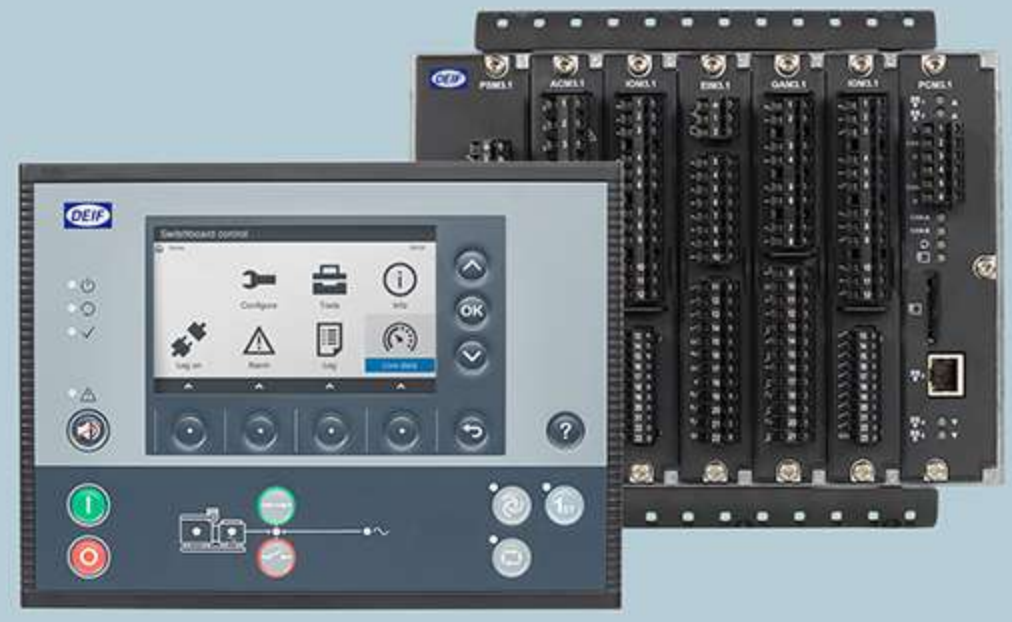
DATA SHEET

Protection and Power Management
PPM 300



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1. Product description

2. Controller types

1. Product description

1.1 System description

1.1.1 Overall description

The PPM 300 Protection and Power Management controller is a highly configurable controller designed for marine use. It includes a wide range of control, protection and supervision functions. Applications range from simple genset control and protection, to fully integrated and engineered power management solutions, developed for fuel-efficient operation. Each controller contains all the functions that are needed to protect and control a diesel generator, an emergency diesel generator, a shaft generator, a shore connection, or a bus tie breaker. You can connect up to 32 controllers to create one integrated system solution for standard applications.

The controllers' power management system controls the system and ensures that it operates optimally. It ensures that the power required is always available and takes preventative actions to ensure a reliable power supply. Up to 64 heavy consumers can be configured in the system.

The PPM 300 controllers work together as a true multi-master system. This means that each controller functions as a master controller. If a controller fails, the remaining controllers continue to function. Redundant communication between the controllers is possible. If a communication link fails, the system continues to function.

The controller display unit has push-buttons for the operator to close and open the breaker. For gensets, the operator can start and stop the genset, and change the controller mode and priority. The colour graphic screen shows status and info messages. It also allows fast access to live data, and alarm management. With the right authorisation, the operator can also check and/or change the input/output and parameter configuration.

Each controller includes processors and high-speed internal communication. This provides fast protection functions and includes built-in redundancy.

The controller design is modular, and hardware modules may be replaced or added in the field.

PICUS is a proprietary, free PC software interface to the controller. The designer can use PICUS to create a single-line diagram for the system, and configure the inputs, outputs and parameters for all the controllers in the system. PICUS also offers system emulation, supervision, and management of permissions, backups and firmware updates.

The network communication can be configured for IP address settings and for type of Ethernet port and connection node.

1.1.2 Software versions

The information in this document corresponds to the following software versions.

Table 1.1 Software versions

Software	Details	Version
PCM APPL	Controller application	1.0.12.x
DU APPL	Display unit application	1.0.13.x
PICUS	PC software	1.0.12.x

1.2 Controller description

1.2.1 General controller functions

Table 1.2 General functions for all PPM 300 controllers

	Functions
Modular and configurable design	• Compact, all-in-one controller ◦ All necessary 3-phase measurements • Optional I/O extension unit • Configurable hardware modules (printed circuit boards) ◦ Placement flexibility in the controller rack ◦ Remove, replace, or add on-site ◦ Automatically recognised ◦ Customisable arrangement (during ordering and/or on-site) • Configurable input and output functions (digital and analogue) ◦ Digital input functions: Commands from operators or 3rd party equipment, changing configuration, operating information ◦ Digital output functions: Alarm status, commands to 3rd party equipment, operating information ◦ Analogue input functions: External set points, operating information, supervised binary inputs ◦ Analogue output functions: Regulation*, operating information • Up to 4 sets of nominal settings ◦ Select a different set of nominal settings at any time • Configurable parameters for controller functions • Several ways to start controller sequences ◦ Automatically, display unit, digital input, PICUS, Modbus, and/or CustomLogic
Plug and play	• Automatic network configuration (uses static IPv6) • Default parameter and input-output configuration for each controller type • Automatic date and time synchronisation between all controllers in the system • NTP time synchronisation with NTP servers
Display unit	• Up to 2 display units (with interlock) per controller • Intuitive, one-touch operator-initiated sequences • 5-inch colour graphic display ◦ Initial configuration ◦ Status and info messages ◦ Live data monitoring and alarm management ◦ Configure live data screens ◦ Input, output, and parameter configuration ◦ Log, info and tools ◦ Manage backup and restore ◦ Soft keys, and virtual keyboard ◦ Context-sensitive help ◦ Configurable brightness • Supports multiple languages ◦ American English ◦ British English ◦ Chinese

	Functions
	◦ French ◦ German ◦ Russian ◦ Spanish
Advanced troubleshooting	• Controller hardware self-test • Event and alarm log, with real-time clock • Access to 24-hour service and support
PICUS	• Free-of-charge PC software to connect to one or more controllers • Single-line diagram tool for design, configuration and broadcast • Manage permissions and passwords (groups and users) • For each controller: ◦ Configure controller inputs, outputs, and parameters ◦ Manage alarms ◦ View status, live data, and log ◦ Manage backup and restore ◦ Use offline projects to view or edit a controller configuration ◦ Projects can be restored or broadcast. • System emulation: ◦ Safely mimic the environment that the controller connects to (loads, inputs, and failure scenarios) ◦ Test the application, get approvals, minimise site time, optimise training • System supervision • Manage controller and display unit software • Supports multiple controller languages
CustomLogic	• User-friendly logic configuration tool, based on ladder logic and function blocks • Up to 20 selectable input events and 20 output commands per controller • Inter-controller communication ◦ Up to 16 outputs per controller ◦ Up to 16 inputs from each controller in the system • Up to 20 Modbus signals (inputs and/or outputs) per controller
Communication	• Static Internet Protocol version 6 (IPv6) • Configurable Internet Protocol version 4 (IPv4) • Configurable Ethernet port settings on PCM3.1 • Multi-master system. All vital data is broadcast to all controllers: ◦ Each controller performs all calculations, then acts accordingly ◦ Power management inputs and outputs may be connected to any controller ◦ Load sharing communication • DEIF network ◦ Controller display unit ◦ Other controllers • Internal communication ◦ Extension rack(s) • Network ◦ PICUS ◦ Modbus • Controllers connected in a ring for communication redundancy: ◦ If there is a failure: Communication path changed within 100 milliseconds.

	Functions
	• Authentication (other equipment cannot disrupt communication) • Password protection ◦ Customisable permission levels

Modbus	• Supports multiple Modbus protocols
	  ◦ Standard protocol: Modbus TCP/IP
	  ◦ Supports use and creation of custom protocols
	  ◦ Import and export Modbus protocols
	• Convert data units and scaling
	• Configure Modbus server settings

Breaker control	• Synchronisation and breaker closing
	  ◦ Dynamic synchronisation: With slip frequency, for fast load acceptance
	  ◦ Static synchronisation: Phases match kept within a phase window
	• De-load before opening
	• Automatic synchronisation and de-loading
	• Operator-initiated synchronisation and de-loading possible
	• Breaker types (with configurable parameters)
	  ◦ Pulse breaker, Compact breaker, Continuous breaker
	• Breaker position detection and alarms

Advanced blackout prevention (optional)	• Run with a closed bus tie breaker during critical operations • If a genset governor or AVR fails, the bus tie breaker trips and disconnects the genset
Redundancy	• True multi-master control • Busbar can have a ring connection • DEIF network ring connection • Internal communication ring connection • Controller commands and operation using the display unit, inputs, PICUS, and/or Modbus • Redundant breaker feedback on bus tie breakers and externally controlled breakers
Additional hardware/ software features	• Hardware/software features: Power supply voltage measurement diode offset • Relay configuration (function, coil state) • Analogue input sensor failure (below and above range) • Analogue input pre-configured curves, plus up to 20 customisable curves • Analogue output pre-configured curves, plus up to 20 customisable curves • Display unit lamp test

Documentation	• Free download at www.deif.com
	  ◦ Quick start guide
	  ◦ Data sheet
	  ◦ Designer's handbook
	  ◦ Installation instructions
	  ◦ Commissioning guidelines
	  ◦ Operator's manual
	  ◦ PICUS manual
	  ◦ Modbus table
	• Context-sensitive help in the display unit

*Note: Only for the GENSET and EMERGENCY genset controllers.

1.2.2 Power management functions

These power management functions apply to the GENSET controller, and also to the other controllers working together as a system.

	Functions

Reliable power	• Blackout prevention
	  ◦ Precautionary genset start (either automatically or by operator action)
	  ◦ De-load before opening breakers
	  ◦ Genset breaker does not open if this would cause overload or a blackout
	• Fast load-reduction
	• Configurable recovery after blackout

Efficient operation	• Intelligent load calculations • Advanced load-dependent start and stop calculations • Advanced (individually configurable) asymmetrical load sharing • Secured operation (power reservation)

Load control	• Load transfer (for synchronisation, de-loading and load sharing)
	• Load-dependent start (two sets of parameters available)
	  ◦ For example, *Normal start* and *Faster start* (low available power)
	  ◦ Based on active or apparent power, or on percentage of nominal power
	• Load-dependent stop (two sets of parameters available)
	  ◦ For example, *Normal stop* and *Faster stop* (high available power)
	  ◦ Based on active or apparent power, or on percentage of nominal power
	• Power management system calculates control set points
	  ◦ Based on system configuration, controller modes, and load sharing
	  ◦ Frequency, power, voltage, power factor and/or var
	• External analogue inputs as control set points

Genset priority selection	• Manual
	  ◦ Set using the display unit 1st priority push-button, the display unit interface, or Modbus
	  ◦ Delayed priority shift
	• Dynamic (first genset to connect has the highest priority)
	• Running hours

Heavy consumer management	• Up to 4 fixed and/or variable heavy consumers per controller • Pre-programmed heavy consumer management sequence (with configurable parameters) • Digital or analogue* feedback from the heavy consumer
Busbar section management	• Configurable power management rules for each section • Up to 4 externally-controlled breakers per controller** ◦ Bus tie breakers and/or shore connection breakers • Ring busbar

Load sharing	• Active power (kW) load sharing (GOV)
	• Reactive power (kvar) sharing (AVR)
	• Load sharing between gensets
	  ◦ Over the DEIF network
	• Load sharing options for each busbar section
	  ◦ Equal load sharing (symmetrical)
	  ◦ Asymmetric P load sharing for gensets
	  ◦ Asymmetric Q load sharing for gensets
	  ◦ Shaft generator base load, with asymmetric load sharing for the gensets
	  ◦ Shore connection base load, with asymmetric load sharing for the gensets

	Functions
	◦ One genset base load, with asymmetric load sharing for the other gensets

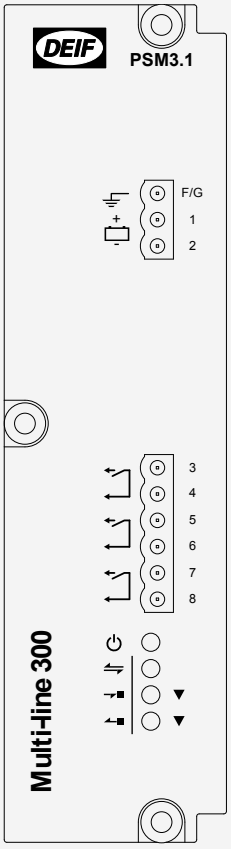
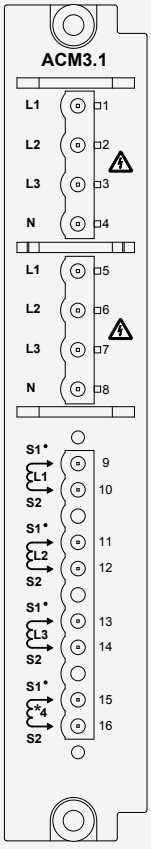
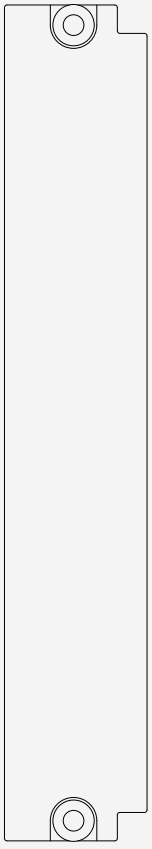
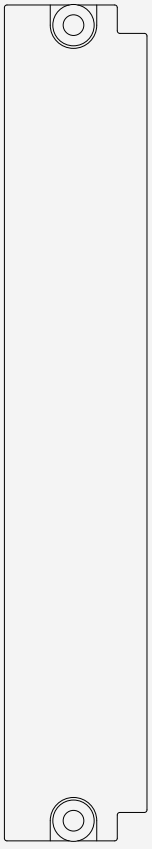
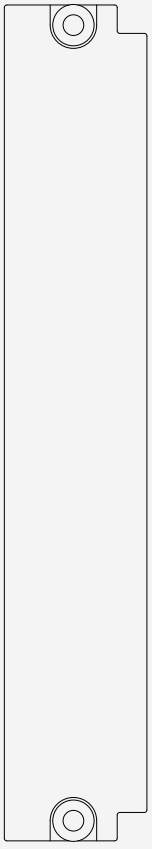
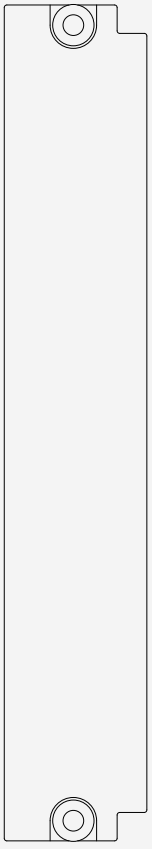
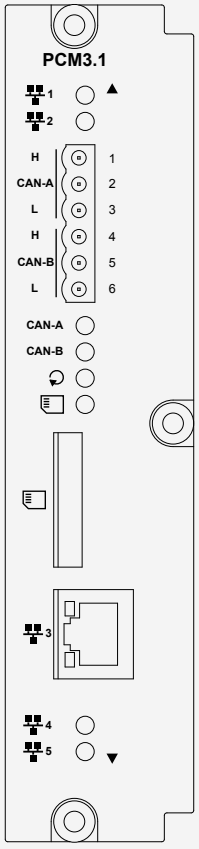
*Note: For some controllers, the default hardware does not include analogue inputs. Extra hardware must be installed if analogue feedback from the heavy consumer is required.

**Note: Up to 3 externally-controlled breakers per EMERGENCY genset controller.

1.2.3 Hardware configuration

The controller minimum hardware is described below. ACM3.2, IOM3.1, IOM3.4, GAM3.1, GAM3.2 and EIM3.1 hardware modules can be ordered and installed in the empty slots. Spare hardware modules may also be ordered for installation in the field.

Table 1.3 Minimum hardware configuration in R7.1*

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5*	Slot 6*	Slot 7*
PSM3.1	ACM3.1	Blind module	Blind module	Blind module	Blind module	PCM3.1
Power supply module	Alternating current module					Processor and communication module
						

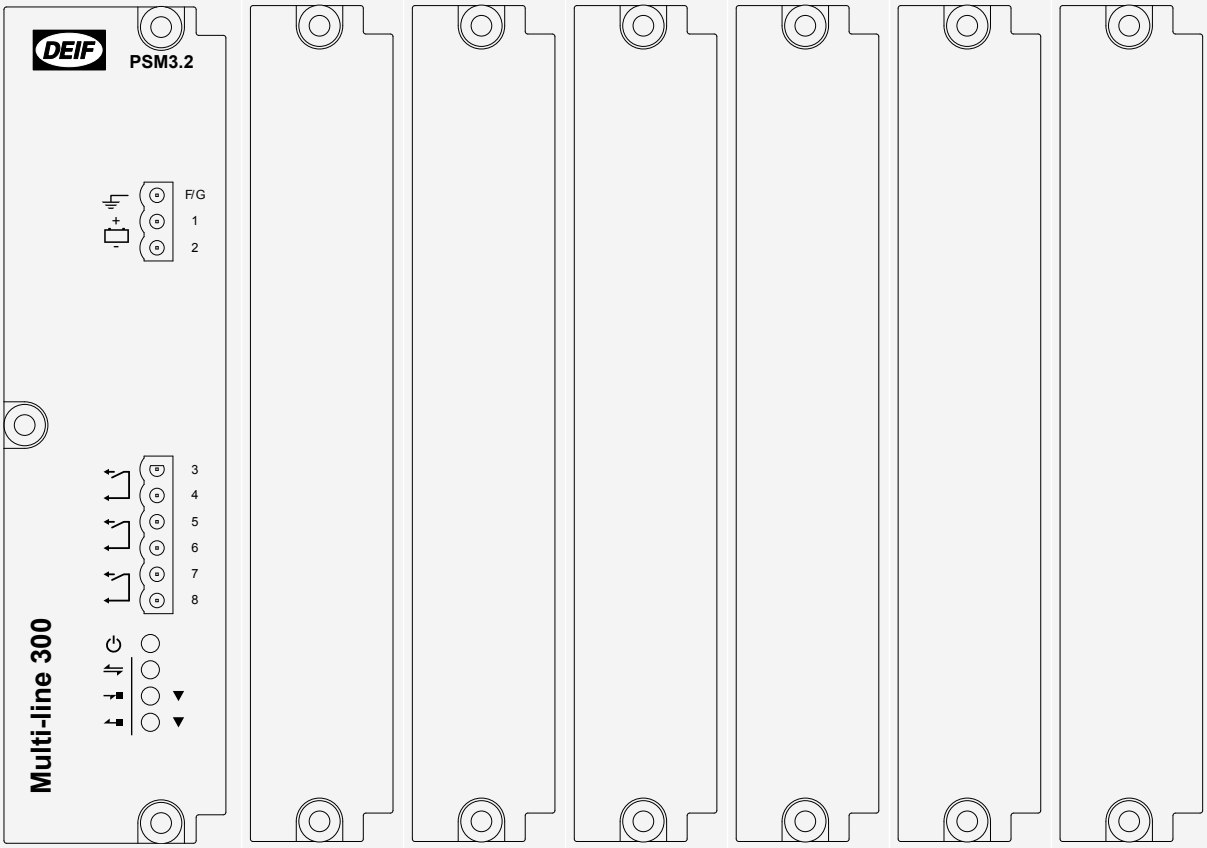
*Note: Alternatively, use a 4-slot rack (R4.1). Slots 5, 6 and 7 are only available in a 7-slot rack (R7.1).

