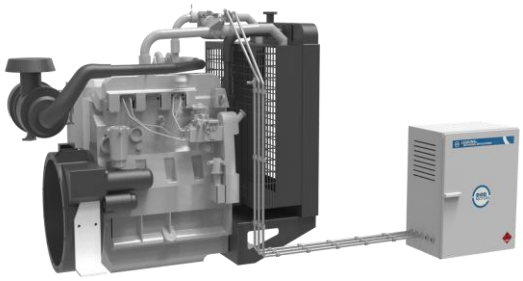
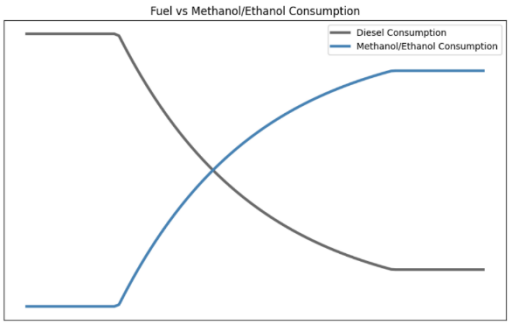
CARMEL

Dual Fuel system for Diesel Gensets





- Ethanol / Methanol / Methane
- Up to 60% Diesel reduction
- Up to 60% PM reduction & 15% NOx reduction
- Up to 60% CO2 reduction with sustainable fuel use
- Cost effective
- Seamless integration
- Engine health monitoring

About

The global diesel genset market, valued at over $22 billion, continues to grow- powering critical infrastructure, construction, agriculture, and remote energy supply. Despite global decarbonization efforts, there is no viable alternative to diesel platforms in most heavy-duty applications. Yet, the environmental cost of diesel applications remains high, and pressure is mounting from regulators, markets, and the public to reduce emissions. The industry faces an urgent need for cleaner, scalable, and economically viable solutions-without abandoning existing diesel assets

Dor's vision is to bring **intelligent dual-fuel** technology to every diesel engine. Our cost-effective and reliable concept is designed for broad compatibility and easy integration, allowing customers to choose the alternative fuel that best fits their needs- Ethanol, Methanol, Methane or others- while maintaining **optimized fuel ratios, and engine health**.

Our Technology – D.F. ECU with AI based combustion detection feedback

At the core of our solution is a combustion detection model specially trained for dual fuel systems. The system dynamically controls the blending of diesel and alternative fuels, while using the AI model to avoid harmful combustion zones. Unlike other dual fuel systems that rely on expensive cylinder pressure sensors or major engine modifications, our controller uses advanced machine learning and peripheral sensors to self-calibrate and optimize combustion in real time. This allows for:

- Plug-and-play integration on most diesel engines (SPI/PFI)
- Dramatic reduction in diesel use - up to 60%
- Elimination of costly sensor infrastructure
- Lower total cost of ownership and faster deployment
- Fuel flexibility – Ethanol, Methanol, Methane
- Abnormal combustion detection
    - DF knocking | Misfire | DF ROHR

CARMEL Genset ECU
A Retrofit Solution for Diesel Gensets

Technical Data Sheet

Product Overview

CARMEL Genset ECU Integration allows dual fuel use in diesel gensets. The system delivers precise, real-time monitoring and control. Tailored for advanced dual fuel abnormal combustion detection and prevention, the solution uses multiple vibration sensors and adaptive algorithms to safeguard engine health and maximize performance. With seamless ECU integration, the retrofit enhances operational reliability and enables effective engine management through direct sensor-to-controller feedback.
In order to develop a realistic economic model for dual-fuel retrofitting of small and medium size engines, the key approach is the use of fumigation – SPI (single point injection) integrated on the engines air intake. The main drawback of this fuel injection strategy is that it exposes the engine to abnormal combustion events, primarily due to the octane limitations and excessive cooling effect of alternative fuels. The Carmel engine controller is designed precisely to solve this problem.

