



Control Electric Co. Pvt. Ltd.

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Delomatic 4, DM-4 Hydro DATA SHEET



Application

- Hydro turbine generator controller for fully automated operation
- Control of the system's valves, pressures, bearings, speed etc.
- Remote access via TCP/IP

Setup

- Modular I/O
- Combi-I/O Module for standard-I/O (temp., analogue I/O, digital I/O)
- Only three module types needed to set up a complex control system
- Double euro format (6HE) rack in two standard sizes of 42 and 60TE
- Parameterisable, ready-made application software
- Local or remote operation using standard PCs or touch panel PCs

Features

- Start/Stop turbine
- Synchronising
- Speed control
- Power control with ramp function
- Water level control
- AVR and CosPhi control
- Control of up to 6 speed control valves
- Main valve control
- Mains protection
- Advanced generator protection
- Built-in trending functionality
- Logbooks with more than 200 entries each
- Peak shaving
- 4 pulse counters (eg. kWh counter)
- Communication to www

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Application

The controller DM-4 Hydro is designed as a modular process control. It covers the special demands of renewable energy plants regarding reliability, robustness, flexibility, and remote accessibility in an optimal way.

Based on an existing generator control system approved for marine applications and used in thousands of ships and land-based power stations over the last 25 years, DM-4 Hydro matches the special demands of harsh environments and far-away-locations faced in the land-based decentralised renewable energy generation.

The control of a hydro turbine is designed for unmanned operation. The user interface provides full information to the user and allows an efficient diagnosis and a fast reestablishment of the operation locally as well as remotely.

Properties

The system DM-4 Hydro covers the following functions as a standard:

Measurements:

- Generator voltages three-phase L1, L2, L3, N
- Mains voltages three-phase L1, L2, L3, N
- Currents L1, L2, L3
- Active power per phase/total
- Reactive power per phase/total
- Active and reactive energy counter
- Operating hours
- Circuit breaker operations counter
- Temperatures and pressures at the turbine
- Measurement values of the plant

Protection functions:

- Mains protection
- Vector jump
- df/dt (R.O.C.O.F.)
- Support of a hardware safety chain with reset function
- Electrical protections generator over- and undervoltage, over- and underfrequency, current asymmetry, overload, reverse power, minimum power, overcurrent, thermal overcurrent, overexcitation, loss of excitation
- Overspeed
- Wire-break proof supervision of the breaker position
- Supervision of hydraulic oil pressure
- Supervision of room temperature
- Supervision of pressure of the water inlet line
- Emergency stop
- Water level monitoring for de-rating of generator by dropping level
- Supervision of main valve
- Supervision of control valve(s)
- Tooth-on-tooth supervision of turbine runup speed
- Level supervision in external oil containers (lube oil, hydraulic oil)
- Configurable inputs for fault messages (eg. for digital auxiliary contacts of automatic cut-outs and motor-protection breakers)

User interface:

- Display of all measurements as graphics and in numbers
- Visualisation of the states of the protections
- Trending function
- Logbooks with more than 200 entries with time stamps each
- Adjustment of parameters
- Multi-user function with standard hardware as touch screens, laptop computers for direct access (USB, TCP/IP)
- Remote access (TCP/IP)
- "Living" P&I diagrams on the screen shows changes and states of components in graphics
- Operation of the plant
- Maintenance calls after operating hours, adjustable

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Control functions:

- Fully automated turbine start/stop
- Synchronisation with voltage adjustment and time supervision
- Speed governor with speed ramping function
- Power ramp function for smooth start and stop
- Prerun and postrun of auxiliaries
- Load reduction function due to generator temperature, control valve position and room air temperature
- Operation of motorised circuit breakers
- Analogue power setpoint
- Peak shaving
- Water level controlled operation
- Voltage adjustment and CosPhi control
- Control of the room temperature
- Support of a safety chain
- Demand signal to a hydraulic power pack

Typical Scope of Delivery:

- DM-4 Hydro hardware
- Touch panel PC
- Example wiring diagram
- I/O list
- List of error messages
- Commissioning check list
- P&ID example
- Handbook

System components

The whole DM-4 Hydro system consists of only three modules in a unique way. Each module contains its own processor, therefore it works independently.

