Canal Power Conversion Technology

The Canal Electronic Generator

The Canal Electronic Generator is the electric power conversion system that allows connection of a motor generator to an AC bus. This power conversion package is bidirectional in terms of power flow.

It allows:

- *The motor/generator to be utilized as a motor using the AC bus as a source of power*
- *The motor/generator to be utilized as a generator, using the main shaft as a source of power and supporting the AC bus (either alone or in parallel with other Electronic Generators or Diesel Generators)*

The Canal Electronic Generator is able to share the load in either direction. For example, two electronic generators can be utilized to support two motors on the same shaft, with each making a proportional contribution to the work. Similarly, two parallel electronic generator systems – whether associated with single or multiple shaft lines – can support a common AC plant. Typically, the Canal Electronic Generator can switch between these modes of operation (eg from motoring to generating or from following a speed reference to a torque reference) seamlessly within milliseconds.

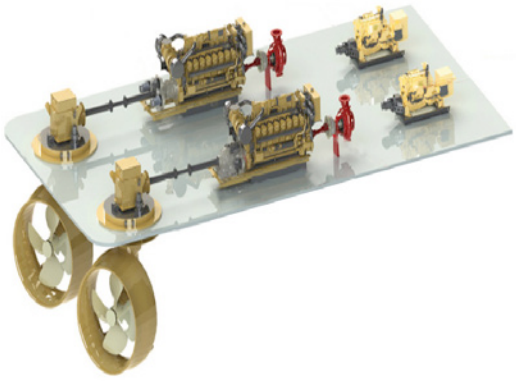
Uses of the Canal Electronic Generator

Support For Propulsion Auxiliaries – *eliminate single points of failure.*

All auxiliaries required for complete operation of the thruster or propeller (including steering if this is a function of the thruster) should best be supported by the propulsion shaft (as opposed to electric power from vessel services). This is a more reliable and robust arrangement as the function relies on less input resources (eg a rotating shaft input and 24V dc control power can be the only two required inputs for self-sufficient, autonomous operation of the propulsion function). A function relying on less input resources for proper operation is statistically more robust.

This also removes risky common dependencies of multiple propulsion functions on a single resource (eg many props relying on a single AC service bus). If a single failure causes loss of the vessel service bus then multiple props can be affected.

The auxiliaries can be supported via the Flexadrive (PTO supporting HPU for hydraulic auxiliaries, or PMG / Canal Electronic Generator for electric auxiliaries). Belt drives can be eliminated by connection of an HPU directly to the Flexadrive PTO.



Read on for more understanding of how to convert your power >

Uses of the Canal Electronic Generator

Low Level Motorized Propulsion via PTI – *take the main engines offline.*

Where a large main engine supports a prop or thruster, the engine may be clutched out and shut down, especially when propulsion power requirements are low. This saves engine hours, reducing costs. It also makes low level operation of the large engine unnecessary, reducing emissions relative to output power and fuel consumption. Alternative use of a smaller, but optimally loaded, diesel generator is known to reduce fuel consumption and therefore CO2 emissions. Notably other undesirable emissions, such as carbon monoxide, sulphur dioxide and particulates are reduced by even greater percentages through cleaner burning within the optimally loaded smaller engine.

A relatively small motor can drive the shaft through one of the Flexadrive's PTI/PTO positions using power originating at one or more auxiliary generators. The power produced from the motor can be sufficient for station keeping, low speed transit, or emergency 'get-me-home' functionality.

Support of Undersized Main Engines via PTI – *reduce the size of your power plant.*

In some cases a main engine may be deliberately undersized. There are obvious advantages in initial cost of machinery and further ongoing benefits in engine efficiency, economy, reduced emissions and maintenance. This is especially attractive if the vessel can operate for long periods below its maximum power requirement.

The Flexadrive system, coupled with the Canal Electronic Generator, allows auxiliary generators to provide additional propulsion power to the shaft via one or more electric motors. In this mode of operation the motors provide a torque contribution to the shaft in support of the main engine.