Benefits

- Non-invasive installation leverages existing engine structure and wiring
- Supports stable operation with alternative fuels, enabling fuel flexibility
- Immediate detection and response to knocking phenomena, reducing risk of engine damage
- Seamless ECU integration - enables direct data transmission from knock sensors to the genset controller
- Compatible with a wide range of diesel genset architectures

Application

Designed for both inline and V-type genset engines with operating speeds between 1500 and 1800 rpm and power outputs up to 1000 kW. Up to 4 vibration sensors can be flexibly deployed, with sensor assignments optimized for knock detection across specific cylinders. The solution is ideal for retrofit projects and supports both standalone and integrated modes.

ECU Functional Overview

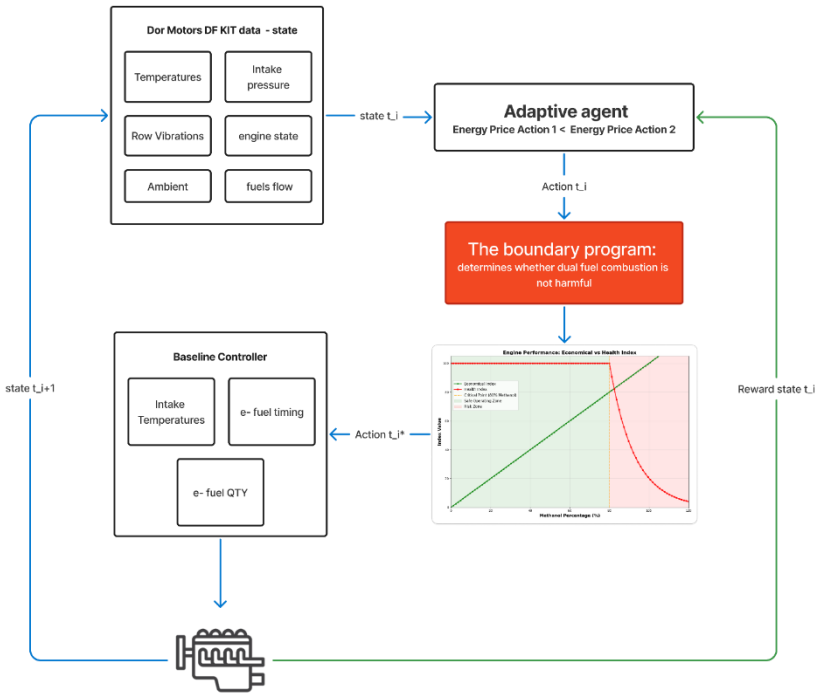
- Indirect knock detection: Utilizes arrayed vibration sensors and hall sensor inputs to identify combustion anomalies
- Fuel OPT: Real-time engine state determines fuel ratios (diesel + e fuel) for total energy price optimization.
- Cycle-by-cycle analysis: Adaptive algorithms process vibration signals for rapid recognition of abnormal events and trend development
- Safety protocols: System triggers immediate intervention when abnormal knock is detected, including fuel and timing correction

ECU System Architecture

Block diagram description:

- **Sensor Inputs:** Up to 4 vibration/knock sensors, additional speed and phase inputs
- **ECU Controller:** Aggregates sensor data, implements knock detection algorithms, controls e-fuel flow and communicates with customers and operators
- **Feedback/Control Loops:** Continuous feedback from sensors enables rapid adjustment of secondary fuel
- **Outputs:** CAN bus and analog/digital outputs for direct communication with genset controls, HTTPs(Post,Get) For user interfaces
  Functional Overview – Dual Fuel Knock Detection