Weight	R7.1: Controller and display unit: 3118 g (6.9 lb) R7.1: Controller (minimum hardware): 2283 g (5.0 lb)

1.2.4 Extension unit hardware configuration

The extension unit's minimum hardware is described below. ACM3.2, IOM3.1, IOM3.4, GAM3.1, GAM3.2 and EIM3.1 hardware modules can be ordered and installed in the empty slots. Spare hardware modules may also be ordered for installation in the field.

Table 1.4 Minimum hardware configuration in R7.1*

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5*	Slot 6*	Slot 7*
PSM3.2	Blind module	Blind module	Blind module	Blind module	Blind module	Blind module and blanking plate
Power supply module						
						

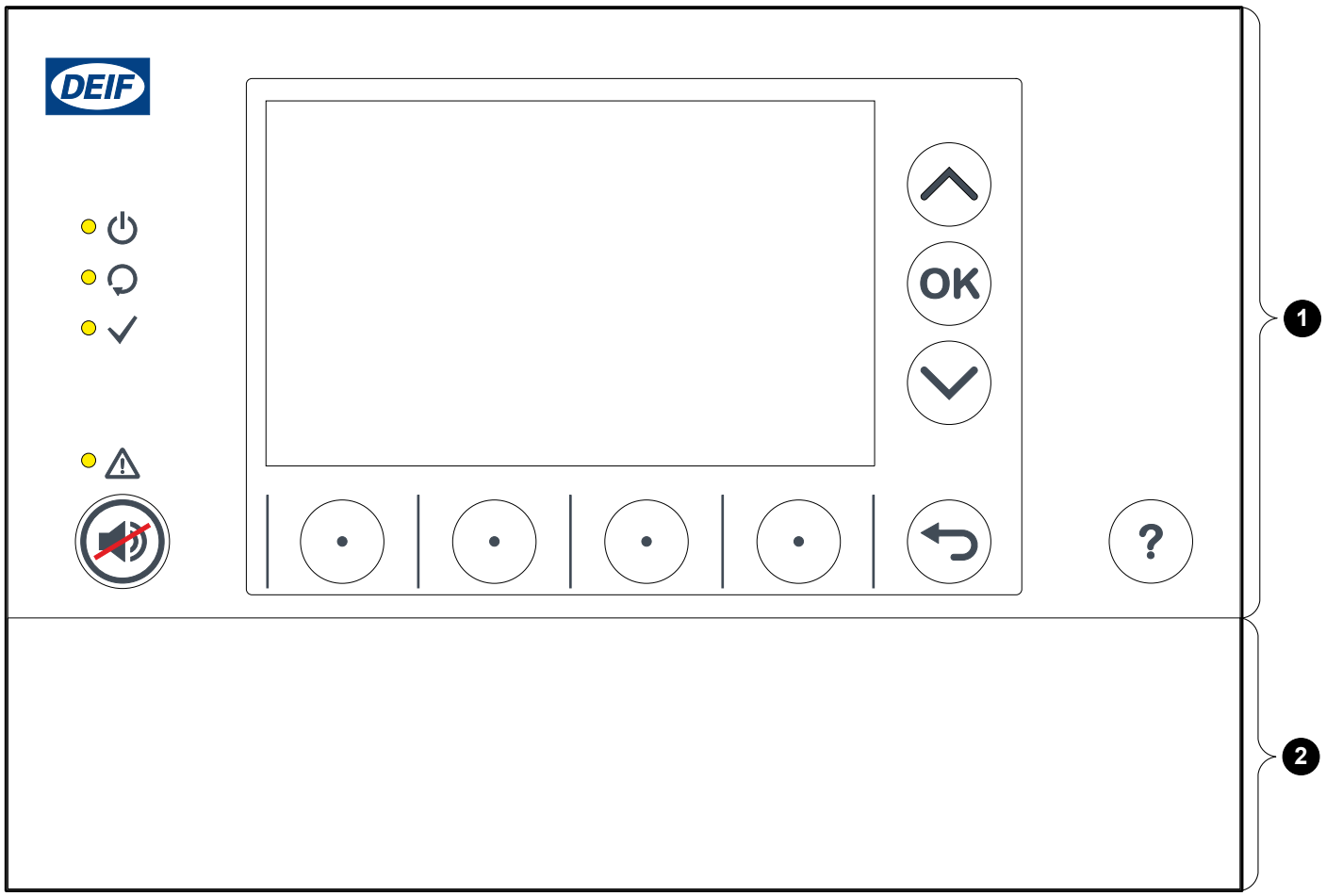
*Note: Alternatively, use a 4-slot rack (R4.1). Slots 5, 6 and 7 are only available in a 7-slot rack (R7.1).

Weight	Extension unit R7.1 (minimum hardware): 1761 g (3.9 lb) Extension unit R4.1 (minimum hardware): 1457 g (3.2 lb)

1.2.5 Display unit DU 300 layout

The front of the display unit consists of a top part and a bottom strip.

Figure 1.1 Display unit DU 300 layout



No.	Description	Notes
1	Top part	Same for all DU 300 display units
2	Bottom strip	Blank bottom strip shown

The LEDs and push-buttons for the top part are the same for all controller types. The LEDs, push-buttons and picture on the bottom strip vary according to the controller type.

1.3 Alarms

1.3.1 Alternating current (AC) protections

The controllers include the following alternating current (AC) protections, according to IEEE Std. C37.2-2008.

The protections comply with the protection functionality in IEC 61850-5 and IEC 61850-7-4, but not the communication requirements of IEC 61850. The protection names in the following tables are derived from the specification that provides the most accurate description of the protection.

The *operate time* is defined in IEV 447-05-05 (from the instant when the need for the protection arises, to when the controller output has responded). For each protection, the *operate time* is given for the minimum user-defined time delay.

Table 1.5 AC protections for the source

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Based on	Alarms	Note
Over-voltage	U>, U>>	59	PTOV	< 100 ms	The highest phase-to-phase (or phase-to-neutral) voltage	2	1
Under-voltage	U<, U<<	27	PTUV	< 100 ms	The lowest phase-to-phase (or phase-to-neutral) voltage	2	1
Voltage unbalance (voltage asymmetry)	UUB>	47	-	< 200 ms*	The highest difference between any of the 3 phase-to-phase (or phase-to-neutral) voltage true RMS values, and the average value	1	1
Negative sequence voltage		47	PNSC	< 200 ms*	The estimated phase-to-neutral voltage phasors	1	2
Zero sequence voltage		59Uo	PZOV	< 200 ms*	The estimated phase-to-neutral voltage phasors	1	2
Over-current	3I>, 3I>>	50TD	PTOC	< 100 ms	The highest phase current true RMS values	2	1
Fast over-current (short circuit)	3I>>>	50/50TD	PIOC	< 50 ms	The highest phase current true RMS values	2	1
Current unbalance	IUB>	46	-	< 200 ms*	The highest difference between any of the 3 phase currents and the average, or nominal value	2	1
Inverse time over-current	It>	51	PTOC	-	The highest phase current true RMS values, based on IEC 60255 part 151	1	1
Directional over-current		67	PTOC	< 100 ms	The highest phase current true RMS value, with the direction from the active power	2	2
Negative sequence current		46	PUBC	< 200 ms*	The estimated phase-to-neutral current phasors	1	3
Zero sequence current		51Io	PTOC	< 200 ms*	The estimated phase-to-neutral current phasors	1	3
Over-frequency	f>, f>>	81O	PTOF	< 100 ms	The lowest fundamental frequency of a phase voltage	2	1
Under-frequency	f<, f<<	81U	PTUF	< 100 ms	The highest fundamental frequency of a phase voltage	2	1
Overload	P>, P>>	32	PDOP	< 100 ms	The active power (all phases)	2	1
Reverse power	P<, P<<	32R	PDRP	< 100 ms	The active power (all phases)	2	4
Over-excitation (reactive power export)	Q>, Q>>	40O	POEX	< 100 ms	The reactive power (all phases)	2	1
Under-excitation (reactive power import/loss of excitation)	Q<, Q<<	40U	PUEX	< 100 ms	The reactive power (all phases)	2	1

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Based on	Alarms	Note
Synchronisation check (including blackout close)	-	25	RSYN	-	The frequency difference, the voltage difference, and the phase angle across the breaker	Not an alarm	1
Stabilized differential current protection (ACM3.2 differential current module required)	Id>	87G	PDIF	< 40ms (When the measured value increases from zero to two times the alarm set point)	The RMS value of the fundamental frequency part of the sum/difference of the neutral side and consumer side currents, dependent on the operating characteristic Operate value accuracy: Based on the largest secondary current • $I_{secondary}$ ≤ 20 A: 1.5 % of $I_{secondary}$ or ±15 mA • 20 A < $I_{secondary}$ ≤ 250 A: 2.5 % of $I_{secondary}$	1	5
High set differential current protection (ACM3.2 differential current module required)	Id>>	87G	PDIF	< 40 ms (When the measured value increases from zero to two times the alarm set point)	The RMS value of the fundamental frequency part of the sum/difference of the neutral side and consumer side currents, independent of the restraint current Operate value accuracy: Based on the largest secondary current • $I_{secondary}$ ≤ 20 A: 1.5 % of $I_{secondary}$ or ±15 mA • 20 A < $I_{secondary}$ ≤ 250 A: 2.5 % of $I_{secondary}$	1	5

*Note: These operate times include the minimum user-defined delay of 100 ms.

Note 1: All controller types.

Note 2: Only GENSET controller.

Note 3: Only GENSET and BUS TIE breaker controllers.

Note 4: Only GENSET, EMERGENCY genset, SHAFT generator and SHORE connection controllers.

Note 5: Only GENSET, EMERGENCY genset and SHAFT generator controllers with ACM3.2 installed.

Table 1.6 AC protections for the busbar

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Based on	Alarms	Note
Over-voltage	U>, U>>	59	PTOV	< 50 ms	The highest phase-to-neutral (or phase-to-phase) voltage	2	1
Under-voltage	U<, U<<	27	PTUV	< 50 ms	The lowest phase-to-neutral (or phase-to-phase) voltage	2	1
Voltage unbalance (voltage asymmetry)	UUB>	47	-	< 200 ms*	The highest difference between any of the 3 phase-to-phase (or phase-to-neutral) voltage true RMS values, and the average value	1	1
Over-frequency	f>, f>>	81O	PTOF	< 50 ms	The lowest fundamental frequency of a phase voltage	2	1
Under-frequency	f<, f<<	81U	PTUF	< 50 ms	The highest fundamental frequency of a phase voltage	2	1

*Note: This operate time includes the minimum user-defined delay of 100 ms.

Note 1: All controller types.

Table 1.7 Other AC protections

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time	Based on	Alarms
Lockout relay		86		-	Protected equipment	1
Earth inverse time over-current*		51G		-	The earth current true RMS value, measured by the 4th current measurement on ACM3.1, filtered to attenuate the third harmonic (at least 18 dB)	1
Neutral inverse time over-current*		51N		-	The neutral current true RMS value, measured by the 4th current measurement on ACM3.1	1

*Note: These alarms are both based on the same measurement hardware. Therefore you can only use one of these alarms at a time.

1.3.2 General controller alarms

All controllers

INFO
Each controller includes the AC protections, the alarms listed here, and the alarms specific to the controller type.

[*B] refers to the breaker that the controller controls. For example, GB for a GENSET controller

	Protections	Alarms
Breaker	[*B] closing failure	1*
	[*B] opening failure	1*
	[*B] position failure	1*
	[*B] configuration failure	1*
	[*B] synchronisation failure	1*
	[*B] de-load failure	1*
	[*B] tripped (external)	1*
	[*B] short circuit	1*
	[*B] vector mismatch alarm	1*
Communication	Modbus communication timeout	1
	DEIF network redundancy broken	1
	No NTP server time synchronisation	1
	No NTP server(s) connected	1
	NTP server # could not connect	2
	NTP server # is not responding	2
Synchronisation	Phase sequence error [Source]	1
	Phase sequence error [Busbar]	1
System monitoring	Breaker # feedback position failure	1
	Live power detected (Emulation)	1
	Emulation disabled (Live power)	1
	Application initialisation error	1
	Controller not part of system	1
	Single-line missing/none active	1
	Missing any controller	1
	Missing all controllers	1
	Missing controllers	1
	System not OK	1
	Critical process error	1
	Different single-line configurations	1
	Controller type mismatch	1
	Controller ID not configured	1
	Duplicate controller ID	1
	Missing controller ID #	1 for each controller (up to 12)
	System power management network error	1
	Power management rules network error	1
	Priority network error	1
	Configuration update delayed	1
Inputs	Digital inputs	Up to 50 customised alarms per controller
	Analogue inputs	Up to 200 customised alarms per controller

	Protections	Alarms
Power management	Forced to switchboard control	1
	PMS disabled due to an error	1
	Different power management rules activated	1
	Blackout detection mismatch	1
	Any tie breaker position failure	1
	Any bus tie breaker position failure	1
	Network protocol incompatible	1
General	PSM3.1 1 supply voltage high	1
	PSM3.1 1 supply voltage low	1
	PCM clock battery failure	1
	Controller temperature too high	1
	Required I/O card(s) not found	1
	Software mismatch on hardware module(s)	1

*Note: The EMERGENCY genset controller controls two breakers (GB and TB). Each of these protections are present for both breakers.

Table 1.8 ACM measurement error protections

	Protections
ACM measurement error	[Source] L1-L2-L3 wire break*
	[Busbar] L1-L2-L3 wire break*
	[Source] L1 wire break*
	[Source] L2 wire break*
	[Source] L3 wire break*
	[Busbar] L1 wire break*
	[Busbar] L2 wire break*
	[Busbar] L3 wire break*
	ACM 1 protections not running
	ACM 1 data is missing

*Note: These alarms only work when the breaker is closed. These alarms are only on GENSET, SHAFT generator, SHORE connection, and BUS TIE breaker controllers.

The following table shows the names for [Source] and [Busbar] for the controllers with ACM measurement error protections.

Controller type	[Source]	[Busbar]
GENSET	Generator	Busbar
SHAFT generator	Generator	Busbar
SHORE connection	Shore busbar	Ship busbar
BUS TIE breaker	Busbar A	Busbar B

Optional hardware

Table 1.9 Alarms for the EIM3.1 hardware (optional)

	Protections	Alarms
General	EIM3.1 1 supply voltage high	1
	EIM3.1 1 supply voltage low or missing	1
	EIM3.1 1 relay 4 wire break	1

Table 1.10 Alarms for the GAM3.2 hardware (optional)

	Protections	Alarms
General	GAM3.2 1 status not OK	1
	GAM3.2 1 supply voltage high	1
	GAM3.2 1 supply voltage low or missing	1

Table 1.11 Alarms for the extension unit (optional)

	Protections	Alarms
General	PSM3.2 1 status not OK	1
	PSM3.2 1 supply voltage high	1
	PSM3.2 1 supply voltage low	1
Communication	DEIF internal communication error	1

2. Controller types

2.1 Introduction

2.1.1 About controller types

Each PPM 300 controller is assigned a type in the factory, which can be changed in the field using the display unit. The controller types are described in sections that follow.

INFO
Controller type changes are restricted, depending on the initial controller type. An EMERGENCY genset and GENSET controller, can be changed in the field to any PPM 300 controller type. But a SHAFT generator, SHORE connection and BUS TIE breaker controller can only be changed to one of these three controller types.

2.2 GENSET controller

2.2.1 Description

A GENSET controller controls and protects a diesel engine and generator (that is, a genset), as well as the generator breaker. A system can include a number of GENSET controllers.