Propulsion Support (where PTO mode is never needed) – "Lite" Version – *a simple solution.*

In cases where the system is never required to function as a generator - only to provide motorized support for propulsion, the system can be used to drive the shaft – or to provide a torque contribution to the shaft in support of the main engine – up to its rated capacity.

Undersized Auxiliary Gens (or Oversized Loads) – *maintain plant stability in older vessels.*

In cases where a vessel is underpowered (in terms of its electrical plant) Canal Electronic Generators can be introduced to increase capacity. This is rarely the case for new-builds, but often additional equipment is added over the life of a vessel in service. In some cases this can lead to difficulty in ensuring that sufficient power can be provided to ensure n+1 redundancy of generators and enough online capacity to handle step loads or other disturbances. These issues arise quite frequently with existing vessels, especially where newer systems have been added or where the vessel has been repurposed.

Double Ended Ferry - *bring power to where you need it.*

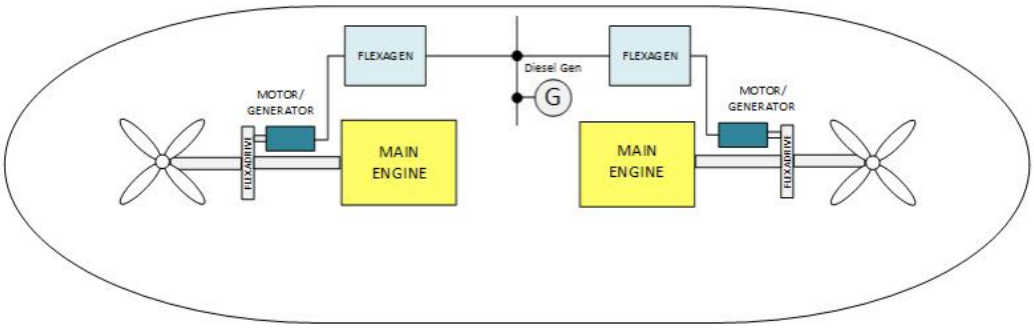
Double-ended ferries have interchangeable bows and sterns, allowing them to shuttle back and forth between two terminals without having to turn around.

A symmetrical FlexaDrive/Canal Electronic Generator arrangement allows power from both main engines to be transferred to either shaft, and for main engine power to be utilized to support the vessel service plant, load sharing with diesel generators or allowing them to be shut down entirely.

In this way, the main engines can be sized for optimum efficiency, reduced emissions during transits and greater redundancy.

Example:
For any crossing, it is most efficient to apply the majority of power to the aft prop. The aft main engine – rated at 500kW - applies 400kW and is supplemented by 200kW from its Canal Electronic Generator in PTI mode for a total power of 600kW to the prop. The 'fwd' main engine drives its Canal Electronic Generator (in PTO mode) consuming 400kW. Of this, 200kW is transferred to the aft shaft, and 200kW supports vessel services (with the diesel generator shut down).

In the scenario above, the aft shaft power is optimized for the crossing, and each main engine is 80% loaded for optimum efficiency and reduced emissions. When the crossing direction is reversed, the roles of the two Canal Electronic Generators are reversed.



Battery Powered Propulsion – *use stored energy.*

For low power propulsion, and in cases where it is undesirable for diesel engines or generators to be running, electric propulsion can be supported by energy storage arrays (typically batteries). Examples are the following;

- A harbor tugboat arriving on location - but before the client vessel is ready for assist - uses low level battery support of vessel systems and propulsion. This allows polluting diesels to be shut down while vessel service power and sufficient propulsion for station keeping is maintained.
- A vessel transiting a protected ecological zone is able to shut down diesel engines and reduce emissions to zero.
- A support vessel serving offshore oil and gas installations is able to shut down all diesels in the event of a blowout or other leakage of flammable gasses. This reduces the risk of the vessel acting as a source of ignition for the gasses. The vessel's essential systems are maintained from batteries along with low level propulsion allowing 'emergency egress' from the danger zone.

