

# Large Engine System Platform (LESP)

## Overview

The Woodward Large Engine System Platform (LESP) enables customers to rapidly develop Woodward® MotoHawk-based engine control applications using a pre-defined modeling framework with plug-n-play logic blocks. LESP offers standard pre-compiled turnkey applications for operating Common Rail Diesel and Dual Fuel engines.

Additionally, the LESP framework offers building blocks to enable customers to develop their own applications and is comprised of starter packages, feature packages, and application templates.

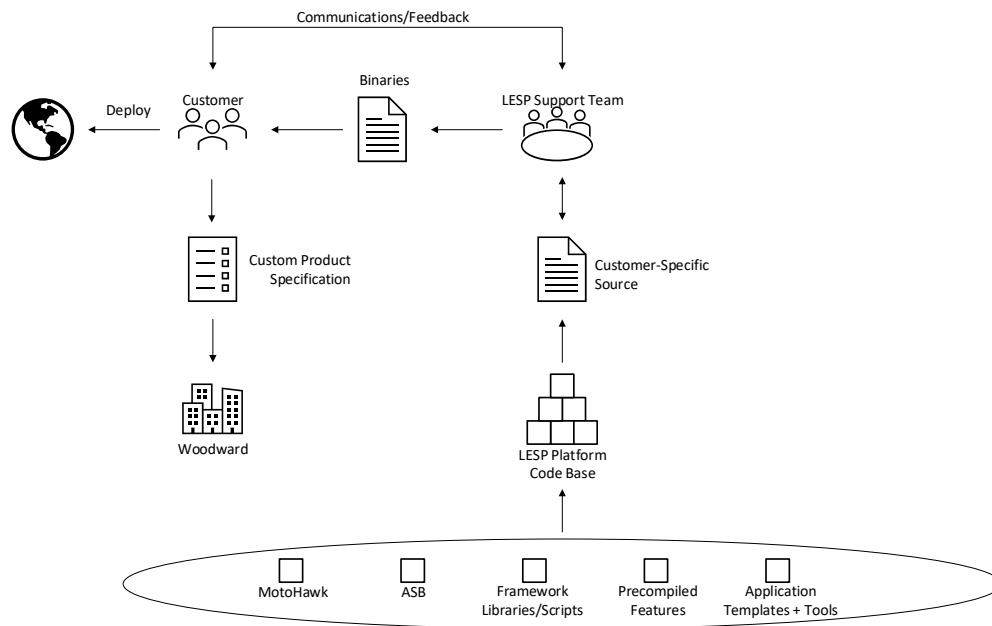


## Turnkey Applications

On a tight timetable, lacking resources, or prefer a pre-built solution based on customized specifications? Woodward offers a precompiled solution using one of the existing LESP application templates that can be customized to meet customer specification for one of the following application types:

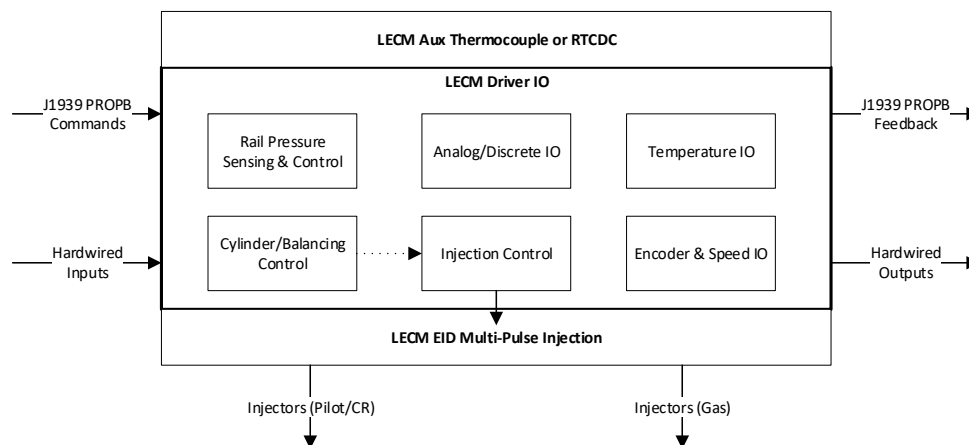
- LECM Diesel Common Rail Application (up to 20 cylinder)
- LECM Diesel Common Rail Multi-Point, Port Fuel Injected Gas Dual Fuel Application (up to 20 cylinder)
- LECM Common Rail Smart Driver IO Application for common rail  $\mu$ P diesel pilot with Multi-Point Port Fuel Gas, Dual Fuel Application (up to 10 cylinder)
- LECM Single or Multi-Point Fumigated Gas Substitution Application (up to 20 cylinder)