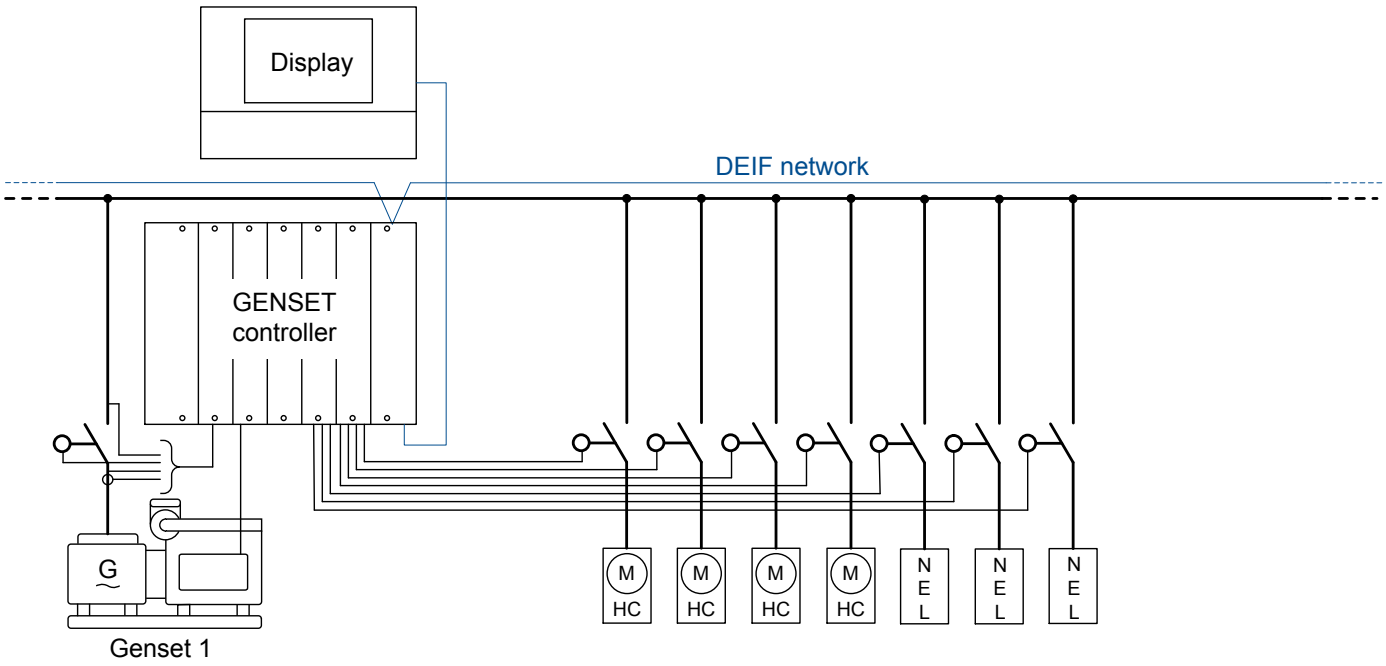
The GENSET controllers work together to ensure effective power management. This includes load-dependent start and stop, and may include setting the genset priority order, managing heavy consumers, and, if necessary, tripping non-essential loads.

2.2.2 Applications

The system must have at least one GENSET controller.

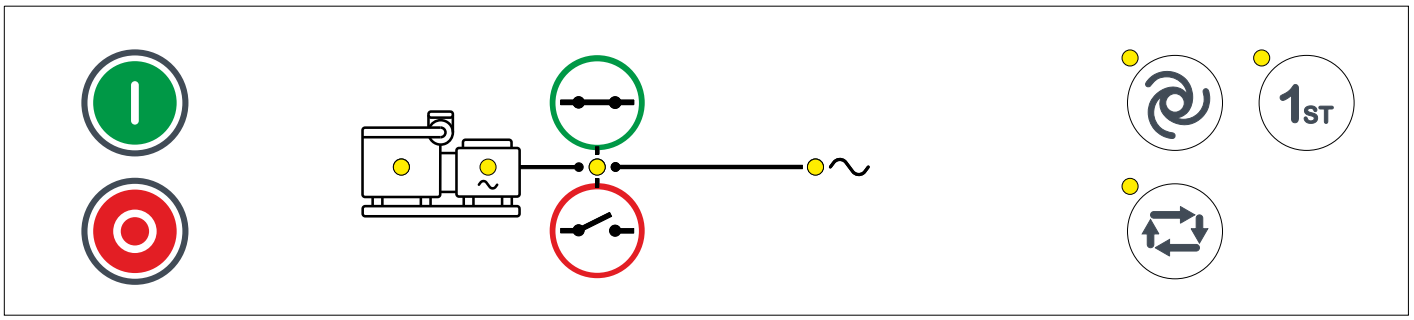
Each GENSET controller can control up to four heavy consumers (HC) and connect up to three non-essential load groups (NEL).

Figure 2.1 Example of a GENSET controller application, with optional heavy consumers and non-essential loads



2.2.3 Display unit

Figure 2.2 Customised section of display unit for the GENSET controller (LEDs shown in yellow)



2.2.4 GENSET controller functions

	Functions
Pre-programmed sequences	• Genset start sequence and genset stop sequence ◦ Running detection (Multiple feedback options: Frequency, MPU/W/NPN/PNP (RPM), Digital input, Oil pressure) ◦ Run coil and/or stop coil for engine control ◦ Temperature-dependent cooldown • Breaker sequences ◦ Generator breaker close sequence (with synchronisation) ◦ Generator breaker open sequence (with de-loading) • Generator breaker blackout close
Genset regulation	• PID regulators for analogue outputs • P regulators for relay outputs ◦ *Relay period time* and *Minimum ON time* configurable • Set point selection ◦ Select mode or external set point, using digital input, Modbus, and/or CustomLogic • Governor ◦ Frequency regulation ◦ Frequency and phase synchronisation ◦ Load sharing (active power) ◦ Fixed power • AVR ◦ Voltage regulation ◦ Load sharing (reactive power) ◦ Fixed reactive power ◦ Fixed cos phi • External set point ◦ From an analogue input ◦ From Modbus • Configurable: Power ramp up, power ramp down • Optional inputs: Manual regulation • Three sets of temperature-dependent power derate settings
Counters	• Display unit counters, to edit or reset ◦ Start attempts ◦ Running hours (total and trip)

	Functions
	◦ Generator breaker operations and trips ◦ Power export (active and reactive) ◦ External breaker operations • Energy counters with configurable digital outputs (for external counters) ◦ Power export (active and reactive)
Other	• Priming • Temperature-controlled start & stop
Control types	• Power management system (PMS) control ◦ AUTO mode ◦ SEMI mode • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active
Control modes	• AUTO mode ◦ Automatic power management ◦ Automatic load-dependent genset start & stop ◦ Automatic synchronisation & de-loading, and breaker control • SEMI mode ◦ Operations only on operator command ◦ Operator-initiated synchronisation and de-loading ◦ Display unit push-buttons for genset start & stop, breaker open & close, and 1st priority • Display unit push-buttons ◦ Change control mode (AUTO & SEMI) ◦ Push-button functions also possible using inputs, PICUS, and/or Modbus ◦ Intuitive, one-touch sequences using the display unit for genset start & stop, and breaker open & close in SEMI mode

2.2.5 GENSET controller alarms

INFO
These alarms are in addition to the AC protections and other alarms for PPM 300 controllers.

	Alarms
Engine	Emergency stop
	Overspeed (2 alarms)
	Under-speed (2 alarms)
	Governor regulation error
	Power ramp up error
	Power ramp down error
	Crank failure
	Primary running feedback failure
	Start failure
	Stop failure
	Engine stop (external)
	Engine start (external)
	Start enable removed during start
	Total running hours notification
	Trip running hours notification
	Magnetic pickup wire break
Generator	Voltage or frequency not OK
	AVR regulation error
Load sharing	P load sharing failure
	Q load sharing failure
Regulator configuration	GOV output selection failure
	GOV output setup failure
	GOV stand-alone configuration failure*
	GOV relay setup incomplete
	AVR output selection failure
	AVR output setup failure
	AVR stand-alone configuration failure*
	AVR relay setup incomplete
Maximum parallel time	DG-SG max. parallel time
	DG-SC max. parallel time
Power management	Heavy consumer feedback timeout (1 alarm for each heavy consumer)
	Heavy consumer reservation not possible (1 alarm for each heavy consumer)
Non-essential load (NEL)	• Up to 3 non-essential loads per controller • Can connect each controller to the same 3 non-essential load breakers
	NEL # over-current (1 alarm for each non-essential load)
	NEL # under-frequency (1 alarm for each non-essential load)
	NEL # overload 1 and 2 (2 alarms for each non-essential load)
	NEL # reactive overload (1 alarm for each non-essential load)

	Alarms
Advanced blackout prevention	P load sharing failure (low frequency)
	P load sharing failure (high frequency)
	Q load sharing failure (low voltage)
	Q load sharing failure (high voltage)
Other	Forced to SEMI mode
	Trip AVR output not configured

*Note: Only in GAM3.2.

2.3 EMERGENCY genset controller

2.3.1 Description

An EMERGENCY genset controller controls and protects an emergency genset (both the engine and the generator), as well as the generator breaker, and the emergency busbar tie breaker. By default, the EMERGENCY genset controller automatically starts the emergency generator when there is no voltage on the busbar.

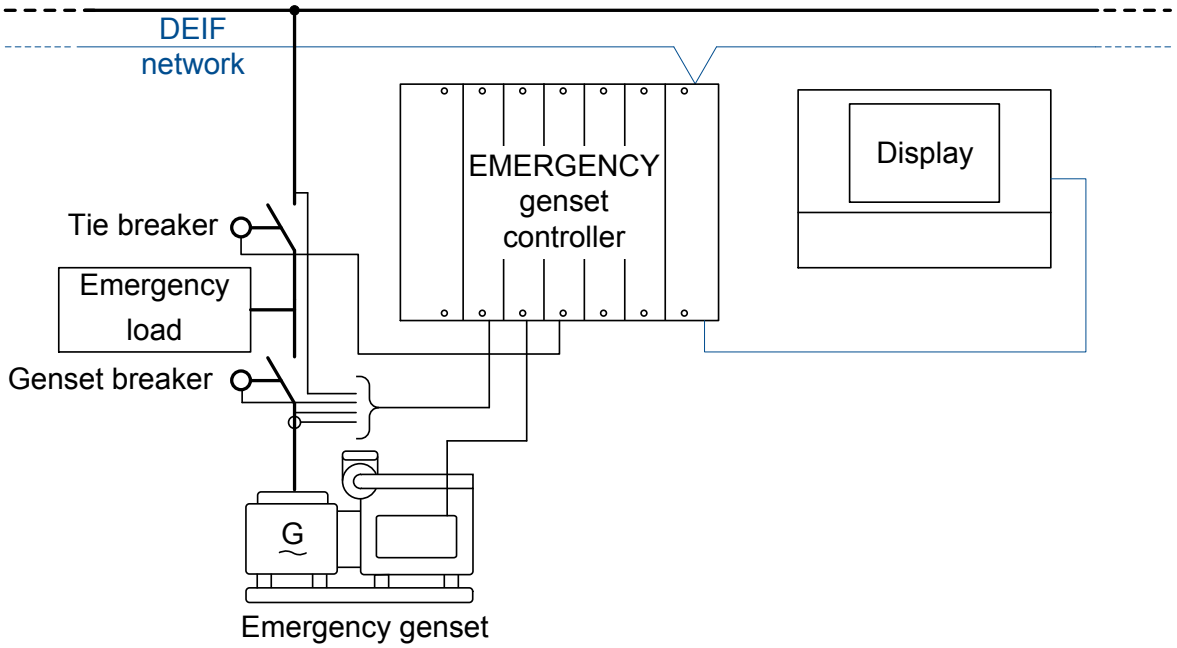
The EMERGENCY genset controller includes a test function, to make regular testing of the emergency generator easier.

The EMERGENCY genset controller allows harbour operation, so that the genset can be used as the ship generator when in harbour. Apart from this, the emergency genset does not normally supply power to the system.

2.3.2 Applications

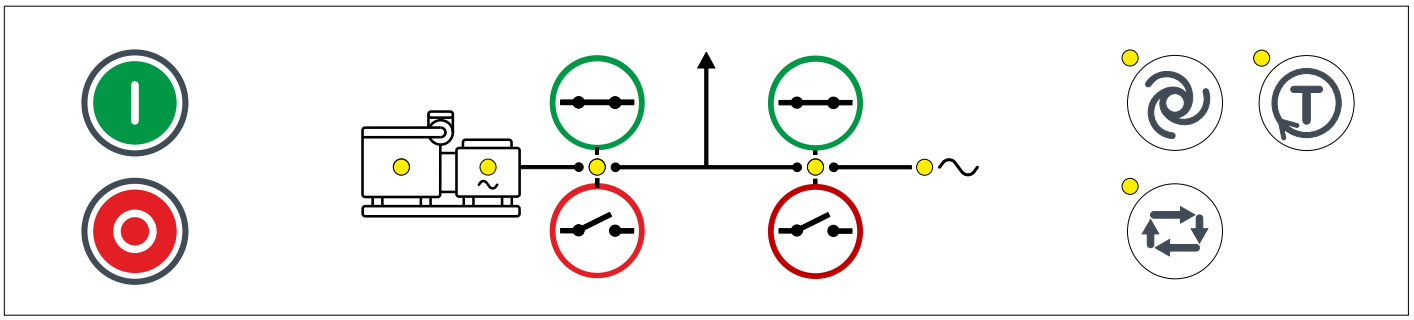
The system can have 0 or 1 EMERGENCY genset controllers. Each EMERGENCY genset controller can connect up to three non-essential load groups (NEL).

Figure 2.3 Example of an EMERGENCY genset controller application



2.3.3 Display unit

Figure 2.4 Customised section of display unit for the EMERGENCY genset controller (LEDs shown in yellow)



2.3.4 EMERGENCY genset controller functions

	Functions
Pre-programmed sequences	• Blackout start • Genset start sequence and genset stop sequence ◦ Running detection ◦ Stop coil and/or run coil for engine control ◦ Temperature-dependent cooldown • Generator breaker open sequence (with de-loading) • Generator breaker close sequence (with synchronisation) • Tie breaker open sequence (with de-loading) • Tie breaker close sequence (with synchronisation) • Load transfer between emergency and main busbar without synchronisation ◦ Uses short blackout, with configurable delay ◦ Tie breaker close sequence and generator breaker close sequence • Test sequence • Harbour mode start and stop sequences
Emergency functions	• Blackout start and handling (immediate or delayed), from AUTO or SEMI mode • Selectively disable protections using the *EDG handling blackout* inhibit • *Main busbar is OK* digital input
Test functions	• Engine test ◦ Emergency genset start (does not synchronise or connect to the busbar) • Load take-over test ◦ Emergency-load (supplies the emergency busbar, tie breaker opened) • Parallel test ◦ Base-load (synchronises and connects to the busbar, tie breaker closed)
Harbour operation	• Emergency genset powers the ship • Economic operation for low loads, for example, in harbour • Confirm harbour operation from display unit
Regulation	• PID regulators for analogue outputs • P regulators for relay outputs ◦ *Relay period time* and *Minimum ON time* configurable • Set point selection ◦ Activate external offsets or set points using DI, CustomLogic, or Modbus • Governor

	Functions
	◦ Frequency regulation ◦ Frequency and phase synchronisation ◦ Load sharing (active power) ◦ Fixed power • AVR ◦ Voltage regulation ◦ Load sharing (reactive power) ◦ Fixed reactive power ◦ Fixed cos phi • External set point ◦ From an analogue input ◦ From Modbus • Configurable: Power ramp up, power ramp down • Optional inputs: Manual regulation • Three sets of temperature-dependent power derate settings
Counters	• Display unit counters, to edit or reset ◦ Start attempts ◦ Running hours (total and trip) ◦ Generator breaker operations and trips ◦ Tie breaker operations and trips ◦ Power export (active and reactive) ◦ External breaker operations • Energy counters with configurable digital outputs (for external counters) ◦ Power export (active and reactive)
Other	• Priming • Temperature-controlled start/stop
Control types	• Power management system (PMS) control ◦ AUTO mode ◦ SEMI mode • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active • Stand-alone emergency genset ◦ Not part of the rest of the system ◦ Controller AC measurements independently detect blackout
Control modes	• AUTO mode ◦ Harbour operation active: Automatic power management ◦ Automatic load-dependent genset start/stop ◦ Automatic synchronisation/de-loading and breaker control • SEMI mode ◦ Operations only on operator command ◦ Automatic synchronisation and de-loading ◦ Display unit push-buttons for genset start/stop, breaker open/close, and test • Test function ◦ Run the pre-configured test • Display unit push-buttons ◦ Change control mode (AUTO/SEMI/test function)

	Functions
	◦ Push-button functions also possible using inputs, PICUS, and/or Modbus ◦ Intuitive, one-touch sequences using the display unit for genset start/stop, and breaker open/close, in SEMI mode

2.3.5 EMERGENCY genset controller alarms

INFO
These alarms are in addition to the AC protections and other alarms for PPM 300 controllers.

INFO
During a blackout, the suppressed alarms are shown as *Warnings*.

	Alarms
Engine	Emergency stop
	Overspeed (2 alarms)
	Under-speed (2 alarms)
	Governor regulation error
	Power ramp up error
	Power ramp down error
	Crank failure
	Primary running feedback failure
	Start failure
	Stop failure
	EIM3.1 # relay 4 wire break (where # is 1 to 3)
	Engine stop (external)
	Engine start (external)
	Start enable removed during start
	Total running hours notification
	Trip running hours notification
	Magnetic pickup wire break
Generator	Voltage or frequency not OK
	AVR regulation error
Maximum parallel time	EDG max. parallel time
Load sharing	P load sharing failure
	Q load sharing failure
Regulator configuration	GOV output selection failure
	GOV output setup failure
	GOV relay setup incomplete
	AVR output selection failure
	AVR output setup failure
	AVR relay setup incomplete

	Alarms
Non-essential load (NEL)	• Up to 3 non-essential loads per controller • Can connect each controller to the same 3 non-essential load breakers
	NEL # over-current (1 alarm for each non-essential load)
	NEL # under-frequency (1 alarm for each non-essential load)
	NEL # overload NEL 1 and 2 (2 alarms for each non-essential load)
	NEL # reactive overload (1 alarm for each non-essential load)
Other	EDG not ready for blackout
	Forced to SEMI mode
	Trip AVR output not configured

2.4 SHAFT generator controller

2.4.1 Description

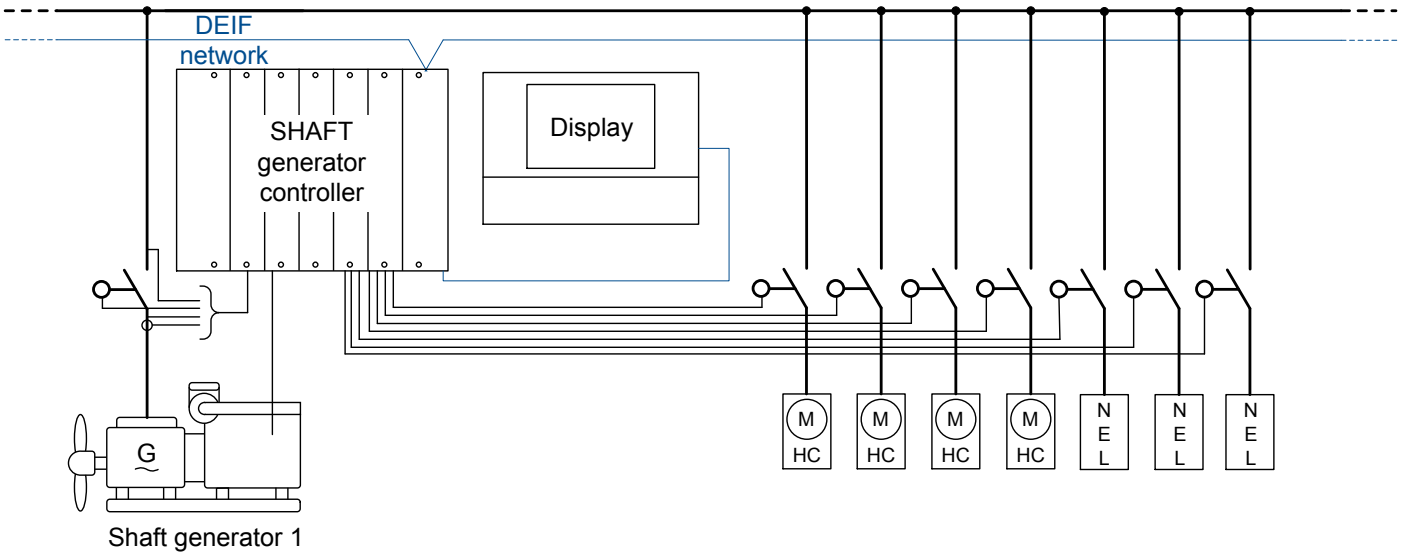
A SHAFT generator controller controls and protects the system when a shaft generator is connected. The SHAFT generator controller also controls and protects the shaft generator breaker.

