

Integrel

E-DRIVE

INTEGREL E-DRIVE PRODUCT DATASHEET

Version 1.3 | July 2025



1 Contents

1 Contents1

2 Introduction2

3 Operation.....3

 3.1 Intelligent Power Generation3

 3.2 Silent Electric Drive.....4

 3.1 Operating Mode.....4

4 Component Specifications.....5

 4.1 System5

 4.2 Motor / Generator.....6

 4.3 Powertrain Control Unit (PCU).....7

 4.4 Motor Controller.....8

 4.5 Battery Bank Sensor.....9

 4.6 Primary Display.....10

 4.7 Secondary Helm Display11

5 Design and Installation.....12

 5.1 Installation Schematic13

6 Supported Engines14

7 Supported Gearboxes.....14

8 Supported Throttles.....14

9 Disclaimer15

2 Introduction

Integrel E-Drive is an innovative marine power generation and hybrid electric drive system that works in-concert with traditional fossil-fuel powered propulsion engines. E-Drive seamlessly handles all your onboard power requirements and offers a tranquil electric drive cruising experience.

At the core of the system is a custom-designed high-efficiency electric motor/generator capable of generating 15kW of electric power or providing 20hp of electric drive at mid-range engine speeds. Installed in-series with the engine, the E-Drive motor adds less than 150mm to the drive train with no modifications to the engine bay.

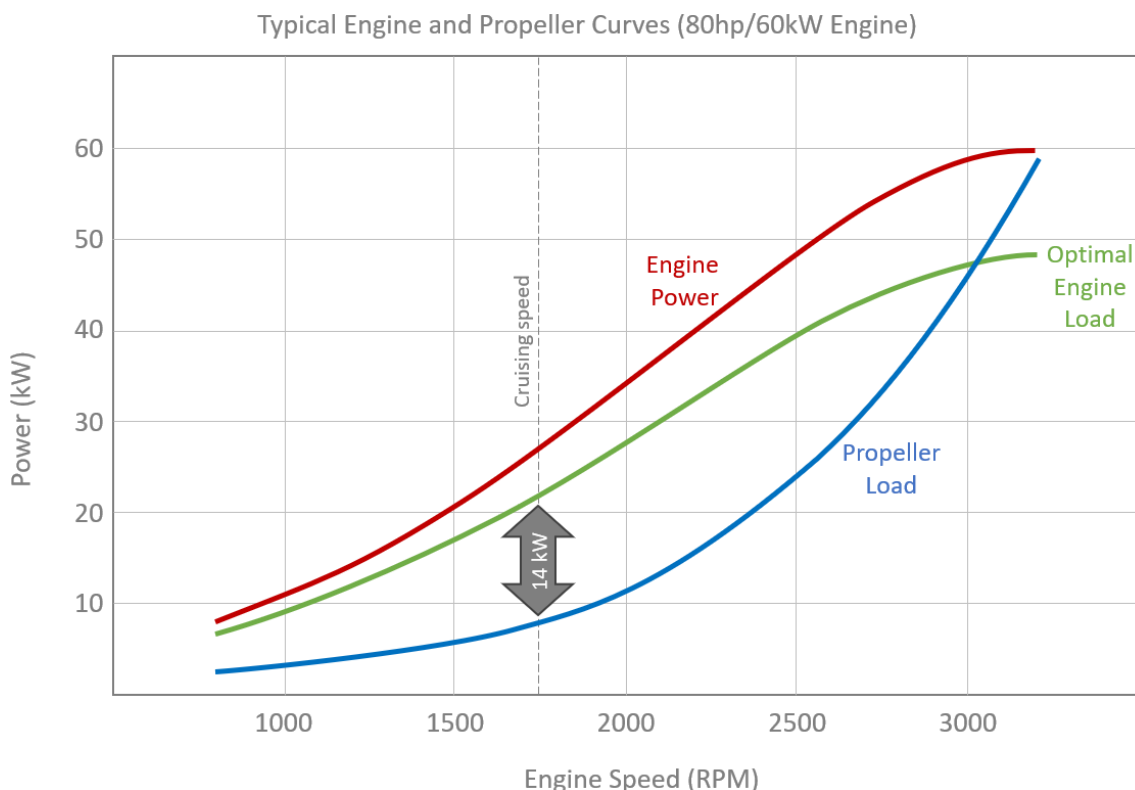
The E-Drive motor is managed under-the-hood by a bespoke electronic system designed from the ground up to maximise power efficiency and operational safety. The system operates automatically in various modes according to throttle demand, the operational state of the fossil-fuel powered engine and the state of charge of the battery bank.