Variable Speed Generator – *reduce the numbers of generators you use or need.*

This technique utilizes a standard asynchronous induction motor or permanent magnet machine to act as a motor when required (see above) or as a shaft generator creating electrical power from the main engine and supporting vessel services. It utilizes modern power converter technology and creates an AC output at plant frequency (eg 50Hz or 60Hz) irrespective of the shaft rpm. The Canal Electronic Generator can mimic the properties of a diesel generator and can be configured to run in parallel, sharing load proportionally according to its configuration settings. It can also support the AC bus independently .

It can be used to mitigate the effects of large step loads on the bus, or to replace a diesel generator connected to the common bus (providing n+1 redundancy), or to make the running of diesel generators unnecessary while the main engine is running. It can also act as a 'bus saver' to maintain the bus in the event that other sources (eg diesel gens) fail.

An Alternative to Traditional Hybrid Power and Propulsion Systems – *smart hybrids.*

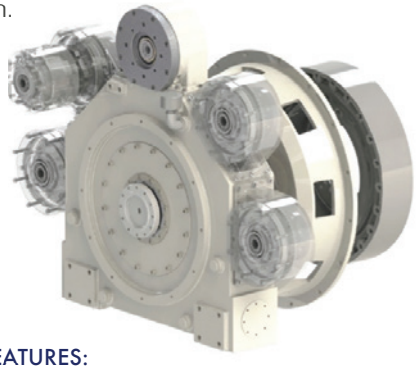
Marine Hybrid power and propulsion systems are relatively new. However several technologies have been introduced and successfully implemented over recent years. Typically an arrangement is used where a large main engine can drive the thruster or propeller through a clutch and a large motor. The clutch may be opened and the main engine shut down, leaving the motor to drive the propulsion shaft using electric power. A 'hybrid' between diesel-electric and direct-drive is achieved. However, the motor must be able to cope with the torque of the main engine, which is transferred directly through it. This can lead to the selection of oversized and expensive motors (and oversized variable frequency drives to support them).

A FlexaDrive/Canal Electronic Generator system allows the use of appropriately sized motors and power converters to achieve the same benefits as the Hybrid power and propulsion systems currently on the market.

Flexadrive Overview

In a typical application, the Logan Flexadrive is sandwiched between an engine and transmission (or marine propulsion shaft); allowing up to ten live PTO pump pads for a wide range of hydraulic pump requirements, such as drive shafts, pumps, pulleys, and clutchable power take-offs. The pad positions can equally be used to attach a motor for power into the shaft (PTI) or for electrical power out, where the use of modern electronic power conversion technology allows the motor to be used as a generator.

This diagram shows a Flexadrive with all five tower positions populated. The unit can be supplied with any number of towers (between zero and five), and additional positions can easily be added at a later date. The gear ratio between the main shaft and each individual PTI/PTO position can be optimized according to the application.



FLEXADRIVE FEATURES:

- Up to ten live PTO/PTI positions
- Short axial length plus full torque transmission
- Available in SAE 1, 2, 3 as well as 0 and 00 Bell Housing sizes
- Flexible couplings in SAE 11.5", 14", 18"and 21" flywheel sizes
- Up to 3000 hp or 2237 kW @ 2600 RPM
- Short axial length plus full torque transmission

A smaller version of the Flexadrive, with a shaft capacity of 730hp and two PTO/PTI towers is also available. The functional descriptions in this document are generally true for either version.