When the shaft generator is connected, it is normally the ship's only power source. However, it is possible for the shaft generator to run in parallel with the gensets and supply a base load for an extended period (long-time parallel). The SHAFT generator controller then works together with the GENSET controllers to ensure effective power management.

2.4.2 Applications

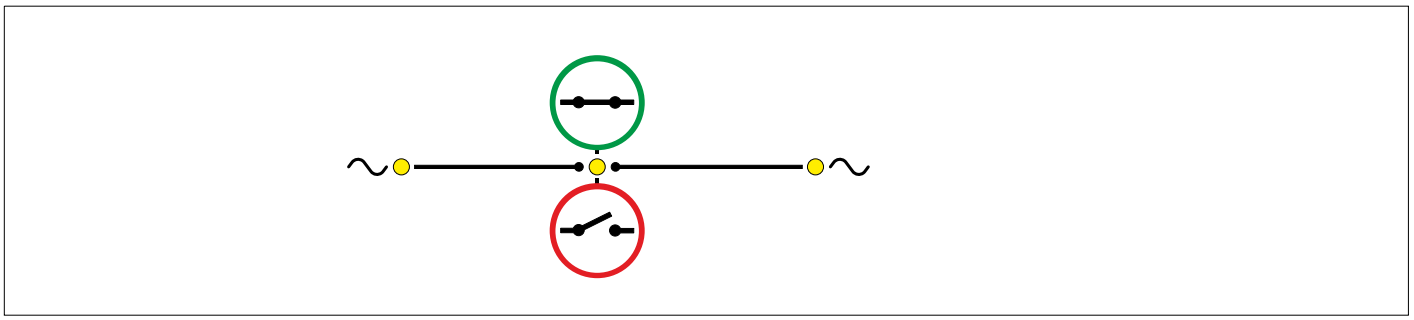
There is no restriction on the number of SHAFT generator controllers.

Figure 2.5 Example of a SHAFT generator controller application with optional heavy consumers and non-essential loads



2.4.3 Display unit

Figure 2.6 Customised section of display unit for the SHAFT generator controller (LEDs shown in yellow)



2.4.4 SHAFT generator controller functions

	Functions
Pre-programmed sequences	• Shaft generator breaker open sequence (with de-loading) • Shaft generator breaker close sequence (with synchronisation) ◦ Running detection • Blackout close • Load transfer from one shaft generator to another (using gensets) • Load transfer from the shaft generator to a shore connection (using gensets) • Frequency variation: Genset(s) automatically start and connect
Load control	• Load transfer between shaft generator and genset(s) • Base load from shaft generator; genset(s) load responds to demand fluctuations • Three sets of temperature-dependent power derate settings for each controller
Power take home (PTH)	• Power take home (PTH) start and stop sequences • Use the shaft generator as a motor to drive the ship's shaft . ◦ Genset(s) drive the ship's shaft ◦ Another shaft generator drives the ship's shaft • Power requirement to drive the ship's shaft treated as a load • Propeller zero pitch digital input • Shaft generator fixed speed digital input
Counters	• Display unit counters, to edit or reset ◦ Running hours (total, and trip) ◦ Shaft generator breaker operations and trips ◦ Energy export (active and reactive) (to the busbar) ◦ Energy import (active and reactive) (to the shaft generator) ◦ External breaker operations • Energy counters with configurable digital outputs (for external counters) ◦ Energy export (active and reactive) (to the busbar) ◦ Energy import (active and reactive) (to the shaft generator)
Control types	• Power management system (PMS) control ◦ Display unit push-buttons for breaker operations ◦ Synchronisation, de-loading, and breaker control ◦ Push-button functions also possible using inputs, PICUS, and/or Modbus • Switchboard control ◦ Operator controls the system from the switchboard

	Functions
	◦ Only the controller protections are active
Regulation	• Regulators for relay outputs and analogue outputs ◦ Regulation delay • Governor regulation ◦ Fixed power ◦ Active power load sharing ◦ Active power ramp down ◦ Frequency-dependent power droop • AVR regulation ◦ Fixed cos phi ◦ Fixed reactive power ◦ Reactive power load sharing ◦ Voltage droop • Configurable: Power ramp up, power ramp down

2.4.5 SHAFT generator controller alarms

INFO
These alarms are in addition to the AC protections and other alarms for PPM 300 controllers.

	Alarms
Shaft generator	Overspeed (2 alarms on the speed measurement)
	Under-speed (2 alarms)
	Primary running feedback failure
	Voltage or frequency not OK
	Magnetic pickup wire break alarm*
	Total running hours notification
	Trip running hours notification
Maximum parallel time	SG-DG maximum parallel time
	SG-SG maximum parallel time
Power management	Heavy consumer feedback timeout (1 alarm for each heavy consumer)
	Heavy consumer reservation not possible (1 alarm for each heavy consumer)
Regulation	• GOV regulation error • GOV regulation mode not selected • GOV stand-alone configuration error** • P load sharing failure • AVR regulation error • AVR regulation mode not selected • AVR stand-alone configuration error** • Q load sharing failure

	Alarms
Non-essential load (NEL)	• Up to 3 non-essential loads per controller • Can connect each controller to the same 3 non-essential load breakers
	NEL # over-current (1 alarm for each non-essential load)
	NEL # under-frequency (1 alarm for each non-essential load)
	NEL # overload 1 and 2 (2 alarms for each non-essential load)
	NEL # reactive overload (1 alarm for each non-essential load)
Other	Trip AVR output not configured

*Note: The default SHAFT generator controller does not include EIM3.1 (required for this alarm).

**Note: Only in GAM3.2.

2.5 SHORE connection controller

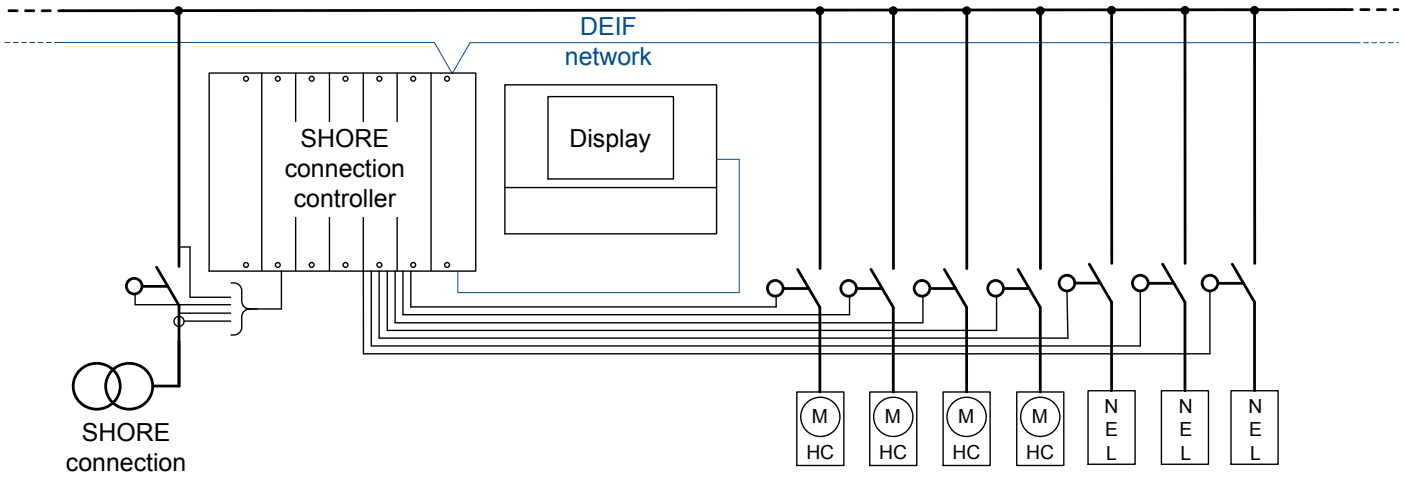
2.5.1 Description

A SHORE connection controller controls and protects the system and the shore connection breaker when a shore connection is connected. When the shore connection is in use, it is normally the ship's only power source. However, the gensets may run in parallel with the shore connection for a limited time.

2.5.2 Applications

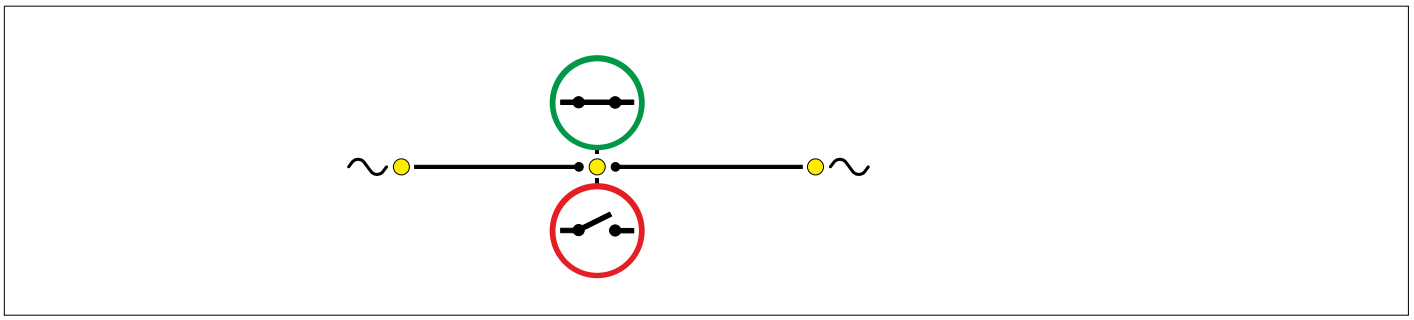
There is no restriction on the number of SHORE connection controllers.

Figure 2.7 Example of a SHORE connection controller application with optional heavy consumers and non-essential loads



2.5.3 Display unit

Figure 2.8 Customised section of display unit for the SHORE connection controller (LEDs shown in yellow)



2.5.4 SHORE connection controller functions

	Functions
Pre-programmed sequences	• Shore connection breaker open sequence (with or without de-loading) • Shore connection breaker close sequence (with synchronisation) • Blackout close • Load transfer from one shore connection to another (using gensets) • Load transfer from the shore connection to a shaft generator (using gensets)
Load control	• Load transfer between shore connection and genset(s) • Base load possible from shore connection; genset(s) load responds to demand fluctuations • Connect multiple shore connections from the same source (configurable) • Connect multiple ship-to-ship supplies (configurable) • Shore connection close load • Sensitive shore connection (overlap)
Counters	• Display unit counters, to edit or reset ◦ Shore connection breaker operations and trips ◦ Power export (active and reactive) (to the shore connection) ◦ Power import (active and reactive) (to the ship busbar) ◦ External breaker operations • Energy counters with configurable digital outputs (for external counters) ◦ Power export (active and reactive) (to the shore connection) ◦ Power import (active and reactive) (to the ship busbar)
Control types	• Power management system (PMS) control ◦ Display unit push-buttons for breaker operations ◦ Synchronisation, de-loading, and breaker control ◦ Push-button functions also possible using inputs, PICUS, and/or Modbus • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active
Redundancy	• Redundant breaker feedback on externally controlled shore connection breakers

2.5.5 SHORE connection controller alarms

INFO
These alarms are in addition to the AC protections and general alarms for PPM 300 controllers.

	Alarms
Maximum parallel time	SC-DG maximum parallel time
	SC-SC maximum parallel time
	SC-SG maximum parallel time
Power management	Heavy consumer feedback timeout (1 alarm for each heavy consumer)
	Heavy consumer reservation not possible (1 alarm for each heavy consumer)
Non-essential load (NEL)	• Up to 3 non-essential loads per controller • Can connect each controller to the same 3 non-essential load breakers
	NEL # over-current (1 alarm for each non-essential load)
	NEL # under-frequency (1 alarm for each non-essential load)
	NEL # overload 1 and 2 (2 alarms for each non-essential load)
	NEL # reactive overload (1 alarm for each non-essential load)

2.6 BUS TIE breaker controller

2.6.1 Description

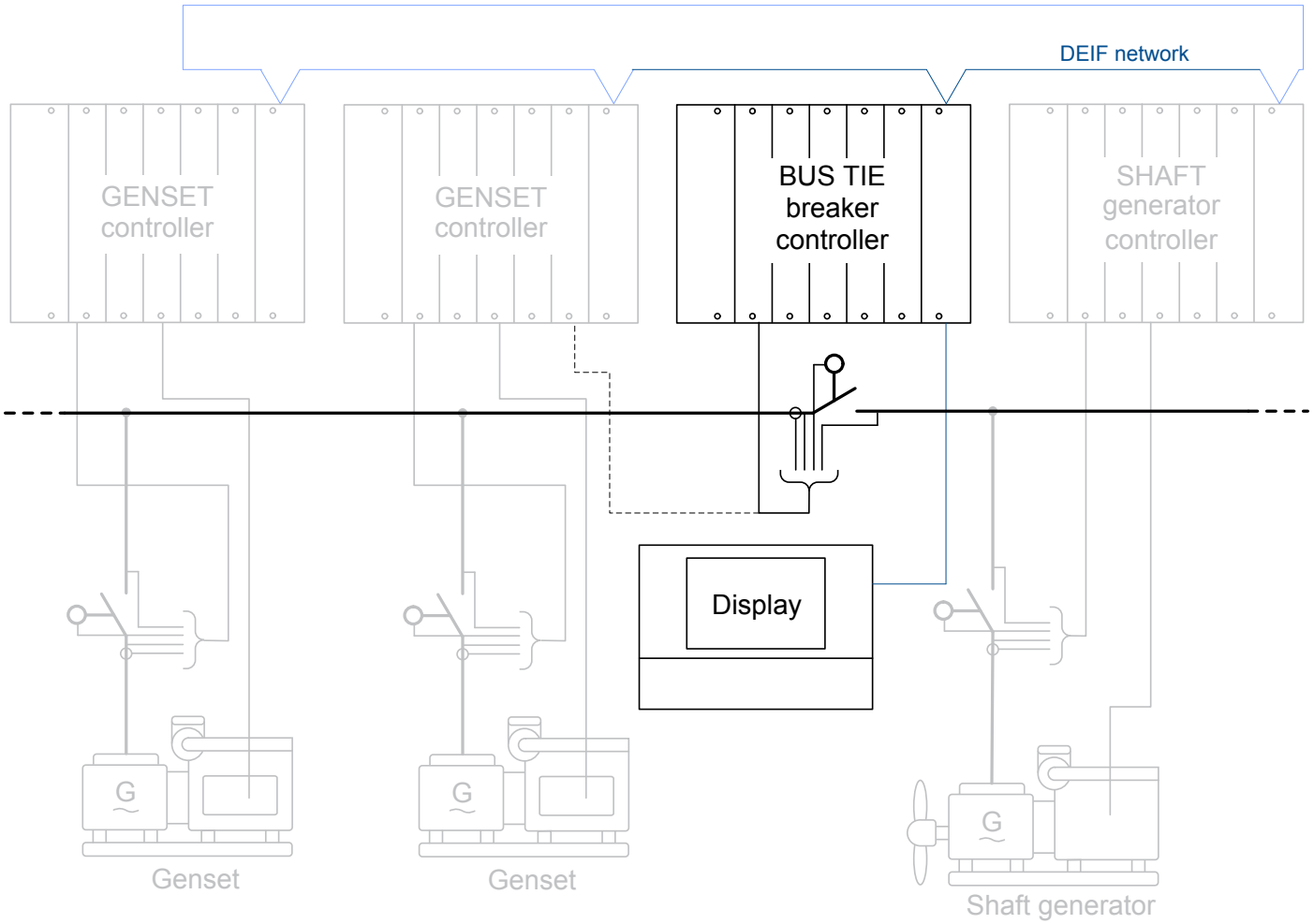
Each BUS TIE breaker controller controls one bus tie breaker. Before closing the bus tie breaker, the power management system synchronises the busbar sections.

Before opening the bus tie breaker, the power management system de-loads the bus tie breaker. The power management system also ensures that enough power is available on each busbar section after the bus tie breaker opens.

