D, 2000C].

Present wisdom appears to be that wheeled vehicles (WV) are within reach of the crankless, magneto-rheological fluid (MRF) or nano-magneto-rheological fluid (NMRF) mechatronic commutator, constant volume, nearly ideal 2-, 4- or even 5-stroke thermodynamic cycle, twin-opposed-piston-type internal combustion engine (ICE) termed the Fijalkowski engine [FIJALKOWSKI 1986, 1998B, 1999D, 2000C], shown in Figure 4.110. This may be achieved with the aid of very advanced technical features such as fully inlet/outlet (I/O) variable valve timing...
(VVT), highly capable engine management units (EMU), and electrically-heated catalytic converters (ECC) designed for greater conversion efficiency and improved durability.

The automotive industry would much prefer to move towards this trend and be well on the way to automotive mechatronic control as well as E-M linear and rotary actuating of every AEAV’s automotive mechatronic control system.

Completely integrated AEAV like the 6 × 6.6 or 8 × 8.8 and 4 × 4.4 all electric combat vehicles (AECV), shown in Figure 4.11, encourage thoughts of what automotive scientists and engineers call a ride-by-wire (RBW) or x-by-wire (XBW) unified chassis mechatronic control hypersystem [FIJALKOWSKI 1999E].

Particular explanations of these SBW 2WS conversion mechatronic control systems are as follows. The aim of the AECVs is to test new concepts of tri-mode hybrid SBW AWS conversion mechatronic control: by conventional steering or skid steering or by a mixture of both. This embraces linear and rotary E-M actuating of SBW AWS conversion, DBW AWD propulsion, BBW AWB dispulsion, and ABW AWA suspension as well as throttle-by-wire (TBW) traction and/or cruise controls. The RBW mechatronic control system could even take over full control of an AECV in response to signals from very advanced collision-evasion (avoidance) sensors.

As the conventional uncontrolled fluidically powered rack-and-pinion (R&P) steering gear can only provide constant power assistance, whereas the AECV ideally requires a variable support, the introduction of an electrically-powered and mechatronically controlled R&P steering gear is introduced mainly to adapt the level of power assistance to off-road vehicle velocity.

To achieve these objectives, a further increase in the flexibility and controllability of the R&P steering gear is required.