- Quickly develop an engine control application using Woodward's large engine hardware
- Utilize the predefined diagnostic management structure for fully integrated diagnostics and management
- Take advantage of a prebuilt, fully flexible, configurable, and failover encoder system design
- Plug-n-Play interfaces to standard Woodward devices
- Leverage precompiled high-level core logic blocks
- IO and datalink structures ready for consumption and customization
- Base ToolKit service tool HMI is easily extended to create a user-friendly service HMI



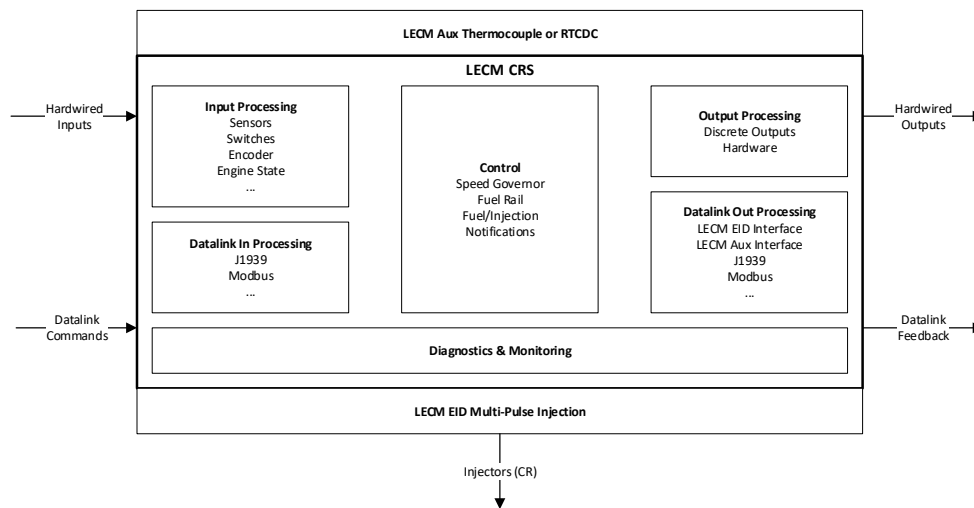
## LECM Smart Driver IO Application

Do you have an existing engine control system and prefer a driver-style support application? LECM supports a pre-built LECM Common Rail Dual Fuel IO “Smart” Driver application that contains a redundant proprietary J1939 interface that converts the LECM into an expansion IO, embedded common rail pressure controller, LECM Electronic Injector Driver (EID) multi-pulse diesel and gas injection control, and supplemental “smart” features for Exhaust Gas Temperature (EGT) or combustion metric-based balancing and cylinder controls. The driver application allows customers to maintain engine control authority with an existing engine control system while leveraging LECM controls and advanced technologies.