2.6.2 Applications

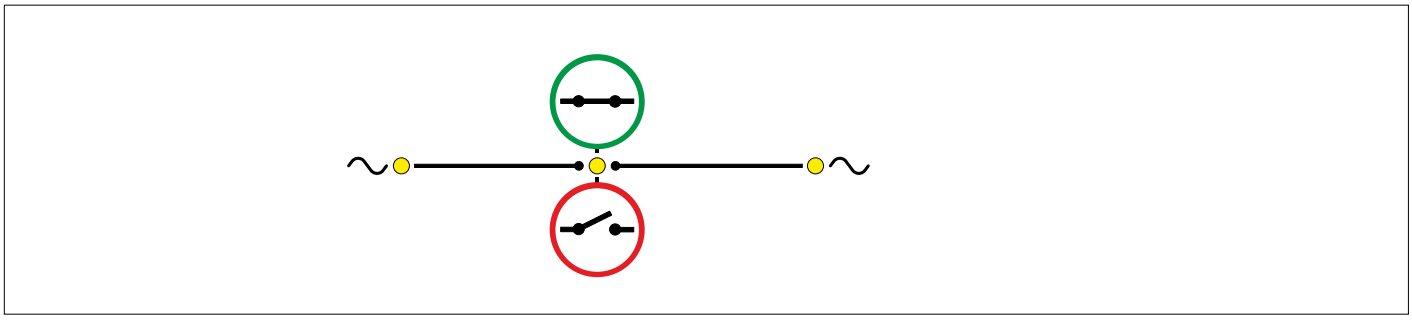
There is no restriction on the number of BUS TIE breaker controllers. There can be a ring busbar connection.

Figure 2.9 Example of a BUS TIE breaker controller application



2.6.3 Display unit

Figure 2.10 Customised section of display unit for the BUS TIE breaker controller (LEDs shown in yellow)



2.6.4 BUS TIE breaker controller functions

	Functions
Pre-programmed sequences	• Bus tie breaker open sequence (with de-loading), to split the busbar into sections • Bus tie breaker close sequence (with synchronisation), to connect the busbar sections
Busbar section management	• Busbar split and connection (configurable) • Busbar section management ◦ For example, independent busbars for dynamic positioning (DP) vessels

	Functions
	◦ A busbar section can be under switchboard control without affecting other busbar sections • Configure up to eight sets of power management rules for busbar sections ◦ Use CustomLogic to determine when to use the power management rules ◦ For example, when the bus tie breaker is open, the rules can specify the minimum and/or maximum number of running gensets • Ring busbar connection
Counters	• Display unit counters, to edit or reset ◦ Bus tie breaker operations and trips ◦ Energy export (active and reactive) (to busbar B) ◦ Energy import (active and reactive) (to busbar A) ◦ Energy differential (active and reactive) ◦ External breaker operations • Energy counters with configurable digital outputs (for external counters) ◦ Energy export (active and reactive) (to busbar B) ◦ Energy import (active and reactive) (to busbar A) ◦ Energy differential (active and reactive)
Control types	• Power management system (PMS) control ◦ Display unit push-buttons for breaker operations ◦ Synchronisation, de-loading, and breaker control ◦ Push-button functions also possible using inputs, PICUS, and/or Modbus • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active
Redundancy	• Redundant breaker feedback on bus tie breakers and externally controlled bus tie breakers

2.6.5 BUS TIE breaker controller alarms

INFO
These alarms are in addition to the AC protections and general alarms for PPM 300 controllers.

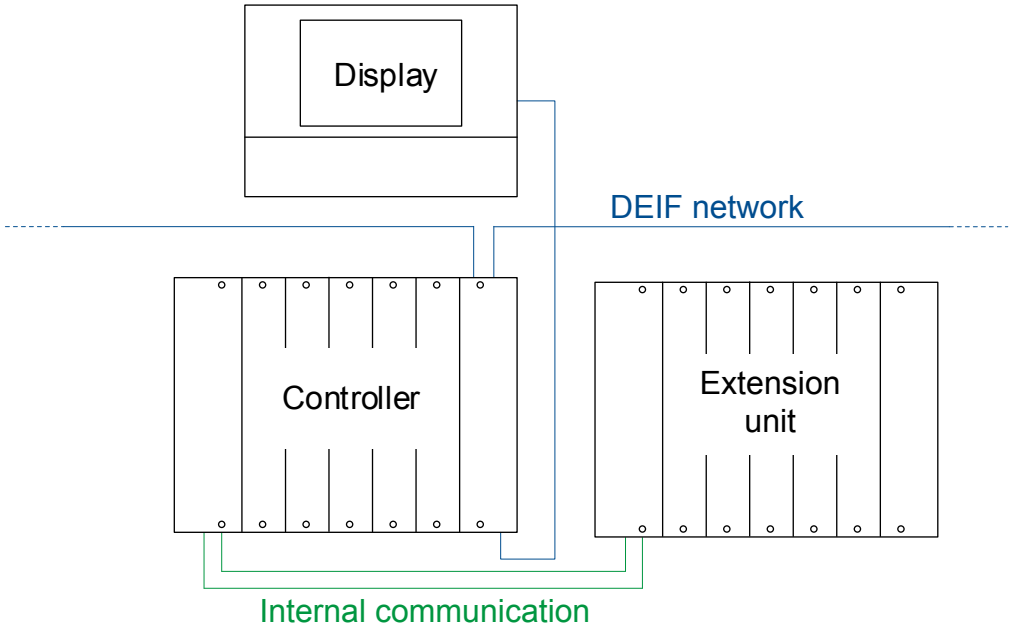
	Alarms
Power management	Heavy consumer feedback timeout (1 alarm for each heavy consumer)
	Heavy consumer reservation not possible (1 alarm for each heavy consumer)
Advanced blackout prevention	P load sharing failure on DG (low frequency)
	P load sharing failure on DG (high frequency)
	Q load sharing failure on DG (low voltage)
	Q load sharing failure on DG (high voltage)
	Overload on a DG
	Reverse power on a DG
	Reactive power export on a DG
	Reactive power import on a DG
	Over-current on a DG

2.7 Extension rack

2.7.1 Application

The extension unit (available as either a 4-slot or 7-slot rack) extends the available inputs and outputs for all controller types. A controller can have five extension units connected to it.

Figure 2.11 Example of a 7-slot extension unit connected to a controller



2.7.2 Extension unit functions

	Functions
General	• Extends I/O interface ◦ 6 additional hardware modules in Rack7.1 ◦ 3 additional hardware modules in Rack4.1 • Controller functions dependent on main controller type and installed hardware modules

3. Technical specifications

3.1 General specifications

3.1.1 Introduction

This chapter includes the technical specifications that apply to all hardware. Refer to the **Hardware** chapter for the technical specifications for specific hardware.

These specifications and approvals apply to the rack (with all the hardware modules properly installed), and also to the display unit.

3.1.2 Electrical specifications

Category	Specification
Safety	EN 61010-1, CAT III, 600V, pollution degree 2 IEC/EN 60255-27, CAT III, 600V, pollution degree 2 UL508 UL6200 CSA C22.2 No. 14-13 CSA C22.2 No. 142 M1987
Electromagnetic compatibility (EMC)	EN 61000-6-3 Residential, commercial and light-industrial environments EN 61000-6-2 Industrial environments IEC/EN 60255-26 IEC 60533 power distribution zone IACS UR E10 power distribution zone for controller rack IEC 60945 for display unit
Load dump	ISO 7637-2 pulse 5a

3.1.3 Mechanical specifications

In the table below, *g* refers to gravitational force (g-force).

Category	Specification	
Vibration	Operation	3 to 8 Hz: 17 mm peak-to-peak 8 to 100 Hz: 4 *g* 100 to 500 Hz: 2 *g*
	Response	10 to 58.1 Hz: 0.15 mm peak-to-peak 58.1 to 150 Hz: 1 *g*
	Endurance	58 to 150 Hz: 2 *g*
	Seismic	3 to 8.15 Hz: 15 mm peak-to-peak 8.15 to 35 Hz: 2 *g*
	IEC 60068-2-6, IACS UR E10, IEC 60255-21-1 (class 2), IEC 60255-21-3 (class 2)	
Shock (base mounted)	10 *g*, 11 ms, half sine IEC 60255-21-2 Response (class 2) 30 *g*, 11 ms, half sine IEC 60255-21-2 Endurance (class 2) 50 *g*, 11 ms, half sine IEC 60068-2-27	
Bump	20 *g*, 16 ms, half sine IEC 60255-21-2 (class 2)	
Material	All plastic materials are self-extinguishing according to UL94 (V0)	

3.1.4 Environment specifications

Category	Specification
Humidity	97 % relative humidity, to IEC 60068-2-30
Operating temperature	**Rack and modules** -40 to 70 °C (-40 to 158 °F) UL/cUL Listed: maximum surrounding air temperature: 55 °C (131 °F) **Display unit** -20 to 70 °C (-4 to 158 °F) UL/cUL Listed: maximum surrounding air temperature: 55 °C (131 °F)
Storage temperature	**Rack and modules** -40 to 80 °C (-40 to 176 °F) **Display unit** -30 to 80 °C (-22 to 176 °F)
Operating altitude	Up to 4,000 m (13,123 ft). Refer to the module specifications for information on altitude derating over 2,000 m (6,562 ft).

3.1.5 Approvals

These approvals apply to the controller rack (with all the modules properly installed), and also to the display unit.

Standards
CE
UL/cUL Listed to UL508 - Industrial Control Equipment, and CSA C22.2 No. 142 M1987 - Process Control Equipment
UL/cUL Recognised to UL6200 - Controls for stationary engine driven assemblies, and CSA C22.2 No. 14-13 - Industrial Control Equipment

3.1.6 Marine approvals

Refer to www.deif.com for the most recent approvals.

4. Hardware

4.1 Controller hardware

4.1.1 Rack R7.1

The rack is an aluminium box with a rack system that houses the hardware modules. Each controller consists of a rack and a number of hardware modules. The hardware modules are replaceable printed circuit boards, and include power supply, control, measurement and I/O interfaces. When the rack is ordered for an I/O extension unit, slot seven contains an additional blanking plate.

The hardware modules in the rack communicate through the rack backplane. For cable organisation, each rack includes two cable strain relief plates (top and bottom), as well as 12 cable tie slots (6 on the top, 6 on the bottom, 2.5 mm (0.1 in) wide). The rack frame has hexagonal holes to maximise cooling and enhance electromagnetic compatibility.

Figure 4.1 Rack R7.1 with dimensions in mm (followed by approximate dimensions in inches), first-angle projection, includes PSM3.1 and blind modules

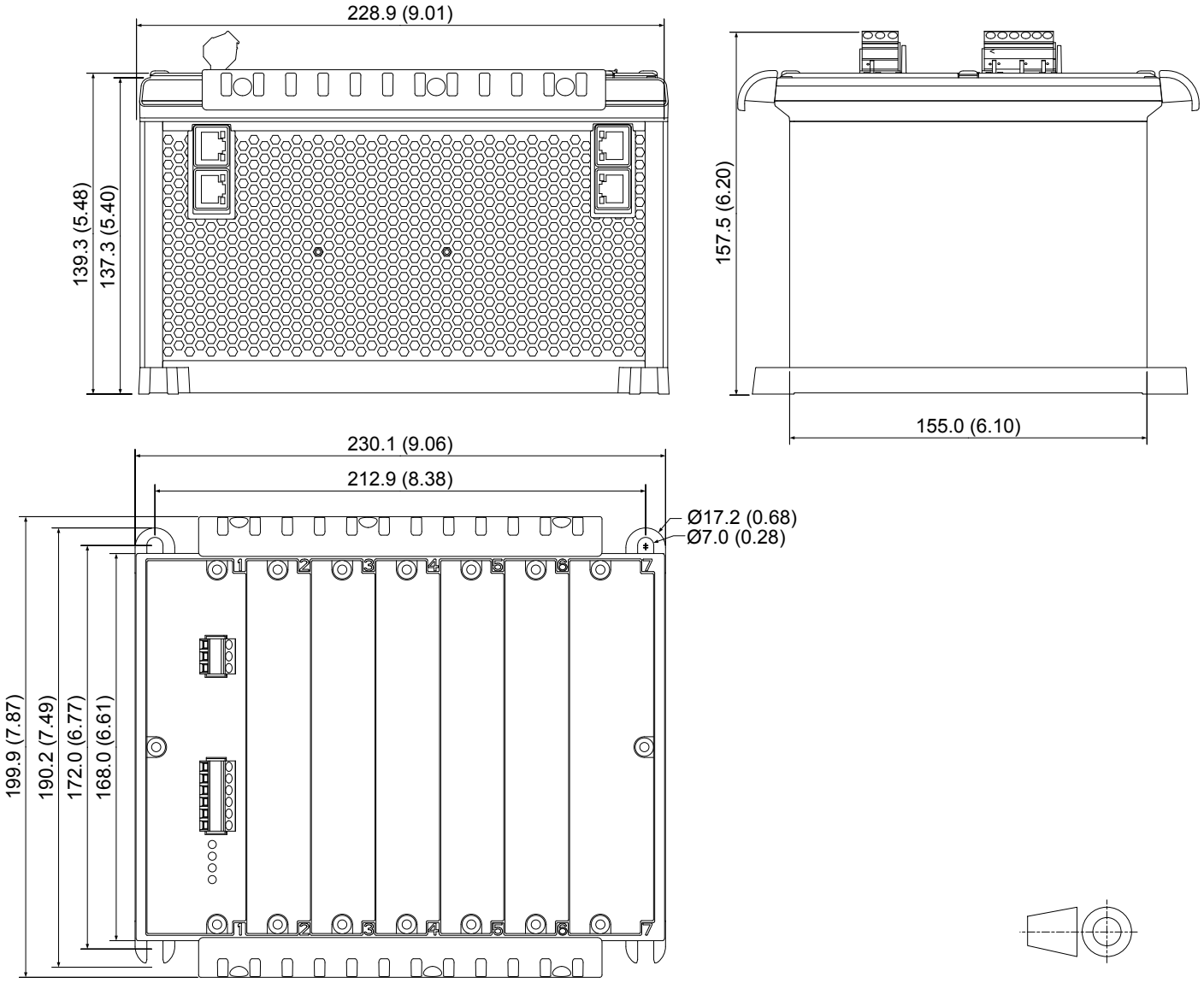


Table 4.1 Rack R7.1 technical specifications

Category	Specification
Ingress protection	IP20 (all slots must have modules or blind modules mounted) according to IEC/EN 60529
UL/cUL Listed	Type Complete Device, Open Type 1
Material	Rack frame: Aluminium
Mounting	Base mount, using four M6 bolts with self-locking washers (or self-locking screws). The bolts and self-locking washers (or self-locking screws) are not included with the rack. UL/cUL Listed: For use on a flat surface of a type 1 enclosure UL/cUL Listed: To be installed in accordance with the NEC (US) or the CEC (Canada)
Tightening torque	Mounting bolts: 4 N·m (35 lb-in)
Size	L 230.1 mm x H 199.9 mm x D 157.5 mm (9.06 in x 7.87 in x 6.20 in) (outer frame, includes cable strain relief plates)
Weight	Without any hardware modules: 1330 g (2.9 lb)

4.1.2 Rack R4.1

The rack is an aluminium box with a rack system that houses the hardware modules. Each controller consists of a rack and a number of hardware modules. The hardware modules are replaceable printed circuit boards, and include power supply, control, measurement and I/O interfaces. When the rack is ordered as an I/O extension rack, slot four contains an additional blanking plate.

The hardware modules in the rack communicate through the rack backplane. For cable organisation, each rack includes two cable strain relief plates (top and bottom), as well as 6 cable tie slots (3 on the top, 3 on the bottom, 2.5 mm (0.1 in) wide). The rack frame has hexagonal holes to maximise cooling and enhance electromagnetic compatibility.

Figure 4.2 Rack R4.1 with dimensions in mm (followed by approximate dimensions in inches), first-angle projection, includes PSM3.1 and blind modules

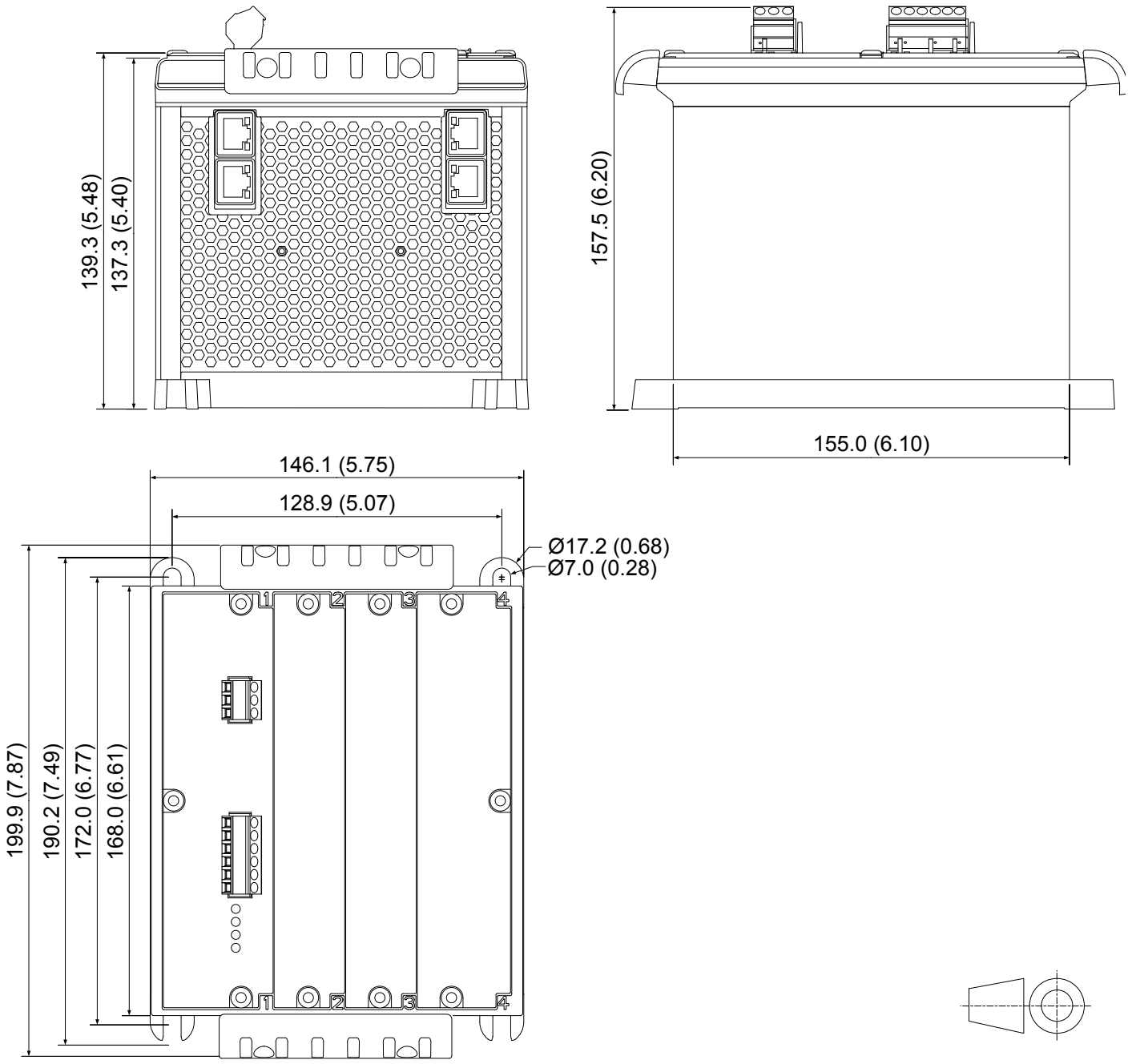


Table 4.2 Rack R4.1 technical specifications

Category	Specification
Ingress protection	IP20 (all slots must have modules or blind modules mounted) according to IEC/EN 60529
UL/cUL Listed	Type Complete Device, Open Type 1
Material	Rack frame: Aluminium
Mounting	Base mount, using four M6 bolts with self-locking washers (or self-locking screws). The bolts and self-locking washers (or self-locking screws) are not included with the rack. UL/cUL Listed: For use on a flat surface of a type 1 enclosure UL/cUL Listed: To be installed in accordance with the NEC (US) or the CEC (Canada)

Category	Specification
Tightening torque	Mounting bolts: 4 N·m (35 lb-in)
Size	L 146.1 mm x H 199.9 mm x D 157.5 mm (5.75 in x 7.87 in x 6.20 in) (outer frame, includes cable strain relief plates)
Weight	Without any hardware modules: 994 g (2.2 lb)

4.1.3 Power supply module PSM3.1

The power supply module provides power to all the hardware modules in the rack. The rack status and alarms activate the PSM's three relay outputs. There are two ports for internal communication with I/O extension units.

