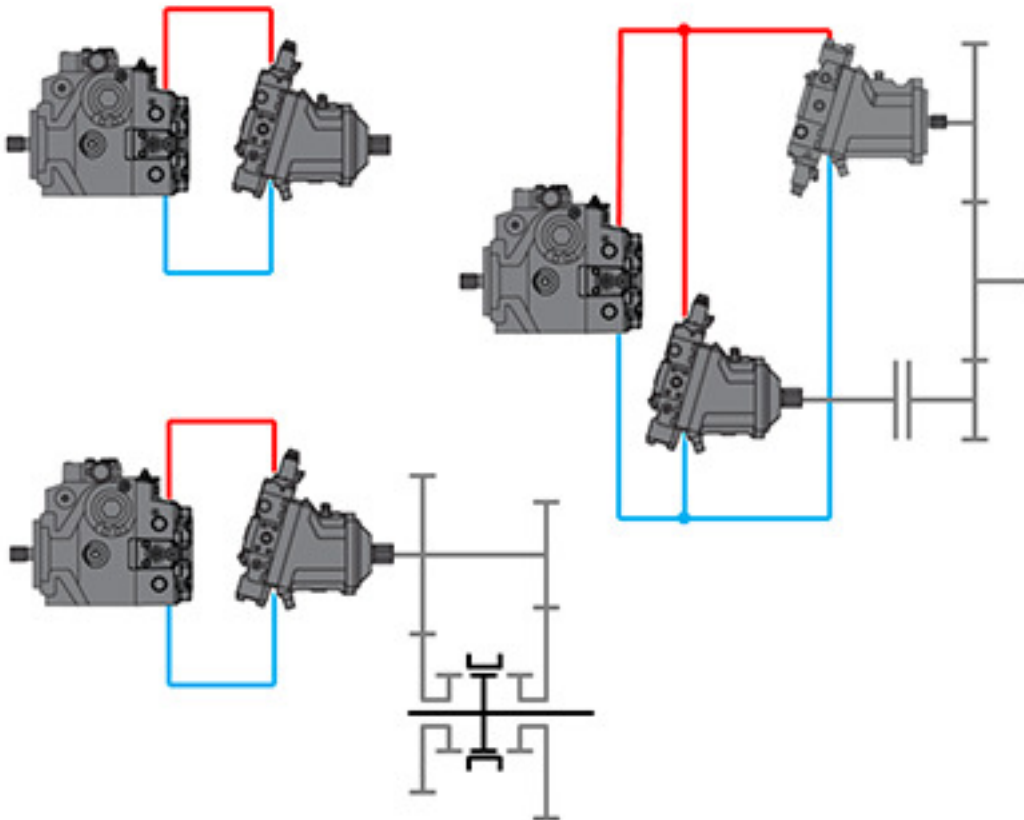


System Description

Propel Controller Solutions

Automotive Control PC-AC



Revision history

Table of revisions

Date	Changed	Rev
July 2020	Added PC-AC SP content	0201
March 2019	First edition	0101

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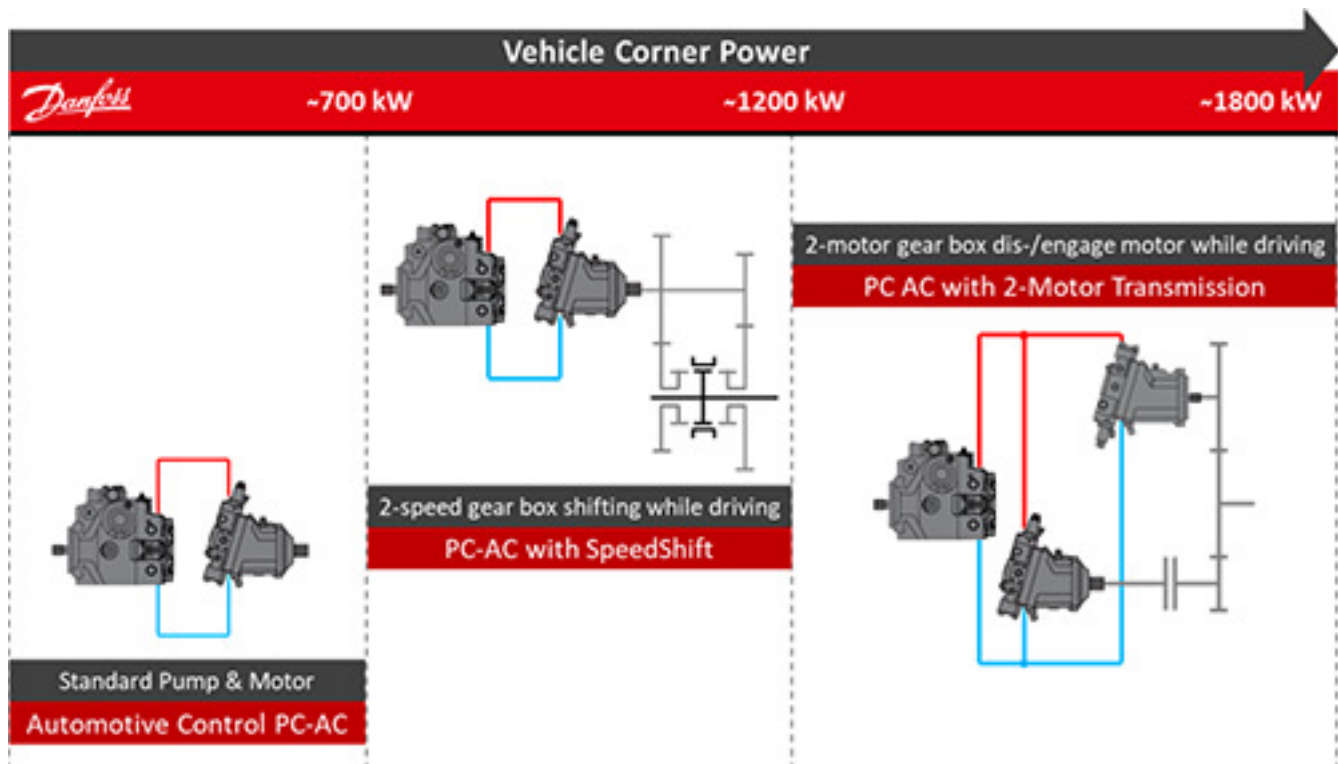
Basic information