Functional Overview – Closed-Loop Control Diagram

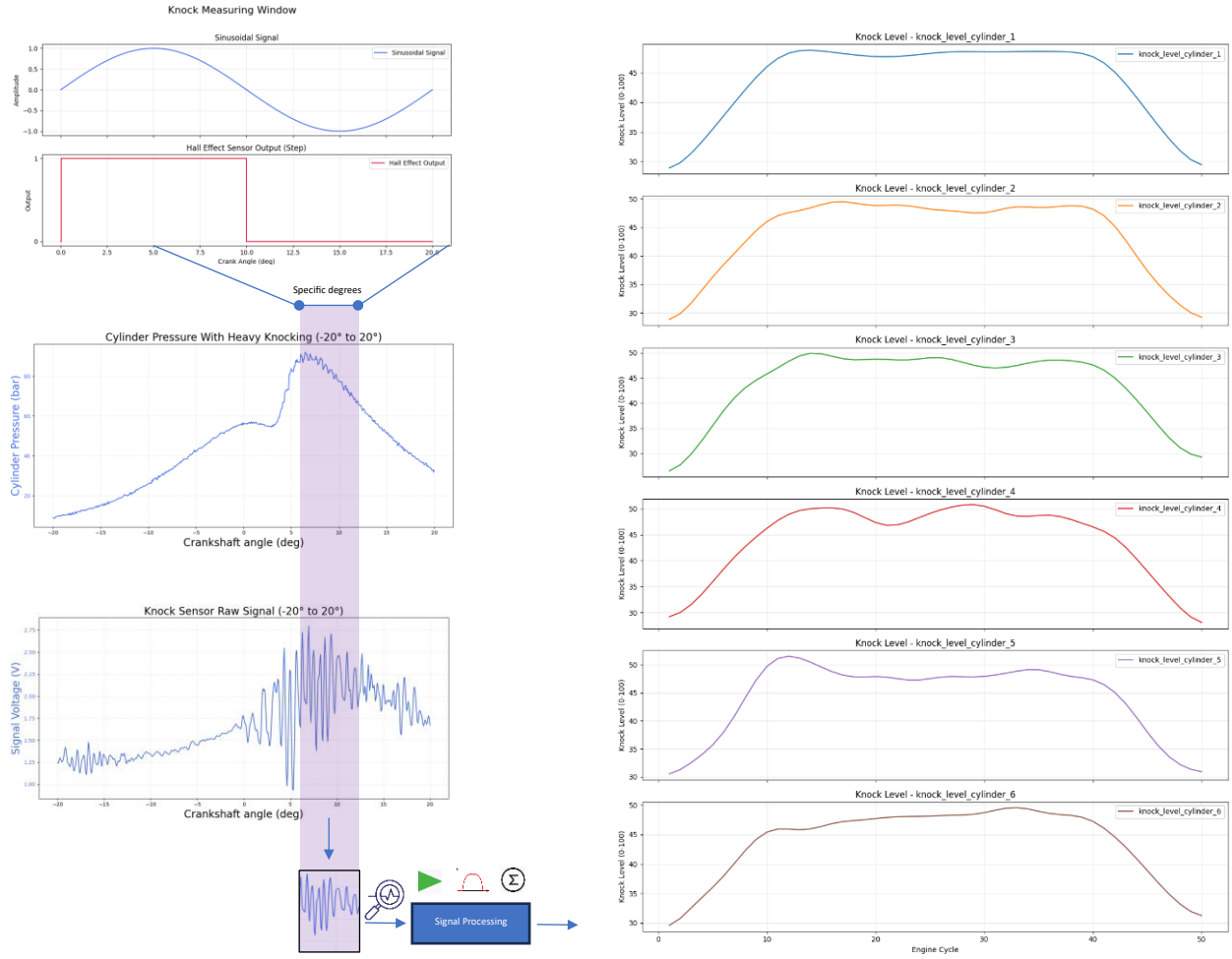


The ECU combines two layers of learning algorithms:

The boundary program
will determine the nature of combustion based on indirect indicators. In this way, it is possible to ensure the health of the engine in dual-fuel operation. The boundary program uses engine combustion detection model as feedback for the fuel control loop. This feature is the key for creating a cost effective and generic retrofit system that can fit all types of diesel engines.

Energy Optimization Model
continuously manipulating the system output to find the best cost / environmental working state. This algorithm aims to bring the system to high efficiency.