PSM3.1 manages the hardware module self-checks for the rack and includes a power LED. The power supply terminals include circuit protection against load dump transients and JEM177 surge transients (rugged design). These terminals also include battery voltage measurement.

Table 4.3 PSM3.1 terminals

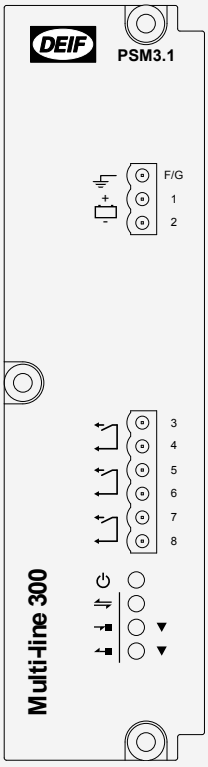
Module	Count	Symbol	Type	Name
	1		Ground	Frame ground
	1		12 or 24 V	Power supply
	3		Relay output	1 × Status OK (fixed), and 2 × configurable
	2		Internal communication (RJ45)	DEIF internal communication connections (to connect to extension unit) (The LEDs are on the front of the hardware module. The connections are at the bottom of the hardware module.)

Table 4.4 PSM3.1 technical specifications

Category	Specification
Frame ground	Voltage withstand: ±36 V DC to the power supply positive (terminal 1) Voltage withstand: ±36 V DC to the power supply negative (terminal 2)
Controller power supply	Input voltage: 12 or 24 V DC nominal (8 to 36 V DC continuously) UL/cUL Listed: 10 to 32.5 V DC 0 V DC for 50 ms when coming from at least 8 V DC (cranking dropout) Consumption: Typical 20 W, maximum 35 W Voltage measurement accuracy: 0 to 30 V: ±1 V; 30 to 36 V: +1/-2 V

Category	Specification
	The power supply inputs are internally protected by a 12 A fuse (not replaceable) (fuse size determined by load dump requirements). Voltage withstand: ±36 V DC Load dump protected by TVS diodes. **Start current** • Power supply current limiter ◦ 24 V: 4 A minimum ◦ 12 V: 8 A minimum • Battery: No limit
Relay outputs 	Relay type: Solid state Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC
Terminal connections	**Frame ground and power supply**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 1.5 to 2.5 mm^2 (16 to 12 AWG), multi-stranded **Other connections**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Communication connections	DEIF internal communication: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications.
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between power supply and other I/Os: 600 V, 50 Hz for 60 s Between relay groups and other I/Os: 600 V, 50 Hz for 60 s Between internal communication ports and other I/Os: 600 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 43.3 mm × H 162 mm × D 150 mm (1.5 in × 6.4 in × 5.9 in)
Weight	331 g (0.7 lb)

4.1.4 Power supply module PSM3.2

The power supply module provides power to all the hardware modules in the extension unit and communicates with the main controller through the internal communication ports. The rack status and alarms activate the PSM's three relay outputs. There are two ports for internal communication with the main controller.

PSM3.2 manages the hardware module self-checks for the rack and includes a power LED. The power supply terminals include circuit protection against load dump transients and JEM177 surge transients (rugged design). These terminals also include battery voltage measurement.

NOTE Extension racks must be powered off when exchanging or re-connecting to another controller. If the extension rack is not powered off, there could be unintended actions from the rack modules.

Table 4.5 PSM3.2 terminals

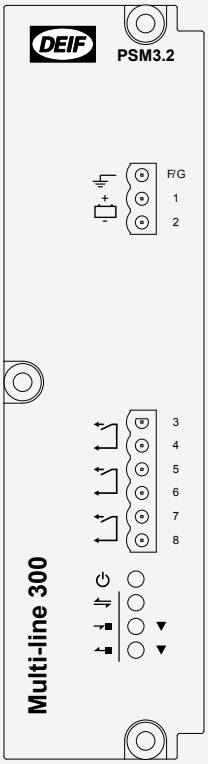
Module	Count	Symbol	Type	Name
	1		Ground	Frame ground
	1		12 or 24 V	Power supply
	3		Relay output	1 × Status OK (fixed), and 2 × configurable
	2		Internal communication (RJ45)	DEIF internal communication connections (to connect to the main controller) (The LEDs are on the front of the hardware module. The connections are at the bottom of the hardware module.)

Table 4.6 PSM3.2 technical specifications

Category	Specification
Frame ground	Voltage withstand: ±36 V DC to the power supply positive (terminal 1) Voltage withstand: ±36 V DC to the power supply negative (terminal 2)
Controller power supply	Input voltage: 12 or 24 V DC nominal (8 to 36 V DC continuously) UL/cUL Listed: 10 to 32.5 V DC 0 V DC for 50 ms when coming from at least 8 V DC (cranking dropout) Consumption: Typical 20 W, maximum 35 W Voltage measurement accuracy: 0 to 30 V: ±1 V; 30 to 36 V: +1/-2 V The power supply inputs are internally protected by a 12 A fuse (not replaceable) (fuse size determined by load dump requirements). Voltage withstand: ±36 V DC Load dump protected by TVS diodes. **Start current** • Power supply current limiter ◦ 24 V: 4 A minimum ◦ 12 V: 8 A minimum • Battery: No limit
Relay outputs	Relay type: Solid state Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC
Terminal connections	**Frame ground and power supply**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 1.5 to 2.5 mm^2 (16 to 12 AWG), multi-stranded **Other connections**: Terminals: Standard 45° plug, 2.5 mm^2

Category	Specification
	Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Communication connections	DEIF internal communication: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications.
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between power supply and other I/Os: 600 V, 50 Hz for 60 s Between relay groups and other I/Os: 600 V, 50 Hz for 60 s Between internal communication ports and other I/Os: 600 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 43.3 mm × H 162 mm × D 150 mm (1.5 in × 6.4 in × 5.9 in)
Weight	331 g (0.7 lb)

4.1.5 Alternating current module ACM3.1

The alternating current module measures the voltage and current on one side of a breaker, and the voltage on the other side. The hardware module responds when the measurements exceed the AC alarm parameters. ACM3.1 uses the AC measurements to check the synchronisation before the breaker closes.

ACM3.1 provides robust frequency detection in environments with electrical noise. ACM3.1 allows extended measurement bandwidth up to 40 times the nominal frequency. ACM3.1 includes a configurable 4th current measurement.

Default: ACM3.1 measures 3-phase systems. Optional: Select split-phase (1-phase, 3-wire, for example, L1-N-L2) or single-phase (1-phase, 2-wire, for example, L1-N).

Table 4.7 ACM3.1 terminals

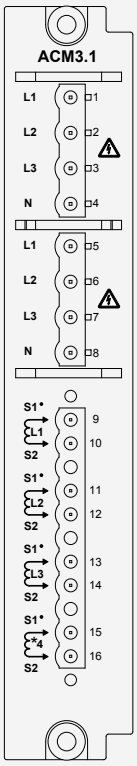
Module	Count	Symbol	Type	Name
	2 × (L1, L2, L3 and N)	L1/L2/L3/N	Voltage	3-phase voltage measurements
	1 × (L1, L2, L3 and 4th)		Current	3-phase current measurement 4th current measurement

Table 4.8 ACM3.1 technical specifications

Category	Specification
Voltage measurements	Nominal value: 100 to 690 V AC phase-to-phase Measurement range: 2 to 897 V AC phase-to-phase Accuracy: Class 0.2 Phase angle accuracy: 0.1° (within nominal voltage range and nominal frequency range) Altitude derating from 2,000 to 4,000 m (6,562 to 13,123 ft): 100 to 480 V AC phase-to-phase UL/cUL Listed: 100 to 600 V AC phase-to-phase Load on external voltage transformer: Maximum 0.2 VA/phase Voltage withstand: 1.2 × Nominal voltage continuously; 1.3 × Nominal voltage for 10 s
Current measurements	Nominal value: 1 or 5 A AC from current transformer Measurement range: 0.02 to 17.5 A AC from current transformer; Truncation level: 11 mA Accuracy: Class 0.2 Earth current: 18 dB attenuation of third harmonic of the nominal frequency UL/cUL Listed: From listed or R/C (XOWD2.8) current transformers 1 or 5 A Load on external current transformer: Maximum 0.3 VA/phase Current withstand: 10 A continuously; 17.5 A for 60 s; 100 A for 10 s; 250 A for 1 s
Frequency measurements	Nominal value: 50 Hz or 60 Hz Measurement range: 35 to 78 Hz Accuracy: Class 0.1 of nominal value (35 to 78 Hz) (-40 to 70 °C) (-40 to 158 °F) Class 0.02 of nominal value (40 to 70 Hz) (15 to 30 °C) (59 to 86 °F)
Power measurements	Accuracy: Class 0.5
Accuracy and temperature	Unless otherwise specified for the above measurements: Nominal range: -40 to 70 °C (-40 to 158 °F) Reference range: 15 to 30 °C (59 to 86 °F) Accuracy: Measurement type specific within reference range. Additional 0.2 % error of full scale per 10 °C (18 °F) outside reference range. Example: The accuracy for Power (P) at 70 °C (158 °F) is 0.5 % + 4 x 0.2 % = 1.3 %.
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Secure the current measurement terminal block to the module faceplate: 0.25 N·m (2.2 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Terminal connections	AC voltage and current terminals: Standard 45º plugs, 2.5 mm^2 Wiring: 2.5 mm^2 (13 AWG), multi-stranded
Galvanic isolation	Between AC voltage and other I/Os: 3310 V, 50 Hz for 60 s Between AC current and other I/Os: 2210 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Accessories (included)	• One roundel with 6 J-shaped voltage encoding pins (for the hardware module) • One roundel with 6 flat voltage encoding pins (for the voltage terminal blocks)
Weight	232 g (0.5 lb)

4.1.6 Differential current module ACM3.2

The differential current module ACM3.2 measures the generator outgoing 3-phase currents (consumer side) and star point 3-phase currents. The ACM3.2 uses the measurements to detect phase-to-phase faults or phase-to-earth faults (star point earthed generator stator only) in the generator stator, and dependent on the mounting of the CT's on the outgoing side, possibly also the cable between the generator and the main switchboard.

The protection consists of:

- A stabilised stage that uses a fixed + 2 x sloped operating characteristic. This current restraint approach is also known as biased differential protection.
- A high set fixed differential stage (non-stabilised).

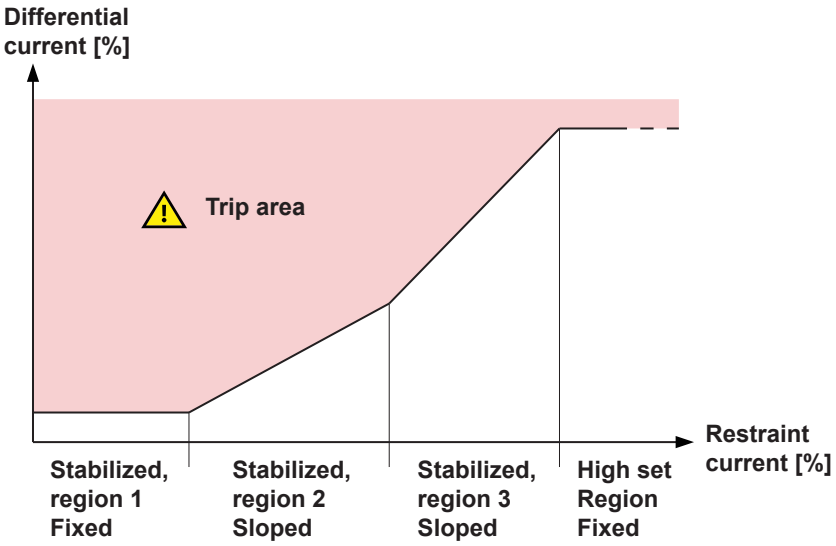


Table 4.9 ACM3.2 terminals

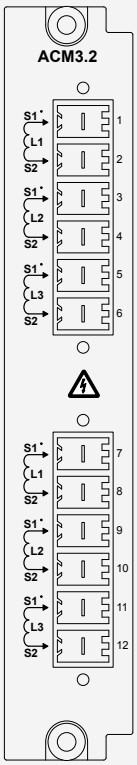
Module	Count	Symbol	Type	Name
	1 × (L1, L2 and L3)		Current	3-phase current measurement - Consumer side
	1 × (L1, L2 and L3)		Current	3-phase current measurement - Neutral side

Table 4.10 ACM3.2 technical specifications

Category	Specification
Nominal, reference and operating values	Current: Nominal value: 1 or 5 A AC from current transformer Frequency:

Category	Specification
	Nominal value: 50 or 60 Hz Reference range: 40 to 70 Hz Operating range: 20 to 78 Hz Temperature: Reference range: 15 to 30 °C (59 to 86 °F) Operating range: -40 to 70 °C (-40 to 158 °F)
Current measurements	Measurement range: 0.025 to 250 A AC. Truncation level: 20 mA Accuracy: • 0.025 to 20 A: ±1 % or ±10 mA of measured current (whichever is greater) • 20 to 250 A: ±1.5 % of measured current UL/cUL Listed: From listed or R/C (XOWD2.8) current transformers 1 or 5 A Load on external current transformer: < 4 mΩ, including the terminal block Current withstand: • 20 A continuously • 100 A for 10 s • 400 A for 1 s • 1250 A for 10 ms (half wave)
Frequency measurement	Accuracy: • Within operating range; > 0.1 A: ±0.1 % of actual frequency
Temperature	Current measurement accuracy temperature coefficient: ±0.25 %, or ±2.5 mA per 10 °C (18 °F) outside reference range (whichever is greater)
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Secure the current measurement terminal block to the module faceplate: 0.25 N·m (2.2 lb-in) Connection of wiring to terminals: ≤ 4 mm^2: 0.5 N·m (4.4 lb-in) to 0.6 N·m (5.3 lb-in) > 4 mm^2: 0.7 N·m (6.2 lb-in) to 0.8 N·m (7.1 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only
Terminal connections	AC current terminals: Standard 0º plugs, 6 mm^2 with securing screws. Wiring: 2.5 to 6 mm^2 (13 to 10 AWG), multi-stranded
Galvanic isolation	Between AC current and other I/Os: 2210 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 152 mm (1.1 in × 6.4 in × 5.9 in)
Weight	230 g (0.5 lb) (including terminal blocks)
Accessories (included)	One roundel with 6 encoding pins (for the hardware module and terminal block)

4.1.7 Input/output module IOM3.1

The input output module has four changeover relay outputs, and 10 digital inputs. These I/Os are all configurable.

Table 4.11 IOM3.1 terminals

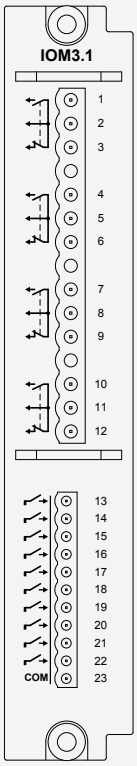
Module	Count	Symbol	Type	Name
	4		Relay output	Configurable
	10		Digital input	Configurable

Table 4.12 IOM3.1 technical specifications

Category	Specification
Relay outputs 	Relay type: Electromechanical Electrical rating and UL/cUL Listed: 250 V AC or 30 V DC, and 6 A, resistive; B300, pilot duty (B300 is a power limit specification for inductive loads) Altitude derating from 3,000 to 4,000 m (9,842 to 13,123 ft): Maximum 150 V AC phase-to-phase Voltage withstand: 250 V AC
Digital inputs 	Bipolar inputs ON: -36 to -8 V DC, and 8 to 36 V DC OFF: -2 to 2 V DC Minimum pulse length: 50 ms Impedance: 4.7 kΩ Voltage withstand: ±36 V DC
Terminal connections	**Relay outputs**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded **Digital inputs**: Terminals: Standard 45° plug, 1.5 mm^2 Wiring: 0.1 to 1.5 mm^2 (28 to 16 AWG), multi-stranded
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to relay output terminals: 0.5 N·m (4.4 lb-in) Connection of wiring to digital input terminals: 0.25 N·m (2.2 lb-in) UL/cUL Listed: Wiring must be minimum 90 ºC (194 °F) copper conductors only.
Galvanic isolation	Between relay groups and other I/Os: 2210 V, 50 Hz for 60 s Between digital input groups and other I/Os: 600 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating

Category	Specification
	Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	196 g (0.4 lb)

4.1.8 Input/output module IOM3.4

The input output module has 12 transistor outputs, and 16 digital inputs. These I/Os are all configurable.

