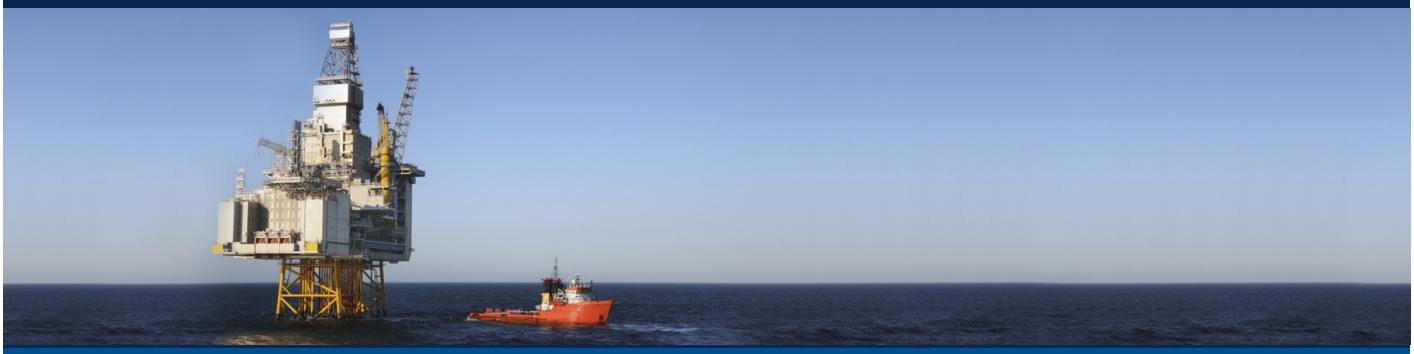
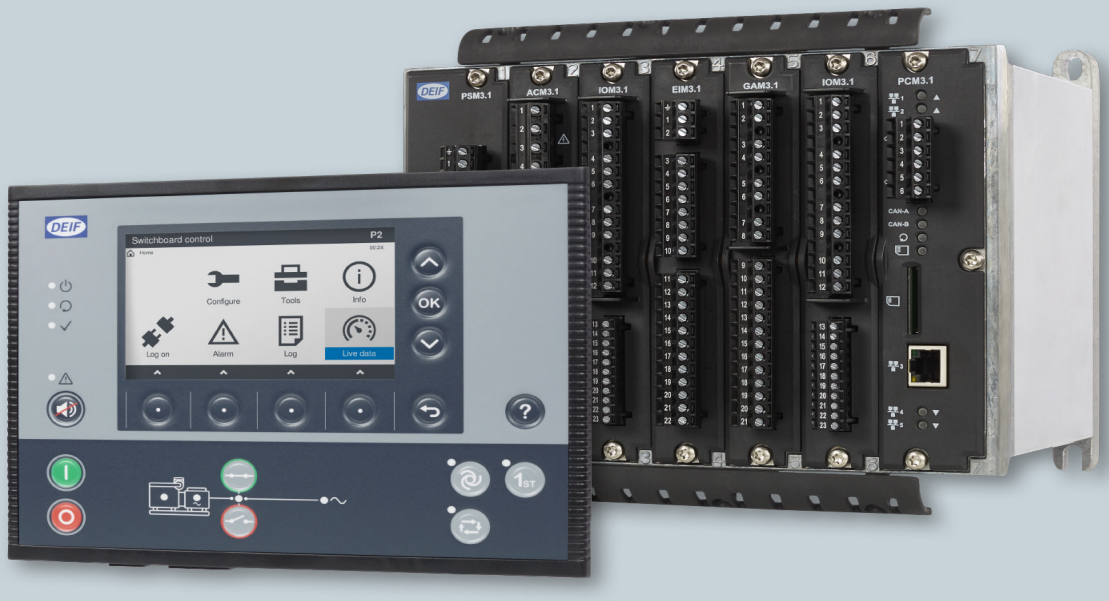
-power in control

DATA SHEET



Protection and Power Management
PPM 300



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Document no.: 4921240464B

1. System description

2. Controller types

3. Protections

4. Technical specifications

5. Hardware

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1. System description

1.1 Description

1.1.1 Overall description

The PPM 300 Protection and Power Management controller is a highly versatile controller designed for marine use. It is capable of a wide range of control, protection and supervision. 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 64 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, keeping the system safe and reliable.

Redundant communication between the controllers is possible. If a communication link fails, the system continues to function.

Each controller includes processor technology and high-speed internal communication. This provides fast protection functions and includes built-in redundancy, for greater reliability. The controller design is modular. Processor, communication, measurement, and input-output hardware modules may be replaced or added in the field. The controller automatically recognises the new hardware modules.

The controller display unit has push-buttons for the operator to change the controller mode and priority, close and open the breaker, and start and stop the genset. The colour graphic screen allows fast access to live data. The operator can use the screen to manage alarms. With the right authorisation, he can also check and/or change the IO and parameter configuration. The light indicators of the display unit are visible over a long distance. The display processor can handle all languages.

PICUS is a proprietary, free PC software interface to the controller. Use PICUS to easily create the system's single-line diagram, and configure the inputs, outputs and parameters for all the controllers in the system. PICUS also offers system emulation, and supervision.

1.2 Functions

1.2.1 General functions

The functions listed here apply to all PPM 300 controllers. The description for each type of controller includes the additional functions that are specific to that controller.

Table 1.1 General functions for all PPM 300 controllers

	Functions
Flexible and modular	• Compact, all-in-one controller • Includes all necessary 3-phase measurements • Placement flexibility for hardware modules (printed circuit boards) in the controller rack • Hardware modules can be removed, replaced, or added on-site • Customisable hardware arrangement (during ordering and/or on-site) • Hardware modules configurable for different applications • Configurable inputs and outputs (both digital and analogue)
Plug & play system setup	• Automatic network configuration • Default configuration for standard applications • Default configuration of input-output hardware modules • Display unit with a 5-inch colour graphic display ◦ Intuitive, one-touch operator initiated sequences ◦ Live data monitoring and alarm management ◦ Input, output, and parameter configuration ◦ Context-sensitive help
Advanced troubleshooting	• Controller hardware self-test • Event and alarm log, with real-time clock ◦ Controller clocks synchronized ±1 ms, according to NTP standard • Remote access to the system • Access to 24-hour service and support
PICUS	• Free-of-charge PC software • Tool to design and configure the system single-line drawing • Broadcast of system single-line drawing • System emulation ◦ Mimic the environment that the controller connects to ◦ Test the application, get approvals, minimise site time, optimise training • Configure controller inputs, outputs, and parameters • Design the power management system and set the system parameters • Monitor operation • Broadcast controller software updates
Breaker control	• Synchronisation and breaker closing ◦ Dynamic synchronisation: For fast load acceptance (with slip frequency) ◦ Static synchronisation: Phases match before closing • Automatically-initiated synchronisation • Operator-initiated synchronisation possible for all breakers • Breaker position detection and alarms • Adjustable breaker spring-load time

	Functions
Protection functions	• Pre-defined alarms, alarm actions, and alarm inhibits • Alarms customised by changing parameters • Three customisable inhibits per controller • Horn output, with automatic or manual reset • Alarm latch available ◦ Based on ISA 18.2
CustomLogic	• User-friendly logic configuration tool, based on ladder logic and function blocks • Selectable input events • Selectable output commands
Communication	• Multi-master system: All vital data is broadcast to all controllers ◦ Each controller performs all calculations, then acts accordingly • TCP/IP ◦ DEIF network ◦ Modbus
Redundancy	• Configurable terminals • True multi-master control • Busbar can have a ring connection • DEIF network ring or interleaved connection • Controller commands and operation using the display unit, PICUS and/or a SCADA system • Redundant power supply on EIM3.1
Documentation	• Free download at www.deif.com ◦ Data sheet ◦ Designer's handbook ◦ Installation instructions ◦ Commissioning guidelines ◦ Operator's manual • Context-sensitive help in the display unit
Other functions	• Password-protected, with customisable permission levels

1.2.2 Power management functions

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

	Functions
Efficient operation	• Intelligent load calculations • Advanced load-dependent start and stop calculations • Advanced (individually configurable) asymmetrical load sharing • Secured operation (power reservation)
Genset priority selection	• Manual (using the display unit 1st priority push-button, or PICUS) • Delayed priority shift • Dynamic (first genset to connect has the highest priority)

	Functions
Heavy consumer management	• Up to 4 heavy consumers per controller • Pre-programmed heavy consumer management sequence • Digital or analogue* feedback from the heavy consumer
Regulation	• PID regulators for the controller's analogue outputs • P regulators for the controller's relay outputs ◦ *Relay period time* and *Minimum ON time* are also configurable • GOV: Regulate genset frequency, active power, and active power load sharing. During synchronisation, regulate phase. • AVR: Regulate genset voltage, reactive power, and reactive power load sharing.
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) • Load-dependent stop (two sets of parameters available) ◦ For example, *Normal stop* and *Faster stop* (high available 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 possible
Load sharing	• Active power (kW) load sharing (GOV) • Reactive power (kvar) sharing (AVR) • Load sharing between gensets ◦ Over the DEIF network • Load sharing options ◦ Equal load sharing (symmetrical) ◦ Asymmetric load sharing for gensets ◦ Shaft generator base load plus asymmetric load sharing for gensets ◦ Shore connection base load plus asymmetric load sharing for gensets ◦ Asymmetric load sharing to create a base load for one genset per independent busbar section
System	• Up to 4 externally-controlled breakers per controller ◦ Bus tie breakers and/or shore connection breakers

Note: *The default SHAFT generator and SHORE connection controller hardware does not include analogue outputs. Extra hardware must be installed if analogue feedback from the heavy consumer is required.

1.2.3 Communication

The DEIF network is an Ethernet network that allows the controllers to communicate with each other to manage the system.

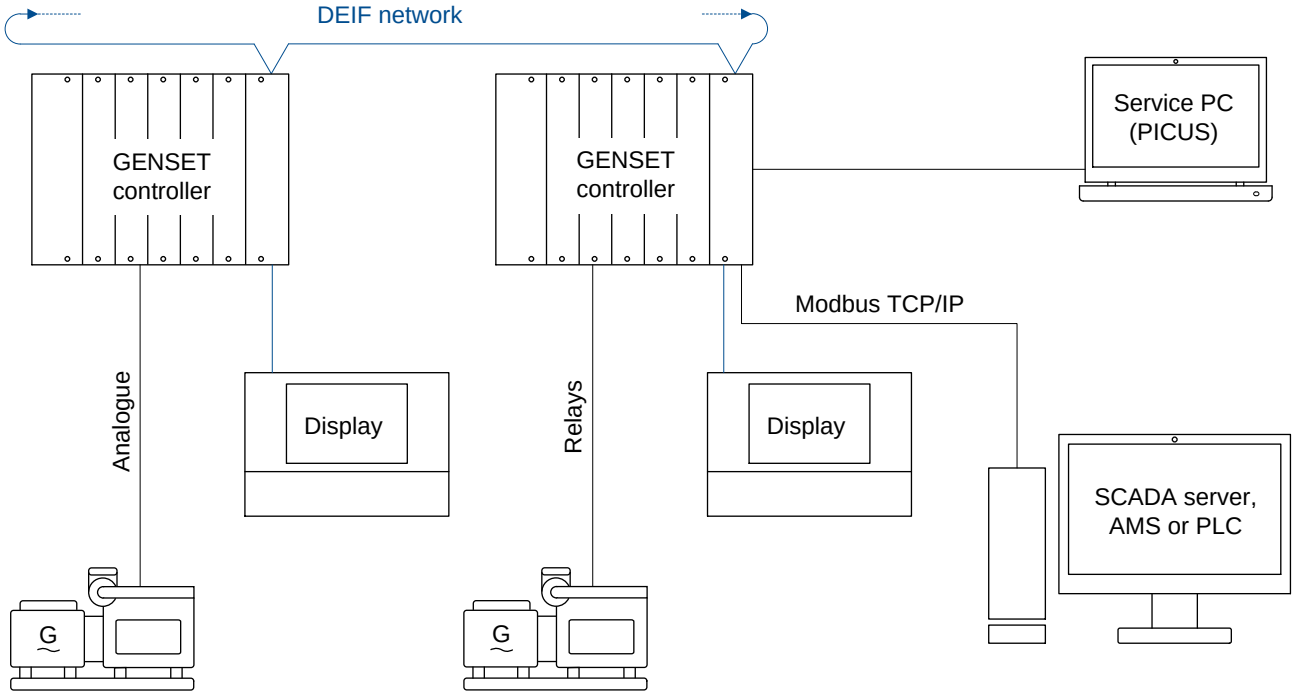
For communication redundancy, the controllers can be interleaved or connected in a ring. If there is a disruption or failure, the DEIF proprietary ring protocol changes the communication path within 100 milliseconds.