- PCM (8 TE):

This is the CPU of the DM-4 Hydro system. It bears the power supply of the rack, the central processor, the I/O router and different external interfaces (3 x CAN, 1 x RS485, ARC-net, USB, Ethernet).

- SCM (6 TE):

Precision 3-phase AC measurement module with class 0.5 measurements of voltages, currents, active power, reactive power, and phase angle. Furthermore, three-phase measurement of the mains side for synchronisation and mains protection according to the requirements.

- IOM (6 TE):

Universal I/O module for standard I/O signals, thereof Pt100/Pt1000 temperature measurements or NiCr/Ni thermocouple measurements (type K), furthermore analogue inputs for current and voltage, digital inputs for positive and negative logic, frequency measurement inputs, analogue current outputs, and digital outputs.

All three modules will be delivered in a standard industry rack. Each rack contains one PCM module and a selectable number of SCM modules (mainly 1) and I/O modules (variable). Available standard sizes:

- 42 TE for 3 to 5 modules
- 60 TE for 6 to 8 modules

A standard configuration for a hydro turbine generator covers eg. the following components in a 42TE rack:

- 1 PCM 4.3
- 1 SCM 4.1
- 3 IOM 4.2

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PCM 4.3

The PCM 4.3 is power supply and main control module of the DM-4 Hydro system with a module width of 8TE. It is mounted leftmost in the rack. It supplies all other modules in the rack and controls the data exchange on the backplane. Furthermore, it bears the control unit with the application software and the following interfaces:

- 3 CAN interfaces 125...1000kBd
- 1 RS485 interface 9600...38400Bd
- 1 ARC-net interface 2.5MBd
- 1 USB interface
- 1 Ethernet 10/100 MBd
- 1 serial port (9600...38400 Bd TTL) for a GSM modem connection (SMS alarming)

In a plant control system, the module behaves as central control. The application software is located in this module, therefore it determines the overall functionality of the plant.

SCM 4.1

The SCM module is used for the measurement of electrical values and execution of fast protections and control functions. It measures voltages up to 690V AC (three-phase) directly (L1 L2 L3 N generator, L1 L2 L3 N mains/busbar). It performs an independent synchro-check function, can directly trip the circuit breaker and evaluates the breaker feedbacks. Three-phase currents are captured via CTs (1A or 5A sec). The SCM module offers a certified measurement of voltage, current, frequency, active power, reactive power, and phase angle at class 0.5 between 40 and 70 Hz.

The measurements are transferred to the PCM module once per period where further protection functions, trending, and logging are located as a part of the application software.

IOM 4.2

The IOM is a multi-functional I/O module for connection of different sensor types. It also interfaces to other systems by standard analogue and digital signals. The module offers:

- **6 inputs for temperature**, Pt100 in 2-, 3-, or 4-wire technique or thermocouples type K (NiCr/Ni)
- **4 analogue inputs** -20...+20mA with 12 bits resolution
- **4 analogue outputs** for transducer signals or setpoint signals, burden up to 500 Ohms, output range -20...+20mA, resolution 10 bits for connection of speed governors, AVR's, or frequency converters.
- **12 digital inputs**, 9...36V DC with common potential for sensors switching to plus or minus.

- **4 individual galvanically separated digital inputs**, 9...36V, for the evaluation of sensor or pulse signals (1.25MHz sampling rate).
- **10 digital outputs** with external power supply 9...36V DC, push-pull outputs with a stable operation against GND and against supply voltage up to 200mA continuously. The outputs are continuously short-circuit proof and furthermore protected against thermal overload.
- Each board possesses an own galvanic separation between analogue I/O, digital I/O and internal potential. This avoids loops through several boards.

User interface

The DM-4 Hydro system shows a unique user interface that allows running the operating terminal function on any standard Windows PC like industrial touch-panel PCs and laptop computers. All possibilities for local and remote access wire-less or wire-bound can be used because the connection can use Ethernet or directly USB to the PCM module.