Table 4.13 IOM3.4 terminals

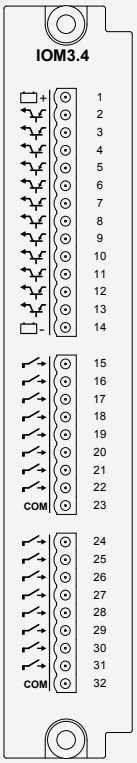
Module	Count	Symbol	Type	Name
	12		Transistor output	Configurable
	16		Digital input	Configurable

Table 4.14 IOM3.4 technical specifications

Category	Specification
Transistor outputs	Transistor type: PNP Supply voltage: 12 or 24 V DC nominal, maximum 36 V DC (relative to common) Maximum current (per output): < 55 °C: 250 mA; > 55 °C: 200 mA Leak current: Typical 1 µA, maximum 100 µA (temperature-dependent) Saturation voltage: Maximum 0.5 V Non-replaceable 4 A fuse Voltage withstand: ±36 V DC Load dump protected by TVS diodes. Short circuit protection Reverse polarity protection Internal freewheeling diode
Digital inputs	Bipolar inputs ON: -36 to -8 V DC, and 8 to 36 V DC OFF: -2 to 2 V DC Minimum pulse length: 50 ms

Category	Specification
	Impedance: 4.7 kΩ Voltage withstand: ±36 V DC
Terminal connections	Terminals: Standard 45° plug, 1.5 mm^2 Wiring: 0.1 to 1.5 mm^2 (28 to 16 AWG), multi-stranded
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.25 N·m (2.2 lb-in) UL/cUL Listed: Wiring must be minimum 90 ºC (194 °F) copper conductors only.
Galvanic isolation	Between groups: 600 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	175 g (0.4 lb)

4.1.9 Governor and AVR module GAM3.1

This governor and AVR module has four relay outputs, two analogue outputs and a pulse width modulation output, and two analogue inputs. These I/Os are configurable.

GAM3.1 also has terminals for analogue load sharing (future use).

Table 4.15 GAM3.1 terminals

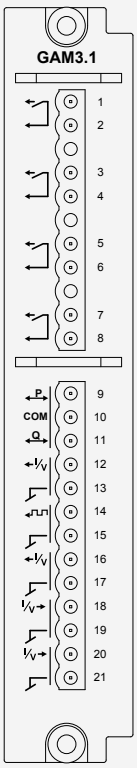
Module	Count	Symbol	Type	Name
	4		Relay output	Configurable
	1	P	Load sharing	Active power (P) (kW) load sharing (future use)
	1	Q	Load sharing	Reactive power (Q) (kvar) sharing (future use)
	2	I/V	Analogue current or voltage output	GOV/AVR/configurable
	1		Pulse width modulation (PWM) output	PWM output (with PWM ground)
	2	I/V	Analogue current or voltage input	Configurable

Table 4.16 GAM3.1 technical specifications

Category	Specification
Relay outputs	Relay type: Electromechanical Electrical rating and UL/cUL Listed: 250 V AC or 30 V DC, and 6 A, resistive; B300, pilot duty (B300 is a power limit specification for inductive loads) Altitude derating from 2,000 to 4,000 m (6,562 to 13,123 ft): Maximum 150 V AC phase-to-phase Voltage withstand: 250 V AC
Load sharing (future use)	Voltage input/output: -5 to 5 V DC Impedance: 23.5 kΩ Accuracy: 1 % of full scale, for both inputs and outputs Voltage withstand: ±36 V DC
Analogue multi-functional outputs	**Current output** -20 to 20 mA, or 0 to 20 mA, or 4 to 20 mA, or any custom range between -25 and 25 mA Accuracy: 1 % of the selected range (minimum range: 5 mA) 16-bit resolution over the range -25 to 25 mA Active output (internal supply) Maximum load: 400 Ω **Voltage output (DC)** -10 to 10 V, 0 to 10 V, 0 to 5 V, -5 to 5 V, 0 to 3 V, -3 to 3 V, or 0 to 1 V, or any custom range between -10 and 10 V Accuracy: 1 % of the selected range (minimum range: 1 V) 16-bit resolution over the range -10 to 10 V Minimum load: 600 Ω. Voltage output internal resistance: < 1 Ω. Voltage withstand: ±36 V DC Controller power off: Internal resistance > 10 MΩ
Pulse width modulation (PWM) output	Frequency: 500 Hz ±50 Hz Resolution: 43,200 levels Voltage: Low level: < 0.5 V. High level: > 5.5 V. Maximum: 6.85 V. Output impedance: 100 Ω Nominal temperature range: -40 to 70 °C (-40 to 158 °F) Reference temperature range: 15 to 30 °C (59 to 86 °F) Duty cycle accuracy (5 to 95 %): 0.25 % within reference temperature range. 0.2 % of full scale additional error per 10 °C (18 °F) outside the reference range. Example: At 70 °C (158 °F) the accuracy of the PWM output is 0.25 % + 4 x 0.2 % = 1.05 % Voltage withstand: ±30 V DC
Analogue multi-functional inputs	**Current inputs** From active transmitter: 0 to 20 mA, 4 to 20 mA, or any custom range between 0 and 24 mA Accuracy: 1 % of selected range **Voltage inputs (DC)** -10 to 10 V, 0 to 10 V, or any custom range between -10 and 10 V Accuracy: 1 % of selected range Voltage withstand: ±36 V DC
Terminal connections	Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between individual relays and other I/Os: 2210 V, 50 Hz for 60 s

Category	Specification
	Between load sharing and other I/Os: 600 V, 50 Hz for 60 s Between terminals 12 to 15 (analogue output 1, PWM output), and other I/Os: 600 V, 50 Hz for 60 s • Analogue output 1 and the PWM output are galvanically connected. Between terminals 16, 17 (analogue output 2) and other I/Os: 600 V, 50 Hz for 60 s Between terminals 18 to 21 (analogue inputs) and other I/Os: 600 V, 50 Hz for 60 s • Analogue inputs 1 and 2 are galvanically connected.
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	224 g (0.5 lb)

4.1.10 Governor and AVR module GAM3.2

This governor and AVR module has its own power supply, two analogue outputs and a pulse width modulation output, five digital inputs, a status relay output, and four relay outputs. Apart from the status relay, all these I/Os are configurable.

GAM3.2 has its own microprocessor. If the rack power supply fails, GAM3.2 can continue to be used for manual operation if it has its own, independent power supply. The power supply terminals include circuit protection against load dump transients and JEM177 surge transients (rugged design). These terminals also include battery voltage measurement.

Table 4.17 GAM3.2 terminals

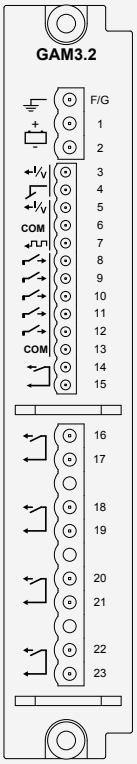
Module	Count	Symbol	Type	Name
	1		Ground	Frame ground
	1		12 or 24 V	Power supply
	2		Analogue current or voltage output	GOV/AVR/configurable
	1		Pulse width modulation (PWM) output	PWM output
	5		Digital input	Configurable
	1		Relay output	GAM3.2 status
	4		Relay output	Configurable

Table 4.18 GAM3.2 technical specifications

Category	Specification
Auxiliary power supply	Input voltage: 12 or 24 V DC nominal (8 to 36 V DC continuously) UL/cUL Listed: 10 to 32.5 V DC 0 V DC for 50 ms when coming from at least 8 V DC (cranking dropout) Consumption: Typical 3 W, maximum 5 W Voltage measurement accuracy: ±0.1 V (measurement range 8 to 36 V DC) The auxiliary supply inputs are internally protected by a 12 A fuse (not replaceable) (fuse size determined by load dump requirements). Voltage withstand: ±36 V DC Load dump protected by TVS diodes. **Start current** • Power supply current limiter ◦ 24 V: 0.6 A minimum ◦ 12 V: 1.2 A minimum • Battery: No limit
Analogue multi-functional outputs	**Current output** Any custom range between -25 and 25 mA Accuracy: 1 % of the selected range (minimum range: 5 mA) 16-bit resolution Active output (internal supply) Maximum load: 400 Ω **Voltage output (DC)** Any custom range between -10 and 10 V Accuracy: 1 % of the selected range (minimum range: 1 V) 16-bit resolution Minimum load: 600 Ω. Voltage output internal resistance: < 1 Ω. Voltage withstand: ±36 V DC Controller power off: Internal resistance > 10 MΩ
Pulse width modulation (PWM) output	Frequency: 500 Hz ±50 Hz Resolution: 43,200 levels Voltage: Low level: < 0.5 V. High level: > 5.5 V. Maximum: 6.85 V. Output impedance: 100 Ω Nominal temperature range: -40 to 70 °C (-40 to 158 °F) Reference temperature range: 15 to 30 °C (59 to 86 °F) Duty cycle accuracy (5 to 95 %): 0.25 % within reference temperature range. 0.2 % of full scale additional error per 10 °C (18 °F) outside the reference range. Example: At 70 °C (158 °F) the accuracy of the PWM output is 0.25 % + 4 x 0.2 % = 1.05 % Voltage withstand: ±30 V DC
Digital inputs	Bipolar inputs ON: -36 to -8 V DC, and 8 to 36 V DC OFF: -2 to 2 V DC Minimum pulse length: 50 ms Impedance: 4.7 kΩ Voltage withstand: ±36 V DC
Relay output (GAM3.2 status)	Relay type: Solid state Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC
Relay outputs	Relay type: Electromechanical

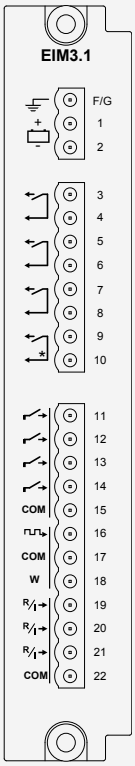
Category	Specification
	Electrical rating and UL/cUL Listed: 250 V AC or 30 V DC, and 6 A, resistive; B300, pilot duty (B300 is a power limit specification for inductive loads) Altitude derating from 2,000 to 4,000 m (6,562 to 13,123 ft): Maximum 150 V AC phase-to-phase Voltage withstand: 250 V AC
Terminal connections	**Frame ground and power supply**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 1.5 to 2.5 mm^2 (16 to 12 AWG), multi-stranded **Analogue inputs, PWM, digital inputs and the status relay**: Terminals: Standard 45° plug, 1.5 mm^2 Wiring: 0.5 to 1.5 mm^2 (28 to 16 AWG), multi-stranded **Relay outputs**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to frame ground and power supply terminals: 0.5 N·m (4.4 lb-in) Connection of wiring to analogue inputs, PWM, digital inputs, and the status relay terminals: 0.25 N·m (2.2 lb-in) Connection of wiring to relay output terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between power supply and other I/Os: 600 V, 50 Hz for 60 s Between analogue inputs, PWM, digital inputs, and the status relay, and other I/Os: 600 V, 50 Hz for 60 s Note: The analogue output on terminals 5 and 6 is galvanically connected to the PWM output (terminal 6 and 7). Between relay groups and other I/Os: 2210 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	246 g (0.5 lb)

4.1.11 Engine interface module EIM3.1

The engine interface module has its own power supply and a tacho input to measure speed. It also has four relay outputs, four digital inputs, and three analogue inputs. These I/Os are configurable.

The power supply terminals include circuit protection against load dump transients and JEM177 surge transients (rugged design).

Table 4.19 EIM3.1 terminals

Module	Count	Symbol	Type	Name
	1		Ground	Frame ground
	1		12 or 24 V DC	Power supply
	3		Relay output	Configurable
	1		Relay output (with wire break detection)	Configurable
	4		Digital input	Configurable
	1		MPU input (with wire break detection)*	Magnetic pickup
	1	W	W input (no wire break detection)*	Generator tacho output or NPN/PNP sensor
	3	R/I	Analogue current or resistance measurement input (RMI)	Configurable

*Note: These inputs cannot both be used at the same time.

Table 4.20 EIM3.1 technical specifications

Category	Specification
Frame ground	Voltage withstand: ±36 V DC to the power supply positive (terminal 1) Voltage withstand: ±36 V DC to the power supply negative (terminal 2)
Auxiliary power supply	Input voltage: 12 or 24 V DC nominal (8 to 36 V DC continuously) UL/cUL Listed: 10 to 32.5 V DC 0 V DC for 50 ms when coming from at least 8 V DC (cranking dropout) Consumption: Typical 3 W, maximum 5 W The auxiliary supply inputs are internally protected by a 12 A fuse (not replaceable) (fuse size determined by load dump requirements). Voltage withstand: ±36 V DC Load dump protected by TVS diodes. **Start current** • Power supply current limiter ◦ 24 V: 0.6 A minimum ◦ 12 V: 1.2 A minimum • Battery: No limit
Relay outputs	Relay type: Electromechanical Electrical rating and UL/cUL Listed: 30 V DC and 6 A, resistive Voltage withstand: ±36 V DC
Relay output with wire break detection	Relay type: Electromechanical Electrical rating and UL/cUL Listed: 30 V DC and 6 A, resistive Includes wire break detection

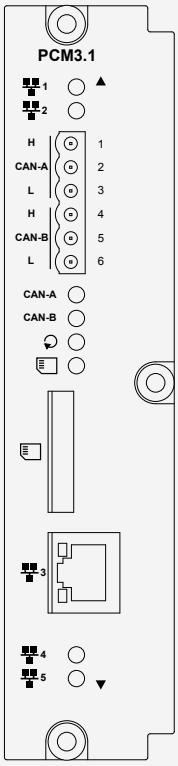
Category	Specification
	Voltage withstand: ±36 V DC
Magnetic pickup	Voltage: 3 to 70 V AC peak Frequency: 2 to 20,000 Hz Accuracy: 2 to 99 Hz: 0.5 Hz; 100 to 20,000 Hz: ±0.5 % of measurement Cable supervision: Resistance maximum 100 kΩ Includes wire break detection Voltage withstand: 70 V AC
Generator tacho (W) w	Voltage: 8 to 36 V DC Frequency: 2 to 20,000 Hz Accuracy: 2 to 99 Hz: 0.5 Hz; 100 to 20,000 Hz: ±0.5 % of measurement No wire break detection Voltage withstand: ±36 V DC
NPN/PNP w	Voltage: 8 to 36 V DC Frequency: 2 to 20,000 Hz Accuracy: 2 to 99 Hz: 0.5 Hz; 100 to 20,000 Hz: ±0.5 % of measurement No wire break detection Voltage withstand: ±36 V DC
Digital inputs	Bipolar inputs ON: -36 to -8 V DC, and 8 to 36 V DC OFF: -2 to 2 V DC Minimum pulse length: 50 ms Impedance: 4.7 kΩ Voltage withstand: ±36 V DC
Analogue multi-functional inputs	**Current input**: From active transmitter: 0 to 20 mA, 4 to 20 mA, or any custom range between 0 and 25 mA Accuracy: 1 % of selected range **Pt100/1000**: -40 to 250 °C (-40 to 482 °F) Accuracy: 1 % of full scale (to IEC/EN60751) Maximum sensor self-heating: 0.5 °C/mW (1 °F/mW). **Resistance measurement**: Any custom range between 0 and 2.5 kΩ Accuracy: 1 % over ranges: 0 to 200 Ω, 0 to 300 Ω, 0 to 500 Ω, 0 to 1000 Ω, and 0 to 2500 Ω **Digital input**: Dry contact with cable supervision Maximum circuit resistance: 330 Ω Minimum current rating for the connected relay: 2.5 mA Voltage withstand: ±36 V DC All analogue multi-functional inputs for EIM3.1 have a common ground.
Terminal connections	**Frame ground and power supply**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 1.5 to 2.5 mm^2 (16 to 12 AWG), multi-stranded **Other connections**: Terminals: Standard 45° plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between relay groups and other I/Os: 600 V, 50 Hz for 60 s Between digital input groups and other I/Os: 600 V, 50 Hz for 60 s Between MPU and W inputs and other I/Os: 600 V, 50 Hz for 60 s

Category	Specification
	Between analogue inputs and other I/Os: 600 V, 50 Hz for 60 s
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	250 g (0.5 lb)

4.1.12 Processor and communication module PCM3.1

The processor and communication module has the controller's main microprocessor, which contains and runs the controller application software. It includes the Ethernet switch to manage the controller Ethernet connections, with five 100BASE-TX Ethernet connections. It has a *Self-check OK* LED. It also has two sets of CAN bus terminals and houses the SD card. The PCM3.1 performs time synchronisation with an NTP server.

Table 4.21 PCM3.1 terminals

Module	Count	Symbol	Type	Name
	5		Ethernet (RJ45)	Network and DEIF network (The LEDs are on the front of the hardware module. Two of the connections are at the top of the hardware module, one on the front, and two at the bottom.)
	2	H, CAN-A, L H, CAN-B, L	CAN bus connection	CAN bus (for future use)
	1		SD card*	External memory

*Note: To meet the temperature and EMC specifications, you must use an industrial grade SD card.

Table 4.22 PCM3.1 technical specifications

Category	Specification
CAN terminals	Voltage withstand: ±24 V DC
Galvanic isolation	Between CAN A and other I/Os: 600 V, 50 Hz for 60 s Between CAN B and other I/Os: 600 V, 50 Hz for 60 s Between Ethernet ports and other I/Os: 600 V, 50 Hz for 60 s
Battery	CR2430 3V rated for operation at -40 to 85 °C (-40 to 185 °F). This battery can be changed. **Not** a standard CR2430 battery.