The Propel Controller Solutions are designed to support single path hydrostatic transmissions systems.

Danfoss offers several solutions for the propel system to cover vehicle corner power ranges up to 1800 kW. All of these propel system solutions combining proven hardware like PLUS+1® Safety Controller and H1 hydraulic pumps and motors with reliable software developed according to current safety standards.

With the pre-installed application software and easily changeable control parameters, it is possible to tailor the vehicle's driving behavior to the individual requirements of the customer.

Propel controller system overview



Definition of vehicle corner power

$$P_c = \frac{F_r \cdot S_{max}}{3600 \cdot \eta_{FD}}$$

Where:

- P_c Corner Power (kW)
- S_{max} max Vehicle Speed (km/h)
- η_{FD} Final drive efficiency (-)

Functional safety

The Propel Controller Software is designed to control a single-path transmission system consisting of one pump and one (or two) hydrostatic motor(s). The propel controller and the application software needs to fulfill the safety requirements according to machine directive (2006/42/EC).

PLUS+1® PC controllers are advanced elements of the PLUS+1® family of mobile machine management products. The design of this general purpose safety controller includes features required for sophisticated machine control strategies. It is equally suited for use in safety related or general machine control applications.

These controllers have dual processors with the secondary processor having access to all controller inputs and supervisory control of outputs. These controllers support smart digital inputs. Current measurement capability has been added to some multifunction inputs. Device outputs can be individually controlled by the secondary processor.

The Safety Manual of the propel controller solutions (available by request from your local Danfoss representative) is intended to guide the system integrator concerning functional safety. The document describes a possible implementation of the needed safety functions.

Standards

Type A Standards

Cover aspects applicable to all types of machines

- IEC 61508 functional safety of electrical/electronic/programmable electronic safety-related systems

Type B Standards

Cover particular safety and ergonomic aspects of machinery

- ISO 15998 Controller for earth moving machinery
- EN ISO 13849-1:2015 Safety of machinery- Safety-related parts of control systems- Parts 1 & 2
- ISO 25119 Agriculture machinery (former EN 16590)

Type C Standards

Machine safety standards dealing with detailed safety requirements for a particular machine or group of machines

- ISO 20474-2017, former DIN/EN 474 Earth moving machinery
- EN 1459-1:2017 Rough-terrain trucks – Safety requirements and verification – Part 1: Variable-reach trucks
- EN 4254:2013 Agricultural machinery – Safety – Part 1: General requirements
- EU 167/2013 Agricultural and Forestry vehicles (Tractor directive)
- – EU 1322/2014
- – EU 68/2015
- – EU 96/2015
- – EU 208/2015
- – EU 1788/2016

PC-AC

The propel controller application PC-AC is designed to control a single-path hydrostatic transmission system consisting of one pump and one motor. The hydrostatic pump is equipped with two proportional valves.

In the PC-AC system the hydrostatic pump can be controlled in pressure dependent (NFPE) or pressure independent (EDC) pump control mode.

The PC-AC system is optimized for use with a hydrostatic motor equipped with a proportional (PROP) valve to control pressure or motor displacement.

The Danfoss patented Flow Controller Motor Displacement (FCMD) allows the software to change the control command according to the system flow. Which brings advantages in controllability, engine power utilization and system load dependency.

Parking brake valve, reverse motion buzzer, forward/reverse lamp indicator, a retarder valve and a stabilizer valve can be controlled by additional digital outputs.

The PC-AC system can read several analog, digital, and frequency signals representing operator input, system demands, and machine status inputs.