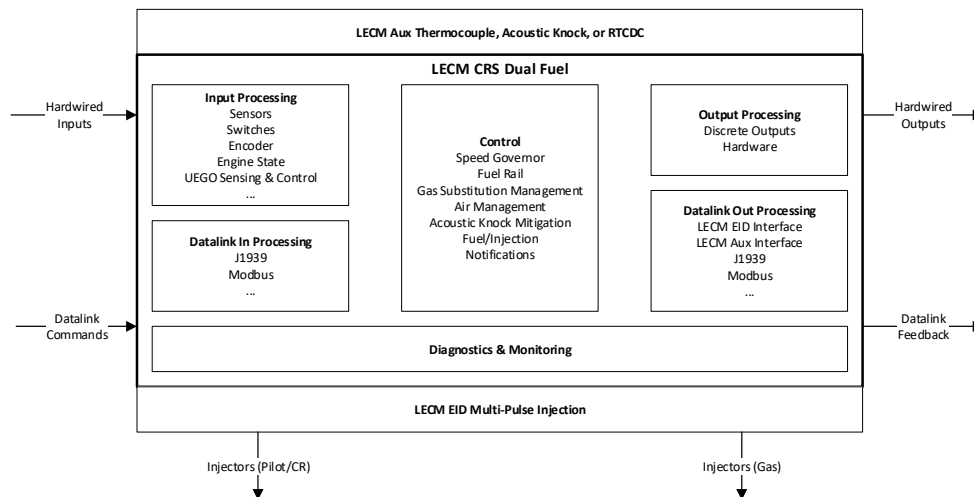
## LECM Diesel Common Rail Application

The LECM Diesel Common Rail application supports up to a 20-cylinder diesel common rail engine and interfaces with the EID injection application variant that enables up to 5 injection events/cylinder/engine cycle. Supported Aux application variants include the Aux 24 thermocouple and Real Time Combustion Diagnostics & Control (RTCDC). The application is a fully functioning engine management system inclusive of sensor processing for CRS applications, redundant and configurable encoder system, speed governing, pump and rail control, engine balancing, fuel trimming, multi-pulse injection, state management, diagnostic management, and support of standard protocols (J1939, Modbus, XCP).



## LECM Diesel Common Rail Micro-pilot, with Multi-Point Port Fuel Injected Gas Dual Fuel Application

The LECM Diesel Common Rail Multi-Point Gas Dual Fuel application supports up to a 20-cylinder diesel common rail injection and gas substituted dual fuel application and interfaces with the EID injection application variant that enables up to 5 diesel injection events/cylinder/engine cycle and a single gas injection event/cylinder/engine cycle. Supported Aux application variants include the Aux 24 thermocouple, Acoustic Knock, or Real Time Combustion Diagnostics & Control (RTCDC). The application is a fully functioning engine management system inclusive of sensor processing for CRS/DF applications, redundant and configurable encoder system, speed governing, pump and rail control, engine balancing, fuel trimming, multi-pulse diesel injection, single-pulse gas injection, acoustic knock mitigation, air management, gas substitution management, state management, diagnostic management, and support of standard protocols (J1939, Modbus, XCP).

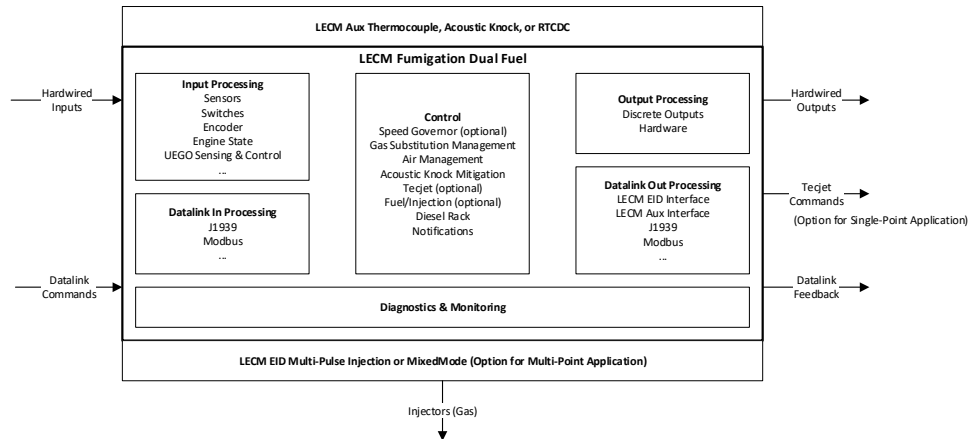


Note: Up to 10 cylinders in a single LECM stack. Larger cylinder counts require an EID expansion module.

## LECM Single or Multi-Point Fumigated Gas Dual Fuel Application

The LECM Single or Multi-Point Fumigated Gas Dual Fuel application supports up to a 20-cylinder gas fumigated diesel rack controlled engine and optionally interfaces with the EID injection or MixedMode application variants that enables a single gas injection event for multi-point style applications. For single-point applications, the application interfaces with a Woodward Tecjet for single-point gas fumigated style applications. Supported Aux application variants include the Aux 24 thermocouple, Acoustic Knock, and Real Time Combustion Diagnostics & Control (RTCDC). The application is a fully functioning *bolt-on* style application to an existing diesel rack controlled engine, inclusive of common sensor processing, redundant and configurable encoder system, optional speed governing feature, single-pulse gas injection for multi-point style applications, Tecjet controlled gas fumigation for single-point style applications, state management, diagnostic

management, acoustic knock mitigation, air management, gas substitution management, and support of standard protocols (J1939, Modbus, XCP).