Category	Specification
Battery life	Design life of the timekeeping battery is 10 years. This is reduced if the ambient temperature is over 40 °C (104 °F).
Communication connections	CAN communication terminals: Standard 45° plug, 1.5 mm^2 Wiring: 0.5 to 1.5 mm^2 (28 to 16 AWG), multi-stranded DEIF network: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications. 100BASE-TX.
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Ingress protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 36.8 mm × H 162 mm × D 150 mm (1.4 in × 6.4 in × 5.9 in)
Weight	214 g (0.5 lb)

4.1.13 Blind module

A blind module must be used to close off each empty slot in the rack.

Table 4.23 Blind module technical specifications

Category	Specification
Tightening torque	Module faceplate screws: 0.5 N·m (4.4 lb-in)
Size	L 28 mm × H 162 mm × D 18 mm (1.1 in × 6.4 in × 0.7 in)
Weight	44 g (0.1 lb)

4.2 Display hardware

4.2.1 Display unit requirements

The controller can run with or without a display. DEIF recommends that you order a display unit for each controller. Alternatively, you can order and configure a touch display from the AGI 400 series from DEIF.

4.2.2 Display unit DU 300

The display unit is the operator's interface to the controller. It allows the operator to use up to 20 push-buttons to set up, operate and supervise the controller. The display unit includes up to 15 tricolour (red, yellow, green), wide angle light indicators to show the system status.

The 5-inch (diagonal measurement) colour graphic display shows real-time operating information. The 800 by 480 pixel display supports 24-bit RGB colour and all languages with UTF-8 fonts. It is anti-reflection and has a configurable dimmer function.

For communication, the display unit has two 100BASE-TX connections, and can be placed up to 100 m from the controller rack.

The power supply terminals include circuit protection against load dump transients and JEM177 surge transients (rugged design).

The display unit specifications apply to all controller types. However, the display unit front folio depends on the controller type. The front folio details are included in the description for each display type.

Figure 4.3 Line drawing of the back of DU 300 with the terminal positions

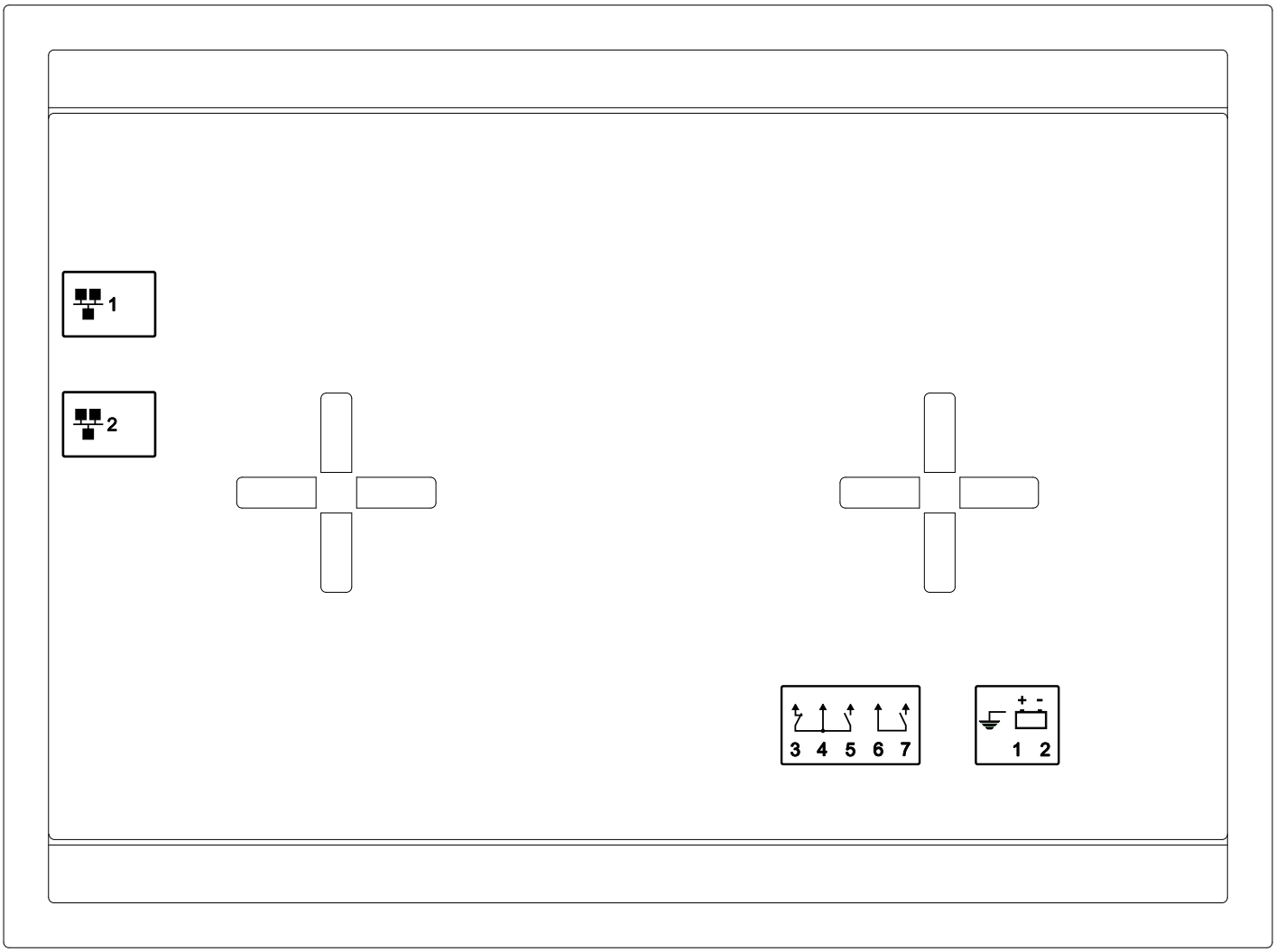


Table 4.24 DU 300 terminals

Count	Symbol	Type	Name
1		Ground	Frame ground
1		12 or 24 V DC	Power supply
1		Relay output	For future use
1		Relay output	Display status OK
2		Ethernet (RJ45)	DEIF network

Figure 4.4 Display unit with dimensions in mm (followed by approximate dimensions in inches), first-angle projection

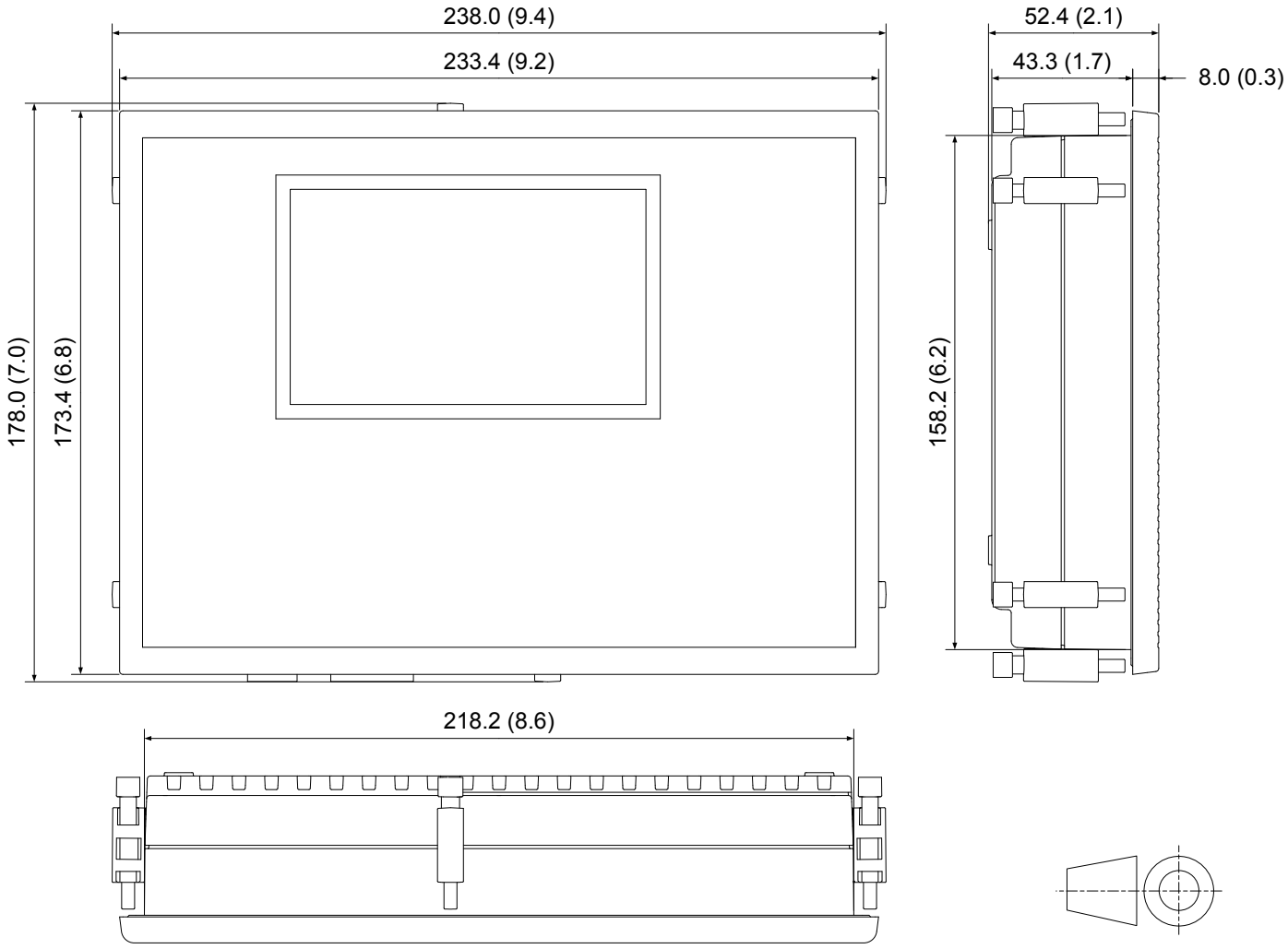


Table 4.25 DU 300 technical specifications

Category	Specification
Ingress protection	From the front: IP65 according to IEC/EN 60529 From the back: IP20 according to IEC/EN 60529
UL/cUL Listed	Type Complete Device, Open Type 1
Frame ground ⏚	Voltage withstand: ±36 V DC to the power supply positive (terminal 1) Voltage withstand: ±36 V DC to the power supply negative (terminal 2)
Power supply + - - -	Input voltage: 12 or 24 V DC nominal (8 to 36 V DC continuously) UL/cUL Listed: 10 to 32.5 V DC 0 V DC for 50 ms when coming from at least 8 V DC (cranking dropout) Consumption: Typical 4 W, maximum 12 W The power supply inputs are internally protected by a 12 A slow-blow fuse (not replaceable) (fuse size determined by load dump requirements). Voltage withstand: ±36 V DC Load dump protected by TVS diodes. **Start current** • Power supply current limiter ◦ 24 V: 2.1 A minimum ◦ 12 V: 4.2 A minimum

Category	Specification
	• Battery: No limit
Relay output 	Relay type: Electromechanical Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC
Relay output 	Relay type: Solid state Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC
Terminal connections	**Frame ground and power supply**: Terminals: Standard plug, 2.5 mm^2 Wiring: 1.5 to 2.5 mm^2 (16 to 12 AWG), multi-stranded **Other connections**: Terminals: Standard plug, 2.5 mm^2 Wiring: 0.5 to 2.5 mm^2 (22 to 12 AWG), multi-stranded
Communication connections	DEIF network: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications. 100BASE-TX.
Torques and terminals	Display unit fixing screw clamps: 0.15 N·m (1.3 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 °C (194 °F) copper conductors only.
Galvanic isolation	Between power supply, relay groups, and network plugs: 600 V, 50 Hz for 60 s
Mounting	Panel mount, using six fixing screw clamps (included) Minimum panel plate thickness: 2.0 mm Maximum panel plate thickness: 5.0 mm UL/cUL Listed: For use on a flat surface of a type 1 enclosure UL/cUL Listed: To be installed in accordance with the NEC (US) or the CEC (Canada)
Cable organisation	4 cable tie slots for cable strain relief (4 mm (0.16 in) wide)
Size	L 235 mm × H 175 mm × D 52 mm (9.3 in × 6.9 in × 2.0 in) (outer frame) Panel cutout: L 220 mm × H 160 mm (8.7 in × 6.3 in)
Accessory (included)	Ethernet cable: Shielded patch cable SF/UTP CAT5e, 2 metres long
Weight	Display unit: 835 g (1.8 lb) Ethernet cable: ~110 g (4 oz)

4.3 Accessories

4.3.1 Ethernet cable

The Ethernet cable connects the display unit to the controller, or connects controllers to one another. The Ethernet cable from DEIF meets the technical specifications below. Use these Ethernet cables to ensure that the system meets the general specifications.

Category	Specification
Cable type	Shielded patch cable SF/UTP CAT5e
Temperature	Fixed installation: -40 to 80 ºC (-40 to 176 °F) Flexible installation: -20 to 80 ºC (-4 to 176 °F)
Minimum bending radius (recommended)	Fixed installation: 25.6 mm (1.01 in) Flexible installation: 51.2 mm (2.02 in)
Length	2 m (6.6 ft)
Weight	~110 g (4 oz)

5. Ordering information

5.1 Ordering

5.1.1 PPM 300 controller order

The PPM 300 controller has four slots that can be configured to your project's requirements. As part of your configuration you can choose to include or exclude a display unit.

Complete the controller configuration table to document your order. The optional hardware table contains a list of hardware modules you can use to configure the controllers. Additional controller configurations can be specified in the **Additional controllers** section of the controller configuration table.

Table 5.1 PPM 300 controller configuration

Item number	Controller	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Display unit	Quantity
2911500040.01	GENSET	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.02	EMERGENCY	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.03	SHAFT	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.04	SHORE	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.05	BUS TIE	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
Extension units										
2912990350.01	Extension unit (R7.1)	PSM3.2	_____	_____	_____	_____	_____	_____	N/A	_____
2912990350.01	Extension unit (R7.1)	PSM3.2	_____	_____	_____	_____	_____	_____	N/A	_____
2912990350.01	Extension unit (R4.1)	PSM3.2	_____	_____	_____	N/A	N/A	N/A	N/A	_____
2912990350.01	Extension unit (R4.1)	PSM3.2	_____	_____	_____	N/A	N/A	N/A	N/A	_____
Additional controllers										
2911500040.__	_____	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.__	_____	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.__	_____	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____
2911500040.__	_____	PSM3.1	ACM3.1	_____	_____	_____	_____	PCM3.1	Yes/No	_____

Table 5.2 PPM 300 order example

Item number	Controller	Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7	Display unit	Quantity
2911500040.01	GENSET	PSM3.1	ACM3.1	**IOM3.1**	**EIM3.1**	**GAM3.1**	**IOM3.1**	PCM3.1	**Yes** /No	**4**
Additional controllers										
2911500040. **01**	**GENSET**	PSM3.1	ACM3.1	**IOM3.1**	**EIM3.1**	**GAM3.2**	**IOM3.4**	PCM3.1	Yes/ **No**	**1**

Table 5.3 Optional hardware modules for controller configuration

Option	Terminals	Comment
ACM3.2	• 2 × 3-phase current measurements	A maximum of one ACM3.2 modules are allowed per controller (including extension units).
IOM3.1	• 4 × Changeover relays • 10 × Digital inputs	
IOM3.4	• 12 × Transistor outputs • 16 × Digital inputs	
EIM3.1	• 1 × Power supply • 4 × Relay outputs (1 with wire break detection) • 4 × Digital inputs • 1 × MPU input • 1 × W input • 3 × Current/resistance analogue inputs	A maximum of three EIM3.1 modules are allowed per controller (including extension units).
GAM3.1	• 4 × Relay outputs • 2 × Current/voltage analogue outputs • 1 × PWM output • 2 × Current/voltage analogue inputs	A maximum of three GAM3.1 and/or GAM3.2 modules are allowed per controller (including extension units).
GAM3.2	• 1 × Power supply • 2 × Current/voltage analogue outputs • 1 × PWM output • 5 × Digital inputs • 5 × Relay outputs	A maximum of three GAM3.1 and/or GAM3.2 modules are allowed per controller (including extension units).
Blind	None	Not allowed between optional modules and the PSM3.1.

5.1.2 Accessories or spare parts order

Complete the following table to order accessories or spare parts for a PPM 300 controller.

Table 5.4 Accessories or spare parts order

Product	Item no.	Options	Quantity
DU 300 Display unit (for PPM 300)	2912990240.01	GENSET	___
		EMERGENCY	___
		SHAFT	___
		SHORE	___
		BUS TIE	___
PSM3.1 Power Supply Module	2912990240.07	-	___
PSM3.2 Power Supply Module (extension unit)	2912990240.42	-	___
ACM3.1 Alternating Current Module	2912990240.03	-	___
ACM3.2 Alternating Current Module	2912990240.40	-	___
IOM3.1 Input Output Module	2912990240.05	-	___
IOM3.4 Input Output Module	2912990240.25	-	___
GAM3.1 Governor and AVR module	2912990240.06	-	___
GAM3.2 Governor and AVR module	2912990240.26	-	___

Product	Item no.	Options	Quantity
EIM3.1 Engine interface module	2912990240.04	-	___
PCM3.1 Processor and communication module for PPM 300 GENSET controller	2912990240.16	-	___
PCM3.1 Processor and communication module for PPM 300 EMERGENCY genset controller	2912990240.17	-	___
PCM3.1 Processor and communication module for PPM 300 SHAFT generator controller	2912990240.19	-	___
PCM3.1 Processor and communication module for PPM 300 SHORE connection controller	2912990240.20	-	___
PCM3.1 Processor and communication module for PPM 300 BUS TIE breaker controller	2912990240.18	-	___
Blind module	2912990240.08	-	___
R7.1 7 slot rack	2912990240.09	-	___
R4.1 4 slot rack	2912990240.41	-	___
Shielded patch cable	2912990240.14	-	___
SD Card 512MB	2912990240.32	-	___
Terminal blocks	2912990240.38	-	___

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