The CAN Communication Interface is used for diagnosis purposes and for information exchanging with other controllers such as engines, other Danfoss power solutions or customer controllers.

Basic functions

The PC-AC commands the basic vehicle driving behavior and performance (i.e. acceleration, deceleration, and vehicle speed). The operator selects the driving mode, driving direction, and basic transmission set point command via throttle or creep/drive pedal. An additional input, the inch pedal command, can be used to override the basic transmission command.

Advanced functions

A number of advanced features can be independently activated and configured depending on the installed application software package. Below is a list of the primary advanced functions:

- Engine and motor over-speed protection
- Engine anti-stall
- Constant speed control
- ECO fuel saving mode
- Vehicle speed limitation and flow limiter
- Intelligent operator presence detection
- Electronic swash plate control
- Temperature compensation and overheat-protection
- Maximum motor torque at vehicle start
- Engine speed dependent retarder control
- Cruise control
- User defined I/Os

PC-AC SP

The PC-AC SP system is dedicated for use with one hydromotor which is mounted on a two speed synchronizer gearbox. A synchroniser allows gear change while driving (SpeedShift).

The SpeedShift function will control and monitor the two speed gearbox. The hydrostatic components are controlled according the requirements to perform a fast and smooth gear change.

A proportional controlled hydromotor with 0° and de-energized minimum displacement is required for SpeedShift. The 0° position of the hydromotor is monitored with a MBS 1250 pressure sensor in port M4 (min. servo chamber).

The gear stage is not linked to a system mode; a gear change is possible for all 4 system modes. It can be automatically or manually triggered. The software will ensure a gear change is only applied if it is possible and safe (dependent on vehicle speed, acceleration/deceleration, and temperature).

The CAN Communication Interface is used for diagnosis purposes and information exchanging with other controllers such as engines and other Danfoss power solutions or customer controllers.

Basic functions

The PC-AC SP offers the same basic function like the PC-AC. It controls basic vehicle driving behavior and performance (i.e. acceleration, deceleration, and vehicle speed). Additionally it controls the two speed gearbox. The operator selects the driving mode, driving direction, driving gear and the transmission set point via throttle or creep/drive pedal.

- Four system modes, selectable by the driver for different drive behavior
- Independent pump/hydromotor profiling and ramping for each system mode
- Independent pump/hydromotor profiles in first and second gear operation
- Electric drive pedal
- Electronic inching
- Load dependent pump displacement control (automotive)
- Proportional hydromotor displacement control by flow (FCMD)
- User defined I/Os

Advanced functions

Protection and safety functions

- Safety controlled vehicle start protection
- Operator presence detection
- Software based pressure protection
- Hydraulic system overheat and low temperature protection
- Hydromotor overspeed protection
- SIL2 compliant

Performance functions

- ECO fuel saving mode
- Vehicle speed limitation
- Dynamic brake light, automatic park brake, reverse buzzer and vehicle speed controlled output functions
- Advanced CAN J1939 interface

PC-AC SP

Engine control and protection

- CAN J1939 engine interface
- Engine speed control via drive pedal with safety controlled monitoring function
- Engine over speed and cold start protection

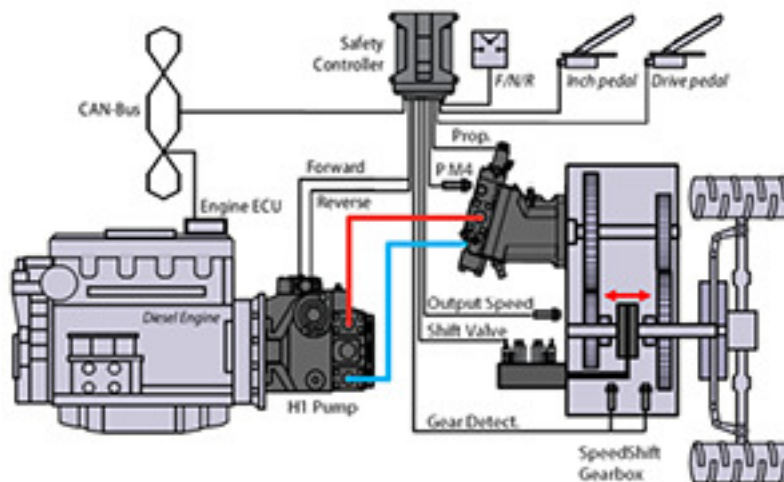
Gearbox control and protection

- Approved by gearbox manufacturer
- Shift valve control (automatic or manual triggered)
- Gear detection
- Measure hydromotor M4 pressure for 0° detection (with start up and plausibility check)
- Fault management

PC-AC SP

System design

System Overview of Danfoss Components



H1P Pump with load dependent NFPE control Electronic pressure limitation by software (without hydraulic pressure limiter valve)

Optional: Control Cut Off (CCO), Swash angle sensor

Technical Information document number: BC152886483968.