Functional Overview – Dual Fuel Knock Detection



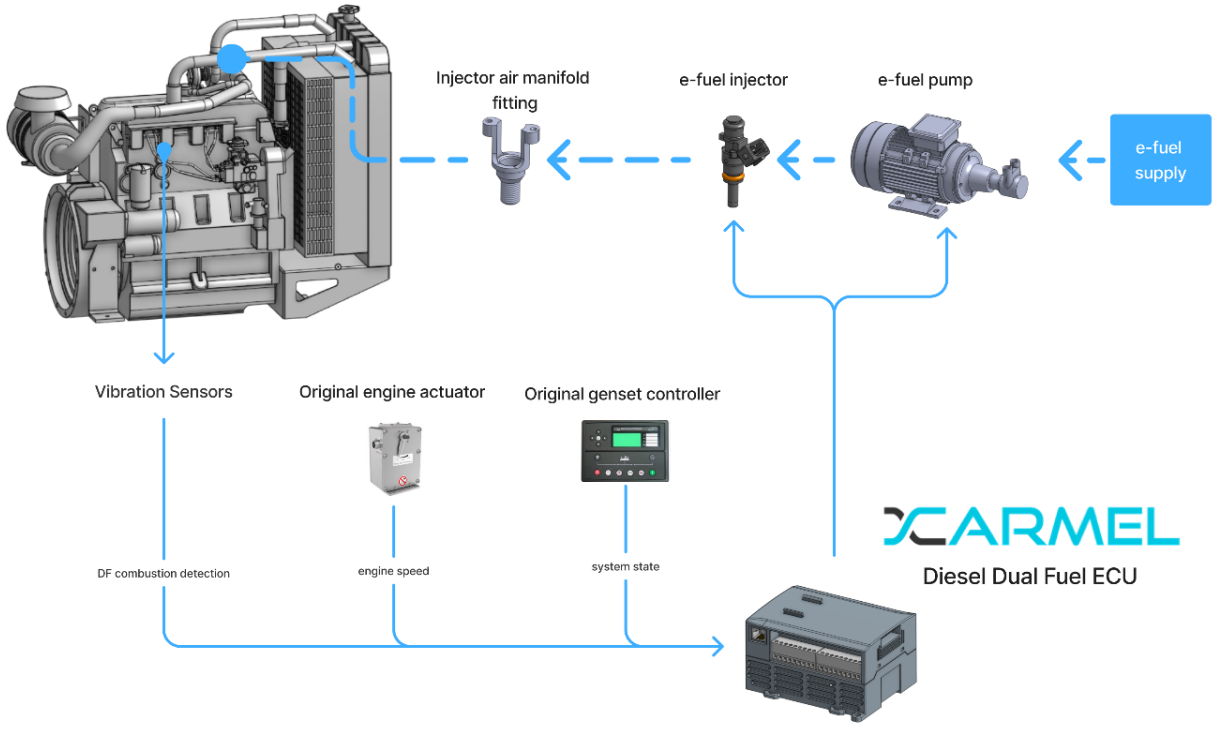
System Integration: Mechanical, Sensors and Wiring Harnesses

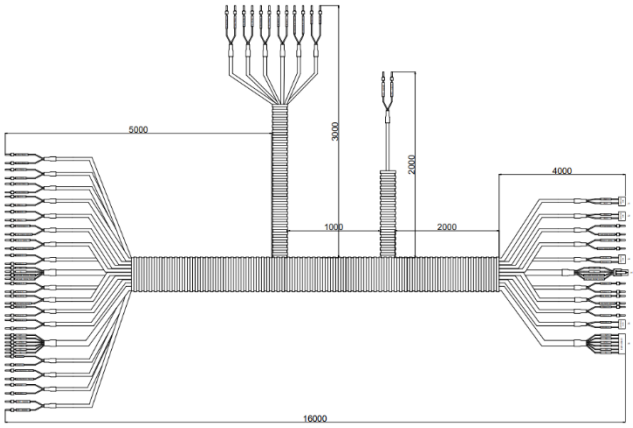
At the core of the system is the Carmel ECU, equipped with advanced software for dual-fuel combustion detection in diesel engines. The controller utilizes 2 to 4 vibration sensors, system status data from the generator controller, and engine speed data from the engine actuator. These parameters serve as inputs, based on which the controller determines the amount of secondary fuel to inject into the intake manifold by controlling its fuel injectors.