INFO
Communication should only be connected with either *Network chain* or *Network ring* configuration. It is not possible in the first release to configure *Star* or *Top ring* connections.

Table 1.2 DEIF network characteristics

Category	Details
Specifications	• Supports Internet Protocol version 6 (IPv6) and Internet Protocol version 4 (IPv4) • Up to 64 controllers per system
Functions	• Power management communication, including load-dependent start/stop, and de-loading • Power management inputs and outputs may be connected to any controller • Load sharing communication • Authentication (non-DEIF equipment cannot disrupt communication) • Connects the controller(s) to: ◦ Controller display unit ◦ PICUS ◦ SCADA server, Alarm management server (AMS) and/or PLC (using Modbus TCP/IP)

Figure 1.1 Recommended controller system communication topology for genset control (single network ring)



The controllers receive inputs from, and send outputs to the controlled equipment. For the GENSET controller, the outputs include regulation outputs, using analogue signals, and/or relays.

2. Controller types

2.1 Introduction

2.1.1 About controller types

The controller types are described in sections that follow.

Each PPM 300 controller is assigned a type in the factory.

The minimum hardware for each controller type is described. If there is space in the controller rack, additional hardware modules can be ordered, and installed in the factory or the field. Spare hardware modules may also be ordered for installation in the field.

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 typically includes a number of GENSET controllers.

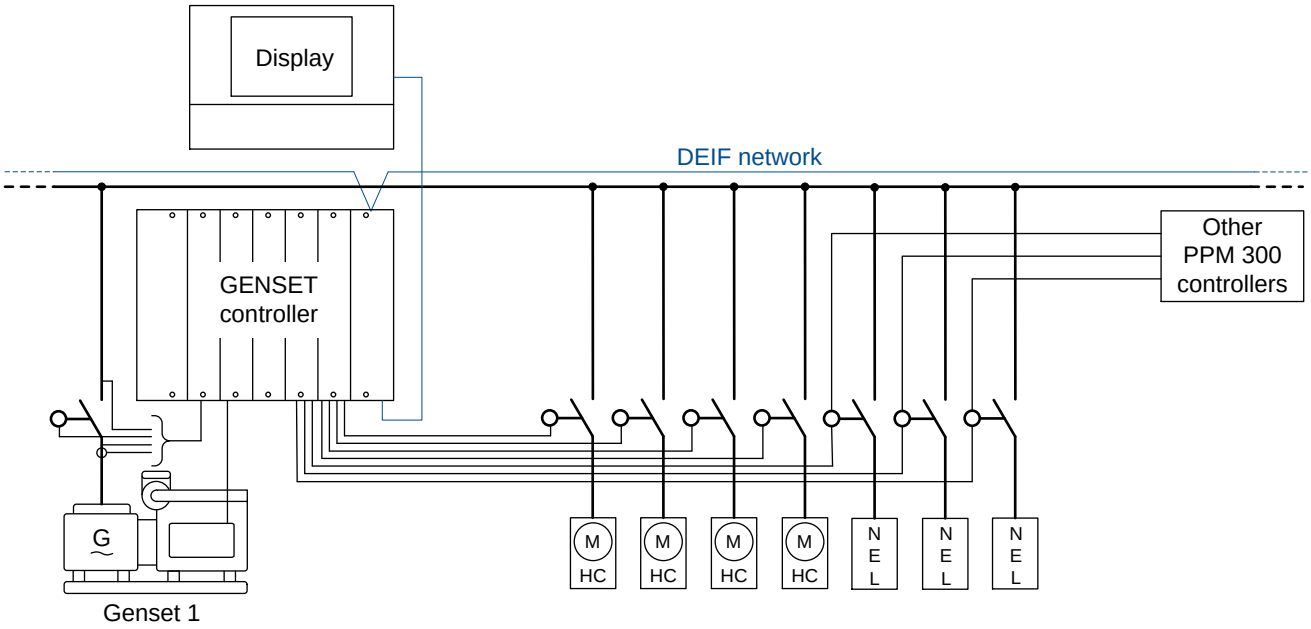
In AUTO mode, the GENSET controllers work together to ensure effective power management. This includes load-dependent start and stop, and may include setting the genset priority order, managing heavy consumers, and, if necessary, tripping non-essential loads.

2.2.2 Applications

The system can have from 1 to 64 GENSET controllers.

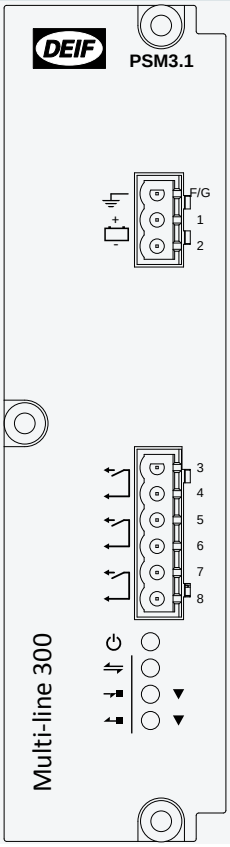
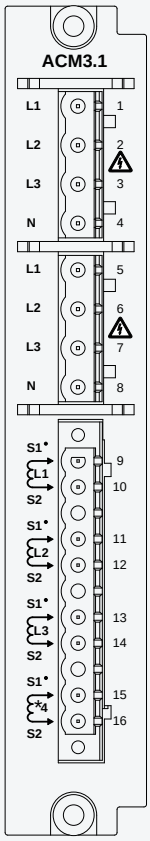
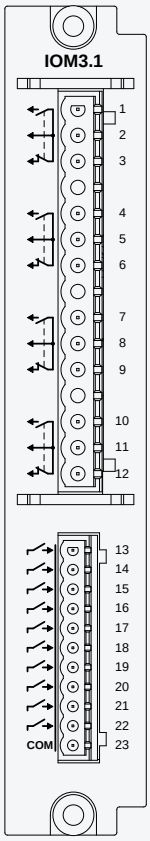
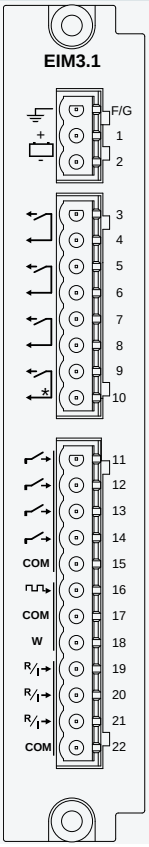
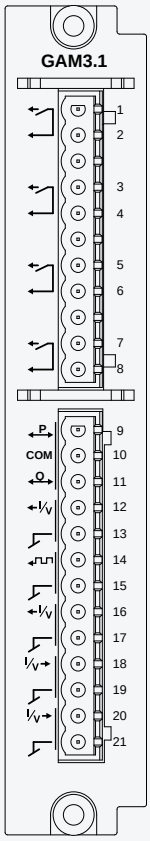
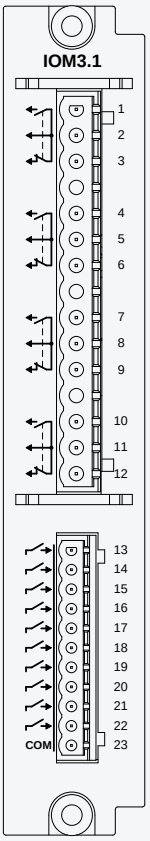
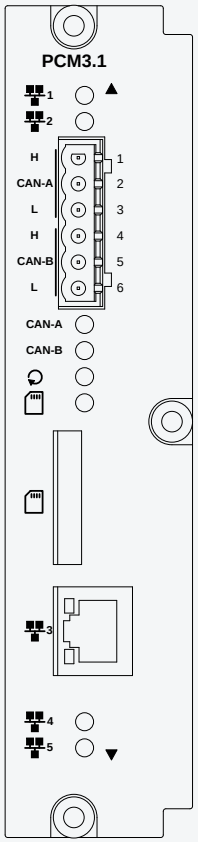
Each GENSET controller can be connected to up to four heavy consumers (HC) and up to three non-essential load groups (NEL).

Figure 2.1 Example of a GENSET controller application



2.2.3 GENSET controller hardware configuration

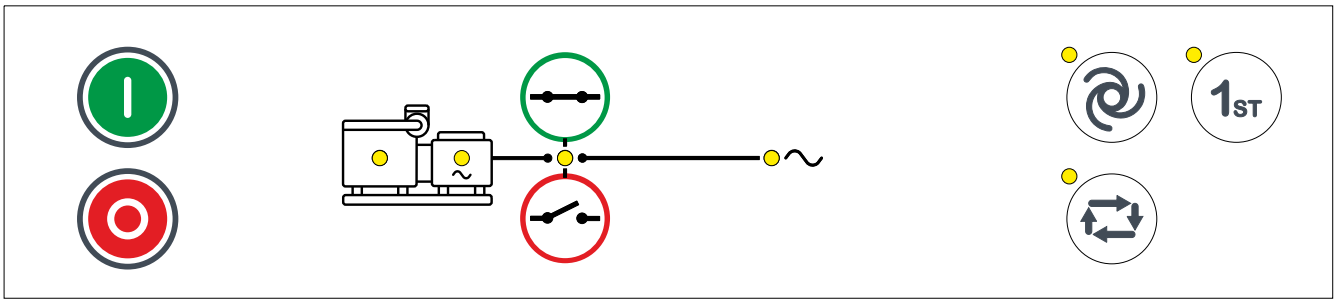
Table 2.1 GENSET controller default hardware configuration

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
PSM3.1	ACM3.1	IOM3.1	EIM3.1	GAM3.1	IOM3.1	PCM3.1
Power supply module	Alternating current module	Input output module	Engine interface module	Governor and AVR module	Input output module	Processor and communication module
						

Weight	Controller and display unit: 3808 g (8.4 lb) Controller (including the default hardware modules): 2973 g (6.5 lb) Display unit: 835 g (1.8 lb)

2.2.4 Display unit

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



2.2.5 Functions

	Functions
Pre-programmed sequences	• Genset start sequence and genset stop sequence ◦ Running detection ◦ Stop coil and/or run coil for engine control ◦ Sequence interruption ◦ Temperature-dependent cooldown • Generator breaker open sequence (with deloading) • Generator breaker close sequence (with synchronisation) • Blackout recovery sequence
Intelligent safety net	• Blackout prevention ◦ Precautionary genset start for some alarms ◦ De-load before opening breakers ◦ Genset breaker does not open if this would cause overload or a blackout • Configurable blackout recovery • Trip non-essential load groups ◦ Up to 3 non-essential loads per controller ◦ If required, can connect several controllers to the same 3 non-essential loads
Regulation	• PID regulators for the controller's analogue outputs • P regulators for the controller's relay outputs (the relay period time and minimum ON time are also configurable) ◦ GOV: Regulate genset frequency (and phase for synchronisation), active power, and active power load sharing. ◦ AVR: Regulate genset voltage, reactive power, and reactive power load sharing. • Three sets of temperature-dependent power derate settings for each controller
Other	• Priming
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 ◦ Automatic 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) ◦ Button functions also possible using inputs, PICUS, and/or a SCADA system ◦ Intuitive, one-touch sequences using the display unit for genset start/stop, and breaker open/close in SEMI mode

2.2.6 Protections

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

	Protections
Engine	Overspeed (2 alarms)
	Underspeed (2 alarms)
	Governor regulation error
	Power ramp up error
	Power ramp down error
	Crank failure
	Primary running feedback failure
	Start failure (maximum attempts)
	Stop failure
	Magnetic pickup wire break
	EIM # relay 4 wire break (# is 1 to 3)
	Engine stop (external)
	Engine start (external)
	Start enable removed during start
Generator	AVR regulation error
	Voltage or frequency not OK
Maximum parallel time	GENSET-SHAFT maximum parallel time
	GENSET-SHORE maximum parallel time
Other	P load sharing failure
	Q load sharing failure
	Forced to SEMI mode
Configuration	GOV manual output selection failure
	GOV output setup failure
	GOV relay setup incomplete
	AVR manual output selection failure
	AVR output setup failure
	AVR relay setup incomplete

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. The emergency genset does not normally supply power to the system. If the emergency genset is connected, the power management calculations do not include any power that it supplies in the total available power.