Electric proportional control (M1/CA control without BPD)

Electronic load limitation by software (without hydraulic PCOR)

De-energized min. displacement

Without Speed Sensor

Technical Information document number: BC152886483576.



User manual Safety Controller PC AC SpeedShift

Technical Information document number: BC152986484387.



Pressure sensors MBS 1250

Data sheet document number: AI152886480966.

PC-AC 2MT

The propel controller application PC-AC 2MT is designed to control a single-path hydrostatic transmission system consisting of one hydrostatic pump, two hydromotors and the gearbox control. The hydrostatic pump is equipped with two proportional valves.

In the PC-AC 2MT application the hydrostatic pump can be controlled in pressure dependent (NFPE) pump control mode.

The PC-AC 2MT system is optimized for use with two hydromotor which are mounted on a gearbox with different ratios to the gearbox output shaft. At slow vehicle speeds (e.g. up to 14 kph) the machine is operated with both hydromotors (high tractive force due to two motors engaged and high ratio of hydromotor M2). At a certain vehicle speed the rated speed capacity of the gearbox and/or hydromotor M2 are reached. At this condition the gearbox control allows the hydromotor M2 to be switched off (jump from x%-displacement to ZERO displacement) and the hydromotor M2 is mechanically disconnected from the gearbox. The disengagement and engagement of hydromotor M2 is actuated on the fly without loss of tractive force while shifting. After the hydromotor M2 is disconnected the vehicle operates up to final vehicle speed (e.g. 40 kph) just with hydromotor M1.

Proportional valves are used on the hydromotor controls. The Danfoss patented Flow Controller Motor Displacement (FCMD) allows the software to change the control command according to the system flow which brings advantages in controllability, engine power utilization and system load dependency.

Parking brake valve, reverse motion buzzer, forward/reverse lamp indicator can be controlled by additional digital outputs.

The PC-AC system can read several analog, digital, and frequency signals representing operator input, system demands, and machine status inputs.

The CAN Communication Interface is used for diagnosis purposes and for information exchanging with other controllers such as engines, other Danfoss Power Solutions or customer controllers.

Basic functions

The PC-AC 2MT commands the basic vehicle driving behavior and performance (i.e. acceleration, deceleration, and vehicle speed). The operator selects the driving mode, driving direction, and basic transmission set point command via throttle or creep/drive pedal. An additional input, the inch pedal command, can be used to override the basic transmission command.

- Four system modes, selectable by the driver for different drive behavior
- Independent pump/motor profiling and ramping for each system mode
- Independent motor profiles in one motor and two motor operation
- Electric drive pedal
- Electronic inching
- Load dependent pump displacement control (automotive)
- Proportional hydromotor displacement control by flow (FCMD)
- User defined I/Os

PC-AC 2MT

Advanced functions

Protection and safety functions

- Safety controlled vehicle start protection
- Operator presence detection
- Software based pressure protection
- Hydraulic system overheat and low temperature protection
- Hydromotor overspeed protection
- SIL2 compliant

Performance functions

- ECO fuel saving mode
- Vehicle speed limitation
- Dynamic brake light, automatic park brake, reverse buzzer and vehicle speed controlled output functions
- Advanced CAN J1939 interface

Engine control and protection

- CAN J1939 engine interface
- Engine speed control via drive pedal with safety controlled monitoring function
- Engine over speed and cold start protection

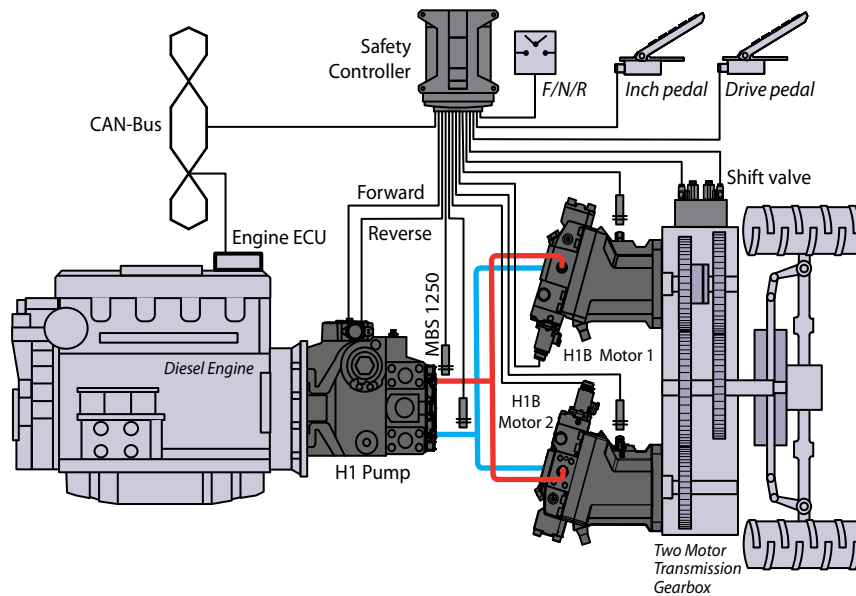
Gearbox control and protection

- Approved by gearbox manufacturer
- Clutch control
- Slip detection
- Fault manager

PC-AC 2MT

System design

System Overview of Danfoss Components



H1P Pump with load dependent NFPE control Electronic pressure limitation by software (without hydraulic pressure limiter valve)

Optional: Control Cut Off (CCO), Swash angle sensor

Technical Information document number: BC152886483968.