3 Operation

3.1 Intelligent Power Generation

Integrel has more than a decade of experience designing and deploying marine power systems to efficiently generate energy using the excess capacity available from diesel propulsion engines. Our multi award-winning E-Power system, introduced in 2019, generates up to 9kW by dynamically increasing load to make the engine operate closer to maximum efficiency. When used to generate power, the E-Drive system uses exactly the same principle, however E-Drive can generate up to 15kW to rapidly charge a bank of 48V batteries.

The following graph shows several power curves; the red line depicts the maximum engine power output, the blue line depicts the power used by the propeller, and the green line is where the engine burns fuel most efficiently. Notice the gap between the blue line and the green line? Except near maximum engine speed, the propeller never uses enough power to make the engine run efficiently. Integrel to the rescue! Integrel adds a generation load to the engine to make the engine operate nearer to optimum efficiency. The result is one engine doing two jobs: turning the propeller AND generating power, with both tasks delivered at near maximum engine efficiency to extract the most energy from the fuel.



As a practical example, at a cruising speed of 1750 RPM with a typical 60 kW engine, the propeller load is about 8 kW and the optimum engine load is about 22 kW, leaving 14 kW excess power. At this speed, the Integrel E-Drive system produces around 11 kW of electrical power and applies just under 13kW of mechanical load on the engine, moving the total engine load into the optimum operating area.

The energy stored in the battery bank can be used to provide power for house loads including air conditioning, cookers, hot showers, winches and now with E-Drive, to silently propel the vessel with the engine powered off.

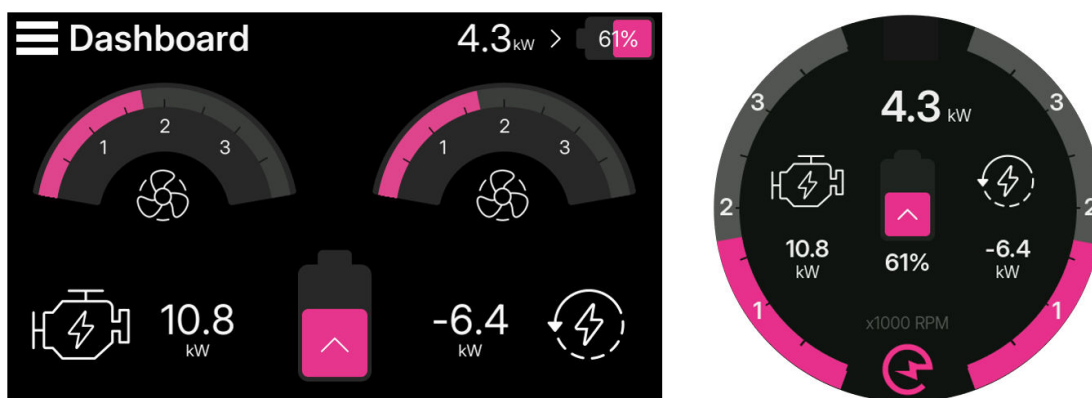
3.2 Silent Electric Drive

The E-Drive electric motor, powered by the onboard 48V battery bank, is installed between the engine and the gearbox. With the fossil-fuel powered engine idling, or powered off, the E-Drive motor silently drives the propeller using power from the batteries. The motor incorporates a patent-pending over-running clutch design to ensure it can never back drive the engine.

3.3 Operating Mode

The E-Drive system integrates with the boat throttle to seamlessly control propulsion and power generation. If desired, the system can be made to generate only, drive only or automatically choose a 'hybrid' mode of operation to suit the throttle demand. Mode selection is available using either the 5" rectangular touchscreen (typically installed at the inside helm), or 3" round touchscreen (typically installed at the secondary helm on the flybridge).