For a full functional description of the Canal Electronic Generator visit www.canal.ca

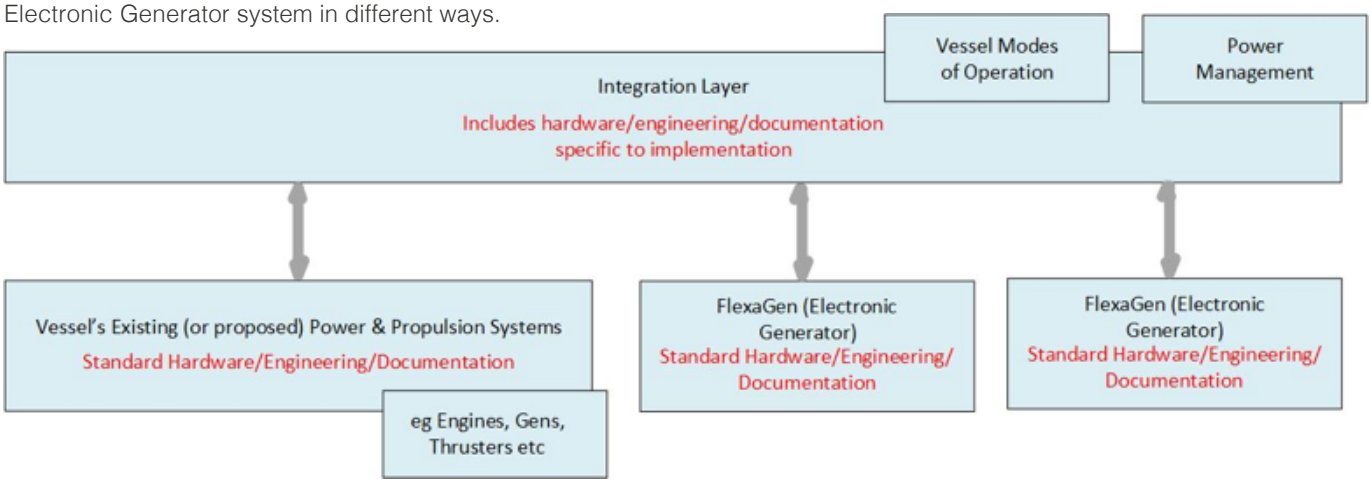
Systems Integration

The Canal Electronic Generator is a clearly defined functional (and physical) unit. In other words, a 'standard' unit with the functionality and properties described in this document. It may be produced in a number of sizes according to power rating, but its functionality remains the same.

In order to perform a meaningful role in the vessel, each Canal Electronic Generator must be integrated with existing systems or, in the case of a new-build, with the other new systems being installed. Typically the interface will be with those systems that relate to the vessel's electrical power plant and/or propulsion. In some cases, controls may be needed to allow the crew to place the vessel into various modes of operation that utilize the Canal Electronic Generator system in different ways.

The Integration Layer, which Canal can provide, typically consists of additional hardware, engineering effort, documentation and on-site commissioning and testing with other vessel systems. The other systems may be propulsion controls, thrusters/props, diesel generators, switchboards, alarm and monitoring systems and power management systems.

The 'Systems Integration Layer' is shown in the diagram below:

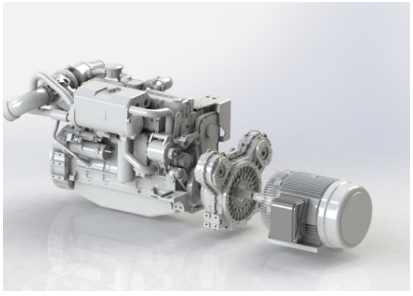


Our Team

The Marine Integration Team is comprised of Canal, The Breakwater Group and Logan Clutch Corporation, three independent companies with complimentary skill sets and demonstrated experience, delivering advanced marine power generation & propulsion systems to a global client base. It is comprised of experienced integration professionals and industry leading component vendors. The team provides world-class products, systems and services that are focused on helping their clients improve productivity, reliability and energy efficiency.

BREAKWATER GROUP

Logan Clutch Corporation®
manufacturers of clutches and brake products



About Canal

Canal provides services to government, industrial, commercial and marine clients in Canada from our headquarters at the hub of the Great Lakes Region in St. Catharines, Ontario.

Want to learn more? Visit www.canal.ca

For more information, please contact us at 905-685-9293 or 1-844-814-0620

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