H1 Bent Axis Motor 1 (always engaged)

Electric proportional control (L1/L2 control)

De-energized max. displacement

Electronic pressure limitation by software (without hydraulic PCOR)

Technical Information document number: BC152886483576.



H1 Bent Axis Motor 2 (can be disconnected)

Electric proportional control (M1/M2 control)

De-energized min. displacement

Electronic pressure limitation by software (without hydraulic PCOR)

Technical Information document number: BC152886483576.



Safety Controller PC AC 2MT

Technical Information document number: BC152986484387.

PC-AC 2MT



Pressure sensors MBS 1250

Data sheet document number: AI152886480966.

Functions

The available functions for the individual software solution can be found in the table below. A more detailed description of the individual function can be found on the following pages.

Function overview

Function	PC-AC	PC-AC SP	PC-AC 2MT
Automotive Transport Mode (FCMD)	x	x	x
Non-automotive Work Mode (FCMD)	x	x	x
ECO fuel saving mode	x	x	x
Mode Transition Control	x	x	x
Start Protection	x	x	x
Quick stop in Automotive Mode	x	x	x
State and Direct Change	x	x	x
Hydromotor Overspeed Protection	x	x	x
Load limiter	x	x	x
ePCOR	-	-	x
ePL	-	-	x
Hydraulic-System Overheat Protection	x	x	x
Vehicle Constant-Speed-Drive (CSD)	x	x	x
Vehicle-Speed-Limitation	x	x	x
Cruise Control	x	x	-
Filter for drive pedal	x	x	x
Vehicle speed depending Ramps	x	x	x
Semi-Auto Calibration Function	x	x	x
J1939-CAN User Interface	x	x	x
CAN User Interface (e.g. Error Messages, calibration start)	x	x	x
Status and Error LED	x	x	x
Engine Speed Control	x	x	x
Engine Anti-stall Protection	x	x	x
All range Engine Overspeed	x	x	x
Engine Over Speed Protection with Retarder	x	x	Optional
Cold Start Protection	x	x	x
Brake light	x	x	x
Automatic Park Brake Control	x	x	x
Gearbox Control	-	x	x
Shift Monitoring	-	x	x

Propel functions

In the following the control functions are described. Not all of the functions are available for all software solutions. The available functions for the individual software solution can be found in table on previous page.

Mode Types

The application software provides different hydrostatic propel methods, defined as mode types, which can be set individually by parameter.

Functions

Automotive Transport Mode

Proportional pump and hydromotor displacement control. The setpoint of the pump drive curves is given by the engine rpm. The engine rpm is commanded by a drive pedal.

The hydromotor setpoint is calculated from the actual pump flow (FCMD - Flow Controlled Motor Displacement). The pump flow is calculated from the displacement of the hydromotor (detected by the control current) and the hydromotor rpm.

- Drive pedal controls vehicle speed
- Load dependent mode
- Brake/inch signal reduce vehicle speed
- Coast down when release the drive pedal

Non-Automotive Work Mode (FCMD)

Proportional pump and hydromotor displacement control. The setpoint of the drive curves is given by a pedal command independent of the engine rpm. The engine rpm is commanded by a hand throttle to mainly fulfill the requirements of the work hydraulic.

The hydromotor setpoint is calculated from the actual pump flow (FCMD - Flow Controlled Motor Displacement). The pump flow is calculated from the displacement of the hydromotor (detected by the control current) and the hydromotor rpm.

- Drive pedal controls vehicle speed
- Engine speed is set separately according requirement of work functions
- Load independent mode
- Brake/inch signal reduce vehicle speed
- Vehicle speed limitation by the drive pedal (no roll down the hill)
- Antistall protect the engine from overloading

ECO fuel saving mode

The ECO fuel saving mode is designed for the Automotive Transport Mode (FCMD). It needs a CAN controlled Engine (TSC1 & EEC1), an electric drive pedal and a larger pump displacement. The ECO Mode function reduces the engine rpm setpoint (TSC1) automatically when a vehicle speed is reached for a defined time. This will reduce the fuel consumption and noise emission. The pump displacement will be increased to keep the vehicle speed on the same level with a reduced engine rpm. The ECO mode is automatically switched off, if the vehicle slows down or the driver releases the electric drive pedal. If the engine is overloaded (EEC1) the "Engine Speed Command" will be increased.

The ECO Mode is available in all Automotive Transport Modes and can be enabled individually in each of the four Modes.