By default, the EMERGENCY genset controller automatically starts the emergency generator when there is no voltage on the busbar.

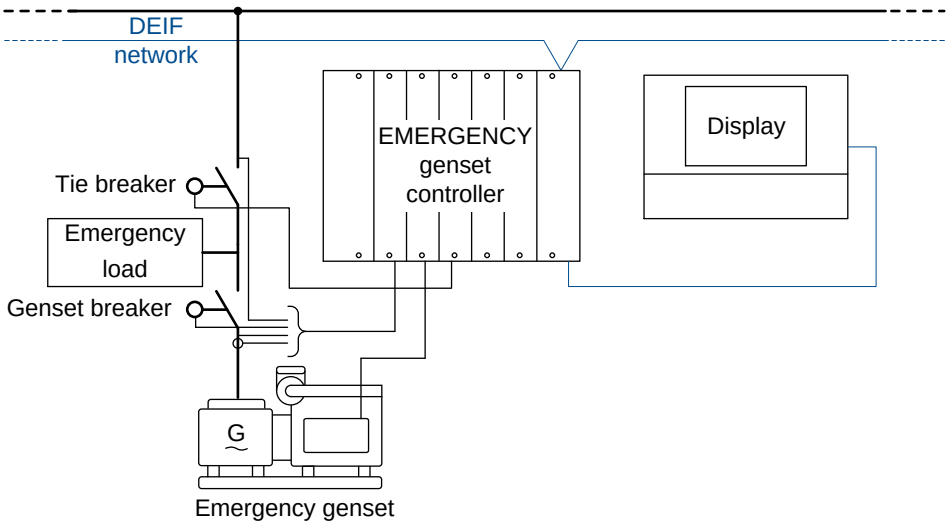
The EMERGENCY genset controller includes harbour operation, so that the genset can be used as the ship generator when in harbour.

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

2.3.2 Applications

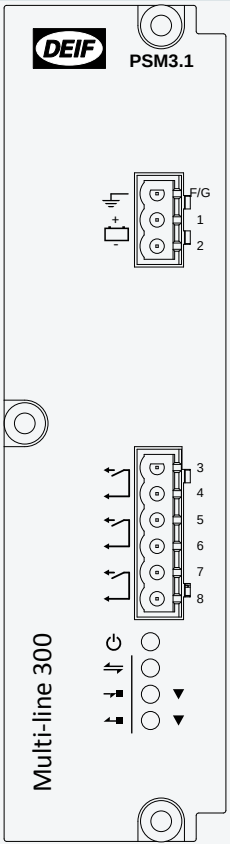
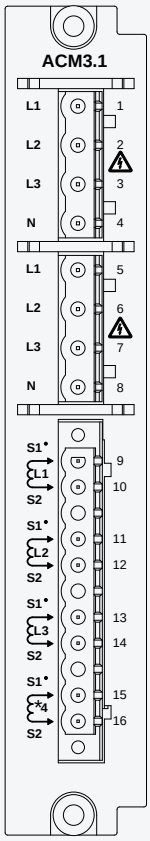
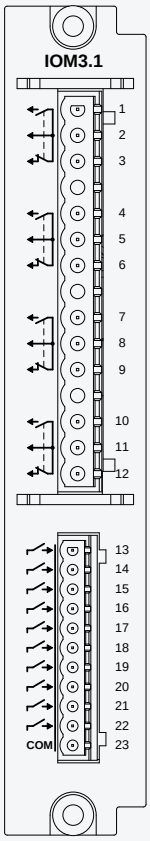
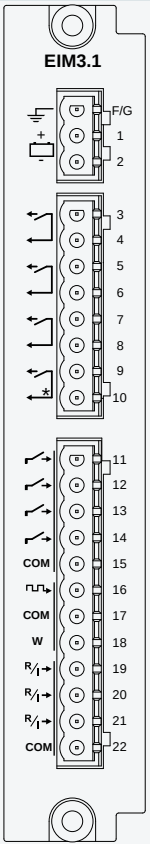
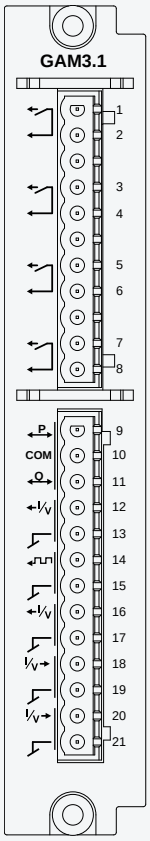
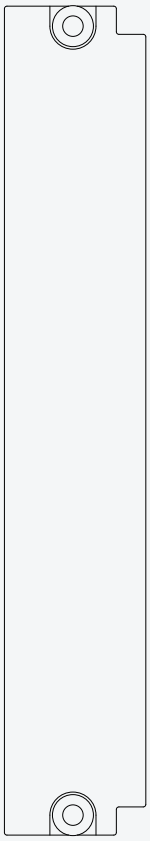
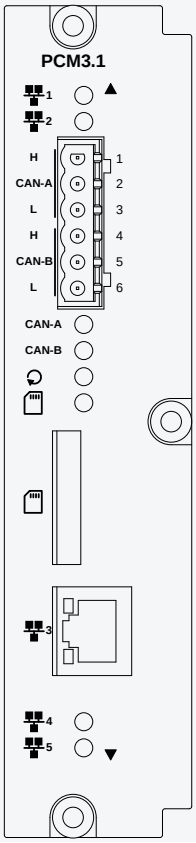
The system can have 0 or 1 EMERGENCY genset controllers.

Figure 2.3 Example of an EMERGENCY genset controller application



2.3.3 EMERGENCY genset controller hardware configuration

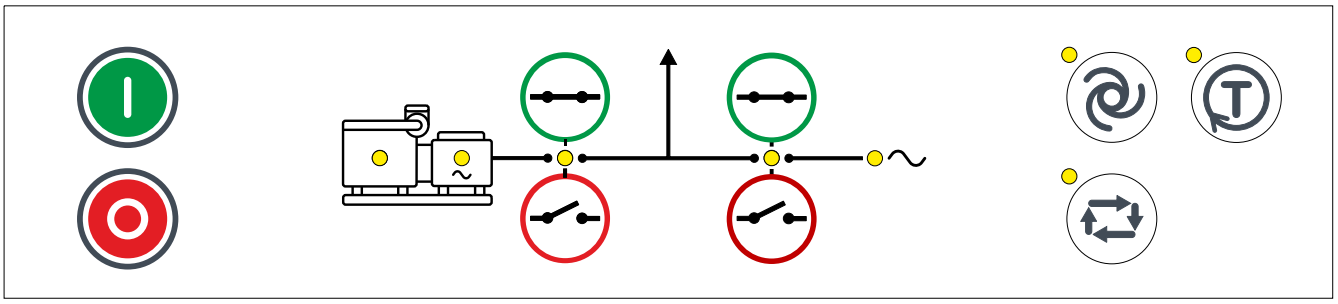
Table 2.2 EMERGENCY genset controller default hardware configuration

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
PSM3.1	ACM3.1	IOM3.1	EIM3.1	GAM3.1	Blind module	PCM3.1
Power supply module	Alternating current module	Input output module	Engine interface module	Governor and AVR module		Processor and communication module
						

Weight	Controller and display unit: 3626 g (8.0 lb) Controller (including the default hardware modules): 2791 g (6.1 lb) Display unit: 835 g (1.8 lb)

2.3.4 Display unit

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



2.3.5 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 ◦ Sequence interruption ◦ 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) • Harbour mode start and stop sequences • Test sequence
Emergency functions	• Blackout start and handling (immediate or delayed)
Harbour operation	• Emergency genset powers the ship • Economic operation for low loads, for example, in harbour
Test function	• Engine test: Emergency genset start (does not synchronise or connect to the busbar) • Parallel test: Base-load (synchronises and connects to the busbar with the tie breaker closed) • Load take-over test: Emergency-load (supplies the emergency busbar; emergency busbar tie breaker opened)
Regulation	• PID regulators for the controller's analogue outputs • P regulators for the controller's relay outputs (the relay period time and minimum ON time are also configurable) ◦ GOV: Regulate genset frequency (and phase for synchronisation), active power, and active power load sharing. ◦ AVR: Regulate genset voltage, reactive power, and reactive power load sharing. • Three sets of temperature-dependent power derate settings for each controller
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 possible ◦ Not part of the rest of the system ◦ The stand-alone emergency genset's AC measurements independently detect blackout
Control modes	• AUTO mode ◦ Timed automatic start if a blackout is detected ◦ Harbour operation active: Automatic power management ◦ Automatic load-dependent genset start/stop ◦ Automatic synchronisation/de-loading and breaker control • SEMI mode ◦ Timed automatic start if a blackout is detected

	Functions
	◦ 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) ◦ Button functions also possible using inputs, PICUS, or a SCADA system ◦ Intuitive, one-touch sequences using the display unit for genset start/stop, and breaker open/close, in SEMI mode

2.3.6 Protections

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

	Protections
Engine	Overspeed (2 alarms)
	Underspeed (2 alarms)
	Governor regulation error
	Power ramp up error
	Power ramp down error
	Crank failure
	Primary running feedback failure
	Start failure (maximum attempts)
	Stop failure
	Magnetic pickup wire break
	EIM # relay 4 wire break (# is 1 to 3)
	Engine stop (external)
	Engine start (external)
	Start enable removed during start
Generator	AVR regulation error
	Voltage or frequency not OK
Maximum parallel time	EMERGENCY-main busbar maximum parallel time
Other	P load sharing failure
	Q load sharing failure
	Forced to SEMI mode
Configuration	GOV manual output selection failure
	GOV output setup failure

	Protections
	GOV relay setup incomplete
	AVR manual output selection failure
	AVR output setup failure
	AVR relay setup incomplete
	Derate configuration failure (3 alarms)

2.4 SHAFT generator controller

2.4.1 Description

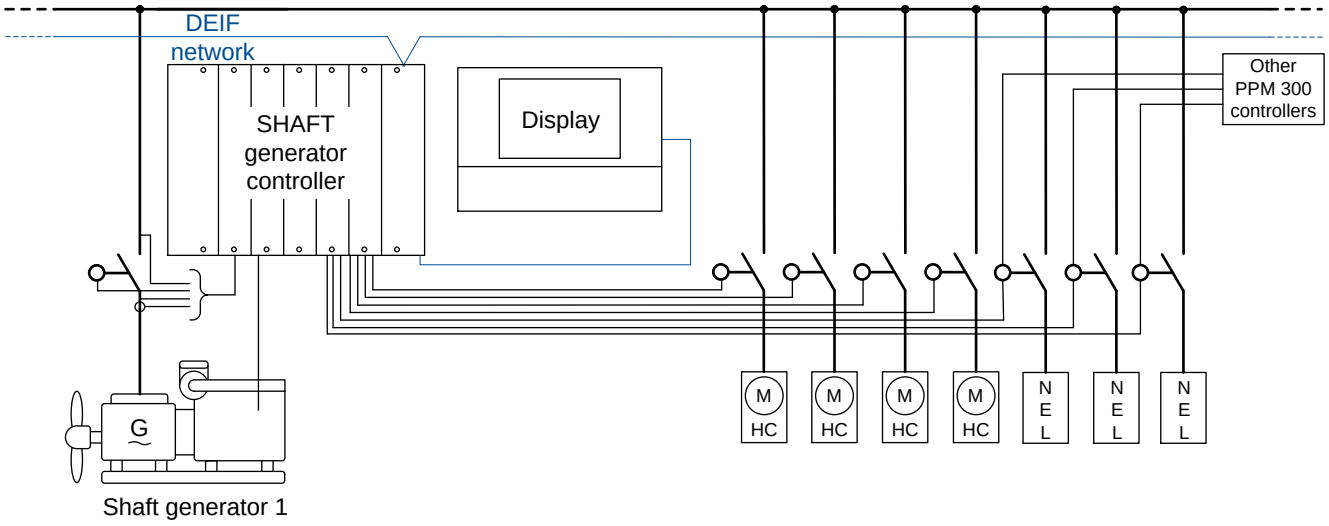
A SHAFT generator controller controls and protects the system when a shaft generator is connected. The SHAFT generator controller also controls and protects the shaft generator breaker.