Changing modes is only possible once the necessary criteria are met; for instance, it is not possible to change to electric drive mode if the capacity of the battery bank is too low.



4 Component Specifications

The following sections outline key points and specifications of E-Drive system components.

For information related to technical installation, refer to the E-Drive Installation Manual.

4.1 System

Parameter	Value
System Voltage	48V
Supported Battery Types	LiFePO ₄ (Lithium) Mastervolt MLI6000 Victron LFP-25.6 / LFP-51.2 (in development) MG Energy LFP 230 / LFP 305 (in development)
Motor Technology	Three-phase PMSM
Communication System	Proprietary CAN bus with integrated power
Third-party Communication Interfaces	NMEA 2000, J1939 engine data

4.2 Motor / Generator

Parameter	Value	Units
Electric Drive Torque (maximum)	120	Nm
Pass Through Torque (maximum)	540	Nm
Continuous Operating Temperature (maximum) ¹	115 (239)	°C (°F)
Operating temperature (minimum)	-5 / 23	°C (°F)
Ambient operating temperature (maximum) ²	<50 (<122)	°C (°F)
Drive Speed (maximum) ³	3200	RPM
Drive Power Consumption (maximum)	15	kW
Drive Power Consumption (continuous)	TBD	kW
Power Generation (maximum)	15	kW
Power Generation (30 minutes) ⁴	15	kW
Power Generation (continuous) ⁵	10	kW
Operating Current (Maximum)	400	Amps
Operating Voltage (Nominal)	48	Volts
Switching Frequency	10	kHz
Mass	42	kg

1. Maximum temperature of the motor windings. The E-Drive system limits power generation / drive speed above this temperature.
2. The ambient temperature of the engine bay, the cooling system should be able to refresh at an adequate rate to maintain this temperature.
3. Depends on propeller type; propellers will typically apply too much load for the motor to drive at maximum speed.
4. Engine generating from cold. Ambient temperature 22C. Seawater temperature 18C.
5. Ambient temperature 22C. Seawater temperature 18C.



4.3 Powertrain Control Unit (PCU)

Parameter	Value	Units
Input voltage range	9 – 32	Volts
Supply Current at 12V (nominal operation) ¹	< 1	A
Supply Current (maximum at 12V) ²	5	A
Supply Current (sleep mode)	200	mA
Storage temperature (minimum)	-40 (-40)	°C (°F)
Storage Temperature (maximum)	95 (203)	°C (°F)
Operating Temperature (minimum)	-5 (23)	°C (°F)
Operating Temperature (maximum)	80 (176)	°C (°F)
Ingress Protection	IP67	N/A
Mass	0.8	kg
Dimensions (W x D x H)	230 x 210 x 68	mm

1. Actual current consumption varies depending on the number of devices connected to the Integrel network which is powered by the PCU.
2. The PCU supplies power to devices on the Integrel network such as Bank Sensors and Screens. Based on a single system, Integrel recommends using a supply capable of sourcing up to 5 Amps.



4.4 Motor Controller

Parameter	Value	Units
Battery Voltage (nominal)	36 - 60V	Volts
Battery Voltage (minimum; output disabled)	19.2	Volts
Battery Voltage (maximum; damage may occur)	120	Volts
Maximum Current	1000	Amps
Min storage and operation temperature	-40 (-40)	°C (°F)
Max Storage Temperature	95 (203)	°C (°F)
Operation Temperature (maximum) ¹	90 (194)	°C (°F)
Mass	8.5	kg
Dimensions (W x H x D)	260 x 210x 172	mm
Terminal Connections (3 Phase - Motor)	3 x M8 x 1.25 95mm ²	N/A
Terminal Connections (DC positive and negative – Bus bar)	2 x M8 x 1.25 95mm ²	N/A