Mode transition control

This function allows configuration of an application specific System Mode transition. The System Mode The propel controller can exchange information with the engine via the CAN J1939 protocol (TSC1 change condition can be dependent on multiple factors including actual FNR direction, drive pedal message or Kubota protocol). All CAN messages can be individually activated and designated for usage.

Input, and ground speed. The following functions and standard messages are provided: The vehicle driving direction change can be configured on vehicle speed.

When a momentary FNR switch logic is configured, the driving direction change request is rejected if the vehicle speed is above a predefined speed.

Start Protection

The Safety Controlled Vehicle Start Protection prevents commanded, unexpected, or otherwise dangerous machine propel movement after initial power on the engine. The Start Protection is monitoring the following signals.

Functions

- Engine rpm
- Battery voltage
- Error status
- Inch calibration
- FNR in Neutral

If all conditions are fulfilled the Start Protection will switch OFF and the vehicle can drive.

Quick stop in automotive mode

When operating the vehicle in Automotive Transport Mode the propel controller will use the engine rpm as the setpoint. The electric drive pedal position (out of the deadband) is used as an enable signal. The driver must press the drive pedal and the engine rpm must rise to move the vehicle. If the driver release the drive pedal fully (drive pedal return into the deadband), the pump current will decrease with an adjustable ramp to a defined value. The vehicle will decelerate much faster compared to the today's behavior.

If the driver release the drive pedal to a minimum value (drive pedal signal is over the deadband), the pump current will follow the drive curve as today. The vehicle will decelerate "normal".

State and direction change

After a direction change request by the FNR switch, the system state will wait until the vehicle speed is lower than the "Vehicle Speed for State Change" before it will switch to Neutral or the other direction.

Hydromotor overspeed protection

The Hydromotor Overspeed Protection prevents the hydromotor(s) from over speeding by either decreasing pump displacement or increasing hydromotor displacement. The hydromotor rpm speed limit, is user defined and valid in all four System Modes when activated

Electronic Pressure Limiter (ePL)

The electronic pressure limiter prevents the pump from over pressure. When the system pressure exceeds the ePL pressure setting (set by parameter) the pump is being stroked towards min displacement to maintain the pressure in the system. The system pressure information is provided by MBS1250 pressure sensor located in the system pressure lines.

Electronic pressure compensator over ride (ePCOR)

The electronic Pressure Compensator Over Ride prevents the motor from over pressure. When the system pressure exceeds the ePCOR pressure setting (set by parameter) the motor is being stroked towards max displacement to maintain the pressure in the system. The system pressure information is provided by MBS1250 pressure sensor located in the system pressure lines. Dependent on the available engine power different features might be required:

- Engine power higher than hydrostatic system can utilize → ePCOR required
- Engine power less than hydrostatic system can utilize → Load Limiter required

Load limiter

The Load Limiter allows the system to utilize maximum available engine power. The commanded engine rpm (TSC1) is compared with the measured engine rpm (EEC1). If the engine is drooped, the engine Load Limiter function will increase the hydrostatic motor displacement to maintain a certain engine droop level set by parameter. It works with CAN controlled engines.

Dependent on the available engine power different features might be required:

Functions

- Engine power higher than hydrostatic system can utilize → ePCOR required
- Engine power less than hydrostatic system can utilize → Load Limiter required

Hydraulic-System overheat protection

An external temperature sensor, in the hydromotor PPU sensor, will measure the hydraulic oil temperature. The function protects the complete hydrostatic system by reducing the pump flow (by pump command) at extreme high temperatures according to user defined temperature curve.

Vehicle constant-speed-drive (CSD)

The CSD function will allow driving with a constant vehicle speed, independent of the load. If the actual vehicle speed differs from the commanded speed, the CSD function will adjust the pump and hydromotor command to compensate the speed difference. The speed set-point usually comes from an electric drive pedal. For the feedback a hydromotor or vehicle speed sensor is required.

Cruise control

The Cruise Control will keep the vehicle speed constant during driving. The driver can release the drive pedal if Cruise Control is enabled.

When the vehicle is driving the required speed, within the defined range, the driver presses the "Set" button, the vehicle speed is captured (frozen). The driver can release the drive pedal. A signal light will show "Cruise Control switched on". The software will keep the vehicle speed constant by adjusting the setpoint.

An actuation of the drive pedal above the captured value (higher wins) will accelerate the vehicle. If the drive pedal is released again, the vehicle speed will return to the captured value.

The cruise control signal light is still on.

The cruise control is switched off, if the inch pedal is pressed (more to a defined level), the FNR is switched to neutral, the seat switch (door switch) is operated, the "Stop" button is pressed or the mode is changed. The cruise control signal light is switched off.

To resume the stored vehicle speed again, the driver has to press the drive pedal and the "Resume" button.

If cruise control is switched on, the driver can increase the vehicle speed by pressing the "Set" button. The speed step and trigger time can be set by parameter. To decrease the vehicle speed, the driver can press the button "Resume".

Filter on drive pedal

When driving over a field or other rough terrain, the vehicle is shaking and the driver has no chance to keep the electric drive pedal constant in one position. The filter function for the drive pedal is able to filter this short movement. The Filter can be configured individually in each Mode.