If several users are online at the same time, they see the same graphical layout, each one on his own computer. The remote start can be blocked by a manual switch on the switchboard panel door for safety reasons. This way – under maintenance – the remote access allows for diagnosis and visualisation, but the start can only be performed locally.

The user interface uses a browser principle with universal, plant-independent browser software. The information that has to be displayed is therefore defined on application level. Because of this principle, the data is always consistent. The PCM module is the "Server" whereas the different users are "Clients".

Buttons on the fully graphical user surface allow easy access to all visualisation pages. The pages are grouped by themes and can be reached fast and easy either using the menu structure or a central navigator. The status field is structured in the same way on all pages. It shows the state of the plant and – if active – the most important error message. Graphical elements like remote position indicators, bar graphs, pointer instruments for electrical values (kW, A, V, CosPhi) give a full overview of the occurrences that take place at turbine, generator, mains and plant.

The protections are visualised on special diagnostic pages together with the actual states, measurements, limits and running timers.

Visualisation examples

User interface: example page overview

The screenshot displays a control interface for a WaterPowerPlant. At the top, the DEIF logo is on the left, the title 'WaterPowerPlant' is in the center, and the date '11-02-2010' and time '14:34:42' are on the right. Below this, a yellow banner reads 'EMERGENCY STOP' with 'access level: 2' and 'operation level: 1' on the right. A red 'emergency stop button' is visible. The main display area shows 'Pel 0 kW' and 'overview'. On the left, there are two overlapping circles and a language selector set to 'English'. A table lists power-related metrics: demand (500 kW), permitted power (500 kW), active power (0 kW), P reduced (0 kW), and stop because. A central gauge shows power levels (150, 200, 400, 500 kW) with a red needle. To the right, a vertical stack of buttons allows power adjustments: +100 kW, +25 kW, +5 kW, -5 kW, -25 kW, and -100 kW. Further right are buttons for 'overview', 'counters, service', 'analysis counter', and 'log off'. At the bottom, a grid of navigation buttons includes 'start', 'acknowledge', 'manual operation', 'quick stop', 'navigator', 'electrical values', 'turbine values', and 'waterway'. A large diagonal watermark 'Control Electric Co. Pvt. Ltd.' is overlaid across the interface.