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

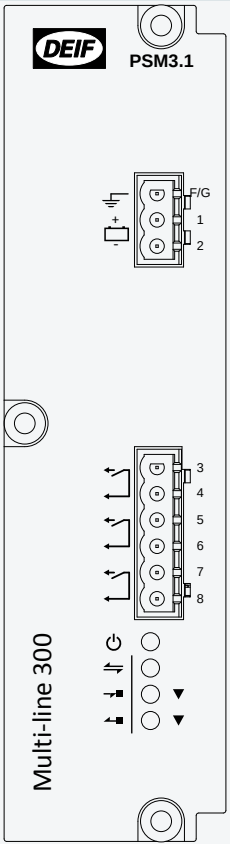
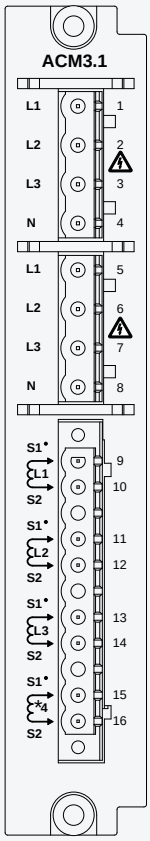
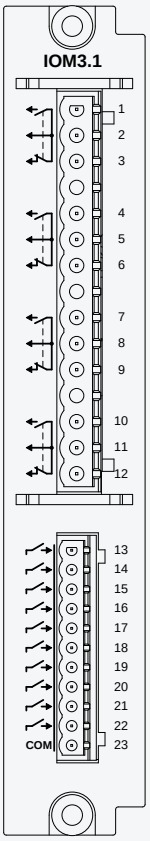
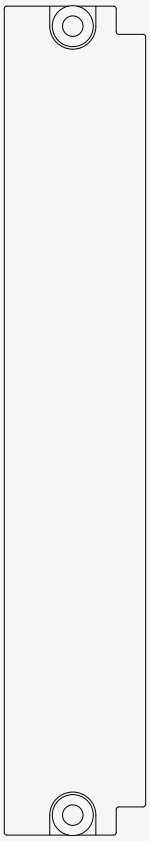
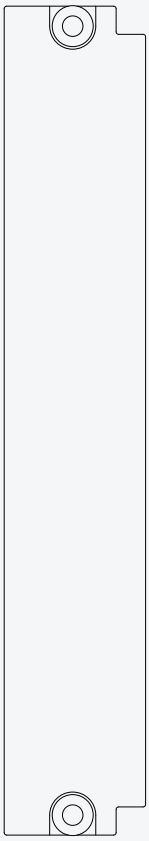
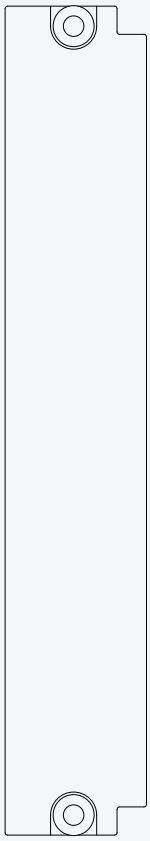
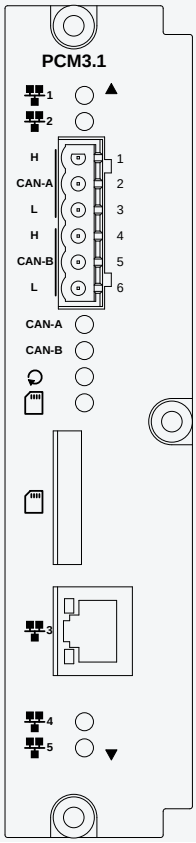
The system can have from 0 to 2 SHAFT generator controllers.

Figure 2.5 Example of a SHAFT generator controller application



2.4.3 SHAFT generator controller hardware configuration

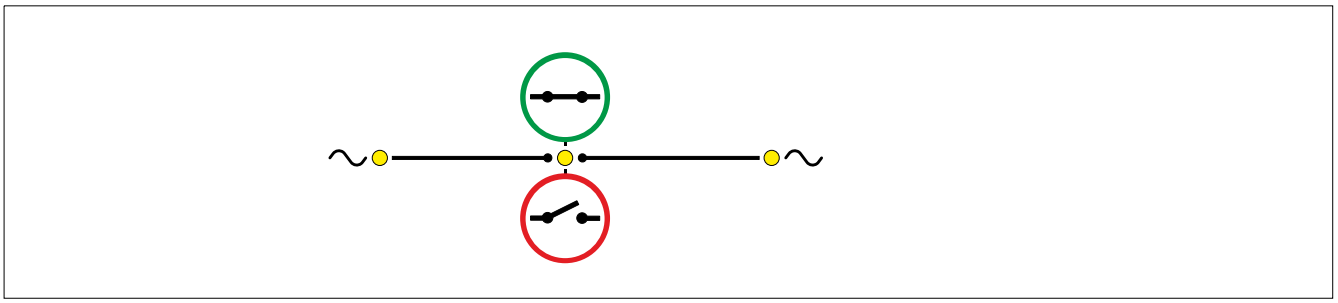
Table 2.3 SHAFT generator controller default hardware configuration

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
PSM3.1	ACM3.1	IOM3.1	Blind module	Blind module	Blind module	PCM3.1
Power supply module	Alternating current module	Input output module				Processor and communication module
						

Weight	Controller and display unit: 3180 g (7.0 lb) Controller (including the default hardware modules): 2345 g (5.2 lb) Display unit: 835 g (1.8 lb)

2.4.4 Display unit

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



2.4.5 Functions

	Functions
Pre-programmed sequences	• Generator breaker open sequence (with de-loading) • Generator breaker close sequence (with synchronisation) • Blackout close • Power take home (PTH) start and stop sequences • Load transfer from one shaft generator to another (using gensets) • Load transfer from the shaft generator to a shore connection (using gensets)
Load control	• Load transfer between shaft generator and diesel genset(s) • Base load from shaft generator; diesel genset(s) load responds to demand fluctuations • Trip non-essential load groups ◦ Up to 3 non-essential loads per controller ◦ If required, can connect several controllers to the same 3 non-essential loads • Three sets of temperature-dependent power derate settings for each controller
Power take home (PTH)	• Diesel genset(s) drive the ship's shaft using the shaft generator as a motor • Alternatively, another shaft generator drives the ship's shaft using the shaft generator as a motor • Power requirement treated as a base load • Propeller zero pitch check possible
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 a SCADA system • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active

2.4.6 Protections

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

	Protections
Shaft generator	Overspeed (2 alarms on the speed measurement)
	Underspeed (2 alarms)
	Primary running feedback failure
	Voltage or frequency not OK
Maximum parallel time	SG-DG maximum parallel time
	SG-SG parallel

2.5 SHORE connection controller

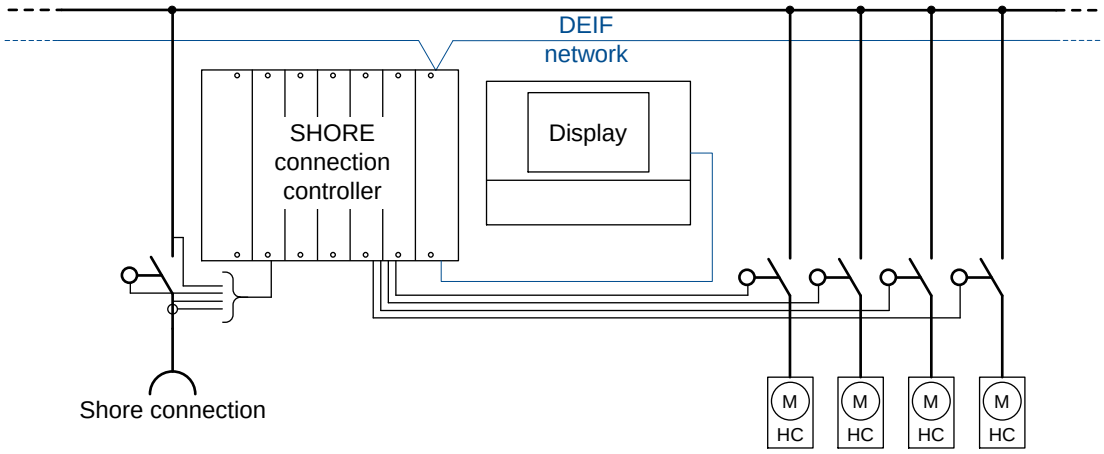
2.5.1 Description

A SHORE connection controller controls and protects the system when a shore connection is connected. The SHORE connection controller also controls and protects the shore connection breaker. 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 (up to 120 seconds).

2.5.2 Applications

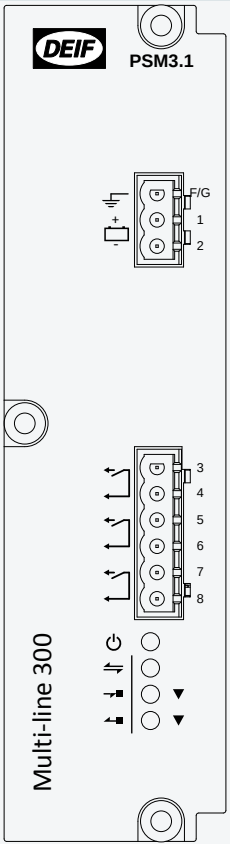
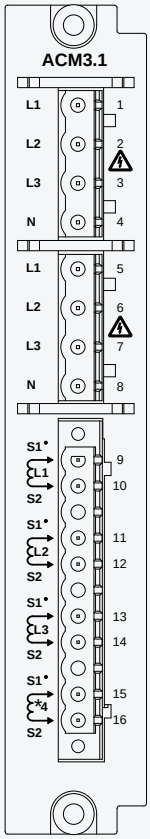
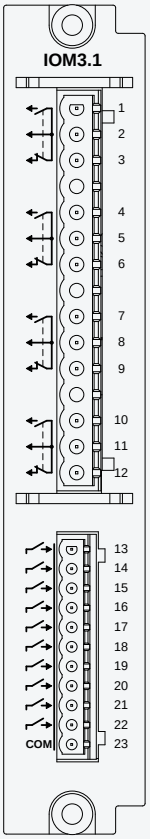
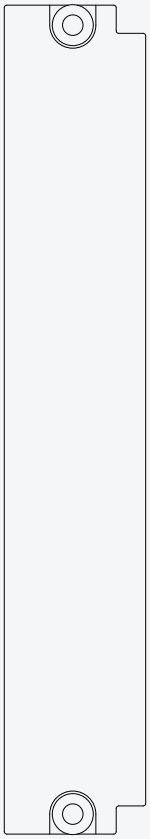
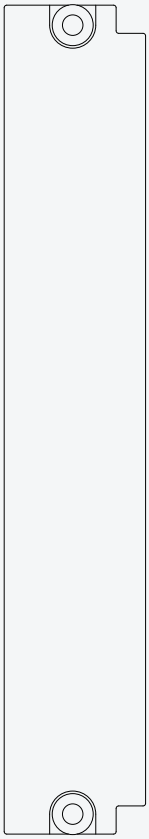
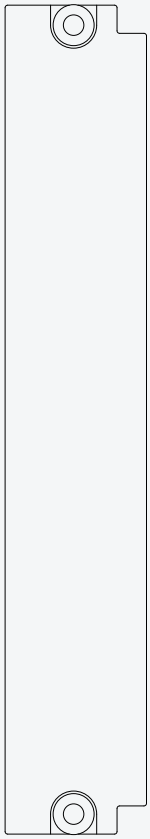
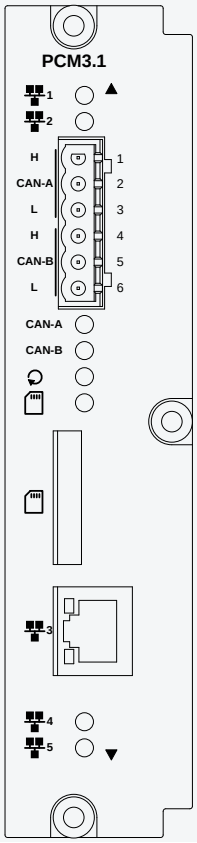
The system can have 0 or 1 SHORE connection controllers.