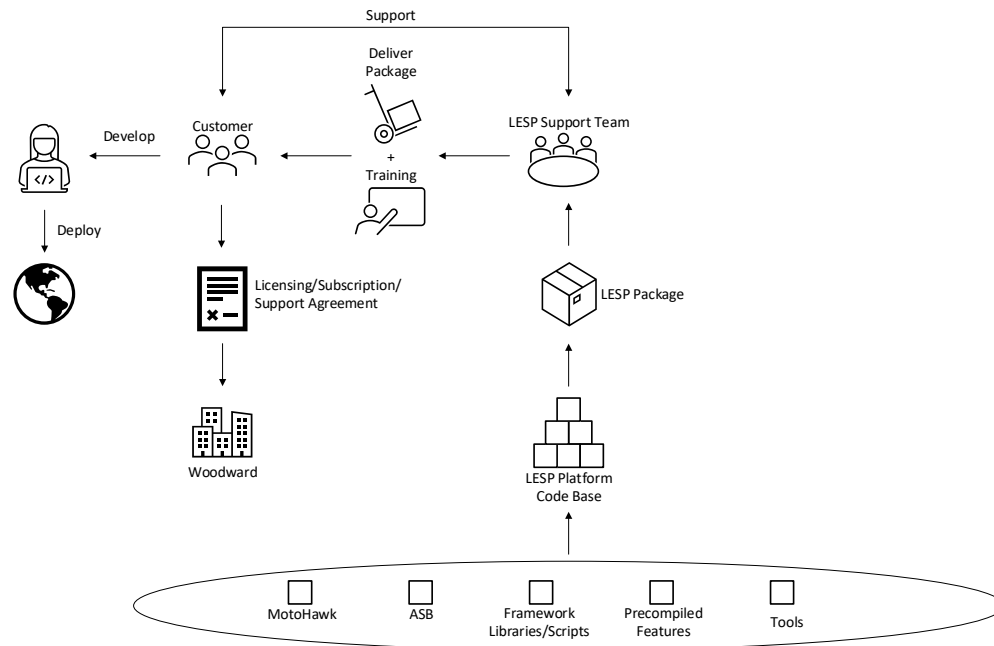


## LESP Framework

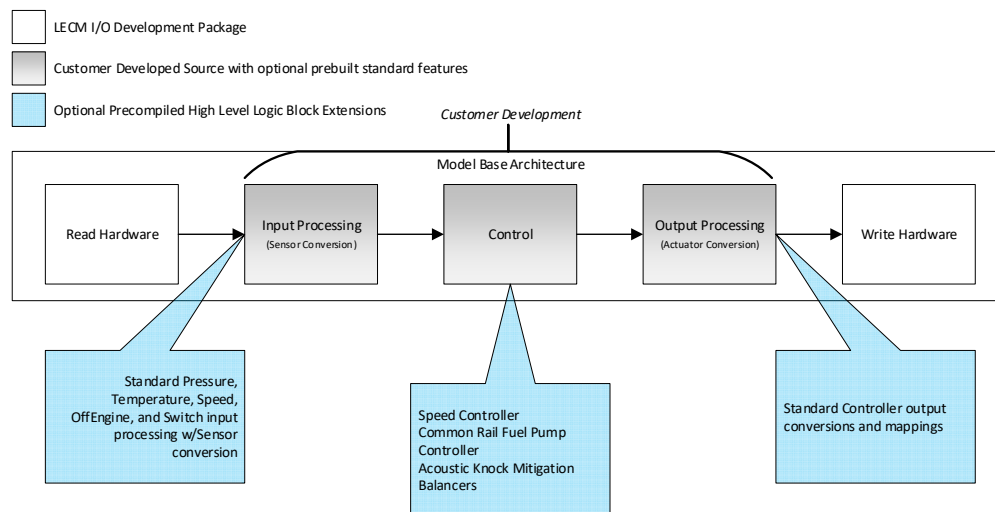
Package	Contents
<b>LECM Hardware (3-Stack, 2-Stack, Standalone)</b>	
<b>LECM IO Starter Package</b>	<ul style="list-style-type: none"> <li>OS Tasking/Events</li> <li>Diagnostics Management</li> <li>Standard HMI Communications</li> <li>LECM Analog, Discrete, Temperature IO sampling</li> <li>LECM Analog, Discrete, Trigger output actuation</li> <li>LECM Aux/EID standard interfaces (EID Ignition, MixedMode, Injection; Aux Knock, RTCDC, Thermocouple, and Protection IO)</li> <li>LECM standard encoder system + emulation (1,2,3-sensor encoder systems; NX,N-M,N+1,Custom pattern support, failover to Cam)</li> <li>ToolKit starter service tool</li> <li>Latest Woodward ASB library</li> <li>B35203V1 developer manual + training</li> </ul>
<b>LECM CRS Package</b>  <b>LECM CRS Dual Fuel Package</b>	<ul style="list-style-type: none"> <li>LECM IO Starter Package Contents</li> <li>Standard engine pressure, temperature, off-engine, and switch input processing</li> <li>High speed, redundant rail pressure input processing</li> <li>Engine state management</li> <li>Rail pressure and fuel metering valve control</li> <li>Analog/digital speed control</li> <li>B35203V2 features manual</li> </ul>