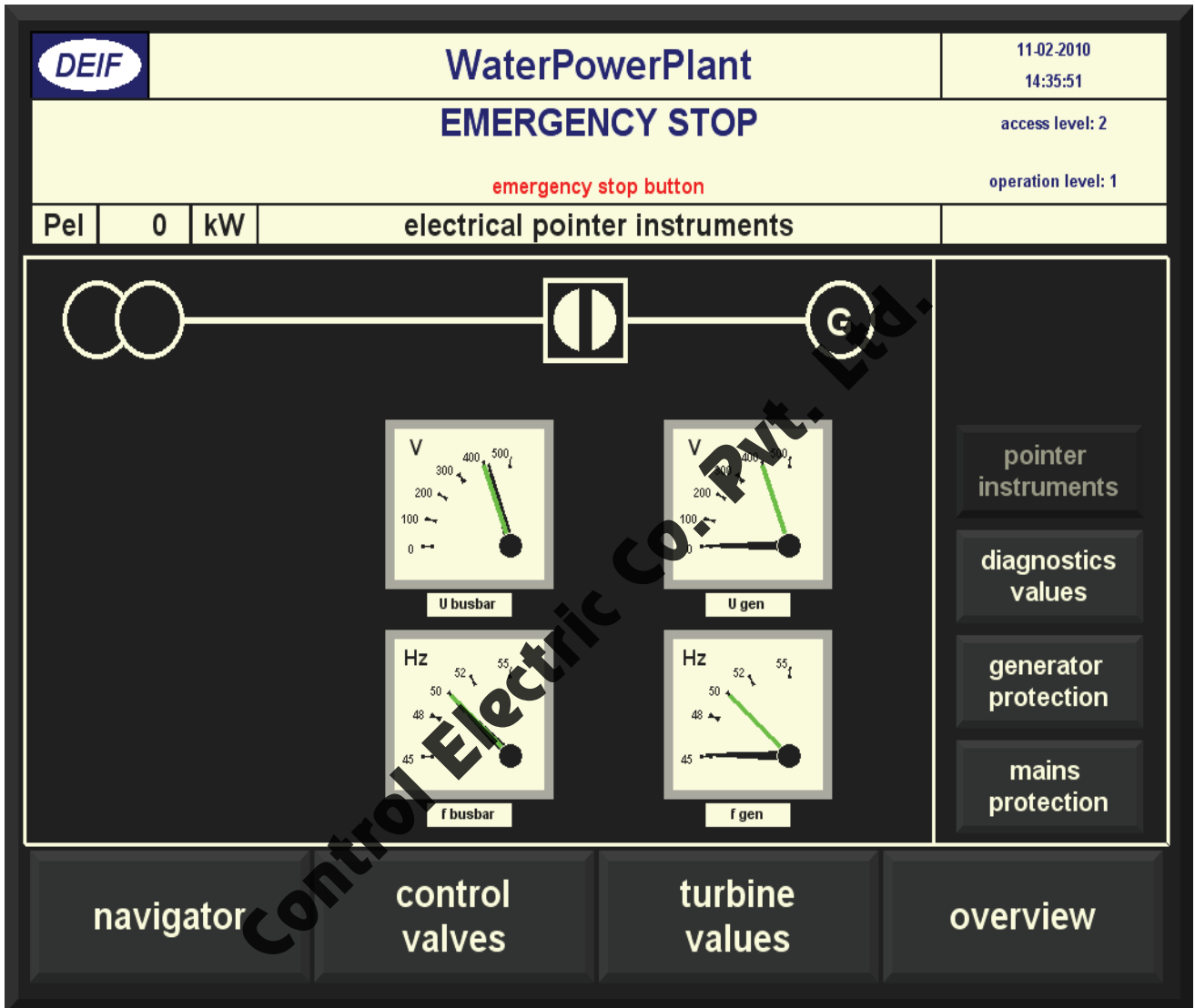
User interface: example page navigator

The screenshot displays a user interface for a 'WaterPowerPlant' in an 'EMERGENCY STOP' state. The interface includes a header with the DEIF logo, the plant name, and the current date and time (11-02-2010, 14:35:10). Below the header, there is a status bar showing 'Pel 0 kW' and 'navigator'. The main area contains a grid of buttons for navigation, including 'trending', 'logbooks', 'system diagnostics', 'electrical values', 'control valves', 'active alarms', 'speed control', 'overview', 'turbine values', 'room air ventilation', 'parameters', 'test of auxiliaries', 'lube oil system', 'hydraulic system', and 'waterway'. A red 'emergency stop button' is also visible. A large diagonal watermark 'Control Electric Co. Pvt. Ltd.' is overlaid on the interface.

	WaterPowerPlant	11-02-2010 14:35:10
EMERGENCY STOP		access level: 2
emergency stop button		operation level: 1
Pel	0	kW
navigator		

trending	active alarms	parameters
logbooks	speed control	test of auxiliaries
system diagnostics	overview	lube oil system
electrical values	turbine values	hydraulic system
control valves	room air ventilation	waterway

User interface: example page electrical values



Technical Data

Rack system

Operating temp.:	-25...70°C (-13...158°F)
Vibration class:	DNV A+C 3mm: 3.0... 13.2Hz, 2.1g: 13.2...50Hz, 0.7g: 50...100Hz
Protection class:	IP 2x Higher class by application of standard housing for DM-4 racks
Climate:	Class E according to DIN 40040
Mounting:	Vertical
EMC/CE:	To EN 61000-6-V2/3/4, SS4631503 (PL4)
Material:	Plastic headers according to UL94-V0, Al housing, steel front plates
Connectors:	Phoenix Cage clamp terminals 6/8/20Arms Screw terminals 20 Arms
Weight:	Depends on configuration

PCM 4.3 module

Aux. supply:	18...30V DC Max. 6A
CAN:	3 independent CAN interfaces 125...1000Mbps Terminals for loop through and termination
RS485:	1 interface up to 38400 Baud, terminals for loop through and termination