Figure 2.7 Example of a SHORE connection controller application



2.5.3 SHORE connection controller hardware configuration

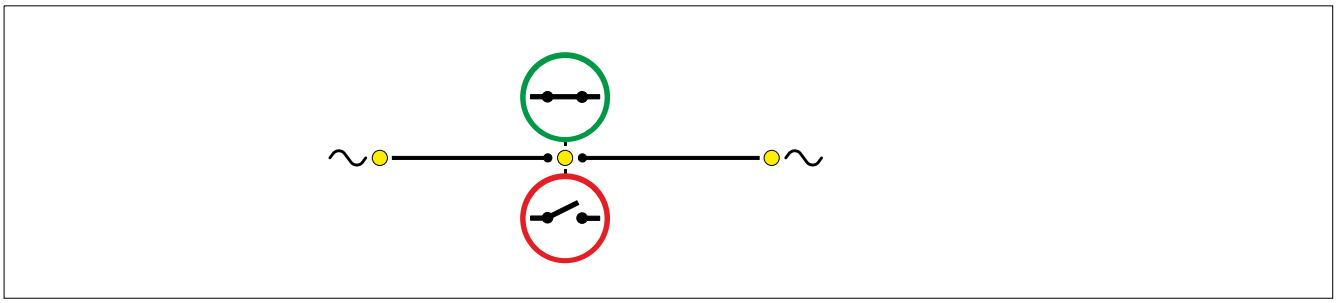
Table 2.4 SHORE connection controller default hardware configuration

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
PSM3.1	ACM3.1	IOM3.1	Blind module	Blind module	Blind module	PCM3.1
Power supply module	Alternating current module	Input output module				Processor and communication module
						

Weight	Controller and display unit: 3180 g (7.0 lb) Controller (including the default hardware modules): 2345 g (5.2 lb) Display unit: 835 g (1.8 lb)

2.5.4 Display unit

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



2.5.5 Functions

	Functions
Pre-programmed sequences	• Shore connection breaker open sequence (with 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 diesel genset(s) • Base load possible from shore connection; diesel genset(s) load responds to demand fluctuations • Possible to connect two shore connections from the same source
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 a SCADA system • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active

2.5.6 SHORE connection controller protections

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

	Protections
Maximum parallel time	SC-DG maximum parallel time
	SC-SC maximum parallel time
	SC-SG maximum parallel time

2.6 BUS TIE breaker controller

2.6.1 Description

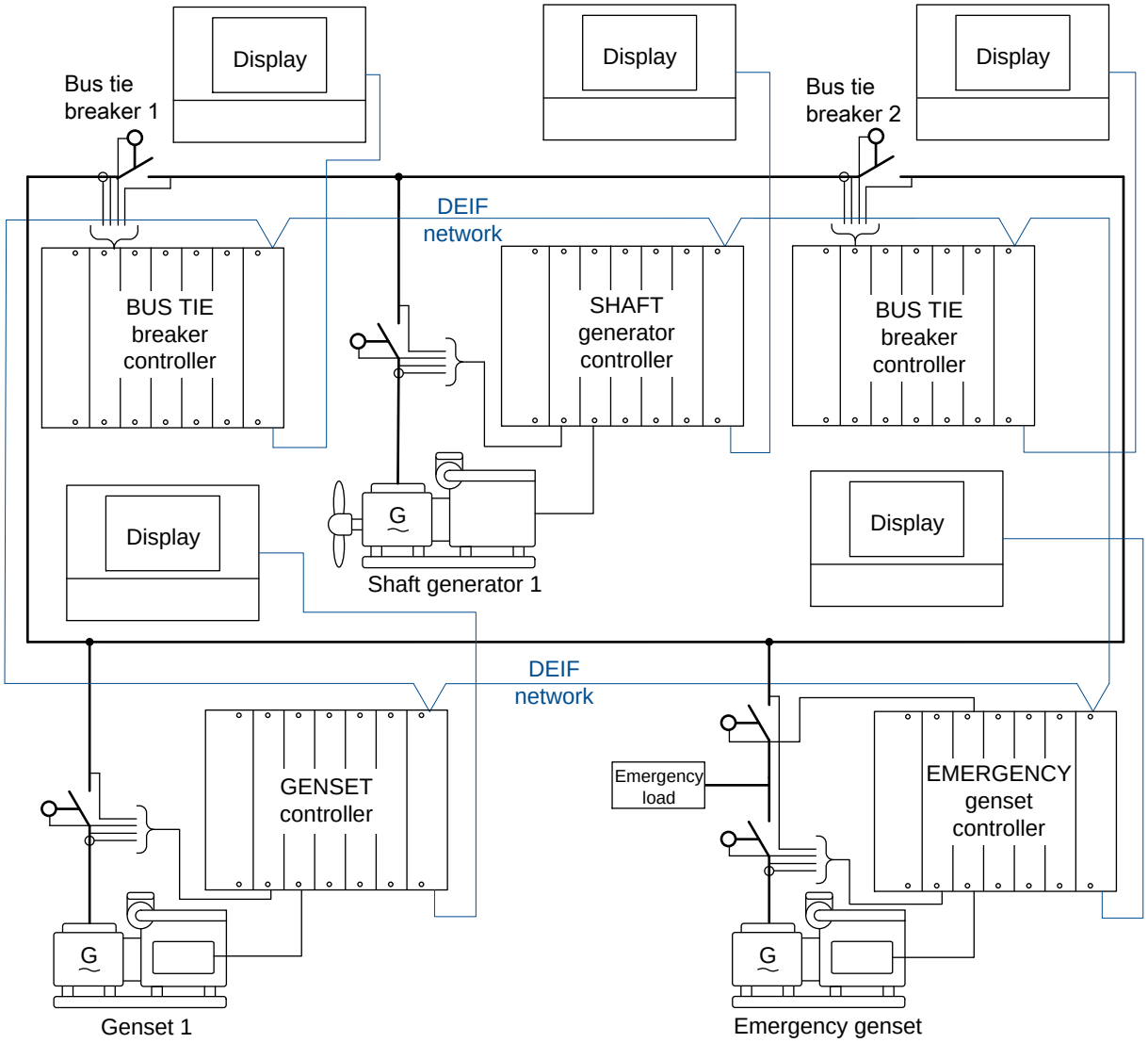
Each BUS TIE breaker controller controls one bus tie breaker. Before closing the bus tie breaker, the power management system synchronises the busbar sections.

Before opening the bus tie breaker, the power management system balances the load to de-load the bus tie breaker. This ensures that enough power is available on each busbar section after the bus tie breaker opens.

2.6.2 Applications

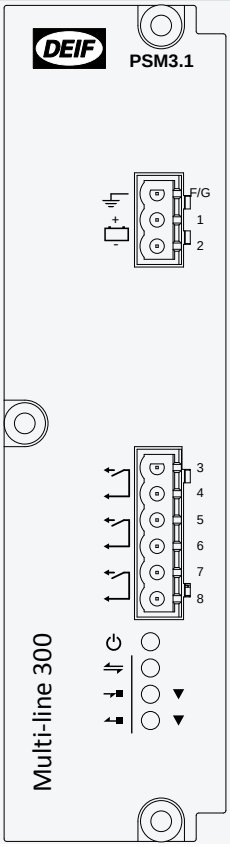
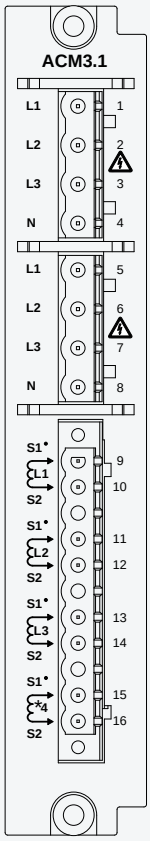
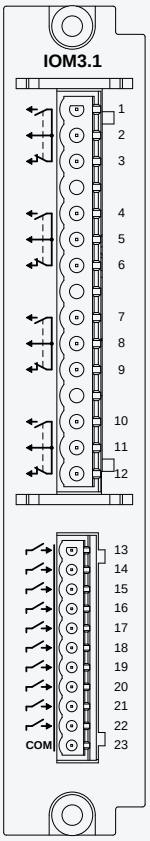
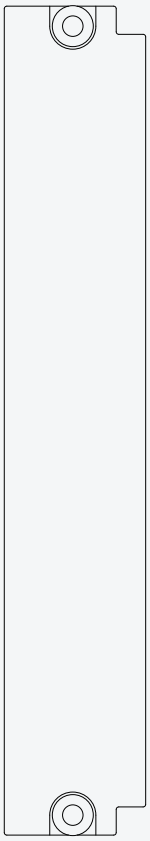
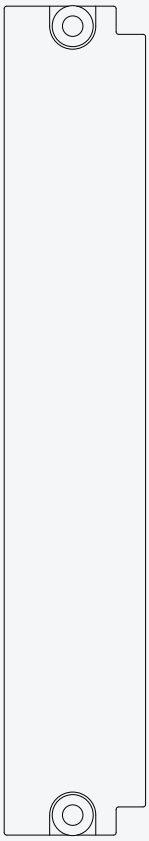
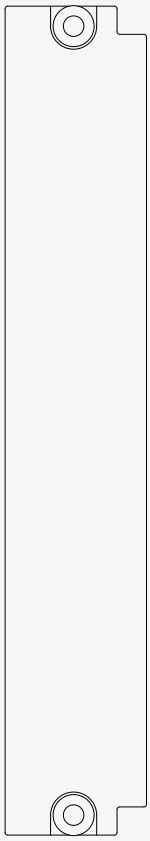
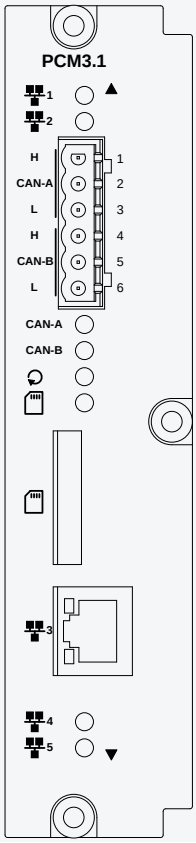
A system can have 0 to 64 BUS TIE breaker controllers.

Figure 2.9 Example of a BUS TIE breaker controller application, including a ring busbar connection



2.6.3 BUS TIE breaker controller hardware configuration

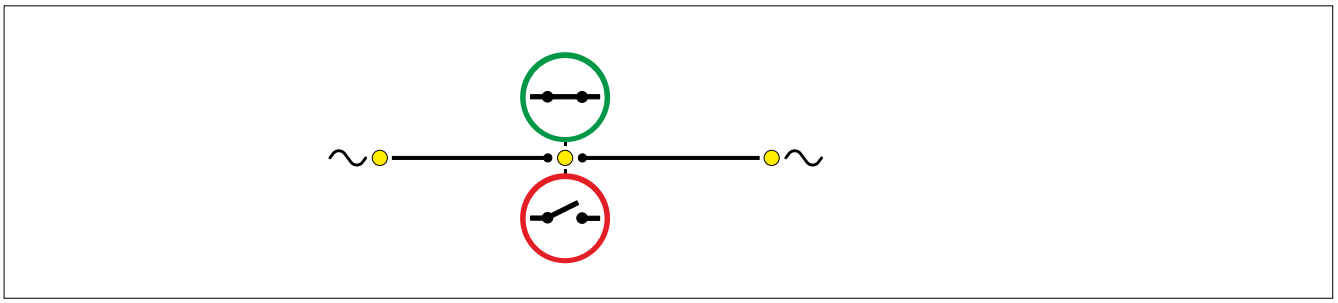
Table 2.5 BUS TIE breaker controller default hardware configuration

Slot 1	Slot 2	Slot 3	Slot 4	Slot 5	Slot 6	Slot 7
PSM3.1	ACM3.1	IOM3.1	Blind module	Blind module	Blind module	PCM3.1
Power supply module	Alternating current module	Input output module				Processor and communication module
						

Weight	Controller and display unit: 3180 g (7.0 lb) Controller (including the default hardware modules): 2345 g (5.2 lb) Display unit: 835 g (1.8 lb)

2.6.4 Display unit

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



2.6.5 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 control	• Busbar split and reconnection • Independent busbars are possible ◦ For example, for dynamic positioning (DP) vessels • Ring busbar connection possible
Section power management	• Divide the system into independent busbar sections ◦ A busbar section can be under switchboard control without affecting other busbar sections • Set up to 8 sets of power management rules for the busbar sections ◦ CustomLogic used to set the conditions for applying the power management rules ◦ For example, when the bus tie breaker is open, the rules specify the minimum and/or maximum number of running gensets
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 a SCADA system • Switchboard control ◦ Operator controls the system from the switchboard ◦ Only the controller protections are active

2.6.6 BUS TIE breaker controller protections

INFO
All the BUS TIE breaker controller protections are included in the AC protections and other protections for PPM 300 controllers.