## LESP Starter Packages:

The LESP-based starter packages for a particular hardware variant (e.g., Woodward LECM) include the LESP framework blocks, Woodward Application Support Blocks (ASB) library, a base hardware-specific application model with a standard MotoHawk model architecture and sampled IO, and a base Woodward ToolKit HMI service tool.



LESP enables the developer to immediately start developing core engine application logic without needing to design the fundamentals of the model layout, diagnostic management, and IO processing. In addition, the base starter package can be extended with prebuilt logic blocks for higher level functionality (e.g., standard sensing, controllers, balancers, etc...), enabling a fully functioning engine control system, allowing the developer to solely focus on specific customizations or creating advanced technologies for a particular application. Additional advantages come from permitting the developer to learn by example, support, and leverage an existing codebase.



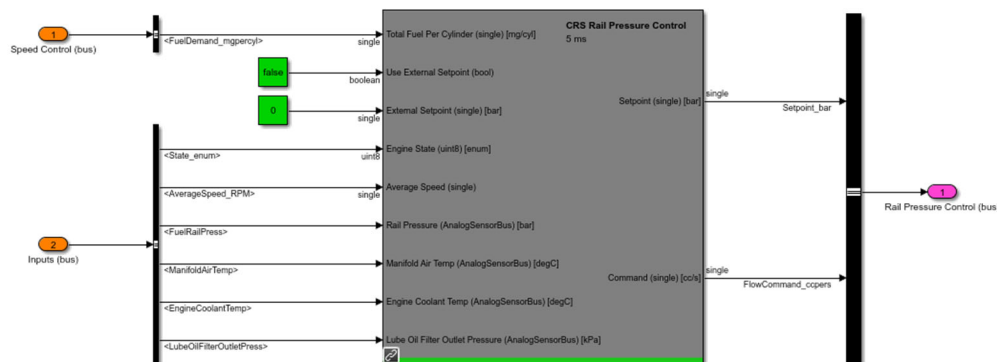
## Features

In addition to the LESP framework and package offerings, LESP also supports precompiled/licensed higher-level logic blocks for core and specialized functionality, enabling leverage of documented and tested common engine functions. This permits customers to spend less time focusing on basic functionality, allowing them to take advantage of specialized features. Examples of prebuilt logic blocks include inputs, functions, and controls include:

- Common pressure, temperature, off-engine, and switch sensors
- Analog/digital speed controllers for common rail and dual fuel applications

- Common rail pressure and valve control
- Generic throttle controllers
- Engine start logic
- Engine state logic
- Universal exhaust gas oxygen sensing and heater control
- Acoustic knock mitigation
- Exhaust gas temperature and combustion metric cylinder balancers
- Combustion metric-based cylinder controllers

Below is an example of a precompiled block that seamlessly integrates into the application using standard LESP framework types and architecture.



## Licensing

LESP software features must be compiled on an LESP node-locked licensed PC. An annual-based license will last for 366 days from the date the license key is retrieved.

### Large Engine Software Platform Software Features (Annual 1Yr License):

PN: 10-028-469

The Woodward MotoHawk Application Support Blocks (ASB) is a development support framework primarily designed for MotoHawk-based application development. This includes a standard Simulink "core" support library of primitive level blocks, higher level feature blocksets, and Matlab/Simulink application development support functions (m-scripts, matlab functions, ...). Licensed ASB logic blocks are also limited to use on a node-locked licensed PC using an independent license from LESP logic blocks.

### MotoHawk Application Support Blocks Part Number (Annual 1Yr License)

PN: 10-028-470

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