SCM 4.1 module

Safety:	To EN 61010-1 Overvoltage category III 690V AC Pollution degree 2
Meas. range (Un):	Up to 690Vrms directly Other ranges after adaptation by VTs ../100 or ../110V AC Burden max 0.5A per phase Overload max. 2*Un tolerated for 10s External prefuse max 2A time-lag
Meas. range (In):	Current transformer ../-1Arms or ../-5Arms Burden max 0.4VA per phase Continuous overload 10Aeff, <75A -10s < 300 A - 1s
Galvanic separation:	2.5kV isolation between voltage tips and all other potentials
Frequency:	40...70Hz
Accuracy:	Class 0.5 according to IEC 688
Harmonics:	Up to 500Hz are measured

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Technical Specifications

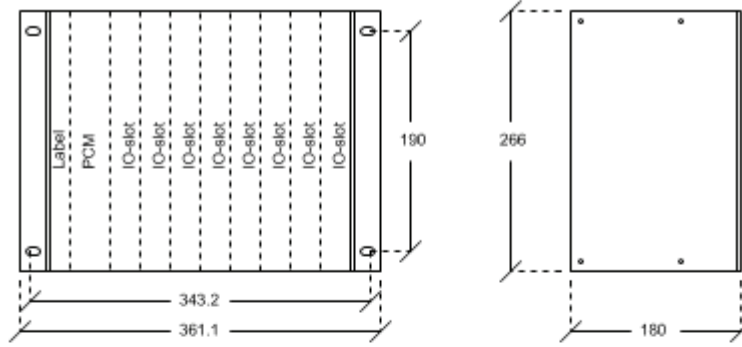
IOM 4.2:

Digital inputs:	9...36 V DC, input resistance typ. 2.4 kOhm, common reference potential + or -, inputs galvanically separated from other potentials (600V)
Frequency inputs:	Same as digital inputs, but with 2 terminals per input. Frequency up to max. 1kHz, for counters up to max. 25Hz at pulse-pause ratio > 40%. Accuracy: 1.25 MHz sampling rate (time measurement to 0.8us accurate)
Analogue inputs:	-20mA ... +20mA, input impedance typ. 50 Ohm, galvanically coupled to the analogue outputs, Pt100 inputs and thermocouple inputs, galvanically separated from the rest of the system (600V rms). Accuracy: 16 bit, better than 0.5% of the full range (40mA) over the entire temperature range.
Pt100 input:	2-, 3-, or 4-wire Pt100 or Pt1000, wire break and short-circuit detection Measurement range: -40...+200°C Accuracy: +/- 0.5 K over the full measurement range with 4-wire connection, +/- 1K with 3- or 2-wire connection, if cable length less than 1m
Thermocouple input:	2-wire thermocouple type K (NiCr/Ni) Measurement range: 0 ...1000K more than cold junction, temperature compensation by measurement of the cold junction with a single Pt100 sensor in the whole system. Accuracy: +/- 5K (@ 500...750°C), +/- 10K (@ 20...500°C)
Analogue outputs:	-20mA ... +20mA, burden up to 500Ohm Accuracy: 10 bits, better than 0.5% of full range (40mA) over the entire temperature range.
Digital outputs :	Output voltage 8...35V DC (with external supply 9...36V DC). Output current 0..200mA (source and sink). Short-circuit protection by current limitation. Continuously short-circuit proof up to thermal overload of the heat sinks. In case of thermal overload of the output drivers, the outputs will be disconnected and an error message will be released.

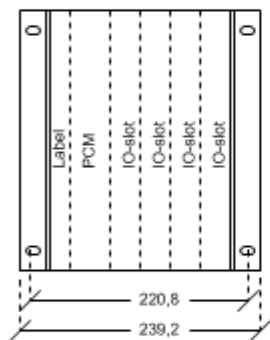
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Unit measurements in mm

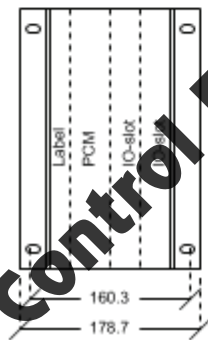
60 TE 8 IO slots



42 TE 4 IO slots



24 TE 2 IO slots



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