Vehicle speed dependent ramps

The time ramps for the pump and hydromotor must be different depending on the vehicle speed. A vehicle speed dependent multiplier will adjust the ramp times.

Semi-Automatic calibration function

All hydraulic components like hydromotors have tolerances. Even during lifetime they will change their control behavior. The semi-automatic calibration routine for the hydrostatic motors can be started by service tool or CAN message. A pump calibration is due to NFPE pump not required.

Protections

Engine control and protection

1939-CAN engine interface

The propel controller can exchange information with the engine via the CAN J1939 protocol (TSC1 message). All CAN messages can be individually activated and designated for usage. The following functions and standard messages are provided:

- Engine speed control (TSC1) via redundant drive pedal
- Engine Anti-Stall protection
- Engine Overspeed protection during inching
- Engine Overspeed protection with Retarder function
- Cold start protection

CAN user interface

The propel controller can exchange information with external devices via DM1 and DM2 CAN messages. A easy realisation to display error messages or the start of calibration routines is possible.

Engine speed control

An electric drive pedal with redundant input can be connected to the AC Control. The Engine Speed setpoint is transmitted via CAN TSC1 to the engine controller.

Engine anti-stall protection

The Engine Antistall protection prevents the engine from being stalled due to overload. The commanded engine rpm (TSC1) is compared with the measured engine rpm (EEC1). If the engine is drooped, the engine Antistall function will reduce the hydrostatic propel command to reduce the engine load and the vehicle speed.

The engine Antistall function can be individually enabled for each system mode and is configurable. It works with CAN controlled engines.

All range engine overspeed

The engine rpm is monitored in all driving situations, independent of the FNR position, seat switch (enable), SAFE or LIMITED state. If the engine is in overspeed, a system mode change is blocked. The overspeed protection is only active if the vehicle is moving.

When the system detects an overspeed situation, the pump will swivel out. That will limit the deceleration of the vehicle. The driver must use the service brake to reduce the vehicle speed.

The rpm range for the overspeed detection can define by parameter. Time ramps for activation and deactivation of the function are available.

Optional the Hydromotor (only proportional Control) is commanded to a smaller displacement. With a larger pump and smaller Hydromotor displacement the deceleration of the vehicle will be lower. The driver has to use the service brake.

All range engine overspeed with retarder

The engine rpm dependent Retarder Control toggles a digital output when the actual engine rpm exceeds a user defined level. The Retarder can activate a valve of the work hydraulic to give load to engine and prevent an over speeding.

Cold start protection

A temperature sensor measures the system temperature. If the temperature is lower than a user defined level, the engine rpm command (TSC1) is limited until the system is warmed up to protect the engine and the hydraulic system.

Protections

Gearbox control and protection

Gearbox control

The gearbox control provides the function to actuate the shift gearbox. It actuates the shift valve and controls the hydrostatic components according to the individual gearbox supplier specification.

Shift monitoring control

The shift monitoring control monitors the shifting process based on sensor information. It also continues to monitor operation condition outside the shifting process.

Auxiliary functions

Automatic park brake control

The park brake logic supports "negative brakes".

Brake applied = output is switched on

Brake released = output switched off

The conditions for the automatic park brake control are:

- Software machine state in STOP mode
- Actual pump valve current below user defined value
- Actual inch pedal command exceeds user defined value.
- Actual vehicle speed is lower than an user defined value

Delay times for park brake application and release are individually configurable.

The park brake is connected in closed loop, that means a short circuit or broken connection will be detected and lead into a SAFE state error.

Brake light

The digital brake light output is switched on if the inch/brake pedal command exceeds a user defined value or the calculated deceleration is too high (measured by the hydromotor rpm sensor). This even applies the brake light if the vehicle decelerates by the hydrostatic system. There will be an on/off delay to avoid flickering of the brake lights.

Reverse buzzer

The reverse buzzer is switched on if the FNR is set to reverse.

Vehicle speed dependent outpost speed

The retarder control (Engine-Speed-Dependent Output) is switched on if the actual engine rpm exceeds a user defined level. It can be used to enable a retarder to increase the braking capability of the system. It can also be used to provide a signal to the boom damping system or the all wheel steering.

Error handling

The control system can detect failures which leads to different type of error modes. The safe state will stop the machine. A limited state will reduce the machine performance and will provide information to the driver. This can be done directly by acoustical signal, or indirectly via display by visual indication triggered by a CAN DM1 or DM2 message.