3. Protections

3.1 AC protections

The controllers include the following alternating current (AC) protections, according to IEEE Std. C37.2-1996 (R2008).

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.

Table 3.1 AC protections for the controlled equipment

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time*	Based on	Alarms
Over-voltage	U>, U>>	59	PTOV	< 100 ms	The highest phase-neutral voltage, or the highest phase-phase voltage	2
Under-voltage	U<, U<<	27	PTUV	< 100 ms	The lowest phase-neutral voltage, or the lowest phase-phase voltage	2
Voltage unbalance (voltage asymmetry)	UUB>	47	-	< 100 ms	The highest difference between any of the 3 phase-phase voltage true RMS values, or the 3 phase-neutral voltage true RMS values	1
Negative sequence voltage		60	PNSC	< 100 ms	The sum of the phase voltages, with a correction for the phase angle	1
Zero sequence voltage		59Uo	PZOV	< 100 ms	The sum of the phase voltages	1
Over-current	3I>, 3I>>	50TD	PTOC	< 100 ms	The highest of 3 phase current true RMS values	2
Fast over-current (short circuit)	3I>>>	50/50TD	PIOC	< 50 ms	The highest of all 3 phase current true RMS values	2
Current unbalance	IUB>	46	-	< 100 ms	The highest difference between any of the 3 phase current true RMS values	2
Inverse time over-current	It>	51	PTOC	-	The highest of all 3 phase current true RMS values, based on IEC 60255 part 151	1
Directional over-current		67	PTOC	< 100 ms	The highest of the 3 phase current true RMS values	2
Negative sequence current		46	PUBC	< 100 ms	The sum of the phase currents, with a correction for the phase angle	1
Zero sequence current		51Io	PTOC	< 100 ms	The sum of the phase currents	1
Over-frequency	f>, f>>	81O	PTOF	< 100 ms	The fundamental frequency of the 3-phase voltage system	2

Protection	IEC symbol (IEC 60617)	ANSI (IEEE C37.2)	IEC 61850	Operate time*	Based on	Alarms
Under-frequency	f<, f<<	81U	PTUF	< 100 ms	The fundamental frequency of the 3-phase voltage system	2
Overload	P>, P>>	32	PDOP	< 100 ms	The 3-phase active power	2
Reverse power	P<, P<<	32R	PDRP	< 100 ms	The 3-phase active power	2
Over-excitation (reactive power export)	Q>, Q>>	40O	POEX	< 100 ms	The 3-phase reactive power	2
Under-excitation (reactive power import/loss of excitation)	Q<, Q<<	40U	PUEX	< 100 ms	The 3-phase reactive power	2
Synchronisation check (including blackout close)	-	25	RSYN	-	The frequency, rate of change of frequency, 3-phase voltage amplitude and phase	Not an alarm

*Note: The *operate time* is defined in IEC 60255-151 (the time from the instant when the need for the protection arises, to when the controller output has responded). These *operate times* are based on the minimum user-defined time delay.

Table 3.2 AC protections for the busbar

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

*Note: The *operate time* is defined in IEC 60255-151 (from the instant when the need for protection arises, to when the controller output has responded). These *operate times* are based on the minimum user-defined time delay.

3.2 Other protections

All controllers

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

	Protections	Alarms*
Breaker*	Breaker open failure	1
	Breaker close failure	1
	Breaker position failure	1
	Breaker tripped (external)	1
	Breaker configuration failure	1
	Breaker de-load failure	1
	Breaker short circuit	1
Synchronisation*	Phase sequence error	2 (1 for busbar, and 1 for controlled equipment)
	Vector mismatch	1
	Breaker synchronisation failure	1
Inputs	Emergency stop input	1
	Digital inputs	1 customised alarm per input
	Analogue inputs	4 levels per input
Network	Ethernet redundancy broken	1
System	Controller software versions incompatible	1
	Controller not part of system	1
	Single-line missing/none active	1
	Missing controllers	1 for all controllers, 1 for critical controllers
	System not OK	1
	Different section settings activated	1
	Different system configurations	1
	Controller type mismatch	1
	Duplicate controller ID	1
	Missing controller ID #	1 for each controller (up to 64)
Power management	Heavy consumer feedback timeout	1
	Heavy consumer reservation not possible	1
	Forced to switchboard control	1
	PMS disabled due to an error	1
	PMS version incompatible	1
	Critical PMS alarm	1

	Protections	Alarms*
	Blackout detection mismatch	1
Other	Clock battery	1
	PSM 1 high voltage	1
	PSM 1 low voltage	1
	EIM # high voltage	Up to 4
	EIM # low voltage	Up to 4
	Internal temperature	1
	Required IO card not found	1

*Note: The EMERGENCY genset controller controls two breakers. All these protections are present for both of these breakers.

Only GENSET, EMERGENCY genset, SHAFT generator and SHORE connection controllers

	Protections
Non-essential load (NEL)	• Up to 3 non-essential loads per controller • Can connect each controller to the same 3 non-essential load breakers
	Over-current NEL trip (1 alarm for each non-essential load)
	Busbar under-frequency NEL trip (1 alarm for each non-essential load)
	Overload NEL trip (1 alarm for each non-essential load)
	High overload NEL trip (1 alarm for each non-essential load)
	Reactive overload trip (1 alarm for each non-essential load)

4. Technical specifications

4.1 General specifications

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.

4.1.1 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

4.1.2 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	

Category	Specification
Bump	20 *g*, 16 ms, half sine IEC 60255-21-2 (class 2)
Material	All plastic materials are self-extinguishing according to UL94 (V0)

4.1.3 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 ºC (131 ºF) **Display unit** -20 to 70 °C (-4 to 158 °F) UL/cUL Listed: maximum surrounding air temperature: 55 ºC (131 ºF)
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).

4.1.4 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

5. Hardware

5.1 Controller hardware

5.1.1 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.

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

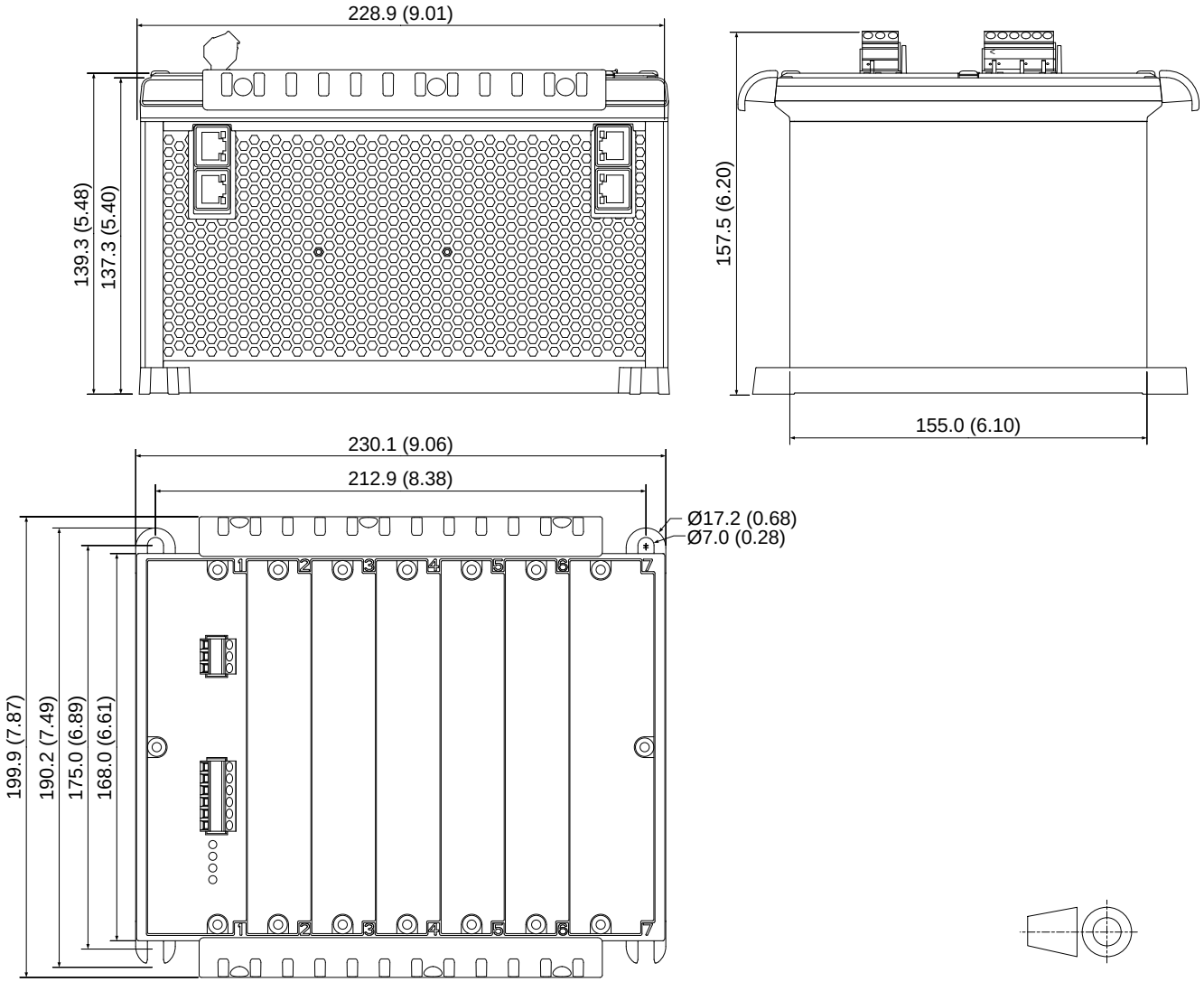


Table 5.1 Rack R7.1 technical specifications

Category	Specification
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)

5.1.2 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 EtherCAT® communication with other racks (future use).

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

Table 5.2 PSM3.1 terminals

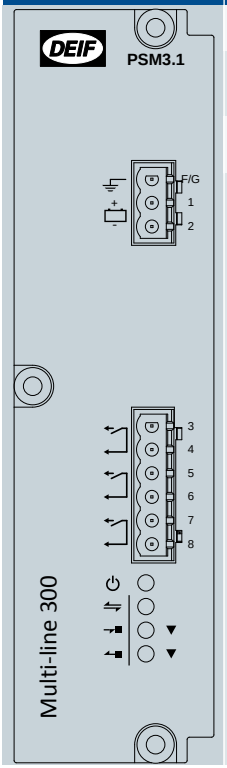
Module	Count	Symbol	Type	Name
	1		Ground	Frame ground
	1		12 or 24 V	Power supply
	3		Relay output	Status OK (fixed) and warning or alarms
	2		EtherCAT® (RJ45)	DEIF EtherCAT® connections (Reserved for future use to connect several extension racks.) (The LEDs are on the front of the hardware module. The connections are at the bottom of the hardware module.)

Table 5.3 PSM3.1 technical specifications

Category	Specification
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 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
Relay outputs	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 (12 to 16 AWG), multi-stranded. **Other connections**: Terminals: Standard 45° plug, 2.5 mm^2. Wiring: 0.5 to 2.5 mm^2 (12 to 22 AWG), multi-stranded.
Communication connections	DEIF EtherCAT®: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications.

Category	Specification
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 ºC 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 EtherCAT ports and other I/Os: 600 V, 50 Hz for 60 s
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)

5.1.3 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 allows extended measurement bandwidth up to 40 times the nominal frequency. ACM3.1 provides robust frequency detection for noisy environments. ACM3.1 includes a configurable 4th current measurement (future use).