1. The motor controller automatically reduces power consumption/generation as the heatsink temperature approaches 90°C.



4.5 Battery Bank Sensor

Parameter	Value	Units
Power Supply (from Integrel network)	15	V
Supply Current (nominal)	80	mA
Supply Current (maximum)	100	mA
Conductor outside diameter	120 (4/0)	mm ² (AWG)
Operating Temperature (minimum)	-5 (23)	°C (°F)
Operating Temperature (maximum)	80 (176)	°C (°F)
Integrel Network Connector	M12 5-pin	-
Mass	182	g
Dimensions (W x H x D)	67 x 160 x 35	mm



4.6 Primary Display

Parameter	Value	Units
Power Supply (from Integrel network)	15	V
Supply Current (nominal)	150	mA
Supply Current (maximum)	200	mA
Screen Size (diagonal)	5	inch
Wi-Fi Frequency Band	2.4	GHz
USB Ports	1	-
Operating Temperature (minimum)	-5 (23)	°C (°F)
Operating Temperature (maximum)	80 (176)	°C (°F)
Ingress Protection	IP67	-
Mass	200	grams
Dimensions (W x H x D)	149 x 102 x 38	mm



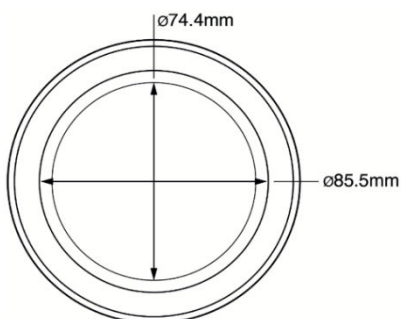
4.7 Secondary Helm Display

The helm display is supplied with looms and adapters to connect to the Integrel network. The display is powered from the Integrel network and does not need an external power supply.

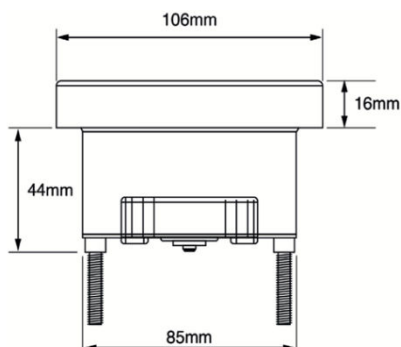
Parameter	Value	Units
Power supply (from Integrel network)	15	V
Supply Current (nominal)	150	mA
Supply Current (maximum)	170	mA
Screen size (round)	3	inch
Operating Temperature (minimum)	-5 (23)	°C (°F)
Operating Temperature (maximum)	80 (176)	°C (°F)
Mass	300	g
Dimensions (diameter x depth)	106 x 65	mm