Existing genset infrastructure integration:
The controller operates on 24 VDC, supplied from the generator through a voltage transformer.
It acquires data via Modbus \ CanBus communication from the generator controller (DeepSea/ DATAKOM…) , including engine load, engine temperature, and additional parameters.
In addition, the controller monitors the motor speed via the hall effect signal connected through straightforward integration to the hall sensor terminal block on the engine actuator.

Additional connections:
Knock sensors (2–4 units): must be mounted on the engine block using bolts and the designated fittings.
Three-phase e-fuel pump: must be connected to the fuel system 3- 5 Bar range,
**consult Dor support for pump flow rate (function of engine size)*
Secondary fuel injector: The secondary fuel injector is installed as a SPI injection type on the engine's intake pipe. Installation is carried out with an injector adapter, which can either be screwed into a threaded bore or welded onto the intake pipe. The injector will be positioned approximately 20 centimeters upstream to the intake manifold and downstream to the intercooler (if present). In any case, the injector will be located downstream of the turbocharger.
**consult Dor support for injector flow rate (function of engine size)*

The full KIT is supplied with **electrical and fuel harnesses**, allowing seamless integration of all components. fuel harness – – I/O harness ——





Technical Specifications

Parameter	Specification
ECU Supply Voltage	24 VDC (nominal 24 VDC)
Current Consumption	Max. 1 A
Protection Grade	depending on enclosure
Sensor Inputs	Up to 4 vibration/knock sensors. 8 Analog 4-20 mV / 0-10V
Outputs	8 PWM outputs, 6 digital outputs
Communication	Cellular Communication Interface: LTE / 4G / 5G support; RS485; Can-Bus
Fuel Injectors	BOSCH EV-14 Ethanol compatible **flow rate of injector will be determined according to the engine size*
Recommended Fuel Pump	3ph; 16 A; 200 L/H; 6 Bar; ATEX
Recommended Fuel Piping	PTFE STL braded pipes 16 Bar; AN8 compatible; AN Aluminum anodize fittings (M/Ethanol compatible)

Contact & Support

For technical details, installation guidance, or ECU integration support, contact:

- **Dor Motors**
- Email: info@dormotors.com
- Web: www.dormotors.com
- *Please consult Dor Motors technical support for site-specific integration data plotting guidance and additional information*

About Dor Group and Dor Motors

Founded in the early 1960s, Dor Group specializes in the development, production, and supply of chemical and energy products. Dor offers a range of products including Methanol, MTBE, and solutions for the chemical, pharmaceutical, and agricultural industries; and is Israel's largest company for marketing methanol and MTBE

The group invests significant efforts in advancing technologies for the use of alternative fuels. Dor led the development of standards for M15 – gasoline blended with 15% methanol.

Additionally, the group developed a methanol-powered gas turbine as an alternative to diesel and has previously collaborated with Fiat-Chrysler to develop vehicles running on 100% methanol.

Today, through its innovation arm, Dor Motors, the group is advancing its dual-fuel system.

In collaboration with the Israeli Ministry of Environmental Protection, Dor has set a global precedent by regulating the use of Methanol and Ethanol as fuels for diesel generators.

Israel is now the world's first innovation hub for the use of Methanol and Ethanol in generators, with Dor leveraging its logistics capabilities to distribute these fuels nationwide.

By the end of 2025, Dor will operate the world's first Methanol/Ethanol fueling line in Israel for refueling generators that supply electricity to off-grid areas.

2005
Conversion of a 25 MW turbine from diesel to methanol.

Collaboration - Israel Electric Corporation

2014
Global-first M15/M70 methanol - gasoline blend standards.

Collaboration - Fiat
> 100K km test kilometers accumulated

2017
Generator powered by 100% methanol

Collaboration - Fiat

2019
100% methanol-powered generator

2024
Dual-fuel tech for diesel engines