By default, ACM3.1 measures 3-phase systems. Alternatively, split-phase (1-phase, 3-wire, that is, L1-N-L2 or L1-N-L3) or single-phase (1-phase, 2-wire, that is, L1-N) can be selected (not supported by all controllers).

Table 5.4 ACM3.1 terminals

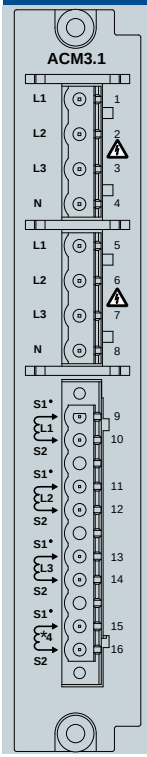
Module	Count	Symbol	Type	Name
	2 × (L1, L2, L3 and N)	L1/L2/L3/N	Voltage	3-phase voltage measurements
	1 × (L1, L2, L3 and 4th)		Current	3-phase current measurement 4th current measurement (future use)

Table 5.5 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

Category	Specification
Frequency measurements	Nominal value: 50 Hz or 60 Hz Dynamic nominal range: 40 to 70 Hz Measurement range: 35 to 65 Hz, or 42 to 78 Hz Dynamic measurement range: 15 to 78 Hz Accuracy: Class 0.1 (-40 to 70 °C) Class 0.02 (15 to 30 °C)
Power measurements	Accuracy: Class 0.5
Accuracy and temperature	Unless otherwise specified for the above measurements: Nominal range: -40 to 70 °C Reference range: 15 to 30 °C Accuracy: Measurement type specific within reference range. Additional 0.2 % error of full scale per 10 °C outside reference range. Example: The accuracy for Power (P) at 70 °C 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: 0.5 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 ºC 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
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	232 g (0.5 lb)

5.1.4 Input output module IOM3.1

The input output module has four changeover switch relay outputs, and 10 digital inputs. These IOs are all configurable.

Table 5.6 IOM3.1 terminals

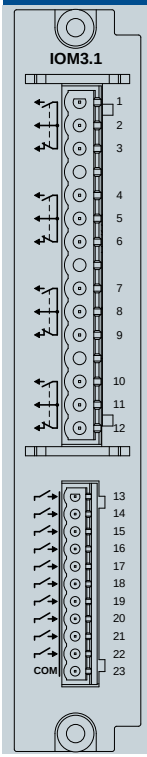
Module	Count	Symbol	Type	Name
	4		Relay output	Configurable
	10		Digital input	Configurable

Table 5.7 IOM3.1 technical specifications

Category	Specification
Relay outputs	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	Bi-directional input ON: 8 to 36 V DC OFF: 0 to 2 V DC 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 (12 to 22 AWG), multi-stranded. **Digital inputs**: Terminals: Standard 45° plug, 1.5 mm^2. Wiring: 0.5 to 1.5 mm^2 (16 to 28 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 copper conductors only

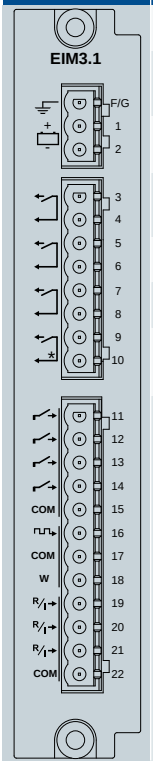
Category	Specification
Galvanic isolation	Between relay groups and other I/Os: 2210 V, 50 Hz for 60 s Between digital input groups and other I/Os: 600 V, 50 Hz for 60 s
Protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529
Size	L 28 mm × H 162 mm × D 150 mm (1.1 in × 6.4 in × 5.9 in)
Weight	196 g (0.4 lb)

5.1.5 Engine interface module EIM3.1

The engine interface module has its own power supply and an MPU/W input to measure engine speed. It also has four relay outputs, four digital inputs, and three analogue inputs. These IOs are configurable.

EIM3.1 has its own microprocessor. EIM3.1 includes circuit protection against load dump transients and JEM177 surge transients (rugged design).

Table 5.8 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**	Magnetic pickup
	1	W	W input**	Alternator tacho output or NPN/PNP sensor
	3		Analogue current or resistance measurement input (RMI)	Configurable

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

Table 5.9 EIM3.1 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 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
Relay outputs	Electrical rating and UL/cUL Listed: 30 V DC and 6 A, resistive Voltage withstand: ±36 V DC

Category	Specification
Relay output with wire break detection 	Electrical rating and UL/cUL Listed: 30 V DC and 6 A, resistive Includes wire break detection. 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 Voltage withstand: 70 V AC
Alternator 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. 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. Voltage withstand: ±36 V DC
Digital inputs 	Bi-directional input ON: 8 to 36 V DC OFF: 0 to 2 V DC Impedance: 4.7 kΩ Voltage withstand: ±36 V DC
Analogue multi-functional inputs R/I	**Current input**: From active transmitter: 0 to 20 mA, or 4 to 20 mA Accuracy: 1 % of selected range **Pt100/1000**: -40 to 250 °C Accuracy: 1 % of full scale (to IEC/EN60751) Maximum sensor self-heating: 0.5 °C/mW. **Resistance measurement**: 0 to 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 resistance for ON detection: 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 (12 to 16 AWG), multi-stranded. **Other connections**: Terminals: Standard 45° plug, 2.5 mm^2. Wiring: 0.5 to 2.5 mm^2 (12 to 22 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 copper conductors only

Category	Specification
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 Between analogue inputs and other I/Os: 600 V, 50 Hz for 60 s
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)

5.1.6 Governor and AVR module GAM3.1

The governor and AVR module has terminals for analogue load sharing. It also has four relay outputs, three analogue outputs, and two analogue inputs. These IOs are configurable.

Table 5.10 GAM3.1 terminals

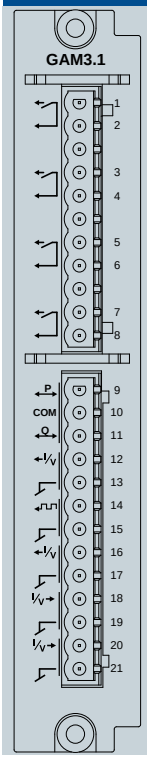
Module	Count	Symbol	Type	Name
	4		Relay output	Configurable
	1	P	Load sharing	Active power (P) (kW) load sharing
	1	Q	Load sharing	Reactive power (Q) (kvar) sharing
	2	I/V	Analogue current or voltage output	GOV/AVR/configurable
	1		Pulse width modulation (PWM) output	PWM output (with PWM ground)
	2	I/V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

Table 5.11 GAM3.1 technical specifications

Category	Specification
Relay outputs	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	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 Active output (internal supply) Maximum load 500 Ω. Current output internal resistance > 100 kΩ. **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 Minimum load 600 Ω. Voltage output internal resistance: < 1 Ω. Voltage withstand: ±36 V DC
Pulse width modulation (PWM) output	Frequency: 500 Hz ±50 Hz Resolution: 43,200 levels Duty cycle: 5 to 95 % Voltage: Low level: < 0.5 V. High level: > 5.5 V Output impedance: 100 Ω Nominal temperature range: -40 to 70 ºC Reference temperature range: 15 to 30 ºC Accuracy: 0.25 % within reference temperature range. 0.2 % of full scale additional error per 10 °C outside the reference range. Example: At 70 ºC 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, or 4 to 20 mA Accuracy: 1 % of selected range **Voltage inputs (DC)** -10 to 10 V or 0 to 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 (12 to 22 AWG), multi-stranded

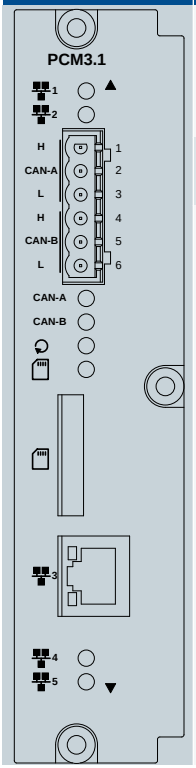
Category	Specification
Torques and terminals	Module faceplate screws: 0.5 N·m (4.4 lb-in) Connection of wiring to terminals: 0.5 N·m (4.4 lb-in) UL/cUL Listed: Wiring must be minimum 90 ºC copper conductors only
Galvanic isolation	Between relay groups and other I/Os: 2210 V, 50 Hz for 60 s Between load sharing and other I/Os: 600 V, 50 Hz for 60 s Between analogue outputs and other I/Os: 600 V, 50 Hz for 60 s Note: The analogue output on terminals 12 and 13 is galvanically connected to the PWM output (terminals 14 and 15). Between PWM output and other I/Os: 600 V, 50 Hz for 60 s Note: The PWM output (terminals 14 and 15) is galvanically connected to the analogue output on terminals 12 and 13. Between analogue inputs and other I/Os: 600 V, 50 Hz for 60 s
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)

5.1.7 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 also has two sets of CAN bus terminals and houses the SD card.

PCM3.1 allows time synchronisation with an NTP server. PCM3.1 includes external memory (the SD card) for alarm logging, trending, black box recording, and installing application software.

Table 5.12 PCM3.1 terminals

Module	Count	Symbol	Type	Name
	5		Ethernet (RJ45)	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 (Future use for engine communication)
	1		SD card*	External memory

*Note: To meet the temperature and EMC specifications, you must order this SD card from DEIF.

Table 5.13 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
Battery	CR2430 3V rated for operation at -40 to 85 ºC (-40 to 185 ºF). **Not** a standard CR2430 battery.
Battery life	Design life of the timekeeping battery is 10 years. This is reduced if the ambient temperature is over 40 ºC (104 ºF).
Communication connections	CAN communication terminals: Standard 45º plug, 1.5 mm^2. Wiring: 0.5 to 1.5 mm^2 (16 to 28 AWG), multi-stranded. DEIF network: RJ45. Use an Ethernet cable that meets or exceeds the SF/UTP CAT5e specifications. 100BASE-TX.
Torque 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 ºC copper conductors only
Protection	Unmounted: No protection rating Mounted in rack: IP20 according to IEC/EN 60529

Category	Specification
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)

5.1.8 Blind module

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

Table 5.14 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)

5.2 Display hardware

5.2.1 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, high visibility 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 display unit includes 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 controller type.

Figure 5.2 Line drawing of the DU 300 front folio for a GENSET controller (LEDs shown in yellow)