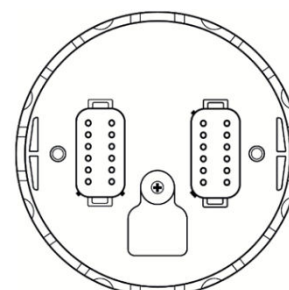
FRONT VIEW



SIDE VIEW



REAR VIEW



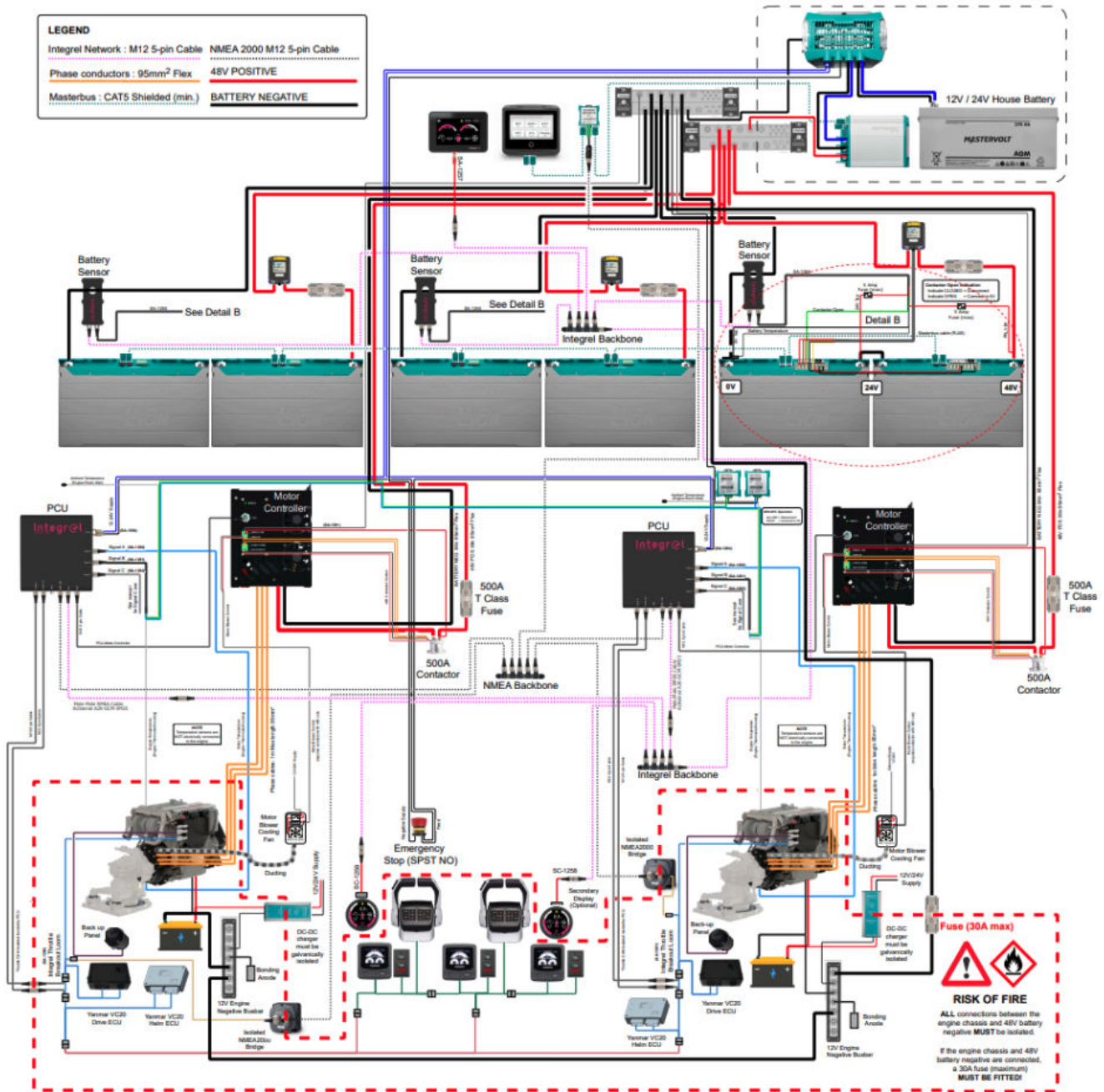
5 Design and Installation

The E-Drive system is designed with a 'safety first' approach. The system has a high fault tolerance and is pre-configured for straight forward installation. A mounting kit is provided to suit various popular marine engines from Yanmar; with support coming for additional engine manufacturers including Nanni and Volvo.

To avoid customer concerns related to engine warranty, Integrel maintains an independent worldwide engine warranty policy. After thousands of hours of operation on many engines, not a single claim has ever been made.

5.1 Installation Schematic

The following schematic depicts a typical installation for a dual E-Drive system.



6 Supported Engines

Yanmar

4JH45

4JH57

4JH80

4JH110

Nanni

N4 50*

N4 65*

N4 80*

Volvo

D2 50*

D2 60*

D2 75*

** Planned or in development*

7 Supported Gearboxes

ZF

SD15

SD60

SD12 *

ZF25

ZF25A

ZF30 *

** Planned or in development*

8 Supported Throttles

Yanmar

VC20

Mechanical *

Nanni

TBC

ZF

TBC

* A mechanical throttle solution is in development and due for release late Q4 2025.
Contact Integrel support to request a custom throttle solution.

9 Disclaimer

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Integral Solutions

Unit 1, Marine Renewable Energy Park

Hayle, Cornwall

TR27 4DD

United Kingdom

Phone: +44 (0) 1736 755466

integrelsolutions.com