Propel controller

Controller specification

Dual Processor	Primary	Flash: 1 MB; RAM: 128 kB
	Secondary	Flash: 512 kB; RAM: 64 kB
Rated supply voltage 12 V system		9-16 V
Rated supply voltage 24 V system		18-36 V
Digital and PWM outputs		3000 mA
Sensor supply (internal)		5 V / 500 mA
Ambient temperature		-40 to 85°C
IP rating with attached connectors		IP69k
EMC immunity		150 V/m
Vibration and shock tested		IEC60068

Input (24 user defined inputs)

Input	Function
7 x digital	FNR (direction selection), temperature switch gearbox, park brake switch, park brake feedback, clutch pressure feedback, pin not used
10 x analog	Inch pedal, drive pedal, hydrostatic oil temperature, operator presence, engine speed setpoint, pressure sensors, system mode switches
4 x frequency	Hydro-motor rpm
3 x frequency	For customized function (option dependent)

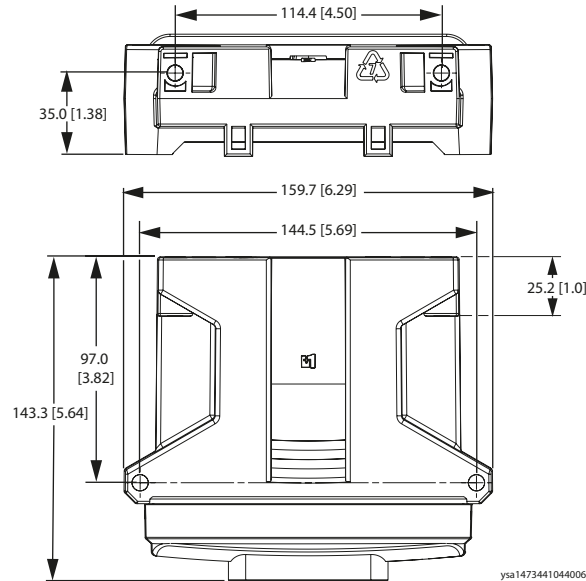
Output (14 user defined outputs)

Output	Function
4 x PWM	Pump and hydro-motor displacement control
2 x PWM	For customized function (option dependent)
8 x digital	Dynamic brake light, park brake, reverse buzzer, retarder control (optional), status LED, clutch valve, low side switches pump and motor

Propel controller

General dimensions

Dimensions in mm [in]



! Caution

PCB damage may occur. All device power supply + pins must be connected to battery +.

! Caution

This device is not field serviceable. Opening the device housing will void the warranty.

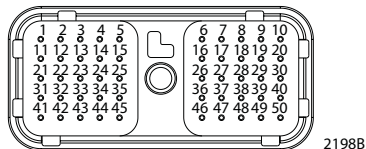
* The Propel Controller is suitable as a safety-related part of a control system up to SIL 2 when used per Danfoss requirements and the machine is so certified by an appropriate notified body or certifying authority.

Use care when wiring mating connector. Pinouts listed are for device pins.

Propel controller

Pin assignments

Pin connector



Pin	Controller function	Pin	Controller function
C1-P1	Power ground -	C1-P26	DIN/AIN/FreqIN
C1-P2	Power supply +	C1-P27	DIN/AIN/FreqIN
C1-P3	CAN0 +	C1-P28	DIN/AIN/FreqIN
C1-P4	CAN0 -	C1-P29	DIN/AIN/FreqIN
C1-P5	DIN/AIN/CAN shield	C1-P30	DIN/AIN/FreqIN
C1-P6	DIN/AIN/SnsrPwr1.6Vdc	C1-P31	DIN/AIN/ResIN/CrntIN
C1-P7	DIN/AIN/SnsrPwr3.3Vdc	C1-P32	DIN/AIN/ResIN/CrntIN
C1-P8	3-12Vdc SnsrPwr +	C1-P33	DOUT
C1-P9	SnsrPwr - (sensor ground)	C1-P34	DOUT
C1-P10	DIN/AIN	C1-P35	DOUT
C1-P11	DIN/AIN	C1-P36	DOUT
C1-P12	DIN/AIN	C1-P37	DOUT
C1-P13	DIN/AIN	C1-P38	DOUT
C1-P14	DIN/AIN	C1-P39	PWMOUT/CrntOUT/DOUT
C1-P15	DIN/AIN	C1-P40	PWMOUT/CrntOUT/DOUT
C1-P16	DIN/AIN	C1-P41	PWMOUT/CrntOUT/DOUT
C1-P17	DIN/AIN	C1-P42	PWMOUT/CrntOUT/DOUT
C1-P18	DIN/AIN/ResIN/CrntIN	C1-P43	PWMOUT/CrntOUT/DOUT
C1-P19	DIN/AIN/ResIN/CrntIN	C1-P44	PWMOUT/CrntOUT/DOUT
C1-P20	CAN1 +	C1-P45	PWMOUT/CrntOUT/DOUT
C1-P21	CAN1 -	C1-P46	PWMOUT/CrntOUT/DOUT
C1-P22	DIN/AIN/CAN shield	C1-P47	Power supply +
C1-P23	DIN/AIN/ResIN/CrntIN	C1-P48	Power supply +
C1-P24	DIN/AIN/ResIN/CrntIN	C1-P49	Power supply +
C1-P25	DIN/AIN/FreqIN	C1-P50	Power supply +

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