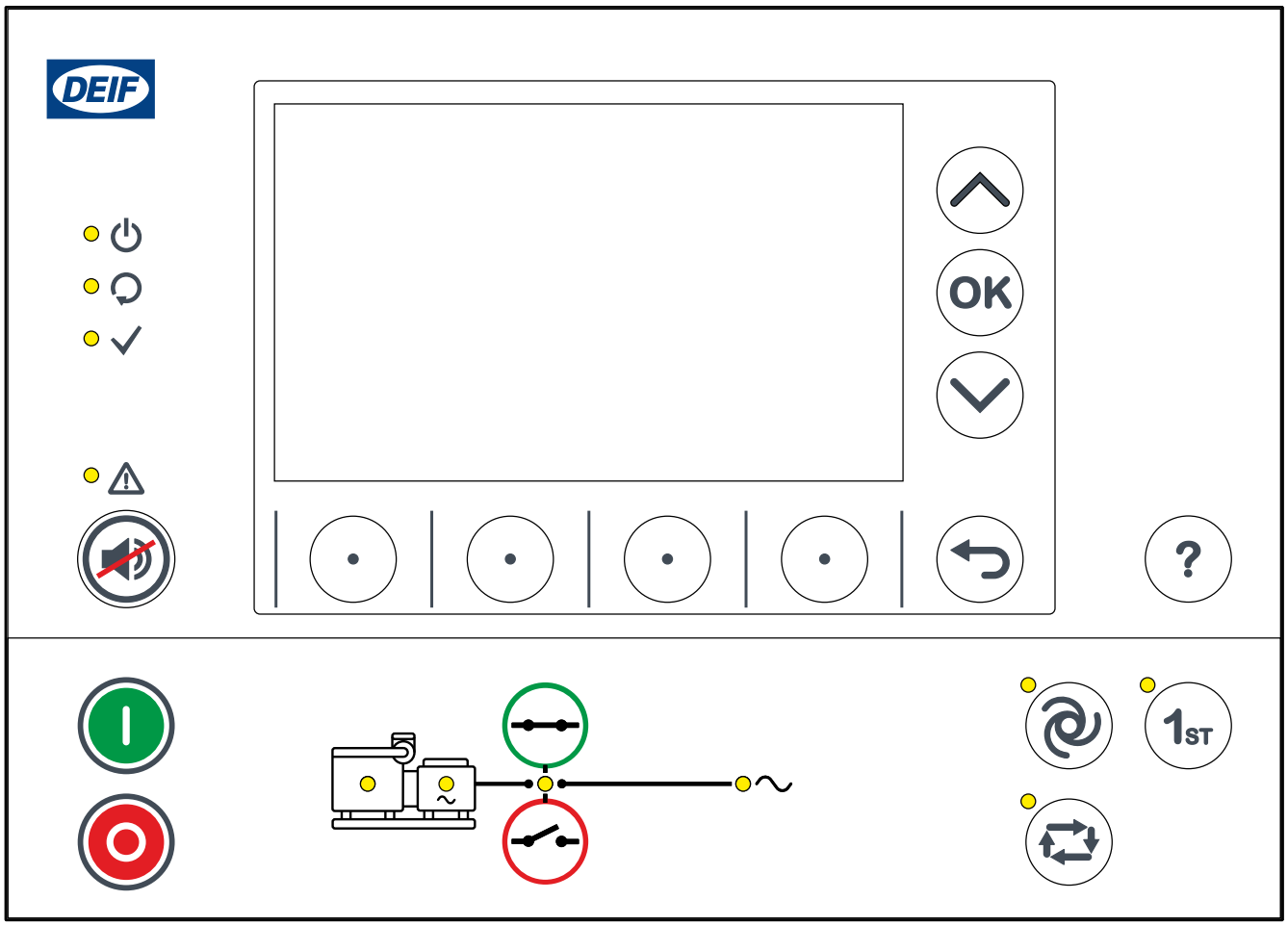


Figure 5.3 Line drawing of the back of DU 300 with the terminal positions

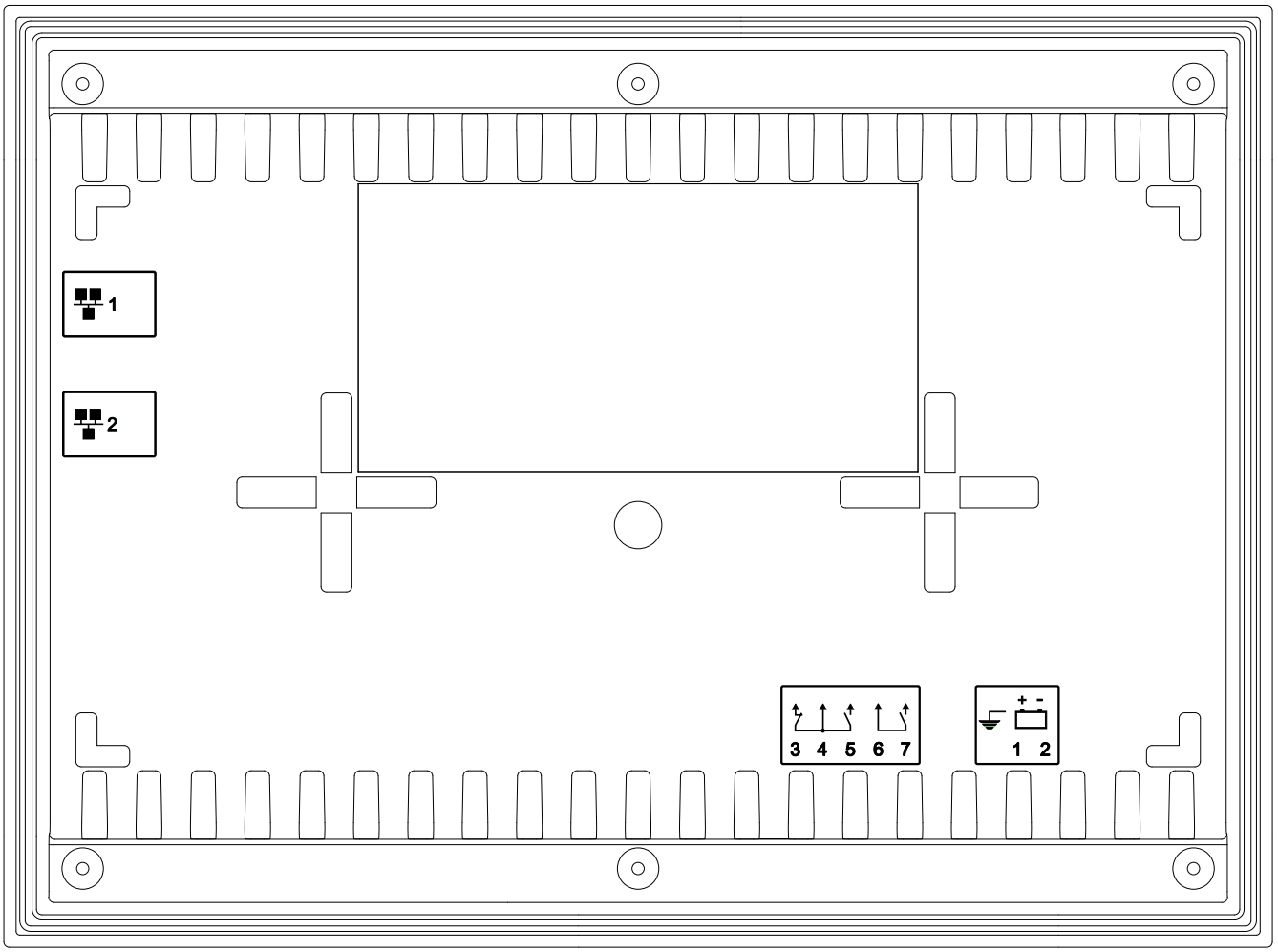


Table 5.15 DU 300 terminals

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

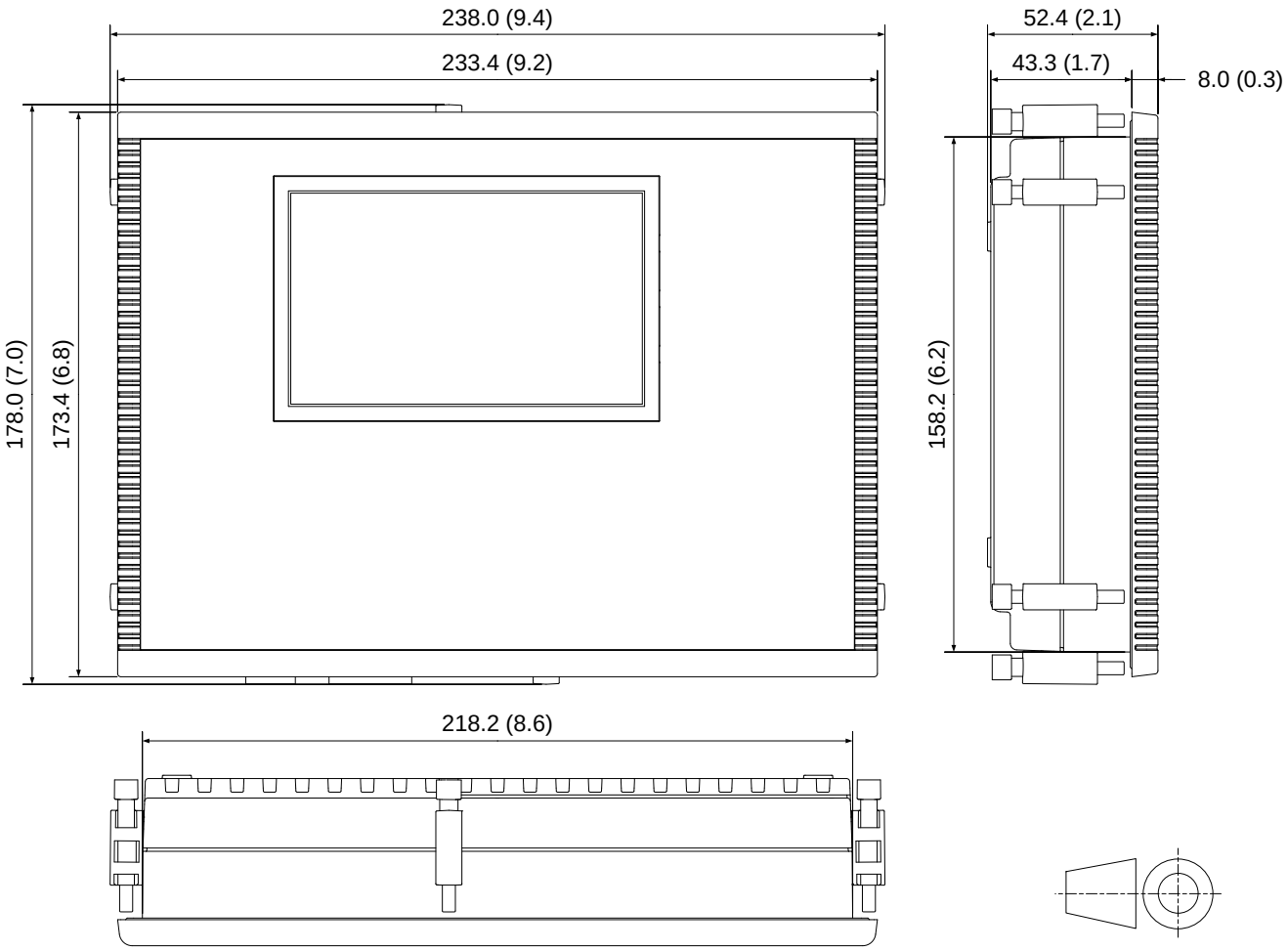
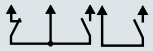


Table 5.16 DU 300 technical specifications

Category	Specification
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
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: Maximum 12 W 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
Relay outputs 	Electrical rating and UL/cUL Listed: 30 V DC and 1 A, resistive Voltage withstand: ±36 V DC

Category	Specification
Terminal connections	**Frame ground and power supply**: Terminals: Standard plug, 2.5 mm^2. Wiring: 1.5 to 2.5 mm^2 (12 to 16 AWG), multi-stranded. **Other connections**: Terminals: Standard plug, 2.5 mm^2. Wiring: 0.5 to 2.5 mm^2 (12 to 22 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 ºC 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 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)
Weight	835 g (1.8 lb)

5.3 Accessories

5.3.1 SD card

The SD card is mounted in PCM3.1 and stores operating data (future use). The SD card from DEIF meets the technical specifications below. Use this SD card to ensure that the system meets the general specifications.

Category	Specification
Memory	512 MB, 2 GB, 8 GB or 16 GB
Protection	IP6X and IP7X, to IEC/EN 60529
Electrostatic discharge (ESD)	Contact pad: ±4 kV Non-contact pad: Coupling plane discharge: ±8 kV, Air discharge: ±15 kV To IEC 61000-4-2
Operating temperature	-40 to 70 ºC (-40 to 158 ºF)
Other	RoHS compliant

5.3.2 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 Flexible installation: -20 to 80 ºC
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)

6. Ordering information

6.1 Ordering

Equipment	Product	Number
Controller*	GENSET controller	
	EMERGENCY genset controller	
	SHAFT generator controller	
	SHORE connection controller	
	BUS TIE breaker controller	
Display unit	GENSET display unit	
	EMERGENCY genset display unit	
	SHAFT generator/SHORE connection/BUS TIE breaker display unit**	
Extra hardware modules	Rack R7.1	
	Power supply module PSM3.1	
	Alternating current module ACM3.1	
	Input output module IOM3.1	
	Engine interface module EIM3.1	
	Governor and AVR module GAM3.1	
	Processor and communication module PCM3.1	
	Blind module	
Accessories	512 MB SD card	
	2 GB SD card	
	8 GB SD card	
	16 GB SD card	
	Shielded patch cable SF/UTP CAT5e, 2 metres long	

*Note: This does not include an interface. DEIF recommends that you order a display unit for each controller. Alternatively, you can use PICUS, or you can order and configure a DEIF AGI.

**Note: These display units are identical.

6.1.1 Disclaimer

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